Appendix K
Additional Reports

4. Additional Reports – Utilities

   i. University of Guam –Water and Environmental Research Institute of the Western Pacific Review of Northern Guam Lens Aquifer Sustainable Yield

   j. Guam Water Well Testing Study to Support U.S. Marine Corps Relocation to Guam – Point Paper

   k. Guam Solid Waste Utility Study for Proposed USMC Relocation

   l. Construction and Demolition Debris Reuse and Diversion Study for DoD Bases Guam

   m. Final Recycling and SW Div Study for DoD Bases Guam

   n. Final Barrigada Utility Study to Support USMC Off-Base Housing Facilities Requirements

   o. Guam Power Authority Memorandum of Understanding

   p. Guam Waterworks Authority Memorandum of Understanding

Appendix K - Utilities

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University of Guam – Water and Environmental Research Institute of the Western Pacific Review of Northern Guam Lens Aquifer Sustainable Yield

Guam Water Utility Study for Proposed USMC Relocation

September 7, 2009

Department of the Navy
Naval Facilities Engineering Command, Pacific
258 Makalapa Drive, Suite 100
Pearl Harbor, HI 96860-3134

Naval Facilities Engineering Command
NAVFAC PACIFIC

Contract Number N62742-06-D-1870, TO 0034

September 7, 2009

Mr. Kevin Oshiro, P.E.
Navy Technical Representative
NAVFAC Pacific
258 Makalapa Drive, Suite 100
Pearl Harbor, HI 96860-3134

Subject: University of Guam – Water and Environmental Research Institute of the Western Pacific Review of Northern Guam Lens Aquifer Sustainable Yield Guam Water Utility Study

Dear Mr. Oshiro:

AECOM Technical Services, Inc. (AECOM) and YU & Associates, Inc. (YU) are pleased to submit this letter report presenting the review performed by University of Guam – Water and Environmental Research Institute of the Western Pacific (UOG-WERI) on the Sustainable Yield of the Northern Guam Lens Aquifer (NGLA) with respect to the Water Utility Study performed by AECOM identifying potable water alternatives to support U.S. Marine Corps (USMC) relocation to Guam. This report presents the background leading to the need for this review, the independent review performed by Professor John J. Jenson, Ph.D. of UOG-WERI and the interpretation of the conclusions of the review for the purposes of the Guam Water Utility Study.

PURPOSE

In July 2007, the Naval Facilities Engineering Command, Pacific (NAVFAC Pacific), under Master Contract No. N62742-06-D-1870 issued a Task Order to TEC JV to prepare Water Utility Study Report and Planning Documents for the evaluation of potable water system improvements to support the USMC relocation. The purpose of the Water Utility Study was to identify all reasonable alternatives for potable water supply to support the USMC relocation to Guam and provide sufficient and detailed information to support the EIS process. In July 2008, AECOM submitted the final Guam Water Utility Study report presenting the detailed analysis of the various water supply alternatives and the recommended water supply options. The study compared the sustainable yield estimates of NGLA from previously published reports and used the sustainable yield estimates presented in the report entitled ***Final Engineering Report, Groundwater in Northern Guam, Sustainable Yield and Groundwater Development, prepared by Barrett Consulting Group, Agana, Guam in Association with John F. Mink, December 30, 1991.***

The primary author of this report was John F. Mink and this study is referred to herein as the Mink Study and the report as the Mink Report.

The purpose of this work assigned to UOG-WERI is to perform an independent review of the Mink Report and provide an assessment on the appropriateness and validity in using the sustainable yield estimates presented in the Mink report for the purposes of the Guam Water Utility Study.

BACKGROUND

AECOM issued a Task Order to UOG-WERI under a subcontract for the referenced project for providing technical review services. For this Task Order, UOG-WERI scope of services was specified as set forth below. The scope under this task order was to review the Mink Report and to confirm the applicability/ non-applicability of the sustainable yield estimates in the water utility study report.

UOG-WERI scope included the following task items:

Review the following publication on sustainable yields of the NGLA and verify or update sustainable yield estimates for the various areas addressed in the publication and provide a report of the findings.

> ***Final Engineering Report, Groundwater in Northern Guam, Sustainable Yield and Groundwater Development, prepared by Barrett Consulting Group, Agana, Guam in Association with John F. Mink, December 30, 1991.***

The deliverables for this work included draft and final reports of the review and these deliverables were to include the narrative of the review, its findings and conclusions and all supporting analyses and computations.

AECOM and YU & Associates (YU) coordinated the review of the Mink Report performed by Professor John J. Jenson, Ph.D. (Dr. Jenson) of UOG-WERI.

TECHNICAL ISSUES IDENTIFIED IN THE UOG-WERI REVIEW

The review performed by Dr. Jenson included the review of the Mink Report and sustainable yield related issues relevant for the purposes of the water system development for the USMC relocation. The report documenting this review is presented herein as Appendix A.

Appendix A: Review of Mink Report and Answers to Questions

The review by Dr. Jenson validates the Mink Report recommendations. The water system development proposed in the July 2008 Guam Water Utility Study already includes applicable Mink Report recommendations. Some specific considerations are noted below.

1. Replacement of "Management Zone" concept. The water utility study uses the aquifer systems approach and the management zones are not used for developing the proposed water system.
2. Additional aquifer development. The proposed development is confined to areas identified as having significant sustainable yield reserves (Northern aquifer sub-basins at AAFB)
3. Redevelopment of existing wells. The option 2 considered in the Water Utility Study covers this and the recommended water system includes this.
4. Update of the NGLS Aquifer Yield Report and management techniques. This was acknowledged during the preparation of the Water Utility Study and the updated sustainable yield estimates from the Mink Report were used in the study. In addition, the conceptual well layout and the proposed water system were developed considering systematic management of the overall water system to optimize the operation. The proposed monitoring well network was also included in the design for this purpose.
5. Chapter IV: Sustainable Yield. We agree with the concept of using sustainable yield estimates as guidance for planning and the actual implementation and operation to be progressively managed based on performance data. It is with this understanding the proposed system layout was developed and a well study had been planned prior to finalizing proposed well locations. A water system management plan needs to be developed as part of the design to optimize system performance.
6. Chapter V: Groundwater Development Program. The rules of thumb referenced have been used in the water utility study for the development of the proposed system. Also, we agree with the recommendations on well installation.
7. Answers to specific questions. The answers provided by Dr. Jenson to the various questions confirm the validity of using the Mink Report estimates of the sustainable yield for planning purposes.

CONCLUSIONS

The conclusions of the review performed by Dr. Jenson clearly confirm the appropriateness of using sustainable yield estimates from the Mink Report for planning purposes. Additionally, his review also validates the general design approach used in the July 2008 Water Utility Study (i.e. use of aquifer subbasins for proposed development planning; development in areas with higher sustainable yield such as the AAFB; targeted placement of new wells in parabasal zones as opposed to subbasin-wide development).

Very truly yours,

YU & Associates, Inc.

Mike Thiagaram, P.E.
Principal Engineer/ Hydrologist

AECOM Technical Services, Inc.

Venu Kolli, P.E.
Project Manager

APPENDIX A

Review of
Groundwater in Northern Guam: Sustainable Yield and Groundwater Development by Barrett Consulting, with J.F. Mink, May 1992.

September 4, 2009

To: AECOM Technical Services, Inc.

Subject: *Review of Groundwater in Northern Guam:* Sustainable Yield and Groundwater Development by Barrett Consulting, with J.F. Mink, May 1992

From: John W. Jenson, Ph.D.

1. Purpose and Content of this Report

This report provides expert technical review of the sustainable yield estimates for the Northern Guam Lens Aquifer (NGLA) contained in *Groundwater in Northern Guam: Sustainable Yield and Groundwater Development by* Barrett Consulting, in association with J.F. Mink, May 1992 (hereafter referred to as "Barrett 1992") to assess the validity of the estimates in sufficient detail and objectivity to assist in obtaining public and professional acceptance of the conclusions of the study. This report begins with general comments on the 1992 study and its relationship to the 1982 *Northern Guam Lens Study* that preceded it. These are followed by a detailed review of the report, and finally by answers to specific questions put to me by AECOM hydrologists regarding the reliability of the 1992 study.

2. General Comments

The Barrett 1992 study was undertaken to provide the Public Utility Agency of Guam (PUAG, since renamed Guam Waterworks, GWA), with an update to the sustainable yield estimates of the 1982 *Northern Guam Lens Study*. As noted in the cover letter from Barrett Consulting Group to PUAG (attached):

> "The report represents the reevaluation by Hydrological Consultant, John F. Mink and our staff of the Northern Lens groundwater supply and proposes an overall well development program to increase the people of Guam's access to this resource."

> "The report presents a new basis for estimating the sustainable yield of the Northern Lens that differs significantly from the approach first applied in the 1982 *Northern Guam Lens Study* and currently used to regulate Guam's groundwater development. The proposed well development program is intended to optimize the development of groundwater resources based on this new analysis of the Northern Len's sustainable yield and hydrodynamics."

As this statement makes clear, the study was done for the express purpose of updating sustainable yield estimates using state-of-the-art techniques to update the estimates of the 1982 study, which had been based on a smaller data set and older techniques. Both the 1982 and 1992 studies provide conservative (minimum) estimates from the data and techniques employed, which is standard professional practice. The estimates from the 1982 study had been adopted by the regulatory authority and continue to be used to this day. The lower values of the 1982 report reflect the lower confidence in the more primitive data and techniques available in the early 1980s; and the upward revision of the estimates in the 1992 study reflect the increased confidence in the larger data set and more accurate techniques available by the early 1990s. The hydrologists conducting the 1992 study felt confident that based on the additional decade of well performance history and other data, along with the more powerful and accurate modeling techniques, they could safely extend the more cautious 1982 estimates. It is my own judgment that they were correct. I thus regard the Barrett 1992 estimates as appropriate for planning for the future development of the aquifer.

The 1992 study was led by one of the most knowledgeable and competent groundwater hydrologists to have worked in the Pacific Basin (J.F. Mink), who had also led the 1982 study. I had personally conferred with Mr. Mink in professional discussions on many occasions, and he had explained to me that in both studies he had prepared conservative estimates, and that he was confident that the 1992 study was a reliable—and conservative—update of the 1982 study. It is not certain (at least I have not personally been able to determine) why the regulatory authority has not adopted the 1992 estimates, which are generally higher than the 1982 estimates. It is my own professional opinion that the 1992 estimates are valid and appropriate, and ought to have been adopted, at least until the next assessment of well performance and aquifer response might permit the next revision.

3. Detailed Comments

Below are detailed comments on the Barrett 1992 study, along with recollections from my personal conversations with the late Mr. Mink. I will first address the specific recommendations of Barrett 1992, as contained in its Executive Summary:

Recommendation 1: Replacement of the "Management Zone" concept

The Management Zones referred to are the zones established in the 1982 Northern Guam Lens Study, which, as noted above, was also directed by Mr. Mink. These zones were arbitrarily designated to provide a systematic, but admittedly preliminary, approach for sustainable management of the aquifer. The revision recommended by Barrett 1992, i.e., replacement of the Management Zones with the Aquifer Systems designated in the 1992 report, would be a positive step forward. It should be noted, however, that the map of the basement rock, which establishes some of the internal hydrologic boundaries within the aquifer, has been revised (Vann, 2000, unpublished map available at WERI), and that the Aquifer Systems recommended in Barrett 1992 should be based on the latest map. The most important point made in Recommendation 1, however, is that "The estimated sustainable yield of the systems *should be revised continually* in light of data obtained from *ongoing well development and monitoring*." (Emphasis added.) This point can not be stressed enough. This recommendation stems from Mr. Mink's recognition that well performance is highly dependent on spatially variable conditions in this island karst aquifer. While rules of thumb (such as estimating sustainable yield (SY) at 30% of recharge) are useful for initial, holistic planning, the actual SY from any given area will depend on specific aquifer characteristics that can vary at the scale of a few 100s or even 10s of meters. For example, of two wells placed only a few hundred meters apart, or even closer, one might easily yield 500 gpm of high quality water (chloride < 30 mg/l) while the other might be surrounded by locally "tight" rock that yields only a few 10s of gpm, or might exhibit similarly high yield but with relatively low water quality (chloride >250 mg/l). Once the initial wells are in place, and their characteristics are known, the well field can best be managed by tracking and adjusting the production of the wells to optimize yield and water quality. The capacity of the well field to support additional wells, optimum placement, and what expected yields might be, can best be determined from performance of the initial wells.

Recommendation 2: Additional aquifer development

Mr. Mink's recommendations for additional development in specific areas remain valid and may in fact have already been implemented to some degree since 1992. It is fortunate for the anticipated development of the northeastern portion of the NGLA that much of the aquifer reserve is in fact located in the northeast.

Recommendation 3: Redevelopment of existing wells

Where redevelopment of existing wells could help meet the projected demand for water, it should be a productive and low-cost option, and in any case, should be part of the long-term aquifer management plan. The extent to with the existing GWA system can be upgraded, expanded, or optimized to provide additional capacity to support the buildup is, of course, subject to political and administrative constraints. If such constraints can be overcome, it is likely that there are wells that are being underutilized (i.e., pumping at lower rates than they can actually sustain) or are underperforming (because they are in need of rehabilitation). Such wells could in principle help meet the projected demand if suitable agreements can be made and administered with GWA. It should also be noted that installation of new wells may be affected by and may affect the performance (i.e., yield or quality) of nearby existing wells, so that some sort of cooperative agreement may be necessary in any case. The best guide to expected well performance (in terms of both yield and water quality) is WERI Technical Report #98, "Chloride History and Trends of Water Production Wells in the Northern Guam Lens Aquifer," which shows the historical performance of the wells in the aquifer up through 1995.

Recommendation 4: Update of the NGLS Aquifer Yield Report and management techniques

Mr. Mink noted that an update of the Aquifer Yield Report, which contains the SY estimates of the 1982 study, would require "a breadth of testing, and modeling and analysis that is beyond the scope of this report." This reflects the point made in reference to Recommendation #1, above, that optimizing the yield of the aquifer is best done, and will require, zone-by-zone, and well-by-well observation and management. WERI Technical Report #98 contains a model for such management in its recommendations for management of the existing wells. As Mr. Mink noted himself, the estimates of the 1982 NGLS (which he directed) were deliberately conservative. It is probably safe to expect that the overall SY estimate from the 1982 study can be expanded by at least 20% with the kind of case-by-case management recommended in the 1992 report.

Chapter IV: Sustainable Yield

The basic information regarding recharge and water loss remains valid. Although some revisions could probably be made on the basis of newer data, they would not alter the basic conclusions or recommendations. As noted above, implementation of a state-of-the-art model along with other management tools tracking aquifer performance will eventually supplant the theoretical calculations and estimates in this chapter in Barrett 1992. However, as also previously noted, the very best guide for optimization to achieve the full Available Sustainable Yield (ASY) is not theoretical estimates but rather actual performance of operating wells and data regarding aquifer response collected from nearby observation wells, rather than improved theoretical estimates of recharge or water loss, or other hydrological parameters. Nevertheless, the estimates of SY provided in Table 4-2 of Barrett 1992 can be regarded as valid and should provide useful starting points for planning, installation, and initial management of new wells to meet the projected demand.

Chapter V: Groundwater Development Program

The general rules of thumb cited in the first three pages of this chapter reflect the parameters established in the 1982 NGLS and still remain useful: depth of wells should not exceed 35 feet in the basal zone or 50 feet in the parabasal zone, and maximum pumping rates should generally be about 300 gpm in the basal zone and up to 700 gpm in the parabasal zone. Again, these are good estimates for initial planning, but planners should understand that actual rates must depend on actual well performance and could be greater or smaller. Because of the high hydraulic conductivity, drawdown in high-yield wells can be very modest (only a few inches). In "tight" rock surrounding a lower-yield well, however, it may be several feet.

Modeling studies (e.g., Jocson et al., 2002) have shown that regional hydraulic conductivity is on the order of 20,000 ft/day, but pumping tests on wells have shown that local conductivity around a given well is generally lower by an order of magnitude, and sometimes even two orders of magnitude or more. Moreover, in island karst aquifers conductivity can vary both laterally and vertically on the scale of only a few tens of meters. The water-bearing zone intercepted by a given well, may extend over only a small fraction of the well screen, where for example a well penetrating 50 feet of the lens draws water through a high-conductivity layer only two or three feet thick. Theory, along with experience from this and similar aquifers, in fact, suggests that the first few feet above and below the present water table should be a zone of enhanced conductivity. Drillers report that it is not uncommon to encounter voids (circulation loss) at and near the water table.

In general, experience has shown that the initial pumping test is a reliable indicator of the long-term performance that can be expected from the well, in terms of both yield and chloride concentration. Where wells are drilled in such locations and a higher yield is needed than the initial test indicates is possible, it will generally be more economical to close and relocate the well rather than to attempt to enhance the well yield by extending its depth or fracturing the formation around the well. It should also be kept in mind that it is possible for wells that are otherwise properly located and constructed to exhibit anomalously high chloride, presumably because the well has intercepted a natural fracture that penetrates the base of the lens. (Barrett 1992 correctly cites well D-13 in Dededo as an example.) Such wells cannot be remediated. Although Barrett 1992 posits (on page 5-11) that wells drilled too deep can possibly be remediated by backfilling, I know of no case in which this was effective. (See WERI Technical Report #98 for specific examples.)

4. Answers to Specific Questions Regarding the Reliability of the Barrett 1992 Study

1. Is the approach and methodology used in Barrett 1992 to estimate the sustainable yield (SY) still valid in light of any new theories/models of the Guam NGLA?

Yes, the basic approach and methodology are still valid. The approach (i.e., assigning 30% of recharge as SY, based on results of the analytical transient model used by Mink and on his professional judgment derived from experience) is still an appropriate starting point for planning. The current methodology (i.e., extraction by shallow-set vertical wells) remains the most feasible and cost-effective technology at the present time. What we have now (that Mink didn't have in 1992) which is most useful is not so much better modeling techniques (although modeling technology is indeed more advanced) as more and better data on well performance, recharge, and water table response—which is the basis for better accuracy in any model.

2. If the approach and methodology are still valid, would rainfall and other hydrologic data collected after the 1992 up to the present significantly affect the 1992 report's conclusions regarding the sustainable yield?

Hydrologists and planners should certainly make use of the full historical record, with the additional 18 years of data, but Mink's basic recommendations remain valid. It should be kept in mind, of course, that his recommendations provide only a (good) basis for initial planning, and that, as he himself pointed out, the actual sustainable yield will be best determined by observing and managing the well fields and individual wells according to their performance. An advantageous attribute of the NGLA is that response and recovery times are relatively rapid (a few years or in some cases only a few months) so, providing the well is properly designed and constructed in the first place, managers can adjust the pumping rate to increase production or decrease chloride as needed over time in order to get optimal production and well performance. SY estimates can then be adjusted upward or downward as the actual capability of the well field or well "comes into view." This concept, however, has not been well understood on Guam, and therefore has never been implemented--but it should be built into the planning and management for the new expansion.

3. Would application of latest computer modeling techniques, such as the one proposed by USGS, likely result in a significantly different outcome of the sustainable yield?

A state-of-the-art model will be a useful tool for long-term management, and should be incorporated into the long-term management plan. Along with other tools and data (such as ongoing tracking of well performance) such a model would provide managers a useful and credible tool. It is not necessary, however, to develop a detailed model to support the initial design and management plan. While I doubt that a state-of-the-art computer model is likely to result in a significantly different outcome for sustainable yield, I expect that it would provide an additional level of confidence in the results.

4. The 1992 Mink study suggests a target of 700 gpm for parabasal zones. Similar conclusions are also in the NGLS. What are the areas that can be targeted for the high yield pumping? It would be good if specific target areas could be identified in the sub-basins with available capacity. What areas should be avoided?

The prime areas are in principle those where parabasal water collects along an extensive flank of basement watershed, especially where the flow of the water down the basement topography is convergent. What Mink said of the Yigo System (as shown on his Fig. 5-1) is still true today, i.e., this area (the head of the Yigo-Tumon Trough) is the most productive and heavily exploited area, but it also probably still has substantial reserve. The other most promising areas are on the northern flank of the Mataguac Rise (Agafo Gumas-Northwest Field Systems) and certainly Mink's "Gugagon System." The most risky areas include the Huchanao and Sasajyan Systems.

5. The past studies use the older basement contour maps. How much variability can be expected in the sustainable yield estimates for the sub-basins if the boundaries are based on the updated basement contours? Are there newer estimates available at WERI?

The advantage of the revised map (the "Vann map") is not so much that it will provide more confidence in SY (which will be only slightly affected in most cases by the revision of internal watershed boundaries) but rather that it should provide more confidence in the productivity of newly installed wells. Keep in mind that an important approach to maximizing sustainable yield in a well field for a given zone is to place the wells to the maximum extent possible in the thickest portion of the parabasal zone. This places a premium on knowing the basement topography to a high degree of confidence. Accurate SY estimates, on the other hand, are more a function of accurate data on recharge and well response/performance.

1 Attch: Letter, Barrett Consulting Group to Mr. Joseph Mesa, Chief Officer, Public Utility Agency of Guam, May 26, 1992.

GROUNDWATER IN NORTHERN GUAM

Sustainable Yield and Groundwater Development

Final Engineering Report

Prepared For The

GOVERNMENT OF GUAM

PUBLIC UTILITY AGENCY OF GUAM

May 1992

Prepared By

BARRETT CONSULTING GROUP

In Association With

JOHN F. MINK

Barrett Consulting Grou

Ada's Professional Cente
Suite 204-F
215-A East Saylor Street
Agana, Guam 96910
Phone: 671 477-0083
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May 26, 1992

Mr. Joseph F. Mesa
Chief Officer
Public Utility Agency of Guam
Government of Guam
P.O. Box 3010
Agana, Guam 96910

Mr. Mesa:

In accordance with our engineering agreement dated September 24, 1990, we are pleased to submit, herewith, the final engineering report, *Groundwater In Northern Guam: Sustainable Yield and Groundwater Development*. The report represents the reevaluation by Hydrological Consultant, John F. Mink and our staff of the Northern Lens groundwater supply and proposes an overall well development program to increase the people of Guam's access to this resource.

The report presents a new basis for estimating the sustainable yield of the Northern Lens that differs significantly from the approach first applied in the 1982 *Northern Guam Lens Study* and currently used to regulate Guam's groundwater development. The proposed well development program is intended to optimize the development of groundwater resources based on this new analysis of the Northern Lens's sustainable yield and hydrodynamics.

We would like to thank PUAG, the many Government of Guam and Federal agencies whose cooperation and assistance made this report possible.

Very truly yours,

Edwin C. Pier, P.E.
Project Manager

Aziz H. Saad
Office Manager

51240E91.141/682

<u>Addendum – Additional Question from the Navy</u>

<u>Question</u>:
Dr. Jenson, citing Mink, notes that the 1982 study is a too conservative an estimate of sustainable yield, and that the 1991 study is a better, more accurate estimate (to be further refined as more pump data is collected and aquifer modeling is developed). For the NGLA as a whole and for its sub-basins individually, could he quantify his confidence in the 1991 study in terms of a "Safety Factor (SF)" that he might recommend to those permitting withdrawals in the near-term?
Something to the effect of "Withdrawals in the Agafa-Gumas sub-basin to a level of 89% of the 1991 Study sustainable yield estimate (11% Safety Factor) would yield a 99% confidence that the long-term sustainable yield would not be exceeded and the aquifer capacity would not be compromised."

Travis W. Hylton
PE, BCEE, D.WRE, CPSWQ, CFM, LEED AP
Environmental Engineer
Naval Facilities Engineering Command, Pacific
(808) 472-1385

<u>Response</u>:
There is no rigorous technique by which to quantify confidence in the sustainable yield estimates for either study; estimates of confidence are necessarily subjective. Based on my own assessment of Mink's work and my conversations with him over the years, however, I'm willing to say that one could safely withdraw water at least at the rates he suggested in the 1992 report (the actual date of transmission to the then Public Utility Agency of Guam, GWA's predecessor). I would also wager that Mink's 1992 estimates are about "20% conservative," that is, it is likely that with proper design, construction, and management of the wells, about 20% more could be extracted without significant degradation in water quality (i.e., rise in chloride concentration). It is important to understand that the concept of sustainable yield is difficult to define precisely, and is actually somewhat controversial among groundwater hydrologists. To obtain some rigor in the definition, for example, it is necessary to specify some arbitrary criteria. In the case of island/coastal aquifers, the most obvious, and arguably most important, criterion is the concentration of chloride that the user is willing to accept as sustainable. In nearly all coastal wells, the chloride concentration will rise somewhat as the lens around the well achieves a new equilibrium state from its undeveloped, pristine condition. If the user is willing and able to tolerate an equilibrium chloride concentration of, say, 250 mgl, then the sustainable limit will be higher than in if the chloride concentration is mandated to remain under, say 100 mgl. In other words, if the sustainable limit is defined in terms of chloride concentration, then the SY can be increased simply by raising the acceptable chloride concentration.

Mink generally defined sustainable limits for wells in the basal zone (i.e., where the lens is underlain by seawater) in terms of production rates that he thought would be unlikely to raise the chloride higher than 150 mgl, which he considered a reasonable design limit for wells in the basal zone. For wells in the para-basal zone (where the lens is not underlain by seawater but rests directly on volcanic basement rock), he felt that 70 mgl was the reasonable design target. Even given these criteria, however, his estimates of what pumping rates would be sustainable, i.e., not raise chloride above these concentrations, were necessarily subjective, relying to a large extent on judgment born of prior experience.

To summarize, I think it is safe to say that Mink did indeed build in a factor of safety of probably about 20%, i.e., pumping could likely exceed his recommended rates by up to about 20% without significant rises in chloride concentration. This is, however, a necessarily subjective judgment. Moreover, his "target" chloride concentrations (of 150 mgl for basal water and 70 mgl for para-basal water) were themselves conservative, in the sense the the USEPA secondary standard for chloride is 250 mgl (within which the water is felt to be aesthetically acceptable for drinking and washing), and the WHO standard is 650 mgl (within which it is felt to be safe for sustained human consumption). Considerably higher pumping rates than those recommended by Mink could be likely be sustained if such levels are chloride were deemed acceptable.

Addendum: Responses (in Aerial font) to EPA Question (in Times Roman font) follow:

Sustainable Yield of the Northern Guam Lens Aquifer (NGLA)
The erDEIS (Based on water utility report) states that impacts on groundwater/aquifer are not considered significant because the total increased extraction by DoD is below maximum sustainable yield of the aquifer basins. We disagree with this conclusion for the following reasons:

There is uncertainty regarding the sustainable yield. The sustainable yield estimates vary considerably between the 1982 and 1991 studies. The erDEIS uses the 1991 sustainable yield estimate of 80.5 MGd instead of the1982 estimate of 57.4 MGd, while acknowledging that both studies are recently cited as being the current estimate (including the USGS 2007 citation of 57.4 MGd in the "Recent Hydrologic Conditions – Guam) (Vol. 2, p. 4-10). The total cumulative use of groundwater for all proposed action alternatives would total approximately 69.4 MGd (Vol 7, Sect 3.4.2).

This issue (of the differences between the two estimates and their respective reliabilities) has been addressed in detail in my response to Mr. Hylton's question above. The 1991 (actually, 1992, if dated from the date of the final report from Barrett Associates to Guam PUAG), study is in my judgment valid, and should be used as the basis for future planning and regulation.

The erDEIS attributes part of the difference in the two estimates to a change in the subbasin boundaries and chooses to use the higher 1991 estimate, stating that it is more recent and was more comprehensive. There is no information as to what percentage of yield the subbasin boundary differences could reasonably account for, and no discussion as to what other factors could cause the remaining difference.

As noted in my response to Mr. Hylton's question, the 1992 study had the benefit of an additional decade of data, including well performance since the 1982 study. It also used more advanced modeling techniques. The changes in sub-basin boundaries didn't contribute to the higher estimates of SY, but only redistributed their respective proportions of the new total between sub-basins.

Because the large difference in these two values, more discussion is warranted. It also interjects a substantial amount of uncertainty in assessing impacts. This uncertainty should be considered in determining impact significance (40 CFR 1508.27 (b) 5).

I believe this point has been addressed in my response to Mr. Hylton's question.

Sustainable yield of sub-basins is exceeded
The 22 proposed DoD wells appear to be clustered in areas rather than spread throughout sub-basins, which could result in localized stress within subaquifers and may increase the cone of depression and increase the risk of saltwater intrusion. A comparison of Table 4.1-1 (Vol 2, p 411) with Table 3.2-5 (Vol 6, page 3-33) indicates that three sub-basins (Agafa Gumas, Finegayan, and Yigo) will approach or exceed sustainable levels. Indeed,

Finegayan and Agana subbasins are seeing increased salinity, suggesting that overdrafting is imminent or has begun. This threatens sustainability of supply and water quality, affecting a beneficial use of the water resource. Clustering wells in a few places also does not add the flexibility needed for an adaptive management approach.

There are three points to consider here: First, the most important consideration is not whether the wells are “clustered” but whether they are placed in the locations where hydrogeologic conditions indicate thate yield and water quality are likely to be maximized. Groundwater yield and quality potential are not uniformly distributed in this aquifer. The “clustering” in the plan reflects the intention to place the wells in the para-basal zone, where the freshwater lens is most likely to be thickest, lowest in chloride, and least vulnerable to salt-water intrusion (since the lens in this zones is underlain by low-permeability volcanic rock rather than seawater in high-permeability limestone). The “clustering” in fact represents an informed and prudent placement of the wells. Second, it should also be understood that the six sub-basins in the Northern Guam Lens Aquifer are hydrologically separate entities, just like separate watersheds on surface terrain. Draft from one has no effect on the draft from an adjacent sub-basin. Third, additional, focused geophysical studies and incremental assessment of well performance as the wells are installed will yield specific and reliable information on where the wells should ultimately be placed in order to ensure optimal performance (in terms of yield, quality, and sustainability).

Simply approaching the sustainable yield is significant on overall groundwater use for Guam.

This is because the project renders this resource unavailable for use by Guamanians. Therefore, we do not agree that there would be no reduction in the availability or accessibility of water resources as a result of the project (v2: 4-90).

As noted above, the sub-basins in the aquifer are distinct and therefore can and must be managed as separate hydrologic units. The proposed development will have no effect on the sub-basins outside of the area proposed for development.

Recommendations: Sustainable yield confirmation studies should occur. We recommend that the USGS study, which will take 3 years to complete, commence as soon as possible. We believe JGPO may have stated that a University of Guam review of the 1991 sustainable yield was being pursued. If this is correct, we support this review since it will provide more timely information and reduce the uncertainty of utilizing this sustainable yield value for planning purposes.

SY confirmation studies should be (and I believe are) built into the management plan.

A conservative approach would be to use the yield from the 1982 study for planning purposes until confirmation of a higher sustainable yield is performed.

The 1982 estimates are excessively conservative in light of the results of the 1992 study, which in my judgment is valid and reliable.

> Regardless of which approach is used, until the sustainable yield estimate used is confirmed, there is not sufficient basis to deem the impacts to the NGLA less than significant.

The 1992 SY estimates are valid and reliable, and were themselves also conservative. (See my response to Mr. Hylton's question.) Future updates of the 1992 study are therefore more likely to increase than to reduce the estimated SY, particularly as improved technology for exploration and extraction becomes available.

> Mitigation measures should be identified to prevent degradation in the three aforementioned sub-basins. Monitoring triggers will need to be identified. Relying on monitoring alone is not an adequate mitigation measure given that three sub-basins may exceed sustainable yields. Reasonable mitigation measures could include increased water conservation in existing DoD facilities, and reduction in leakage in GWA distribution system.

As noted in my response to Mr. Hylton's question, the question of what withdrawal rates are sustainable turns necessarily on the question of what chloride levels are acceptable. The chloride concentration is arguably the most useful and relevant "monitoring trigger," but some decision will have to be made by the users and regulators as to what concentrations are acceptable over the long term.

> The relationship between the existing and proposed wells, rate of withdrawal, and response of the aquifer needs further explanation. We also recommend that the DEIS make clear what coordination will occur with GWA regarding future GWA wells, and the relationship between proposed GWA wells and DoD wells.

This question/comment will have to be framed more precisely and in more detail in order to be answered in detail. However, I think I have already addressed above some of the concerns that seem implicit in this question, such as the degree to which development of one sub-basin might affect the performance of another, and the necessity, indeed the advisability, of concentrating wells in the para-basal zone, rather than distributing them across the lower quality and more vulnerable portions of the lens.

Final Report

Guam Water Well Testing Study to Support U.S. Marine Corps Relocation to Guam—Point Paper

February 2010

Department of the Navy
Naval Facilities Engineering Command, Pacific
258 Makalapa Drive, Suite 100
Pearl Harbor, HI 96860-3134

Contract Number N62742-06-D-1870, CTO 0036

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February 2010

Prepared for:

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Naval Facilities Engineering Command, Pacific
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A Joint Venture of TEC Inc., AECOM TS Inc., and EDAW, Inc.

Contract Number N62742-06-D-1870, CTO 0036

EXECUTIVE SUMMARY

This point paper outlines a test program to locate and design wells for potable water supply in support of the proposed United States Marine Corps (Marine Corps) relocation to Guam (hereafter referred to as the Marine Corps relocation) and provides detailed information to support the environmental impact statement. In July 2007, the Naval Facilities Engineering Command, Pacific (NAVFAC Pacific), under Master Contract number N62742-06-D-1870, issued a task order to TEC Joint Venture requesting a water utility study report and planning documents that evaluates improvements to the potable water system, which would support the Marine Corps relocation. In June 2009, NAVFAC Pacific issued Task Order 036 to TEC Joint Venture requesting a water well testing study that supports the evaluation of improvements to the potable water system.

As part of Task Order 036, this point paper presents an evaluation of the current and historic water systems and geologic, hydrogeologic, water quality, and water quantity data. Plus, it includes recommendations for 11 test boring locations to help determine optimal well and well field configurations. Seven locations are proposed at Naval Support Activity Andersen (formerly Andersen Air Force Base), two are proposed at Andersen South, and two are proposed at Navy Barrigada.

At the completion of the field study, a separate report will be prepared that includes discussions of the drilling methodologies employed, results of logging and pump testing activities, results of water quality tests, and recommendations for well design criteria, construction details, well development procedures, and the estimated number of wells required to meet future demands.

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ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFMW	Air Force MARBO Well
ATS	AECOM Technical Services, Inc.
DoD	Department of Defense
E. coli	Escherichia coli
ft	feet or foot
ft/day	feet per day
GEPA	Guam Environmental Protection Agency
GIMDP	Guam Integrated Military Development Plan
GNWR	Guam National Wildlife Refuge
gpm	gallons per minute
GWA	Guam Waterworks Authority
GWUDI	groundwater under the direct influence of surface water
JGMMP	Joint Guam Military Master Plan
MARBO Annex	Marianas Bonins Command Annex
Marine Corps	United States Marine Corps
MEC	munitions and explosives of concern
mg/L	milligram per liter
MGd	million gallons per day
msl	mean sea level
NAVFAC Pacific	Naval Facilities Engineering Command, Pacific
NCTS	Naval Communications Transmission Station
NGLA	Northern Guam Lens Aquifer
NGLS	Northern Guam Lens Study
NRMC	Navy Regional Medical Center
NSA	Naval Support Activity
NWF	Northwest Field
U.S.	United States
UIC	underground injection control
USEPA	U.S. Environmental Protection Agency
UXO	unexploded ordnance
VOC	volatile organic compound
WERI	Water and Environmental Research Institute of the Western Pacific
WTP	Water Treatment Plant

1. Introduction

1.1 PURPOSE

This point paper outlines a test program to locate and design wells for potable water supply in support of the proposed United States Marine Corps (Marine Corps) relocation to Guam (hereafter referred to as the Marine Corps relocation) and provides detailed information to support the environmental impact statement. In July 2007, the Naval Facilities Engineering Command, Pacific (NAVFAC Pacific), under Master Contract number N62742-06-D-1870, issued a task order to TEC Joint Venture requesting a water utility study report and planning documents that evaluates improvements to the potable water system, which would support the Marine Corps relocation. In June 2009, NAVFAC Pacific issued Task Order 036 to TEC Joint Venture requesting a water well testing study that supports the evaluation of improvements to the potable water system.

This report includes an evaluation of the historical and current water systems and geologic, hydrogeologic, water quality, and water quantity data; and recommends locations for further study. At the completion of the field study, a separate report will be prepared that includes discussions of the drilling methodologies employed, results of logging and pump testing activities, results of water quality tests, and recommendations for well design criteria, construction details, well development procedures, and the estimated number of wells required to meet future demands. This report will support the recommended water supply options that were discussed in the water utility study (NAVFAC Pacific 2008).

1.2 PROJECT BACKGROUND INFORMATION

1.2.1 Guam Integrated Military Development Plan

The *Guam Integrated Military Development Plan* (GIMDP), formerly the *Joint Guam Military Master Plan* (JGMMP), identified a plan to increase the military population on Guam. Naval Computer and Telecommunications Station (NCTS) Finegayan, South Finegayan Housing Area, Naval Support Activity (NSA) Andersen (formerly Andersen Air Force Base [AFB]), NSA Andersen Northwest Field, and Andersen South would bear the brunt of the military personnel increase on Guam.

Potable water for these bases is provided by separate Navy and Air Force water systems. The Navy also provides water to Guam Waterworks Authority (GWA) from its surface water reservoir for a limited number of civilians in the southern part of the island. The Air Force leases a well to GWA on NSA Andersen. The construction of new wells and associated appurtenance on U.S. Department of Defense (DoD) property is needed to support Marine Corps personnel and mission.

1.2.2 Guam Water Utility Study Report for Proposed U.S. Marine Corps Relocation

NAVFAC Pacific reviewed the findings presented in the GIMDP and decided to perform a water utility study (NAVFAC Pacific 2008) that would identify all reasonable options for supplying potable water in support of the Marine Corps relocation to Guam. The study identified reasonable options with sufficient information to support the environmental impact statement. The study evaluated and recommended water resource, distribution, and storage and treatment system improvements to Navy and Air Force water systems to meet future DoD requirements. The study identified and developed alternatives to support the existing and planned DoD development. The study analyzed the environmental impacts that could result from implementation of the most feasible alternatives for improving the water systems. The study identified and developed planning documents for projects that represent the best value alternative for the water.

The water utility study recommended:

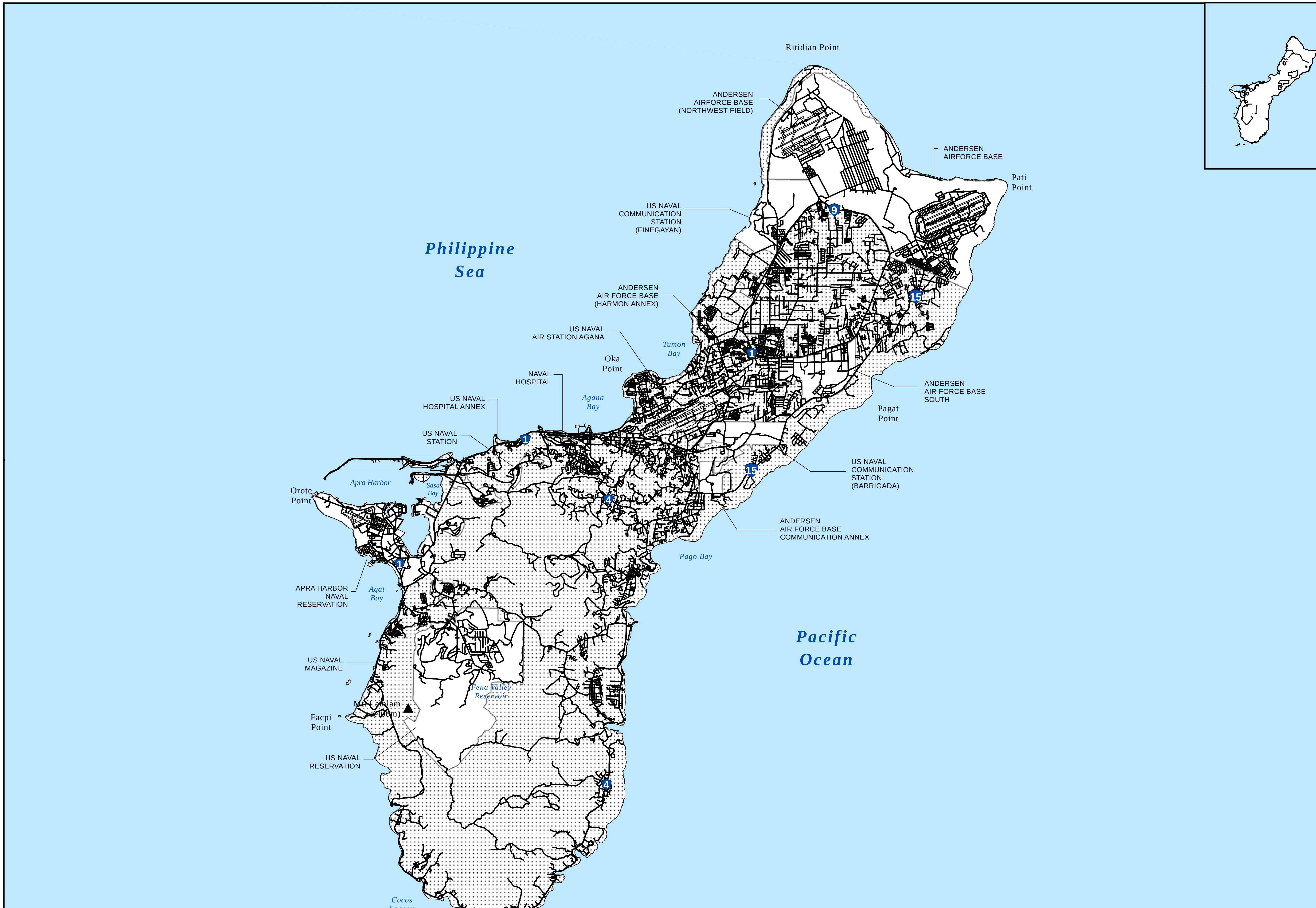
- Installing 21 water supply wells plus one contingency well on NSA Andersen
- Continuing to use existing Navy wells on Finegayan
- Rehabilitating Navy Regional Medical Center Well #3
- Installing observation wells on NSA Andersen, Finegayan, Andersen South, and Naval Hospital
- Installing and utilizing the five new wells planned on NSA Andersen

NAVFAC Pacific issued the scope of work for this study to evaluate additional groundwater wells in the northern part of Guam (Figure 1-1). The new wells would provide a potable water source to support the Marine Corps relocation.

In the meantime, the Air Force has completed and is operating five new wells on NSA Andersen (AF-1 through AF-5). The Air Force is also redrilling five wells on Andersen South. The Navy has redrilled and is in the process of permitting and re-equipping NCS#3 at Navy Barrigada.

Following the completion of this study, AECOM Technical Services, Inc. (ATS) will estimate the total number of wells needed to support additional groundwater requirements, provide a preliminary range of expected pumping rates, and recommend potential well field locations. In addition, a discussion of water quality and production from existing off-base GWA wells in close proximity to the ATS test borings will be included in the final water well testing study report.

Figure 1-1
Island and Base Location Maps



Legend
- Non-DOD Area
- Roads

N W E S

Miles
0 0.5 1 2

0 0.45 0.9 1.8
Kilometers

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2. Scope of Work

ATS was assigned the following tasks:

- Visit the University of Guam Water and Environmental Research Institute of the Western Pacific (WERI) to review readily available wells/boring logs from the Navy, Air Force, GWA, and Guam Environmental Protection Agency (GEPA) and update the volcanic basement contour map (Vann 2000).
- Review unexploded ordnance (UXO)/munitions and explosives of concern (MEC) records at University of Guam, the War in the Pacific National Historical Park, and NSA Andersen and Navy explosive ordinance disposal offices.
- Prepare this point paper to evaluate the historical and current water systems; geologic, hydrogeologic, water quality, and water quantity data; and recommend locations for further study.
- Acquire permits necessary for test boring drilling and testing.
- Drill 11 pilot test borings to characterize the production capacity of well fields in the areas of interest. The objective is to have some test borings eventually converted to production wells.
- Mobilize equipment to perform drilling and testing operations including: utility and UXO/MEC avoidance, surveying, and clearing the site, if necessary.
- Perform the following actions for each proposed pilot test boring:
  - Drill test boring.
  - Determine borehole plumbness.
  - Perform geophysical logging of borehole.
  - Perform step-drawdown and 72-hour constant-rate pumping tests at appropriate pumping rates to determine well capacity.
  - Log salinity and basic water quality parameters of the saturated zone at appropriate intervals.
  - Collect groundwater samples at least 24 hours after the start of the constant-rate pump test and have the samples analyzed by a U.S. Environmental Protection Agency (USEPA)–certified laboratory for primary and secondary drinking water standard contaminants.
  - Supply and install a test boring cover and 20 feet (ft) of steel casing at each of the 11 boreholes at the conclusion of testing.
  - Survey each test boring site to determine the groundwater elevations.
- Deepen one of the 11 test borings (AECOM 3) (before installing the cover) to allow future monitoring (outside this contract) of depth and thickness of the transition zone between fresh and salt water.
- Prepare a report documenting the water well study and include details on the drilling methodologies employed, logging and pump testing activities results, water quality test results, and suggestions for production well design criteria, construction details, and well development procedures. The report will recommend final production well locations and give anticipated production rates.

3. Background Information

Guam is the southernmost and largest of the Mariana Islands, a group of 15 islands located approximately 3,800 miles west of Hawaii and 1,400 miles south of Japan. The island is an unincorporated territory of the U.S. The main axis of the island runs roughly northeast to southwest for a total length of 30 miles and the width varies from about 8 miles at its northern tip to about 4 miles near the center to roughly 12 miles in the south. The total area of the island is about 212 square miles. According to the U.S. Census, the 2005 population of Guam was 168,564.

3.1 GEOLOGY

The roughly northwest-to-southeast trending Pago-Adelup Fault sharply divides Guam into two distinct geologic provinces approximately the same size. North of the fault lies a limestone plateau, which generally slopes from north to south. A dissected volcanic upland lies south of the fault. Volcanic units preceded the limestone deposition north of the fault and the volcanic surface eroded before the limestone emplacement appeared such that gross unconformities separate the rock types.

The oldest rocks on Guam are Late Middle Eocene pillow basalts and basalt flows and came from a volcano located west of Guam. These rocks are overlain by Late Eocene to Early Oligocene tuffaceous shale and sandstone, which are interbedded with breccia and lava flows. A second volcanic center developed to the southwest and produced extensive lavas and pyroclastic deposits until its final collapse in the Early Oligocene. Volcaniclastic sedimentation continued through the Late Oligocene to the Early Miocene, when massive reef and lagoonal limestone formed over the volcanics.

The Miocene Bonya Limestone and the Miocene-Pliocene Alifan Limestone are found directly on top of the volcanic units in the interior highlands of southern Guam. The Alifan Limestone is also found in the northwest corner of the southern province and on the flanks of Mt. Santa Rosa, a horst structure, in the north. The Alifan Limestone was succeeded by deposition of detrital Miocene-Pliocene Barrigada Limestone, which is an extensive unit exposed in the interior of the northern plateau. This unit is a principal aquifer in that province and extends well above and below the position of the freshwater lens. The Barrigada Limestone grades laterally and upward into the Pliocene-Pleistocene Mariana Limestone, a reef and lagoonal deposit that dominates the northern plateau. The high cliffs north of the Pago-Adelup Fault are exposures of the Mariana Limestone, as are the cliffs of the Orote Peninsula to the south of Apra Harbor.

The Mariana Limestone has been interpreted as a shallow-water fringing and barrier reef deposit that is thickest along the periphery of the northern peninsula. The Mariana contains large openings, voids, and caverns, which are typical of massive coral growth. Inland, a lagoonal facies of the Mariana Limestone grades into the Barrigada Limestone. The Barrigada is interpreted as a deep-water limestone of bank and off-reef detrital deposits. These deposits are heterogeneous and are often cemented and filled with fine calcareous mud. The Barrigada Limestone dominates the interior of the northern plateau. Most of the limestone bedrock of Guam has undergone extensive freshwater diagenesis, resulting in significant changes in porosity, most notably modification by karst processes. In northern Guam, infiltrating rainwater and algae dissolve the limestone creating karst features such as sinkholes and caves. The Tumon-Yigo Trough, Harmon Sink, and Agana Swamp are major expressions of these processes.

3.2 HYDROGEOLOGY

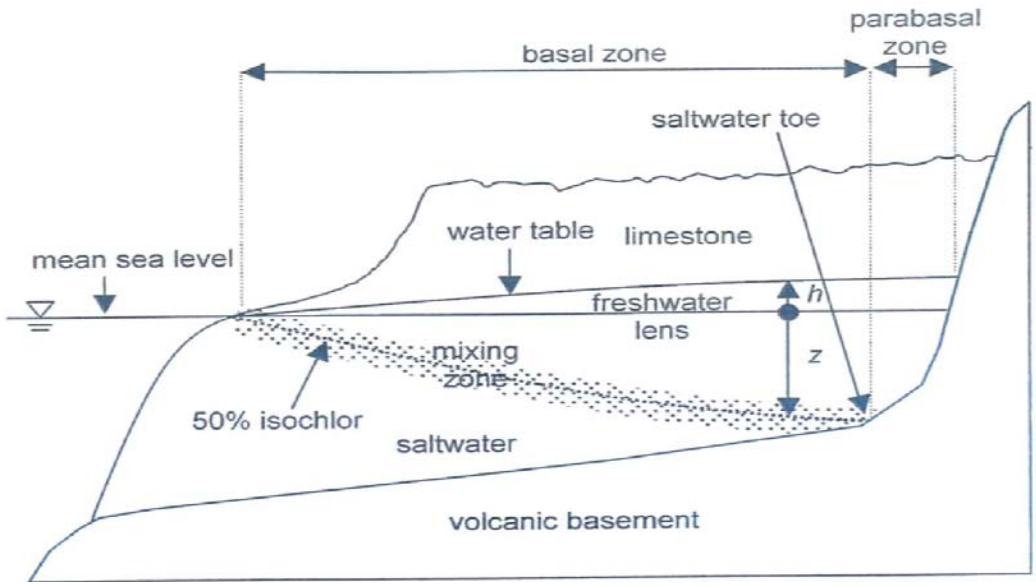
Nearly all of Guam can be described in terms of two rocks types: limestone and volcanics. Generally speaking, the volcanics can be considered aquicludes as contrasted with limestone. In a strict sense, both the limestone and the volcanics are aquifers; however, aquifer properties of the limestone make it favorable for use as an exploitable freshwater source. In southern Guam, the lack of extensive limestone deposits and the unfavorable hydraulic properties of the volcanic rock typically preclude the exploitation of groundwater as a freshwater source. The primary water supply in the south is surface water in the form of the Navy Reservoir, which is supplemented to a minor degree by springs (Barrett 1994). In northern Guam, the sole water source is a limestone aquifer that contains a freshwater body within the Mariana and Barrigada Limestones called the Northern Guam Lens Aquifer (NGLA) (Mink 1976, CDM 1982, Barrett and Mink 1991). The Barrigada Limestone dominates the interior of the northern plateau and accounts for the greatest volume of the freshwater lens aquifer.

Hydraulic characteristics of the limestone aquifer are highly variable in the horizontal and vertical directions. Mink (1976) suggested that the hydraulic conductivity of limestone units, particularly the Barrigada Limestone, is "profoundly affected by the quantity of clay mixed with the limestone components" and further implied that local hydraulic properties are skewed to lower values, because of conditions surrounding a specific location (e.g., well, infiltration gallery), whereas regional hydraulic properties are generally higher, because they represent an average between impermeable rock and open caverns (e.g., fractures and solution conduits). Mink classified argillaceous limestone as containing up to 10 percent clay and having a local hydraulic conductivity as low as 20 ft per day (ft/day). This contrasts to a "clean" limestone, having low clay content and having local conductivities of about 200 ft/day. Regional hydraulic conductivities are lowest in the more argillaceous southern portion of the NGLA, ranging from 500 to 1,500 ft/day, whereas clean limestone to the north can reach as high as 15,000 to 20,000 ft/day (CDM 1982). An average regional hydraulic conductivity of 2,000 ft/day was proposed by Mink (1976); however, modeling studies suggest a regional hydraulic conductivity of around 20,000 ft/day (McDonald and Jenson 2003).

The area southeast of Barrigada Hill is characterized by more heterogeneous, classic karst features (e.g., sinkholes, caves) and may exhibit more tendency for wells to "salt up" (i.e., display rapid dissolved solids concentrations with pumping). This salting up may lead to rapid upconing of saltwater as a result of increased vertical communication caused by caverns and localized faulting.

The NGLA is generally lens shaped in cross-section and is underlain by denser seawater; however, the base is modified where it contacts the relatively impermeable basement volcanic rock. Mink (1976) proposed the term "basal zone" where the lens is underlain by seawater, and "para-basal zone" where the base of the lens is volcanic rock. The saltwater toe refers to the contact between the saltwater/freshwater mixing zone and the para-basal zone. The typical steady-state hydraulic head in the basal zone is near sea level at the coast and approximately a meter above msl farther inland; in the para-basal zone it can range from 2 to 5 meters above msl. As shown in the image below, under steady-state condition the 50 percent isochlor (half the salinity of seawater) would be found at an elevation of 40h below msl, where h equals the water table elevation above msl. With a water table elevation of 4 meters msl, the basal lens would extend to 160 meters below msl. However, because water with half the salinity of seawater is not potable, the practical thickness of the freshwater lens is generally taken to be about 20 to 40 meters (66 to 132 ft). Lens geometry in the para-basal zone depends on freshwater recharge rates, basement elevations, basement slopes, hydraulic conductivity, and groundwater extraction rates. A typical representation of the lens geometry is presented in Figure 3-1.

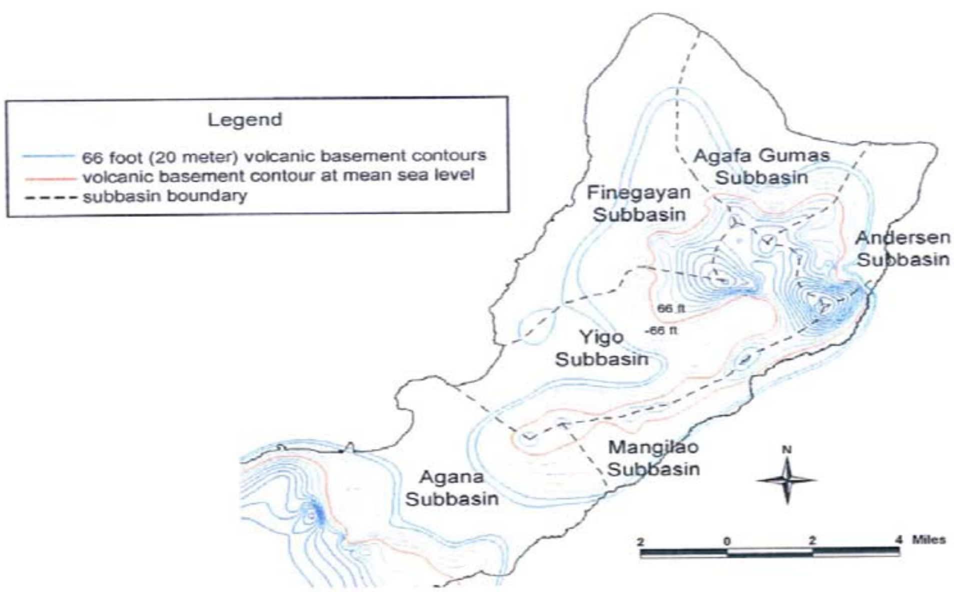
Figure 3-1: Lens Geometry



Note: Figure taken from McDonald and Jenson 2003, as originally depicted in CDM

The NGLA was divided into a series of six subbasins based on basement volcanic contours (CDM 1982). The subbasin boundaries reflect the basement topography forming hydrological divides in the subsurface. Subbasin boundaries were subsequently revised by McDonald and Jensen (2003) on the basis of updated basement contours from Vann (2000) and are shown in Figure 3-2. While some "spillage" exists when they are "full", little communication generally takes place among subbasins.

Figure 3-2: Volcanic Basement Contours



Note: Figure taken from McDonald and Jenson 2003.

As depicted in Table 3-1, the *Northern Guam Lens Study* (NGLS) (CDM 1982) proposed guidelines that prescribed appropriate well depths and pumping rates for basal and para-basal zones of the NGLA.

Table 3-1: 1982 Northern Guam Lens Study Guidelines for Supply Wells

Groundwater Area	Maximum Capacity (gpm)	Minimum Spacing (ft)	Preferred Depth of Future Wells (ft)	Maximum Depth of Future Wells (ft)
Basal				
Groundwater head <4 ft above msl	200	300	≤25	40
Groundwater head >4 ft above msl	350	300	≤35	50[b]
Para-basal				
Southern Agana subbasin	200[a]	300	--	50 [b]
Upper Yigo-Tumon subbasin	750	300	--	50–60 [b]
Other para-basal areas	500	300	--	50 [b]

Source: CDM 1982
gpm gallons per minute
[a] 350 gpm under special conditions
[b] Based on conversation with GEPA, we understand that they now limit all new wells to no deeper than 40 ft below the top of the water table

GEPA currently uses these guidelines and bases other local regulations on the 1982 NGLS.

3.3 GROUNDWATER QUALITY

Shallow groundwater in the NGLA is potable. The USEPA's Secondary Safe Drinking Water Act for chloride concentration is 250 milligrams per liter (mg/L) (USEPA 2001). As discussed in McDonald and Jenson (2003), seawater typically contains 19,000 mg/L or greater chloride, while rainwater is about 1 mg/L or less. Groundwater concentrations may range from a few mg/L near the lens surface to 100 percent seawater beneath the basal zone. Within the lens, concentrations can vary in response to long-term and short-term sea level fluctuations, groundwater extraction, tidal pumping, seasonal changes in recharge rates, and chloride from sea spray mixed with storm water during heavy storms. CDM's (1982) typical chloride ranges for the different environments within the NGLA (and recommended as criteria for engineering and management decisions) are:

- Para-basal groundwater – <30 mg/L
- Saltwater toe groundwater – 30 to 70 mg/L
- Basal groundwater – >70 to <150 mg/L
- Salt water upconing indicator level – ≥150mg/L

Some issues with NGLA water quality are:

- Groundwater from the NGLA is typically hard, containing calcium and magnesium carbonate.
- Tumon Maui and Air Force MARBO Well (AFMW) #2 are not in service because of historic detections of dissolved volatile organic compounds (VOCs).
- Bacteriological testing has identified the presence of total coliform and Escherichia coli (E. coli) at various times and in various wells.
- Chloride levels have risen to unacceptable levels (i.e., greater than 250 mg/L) in some wells.

- VOCs exist in groundwater in some locations on NSA Andersen and Andersen South.
- Thallium was reported in the northern watershed restoration strategy plan (Northern Watershed Working Group, n.d).

The USEPA is currently evaluating whether groundwater produced from the NGLA is considered groundwater under the direct influence of surface water (GWUDI) and thus required to meet specific disinfection requirements. Certain wells have already been designated as GWUDI.

McDonald and Jenson (2003) used the wellhead chloride sampling records for 128 production wells between 1973 and 1999 to assess trends in chloride concentrations. Although samples from water extracted at the wellhead are a composite of water drawn from across the entire length of the well screen at different depths, they are considered a practical indicator of chloride contamination. Results of this study are discussed in the later sections.

3.4 WATER SYSTEMS

The following sections describe the DoD and GWA water systems that will be affected by the proposed Marine Corps relocation. A small number of DoD and private nonpotable irrigation and private potable water wells also exist on Guam. They are not included in the discussion below.

3.4.1 Air Force Water Systems

NSA Andersen is located in northern Guam and covers approximately 24.5 square miles. The base consists of two major areas and several smaller areas called annexes. The major areas, collectively known as the “main base,” are North Field, which contains the base’s active operations, and Northwest Field (NWF), which contains abandoned runways and landing fields. The annexes are scattered throughout northern Guam and contain base housing, communications services, and water and petroleum storage facilities. The two largest annexes are the Marianas Bonins Command Annex (also known as MARBO Annex or Andersen South) and the Harmon Annex. Andersen South lies about 4 miles south of the main base and covers approximately 3.8 square miles. The Harmon Annex, 4 miles south of NWF, covers about 2.8 square miles in western Guam. The NSA Andersen water system supplies water to Andersen NWF and Andersen South, and includes an off-base water supply, treatment, storage, and transmission system and an on-base water distribution system. The off-base water supply and transmission system includes nine water production wells, two booster pumping stations, three reservoirs, chlorination facilities, and a fluoridation facility. The existing on-base water distribution system includes a pumping station and three water storage tanks.

Water is currently supplied to NSA Andersen from seven of the nine off-base water production wells and five on-base wells. Two wells, AFMW#2 and Tumon Maui Well, are currently not operational because VOCs were detected in the groundwater at concentrations that have exceeded USEPA maximum contaminant levels for drinking water. We understand that the VOC concentrations in the Tumon Maui may no longer exceed these levels. The five Andersen South wells (AFMW#5 through #9) are 40 to 50 years old and currently being redrilled and replaced. Five wells (AF-1 through AF-5) have been installed in the NWF and began operating in 2009.

3.4.2 Navy Water System

The Navy water system and service areas are NCTS Finegayan, South Finegayan, NCTS Barrigada, Nimitz Hill, Naval Hospital, Ordnance Annex, and the Apra Harbor Complex.

The existing Navy water system is an island-wide system extending from the Navy Reservoir in Southern Guam to NCTS Finegayan near the northern tip of Guam. Water for the system is primarily supplied from the Navy Water Treatment Plant (WTP). Water is distributed from the treatment plant to reservoirs designed to serve different service zones and transfer water to other Navy installations across the island. The Navy system is interconnected to supply water to GWA and for emergency service capability. The connection with the NSA Andersen system is out of service.

In most of the service areas, water is supplied from onsite groundwater wells, through the Navy island-wide water system or by interconnection with the GWA. The island-wide water system consists of three primary sources, which are located at the southern region of Guam: Almagosa Springs, Bona Springs, and the Navy Reservoir surface water impoundment. Water from the above three sources are treated at the Navy WTP and distributed through a network of reservoirs, transmission mains, and booster pumping stations. A brief description of the water supply sources in each of the Navy service areas is provided below:

- NCTS Finegayan – supplied by groundwater wells located on site and at South Finegayan. If necessary, water can be supplied by interconnections with the GWA system or the Navy island-wide system.
- South Finegayan Housing Area – water is primarily supplied by groundwater wells on site and at NCTS Finegayan. If necessary, water can be supplied by interconnections with the GWA system or the Navy island-wide system.
- NCTS Barrigada – water is primarily supplied by groundwater wells. As a backup, the water storage system is connected to the Navy island-wide systems. The Navy recently redrilled NCS#3 because of high chloride concentrations and poor well yield. According to GEPA and the Navy, the new well will likely be limited to 50 gpm because of the high chloride concentrations observed during pump testing. NCS#4 was abandoned years ago reportedly because of poor yield and high chloride concentrations. NCS#8 is reportedly offline because of a collapsed screen.
- Naval Hospital – water can be supplied from either the Navy island-wide water system or from onsite groundwater wells. Two wells are operational and one well is inactive because of high chloride levels. Three wells have tested positive for total coliform and two have tested positive for E. coli (Engineering Concepts 2005).
- Apra Harbor Naval Base Complex and other Navy areas south of the Piti Power Plant – supplied entirely by the Navy WTP.

3.4.3 GWA Water System

The GWA water system consists of three public water systems known as the Northern, Central, and Southern Public Water Systems, serving the respective areas of the island with some overlaps. The northern and central systems are designated as “Large” and the southern system is designated as “Small.”

The Northern Public Water System is bounded on the north by NSA Andersen, includes the remaining northern half of Guam, and extends southward toward Tamuning and Barrigada and along the east side to Route 17 to Yona. The northern system overlaps the southern system in Windward Hills and Talofofo along Routes 14, 4, and 4A.

The Central Public Water System extends along the west side of Guam from Mongmong-Toto-Maite south to Agat. The system extends inland to Sinjana and roughly follows the western borders of Chalan Pago and Yona to Route 17, and then follows the western border of Tolofofo to Agat. The main source of water for this area is the Navy WTP.

The Southern Public Water Systems roughly extends south of Route 17 and around the southern tip of Guam to Umatac.

The Northern Public Water System is the largest system serving all public areas in the north and central parts of the island south of NSA Andersen and serves an approximate population of 146,050. This system consists of 119 groundwater wells (about 110 currently in use), 14 reservoirs (11 in use), and 10 booster pumping stations (9 in use). The Central Public Water System consists of one spring, eight reservoirs (five in use), and nine booster stations (six in use). The main source of water for this system is the Navy water system. Water from the northern system can also be fed to the central system in the areas of Mongmong-Toto-Maite, Sinjana, Hagatna Heights, Asan, and parts of Piti. Northern water can also be supplied to Apra Heights, Santa Rita, and Agat through water mains that run along Routes 17, 5, 12, and 2.

To accommodate organic growth and DoD buildup, GWA is planning about 30 new wells in the NGLA.

Table 4-1 lists the wells reported to be in use by the Air Force, Navy, and GWA with their respective pumping capacities.

4. Sustainable Yield

Sustainable yield was originally determined in the 1982 NGLS (CDM 1982) and was adopted as the regulatory standard for future development. In 1991, those estimates were updated by one of the original authors (John Mink) of the NGLS using an additional decade worth of data and more accurate modeling techniques. The 1991 estimate is considered a more accurate estimate of the sustainable yield because the estimate was determined using a dynamic model of the aquifer. The 1982 estimate was determined using a static model. In addition, the NGLA Sustainable Yield Review (NAVFAC Pacific 2009) confirmed that the current situation on Guam does not alter the results of the 1991 sustainable yield assessment. Although the 1991 Barrett/Mink study (Barrett and Mink 1991) recommended that the 1982 safe yield estimates be extended, the current regulatory standard is still the 1982 (more conservative) estimate.

Table 4-2, which is from the water utility study, summarizes the future available yield estimates using both the 1982 NGLS (CDM 1982) and the 1991 Barrett/Mink Study (Barrett and Mink 1991).

The water utility study estimated that approximately 13 million gallons per day (MGd) of additional water supply is needed for the Marine Corps relocation. Ongoing discussions and negotiations are being conducted to finalize the additional water supply needed.

The recommended number of wells required to meet these demands will be determined after the 11 test borings are advanced and pump tested and water demands are finalized. This information will be compiled and provided in a separate report after completion of our testing.

Table 4-1: Northern Guam Active Supply Wells

Well	Capacity (gpm)	Well	Capacity (gpm)	Well	Capacity (gpm)
Air Force		**GWA (cont.)**		**GWA (cont.)**	
AFMW #1	170	A-25	250	F-12	
AFMW #3	210	A-26	70	F-13	150
AFMW #5	180	A-30	760	F-15	
AFMW #6	480	A-31	280	F-16	330
AFMW #7	255	A-32	173	F-17	240
AFMW #8	490	AG-1	120	F-18	240
AFMW #9	400	AG-2A	500	F-19	219
AF-1	250	D-1	210	F-20	254
AF-2	200	D-2	187	G-501	190
AF-3	200	D-4	240	H-1	265
AF-4	200	D-5	180	HG-2	470
AF-5	200	D-6	280	M-1	140
Navy		D-8	230	M-2	220
NCTS A	180	D-9	220	M-3	45
NCTS B1	200	D-10	170	M-4	160
NCTS #5	100	D-12	190	M-5	160
NCTS #6	125	D-16	170	M-6	160
NCTS #7	235	D-19	150	M-7	175
NCTS #9	200	D-20	190	M-8	170
NCTS #10	180	D-21	190	M-9	160
NCTS #11	180	D-22	200	M-14	220
NCTS #12	180	ET-F19	200	M-15	190
NRMC #1	234	ET-F20	200	M-17A	210
NRMC #2	200	ET-D25	400	M-17B	160
GWA		ET-D26	250	M-18	220
A-1	70	ET-D27	400	M-20A	400

Well	Capacity (gpm)	Well	Capacity (gpm)	Well	Capacity (gpm)
A-2	200	ET-D28	200	M-21	180
A-3	190	ET-Y18	250	M-23	220
A-4	280	ET-Y19	500	Y-1	150
A-5	250	ET-Y20	500	Y-2	161
A-6	280	ET-Y27	300	Y-3	138
A-8	220	EX-5	240	Y-4A	220
A-9	230	EX-11	210	Y-5	160
A-10	255	F-1	140	Y-6	180
A-12	170	F-2	121	Y-9	472
A-13	237	F-3	142	Y-10	200
A-14	190	F-4	137	Y-12	235
A-15	270	F-6	151	Y-15	650
A-17	240	F-7	170	Y-16	200
A-18	100	F-8	140	Y-17	300
A-19	160	F-9	200	Y-21A	350
A-21	205	F-10	200	Y-23	300
A-23	340	F-11	158		

Notes: NRMC #2 is operational but production is limited.
The production rates for NCTS#10, #11, and #12 are assumed to be 180 gpm
NCTS A is not used due to poor quality

Sources: Navy: measured or calculated values from the Navy utility report (Engineering Concepts 2005) and input from the Navy
Air Force: measured values from NSA Andersen utility report
GWA: 30-day average rates from the GWA water resources master plan (GWA 2007) and GWA email Communication
Blanks indicate data not provided to ATS

Table 4-2: Estimates of Sustainable and Available Yield for Subbasins in the Northern Guam Lens Aquifer (MGd)

		Northern Guam Lens Study (CDM 1982)		Barrett & Mink (1991)	
Subbasin	Well Production	Sustainable Yield	Available Yield	Sustainable Yield	Available Yield
Agana	10.7	11.7	1.0	20.5	9.8
Mangilao	1.9	3.9	2.0	6.6	4.7
Andersen	1.2	6.2	5.0	9.8	8.6
Agafa-Gumas	3.9	10.1	6.2	12.0	8.1
Finegayan	8.1	6.4	-1.7	11.6	3.5
Yigo-Tumon	23.5	19.1	-4.4	20.0	-3.5
TOTALS	**49.3**	**57.4**	**8.1**	**80.5**	**31.3**

Sources: NAVFAC Pacific 2008, CDM 1982, Barrett 1991, Personal communication with GWA and the Navy on 26 July 2009

5. Proposed Test Borings

As detailed in the scope of work, this point paper proposes 11 test boring locations to help determine optimal well and well field configurations to meet the future Marine Corps water demands and meet future regulatory requirements. Seven locations are proposed at NSA Andersen; two at Andersen South; and two at Navy Barrigada.

Using the 1991 estimates of sustainable yield, it appears that sufficient groundwater is available within military reservation boundaries to meet the new DoD demand resulting from the Marine Corps relocation. Reevaluation of these subbasin sustainable yields is outside the scope of this study. Following our field investigation, production wells will be sited by considering the following:

- Limit well locations to DoD property
- Limit well production within subbasins limited by the sustainable yield, considering reported demands from GWA
- Preferentially locate wells in para-basal zones to achieve higher yield with lower chloride levels, a lower number of wells, and associated costs
- Maintain a 1,000-ft setback distance from the shoreline to minimize saltwater intrusion
- Maximize setback from other supply wells
- Environmental installation restoration sites (e.g., landfills)
- Locate wells away from areas actively used (or planned) for training and operations by Air Force, Navy, or Marine Corps personnel (e.g., airfields, munitions storage, live fire ranges)
- Base housing
- Fuel pipelines and utility corridors
- Underground injection control (UIC) wells
- Current and planned future roadways
- Natural features such as springs and sinkholes
- Dissolved contaminant plumes
- Biological habitat (e.g., habitat management unit)
- Historical/cultural resources

Note that GEPA will entertain setbacks less than 1,000 ft from potential contamination sources based on site-specific information, such as topography and best management practices.

Figure 5-1, Figure 5-2, Figure 5-3, and Figure 5-4 present the locations of the proposed test borings. Spatial limitations result in some proposed boring locations near or in areas of one or more of the above listed constraints. The para-basal zone is assumed to extend seaward to a point where the top of the impermeable volcanic basement underlies the limestone aquifer at depth of approximately 40 meters below msl (132 ft msl). A transitional para-basal/basal zone is assumed to exist in the area where the top of the volcanic basement underlies the limestone aquifer at depths between 40 and 60 meters below msl. These assumptions are based on existing GWA well locations described as para-basal or transitional that appear to meet these characteristics according to available volcanic basement contour maps (Vann 2000). In Figure 5-1, Figure 5-2, Figure 5-3, and Figure 5-4, the interval between the 0 and -40 meter basement contour lines have been shaded light blue to highlight areas where the assumed para-basal lens is most likely to exist.

5.1 NAVAL SUPPORT ACTIVITY ANDERSEN TEST BORINGS

Seven proposed test boring locations are on NSA Andersen (AECOM 1 through 7) as shown on Figure 5-1 and Figure 5-2 and described in Table 5-1. Three of the proposed locations (AECOM 1 through 3) are in the Agafa-Gumas subbasin and four (AECOM 4 through AECOM 7) are in the Andersen subbasin. AECOM 1 through 4 will be drilled from surface to final depth in the Barrigada Limestone. After pump testing, AECOM 3 will be deepened up to 250 ft into the saltwater zone, depending on contact with volcanic bedrock. AECOM 5 will be drilled in a potential perched zone of the Barrigada Limestone. AECOM 6 and 7 will be drilled in the detrital facies of the Marianas Limestone, which grades at depth into the Barrigada Limestone.

According to the Vann (2000) basement contour map, the 0 to 20 meter (66 ft) below msl zone of the para-basal lens is south of the NSA Andersen property boundary. Because of the uncertainty of the subsurface contours, the para-basal, transition zone, and basal lens boundaries are not precisely known. So test borings AECOM 1 through 4 may be located in the transition zone between the para-basal and basal lenses.

5.1.1 Test Boring Placement Constraints

As discussed in Section 5.1, proposed test boring locations were selected with keeping physical and regulatory constraints in mind. The following subsections discuss constraints specific to NSA Andersen.

5.1.1.1 BURIED FUEL AND UTILITY CORRIDOR

A buried fuel pipeline and utility corridor containing water and fiber-optic line runs west to east along the southern boundary of NSA Andersen. This corridor is approximately 30 to 40 ft wide and generally clear of tall vegetation.

Table 5-1: Proposed Test Borings at the Naval Support Activity Andersen

Proposed Test Boring ID	Approximate Surface Elevation (ft msl)	Approximate Depth of Test Boring (ft)	Anticipated Geologic Unit(s)	Approximate Volcanic Bedrock Elevation (ft msl) [a]	Zone	Subbasin
AECOM 1	465	505	Barrigada Limestone	-130	Transition	Agafa-Gumas
AECOM 2	485	525	Barrigada Limestone	-90	Transition	Agafa-Gumas
AECOM 3	540	580/830 [b]	Barrigada Limestone	-180	Transition (after pump testing this test boring will be deepened to saltwater)	Agafa-Gumas
AECOM 4	520	560	Barrigada Limestone	-60	Transition	Andersen
AECOM 5	555	475	Barrigada Limestone	+240	Perched	Andersen
AECOM 6	530	570	Marianas Limestone Barrigada Limestone [c]	-55	Para-basal	Andersen

Proposed Test Boring ID	Approximate Surface Elevation (ft msl)	Approximate Depth of Test Boring (ft)	Anticipated Geologic Unit(s)	Approximate Volcanic Bedrock Elevation (ft msl) [a]	Zone	Subbasin
AECOM 7	525	565	Marianas Limestone Barrigada Limestone [c]	-60	Para-basal	Andersen

Notes: Actual location, surface elevation, depth of proposed boring location, and depth of volcanic bedrock will vary
Source: Data compiled by ATS in 2009.
[a] Vann 2000
[b] 830 ft is the expected maximum depth boring could be extended following pump test
[c] Barrigada Limestone underlies the Marianas Limestone and is the likely water-bearing unit

Proposed borings AECOM 1 through 4 are located on the southern edges of the utility corridor. These locations were selected for the following reasons:

- To be as close as possible to the para-basal lens, which transitions to basal lens along the DoD property boundary on the western and southern edge of the base
- To minimize the impact on the Guam National Wildlife Refuge (GNWR) and need for a Section 7 consultation by selecting areas already clear of vegetation
- To generally be on the upgradient side of the fuel and water lines to minimize potential impacts on wells from a fuel release (Subsurface water flow on this part of the island is generally from south to north toward the shore)
- To be close to an established water transmission line

5.1.1.2 Guam National Wildlife Refuge

An additional constraint in siting proposed borings AECOM 1 through 4 is the location of the GNWR. As indicated on Figure 5-5, proposed test borings AECOM 1 through 3 are situated in the GNWR, which requires a Section 7 consultation with the U.S. Fish and Wildlife Service before clearing vegetation. However, because the proposed borings are in a cleared utility corridor, we understand that a Section 7 consultation is not required. Future wells may be subject to a Section 7 consultation if they are located outside of the cleared utility corridor.

5.1.1.3 Active Landfill

Proposed boring AECOM 4 is tentatively located east of the active NSA Andersen sanitary landfill near an abandoned transfer station.

5.1.1.4 Housing Areas

Potential conflicts with mission activities and quality-of-life issues prevent the installation of test borings and future wells in the middle of housing tracts or in the portion of the para-basal lens under the runways. In addition, a large natural sink hole with nine UIC wells in the southern housing was ruled out as a possible test boring location.

Given the density of the housing areas, proposed borings AECOM 6 and 7 are located in areas of open grass fields in the suspected para-basal zone. AECOM 5 is proposed just outside a housing area but near a closed depression and five UIC wells.

5.1.2 Chloride Trends in Production Wells

As shown in Table 5-1, test borings are proposed in two subbasins on NSA Andersen (Agafa-Gumas, and Andersen). Active wells near our proposed test borings on NSA Andersen are GWA-well AG-1 and Air Force–owned wells AF-1 through AF-5. Data from the 1990s for AG-1 show chloride concentration between 30 mg/L and 70 mg/L (transition zone) and a gentle upward linear trend (McDonald and Jenson 2003). More recent water quality data from AG-1 confirm that pumping rates need to be closely monitored to mitigate increasing salinity. Long-term pumping water quality data are not yet available for AF-1 through AF-5; however, water samples were collected in September 2009 from AF-1 through AF-5 following installation. Preliminary results show a chloride concentration range of approximately 18 mg/L (AF-3) to 101 mg/L (AF-4). At the request of GEPA, NAVFAC Pacific directed that AECOM 3 be deepened through the transition zone. This well will be used by others to monitor the depth and thickness of the transition zone over the coming years. This area was selected because a deep saltwater monitoring well in this area (EX-8) was apparently damaged and is now inaccessible, and this location is more likely to be in the basal zone than the other nearby planned test wells.

5.1.3 Potential Perched Water Wells

Based on a review of the Vann (2000) volcanic basement contours, wells Y-15, Y-17, and Y-23 are drilled upgradient of the para-basal zone. GWA records indicate that the static water levels in the three wells are about 200 to 340 ft above msl. Additionally, the chloride concentrations are generally in the 20 to 40 mg/L range. Production rates have been in the 300 to 600 gpm range. These data suggest that these wells were completed in perched water. This information led ATS to recommend that one test boring (AECOM 5) be drilled in this potential perched zone. It should be noted that this perched water may exist because of low-permeability materials that impede the downgradient movement of water. Due to the heterogeneity of this material, not every location in this area may have viable perched water available.

5.2 ANDERSEN SOUTH TEST BORINGS

Two proposed test boring locations are on Andersen South (AECOM 8 and 9). Details about these test boring locations are provided in Table 5-2. Both borings are located in the Yigo subbasin and will be drilled in the detrital facies of the Marianas Limestone, which grades at depth into the Barrigada Limestone. Existing nearby wells AFMW#5 through #9 produce between 180 and 490 gpm and are currently being redrilled due to the age of wells.

Table 5-2: Proposed Test Borings at Andersen South

Proposed Test Boring ID	Approximate Surface Elevation(ft msl)	Approximate Depth of Test Boring (ft)	Anticipated Geologic Unit(s)	Approximate Volcanic Bedrock Elevation [a] (ft msl)	Zone	Subbasin
AECOM 8	475	515	Marianas Limestone Barrigada Limestone [b]	-60	Para-basal	Yigo
AECOM 9	360	400	Marianas Limestone Barrigada Limestone [b]	-30	Para-basal	Yigo

Notes: Actual location, surface elevation, depth of proposed boring location, and depth of volcanic bedrock will vary
Source: Data compiled by ATS in 2009
[a] Vann 2000
[b] Barrigada Limestone underlies the Marianas Limestone and is the likely water-bearing unit

Andersen South will see a substantial buildout of training facilities to accommodate the Marine Corps relocation. However, the proposed borings will be immediately off an existing U-shaped road and will not affect the proposed nonlive fire training area in the middle of the facility. These two locations could take advantage of the existing water utility infrastructure and are located in the middle of the para-basal zone. At this time, no known biological or cultural issues exist that would preclude the use of these boring locations.

While the Yigo subbasin is highly exploited and extractions currently exceed the sustainable yield value estimated by Mink, these values were quite conservative. Dr. Jenson has said the best indicators of sustainable yield are temporal pumping and chloride relationships. (Personal communication 2009). Therefore, temporal pumping and chloride data will be reviewed before siting final well locations.

Active wells close to our proposed test borings on Andersen South are GWA wells (i.e., Y-18, Y-19, and Y-20) and Air Force–owned wells (i.e., AFMW#5 through AFMW#9). Data from the 1990s for Y-18, Y-19, and Y-20 show chloride concentrations below 30 mg/L and no significant upward linear trend (McDonald and Jenson 2003). However, more recent chloride data for Y-18, Y-19, and Y-20 show an increasing upward trend in chloride concentration.

In November 2009, ATS personnel conducted site walks of the proposed Andersen South test boring locations with NAVFAC Pacific, NAVFAC Marianas, and GEPA.

5.3 NAVY BARRIGADA TEST BORINGS

As shown on Figure 5-4 and in Table 5-3 below, two proposed test boring locations are on Navy Barrigada (AECOM 10 and 11). Boring AECOM 10 is located in the Mangilao subbasin and are expected to be drilled in the detrital facies of the Marianas Limestone, which grades into the Barrigada Limestone. Proposed boring AECOM 11 is located in the Mangilao subbasins and will be drilled in the Barrigada Limestone. The lithology of the Barrigada Limestone in this area south and east of Barrigada Hill tends to be heterogeneous and the chloride concentrations may rise more quickly as compared to wells in the reef facies of the Marianas Limestone (Jenson 2009). This may be because of vertical conduits associated with normal faulting and/or paleo watertable caves along the horst, which makes up Barrigada Hill.

Currently, the portion of Navy Barrigada where ATS proposes test borings consists of abandoned housing, active and abandoned radio transmission towers, and an active golf course. Both of the proposed borings is easily accessible by a drill rig, does not require heavy brush clearing, and will not affect the golf course activities. At this time, no known biological or cultural issues exist that would preclude using these boring locations.

Table 5-3: Proposed Test Borings at Navy Barrigada

Proposed Test Boring ID	Approximate Surface Elevation (ft msl)	Approximate Depth of Test Boring (ft)	Anticipated Geologic Unit(s)	Approximate Volcanic Bedrock Elevation(ft msl) [a]	Zone	Subbasin
AECOM 10	390	430	Barrigada Limestone	-40	Para-basal	Mangilao
AECOM 11	340	380	Barrigada Limestone	-55	Para-basal	Mangilao

Notes: Actual location, surface elevation, depth of proposed boring location, and depth of volcanic bedrock will vary
Source: Data compiled by ATS in 2009
[a] Vann 2000

McDonald and Jenson (2003) evaluated chloride trends in water from the Agana subbasin and concluded that saltwater upconing in the subbasin seems to have been isolated to the southwestern area. Wells near our proposed test borings on Navy Barrigada are NCS#3 and NCS#8. NCS#3 was recently redrilled because of production and chloride problems. We understand that this well will likely be permitted for less than or equal to 50 gpm because of high chloride concentrations observed during pump testing. NCS#4 was abandoned years ago because of high chloride concentrations. NCS#8 is reportedly offline because of a collapsed screen. These wells are incorrectly labeled in the figures in McDonald and Jenson (2003), but both wells report chloride concentrations in the 1990s between 70 mg/L and 150 mg/L. Both wells are in areas which, based on the volcanic contours, should be para-basal, something the historic water quality does not support. Possible reasons for this could be the presence of the argillaceous Barrigada Limestone and/or vertical fractures/conduits.

In October 2009 and again in November 2009, ATS personnel conducted site walks of the proposed Navy Barrigada test boring locations with Dr. Jenson of WERI. He indicated that based on his experience with the Barrigada Limestone, the subsurface geology can be very heterogeneous and water quantity and quality could vary significantly over very short distances. Proposed borings AECOM 10 and 11 will provide important information on the geology and water quality in the area.

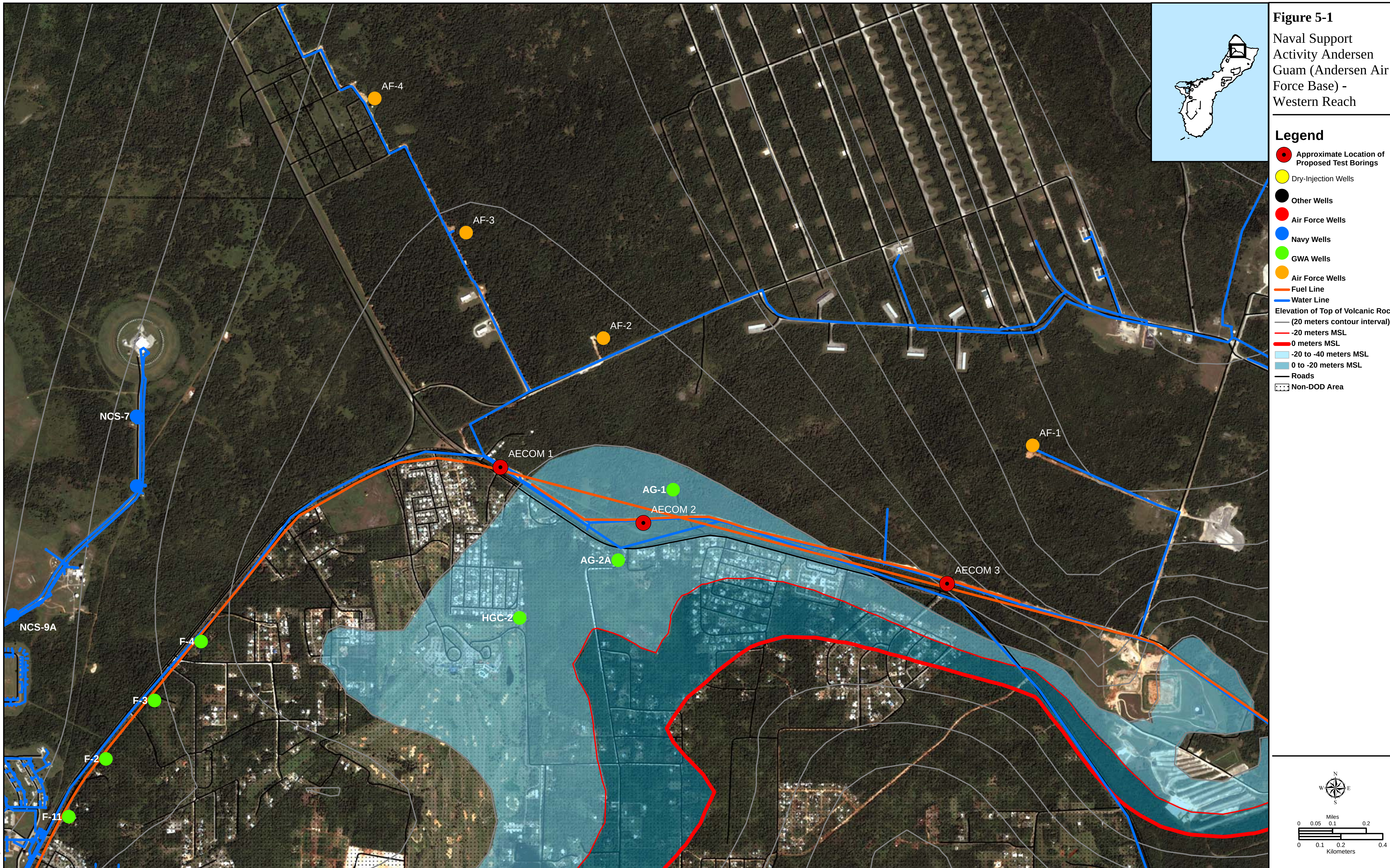


Figure 5-1

Naval Support Activity Andersen Guam (Andersen Air Force Base) - Western Reach

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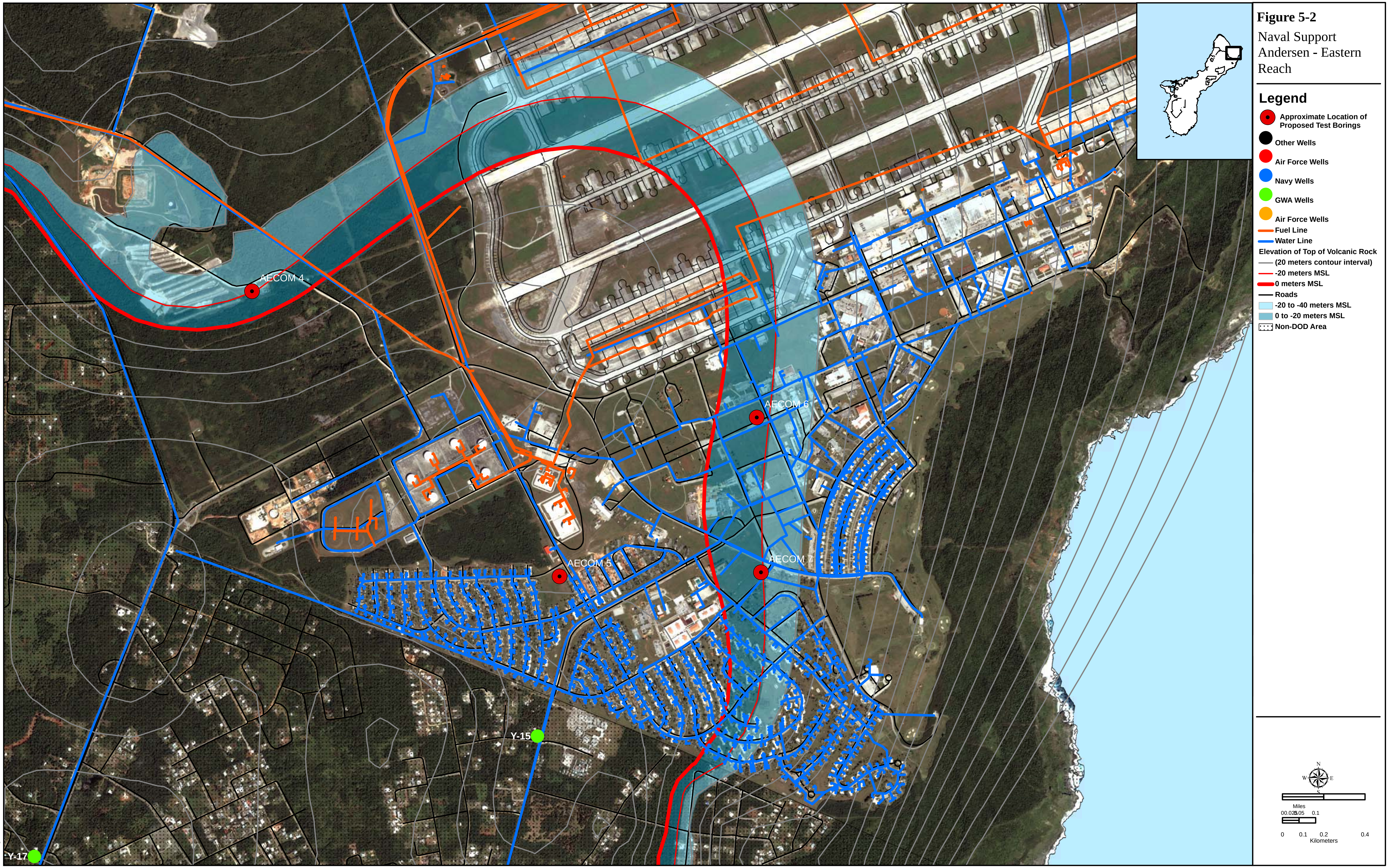

Figure 5-2
Naval Support Andersen - Eastern Reach

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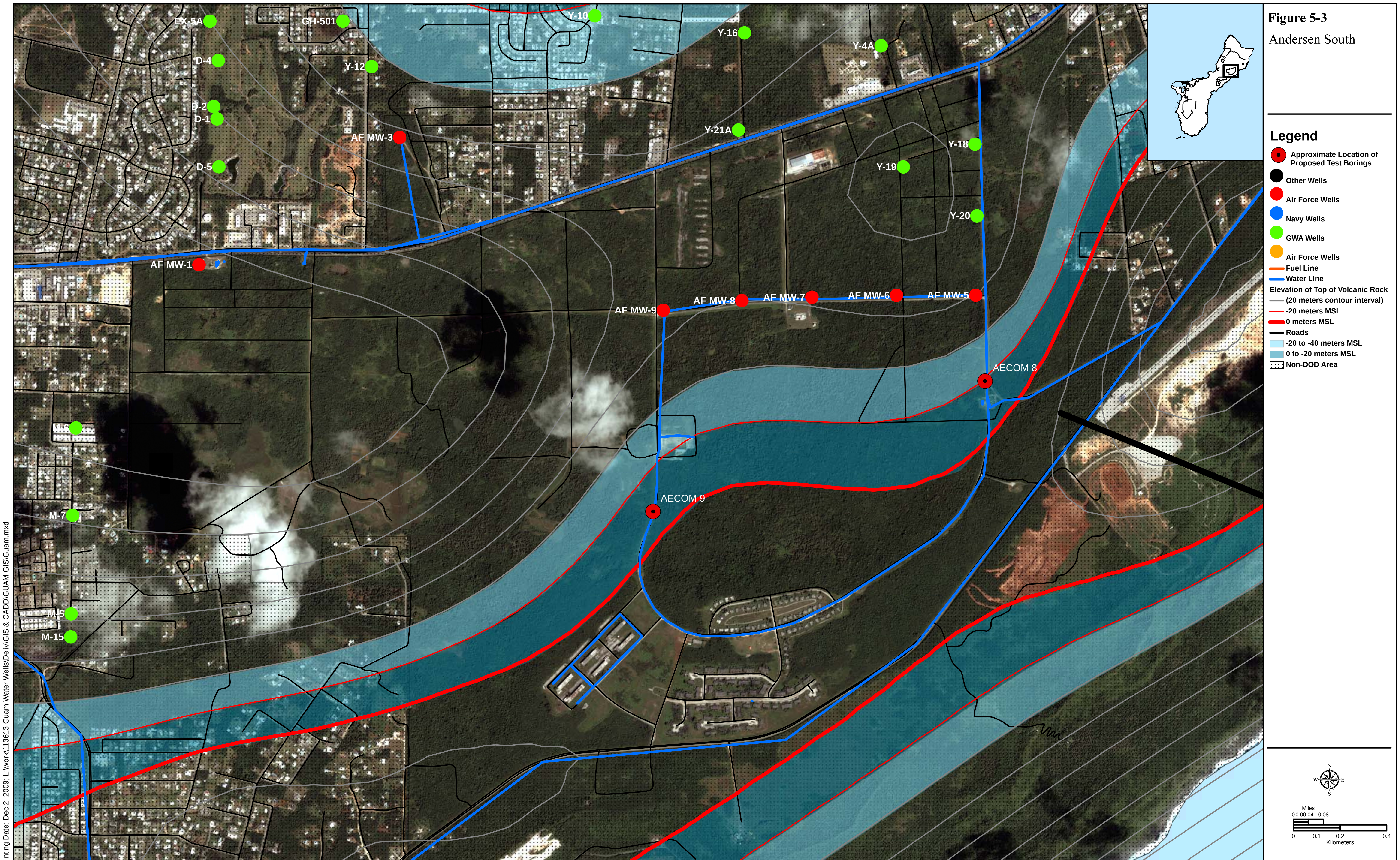

Figure 5-3
Andersen South
Legend
Approximate Location of Proposed Test Borings
Other Wells
Air Force Wells
Navy Wells
GWA Wells
Air Force Wells
Fuel Line
Water Line
Elevation of Top of Volcanic Rock
(20 meters contour interval)
-20 meters MSL
0 meters MSL
Roads
-20 to -40 meters MSL
0 to -20 meters MSL
Non-DOD Area
EX-5A
GH-501
Y-10
Y-16
Y-4A
D-4
Y-12
D-2
D-1
AF MW-3
Y-21A
Y-18
D-5
Y-19
Y-20
AF MW-1
AF MW-9
AF MW-8
AF MW-7
AF MW-6
AF MW-5
AECOM 8
AECOM 9
M-7
M-5
M-15
Miles
0.08
Kilometers
0
0.1
0.2
0.4
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Figure 5-4

Navy Barrigada

Legend

- Approximate Location of Proposed Test Borings
- Dry-Injection Wells
- Other Wells
- Air Force Wells
- Navy Wells
- GWA Wells
- Air Force Wells
- Fuel Line
- Water Line

Elevation of Top of Volcanic Rock

- (20 meters contour interval)
- -20 meters MSL
- 0 meters MSL
- -20 to -40 meters MSL
- 0 to -20 meters MSL
- Roads
- Non-DOD Area

N W E S

Miles 0 0.05 0.1 0.2

0 0.15 0.3 0.6 Kilometers

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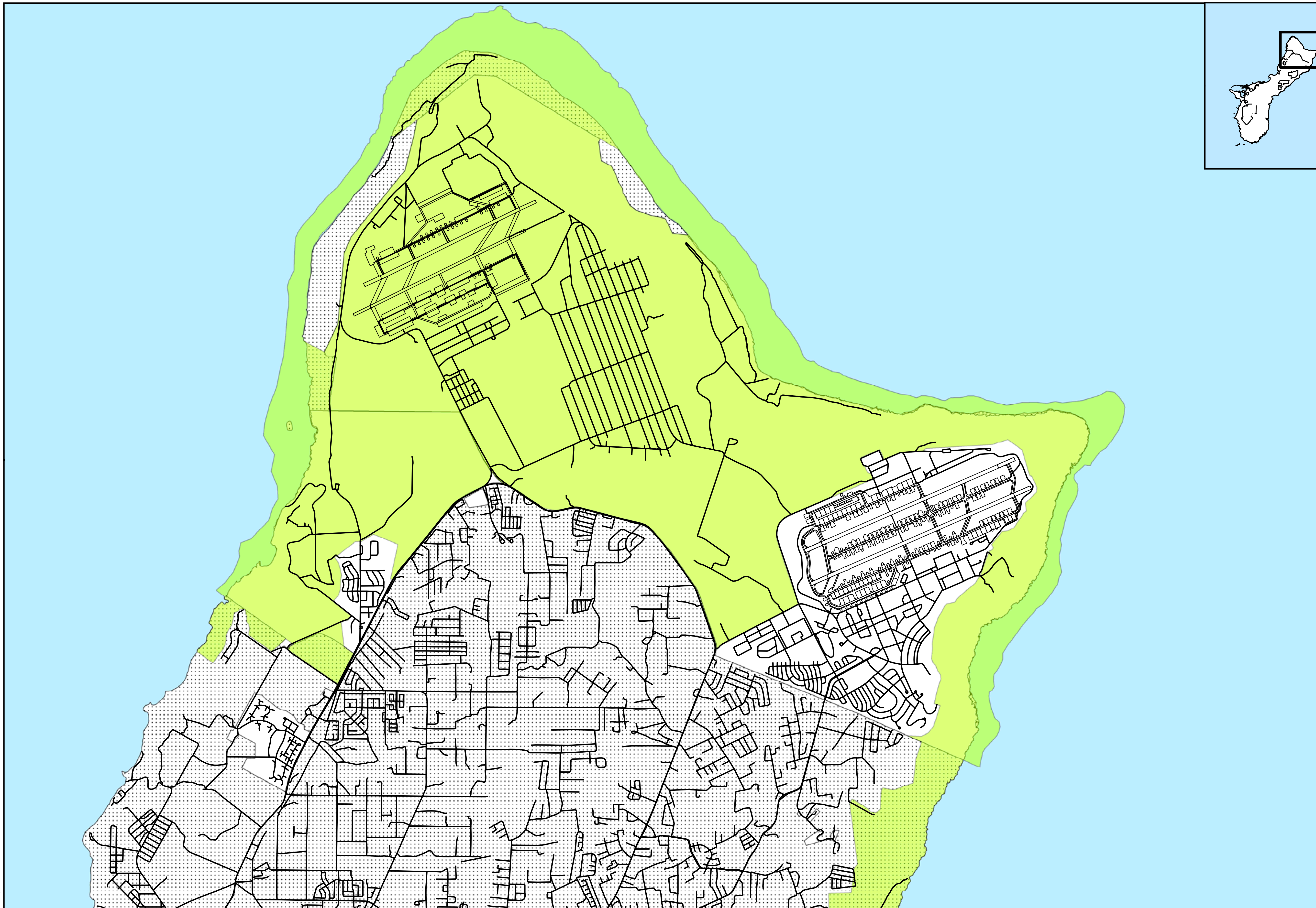
Figure 5-5

Guam National Wildlife Refuge Overlay, Andersen



Legend

- Guam National Wildlife Refuge
- Non-DOD Area
- Roads

N
W E
S

Miles
0 0.2 0.4 0.8

0 0.35 0.7 1.4
Kilometers

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Revised Final Report

Guam Solid Waste Utility Study for Proposed USMC Relocation

Prepared For:

Naval Facilities Engineering Command Pacific
Pearl Harbor, Hawaii

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Prepared by:

HDR|Hawaii Pacific Engineers

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Executive Summary

Background

The Guam Integrated Military Development Plan (GIMDP), formerly the Joint Guam Military Master Plan (JGMMP), provides for the planned increase in military population on Guam. The Northern Guam bases, NCTS Finegayan, South Finegayan Housing area, Andersen Air Force Base (AAFB), AAFB Northwest Field, and AAFB South will experience most of the military personnel increase. Solid waste disposal facilities for these installations and all other Department of Defense (DoD) installations on Guam are currently provided by separate Navy and Air Force landfills.

This study evaluates long-term solid waste disposal facility alternatives for the DoD to service its current and proposed future United States Marine Corps (USMC) solid waste disposal needs and to meet future regulatory requirements. Although solid waste systems typically benefit from economies of scale, this study focuses on developing facilities that will only dispose solid waste generated from DoD activities. It includes planning for projects that represent the best value alternative solid waste disposal facilities that will enable the DoD on Guam to meet the defined future DoD requirements.

Solid Waste Quantities

The military personnel and dependent population on Guam is projected to increase from the current baseline population of about 15,080 persons to about 40,000 persons in the year 2016 when the proposed USMC relocation to Guam is scheduled to be complete. The total projected additional military and dependent population associated with the proposed USMC relocation to Guam is about 17,552 persons. The total projected additional military and dependent population associated with other services is about 9,912 persons. Solid waste quantities are correspondingly projected to increase from current design capacity levels of approximately 16,230 tons per year to approximately 53,320 tons per year in the year 2019. The projected solid waste quantity associated with the proposed USMC relocation is approximately 23,710 tons per year.

Regulations Applicable to Solid Waste

The Guam Environmental Protection Agency (GEPA) developed a State program and was granted primacy for enforcing the requirements of 40 CFR Part 258 Criteria for Municipal Solid Waste Landfills. The Rules and Regulations for GEPA, Title 22, Division 4, Chapter 23 Solid Waste Disposal include the 40 CFR Part 258 requirements as a minimum and are applicable to DoD solid waste activities on Guam.

Guam does not have total primacy for implementation and enforcement of the Clean Air Act Amendments, since GEPA has not prepared a “State Implementation Plan” for incorporating these regulations into its requirements.

Therefore, the requirements of 40 CFR Part 60 Subpart AAAA New Source Performance Standards for Small Municipal Waste Combustion Units would be applicable to DoD solid waste activities involving solid waste incineration or waste to energy alternatives.

Guam laws and regulations pertaining to solid waste handling and disposal are codified in the Guam Code Annotated, Title 10, Chapter 33 Solid Waste, Chapter 51 Solid Waste Management and Litter Control, and Chapter 73 Fire Prevention. Chapter 73 contains a provision that prohibits the construction and operation of municipal solid waste incinerators and waste to energy (WTE) facilities on Guam. These laws and regulations are not all directly applicable to DoD solid waste activities located within DoD property on Guam.

Solid Waste Disposal Alternatives

Based on a preliminary review of the available solid waste disposal alternatives for DoD on Guam, the following alternatives were identified for evaluation:

(1) Install liner and other improvements at existing Navy Sanitary Landfill at Apra Harbor.

(2) Use new landfill constructed by GovGuam

(3) Construct new landfill in Central Guam.

(4) Incinerator/Waste-to-Energy

(5) Barge Waste off island.

(6) Status Quo, continue to use unlined Apra Harbor Navy Landfill.

(7) Construct new landfill in Northern Guam.

(8) Utilize existing landfill at Andersen Air Force Base.

(9) Expand existing landfill at Andersen Air Force Base.

(10) Use potential new private waste-to-energy facility with landfill at Guatali

The focus of this study is final disposal of solid waste. Therefore, methodologies such as materials recovery, waste diversion, waste minimization, and source reduction were not incorporated into the analysis. These methodologies would generally reduce the volume of solid waste requiring final disposal. However, for this study, they would not significantly affect the selection of a particular disposal technology.

A preliminary screening analysis was conducted. The technical aspects of the alternatives were developed to a conceptual level to allow evaluation of the relative viability of the ten identified alternatives. The alternatives were screened on the basis of environmental and regulatory issues, implementation and policy issues, and potential scheduling issues. Based on the screening analysis, Alternatives 5 through 10 were judged as nonviable and were eliminated from further consideration, as summarized below.

Alternative 5 – Barging solid waste to an off-island landfill or other solid waste disposal facility was judged as nonviable because of the very high costs and potential socio-political as well as environmental concerns.

Alternative 6 – Pursuing the status quo by operating the Apra Harbor Navy Sanitary Landfill without installation of a liner system was judged as nonviable because it is believed that GEPA will not allow significant additional disposal without installation of a liner system.

Alternative 7 – Navy/DoD construction of a new landfill in northern Guam was judged as nonviable because it would be placed over the Northern Guam Lens Aquifer (NGLA), an environmentally sensitive groundwater protection zone providing the only significant potable groundwater source and almost 80 percent of the drinking water for the island. The NGLA area had been ruled out as a suitable area for siting a new landfill during an EIS process conducted by GovGuam. GEPA may be unlikely to approve a new landfill over the NGLA given less-sensitive available locations on the inland.

Alternative 8 – Using the existing landfill at Andersen Air Force Base (AAFB) was judged as nonviable because it has very limited site life remaining. A 2-acre lined expansion recently pursued would only provide capacity for an estimated two to four additional years.

Alternative 9 – Expansion of the landfill at AAFB was judged as nonviable because it would be located over the NGLA. Similar to Alternative 7, it may not be advisable or possible to pursue permitting a significant new landfill footprint located above the NGLA.

Alternative 10 – The potential new private WTE facility with a landfill at Guatali has yet to obtain permits for construction of either the landfill or WTE facility. This process could be long and contentious given the litigious history of the project. Funding for the project is still uncertain. Given these factors, Alternative 10 was judged as non-viable.

Alternatives 1 through 4 were developed in more detail for evaluation. The evaluation included environmental issues, regulatory issues, implementation and policy issues, economics and net present value life cycle cost analysis, and schedule. Because Guam is a relatively small island with limited land availability, a long term solid waste solution is needed. Therefore the analysis period for the life cycle cost analysis was set at 50 years. The net present value life cycle cost analysis under military construction funding is summarized in Table ES-1, which is included at the end of this section. The net present value life cycle cost analysis under private sector financing is summarized in Table ES-2, which is included at the end of this section. The results of the comparative evaluation are summarized in Table ES-3, which is also included at the end of this section.

Summary of Findings

The major findings of the study are summarized below.

- Continued use of the existing Navy Landfill at the Apra Harbor Naval Complex is necessary to provide sufficient time to implement planning and construction of new solid waste disposal facilities.
- GEPA has regulatory primacy for enforcing USEPA solid waste regulations on Guam. It is anticipated that soon after the new GovGuam lined landfill becomes operational, GEPA would require all landfills on Guam to be lined or to close. This would have a direct impact on the existing unlined Navy Landfill at Apra Harbor. It would be prudent to begin programming a project that would include a liner for the inactive portion of the existing landfill and a separation liner for the active portion of the existing landfill.
- A landfill is needed for essentially any alternative considered. Materials that cannot be handled by a particular process and the residual material generated by a process will require landfill disposal.
- Continued use of the existing Navy Landfill at the Apra Harbor Naval Complex would not provide 50 years of service unless the DoD is willing to fill to elevations higher than 100 feet mean sea level (MSL). Based on current design criteria for constructing landfills, the existing landfill could be filled to elevation 140 feet MSL.
- Construction of a new DoD landfill on DoD property in central Guam is the most cost-effective and reliable alternative on a 50-year life cycle cost basis under both military construction and private funding. Because the landfill would be a DoD landfill, the DoD would control the waste allowed to be disposed in the landfill. Certain waste streams could be diverted to other available solid waste facilities, such as the GovGuam landfill, to extend the life of the DoD landfill.
- Use of the GovGuam Layon Landfill has a 50-year life cycle cost comparable to construction of a new DoD landfill. However, the Layon Landfill has not yet begun construction and it is uncertain when the landfill would become operational. In addition, under this alternative, the DoD would be entirely dependent on the Layon Landfill. If the capacity is reached earlier than anticipated and GovGuam again has difficulties in constructing a replacement landfill, the DoD will be significantly impacted.
- Construction and operation of a waste to energy (WTE) facility has the highest 50-year life cycle cost. However, a WTE facility has potential for extending the life of the existing Navy Landfill at the Apra Harbor Naval Complex well beyond the 50-year service life considered for this study.

Summary of Recommendations

Based on the results of the analysis and evaluations performed for this study, the recommendations below are offered.

- Establish a planned final fill plan for the existing Navy Landfill at the Apra Harbor Naval Complex corresponding to the alternative final fill plan for elevation 100 feet mean sea level. Retain the option to fill to elevation 140 feet mean sea level if the need arises in the future.
- Revise landfill operation practices as recommended in the Sanitary Landfill Management Plan. The revised practices include utilizing a systematic daily cell construction method with a single application of daily cover material, and obtaining heavier landfill operating equipment, such as a Caterpillar D8 or equivalent, outfitted for landfill service.
- Implement improvements to the existing Navy Landfill including the construction of a liner for the inactive area and a separation liner for the active area. The project can be phased to allow flexibility to make adjustments if construction of a Waste-to-Energy Facility moves forward. The liner should be designed to accommodate filling to elevation 140 feet mean sea level. This would provide DoD the flexibility to fill to that elevation if it became necessary to do so.
- Conduct a study to develop a long-term strategy for managing potential releases from the unlined active portion of the existing Navy Landfill. The study should include assessment of mitigation measures that might be needed if a separation liner is constructed over the existing active portion of the landfill.
- Develop a project to construct a new Navy Landfill within the Apra Harbor Naval Complex Ordnance Annex. This landfill will be needed in the foreseeable future, particularly if a Waste-to-Energy Facility does not move forward.
- Track status of construction of the new GovGuam landfill and continue to evaluate its potential for disposal of DoD solid waste, particularly residential solid waste generated from housing areas, in the future.

Table ES-1
Summary of Present Value Analysis – Military Construction Funding

Alternative	PV Analysis 25 - Year	PV Analysis 50 - Year
Alternative 1-1 Apra Harbor Landfill - 54 ft MSL See Note b	Inadequate Service Life	Inadequate Service Life
Alternative 1-2 Apra Harbor Landfill - 100 ft MSL See Note c	56,000,000	Inadequate Service Life
Alternative 2 GovGuam landfill See Note d,e	123,000,000	189,000,000
Alternative 3 New Navy Landfill See Note f	149,000,000	174,000,000
Alternative 4a Modular WTE Facility See Note g	179,000,000	270,000,000
Alternative 4b Field-Erected WTE Facility See Note g	210,000,000	277,000,000

Notes:

a Present Value Analysis uses a real discount rate of 2.8 percent in accordance with OMB Circular No. A-94, Appendix C, Rev January 2008.

b Estimated service life is limited to the year 2023 and would be exhausted prior to the end of the 25-year and 50-year analysis periods.

c Estimated service life is limited to the year 2036 and would be exhausted prior to the end of the 50-year analysis period.

d Assumed tip fee at the GovGuam landfill is $95/ton over the analysis period.

e Costs include an estimated 40 percent increase in collection driver/truck costs to use GovGuam landfill as compared to the current system. After the proposed relocation of Marines is completed, 80 percent of the DoD solid waste stream will be generated in Northern Guam.

f Costs include an estimated 15 percent increase in collection driver/truck costs to use new Navy landfill in Central Guam as compared to the current system. After the proposed relocation of Marines is completed, 80 percent of the DoD solid waste stream will be generated in Northern Guam.

g It is assumed that WTE would extend service life of the Apra Harbor Landfill to 65 years for landfilling of incombustible waste and residual ash.

Table ES-2
Summary of Present Value Analysis – Private Entity Funding

Alternative	PV Analysis 25 - Year	PV Analysis 50 - Year
Alternative 1-1 Apra Harbor Landfill - 54 ft MSL See Note b	Inadequate Service Life	Inadequate Service Life
Alternative 1-2 Apra Harbor Landfill - 100 ft MSL See Note c	60,000,000	Inadequate Service Life
Alternative 2 GovGuam Landfill See Notes d,e	123,000,000	189,000,000
Alternative 3 New Navy Landfill See Note f	153,000,000	176,000,000
Alternative 4a Modular WTE Facility See Note g	184,000,000	270,000,000
Alternative 4b Field-Erected WTE Facility See Note g	217,000,000	283,000,000

Notes:

a Present Value Analysis uses a real discount rate of 2.8 percent in accordance with OMB Circular No. A-94, Appendix C, Rev January 2008.

b Estimated service life is limited to the year 2023 and would be exhausted prior to the end of the 25-year and 50-year analysis periods.

c Estimated service life is limited to the year 2036 and would be exhausted prior to the end of the 50-year analysis period.

d Assumed tip fee at the GovGuam landfill is $95/ton over the analysis period, which is discounted over the analysis period.

e Costs include an estimated 40% collection driver/truck cost increase to use GovGuam landfill as compared to the current system. After proposed USMC relocation is completed, 80% of the DoD solid waste stream will be generated in Northern Guam.

f Costs include an estimated 15% collection driver/truck cost increase to use new Navy landfill in Central Guam as compared to the current system. After proposed USMC relocation is completed, 80% of the DoD solid waste stream will be generated in Northern Guam.

g It is assumed that WTE would extend service life of the Apra Harbor Landfill to 65 years for landfilling of incombustible waste and residual ash.

h. Capital projects over the study period were assumed to be financed or funded through a sinking fund, except for Alternative 2, which utilizes planned GovGuam Landfill costs.

i. Capital projects financing assumed 20-year periods except for Alternative 1-1, which used a 15-year period based on projected service life.

j. Capital projects financing assumed Japanese bank financing with an amortized origination fee of 1.00 percent and an interest rate of 2.5 percent.

k. Capital project sinking funds used various accumulation periods based on cash flow requirements and assumed earned interest at an annual percentage rate of 1.0%.

l. Equal annual landfill closure fund deposits were accumulated over the alternative landfill life including earned interest at an annual percentage rate of 1.0%.

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TABLE ES-3
SUMMARY MATRIX OF COMPARATIVE PROS AND CONS (P= Pro; C= Con)

Alt.	Option/Issue	Environmental	Regulatory	Implementation/Policy	Economics	Schedule
1	Improve Existing Navy Landfill at Apra Harbor (AHNLF)	C- May increase extent/duration of VOC migration C- Slightly greater degree of GHG emissions compared to adding WTE and/or MRF C- Separation liner (Alt 1-2) has potential to fail due to differential settlement.	C- GEPA likely to request separation liner over active area (assumed for Alternative 1-2 but not Alternative 1-1). C- Would use AHNLF up to 27 years by filling to elevation 100 MSL (Alt. 1-2). The GEPA may not approve a permit for continued use of the landfill for this long of a period.	C- GovGuam and GEPA prefer regional landfill for entire island	P/C – Alternative 1-1 does not provide comparison to other alternatives for 25 and 50-year periods; however, can be used as less costly interim alternative to Alternatives 2 through 4. C- Significant capital cost required for liner and LCRS system under Alternative without providing long-term strategy.	P- Although not providing a long-term strategy, provides more than adequate flex time for decisions and implementing other alternatives (Alt. 1-1= 2015 with current fill practices; Alt. 1-2=2036, with revised filling practices).
2	Use New Landfill Constructed by GovGuam	P- Entire new GovGuam landfill would be lined with base liner on native soil (compared to separation liner over waste for Alt 1-2)	P- If available soon (assumed expedited by 2010), $11M for site improvements and liner for inactive area of AHNLF would not be required. P- Based on letter communication GEPA appears to favor DoD use of the proposed GovGuam Landfill and closure of the AHNLF as soon as possible.	C- Historical and current lack of stable garbage fee collection is impediment to obtaining financing of proposed new GovGuam Landfill. C- Navy would be at risk if GovGuam cannot implement proposed new landfill when needed to replace AHNLF. C- Navy would be dependent on the GovGuam landfill; with less control if funding, environmental control, operational or other problems occur with the landfill.	C- Present Value analysis indicates $123M and $189M for 25 and 50 year analysis, respectively, at an assumed $95/ton tip fee. The 50 year analysis indicates that this alternativeis nine percent higher than Alternative 3. C- Increase in collection costs from AAFB, the proposed USMC relocation and Navy Base to new GovGuam landfill in south (Estimated 40 percent increase in truck and driver cost compared to AHNLF location). P- New large liner capital investment by DOD not required C- Lack of enforceable fee collection system by GovGuam could negatively affect reliable economics for DoD.	P- There is adequate capacity at the AHNLF provided that GovGuam can resolve all Consent Decree and permitting issues to allow Navy disposal. The AHNLF has a range of 7 to 12 years with current operating conditions and up to 14 to 27 years with recommended operational improvements; depending up whether AHNLF can be filled to elevation 54MSL or 100MSL. C – The timing for resolution of permitting issues for the proposed GovGuam landfill is not clear at this time.
3	Construct New Navy Landfill in Central Guam	P- Lined Landfill should reduce degree/term of VOC migration from existing AHNLF if closed sooner	C- Appears that GEPA wants the DOD to use the planned GovGuam landfill near Layon (letter).	P- New landfill would provide 50 years of service and operational flexibility to the DoD. C- Historic asset mitigation required at preliminary site. C- Potential impact to Santa Rita Spring must be determined. C- Permit from GEPA required	P- Present Value analysis indicates $149M and $174M for 25 and 50 year analysis including capital, landfill operations, and collection driver and truck costs under MCON funding. Under private funding this alternative has a PV of $153M and $176M for 25 and 50 yr analysis, respectively. C- Slightly less collection economics (Estimated 15 percent increase in truck and driver cost) compared to current system using AHNLF	P- Siting and constructing a new MSWLF typically can take at least 4 years. Given that Alternative 1-1 provides 7 years of capacity without operational improvements (heavier equipment and operational improvements may increase this to 14 years); scheduling for developing the new landfill is judged as viable.
4	Incinerator/Waste-to-Energy	P- Less GHG emissions than landfill for combustible fraction of waste stream; also would provide an energy offset C- Landfill still required for significant portion (46 percent) of the waste stream	C- Significant air quality permitting. C- Would use AHNLF in long term for disposal of non-combustible waste and ash. The GEPA may not approve the continued use of the landfill for >50 years given existing portion of unlined waste. C- Guam PL 25-175 Amended 10 GCA Chapter 73, Fire Prevention to prohibit municipal solid waste incinerators. A determination must be made regarding the applicability of 10 GCA Chapter 73 to DoD.	C- Significant initial financing is required: $46M and $98 capital cost, respectively, for Modular (4a) or Field Erected (4b) facilities.	C - Present Value analysis for Modular (4a) facility indicates $179M and $270M for 25 and 50 year analysis, respectively under MCON funding. Under private funding this alternative has a PV of $184M and $270M for 25 and 50 yr analysis, respectively. C - Present Value analysis for Modular (4b) facility indicates $210M and $277M for 25 and 50 year analysis, respectively under MCON funding. Under private funding this alternative has a PV of $217M and $283M for 25 and 50 yr analysis, respectively.	C- Expedited earliest schedule is assumed to allow phased construction in 2012 and 2013 at the soonest.

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ACRONYMS

°C	degree Celsius
°F	degree Fahrenheit
AAFB	Andersen Air Force Base
ac-ft	acre foot
Cd	Cadmium
CI	Activated Carbon Injection
COC	Constituents of Concern
CY	cubic yards
DoD	Department of Defense
DPW	Department of Public Works
DPW	Department of Public Works, Government of Guam
EIS	Environmental Impact Analysis
EPA	Environmental Protection Agency, United States
FAA	Federal Aviation Agency
FF	Fabric Filter
ft	feet or foot
ft/day	feet per day
GCMP	Guam Coastal Management Program
GDAWR	Guam Department of Agriculture - Division of Aquatic & Wildlife Resources
GEPA	Guam Environmental Protection Agency
GIMDP	Guam Integrated Military Development Plan (GIMDP)
GLUP	Guam Land Use Plan
GovGuam	Government of Guam
GWUDI	Groundwater under the direct influence of surface water
HDPE	High density polyethylene
HCl	Hydrochloric Acid
Hg	Mercury
JGMMP	Joint Guam Military Master Plan JGMMP
LCRS	Leachate collection and removal system
LLDPE	linear low-density polyethylene
MALS	Marine Air Logistics Squadron
MCON	Military Construction

MCY	million cubic yards
MG	Megagrams
mg/L	milligrams per liter
MLG	Marine Logistic Group
MLLW	mean lower low water
Mm	millimeter
MSL	mean sea level
NAVFAC	Naval Facilities Engineering Command
NAVMAG	Naval Magazine
NGLA	Northern Guam Lens Aquifer
NGLS	Northern Guam Lens Study
NOx	Nitrogen Oxides
NPDES	National Pollution Discharge Elimination System
O&M	Operation and maintenance
Pb	Lead
PM	Particulate
psi	pounds per square inch
SDA	Spray Dryer Absorber
SNCR	Selective Non-Catalytic Reduction
SO2	Sulfur Dioxide
SOF	Special Operations Forces
SPE	Special Purpose Entity
SWDRR	Solid Waste Disposal Rules and Regulations (government of Guam)
tpd	tons per day
tpy	tons per year
U.S.	United States
USGS	United States Geological Survey
USMC	United States Marine Corps
VOC	volatile organic compound
WWTP	Wastewater treatment plant
WTE	Waste-to-Energy

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1.0 Introduction

1.1 Purpose

The Guam Integrated Military Development Plan (GIMDP), formerly the Joint Guam Military Master Plan (JGMMP), describes the planned increase in military population on Guam. NCTS Finegayan, South Finegayan Housing area, Andersen Air Force Base (AAFB), AAFB Northwest Field, and AAFB South will experience most of the military personnel increase on Guam. Solid waste disposal facilities for these installations and all other Department of Defense (DoD) installations on Guam are currently provided by separate Navy and Air Force landfills.

The United States of America (U.S.) and Japan agreement involves in part the Special Purpose Entity (SPE), which was conceived as a business venture to allow Japan to provide family housing and utilities for the proposed United States Marine Corps (USMC) relocation to Guam. Like a public-private venture, the SPE would recoup its investments and expenditures through housing leases and utilities service charges. Although few details are known about the SPE, all solid waste disposal alternatives on DoD property are being considered by the SPE.

The purpose of this study is to identify reasonable alternatives for solid waste disposal facility improvements to support the proposed USMC relocation on Guam as well as supporting other existing and known future DoD requirements

1.2 Background Information

The island of Guam is part of the Marianas Island chain. Guam is a U.S. territory and is located approximately 3,800 miles west of Hawaii and 1,500 miles south of Japan. The island is approximately 30 miles long and ranges from 4 to 11 miles wide. The total land area is approximately 212 square miles. The 2007 population of Guam is estimated at approximately 171,000.

The solid waste management system on Guam includes the Navy Sanitary Landfill located at Apra Harbor, the landfill and recycling center located at Andersen Air Force Base, and the Ordot Dump owned and operated by the Government of Guam (GovGuam). The Navy and Air Force disposal sites are operated by the DoD and provide service to military personnel and residents of the bases as well as commercial waste streams from base activities. The remaining waste stream of Guam is serviced by GovGuam using the Ordot Dump and citizen drop-off transfer stations.

The Guam Department of Public Works (DPW) was operating the Ordot Dump, which is now under federal receivership. Under a Consent Decree with the United States Environmental Protection Agency (USEPA) the Ordot Dump was directed to achieve complete closure by October 23, 2007. In response to this requirement, the DPW advertised Requests for Letters of Interest for these projects in January 2006 and prepared procurement packages for the design and construction for closure of the Ordot Dump, the design, construction and operation of a new landfill at Layon, and the design, construction and operation of other solid waste operations and activities. However, the construction of the planned new landfill has been delayed for a number of reasons including local opposition and the inability to secure adequate funding for the landfill construction and closure activities.

This Study evaluates solid waste disposal facility alternatives for the DoD to service its current and proposed future Marine Corps solid waste disposal needs and to meet future regulatory requirements. Although solid waste systems typically benefit from economies of scale, this study focuses on developing facilities that will only dispose solid waste generated from DoD activities. It includes planning for projects that represent the best value alternative solid waste disposal facilities that will enable the DoD on Guam to meet the defined future DoD requirements. This study also provides a basis for the SPE to plan, design and execute recommended solid waste projects.

1.3 Proposed U.S. Marine Corps Relocation and Other DoD Growth

The DoD is planning to increase the military population on the island of Guam. The official military loading is expected to increase by approximately 12,569 military personnel over the current baseline population of 7,653 military personnel. This includes military personnel from the Air Force, Army, Coast Guard, Marines, and Navy. The number of additional dependents associated with accompanied personnel is expected to be about 11,833. The total population increase is expected to be approximately 24,402 personnel, close to 15 percent of the current population of Guam. Of the total DoD population increase, about 17,552 military personnel and dependents are associated with the proposed USMC relocation from Okinawa to Guam.

1.4 Solid Waste Disposal Alternatives

Based on a preliminary review of the available disposal alternatives for DoD on Guam, the following alternatives were identified for evaluation:

(1) Provide liner and other improvements at the existing Navy Landfill.

(2) Use new landfill constructed by GovGuam

(3) Construct new landfill in Central Guam.

(4) Incinerator/Waste-to-Energy

(5) Barge Waste off island.

(6) Status Quo, Navy to continue to use unlined Apra Harbor landfill.

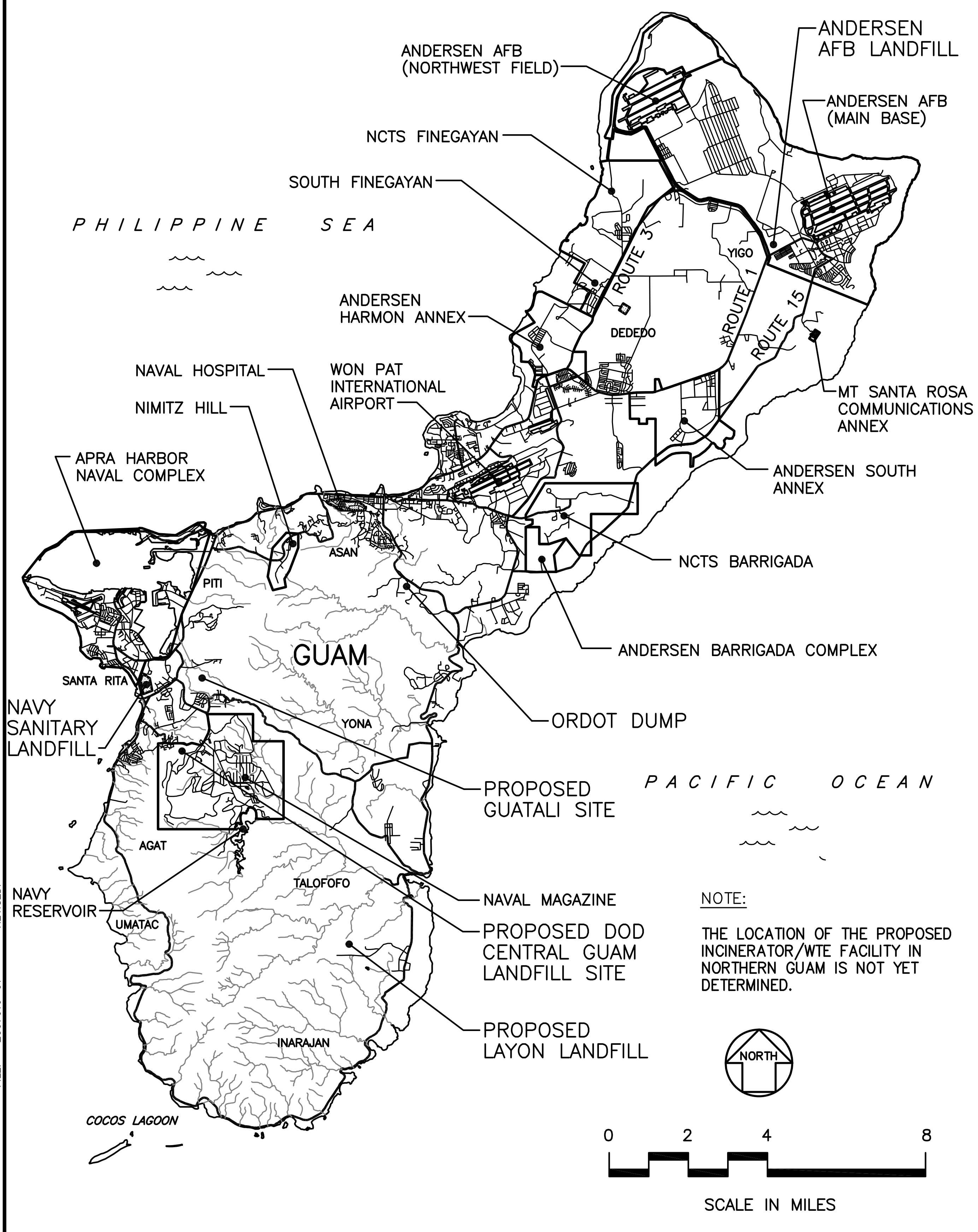
(7) Construct new landfill in Northern Guam.

(8) Utilize existing landfill at Andersen Air Force Base.

(9) Expand existing landfill at Andersen Air Force Base.

(10) Use proposed new private waste-to-energy facility with landfill at Guatali

The general locations of the alternatives are shown on Figure 1-1. In addition to these disposal alternatives, the DoD could utilize waste diversion programs, including recycling and composting programs. However, these programs will only extend the life of these disposal alternatives; not replace the need for them.



NOTE:

THE LOCATION OF THE PROPOSED INCINERATOR/WTE FACILITY IN NORTHERN GUAM IS NOT YET DETERMINED.

HDR | HPE Hawaii Pacific Engineers, Inc.

GUAM SOLID WASTE UTILITY STUDY FOR PROPOSED USMC RELOCATION

VICINITY MAP

FIGURE 1–1

DATE: 02/05/08
PLOT: 1 = 1
FILE: 2007019–01
PM: FTH
OPER: LI
REVISED: –

2.0 Solid Waste Generation and Disposal Conditions

2.1 Existing Conditions

2.1.1 Waste Collection System

The Navy Sanitary Landfill receives all of the non-hazardous solid wastes generated on the Navy installations. This section presents a brief overview of the solid waste generation and then focuses on the existing solid waste stream entering the landfill. Field investigations and review of landfill records were conducted to quantify and characterize the solid waste stream entering the landfill. Projected base loadings were then used to develop future quantities and characteristics of the solid waste stream entering the landfill.

Solid wastes generated by the Navy installations and their tenants were categorized into four general source categories for this study:

- Family housing;
- Commercial and industrial activities;
- Construction activities; and
- Other wastes.

Housing waste is collected in 90-gallon refuse containers emptied by 40-cubic yard capacity, side-loading, compacting refuse trucks. Commercial and industrial waste is collected in 3-, 6- and 8-cubic yard "front loader" containers placed near various facilities at the Naval installations. The containers are emptied by 40-cubic yard capacity, front-loading, compacting refuse collection trucks. Selected Naval facilities have 20- and 40-cubic yard "dinosaur" containers that are collected by roll-on/roll-off, rear-loading tractors. Refuse from ships is collected in special containers located along the ship's berthing pier. The containers are picked up from the pier and transported to the steam sterilization facility for decontamination of the ship refuse. After the ship refuse is decontaminated, the steam-sterilized waste is transported to the Navy Sanitary Landfill for disposal.

The landfill accepts various waste debris from construction projects such as excess soil, wood, concrete, and construction and demolition debris. Asbestos waste is accepted on a case-by-case basis. The asbestos contractor places the asbestos waste and covers the waste with at least six inches of soil cover. The landfill operator is required to observe the process and ensure that the landfill remains in compliance with its permit.

2.1.2 Assessment of Existing Waste Generation

Field investigations and data collection were performed to assess the quantity of solid waste entering the Navy Sanitary Landfill; to develop projected solid waste stream quantities and characteristics, and to allow subsequent analysis of remaining landfill life and potential future disposal alternatives. Field investigations were conducted between 11 December 2006 and 18 December 2006. Data was analyzed for the landfill airspace volume utilization using topographic mapping and related to the volume of material added to the landfill.

The following parameters were estimated based on volumetric calculations and visual observations of the landfilling operations:

- The annual landfilling rate was calculated to be 49,580 cubic yards per year, based on a total landfill volume change of 529,000 cubic yards between February 1996 and October 2006.
- An observed in-place density of 625 pounds per cubic yard and in-place solid waste to cover material ratio of 1:1 were used to calculate a daily solid waste generation rate of 21 tons per day.
- Based on a present Navy population of 7,000, the unit solid waste generation rate was calculated to be 6.1 pounds per capita per day. A previous study [Guam Water Quality Management Plan, 1979] indicated a military per capita generation rate of 7.4 pounds per day.

Annual solid waste volumes for 2006 were estimated based on the reported volumes, refuse collection schedule, trip tickets and disposal logs.

- The total solid waste generated based on the reported volumes to GEPA was calculated to be 309,400 cubic yards. It should be noted that the volume of the housing waste appears to be a compacted volume.
- The calculated annual solid waste generated based on the refuse collection schedule is 187,300 cubic yards. It should be noted that this value includes only the waste from commercial and industrial activities collected in the 3-, 6-, 8-, 20- and 40-cubic yard containers and assumes that the refuse container is full.
- The estimated solid waste volume generated based on the trip tickets is 134,300 cubic yards. It should be noted that this total includes only commercial and industrial waste. Housing and customer-hauled waste is not included. It was also assumed that the containers were full.
- The total solid waste volume generated based on the disposal logs was calculated to be 135,600 cubic yards. It should be noted that the volumes recorded for housing and some of the commercial and industrial waste volumes appears to be a compacted volume.

It appeared that the solid waste volumes recorded on the reports to GEPA and disposal logs were overestimated. Because the estimated volumes based on the solid waste records did not appear to be sufficiently accurate, the calculated change in landfill volume based on the available topographic survey maps and information and observations of landfill placement practices were used to develop the basic solid waste data to project quantities of future solid waste stream entering the landfill.

Basic solid waste data for the existing solid waste stream based on the analyses and investigations described above and per capita parameters used for projection of solid waste quantities are presented in Table 2-1.

Table 2-1

Basic Solid Waste Stream Data

Parameter	Value	Unit
Total landfilled volume, solid waste and cover material	49,580	cy/yr
Cover material to solid waste ratio	1.0	
In-place solid waste volume	24,790	cy/yr
Cover material volume	24,790	cy/yr
In-place solid waste density	625	lbs/cy
Total solid waste entering landfill	21	tons/day
Current population served by landfill	7,000	
Per capita unit waste generation investigation	6.1	lbs/day
Per capita unit waste generation used for this report	7.4	lbs/day

2.2 Projected Conditions

Activity at the DoD installations is expected to increase due to planned development of additional facilities for DoD operations and the proposed relocation of USMC operations. The proposed USMC relocation is anticipated to start in 2012 and be completed by 2016. Furthermore, the existing Andersen Air Force Base Landfill is currently near capacity. The current Government of Guam Ordot Dump is scheduled to be closed due to violations of EPA regulations. The new Government of Guam landfill is behind schedule and the completion date is uncertain. There is a potential for disposing solid waste from the Air Force facilities in the Navy Sanitary Landfill until the Government of Guam opens their new landfill. Updated projected population data was obtained and is summarized in Table 2-2.

The solid waste alternatives included in this study were developed to serve the entire DoD population on Guam. Therefore, the proportional share of the solid waste stream and the associated costs of the facilities and operations attributable to the proposed USMC relocation corresponds to the population associated with the proposed USMC relocation relative to the total planned DoD population on Guam.

Table 2-2
Military Population

Year	USMC	Air Force	Navy	Army	USCG	SOF	Total
2008	5	4,597	7,016	80	320	0	12,018
2009	5	5,095	9,580	80	320	0	15,080
2010	305	6,745	9,910	80	320	0	17,360
2011	305	6,745	9,910	130	320	50	17,460
2012	905	7,451	9,910	130	320	50	18,766
2013	5,900	7,451	9,910	130	504	50	23,945
2014	10,895	7,451	10,130	130	504	50	29,160
2015	15,890	7,451	10,930	1,660	504	980	37,415
2016	17,557	7,451	10,930	1,660	504	980	39,082
2017	17,557	7,451	10,930	1,660	504	980	39,082
2018	17,557	7,451	10,930	1,660	504	980	39,082
2019	17,557	7,851	10,930	1,660	504	980	39,482
2020	17,557	7,851	10,930	1,660	504	980	39,482
Percent of Total	44.5%	19.9%	27.7%	4.2%	1.3%	2.5%	100.0

The basic solid waste data was combined with projected base loading for all military installations on Guam to derive the projected quantities of the future solid waste stream entering the landfill. The estimated solid waste quantity breakdown between the Navy, Air Force and the proposed USMC relocation for year 2014 is as follows:

	Solid Waste Quantity at 6.1 lbs/cpd	Solid Waste Quantity at 7.4 lbs/cpd
Navy	12,168 tons/year	14,761 tons/year
Air Force	7,740 tons/year	10,603 tons/year
USMC	19,545 tons/year	23,711 tons/year
Army	1,848 tons/year	2,242 tons/year
USCG	561 tons/year	681 tons/year
SOF	1,091 tons/year	1,323 tons/year
Total	43,953 tons/year	53,320 tons/year

The estimated quantities for the solid waste stream entering the Navy Sanitary Landfill are summarized in Table 2-3. As shown, this includes projected generation at 6.1 lbs/cpd and 7.4 lbs/cpd.

Table 2-3

Projected Solid Waste Quantities

Year	Population	Projected Solid Waste at 6.1 lbs/cpd (tons/year)	Projected Solid Waste at 7.4 lbs/cpd (tons/year)	Remarks
2008	12,018	13,379	16,230	
2009	15,080	16,788	20,366	Baseline
2010	17,360	19,326	23,445	
2011	17,460	19,437	23,580	
2012	18,766	20,891	25,343	Proposed USMC relocation begins
2013	23,945	26,657	32,338	
2014	29,160	32,462	39,381	
2015	37,415	41,652	50,529	
2016	39,082	43,508	52,780	Proposed USMC relocation complete
2017	39,082	43,508	52,780	
2018	39,082	43,508	52,780	
2019	39,482	43,953	53,320	
2020	39,482	43,953	53,320	
2021	39,482	43,953	53,320	
2022	39,482	43,953	53,320	

A solid waste characterization analysis was not conducted as a part of this study. A solid waste characterization study was conducted for the Marine Corps Base Hawaii, Kaneohe Bay (MCBH-KB). Solid waste generation activities for military installations on Guam and MCBH-KB are similar. Both military installations on Guam and MCBH-KB have similar facilities including maintenance shops, administrative offices, commissary and exchange facilities, fast-food establishments, club operations, family housing and unaccompanied personnel housing. Furthermore, both military installations on Guam and MCBH-KB are located in an island environment with similar climate and weather conditions. Due to the lack of solid waste characterization data for military installations on

Guam, it was assumed that the solid waste characterization for MCBH-KB would best represent the solid waste characteristics for military installations on Guam.

For purposes of this study it was assumed that the residential and commercial/industrial per capita solid waste generation for military installations on Guam would be 7.4 lbs/day based on the 1979 Guam Water Quality Management Plan. This is higher than the calculated present per capita solid waste generation for Naval facilities on Guam. However, it is judged as a prudent conservative assumption for planning purposes.

The projected average daily solid waste quantities and composition for military installations on Guam are summarized in Table 2-4. Table 2-5 summarizes the projected solid waste quantities and composition for the solid waste management alternatives evaluated in this report. The column titled "No Waste Diversion" shows the waste generated that it is assumed would have to be disposed, absent any increase in diversion activities over current conditions. This is the landfill quantity assumed for all alternatives except Alternatives 4, 5, and 10. The right column of Table 2-5 shows the assumed residual ash volume that would need to be land filled at a Navy facility under Alternative 4 after processing of waste at a Navy WTE facility. Alternative 5 assumes that the total solid waste quantity would be barged off-island. Alternative 10 assumes use of a proposed private WTE and landfill facility at Guatali. Table 2-6 shows the projected solid waste stream quantities by source category.

Table 2-4

Projected Average Daily Solid Waste Quantities and Composition

	Residential		Commercial/ Industrial		Composite	
Per Capita Waste Generation (lbs/day)						7.4
Current Military Population						12,018
Total Current Weight (lbs/day)						88,933
Baseline Military Population						15,080
Total Baseline Weight (lbs/day)						111,592
Projected Military Population						39,482
Total Projected Weight (lbs/day)						292,167
Residential/Commercial/Industrial Waste						
Percent of Total		19.7		42.6		
Total Current Computed Weight (lbs/day)		17,520		37,886		55,406
Total Projected Weight (lbs/day)		57,557		124,463		182,020
Composition	percent	lbs/day	percent	lbs/day	percent	lbs/day
Aluminum Cans	3.4	1,956.9	1.2	1,493.6	1.9	3,450.5
Glass (Brown)	4.0	2,302.3	0.5	622.3	1.6	2,924.6
Glass (Clear)	3.0	1,726.7	1.8	2,240.3	2.2	3,967.0
Glass (Green)	0.8	460.5	0.2	248.9	0.4	709.4
Ferrous Metals	0.8	460.5	5.0	6,223.2	3.7	6,683.7
Non-Ferrous Metals	1.4	805.8	1.4	1,742.5	1.4	2,548.3
Newspaper	1.3	748.2	0.9	1,120.2	1.0	1,868.4
Mixed Paper	1.9	1,093.6	4.0	4,978.5	3.3	6,072.1
Office Paper	0.3	172.7	3.0	3,733.9	2.1	3,906.6
Cardboard	6.6	3,798.8	2.3	2,862.6	3.7	6,661.4
Plastics	1.7	978.5	1.2	1,493.6	1.4	2,472.1
Compostable Material	6.2	3,568.5	15.7	19,540.7	12.7	23,109.2
Miscellaneous Waste	68.6	39,484.1	62.8	78,162.8	64.6	117,646.9
Total Collected Waste	100.0	57,557.1	100.0	124,463.1	100.0	182,020.2
Construction Waste						
Percent of Total						37.7
Total Current Computed Weight (lbs/day)						33,528
Total Projected Weight (lbs/day)						110,147

Table 2-5

Projected Solid Waste Quantities and Composition for Waste Diversion Alternatives

Composition	No Waste Diversion (lbs/day)	Materials Recovery (lbs/day)	Waste-to-Energy (lbs/day)
Aluminum Cans	3,451	0	3,451
Glass (Brown)	2,925	0	2,925
Glass (Clear)	3,967	0	3,967
Glass (Green)	709	0	709
Ferrous Metals	6,684	0	6,684
Non-Ferrous Metals	2,548	0	2,548
Newspaper	1,868	0	0
Mixed Paper	6,072	0	0
Office Paper	3,907	0	0
Cardboard	6,661	0	0
Plastics	2,472	0	0
Compostable Material (See Note 1)	23,109	23,109	0
Miscellaneous Waste (See Note 2)	117,647	117,647	11,765
Total Collected Waste	182,020	140,756	32,048
Total Self-Hauled Waste (See Note 3)	110,147	110,147	110,147
Total Projected Weight to Landfill	292,167	250,903	142,195

Notes:
1. Compostable material includes food waste and green waste.
2. Miscellaneous waste includes discarded items, such as clothing, shoes, small appliances, small furniture and carpet. It was assumed that 10 percent of the miscellaneous waste was non-combustible.
3. Self-hauled waste includes construction and demolition debris.

Table 2-6

Projected Average Daily Solid Waste Quantities by Source Category

	Residential	Commercial/ Industrial	Construction	Total
Per Capita Waste Generation (lbs/day)				7.4
Current Military Population				12,018
Total Current Weight (lbs/day)				88,933
Baseline Military Population				15,080
Total Baseline Weight (lbs/day)				111,592
Projected Military Population				39,482
Total Projected Weight (lbs/day)	57,557	124,463	110,147	292,167

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3.0 Regulatory Involvement for Solid Waste Disposal Alternatives

3.1 Regulations Overview

This section summarizes the regulations applicable to the Navy Sanitary Landfill, a new landfill on Guam, and a WTE facility on Guam.

3.1.1 Landfill Regulations

The Federal regulations pertinent to landfills on Guam are contained in Title 40 of the Code of Federal Regulations (CFR), Part 258. Local regulations are included in the Guam Environmental Protection Agency (GEPA) Rules and Regulations for Solid Waste Disposal. The GEPA Rules and Regulations for Solid Waste Disposal are based on the Federal regulations contained in 40 CFR Part 258.

3.1.1.1 Federal Regulations

The Federal regulations governing the operation of municipal solid waste landfills are contained in 40 CFR Part 258. The Federal regulations contain guidance and policies on the purpose, scope and applicability of the regulations, location restrictions, operating criteria, design criteria, groundwater monitoring and corrective actions, closure and post-closure care, and financial assurance criteria.

The purpose of the regulations is to establish minimum standards for all municipal solid waste landfills to ensure the protection of human health and the environment. The regulations apply to all new municipal solid waste (MSW) landfills, existing MSW landfills and lateral expansions of existing landfills.

The location restrictions of the regulations include criteria related to airport safety, floodplains, wetlands, fault areas, seismic impact zones, and unstable areas such as landslides, mudslides or sinkholes. The operating criteria in the regulations establishes requirements for excluding hazardous waste, applying cover material, controlling disease vectors, controlling explosive gases, controlling air emissions, restricting access, controlling storm water run-on and run-off, protecting surface waters, restricting liquids, and recordkeeping. The design criteria in the regulations apply to new landfills and lateral expansions of existing landfills. New and landfill expansions must be constructed with a composite liner and a leachate collection system, which has been approved by the GEPA. The liner and leachate collection system should be designed for groundwater protection by ensuring that levels of contaminants do not exceed the Federal limits for safe drinking water. The groundwater monitoring and corrective action criteria established in the regulations apply to all municipal solid waste landfills unless the owner/operator can demonstrate that there is no potential for migration of hazardous constituents from the landfill to the uppermost aquifer. The regulations establish criteria for groundwater monitoring systems, sampling and analysis programs, and corrective actions for the protection of human health.

The closure and post-closure care criteria established in the regulations are intended to reduce potential difficulties in the future. Upon closure of the landfill, the owner/operator must notify GEPA prior to closure, prepare a closure plan, install a final cover designed to minimize infiltration and erosion, and record a notation on the deed of the property that the land has been used as a landfill facility and that future use is restricted. Following closure of the landfill, the owner/operator must maintain the integrity of the final cover, maintain the leachate collection system, monitor the groundwater in accordance with the criteria established, and maintain the gas monitoring system for a period of 30 years. The length of the post-closure care period may be increased or decreased at the discretion of GEPA.

The financial assurance criteria established in the regulations apply to all owners and operators of municipal solid waste landfills except owners or operators who are Federal government entities. The owner/operators must demonstrate the ability to cover expenses for site closure, post-closure maintenance, and corrective actions for known releases. The owner/operator may demonstrate financial assurance through the following mechanisms: trust fund, surety bond, letter of credit, insurance, corporate financial test, local government financial test, corporate guarantee, local government guarantee, state approved mechanism, state assumption of responsibility or a combination of these mechanisms.

3.1.1.2 GEPA Landfill Rules

The GEPA Rules and Regulations for Solid Waste Disposal; Title 22, Division 4, Chapter 23 establishes minimum standards governing the design, construction, installation, operation and maintenance of solid waste disposal facilities on Guam. The GEPA requirements for a landfill permit are similar to the Federal regulations except for a few differences:

- Permit requirements for the operation of a solid waste management facility, including landfill are included.
- List of solid wastes that are prohibited for disposal at the landfill is included. These wastes include waste oil, regulated hazardous wastes, whole or partially whole vehicles, vehicle parts, tires, batteries, septic tank pumping, appliances, sewage sludge, and other petroleum based products and oil based paints.
- Health and safety requirements for the protection of all personnel associated with the operation of the landfill disposal site are included.

The GEPA Rules and Regulations for Solid Waste Disposal; Title 22, Division 4, Chapter 23 is included as Appendix A.

3.1.2 WTE Requirements

Since the GEPA has not received approval of a State Implementation Plan relating to the Clean Air Act Amendments regulations for municipal waste combustors (MWC), the federal rules would apply. The federal WTE facility emission guidelines for small municipal waste combustion (MWC) units (*i.e.*, units with a design combustion capacity of 35 to 250 tons per day of municipal waste) located in areas not covered by an approved State or tribal plan, must comply with Subpart AAAA of 40 CFR Part 60 (New Source Performance Standards for Small Municipal Waste Combustion Units) which were issued in final form on January 31, 2003.

In addition, ash residue from MWCs was determined by the US Supreme Court to be not exempt from regulation as a hazardous waste treatment, storage, or disposal facility under Subtitle C of the Resource Conservation and Recovery Act (RCRA), even though MWCs that burn household waste alone or in combination with non-hazardous wastes from industrial and commercial sources are exempt. On April 12, 1995, EPA issued its Revised Implementation Strategy for MWC ash. The revised strategy requires MWCs that burn household and non-hazardous commercial wastes to have programs in place that determine whether the ash generated is considered hazardous based on certain leachate toxicity criteria. Waste not meeting the criteria must be disposed as a hazardous waste in full compliance with RCRA Subtitle C. The strategy specifies that the hazardous waste determination sampling must be conducted following the combustion and air pollution control processes at the point where the ash exits the combustion building.

Pursuant to the Supreme Court Rulings and EPA regulations, any WTE facility would be required to conduct tests of the ash residue generated to determine whether it meets the requirements for disposal in a Subtitle D landfill. These tests would be required to comply with the draft “Sampling and Analysis of Municipal Refuse Incinerator Ash” published by the Office of Solid Waste, EPA; Chapter 9, Sampling Plan, of SW 846-Test Methods For Evaluating Solid Waste,

3.2 Regulatory Involvement

3.2.1 GEPA

The GEPA was created in March 1973 and is responsible for establishing and maintaining the quality of the air, land and water of Guam. In December 1998, Public Law 24-304 created the Solid Waste Management Program. The Program is responsible for permitting solid waste collection and treatment, storage, and disposal facilities. In addition, the Program is responsible for inspection, compliance monitoring, enforcement, and corrective action on all solid waste-related activities. Other activities include beverage container inspections, public education, and pollution prevention incentives.

In 1996, the Solid Waste Management and Litter Control Act was revised giving Guam EPA authority to impose administrative penalties for solid and hazardous waste management violations and defined civil versus criminal penalties. The revised Act provided provisions for citizen suits, established permit fees for certain solid waste activities, and created a Solid Waste Management Fund to support activities to effectuate the Act, which includes paying for full-time employees and related expenses. Aside from the Fund, the Program's activities are supported by the Litter Revolving Fund which was created to be used primarily for anti-littering campaigns. At its meeting on September 27, 2006, the Guam EPA Board of Directors approved the *Guam 2006 Integrated Solid Waste Management Plan*, which updated the previous *Guam 2000 Integrated Solid Waste Management Plan* (2006 ISWMP) as required by Chapter 51, of Title 10 Guam Code Annotated.

The ISWMP includes the following principal provisions:

- Controlled privatization of solid waste management operations
- Assignment of the oversight on the privatized solid waste operations to the CCU
- Inclusion of all federal facilities in the operations and use of the landfill
- Requirement of a Waste Composition and Characterization study
- Exclusion of recyclable and compostable materials from the landfill
- Development of solid waste transfer stations for accepting of waste and recyclables and for transfer of waste to large carriers to haul it to the landfill
- Improved public information on solid waste management
- Satisfaction of the Consent Decree calling for opening and privately operating a legally conforming landfill by October 2007 and closing Ordot Dump before October 2007.

3.2.2 USEPA Region 9

USEPA's Region 9 office headquartered in San Francisco provides public health and environmental oversight for the southwestern United States (Arizona, California, Nevada, Hawaii, U.S. territories of Guam and American Samoa, the Commonwealth of the Northern Mariana Islands, and other unincorporated U.S. Pacific possessions). EPA Region 9 also works with 147 federally recognized tribes in the Pacific Southwest. In addition, Region 9 has a field office in Hawaii to better serve the Pacific Islands.

Although GEPA has been designated as the administrator for solid waste disposal issues, the USEPA is working closely with the 42 staff personnel at Guam EPA and other organizations within Guam to address certain specific environmental issues on the island, two of which include:

- Guam has a fragile drinking water infrastructure which is chronically at risk of contamination from wastewater. Until recently, Guam had extensive wastewater problems, with more than 500 million gallons of raw sewage spills between 1999 and 2002. Almost 8 percent of residents do not have access to adequate plumbing, 6.5 times the national average of 1.2 percent. All residents have experienced boil-water notices within the last several years.
- The Ordot municipal dump is an unlined, uncontrolled dump that was initially used as a disposal area during World War II. It has reached its capacity and was scheduled for closure by October 2007 under an EPA consent decree. The EPA consent decree arose due to the historic and continuing discharge of pollutants to the Lonfit River. The dump has also experienced operational difficulties during its history, including fires.

3.2.3 Guam Department of Public Works (DPW)

DPW is one of several agencies of the Government of Guam and consists of several divisions including the Solid Waste Management Division (SWMD). The operation of the DPW is supported by the revenues derived from the services that it renders, fines and penalties that it collects, grants, and appropriations from the Guam General Fund (General Fund).

The Guam DPW and other non-DoD entities must comply with the Guam laws and regulations as codified under the Guam Code Annotated. Although all of the Guam laws and regulations are not directly applicable to DoD solid waste activities that involve only DoD installations, they can have an indirect impact. The most notable indirect impact is the non-compliant status of the Ordot Dump and the delayed construction of the new GovGuam landfill. The Guam laws and regulations would also be applicable to any facilities, such as regional facilities, that handle both DoD and non-DoD solid waste. The Guam laws and regulations relevant to solid waste handling and disposal are included in Appendix B.

The SWMD currently has five sections: administration, customer service, residential solid waste collection, transfer station drop-off locations and landfill operations. Support for SWMD's operations comes from revenues derived from solid waste services charges and occasional cash infusions from the Federal grants, Compact Impact funds and the General Fund. Until recently, there was no separate monthly financial reporting for SWMD's operations. DPW is responsible for complying with the tasks and deadlines mandated by the EPA Consent Decree.

Due to the delays in meeting the Consent Decree deadlines for the closure of the Ordot Dump and completion of the new landfill, the US District Court has placed the SWMD in federal receivership.

3.2.4 Public Utility Commission (PUC)

The PUC is comprised of a seven member board appointed by the Governor and confirmed by the Legislature. Pursuant to the recent enactment of Public Law 28-56, the PUC is responsible for establishing tipping and user fees including business and governmental tipping fees and a variable residential tipping fee, which were previously set by the DPW. These fees are intended to provide the principal funding source for the Project and all SWMD operations.

In September, 2005, after the DPW filed its first formal rate increase petition, a rate increase of 25 percent was awarded by the PUC. The rate increase became effective on April 10, 2006. The DPW is preparing a petition to the PUC for a series of increases which are intended to ensure that the SWMD would continue to be able to meet the debt service covenants of its borrowing obligations and to provide sufficient ongoing equity in the Solid Waste System.

4.0 Assessment of Solid Waste Disposal Alternatives

4.1 Alternative 1 – Improve Navy Sanitary Landfill – Apra Harbor

4.1.1 Description

4.1.1.1 Existing Landfill Conditions

The Navy Sanitary Landfill is currently operating under an expired Waste Management Facility Permit (Permit Number 95-1009, dated 26 December 1995), issued by the Guam Environmental Protection Agency (GEPA). The Navy Sanitary Landfill at the Apra Harbor Naval Complex is located in the southeastern portion of the Naval Complex. The landfill is located on U.S. Navy property and is exempt from local zoning requirements. The existing landfill is shown on Figure 4-1. The landfill boundary information was obtained from the Naval Station boundary coordinate data indicated on a previous topographic survey map, NAVFAC Drawing Number 73139263, completed under Project Number PWC 15161. The active waste placement area is in the southeast corner of the landfill site. Other designated areas of the landfill site include asbestos, hardfill, wood waste and sewage sludge disposal areas.

The Navy Sanitary Landfill is operated by the Base Operations Support (BOS) contractor, DZSP-21 and used as a disposal site for non-hazardous solid wastes generated from all Naval activities on Guam, including Apra Harbor Naval Complex, Ordnance Annex (Naval Magazine), Nimitz Hill, Naval Hospital, Naval Computer and Telecommunication Station (NCTS) Barrigada, South Finegayan and NCTS Finegayan.

Naval activities on Guam generate approximately 21 tons of solid waste daily. The Navy Sanitary Landfill currently accepts waste from housing, commercial and industrial activities, hardfill from on-base construction projects, sterilized waste from ships, asbestos waste, and wastewater treatment sludge that has passed the paint filter test.

An office located at the landfill entrance is the only on-site structure. There is no scale house on-site. No particular waste placement method is indicated in the permit. The area waste disposal method of landfill operation is generally employed at the landfill site. In this method, the waste that enters the landfill is spread out on the current active waste placement area and compacted by a bulldozer. The soil for covering the wastes comes from stockpiled soils brought into the landfill from landscapers and on-base construction projects. Additional soils, when other soil sources are not available, could be excavated from two locations on site; the northwest corner or an area near the center of the landfill. Soil is spread and compacted over the solid waste after each load.

There are two up-gradient groundwater wells located to the east and northeast of the landfill boundary, two down-gradient groundwater wells located to the west of the landfill boundary and west of Route 2, and four groundwater monitoring wells

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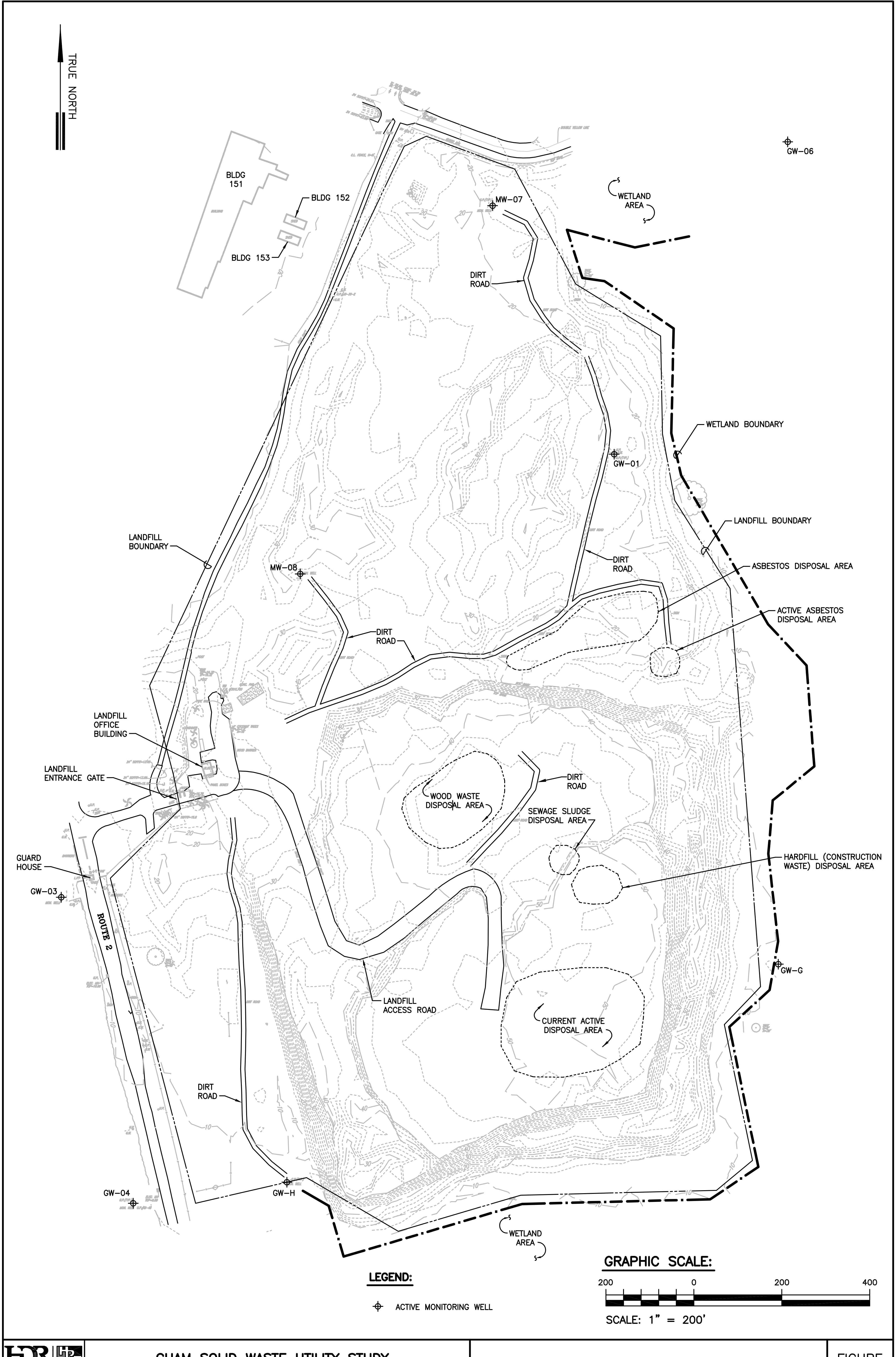

HDR | HPE Hawaii Pacific Engineers, Inc.

GUAM SOLID WASTE UTILITY STUDY FOR PROPOSED USMC RELOCATION

EXISTING NAVY SANITARY LANDFILL PLAN

FIGURE 4-1

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located within the landfill boundary. The 1995 permit states that a total of eight groundwater wells are monitored semi-annually. The permit also states that the site is monitored for the presence of landfill gas, on a quarterly basis. Groundwater and methane monitoring reports are provided as part of the semi-annual Solid Waste Reports to GEPA.

4.1.1.2 Liner and Other Improvements

Preliminary recommendations regarding liner and other improvements for the existing Navy Sanitary Landfill include the following:

- Reduce the quantity of daily soil cover and revise the soil cover placement frequency to once each day.
- Purchase a larger dozer or equivalent equipment and use the larger dozer for all waste compacting and cell construction activities wherever possible.
- Install a truck scale at the Navy Sanitary Landfill for use in self-hauled industrial/commercial wastes and the refuse collection trucks
- Construct a new landfill control building and paved access road. The facility would include an office, storage area, electrical room and restroom with a total area of approximately 600 square feet.
- Provide a Subtitle D liner system and leachate collection systems for the existing inactive area within the landfill boundary. Consider an expansion separation liner for the existing active landfill area.
- Develop a new lined sanitary landfill. A potentially suitable site within the Ordnance Annex has been identified with possible future access via public roadways. Areas within the Ordnance Annex are encumbered and opportunities for beneficial use of those areas are limited. (Section 4.2 discusses this further).
- Consider disposal of residential solid waste in the new Government of Guam landfill when the landfill becomes operational.
- Explore the possibility to provide a materials recovery facility (MRF) to reduce waste generation by diverting materials for recycling and recovery.

This alternative assumes that the recommendations listed above will be implemented except for the last item. Although it may be advisable to implement an MRF for DoD waste, it is not assumed as a condition for any of the alternatives in this report. This is discussed further in Section 5.

4.1.1.3 Landfill Geometry and Volume

Several approaches to maximizing the useable life of the Navy Sanitary Landfill were evaluated. Alternatives considered include looking at the potential for increasing waste disposal capacity through landfill design alterations and possible airspace savings achievable through operational changes described in 4.1.1.2. Three alternative final fill plans were first evaluated based on comparison of their relative non-monetary advantages and disadvantages. A final fill plan is selected based on the considerations discussed, below.

Remaining Usable Landfill Capacity

The Navy Sanitary Landfill does not appear to be filled to any particular final filling plan. A grading plan was developed under a previous study “Vertical Landfill Expansion Evaluation” by GMP Associates, Inc. dated September 1996. However, the grading plan was not adopted for landfill operations, and it was observed that the landfill was not being filled to conform to any specific landfill grading plan.

Calculations for the 1996 study estimated a remaining landfill airspace volume of 1,724,900 cubic yards based on utilizing the entire area within the existing landfill boundaries and a final fill height of 48 feet mean sea level. The 1996 study projected a landfill life extending through the year 2045 based on receiving 77,000 cubic yards of uncompacted waste annually, an uncompacted specific weight of 717 pounds per cubic yard, a compacted specific weight of 1864 pounds per cubic yard, and a waste to cover ratio of 5 to 1. The change in landfill volume from 1996 to 2006 would have been about 355,000 cubic yards. The projected annual waste volume did not include construction generated waste.

The 1996 study estimated that as much as 69,600 additional cubic yards of construction related materials could be generated annually for a total of 146,600 cubic yards annually. The 1996 study projected that at this accelerated rate of solid waste generation, the landfill life would extend 25 years through the year 2021. The projection was based on receiving 146,600 cubic yards of un-compacted waste annually, an un-compacted specific weight of 717 pounds per cubic yard, a compacted specific weight of 1864 pounds per cubic yard, and a waste to cover ratio of 5 to 1. The change in landfill volume would have been about 677,000 cubic yards.

Calculations carried out for this study indicated that from the condition shown on the 1996 topographic map to the landfill topographic survey conducted in October 2006, the landfill had received a total of approximately 529,000 cubic yards of material.

Alternative Final Fill Plans

Although a filling plan was developed under the 1996 GMP study, based on the current landfilling operations, based on site observations the current landfill operations do not follow the proposed grading plan. The 1996 GMP landfill filling plan is characterized by vertical elevation changes of six feet, separated by 15-foot wide benches, and 4Horizontal:1Vertical (4H:1V) side slopes. The 1996 GMP final grading plan proposed a maximum elevation of 48 feet mean sea level (MSL). However, certain areas of the landfill have been filled higher than the proposed maximum elevation of 48 feet MSL. Based on the topographic survey completed in October 2006, the highest elevation within the landfill boundary was approximately 52 feet MSL.

Typical current landfill practices utilize vertical elevation changes of 50 feet with side slopes of 3H:1V, separated by 15-foot wide benches. Therefore, an increase in remaining available landfill volume can be achieved under a revised final fill plan utilizing updated landfill design and operational practices.

The basic landfill grading criteria established for developing alternative final fill plans for the Navy Sanitary Landfill are summarized in Table 4-1 below.

Table 4-1

Landfill Design Criteria

Maximum final landfill side-slope surface grade, post-settlement	3H:1V
All-weather access road	
Width, including shoulder	25 feet
Maximum gradient	8 percent
Minimum cross-slope	2 percent
Perimeter road and buffer zone minimum width	50 feet
Design storm for run-on storm water	25-year 24-hour storm
Design storm for run-on site facilities for contact water only	100-year 24-hour storm
Waste density, typical industry standard with D8 dozer	1200 lbs/cy
Refuse to Soil Cover Ratio, typical for well run landfill	3:1

Three alternative final fill plans based on different final maximum elevations were developed and evaluated for additional landfill airspace achievable. In each case, a volumetric computation was performed to estimate the total volume of fill space (airspace) remaining in the landfill. The remaining airspace volume is the difference between the final grades developed for each alternative and the grades shown on the October 2006 topographic map. This airspace would be displaced by refuse and daily, intermediate and final cover. The airspace volumes provided by each alternative grading configuration were then compared to assess their relative difference.

The final fill plan alternatives encompass a footprint of approximately 60 acres and considered side slopes graded at a ratio of 3Horizontal:1Vertical (3H:1V).

These are shown as Figures 4-2 through 4-4 and termed alternative final fill plans 1 through 3, respectively.

Each alternative is based on landfilling of both the active and “inactive” areas of the landfill. They each include a refuse vehicle access road alignment from the landfill entrance to the top of the proposed fill area, an operations area consisting of a truck scale and a new landfill control building, a 50-foot wide perimeter road, a vegetative buffer zone on the north side of the landfill, and an area for a future run-off control system.

Table 4-2 summarizes the remaining landfill life that would be available under the three alternative final fill plans. It lists the estimated available remaining volume and site life with and without the operational improvements at waste generation rates of 6.1 and 7.4 lbs./capita/day. Operational improvements are discussed in more detail in Section 5.1.

Alternative Final Fill Plan 3, shown on Figure 4-4, shows an approach to maximizing the remaining landfill capacity, filling to a potential maximum final landfill height of 140 feet above MSL. A constraint on the maximum landfill height was not identified in any regulation or land use document, however, there may be a practical maximum height based on maintaining minimal aesthetic impacts of surrounding areas. Alternative Final Fill Plan 3 was considered to determine, from a technical standpoint, how much additional airspace could be realized while retaining adequate area for operations.

The greatest amount of landfill airspace gain is provided by Alternative Final Fill Plan 3. However, the visual impact of this alternative may not be desirable. It is therefore not considered further in this study.

Alternative Final Fill Plan 1 is judged a very conservative approach given that the maximum elevation is 54 MSL and the landfill has already been filled to elevation 52 MSL, based on 2006 topographic mapping. Alternative Final Fill Plan 2 is judged as a compromise between optimizing landfill capacity and visual aesthetics and is therefore selected along with the Alternative 1 grading plan as a potential final fill plan for the Navy Sanitary Landfill under Alternative 1 of this study.

The active waste placement area is currently limited to the southern portion of the landfill site. The northern portion of the landfill site, consisting of approximately 14 acres, is believed to have been used for limited waste placement in the distant past.

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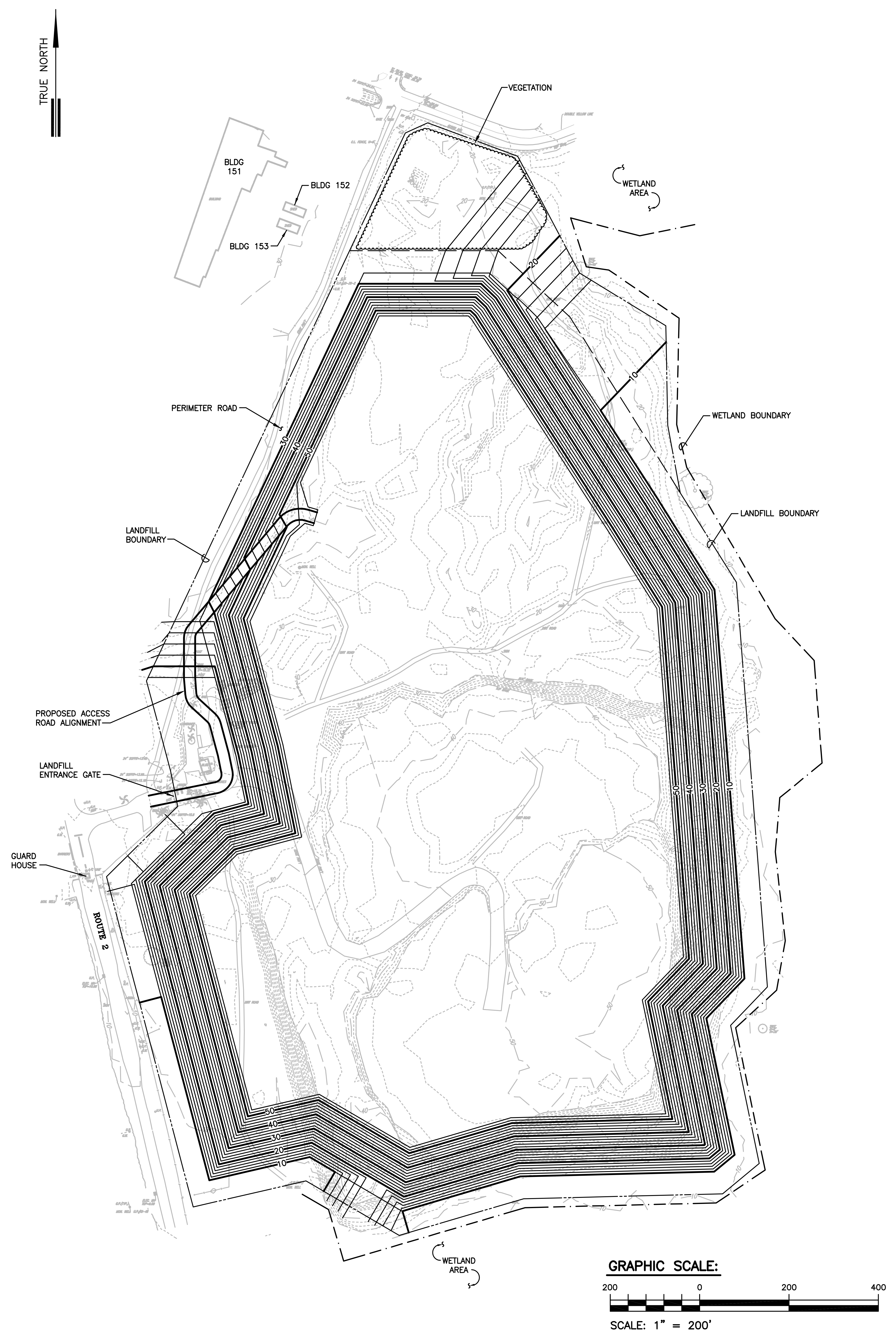

HDR HPE Hawaii Pacific Engineers, Inc.	GUAM SOLID WASTE UTILITY STUDY FOR PROPOSED USMC RELOCATION	ALTERNATIVE FINAL FILL PLAN 1 MAXIMUM ELEVATION = 54 FEET	FIGURE 4–2

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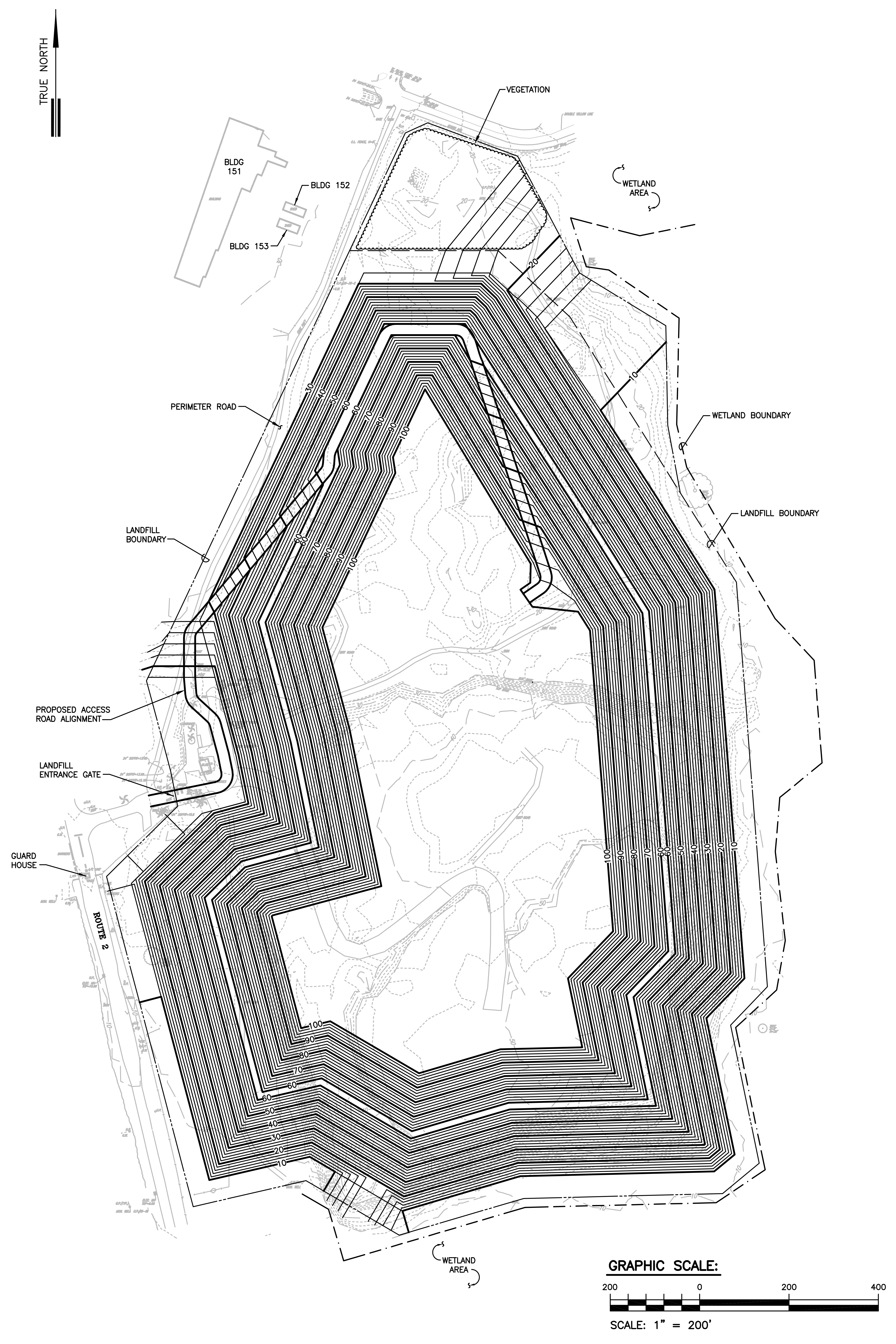

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GUAM SOLID WASTE UTILITY STUDY FOR PROPOSED USMC RELOCATION

ALTERNATIVE FINAL FILL PLAN 2 MAXIMUM ELEVATION = 100 FEET

FIGURE 4–3

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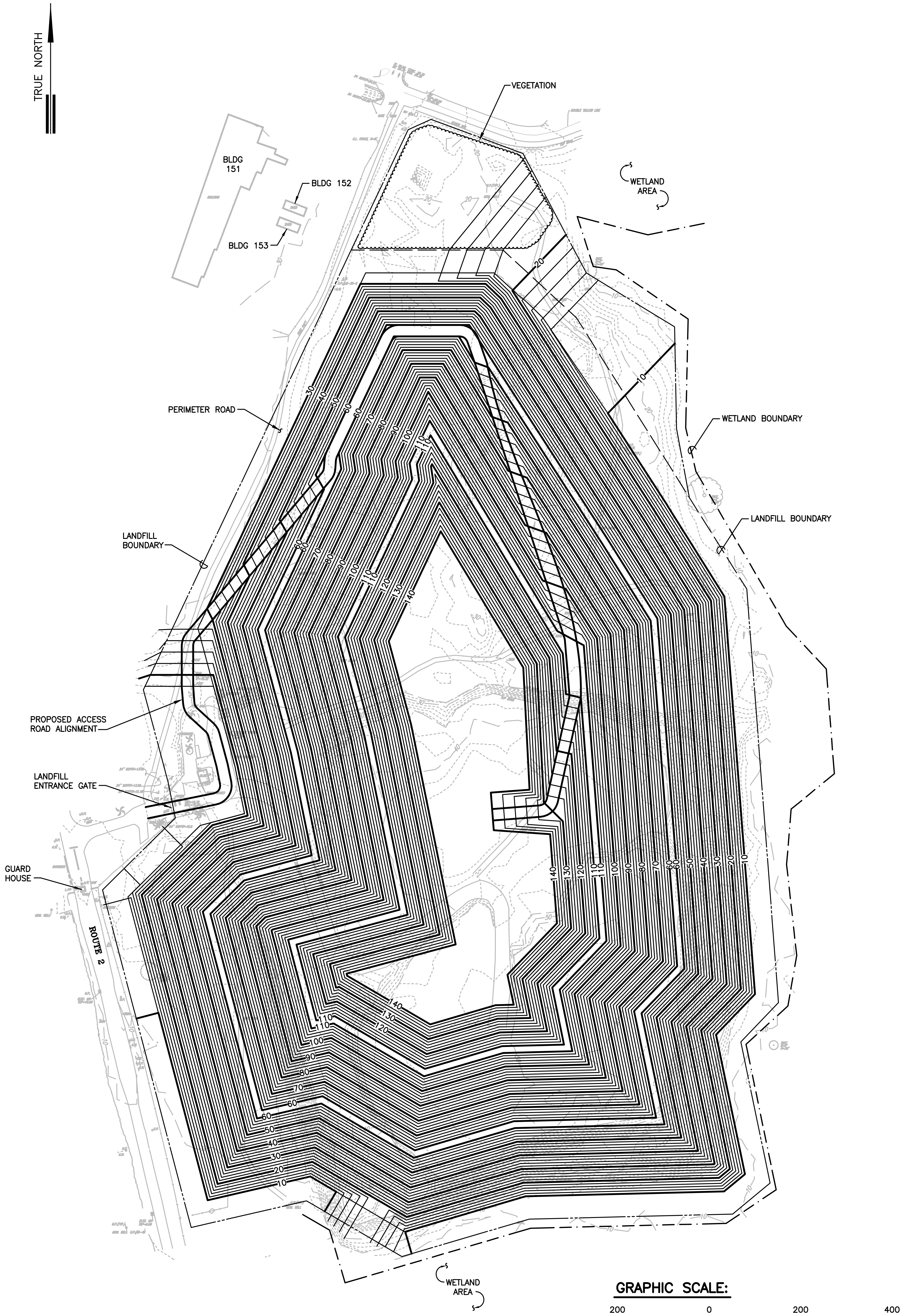

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Hawaii Pacific Engineers, Inc.

GUAM SOLID WASTE UTILITY STUDY
FOR PROPOSED USMC RELOCATION

ALTERNATIVE FINAL FILL PLAN 3
MAXIMUM ELEVATION = 140 FEET

FIGURE
4–4

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Table 4-2

Projected Remaining Landfill Life Under Various Conditions, Years

	Alternative Final Fill Plan 1		Alternative Final Fill Plan 2		Alternative Final Fill Plan 3	
Estimated Available Remaining Volume, cy	1,200,000		2,900,000		3,500,000	
Waste Generation Rate, lbs/capita/day	6.10	7.40	6.10	7.40	6.10	7.40
Lighter compacting equipment[1]						
Current waste composition	8	**7**	14	**12**	16	**14**
Current waste composition Revise filling practices[2]	10	**9**	19	**16**	22	**19**
Current waste composition Use ADC tarp[3]	11	**10**	21	**18**	25	**21**
Current, heavier compacting equipment[4]						
Current waste composition[5]	12	**10**	23	**20**	27	**23**
Current waste composition Revise filling practices[2]	16	**14**	32	**27**	38	**32**
Current waste composition, Revise filling practices[2] Divert Housing Waste in 5 years[6]	18	**16**	39	**33**	46	**39**
Current waste composition Use ADC tarp[3]	18	**15**	38	**32**	45	**38**
Heavier compacting equipment and revise filling practices						
Implement materials recovery[7]	19	**16**	41	**34**	49	**41**
Implement materials recovery Use ADC tarp[3]	21	**18**	46	**39**	55	**46**
Implement waste-to-energy[8]	29	**25**	65	**55**	78	**65**
Implement waste-to-energy Use ADC tarp[3]	24	**28**	74	**57**	89	**74**

Table Footnotes

1 In-place unit weight achieved = 625 lbs./cy.
2 In-place solid waste to cover material ratio of 3:1 used for revised filling practices (Except ADC Tarp)
3 Use of ADC tarp assumes a cover material ratio of 8:1 with only periodic cover material placement
4 Heavier equipment assumes an in-place unit weight achieved = 1,200 lbs./cy
5 In-place solid waste to cover material ratio of 1:1 used for current filling practices
6 Assumes diversion of housing waste = 19.7 percent of cy landfilled
7 Assumes diversion as a result of recovery = 23 percent of cy landfilled
8 Assumes diversion from WTE facility = 54 percent of cy landfilled

The least cost approach to utilizing the remaining life of the existing landfill would be to continue to utilize the existing area as an unlined landfill. However, lining a portion or all of the landfill area may become necessary as a result of local regulatory changes or other considerations. Therefore, it is assumed that for all Alternative Final Fill Plans that a Subtitle D liner system would be provided for the existing inactive area within the landfill boundary. Because the existing Navy Sanitary Landfill was in operation before the Subtitle D liner system requirement became effective, the Navy is not categorically required to incorporate a liner system for the active area. However, providing a liner system for the existing inactive landfill area would indicate the Navy's initiative to comply with the intent of the current Environmental Protection Agency (EPA) regulations and could be viewed favorably by Guam Environmental Protection Agency (GEPA) for any future landfill permit applications. Although under current EPA regulations a liner system is not required for the Navy Sanitary Landfill, GEPA has the regulatory authority for permitting and enforcement. The Navy must comply with the GEPA regulations, which are at least stringent as EPA regulations.

To effectively manage the entire existing landfill site, it is assumed under Alternative Final Fill Plan 1 that the Navy could continue filling operations in the active portion of the landfill site to the proposed maximum elevation of approximately 54 feet MSL. At that point, the Navy would line the "inactive" 14-acre northern area; complete filling of this area, and then complete capping and closure of the entire landfill. Under Alternative Final Fill Plan 2, it is assumed that a separation liner would be installed in the active portion of the landfill. Under this scenario, filling would take place in the active area to appropriate grades for constructing the separation liner and this configuration would be allowed to stabilize until lining and filling of the 14-acre inactive area was completed to a point requiring extending the fill over the active area. At that point, a separation liner would be installed over the active area to allow filling of the entire landfill to final grades and then capping and closure. This phasing of operations will allow some settlement of the active area prior to placement of the separation liner. Even under these conditions, the separation liner design should consider use of materials such as LLDPE, which will better withstand differential settlement than HDPE materials typically used for base liner systems. Slope stability analysis will also be needed to verify the adequacy of the separation liner grading configuration and separation liner materials.

For purposes of this study it is assumed that the separation liner over the active area must be approved by the GEPA Administrator, but not necessarily the level of a prescriptive composite liner required under Subtitle D. We have assumed that the separation liner would consist of a textured (both sides given that slope stability has not been performed) 80 mils linear low-density polyethylene (LLDPE) membrane that can deform much more than a typical base liner HDPE material. It is not clear that a composite liner will be required given that the landfill was in operation before Subtitle D became effective. However, it is assumed that the liner design for the inactive area would be a composite liner using 80-mils LLDPE with a lower component consisting of a minimum 2-foot thick compacted soil layer with a maximum hydraulic conductivity of 1.0 x 10-7 cm/sec. This will meet the performance requirements of Subtitle D given the inactive area may not have waste placed in all areas and yet be more flexible than typical HDPE for potential differential settlement that could occur from decomposition of irregular areas of old waste that may have been placed.

4.1.2 Viability

4.1.2.1 Environmental / Regulatory Issues

Two main environmental issues were identified for consideration when comparing this alternative to other alternatives. The existing Navy Sanitary Landfill is unlined and has experienced an apparent groundwater release of low level VOCs and thallium, which could have varying impacts depending on the alternatives selected. Closure of the Navy Landfill would eventually be required for all alternatives of this study and would involve closure of both the inactive and active areas of the landfill as described in the previous section. However, this will vary somewhat if this landfill operation is combined with Alternative 6, which would require capping and closure of the active area and only minimal action regarding the inactive area.

As discussed above, it is expected that GEPA will request that the inactive area be lined and the active area be equipped with a separation liner between the existing unlined landfill and vertical expansion. It is also expected that GEPA will require that a LFG control system be installed for the additional horizontal and vertical landfilling that would occur at the Navy Landfill under Alternative 1.

<u>Apparent Releases from the Navy Sanitary Landfill</u>

Due to the apparent releases from the Navy Sanitary Landfill, the Site Operations Plan indicates that quarterly groundwater monitoring is required. DZSP-21 SOP for groundwater monitoring requires compliance with 40 CFR Part 141 G, sets procedures for sampling, analysis of samples, and contaminant level requiring additional assessment.

Based on the DZSP-21 monitoring program, “statistically significant” concentrations of the pesticide chlordane and five volatile organic compounds (VOCs) were detected in the down-gradient wells in 2006. The constituents were detected at statistically significant concentrations, but the concentrations did not exceed action levels for those constituents. The VOCs detected at “statistically significant” concentrations are listed below.

- Toluene;
- 1,4-dichlorobenzene;
- 2-hexanone;
- Chlorobenzene; and

- Trichloroethene (TCE).

There is some uncertainty regarding the spatial distribution on VOCs from the Navy Landfill. However, regardless of the spatial distribution, the presence of low level VOC in groundwater wells is a concern because these are manmade compounds believed to be migrating from the unlined Navy Landfill. It is not unusual for unlined landfills to release low level VOC to groundwater as this typically occurs from migration of LFG or leachate from the landfill.

When constituents are detected at statistically significant levels, the landfill groundwater monitoring plan calls for additional assessment monitoring. The assessment monitoring program includes groundwater monitoring two times per year and includes an expanded list of analytical parameters. During the second assessment monitoring round, thallium was detected and confirmed to be present in one monitoring well at levels requiring agency notification and follow-up action. The required notifications were made, and follow-up actions are in progress.

When comparing the alternatives of this study it should be noted that even if the Navy closed the landfill as soon as possible to implement another alterative, the release of VOCs would likely persist and require remedial action such as capping of the landfill or additional measures if capping does not show a decreasing trend in VOC levels detected in the monitoring wells. Adding the liner for the inactive area and separation liner for the active area would minimize potential release from waste placed in the inactive area and above the separation liner but the VOC releases from unlined waste in the active area would persist. The installation of a LFG control system, both above and below the separation liner, can be expected to help reduce the level of VOC release. However, continued use of the space above the separation liner could increase the difficulty of implementing measures to mitigate continued release of constituents from areas below the liner if determined to be necessary in the future.

Greenhouse Gas Emissions

Public and governmental interest in climate change has increased dramatically over the past ten years. State and local governments have taken the lead in developing regulations and mandates related to reducing greenhouse gas emissions (GHG). Recently, momentum has been building in the United States (US) Congress to pass some type of national climate change legislation. Politicians are being pressured by concerned citizens who would like to reduce GHG emissions and by private companies who would like to replace the uneven policy environment with a uniform federal regulation. Methane emissions from landfills have been identified as a significant source of GHG emissions and are between 21 and 23 times as potent as carbon dioxide in terms of a GHG impact.

Installation of a LFG collection system at the Navy Landfill will decrease the level of GHG emissions compared to current conditions. GHG emissions from future DoD waste disposal using other landfill alternatives (2, 3, 5, 7, 8, and 9) can be expected to be similar as it is assumed these other landfills will also be equipped with LFG control systems. However, GHG emissions using WTE alternatives (4 and 10) would result in a comparative decrease in GHG emissions. Studies have indicated that a WTE facility could reduce GHG emissions from fossil fuel energy offsets by as much as 40 percent when compared to landfill disposal and as much as 60 percent if landfill gas collection and flaring is not part of the landfill option.

Alternative 6, continuing the status quo, would involve continued landfilling without a LFG control system. It is not clear if this is even viable from a regulatory view from a groundwater protection standpoint, but Alternative 1 providing a LFG control system would significantly reduce GHG emissions compared to Alternative 6 because a LFG control system can be expected to be 75 percent to 90 percent efficient in collecting and destroying LFG.

4.1.2.2 Implementation or Policy Issues

There does not appear to be implementation flaws with the Navy pursuing the improvement and continued use of its landfill at Apra Harbor considering the approach would be to line the remaining portion of the landfill and install a LFG control system for the landfill meets and exceed applicable regulations.

Improvement and continued use of the Navy Landfill at Apra Harbor assumes it would be used for all DoD waste on Guam over the planning period described in Section 3 and that other non DoD waste would be disposed at a new landfill constructed by GovGuam. GovGuam and the GEPA have proposed a policy that a regional approach to landfilling should be undertaken using the proposed GovGuam landfill near Layon (Alternative 2) due in part to the economies of scale of using a regional/island-wide approach. The potential economy of scale for a regional landfill for the island is valid at the relatively limited tonnage generated on the island. However, there are implementation concerns with the DoD relying on the proposed GovGuam landfill due to problems GovGuam has experienced with collection of solid waste fees. This lack of a reliable fee collection and funding source has been one of several issues delaying the proposed GovGuam landfill. The implementation problems and concerns related to the proposed GovGuam landfill are discussed further in 4.2. A separate DoD landfill would not be subject to many of the delays and issues associated with the implementation of the new GovGuam landfill.

4.2 Alternative 2 – Use New Landfill Constructed by GOVGUAM

The DPW has developed detailed plans for the construction of a new landfill to replace the Ordot Dump in the south central part of the island.

4.2.1 Description

The site selected for the Layon Landfill is approximately 176 acres in size and is located near the village of Inarajan. The Layon Landfill location is shown on

Figure 4-5. Layon is located in the higher badland (highly eroded rocky) areas on the west side of the Dandan parcel, southwest of the former NASA tracking station. The landfill site will be accessed from Route 4 by approximately 3.3 miles of reconstructed and new road consisting of two segments, which would be constructed under the Phase 1 construction project:

- Approximately 1.3 miles of existing Dandan Road that will be reconstructed to provide safe and suitable access for heavy trucks; and
- Approximately 2.0 miles of new road.

The Phase 1 will also include bulk excavation needed prior to the construction of the Landfill. The Phase 2 construction will complete the Landfill construction and the support facilities. DPW has determined requirements for capacity and life of the Layon Landfill. Based on studies of future waste disposal requirements, DPW has established a minimum design capacity of the site at 14 million cubic yards as an estimate of the volume required to manage Guam's municipal solid waste for a 30-year period, including DoD waste. The total size of the landfill refuse footprint is based on alternatives evaluated in the Supplemental Environmental Impact Statement ("SEIS"). The recommended design in the SEIS indicates a refuse footprint of 141 acres.

4.2.2 Design Criteria

The Landfill IFB design criteria and specifications are based on the February 5, 2006 Design Specification documents. The proposed cell construction phases are shown on Figure 4-6.

4.2.2.1 Cell Construction

The Layon Landfill is designed for the disposal of municipal solid waste according to the requirements of the GEPA as set forth in its Solid Waste Disposal Rules and Regulations (SWDRR) under 10 GCA Chapter 51: Solid Waste Management and Litter Control Act. The fundamental design criteria for municipal solid waste landfills are generally set forth in SWDRR §23401, consisting of:

- The landfill must have a liner system approved by the GEPA Administrator, or a prescriptive composite liner consisting of an upper component and a lower component. The proposed liner design consists of an upper component that is a flexible membrane liner of at least 30 mils (0.030 inch) thickness, or 60 mils if composed of HDPE. The lower component is to be minimum 2-feet thick compacted soil layer with a maximum hydraulic conductivity of 1.0 x 10-7 cm/sec. Sub-drains are placed below the liner to manage shallow groundwater and maintain separation between the groundwater surface and the liner system.

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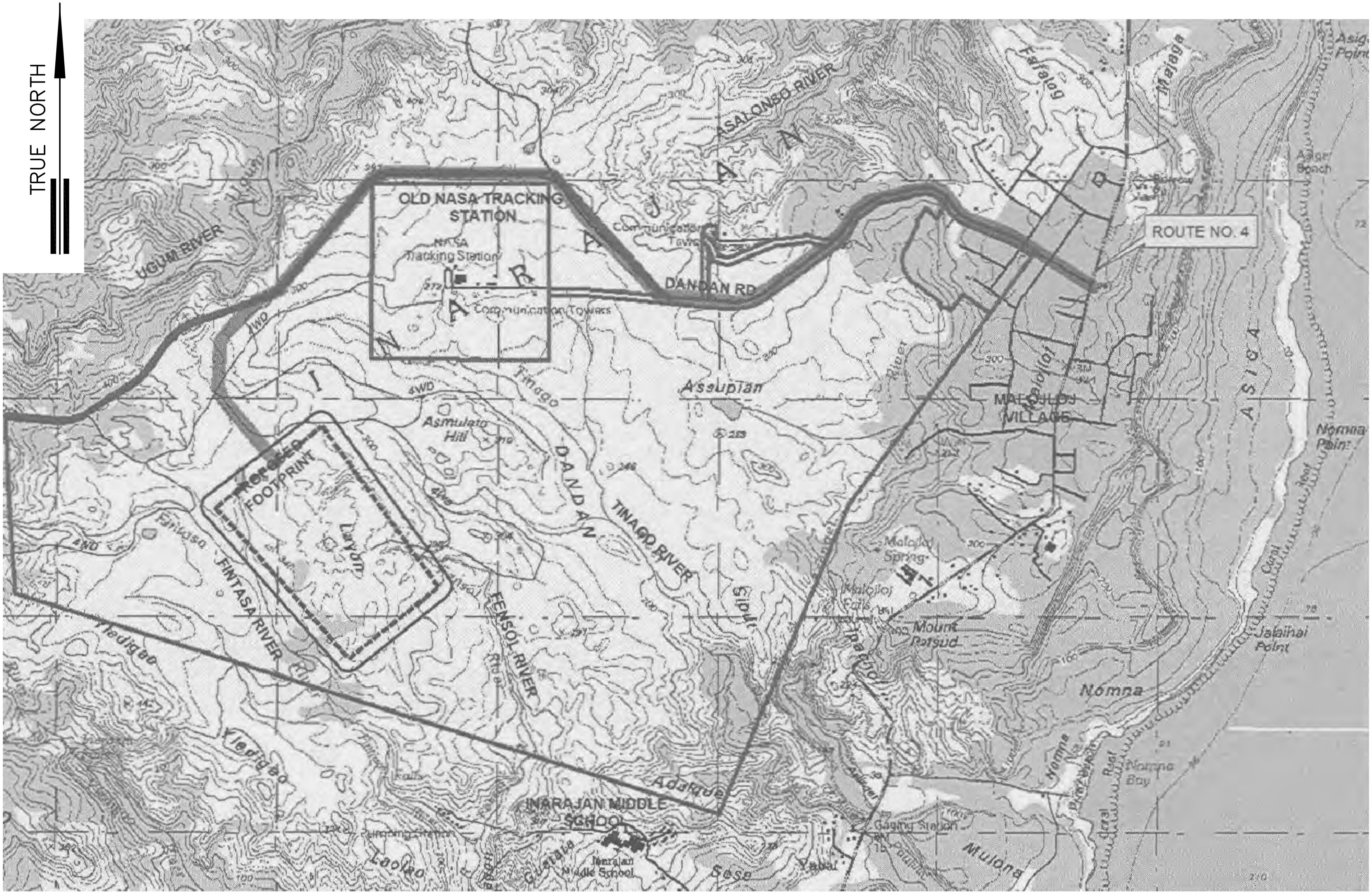

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GUAM SOLID WASTE UTILITY STUDY
FOR PROPOSED USMC RELOCATION

LAYON LANDFILL LOCATION

FIGURE
4–5

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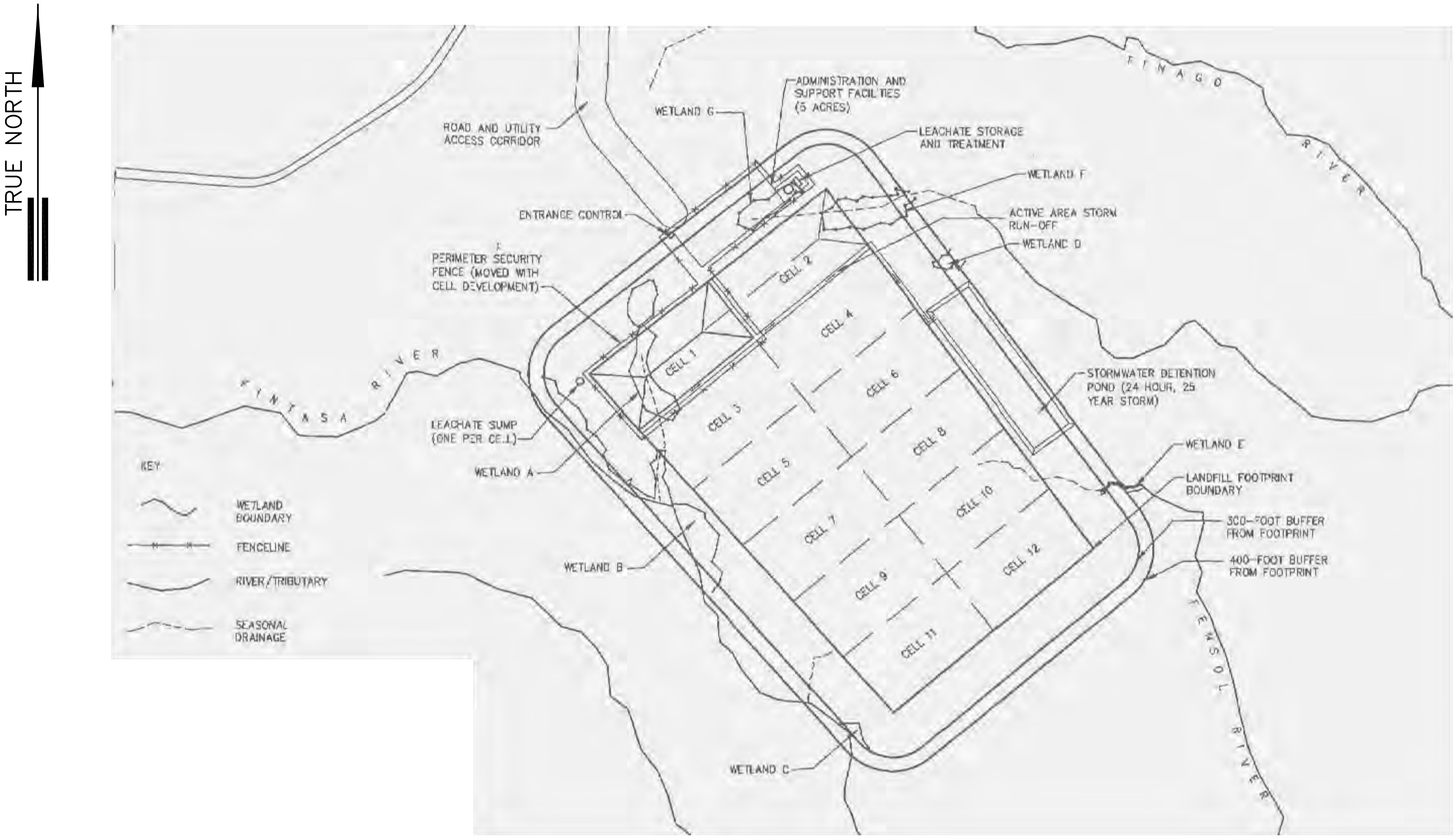

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HDR HPE Hawaii Pacific Engineers, Inc.	GUAM SOLID WASTE UTILITY STUDY FOR PROPOSED USMC RELOCATION	LAYON LANDFILL CELL CONSTRUCTION PHASES	FIGURE 4–6

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- The landfill is designed to have a leachate collection and removal system ("LCRS") consisting of a 12-inch granular drainage layer on the floor of each cell, which is sloped to a central gravel-filled trench within which a thick-walled perforated HDPE collection pipe is installed and designed and constructed to maintain a maximum of 30 centimeters (approximately 12 inches) of leachate above the liner system.
- Gas is designed to be managed by installation of horizontal collectors and vertical wells within the refuse, developing a main loop header system, and delivering gas to a central blower and flare station located in the entrance area. Subject to demonstration of economic feasibility, an energy recovery facility is likely to be added in the future.

4.2.2.2 Leachate Management

Layon Landfill will be designed and operated to manage leachate primarily by recirculation to the waste mass. Leachate will be pumped from the temporary holding tanks and reintroduced to the landfill by several different methods including any or all of the following:

- During dry weather periods, leachate may be pumped directly to sprinkler systems for spreading over the surface of the landfill top deck.
- Leachate may be pumped to a site water truck and delivered to the working face for spreading over the refuse before it is covered with daily cover soil.
- Leachate may be pumped or delivered by tanker truck to horizontal trenches or vertical infiltration wells for subsurface reintroduction to the refuse mass.

Specific means and methods of leachate reintroduction will be detailed in the site's operations plan prior to beginning disposal operations.

Recirculation of leachate is generally known to increase the rate of biological activity within the waste mass, thereby advancing decomposition, settlement and consolidation of the waste mass and enhancing the generation of landfill gas.

During initial operation of the site, it is likely that leachate will be generated before sufficient refuse has been placed in Cell 1 to make leachate reintroduction practical. During this interim period, any leachate generated will be transported to the nearest public wastewater treatment facility using conventional tanker trucks.

4.2.2.3 Support Facilities

The Layon Landfill Project includes three buildings to facilitate the operation of the landfill.

- *An Administration Building:* The facility is a single story 2,358 square foot building which will house the administrative staff. The building is located adjacent to the scales and the staff will interact with the vehicles entering the site. The facility has a break room with cooking facilities and restroom with a shower for extended stays during times of natural disasters.
- *A Maintenance Building:* The 6,734 square foot building will handle the maintenance of the landfill equipment. The maintenance bays are high-bay story and are equipped with compressed air connections and overhead reels for engine oil, grease, gear oil, hydraulic oil, and transmission oil. The two-story portion of the facility houses an office area, men and women's locker rooms, break room, and storage areas.
- *Generator Building:* A 798 square foot single story building which contains the main electrical room for the site, emergency generator, and pumps for the water system

In addition, a new 10-inch diameter waterline will be installed to service the Access Road and the Layon Landfill, connecting to the existing system at Kumati Road. Therefore, the existing 6-inch waterline that currently extends to the Tracking Station will be replaced when the new road is constructed. Underground utilities will be brought to the site, including power and telephone, and provisions for telemetry and cable TV. The existing overhead power lines currently installed from Route 4 to the new service road origination point will be converted to underground lines. All existing customers currently connected to overhead power lines being removed will be connected to the new underground lines. The storm-water conveyance systems will be designed to maintain peak discharges from the landfill site at flow volumes estimated for existing (pre-development) conditions.

4.2.3 Viability

4.2.3.1 Environmental / Regulatory Issues

The DPW is currently using the Ordot Dump for disposal of its solid waste and has not met the Consent Decree deadlines for closure of the Ordot Dump and the construction of the new landfill. The Guam Legislature has not acted to pass legislation necessary to finance and begin construction of the Layon Landfill. As a result on December 14, 2007 the United States District Court for the Territory of Guam imposed a fine on GovGuam that was due on January 24, 2008. New deadlines are being negotiated for compliance with the Consent Decree.

The DPW has submitted all the required permit applications for the development of the landfill site to the GEPA and there are no apparent regulatory impediments to the construction of the landfill.

4.2.3.2 Implementation or Policy Issues

The disposal charges at the new landfill facility would likely be set by the PUC. However, it is difficult to accurately predict when the facility might be available and what the cost for disposal might be.

The US District Court administering the Consent Decree has placed the Guam solid waste management program into receivership and will be administered by a third party reporting directly to the court. It is not clear at this time how this might impact the project development.

4.2.3.3 Schedule Issues

The schedule for implementation of the Layon Landfill Project established under the Consent Decree has not been met. This issue is now before the U.S. District Court for resolution.

Table 4-3

Original Consent Decree Implementation Schedule

Key Milestones	Consent Decree Compliance Date	Status
Consent Decree	02/11/04	Complete
List of New Landfill sites	03/12/04	Complete
Draft Closure Plan & EIS	12/07/04	Complete
Ordot Permit Application	12/07/06	Under Revision
90% Draft Closure/Post Closure Plan	05/06/05	Complete
New Landfill Draft Plan	08/04/05	Complete
Final Closure/Post closure Plan	09/03/05	Under Revision
90% Ordot wetland Mitigation Plan	09/03/05	Ongoing
Ordot Interim Permit Issued	12/02/05	Complete
Ordot Bid Advertisement	01/11/06	Delayed
90% Draft landfill Design Plan/Permit Application	02/05/06	Complete
90% :amdfill Wetland Mitigation Plan	02/05/06	Not Required
Award Closure Contract	04/21/06	Delayed
100% Landfill Design Plan	06/05/06	Under Revision
Landfill Invitation for Bid Issued	06/05/06	Delayed
Landfill Permit Approved	09/03/06	Delayed
Landfill Contract Award	10/13/06	Delayed
Landfill Construction Complete/Operations Begin	09/23/07	Delayed
Ordot Closure Complete/All Discharges Cease	10/23/07	Delayed

Table 4-4

Original Consent Decree Penalties

§	Task	Consent Decree Deadline	Requested Revised Deadline	Total Stipulated Penalties
Ordot Dump Closure				
8.f.	Advertise for Construction IFB	1/11/06	3/8/06	$20,500
8.g.	Award Closure Contract	4/21/06	6/21/06	$47,000
8.h	Complete Ordot Closure	10/23/07	4/24/09	$2,535,000
8.i	Cease All Discharges	10/23/07	4/24/09	$2,535,000
Layon Landfill				
9.h	Award New Construction Contract	10/13/06	11/30/06	$33,000
9.i.	Begin Operations	9/23/07	9/19/08	1,600,000
17	SEP	2/11/08	5/21/09	Not Determined
				$6,770,500

4.3 Alternative 3 – Construct New Landfill in Central Guam

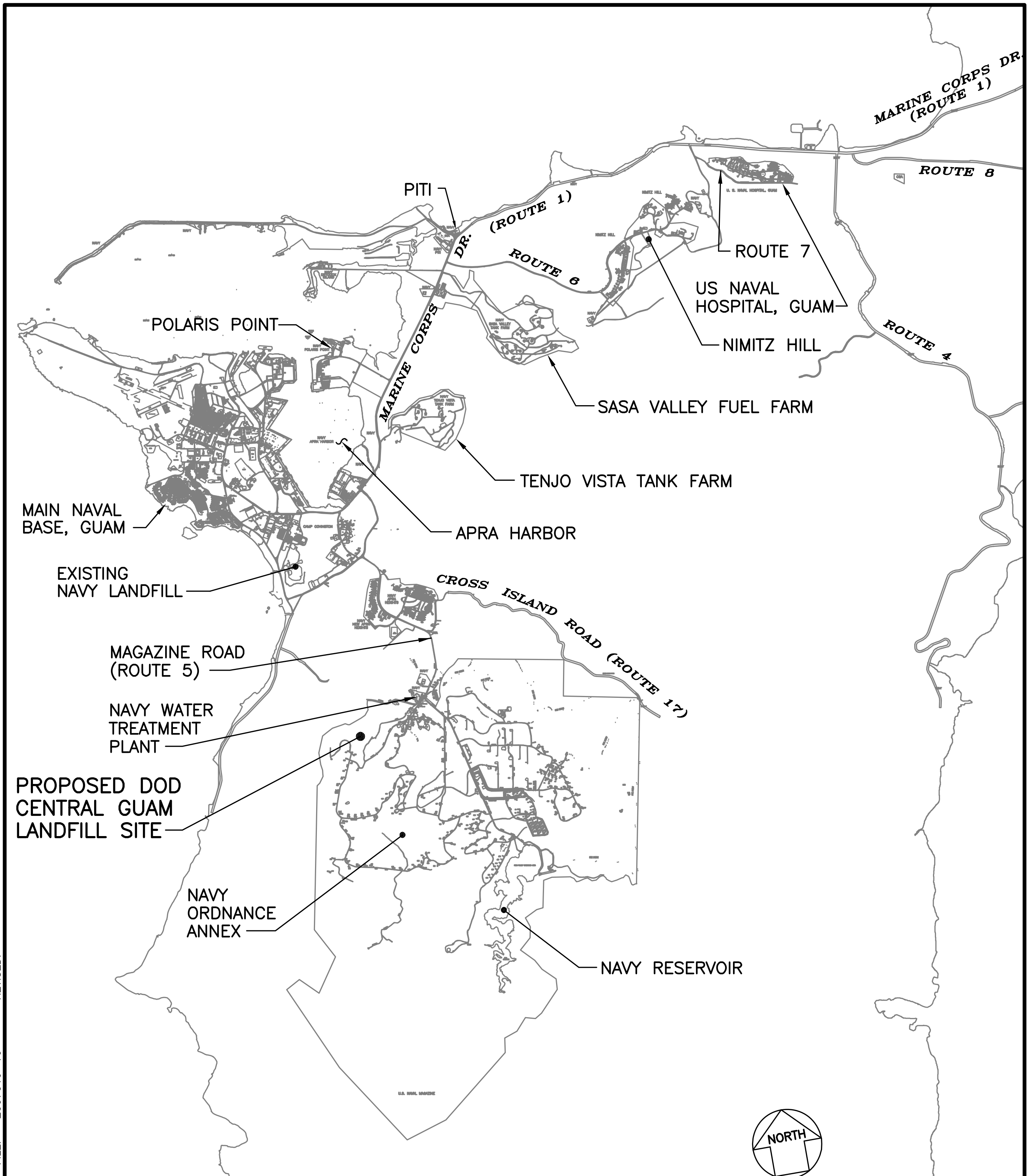
4.3.1 Description

The Navy has not performed a siting study for a replacement facility for the existing landfill at Apra Harbor. However, initial planning has focused on potential locations in central Guam that would provide favorable collection economics, and in particular have included a potential 50 acre site in the northwest portion of the Ordnance Annex. Although the site has not been evaluated in detail, it provides a potential site for comparison to other alternatives in this report. The general location of the site is shown on Figure 4-7.

4.3.1.1 Overview

The site assumed for a new Navy Landfill in central Guam would provide approximately a 40-acre to 50 -acre landfill footprint as shown on Figure 4-8. The site is located within a former quarry area and the terrain is steep. The existing topography of the site ranges from about 400 feet MSL to approximately 600 feet MSL. The landfill site could be accessed from Route 5 by a new road.

A conceptual base and final grading configuration was developed for this report. Based on preliminary calculations this configuration could provide a design capacity of 6.35 million cubic yards, or about 2.86 million tons at a waste density of 1,200 lbs/CY and a waste to cover material ratio of 3:1. Given the projected annual solid waste stream of 53,320 tons beginning in 2019 after the proposed USMC relocation and other planned operations is completed, the estimated capacity would provide a service life of about 50 years.



GENERAL ISLAND LOCATION MAP
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HDR / HPE Hawaii Pacific Engineers, Inc.	GUAM SOLID WASTE UTILITY STUDY FOR PROPOSED USMC RELOCATION	PROPOSED DOD LANDFILL LOCATION MAP	FIGURE 4-7

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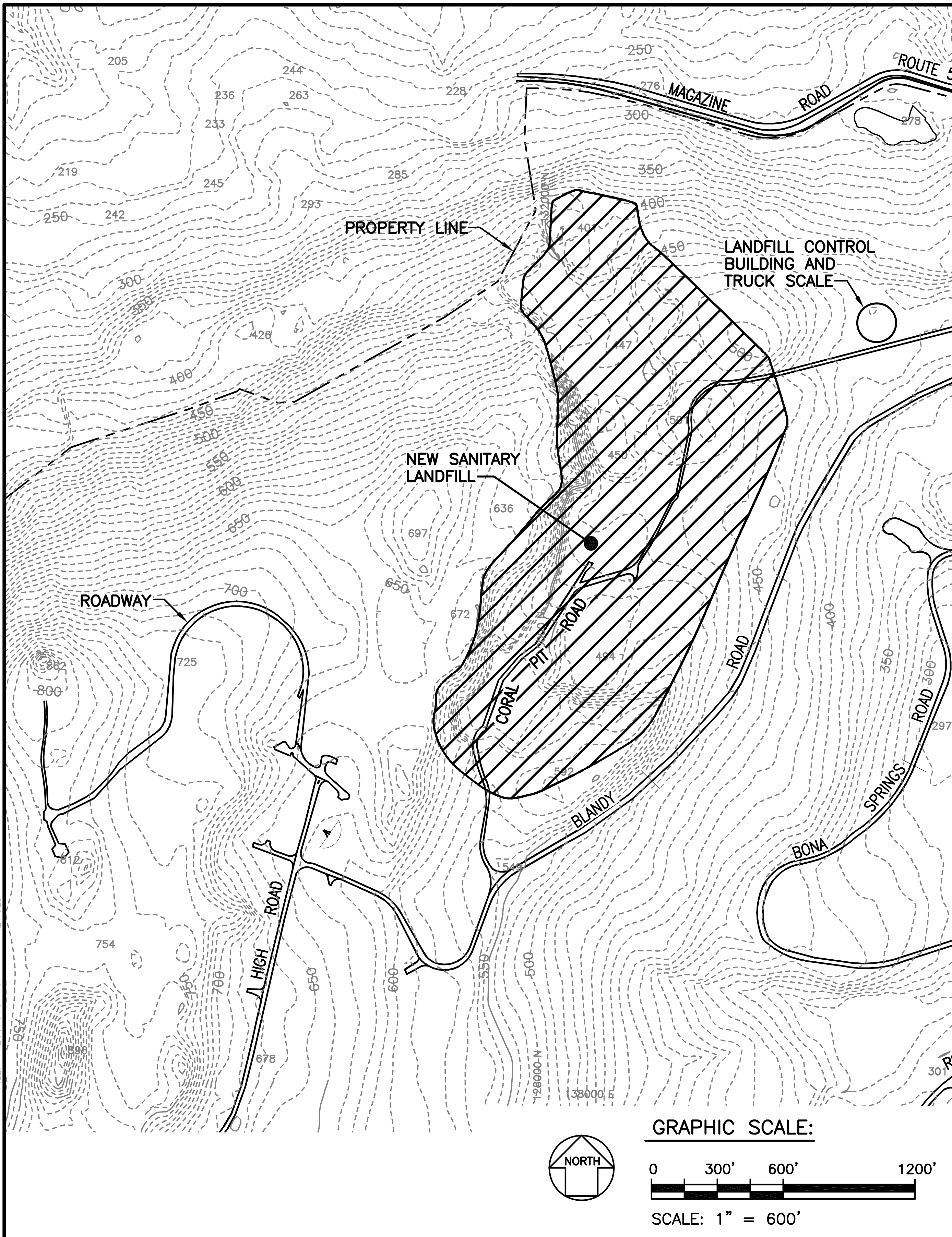

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HDR | HPE Hawaii Pacific Engineers, Inc.	GUAM SOLID WASTE UTILITY STUDY FOR PROPOSED USMC RELOCATION	PROPOSED DOD LANDFILL LOCATION PLAN	FIGURE 4–8

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4.3.1.2 Cell Construction

The new landfill would be designed for the disposal of municipal solid waste according to the requirements of the GEPA as set forth in its Solid Waste Disposal Rules and Regulations (SWDRR) under 10 GCA Chapter 51: Solid Waste Management and Litter Control Act. The fundamental design criteria for municipal solid waste landfills were previously discussed in Section 4.2, describing the planned GovGuam Landfill near Layon. A new Navy Landfill in central Guam would be required to meet the same requirements, and would include a Subtitle D composite liner system, leachate collection system and LFG control system. According to new source performance standard requirements, the LFG control system would need to be installed prior to a predicted annual nonmethane organic compounds emission rate of 50 MG.

4.3.1.3 Leachate Management

The new Navy Landfill could be designed and operated to manage leachate primarily by recirculation to the waste mass. Leachate would be pumped from the temporary holding tanks and reintroduced to the landfill. Recirculation of leachate is generally known to increase the rate of biological activity within the waste mass, thereby advancing decomposition, settlement and consolidation of the waste mass and enhancing the generation of landfill gas.

During initial operation of the site, it is likely that leachate will be generated before sufficient refuse has been placed in the first cell to make leachate reintroduction practical. During this interim period, leachate generated would be transported to the nearest public wastewater treatment facility using conventional tanker trucks.

4.3.1.4 Support Facilities and Utilities

It is assumed that development for the new Navy Landfill facility will include a 600 square foot landfill control building located near a truck scale. Mechanical and electrical systems would have to be provided for the scale facility and leachate collection and removal/recirculation system. In the future when the LFG collection system would be installed, the flare and associated electrical and mechanical systems would have to be installed.

Additional utilities will be brought to the site, including power and telephone, potable water, sewage collection and provisions for communications. The landfill storm-water conveyance systems will be designed to maintain peak discharges from the landfill site to control ponding of rain water and to minimize erosion.

4.3.2 Viability

4.3.2.1 Environmental / Regulatory Issues

The new Navy Landfill site has several remnants of World War II structures that are of historic significance. Section 106 consultation with the Guam Historic Preservation Office would be needed and mitigation measures may be required.

Santa Rita spring is located near the proposed site, and a study to determine the potential impact to the spring may be required.

4.3.2.2 Implementation or Policy Issues

As noted above historic preservation and potential impact to an existing spring would need to be addressed and resolved as determined to be necessary.

4.3.2.3 Schedule Issues

It is generally believed that permitting and construction of the initial module of a new landfill takes from 4 to 5 years, given no significant impediments or challenges. This does not include time for an alternative site evaluation and siting process, which has yet to be performed.

4.4 Alternative 4 – Construct an Incinerator/ Waste-to-Energy facility

A waste incineration or WTE facility could be constructed to dispose of the combustible portion of the DoD waste stream and reduce the volume of landfilled material. This WTE facility would process only the DoD waste stream. A private WTE facility on Guam has been proposed, but has not yet been developed due to a variety of legal and environmental issues. In the year 2000, after the private WTE facility was proposed, Public Law 25-175 prohibiting municipal solid waste incinerators and waste-to-energy facilities was passed by the Guam Legislature. PL 25-175 is included in Appendix C. The Supreme Court of Guam is expected to issue a decision that may determine the fate of the proposed private WTE facility. A DoD WTE facility located on federal government property and processing only DoD solid waste may be able to proceed through construction and implementation if it is a separate, independent facility.

WTE facilities have been installed to process municipal solid waste and various other types of non-hazardous wastes in many locations in the U.S. and are widely used in Europe, Japan, Korea, Taiwan, and other areas for waste disposal. An incinerator does not recover energy whereas a WTE facility includes a waste heat boiler to capture much of the energy from the hot flue gases to produce steam and electricity. The technology can be used in an integrated manner with recycling, composting or other means of handling portions of the waste stream. Not all waste components are applicable to WTE and thus the waste management system still requires a landfill or other disposal means for certain components. For instance large bulky items, large quantities of non-combustible items, and certain construction and demolition materials, are not processible. An ash residue also remains after processing that needs to be addressed. The following discussion addresses what the WTE facility might entail in this application.

4.4.1 Description

The WTE facility size is assumed to be 120 to 150 tpd or approximately 38,000 to 47,000 tpy of waste processed depending on the number of processing trains installed. This size was selected to allow processing of the assumed total combustible waste based upon 7.4 lb per capita per day on the military installations. The total average assumed daily waste generation is just over 150 tpd. Daily and seasonal waste generation variations are not known. For waste storage calculations, it is assumed that waste collection would occur over an 8 to 16 hour period 5 – 5 ½ days per week.

Not all the waste would be processible in WTE facilities. A portion of the waste stream cannot be processed by a WTE including construction and demolition rubble, bulky metal items, and large white goods that are not combustible, too large to feed into the units, or not combustion compatible. When possible, full truckloads of non-processible material would be directed to proceed directly to the landfill to avoid double handling at the facility. Waste received on the tipping floor would be sorted to remove any non-processible material. This material would be re-loaded on a roll-off or other truck and transported to the landfill.

The facility could consist of multiple (2 or 3) units in sizes ranging from about 40 tons per day (tpd) or a single field-erected unit of 130 - 150 tpd. All of these unit sizes would be classified as Small Municipal Waste Combustor for EPA regulatory purposes. Maintenance requirements normally require approximately 15 percent downtime for each unit. Therefore, the modular units provide more flexibility in operations and would allow operation even when only one unit would be out of service. During periods of reduced operation or high waste generation, excess waste could be more readily stored until it can be processed within certain limits.

Field erected units would be expected to be about 100 tpd in size or larger and thus only a single field erected unit may be possible. If a single unit is installed, the waste storage would need to be oversized for storage of all of the waste until it can be processed. To account for this extra waste storage and to ensure capacity will be available, it is assumed a single processing train would need to be oversized or have about 130 - 150 tpd processing capacity. Field-erected units generally have a better performance record, higher availability and longer life but tend to have higher capital costs.

An incinerator or WTE facility could be located near industrial locations that require steam or electrical power or located at one of the existing landfill sites. In this manner it may be possible to utilize some existing infrastructure such as landfill roadways, truck scales and support facilities for the WTE facility. The ash could also be disposed in the landfill or used for alternate daily cover at the landfill or roadway construction, if ash testing shows the material does not exhibit any hazardous characteristics. Waste that needs to be bypassed from the WTE facility and waste that cannot be processed at the facility would be diverted to the landfill.

Depending on the arrangement, a facility of this size should be able to be located in a 4 to 8 acre location with limited on-site roadways and queuing space. It is best if the site is generally flat or gently sloped with access to major roadways and water for boilers, condensers and ash quench.

Packer trucks and roll-off vehicles would be able to utilize the tipping floor. Refuse trucks would enter the site from the access road and normally are weighed for accounting purposes before proceeding to the tipping floor. An enclosed maneuvering area is typically provided with a clear span and 30 foot roof height that would allow packers and roll-offs unloading. The concrete floor surface is made from high strength concrete to maximize surface life. Facilities with field-erected units generally have a large pit for storage of waste. Waste may be deposited directly into the pit or pushed in by front-end loader. Redundant cranes are used to mix the waste and charge the combustor hopper. Modular units however generally utilize floor storage and small bobcat to mid-size front-end loaders for waste handling and storage. The pit and crane system is generally more expensive but provides more efficient waste storage. The floor storage arrangement requires a very large storage floor for peak deliveries such as over holiday weekends.

Waste may be charged to the combustion units by means of the same bobcat or small front-end loader used for storage or the cranes. Material would be fed into a feed hopper and fall by gravity through a chute onto a ram feeder where it will be pushed into the combustion chamber. This waste will also help maintain an air seal to provide a more stable control of the combustion air. Some systems have a sliding door that opens for charging and closes afterwards to help maintain combustion air control. Waste in the hopper will be maintained within a determined range to allow for steady operation and must be charged periodically 24-hours per day seven days per week.

The ram feeder will push the waste into the combustion chamber. Smaller modular units are typically equipped with refractory lined furnaces while larger field erected units may have a waterwall refractory lined enclosure. Modular units generally have several grate steps or downward inclined stages or rams that serve as the grate. As the wastes are pushed forward through the furnace it tumbles down the steps helping to mix the waste and complete combustion. Field-erected units have a more sophisticated grate system consisting of grate bars and grate sections with more steps and better combustion air mixing to improve burnout.

Primary combustion air is provided to combust the waste. Most modular units utilize a two chamber combustion approach where the waste is partially volatilized in the primary chamber and the gases driven off the waste to complete combustion in a smaller secondary chamber. Auxiliary fuel may need to be provided to complete combustion periodically in the second chamber when the gas is not rich enough to fully combust the volatile gases. Larger field erected units generally have an upper furnace area where additional secondary air is introduced to complete combustion. Startup auxiliary fuel burners are provided to warm up the unit and also help maintain proper combustion conditions during shutdowns and occasional upset conditions.

For modular units often the bottom ash drops into a submerged drag chain conveyor. The water extinguishes any remaining embers and cools the ash. The drag chain conveyor pushes the ash up an inclined slope for dewatering. Field erected units may use an ash extractor for the same application. The ash falls off the end of the grate into a quench basin. An ash extractor pushes the ash up an inclined slope for dewatering. Waste burnout is usually less efficient in a modular combustor and thus ash quantities generally are higher than for a field erected unit. In addition ash extractors can usually remove more water from the ash than a drag chain conveyor. Some fines and ash will fall through the grate system and must be collected. This material is usually combined with the bottom ash.

Combustion controls are provided for stable operation. Control of primary and secondary combustion air, refuse feed rate, and grate movement are used to control the thermal release and burnout of the waste. Feedback from instrumentation informs the operator how the unit is performing.

An incinerator would pass the hot flue gas from the combustion chamber to the air pollution control systems through refractory lined ducts. Incinerators without heat recovery are not commonly used today. For a facility with energy recovery the flue gas passes through a boiler where steam is generated. In a modular combustor, the boiler is generally a waste heat boiler connected to the unit by a short duct. For a field-erected unit the boiler is integral with the combustion chamber. Tube bundles suspended in the ductwork generate steam. Since fly ash can cause tube erosion and collect on tube surfaces, tube bundles normally consist of in-line tubes with large clearances. Usually modular units generate saturated steam at about 200 – 250 pounds per square inch (psig). Field erected units usually are equipped with a waterwall boiler and superheaters and may generate steam at much higher temperatures and pressures, typically 650 psig and 750^{o}F. An economizer increases efficiency. The lower pressure steam is not as efficient for electrical production but can be very useful if steam can be used on base or for other process applications. The higher pressure steam can also be extracted for steam uses.

The fly ash will accumulate in the boiler tube bundles and must be removed. The most common method is to use soot-blowers. Rappers may also be used in some cases. The fly ash drops into hoppers and is removed from the boiler. The fly ash is generally combined with the bottom ash for disposal.

A turbine generator is used to produce electricity. If no steam sales are possible a condensing unit is used and either an air cooled condenser or condenser and cooling tower is used to condense the steam to condensate. Condensate pumps are used to pump the water to a deaerator and boiler feed pumps deliver the water to the boiler economizer. A condenser and cooling tower is more efficient than an air cooled condenser, however the system requires more water for condensing the steam. In the event the turbine generator must be taken out of service, it is advisable to include a bypass condenser so that waste can continue to be processed. A water treatment system consisting of reverse osmosis (RO) units and/or a demineralizer is used to produce high quality water for boiler makeup.

A number of air pollution control devices are required. Modular units generally have low NOx emissions and control may not be required. Field erected units in the U.S. generally use selective non-catalytic reduction (SNCR) for control of NOx. This technology injects ammonia or urea reagent into a temperature zone on the boiler where the reagent reacts with the nitrogen compounds turning them into nitrogen gas. More than 50 percent reduction is possible in most cases. Where more control is required certain additional steps can be taken to enhance the performance of the SNCR system.

A spray dryer absorber (SDA) sometimes called a semi-dry scrubber or dry injection of lime is generally used for acid gas control. Dry injection is less effective but lower cost. The lime reacts with sulfur dioxide (SO_2), hydrochloric acid (HCl) and other acid gases in the flue gas stream minimizing their emission. The scrubber residue is captured in a fabric filter (FF) or baghouse along with other particulate. Activated carbon injection (CI) is used for mercury (Hg) control. The activated carbon is injected in the ductwork upstream of the FF or SDA. Dioxins and furans (Dioxins) and other organics are controlled by good combustion controls and any remaining dioxins are further controlled by CI. The FF captures the particulate (PM). The PM contains most of the other metals that were volatilized in the combustion chamber. The clean flue gas is then discharged from a stack. A continuous emission monitoring system (CEMS) is used to demonstrate continuous air emission environmental performance. It is used to measure carbon monoxide (CO) SO_2, NOx, oxygen (O_2) and certain boiler and APC readings to demonstrate compliance.

Boiler flyash, scrubber residue, and particulate are all collected and conveyed to the ash storage area. This material is mixed with the bottom and both are disposed as combined ash. Testing is required to demonstrate the ash achieves the EPA Toxicity Characteristic Leaching Procedure (TCLP) before it can be disposed of in a landfill. Ferrous metal may be recovered from the ash. The ash may be used for cover material if regulatory approvals are achieved.

4.4.2 Viability

While this option is potentially viable, there are a number of issues that would need to be addressed.

4.4.2.1 Environmental / Regulatory Issues

A WTE facility or incinerator would be required to comply with EPA's regulations for New Small Municipal Waste Combustors as provided in 40 CRF Part 60 Subpart AAAA. These requirements are further discussed in Section 5. This facility would be less than 250 tpd and thus would be a Class II facility. The regulations stipulate requirements for materials separation and public hearings that must be completed to address this plan. A siting analysis and hearings are also required. Operating requirements, emission limits, emission monitoring requirements, stack testing and other monitoring and recordkeeping requirements are contained in the rules. However, GEPA could impose additional requirements increasing the stringency for the facility as have been done in some of the other state regulations.

To achieve the emissions requirements, air pollution control equipment would be required to address the various pollutants. Several reagents may be required to reduce emissions below required limits. Lime or sodium bicarbonate would be needed for acid gas control, depending on which might be easiest to obtain on island. Lime as either calcium oxide or calcium hydroxide is usually less expensive than sodium bicarbonate but sodium bicarbonate is sometimes used due to it higher reactivity. Aqueous ammonia, anhydrous ammonia or urea would be needed for NOx control on field erected units. Modular units usually have lower NOx emissions; however it may be difficult if not impossible to install additional controls to lower NOx emissions. Anhydrous ammonia has certain handling requirements and thus is not normally used. Activated carbon would be required for mercury control. All of these reagents would need to be imported to the island.

The ash residue would be required to meet the TCLP requirements. Generally the excess lime used for emissions control conditions the ash as well minimizing leaching of metals. If sodium bicarbonate is used for acid gas control, it may be more difficult for the ash to achieve compliance with the TCLP test criteria as compared with use of a lime-based control technology.

4.4.2.2 Implementation or Policy Issues

The economics of a facility is improved if energy recovery occurs. Electric rates on the island are high due to the cost of importing fuel for power generation. The current avoided fuel cost for electricity is approximately $0.11 per kWh. The viability would be better if consistent steam customers could be identified that are close enough to the facility to justify installing a steam line. An extraction turbine could be used to produce electrical power with extractions ports for steam at the desired market conditions.

Currently wastes from incoming ships and planes are autoclaved to destroy any pathogens prior to disposal in a landfill. With proper approval and operator training, this waste could be brought to the WTE facility and combusted for assured destruction. The cost savings for not having to autoclave the waste could be used to help offset the cost of the facility. There may also be other combustible high security sensitive wastes that require special handling that could be processed for a higher fee. Examples include bank notes, expired pharmaceuticals, confidential documents or contraband.

An extended time period is required for permitting and construction of a WTE facility. Generally about three (3) to five (5) years is adequate to get a WTE facility to commercial operation.

In the interim period waste would need to continue to be disposed in a landfill. After the facility is on line, the ash residue remaining is approximately 30 percent of the incoming waste by weight and 10 to 12 percent of the incoming waste by volume. With proper approval, the ash could be used for alternate daily cover material at a landfill reducing soil needs. In some cases the residue may be used for road construction, drainage layers, or other landfill uses. Development of other residue reuse applications is in progress and may be viable in the future.

Public Law 25-175 added a provision to Chapter 73, Fire Prevention, Division 3 of Title 10 of the Guam Annotated Code that prohibits construction or operation of a municipal solid waste incinerator or waste to energy facility. Although the DoD is generally not subject to Guam laws and regulations, the DoD must comply with certain U.S. federal laws that are administered by the Government of Guam. The GEPA has primacy for enforcement of 40 CFR Part 258, Criteria for Municipal Solid Waste Landfills, which is applicable to the DoD on Guam.

4.5 Alternative 5 – Barge Waste Off-Island

An alternative to disposing solid waste on Guam is to ship solid waste to a location outside Guam for disposal. A majority of the materials that result in waste generation on the island are brought to Guam in cargo containers, resulting in an excess capacity of shipping containers that are sent back empty. These excess containers could be used to back-ship the waste off the island. However, shipment of DoD's solid waste would be subject to the availability of excess containers. Therefore, this alternative included scheduled barge service dedicated to the movement of DoD solid waste to a location outside Guam.

4.5.1 Description

Based on a similar option evaluated in Hawaii, the DoD waste would be compressed into double-plastic-wrapped MSW bales and barged to a continental landfill for disposal. Under the Hawaii alternative, the waste would be barged to Oregon where it would be disposed in the Roosevelt Regional Landfill near Roosevelt, Washington.

Although the acceptability or associated cost of waste receipt and disposal could not be confirmed, the relative costs for waste transport to possible landfills in closer than the continental US were evaluated. Specifically, two landfills; the Tai Chung landfill in Taipei and the Carmona landfill in the Philippines were identified as possible disposal sites. It should be noted that while each of these major metropolitan communities (Taipei and Manila) have appropriate barge receipt infrastructure, these communities appear to be struggling with waste management issues. Similar to much of Southeast Asia, many of these communities lack environmentally adequate landfills that are constructed and operated in a manner comparable to US standards. Reports of illegal waste disposal due to the lack of adequate sanitary landfill capacity are prominent in the news. While the specific tip fee costs of waste receipt and disposal at these locations are unknown, the primary benefit of these sites is that the estimated time in transit is only 10 and 12 days respectively. As compared to the estimated 71 days in transit to Oregon, these two landfills offer a notably closer and therefore less costly transit cost.

The technology required would consist of a shredding and baling facility sized to handle the tonnage throughput. The bales would be hauled on flat bed trucks to the port for loading on to barges by the barge operators. Deployment schedules would be dependent on the bale configuration and size, “backhaul cargo” opportunities and port “turn-around” times. For instance, the bales could be loaded in cargo shipping containers which would normally be shipped back empty. “Turn-around” times would be dependent on stevedoring activity, cargo availability, equipment maintenance and weather. Based on the projected annual waste from DoD facilities of approximately 53,320 tons means the system would have to be sized to handle approximately 210 tons per working day.

A single-tow ocean-barge could handle approximately 6,500 tons of waste. A double-tow ocean barge could handle approximately 10,000 tons of waste. Based on the DoD waste quantity, transporting waste off-island would require approximately 6 double-tow barge loads per year. The estimated ocean transit time is approximately 71 days plus approximately 5 days of port time. Barge loading/unloading would require a staging area at the port for the baled waste which is assumed to be delivered as approximately 1.9 ton bales (i.e., about 3,600 bales; about 16 square feet per bale). Based on stacking the bales three high, the area required would be approximately 20,000 square feet.

Operators would load the bales on flatbed shuttle trucks with forklifts with lift arms or paddles for delivery to the barges. Each flatbed truck could handle approximately thirteen bales. Shore cranes would lift the bale from the flatbed trucks on to the barge. A similar off-loading operation is expected at the continental port. Hawaii looked at existing port infrastructure in the Pacific Northwest and identified three possible candidate ports: Longview, Washington; Vancouver, Washington and Portland, Oregon. To minimize the truck hauling distance to the Roosevelt Landfill, the Port of Portland was selected as the most economical. The one-way driving distance to the landfill is approximately 140 miles and would take approximately 3 hours. Since most of the other waste delivered to the Roosevelt Landfill is delivered in containers or semi-trailers and not baled, the bales would require special handling at the landfill.

4.5.2 Viability

Preliminary assessment indicates that the life-cycle costs associated with this alternative are very high. In addition, there is a high probability for cargo handling inefficiencies, truck driver unavailability and transit delays that would further increase costs and risks for this alternative. Therefore, this alternative is not considered to be viable.

The option of barging wastes to landfills located in Southeast Asia could potentially reduce transit and shipping costs. However, the lack of appropriate sanitary landfills equipped with US equivalent protection standards makes this option non viable for the purposes of this study.

4.5.2.1 Environmental / Regulatory Issues

Under 7 CFR 330.400 and 9 CFR 94.5, the Animal and Plant Health Inspection Service (APHIS), a division of U.S. Department of Agriculture regulates the importation and interstate movement of garbage that may pose a risk of introducing or disseminating animal or plant pests or diseases that are new to or not widely distributed within the United States.

In response to a request by business interests and public officials in Hawaii, APHIS prepared a draft pest risk assessment (PRA), titled ``The Risk of Introduction of Pests to the Continental United States via Plastic-Baled Municipal Solid Waste from Hawaii `` (March 2006) to evaluate the interstate movement of garbage from Hawaii to the mainland of the United States. The objective of the PRA was to evaluate whether a baling technology that would bundle, wrap, and seal the MSW into airtight bales would effectively mitigate potential plant pest risks associated with MSW from Hawaii. The PRA focused on the planned use of the baling technology because airtight enclosure from creation to burial would mitigate the risks of establishment by any plant pests. The PRA addressed the following three issues:

- The ability of the baling technology to provide a strong, airtight barrier;
- The examination of the occurrence of ruptures or punctures; and
- The examination of general pathway procedures to reduce pest incidence in the bales and the chances of escape in the event of accidental ruptures or punctures.

The PRA concluded that transporting MSW from Hawaii to the continental United States in airtight bales poses a low risk of pest introduction and dissemination because the baling technology mitigates the risk from all types of plant pests. Pest mitigation processes such as the baling technology itself or features of the proposed pathway, including the waste type, and how bales are staged, handled, transported, and buried, are added safeguards that would prevent the introduction and dissemination of exotic pests. As a complement to the baling technology, the PRA recommended proper staging of bales and certification that the bales are mollusk-free to mitigate against contaminating pests. The PRA also recommended diversion of yard and agricultural waste, prompt shipment of bales, monitoring and inspection of bales, and thorough cleanup of any ruptures that do occur.

Therefore, APHIS adopted a rule change published in the Federal Register on August 23, 2006 that allows the barging of double-plastic-wrapped MSW bales to the continental U.S, which became effective on September 22, 2006. However, the rules restrict the baling of any fruit products to incidental quantities. Similar regulatory approvals will likely be required in order to transport DoD waste from Guam to any other country.

4.5.2.2 Implementation or Policy Issues

Implementation of this alternative would require a receiving facility willing to accept the solid waste. The receiving facility would also need to be capable of handling and disposing the solid waste in an environmentally sound manner. The facilities identified as meeting the above criteria are located on the west coast of the continental United States. As noted above, there may be solid waste handling and disposal facilities located closer to Guam. However, no contact has been made with either the Taipei or Philippines landfills to determine the technical viability and cost of waste receipt and disposal. .

4.6 Alternative 6 – Use Existing Unlined Landfill – Apra Harbor

4.6.1 Description

The existing Navy Sanitary Landfill conditions are described in Section 4.1.1.1. Alternative 1 assumed that a number of landfill site and operational improvements including upgraded equipment purchases would take place, including construction of a liner for the landfill. This Alternative 6 assumes that the Navy would continue to landfill at the Apra Harbor site but would not install a liner system. Similar to Alternative 1, a passive landfill gas venting system would be installed.

The basic final grading criteria would be the same as Alternative 1 as described in Section 4.1.1.3. It is assumed that the Navy would implement either Alternative Final Filling Plan 1 or 2 as previously described for Alternative 1 with the estimated resulting site lives as shown in Table 4-5. This would be less costly than Alternative 1 because the Navy would not install the liner over the inactive area using Alternative Final Filling Plan 1 (54 MSL) or a separation liner if Final Filling Plan 2 (100 MSL) were implemented. The table below shows the difference in capital costs for Alternative 6 compared to Alternative 1 for the two alternative final filling plans. The preliminary capital costs shown in Table 4-5 include estimated closure cap costs.

Table 4-5

Preliminary Capital Cost Comparison – Alternative 6 Versus Alternative 1

Alternative 6 (Max. 54 MSL or 100 MSL)	Alternative 1 (Max. 54 MSL)	Alternative 1 (Max. 100 MSL)
$8,400,000	$18,900,000	$30,600,000

4.6.2 Viability

As indicated in Section 4.1 it is expected that GEPA will request that the inactive area of the Navy Sanitary Landfill be equipped with a liner and that if significant additional filling in the active area is implemented, that a separation liner be installed. Although not categorically required by USEPA regulations, GEPA has regulatory primacy and has expressed a desire that future landfilling on the island of Guam at a minimum be performed on a Subtitle D compliance liner system. GEPA and other GovGuam personnel have proposed that the Navy and Air Force both consider use of the GovGuam landfill planned near Layon as would be implemented described in Alternative 2. Furthermore, a letter by GEPA, dated April 17, 2006 to the Air Force indicated that "Guam EPA will address the Navy Landfill in the very near future. The ideal compliance scenario would have the Air Force transition directly to the new Layon Landfill and concurrently have the Navy Landfill in the process of regulatory closure."

This would appear to indicate that the continuation of the status quo where the Navy would continue unlined landfill operations would not be viable in view of the GEPA position. It also might not be an environmentally proactive position for the Navy to pursue given the VOCs detected in groundwater monitoring wells. GEPA has regulatory primacy for enforcing the USEPA municipal solid waste regulations and can impose more stringent requirements for landfills within their jurisdiction. It is anticipated that soon after the new GovGuam lined landfill becomes operational, GEPA would enact and implement a requirement that all operating landfills have a liner system or close within a specified period.

Given the difficulties with implementing the planned new GovGuam landfill as previously discussed in Section 4.2, the GEPA may not be in a position to force the Navy to use that facility. However, it seems unlikely that GEPA will continue to allow unlined operations at the Navy Sanitary Landfill to continue into the long-term future, particularly after the GovGuam new lined landfill becomes operational. Therefore, this alternative is not viewed as viable and is not considered further in Section 5.

4.7 Alternative 7 – Construct New Landfill in Northern Guam

4.7.1 Description

This alternative would have the Navy construct a new lined landfill somewhere in northern Guam. A siting study nor preliminary assessment of a specific location have not been performed or analyzed to this point.

An advantage of this approach would be that it could be located closer to the larger DoD waste generator, which would be Northern Guam, where the proposed relocation of the Marines is focused. However, a significant risk and drawback to this approach would be that it would be located over the Northern Guam Lens Aquifer (NGLA), a sole source aquifer providing nearly 80 percent of all drinking water on Guam.

4.7.2 Viability

4.7.2.1 Environmental / Regulatory Issues

Given the high environmental sensitivity of the NGLA, it would be difficult for the Navy to site a new landfill in Northern Guam given some of the other alternatives in this study that would not pose a long term risk to contamination of such an important aquifer. Even though a modern Subtitle D landfill liner greatly mitigates this risk, it cannot entirely remove it.

If the Navy did undertake a siting study for a new landfill in Northern Guam this would likely create significant public opposition due to the NGLA as well as regulatory scrutiny by the GEPA. At present, water drawn from the Northern Guam Lens is not considered to be groundwater under the influence of surface water, limiting required treatment to disinfection only. However, indications of contamination from onsite wastewater disposal systems are occurring on a more frequent and consistent basis. GEPA and EPA have initiated public discussions to notify water purveyors that full compliance with the surface water treatment rule will be required. The increased military population in northern Guam, and the civilian population increase that will likely also occur, would increase the importance of the Northern Guam Lens, and the need to protect it to the fullest extent possible. As an example, during the GovGuam EIS siting study, Guam's *Groundwater Protection Zone* and other potential groundwater producing areas were eliminated from consideration for a landfill. Any siting study performed by the Navy would need to provide similar consideration for the Groundwater Protection Zone.

Given the above environmental policy and technical considerations and regulatory issues this alternative is not viewed as viable and is not considered further in Section 5.

4.8 Alternative 8 – Use Existing Andersen Air Force Base Landfill

4.8.1 Description

The existing landfill operations at Andersen Air Force Base include a municipal solid waste landfill area and a construction and demolition debris disposal area. The AAFB municipal solid waste landfill is a vertical expansion constructed over an unlined landfill area. The AAFB landfill began operation in late 1998 with a design capacity of 172,000 cubic yards and expected life of ten years. The landfill was planned to have sufficient capacity to handle AAFB solid waste only until the opening of the new GovGuam landfill. At the time of permitting for the AAFB landfill, the GovGuam landfill was scheduled to be operational by the year 2008. When it became apparent that the GovGuam landfill would not be ready for use as originally anticipated, AAFB planned a further incremental expansion of their lined expanded landfill to provide a limited amount of additional volume.

A recycling center is operated at AAFB by a contractor. The recycling center primarily serves as an accumulation point for cardboard, paper, plastic bottles, aluminum cans and glass. Covered storage area is very limited, and the majority of the accumulated materials are stored in uncovered open areas at the recycling center site. The recycling center operator and AAFB usually arrange for transport of the materials off AAFB on an annual basis by a recycler. Because of the small quantities involved, and the poor condition of the cardboard materials, the recycling operation generally does not generate any offsetting revenue.

This alternative assumes that the AAFB Landfill will run out of space in the recently implemented 2-acre expansion as early as 2009. Alternative 9 is based on a larger expansion of the AAFB Landfill.

4.8.2 Viability

4.8.2.1 Environmental / Regulatory Issues

Because the AAFB Landfill is above the NGLA, it will receive the same scrutiny as any proposed landfill in northern Guam. In addition, the existing AAFB landfill is located upgradient from several freshwater subzones that lie within the AAFB boundary. Monitoring wells installed under the Base Installation Restoration Program have not detected significant levels of contaminants in the downstream groundwater. However, because the coralline structure of northern Guam is characterized by highly variable porosity, fractures and voids, there is concern about the location of water supply wells relative to the landfill location. These concerns placed substantial constraints on the location of water supply wells recently constructed in the Northwest Field area. Further expansion of the AAFB landfill would heighten concerns for protection of the water supplies within DoD property.

4.8.2.2 Implementation or Policy Issues

Based on planning for the AAFB, the Air Force intended to use the planned new GovGuam Landfill near Layon for disposal when the AAFB Landfill existing active area runs out of capacity. The current active area capacity is exhausted. Because the new GovGuam Layon landfill is not operational, the AAFB has initiated a separate project that will expand the existing permitted landfill by 2 acres and extend the lifespan of the landfill to at least 2009. If the GovGuam landfill does not become available at that time, the Air Force would need to further expand the landfill to serve beyond 2009 or use another landfill such as the Navy Sanitary Landfill.

The 2-acre lined landfill expansion being implemented by the AAFB is an interim measure. It does not provide adequate capacity for the longer term DoD waste steam described in Section 3 that must be serviced to satisfy the goal of this study; therefore, Alternative 8 is not considered viable and is not considered further in Section 5.

4.9 Alternative 9 – Expand Existing Andersen Air Force Base Landfill

4.9.1 Description

As described in Section 4.8, the AAFB Landfill is implementing a 2-acre expansion planned to extend capacity until the GovGuam Landfill becomes operational. It is located over the NGLA, a sensitive environmental area that provides almost 80 percent of the drinking water for the island. This alternative would involve expansion of the AAFB Landfill to serve the future disposal needs of the DoD described in Section 3. No detailed planning or design work has been performed for this alternative as there are planning level environmental and regulatory concerns for expansion of the landfill that are discussed further, below.

4.9.2 Viability

4.9.2.1 Environmental / Regulatory Issues

Similar to discussion of environmental/regulatory and implementation and policy issues facing Alternative 7, it will be difficult for the AAFB to expand the landfill as part of a long term strategy to serve the DoD solid waste future disposal needs described in Section 3. The landfill is located over the NGLA and a significant expansion would likely receive as much scrutiny as a new landfill. As noted for Alternative 7, a previous landfill siting process by GovGuam has ruled out the NGLA area. It is likely that GEPA would not be in favor of a landfill expansion in northern Guam given the predisposition to having future landfilling occur at the planned GovGuam Layon Landfill, in part because it is not located above the NGLA.

Given the above environmental and regulatory issues, this alternative is not viewed as viable and is not considered further in Section 5.

4.10 Alternative 10 – Proposed WTE Facility /Landfill – Guatali

4.10.1 Description

A private developer is planning to develop a WTE facility to serve the entire island which could potentially provide disposal services to DoD as well. In 1982 the Government of Guam issued an exclusive license to build an incinerator to a company called International Energy Enterprises Inc. In 1989 the island's master plan included an incinerator, but Energy Enterprises sold its license to G Power, who teamed up with Wheelabrator Technologies and formed a partnership with a local company called GMP and Associates, which created a company called Guam Resource Recovery Partners or GRRP.

In 1991 the Guam Economic Development Authority agreed to sell $75 million in bonds to fund the incinerator project and in July 1996, signed a contract with GRRP. However in August 25, 2000, the Guam legislature passed a law (Public Law 24-57) blocking public funding for a WTE project. In addition, the legislature passed a law (Public Law 25-175) which prohibits the construction and operation of a "municipal solid waste incinerator or a waste–to-energy facility" on the island. This project has been the subject of numerous litigation battles in the Guam Superior and Supreme Courts regarding whether the WTE license and funding agreement are still valid.

On December 13, 2007, GRRP held a ceremonial groundbreaking at the Guatali site for the development of the landfill. According to GRRP estimates based upon the projected municipal solid waste generation for Guam, the proposed landfill site with the addition of a waste-to-energy facility would accommodate landfill operations for 19 to 21 years. Without the waste-to-energy facility, the proposed site would accommodate landfill operations for approximately 12 years, according to GRRP.

4.10.2 Viability

4.10.2.1 Environmental / Regulatory Issues

A Draft Environmental Impact Statement – Solid waste Management Facility for the Island of Guam conducted a screening process for a potential landfill site but ruled out the Guatali, Piti site based on slope and geological exclusionary criterion. Deficiencies in the screening process were identified during the Ordot Consent Decree negotiation, which mandated that a new landfill siting process be initiated. This process resulted in the selection of the Layon Landfill site as discussed in Alternative 2.

4.10.2.2 Implementation or Policy Issues

GRRP has not yet obtained permits for the construction of either the landfill or the WTE facility. This process could be long and contentious given the litigious history of the project.

Given these major implementation and policy impediments, this alternative is not considered as a viable option at this time.

4.11 Summary of Screening of Nonviable Alternatives

As discussed above, Alternatives 5 through 10 were judged as nonviable for further consideration, summarized as follows:

Alternative 5 – Barging solid waste to an off-island landfill or other solid waste disposal facility was judged as nonviable because of the very high costs and potential socio-political as well as environmental concerns.

Alternative 6 – Pursuing the status quo by operating the Apra Harbor Navy Sanitary Landfill without installation of a liner system is judged as nonviable because it is believed that GEPA will not allow significant additional disposal without installation of a liner system.

Alternative 7 – Navy/DoD construction of a new landfill in northern Guam is judged as nonviable because it would be placed over the NGLA, an environmentally sensitive groundwater protection zone providing the only significant potable groundwater source and almost 80 percent of the drinking water for the island. The NGLA has been ruled out as a suitable area for siting a new landfill during an EIS process conducted by GovGuam and GEPA may be unlikely to approve a new landfill over the NGLA given less-sensitive available locations on the island.

Alternative 8 – Using the existing landfill at the AAFB is judged as nonviable because it has very limited site life remaining. A 2-acre lined expansion recently pursued would only provide capacity for an estimated two to four additional years.

Alternative 9 – Expansion of the landfill at the AAFB is judged as nonviable because it would be located over the NGLA. Similar to Alternative 7, it may not be advisable or possible to pursue permitting significant new landfill footprint located above the NGLA.

Alternative 10 – The potential new private WTE facility with a landfill at Guatali has yet to obtain permits for construction of either the landfill or WTE facility. This process could be long and contentious given the litigious history of the project and it is not clear how funding for the project will occur. Given these factors, Alternative 10 is judged as non-viable.

It should be noted that the judgments above are based on a relative comparison of the alternatives. The reasons these alternatives are dropped from further consideration may not be categorical fatal flaws, but they are considered to be significant impediments to successful implementation as compared to Alternatives 1 through 4. Based on this preliminary comparative assessment, Alternatives 1 through 4 are analyzed in more detail in Section 5.

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5.0 Viable Solid Waste Disposal Alternatives

5.1 Alternative 1 – Improve Navy Sanitary Landfill – Apra Harbor

5.1.1 Analysis

5.1.1.1 Site Life under Varying Conditions

As discussed in Section 4, landfill design configurations can provide a range of site lives using various operational improvements or landfill diversion strategies. Alternative final fill plans 1 and 2 shown in the table are identified as viable possibilities as discussed in Section 4.1.1. At the assumed waste generation rate of 7.4 lbs/cy assumed for this study, the range of site lives for these alternative final plans ranges from 7 to 28 years under the lowest Alternative 1 Final Fill Plan (54MSL) compared to 12 to 57 years under the Alternative 2 Final Fill Plan (100MSL), under a range of operating conditions.

The Alternative Final Fill Plan 1 is a minimal approach and is viewed as a transition phase to the Navy pursuing one of the other alternatives in the long term after closure of the Apra Harbor site. The projected site life of 7 years is a very conservative approach based on continuing the status quo in terms of operations. With the recommended heavier compaction equipment, the site life filling only to elevation 54 MSL would provide 10 to 14 years of capacity combined with revised filling practices. The Sanitary Landfill Management Plan contains a description of the recommended heavier dozer and improved filling practices. In addition to use of heavier equipment, the improved filling practices would primarily involve systematic construction of daily cells and application of a single soil cover layer at the end of the day.

Alternative final fill plan 2 optimizes the remaining capacity of the landfill by extending the fill height only to elevation 100 MLS out of consideration of visual impacts, even though technically it could be extended to elevation 140 MSL. As noted in Table 4-2, this will generally more than double the site life compared to only filling to elevation 54 MSL.

Other strategies to extending the site life of the landfill evaluated, as summarized in Table 4-2, include use of ADC tarps, which is expected to provide roughly a 15 percent increase in site life. This is shown in combination with various filling practices. The performance from using ADC tarps assumes that soil or other cover material would have to be used periodically.

The next tier of landfill space conservation shown on the bottom portion of Table 4-2 portrays diversion using a materials recovery facility or WTE facility. The materials recovery facility is assumed to divert 54 percent of the volume of the landfill. The MRF strategy combined with recommended landfill operational improvements is expected to extend the site life from 27 years to 34 years. If employing ADC tarps could provide a waste to soil ratio of 8:1, the site life would be increased to 39 years.

Pursuing a WTE facility is included as Alternative 4 of this study, below. The expectation is that a WTE would divert 54 percent of the landfill volume. Under this scenario, the landfill life would be extended from 27 to 55 years. If employing ADC tarps could provide a waste to soil ratio of 8:1, the site life with WTE would be increased to 57 years.

5.1.1.2 Environmental Considerations

As indicated in Section 4.1.2.1, landfilling of additional waste has the potential to increase the degree and extent of duration of VOC releases from the landfill. Under the limited Alternative Final Fill Plan 1 to maximum elevation 54 feet MSL, the portion of the estimated additional 1,200,000 cy of landfill volume above the active area would not be lined and could contribute to continuing VOC releases. Installation of an active LFG control system is expected to help reduce the VOC emissions to soil and groundwater to some degree.

Under the proposed Alternative Final Fill Plan 2 utilizing a maximum elevation of 100 MLS a separation liner would be installed which would minimize the level of VOC release to groundwater from material placed above the separation liner. Due to expected differential settlement of waste beneath the separation liner there is a risk that the liner could fail. Although methods could be undertaken to consolidate waste prior to liner construction there will be differential settlement as the decomposable waste fraction in the fill breaks down.

Two important factors should be noted when comparing the potential groundwater impacts of continuing to use the Apra Harbor Landfill to other viable alternatives (1 through 4). First, the Navy would still be required to minimize and remediate the release of VOCs from the existing unlined landfill. Secondly, the Navy would still be required to landfill a majority of the waste stream at another landfill site on Guam or an off-shore landfill if barging of waste were pursued. Placing a base liner in the inactive area of the Navy Landfill at Apra Harbor prior to waste placement will result in performance similar to other options because a Subtitle D liner system will be employed. The additional waste placed above a separation liner would have similar containment as provided with other landfill alternatives. Because much of the waste beneath the separation liner would have been placed with light compaction equipment and significant cover soil, differential settlement that could compromise the integrity of the liner system is a significant risk compared to other landfill options.

Groundwater monitoring is required by the Rules and Regulations for the Guam Environmental Protection Agency (GEPA) Solid Waste Disposal, Title 22, Division 4, Chapter 23, Article 5. This would continue over the operational lives of the landfill and the post closure maintenance period and potentially longer if landfill releases to the environment are occurring and the GEPA determines that the facility poses a contamination threat to the environment.

As indicated in Section 4.1.2.1, installation of a LFG collection system at the Navy Landfill will decrease the level of GHG emissions compared to current conditions. GHG emissions from future DoD waste disposal using other landfill alternatives (2, 3, 5, 7, 8, and 9) can be expected to be similar as it is assumed these other landfills will also be equipped with LFG control systems. However, GHG emissions using WTE Alternative 4 would result in a comparative decrease in GHG emissions. Studies have indicated that a WTE facility could reduce GHG emissions from fossil fuel energy offsets by as much as 40 percent when compared to landfill disposal and as much as 60 percent if landfill gas collection and flaring is not part of the landfill option.

5.1.2 Costs

The costs vary between Alternative Final Fill Plan 1 and 2, because of the difference in the amount of landfill liner that would be required. Following is a description of the major cost components for this alternative, including the final fill plan sub-alternatives. Because these options are the easiest to implement, they can provide interim solutions to allow proper planning and development of some of the other longer term alternatives. Therefore, these cost factors below are also applied transitionally to the other alternatives in the comparative analysis discussion in Section 5.5.

Estimated capital dollar costs for Final Filling Plan 1 (termed Alternative 1-1) include a landfill control building, truck scale facility, site work, liner and leachate collection system, leachate treatment system, landfill gas control system, and closure cap for a total of $20.5M. This includes cost for a closure cap for 60 acres including both the inactive and active landfill area. For Alternative 1-1, it is assumed that 14 acres of the “inactive” area of the Navy Landfill would be lined and equipped with a LCRS; however, the active area would not be lined. The costs assume that a LFG control system would be installed on 60 acres to include a flare. This is not categorically required under the new source performance standards, but it was assumed that it would be installed based on requirements or option of the GEPA or Navy as discussed in Section 4.1. It is assumed that the construction of all items except the LFG control system and closure cap would occur in 2009. For the private financing model, it is assumed that these initial landfill costs would finance and amortized for anticipated landfill life of 15 years. For the economic analysis, installation of the LFG control system is conservatively assumed to occur in 2013 to allow time for filling on the inactive area to appropriate grades. Closure capping would occur when the entire landfill reaches final grades.

The estimated capital costs for Alternative 1-2 total $32.2M. The main difference is that the liner and LCRS system would include a separation liner over the active landfill area.

The estimated annual operational costs for Alternative 1 are shown below and include costs for the current troop levels and the estimated costs after completion of the proposed Marine relocation.

Landfill Operation Cost - Current

Description	Qty	Hrs /Day	Hourly Wage	Hourly Equipt	Daily Cost	Annual Cost
Personnel						
Manager/Supervisor	1	8	25.00		200	50,400
Operator/Equipment Operator Onsite	1	8	16.12		129	32,503
Equipment Operator Onsite	1	8	16.12		129	32,503
Drivers/Operators Refuse Collection	8	8	9.50		608	153,216
Laborers	3	8	10.29		247	62,225
Environmental Specialist	1	2	21.10		42	10,634
Equipment						
Dozer Operation	1	4		66.77	267	67,304
Refuse Truck Operation	8	6		25.55	1,226	309,017
Totals					2,848	717,802
Collection Drivers and Trucks Only						462,233

Note: Refuse truck operation based on Apra Harbor Landfill location

Landfill Operation Cost - Projected

Description	Qty	Hrs /Day	Hourly Wage	Hourly Equipt	Daily Cost	Annual Cost
Personnel						
Manager/Supervisor	1	8	25.00		200	50,400
Operator/Equipment Operator Onsite	1	8	16.12		129	32,503
Equipment Operator Onsite	1	8	16.12		129	32,503
Drivers/Operators Refuse Collection	29	8	9.50		2,128	555,408
Laborers	5	8	10.29		412	103,708
Environmental Specialist	1	2	21.10		84	21,269
Equipment						
Dozer Operation	1	8		66.77	534	134,608
Refuse Truck Operation	29	6		25.55	4,292	1,120,185
Totals					8,137	2,050,584
Collection Drivers and Trucks Only						1,675,593

Note: Refuse truck operation based on Apra Harbor Landfill location

These include the collection and costs and landfill operations costs, as denoted. The expected increase in operating staff hours is in part due to tonnage increase and also due to additional duties related to operating a landfill with a LFG control system.

The economic analysis in Section 5.5 assumes that these costs will grow in relation to the waste stream tonnage between the two scenarios shown. It also includes estimated annual sums for operations and maintenance of LFG control system during operations and in the post closure maintenance period.

5.1.3 Issues

The principal issue with this alternative is that neither sub-alternative will provide the desired 50 year economic service life.

5.2 Alternative 2 – Use New Landfill Constructed by GOVGUAM

5.2.1 Analysis

The permitting for the Layon Landfill is virtually complete and DPW ready to issue a two-phase construction bid package. Construction was expected to be completed in 24 months. In 2006, the DPW developed a financing plan for closure of Ordot and the construction of the new Layon Landfill that included approximately $13 million in DPW reimbursement costs for planning, design development and permitting activities, approximately $23.4 million in Ordot closure costs, $62.5 million for the development of new landfill and approximately $2 million transfer station improvements through the issuance of approximately $118 million in revenue bonds. However, the legislative approval and PUC rate increase approvals necessary for providing the revenue assurance to the financing community has delayed the revenue bond financing. This delay in closure of Ordot as required under the Consent Decree has resulted in DPW being fined. In addition, the US District Court has placed the Guam Solid Waste Management program in receivership for not complying with the Consent Decree.

5.2.2 Costs

Expense estimates for operations, which are subject to certain economies of scale, will vary based on the quantity of waste delivered to the Layon Landfill. The rate of delivery will also affect the actual timing for the required future cell expansions.

The DPW will incur expenses from the Layon Landfill operations which will include:

- Layon Contractor landfill operating fee
- DPW scale facility operations

Preliminary operating cost estimates were prepared for the financing of Layon Landfill assumed a September 2008 start of operations in accordance with the Consent Decree schedule. At that time, it was estimated that the Layon Contractor operating fee will be approximately $16 per ton (in 2007 dollars), based on the projected tonnage delivery quantities. These rates are assumed to escalate at an annual rate of 3 percent per year.

In addition, debt service costs for revenue bonds for the entire financing were estimated at that time to be approximately $8.8 million per year. Approximately 65 percent of these estimated capital costs were directly related to the Layon Landfill development. However, the project implementation delays have likely increased these costs.

The DPW plans to manage the scale facility operations which will require at least two full-time personnel as well as a part-time person to cover periods of vacation and sick leave. The operating expenses associated for the scale house are anticipated to be approximately $105,500 per year, escalated at 3 percent per annum.

There are also significant future costs that would be incurred for landfill cell expansions, landfill closure and post-closure care that were not included in the original financing package. In order to cover these future capital costs, the DPW had planned on establishing a sinking fund surcharge. The plan was to ramp up these surcharges to minimize the initial “rate shock” on the residential population. Therefore, the early 2007 projection for the 2009 tipping fee at the landfill was approximately $95 per ton.

This rate assumed that the DPW improved residential bill collection efficiency for solid waste collection services to reduce the delinquent accounts, which was more than 50 percent. The revenue shortfall from these delinquent accounts has historically resulted in funding shortfalls for equipment maintenance and unsatisfactory service quality.

5.2.3 Schedule

As discussed in Section 4, GovGuam has not met the deadlines established by the EPA Consent Decree for opening of their new landfill and closure of the Ordot Dump. At this time, the landfill design documents are reported to be under revision, and a definite implementation schedule for construction and operation of the new landfill has not yet been established.

5.2.4 Issues

As discussed in Section 4 above, there are conflicting opinions in the legislature regarding the landfill location, project financing approvals, private versus public solid waste services and waste disposal options. Therefore, while a GovGuam option could eventually be implemented, the final costs and schedule for availability are uncertain. Therefore, the DoD would need an alternative that assures that viable waste disposal will be available.

5.3 Alternative 3 – Construct New Landfill in Central Guam

5.3.1 Analysis

The preliminary site assumed for a new DoD landfill in Central Guam is located in the Ordnance Annex. The site assumed for a new Navy Landfill in central Guam would provide approximately a 60-acre landfill footprint. The existing topography of the site ranges from about 400 feet MSL at the north along Route 5, to approximately 650 feet MSL at the southwestern edge. The landfill site would be accessed from Route 5 by a new road.

A conceptual base and final grading configuration was developed for this report, and would have a maximum elevation of approximately 680 feet MSL. Based on preliminary calculations this configuration would provide a design capacity of 6.35 million cubic yards, or about 2.86 million tons at a waste density of 1,200 lbs/cy and a waste to cover material ratio of 3:1. At the projected annual solid waste stream of 53,320 tons beginning in 2019 after the proposed USMC relocation is completed, the estimated capacity would provide a service life of about 50 years.

The new Navy Landfill would require a permit from the GEPA. There are also remnants of World War II structures that are of historic significance. Section 106 consultation with the Guam Historic Preservation Office would be needed, and mitigation measures may be required. Santa Rita spring is located near the proposed site, and a study to determine the potential impact to the spring may be required.

5.3.2 Costs

Estimated capital dollar costs for initial landfill development under Alternative 3 are shown below for a total of $97,000,000. This includes initial construction for a 60-acre facility with a liner and LCRS. The private financing model assumes that the initial site development and construction of the first two landfill modules would be financed and amortized for 20 years. The remaining eight landfill modules would be funded by scheduled sinking funds (see Appendix D.2). The economic analysis in Section 5.5 assumes this facility would be available in 2012.

ALTERNATIVE 3 NEW LANDFILL	
Landfill Control Building	$687,000
Truck Scale Facility	$140,400
Leachate Treatment System	$2,328,560
Site Work	$65,057,200
Liner and Leachate Collection System	$28,379,520
	$96,593,120

This landfill cost summary does not include costs for a closure cap or LFG control system, which will occur as the site develops. The economic analysis in Section 5.5 is based on a 50 year period for cost comparison of the alternatives (to 2058). During this period the following additional capital costs are assumed to be required, which would be funded using a sinking fund approach.

- 2032 – Construction of the initial phase of the LFG control system over 20 acres and an associated flare. Estimated current dollars cost is $600,000.
- 2038 – Half of the closure cap, involving the estimated landfill capacity of 50 years, is accounted in the analysis based on a current dollars cost of $3,800,000.
- 2045 – It is assumed that the LFG control system will be extended 15 acres (for a total of 35 acres) at an estimated current dollars cost of $450,000.
- 2058 – at the end of the 50-year alternative cost effectiveness comparison in Section 5.5 the estimated current dollars cost of $300,000 for extending the LFG control system an additional 10 acres (total system of 45 acres at that time) is applied. A prorated portion of remaining portion of the landfill final cover cap (20 of 25 years) is also applied in the year 2058. This is estimated to be $3,000,000. (The landfill life would extend to 2063).

The estimated annual operational costs for the Apra Harbor landfill staff and collections operations in 2013 were previously itemized in Section 5.1.2. In the economic comparison in Section 5.5, it is assumed that collection costs under Alternative 3 will increase by 15 percent based on the additional off-route truck time compared to use of the Apra Harbor Landfill (basis of that estimated figure is included in Section 5.5).

5.3.3 Issues

The principal issues regarding this option include verifying the site, performing environmental studies, developing historic asset mitigation measures and obtaining the required permit from the GEPA.

5.4 Alternative 4 – Construct an Incinerator/ Waste-to-Energy facility

DoD has implemented WTE facilities at other base locations to provide steam and electrical energy for its facilities. Therefore this option was considered potentially viable considering the high cost of energy production on Guam.

5.4.1 Analysis

Both a multi-unit modular mass burn facility and a single-unit field-erected waste-to-energy facility were evaluated. Each of these technologies has certain advantages and limitations, but either could be used to manage the combustible portion of the waste stream. The non-combustible components of the waste stream and items such as metal lawn chairs, bicycles, tree trunks, sludge materials, and other materials normally would not be received or would be sorted on the tipping floor and not processed. Pallets may be broken up on the floor or by the crane or loader and then may be charged. Green waste could be taken to a composting operation or may be processed other than large limbs and tree trunks. The retention time in the combustion chamber is not long enough to fully combust such large items and will show up in the ash, which could cause a pluggage in the ash handling system. Recyclable materials could be removed from the waste stream prior to delivery to the WTE facility to minimize the size of the combustion unit. Ash and residue from the modular facility may have a slightly higher residual combustible content and moisture content, but the difference is usually small.

Because some materials cannot be processed and due to the ash residue a landfill is still required if a WTE facility is used. The landfill would also serve as a backup, if the WTE facility is down for maintenance and not capable of processing some or all of the combustible waste. Waste reduction is about ninety percent by volume for the material processed, greatly increasing landfill life. For this analysis it is assumed that about 54 percent reduction can be expected in the volume of material required to be landfilled. It may be possible to find reuses for some or the entire ash residue. Research is underway and applications as a replacement for aggregate material may be possible in the future. In Europe, the bottom ash material is often used in the sub-base of roadways and similar projects. Bottom ash constitutes about 70 to 80 percent of the total ash residue material, thus significant reduction may occur. However, management of the remaining fly ash may require special treatment. Therefore, for this study, ash reuse has not been considered.

Ferrous (magnetic) metal is often recovered from WTE facility ash. It is anticipated that much of the ferrous metal would be removed prior to the waste being sent to the WTE facility and that insufficient ferrous metal will remain to warrant installation of a ferrous recovery system. A reassessment of this assumption could be completed after a facility has been installed and a ferrous recovery system could be added later. Ferrous recovery could offer another potential revenue stream for the facility.

The processing unit(s) requires periodic maintenance. Modular units likely will require short planned outages at least quarterly and possibly as frequently as monthly. Glass material may need to be removed from the primary chamber and other repairs may be required. Field-erected units can achieve longer run cycles. Generally outages are scheduled every six months. Unplanned outages also will occur generally due to equipment failures and material handling issues. The overall capacity factor for the facility however is expected to be 85 percent for modular units and possibly slightly higher (88 percent) for field-erected units.

This analysis assumes energy recovery will be completed. The value of electrical power helps to justify the addition of a turbine generator for the facility. No suitable steam uses have been identified at this time. Use of steam for process applications can greatly increase the economics of the facility by offsetting fossil fuel currently used to generate the steam. This could be a possible upside potential for a facility if a significant steam user is identified.

Air emissions requirements from the facility can be achieved with existing technology. Highly restrictive requirements for larger facilities have been in place for many years and much experience has been demonstrated with field-erected facilities. Somewhat less data is available documenting experience with modular units, however a number of facilities exist and have achieved the requirements. Modular units may have lower emissions for certain pollutants such as NOx; however some of the control technologies used on larger field erected units can greatly reduce this pollutant. Not all of these control technologies may be as effective on modular units.

WTE facilities do require significant consumption of water. The water may be used for boiler makeup, steam cooling, ash quenching, flue gas cooling, and other uses. In an area where water is limited, this may be a concern. Not all water used by the facility is required to be potable or even fresh water. Some facilities use wastewater treatment tertiary water for certain applications. The specific demand for any facility would need to be evaluated. A preliminary site for the WTE facility could be at the south end of South Finegayan adjacent to the proposed location of a possible DoD wastewater treatment plant.

5.4.2 Costs

Capital and operating costs for WTE were developed for both a modular mass burn WTE facility as well as a field-erected mass burn WTE facility. Because energy revenues are significant, a case for an incinerator without energy recovery was not considered. In both cases, it was assumed electricity would be produced and no steam sales would occur. The modular facility is less capital intensive; however the life of the facility is shorter and is less efficient at energy recovery. The field-erected unit is more expensive, but is more durable and part of the extra cost is offset by higher revenue generation.

Because a specific site has not been definitively selected, site development costs are based on a generic site and could vary depending on the site characteristics. It is assumed however that site roadway, utilities, and other improvements are required. No assumption regarding demolition of existing structures was included. It is assumed that water would be obtained from existing nearby supply systems and wells are not needed. Scales and a scale house are included in the estimate.

Since the location of the landfill relative to the combustion facility is not definitively known, for purposes of this analysis it is assumed that the landfill is relatively close and a typical haul cost and disposal fee is included. The actual values will depend upon the final facility arrangement. Overhead and profit for a contract operator is included for both alternatives. No revenues from recovery of ferrous metal were included.

The capital cost for a modular facility is estimated to be about $48 million for the equipment and facility. It is assumed that these initial capital costs would be financed and amortized over 20 years. This includes design engineering, permitting construction, start-up and testing, and other costs to bring the facility to the point of commercial operation. The modular boilers are expected to arrive in a series of shipping crates. The components are partially preassembled minimizing field erection time and costs. Additional equipment such as ash handling and water treatment would be added around the combustion units. The single stage steam turbine would be located in a separate building along with other waterside equipment. Administration and locker areas are also included. Nearly all equipment and operations will be located indoors with waste received and stored on a tipping floor. The waste will be handled with a front-end loader

Annual operating costs are projected to be about $6 million dollars. A large portion of this cost is for labor. It is assumed that about 23 people would be required to operate the facility. Shifts will be maintained around the clock, seven days a week with three people required to operate the facility. During the daytime, additional personnel will be on site to complete administrative tasks, maintenance work, general housekeeping, operate the scales, transport ash and similar tasks. As needed, maintenance and operational help would be called in for other shifts.

Both planned and forced outages will occur for the facility. Planned outages are expected to be required about every two months for each combustor to complete some basic tuning and repairs. Generally these will be short outages just long enough to cool the unit down, inspect the unit and complete the work required. Two to four times per year extra time for additional tasks will be required. Forced outages will also occur. Issues may include boiler tube failures, issues with air pollution control equipment or combustor components. The repairs will be completed and the unit returned to service. The most common system upset is caused by charging something that is too large to process that gets hung up in the ash system or feed system. These issues may be addressed on-line or may require a short outage. It is expected that about 80 to 85 percent availability will be possible.

Electrical revenues are estimated for the modular facility to produce about $490,000 of income for the project. It is assumed that 11 cents per kilowatt can be obtained for the power produced. No steam sales revenue is included in the analysis but would offer potential additional revenue stream if a steam customer is identified.

Life extension measures are required to keep the facility operating through the term of evaluation period. These measures are needed for the comparative analysis with other long-term options for waste disposal. Various components of the facility require ongoing repair and replacement but some component systems eventually wear out and require more significant replacement. For instance, the refractory inside the combustor will crack and need to be replaced as part of the general maintenance for the unit. Over time, however, the entire combustor shell will need to be replaced due to the temperatures and operating conditions encountered. Although the estimated operating costs includes typical maintenance reserves for operating over a typical twenty year contract period, additional capital investment would likely be required to maintain the facility over a 50-year analysis period. The timing of these capital investments is difficult to predict for any particular facility, but based on available data the net present value of these capital investments is expected to be nearly $30 million for the modular WTE facility. Under the private financing model, it is assumed that the majority of these capital costs would be financed and amortized over 20 years, except for smaller costs for minor facility rehabilitation, which would be funded using sinking funds.

The capital cost for a field-erected facility is estimated to be more than twice the cost of a modular facility at about $98 million dollars for the equipment and facility. It is assumed that these initial capital costs would be financed and amortized over 20 years. This includes design engineering, permitting construction, start-up and testing, and other costs to bring the facility to the point of commercial operation. The field-erected boiler has a higher cost for a number of reasons including the extra cost of construction at the site. Since a single unit is provided the nominal size of the facility is larger to provide some additional margin to process accumulated waste after facility outages. Field erection results in a more durable unit. Additional equipment such as ash handling and water treatment would be added around the combustion units. The condensing steam turbine would be located in a separate building along with other waterside equipment. Administration and locker areas are also included. Nearly all equipment and operations will be located indoors with waste received and stored in a concrete bunker. The waste will be mixed and charged using refuse cranes.

Annual operating costs are projected to be about $7 million dollars. Labor required for the field-erected unit is assumed to be similar to that required for the modular facility. It is assumed that about 23 personnel would be required to operate the facility. Shifts will be maintained around the clock seven days a week with three personnel required to operate the facility. During the daytime additional personnel will be on site to complete administrative tasks, maintenance work, general housekeeping, operate the scales, transport ash and similar tasks. Maintenance and operational help would be called in for other shifts as needed.

Both planned and forced outages will occur for the facility. Planned outages are expected to be required about every six months to complete some basic tuning and repairs. Generally these will last several days to allow for inspection of the unit and completion of the work required. Forced outages will also occur. The most common problems include boiler tube failures, issues with air pollution control equipment or combustor components. The repairs will be completed and the unit returned to service. Short term outages or upsets may result from charging something that is too large to process or gets hung up in the ash system. It is expected that about 85 to 88 percent availability will be possible.

Electrical revenues are estimated for the modular facility to produce about $1,700,000 of income for the project. It is assumed that 11 cents per kilowatt can be obtained for the power produced. No steam sales revenue is included in the analysis but would offer potential additional revenue stream if a steam customer is identified.

Life extension measures are required to keep the facility operating through the term of evaluation period. These measures are needed for the comparative analysis with other options for waste disposal. Various components of the facility require ongoing repair and replacement but some component systems eventually wear out and require more significant replacement. Although the estimated operating costs includes typical maintenance reserves for operating over a typical twenty year contract period, additional capital investment would likely be required to maintain the facility over a 50-year analysis period. Over the life of this extended evaluation period, it is assumed that a fund with $5.3 million would be required for the field erected WTE facility. It is assumed that the majority of these capital costs would be financed and amortized over 20 years, except for smaller minor facility rehabilitation costs, which would be funded using sinking funds.

5.4.3 Schedule

Development, permitting, and construction of a WTE facility must be completed prior to commercial operation of the facility. It is estimated that five years is required to complete these steps. Implementation of a project can be achieved prior to 2014 when it is anticipated that the facility would be required. Progress would however need to begin soon and no major roadblocks occur for it to be in place by that time. A landfill will still be required at that time for ash disposal and for disposal of non-combustible waste and bypass waste.

5.5 Alternative Comparisons

5.5.1 Implementation and Scheduling Issues

Table 5-1 describes the major scheduling assumptions for this report. As shown, these are what are judged the most optimistic or aggressive scheduling assumptions also used in the cost comparison in the following section.

The first row shows the assumed implementation actions for the Navy Landfill at Apra Harbor. For Alternative 1, including both final fill configurations, 1-1 and 1-2 it is assumed that the Navy would install a liner on all or part of the permitted landfill area footprint in 2009 to allow additional landfilling.

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TABLE 5-1

Scheduling Assumptions

Alternative	1-1	1-2	2	3	4
Description	Apra Harbor Landfill (54 MSL)	Apra Harbor Landfill (100 MSL)	GovGuam Landfill near Layon	New Navy Landfill in Central Guam	Waste-to-Energy
Major Implementation Actions at Apra Harbor Landfill	2009 Landfill improvements and line inactive area only 2013 LFG control system and flare	2009 Landfill improvements and line entire footprint 2013 LFG control system and flare	2010 Construct closure cap and LFG venting system (active area only - no liner)	2009 Landfill improvements and line inactive area 2013 Closure cap and LFG control system installation	2009 Landfill improvements and line entire footprint 2013 LFG control system and flare
Alternative Implementation			2010 Begin landfilling at GovGuam Landfill (pending resolution of issues)	2012 Construction of initial module and site ancillary facilities needed for operation.	2012/13 Construct WTE Facility
Assumed Life of Alternative Implementation Measures	14 years (2023) (7.4 ppp/d and revised operations)	27 years (2036) (7.4 ppp/d and revised operations)	>50 years (>2058)	>50 years (>2058)	>50 years (>2058)
Major Projects Over Life or 50 years	2023 Assumed closure cap	2036 Assumed closure cap		2038 Assumed incremental closure of ½ of landfill	2029, 2039, 2049 Minor life extension measures 2034, 2054 Minor life extension measures

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For Alternative 2, it is assumed that GovGuam would resolve permitting and implementation issues and the new landfill near Layon would be available for landfilling in 2010. In this case, it is assumed that the Navy would not need to provide the investment of lining the inactive area of the Navy Landfill and would perform limited filling of the active area prior to performing closure in 2010.

Alternative 3 assumed that it will take three years for the Navy to perform site selection, design and permitting of a landfill in Central Guam. Construction of the initial lined module and ancillary facilities would occur in 2012 to allow filling operations to begin at the new site and closure of the Apra Harbor Landfill in 2013.

The implementation of Alternative 4 is assumed to require construction of a WTE facility in 2012 and 2013.

A major difference between Alternative 1 and the other alternatives implementing new strategies or facilities is that Alternative 1 does not provide service for the 50 year period analyzed in the cost effectiveness analysis in the following section. The site lives for the two final fill configurations used for Alternative 1 are estimated to extend to 2023 and 2036, respectively. One of the other alternatives would have to be implemented to provide a long term strategy of 50 years to the year 2058. Under these scenarios minor and major rehabilitation of the WTE facility would have to occur for Alternative 4.

Given its considerable size, out of operational considerations it is assumed that the Navy will consider developing the new Landfill in Central Guam in modules. Constructing the new landfill sequentially in modules is recommended to reduce the exposure of unused liner to degradation from ultraviolet rays and to storm-water that must be managed separate from the LCRS flows. Constructing an entire liner for 50 years of landfill area is not preferred because exposure to the elements, in particular sunlight ultraviolet rays would compromise the liner. However, the entire landfill liner and development cost is discounted in a lump sum in 2012, the initial year of liner construction.

As discussed previously, the schedule allowing the Navy to use the GovGuam facility is a significant uncertainty at this time. However, even if it is delayed longer than the assumed year of availability of 2010 it is unlikely that it would be delayed beyond 2013 when the other alternatives would become operational unless there is a fatal flaw and the GovGuam landfill cannot become operational as proposed by GovGuam. In this case it would not be a viable alternative.

5.5.2 Cost Comparison

The total net present value costs based on 25-year and 50-year periods under military construction funding for the detailed evaluation of solid waste alternatives are summarized in Table 5-2. The total net present value costs based on 25-year and 50-year periods under private funding for the detailed evaluation of solid waste alternatives are summarized in Table 5-3. Appendix D contains the spreadsheet tables that show the annual current dollars and present value analysis for the capital, operating and revenues (WTE Alternative) for the alternatives under both military construction funding and private funding. Appendix D also contains the detailed cost assumptions and calculations used for the analysis.

Following are major findings regarding the cost and economic analysis:

- Continued use of the existing Navy Landfill at Apra Harbor with lining of the inactive portion of the landfill and a separation liner over the active portion of the landfill is the most cost-effective alternative when considering only a 25-year planning period. This alternative would not provide 50-years of service unless the Navy was willing to exceed the anticipated target elevation of 100 feet MSL.
- Navy implementation of a new landfill in Central Guam (Alternative 3) at the assumed location provides the most cost effective alternative over the 50-year analysis period, assuming a $95/ton tip fee for use of the proposed GovGuam Landfill near Layon (Alternative 2). The long term 50-year analysis shows the present value of Alternative 3 as approximately nine percent lower given the economic assumptions.
- Although the Apra Harbor Landfill does not provide 50 years of service without implementing another alternative strategy; utilizing the existing Apra Harbor Landfill to the capacity provided by Alternative 1-2 prior to implementing a new landfill in Central Guam would provide the most cost effective strategy. This is demonstrated by the result that the net present value cost of Alternative 1-2 is less than Alternative 3 for the 25-year analysis.
- The WTE alternatives are roughly 1.5 times the estimated present value of a new Central Guam Landfill due to retention of the landfill costs for non-burnable waste and ash plus the higher operating costs for a WTE facility.

Table 5-2
Summary of Present Value Analysis – Military Construction Funding

Alternative	PV Analysis 25 - Year	PV Analysis 50 - Year
Alternative 1-1 Apra Harbor Landfill - 54 ft MSL See Note b	Inadequate Service Life	Inadequate Service Life
Alternative 1-2 Apra Harbor Landfill - 100 ft MSL See Note c	56,000,000	Inadequate Service Life
Alternative 2 GovGuam landfill See Note d,e	123,000,000	189,000,000
Alternative 3 New Navy Landfill See Note f	149,000,000	174,000,000
Alternative 4a Modular WTE Facility See Note g	179,000,000	270,000,000
Alternative 4b Field-Erected WTE Facility See Note g	210,000,000	277,000,000

Notes:

a Present Value Analysis uses a real discount rate of 2.8 percent in accordance with OMB Circular No. A-94, Appendix C, Rev January 2008.

b Estimated service life is limited to the year 2023 and would be exhausted prior to the end of the 25-year and 50-year analysis periods.

c Estimated service life is limited to the year 2036 and would be exhausted prior to the end of the 50-year analysis period.

d Assumed tip fee at the GovGuam landfill is $95/ton over the analysis period.

e Costs include an estimated 40 percent increase in collection driver/truck costs to use GovGuam landfill as compared to the current system. After the proposed relocation of Marines is completed, 80 percent of the DoD solid waste stream will be generated in Northern Guam.

f Costs include an estimated 15 percent increase in collection driver/truck costs to use new Navy landfill in Central Guam as compared to the current system. After the proposed relocation of Marines is completed, 80 percent of the DoD solid waste stream will be generated in Northern Guam.

g It is assumed that WTE would extend service life of the Apra Harbor Landfill to 65 years for landfilling of incombustible waste and residual ash.

Table 5-3
Summary of Present Value Analysis – Private Entity Funding

Alternative	PV Analysis 25 - Year	PV Analysis 50 - Year
Alternative 1-1 Apra Harbor Landfill - 54 ft MSL See Note b	Inadequate Service Life	Inadequate Service Life
Alternative 1-2 Apra Harbor Landfill - 100 ft MSL See Note c	60,000,000	Inadequate Service Life
Alternative 2 GovGuam Landfill See Notes d,e	123,000,000	189,000,000
Alternative 3 New Navy Landfill See Note f	153,000,000	176,000,000
Alternative 4a Modular WTE Facility See Note g	184,000,000	270,000,000
Alternative 4b Field-Erected WTE Facility See Note g	217,000,000	283,000,000

Notes:

a Present Value Analysis uses a real discount rate of 2.8 percent in accordance with OMB Circular No. A-94, Appendix C, Rev January 2008.

b Estimated service life is limited to the year 2023 and would be exhausted prior to the end of the 25-year and 50-year analysis periods.

c Estimated service life is limited to the year 2036 and would be exhausted prior to the end of the 50-year analysis period.

d Assumed tip fee at the GovGuam landfill is $95/ton over the analysis period, which is discounted over the analysis period.

e Costs include an estimated 40% collection driver/truck cost increase to use GovGuam landfill as compared to the current system. After proposed USMC relocation is completed, 80% of the DoD solid waste stream will be generated in Northern Guam.

f Costs include an estimated 15% collection driver/truck cost increase to use new Navy landfill in Central Guam as compared to the current system. After proposed USMC relocation is completed, 80% of the DoD solid waste stream will be generated in Northern Guam.

g It is assumed that WTE would extend service life of the Apra Harbor Landfill to 65 years for landfilling of incombustible waste and residual ash.

h. Capital projects over the study period were assumed to be financed or funded through a sinking fund, except for Alternative 2, which utilizes planned GovGuam Landfill costs.

i. Capital projects financing assumed 20-year periods except for Alternative 1-1, which used a 15-year period based on projected service life.

j. Capital projects financing assumed Japanese bank financing with an amortized origination fee of 1.00 percent and an interest rate of 2.5 percent.

k. Capital project sinking funds used various accumulation periods based on cash flow requirements and assumed earned interest at an annual percentage rate of 1.0%.

l. Equal annual landfill closure fund deposits were accumulated over the alternative landfill life including earned interest at an annual percentage rate of 1.0%.

5.5.3 Pros and Cons

Table 5-4 is a matrix of the four viable alternatives analyzed in this section after alternatives 5 through 10 were judged non-viable as described in Section 4. The table lists the pros and cons of the alternatives in terms of environmental, regulatory, implementation/policy, economics and scheduling issues.

Although Alternative 1 presents the most economical approach, it is limited in service life for Alternative 1-1 (7 to 14 year site life depending on operations) and does not present a comparable 50-year economic life for Alternative 1-2. Although with improved equipment and operational practices at the Apra Harbor Navy Landfill it is estimated that an additional 27 years of site life would remain. There may be some concerns about a separation liner above waste being compromised in the long term by differential settlement, or the affects of significant waste overburden on the existing unlined portion of the landfill that may be releasing low levels of VOCs. Based on this evaluation, Alternative 1 appears to provide an interim approach to implementing one of the other alternatives in the long term.

Alternative 2, use of the planned GovGuam landfill, provides an economical approach. Based on the projected $95/ton tip fee, use of the proposed GovGuam landfill was shown to be comparable in cost-effectiveness to construction of a new Navy Landfill. However, given the level of uncertainty and difficulties experienced by GovGuam in implementing the new landfill, the proposed GovGuam landfill does not appear to be as reliable as implementing a new Navy Landfill in Central Guam.

Alternative 3, a new Navy landfill in Central Guam, provides an economical approach based on the present value analysis over both 25 and 50 year periods. A drawback to this approach appears to be that the GEPA has indicated a preference that the Navy and DoD use Alternative 2, the planned GovGuam Landfill near Layon.

Alternative 4 is significantly more costly than use of the proposed GovGuam landfill and a new Navy Landfill in Central Guam. A WTE facility at the relatively small scale required has poor economics which are even more costly as a strategy given that a landfill operation would also need to continue for non-burnable waste and residual ash. However, a WTE facility also provides for continued solid waste disposal capacity well beyond 50-year period utilized for this study. Because of the very limited availability of land on Guam, WTE should continue to be considered as part of a "very-long-term" strategy for handling and disposal of DoD solid waste on Guam.

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TABLE 5-4
SUMMARY MATRIX OF COMPARATIVE PROS AND CONS (P= Pro; C= Con)

Alt.	Option/Issue	Environmental	Regulatory	Implementation/Policy	Economics	Schedule
1	Improve Existing Navy Landfill at Apra Harbor (AHNLF)	C- May increase extent/duration of VOC migration C- Slightly greater degree of GHG emissions compared to adding WTE and/or MRF C- Separation liner (Alt 1-2) has potential to fail due to differential settlement.	C- GEPA likely to require separation liner over active area (assumed for Alternative 1-2 but not Alternative 1-1). C- Would use AHNLF up to 27 years by filling to elevation 100 MSL (Alt. 1-2). The GEPA may not approve a permit for continued use of the landfill for this long of a period.	C- GovGuam and GEPA prefer regional landfill for entire island	P/C – Alternative 1-1 does not provide comparison to other alternatives for 25 and 50-year periods; however, can be used as less costly interim alternative to Alternatives 2 through 4. C- Significant capital cost required for liner and LCRS system under Alternative without providing long-term strategy.	P- Although not providing a long-term strategy, provides more than adequate flex time for decisions and implementing other alternatives (Alt. 1-1= 2015 with current fill practices; Alt. 1-2=2036, with revised filling practices).
2	Use New Landfill Constructed by GovGuam	P- Entire new GovGuam landfill would be lined with base liner on native soil (compared to separation liner over waste for Alt 1-2)	P- If available soon (assumed expedited by 2010), $11M for site improvements and liner for inactive area of AHNLF would not be required. P- Based on letter communication GEPA appears to favor DoD use of the proposed GovGuam Landfill and closure of the AHNLF as soon as possible.	C- Historical and current lack of stable garbage fee collection is impediment to obtaining financing of proposed new GovGuam Landfill. C- Navy would be at risk if GovGuam cannot implement proposed new landfill when needed to replace AHNLF. C- Navy would be dependent on the GovGuam landfill; with less control if funding, environmental control, operational or other problems occur with the landfill.	C- Present Value analysis indicates $123M and $189M for 25 and 50 year analysis, respectively, at an assumed $95/ton tip fee. The 50 year analysis indicates that this alternative is nine percent higher than Alternative 3. C- Increase in collection costs from AAFB, the proposed USMC relocation and Navy Base to new GovGuam landfill in south (Estimated 40 percent increase in truck and driver cost compared to AHNLF location). P- New large liner capital investment by DOD not required C- Lack of enforceable fee collection system by GovGuam could negatively affect reliable economics for DoD.	P- There is adequate capacity at the AHNLF provided that GovGuam can resolve all Consent Decree and permitting issues to allow Navy disposal. The AHNLF has a range of 7 to 12 years with current operating conditions and up to 14 to 27 years with recommended operational improvements; depending up whether AHNLF can be filled to elevation 54MSL or 100MSL. C – The timing for resolution of permitting issues for the proposed GovGuam landfill is not clear at this time.
3	Construct New Navy Landfill in Central Guam	P- Lined Landfill should reduce degree/term of VOC migration from existing AHNLF if closed sooner	C- Appears that GEPA wants the DOD to use the planned GovGuam landfill near Layon (letter).	P- New landfill would provide 50 years of service and operational flexibility to the DoD. C- Historic asset mitigation required at preliminary site. C- Potential impact to Santa Rita Spring must be determined. C- Permit form GEPA required	P- Present Value analysis indicates $149M and $174M for 25 and 50 year analysis including capital, landfill operations, and collection driver and truck costs under MCON funding. Under private funding this alternative has a PV of $153M and $176M for 25 and 50 yr analysis, respectively. C- Slightly less collection economics (Estimated 15 percent increase in truck and driver cost) compared to current system using AHNLF	P- Siting and constructing a new MSWLF typically can take at least 4 years. Given that Alternative 1-1 provides 7 years of capacity without operational improvements (heavier equipment and operational improvements may increase this to 14 years); scheduling for developing the new landfill is judged as viable.
4	Incinerator/Waste-to-Energy	P- Less GHG emissions than landfill for combustible fraction of waste stream; also would provide an energy offset C- Landfill still required for significant portion (46 percent) of the waste stream	C- Significant air quality permitting. C- Would use AHNLF in long term for disposal of non-combustible waste and ash. The GEPA may not approve the continued use of the landfill for >50 years given existing portion of unlined waste. C- Guam PL 25-175 Amended 10 GCA Chapter 73, Fire Prevention to prohibit municipal solid waste incinerators. A determination must be made regarding the applicability of 10 GCA Chapter 73 to DoD.	C- Significant initial financing is required: $46M and $98 capital cost, respectively, for Modular (4a) or Field Erected (4b) facilities.	C - Present Value analysis for Modular (4a) facility indicates $179M and $270M for 25 and 50 year analysis, respectively under MCON funding. Under private funding this alternative has a PV of $184M and $270M for 25 and 50 yr analysis, respectively. C - Present Value analysis for Modular (4b) facility indicates $210M and $277M for 25 and 50 year analysis, respectively under MCON funding. Under private funding this alternative has a PV of $217M and $283M for 25 and 50 yr analysis, respectively.	C- Expedited earliest schedule is assumed to allow phased construction in 2012 and 2013 at the soonest.

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6.0 Limitations

6.1 Waste Diversion Potential

The focus of this study is the final disposal of solid waste. Therefore, methodologies such as materials recovery, waste diversion, waste minimization, and source reduction were not incorporated into the analysis. These methodologies would generally reduce the volume of solid waste requiring final disposal. However, for this study, they would not significantly affect the selection of a particular disposal technology. When final selection of a disposal facility is selected, however, waste diversion potential should be reevaluated.

6.2 Additional Development Studies

Additional development studies will be needed and include the following:

- Conduct a site engineering investigation for improvements to the existing Navy Landfill at the Apra Harbor Naval Complex. Prepare a landfill operation and implementation manual with grading plans to facilitate filling to the target final landfill elevation.
- Conduct a site engineering investigation of the proposed site for a new Navy Landfill in the Apra Harbor Naval Complex Ordnance Annex.
- Conduct environmental investigations for the proposed site for a new Navy Landfill in the Apra Harbor Naval Complex Ordnance Annex. The environmental investigations would more definitively identify the potential impacts and mitigative measures that may be required.
- Conduct a preliminary engineering study for development of a DoD Waste-to-Energy Facility.
- Conduct an engineering study to investigate the feasibility of a solid waste transfer station and materials recovery facility on DoD property in northern Guam.

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7.0 Recommendations

The major findings of the study are summarized below.

- Continued use of the existing Navy Landfill at the Apra Harbor Naval Complex is necessary to provide sufficient time to implement planning and construction of new solid waste disposal facilities.
- GEPA has regulatory primacy for enforcing USEPA solid waste regulations on Guam. It is anticipated that soon after the new GovGuam lined landfill becomes operational, GEPA would require all landfills on Guam to be lined or to be closed. This would have a direct impact on the existing unlined Navy Landfill at Apra Harbor. It would be prudent to begin programming a project that would include a liner for the inactive portion of the existing landfill and a separation liner for the active portion of the existing landfill.
- A landfill is needed for essentially any alternative considered. Materials that cannot be handled by a particular process and the residual material generated by a process will require landfill disposal.
- Continued use of the existing Navy Landfill at the Apra Harbor Naval Complex would not provide 50 years of service unless the DoD is willing to fill to elevations higher than 100 feet mean sea level (MSL). Based on current design criteria for constructing landfills, the existing landfill could be filled to elevation 140 feet MSL.
- Construction of a new DoD landfill on DoD property in central Guam is the most cost-effective and reliable alternative on a 50-year life cycle cost basis under both military construction and private sector funding. Because the landfill would be a DoD landfill, the DoD would control the waste allowed to be disposed in the landfill. Certain waste streams could be diverted to other available solid waste facilities, such as the GovGuam landfill, to extend the life of the DoD landfill.
- Use of the GovGuam Layon Landfill has a 50-year life cycle cost that is slightly higher but essentially comparable to construction of a new DoD landfill. However, the Layon Landfill has not yet begun construction and it is uncertain when the landfill would become operational. In addition, under this alternative, the DoD would be entirely dependent on the Layon Landfill. If the capacity is reached earlier than anticipated and GovGuam again has difficulties in constructing a replacement landfill, the DoD will be significantly impacted.

- Construction and operation of a waste to energy (WTE) facility has the highest 50-year life cycle cost. However, a WTE facility has potential for extending the life of the existing Navy Landfill at the Apra Harbor Naval Complex well beyond the 50-year service life considered for this study.

Based on the results of the analysis and evaluations performed for this study, the recommendations below are offered.

- Establish a planned final fill plan for the existing Navy Landfill at the Apra Harbor Naval Complex corresponding to the alternative final fill plan for elevation 100 feet mean sea level. Retain the option to fill to elevation 140 feet mean sea level if the need arises in the future.
- Revise landfill operation practices as recommended in the Sanitary Landfill Management Plan. The revised practices include utilizing a systematic daily cell construction method with a single application of daily cover material, and obtaining heavier landfill operating equipment, such as a Caterpillar D8 or equivalent, outfitted for landfill service.
- Implement improvements to the existing Navy Landfill including the construction of a liner for the inactive area and a separation liner for the active area. The project can be phased to allow flexibility to make adjustments if construction of a Waste-to-Energy Facility moves forward. The liner should be designed to accommodate filling to elevation 140 feet mean sea level. This would provide DoD the flexibility to fill to that elevation if it became necessary to do so.
- Conduct a study to develop a long-term strategy for managing potential releases from the unlined active portion of the existing Navy Landfill. The study should include assessment of mitigation measures that might be needed if a separation liner is constructed over the existing active portion of the landfill.
- Develop a project to construct a new Navy Landfill within the Apra Harbor Naval Complex Ordnance Annex. This landfill will be needed in the foreseeable future, particularly if a Waste-to-Energy Facility does not move forward.
- Track status of construction of the new GovGuam landfill and continue to evaluate its potential for disposal of DoD solid waste, particularly residential solid waste generated from housing areas, in the future.

8.0 References

U.S. EPA, Title 40 CFR Chapter 1 Part 258, Criteria for Municipal Solid Waste Landfills, 1 July 1996.

U.S. EPA, Title 40 CFR Chapter 1 Part 60, Subpart AAAA, New Source Performance Standards for Small Municipal Waste Combustion Units, 31 January, 2003

Subtitle C of the Resource Conservation and Recovery Act (RCRA),

GEPA, Rules and Regulations for the Guam Environmental Protection Agency – Solid Waste Disposal, Title 22, Division 4, Chapter 23.

Guam 2006 Integrated Solid Waste Management Plan

U.S. Navy Public Works Center, Guam, Sanitary Landfill Closure Plan and Post Closure Plan, September 1999.

Barrett Consulting Group, Inc., Hydrogeologic Investigation of the Naval Station Landfill, Guam, Mariana Islands, 1 February 1988.

GMP Associates, Landfill Vertical Expansion Evaluation, PWC Guam Landfill, U.S. Naval Public Works Center, Guam, Marianas Islands, September 1996.

A Draft Environmental Impact Statement – – Layon Landfill Location (1995, J.C. Tenorio and Associates, Inc., Consulting Engineers

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Appendices

Appendix A

GEPA Rules and Regulations for Solid Waste Disposal

RULES AND REGULATIONS FOR THE GUAM ENVIRONMENTAL PROTECTION AGENCY (GEPA) SOLID WASTE DISPOSAL

Title 22

Division 4

Chapter 23

Article 1

General regulations

Article 2

Location restrictions

Article 5

Ground-water monitoring and corrective action

Article 6

Closure and post-closure care

Article 7

Financial assurance criteria

Addendum A

Schedule of permit fees for all other solid waste management facilities.

Addendum B

Duration of permit fees for all other solid waste management facilities.

Addendum C

Administrative penalties.

Appendix I

Constituents for detection monitoring.

Appendix II

List for hazardous and organic constituents.

Article 1

General regulations

§23101. Purpose, scope, and applicability. (a) The purpose of this Chapter is to establish the Guam's minimum criteria for all Municipal Solid Waste Landfill (MSWLF) units and other solid waste management facilities. These minimum criteria are intended to ensure the protection of human health and the environment.

(b) These rules and regulations apply to owners and operators of new Municipal Solid Waste Landfill units, existing Municipal Solid Waste Landfill units, and lateral expansions, except as otherwise specifically provided in this Chapter. All other solid waste management facilities and practices that are not regulated under Subtitle C of Resource Conservation and Recovery Act ('RCRA'), 42 U.S.C. §6941, as amended, are subject to the criteria contained in 40 CFR, Part 257.

(c) These criteria do not apply to Municipal Solid Waste Landfill units that do not receive waste after October 9, 1991.

(d) Municipal Solid Waste Landfill units that receive waste after October 9, 1991 but stop receiving waste before October 9, 1993 are exempt from all the requirements of this Chapter, except the final cover requirement specified in Article 6, §23601 'Closure criteria' of this Chapter. The final cover must be installed within Six (6) months of last receipt of wastes. Owners or operators of Municipal Solid Waste Landfill units described in this paragraph that fail to complete cover installation within this Six (6) month period will be subject to all the requirements of this Chapter unless otherwise specified.

(e) All Municipal Solid Waste Landfill units that receive waste on or after October 9, 1993 must comply with all requirements of this Chapter unless otherwise specified.

(f) Municipal Solid Waste Landfill units failing to satisfy these criteria are considered open dumps for purposes of Guam solid waste management planning under RCRA.

(g) Municipal Solid Waste Landfill units failing to satisfy these criteria constitute open dumps, which are prohibited under §4005 of the RCRA.

(h) Municipal Solid Waste Landfill units containing sewage sludge and failing to satisfy these criteria violate §§309 and 405(e) of the Clean Water Act of 1977, 33 U.S.C. 1251, as amended.

(i) This Part shall be effective immediately.

§23102. Definitions. (a) Unless otherwise noted, all terms contained in this Section are defined by their plain meaning. This Section contains definitions for terms that appear throughout this Chapter; additional definitions appear in the specific sections to which they apply.

(1) 'Active area' shall mean that portion of a facility where solid waste recycling, treatment, storage, or disposal operations are being conducted, designed to be, or have been conducted. Buffer zones shall not be considered part of the active area of a facility.

(2) 'Active life' means the period of operation beginning with the initial receipt of solid waste and ending at completion of closure activities in accordance with Article 6, §23601 'Closure criteria' of this Chapter.

(3) 'Active portion' means that part of a facility or unit that has received or is receiving wastes and that has not been closed in accordance with Article 6, §23601 'Closure criteria' of this Chapter.

(4) 'Administrator' shall mean the Administrator of the Guam Environmental Protection Agency or his designee.

(5) 'Agency' shall mean the Guam Environmental Protection Agency.

(6) 'Agricultural waste' shall mean wastes on farms resulting from the production of agricultural products including, but not limited to manures and carcasses of dead animals.

(7) 'Air quality standard' shall mean a standard set for maximum allowable contamination in ambient air as set forth in Guam's Air Pollution Control Standards and Regulations.

(8) 'Alternate Boundary' shall mean a boundary line that may be used in lieu of the disposal facility's property line, subject to the Administrator's approval.

(9) 'Aquifer' means a geological formation, group of formations, or portion of a formation capable of yielding significant quantities of ground-water to wells or springs.

(10) 'Ashes' shall mean the residue including any air pollution flue dusts from combustion or incineration of material including solid wastes.

(11) 'Base Flood' shall mean a flood that has a One Percent (1%) or greater chance of occurring in any year or a flood of a magnitude equalled or exceeded once in One Hundred (100) years.

(12) 'Bioremediation' shall mean the process by which organic materials (e.g. petroleum products) are biologically degraded, usually to innocuous materials such as carbon dioxide, methane, water, inorganic salts, biomass, and by-products that are less complex than the parent compound.

(13) 'Board' shall mean the Board of Directors of the Guam Environmental Protection Agency.

(14) 'Buffer zone' shall mean that part of a facility that lies between the active area and

the property boundary.

(15) 'Bulky waste' shall mean large items of refuse, such as appliances, furniture, automobiles, and other oversize wastes which would typically not fit into reusable or disposable containers.

(16) 'Cell' shall mean compacted solid wastes that are enclosed by natural soil or cover material in a sanitary landfill.

(17) 'Clean Water Act' shall mean the Clean Water Act of 1977 which amended the Federal Water Pollution Control Act of 1972, codified as 33 U.S.C. §1251, as amended.

(18) 'Closure' shall mean those actions taken by the owner or operator of a solid waste site or facility to cease operations and to ensure that all such facilities are closed in conformance with applicable regulations at the time of such closures and to prepare the site for the post-closure period.

(19) 'Collecting agency' shall mean any agency, business or service operated by a person with a Solid Waste Collection Permit for the collection of solid waste.

(20) 'Commercial solid waste' means all types of solid waste generated by stores, offices, restaurants, warehouses, multiple dwellings of five or more units, hotels, motels, bunkhouses, ranger stations, crew quarters, campgrounds, picnic areas, and day-use recreation areas and other non-manufacturing activities, excluding residential and industrial wastes.

(21) 'Compliance schedule' shall mean a written schedule of required measures in a permit including an enforcement sequence leading to compliance with this Chapter.

(22) 'Composting' shall mean the controlled degradation of organic solid waste.

(23) 'Container' shall mean a device used for the collection, storage, or transportation

of solid waste including but not limited to reusable containers, disposable containers and tanks, fixed or detachable.

(24) 'Cover material' shall mean soil or other approved suitable material that is used to cover compacted solid wastes in a land disposal site.

(25) 'Daily cover' shall mean cover material that is spread and compacted on the top and side slopes of a solid waste cell at the end of each operating day or after a period of Twenty-four (24) hours in order to control vectors, fire, moisture and erosion, and to assure aesthetic appearance.

(26) 'Demolition waste' shall mean solid waste, largely inert waste, resulting from the demolition or razing of buildings, roads and other man-made structures. Demolition wastes consists of, but is not limited to, concrete brick, bituminous concrete, wood and masonry, roofing material, steel, and minor amounts of other metals like copper. All these materials can be used as hardfill materials. Plaster or any other material that is likely to produce gases or a leachate during the decomposition process are not considered to be demolition waste for the purposes of this Chapter. Asbestos waste is also not considered to be demolition waste for the purpose of this Chapter.

(27) 'Detachable containers' shall mean reusable containers that are mechanically loaded or handled such as a 'dumpster' or drop box.

(28) 'Disposal containers' shall mean containers that are used once to handle solid waste such as plastic bags, cardboard boxes, and paper bags.

(29) 'Disposal' shall mean the discharge, deposit, injection, dumping, spilling, leaking or placing of any solid waste or hazardous waste into or on any land or water so that such solid

waste or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters including ground-water.

(30) 'Disposal site' shall mean the location where any treatment, utilization, processing, or deposition of solid waste occurs. See also the definition of interim solid waste facility.

(31) 'Endangered or threatened species' shall mean any species listed as such pursuant to the Endangered Species Act of Guam, §63201 of Title 5, Guam Code Annotated or the United States Endangered Species Act of 1973, as amended.

(32) 'Energy recovery' shall mean the recovery of energy in a usable form from mass burning or refuse derived fuel incineration, pyrolysis of any other means of using the heat of combustion of solid waste that involves high temperature processing.

(33) 'Existing facility' shall mean a facility which is owned or leased, and in operation, or for which construction has begun, on or before the effective date of this Chapter and the owner or operator has obtained permits or approvals necessary under Federal and Guam statutes, regulations and ordinances. A facility has commenced construction if either:

(A) on-site physical construction program has begun; or

(B) the owner or operator has entered into contractual obligations which cannot be cancelled or modified without substantial loss for physical construction of the facility to be completed within a reasonable time frame.

(34) 'Existing municipal solid waste landfill unit' shall mean any municipal solid waste landfill unit that is receiving solid waste as of October 9, 1993. Waste placement in existing units must be consistent with past operating practices or modified practices to ensure good management.

(35) 'Expanded facility' shall mean a facility adjacent to an existing facility for which

the land is purchased and approved by GEPA after the effective date of this Chapter. A vertical expansion approved and permitted by GEPA after the effective date of this Chapter shall also be considered an expanded facility.

(36) 'Facility' shall mean all contiguous land and structures, other appurtenances, and improvements on the land used for the disposal, transfer, storage, treatment, and processing, of solid waste.

(37) 'Facility structures' shall mean buildings, sheds, utility lines, and drainage pipes on the facility.

(38) 'Final cover' shall mean a cover system designed and constructed to:

(A) have permeability less than or equal to the permeability of any bottom liner system or natural subsoils present of a permeability no greater than 1 x 10^{-5} cm/sec, which ever is less, and

(B) minimize infiltration through the closed Municipal Solid Waste Landfill unit by the use of an infiltration layer that contains a minimum of Eighteen (18) inches of an earthen material, and

(C) minimize erosion of the final cover by the use of an erosion layer that contains a minimum Six (6) inches of earthen material that is capable of sustaining native plant growth.

(39) 'Final treatment' shall mean the act of processing or preparing solid waste for disposal, utilization reclamation or other approved method of use.

(40) 'Free-liquids' shall mean any sludge which produces measurable liquids when the Paint Filter Liquids Test, Method 9095 of Environmental Protection Agency Publication Number

SW-846, is performed.

(41) 'Free moisture' shall mean liquid that will drain freely by gravity from solid materials.

(42) 'Garbage' shall mean discarded animal and vegetable wastes, and animal and vegetable wastes resulting from the handling, preparation, cooking and serving of foods, including cans, bottles and cartons, in which it was received and wrapping in which it may have been placed for disposal, swill and carcasses of dead animals of such a character and proportion as to be capable of attracting or providing food for vectors. This does not include raw sewage or sludge related to wastewater processes.

(43) 'Ground-water' shall mean water below the land surface in a zone of saturation.

(44) 'Hardfill' shall mean a method of compaction and earth cover of solid waste, other than those containing garbage or other putrescible (putrescent) waste, including, but not limited to, demolition waste and like waste not constituting a health or nuisance hazard, where cover need not be applied on a per day used basis.

(45) 'Hazardous waste' shall mean any material or substance which, by reason of its composition or characteristics,

(A) is hazardous waste as defined in the Solid Waste Disposal Act, 42 USC §6901, et seq., as amended, replaced or superseded and the regulations implementing same,

(B) is a hazardous substance as defined by the Comprehensive Environmental Response, Compensation and Liability Act of 1980, 42 USC §9601, et seq.,

(C) is material the disposal of which is regulated by the Toxic Substances Control

Act, 15 USC §2601, et seq., as amended, replaced, or superseded, and the regulations implementing same,

(D) is special nuclear or by-products material within the meaning of the Atomic Energy Act of 1954,

(E) is pathological, infectious or biological waste,

(F) is treated as hazardous waste or as a hazardous substance under applicable law, or

(G) requires a hazardous waste or similar permit for its storage, treatment, incineration of disposal.

(46) 'Household waste' shall mean any solid waste (including garbage, trash, and sanitary waste in septic tanks) derived from households (of single and multiple residences of up to four units).

(47) 'Incineration' shall mean reducing the volume of solid wastes by use of an enclosed device using controlled flame combustion.

(48) 'Incinerator' shall mean an enclosed device using controlled flame combustion, the primary purpose of which, is to thermally break down solid waste.

(49) 'Industrial solid waste' shall mean solid waste generated by manufacturing or industrial processes that is not a hazardous waste regulated under Subtitle C of the Resource Conservation and Recovery Act (RCRA) or Guam's Hazardous Waste Management Regulations. Such waste may include, but is not limited to, waste resulting from the following manufacturing processes/operations: electric power generation; fertilizer/agricultural chemicals; food and related products/by-products; inorganic chemicals; iron and steel manufacturing; leather and leather

products; nonferrous metals manufacturing/foundries; organic chemicals; plastics and resins manufacturing; pulp and paper industry; rubber and miscellaneous plastic products; stone, glass, clay, and concrete products; textile manufacturing; transportation equipment; and water treatment. This term does not include mining waste or oil and gas waste.

(50) 'Inert wastes' shall mean non-combustible waste that will not cause any leachate or cause any environmental concern that are likely to retain their physical and chemical structure under expected conditions of disposal, including resistance to biological attack and chemical attack from acidic rainwater.

(51) 'Infectious waste' shall mean:

(A) equipment, instruments, utensils and fomites of a disposed nature used in the treatment of patients or animals who are suspected by a medical professional to have or have been diagnosed as having a communicable disease and must therefore, be isolated as required by public-health agencies; or

(B) laboratory wastes, including pathological specimens (i.e., all tissues, specimens of blood elements, excreta, and excretion obtained from patients or laboratory animals) and disposal fomites attendant thereto and similar disposal materials from outpatient areas and emergency rooms; or

(C) carcass of any animal that has died from a communicable disease.

(52) 'Interim solid waste handling facilities' shall mean interim treatment, utilization or processing site engaged in solid waste handling which is not the final site of disposal. Transfer stations, composting, source separation centers, and treatment centers are considered as some of the interim solid waste handling facilities.

(53) 'Intermediate cover' shall mean cover material that serves the same function as daily cover, but must resist erosion for a longer time, because it is applied on areas where additional cells will not be constructed for extended periods of time.

(54) 'Landspreading disposal facility' shall mean a facility that applies sludge or other solid wastes onto or incorporates solid waste into the soil surface at a greater than vegetative utilization and soil conditioners/immobilization rates.

(55) 'Lateral expansion' shall mean a horizontal expansion of the waste boundaries of an existing Municipal Solid Waste Landfill unit.

(56) 'Leachate' shall mean a liquid that has passed through or emerged from solid waste and contains soluble, suspended, or miscible materials removed from such waste.

(58) 'Lower explosive limit' shall mean the lowest percent by volume of a mixture of explosive gases which will propagate a flame in air at 25 degrees centigrade and atmospheric pressure.

(59) 'Material resource recovery facility' shall mean a facility where recyclable materials such as scrap metal, aluminum, newspaper, and paper are accepted for recycling.

(60) 'Medical waste' shall mean any solid waste which is generated in the diagnosis, treatment, or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biologicals. Such terms does not include any hazardous or household waste identified, listed, or defined under 10 Guam Code Annotated Chapter 51 or regulations promulgated under this Chapter.

(61) 'Municipal solid waste landfill unit' shall mean a discrete area of land or an excavation that receives household waste, and that is not a land application unit, surface

impoundment, injection well, or waste pile, as those terms are defined under the Code of Federal Regulations 40 Part §257.2. A Municipal Solid Waste Landfill unit also may receive other types of RCRA Subtitle D wastes, such as commercial solid waste, nonhazardous sludge, small quantity generator waste and industrial solid waste. Such a landfill may be publicly or privately owned. A Municipal Solid Waste Landfill unit may be a new Municipal Solid Waste Landfill unit, an existing Municipal Solid Waste Landfill unit or a lateral expansion.

(62) 'New municipal solid waste landfill unit' shall mean any municipal solid waste landfill unit that has not received waste prior to October 9, 1993.

(63) 'Open burning' shall mean the combustion of solid waste without:

(A) Control of combustion air to maintain adequate temperature for efficient combustion,

(B) Containment of the combustion reaction in an enclosed device to provide sufficient residence time and mixing for complete combustion, and

(C) Control of the emission of the combustion products.

(64) 'Open dump' shall mean a land disposal site which does not meet standards set forth in this Chapter and where solid wastes are disposed in a manner that does not protect the environment, is susceptible to open burning, and is exposed to the elements, vectors and scavengers.

(65) 'Operator' shall mean any person who accepts solid waste from a collector for transfer, storage, recycling, combustion, processing or disposal.

(66) 'Owner' shall mean the person(s) who owns a facility or part of a facility.

(67) 'Performance standards' shall mean the criteria for the performance of solid waste

handling facilities.

(68) 'Permeability' shall mean the ease with which a porous material allows liquid or gaseous fluids to flow through it. For water, this is usually expressed in units of centimeters per second and termed hydraulic conductivity.

(69) 'Permit' shall mean an authorization issued by the Guam Environmental Protection Agency which allows a person to perform solid waste management activities at a specific location and which includes specific conditions for such facility operations.

(70) 'Person' shall mean any individual, partnership, co-partnership, firm, company, corporation, association, joint stock company, trust, estate, or any agency, department, or instrumentality of the Federal or local government, or any other legal representatives, agents or assigns.

(71) 'Pile' shall mean any non-containerized accumulation of solid waste that is used for treatment or storage.

(72) 'Plans' shall mean reports and drawings, including a narrative operating description, prepared to describe the land disposal site and its proposed operation.

(73) 'Point of compliance' shall mean that part of ground-water that lies beneath the perimeter of a solid waste facility's active area as that active area would exist at closure of the facility.

(74) 'Post-closure' shall mean the requirements placed upon disposal sites after closure to ensure their environmental safety for at least a twenty-year period or until the site becomes stabilized (i.e., little or no settlement, gas production or leachate generation).

(75) 'Premises' shall mean a tract or parcel of land with or without habitable buildings.

(76) 'Processing' shall mean any method, system, or other treatment designed to change the physical, chemical or biological character or composition of any solid waste. This includes the neutralization of any hazardous waste; rendering of any hazardous waste non-hazardous, safer for transport, amenable for recovery, amenable for storage, or reduced in volume; or any other activity or processing designed to change the physical form or chemical composition of hazardous waste so as to render it non-hazardous.

(77) 'Putrescible waste' shall mean solid waste which contains material capable of being decomposed by micro-organisms, producing a foul-smelling matter.

(78) 'Pyrolysis' shall mean the process in which solid wastes are heated in an enclosed device in the absence of oxygen to vaporization, producing a hydrocarbon-rich gas capable of being burned for recovery of energy.

(79) 'Reclamation site' shall mean a location used for the processing or the storage of recyclable waste.

(80) 'Refuse' shall mean anything that is discarded as worthless and useless.

(81) 'Remediation' shall mean a permitted process by which the concentration of contamination is reduced to acceptable Guam Environmental Protection Agency levels.

(82) 'Reserved' shall mean a section having no requirements and which is set aside for future possible rule-making as a note to the regulated community.

(83) 'Residential waste' see household waste.

(84) 'Residue' shall mean all the materials that remain after completion of thermal processing, including bottom ash, fly ash and grate shifting.

(85) 'Resource Conservation and Recovery Act' (RCRA) shall mean the Resource

Conservation and Recovery Act (42 U.S.C. §6941) as amended.

(86) 'Reusable containers' shall mean containers that are used more than once to handle solid waste such as garbage cans.

(87) 'Rubbish' shall mean nonputrescible solid waste, including ashes, consisting of both combustible and noncombustible waste such as paper, cardboard, cans, yard clippings, wood, glass, bedding, crockery and broken or rejected matter or litter of any kind.

(88) 'Run-off' shall mean any rainwater, leachate, or other liquid that drains over land from any part of a facility.

(89) 'Run-on' shall mean any rainwater, leachate, or other liquid that drains over land onto any part of a facility.

(90) 'Salvaging' shall mean the controlled removal of waste materials for utilization.

(91) 'Saturated zone' shall mean that part of the earth's crust in which all voids are filled with water.

(92) 'Scavenging' shall mean uncontrolled and unauthorized removal of solid waste materials from a municipal solid waste storage or disposal site(s).

(93) 'Septage' shall mean a semi-solid consisting of settled sewage solids combined with varying amounts of water and dissolved materials generated from a septic tank system.

(94) 'Sludge' shall mean any solid, semi-solid, or liquid waste generated from a municipal, commercial, or industrial wastewater treatment plant, water supply treatment plant, or air pollution control facility or any other such waste having similar characteristics and effects exclusive of the treated effluent from a wastewater treatment plant.

(95) 'Sole source aquifer' shall mean an aquifer designated by the Environmental

Protection Agency pursuant to Section 1424e of the Safe Drinking Water Act (PL 93-523).

(96) 'Solid waste' shall mean any garbage, rubbish, refuse, or sludge from a wastewater treatment plant, water supply treatment plant, or air pollution control facility and other discarded or spilled material(s), including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities, but does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges which are point sources subject to permits under Section 402 of the Federal Water Pollution Control Act, as amended (86 Stat. 880), or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954, as amended (68 Stat. 923).

(97) 'Solid waste handling' shall mean the management, storage, collection, transportation, treatment, utilization, processing or final disposal of solid wastes, including the recovery and recycling of materials from solid wastes, the recovery of energy resources from such wastes or the conversion of the energy in such wastes to more useful forms or combinations thereof.

(98) 'Solid waste management' shall mean the purposeful systematic control of the generation, storage, collection, transportation, separation, processing, recovery and disposal of solid waste.

(99) 'State' shall mean any of the states of the United States of America, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, Guam, American Samoa, and the Commonwealth of the Northern Marianas Islands.

(100) 'Storage' shall mean the interim containment of solid waste in accordance with

Federal and local regulations.

(101) 'Surface impoundment' shall mean a facility or part of a facility which is a natural topographic depression, man-made excavation or diked area formed primarily of earthen materials (although it may be lined with man-made materials), and which is designed to hold an accumulation of liquids or sludge. The term includes holding, storage, settling and aeration pits, ponds or lagoons, but does not include injection wells.

(102) 'Surface water' shall mean all lakes, rivers, ponds, streams, inland waters and all other water and water courses.

(103) 'Transfer station' shall mean any intermediate waste facility in which solid waste collected from any source is temporarily deposited and stored while awaiting transportation to another solid waste management facility.

(104) 'Treatment' shall mean the physical, chemical or biological processing of solid waste to make such solid wastes safer for storage or disposal, amendable for energy or material resource recovery or reduced in volume.

(105) 'Uppermost aquifer' shall mean the geologic formation nearest the natural ground surface that is an aquifer, as well as, lower aquifers that are hydraulically interconnected with this aquifer within the facility's property boundary.

(106) 'Utilization' shall mean consuming, expending or exhausting by use, solid waste materials.

(107) 'Vector' shall mean any insect or other arthropod, rodent or other animal capable of transmitting the causative agents of human disease, or disrupting the normal enjoyment of life by adversely affecting the public health and well-being.

(108) 'Vertical expansion' shall mean the disposal of solid waste within the footprint of an existing Municipal Solid Waste Landfill following the proper engineering procedures.

(109) 'Waste management unit boundary' shall mean a vertical surface located at the hydraulically downgradient limit of the unit. This vertical surface extends down into the uppermost aquifer.

(110) 'Waste recycling' shall mean reusing waste materials and extracting valuable materials from a waste stream.

(111) 'Waste reduction' shall mean reducing the amount or type of waste generated.

(112) 'Water quality standard' shall mean the Guam Water Quality Standards, as amended.

(113) 'Water table' shall mean the upper most aquifer.

(114) 'Working face' shall mean that portion of the sanitary landfill where solid wastes are discharged and are spread and compacted prior to the placement of cover material.

§23103. Consideration of other federal laws. The owner or operator of municipal solid waste landfill units and other facilities must comply with other applicable Federal rules, laws, regulations, and or other requirements.

§23104. Solid waste management permit system. (a) Permits Required. It shall be unlawful for any person to initiate construction of, establish or operate any solid waste management facility or modify an existing solid waste management facility without a permit issued in accordance with the provisions of this Chapter. All permitted solid waste management facilities shall be operated in accordance with the provisions of Chapter 51 of Title 10, Guam Code Annotated, and this Chapter. For the purposes of these regulations, the following are considered solid waste management facilities:

(1) municipal solid waste landfill facility;

(2) industrial solid waste landfill facility (reserved);

(3) solid waste transfer facility;

(4) solid waste hardfill facility;

(5) solid waste storage facility;

(6) solid waste processing facility:

(A) solid waste composting facility;

(B) solid waste material resource recovery facility;

(C) solid waste remediation facility:

(1) bioremediation;

(2) all other remediation;

(D) solid waste incinerator facility;

(E) solid waste-to-energy recovery facility;

(F) other processing facility.

(b) Application for permit.

(1) Application for a permit shall be completed on forms furnished by the Administrator and shall include the following information:

(A) detailed plans and specifications of the facility and a brief description of the type of facility; a map showing the location of the proposed facility;

(B) certification of compliance with zoning requirements and local ordinances by the Department of Land Management, Department of Public Health and Social Services, Department of Public Works, and the Guam Environmental

Protection Agency;

(C) an operations plan detailing such items as, the proposed method and length of operation; population and area to be served; the characteristics, quantity and source of material to be disposed; the type of equipment to be used; the number and responsibilities of site personnel; source and type of cover material; emergency operating procedures; and the proposed ultimate use of the disposal site. In those cases where only landfilling with demolition debris will take place, certain items may be excluded from the application form by the Administrator;

(D) the Administrator may require any additional information necessary to adequately assess the environmental impact of the proposed solid waste management facility, and prevent injury to the public health, welfare or environment of Guam.

(2) A proof of performance bond obtained from a bonding company authorized to do business in Guam may be required by the Administrator. The bond shall be payable to the government of Guam and conditioned on the fulfillment by the holder of the requirements of this Chapter.

(3) Each application shall be signed by the owner or his authorized representative, and shall constitute an agreement that the owner will assume responsibility for the construction or modification and operation of the facility in accordance with this Chapter. If the owner is a partnership or group other than a corporation, the application shall be signed by One (1) individual who is a member of the group. If the owner is a corporation, the application shall be signed by an officer of the corporation or general

manager of the facility.

(4) All new applications or renewal applications for a permit for a municipal solid waste landfill shall be accompanied by a non-refundable application fee of Ten thousand Dollars ($10,000.00) payable to the Treasurer of Guam and deposited into the Solid Waste Management Fund pursuant to Section 51117 of Public Law 23-64. New applications or renewal applications for permits for all other solid waste management facilities shall be accompanied by a non-refundable application fee payable to the Treasurer of Guam in the amount indicated on the attached schedule of fees as listed on Addendum A. These non-refundable application fees shall be deposited into the Solid Waste Management Fund.

(5) The Administrator shall approve an application for permit if the application and supporting information clearly show that the issuance, thereof, does not pose a threat to the environment, public health or welfare, and that the solid waste disposal facility is designed, built, and equipped in accordance with the best practicable technology so as to operate without causing a violation of applicable rules and regulations.

(6) The Administrator may issue to the applicant a conditional approval. Under such an approval the Administrator may:

(A) require the applicant to provide for sampling and testing to determine the degree of pollution from the solid waste management facility, if necessary;

(b) specify conditions which will bring the operation of the solid waste management facility described in the application within the requirements of this

Chapter.

(7) Written acceptance of any and all permit conditions by the applicant shall be necessary prior to any construction for which a permit is required.

(8) Unless otherwise provided for in §23104 of this Chapter, the Administrator may hold a public hearing to solicit public reaction and recommendations on a proposed permit application or permit renewal if the Administrator determines there is a significant degree of public interest in the proposed permit.

(c) Municipal Solid Waste Landfill permits.

(1) All owners of existing municipal solid waste landfill facilities shall file immediately an application for permit to continue to operate.

(2) The Administrator shall, within a reasonable time, not to exceed One hundred and twenty (120) days from the date the application is received with payment of the application fee, notify the applicant in writing if the application has been filled out properly and contains all the necessary information.

If additional information is requested by the Agency, then the request stops the One hundred and twenty (120) day time period and the remaining days left shall resume on the day after the supplementary information is received.

(3) Before issuing a permit for a municipal solid waste landfill facility, the Administrator shall cause to be published notice of Agency's intention to issue such a permit and that the public has Forty-five (45) days to summit written comments on the proposed action; The contents of the public notice shall include at least the following:

(A) name, address, and phone number of Agency issuing the public notice;

(B) name and address of each applicant;

(C) brief description of each applicant's activities or operations which result in the disposal or other activities described in the application;

(D) a short description of the location of each disposal or activity indicating whether such disposal or activity is new or existing; and

(E) address and phone number of agency premises at which interested persons may obtain further information and inspect a copy of the variance applications and supporting and related documents.

(4) If within Forty-five (45) days after publication and broadcast, the Agency receives written notice of opposition to the Agency's intention to issue such a permit and a request for a hearing is made by a substantially affected party, then the Agency shall provide for a hearing in accordance with the Administrative Adjudication Law, Chapter 9 of Title 5, Guam Code Annotated.

(A) A request for a hearing shall be in writing and shall state the nature of the issues proposed to be raised in the hearing and the basis for being the proper party to request a hearing.

(B) The Board shall affirm, modify, or revoke the proposed action to be taken by the Agency. The Board may delay making a decision if it determines that the application was incomplete or public comments have not been adequately addressed.

(5) Written comments to GEPA with all supporting evidence, along with a copy

for the applicant, must be received or postmarked within the Forty-five (45) day comment period to be considered by the Agency.

(6) All comments received during the comment period shall be considered in making a decision and the Administrator will prepare a written response to all significant comments, as determined by the Administrator, that were received during the public comment period or raised during an Agency hearing. The response to comments shall be made available to the public upon request.

(d) Permits for facilities other than MSWLF.

(1) The Administrator shall, within a reasonable time, not to exceed One hundred twenty (120) days from the date the application is received, notify the applicant in writing, if the application has been filled out properly and contains all the necessary information. If the Administrator has not acted (i.e., approved, denied, or requested for additional information) within the One hundred twenty (120) day period from the day the application is received, the application shall be deemed to have been approved. The request for additional information stops the One hundred twenty (120) day period and the remaining days out of this period shall resume on the day the supplementary information is received.

(2) The applicant may submit questions and comments, in duplicate, in response to the Administrator's action on the application.

(3) The Administrator shall consider the applicant's questions and comments, and shall notify the applicant, in writing, of his final approval or denial of the application.

(4) Before issuing a permit for the processing, storage or disposal of solid

waste, the Administrator shall:

(A) cause to be published in a major local newspaper or newspaper of general circulation, and broadcast over a local radio station or stations, notice of the Agency's intention to issue such a permit;

(B) if, within Forty-five (45) days after publication and broadcast, the Agency receives written notice of opposition to the Agency's intention to issue such permit and a request for a hearing is made, provide for a hearing in accordance with the Administrative Adjudication Law, Chapter 9 of Title 5, Guam Code Annotated, if requested by a substantially affected party;

(C) allow interested persons to submit written significant comments during the Forty-five (45) day period.

(5) Composting waste generated from no more than Three (3) households for personal use is exempted from permit requirements.

(e) Effect of the permit. The general and special conditions of the permit become the standards and guide for the facility.

(1) The owner or operator must notify the Agency that the construction has been completed in accordance with the approved plans and specifications.

(2) An inspection of the facility will be conducted by the Agency to confirm that the facility is ready to accept solid wastes.

(3) The conditions will specify that the facility operate in accordance with the approved Operation Manual.

(4) Additional conditions specify type, frequency and data required for

monitoring and record keeping.

(f) Permit denial. If a permit is denied, the applicant shall have the opportunity to appeal the decision at a hearing by the Board of Directors of GEPA in accordance with the Administrative Adjudication Law, Chapter 9 of Title 5, Guam Code Annotated. Such hearing shall be held not more than Sixty (60) days after the Board receives this notice of intent to appeal.

(g) Duration of Permit. The Administrator shall grant a permit for Five (5) years for all municipal solid waste landfills following the date of issuance. The duration of permit for all other solid waste management facilities are listed on the attached Addendum B.

(h) Modification to existing permits. The Administrator may, on his own motion or the application of any person, modify a permit if, after affording the applicant an opportunity for a hearing, the Administrator determines that:

(1) any condition of the permit has been violated or due to a change in any condition requiring either a temporary or permanent reduction or elimination of the permitted disposal;

(2) there is a change in applicable laws or regulations governing solid waste management; or

(3) such action is in the public interest.

The Agency will develop a schedule to revisit and reissue all existing permits affected by the change in the law or regulations at the time of the change. Modification of the permit shall become final Ten (10) days after service of notice of the final decision to modify the permit on the holder of the permit.

(i) Suspension of permit. The Administrator may, on his own motion or the application of any person, suspend a permit if, after affording the applicant an opportunity for a hearing, the Administrator determines that:

(1) any condition of the permit has been violated or any regulations of the agency has been violated; or

(2) such action is in the public interest.

The permit shall be suspended until all conditions of the permit are met or all violations have been properly corrected. Suspension of a permit shall become final Ten (10) days after service of notice of the final decision to suspend on the holder of the permit.

(j) Revocation of permits. The Administrator may, on his own motion or the application of any person, revoke any permit if, after affording the applicant an opportunity for a hearing, the Administrator determines that:

(1) there is a violation of any condition of the permit;

(2) the permit was obtained by misrepresentation, or failure to disclose fully all relevant facts;

(3) there is a change in any condition that requires either a temporary or permanent reduction or elimination of the permitted disposal; or

(4) such is in the public interest.

Revocation of a permit shall become final Ten (10) days after service of notice of the final decision to revoke on the holder of the permit.

(k) Permit renewal. Each permittee must apply for a renewal of the permit Sixty (60) days before the permit expires. At the time of renewal of a solid waste management permit, the facility is reevaluated and the permit conditions updated to reflect changes and the current operational procedures.

(l) Transfer of permit. A permit shall not be transferable, whether by operation of law or otherwise, either from one location to another, from one solid waste disposal facility to another or from one person to another, without the written approval of the Administrator.

(m) Reporting termination. Sixty (60) days prior to closure any person issued a permit shall report the permanent termination of a solid waste processing or disposal facility for which the permit has been issued to the Administrator and within the Thirty (30) days after closure shall surrender the permit to the Administrator, unless otherwise noted in this Chapter. The Administrator may approve immediate closure of any solid waste management facility if the facility poses major threat to human health and the environment.

(n) Posting of permit. Upon granting an approval for a permit, the Administrator shall issue to the applicant a permit which shall be posted in a conspicuous place at or near the operation site for which the permit was issued.

(o) Falsifying or altering permit. No person shall knowingly deface, alter, forge, counterfeit or falsify a permit. Any such activity shall bring about immediate revocation of the permit.

Article 2

Location restrictions

§23201. Airport safety. (a) Owners or operators of new MSWLF units, existing MSWLF units, and lateral expansions that are located within Ten thousand feet (10,000') (Three thousand forty-eight (3,048) meters) of any airport runway end used by turbojet aircraft or within Five thousand feet (5,000') (One thousand five hundred and twenty-four (1,524) meters) of any airport runway end used by only piston-type aircraft must demonstrate that the units are designed and operated so that the MSWLF unit does not pose a bird hazard to aircraft. Components of such demonstrations are identified in Chapter 2, Subpart B, of the EPA Solid Waste Disposal Facility Criteria, Technical Manual, published in November 1993 or as updated.

(b) Owners or operators proposing to site new MSWLF units and lateral expansions located within a five-mile radius of any airport runway end used by turbojet or piston-type aircraft must notify the affected airport and the Federal Aviation Administration (FAA).

(c) The owner or operator must place the demonstration in Subsection (a) of this §23201 in the operating record and notify the Administrator that it has been placed in the operating record.

(d) Additional definitions, for the purposes of this Article 2:

(1) 'Airport' means public-use airport open to the public without prior permission and without restrictions within the physical capacities of available facilities.

(2) 'Bird hazard' means an increase in the likelihood of bird/aircraft collisions that may cause damage to the aircraft or injury to its occupants.

§23202. Floodplains. (a) Owners or operators of new MSWLF units, existing MSWLF units, and lateral expansions located in One hundred (100) year floodplains must demonstrate that the unit will not restrict the flow of the One hundred (100) year flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste so as to pose a hazard to human health and the environment. The owner or operator must place the demonstration in the operating record and notify the Administrator that it has been placed in the operating record. Components of such demonstrations are identified in Chapter 2, Subpart B, of the EPA Solid Waste Disposal Facility Criteria, Technical Manual, published in November 1993 or as updated.

(b) For the purposes of this Chapter:

(1) 'Floodplain' means the lowland and relatively flat areas adjoining inland and coastal waters, including flood-prone areas of offshore islands, that are inundated by the One hundred (100) year flood.

(2) 'One hundred (100) year flood' means a flood that has a One Percent (1%) or greater chance of recurring in any given year or a flood of a magnitude equalled or exceeded once in One Hundred (100) years on the average over a significantly long period.

(3) 'Washout' means the carrying away of solid waste by waters of the base flood.

§23203. Wetlands. (a) New MSWLF units and lateral expansions shall not be located in wetlands, unless the owner or operator can make the following demonstrations to the Administrator:

(1) Where applicable, under §404 of the Clean Water Act or applicable Territorial wetlands laws, the presumption that a practicable alternative to the proposed landfill is available which does not involve wetlands is clearly rebutted;

(2) The construction and operation of the MSWLF unit will not:

(A) cause or contribute to violations of any applicable Territorial water quality standard;

(B) violate any applicable toxic effluent standard or prohibition under Section 307 of the Clean Water Act;

(C) jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat, protected under the Endangered Species Act of 1973 or the Endangered Species Act of Guam, as amended; and

(D) violate any requirement under the Marine Protection, Research, and Sanctuaries Act of 1972, for the protection of a marine sanctuary;

(3) The MSWLF unit will not cause or contribute to significant degradation of wetlands. The owner or operator must demonstrate the integrity of the MSWLF unit and its ability to protect ecological resources by addressing the following factors:

(A) erosion, stability, and migration potential of native wetland soils, mud, and deposits used to support the MSWLF unit;

(B) erosion, stability, and migration potential of dredged and fill materials used to support the MSWLF unit;

(C) the volume and chemical nature of the waste managed in the MSWLF unit;

(D) impacts on fish, wildlife, and other aquatic resources and their habitat from release of the solid waste;

(E) the potential effects of catastrophic release of waste to the wetland and the resulting impacts on the environment; and

(F) any additional factors, as necessary, to demonstrate that ecological resources in the wetland are sufficiently protected;

(4) to the extent required under §404 of the Clean Water Act or applicable

territorial wetlands laws, steps have been taken to attempt to achieve no net loss of wetlands (as defined by acreage and function) by first avoiding impacts to wetlands to the maximum extent practicable as required by paragraph A. 1 of this section, then minimizing unavoidable impacts to the maximum extent practicable, and finally offsetting remaining unavoidable wetland impacts through all appropriate and practicable compensatory mitigation actions (e.g., restoration of existing degraded wetlands or creation of man-made wetlands); and

(5) sufficient information is available to make a reasonable determination with respect to these demonstrations.

(b) For the purposes of this section, 'wetlands' means those areas that are inundated by surface or ground-water with a frequency sufficient to support and under normal circumstances does or would support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, mangroves, natural ponds, surface springs, estuaries and similar such areas.

§23204. **Fault areas.** (a) New MSWLF units and lateral expansions shall not be located within Two hundred (200) feet (Sixty (60) meters) of a fault that has had displacement in Holocene time unless the owner or operator demonstrates to the Administrator that an alternative setback distance of less than Two hundred (200) feet (Sixty (60) meters) will prevent damage to the structural integrity of the MSWLF unit and will be protective of human health and the environment. Components of such demonstrations are identified in Chapter 2, Subpart B, of the EPA Solid Waste Disposal Facility Criteria, Technical Manual, published in November 1993 or as updated.

(b) For the purposes of this Article:

(1) 'Fault' means a fracture or a zone of fractures in any material along which strata on One (1) side have been displaced with respect to that on the other side.

(2) 'Displacement' means the relative movement of any Two (2) sides of a fault measured in any direction.

(3) 'Holocene' means the most recent epoch of the Quaternary period, extending from the end of the Pleistocene Epoch to the present.

§23205. **Seismic impact zones.** (a) New MSWLF units and lateral expansions shall not be located in seismic impact zones, unless the owner or operator demonstrates to the Administrator that all containment structures, including liners, leachate collection systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the site. The owner or operator must place the demonstration in the operating record and notify the Administrator that it has been placed in the operating record. Components of such demonstrations are identified in Chapter 2, Subpart B, of the EPA Solid Waste Disposal Facility Criteria, Technical Manual, published in November 1993 or as updated.

(b) For the purposes of this Article:

(1) 'Seismic impact zone' means an area with a Ten Percent (10%) or greater probability that the maximum horizontal acceleration in lithified earth material, expressed as a percentage of the earth's gravitational pull (g), will exceed 0.10g in Two hundred and fifty (250) years.

(2) 'Maximum horizontal acceleration in lithified earth material' means the maximum expected horizontal acceleration depicted on a seismic hazard map, with a

Ninety Percent (90%) or greater probability that the acceleration will not be exceeded in Two hundred and fifty (250) years, or the maximum expected horizontal acceleration based on a site-specific seismic risk assessment.

(3) 'Lithified earth material' means all rock, including all naturally occurring and naturally formed aggregates or masses of minerals or small particles of older rock that formed by crystallization of magma or by induration of loose sediments. This term does not include man-made materials, such as fill, concrete, and asphalt, or unconsolidated earth materials, soil, or regolith lying at or near the earth surface.

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§23206. Unstable Areas. (a) Owners or operators of new MSWLF units, existing MSWLF units, and lateral expansions located in an unstable area must demonstrate that engineering measures have been incorporated into the MSWLF unit's design to ensure that the integrity of the structural components of the MSWLF unit will not be disrupted. The owner or operator must place the demonstration in the operating record and notify the Administrator that it has been placed in the operating record. Components of such demonstrations are identified in Chapter 2, Subpart B, of the EPA Solid Waste Disposal Facility Criteria, Technical Manual, published in November 1993 or as updated. The owner or operator must consider the following factors, at a minimum, when determining whether an area is unstable:

(1) on-site or local soil conditions that may result in significant differential settling;

(2) on-site or local geologic or geomorphologic features; and

(3) on-site or local human-made features or events (both surface and

subsurface).

(b) For the purposes of this Article:

(1) 'Unstable area' means a location that is susceptible to natural or human-induced events or forces capable of impairing the integrity of some or all of the landfill structural components responsible for preventing releases from a landfill. Unstable areas can include poor foundation conditions, areas susceptible to mass movements, and Karst terrains.

(2) 'Structural components' means liners, leachate collection systems, final covers, run-on/run-off systems, and any other component used in the construction and operation of the MSWLF that is necessary for protection of human health and the environment.

(3) 'Poor foundation conditions' means those areas where features exist which indicate that a natural or man-induced event may result in inadequate foundation support for the structural components of a MSWLF unit.

(4) 'Areas susceptible to mass movement' means those areas of influence (i.e., areas characterized as having an active or substantial possibility of mass movement) where the movement of earth material at, beneath, or adjacent to the MSWLF unit, because of natural or man-induced events, results in the downslope transport of soil and rock material by means of gravitational influence. Areas of mass movement include, but are not limited to, landslides, avalanches, debris slides and flows, soil fluction, block sliding, and rock fall.

(5) 'Karst terrains' means areas where karst topography, with its characteristic

surface and subterranean features, is developed as the result of dissolution of limestone, dolomite, or other soluble rock. Characteristic physiographic features present in karst terrains include, but are not limited to, sinkhole, sinking streams, caves, large springs, and blind valleys.

§23207. Closure of existing municipal solid waste landfill units. (a) Existing MSWLF units that cannot make the demonstration specified in §§23201, 23202, and 23206 of this Article 2, must close immediately, in accordance with §23601 and conduct post-closure activities in accordance with §23602, all of this Chapter.

(b) The deadline for closure required by Subsection (a) of this §23207 may be extended up to Two (2) years if the owner or operator demonstrates to the Administrator that:

(1) there is no available alternative disposal capacity; and

(2) there is no immediate threat to human health and the environment.

Article 3

Operating criteria

§23301. Solid waste accepted. (a) As a part of the permit application, the owner/operator shall report what wastes shall be accepted and identify any special handling required. Only wastes for which the facility has been permitted shall be accepted.

(b) The permit application shall specify procedures for wastes requiring special handling. Wastes approved for acceptance at each are:

(1) Municipal Solid Waste Landfill Facility:

(A) residential waste;

(B) commercial waste;

(C) animal carcasses, body parts, etc. (to be disposed of only in the approved area as designated in the permit)

(2) Industrial Solid Waste Landfill Facility (Reserved)

(3) Solid Waste Transfer Facility:

(A) residential waste;

(B) yard waste.

(4) Solid Waste Hardfill Facility:

(A) demolition and construction debris (bricks, concrete, stones, masonry materials, rocks, asphalt, rebar, corrugated steel, scrap metal, paving materials, and undecayed wood materials attached to the construction debris);

(B) packaging and rubble resulting from construction, remodeling, repair, or demolition operations on pavements, houses, commercial buildings, and other structures, excluding asbestos containing materials;

(c) clay, limestone, coral, broken glass and pottery.

(5) Solid Waste Storage Facility:

(A) vehicles, vehicle parts, appliances, and metals still having worth and use.

Salvaged materials, such as automobile bodies, metals, and appliances may be salvaged in a controlled manner only by the permit holder. These materials must be drained of any free liquids and hazardous waste; the liquids and hazardous waste must be transferred to a solid waste processing facility for final disposal or processing. Chlorofluorocarbons (CFCs) must be properly removed for recycling at the processing facility or CFC recovery center, as approved by the Guam Air Pollution Control Program.

(6) Solid Waste Processing Facility

(A) Solid Waste Composting Facility:

(1) yard waste such as grass clippings, tree branches, leaves, and other organic waste;

(2) paper waste;

(3) vegetative waste.

(B) Solid Waste Material Resource Recovery Facility:

(1) scrap metal, aluminum, and batteries;

(2) newspapers, paper, magazines, cardboard, glass, and plastics;

(3) tires, oil, and CFCs.

(C) Solid Waste Remediation Facility:

(1) bioremediation

(A) petroleum contaminated waste;

(2) all other remediation.

(D) Solid Waste Incinerator Facility:

(1) residential waste;

(2) construction waste.

(E) Solid Waste-to-Energy Recovery Facility:

(1) residential waste;

(2) construction waste.

(F) Other Processing Facility:

(1) vehicles and vehicle parts;

(2) appliances.

§23302. Solid waste excluded. (a) Using information indicated on the permit application, the Administrator determines specific wastes to be excluded and the permittee shall identify them in the plans. The generator of excluded wastes and hazardous material shall report these wastes to the Administrator prior to disposal and consult with the Administrator in determining method of disposal. The criteria used in this Chapter shall determine what types of waste shall be excluded.

(b) Regular users of the land disposal site shall be provided with a list of excluded waste. The list shall be displayed prominently at the site entrance.

(c) Wastes excluded from solid waste management facilities shall include but not limited to the following:

(1) Municipal Solid Waste Landfill Facility:

(A) waste oil and regulated hazardous waste;

(B) whole or partially whole vehicles, vehicle parts, tires, batteries, appliances, septic tank pumping, sewage sludge and other petroleum products and oil based paints.

(2) Industrial Solid Waste Landfill Facility (Reserved)

(3) Solid Waste Transfer Facility:

(A) commercial, government and military solid wastes (unless approved by the administrator);

(B) inert material or waste;

(C) biological waste, pathological wastes, radioactive wastes, medical wastes, infectious waste, free liquids, asbestos, animal carcasses and offal, ashes, putrescible animal waste, sewage sludge, other sludge and other petroleum products;

(D) all wastes excluded from MSWLFs are also excluded from Solid Waste Transfer Facilities.

(4) Solid Waste Hardfill Facility:

(A) hazardous waste, infectious waste, biological waste, radioactive waste, medical waste, liquid waste, asbestos, animal carcasses and offal, ashes composting material, decayed matter, putrescible animal and vegetable waste;

(B) lawn and yard clippings, grass and leaves, and other organic waste;

(C) paper products, cardboard, cans, whole or partially whole vehicles, vehicle parts, tires and other rubber and synthetic products, or automobile batteries;

(D) residential waste, plastic products, mattresses and box springs, clothing, cloth and bedding, appliances and furniture, septic tank pumping, sewer sludge and other sludges, waste oil and other petroleum products, and miscellaneous trash and litter.

(5) Solid Waste Storage Facility:

(A) hazardous waste;

(B) residential waste.

(6) Solid Waste Processing Facility:

(A) Solid Waste Composting Facility:

(1) hazardous waste;

(2) residential waste.

(B) Solid Waste Material Resource Recovery Facility:

(1) hazardous waste.

(C) Solid Waste Remediation Facility:

(1) bioremediation

(a) hazardous waste

(2) all other remediation

(a) hazardous waste

(D) Solid Waste Incinerator Facility:

(1) hazardous waste.

(E) Solid Waste Energy Recovery Facility:

(1) hazardous waste.

(F) Other processing facility:

(1) hazardous waste;

(2) residential waste;

(3) yard waste.

§23303. Procedures for excluding the receipt of hazardous waste.

(a) Owners or operators of all MSWLF units must implement a program at the facility for detecting and preventing the disposal of regulated hazardous wastes as defined in Guam's Hazardous Waste Management Regulations and polychlorinated biphenyl (PCB) wastes as defined in 40 CFR Part 761. This program must include, at a minimum:

(1) random inspections of incoming loads;

(2) records of any inspections;

(3) training of facility personnel to recognize regulated hazardous waste and PCB wastes; and

(4) notification of Administrator if a regulated hazardous waste or PCB waste is discovered at the facility.

(b) For purposes of this section, 'regulated hazardous waste' means a solid waste that is a hazardous waste or was not generated by a conditionally exempt small quantity generator as defined in Guam's Hazardous Waste Management Regulations.

§23304. Cover material requirements. (a) Except as provided in Subsection (b) of this §23304, the owners or operators of all MSWLF units must cover disposed solid waste with Six (6) inches of earthen material at the end of each operating day, or at more frequent intervals if necessary, to control disease vectors, fires, odors, blowing litter, and scavenging.

(b) Alternative materials of an alternative thickness (other than at least Six (6) inches of earthen material) may be approved by the Administrator if the owner or operator demonstrates that the alternative material and thickness control disease vectors, fires, odors, blowing litter, and scavenging without presenting a threat to human health and the environment.

(c) In order to conserve land disposal site capacity, thereby preserving land resources, and to minimize moisture infiltration and settlement, solid waste and cover material shall be compacted to the smallest practicable volume. Solid wastes may be reduced in volume by using balers, shredders, or other reducing devices before placement in cells.

(d) The Administrator may grant a temporary waiver from the requirement of Subsections (a) and (b) of this §23304, if the owner or operator demonstrates that there are extreme short term climatic conditions that make meeting such requirements impractical.

§23305. Disease vector control. (a) Owners or operators of all MSWLF units must prevent or control on-site populations of disease vectors using techniques appropriate for the protection of human health and the environment.

(b) For purposes of this Section, 'disease vectors' means any rodents, flies, mosquitoes, or other animals, including insects, capable of transmitting disease to humans.

§23306. Explosive gases control. (a) Owners or operators of all MSWLF units must ensure that:

(1) the concentration of methane gas generated by the facility does not exceed Twenty-five Percent (25%) of the lower explosive limit for methane in facility structures (excluding gas control or recovery system components); and

(2) the concentration of methane gas does not exceed the lower explosive limit for methane at the facility property boundary.

(b) Owners or operators of all MSWLF units must implement a routine methane monitoring program to ensure that the standards of Subsection (a) of this §23306 are met.

(1) The type and frequency of monitoring must be determined based on the following factors:

(A) soil conditions;

(B) the hydrogeologic conditions surrounding the facility;

(C) the hydraulic conditions surrounding the facility; and

(D) the location of facility structures and property boundaries.

(2) The minimum frequency of monitoring shall be quarterly.

(c) If methane gas levels exceeding the limits specified in Subsection (a) of this §23306 are detected, the owner or operator must:

(1) immediately take all necessary steps to ensure protection of human health and notify the Administrator;

(2) within Seven (7) days of detection, place in the operating record the methane gas levels detected and a description of the steps taken to protect human health; and

(3) within Sixty (60) days of detection, implement a remediation plan for the methane gas releases, place a copy of the plan in the operating record, and notify the Administrator that the plan has been implemented; the plan shall describe the nature and extent of the problem and the proposed remedy;

(4) the Administrator may establish alternative schedules for demonstrating compliance with Items (2) and (3) of Subsection (c) of this §23306.

(d) For purposes of this Section, 'lower explosive limit' means the lowest percent by volume of a mixture of explosive gases in air that will propagate a flame at Twenty-five Degrees Celsius (25°C) and atmospheric pressure.

§23307. Air criteria. (a) Owners or operators of all MSWLFs must ensure that the units do not violate any applicable requirements developed under a State Implementation Plan

(SIP) approved or promulgated by the United States Environmental Protection Agency (USEPA) Administrator pursuant to Section 110 of the Clean Air Act, as amended, or any additional requirements of the Guam Air Pollution Control rules, regulations, or laws.

(b) Open burning of solid waste, except for the infrequent burning of agricultural wastes, silvicultural wastes, landclearing debris, diseased trees, or debris from emergency clean-up operations, is prohibited at all MSWLF units.

§23308. Access requirements. (a) Owners or operators of all MSWLF units must control public access and prevent unauthorized vehicular traffic and illegal dumping of wastes by using artificial barriers, natural barriers, or both, as appropriate to protect human health and the environment.

(b) Characteristics of on-site soil shall be evaluated with respect to their effects on site operations, such as vehicle maneuverability and their use as cover material shall be included in the design of the facility.

(c) The site shall be accessible to vehicles for which the site is designed by all weather roads leading from the public road system; temporary roads maintained in a passable condition shall be provided as needed to deliver wastes to the working face.

§23309. Run-on/run-off control systems. (a) Owners or operators of all MSWLF units must design, construct, and maintain:

(1) a run-on control system to prevent flow onto the active portion of the landfill during the peak discharge from a Twenty-five (25) year storm;

(2) a run-off control system from the active portion of the landfill to collect and control at least the water volume resulting from a Twenty-four (24) hour, Twenty-five (25)

year storm.

(b) Run-off from the active portion of the landfill unit must be handled in accordance with §233010 'Surface water requirements' of this Chapter.

§23310. Surface water requirements. MSWLF units shall not cause a discharge of pollutants into waters of the United States, including wetlands, that violates any requirements of the Clean Water Act, including, but not limited to, the National Pollutant Discharge Elimination System (NPDES) requirements, pursuant to Section 402, or cause the discharge of a nonpoint source of pollution to waters of the United States, including wetlands, that violates any requirement of an area-wide or territorial-wide water quality management plan that has been approved under Section 208 or 319 of the Clean Water Act, as amended.

§23311. Liquid restrictions. (a) Bulk or non-containerized liquid waste may not be placed in MSWLF units unless:

(1) the waste is household waste other than septic waste; or

(2) the waste is leachate or gas condensate derived from the MSWLF unit and the MSWLF unit, whether it is a new or existing MSWLF or lateral expansion, is designed with a composite liner and leachate collection system as described in Item (2) of Subsection (a), §23401 of this Chapter. The owner or operator must place the demonstration in the operating record and notify the Administrator that it has been placed in the operating record.

(b) Containers holding liquid waste may not be placed in a MSWLF unit unless:

(1) the container is a small container similar in size to that normally found in household waste;

(2) the container is designed to hold liquids for use other than storage; or

(3) the waste is household waste;

(4) the oil filters are drained for at least Twenty-four(24) hours or crushed and are not regulated as hazardous waste.

(c) For the purposes of this Section:

(1) 'Liquid waste' means any waste material that is determined to contain 'free liquids' as defined by Method 9095 (Paint Filter Liquids Test), as described in 'Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods' (EPA Pub. No. SW-846).

(2) 'Gas condensate' means the liquid generated as a result of gas recovery process(es) at the MSWLF unit.

§23312. Recordkeeping requirements. (a) The owner or operator of a MSWLF unit must record and retain near the facility in an operating record or in an alternative location approved by the Administrator, the following information as it becomes available:

(1) any location restriction demonstration required under Article 2 of this Chapter;

(2) inspection records, training procedures, and notification procedures required in Subsection (a) of §23303 of this Chapter;

(3) gas monitoring results from monitoring and any remediation plans required by §23306 of this Chapter;

(4) any MSWLF unit design documentation for placement of leachate or gas condensate in a MSWLF unit as required under Item (2) of Subsection (a), §233011 of this

Chapter;

(5) any demonstration, certification, finding, monitoring, testing, or analytical data required by Article 5 of these this Chapter;

(6) closure and post-closure care plans and any monitoring, testing, or analytical data as required by Article 6 of this Chapter;

(7) any cost estimates and financial assurance documentation required by Article 7 of this Chapter;

(8) description of solid waste materials received, identified by source of materials; and the license plate number of the vehicle transporting them for disposal; these records shall be maintained on a daily basis and summarized monthly as to the number of tons received, number of vehicles by type, and kinds of waste materials received;

(9) operation problems, complaints or difficulties;

(10) air quality and litter control efforts;

(11) vector control efforts.

(b) The owner/operator must notify the Administrator when the documents from Subsection (a) of this §23312 have been placed or added to the operating record, and all information contained in the operating record must be furnished upon request to the Administrator or be made available at all reasonable times for inspection by the Administrator.

(c) The Administrator may set alternative schedules for recordkeeping and notification requirements as specified in Subsections (a) and (b) of this §23312, except for the notification requirements in Subsection (b) of §23201 and Item (3) of Subsection (g), §23506 of this Chapter.

§23313. Safety. (a) The land disposal site shall be designed, constructed, and operated in such a manner as to protect the health and safety of personnel associated with the operation and meet all appropriate federal and local Occupational Safety and Health Act requirements.

(b) The operating manual shall describe safety precautions and procedures to be employed at the site during the working day. In addition, the following safety measures are required:

(1) personal safety devices such as hard hats, gloves, and footwear shall be worn by all facility employees while on the site;

(2) safety devices, including but not limited to such items as rollover protective structures, seat-belts, and audible reverse warning devices shall be provided on all equipment used to spread and compact solid wastes or cover material at the facility; fire extinguisher shall be provided and be located within the immediate vicinity of the working face;

(3) provisions shall be made to extinguish any fires in wastes being delivered to the site or which occur at the working face or within equipment or personnel facilities;

(4) communications equipment shall be available on-site for emergency situations;

(5) scavenging shall be prohibited at all times to avoid injury and to prevent interference with site operations;

(6) access to the disposal site shall be controlled and shall be by established roadways only. The site shall be accessible only when operating personnel are on duty. Large volume containers may be placed at the site entrance so that users can conveniently

deposit waste after hours. The containers and the areas around them shall be maintained in a sanitary and litter-free condition. Containers shall be emptied daily unless an alternate schedule is approved by the Administrator;

(7) traffic signs, markers or site personnel shall be provided to promote an orderly traffic pattern to and from the discharge area, maintain efficient operating conditions, and, if necessary, restrict access to hazardous areas. Drivers of manually discharging vehicles shall not hinder operation of mechanically discharging vehicles. Vehicles shall not be left unattended at the working face or along traffic routes. If a regular user persistently poses a safety hazard, he may be barred from the site and reported to the Agency.

Article 4

Design criteria

§23401. Design criteria for Municipal Solid Waste Landfills.

(a) New MSWLF units and lateral expansions shall be constructed:

(1) in accordance with a design approved by the Administrator. The design must ensure that the concentration values listed in §23403 of this Chapter will not be exceeded in the uppermost aquifer at the relevant point of compliance, as specified by the Administrator under Subsection (d) of this §23401, or

(2) with a composite liner, as defined in Subsection (b) of this §23401 and a leachate collection system that is designed and constructed to maintain less than a Thirty centimeter (30cm) (Twelve inches (12")) depth of leachate over the liner.

(3) So as not to cause or contribute to the taking of any endangered or

threatened species of plant, fish or wildlife, and not cause the destruction of critical habitat of endangered or threatened species.

(b) For purposes of this section, 'composite liner' means a system consisting of two components; the upper component must consist of a minimum 30-mil flexible membrane liner (FML), and the lower component must consist of at least a two-foot layer of compacted soil with a hydraulic conductivity of no more than 1×10^{-7} cm/sec. FML components consisting of High Density Polyethylene (HDPE) shall be at least 60-mil thick. The FML component must be installed in direct and uniform contact with the compacted soil component.

(c) When approving a design that complies with Item (1) of Subsection (a) of this §23401, the Administrator shall consider at least the following factors:

(1) The hydrogeologic characteristics of the facility and surrounding land;

(2) The climatic factors of the area;

(3) The volume and physical and chemical characteristics of the leachate;

(4) The types and quantities of solid waste expected to be disposed of at the facility. Survey methods and results shall be incorporated in the design of the facility;

(5) Land use and zoning within one-quarter mile of the site including location of all residences, buildings, wells, water courses, historical sites, recreational areas and roads;

(6) Facilities for employee convenience and equipment maintenance;

(7) Litter control program proposed by applicant; and

(8) Site operation and maintenance plan.

(d) The relevant point of compliance specified by the Administrator shall be no more than 150 meters from the waste management unit boundary and shall be located on land owned by the owner of the MSWLF unit. In determining the relevant point of compliance, the Administrator shall consider at least the following factors:

(1) the hydrogeologic characteristics of the facility and surrounding land;

(2) the volume and physical and chemical characteristics of the leachate;

(3) the quantity, quality, and detection, of flow of ground-water;

(4) the proximity and withdrawal rate of the ground-water users;

(5) the availability of alternative drinking water supplies;

(6) the existing quality of the ground-water, including other sources of contamination and their cumulative impacts on the ground-water and whether ground-water is currently used or reasonably expected to be used for drinking water;

(7) public health, safety, and welfare effects; and

(8) practicable capability of the owner or operator.

§23402. Design criteria for Solid Waste Management Facilities other than MSWLF. (a) Plans for the design, construction, and operation of solid waste management sites or modifications to existing sites shall be prepared or approved by a professional engineer and submitted to the Administrator for approval.

(b) The types and quantities of all solid wastes expected to be at the facility should be determined by survey and analysis to form a basis for design. The survey methods and results shall be incorporated with the application for a permit for the facility.

(c) Site development plans shall include the following design factors:

(1) initial and final topographies at contour intervals of Ten (10) feet or less;

(2) land use and zoning within One-quarter (1/4) mile of the site including location of all residences, buildings, wells, water courses, historical sites, recreational areas and roads. All airports within Two (2) miles of the site shall be identified to aid in assessing the potential hazard of birds to aircraft;

(3) location of all utilities within Five Hundred (500) feet of the site;

(4) facilities for employee convenience and equipment maintenance;

(5) narrative description, with associated drawings, indicating site development and operation procedures.

(d) The construction operation of a solid waste management facility other than a MSWLF shall not cause or contribute to the taking of any endangered or threatened species of plant, fish, or wildlife and shall not cause the destruction of the critical habitat of endangered or threatened species.

(e) The design, construction, and operation of a solid waste management facility other than a MSWLF shall not restrict the flow of the base flood, reduce the temporary water storage capacity of the floodplain, or result in a washout of solid waste so as to pose a hazard to human life, wildlife, or land or water resources.

(f) The solid waste management facility, other than a MSWLF, shall not be located, constructed, or operated so that birds attracted to the facility pose a hazard to aircraft approaching or leaving any airport.

§23403. Table of maximum contaminant levels (MCL) for constituents at the relevant point of compliance.

Chemical	MCL (mg/l)

Arsenic	0.05
Barium	1.0
Benzene	0.005
Cadmium	0.01
Carbon tetrachloride	0.005
Chromium (hexavalent)	0.05
2,4-Dichlorophenoxy acetic acid	0.1
1,4-Dichlorobenzene	0.075
1,2-Dichloroethane	0.005
1,1-Dichloroethylene	0.007
Endrin	0.0002
Fluoride	4.0
Lindane	0.004
Lead	0.05
Mercury	0.002
Methoxychlor	0.1
Nitrate	10.0
Selenium	0.01
Silver	0.05
Toxaphene	0.005
1,1,1-Trichloromethane	0.2
Trichloroethylene	0.005

2,4,5-Trichlorophenoxy acetic acid	0.01
Vinyl Chloride	0.002

Article 5

Ground-water monitoring and corrective action

§23501. Applicability. (a) The requirements in this part apply to MSWLF units, except as provided in Subsection (b) of this §23501.

(b) Ground-water monitoring requirements under §§23502 through 506 of this Chapter may be suspended by the Administrator for a MSWLF unit if the owner or operator can demonstrate that there is no potential for migration of hazardous constituents from that MSWLF unit to the uppermost aquifer (as defined in §23102 of this Chapter) during the active life of the unit and the post-closure care period. This demonstration must be certified by a qualified ground-water scientist and approved by the Administrator, and must be based upon:

(1) site-specific field collected measurements, sampling, and analysis of physical, chemical, and biological processes affecting contaminant fate and transport; and

(2) contaminant fate and transport predictions that maximize contaminant migration and consider impacts on human health and environment.

(c) Owners and operators of MSWLF units must comply with the ground-water monitoring requirements of this Chapter according to the following schedule unless an alternative schedule is specified as discussed in Article 6 of this Chapter.

(1) Existing MSWLF units and lateral expansions less than One (1) mile from a drinking water intake (surface or subsurface) must be in compliance with the ground-

water monitoring requirements specified in §§23502 through 23506 of this Chapter;

(2) Existing MSWLF units and lateral expansions greater than one mile but less than Two (2) miles from a drinking water intake (surface or subsurface) must be in compliance with the ground-water monitoring requirements specified in §§23502 through 23506 of this Chapter;

(3) Existing MSWLF units and lateral expansions greater than Two (2) miles from a drinking water intake (surface or subsurface) must be in compliance with the ground-water monitoring requirements specified in §§23502 through 23506 of this Chapter.

(4) New MSWLF units must be in compliance with the ground-water monitoring requirements specified in §§23502 through 23506 of this Chapter before waste can be placed in the unit.

(d) Once established at a MSWLF unit, ground-water monitoring shall be conducted throughout the active life and post-closure care period of that MSWLF unit as specified in §23602 of this Chapter.

(e) For the purposes of Article 5 of this Chapter, a 'qualified ground-water scientist' is a scientist or engineer who has received a baccalaureate or post-graduate degree in the natural sciences or engineering and has sufficient training and experience in ground-water hydrology and related fields as may be demonstrated by state or territorial registration, professional certifications, or completion of accredited university programs that enable that individual to make sound professional judgements regarding ground-water monitoring, contaminant fate and transport, and corrective-action.

(f) The Administrator may establish alternative schedules for demonstrating compliance with Item (2) of Subsection (d), §23502, pertaining to notification of placement of certification in operating record; Item (1) of Subsection (c), §23505, pertaining to notification that statistically significant increase (SSI) notice is in operating record; Items (2) and (3) of Subsection (c), §23506, pertaining to an assessment monitoring program; Subsection (b) of §23506, pertaining to sampling and analyzing Appendix II constituents; Item (1) of Subsection (d), §23506, pertaining to placement of notice (Appendix II constituents detected) in record and notification of notice in record; Item (2) of Subsection (d), §23506, pertaining to sampling for Appendix I and II; Item (2) of Subsection (g) of §23506, pertaining to notification (and placement of notice in record) of SSI above ground-water protection standard; Item (4) of Subsection (g), §23506 and Subsection (a) of §23507 pertaining to assessment of corrective measures; Subsection (a) of §23508, pertaining to selection of remedy and notification of placement in record; Item (4) of Subsection (c), §23509, pertaining to notification of placement in record (alternative corrective action measures); and Subsection (f) of §23509, pertaining to notification of placement in record (certification of remedy completed), all of this Chapter.

§23502. **Ground-water monitoring systems.** (a) A ground-water monitoring system must be installed that consists of a sufficient number of wells, installed at appropriate locations and depths, to yield ground-water samples from the uppermost aquifer (as defined in §23102 of this Chapter) that:

(1) represent the quality of background ground-water that has not been affected by leakage from a unit. A determination of background quality may include sampling of wells that are not hydraulically upgradient of the waste management area

where:

(A) hydrogeologic conditions do not allow the owner or operator to determine what wells are hydraulically upgradient; or

(B) sampling at other wells will provide an indication of background ground-water quality that is as representative or more representative than that provided by the upgradient wells; and

(2) represent the quality of ground-water passing the relevant point of compliance specified by the Administrator under Subsection (d) of §23401 of this Chapter. The downgradient monitoring system must be installed at the relevant point of compliance specified by the Administrator under Subsection (d) of §23401 that ensures detection of ground-water contamination in the uppermost aquifer. When physical obstacles preclude installation of ground-water monitoring wells at the relevant point of compliance at existing units, the down-gradient monitoring system may be installed at the closest practicable distance hydraulically down-gradient from the relevant point of compliance specified by the Administrator under §23401 of this Chapter that ensure detection of groundwater contamination in the uppermost aquifer.

(b) The Administrator may approve a multi-unit ground-water monitoring system instead of separate ground-water monitoring systems for each MSWLF unit when the facility has several units, provided the multi-unit ground-water monitoring system meets the requirement of Subsection (a) of §23502 of this Chapter and will be as protective of human health and the environment as individual monitoring systems for each MSWLF unit, based on the following factors:

(1) number, spacing, and orientation of the MSWLF units;

(2) hydrogeologic setting;

(3) site history;

(4) engineering design of the MSWLF units; and

(5) type of waste accepted at the MSWLF units.

(c) Monitoring wells must be cased in a manner that maintains the integrity of the monitoring well bore hole. This casing must be screened or perforated and packed with gravel or sand, where necessary, to enable collection of ground-water samples. The annular space (i.e., the space between the bore hole and well casing) above the sampling depth must be sealed to prevent contamination of samples and the ground-water.

(1) The owner or operator must notify the Administrator that the design, installation, development, and decommission of any monitoring wells, piezometers and other measurement, sampling, and analytical devices documentation has been placed in the operating record; and

(2) The monitoring wells, piezometers, and other measurement, sampling, and analytical devices must be operated and maintained so that they perform to design specifications throughout the life of the monitoring program.

(d) The number, spacing, and depths of monitoring systems shall be:

(1) determined based upon site-specific technical information that must include thorough characterization of:

(A) aquifer thickness, ground-water flow rate, ground-water flow direction including seasonal and temporal fluctuations in ground-water flow; and

(B) saturated and unsaturated geologic units and fill materials overlying the uppermost aquifer, materials comprising the uppermost aquifer, and materials comprising the confining unit defining the lower boundary of the uppermost aquifer; including, but not limited to thicknesses, stratigraphy, lithology, hydraulic conductivities, porosities, and effective porosities.

(2) certified by a qualified ground-water scientist or approved by the Administrator. Within Fourteen (14) days of this certification, the owner or operator must notify the Administrator that the certification has been placed in the operating record.

§23503. (Reserved)

§23504. Ground-water sampling and analysis requirements. (a) The ground-water monitoring program must include consistent sampling and analysis procedures that are designed to ensure monitoring results that provide an accurate representation of ground-water quality at the background and downgradient wells installed in compliance with Subsection (a) of §23502 of this Chapter. The owner or operator must notify the Administrator that the sampling and analysis program documentation has been placed in the operating record and the program must include procedures and techniques for:

(1) sample collection;

(2) sample preservation and shipment;

(3) analytical procedures;

(4) chain of custody control; and

(5) quality assurance and quality control.

(b) The ground-water monitoring program must include sampling and analytical methods that are appropriate for ground-water sampling and that accurately measure hazardous constituents and other monitoring parameters in ground-water samples. Ground-water samples shall not be field-filtered prior to laboratory analysis.

(c) The sampling procedures and frequency must be protective of human health and the environment.

(d) Ground-water elevations must be measured in each well immediately prior to purging, each time ground-water is sampled. The owner or operator must determine the rate and direction of ground-water flow each time ground-water is sampled. Ground-water elevations in wells which monitor the same waste management area must be measured within a period of time short enough to avoid temporal variations in ground-water flow which could preclude accurate determination of ground-water flow rate and direction.

(e) The owner or operator must establish background ground-water quality in a hydraulically upgradient or background wells for each of the monitoring parameters or constituents required in the particular ground-water monitoring program that applies to the MSWLF unit, as determined under Subsection (a) of §23505 or Subsection (a) of §23506 of this Chapter. Background ground-water quality may be established at wells that are not located hydraulically upgradient from the MSWLF unit if it meets the requirements of Item (1) of Subsection (a), §23502 of this Chapter.

(f) The number of samples collected to establish groundwater quality data must be consistent with the appropriate statistical procedures determined pursuant to Subsection (g) of this §23504. The sampling procedures shall be those specified under Subsection (b) of §23505 for detection monitoring, Subsections (b) and (d) of §23506 for assessment monitoring, and Subsection (b) of §23507 for corrective action, all of this Chapter.

(g) The owner or operator must specify in the operating record one of the following statistical methods to be used in evaluating ground-water monitoring data for each hazardous constituent. The statistical test chosen shall be conducted separately for each hazardous constituent in each well.

(1) A parametric analysis of variance (ANOVA) followed by multiple comparisons procedures to identify statistically significant evidence of contamination. The method must include estimation and testing of the contrasts between each compliance well's mean and the background mean levels for each constituent.

(2) An analysis of variance (ANOVA) based on ranks followed by multiple comparisons procedures to identify statistically significant evidence of contamination. The method must include estimation and testing of the contrasts between each compliance well's median and the background median levels for each constituent.

(3) A tolerance or prediction interval procedure in which an interval for each constituent is established from the distribution of the background data, and the level of each constituent in each compliance well is compared to the upper tolerance or prediction limit.

(4) A control chart approach that gives control limits for each constituent.

(5) Another statistical test method that meets the performance standards of Subsection (h) of this §23504. The owner or operator must place a justification for this alternative in the operating record and notify the Administrator of the use of this

alternative test. The justification must demonstrate that the alternative method meets the performance standards of Subsection (h) of this §23504. Components of such demonstrations are identified in Chapter 5, Subpart E, of the EPA Solid Waste Disposal Facility Criteria, Technical Manual, published in November 1993 or as updated.

(h) Any statistical method chosen under Subsection (g) of this §23504 shall comply with the following performance standards, as appropriate.

(1) The statistical method used to evaluate ground-water monitoring data shall be appropriate for the distribution of chemical parameters or hazardous constituents. If the distribution of the chemical parameters or hazardous constituents is shown by the owner or operator to be inappropriate for a normal theory test, then the data should be transformed or a distribution-free theory test should be used. If the distributions for the constituents differ, more than one statistical method may be needed.

(2) If an individual well comparison procedure is used to compare an individual compliance well constituent concentration with background constituent concentrations or a ground-water protection standard, the test shall be done at a Type I error level no less than 0.01 for each testing period. If a multiple comparisons procedure is used, the Type I experiment wise error rate for each testing period shall be no less than 0.05; however, the Type I error of no less than 0.01 for individual well comparisons must be maintained. This performance standard does not apply to tolerance intervals, prediction intervals, or control charts.

(3) If a control chart approach is used to evaluate ground-water monitoring data, the specific type of control chart and its associated parameter values shall be

protective of human health and the environment. The parameters shall be determined after considering the number of samples in the background data base, the data distribution, and the range of the concentration values for each constituent of concern.

(4) If a tolerance interval or a predictional interval is used to evaluate ground-water monitoring data, the levels of confidence and, for tolerance intervals, the percentage of the population that the interval must contain, shall be protective of human health and the environment. These parameters shall be determined after considering the number of samples in the background data base, the data distribution, and the range of the concentration values for each constituent of concern.

(5) The statistical method shall account for data below the limit of detection with One (1) or more statistical procedures that are protective of human health and the environment. Any practical quantitative limit (pql) that is used in the statistical method shall be the lowest concentration level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions that are available to the facility.

(6) If necessary, the statistical method shall include procedures to control or correct for seasonal and spatial variability as well as temporal correlation in the data.

(i) The owner or operator must determine whether or not there is a statistically significant increase over background values for each parameter or constituent required in the particular ground-water monitoring program that applies to the MSWLF unit, as determined under Subsection (a) of §23505 or Subsection (a) of §23506, all of this Chapter.

(1) In determining whether a statistically significant increase has occurred,

the owner or operator must compare the ground-water quality of each parameter or constituent at each monitoring well designated pursuant to Item (2) of Subsection (a) of §23502 of this Chapter, to the background value of that constituent, according to the statistical procedures and performance standards specified under Subsections (g) and (h) of this §23504.

(2) Within a reasonable period of time after completing sampling and analysis, the owner or operator must determine whether there has been a statistically significant increase over background at each monitoring well.

§23505. Detection monitoring program. (a) Detection monitoring is required at MSWLF units at all ground-water monitoring wells defined under Items (1) and (2) of Subsection (a), §23502 of this Chapter. At a minimum, a detection monitoring program must include the monitoring for the constituents listed in Appendix I of this Chapter.

(1) The Administrator may delete any of the Appendix I monitoring parameters for a MSWLF unit if it can be shown that the removed constituents are not reasonably expected to be contained in or derived from the waste contained in the unit.

(2) The Administrator may establish an alternative list of inorganic indicator parameters for a MSWLF unit, in lieu of some or all of the heavy metals (constituents 1-15 in Appendix I of this Chapter), if the alternative parameters provide a reliable indication of inorganic releases from the MSWLF unit to the ground-water. In determining alternative parameters, the Administrator shall consider the following factors:

(A) the types, quantities, and concentrations of constituents in waste managed at the MSWLF unit;

(B) the mobility, stability, and persistence of waste constituents or their reaction products in the unsaturated zone beneath the MSWLF unit;

(C) the detectability of indicator parameters, waste constituents, and reaction products in the ground-water; and

(D) the concentration or values and coefficients of variation of monitoring parameters or constituents in the ground-water background.

(b) The monitoring frequency for all constituents listed in Appendix I of this Chapter, or in the alternative list approved in accordance with Item (2) of Subsection (a) of this §23505, shall be at least semi-annual during the active life of the facility (including closure) and the post-closure period. A minimum of Four (4) independent samples from each well (background and downgradient) must be collected and analyzed for the Appendix I constituents, or the alternative list approved in accordance with Item (2) of Subsection (a) of this §23505, during the first semiannual sampling event. At least One (1) sample from each well (background and downgradient) must be collected and analyzed during subsequent semiannual sampling events. The Administrator may specify an appropriate alternative frequency for repeated sampling and analysis for Appendix I constituents, or the alternative list approved in accordance with Item (2) of Subsection (a) of this §23505, during the active life (including closure) and the post-closure care period. The alternative frequency during the active life (including closure) shall be no less than annual. The alternative frequency shall be based on consideration of the following factors:

(1) lithology of the aquifer and unsaturated zone;

(2) hydraulic conductivity of the aquifer and unsaturated zone;

(3) ground-water flow rates;

(4) minimum distance between upgradient edge of the MSWLF unit and downgradient monitoring well screen (minimum distance of travel); and

(5) resource value of the aquifer.

(c) If the owner or operator determines, pursuant to Subsection (g) of §23504, that there is a statistically significant increase over background for One (1) or more of the constituents listed in Appendix I of this Chapter, or in the alternative list approved in accordance with Item (2) of Subsection (a) of this §23505, at any monitoring well at the boundary specified under Item (2) of Subsection (a) of §23502, the owner or operator:

(1) must within Fourteen (14) days of this finding place a notice in the operating record indicating which constituents have shown statistically significant changes from background levels, and notify the Administrator that this notice was placed in the operating record; and

(2) must establish an assessment monitoring program meeting the requirements of §23506 within Ninety (90) days except as provided for in Item (3) of Subsection (c) of this §23505.

(3) may demonstrate that a source other than a MSWLF unit caused the contamination or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in ground-water quality. Components of such demonstrations are identified in Chapter 5, Subpart E, of the EPA Solid Waste Disposal Facility Criteria, Technical Manual, published in November 1993

or as updated. A report documenting this demonstration must be certified by a qualified ground-water scientist or approved by the Administrator and be placed in the operating record. If a successful demonstration is made and documented, the owner or operator may continue detection monitoring as specified in this section. If, after Ninety (90) days, a successful demonstration is not made, the owner or operator must initiate an assessment monitoring program as required in §23506 of this Chapter.

§23506. Assessment monitoring program. (a) Assessment monitoring is required whenever a statistically significant increase over background has been detected for one or more of the constituents listed in Appendix I or in the alternative list approved in accordance with Item (2) of Subsection (a) of §23505.

(b) Within Ninety (90) days of triggering an assessment monitoring program, and annually thereafter, the owner or operator must sample and analyze the ground-water for all constituents identified in Appendix II of this Chapter. A minimum of One (1) sample from each downgradient well must be collected and analyzed during each sampling event. For any constituent detected in the downgradient wells as the result of the complete Appendix II analysis, a minimum of Four (4) independent samples from each well (background and downgradient) must be collected and analyzed to establish background for the new constituents.

The Administrator may specify an appropriate subset of wells to be sampled and analyzed for Appendix II constituents during assessment monitoring. The Administrator may delete any of the Appendix II monitoring parameters for a MSWLF unit if it can be shown that the removed constituents are not reasonably expected to be in or derived from the waste contained in the unit.

(c) The Administrator may specify an appropriate alternate frequency for repeated sampling and analysis for the full set of Appendix II constituents required by Subsection (b) of §23506, during the active life (including closure) and post-closure care of the unit considering the following factors:

(1) lithology of the aquifer and unsaturated zone;

(2) hydraulic conductivity of the aquifer and unsaturated zone;

(3) ground-water flow rates;

(4) minimum distance between upgradient edge of the MSWLF unit and downgradient monitoring well screen (minimum distance of travel);

(5) resource value of the aquifer; and

(6) nature (fate and transport) of any constituents detected in response to this §23506.

(d) After obtaining the results from the initial or subsequent sampling events required in Subsection (b) of this §23506, the owner or operator must:

(1) within Twenty-four (24) hours, place a notice in the operating record identifying the Appendix II constituents that have been detected and notify the Administrator that this notice has been placed in the operating record;

(2) within Ninety (90) days, and on at least a semi-annual basis thereafter, resample all wells specified by Subsection (a) of §23502, conduct analyses for all constituents in Appendix I of this Chapter or in the alternative list approved in accordance with Item (2) of Subsection (a) of §23505, and for those constituents in Appendix II of these regulations that are detected in response to Subsection (b) of this

§23506, and record their concentrations in the facility operating record. At least One (1) sample from each well (background and downgradient) must be collected and analyzed during these sampling events.

The Administrator may specify an alternative monitoring frequency during the active life (including closure) and the post closure period for the constituents referred to in this paragraph. The alternative frequency for Appendix I constituents, or the alternative list approved in accordance with Item (2) of Subsection (a) of §23505, during the active life (including closure) shall be no less than annual. The alternative frequency shall be based on consideration of the factors specified in Subsection (c) of this §23506;

(3) establish background concentrations for any constituents detected pursuant to Subsection (b) or Item (2) of Subsection (d), all of this §23506; and

(4) establish ground-water protection standards for all constituents detected pursuant to Subsections (b) and (d) of this §23506. The ground-water protection standards shall be established in accordance with Subsections (h) or (i) of this §23506.

(e) If the concentrations of all Appendix II constituents are shown to be at or below background values, using the statistical procedures in Subsection (g) of §23504, for Two (2) consecutive sampling events, the owner or operator must notify the Administrator of this finding and may return to detection monitoring.

(f) If the concentrations of any Appendix II constituents are above background values, but all concentrations are below the ground-water protection standard established under Subsections (h) or (i) of this §23506, using the statistical procedures in Subsections (g) of §23504, the owner or operator must continue assessment monitoring in accordance with this

§23506.

(g) If One (1) or more Appendix II constituents are detected at statistically significant levels above the ground-water protection standard established under Subsections (h) or (i) of this §23506, in any sampling event, the owner or operator must, within Fourteen (14) days of this finding, place a notice in the operating record identifying the Appendix II constituents that have exceeded the ground-water protection standard and notify the Administrator and all appropriate local government officials that the notice has been placed in the operating record. The owner or operator also:

(1) must characterize the nature and extent of the release by installing additional monitoring wells as necessary;

(2) must install at least One (1) additional monitoring well at the facility boundary in the direction of contaminant migration and sample this well in accordance with Item (2) of Subsection (d) of this §23506;

(3) must notify all persons who own the land or reside on the land that directly overlies any part of the plume of contamination if contaminants have migrated off-site if indicated by sampling of wells in accordance with Item (1) of Subsection (g) of this §23506; and

(4) must initiate an assessment of corrective measures as required by §23507 of this Chapter within Ninety (90) days; or

(5) may demonstrate that a source other than a MSWLF unit caused the contamination, or that the SSI resulted from error in sampling, analysis, statistical evaluation, or natural variation in ground-water quality. Components of such

demonstrations are identified in Chapter 5, Subpart E, of the EPA Solid Waste Disposal Facility Criteria, Technical Manual, published in November 1993 or as updated. A report documenting this demonstration must be certified by a qualified ground-water scientist or approved by the Administrator and placed in the operating record. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this §23506, and may return to detection monitoring if the Appendix II constituents are at or below background as specified in Subsection (e) of this §23506. Until a successful demonstration is made, the owner or operator must comply with Subsection (g) of this §23506, including initiating an assessment of corrective measures.

(h) The owner or operator must establish a ground-water protection standard for each Appendix II constituent detected in the ground-water. The ground-water protection standard shall be:

(1) for constituents for which a maximum contaminant level (MCL) has been promulgated under Section 1412 of the Safe Drinking Water Act (42 U.S.C. §300g) and under 40 CFR Part 141, the MCL for that constituent;

(2) for constituents for which MCLs have not been promulgated, the background concentration for the constituent established from wells in accordance with Item (1) of Subsection (a) of §23502; or

(3) For constituents for which the background level is higher than the MCL identified under Item (1) of Subsection (h) of this §23506 or health based levels identified under Item (1) of Subsection (i) of this §23506, the background concentration.

(i) The Administrator may establish an alternative ground-water protection standard for constituents for which MCLs have not been established. These ground-water protection standards shall be appropriate health based levels that satisfy the following criteria:

(1) the level is derived in a manner consistent with USEPA guidelines for assessing the health risks of environmental pollutants (51 FR 33992, 34006, 34014, 34028, September 24, 1986);

(2) the level is based on scientifically valid studies conducted in accordance with the Toxic Substances Control Act Good Laboratory Practice Standards (40 CFR Part 792) or equivalent;

(3) for carcinogens, the level represents a concentration associated with an excess lifetime cancer risk level (due to continuous lifetime exposure) with the 1×10^{-4} to 1×10^{-6} range; and

(4) for systemic toxicant, the level represents a concentration to which the human population (including sensitive subgroups) could be exposed to on a daily basis that is likely to be without appreciable risk of deleterious effects during a lifetime. For purposes of this Subsection (i) of this §23506, systemic toxicant includes toxic chemicals that cause effects other than cancer or mutation.

(j) In establishing ground-water protection standards under Subsection (i) of this §23506, the Administrator may consider the following:

(1) multiple contaminants in the ground-water;

(2) exposure threats to sensitive environmental receptors; and

(3) other site-specific exposure or potential exposure to ground-water.

§23507. Assessment of corrective measures. (a) Within Ninety (90) days of finding that any of the constituents listed in Appendix II have been detected at a statistically significant level exceeding the ground-water protection standards defined under Subsections (h) or (i) of §23506 of this Chapter, the owner or operator must initiate an assessment of corrective measures. Such an assessment must be completed within a reasonable period of time.

(b) The owner or operator must continue to monitor in accordance with the assessment monitoring program as specified in §23506 of this Chapter.

(c) The assessment shall include an analysis of the effectiveness of potential corrective measures in meeting all of the requirements and objectives of the remedy as described under §23508 of this Chapter, addressing at least the following:

(1) the performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination;

(2) the time required to begin and complete the remedy;

(3) the costs of remedy implementation; and

(4) The institutional requirements such as territorial or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy.

(d) The owner or operator must discuss the results of the corrective measures assessment, prior to the selection of remedy, in a public meeting with interested and affected parties.

§23508. Selection of remedy. (a) Based on the results of the corrective measures assessment conducted under §23507 of this Chapter, the owner or operator must select a remedy that, at a minimum, meets the standards listed in Suybsection (b) of this §23508. The owner or operator must notify the Administrator, within Fourteen (14) days of selecting a remedy, a report describing the selected remedy has been placed in the operating record and how it meets the standards in Subsection (b) of this §23508.

(b) Remedies must:

(1) be protective of human health and the environment;

(2) attain the ground-water protection standard as specified pursuant to Subsections (h) or (i) of §23506 of this Chapter;

(3) control the source(s) of releases so as to reduce or eliminate, to the maximum extent practicable, further releases of Appendix II constituents into the environment that may pose a threat to human health or the environment; and

(4) comply with standards for management of wastes as specified in Subsection (d) of §23509 of this Chapter.

(c) In selecting a remedy that meets the standards of Subsection (b) of this §23508, the owner or operator shall consider the following evaluation factors:

(1) The long-term and short-term effectiveness and protectiveness of the potential remedy(ies), along with the degree of certainty that the remedy will prove successful based on consideration of the following:

(A) magnitude of reduction of existing risks;

(B) magnitude of residual risks in terms of likelihood of further releases due to waste remaining following implementation of a remedy;

(C) the type and degree of long-term management required, including monitoring, operation, and maintenance;

(D) short-term risks that might be posed to the community, workers, or the environment during implementation of such a remedy, including potential threats to human health and the environment associated with excavation, transportation, and redisposal or containment;

(E) time until full protection is achieved;

(F) potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, redisposal, or containment;

(G) long-term reliability of the engineering and institutional controls; and

(H) potential need for replacement of the remedy.

(2) The effectiveness of the remedy in controlling the source to reduce further releases based on consideration of the following factors:

(A) the extent to which containment practices will reduce further releases;

(B) the extent to which treatment technologies may be used.

(3) The ease or difficulty of implementing a potential remedy(ies) based on consideration of the following types of factors:

(A) degree of difficulty associated with constructing the technology;

(B) expected operational reliability of the technologies;

(C) need to coordinate with and obtain necessary approvals and permits from other agencies;

(D) availability of necessary equipment and specialists; and

(E) available capacity and location of needed treatment, storage, and disposal services.

(4) Practicable capability of the owner or operator, including a consideration of the technical and economic capability.

(5) The degree to which community concerns are addressed by a potential remedy(ies).

(d) The owner or operator shall specify as part of the selected remedy a schedule(s) for initiating and completing remedial activities. Such a schedule must require the initiation of remedial activities within a reasonable period of time taking into consideration the factors set forth in Items (1) through (8) of Subsection (d) of this §23508. The owner or operator must consider the following factors in determining the schedule of remedial activities:

(1) extent and nature of contamination;

(2) practical capabilities of remedial technologies in achieving compliance with ground-water protection standards established under Subsections (g) or (h) of §23506 of this Chapter and other objectives of the remedy;

(3) availability of treatment or disposal capacity for wastes managed during implementation of the remedy;

(4) desirability of utilizing technologies that are not currently available, but

which may offer significant advantages over already available technologies in terms of effectiveness, reliability, safety, or ability to achieve remedial objectives;

(5) potential risks to human health and the environment from exposure to contamination prior to completion of the remedy;

(6) resource value of the aquifer including:

(A) current and future uses;

(B) proximity and withdrawal rate of users;

(C) ground-water quantity and quality;

(D) the potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituent;

(E) the hydrogeologic characteristic of the facility and surrounding land;

(F) ground-water removal and treatment costs; and

(G) the cost and availability of alternative water supplies.

(7) practicable capability of the owner or operator;

(8) other relevant factors.

(e) The Administrator may determine that remediation of a release of an Appendix II constituent from a MSWLF unit is not necessary if the owner or operator demonstrates to the Administrator that:

(1) the ground-water is additionally contaminated by substances that have originated from a source other than a MSWLF unit and those substances are present in concentrations such that cleanup of the release from the MSWLF unit would provide no

significant reduction in risk to actual or potential receptors; or

(2) the constituent(s) is present in ground-water that:

(A) is not currently or reasonably expected to be a source of drinking water; and

(B) is not hydraulically connected with waters to which the hazardous constituents are migrating or are likely to migrate in a concentration(s) that would exceed the ground-water protection standards established under Subsections (h) or (i) of §23506; or

(3) remediation of the release(s) is technically impracticable; or

(4) remediation results in unacceptable cross-media impacts.

(f) A determination by the Administrator pursuant to Subsection (e) of §23508 shall not affect the authority of Guam to require the owner or operator to undertake source control measures or other measures that may be necessary to eliminate or minimize further releases to the ground-water, to prevent exposure to the ground-water, or to remediate the ground-water to concentrations that are technically practicable and significantly reduce threats to human health or the environment.

§23509. Implementation of the corrective action program. (a) Based on the schedule established under Subsection (d) of §23508 of this Chapter, for initiation and completion of remedial activities the owner or operator must:

(1) establish and implement a corrective action ground-water monitoring program that:

(A) at a minimum, meet the requirements of an assessment monitoring program under §23506 of this Chapter;

(B) indicate the effectiveness of the corrective action remedy; and

(C) demonstrate compliance with ground-water protection standard pursuant to Subsection (e) of this §23509. Components of such demonstrations are identified in Chapter 5, Subpart E, of the EPA Solid Waste Disposal Facility Criteria, Technical Manual, published in November 1993 or as updated.

(2) implement the corrective action remedy selected under §23508 of this Chapter; and

(3) take any interim measures necessary to ensure the protection of human health and the environment. Interim measures should, to the greatest extent practicable, be consistent with the objectives of, and contribute to, the performance of any remedy that may be required pursuant to §23508 of this Chapter. The following factors must be considered by an owner or operator in determining whether interim measures are necessary:

(A) time required to develop and implement a final remedy;

(B) actual or potential exposure of nearby populations or environmental receptors to hazardous constituents;

(C) actual or potential contamination of drinking water supplies or sensitive ecosystems;

(D) further degradation of the ground-water that may occur if remedial action is not initiated expeditiously;

(E) weather conditions that may cause hazardous constituents to migrate or be released;

(F) risks of fire or explosion, or potential for exposure to hazardous constituents as a result of an accident or failure of a container or handling system; and

(G) other situations that may pose threats to human health and the environment.

(b) An owner or operator may determine, based on information developed after implementation of the remedy has begun or other information, that compliance with requirements of Subsection (b) of §23508 of this Chapter are not being achieved through the remedy selected. In such cases, the owner or operator must implement other methods or techniques that could practicably achieve compliance with the requirements, unless the owner or operator makes the determination under Subsection (c) of this §23509.

(c) If the owner or operator determines that compliance with requirements under Subsection (b) of §23508 cannot be practically achieved with any currently available methods, the owner or operator must:

(1) obtain certification of a qualified ground-water scientist or approval by the Administrator that compliance with requirements under Subsection (b) of §23508 cannot be practically achieved with any currently available methods;

(2) implement alternate measures to control exposure of humans or the environment to residual contamination, as necessary to protect human health and the environment; and

(3) implement alternate measures for control of the sources of contamination,

or for removal or decontamination of equipment, units, devices, or structures that are:

(A) technically practicable; and

(B) consistent with the overall objective of the remedy.

(4) notify the Administrator within Fourteen (14) days that a report justifying the alternative measures prior to implementing the alternative measures has been placed in the operating record.

(d) All solid wastes that are managed pursuant to a remedy required under §23508 of this Chapter, or an interim measure required under Item (3) of Subsection (a) of this §23509, shall be managed in a manner;

(1) that is protective of human health and the environment; and

(2) that complies with applicable RCRA requirements.

(e) Remedies selected pursuant to §23508 of this Chapter, shall be considered complete when:

(1) the owner or operator complies with the ground-water protection standards established under Subsections (h) or (i) of §23506 at all points within the plume of contamination that lie beyond the ground-water monitoring well system established under Subsection (a) of §23502;

(2) compliance with the ground-water protection standards established under Subsections (h) or (i) of §23506 has been achieved by demonstrating that concentrations of Appendix II constituents have not exceeded the ground-water protection standard(s) for a period of Three (3) consecutive years using the statistical procedures and performance standards in Subsections (g) or (h) of §23504. Components of such

demonstrations are identified in Chapter 5, Subpart E, of the EPA Solid Waste Disposal Facility Criteria, Technical Manual, published in November 1993 or as updated. The Administrator may specify an alternative length of time during which the owner or operator must demonstrate that concentrations of Appendix II constituents have not exceeded the ground-water protection standard(s) taking into consideration:

(A) extent and concentration of the release(s);

(B) behavior characteristics of the hazardous constituents in the ground-water;

(C) accuracy of monitoring or modeling techniques, including any seasonal, meteorological, or other environmental variabilities that may affect the accuracy; and

(D) characteristics of the ground-water;

(3) all actions required to complete the remedy have been satisfied.

(f) Upon completion of the remedy, the owner or operator must notify the Administrator within Fourteen (14) days that a certification that the remedy has been completed in compliance with the requirements of Subsection (e) of this §23509 has been placed in the operating record. The certification must be signed by the owner or operator and by a qualified ground-water scientist or approved by the Administrator.

(g) When, upon completion of the certification, the owner or operator determines that the corrective action remedy has been completed in accordance with the requirements under Subsection (e) of this §23509, the owner or operator shall be released from the requirements for financial assurance for corrective action under §23704.

Article 6

Closure and post-closure care

§23601. Closure criteria. (a) Owners or operators of all MSWLF units must install a final cover system that is designed to minimize infiltration and erosion. The final cover system must be comprised of an erosion layer underlain by an infiltration layer as follows:

(1) the infiltration layer must be comprised of a minimum of Eighteen (18) inches of earthen material that has a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1×10^{-5} cm/sec, whichever is less, and

(2) the erosion layer must consist of a minimum Six (6) inches of earthen material that is capable of sustaining native plant growth.

(b) The Administrator may approve an alternative final cover design that includes:

(1) an infiltration layer that achieves an equivalent reduction in infiltration as the infiltration layer specified in Item (1) of Subsection (a) of this §23601; and

(2) an erosion layer that provides equivalent protection from wind and water erosion as the erosion layer specified in Item (2) of Subsection (a) of this §23601.

(c) The owner or operator must prepare a written closure plan that describes the steps necessary to close all MSWLF units at any point during its active life in accordance with the cover design requirements in Subsections (a) or (b) of this §23601, as applicable. This plan must be approved by Guam EPA prior to the initiation of closure activities. The closure plan, at a minimum, must include the following information:

(1) a description of the final cover, designed in accordance with Subsections

(a) of this §23601 and the methods and procedures to be used to install the cover;

(2) an estimate of the largest area of the MSWLF unit ever requiring a final cover as required under Subsections (a) of this §23601 at any time during the active life;

(3) an estimate of the maximum inventory of wastes ever on-site over the active life of the landfill facility; and

(4) a schedule for completing all activities necessary to satisfy the closure criteria in this §23601.

(d) The owner or operator must notify the Administrator that a closure plan has been prepared and placed in the operating record immediately or by the initial receipt of waste, whichever is later.

(e) Prior to beginning closure of each MSWLF unit as specified in Subsections (f) of this §23601, an owner or operator must notify the Administrator that a notice of the intent to close the unit has been placed in the operating record.

(f) The owner or operator must begin closure activities of each MSWLF unit no later than Thirty (30) days after the date on which the MSWLF unit receives the known final receipt of wastes or, if the MSWLF unit has remaining capacity and there is a reasonable likelihood that the MSWLF unit will receive additional wastes, no later than One (1) year after the most recent receipt of wastes. Extensions beyond the One (1) year deadline for beginning closure may be granted by the Administrator if the owner or operator demonstrates that the MSWLF unit has the capacity to receive additional wastes and the owner or operator has taken and will continue to take all steps necessary to prevent threats to human health and the environment from the unclosed MSWLF unit.

(g) The owner or operator of all MSWLF units must complete closure activities of each MSWLF unit in accordance with the closure plan within One hundred and eighty (180) days following the beginning of closure as specified in Subsection (f) of this §23601. Extensions of the closure period may be granted by the Administrator if the owner or operator demonstrates that closure will, of necessity, take longer than One hundred and eighty (180) days and he has taken and will continue to take all steps to prevent threats to human health and the environment from the unclosed MSWLF unit.

(h) Following closure of each MSWLF unit, the owner or operator must notify the Administrator that a certification, signed by an independent registered professional engineer and approved by the Administrator, verifying that closure has been completed in accordance with the closure plan, has been placed in the operating record.

(i) Following closure of all MSWLF units, the owner or operator must record a notation on the deed to the landfill facility property, or some other instrument that is normally examined during title search, and notify the Administrator that the notation has been recorded and a copy has been placed in the operating record.

(j) The notation on the deed must in perpetuity notify any potential purchaser of the property that:

(1) the land has been used as a landfill facility; and

(2) its use is restricted under Item (3) of Subsection (c) of this §23602.

(k) The owner or operator may request permission from the Administrator to remove the notation from the deed if all wastes are removed from the facility.

§23602. Post-closure care requirements. (a) Following closure of each

MSWLF unit, the owner or operator must conduct post-closure care. Post-closure care must be conducted for Thirty (30) years, except as provided under Subsection (b) of this §23602, and consist of at least the following:

(1) maintaining the integrity and effectiveness of any final cover, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the final cover;

(2) maintaining and operating the leachate collection system in accordance with the requirements in §23401 of this Chapter. The Administrator may allow the owner or operator to stop managing leachate if the owner or operator demonstrates that leachate no longer poses a threat to human health and the environment;

(3) monitoring the ground-water in accordance with the requirements of Article 5 of this Chapter and maintaining the ground-water monitoring system, if applicable; and

(4) Maintaining and operating the gas monitoring system in accordance with the requirements of §23306.

(b) The length of the post-closure care period may be:

(1) decreased by the Administrator if the owner or operator demonstrates that the reduced period is sufficient to protect human health and the environment and this demonstration is approved by the Administrator; or

(2) increased by the Administrator, if the Administrator determines that the lengthened period is necessary to protect human health and the environment.

(c) The owner or operator of all MSWLF units must prepare a written post-closure plan that includes, at a minimum, the following information:

(1) a description of the monitoring and maintenance activities required in Subsection (a) of this §23602, for each MSWLF unit, and the frequency at which these activities will be performed;

(2) name, address, and telephone number of the person or office to contact about the facility during the post-closure period; and

(3) a description of the planned uses of the property during the post-closure period. Post-closure use of the property shall not disturb the integrity of the final cover, liner(s), or any other components of the containment system, or the function of the monitoring systems unless necessary to comply with the requirements in this Chapter. The Administrator may approve any other disturbance if the owner or operator demonstrates that disturbance of the final cover, liner or other component of the containment system, including any removal of waste, will not increase the potential threat to human health or the environment.

(d) The owner or operator must notify the Administrator that a post-closure plan has been prepared and placed in the operating record immediately or by the initial receipt of waste, whichever is later.

(e) Following completion of the post-closure care period for each MSWLF unit, the owner or operator must notify the Administrator that a certification, signed by an independent registered professional engineer and approved by the Administrator, verifying that post-closure care has been completed in accordance with the post-closure plan, has been placed in the operating record.

Article 7

Financial assurance criteria

§23701. **Applicability and effective date.** (a) The requirements of this Article 7 apply to owners and operators of all MSWLF units, except owners or operators who are local or federal government entities whose debts and liabilities are the debts and liabilities of Guam or the United States.

(b) The requirements of this Article shall be effective immediately.

§23702. **Financial assurance for closure.** (a) The owner or operator must have a detailed written estimate, in current dollars, of the cost of hiring a third party to close the largest area of all MSWLF units ever requiring a final cover as required under §23601 of this Chapter at any time during the active life in accordance with the closure plan. The owner or operator must notify the Administrator that the estimate has been placed in the operating record.

(1) The cost estimate must equal the cost of closing the largest area of all MSWLF units ever requiring a final cover at any time during the active life when the extent and manner of its operation would make closure the most expensive, as indicated by its closure plan (see Item (2) of Subsection (c), §23601 of this Chapter).

(2) During the active life of the MSWLF unit, the owner or operator must annually adjust the closure cost estimate for inflation.

(3) The owner or operator must increase the closure cost estimate and the amount of financial assurance if changes to the closure plan or MSWLF unit conditions increase the maximum cost of closure at any time during the remaining active life.

(4) The owner or operator may reduce the closure cost estimate and the amount of financial assurance if the cost estimate exceeds the maximum cost of closure at any time during the remaining life of the MSWLF unit. The owner or operator must notify the Administrator that the justification for the reduction of the closure cost estimate and the amount of financial assurance has been placed in the operating record.

(b) The owner or operator of each MSWLF unit must establish financial assurance for closure of the MSWLF unit in compliance with §23705 of this Chapter. The owner or operator must provide continuous coverage for closure until released from financial assurance requirements by demonstrating compliance with Subsections (h), (i), and (j) of §23601 of this Chapter.

§23703. Financial assurance for post-closure care. (a) The owner or operator must have a detailed written estimate, in current dollars, of the cost of hiring a third party to conduct post-closure care for the MSWLF unit in compliance with the post-closure plan developed under §23602 of this Chapter. The post-closure cost estimate used to demonstrate financial assurance in Subsection (b) of this §23703 must account for the total costs of conducting post-closure care, including annual and periodic costs as described in the post-closure plan over the entire post-closure care period. The owner or operator must notify the Administrator that the estimate has been placed in the operating record.

(1) The cost estimate for post-closure care must be based on the most expensive costs of post-closure care during the post-closure care period.

(2) During the active life of the MSWLF unit and during the post- closure care period, the owner or operator must annually adjust the post-closure cost estimate

for inflation.

(3) The owner or operator must increase the post-closure care cost estimate and the amount of financial assurance provided under Subsection (b) of this §23703 if changes in the post-closure plan or MSWLF unit conditions increase the maximum costs of post-closure care.

(4) The owner or operator may reduce the post-closure cost estimate and the amount of financial assurance provided under Subsection (b) of this §23703 if the cost estimate exceeds the maximum costs of post-closure care remaining over the post-closure care period. The owner or operator must notify the Administrator that the justification for the reduction of the post-closure cost estimate and the amount of financial assurance has been placed in the operating record.

(b) The owner or operator of each MSWLF unit must establish, in a manner in accordance with §23705, financial assurance for the costs of post-closure care as required under §23602 of this Chapter. The owner or operator must provide continuous coverage for post-closure care until released from financial assurance requirements for post-closure care by demonstrating compliance with Subsection (e) of §23602 of this Chapter.

§23704. **Financial assurance for corrective action.** (a) An owner or operator of a MSWLF unit required to undertake a corrective action program under §23509 of this Chapter must have a detailed written estimate, in current dollars, of the cost of hiring a third party to perform the corrective action in accordance with the program required under that Section. The corrective action cost estimate must account for the total costs of corrective action activities as described in the corrective action plan for the entire corrective action period. The owner or operator must notify the Administrator that the estimate has been placed in the operating record.

(1) The owner or operator must annually adjust the estimate for inflation until the corrective action program is completed in accordance with Subsection (f) of §23509 of this Chapter.

(2) The owner or operator must increase the corrective action cost estimate and the amount of financial assurance provided under Subsection (b) of this §23704 if changes in the corrective action program or MSWLF unit conditions increase the maximum costs of corrective action.

(3) The owner or operator may reduce the amount of the corrective action cost estimate and the amount of financial assurance provided under Subsection (b) of this §23704 if the cost estimate exceeds the maximum remaining costs of corrective action. The owner or operator must notify the Administrator that the justification for the reduction of the corrective action cost estimate and the amount of financial assurance has been placed in the operating record.

(b) The owner or operator of each MSWLF unit required to undertake a corrective action program under §23509 of this Chapter must establish, in a manner in accordance with §23705 of this Chapter, financial assurance for the most recent corrective action program. The owner or operator must provide continuous coverage for corrective action until released from financial assurance requirements for corrective action by demonstrating compliance with Subsections (f) and (g) of §23509 of this Chapter.

§23705. Allowable mechanisms. The mechanisms used to demonstrate financial assurance under this section must ensure that the funds necessary to meet the costs of closure, post-closure care, and corrective action for known releases will be available whenever they are needed. Owners and operators must choose from the options specified in Subsections (a) through (f) of this §23705.

(a) Trust fund.

(1) An owner or operator may satisfy the requirements of this §23705 by establishing a trust fund which conforms to the requirements of Subsection (a) of this §23705. The trustee must be an entity which has the authority to act as a trustee and whose trust operations are regulated and examined by a federal or local agency. A copy of the trust agreement must be placed in the facility's operating record. The owner or operator must notify the Administrator that a copy of the trust fund agreement has been placed in the facility's operating record.

(2) Payments into the trust fund must be made annually by the owner or operator over the term of the initial permit or over the remaining life of the MSWLF unit, whichever is shorter, in the case of a trust fund for closure or post-closure care, or over One-half (1/2) of the estimated length of the corrective action program in the case of corrective action for known releases. This period is referred to as the pay-in period.

(3) For a trust fund used to demonstrate financial assurance for closure and post-closure care, the first payment into the fund must be at least equal to the current cost estimate for closure or post-closure care, divided by the number of years in the pay-in period as defined in Item (2) of Subsection (a) of this §23705. The amount of

subsequent payments must be determined by the following formula:

(A) Next payment = (CE - CV)/Y.

(B) CE is the current cost estimate for closure or post-closure care (updated for inflation or other changes), CV is the current value of the trust fund, and Y is the number of years remaining in the pay-in period.

(4) For a trust fund used to demonstrate financial assurance for corrective action, the first payment into the trust fund must be at least equal to One-half (1/2) of the current cost estimate for corrective action, divided by the number of years in the corrective action pay-in period as defined in Item (2) of Subsection (a) of this §23705. The amount of subsequent payments must be determined by the following formula:

(A) Next payment = (RB - CV)/Y.

(B) RB is the most recent estimate of the required trust fund balance for corrective action (i.e., the total costs that will be incurred during the second half of the corrective action period), CV is the current value of the trust fund, and Y is the number of years remaining on the pay-in period.

(5) The initial payment into the trust fund must be made immediately or before the initial receipt of waste, whichever is later, in the case of closure and post-closure care, or no later than One hundred twenty (120) days after the corrective action remedy has been selected in accordance with the requirements of §23509 of this Chapter.

(6) If the owner or operator establishes a trust fund after having used One (1) or more alternate mechanisms specified in this Article, the initial payment into the trust

fund must be at least the amount that the fund would contain if the trust fund were established initially and annual payments made according to the specifications of Subsection (a) of this §23705, as applicable.

(7) The owner or operator, or other person authorized to conduct closure, post-closure care, or corrective action activities may request reimbursement from the trustee for these expenditures. Requests for reimbursement will be granted by the trustee only if sufficient funds are remaining in the trust fund to cover the remaining costs of closure, post-closure care, or corrective action, and if justification and documentation of the cost is placed in the operating record. The owner or operator must notify the Administrator that the documentation of the justification for reimbursement has been placed in the operating record and that reimbursement has been received.

(8) The trust fund may be terminated by the owner or operator only if the owner or operator substitutes alternate financial assurance as specified in this section or if he is no longer required to demonstrate financial responsibility in accordance with the requirements of Subsection (b) of §23703 or Subsection (b) of §23704, all of this Chapter.

(b) Surety bond guaranteeing payment or performance.

(1) An owner or operator may demonstrate financial assurance for closure or post-closure care by obtaining a payment or performance surety bond which conforms to the requirements of this Item (1) of Subsection (b) of this §23705. An owner or operator may demonstrate financial assurance for corrective action by obtaining a performance bond which conforms to the requirements of this paragraph. The bond must

be effective immediately or before the initial receipt of waste, whichever is later, in the case of closure and post-closure care, or no later than One hundred twenty (120) days after the corrective action remedy has been selected in accordance with the requirements of §23509. The owner or operator must notify the Administrator that a copy of the bond has been placed in the operating record. The surety company issuing the bond must, at a minimum, be among those listed as acceptable sureties on federal bonds in Circular 570 of the U.S. Department of the Treasury.

(2) The penal sum of the bond must be in an amount at least equal to the current closure, post-closure care or corrective action cost estimate, whichever is applicable, except as provided in Subsection (g) of §23705.

(3) Under the terms of the bond, the surety will become liable on the bond obligation when the owner or operator fails to perform as guaranteed by the bond.

(4) The owner or operator must establish a standby trust fund. The standby trust fund must meet the requirements of Subsection (a) of §23705, except the requirements for initial payment and subsequent annual payments specified in Items (2), (3), (4), and (5) of Subsection (a) of this §23705.

(5) Payments made under the terms of the bond will be deposited by the surety directly into the standby trust fund. Payments from the trust fund must be approved by the trustee.

(6) Under the terms of the bond, the surety may cancel the bond by sending notice of cancellation by certified mail to the owner and operator and to the Administrator One hundred and twenty (120) days in advance of cancellation. If the

surety cancels the bond, the owner or operator must obtain alternate financial assurance as specified in this Article 7.

(7) The owner or operator may cancel the bond only if alternate financial assurance is substituted as specified in this section or if the owner or operator is no longer required to demonstrate financial responsibility in accordance with Subsection (b) of §23702, Subsection (b) of §23703, or Subsection (b) of §23704, all of this Chapter.

(c) Letter of credit.

(1) An owner or operator may satisfy the requirements of this Article 7 by obtaining an irrevocable standby letter of credit which conforms to the requirements of this Subsection (c). The letter of credit must be effective immediately or before the initial receipt of waste, whichever is later, in the case of closure and post-closure care, or no later than One hundred and twenty (120) days after the corrective action remedy has been selected in accordance with the requirements of §23509 of this Chapter. The owner or operator must notify the Administrator that a copy of the letter of credit has been placed in the operating record. The issuing institution must be an entity which has the authority to issue letters of credit and whose letter-of-credit operations are regulated and examined by a federal or local agency.

(2) A letter from the owner or operator referring to the letter of credit by number, issuing institution, and date, and providing the following information: name, and address of the facility, and the amount of funds assured, must be included with the letter of credit in the operating record.

(3) The letter of credit must be irrevocable and issued for a period of at least

One (1) year in an amount at least equal to the current cost estimate for closure, post-closure care or corrective action, whichever is applicable, except as provided in Subsection (a) of §23705. The letter of credit must provide that the expiration date will be automatically extended for a period of at least One (1) year unless the issuing institution has cancelled the letter of credit by sending notice of cancellation by certified mail to the owner and operator and to the Administrator One hundred and twenty (120) days in advance of cancellation. If the letter of credit is cancelled by the issuing institution, the owner or operator must obtain alternate financial assurance.

(4) The owner or operator may cancel the letter of credit only if alternate financial assurance is substituted as specified in this §23705 or if the owner or operator is released from the requirements of this section in accordance with Subsection (b) of §23702, Subsection (b) of §23703, or Subsection (b) of §23704, all of this Chapter.

(d) Insurance.

(1) An owner or operator may demonstrate financial assurance for closure and post-closure care by obtaining insurance which conforms to the requirements of this paragraph. The insurance must be effective immediately or before the initial receipt of waste, whichever is later. At a minimum, the insurer must be licensed to transact the business of insurance, or eligible to provide insurance as an excess or surplus lines insurer, in Guam or One (1) or more States. The owner or operator must notify the Administrator that a copy of the insurance policy has been placed in the operating record.

(2) The closure or post-closure care insurance policy must guarantee that

funds will be available to close the MSWLF unit whenever final closure occurs or to provide post-closure care for the MSWLF unit whenever the post-closure care period begins, whichever is applicable. The policy must also guarantee that once closure or post-closure care begins, the insurer will be responsible for the paying out of funds to the owner or operator or other person authorized to conduct closure or post-closure care, up to an amount equal to the face amount of the policy.

(3) The insurance policy must be issued for a face amount at least equal to the current cost estimate for closure or post-closure care, whichever is applicable, except as provided in Subsection (a) of this §23705. The term 'face amount' means the total amount the insurer is obligated to pay under the policy. Actual payments by the insurer will not change the face amount, although the insurer's future liability will be lowered by the amount of the payments.

(4) An owner or operator, or any other person authorized to conduct closure or post-closure care, may receive reimbursements for closure or post-closure expenditures, whichever is applicable. Requests for reimbursement will be granted by the insurer only if the remaining value of the policy is sufficient to cover the remaining costs of closure or post-closure care, and if justification and documentation of the cost is placed in the operating record. The owner or operator must notify the Administrator that the documentation of the justification for reimbursement has been placed in the operating record and that reimbursement has been received.

(5) Each policy must contain a provision allowing assignment of the policy to a successor owner or operator. Such assignment may be conditional upon consent of

the insurer, provided that such consent is not unreasonably refused.

(6) The insurance policy must provide that the insurer may not cancel, terminate or fail to renew the policy except for failure to pay the premium. The automatic renewal of the policy must, at a minimum, provide the insured with the option of renewal at the face amount of the expiring policy. If there is a failure to pay the premium, the insurer may cancel the policy by sending notice of cancellation by certified mail to the owner and operator and to the Administrator One hundred and twenty (120) days in advance of cancellation. If the insurer cancels the policy, the owner or operator must obtain alternate financial assurance as specified in this section.

(7) For insurance policies providing coverage for post-closure care, commencing on the date that liability to make payments pursuant to the policy accrues, the insurer will thereafter annually increase the face amount of the policy. Such increase must be equivalent to the face amount of the policy, less any payments made, multiplied by an amount equivalent to Eighty-five Percent (85) of the most recent investment rate or of the equivalent coupon-issue yield announced by the U.S. Treasury for Twenty-six (26) week Treasury securities.

(8) The owner or operator may cancel the insurance policy only if alternate financial assurance is substituted as specified in this section or if the owner or operator is no longer required to demonstrate financial responsibility in accordance with the requirements of Subsection (b) of §23702, Subsection (b) of §23703, or Subsection (b) of §23704, all of this Chapter.

(e) Local approved mechanism. An owner or operator may satisfy the requirements of this section by obtaining any other mechanism that meets the criteria specified in Subsection (h) of this §23705, and that is approved by the Administrator.

(f) Local assumption of responsibility. If the Administrator either assumes legal responsibility for an owner or operator's compliance with the closure, post-closure care or corrective action requirements of this Article 7, or assures that the funds will be available from local sources to cover the requirements, the owner or operator will be in compliance with the requirements of this section. Any local assumption of responsibility must meet the criteria specified in Subsection (h) of this §23705.

(g) Use of multiple financial mechanisms. An owner or operator may satisfy the requirements of this Article 7 by establishing more than One (1) financial mechanism per facility. The mechanisms must be as specified in Subsections (a) through (f) of this §23705, except that it is the combination of mechanisms, rather than the single mechanism, which must provide financial assurance for an amount at least equal to the current cost estimate for closure, post-closure care or corrective action, whichever is applicable. The financial test and a guarantee provided by a corporate parent, sibling, or grandparent may not be combined if the financial statements of the Two (2) firms are consolidated.

(h) Criteria for language of financial assurance mechanisms. The language of the mechanisms listed in Subsections (a) through (g) of this §23705, must satisfy the following criteria:

(1) the financial assurance mechanisms must ensure that the amount of funds assured is sufficient to cover the costs of closure, post-closure care, and corrective action for known releases when needed;

(2) the financial assurance mechanisms must ensure that funds will be available in a timely fashion when needed;

(3) the financial assurance mechanisms must be obtained by the owner or operator immediately or prior to the initial receipt of solid waste, whichever is later, in the case of closure and post-closure care, and no later than One hundred and twenty (120) days after the corrective action remedy has been selected in accordance with the requirements of §23509 of this Chapter, until the owner or operator is released from the financial assurance requirements under §§23702, 23703, and 23704 of this Chapter;

(4) the financial assurance mechanisms must be legally valid, binding, and enforceable under federal and local law;

(5) the financial assurance mechanism required by this Chapter may not be canceled by the guarantor unless the Administrator has received written notice thereof and there has been a lapse of One hundred and twenty (120) days between receipt of notice and cancellation date.

Addendum A

Fee schedule for all other solid waste management facilities.

1. Solid Waste Transfer Facility	$500.00
2. Industrial Solid Waste Landfill Facility	(Reserved)
3. Solid Waste Hardfill Facility	$500.00
4. Solid Waste Storage Facility	$500.00
5. Solid Waste Processing Facility	
a. Solid Waste Composting Facility	$100.00
b. Solid Waste Material Resource Recovery Facility	$200.00
c. Solid Waste Remediation Facility	
(1) Bioremediation	
(a) Temporary Site Specific	$200.00
(b) Permanent	$500.00
(2) All other remediation	$500.00
d. Solid Waste Incinerator Facility	$500.00
e. Solid Waste-to-Energy Recovery Facility	$10,000.00
f. Other Processing Facility	$200.00

Addendum B The following is the duration of permit for all other solid waste management facilities.

1. Solid Waste Transfer Facility	5 years
2. Industrial Solid Waste Landfill Facility	(Reserved)
3. Solid Waste Hardfill Facility	2 years
4. Solid Waste Storage Facility	2 years
5. Solid Waste Processing Facility	
a. Solid Waste Composting Facility	5 years
b. Solid Waste Material Resource Recovery Facility	5 years
c. Solid Waste Remediation Facility	
(1) Bioremediation	
(a) Temporary Site Specific	2 years
(b) Permanent	5 years
(2) All other remediation	2 years
d. Solid Waste Incinerator Facility	5 years
e. Solid Waste-to-Energy Recovery Facility	5 years
f. Other Processing Facility	2 years

Addendum C **Administrative Penalties.** After following the procedures as outlined in Subsection (e) of §51115 of Public Law 23-64, the Administrator may impose the following administrative penalties up to the listed amount per day for each violation. The violations are including but not limited to the following:

1.	Acceptance of Prohibited Solid Wastes	$1,000.00
2.	Procedures for Excluding Receipt of Hazardous Waste	$1,000.00
3.	Failure to Meet Cover Material Requirements	$1,000.00
4.	Failure to Provide Disease Vector Control	$500.00
5.	Failure to Provide Explosive Gases Control	$800.00
6.	Failure to Meet Air Criteria	$500.00
7.	Failure to Meet Access Requirements	$500.00
8.	Lack of Run-on/Run-off Control Systems	$1,000.00
9.	Failure to Meet Surface Water Requirements	$1,000.00
10.	Acceptance of Liquid Wastes	$1,000.00
11.	Failure to Meet Recordkeeping Requirements	$500.00
12.	Failure to Provide Safety Equipment	
a.	Appropriate Hard Hats	$500.00
b.	Appropriate Respirators/Breathing Equipment	$500.00
c.	Appropriate Safety Shoes	$500.00
d.	Ear Protection	$500.00
e.	Appropriate Work Gloves	$500.00
f.	Appropriate Fire Extinguisher(s)	$1,000.00

g.	First Aid	$1,000.00
h.	Communication Equipment	$500.00
i.	Rollover Protective Structures	$500.00
j.	Seat Belts	$500.00

Appendix B

Guam Code Annotated - Laws Relevant to Solid Waste

Appendix B.1

10GCA Chapter 33 Solid Waste

CHAPTER 33
SOLID WASTE

ARTICLE 1
SOLID WASTE

§ 33101. Definitions.

As used in this Chapter:

(a) *Garbage* means the solid or semi-solid but reusable animal and vegetable waste resulting from the handling, preparation, cooking and serving of foods, including cans, bottles and cartons, in which it was received and wrapping in which it may have been placed for disposal;

(b) *Rubbish* means nonputrescible solid waste, including ashes, consisting of both combustible and noncombustible waste such as paper, cardboard, tin cans, yard clippings, wood, glass, bedding, crockery and broken or rejected matter or litter of any kind;

(c) *Dump* means any area, whether on public or private property, where garbage, trash, refuse, junk, debris or other broken and rejected material is deposited, other than in legal trash or garbage receptacles or other authorized disposal sites; and

(d) *Premises* means any vacant lot or any private property on which is located one (1) or more of the following: home, apartment, hotel or commercial or manufacturing establishment but does not include a dump.

SOURCE: GC § 9630.

§ 33102. Prohibition.

No person shall have on his premises any garbage or rubbish except as provided in this Chapter.

SOURCE: GC § 9630.1.

§ 33103. Storage.

All garbage and rubbish shall be stored and maintained in durable receptacles which shall have close fitting covers, unless otherwise prescribed in the rules and regulations promulgated under this Chapter.

SOURCE: GC § 9630.2.

§ 33104. Residence.

Each person shall provide adequate containers for the storage of all garbage and rubbish prior to collection on the premises where he resides except that where there are multiple dwelling units confined to one (1) property and consisting of five (5) or more units, the owner shall provide adequate containers for all tenants.

SOURCE: GC § 9630.3.

§ 33105. Commercial Establishments.

The owner or operator of any business establishments or commercial operation shall provide adequate containers for the storage of garbage or rubbish that is generated in the course of operating his business or commercial enterprise.

SOURCE: GC § 9630.4.

§ 33106. Removal.

Garbage and rubbish shall be removed from all premises at regular intervals as may be established by regulation, but under no circumstances shall garbage or rubbish accumulate for a period exceeding seven (7) days.

SOURCE: GC § 9630.5.

§ 33107. Dumps.

No person shall maintain or permit the establishment of a dump on their premises unless as otherwise permitted by law.

SOURCE: GC § 9630.6.

§ 33108. Edible Garbage.

The Director is authorized to prescribe by regulation such processing and limitations with respect to the use of garbage as animal feed or other use as he may deem necessary for the public health. No garbage shall be sold or disposed of as food for human consumption.

SOURCE: GC § 9630.7.

§ 33109. Vehicles.

Vehicles used for conveying garbage or rubbish shall not be used for the transportation or conveyance of any food or drink that will or may be used for human consumption.

SOURCE: GC § 9630.8.

ARTICLE 2
SWMF HEALTH MONITORING AND COMPENSATION.

SOURCE: This article was added by P.L. 24-181:1.

§ 33201. Legislative Finding and Intent.

Solid Waste Management Facilities ('SWMF') have byproducts that if exposed repeatedly, or consumed in finite amount, can be detrimental to good health. The community where the SWMF is processing municipal solid waste should be compensated for accepting a facility (incinerator, landfill, WTEF, combustion, plasma, processing) which is essential for the Islands' health and welfare, but inherently exposes that village with not only noxious and eyesore surroundings, but perhaps imposes respiratory disease, infection disorders, cancer ailments and other disorders more than the expected distribution for such illnesses. It is therefore imperative that the monitoring of people, since the facilities and the environment are being monitored already by the Guam Environmental Protection Agency ('GEPA') and the Department of Public Health and Social Services ('DPHSS'), be established and also logically that we should compensate villages.

Recognizing the critical need to establish a Municipal SWMF, it is the intent of the Guam Legislature to provide for the monitoring and compensation of the environmental impact of the Municipal SWMF on the health and welfare of residents in the neighborhood.

§ 33202. Title.

This Article may be cited or referred to as the, "*SWMF Health Monitoring and Compensation Act of 1998.*"

§ 33203. Additional Definitions to this Chapter.

In addition to the words and phrases defined herein, all definitions contained in §51102 of Chapter 51, Part 2, Division 2 of Title 10 of the Guam Code Annotated are applicable, unless specifically defined for in this Chapter:

(1) *Department* means the Department of Public Health and Social Services ('DPHSS').

(2) *Director* means the Director of DPHSS.

(3) *Division* means the Division of Environmental Health of DPHSS.

(4) *DISID* means the Department of Integrated Services for Individuals with Disabilities.

(5) *Base Line Study* shall mean a collection of information and/or test results for the following, but not limited to: laboratory studies, radiology, tissue and specimen samples, etc.

(6) *GEPA* shall mean the Guam Environmental Protection Agency.

(7) *DOAg* shall mean the Department of Agriculture.

§ 33204. Monitoring.

All efforts toward the opening, maintenance, operation and closure of solid waste management facilities, including dump sites, landfills, incinerators and the like, shall be taken with utmost caution, taking into consideration the environmental impact of such municipal solid waste management programs upon the lives and health of the families residing in the neighborhood of such facilities. Specifically, the following related tasks are assigned:

(a) Monitoring Authority. All SWMF that are involved in the following: landfill, waste to energy facility, incineration, plasma torch or flame technology and other SWMF that the Director of DPHSS or

Administrator of GEPA designates shall be monitored. The Environmental Health Division of DPHSS shall conduct an initial base-line study of the people, vectors and other animals around the solid waste management facility within a radius of one (1) mile from the perimeter of the SWMF and may be extended to cover an area up to five (5) miles at the discretion of the Director of DPHSS. The GEPA and DOAg shall provide assistance to DPHSS, not limited to technical support, training, collaboration of data, etc. The base-line data shall be established and should at least include relevant data of the best indicators determining whether the prevalence of allergies, respiratory disorders, infectious diseases, cancer ailments and other diseases are more than the expected distribution than that of a national standard or an established local standard. The summary report of such findings shall be reported to the Governor, the Speaker of the Guam Legislature, and the Director of DISID for the Division of Health Planning. The follow-up analysis shall be no less than every two (2) years and may be as frequent as authorized by the Director of DPHSS. The Director of DPHSS may hire the assistance of no more than three (3) consultants, such that one (1) must be a certified epidemiologist and one (1) must be a licensed physician. The Director may also contract the project to a qualified company with a certified epidemiologist and a licensed physician staff according to the Procurement Laws, Chapter 5 of Title 5 of the Guam Code Annotated.

(b) Source of Funding. Any person operating a Solid Waste Management Facility(ies) shall be levied one percent (1%) of all tipping fees, as defined in § 51118 of Part 2, Division 2 of Title 10 of the Guam Code Annotated. The collected amount by DPW shall be deposited to the SWMF Medical Monitoring Fund ('SWMF-MMF').

(c) Distribution of Funds. There shall be a quarterly disbursement of funds from the SWMF-MMF by the Director of DPHSS for the amount collected in Paragraph (b) above as follows:

(1) For Landfill Closure. The village(s) where the landfill facility is to be closed shall receive twenty-five percent (25%) of the levied amount from Subsection (b), Source of Funding, up to five (5) years after the date of closure declared by DPW. The monetary amount shall be appropriated from the SWMF-MMF to the respective village(s) Mayor's operational account for community health care needs or community health programs. After the fifth (5^{th}) year, the amount set aside for this Paragraph shall be appropriated equally to Paragraphs

(2) and (3) below. The Village of Ordot/Chalan Pago Landfill closure shall be the first recipient of this Provision.

(2) For other village(s) with a Solid Waste Management Facility(ies), the sum of twenty-five percent (25%) of the levied amount from Paragraph (b), Source of Funding, shall be appropriated from the SWMF-MMF to the respective village Mayor's operational account for community health care needs or community health programs.

(3) The Department of Public Health and Social Services shall receive fifty percent (50%) of the levied amount from Paragraph (b), Source of Funding, for the purpose of this Act. GEPA and DOAg shall be compensated for all expenses relative to the enforcement of this Act from the SWMF-MMF by the Director of DPHSS.

(4) Administrative Responsibility and Accountability. The respective recipient mayor(s), Director of DPHSS, GEPA and DOAg are hereby authorized to use their share of the SWMF-MMF for the purposes intended in this Act and shall prepare a financial summary report to the Governor and the Speaker of the Guam Legislature on an annual basis, or as per request by the Governor or Speaker of the Guam Legislature.

(5) Creation of SWMF-MMF. There is hereby created, separate and apart from other funds within the Department, a fund to be known as the Solid Waste Management Facilities - Medical Monitoring Fund ('SWMF-MMF'). The SWMF-MMF shall not be commingled with the General Fund or any other funds of the government of Guam, and it shall be maintained in a separate bank account as required under this Article and may be deposited in an interest bearing account.

(6) Promulgating Rules and Regulations. DPHSS shall promulgate rules and regulations within sixty (60) days after enactment of this Act through the Administrative Adjudication Law. The rules and regulations shall include revising and creating forms, maintaining the confidentiality of records, summary reports appropriate for public disclosure, other documents as are necessary in accordance with the management of confidentiality of patient records, provisions for violation or breech of information management and any other provision to falsify the intent and the enforcement of this Act.

(7) The lack of rules and regulations shall not impede the enforcement of Paragraphs (1), (2) and (3) above.

§ 33205. Standing to Sue, Injunction.

The Director of DPHSS shall have standing to bring a lawsuit in the Superior Court of Guam for public nuisance in order to enjoin the operation of a SWMF.

Appendix B.2

10GCA Chapter 51 Solid Waste Management and Litter Control

CHAPTER 51
SOLID WASTE MANAGEMENT AND LITTER CONTROL

ARTICLE 1
SOLID WASTE MANAGEMENT

SOURCE: GC § 57170 et seq. (1974 GC Supplement). Repealed and reenacted by P.L. 14-37:1 (June 18, 1977); P.L. 17-87 (Jan. 18, 1985); and P.L. 23-64 (Dec. 5, 1995). Further amended as indicated herein.

NOTE: This Article was amended in part by P.L. 24-139 (Feb. 7, 1998) and P.L. 24-272 (Oct. 2, 1998), which were found by the Guam Supreme Court in *Pangelinan v. Gutierrez*, 2000 Guam 11 (Mar. 10, 2000) and 2004 Guam 16 (Sept. 9, 2004), to be invalid. **Thus, the amendments by P.L.s 24-139 and 24-272 are void and of no effect**. However, notwithstanding the aforementioned court holdings and without consideration thereof, parts of this Article were amended or added by P.L. 24-309 (Dec. 18, 1998); P.L. 25-70 (July 15, 1999); P.L. 25-93 (Dec. 29, 1999); P.L. 25-175 (Dec. 14, 2000); P.L. 26-35 (Oct. 1, 2001); P.L. 28-11 (Mar. 9, 2005); and P.L. 28-56 (June 30, 2005). Therefore, until this Article is corrected by the legislature, it is presented here in the form repealed and reenacted by P.L. 24-272 and amended by subsequent laws as indicted in SOURCE comments. **However, reference must be made to the Article as it existed prior to P.L. 24-139**. Thus, the Article, as repealed and reenacted by P.L. 23-64, is included in its entirety in a NOTE at the end of this Article.

§ 51101. Legislative Findings.

(a) The Guam Legislature finds:

(1) the Ordot Landfill is a threat to the health and safety of the residents of Guam, and specifically for the residents of Ordot-Chalan Pago, Yona and the villages down river and downwind;

(2) solid waste collection and disposal on Guam does not adequately eliminate the threat that improperly disposed solid waste poses to the health, safety, and welfare of Guam residents;

(3) under the Government of Guam Property Act, the Ordot Landfill shall be converted to a public park after it is closed in accordance with applicable U.S. E.P.A. and government of Guam regulations. In order to protect the health and welfare of the residents of Chalan Pago-Ordot and the people of Guam, the Agency shall monitor the landfill on an on-going basis for compliance with this Section and take proper measures to mitigate environmental damage;

(4) the Ordot Landfill reached its capacity in the 1990's, and the closure of the dump is necessary in order to eliminate this existing serious environmental hazard. The dump should be converted to a public park;

(5) even with closure of the Ordot Landfill and construction of a new landfill at the same or any other site, landfilling cannot continue as the sole method of waste disposal for Guam due to the shortage of land on Guam, and the general aversion of any community to the location of a landfill within their proximity;

(6) it is in the best interest of the government to privatize through free and fair competition, the solid waste management operations of the Island, from collection to disposal, without jeopardizing the job

security for the employees of the Solid Waste Management Division of the Department of Public Works as well as the private businesses currently engaged in solid waste collection, recycling and other solid waste management operations;

(7) it is in the best interest of the government to establish a funding procedure or financial arrangement which will pay for operations and meet the requirements for a totally funded program for solid waste management;

(8) Guam contains approximately 215 square miles of landmass. Over half of that mass is located over the northern Guam Lens, a pure groundwater resource that requires protection. Thus, any landfill more likely should be located in southern Guam, south of a line running approximately from Cabras Island to Pago Bay. With the pristine south already imposed upon by this geological and environmental constraint, and in order to protect the cultural traditional nature of the villages in the south and the unique environments there, a source and waste disposal reduction policy shall be implemented to minimize the requirement for landfilling;

(9) source reduction shall include a conservation and recycling program. It shall also consider the disposal of green waste through mulching or composting, or the recovery of resources through recycling of the green waste. Construction or demolition waste and metallic debris shall be addressed alternately, and the alternate plan should include hardfilling or quarrying, recycling or disposal other than at the landfill. Rubber tires, rubber products, and batteries shall be addressed and recycled, recovered or disposed of at alternate sites;

(10) a solid waste management plan for Guam shall address typhoon and other disaster recovery; it is estimated that Super Typhoon Paka produced over 750,000 cubic yards of waste, which should be recycled or disposed of; Guam is in: the typhoon belt; in an active volcanic range; and, an active seismic zone so disasters will happen on a regular basis;

(11) the Guam Legislature further finds that while other communities with alternative sites for landfilling enjoy the option of not paying for source reduction and resource recovery, we must establish a Guam site-specific solid waste management policy,

because we have very limited alternative acceptable sites for future disposal requirements;

(12) in 1983, the Guam Environmental Protection Agency ('GEPA') adopted a Solid Waste Management Plan for Guam and also adopted regulations for solid waste collection and disposal;

(13) the government must now establish an updated Solid Waste Management Plan ('SWMP' *or* the 'Plan') , which shall include the closure and beneficial use of the Ordot Landfill, the privatization of the complete solid waste program, including landfill operations and provisions for job protection for the employees of the Solid Waste Division, source reduction, recycling, composting, resource recovery, waste reduction and regulated landfill disposal in an integrated program for solid waste collection and disposal, and the funding for the Plan. The SWMP shall also address construction debris or demolition waste; metallic debris; tires; waste oil; household hazardous waste; abandoned vehicles and other bulky metallic waste; white goods, such as washers, dryers and refrigerators; and green waste, which may be useful in some form, but unnecessarily contribute to landfill volume;

(14) the Department of Public Works shall implement the updated Solid Waste Management Plan, as approved by the Guam Legislature, regulated by GEPA;

(15) any and all solid waste handling and disposal contemplated by and authorized under this Act shall obtain and operate under any and all permits required by laws, rules and regulations applicable to Guam; and

(16) The government of Guam shall not direct or regulate existing permitted private entities actively engaged in solid waste collection or recycling beyond the scope and extent of Federal statutory and regulatory requirements. The standings of such private businesses permitted to actively engage in solid waste collection shall be given maximum protection and support under this Act to promote their viability and longevity under a free enterprise system.

(b) The purposes of this Chapter are to:

(1) plan for and regulate the storage, collection, transportation, separation, processing and disposal of solid waste to protect the public

safety, health and welfare, and to enhance the environment of the people of Guam;

(2) provide the authority and resources, including funding to plan for, establish, finance, operate and maintain efficient, environmentally acceptable solid waste management systems, privatized, but administered by the Department of Public Works and regulated by GEPA;

(3) privatize Guam's Solid Waste Management System ('SWMS') subject to all applicable laws and Public Law Number 24-06;

(4) establish the SWMS to be operated by private ventures, entities or individuals, to promote land conservation by limiting landfilling requirements consistent with the SWMP, and to establish as a limit the reusing, recycling and composting of no less than twenty percent (20%) of the total solid waste generated on Guam from all sources within the time frame established by the Plan and a comprehensive solid waste disposal and resource recovery program that ultimately will minimize Guam's need for additional landfills beyond replacing the Ordot Landfill; quantitative factors to meet such an objective shall be specified and substantiated in the SWMP;

(5) continue authority to regulate solid waste storage practices within the Department of Public Health and Social Services pursuant to Chapter 33 of this Title and, where applicable, establish such authority in the Department of Public Works to insure that such practices do not constitute a danger to human health, safety and welfare;

(6) continue authority in GEPA to review the design of and to issue permits for the operation of solid waste collection, transport, processing and disposal activities;

(7) continue authority in GEPA to undertake a comprehensive investigation of and set minimum standards for the transportation, processing, storage, treatment, and disposal of hazardous waste, and conduct surveys for special disposal facilities for hazardous waste, to protect public health, other living organisms and the environment through an effective and efficient hazardous waste management system;

(8) continue authority in GEPA to establish and implement an enforcement system to prevent the improper disposal of solid waste;

(9) promote the application of a Solid Waste Management System which preserves and enhances the quality of air, water and land resources;

(10) promote and assist in the development of markets for recovered and recycled materials;

(11) support and encourage the rapid and efficient removal, recycling, processing, or disposal of abandoned vehicles and other bulky waste, and to assure that the recovery of resources is facilitated;

(12) authorize the closure and beneficial use of the Ordot Landfill site, and promote, assist and support the construction and operation of a privatized sanitary landfill, resource recovery and other solid waste management facilities;

(13) require consideration and evaluation of treatment of bottom and fly ash generated from resource recovery facilities that any municipal solid waste incinerator company which operates a facility which generates bottom and fly ash or waste ash shall be responsible for the collection and disposal thereof and cost of the collection and disposal thereof; and

(14) authorize GEPA to establish such advisory committees as are necessary to carry out its planning and solid waste management responsibilities; the committees shall include but limited to representatives of GEPA, DPW, the Department of Public Health and Social Services, collectors, operators, applicable Federal agencies, educational/environmental groups and the public at large.

SOURCE: Repealed and reenacted by P.L. 24-139:2. Repealed and reenacted by P.L. 24-272:1.

§ 51102. Definitions.

For the purpose of this Chapter, the following words and phrases shall have the meanings given herein, unless their use in the text of the Chapter clearly demonstrates a different meaning.

(1) *Administrator* means the Administrator of GEPA or his designee.

(2) *Agency* means GEPA.

(3) *Best public interest* means any activity which: lessens the demand for landfill sites, conserves land resources and serves to insure proper, cost

effective and environmentally sound disposal of solid waste; and, does not pose health risks to human life or endanger plant and animal life.

(4) *Board* means the Board of Directors of GEPA.

(5) *Business* means and includes any activity or conduct, whether proprietary, partnerships, corporate or whatever form, engaged in, or caused to be engaged in, with the object of gain or economic benefit, either direct or indirect, but shall not include casual sales, personal service contracts, fundraising activities by political candidates or the activities of non-profit associations.

(6) *Collection* or *Collect* means the act of removing solid waste from a generator.

(7) *Collector* means any individual, governmental organization or business which has received a permit to collect and transport waste in accordance with applicable laws and regulations.

(8) *Combustion* means to thermally break down certain types of solid waste in an enclosed device using controlled temperatures.

(9) *Composting* means the controlled degradation of organic solid waste.

(10) *Department* means the Department of Public Works ('DPW') .

(11) *Director* means the Director of DPW.

(12) *Disposal* means the discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste or hazardous waste into or on any land or water so that such solid waste or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including ground water.

(13) *Division* means the Division of Solid Waste Management of the DPW.

(14) *Dump* means a land site where solid waste is disposed without a valid permit or a landfill that has historically been in regulatory noncompliance.

(15) *Dwelling* means a building or portion thereof designed exclusively for residential occupancy by one (1) family for living and sleeping purposes and not to exceed two (2) dwelling units.

(16) *Dwelling unit* means one (1) or more rooms and a single kitchen in a dwelling, designed as a unit for occupancy by one (1) family for living and sleeping purposes.

(17) *Financial assurance* means a financial guarantee assuring that funds are available to pay for the design, construction, operation and closure of a solid waste landfill facility, for rendering post-closure at a solid waste landfill facility, for corrective action and to compensate third parties for bodily injury and property damage caused by sudden and non-sudden accidents related to the operation of a solid waste landfill facility.

(18) *Generator* means any person that generates or produces solid waste.

(19) *Government* means the government of Guam, all of its agencies, whether line or autonomous, and all public corporations.

(20) *Hardfill* shall mean a method of compaction and earth cover of solid wastes other than those containing garbage or other putrescible (putrescent) waste, including, *but not limited to*, demolition material, and like materials not constituting a health or nuisance hazard, where cover need not be applied on a per day used basis. No combustible materials shall be deposited in a hardfill.

(i) *Combustible Materials* shall mean any solid or liquid that may be ignited.

(a) *Combustible Solids*, as defined in Title 49 of the Code of Federal Regulations, Chapter 1, Subtitle B, Part 173.124, are those capable of igniting and burning.

(b) *Combustible Liquids*, as defined in Title 29 of the Code of Federal Regulations, Chapter 17, Subtitle B, Part 1910.106, shall mean any materials having a flash point at or above 100 degrees Fahrenheit (37.8 degrees Celsius) , but below 200 degrees Fahrenheit (93.3 degrees Celsius) , except any mixture having components with flashpoints of 200 degrees Fahrenheit (93.3 degrees Celsius) , or higher, the total volume of which make up ninety-nine percent (99%) or more of the total volume of the mixture.

(21) *Hazardous Waste* means any material or substance which, by reason of its composition or characteristics,

(i) is hazardous waste as defined in the Solid Waste Disposal Act, 42 USC §6901, et seq., as amended, replaced or superseded and the regulations implementing same,

(ii) is a hazardous substance as defined by the Comprehensive Environmental Response, Compensation and Liability Act of 1980, 42 USC § 9601, et seq.,

(iii) is material the disposal of which is regulated by the Toxic Substances Control Act, 15 USC § 2601, et seq., as amended, replaced or superseded, and the regulations implementing same,

(iv) is special nuclear or by-products material within the meaning of the Atomic Energy Act of 1954,

(v) is pathological, infectious or biological waste,

(vi) is treated as hazardous waste or as a hazardous substance under applicable law,

(vii) requires a hazardous waste or similar permit for its storage, treatment, incineration of disposal,

(viii) may cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible illness, or

(ix) may pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported or disposed of, or otherwise damaged.

(22) *Highway* means the entire width between the boundary lines of every right-of-way or publicly maintained travel ways when any part thereof is open to the use of the public for purposes of vehicular travel.

(23) *Incinerator* means an enclosed device using controlled flame combustion, the primary purpose of which is to thermally break down solid waste.

(24) *Multi-family dwelling* means a building containing three (3) or more dwellings.

(25) *Office* means the Office of Recycling of the Division.

(26) *Operator* means any person who accepts solid waste from a collector for transfer, storage, recycling, combustion, processing or disposal.

(27) *Performance bond* means a security for financial loss caused by the act or default performance of a person or by uncontrollable conditions.

(28) *Person* means any individual, partnership, co-partnership, firm, company, corporation, association, joint stock company, trust, estate, or any agency, department, or instrumentality of the Federal or local government, or any other legal representatives, agents or assigns.

(29) *Plan* means the interim or final Solid Waste Management Plan (‘SWMP’) to be prepared and adopted by the Agency in accordance with the Administrative Adjudication Law.

(30) *Plasma torch heating technology* means converting electrical energy into heat energy producing clean fuel gas and recyclable slag.

(31) *Plasma Remediation In-Situ Materials* ('PRISM') means a plasma torch technology process that melts down and converts landfill material into slag and fuel gas.

(32) *Pollution* means the condition caused by the presence in the environment of substances of such character and in such quantities that the quality of the environment is impaired or rendered offensive to life.

(33) *Processing* means any method, system or other treatment designed to change the physical, chemical or biological character or composition of any solid waste. This includes the neutralization of any hazardous waste; the rendering of any hazardous waste non-hazardous, safer for transport, amenable for recovery, amenable for storage or reduced in volume; or any other activity or processing designed to change the physical form or chemical composition of hazardous waste so as to render it non-hazardous.

(34) *Recyclable materials* includes the following materials discarded from households, businesses, commercial and industrial establishments, hotels, government, agricultural, landscaping, yard maintenance and military operations which may be reused or for which a market exists:

(i) *aluminum* means any product manufactured of aluminum or aluminum alloy;

(ii) *battery* means any lead acid battery or dry cell battery discarded on Guam, independent of intended use;

(iii) *biomass* means any large biomass source, such as trees, wood, grass, hedge cuttings, jungle growth, yard waste and sewage sludge;

(iv) *construction debris* means the materials from building construction;

(v) *corrugated cardboard* means kraft, jute or test liner pulp which is made by combining two (2) or more webs of paper and formed or shaped into wrinkles or folds or into alternate ridges and grooves;

(vi) *demolition waste* means the materials obtained from the demolishment or razing of buildings;

(vii) *glass* means any product manufactured from a mixture of silicates, borates or phosphates;

(viii) *metal scrap* means any metal, in whole or in parts, from buildings, equipment, machinery or vehicles;

(ix) newspaper means a publication which is distributed and contains news articles, opinions, features, and advertising and is printed on impermanent wood pulp materials;

(x) *office paper* means computer paper and white and colored ledger paper;

(xi) *used oil* means any petroleum-based, mineral, or synthetic oil which through use, storage or handling has become unsuitable for its original purpose due to the presence of impurities or loss of original properties; and

(xii) such other materials which the Department determines, from time to time, may be recycled.

(35) *Recycle* or *Recycling* means the method by which recovered resources are converted for use as raw material or feedstock to make new products.

(36) *Recycling Officer* means the head of the Office of Recycling.

(37) *Resource recovery* means the process of recovering recyclable materials or the recovery of energy from solid waste.

(38) *Resource Recovery Facility* ('RRF') is a facility which recovers for sale or reuse of recyclable materials.

(39) *Reusing* means the reintroduction of a commodity in the economic stream without any changes.

(40) *Sanitary landfill* means an approved site where solid waste and ash are disposed using modern sanitary landfilling techniques in accordance with Federal and local regulations.

(41) *Sanitary landfilling* means an engineered method of disposing of solid waste on land in accordance with Federal and local regulations in a manner that protects the environment by spreading the waste in thin layers, compacting it to the smallest practical volume, and covering it with approved material at the end of each working day.

(42) *Separation* means the systematic division of solid waste into designated components.

(43) *Solid waste* means any garbage, refuse or sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded and/or spilled materials, including solid, liquid, semisolid or contained gaseous material resulting from industrial, mining, commercial, and agriculture operations, and from community activities, but does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges which are point sources subject to permits under §402 of the Federal Water Pollution Control Act, as amended (68 Stat. 880) , or source, special nuclear, or by-product material as defined by the Atomic Energy Act of 1954, as amended (68 Stat. 923) .

(44) *Solid waste management* means the purposeful, systematic control of the generation, storage, collection, transportation, separation, processing and disposal of solid waste.

(45) *Solid waste management facilities* means any facility, or any machinery, equipment, vehicles, structures or any part of accessories thereof installed or acquired for the primary purpose of: collection, transportation, storage, recycling, processing or disposal of solid waste, and shall include sanitary landfills, resource recovery facilities, or plasma torch.

(46) *Solid Waste Management Plan* means a comprehensive plan and all amendments and revisions thereto for provisions of solid waste management throughout Guam.

(47) *Solid waste management practices* means the actions to effectuate the generation, storage, collection, transportation, processing, recycling, incineration, plasma torch or resource recovery or disposal of solid waste.

(48) *Solid Waste Management System* ('SWMS') means the entire system covered in the SWMP and designated by the Director for the storage, collection, generation, transportation, processing, recycling, incineration, plasma torch and disposal of solid waste within Guam.

(49) *Source separated waste* means recyclable materials which are set aside by the generator for segregated collection and transport to solid waste management facilities.

(50) *Storage* means the interim containment of solid waste in accordance with Federal and local regulations.

(51) *Transfer station* shall mean any intermediate waste facility in which solid waste collected from any source is temporarily deposited and stored while awaiting transportation to another solid waste management facility.

(52) *Duplex* means a residential building containing two (2) separate dwelling units either side by side or one above the other.

(53) *Single Family Residence* means a detached building designed for and/or occupied exclusively by one (1) family, or one (1) of two (2) dwelling units on a duplex.

SOURCE: Repealed and reenacted by P.L. 24-139:3. Repealed and reenacted by P.L. 24-272:1. Subsection (17) repealed and reenacted by P.L. 24-309:2. Subsection (52) added by P.L. 25-93:12. Subsection (53) added by P.L. 25-93:13. Subsection (20) repealed and reenacted ny P.L. 28-11:2 and subsection 20(i) added by P.L. 28-11:3.

§ 51103. Powers and Duties of the Agency and the Department.

(a) The Agency shall have the authority under this Act and other laws of Guam, pursuant to the Administrative Adjudication Law, to:

(1) prepare and adopt in accordance with the Administrative Adjudication Law an interim Solid Waste Management Plan, consistent with the provisions of this Act, within one hundred eighty (180) days of the effective date of this Act;

(2) prepare and adopt in accordance with the Administrative Adjudication Law a final Solid Waste Management Plan, consistent with the provisions of this Act, within three hundred (300) days of the effective date of this Act. The Plan shall be revised at least every five (5) years, or sooner as needed;

(3) administer Guam's Solid Waste Management Program pursuant to provisions of this Chapter;

(4) prepare, adopt, promulgate, modify, update, and repeal rules and regulations in cooperation with appropriate government agencies, industries and private parties, for the collection, transportation, storage and disposal of hazardous waste;

(5) prepare, adopt, promulgate, modify, update, repeal, and enforce rules and regulations setting environmental standards for collection, transportation, separation, processing, recycling, materials and resource recovery, incineration, plasma torch and disposal of solid waste in order to conserve the air, water, and land resources of Guam, protect the public health, prevent environmental pollution and public nuisances, and enable it and the Department to carry out the purposes and provisions of this Chapter and the Plan;

(6) establish the procedures for review and issuance of permits governing the design, operation, closure, and post-closure of solid waste management facilities, which procedures shall be consistent with the procedures used by the United States Environmental Protection Agency in the issuance of similar permits;

(7) enforce compliance with any of its rules and regulations issued pursuant to this Chapter and require the taking of such remedial measures for solid waste management or solid waste management practices as may be necessary or appropriate to implement or effectuate its responsibilities under this Chapter;

(8) prepare, adopt, promulgate, modify, update, repeal, and enforce such other rules and regulations as may be necessary to establish a hazardous waste program which meets the requirements of Section 3006 of the Federal Resource Conservation and Recovery Act (42 U.S.C. 6926, et seq.) and regulations promulgated pursuant thereto;

(9) prepare, issue, modify, remove and enforce orders for compliance with any of the provisions of this Chapter or of any rules and regulations issued pursuant thereto and requiring the taking of such remedial measures for solid waste management as may be necessary or appropriate to implement or effectuate the provisions and purposes of this Chapter;

(10) impose and collect penalties against any person for the violation of any of its rules, regulations or compliance orders issued under this Chapter;

(11) require a financial guarantee assuring that funds are available to pay for the design, construction, operation and closure of a solid waste landfill facility, for rendering post-closure at a solid waste landfill facility, for corrective action and to compensate third parties for bodily injury and property damage caused by sudden and non-sudden accidents related to the operation of solid waste landfill facility.

(12) serve as the official government of Guam representative for all purposes of the Federal Solid Waste Disposal Act, (P.L. No. 91-512), or as subsequently amended, and for the purpose of such other local or Federal legislation as has been or may hereafter be enacted to assist in the management of solid waste;

(13) provide technical assistance to local and Federal agencies, and other persons, and cooperate with appropriate local agencies and private organizations in carrying out the duties under this Chapter;

(14) encourage and recommend procedures for private financing to develop, design, construct and operate solid waste management system in accomplishing the desired objectives of this Chapter; and

(15) insure that the interest of existing permitted private entities actively engaged in solid waste management operations are duly and lawfully protected and are not unfairly jeopardized or removed.

(16) determine the applicability, type and sum required for posting a performance bond on solid waste management facilities that are not municipal solid waste landfills.

(b) The Department shall have the following powers and duties pursuant to the Administrative Adjudication Law to:

(1) adopt and enforce rules, regulations and other procedures for the implementation of the solid waste management system created by the Plan and such other rules and regulations as are necessary to fulfill the Department's powers and duties under this Act;

(2) privatize all other solid waste management facilities and operations not addressed above in Subsection (2) and within the policy guidelines of the Solid Waste Management Plan, including the closure and beneficial use of the Ordot Landfill site, source reduction, recycling, composting, resource recovery, waste reduction, new landfill and transfer stations. This responsibility shall also address

construction debris or demolition waste, metallic debris, white goods, tires and green waste; contracts with private entities shall fully encompass development, financing, construction and operation of any such facilities;

(3) fulfill any of its duties under this Act and consistent with the SWMP by entering into contracts with private entities; all such new contracts shall be entered into according to the procedures of the Guam Procurement Law, Chapter 5, Division 1 of Title 5 of the Guam Code Annotated, and other applicable laws of Guam;

(4) establish administrative procedures for the dissemination of rates and fee schedules and the collection of fees and charges authorized and duly adopted or set under this Act for the collection, processing, resources recovery or disposal of solid waste within Guam, including, but not limited to, fees assessed to owners of dwellings, fees assessed to any other generators or collectors, and fees assessed for solid waste received at designated solid waste management facility within Guam;

(5) administer, supervise and fulfill the responsibilities of the government in any contract entered into pursuant to provisions of the Guam Procurement Law (5 GCA Chapter 5) for the development, construction, operation or closure of landfills, RRF or any other solid waste management facility contracted or prescribed in the Plan and legally established under Guam and Federal laws, rules and regulations;

(6) organize, plan for, secure and manage resources and promote the implementation of the Plan;

(7) evaluate and promote capital improvements and maintenance programs to the solid waste management system;

(8) address the necessity for a facility for the shredding of tires for recycling or for use as rubberized asphalt;

(9) address the necessity for a facility for the recycling of glass, including its use as glassphalt;

(10) address the necessity for a facility for the recycling of scrap metals, including discarded vehicles, appliances and equipment, including shredding for containerization or other shipment;

(11) require the preparation of any necessary environmental impact assessments or environmental impact reports;

(12) mandate the inspection and monitoring of all solid waste management facilities to assure compliance with this Act, the Plan, other law, rules and regulations applicable to Guam; and

(13) apply for all grants-in-aid requests and administration of any such programs or funds, except those established for recycling.

(c) There is established within the Division of Solid Waste of the Department, the Office of Recycling and the position of Recycling Officer who shall head the Office. The Office shall be responsible for the following:

(1) establishing and managing in conjunction with the Plan a promotional program for recycling, composting and the recovery of resources, including recommendations on the size, character, location and ownership of any RRF or composting facility;

(2) evaluating and insuring adequate capacities within the solid waste management system for recycling;

(3) plan, organize, coordinate and pursue the following objectives:

(i) publish and disseminate guidebooks, newsletters and instruction manuals to promote recycling;

(ii) in conjunction with the Mayors Council of Guam, conduct public outreach activities to promote recycling;

(iii) establish a recycling demonstration project in at least six (6) selected villages throughout Guam, wherein compartmentalized containers will be located and serve as recycling drop-off centers for the community; the Department shall contract for the supply of the containers and their hauling for recycling or other disposal; all revenues generated by the sale of recyclable materials shall be paid to the Mayors and be used by the Mayors to support programs which further encourage recycling; moreover, individual accounts shall be established for each Mayor to record all costs and revenues in order to evidence the commercial feasibility, or lack thereof, of recycling;

(iv) develop a recommended program for composting of biomass on government property;

(v) formulate and recommend other recycling demonstration projects and initiatives;

(vi) identify economically priced products manufactured of recycled material which are usable by the government in the place of products manufactured of virgin material;

(vii) study recycling techniques to determine the most cost-effective manner of collecting, processing, storing, marketing, transporting or reusing recyclable materials;

(viii) establish a recycling telephone hotline serving to take inquiries and disseminate information on recycling;

(ix) recommend the establishment or revision of administrative or procurement practices which will promote recycling;

(x) determine and report through the Director to the Guam Legislature the costs and benefits of establishing a system for source separated waste;

(xi) recommend new legislation to facilitate recycling through planning, market research, source separated waste, surcharges, fees, operational subsidies, tax incentives and other similar means;

(xii) identify and promote businesses reusing or converting recyclable materials;

(xiii) advise and assist collectors on efficient techniques for recycling; and

(xiv) conduct media advertising, public opinion surveys, seminars, workshops and community relations campaigns to promote public awareness of the benefits and methods of recycling.

SOURCE: Repealed and reenacted by P.L. 24-139:4. Repealed and reenacted by P.L. 24-272:1. Subsection (a) (11) repealed and reenacted by P.L. 24-309:3. Subsection (a) (16) added by P.L. 24-309:4.

§ 51104. Permits.

(a) The Administrator is authorized and directed to issue permits for all collectors, operators and solid waste management facilities, their design, operation, maintenance, substantial alteration, modification or enlargement. All such permits shall be non-transferable and conditioned upon the observance of the laws of Guam and rules, compliance orders or regulations authorized in this Chapter. All such permits shall include provisions to hold the permittee liable during the duration of the permit and twenty-five (25) years after the expiration of the permit for all costs related to health and environmental restoration attributed to the operation of the facility.

(b) Each permit holder shall apply for the renewal of each permit held, upon forms provided by the Agency, not less than sixty (60) days prior to the expiration date of such solid waste management permit to be renewed, or not less than one hundred eighty (180) days prior to the expiration date of each hazardous waste management permit to be renewed.

(c) Each permit application and each permit renewal application shall be submitted with proof of financial assurance, of a type and in a sum established by the Administrator conditioned on the fulfillment by the permit holder of the requirements of this Chapter and the rules and regulations authorized therein. No financial assurance mechanism required under this Chapter may be canceled by the guarantor unless the Administrator has received written notice thereof and there has been a lapse of one hundred twenty (120) days between receipt of notice and cancellation date.

(d) Before issuing a solid waste management permit to any person with respect to any facility for the processing, storage or disposal of solid waste, the Administrator shall:

(1) Cause to be published in a major local newspaper or newspaper of general circulation, and broadcast over a local radio station or stations, notice of the Agency's intention to issue such a permit.

(2) If, within forty-five (45) days after publication and broadcast, the Agency receives written notice of opposition to the Agency's intention to issue such permit and a request for a hearing is made, the Agency shall provide for a hearing in accordance with the Administrative Adjudication Law, if requested by a substantially affected party or an informal public meeting if requested by any other person.

(e) Before issuing a hazardous waste management permit to any person with respect to any facility for the processing, storage or disposal of hazardous waste, the Administrator shall:

(1) cause to be published in a major local newspaper or newspaper of general circulation, and broadcast over a local radio station or stations, notice of the Agency's intention to issue such a permit; and

(2) if, within forty-five (45) days after publication and broadcast, the Agency receives written notice of opposition to the Agency's intention to issue such permit and a request for a hearing is made, the Agency shall provide for a hearing in accordance with the Administrative Adjudication Law, if requested by a substantially affected party or an informal public meeting if requested by any other person.

(f) The Administrator is authorized and directed to suspend, revoke, condition, modify or terminate any permit issued under Subsection (a) of this Section for non-compliance with any of the rules, compliance orders, regulations or permit conditions authorized in this Chapter.

(g) The Administrator shall determine the applicability for requiring a performance bond for permit applications and permit renewal applications for solid waste management facilities that are not landfills. Upon the determination that a performance bond is required, that Administrator will decide the type and sum required to ensure fulfillment by the permit holder of the requirements of this Chapter and the rules and regulations authorized therein.

SOURCE: Repealed and reenacted by P.L. 24-139:5. Repealed and reenacted by P.L. 24-272:1. Subsection (g) added by P.L. 24-309:5.

§ 51105. Permit Fees.

Each application for a permit, or renewal application, shall be accompanied by a certified check or money order in the amount prescribed by regulations. All fees required by the section shall be non-returnable and shall be placed in the revolving fund established under Section 51117 of this Chapter.

§ 51106. Inspections.

(a) The Agency is hereby authorized to inspect all solid waste and hazardous waste management facilities at all reasonable times to insure compliance with the laws of Guam, the provisions of this Chapter and the rules and regulations authorized herein. This authority shall include access to and authority to copy all records relating to solid or hazardous waste, as well as the authority to obtain samples, or require monitoring or testing to ensure that the owner or operator is in compliance.

(b) The Agency is authorized to have the power to enter at reasonable times upon any private or public property for the purpose of inspecting and investigating conditions relating to solid or hazardous waste on Guam.

(c) It shall be a misdemeanor for any person to interfere with such inspections or investigations.

(d) Administrative Inspection Warrants.

(i) The Agency, by its duly authorized representatives, shall have the power to enter and inspect any property, premises or place for the purpose of determining the compliance or noncompliance with any provision of this Chapter, any rule and regulations promulgated thereto, or any order or permit or term or condition thereof, issued pursuant to this Chapter rule and regulation promulgated thereto.

(ii) *Unless* an emergency exists or the Agency has reason to believe that any unlawful activity is being conducted, or will be conducted, the Agency shall provide prior notification of such inspection, and the inspection shall be during normal business hours. If such entry or inspection is denied or *not* consented to *and* no emergency exists, the Agency is empowered to and shall obtain from the appropriate court a warrant to enter and conduct an inspection. The courts on Guam are empowered to issue such warrants upon a showing that such entry and inspection is required to verify that the purposes of the Act are being carried out. *If* samples are taken, the owner and operator of the premises for which such samples are taken shall be entitled to a receipt for such samples and, upon request, a sufficient portion to perform an analysis equivalent to that which the Agency may perform.

(iii) In the event of an emergency which presents an immediate and substantial threat to the public health and safety or the environment, the Agency shall have the authority to issue such orders as may be appropriate to protect the public health and safety or the environment, including emergency authorization for procurement.

(iv) Any person against whom an emergency order is issued shall be entitled to a hearing within twenty-four (24) hours. The GEPA Board shall affirm, modify or set aside the order of the Agency.

SOURCE: Repealed and reenacted by P.L. 24-309:6.

§ 51106.1. Criminal Search Warrants.

A search warrant relating to offenses of environmental laws may be served at any time of the day or night *if* the judge or magistrate issuing the warrant is satisfied that there is probable cause to believe that grounds exist for the warrant.

SOURCE: Added by P.L. 24-309:7.

§ 51107. Inspection Fees.

The Agency is hereby authorized to include as part of permit fees under § 51105, fees for inspections conducted of all solid waste management facilities, hazardous waste treatment, storage and disposal facilities, hazardous waste transporters, generators of hazardous waste, waste oil generators, recyclers, marketers, brokers and all other waste oil facilities including boilers and industrial furnaces as well as waste to energy facilities.

§ 51108. Notice.

Any notice, order or other official correspondence affecting the rights of any person under this Chapter shall be delivered by personal service or sent by registered or certified mail with a return receipt to the address of such person as shown by the records of the Agency. The return receipt, signed by the addressee, or his agent, shall be conclusive proof of delivery.

§ 51109. Hearings.

(a) Any person who received an order from the Administrator as authorized by this Chapter and any person whose permit application is disapproved by the Administrator may, within fifteen (15) days of the date of receipt of such order or disapproval, file a Notice of Intent to appeal with the Board, setting forth in such Notice a verified petition outlining the legal and factual basis for such appeal.

(b) The Board of Directors shall, not more than sixty (60) days after receipt of such Notice of Appeal, hold a public hearing at which time the person appealing may appear and present evidence in person or through counsel in support of this petition.

(c) The Agency is hereby authorized to administer oaths, examine witnesses and issue subpoenas to compel the attendance of witnesses and the production of evidence relevant to the matter involved in the hearing.

(d) The Board shall affirm, modify or revoke any action which is appealed and shall notify the appellant of its decision not more than thirty (30) days after the conclusion of the hearing. Such notice shall be in writing and shall state the reasons for the decision.

(e) Any person may appeal such decision to the Superior Court of Guam by filing with the Agency a written notice of such intent to appeal within ten (10) days of the notice in subsection (d) of this Section and shall have a transcript of the proceedings upon request.

§ 51110. Prohibited Solid Waste Activities.

(a) It shall be unlawful for any person to:

(1) Violate any provision of this Chapter or any rule, regulation, standard, or order issued pursuant to this Chapter;

(2) Own, operate or use a dump for the disposal of solid waste;

(3) Place, or allow to be placed, any solid waste upon the highways, public or private property contrary to the provisions of this Chapter;

(4) Manage solid waste facilities without a permit issued pursuant to this Chapter;

(5) Store, collect, transport, process, or dispose of solid waste in such a manner as to degrade the environment, create a public nuisance, create a health or safety hazard, or violate any provisions of this Chapter;

(6) Transport any solid waste in any vehicle in any street or highway unless adequate precautions are taken to prevent such solid waste from falling or from being dislodged from such vehicle upon any street, highway, or any other public or private property;

(7) Not immediately pick up and remove waste which has fallen off the vehicle they are operating during the course of transportation upon any street, highway or any other public or private property;

(8) No person shall destroy or attempt to destroy by burning, except as authorized by 10 GCA §73113, any garbage, dead animals or other offensive substances, the burning of which may give off foul and

noisome odor. Nothing in this Section shall preclude the burning of trees, brush, grass and other vegetable matter authorized by the Administrator.

(9) Improperly manage or operate a solid waste management facility.

(10) Improperly manage or operate a hazardous waste management facility.

(b) Each day of continued violation of this section or the provisions of this Chapter or rules and regulations authorized herein shall be deemed a separate offense or violation.

SOURCE: Subsection (a) (8) repealed and reenacted by P.L. 24-139:6; P.L. 25-175:6. Subsection (a) (9) added by P.L. 24-139:7. Subsection (a) (8) repealed and reenacted by P.L. 24-272:1. Subsection (a) (9) repealed and reenacted by P.L. 24-272:1. Subsection (a) (10) repealed and reenacted by P.L. 24-272:1.

§ 51111. Prohibited Hazardous Waste Activities.

(a) It shall be unlawful for any person to:

(1) Violate any provision of this Chapter or any rule, regulation, standard, or order issued pursuant to this Chapter;

(2) Own, operate or use a dump for the disposal of hazardous waste;

(3) Place, or allow to be placed, any hazardous waste upon the highways, public or private property contrary to the provisions of this Chapter;

(4) Manage hazardous waste facilities without a permit issued pursuant to this Chapter;

(5) Store, collect, transport, process or dispose of hazardous waste in such a manner as to degrade the environment, create a public nuisance, create a health or safety hazard as determined by the Director of the Department of Public Health and Social Services or the Administrator or violate any provision of this Chapter;

(6) Knowingly make any false statement or representation in any hazardous waste application, label, manifest, record, report, permit or other document filed, maintained, or used for purposes of compliance with the provisions of this Chapter.

(7) Improperly manage or operate a hazardous waste management facility.

(b) Each day of continued violation of this section or the provisions of this Chapter or rules and regulations authorized herein shall be deemed a separate offense or violation.

SOURCE: Subsection (a) (7) added by P.L. 24-139:8.

§ 51112. Injunction.

The Agency shall maintain an action to restrain any violation or threatened violation of the provisions of this Chapter or the rules and regulations authorized herein. Such right to injunctive relief is in addition to any other powers or penalties conferred by this Chapter.

§ 51113. Plats.

All persons operating a sanitary landfill, hardfill, or other approved disposal site under permits issued pursuant to this Chapter shall, upon completion of the sanitary landfill or hardfill, file with the Department of Land Management and the Building Permit Section of the Department of Public Works, a plat of each site, together with a description of the waste placed therein and in conformance with rules and regulations adopted pursuant to § 51103(a) (8) of this Chapter.

§ 51114. Applicability to Government Agencies.

Government agencies shall comply with all provisions of this Chapter including planning, review, and permit requirements, with the exception of § 51104(c) . Government agencies may contract with any person to carry out their responsibilities under this Chapter. Such contractors shall also comply with the provisions of this Chapter.

§ 51115. Penalties.

(a) Solid Waste-Criminal Penalties. Any person who knowingly violates any solid waste management provision of this Chapter, or any valid solid waste management rule or regulation promulgated under this Chapter, or who refuses or neglects to comply with any lawful order issued by the Administrator in carrying out the provisions of this Chapter shall, upon conviction, be imprisoned for a term of not more than one (1) year, and/or be fined not more than $1,000 per day for each violation or noncompliance, and shall make restitution.

(b) Solid Waste-Civil Penalties. Any person who violates any solid waste management provision of this Chapter, or any valid solid waste management rule or regulation promulgated under this Chapter, or who refuses or neglects to comply with any lawful order issued by the Administrator in carrying out the provisions of this Chapter shall, in addition to clean-up costs and other damages, forfeit and pay a civil penalty of not more than $1,000 per day for each violation or noncompliance.

(c) Hazardous Waste-Criminal Penalties. Any person who knowingly violates any hazardous waste management provisions of this Chapter, or any valid hazardous waste management rule or regulation promulgated under this Chapter, or who refuses or neglects to comply with any lawful order issued by the Administrator in carrying out the provisions of this Chapter shall be guilty upon conviction of a felony of the third degree, and be fined not less than $10,000 per day for each violation and/or noncompliance, and shall make restitution.

(d) Hazardous Waste-Civil Penalties. Any person who violates any hazardous waste management provision of this Chapter, or any valid hazardous waste management rule or regulation promulgated under this Chapter, or who refuses or neglects to comply with any lawful order issued by the Administrator in carrying out the provisions of this Chapter shall, in addition to clean-up costs and other damages, forfeit and pay a civil penalty of not less than $10,000 per day for each violation or noncompliance.

(e) Administrative Penalties. In addition to any other administrative or judicial remedy provided by this Chapter, or by rules adopted under this Chapter, the Administrator is authorized to impose by order the penalties specified in § 51115(b) and (d) respectively. Factors to be considered in imposing an administrative penalty include the nature and history of the violation and of any prior violations, and the opportunity, difficulty, and history of corrective action. It is presumed that the violator's economic and financial conditions allow payment of the penalty, and the burden of proof to the contrary is on the violator. In any proceeding to recover the civil penalty imposed, the Administrator need only show that notice was given, a hearing was held or the time granted for requesting a hearing has expired without such a request, the civil penalty was imposed, and that the penalty remains unpaid.

§ 51116. Citizen's Suits.

(a) Any person may commence a civil action on his behalf:

(1) Against any person (including the United States, and any other governmental instrumentality or agency, to the extent permitted by law) who is alleged to be in violation of any permit, standard, regulation, condition, requirement, prohibition, or order which has become effective pursuant to this Chapter; or

(2) Against any person, including the United States, and any other governmental instrumentality or agency, to the extent permitted by law, and including any past or present generator, past or present transporter, or past or present owner or operator of a treatment, storage, or disposal facility, who has contributed or who is contributing to the past or present handling, storage, treatment, transportation, or disposal of any solid or hazardous waste which may present an imminent and substantial endangerment to health or the environment; or

(3) Against the Administrator where there is alleged a failure of the Administrator to perform any duty under this Chapter which is not discretionary with the Administrator.

Any action under paragraph (a) (1) , (a) (2) , or (a) (3) of this Section shall be brought in the Superior Court of Guam. The Superior Court shall have jurisdiction, without regard to the amount in controversy or the citizenship of the parties, to enforce the permit, standard, regulation, condition, requirement, prohibition, or order referred to in paragraph (a) (1) , to restrain any person who has contributed or is contributing to the past or present handling, storage, treatment, transportation, or disposal of any solid or hazardous waste referred to in paragraph (a) (2) , to order such person to take such further action as may be necessary, or both, or to order the Administrator to perform the act or duty referred to in paragraph (a) (3), as the case may be, and to apply any appropriate civil penalties under § 51115(b) and (d) . No bond shall be required for issuance of an injunction or temporary injunction after a duly noticed hearing.

(b) Except for injunctive relief, no action may be commenced under subsection (a) (1) or (a) (2) of this Section:

(1) Prior to ninety (90) days after the plaintiff has given notice of the violation or endangerment to (i) the Administrator; (ii) the government of Guam; and (iii) to any alleged violator of such permit, standard, regulation, condition, requirement, prohibition, or order

referred in subsection (a) (1) of this Section if applicable or to any person alleged to have contributed or to be contributing to the past or present handling, storage, treatment, transportation, or disposal of any solid or hazardous waste referred to in subsection (a) (2) of this Section if applicable.

(2) Except for injunctive relief, if the Administrator or government of Guam has commenced and is diligently prosecuting a civil or criminal action to require compliance with such permit, standard, regulation, condition, requirement, prohibition, or order pursuant to subsection (a) (1) of this Section or if the Administrator or government of Guam, in order to restrain or abate acts or conditions which may have contributed or are contributing to the activities which may present the alleged endangerment under subsection (a) (2) of this Section has commenced and is diligently prosecuting an action under local law or under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) or is actually engaging in a removal action under CERCLA or has incurred cost to initiate a remedial Investigation and Feasibility Study under CERCLA and is diligently proceeding with a remedial action.

(c) Except for injunctive relief, no action may be commenced under subsection (a) (3) of this Section prior to sixty (60) days after the plaintiff has given notice to the Administrator and the government of Guam in which the failure has occurred that he will commence such action.

§ 51117. Solid Waste Management Fund.

There is established a non lapsing, revolving fund, hereafter referred to as the "Solid Waste Management Fund" which shall be maintained separate and apart from any other funds of the Government of Guam, and shall be administered by the Administrator. Independent records and accounts shall be maintained in connection therewith. All fees, reimbursements, assessments, fines, bail forfeitures, and other funds collected or received pursuant to this Article shall be deposited in this Fund and used for the administration and implementation of this Article, including purchase of equipment and payment of personnel costs of the Agency.

§ 51118. Tipping/User Fees and Solid Waste Operations Fund.

(a) Legislative Intent. Tipping and user fees shall provide a financing source for government of Guam costs and expenses directly related to the closure of the Ordot landfill, the development, design, construction, operation and final closure of a new sanitary landfill and the Ordot Landfill, as well as other solid waste management facilities that are contracted or may be established by this Act and in accordance with the plan and annual fiscal year appropriation for the Division of Solid Waste Management of DPW.

(1) Tipping/user fees will vary depending on the nature of collection, privatized contract for residential dwellings or hired commercial collectors for other municipal solid wastes outlets.

(2) For residential or dwelling, the charge is a user fee which includes the collection fee with the disposal tipping fee.

(3) For commercial, including multi-family dwellings and government agencies, the charge is a disposal tipping fee and does not include collection fees independently charged by commercial waste haulers.

(b) Effective Date of Charging Tipping Fees. The commercial and residential tipping fees established in this § 51118 are charged beginning the first day of the month following the adoption of supporting rules and regulations by DPW under the Administrative Adjudication Law.

(c) Business and Governmental Tipping Fees. A tipping fee of Four Dollars ($4.00) per cubic yard, uncompacted, is hereby established for business and government generators. For compacted trash, a tipping fee of Four Dollars ($4.00) per cubic yard multiplied by the compaction ratio of any vehicle or container with compaction equipment, is hereby established for business and government generators. Commercial and government collectors shall provide the Department of Public Works the compaction ratios of all equipment used to haul solid waste to the landfill to insure the accurate assessment of tipping fees for compacted trash. This fee does *not* include collection charges that are independently set by licensed commercial collectors.

(d) Residential Tipping Fees. A residential tipping fee, which includes collection charges, is hereby established for residential generators in the amount of Eight Dollars ($8.00) per dwelling per month.

(e) PUC Rate-making. The Public Utilities Commission of Guam ['PUC'] is hereby authorized to establish and amend commercial, government and residential tipping and user fees [including without limitation a self-drop fee, a variable residential tipping fee and a targeted lifeline rate for residential tipping fee, *collectively referred to as 'tipping* *fees'],* which when established shall replace those previously created by law or by the Department of Public Works ['DPW']. Tipping fees established by PUC shall be based on volume and on an actuarial analysis of costs of service. Rate-making authority, which was previously given to the DPW under this Section, is hereby *revoked.* PUC is empowered to undertake a focused management audit of the existing operations of the DPW Division of Solid Waste Management. In performing its duties under this Section, PUC shall have the full authority and powers conferred upon it by its enabling legislation, 12 GCA 12000 *et. sec.,* including the audit power conferred upon it by Public Laws 25-05:12 and 26-78:2.

(f) Solid Waste Operations Fund. All tipping, user and other fees authorized under this Section and collected based on duly established rules and regulations or on a PUC rate order shall be deposited in a special fund designated and hereby established as the Solid Waste Operations Fund. All tipping/user fees in the Fund shall be used *solely* for solid waste management practices and, pursuant to PUC order, for the payment of regulatory costs and expenses as may be incurred by PUC in performing its regulatory duties under Subsection (e).

(g) Notification to Department of Interior. Within thirty (30) days of the enactment of this Act, the Governor shall notify the Department of Interior of the establishment of tipping fees, for the purpose of releasing Federal funds available to resolve environmental issues relative to the Ordot Landfill. Unless otherwise restricted by any conditions, Federal-funding will be allocated between the Ordot Landfill compliance mitigation work and closure.

(h) DPW to Develop Variable Residential Tipping Fees In recognition of the fact that the initial residential tipping fee established by Public Law Number 24-272 is a flat fee, which discourages trash reduction, penalizes smaller families and subsidizes large residential generators of waste, the Department of Public Works shall develop a plan to institute a sliding scale of residential tipping fees. The sliding scale shall, at a minimum, charge residential generators based on the amount of waste produced and picked up by the department. The plan shall also address the methodology for billing individual residential customers based on the revised variable tipping fee. The plan shall be submitted to *I Liheslaturan Guåhan* within four (4) months of enactment of this Act.

(h) (1) Lifeline Rates for Tipping Fees. Notwithstanding any other provision of law, the Department of Public Works shall, through the development of rules and regulations pursuant to the Administrative Adjudication Law, establish and modify from time to time, Targeted Lifeline Rates for Residential Tipping Fees covering pick-up and delivery of residential trash *only* that are consistent with and meeting the low income eligibility criteria, requirement, policies or procedures established by the Guam Housing and Urban Renewal Authority ('GHURA') applicable to their Low Income Public Housing Program.

(i) Self-Drop Fee Established. Any person or entity that is *not* a business or government generator shall be billed Two Dollars ($2.00) per vehicle load of solid waste delivered to a landfill operated by the Department or its contractor; provided, that the vehicle load capacity is one (1) ton or less. Vehicles in excess of said load capacity shall be billed a rate that is based on an established formula developed by the Department.

(j) Temporary Exemption from Tipping Fees for Municipal Waste Collection. For a period of one (1) year commencing the date of the enactment of this Act, all waste collected by any Mayor or Vice-Mayor in the performance of their official duties, and transported to a landfill operated by the Department or its contractor, shall be exempt from all tipping fees. The Department of Public Works shall monitor and record the amount of solid waste delivered by Mayors and Vice-Mayors under this Section. This information shall be provided on a quarterly basis to the Mayors Council, *I Maga'lahen Guåhan, and I Liheslaturan Guahån* for the purpose of determining an appropriate budget for each municipality following the end of the exemption.

(k) 'Good Citizen' Exemption Established. Any individual, registered non-profit organization, or other person who intends to volunteer their resources for the purpose of cleaning up and collecting trash and litter from public places or facilities may be granted a temporary exemption from the fees established herein by securing a written exemption from the Department of Public Works in advance of their planned collection activities. The Department of Public Works shall determine the manner, time limit and procedure by which such an exemption may be granted and honored.

(l) Temporary Exemption of Tipping Fees Following a Force Majeure. Following a force majeure, *I Maga´lahen Guåhan* shall be authorized to suspend tipping fees for all solid waste collected and transported to a landfill that is operated by the Department or its contractor for a period *not to exceed* sixty (60) days.

(m) Exemption from Tipping Fees for Municipal Waste Collection. All Mayors or Vice-Mayors who collect waste in the performance of their official duties shall be allowed to dump the waste at the Ordot landfill, the Agat transfer station and any other landfill or transfer station operated by the Department of Public Works ('DPW') , or its contractor. The Mayors or Vice-Mayors shall be exempt from all tipping fees when dumping the waste collected in their official capacity.

SOURCE: Added by P.L. 24-139:9. Repealed and reenacted by P.L. 24-272:1. Subsection (c) amended by P.L. 25-70:2 & P.L. 25-93:1. Subsection (d) amended by P.L. 25-93:2. Subsection (e) amended by P.L. 25-70:3; repealed and reenacted by P.L. 28-56:1 (June 30, 2005). Subsection (f) amended by P.L. 28-56:2 (June 30, 2005). Subsection (h) added by P.L. 25-93:3. Subsection (i) added by P.L. 25-93:4. Subsection (j) added by P.L. 25-93:5. Subsection (k) added by P.L. 25-93:6. Subsection (l) added by P.L. 25-93:7. Subsection (m) added by P.L. 26-35:III:23(c) .

§ 51119. The Solid Waste Management Plan.

(a) The Plan to be adopted by the Agency shall address a solid waste management system for Guam which shall include, but not be limited to, source reduction, recycling, composting, resource recovery and sanitary landfilling, with the objective of reducing the amount of solid waste to be processed, landfilled or otherwise legally disposed of. It shall also require the application of plasma torch or flame technology, if permitted and cost effective, to stabilize materials at the Ordot Landfill. It shall also include:

(1) a program for the privatization of all solid waste management and operations within the authorized frameworks as enacted by this Article; the Agency shall submit a privatization plan to the Guam Legislature. The Guam Legislature shall have up to ninety (90) calendar days after official receipt to review and amend the plan as appropriate, and approve or disapprove the plan;

(2) an inventory of current residential, business, military and other institutional solid waste generation;

(3) an inventory of existing publicly available solid waste management facilities and an inventory of existing collection systems and routes;

(4) projections of residential, business, military and other institutional solid waste that will be generated within Guam during the five (5) and ten (10) year periods following the effective date of this Section;

(5) projections for decrease in solid waste disposal as a result of source reduction, recycling and solid waste management facilities;

(6) an identification of potential sites for future sanitary landfills;

(7) projections for potential requirements for monofills at future sanitary landfill for special wastes, such as asbestos or ash;

(8) provide for and incorporate recycling activities required in Item (3) of Subsection (b) of § 51120 of this Article;

(9) provide guidelines for the orderly collection, transportation, storage, separation, processing, recycling, combustion and disposal of all solid waste;

(10) provide programs for the educational training of collectors, operators and other solid waste management professionals;

(11) provide for a public education program encouraging recycling and source reduction and explaining the Plan;

(12) suggest new legislation to improve solid waste management;

(13) evaluate and determine markets for recycled materials;

(14) investigate and recommend new technologies for source reduction, recycling, composting, sanitary landfill and other solid waste disposal; and

(15) provide guidelines, including timeline for converting the Ordot Landfill to beneficial use.

(b) The Plan shall be revised and updated by the Agency every five (5) years.

SOURCE: Added by P.L. 24-139:10. Repealed and reenacted P.L. 24-272:1.

NOTE: As stated above, because P.L.s 24-179 and 25-272 were found to be invalid by the Supreme Court of Guam, Article 1 repealed and reenacted by P.L. 23-64, is presented herein:

ARTICLE 1
SOLID WASTE MANAGEMENT

§ 51101. Findings of Necessity and Declaration of Purposes.

(a) The people of this Territory find:

(1) Continuing technological changes in methods of packaging and marketing of consumer products, together with the economic and population growth of the Territory, the rising affluence of its citizens, and its expanding industrial activity have created new and ever mounting problems involving disposal of garbage, refuse, and solid waste materials resulting from domestic, commercial, agricultural, institutional and industrial activities.

(2) Traditional methods of disposing of solid waste in the Territory are no longer adequate to meet the ever-increasing problem. Improper methods and practices of handling and disposal of solid wastes pollute our land, air and water resources, blight our countryside, adversely affect land values and damage the overall quality of our environment.

(b) It is hereby declared to be the purpose of this Chapter to:

(1) Plan for and regulate the storage, collection, transport, separation, processing and disposal of solid waste in order to protect the public safety, health and welfare and to enhance the environment of the people of the Territory;

(2) Continue authority to regulate solid waste storage practices within the Department of Public Health and Social Services pursuant to Chapter 33 of this Title to ensure that such practices do not constitute a danger to human health and welfare;

(3) Provide the authority and resources to operate and maintain efficient, environmentally acceptable solid waste management systems within the Department of Public Works;

(4) Establish permanent responsibility for long range solid waste management planning with the Guam Environmental Protection Agency. Operational planning necessary for daily activities of the Solid Waste Division shall remain the responsibility of the Department of Public Works. The Guam Environmental Protection Agency shall be responsible to provide technical assistance in solid waste management and shall have

the authority to establish such advisory committees as are necessary to carry out the planning and assistance functions. Such committees should be composed of representatives from concerned government agencies, private solid waste operators, educational groups, federal agencies when applicable, and the public at large;

(5) Require review of the design and the issuance of permits for the operation of solid waste collection, transport, transport-related, processing, and disposal activities by the Guam Environmental Protection Agency;

(6) Promote the application of resource recovery systems which preserve and enhance the quality of air, water and land resources;

(7) Promote and assist in the development of markets for recovered and recycled materials;

(8) Support and encourage the rapid and efficient removal of abandoned vehicles and bulky waste from public and private premises to assure that related resource recovery is facilitated, and for other purposes;

(9) Undertake a comprehensive investigation of and set minimum standards for the generation, transportation, processing, storage, treatment and disposal of hazardous waste; conduct surveys for special disposal facilities, to protect public health, other living organisms and the environment through an effective and efficient hazardous waste management system;

(10) Establish an effective enforcement system to prevent the improper disposal of solid wastes.

§ 51102. Definitions.

For the purpose of this Chapter, the following words and phrases shall have the meaning given herein unless their use in the text of the Chapter clearly demonstrates a different meaning.

(1) Administrator shall mean the Administrator of the Guam Environmental Protection Agency or his designee.

(2) Agency shall mean the Guam Environmental Protection Agency.

(3) Board shall mean the Board of Directors of the Guam Environmental Protection Agency.

(4) Collection shall mean the act of removing solid waste from the central storage point of the source of generation.

(5) Disposal shall mean the discharge, deposit, injection, dumping, spilling, leaking or placing of any solid waste or hazardous waste into or on any land or water so that such solid waste or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including ground water.

(6) Dump shall mean a land site where solid waste is disposed without a valid permit.

(7) Financial Assurance shall mean a financial guarantee assuring that funds are available to pay for closure of a solid waste management facility, rendering post-closure at a solid waste management facility, and to compensate third parties for bodily injury and property damage caused by sudden and non-sudden accidents related to the operation of a solid waste management facility.

(8) Government shall mean the government of Guam.

(9) Hardfill shall mean a method of compaction and earth cover of solid wastes other than those containing garbage or other putrescible (putrescent) waste, including, but not limited to, tree limbs and stumps, demolition material, and like materials not constituting a health or nuisance hazard, where cover need not be applied on a per day used basis.

(10) Hazardous Waste shall mean a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may:

(a) cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or

(b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported or disposed of, or otherwise damaged.

(11) Highway means the entire width between the boundary lines of every right-of-way or publicly maintained travel ways when any part thereof is opened to the use of the public for purposes of vehicular travel.

(12) Incinerator shall mean an enclosed device using controlled flame combustion, the primary purpose of which is to thermally break down solid waste.

(13) Person shall mean any individual, partnership, co-partnership, firm, company, trust, estate, or any agency, department of instrumentality of the Federal Government or Government of Guam, or any other legal representative, agent or assigns.

(14) Pollution shall mean the condition caused by the presence in the environment of substances of such character and in such quantities that the quality of the environment is impaired or rendered offensive to life.

(15) Public Nuisance shall anything which is dangerous to life, injurious to health, or renders soil, or water or food impure or unwholesome.

(16) Processing shall mean any method, system, or other treatment designed to change the physical, chemical or biological character or composition of any solid waste. This includes the neutralization of any

hazardous waste; the rendering of any hazardous waste non-hazardous, safer for transport, amenable for recovery, amenable for storage, or reduced in volume; or any other activity or processing designed to change the physical form or chemical composition of hazardous waste so as to render it non-hazardous.

(17) Resource Recovery shall mean the act of recycling or reusing materials which still have useful physical or chemical properties after serving a specific purpose for the same or other purposes.

(18) Recycling shall mean the process by which recovered resources are transformed into new products in such a manner that products lose their identity.

(19) Reusing shall mean the reintroduction of a commodity in the economic stream without any change.

(20) Sanitary Landfill shall mean an approved site where solid waste is disposed using sanitary landfilling techniques.

(21) Sanitary Landfilling shall mean an engineered method of disposing of solid waste on land in an approved manner that protects the environment by spreading the waste in thin layers, compacting it to the smallest practical volume, and covering it with soil by the end of each working day.

(22) Separation shall mean the systematic division of solid waste into designated components.

(23) Solid Waste shall mean any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded and/or spilled materials, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities, but does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges which are point sources subject to permits under Section 402 of the Federal Water Pollution Control Act, as amended (86 Stat. 880), or source, special nuclear, or byproduct materials as defined by the Atomic Energy Act of 1954, as amended (68 Stat. 923).

(24) Solid Waste Management shall mean the purposeful, systematic control of the generation, storage, collection, transportation, separation, processing, recovery and disposal of solid waste.

(25) Solid Waste Management Facilities shall mean machinery, equipment, vehicles, structures or any part of accessories thereof installed or acquired for primary purpose of collecting, transporting, storage, processing or disposing of solid waste.

(26) Solid Waste Management Practices shall mean the actions to effectuate the generation, storage, collection, transportation, processing or

the ultimate disposal of solid waste.

(27) Solid Waste Management System shall mean the entire process of storage, collection, transportation, processing and disposal of solid waste by any person engaging in such process as a business or any government agency.

(28) Storage shall mean the interim containment of solid waste in approved manner.

(29) Territorial Solid Waste Management Plan shall mean a comprehensive plan and all amendments and revisions thereto for provisions of solid waste management throughout the Territory.

(30) Transfer Station shall mean any intermediate waste facility in which solid waste collected from any source is temporarily deposited and stored while awaiting transportation to another solid waste management facility.

§ 51103. Power and Duties.

(a) The Agency shall have the responsibility to:

(1) Administer the territorial solid waste management program pursuant to provisions of this Chapter;

(2) Provide technical assistance to local and federal agencies, and other persons, and cooperate with appropriate local agencies and private organizations in carrying out the duties under this Chapter;

(3) Encourage and recommend procedures for the utilization of self-financing solid waste management systems and agencies in accomplishing the desired objectives of this Chapter;

(4) Promote the planning and application of resource recovery to preserve and enhance the quality of air, water and land resources;

(5) Serve as the official territorial representative for all purposes of the Federal Solid Waste Disposal Act, (Public Law 91-512), or as subsequently amended, and for the purpose of such other territorial or federal legislation as has been or may hereafter be enacted to assist in the management of solid waste;

(6) Survey the solid waste management practices within the territory and prepare a solid waste management plan; such plan to include but not necessarily be limited to the development, investigation and research, including the preparation of legislative action as may be required for new disposal sites, processes, recycling facilities or methods. The plan shall be revised at least every five (5) years, or sooner as needed;

(7) Develop regulations in cooperation with appropriate

government agencies, industrial and private parties, for the generation, collection, transportation, storage, processing and disposal of hazardous waste, in accordance with the Administrative Adjudication Act;

(8) Prepare, adopt, promulgate, modify, update, repeal, and enforce rules and regulations governing solid waste collection, transport, separation, processing, and disposal in order to conserve the air, water, and land resources of the Territory, protect the public health, prevent environmental pollution and public nuisances, and enable it to carry out the purposes and provisions of this Chapter and the adopted Territorial Solid Waste Management Plan;

(9) Establish the procedures for review and issuance for permit application, governing the design, operation, closure and post-closure of solid waste management facilities;

(10) Prepare, issue, modify, remove and enforce orders for compliance with any of the provisions of this Chapter or of any rules and regulations issued pursuant thereto and requiring the taking of such remedial measures for solid waste management as may be necessary or appropriate to implement or effectuate the provisions and purposes of this Chapter;

(11) Prepare, adopt, promulgate, modify, update, repeal, and enforce such other rules and regulations as may be necessary to establish a hazardous waste program which may be at least equivalent to or more stringent, or broader in scope than the requirements of Section 3006 of the Federal Resource Conservation and Recovery Act (42 U.S.C. 6926, et seq.) and regulations promulgated pursuant thereto.

(b) The Department of Public Works shall be responsible for:

(1) Public solid waste collection, transport and disposal. Such collection and disposal services shall be furnished to all villages and urban areas, and may be extended to further areas by administrative action. The Director of Public Works may by regulation prescribe requirements with regards to solid waste containers, and collection of solid and bulky waste. Public sanitary landfills, hardfills, transfer stations, processing or recycling plants as currently exist or may be established will be operated and maintained by the Department of Public Works. The Director of Public Works, with the approval of the Governor, may execute a contract after public bid with a private party or firm for the collection and disposal of any solid or bulky waste, or other offensive substances, or separate items thereof including the operation of any sanitary landfill, hardfill, transfer station, processing, recycling, or storage plant which is publicly owned provided that any employee whose job is adversely affected by any such contract shall be given first preference for any other job for

which he qualifies in the Government of Guam.

(2) Operational and logistic planning for solid and bulky waste management to include collection, routing equipment, material and equipment procurement disposal, transfer and storage site operations, processing and recycling plant operations and maintenance, and engineering functions related thereto. The Director of Public Works is authorized to negotiate for and approve contracts for recycling and composting at the Order Landfill, or at any other site approved by the Guam Environmental Protection Agency, under the following procedures: The Director, after duly advertising for a request for proposals for the removal or composting of recyclable materials from the landfill, shall enter into a contract with any interested business organization, either local or off island, to collect and recycle or compost such materials.

The successful bidder or bidders shall not be charged for the materials. The Department may assist successful bidders in collecting storage batteries and waste oil which are to be found in the various villages of Guam.

§ 51104. Permits.

(a) The Administrator is hereby authorized and directed to issue permits for solid waste management facilities and hazardous waste management facilities, including design, operation, maintenance, substantial alteration, modification or enlargement. All such permits shall be non-transferable and conditioned upon the observance of the laws of the territory and rules and regulations authorized herein.

(b) Each permit holder shall apply for the renewal of each permit held, upon forms provided by the Agency, not less than sixty (60) days prior to the expiration date of such solid waste management permit to be renewed, or not less than one hundred eighty (180) days prior to the expiration date of each hazardous waste management permit to be renewed.

(c) Each permit application and each permit renewal application shall be submitted with proof of financial assurance, of a type and in a sum established by the Administrator conditioned on the fulfillment by the permit holder of the requirements of this Chapter and the rules and regulations authorized therein. No financial assurance mechanism required under this Chapter may be canceled by the guarantor unless the Administrator has received written notice thereof and there has been a lapse of one hundred twenty (120) days between receipt of notice and cancellation date.

(d) Before issuing a solid waste management permit to any person with respect to any facility for the incineration, recycling, or disposal of solid waste, the Administrator shall:

(1) Cause to be published in a major local newspaper or

newspaper of general circulation, and broadcast over a local radio station or stations, notice of the Agency's intention to issue such a permit.

(2) If, within forty-five (45) days after publication and broadcast, the Agency receives written notice of opposition to the Agency's intention to issue such permit and a request for a hearing is made, the Agency shall provide for a hearing in accordance with the Administrative Adjudication Act if requested by a substantially affected party.

(e) Before issuing a hazardous waste management permit to any person with respect to any facility for the processing, storage, or disposal of hazardous waste, the Administrator shall:

(1) Cause to be published in a major local newspaper or newspaper of general circulation, and broadcast over a local radio station or stations, notice of the Agency's intention to issue such a permit.

(2) If, within forty-five (45) days after publication and broadcast, the Agency receives written notice of opposition to the Agency's intention to issue such permit and a request for a hearing is made, the Agency shall provide for a hearing in accordance with the Administrative Adjudication Act if requested by a substantially affected party or an informal public meeting if requested by any other person.

§ 51105. Permit Fees.

Each application for a permit, or renewal application, shall be accompanied by a certified check or money order in the amount prescribed by regulations. All fees required by the section shall be non-returnable and shall be placed in the revolving fund established under Section 51117 of this Chapter.

§ 51106. Inspections.

The Agency is hereby authorized to inspect all solid waste management facilities and hazardous waste management facilities at all reasonable times to insure compliance with the laws of the Territory, the provisions of this Chapter and the rules and regulations authorized herein. This authority shall include access to and authority to copy all records relating to hazardous waste, as well as the authority to obtain samples of any waste handled in the facilities. It shall be a misdemeanor for any person to interfere with such inspections. It shall also constitute a violation of Prohibited Solid Waste Activities and Prohibited Hazardous Waste Activities and shall carry the Solid Waste Civil Penalties and Hazardous Waste Civil Penalties as set forth respectively in § 51114(b) and § 51114(d) below.

§ 51107. Inspection Fees.

The Agency is hereby authorized to include as part of permit fees under § 51105, fees for inspections conducted of all solid waste management facilities, hazardous waste treatment, storage and disposal facilities, hazardous waste transporters, generators of hazardous waste, waste oil generators, recyclers, marketers, brokers and all other waste oil facilities including boilers and industrial furnaces as well as waste to energy facilities.

§ 51108. Notice.

Any notice, order or other official correspondence affecting the rights of any person under this Chapter shall be delivered by personal service or sent by registered or certified mail with a return receipt to the address of such person as shown by the records of the Agency. The return receipt, signed by the addressee, or his agent, shall be conclusive proof of delivery.

§ 51109. Hearings.

(a) Any person who received an order from the Administrator as authorized by this Chapter and any person whose permit application is disapproved by the Administrator may, within fifteen (15) days of the date of receipt of such order or disapproval, file a Notice of Intent to appeal with the Board, setting forth in such Notice a verified petition outlining the legal and factual basis for such appeal.

(b) The Board of Directors shall, not more than sixty (60) days after receipt of such Notice of Appeal, hold a public hearing at which time the person appealing may appear and present evidence in person or through counsel in support of this petition.

(c) The Agency is hereby authorized to administer oaths, examine witnesses and issue subpoenas to compel the attendance of witnesses and the production of evidence relevant to the matter involved in the hearing.

(d) The Board shall affirm, modify or revoke any action which is appealed and shall notify the appellant of its decision not more than thirty (30) days after the conclusion of the hearing. Such notice shall be in writing and shall state the reasons for the decision.

(e) Any person may appeal such decision to the Superior Court of Guam by filing with the Agency a written notice of such intent to appeal within ten (10) days of the notice in subsection (d) of this Section and shall have a transcript of the proceedings upon request.

§ 51110. Prohibited Solid Waste Activities.

(a) It shall be unlawful for any person to:

(1) Violate any provision of this Chapter or any rule, regulation, standard, or order issued pursuant to this Chapter;

(2) Own, operate or use a dump for the disposal of solid

waste;

(3) Place, or allow to be placed, any solid waste upon the highways, public or private property contrary to the provisions of this Chapter;

(4) Manage solid waste facilities without a permit issued pursuant to this Chapter;

(5) Store, collect, transport, process, or dispose of solid waste in such a manner as to degrade the environment, create a public nuisance, create a health or safety hazard, or violate any provisions of this Chapter;

(6) Transport any solid waste in any vehicle in any street or highway unless adequate precautions are taken to prevent such solid waste from falling or from being dislodged from such vehicle upon any street, highway, or any other public or private property;

(7) Not immediately pick up and remove waste which has fallen off the vehicle they are operating during the course of transportation upon any street, highway or any other public or private property;

(8) No person shall destroy or attempt to destroy by burning, except in an incinerator the construction and operation of which is approved by the Administrator, or as may otherwise be authorized by the Administrator, any garbage, dead animals, or other offensive substances, the burning of which may give off foul and noisome odor. Nothing in this Section shall preclude the burning of trees, brush, grass and other vegetable matter authorized by the Administrator.

(b) Each day of continued violation of this section or the provisions of this Chapter or rules and regulations authorized herein shall be deemed a separate offense or violation.

§ 51111. Prohibited Hazardous Waste Activities.

(a) It shall be unlawful for any person to:

(1) Violate any provision of this Chapter or any rule, regulation, standard, or order issued pursuant to this Chapter;

(2) Own, operate or use a dump for the disposal of hazardous waste;

(3) Place, or allow to be placed, any hazardous waste upon the highways, public or private property contrary to the provisions of this Chapter;

(4) Manage hazardous waste facilities without a permit issued pursuant to this Chapter;

(5) Store, collect, transport, process or dispose of hazardous waste in such a manner as to degrade the environment, create a public nuisance, create a health or safety hazard as determined by the Director of the Department of Public Health and Social Services or the Administrator or violate any provision of this Chapter;

(6) Knowingly make any false statement or representation in any hazardous waste application, label, manifest, record, report, permit or other document filed, maintained, or used for purposes of compliance with the provisions of this Chapter.

(b) Each day of continued violation of this section or the provisions of this Chapter or rules and regulations authorized herein shall be deemed a separate offense or violation.

§ 51112. Injunction.

The Agency shall maintain an action to restrain any violation or threatened violation of the provisions of this Chapter or the rules and regulations authorized herein. Such right to injunctive relief is in addition to any other powers or penalties conferred by this Chapter.

§ 51113. Plats.

All persons operating a sanitary landfill, hardfill, or other approved disposal site under permits issued pursuant to this Chapter shall, upon completion of the sanitary landfill or hardfill, file with the Department of Land Management and the Building Permit Section of the Department of Public Works, a plat of each site, together with a description of the waste placed therein and in conformance with rules and regulations adopted pursuant to § 51103(a)(8) of this Chapter.

§ 51114. Applicability to Government Agencies.

Government agencies shall comply with all provisions of this Chapter including planning, review, and permit requirements, with the exception of § 51104(c). Government agencies may contract with any person to carry out their responsibilities under this Chapter. Such contractors shall also comply with the provisions of this Chapter.

§ 51115. Penalties.

(a) Solid Waste-Criminal Penalties. Any person who knowingly violates any solid waste management provision of this Chapter, or any valid solid waste management rule or regulation promulgated under this Chapter, or who refuses or neglects to comply with any lawful order issued by the Administrator in carrying out the provisions of this Chapter shall, upon conviction, be imprisoned for a term of not more than one (1) year, and/or be fined not more than $1,000 per day for each violation or noncompliance, and shall make restitution.

(b) Solid Waste-Civil Penalties. Any person who violates any solid waste management provision of this Chapter, or any valid solid waste management rule or regulation promulgated under this Chapter, or who refuses or neglects to comply with any lawful order issued by the Administrator in carrying out the provisions of this Chapter shall, in addition to clean-up costs and other damages, forfeit and pay a civil penalty of not more than $1,000 per day for each violation or noncompliance.

(c) Hazardous Waste-Criminal Penalties. Any person who knowingly violates any hazardous waste management provisions of this Chapter, or any valid hazardous waste management rule or regulation promulgated under this Chapter, or who refuses or neglects to comply with any lawful order issued by the Administrator in carrying out the provisions of this Chapter shall be guilty upon conviction of a felony of the third degree, and be fined not less than $10,000 per day for each violation and/or noncompliance, and shall make restitution.

(d) Hazardous Waste-Civil Penalties. Any person who violates any hazardous waste management provision of this Chapter, or any valid hazardous waste management rule or regulation promulgated under this Chapter, or who refuses or neglects to comply with any lawful order issued by the Administrator in carrying out the provisions of this Chapter shall, in addition to clean-up costs and other damages, forfeit and pay a civil penalty of not less than $10,000 per day for each violation or noncompliance.

(e) Administrative Penalties. In addition to any other administrative or judicial remedy provided by this Chapter, or by rules adopted under this Chapter, the Administrator is authorized to impose by order the penalties specified in § 51115(b) and (d) respectively. Factors to be considered in imposing an administrative penalty include the nature and history of the violation and of any prior violations, and the opportunity, difficulty, and history of corrective action. It is presumed that the violator's economic and financial conditions allow payment of the penalty, and the burden of proof to the contrary is on the violator. In any proceeding to recover the civil penalty imposed, the Administrator need only show that notice was given, a hearing was held or the time granted for requesting a hearing has expired without such a request, the civil penalty was imposed, and that the penalty remains unpaid.

§ 51116. Citizen's Suits.

(a) Any person may commence a civil action on his behalf:

(1) Against any person (including the United States, and any other governmental instrumentality or agency, to the extent permitted by law) who is alleged to be in violation of any permit, standard, regulation, condition, requirement, prohibition, or order which has become effective pursuant to this Chapter; or

(2) Against any person, including the United States, and any other governmental instrumentality or agency, to the extent

permitted by law, and including any past or present generator, past or present transporter, or past or present owner or operator of a treatment, storage, or disposal facility, who has contributed or who is contributing to the past or present handling, storage, treatment, transportation, or disposal of any solid or hazardous waste which may present an imminent and substantial endangerment to health or the environment; or

(3) Against the Administrator where there is alleged a failure of the Administrator to perform any duty under this Chapter which is not discretionary with the Administrator.

Any action under paragraph (a)(1), (a)(2), or (a)(3) of this Section shall be brought in the Superior Court of Guam. The Superior Court shall have jurisdiction, without regard to the amount in controversy or the citizenship of the parties, to enforce the permit, standard, regulation, condition, requirement, prohibition, or order referred to in paragraph (a)(1), to restrain any person who has contributed or is contributing to the past or present handling, storage, treatment, transportation, or disposal of any solid or hazardous waste referred to in paragraph (a)(2), to order such person to take such further action as may be necessary, or both, or to order the Administrator to perform the act or duty referred to in paragraph (a)(3), as the case may be, and to apply any appropriate civil penalties under § 51115(b) and (d). No bond shall be required for issuance of an injunction or temporary injunction after a duly noticed hearing.

(b) Except for injunctive relief, no action may be commenced under subsection (a)(1) or (a)(2) of this Section:

(1) Prior to ninety (90) days after the plaintiff has given notice of the violation or endangerment to (i) the Administrator; (ii) the government of Guam; and (iii) to any alleged violator of such permit, standard, regulation, condition, requirement, prohibition, or order referred in subsection (a)(1) of this Section if applicable or to any person alleged to have contributed or to be contributing to the past or present handling, storage, treatment, transportation, or disposal of any solid or hazardous waste referred to in subsection (a)(2) of this Section if applicable.

(2) Except for injunctive relief, if the Administrator or government of Guam has commenced and is diligently prosecuting a civil or criminal action to require compliance with such permit, standard, regulation, condition, requirement, prohibition, or order pursuant to subsection (a)(1) of this Section or if the Administrator or government of Guam, in order to restrain or abate acts or conditions which may have contributed or are contributing to the activities which may present the alleged endangerment under subsection (a)(2) of this Section has commenced and is diligently prosecuting an action under local law or under the Comprehensive Environmental Response, Compensation and Liability Act

(CERCLA) or is actually engaging in a removal action under CERCLA or has incurred cost to initiate a remedial Investigation and Feasibility Study under CERCLA and is diligently proceeding with a remedial action.

(c) Except for injunctive relief, no action may be commenced under subsection (a)(3) of this Section prior to sixty (60) days after the plaintiff has given notice to the Administrator and the government of Guam in which the failure has occurred that he will commence such action.

§ 51117. Solid Waste Management Fund.

There is established a non lapsing, revolving fund, hereafter referred to as the "Solid Waste Management Fund" which shall be maintained separate and apart from any other funds of the Government of Guam, and shall be administered by the Administrator. Independent records and accounts shall be maintained in connection therewith. All fees, reimbursements, assessments, fines, bail forfeitures, and other funds collected or received pursuant to this Article shall be deposited in this Fund and used for the administration and implementation of this Article, including purchase of equipment and payment of personnel costs of the Agency.

ARTICLE 2
LITTER CONTROL

SOURCE: Added by P.L. 14-37:1 (June 18, 1977). Repealed and reenacted by P.L. 17-87 (Jan. 18, 1985) and P.L. 23-64 (Dec. 5, 1995). Further amended as indicated herein.

§ 51201. Declaration of Purpose.

It is hereby declared to be the purpose of this Article to define and prescribe procedures pertaining to littering, and to provide authority for the regulation of littering in order to enhance the environment for the people of Guam.

§ 51202. Definitions.

For the purpose of this Article, the following words shall have the meaning given herein unless their use in the text clearly demonstrates a different meaning:

(a) *Apprehending Officers* shall mean any designated individual with the Department of Parks and Recreation, the Department of Agriculture, the Guam Environmental Protection Agency, the Department of Public Health and Social Services, the Department of Public Works, all village mayors and assistant mayors, and any peace officer in the Guam Police Department.

(b) *Litter* shall mean discarded, used or leftover solid materials, including but not limited to garbage, trash, rubbish, refuse, paper, containers, bulky metallic waste, packing or construction materials or carcasses of dead animals.

(c) *Littering* shall mean willful or negligent throwing, dropping, placing, depositing, or sweeping, allowing or causing such acts, of any litter on land or water, in other than appropriate storage containers or areas designated for such purpose.

(d) *Vehicle* shall mean a device in, upon or by which any person or property may be propelled, moved, or drawn upon a highway, except a device moved by human or animal power.

(e) *Watercraft* shall mean any boat, ship, vessel, barge or other floating craft.

§ 51203. Power and Duties.

(a) The Administrator of the Guam Environmental Protection Agency, in consultation with the Attorney General's Office, is empowered to prescribe and amend such rules and procedures as are necessary for the efficient implementation of this Article.

(b) Violations of this Article will be recorded on forms approved by and prosecuted within the Traffic Division of the Superior Court of Guam.

(c) Apprehending officers, as defined herein, shall have the power to apprehend persons violating this Article and issue citations for such violation.

§ 51204. Litter Control Revolving Fund.

There is established a fund to be known as the Litter Control Revolving Fund which shall be maintained separate and apart from any other fund of the Government of Guam and shall be administered by the Administrator. Independent records and accounts shall be maintained in connection therewith. Except as provided in §40115 of Title 5, Guam Code Annotated, 50 percent (50%) of all assessments, fines, bail forfeitures and other funds collected or received pursuant to this Article shall be deposited in the Litter Control Revolving Fund and used for the administration and implementation of this Article; for education programs and advertisement promotions aimed at increasing awareness of litter and defacement problems; for the placement of anti-litter and anti-graffiti signs around the island; and for the cleanup of litter and defacement from public highways, streets, alleys, roads, bridges, buildings, signs, restrooms, public recreational areas or other public lands that are most visible to the public, and 50 percent (50%) shall be deposited in the Guam Beautification Fund as provided in 21 GCA §77114.1.

§ 51205. Prohibited Activities.

(a) It shall be unlawful for any person to willfully or negligently dump, deposit, throw, leave or abandon any litter upon any public highway, street, alley or road, upon public parks or recreation areas or upon any other public property except as designated for such use, or upon property owned by another person without written permission of the owner, or into any bay, channel, harbor, river, creek, stream, reservoir, coastal waters, or other waters of the Territory.

(b) Apprehension of Violation. Apprehension for violation of prohibitions may be initiated by an apprehending officer who witnessed an offense or discovered an article bearing a person's name on the property of another, or any public property except as designated for such use, or by any private citizen, who witnessed an offense or discovered incriminating evidence, who is willing to make the initial charge and testify for the Government.

(c) Any person who shall witness the throwing, dumping, or depositing of litter from a vehicle or water craft which is in violation of prohibitions may report the date, time of day and location of the littering and the license registration number to apprehending officers. The registration number as recorded shall constitute prima facie evidence that the littering was done by the person to whom such vehicle or water craft is registered. Nothing in this Section shall be construed to modify or change the burden of the Government to prove the defendant guilty beyond a reasonable doubt.

(d) Any person who violates this section while occupying a motor vehicle which is moving, or located on public property or a public right of way, shall be deemed to have committed a violation no only of this section, but of 16 GCA Chapter (Rules of the Road) , and shall be guilty of a petty misdemeanor.

SOURCE: Subsection (d) added by P.L. 25-170:4.

§ 51206. Enforcement.

Any person apprehended for violation of any of the above prohibitions shall be served by the apprehending officer with a citation and an order to appear at the Traffic Court Division of the Superior Court of Guam for prosecution. Parents or legal guardians will assume all responsibility for any violations of this Chapter committed by any minors under their care.

§ 51207. Penalties.

(a) Littering shall be punishable by a fine of *not less than* One Hundred Dollars ($100.00) , nor more than One Thousand Dollars ($1,000.00) . Any person convicted of a second or subsequent litter offense shall be required by the Court to pick up and remove litter from a public place under the supervision of the Superior Court of Guam's Probation Office, or its designee, or as the Court shall otherwise provide, for a period of *not less than* eight (8) hours for each offense.

Any person convicted of any litter offense may also be required by the Court to pay the cost of removing the litter they caused. The Superior Court of Guam shall transfer all money collected to pay fines imposed under this Section to the Guam Environmental Protection Agency for use in the Litter and Defacement Control Revolving Fund established by § 51204 of Title 10 of the Guam Code Annotated. Any peace officer, as that term is defined by 8 GCA § 5.55, may issue a citation for a litter offense.

(b) A person charged with a first violation may avoid a court hearing by posting bail in the amount of the minimum fine or paying such prescribed fine as the Traffic Court Division of the Superior Court shall prescribe.

SOURCE: Subsection (a) amended by P.L. 25-170:5.

§ 51208. Severability Clause.

The provisions of this Chapter are severable and if any provision or part thereof shall be held invalid or unconstitutional or inapplicable to any person or circumstances, such invalidity, unconstitutionality or inapplicability shall not affect or impair the remaining provisions of this Chapter.

ARTICLE 3
ANNUAL CONTRACT FOR SCRAP REMOVAL

SOURCE: Added by P.L. 23-64 (Dec. 5, 1995). Further amended as indicated herein.

§ 51301. Contract to Remove Scrap.

The Director of Public Works, after duly advertising for a request for proposals for the removal of scrap metal, shall enter into a contract with any interested business organization, either local or off-island, to collect and remove from Guam scrap metal. The successful offeror may not be charged for the scrap metal but may post a one hundred thousand dollars ($100,000) performance bond to assure its completion of the removal project within twelve (12) months from receiving from the Director a Notice to Proceed. "Scrap Metal" for the purpose of this Article means abandoned vehicles and other abandoned metal implements of which the Department of Public Works has jurisdiction and the right to dispose. In so disposing of such scrap metal, the Director shall not charge any fees to the owner of the same.

§ 51302. Annual Contract.

The Director shall advertise for and execute such a contract each year with any qualified party on the same terms as are set out in § 51301 of this Article.

§ 51303. Environmental Impact Study.

The Guam Environmental Protection Agency (GEPA) shall annually cause an environmental impact study to be undertaken by the successful offeror to ensure that there are no potential adverse ecological damage to aquifers caused by the annual scrap removal contract.

§ 51304. Conformity to Waste Removal Regulations.

The successful offeror shall perform all work under this Article in compliance with applicable rules and regulations of GEPA on the removal of scrap metal and hazardous waste. As a minimum, the Department of Public Works Director shall ensure that all successful offerors include as part of their processing, an intake system to screen and remove batteries and other potentially hazardous residual material including, engine oil, hydraulic fluids and coolant and Freon from air conditioning units.

ARTICLE 4
CONTRACT FOR COLLECTION OF RECYCLABLE PAPER.

SOURCE: Added by P.L. 24-246:3. (Aug. 14, 1998) except for § 51404 and any following.

§ 51401. Contract to Accept and Collect Recyclable Paper.

The Director of Public Works, in accordance with the applicable procurement laws, and after advertising for a request for proposals ('RFP') for the collection of recyclable paper, shall enter into a two (2) - year contract with any qualified local interested business or nonprofit organization, to accept and collect recyclable paper to include newsprint, office paper and magazines from the public, and to implement a plan to prevent them from entering Guam's waste stream. The qualified local business or nonprofit organization shall have active recycling experience and knowledge in Guam. The RFP shall include the requirement that the prospective contractor accepts and pays for all recyclable paper, to include newsprint, office paper and magazines offered by the public. The successful offeror shall be one who bids the highest amount per pound to be paid to the public for the recyclable paper for the duration of the contract term. The contractor shall be granted One Hundred Fifty Thousand Dollars ($150,000.00) per annum, to be appropriated from the Solid Waste Operations Fund established in this Chapter, to supplement its operations in accordance with the terms and conditions negotiated between the successful offeror and the Department of Public Works. No part of the contract shall require the government to grant more than the annual sum granted at the beginning of the contract period.

§ 51402. Biennial Contract.

The Director shall advertise for and execute such a contract every two (2) years with any qualified party on the same terms as are set out in § 51401 of this Article.

§ 51403. Conformity to All Laws and Rules and Regulations.

The successful offeror shall perform all work under this Article incompliance with all applicable laws, including those of this Chapter, and rules and regulations of GEPA as may be established. As a minimum, the Department of Public Works Director shall ensure that all offerors include as part of their processing, a plan to remove the collected paper from Guam's waste stream.

§ 51404. Report.

Each successful bidder shall file a report on a quarterly basis with I Maga'lahen Guåhan [the Governor] and I Liheslaturan Guåhan [the Legislature], outlining the following:

(a) total type and amount of paper recycled;

(b) cost comparison of the cost of the paper-recycling program versus landfill disposal of paper, or any less-than-conventional methods of paper waste reduction; and

(c) recommendations for permanent implementation and improvements to the recycling program.

SOURCE: Added by P.L. 26-147:3.

ARTICLE 5
RECYCLING REVOLVING FUND

SOURCE: Added by P.L. 27-38:2 (Nov. 13, 2003). This Article was repealed and reenacted in its entirety by P.L. 28-171:2 (Jan. 29, 2007).

§ 51501. Definitions.

As used in this Article, and except as otherwise provided, the following words and phrases shall mean:

(a) 'Administrator' shall mean the Administrator of the Guam Environmental Protection Agency, or his designee.

(b) 'DPW' shall mean the Department of Public Works.

(c) 'Director' shall mean the Director of the Department of Public Works.

(d) 'Enameled white goods' shall mean appliances for home or commercial use including, but *not limited to,* refrigerators, water heaters, air conditioners, washers, dryers, and stoves.

(e) 'GEPA' shall mean the Guam Environmental Protection Agency.

(f) 'Gross Vehicle Weight' or 'Gross Vehicle Weight Rating' means the value specified by the manufacturer as the loaded weight of a single vehicle.

(g) 'Heavy Equipment' shall mean any equipment, motor vehicle or motor carrier, or non-road motor vehicle with a gross weight or gross vehicle weight of five (5) tons or more.

(h) 'Junk Vehicle' means a motor vehicle, regardless of operating condition, that the registered owner has declared to have no value or no use, or that is abandoned by being placed, discarded, or disposed of on public or private property without approval by owners of said property for more than seven (7) calendar days, or that is no longer registered in accordance with Chapter 7 of Title 16 GCA.

(i) 'Motor Vehicle' or 'motorized vehicle' shall mean automobiles, automobile trucks, automobile wagons, buses, trucks, motorcycles or other self propelled wheeled conveyances that are primarily for use on Guam's public streets, roads, and highways that are required to be registered with the Motor Vehicles Division, Department of Revenue and Taxation, Government of Guam.

(j) 'Municipal Solid Waste' is a subset of solid waste and is defined as durable goods (e.g., appliance, batteries, tires), nondurable goods (e.g., newspapers, books, magazines), containers and packaging, food wastes, yard trimmings, and miscellaneous organic wastes from residential, commercial, and industrial non-process sources.

(k) 'Recyclable materials' means materials which still have useful physical or chemical properties after serving a specific purpose for the same or other purpose. Recyclable materials are as follows:

(1) batteries (i.e., lead-acid, portable computer batteries, nickel-cadmium, sealed types for power backup);

(2) automobiles, buses, and trucks or any motor vehicle;

(3) tires (passenger/commercial);

(4) enameled white goods;

(5) home appliances (other small appliances that are not considered enameled white goods);

(6) glass and plastic bottles;

(7) foam padding;

(8) lead;

(9) metals (ferrous/non-ferrous);

(10) organic material (i.e., tree trimmings, palm fronds, grass, food waste, soiled cardboard);

(11) paper products;

(12) wood pallets and scrap wood;

(13) construction and demolition debris ('C&D');

(14) x-ray film;

(15) automobile oil and fluids;

(16) freon and other refrigerant gases;

(17) electronic waste (i.e., computers, circuit boards, televisions, and portable phones);

(18) heavy equipment; and

(19) other recyclable materials deemed recyclable by GEPA pursuant to its rules and regulations.

(l) 'Recycle or Recycling' means a method by which recovered resources are converted for use as raw materials or feedstock to make new products, as defined in § 51102 (35) of Chapter 51 of Title 10 GCA.

(m) 'Recycling Company' shall mean any business licensed by the Department of Revenue and Taxation, and permitted, as required in § 51104 of Chapter 51 of Title 10 GCA, by the Guam Environmental Protection Agency to conduct business on Guam.

(n) 'Recycling Facility' shall mean all contiguous land, structures, and other appurtenances, and improvements on land used for the collection, separation, recovery, and sale or reuse of recovered resources that would otherwise be disposed of as municipal solid waste, and is an integral part of a manufacturing process aimed at producing a marketable product made of post consumer material.

(o) 'Recycling fee' shall mean an annual fee levied upon the registered owner of a motor vehicle to assist in the recycling and disposal of motor vehicles and other recyclable materials in accordance with this Article.

§ 51502. Recycling Revolving Fund.

There is hereby created the Recycling Revolving Fund ('Fund'), which shall be maintained separate and apart from any other funds, including the General Fund of the government of Guam, and independent records and accounts shall be maintained thereof. All revenue generated from recycling fees collected pursuant to this Article, including interest earned, shall be deposited into the 'Recycling Revolving Fund', hereinafter in this Article referred to as the 'Fund'.

§ 51503. Continuing Appropriation

(a) All revenues from the Recycling Revolving Fund are hereby appropriated to the Department of Public Works to fund the costs of the administration and implementation of this Article.

(b) In Fiscal Year 2007, the Director of Public Works *shall* expend monies from the Recycling Revolving Fund to pay current obligations of the Department of Public Works arising from the ongoing Island-Wide Collection and Off-Island Disposal of Abandoned Vehicles, White Goods, Tires, and Batteries program pursuant to GSA Bid No. 038-05.

SOURCE: P.L. 28-171:2 (Jan. 29, 2007). Amended by P.L. 29-002:VI:11 (May 18, 2007).

§ 51504. Administration of the Recycling Revolving Fund.

The Director of Public Works shall administer the Fund and shall encumber all amounts available in the Fund as expeditiously as possible for the purposes of assisting and encouraging recycling of recyclable materials. The Director shall administer the Fund in accordance with this Article to cause the following material/waste to be recycled or otherwise disposed according to the following priority:

(a) First Priority - junk vehicles, tires, batteries, waste oil, white goods/appliances,

(b) Second Priority - paper, cardboard, plastic, and glass,

(c) Third Priority - other recyclable materials as determined by the Director.

(d) *Not more than* one (1) FTE employee at Guam Environmental Protection Agency to administer this Article.

The Director of Public Works, *no later than* ten (10) days after the end of each fiscal year, shall transfer from the Recycling Revolving Fund three percent (3%) of the total amount collected during that fiscal year to fund one (1) FTE employee at the Guam Environmental Protection Agency. The Fund shall be subject to audits by the Public Auditor.

§ 51505. Levy and Collection of Recycling Fees.

The Director of Revenue and Taxation is hereby authorized to levy a Recycling Fee on individuals who are renewing their annual motor vehicle registration with the Department of Revenue and Taxation Division of Motor Vehicles, through the vehicle registration system. The Director of Revenue and Taxation shall collect the Recycling Fees mandated by this Article and transmit the fees to the Director of DPW for deposit in the Recycling Revolving Fund.

§ 51506. Recycling Fees.

The Recycling Fees authorized in § 51505 are hereby imposed as follows:

(a) *Twenty Five Dollars ($25.00)* annually for each automobile, bus and truck registered by the Department of Revenue and Taxation through the annual vehicle registration system.

(b) *Three Dollars ($3.00)* for each motorcycle and trailer registered by the Department of Revenue and Taxation through the annual vehicle registration system.

(c) *Thirty Dollars ($30.00)* for each piece of heavy equipment registered by the Department of Revenue and Taxation through the annual vehicle registration system.

§ 51507. Authorization for DPW to Contract with Recycling Companies.

(a) DPW is authorized, in accordance with the applicable procurement laws, to enter into contracts with recycling companies for the collection, recycling, disposal, and processing, or any combination thereof, of automobiles, buses, heavy equipment, trucks, batteries, tires, white goods, and other recyclable materials, and as required by, or in accordance with, Articles 3 and 4 of Title 10 GCA, Chapter 51. The Director of DPW shall submit any proposed Requests for Proposals to *I Liheslaturan Guahan* within three (3) months of the enactment hereof.

(b) At a minimum, the Director of Department of Public Works shall require that all offerors include, as part of their written offers, proof of current approved permits, certification of compliance with Title 10 GCA Chapter 51 from GEP A and a plan to remove collected recyclable materials, including abandoned vehicles, from Guam's waste stream. Contractors employed under this Section shall perform all work under this Article in compliance with all applicable laws, including those of this Chapter, and the applicable Rules and Regulations of GEP A and DPW.

(c) DPW shall promulgate the necessary rules and regulations, in accordance with the Administrative Adjudication Law, to properly implement this Article.

§ 51508. Adjustment of Recycling Fees.

The Director shall review the fee authorized by § 51506, supra, every twenty four (24) months and is authorized to adjust the fee by *not more than* twenty-five percent (25%) in accordance with the Administrative Adjudication Law.

ARTICLE 6
MUNICIPAL RECYCLING PROGRAM

SOURCE: Added by P.L. 27-37:2 (Nov. 14, 2003).

§ 51601. Definitions.

For purposes of this Article, except as otherwise provided, the following words and phrases, together with all of the common derivatives thereof, shall have the meaning ascribed to them as follows:

(a) 'GEPA' shall mean the Guam Environmental Protection Agency.

(b) 'Recycling' means the process by which recovered resources are transformed into new products in such a manner that products lose their initial identity, as defined in § 51102 (18) of Chapter 51 of Title 10 of the Guam Code Annotated.

(c) 'Recyclable materials' means materials which still have useful physical or chemical properties after serving a specific purpose for the same or other purpose. Recyclable materials are as follows:

(1) batteries (i.e., lead-acid, portable computer batteries, nickel-cadmium, sealed types for power backup);

(2) automobiles, buses, and trucks or any form of motorized vehicle;

(3) tires (passenger/commercial);

(4) enameled white goods;

(5) home appliances (other small appliances that are not considered enameled white goods);

(6) glass and plastic bottles;

(7) foam padding;

(8) lead;

(9) metals (ferrous/non-ferrous);

(10) organic material (i.e., tree trimmings, palm fronds, grass, food waste, soiled cardboard);

(11) paper products;

(12) wood pallets and scrap wood;

(13) construction and demolition debris ('C&D');

(14) x-ray film;

(15) automobile oil and fluids;

(16) Freon and other refrigerant gases;

(17) electronic waste (i.e., computers, circuit boards, televisions, and portable phones);

(18) heavy equipment; and

(19) other recyclable materials deemed recyclable by GEPA pursuant to the Rules and Regulations.

(d) 'Recycling company' means any business licensed by the Department of Revenue and Taxation, and issued a permit, as required in § 51104 of Chapter 51 of Title 10 of the Guam Code Annotated, from the Guam Environmental Protection Agency to conduct business on Guam.

(e) 'DPW' means the Department of Public Works.

SOURCE: Added by P.L. 27-37:2 as section 61601 and renumbered by Compiler to section 51601 to fit within the appropriate chapter and article.

§ 51602. Creation of Municipal Recycling Proceeds Fund for Each Village.

There is hereby established a Municipal Recycling Proceeds Fund for each municipality which shall be maintained separate and apart from any other funds, including the General Fund of the government of Guam, and independent records and accounts shall be maintained in connection therewith. The proceeds from the sale of recyclable materials collected, in accordance with the Municipal Recycling Program, from each village shall be deposited in the respective Municipal Recycling Proceeds Fund. All revenue deposited in each Municipal Recycling Proceeds Fund shall not be commingled with General Fund monies and shall be kept in a separate bank account. All proceeds from fees collected in accordance with §61603 of this Article shall be deposited in the Municipal Recycling Proceeds Fund for the respective village and used exclusively for the purposes authorized in §61604 of this Article. The Municipal Planning Council of each municipality shall administer the Municipal Recycling Proceeds Fund for its municipality which shall be subject to audits by the Public Auditor.

SOURCE: Added by P.L. 27-37:2 as section 61602 and renumbered by Compiler to section 51602 to fit within the appropriate chapter and article.

§ 51603. Creation of the Municipal Recycling Program.

There is hereby created a Municipal Recycling Program within the Recycling Office of the Department of Public Works to promote recycling on the municipal level in partnership with the village mayors. The program shall incorporate the following components:

(1) Recycling Drop-Off Bins. DPW shall solicit drop-off bins from recycling companies that would be made available to each mayor participating in the Municipal Recycling Program. The recycling drop-off bins shall be rust-proof, and located at a suitable site within the respective villages so that the residents will have a repository to which they can bring recyclable materials in accordance with guidelines established by DPW.

The mayors of each village participating in the program will be responsible for the security and cleaning of the bins and the supervision of their use for recycling purposes.

(2) Village Education Program. In coordination with the village mayors, DPW and GEPA shall create educational programs to promote recycling and the use of the recycling drop-off bins within each village.

(3) Sale of Recyclable Materials. In partnership with the village mayors, DPW shall arrange for the sale of recyclable materials, collected at the Recycling Drop-off Bins in each village, to recycling companies. The proceeds from the sale of recyclable materials shall be deposited into the respective Municipal Recycling Proceeds Fund of the village from which the recyclable materials were collected.

(4) The Program shall first begin with pilot programs at three (3) villages; one (1) each from northern, central, and southern Guam. The selection of the three (3) villages shall be made by DPW in concert with the village mayors.

SOURCE: Added by P.L. 27-37:2 as section 61603 and renumbered by Compiler to section 51603 to fit within the appropriate chapter and article.

§ 51604. Authorization for Municipal Planning Councils to Use the Proceeds from the Sale of Recyclable Materials for Village Needs.

The proceeds from the sale of recyclable materials from a village site shall be retained for use by the municipal government of that village in its Municipal Recycling Proceeds Fund. Expenditures from a village's Municipal Recycling Proceeds Fund shall be exclusively for the needs of that village as determined by the respective Municipal Planning Council through adoption of a resolution.

SOURCE: Added by P.L. 27-37:2 as section 61604 and renumbered by Compiler to section 51604 to fit within the appropriate chapter and article.

ARTICLE 7
RECYCLING ENTERPRISE ZONE

SOURCE: Added by P.L. 28-92 (Dec. 12, 2005), An Act to Create a Recycling Enterprise Zone at the Jose D. Leon Guerrero Commercial Port," as an uncodified permanent law. Codified here as Article 7 of this Chapter by the Compiler of Laws.

§ 51701. Definitions.

§ 51701. Definitions.

For purposes of this Act, and except as otherwise provided, the following words and phrases, together with all of the common derivatives thereof, shall have the meaning ascribed to them as follows:

(a) 'JLGCP' shall mean the Jose D. Leon Guerrero Commercial Port.

(b) 'Recycle' or 'Recycling' means the method by which recovered resources are converted for use as raw material or feedstock to make new products, as defined in §51102 (35) of Chapter 51, Title 10 of the Guam Code Annotated.

(c) 'Recycling company' means any business licensed by the Department of Revenue and Taxation, and has been issued a permit as required in §51104 of Chapter 51, Title 10 of the Guam Code Annotated by the Guam Environmental Protection Agency ('GEPA') to conduct business on Guam and that specifically commits eighty percent (80%) of its operations to recycling.

(d) 'Transshipment' shall mean to transfer for further transportation from one (1) ship or conveyance to another.

(e) 'Recyclable materials' means materials that still have useful physical or chemical properties after serving a specific purpose for the same or other purpose. Recyclable materials are as follows:

(1) batteries (i.e., lead-acid, portable computer batteries, nickel-cadmium, sealed types for power backup);

(2) automobiles, buses, and trucks or any form of motorized vehicle;

(3) tires (passenger/commercial);

(4) enameled white goods;

(5) home appliances (other small appliances that are not considered enameled white goods);

(6) glass and plastic bottles;

(7) foam padding;

(8) lead;

(9) metals (ferrous/non-ferrous);

(10) organic material (i.e., tree trimmings, palm fronds, grass, food waste, soiled cardboard);

(11) paper products;

(12) wood pallets and scrap wood;

(13) construction and demolition debris ('C&D');

(14) x-ray film;

(15) automobile oil and fluids;

(16) freon and other refrigerant gases;

(17) electronic waste (i.e., computers, circuit boards, televisions, and portable phones);

(18) heavy equipment; and

(19) other recyclable materials deemed recyclable by GEPA pursuant to the Rules and Regulations.

§ 51702. Establishment of Recycling Enterprise Zone.

There is established a "Recycling Enterprise Zone" at the Jose D. Leon Guerrero Commercial Port for use by recycling companies for the processing of automobiles, trucks, and tires for recycling purposes and the transshipment of recyclable materials. The size of the zone and its site on the JLGCP property shall be designated by the Board of Directors of the Port Authority of Guam and guided by the provisions of Section 7.10.4 of the Integrated Solid Waste Management Plan. Such designation shall be made within sixty (60) days of the enactment hereof and the site shall be made available for lease to recycling companies eligible under Section 4 of this Act. The Board of Directors of the Port Authority of Guam shall determine and charge a reasonable rate for the lease of said property.

§ 51703. Eligibility of Recycling Companies for use of the Recycling Enterprise Zone.

Lease space in the Recycling Enterprise Zone shall only be available to companies that qualify for Qualifying Certificates as recycling companies under guidelines established by the Guam Economic Development and Commerce Authority.

Appendix B.3

10GCA Chapter 73 Fire Prevention

CHAPTER 73
FIRE PREVENTION

§ 73101. Theaters: Prohibition.

No manager or other person shall use, or assist in, or countenance the use of, any theater, hall or other building for theatrical purposes, or for public entertainment of any kind where stage scenery and apparatus are employed, without a certificate in writing by the Fire Chief to the effect that the provisions of all existing regulations for the prevention of fires have been complied with to his satisfaction.

SOURCE: Added by P.L. 17-78.

§ 73102. Same: Fire Equipment.

Every manger or other person using any such building shall keep and maintain in good condition therein such fire fighting equipment as the Fire Chief, by regulation, shall prescribe.

SOURCE: Added by P.L. 17-78.

§ 73103. Same: Freedom from Obstruction.

Every manager or other person using any such building shall, at all times during performances, or when such building is open to the public, keep every aisle, passageway, exit, entrance, and stairway open and clear of temporary seats or other obstructions and all doors and gates in or of every such aisle, passageway, exit, entrance and stairway, unlocked and fastened so that they will open freely, and no person shall stand or remain in any such aisle, passageway, exit, entrance, or stairway during performances, or while such building is open.

SOURCE: Added by P.L. 17-78.

§ 73104. Same: Admission of Fire Department.

Every manager or person using any such building shall at all times freely admit a detail from the Guam Fire Department in every building used as a theater or place of public amusement, whenever the same shall be necessary in the discretion of the Fire Chief for the purposes of assisting in case of fire or in enforcing the provisions of this Chapter.

SOURCE: Added by P.L. 17-78.

§ 73105. Fire Equipment: Woodworking Establishments.

Sawmills, carpenter shops and other places where wood is sawed, planed or worked in such manner as to cause accumulations of sawdust or shavings, shall maintain in good condition therein such fire fighting equipment as the Fire Chief, by regulation, shall prescribe.

SOURCE: Added by P.L. 17-78.

§ 73106. Woodworking Establishments: Fire Prevention.

Before a sawmill or woodworking shop is closed for the day, the floors and machinery of the same shall be swept clean of accumulations of wood, dust and shavings, which shall be placed outside the building in trash cans or in a place approved by the Fire Chief for storage of such materials.

No furnace or anvil shall be used or placed nearer than twenty-five (25) feet from any saw, plane, or woodworking machine.

Lumber shall be stored so as not to constitute a fire hazard.

The Fire Chief or his agents may inspect any sawmill or woodworking shop at any time.

SOURCE: Added by P.L. 17-78.

§ 73107. Fire Equipment: Garages.

Every space maintained as a garage for taxis or for commercial repairing, cleaning, upkeep, or storage of automobiles, trucks or gasoline engines, shall maintain in good condition therein such fire fighting equipment as the Fire Chief, by regulation, shall prescribe.

SOURCE: Added by P.L. 17-78.

§ 73108. Prohibition.

It shall be unlawful for any person to remove the gasoline tank cover of any vehicle in the vicinity of a gasoline pump, while the motor of such vehicle is running.

SOURCE: Added by P.L. 17-78.

§ 73109. Fire Hydrant Inspection.

The Fire Chief shall have all fire hydrants inspected quarterly to see that they are maintained in good working order.

SOURCE: Added by P.L. 17-78.

§ 73110. Penalty.

Violation of any provision of this Chapter is a misdemeanor.

SOURCE: Added by P.L. 17-78.

§ 73111. Uniform Fire Code.

Inspection of premises and areas and relative to the prevention of fires or the spread thereof, shall be in accordance with the Uniform Fire Code issued by the International Conference of Building Officials and the Western Fire Chief's Association. Standards and requirements for fire prevention enforcement as set out in the Uniform Fire Code and its appendices, and in the standards published by the International Conference of Building Officials and by the Western Fire Chiefs' Association shall apply in Guam in the absence of any specific provisions on the subject matter of such standards in this Chapter.

SOURCE: Added by P.L. 17-78; amended by P.L. 20-135:1; further amended by P.L. 22-82:1.

§ 73112. Updating of Uniform Fire Code.

The Uniform Fire Code, along with its appendices, shall automatically be adopted in Guam as such code and its appendices are updated every three (3) years by the International Conference of Building Officials and by the Western Fire Chiefs' Association. The Guam Fire Department (the A**GFD**@) shall transmit copies of such code and its appendices as updated every three (3) years to the Department of Public Works, to the Public Utility Agency of Guam, to the Guam Environmental Protection Agency, to the Guam Contractors Association, and to the Guam Chapter of the American Institute of Architects. The GFD shall develop and promulgate, pursuant to the Administrative Adjudication Law, rules setting forth grace periods within which parties in violation of the Uniform Fire Code may bring their premises up to code. None of the provisions of such code shall be enforced so as to prevent the issuance of building or occupancy permits until such rules have been duly promulgated, and no building built prior to promulgation of such rules which is not in compliance with such code shall be condemned for such violation; provided, however, that as such building is renovated or rebuilt, it shall be brought into compliance with such code. The GFD and the other government agencies together with the associations to which copies of such code are transmitted shall work together on a voluntary basis to plan how construction in Guam can be brought into compliance with such code, which plan shall be incorporated into the rules to be promulgated by the GFD; provided, however, that such plan shall be completed and such rules submitted to the Legislature pursuant to the Administrative Adjudication Law within one (1) year of the enactment of this section.

SOURCE: Added by P.L. 22-82:2.

§ 73113. Municipal Solid Waster Incinerators Prohibited.

Notwithstanding any other provision of law, it shall be unlawful for any person to construct or operate on Guam a municipal solid waste incinerator or waste-to-energy facility, as defined by the rules and regulations of the United States Environmental Protection Agency or laws of the United States of America. Nothing in this section shall be construed as prohibiting the construction or operation of hazardous waste incinerators or biomedical incinerators as defined by the rules and regulations of the U.S. Environmental Protection Agency or the laws of the United States of America.

SOURCE: Added by P.L. 25-175:5.

Appendix C

Selected Guam Public Laws

Public Law 25-175

MINA'BENTE SINGKO NA LIHESLATURAN GUÅHAN
2000 (SECOND) Regular Session

Bill No. 478 (LS)
As substituted by the Committee
on Natural Resources and amended on
the Floor.

Introduced by:

J. M.S. Brown
F. B. Aguon, Jr.
E. C. Bermudes
A. C. Blaz
E. B. Calvo
M. G. Camacho
Mark Forbes
L. F. Kasperbauer
A. C. Lamorena, V
C. A. Leon Guerrero
K. S. Moylan
V. C. Pangelinan
J. C. Salas
S. A. Sanchez, II
A. R. Unpingco

AN ACT TO APPROVE AND AMEND THE INTEGRATED SOLID WASTE MANAGEMENT PLAN.

BE IT ENACTED BY THE PEOPLE OF GUAM:

Section 1. Legislative Findings and Intent. Public Law Number 24-272 required that the Guam Environmental Protection Agency, pursuant to the Administrative Adjudication Law, create a Solid Waste Management Plan for Guam and submit said Plan to *I Liheslaturan Guåhan*. *I Maga'lahen Guåhan* submitted the Integrated Solid Waste Management Plan for the Island of Guam on August 25, 2000. Said Plan consists of three (3) parts, Phase I, Phase II and Part III consisting of Attachments created by the Guam Planning Council which are affixed thereto. *I Mina'Bente Singko Na Liheslaturan Guåhan* wants to approve said Plan with certain deletions. Said Plan recommends the implementation of a purported contract between the government of Guam and Guam Resource Recovery Partners, which *I Liheslaturan Guåhan* has already disapproved of and refused to fund. *I Liheslaturan Guåhan* wants to maintain and continue government of Guam policy against the use of municipal waste incinerators for trash disposal.

The Plan calls for the creation of a separate government agency to deal with waste management, a function which is adequately performed by the Department of Public Works, and *I Liheslaturan Guåhan* believes the creation of such an agency would result in unnecessary expense and duplication of effort with in the Executive Branch of government. The Committee on Natural Resources of this *Liheslatura* conducted a public hearing on this Plan on September 19, 2000 and October 12, 2000 at which public co mments were received, much of it unfavorable to the concept of an incinerator and the aforem entioned contract with Guam Resource Re covery Partners. A copy of said Plan is attached hereto. Phase I, Phase II, and the Attachments are denominated Exhibits A, and B, respectively.

Section 2. *Except* as provided herein, the Integrated Solid Waste Management Plan for the Island of Guam is hereby adopted, recognized and established as the sole governing Plan on the subj ect, and shall supercede any Integrated Solid Waste Management Plan whic h the Executive Branch may, or may not, legally have in place. Said Plan may be modified by the Guam Environmental Protection Agency in accordance with the prov isions of the Administrative Adjudication Law and Public Law Number 24-272, but *only* in a manner consistent with this Act. No officer or agency of the government of Guam shall implement or expend funds , or commit resources to implement any portion of the Integrated Solid Waste Management Plan for the Island of G uam which is disapproved or deleted by this Act or any waste-to-energy facility, or any incineration project aim ed at reduction of municipal solid waste. It is against government of Guam policy to create an incinerator fo r the disposal of municipal solid waste or the disposal of any waste other than biologically hazardous waste.

Section 3. Any tables, photographs, graphs, statistics or the like, in the Plan, which are inconsistent with the language herein or t he attachments, or wh ich support the cr eation of an incinera tor or waste-to-energy facility are deemed deleted.

Section 4. This Act shall take effect immediately.

Section 5. Section 73113 is hereby *added* to Chapter 73, Division 3 of Ti tle 10 of the Guam Code Annotated to read as follows:

"Section 73113. Munici pal Solid Waste Incinerators Prohibited.

Notwithstanding any other provision of la w, it shall be unlawful for any pers on to construct or operate on Guam a municipal solid waste in cinerator or a waste-to -energy facility, as defined by the rules an d regulations of the United States Environmental Protection Agency or the laws of the United States of Am erica. Nothing in this Section shall be construed as prohibi ting the construction or operation of hazardous waste incinerators o r biomedical incinerators, as defined by the rules and r egulations of the United Stat es Environmental Protection Agency or the laws of the United States of America. "

Section 6. Section 51110(a)(8) of Article 1, Chapter 51, Part 2 of Title 10 of the Guam Code Annotated is hereby *repealed and reenacted* to read as follows:

"(8) No person shall destroy or attempt to destroy by burning, *except* as authorized by §73113 of Chapter 73, Division 3 of Title 10 of the Guam Code Anno tated, any garbage, dead animals or other offensive substances, the buming of which may give off foul and noisome odor. Nothing in this Section shall preclude the burning of trees, brush, grass and other vegeta ble matter authorized by the Administrator."

Section 7. Severabilit y. *If* any provision of this Section or its application to any pers on or circumstance is found to be invalid or contrary to law, such invalidity shall *not* affect other provisions or applic ations of this Section which can be given effect without the invalid provisions or applicat ions, and to this end the provisions of this Section are severable.

Appendix D

Cost Data

Appendix D.1

Cost Data – Military Construction Funding

Appendix D.1

Cost Data – Military Construction Funding

PV Analysis	Alternative 1-1[b] Apra Harbor LF (54MSL)	Alternative 1-2[c] Apra Harbor LF (100MSL)	Alternative 2[d,e] GovGuam Landfill	Alternative 3[f] New Navy Landfill	Alternative 4a[g] Modular WTE Facility	Alternative 4b[g] Erected WTE Facility
25 -Year	Inadequate Service Life	56,000,000	123,000,000	149,000,000	179,000,000	210,000,000
		38%	83%	100%	120%	141%
50 - Year	Inadequate Service Life	Inadequate Service Life	189,000,000	174,000,000	270,000,000	277,000,000
			109%	100%	155%	159%

Notes

a Present Value Analysis uses a real discount rate of 2.8 percent, with inflation premium removed per OMB Circular No. A-94; Appendix C, rev January 2008

b Estimated service life is limited to the year 2023 and would be exhausted prior to 25 and 50 year analysis periods.

c Estimated service life is limited to the year 2036 and would be exhausted prior to 50 year analysis periods.

d Assumed a tip fee at the Gov Guam landfill of $95/ton over the analysis period, which is discounted over the analysis period.

e Includes estimated 40% increase in collection driver/truck costs to use GovGuam LF vs current system (80 % waste from northern Guam after troop relocation).

f Includes estimated 15% increase in collection driver/truck costs to use Central Guam LF vs current system (80 % waste from northern Guam after troop relocation).

g Assumes WTE would extend Apra Harbor Landfill site life to 65 years for landfilling of unburnable waste and residual ash.

CURRENT DOLLARS ANALYSIS

	Alternative 1-1 (54 MSL)		Alternative 1-2 (100 MSL)		Alternative 2		Alternative 3		Alternative 4a			Alternative 4b		
	Apra Harbor Landfill		Apra Harbor Landfill		Gov Guam Landfill		New Navy Landfill		Modular Waste-to-Energy Facility			Erected Waste-to-Energy Facility		
Year	Capital	Operating	Capital	Operating	Capital	Operating	Capital	Operating	Capital	Operating	Revenue	Capital	Operating	Revenue
2008														
2009	$ 11,133,317	$ 873,908	$ 22,825,361	$ 873,908		$ 1,228,470	$ 11,133,317	$ 873,908	$ 22,825,361	$ 873,908		$ 22,825,361	$ 873,908	
2010		$ 994,824		$ 994,824	$ 7,198,973	$ 3,159,235		$ 994,824		$ 994,824			$ 994,824	
2011		$ 1,003,782		$ 1,003,782		$ 3,771,600		$ 1,003,782	$ 2,629,000	$ 1,003,782		$ 5,047,000	$ 1,003,782	
2012		$ 1,066,791		$ 1,066,791		$ 4,009,271	$ 95,927,520	$ 1,066,791	$ 17,284,000	$ 1,066,791		$ 37,142,000	$ 1,066,791	
2013	$ 1,790,609	$ 1,331,541	$ 1,790,609	$ 1,331,541		$ 4,951,764	$ 9,389,965	$ 2,245,264	$ 27,866,609	$ 1,331,541		$ 57,825,609	$ 1,371,541	
2014		$ 1,557,676		$ 1,557,676		$ 5,900,808		$ 2,475,092		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2015		$ 1,900,734		$ 1,900,734		$ 7,403,083		$ 2,838,896		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2016		$ 2,090,584		$ 2,090,584		$ 7,706,450		$ 2,912,362		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2017		$ 2,090,584		$ 2,090,584		$ 7,706,450		$ 2,912,362		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2018		$ 2,090,584		$ 2,090,584		$ 7,706,450		$ 2,912,362		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2019		$ 2,090,584		$ 2,090,584		$ 7,779,243		$ 2,929,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2020		$ 2,090,584		$ 2,090,584		$ 7,779,243		$ 2,929,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2021		$ 2,090,584		$ 2,090,584		$ 7,779,243		$ 2,929,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2022		$ 2,090,584		$ 2,090,584		$ 7,779,243		$ 2,929,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2023	$ 7,599,356	$ 2,090,584		$ 2,090,584		$ 7,779,243		$ 2,929,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2024				$ 2,090,584		$ 7,779,243		$ 2,929,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2025				$ 2,090,584		$ 7,779,243		$ 2,929,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2026				$ 2,090,584		$ 7,779,243		$ 2,929,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2027				$ 2,090,584		$ 7,779,243		$ 2,929,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2028				$ 2,090,584		$ 7,779,243		$ 2,929,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2029				$ 2,090,584		$ 7,779,243		$ 2,929,990	$ 8,079,000	$ 8,460,586	$ (489,000)	$ 1,312,500	$ 8,810,586	$ (1,733,000)
2030				$ 2,090,584		$ 7,779,243		$ 2,929,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2031				$ 2,090,584		$ 7,779,243		$ 2,929,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2032				$ 2,090,584		$ 7,779,243	$ 596,870	$ 2,929,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2033				$ 2,090,584		$ 7,779,243		$ 2,929,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2034				$ 2,090,584		$ 7,779,243		$ 2,929,990	$ 16,158,000	$ 8,460,586	$ (489,000)	$ 2,625,000	$ 8,810,586	$ (1,733,000)
2035				$ 2,090,584		$ 7,779,243		$ 2,929,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2036			$ 7,599,356	$ 2,090,584		$ 7,779,243		$ 2,929,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2037						$ 7,779,243		$ 2,929,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2038						$ 7,779,243	$ 3,799,678	$ 2,929,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2039						$ 7,779,243		$ 2,929,990	$ 8,079,000	$ 8,460,586	$ (489,000)	$ 1,312,500	$ 8,810,586	$ (1,733,000)
2040						$ 7,779,243	$ -	$ 2,929,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2041						$ 7,779,243		$ 2,929,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2042						$ 7,185,076		$ 2,929,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2043						$ 7,185,076		$ 2,929,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2044						$ 7,185,076		$ 2,114,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2045						$ 7,185,076	$ 447,652	$ 2,114,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2046						$ 7,185,076		$ 2,114,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2047						$ 7,185,076		$ 2,114,990	$ 8,079,000	$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2048						$ 7,185,076		$ 2,114,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2049						$ 7,185,076		$ 2,114,990		$ 8,460,586	$ (489,000)	$ 1,312,500	$ 8,810,586	$ (1,733,000)
2050						$ 7,185,076		$ 2,114,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2051						$ 7,185,076		$ 2,114,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2052						$ 7,185,076	$ -	$ 2,114,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2053						$ 7,185,076		$ 2,114,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2054						$ 7,185,076		$ 2,114,990	$ 16,158,000	$ 8,460,586	$ (489,000)	$ 2,625,000	$ 8,810,586	$ (1,733,000)
2055						$ 7,185,076		$ 2,114,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2056						$ 7,185,076		$ 2,114,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2057						$ 7,185,076		$ 2,114,990		$ 8,460,586	$ (489,000)		$ 8,810,586	$ (1,733,000)
2058						$ 7,185,076	$ 3,338,177	$ 2,114,990	$ 5,845,658	$ 8,460,586	$ (489,000)	$ 5,845,658	$ 8,810,586	$ (1,733,000)
	$ 20,523,281		$ 32,215,325		$ 7,198,973		$ 124,633,178		$ 133,003,628			$ 137,873,128		

PRESENT VALUE ANALYSIS

	Alternative 1-1 (54 MSL) Apra Harbor Landfill		Alternative 1-2 (100 MSL) Apra Harbor Landfill		Alternative 2 Gov Guam Landfill		Alternative 3 New Navy Landfill		Alternative 4a Modular Waste-to-Energy Facility			Alternative 4b Erected Waste-to-Energy Facility		
Year	Capital	Operating	Capital	Operating	Capital	Operating	Capital	Operating	Capital	Operating	Revenue	Capital	Operating	Revenue
2009	$ 10,830,075	$ 850,105	$ 22,203,658	$ 850,105	$ -	$ 1,195,009	$ 10,830,075	$ 850,105	$ 22,203,658	$ 850,105	$ -	$ 22,203,658	$ 850,105	$ -
2010	$ -	$ 941,370	$ -	$ 941,370	$ 6,812,152	$ 2,989,481	$ -	$ 941,370	$ -	$ 941,370	$ -	$ -	$ 941,370	$ -
2011	$ -	$ 923,975	$ -	$ 923,975	$ -	$ 3,471,733	$ -	$ 923,975	$ 2,419,977	$ 923,975	$ -	$ 4,645,730	$ 923,975	$ -
2012	$ -	$ 955,228	$ -	$ 955,228	$ -	$ 3,589,988	$ 85,895,568	$ 955,228	$ 15,476,466	$ 955,228	$ -	$ 33,257,747	$ 955,228	$ -
2013	$ 1,559,679	$ 1,159,816	$ 1,559,679	$ 1,159,816	$ -	$ 4,313,148	$ 8,178,966	$ 1,955,698	$ 24,272,726	$ 1,159,816	$ -	$ 50,367,992	$ 1,194,657	$ -
2014	$ -	$ 1,319,831	$ -	$ 1,319,831	$ -	$ 4,999,802	$ -	$ 2,097,166	$ -	$ 7,168,722	$ (414,334)	$ -	$ 7,465,280	$ (1,468,385)
2015	$ -	$ 1,566,641	$ -	$ 1,566,641	$ -	$ 6,101,840	$ -	$ 2,339,902	$ -	$ 6,973,465	$ (403,048)	$ -	$ 7,261,946	$ (1,428,390)
2016	$ -	$ 1,676,188	$ -	$ 1,676,188	$ -	$ 6,178,875	$ -	$ 2,335,073	$ -	$ 6,783,527	$ (392,070)	$ -	$ 7,064,149	$ (1,389,484)
2017	$ -	$ 1,630,533	$ -	$ 1,630,533	$ -	$ 6,010,579	$ -	$ 2,271,471	$ -	$ 6,598,761	$ (381,391)	$ -	$ 6,871,741	$ (1,351,638)
2018	$ -	$ 1,586,122	$ -	$ 1,586,122	$ -	$ 5,846,867	$ -	$ 2,209,603	$ -	$ 6,419,028	$ (371,003)	$ -	$ 6,684,573	$ (1,314,823)
2019	$ -	$ 1,542,920	$ -	$ 1,542,920	$ -	$ 5,741,338	$ -	$ 2,162,429	$ -	$ 6,244,191	$ (360,898)	$ -	$ 6,502,503	$ (1,279,011)
2020	$ -	$ 1,500,895	$ -	$ 1,500,895	$ -	$ 5,584,959	$ -	$ 2,103,530	$ -	$ 6,074,116	$ (351,068)	$ -	$ 6,325,392	$ (1,244,174)
2021	$ -	$ 1,460,015	$ -	$ 1,460,015	$ -	$ 5,432,839	$ -	$ 2,046,236	$ -	$ 5,908,673	$ (341,506)	$ -	$ 6,153,105	$ (1,210,286)
2022	$ -	$ 1,420,248	$ -	$ 1,420,248	$ -	$ 5,284,863	$ -	$ 1,990,502	$ -	$ 5,747,736	$ (332,204)	$ -	$ 5,985,510	$ (1,177,321)
2023	$ 5,022,039	$ 1,381,564	$ -	$ 1,381,564	$ -	$ 5,140,917	$ -	$ 1,936,286	$ -	$ 5,591,183	$ (323,156)	$ -	$ 5,822,481	$ (1,145,254)
2024	$ -	#VALUE!	$ -	$ 1,343,934	$ -	$ 5,000,892	$ -	$ 1,883,546	$ -	$ 5,438,894	$ (314,354)	$ -	$ 5,663,892	$ (1,114,060)
2025	$ -	#VALUE!	$ -	$ 1,307,329	$ -	$ 4,864,681	$ -	$ 1,832,243	$ -	$ 5,290,753	$ (305,792)	$ -	$ 5,509,623	$ (1,083,716)
2026	$ -	#VALUE!	$ -	$ 1,271,720	$ -	$ 4,732,180	$ -	$ 1,782,338	$ -	$ 5,146,647	$ (297,463)	$ -	$ 5,359,555	$ (1,054,199)
2027	$ -	#VALUE!	$ -	$ 1,237,082	$ -	$ 4,603,288	$ -	$ 1,733,792	$ -	$ 5,006,466	$ (289,361)	$ -	$ 5,213,575	$ (1,025,485)
2028	$ -	#VALUE!	$ -	$ 1,203,387	$ -	$ 4,477,907	$ -	$ 1,686,568	$ -	$ 4,870,103	$ (281,479)	$ -	$ 5,071,571	$ (997,554)
2029	$ -	#VALUE!	$ -	$ 1,170,610	$ -	$ 4,355,940	$ -	$ 1,640,630	$ 4,523,788	$ 4,737,454	$ (273,813)	$ 734,926	$ 4,933,435	$ (970,383)
2030	$ -	#VALUE!	$ -	$ 1,138,726	$ -	$ 4,237,296	$ -	$ 1,595,944	$ -	$ 4,608,419	$ (266,355)	$ -	$ 4,799,061	$ (943,952)
2031	$ -	#VALUE!	$ -	$ 1,107,710	$ -	$ 4,121,883	$ -	$ 1,552,475	$ -	$ 4,482,897	$ (259,100)	$ -	$ 4,668,347	$ (918,242)
2032	$ -	#VALUE!	$ -	$ 1,077,539	$ -	$ 4,009,614	$ 307,641	$ 1,510,189	$ -	$ 4,360,795	$ (252,043)	$ -	$ 4,541,194	$ (893,231)
2033	$ -	#VALUE!	$ -	$ 1,048,190	$ -	$ 3,900,403	$ -	$ 1,469,056	$ -	$ 4,242,019	$ (245,178)	$ -	$ 4,417,504	$ (868,902)
2034	$ -	#VALUE!	$ -	$ 1,019,640	$ -	$ 3,794,166	$ -	$ 1,429,043	$ 7,880,733	$ 4,126,477	$ (238,500)	$ 1,280,290	$ 4,297,183	$ (845,235)
2035	$ -	#VALUE!	$ -	$ 991,867	$ -	$ 3,690,823	$ -	$ 1,390,119	$ -	$ 4,014,083	$ (232,004)	$ -	$ 4,180,139	$ (822,213)
2036	$ -	#VALUE!	$ 3,507,273	$ 964,851	$ -	$ 3,590,295	$ -	$ 1,352,256	$ -	$ 3,904,750	$ (225,684)	$ -	$ 4,066,283	$ (799,818)
2037	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 3,492,505	$ -	$ 1,315,424	$ -	$ 3,798,395	$ (219,537)	$ -	$ 3,955,528	$ (778,033)
2038	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 3,397,378	$ 1,659,409	$ 1,279,595	$ -	$ 3,694,937	$ (213,558)	$ -	$ 3,847,790	$ (756,842)
2039	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 3,304,843	$ -	$ 1,244,743	$ 3,432,188	$ 3,594,296	$ (207,741)	$ 557,587	$ 3,742,986	$ (736,227)
2040	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 3,214,828	$ -	$ 1,210,839	$ -	$ 3,496,397	$ (202,083)	$ -	$ 3,641,037	$ (716,175)
2041	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 3,127,264	$ -	$ 1,177,859	$ -	$ 3,401,165	$ (196,579)	$ -	$ 3,541,865	$ (696,668)
2042	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,809,736	$ -	$ 1,145,777	$ -	$ 3,308,526	$ (191,224)	$ -	$ 3,445,394	$ (677,692)
2043	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,733,206	$ -	$ 1,114,569	$ -	$ 3,218,410	$ (186,016)	$ -	$ 3,351,551	$ (659,234)
2044	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,658,761	$ -	$ 782,629	$ -	$ 3,130,749	$ (180,949)	$ -	$ 3,260,263	$ (641,278)
2045	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,586,343	$ 161,137	$ 761,313	$ -	$ 3,045,476	$ (176,021)	$ -	$ 3,171,462	$ (623,811)
2046	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,515,898	$ -	$ 740,577	$ -	$ 2,962,525	$ (171,226)	$ -	$ 3,085,080	$ (606,820)
2047	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,447,372	$ -	$ 720,405	$ 2,751,859	$ 2,881,834	$ (166,563)	$ -	$ 3,001,051	$ (590,292)
2048	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,380,712	$ -	$ 700,783	$ -	$ 2,803,341	$ (162,026)	$ -	$ 2,919,310	$ (574,214)
2049	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,315,867	$ -	$ 681,696	$ -	$ 2,726,985	$ (157,613)	$ 423,040	$ 2,839,796	$ (558,574)
2050	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,252,789	$ -	$ 663,128	$ -	$ 2,652,709	$ (153,320)	$ -	$ 2,762,447	$ (543,360)
2051	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,191,429	$ -	$ 645,066	$ -	$ 2,580,456	$ (149,144)	$ -	$ 2,687,205	$ (528,560)
2052	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,131,741	$ -	$ 627,496	$ -	$ 2,510,172	$ (145,081)	$ -	$ 2,614,013	$ (514,164)
2053	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,073,678	$ -	$ 610,405	$ -	$ 2,441,801	$ (141,130)	$ -	$ 2,542,814	$ (500,159)
2054	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,017,196	$ -	$ 593,779	$ 4,536,327	$ 2,375,293	$ (137,286)	$ 736,964	$ 2,473,555	$ (486,536)
2055	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 1,962,253	$ -	$ 577,606	$ -	$ 2,310,596	$ (133,546)	$ -	$ 2,406,182	$ (473,284)
2056	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 1,908,806	$ -	$ 561,874	$ -	$ 2,247,662	$ (129,909)	$ -	$ 2,340,644	$ (460,393)
2057	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 1,856,816	$ -	$ 546,570	$ -	$ 2,186,441	$ (126,371)	$ -	$ 2,276,891	$ (447,853)
2058	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 1,806,241	$ 839,177	$ 531,683	$ 1,469,527	$ 2,126,888	$ (122,929)	$ 1,469,527	$ 2,214,874	$ (435,655)
Sum 25 Year	$ 17,411,792	#VALUE!	$ 23,763,337	$ 31,821,676	$ 6,812,152	$ 116,186,325	$ 105,212,250	$ 43,805,353	$ 68,896,614	$ 116,524,344	$ (6,455,616)	$ 111,210,054	$ 121,179,769	$ (22,878,491)
25 Year PV	#VALUE!		55,585,013		122,998,477		149,017,603		178,965,342			209,511,331.54		
Sum 50 Year	$ 17,411,792	#VALUE!	$ 27,270,610	#VALUE!	$ 6,812,152	$ 182,447,271	$ 107,871,973	$ 66,210,589	$ 88,967,248	$ 192,064,710	$ (10,821,654)	$ 115,677,462	$ 199,845,111	$ (38,351,587)
50 Year PV	#VALUE!		#VALUE!		189,259,422		174,082,562		270,210,304			277,170,986		

COST ESTIMATING AND ECONOMIC ASSUMPTIONS

General Cost factors

Costs shown below have been adjusted for Guam in detail sheets or use the following factors, applied as noted in line item description.

For Construction projects - PAX Newsletter No 3.2.1, 30 April 2007 - Area Cost Factors (ACF) - (See example factors used)

1.15	California
2.64	Guam
2.296	Use Factor

For Primarily Labor or O&M Projects

May 2006 State Occupational Employment and Wage Estimates

Installation, Maintenance and Repair Occupations - 49-0000

Guam	49-0000	$	27,970	
California	49-0000	$	42,760	
Labor	Conversion		0.65	Guam/CA

Given that material factor in Means is 1.4 use below:

0.8 Use Factor

ALTERNATIVE 1-1: Landfill Improvements and Liner "Untouched Area" in 2009; LFG Control in 2013; Closure in 2024

Capital Costs			
2009	$	11,133,317	Scale, Control Building, Line Untouched, LCRS, Site Work
2013	$	1,790,609	LFG Control System and Flare for 60 Acres @$10k/acre & $150,000 Flare + tax- (x Guam/CA ACF)
2023	$	7,599,356	Closure Cap (assumes 7.4ppd and revised filling practices yielding 14 years site life)
Oper Costs			
Reference	$	717,802	Annual Landfill Operating and Collection Cost 2007 (Includes Refuse Trucks and Drivers - tonnage prorated to 2012)
	$	2,050,584	Annual Landfill Operating Cost 2016 - future tonnage (Includes Refuse Trucks and Drivers)
2013	$	40,000	Additional Annual LFG Control Operating Cost - $50,000 (Guam/CA O&M Factor, above)
	$	775,000	Annual PC Care w/o LFG/GW items
	$	*40,000*	*Additional O&M for LFG in PCM period - $50,000 X O&M Guam factor*
2024 to 2054	*$*	*815,000*	*Total Annual PCM Costs; 30 years (does not in include GW monitoring Assumed needed under All).*

ALTERNATIVE 1-2: Landfill Improvements and Liner in 2009; LFG Control in 2013; Closure in 2036

Capital Costs			
2009	$	22,825,361	Scale, Control Building, Line entire acreage, LCRS, Site Work
2013	$	1,790,609	LFG Control System and Flare for 60 Acres @$10k/acre & $150,000 Flare- (x Guam/CA ACF)
2036	$	7,599,356	Closure Cap (assumes 7.4ppd and revised filling practices yielding 27 years site life)
Oper Costs			
Reference	$	717,802	Reference Annual Landfill Operating & Collection Cost 2007 (Includes Refuse Trucks and Drivers - prorated to 2016)
2016 to future	$	2,050,584	Annual Landfill Operating Cost 2016 - future tonnage (Includes Refuse Trucks and Drivers)
2013 to future	$	40,000	Additional Annual LFG Control Operating Cost - $50,000 (Guam/CA O&M Factor, above)
2036	$	775,000	Annual PC Care w/o LFG/GW items (grass cutting high?)
	$	*40,000*	*Additional O&M for LFG in PCM period - $50,000 X O&M Guam factor*
2036 to 2066	*$*	*815,000*	*Total Annual PCM Costs; 30 years (does not in include GW monitoring Assumed needed under All).*

ALTERNATIVE 2: GovGuam Landfill Operational in 2010; tip fee (shown as annual "operating" cost) as shown.

2010 to future	$	95.00	Assumed Tip Fee for use of GovGuam Landfill
2010 to future		140%	Comparative Collection Cost over Alternative 1 due to greater off-route collection costs
			Includes Closure costs for 46 acres (assumed untouched area not included) below:
2010	$	7,198,973	Closure (Cap and LFG venting) of 46 acres (prorated from 60 acres); NO LINER
2011 to 2041	$	594,167	Total Annual PCM Costs (46 acres); 30 years; LFG venting, no LFG control system (not including GW monitoring).

ALTERNATIVE 3: AHLF (line untouched only) to 2013; Close AHLF in 2013; Construct new LF 2012; Operations 2013.

<u>Apra Harbor Landfill in interim</u>

Capital Costs (Apra Harbor interim)			
2009	$	11,133,317	Scale, Control Building, Site Work (Liner for untouched area only - 14 acres)
2013	$	1,790,609	LFG Control System and Flare for 60 Acres @$10k/acre & $150,000 Flare- (x Guam/CA ACF)
2013	$	7,599,356	Closure Cap for 60 acres
Oper Costs			
to 2016	$	717,802	Reference Annual Landfill Operating & Collection Cost 2007 (Includes Refuse Trucks and Drivers - prorated to 2016)
	$	775,000	Annual PC Care w/o LFG/GW items
	$	40,000	Additional O&M for LFG in PCM period - $50,000 X O&M Guam factor
2013 to 2043	*$*	*815,000*	*Total Annual PCM Costs; 30 years (does not in include GW monitoring Assumed needed under All).*

New Navy Landfill In Central Guam			
2012		95,927,520	Scale, Control Building, Liner, LCRS, Site Work (Includes all of earthwork per MCON Accounting Funding)
2032	$	596,870	Initial Portion [20 year] of LFG Control and Flare for 20 Acres @$10k/acre & $150,000 Flare- (x Guam/CA ACF)
2045	$	447,652	Add to LFG Control System 15 Acres ($10k/acre CA x factor adjust to Guam)
2058	$	298,435	Add to LFG Control System 10 Acres (15 acres to be completed at closure beyond 2058)
Reference	$	7,599,356	Closure Cap -60 acres (Apply in 2038 [25 year of life] and prorated in 2058 for 20/25 years of remaining life)
2038	$	3,799,678	1/2 of closure cap cost prorated for first 25 years of site life
2058	$	3,039,742	remainder of closure cap cost prorated for year-26 to year 2058; or 20 years out of remaining site life
2013	$	374,991	New Landfill Operating Cost - Minus Collection Costs
Oper Costs			
2013 to 2063		115%	Apply Comparative Collection Cost over Alternative 1 due to greater off-route collection costs

ALTERNATIVE 4a: Modular WTE Facility

2011	$	2,629,000	Permitting, survey, and 70% engineering work
2012	$	17,284,000	40% of Total Construction Cost less Start up, permitting, survey, 70% of engineering costs
2013	$	26,076,000	60% of Total Construction Cost plus Startup; less permitting, survey and engineering
2014 to Future	$	6,445,000	Annual Operating Cost
2014 to Future	$	489,000	Annual Electrical Sales Revenue
2029	$	8,079,000	Minor Life Extension Measures (replacement of system components)
2034	$	16,158,000	Major Life Extension Measures (replacement of combustion units and major boiler components)
2039	$	8,079,000	Minor Life Extension Measures (replacement of system components)
2049	$	8,079,000	Minor Life Extension Measures (replacement of system components)
2054	$	16,158,000	Major Life Extension Measures (replacement of combustion units and major boiler components)
Residual Waste and Ash Landfill Costs (46% of waste stream - Based on adjustments of Alt 1-2 landfill costs)			
2009	$	22,825,361	Scale, Control Building, Line entire acreage, LCRS, Site Work
2013	$	1,790,609	LFG Control System and Flare for 60 Acres @$10k/acre & $150,000 Flare- (x Guam/CA ACF)
2058	$	5,845,658	Prorate closure cap to end of 50 year period (50 of 65 year site life [See Table 4-1])
Oper Costs			
Ref to 2014	$	717,802	Reference Annual Landfill Operating & Collection Cost 2007 (Includes Refuse Trucks and Drivers - prorated to 2016)
2014 to future	$	299,993	Annual Landfill Operating Cost 2014 - 80% of landfill only cost for **Alt 1-2**)
2014 to future	$	1,675,593	Collection Cost for Refuse trucks and Drivers
2013 to future	$	40,000	Additional Annual LFG Control Operating Cost - $50,000 (Guam/CA O&M Factor, above)

ALTERNATIVE 4b - Field Erected WTE

2011	$	5,047,000	Permitting, survey, and 70% engineering work
2012	$	37,142,000	40% of Total Construction Cost less Start up, permitting, survey, 70% of engineering costs
2013	$	56,035,000	60% of Total Construction Cost plus Startup; less permitting, survey and engineering
2014 to future	$	6,795,000	Annual Operating Cost
2014 to future	$	1,733,000	Annual Electrical Sales Revenue
2029	$	1,312,500	Minor Life Extension Measures (replacement of system components)
2034	$	2,625,000	Major Life Extension Measures (replacement of combustion units and major boiler components)
2039	$	1,312,500	Minor Life Extension Measures (replacement of system components)
2049	$	1,312,500	Minor Life Extension Measures (replacement of system components)
2054	$	2,625,000	Major Life Extension Measures (replacement of combustion units and major boiler components)
Residual Waste and Ash Landfill Costs (46% of waste stream - Based on adjustments of Alt 1-2 landfill costs)			
2009	$	22,825,361	Scale, Control Building, Line entire acreage, LCRS, Site Work
2013	$	1,790,609	LFG Control System and Flare for 60 Acres @$10k/acre & $150,000 Flare- (x Guam/CA ACF)
2058	$	5,845,658	Prorate closure cap to end of 50 year period (50 of 65 year site life [See Table 4-1])
Oper Costs			
Ref to 2014	$	717,802	Reference Annual Landfill Operating & Collection Cost 2007 (Includes Refuse Trucks and Drivers - prorated to 2016)
2014 to future	$	299,993	Annual Landfill Operating Cost 2014 - 80% of landfill only cost for Alt 1-2)
2014 to future	$	1,675,593	Collection Cost for Refuse trucks and Drivers
2013 to future	$	40,000	Additional Annual LFG Control Operating Cost - $50,000 (Guam/CA O&M Factor, above)

COMPARISON OF COLLECTION COST INCREASE USING VARIOUS ALTERNATIVE LANDFILLS
(ASSUMED AFTER FULL TROOP RELOCATION - 80% GENERATED IN NORTHERN GUAM)
Cost factor of 100% set for Apra harbor landfill based on 2 full load basis, below - variables in bold

ALT 1,4,6 **ASSUMED EXISTING CASE USING APRA HARBOR LANDFILL**

	Route time assumptions		Collection cycle		Cumul min	Cum hrs.
	15	yard to route	15	yard to route	15	0.25
	120	Assumed on-route	120	On route first load	135	2.25
Note 1	**40**	Route to LF or back	40	Route to LF	175	2.92
	15	Unload at LF	15	Unload at LF	190	3.17
	40	Break time/day	40	LF to Route	230	3.83
	40	LF to yard	120	On-route second	350	5.83
			15	Route to LF	365	6.08
			15	Unload at LF	380	6.33
			40	LF to yard	420	7.00
			40	Breaks	460	*7.67*

Notes:

1	Assumes 80 percent of waste from AF and Marines located in north - 20 miles one way
100%	% full last load using minutes deduction to get 8 hours total
100%	Total Daily Efficiency prorated over 2 loads
100%	Cost Factor

ALT 2 **ASSUMED USING NEW GOV GUAM LANDFILL**

	Route time assumptions		Collection cycle		Cumul min	Cum hrs.
	15	yard to route	15	yard to route	15	0.25
	120	Assumed on-route	120	On route first load	135	2.25
Note 2	**70**	Route to LF or back	70	Route to LF	205	3.42
	15	Unload at LF	15	Unload at LF	220	3.67
	40	Break time/day	70	LF to Route	290	4.83
	40	LF to yard	**25**	On-route second	315	5.25
			70	Route to LF	385	6.42
			15	Unload at LF	400	6.67
			40	LF to yard	440	7.33
			40	Breaks	480	*8.00*

Notes:

2	Assumes 80 percent of waste from AF and Marines located in north - 35 miles one way
21%	% full last load using minutes deduction to get 8 hours total
60%	Total Daily Efficiency prorated over 2 loads
140%	Increase Cost Factor

ALT 3 **ASSUMED USING NEW NAVY CENTRAL GUAM LANDFILL**

	Route time assumptions		Collection cycle		Cumul min	Cum hrs.
	15	yard to route	15	yard to route	15	0.25
	120	Assumed on-route	120	On route first load	135	2.25
Note 3	**50**	Route to LF or back	50	Route to LF	185	3.08
	15	Unload at LF	15	Unload at LF	200	3.33
	40	Break time/day	50	LF to Route	250	4.17
	40	LF to yard	**85**	On-route second	335	5.58
			50	Route to LF	385	6.42
			15	Unload at LF	400	6.67
			40	LF to yard	440	7.33
			40	Breaks	480	*8.00*

Notes:

3	Assumes 80 percent of waste from AF and Marines located in north - 25 miles one way
71%	% full last load using minutes deduction to get 8 hours total
85%	Total Daily Efficiency prorated over 2 loads
115%	Increase Cost Factor

LANDFILL OPERATION COST (current) - Refuse Trucks for Apra Harbor Landfill Location

Description	Quantity	Hours/Day	Wage $/Hour	Equipment Cost, $/Hour	Daily Cost $	Annual Cost $
Personnel						
Manager/Supervisor	1	8	$ 25.00	-	$ 200	$ 50,400
Operator/Equipment Operator (On-site)	1	8	$ 16.12	-	$ 129	$ 32,503
Equipment Operator (On-site)	1	8	$ 16.12	-	$ 129	$ 32,503
Drivers/Operators for Refuse Collection Trucks	8	8	$ 9.50	-	$ 608	$ 153,216
Laborers	3	8	$ 10.29	-	$ 247	$ 62,225
Environmental Specialist	1	2	$ 21.10	-	$ 42	$ 10,634
Equipment						
Dozer Operation	1	4	-	$ 66.77	$ 267	$ 67,304
Refuse Trucks Operation	8	6	-	$ 25.55	$ 1,226	$ 309,017
TOTALS					$ 2,848	$ 717,802
Collection Drivers and Trucks Only						$ 462,233

LANDFILL OPERATION COST (2016 and beyond @ approx 55,000 TPY) - Refuse Trucks (Apra Harbor Landfill Location)

Description	Quantity	Hours/Day	Wage $/Hour	Equipment Cost, $/Hour	Daily Cost, $	Annual Cost, $
Personnel						
Manager/Supervisor	1	8	$ 25.00	-	$ 200	$ 50,400
Operator/Equipment Operator (On-site)	1	8	$ 16.12	-	$ 129	$ 32,503
Equipment Operator (On-site)	1	8	$ 16.12	-	$ 129	$ 32,503
Drivers/Operators for Refuse Collection Trucks	**29**	8	$ 9.50	-	$ 2,204	$ 555,408
Laborers	**5**	8	$ 10.29	-	$ 412	$ 103,708
Environmental Specialist	1	**4**	$ 21.10	-	$ 84	$ 21,269
Equipment						
Dozer Operation	1	**8**	-	$ 66.77	$ 534	$ 134,608
Refuse Trucks Operation	**29**	6	-	$ 25.55	$ 4,445	$ 1,120,185
TOTALS					$ 8,137	$ 2,050,584
Collection Drivers and Trucks Only						$ 1,675,593

ALTERNATIVE 1-1 - LINE INACTIVE AREA OF LANDFILL

	ITEMS OF WORK	QUANTITIES		LABOR COST		TOTAL COST	
	REVISED	NO OF UNITS	UN-IT	UNIT COST	COST	UNIT COST	COST
001	**Landfill Control Building**						
	Landfill Control Building	600	SF	725	435,000	725	435,000
	SUBTOTAL						435,000
	TAX					4%	17,400
	TOTAL						452,400
002	**Truck Scale Facility**						
	Truck Scale Structure	780	CF	25	19,500	25	19,500
	Truck Scale	1	EA	70,000	70,000	70,000	70,000
	SUBTOTAL						89,500
	TAX					4%	3,580
	TOTAL						93,080
003	**Closure Cap**						
	Closure Cap (60 Acres)	1	LS	7,307,073	7,307,073	7,307,073	7,307,073
	SUBTOTAL						7,307,073
	TAX					4%	292,283
	TOTAL						7,599,356
004	**Landfill Gas Control System**						
	LFG Control System (60 Acres)	1	LS	1,721,739	1,721,739	1,721,739	1,721,739
	SUBTOTAL						1,721,739
	TAX					4%	68,870
	TOTAL						1,790,609
005	**Leachate Treatment System**						
	Leachate Treatment System (14.4 Acres)	1	LS	719,924	719,924	719,924	719,924
	Mechanical for Leachate Treatment System (14.4 Acres)	1	LS	15,566	15,566	15,566	15,566
	Electrical for Leachate Pumps (14.4 Acres)	1	LS	31,132	31,132	31,132	31,132
	SUBTOTAL						766,622
	TAX					4%	30,665
	TOTAL						797,287
006	**Site Work**						
	Chain Link Fence	1100	LF	64	70,683	64	70,683
	Gate	1	EA	3,753	3,753	3,753	3,753
	SUBTOTAL						74,436
	TAX					4%	2,977
	TOTAL						77,414
007	**Liner and Leachate Collection System**						
	Liner and Leachate Collection System (14.4 Acres)	1	LS	9,339,554	9,339,554	9,339,554	9,339,554
	SUBTOTAL						9,339,554
	TAX					4%	373,582
	TOTAL						9,713,136

COST MODEL SUMMARY SHEET

PROJECT TITLE			CONTRACT NO.
ACTIVITY: Apra Harbor Naval Complex	LOCATION: Guam		AMENDMENT NO.
PREPARED BY (Name)	TITLE OR ORGANIZATION: HDR|Hawaii Pacific Engineers, Inc.	DATE	TYPE OF ESTIMATE
ACF / FY	FER	CATEGORY CODE	COST ESCALATED TO

	$/SYS	SYS QUAN (UM)	TOTAL	BUILDING	BUILT-IN EQUIPMENT
ALTERNATIVE 1-1 - LINE INACTIVE AREA OF LANDFILL					
PRIMARY FACILITIES					
001 Landfill Control Building	$ 452,400	1	$ 452,400.0		
002 Truck Scale Facility	$ 93,080	1	$ 93,080.0		
003 Closure Cap	$ 7,599,356	1	$ 7,599,355.9		
004 LFG Control System (60 Acres)	$ 1,790,609	1	$ 1,790,609		
005 Leachate Treatment System	$ 797,287	1	$ 797,286.9		
006 Site Work	$ 77,414	1	$ 77,413.6		
007 Liner and Leachate Collection System	$ 9,713,136	1	$ 9,713,136.2		
			$ 20,523,281.2		

ALTERNATIVE 1-2 - LINE EXIST AND INACTIVE AREA OF LANDFILL							
	ITEMS OF WORK	QUANTITIES		LABOR COST		TOTAL COST	
	REVISED	NO OF UNITS	UN-IT	UNIT COST	COST	UNIT COST	COST
001	**Landfill Control Building**						
	Landfill Control Building	600	SF	725	435,000	725	435,000
	SUBTOTAL						435,000
	TAX					4%	17,400
	TOTAL						452,400
002	**Truck Scale Facility**						
	Truck Scale Structure	780	CF	25	19,500	25	19,500
	Truck Scale	1	EA	70,000	70,000	70,000	70,000
	SUBTOTAL						89,500
	TAX					4%	3,580
	TOTAL						93,080
003	**Closure Cap**						
	Closure Cap (60 Acres)	1	LS	7,307,073	7,307,073	7,307,073	7,307,073
	SUBTOTAL						7,307,073
	TAX					4%	292,283
	TOTAL						7,599,356
004	**Landfill Control System**						
	LFG Control System (60 Acres)	1	LS	1,721,739	1,721,739	1,721,739	1,721,739
	SUBTOTAL						1,721,739
	TAX					4%	68,870
	TOTAL						1,790,609
005	**Leachate Treatment System**						
	Leachate Treatment System (60 Acres)	1	LS	1,520,784	1,520,784	1,520,784	1,520,784
	Mechanical for Leachate Treatment System (60 Acres)	1	LS	32,882	32,882	32,882	32,882
	Electrical for Leachate Pumps (60 Acres)	1	LS	65,764	65,764	65,764	65,764
	SUBTOTAL						1,619,430
	TAX					4%	64,777
	TOTAL						1,684,207
006	**Site Work**						
	Chain Link Fence	1100	LF	64	70,683	64	70,683
	Gate	1	EA	3,753	3,753	3,753	3,753
	SUBTOTAL						74,436
	TAX					4%	2,977
	TOTAL						77,414
006	**Liner and Leachate Collection System**						
	Liner and Leachate Collection System (60 Acres)	1	LS	19,729,096	19,729,096	19,729,096	19,729,096
	SUBTOTAL						19,729,096
	TAX					4%	789,164
	TOTAL						20,518,260

COST MODEL SUMMARY SHEET

PROJECT TITLE			CONTRACT NO. N62742-06-D-1881
ACTIVITY Apra Harbor Naval Complex	LOCATION Guam		AMENDMENT NO.
PREPARED BY (Name)	TITLE OR ORGANIZATION HDR|Hawaii Pacific Engineers, Inc.	DATE	TYPE OF ESTIMATE
ACF / FY	FER	CATEGORY CODE	COST ESCALATED TO

	$/SYS	SYS QUAN (UM)	TOTAL	BUILDING	BUILT-IN EQUIPMENT
ALTERNATIVE 1-2 - LINE EXIST AND INACTIVE AREA OF LANDFILL					
PRIMARY FACILITIES					
001 Landfill Control Building	$ 452,400	1	$ 452,400		
002 Truck Scale Facility	$ 93,080	1	$ 93,080		
003 Closure Cap	$ 7,599,356	1	$ 7,599,356		
004 Landfill Control System	$ 1,790,609	1	$ 1,790,609		
005 Leachate Treatment System	$ 1,684,207	1	$ 1,684,207		
006 Site Work	$ 77,414	1	$ 77,414		
007 Liner and Leachate Collection System	$20,518,260	1	$ 20,518,260		
			$ 32,215,325		

ALTERNATIVE 2 - USE GOVGUAM LANDFILL CLOSE EXISTING LANDFILL							
ITEMS OF WORK	QUANTITIES		COST		TOTAL COST		
REVISED	NO OF UNITS	UN-IT	UNIT COST	COST	UNIT COST	COST
001 Closure Cap						
Closure Cap (60 Acres)	1	LS	7,307,073	7,307,073	7,307,073	7,307,073
SUBTOTAL						7,307,073
TAX					4%	292,283
TOTAL						7,599,356
002 Landfill Gas Venting System						
LFG Venting System (60 Acres)	1	LS	1,721,739	1,721,739	1,721,739	1,721,739
SUBTOTAL						1,721,739
TAX					4%	68,870
TOTAL						1,790,609

COST MODEL SUMMARY SHEET

PROJECT TITLE						CONTRACT NO. N62742-06-D-1881	
ACTIVITY Apra Harbor Naval Complex		LOCATION Guam				AMENDMENT NO.	
PREPARED BY (Name)	TITLE OR ORGANIZATION HDR|Hawaii Pacific Engineers, Inc.			DATE		TYPE OF ESTIMATE	
ACF	FY	FER		CATEGORY CODE		COST ESCALATED TO	
			$/SYS	SYS QUAN (UM)	TOTAL	BUILDING	BUILT-IN EQUIPMENT
ALTERNATIVE 2 - USE GOVGUAM LANDFILL CLOSE EXISTING LANDFILL							
PRIMARY FACILITIES							
001 Closure Cap			7,599,356	1	7,599,356		
002 Landfill Gas Venting System			1,790,609	1	1,790,609		
					9,389,964		

ALTERNATIVE 3 - NEW LANDFILL

ITEMS OF WORK	QUANTITIES		LABOR COST		TOTAL COST	
REVISED	NO OF UNITS	UN-IT	UNIT COST	COST	UNIT COST	COST
001 Landfill Control Building						
Landfill Control Building	600	SF			1,102	661,000
SUBTOTAL						661,000
TAX					4%	26,440
TOTAL						687,440
002 Truck Scale Facility						
Truck Scale Structure	780	CF			37	29,000
Truck Scale	1	EA			106,000	106,000
SUBTOTAL						135,000
TAX					4%	5,400
TOTAL						140,400
003 Leachate Treatment System						
Leachate Treatment System (60 Acres)	1	LS			2,103,000	2,103,000
Mechanical for Leachate Treatment System (60 Acres)	1	LS			45,000	45,000
Electrical for Leachate Pumps (60 Acres)	1	LS			91,000	91,000
SUBTOTAL						2,239,000
TAX					4%	89,560
TOTAL						2,328,560
004 Site Work						
Clearing and Grubbing	1	LS			101,000	101,000
Chain Link Fence	6000	LF			97	583,000
Gate	1	EA			6,000	6,000
Earthwork	1200000	CY			10	12,000,000
Gunite Lining, fiber reinforced, 4-in thick	2000000	SF			23	46,000,000
Potable Water	1	LS			21,000	21,000
Septic Tank and Subsurface Disposal	1	LS			168,000	168,000
Groundwater Monitoring Wells	1	LS			1,885,000	1,885,000
Electrical	1	LS			402,000	402,000
Mechanical	1	LS			749,000	749,000
SUBTOTAL						61,915,000
TAX					4%	2,476,600
TOTAL						64,391,600
005 Liner and Leachate Collection System						
Liner and Leachate Collection System (60 Acres)	1	LS			27,288,000	27,288,000
SUBTOTAL						27,288,000
TAX					4%	1,091,520
TOTAL						28,379,520

COST MODEL SUMMARY SHEET

PROJECT TITLE			CONTRACT NO. N62742-06-D-1881
ACTIVITY Apra Harbor Naval Complex	LOCATION Guam		AMENDMENT NO.
PREPARED BY (Name)	TITLE OR ORGANIZATION HDR|Hawaii Pacific Engineers, Inc.	DATE	TYPE OF ESTIMATE
ACF	FY	FER / CATEGORY CODE	COST ESCALATED TO

	$/SYS	SYS QUAN (UM)	TOTAL	BUILDING	BUILT-IN EQUIPMENT
ALTERNATIVE 3 - NEW LANDFILL					
PRIMARY FACILITIES					
001 Landfill Control Building	$ 687,440	1	$ 687,440		
002 Truck Scale Facility	$ 140,400	1	$ 140,400		
003 Leachate Treatment System	$ 2,328,560	1	$ 2,328,560		
004 Site Work	$ 64,391,600	1	$ 64,391,600		
005 Liner and Leachate Collection System	$ 28,379,520	1	$ 28,379,520		
			$ 95,927,520		

Project:	**Guam Modular WTE Feasibility Study**
Technology:	**Modular Mass Burn Facility 120 tpd-7 days per week**
Date:	**02/12/08**
Estimate Basis:	**Conceptual Layout (Average 120tpd)**
Costs:	**2008$**
Location:	**Guam**

ALTERNATIVE 4a
COST SUMMARY[1]
MODULAR MASS BURN FACILITY
Conceptual Layout (Average 120tpd)

TOTAL CAPITAL COST	$41,390,000	to	$50,588,000
ANNUAL OPERATION & MAINTENANCE COST	$6,445,154	to	$7,090,000
ANNUAL COST	$10,661,154	to	$12,242,000
YEAR 2008 ANNUAL TONNAGE	37,230	Short tons	
COST PER TON (Before Energy Revenues)	$286	to	$329

Notes
(1) All costs are presented in 2008 Dollars

Project:	**Guam Modular WTE Feasibility Study**	
Technology:	**Modular Mass Burn Facility**	**120 tpd-7 days per week**
Date:	**02/12/08**	
Estimate Basis:	**Conceptual Layout (Average 120tpd)**	
Costs:	**2008$**	
Location:	**Guam**	

ALTERNATIVE 4a
MODULAR MASS BURN FACILITY
CAPITAL COST SUMMARY (1)
Conceptual Layout (Average 120tpd)

			Estimated Costs(2)
I.	SITE AQUISITION		$ -
II.	SITE DEVELOPMENT		$ 2,739,400
III.	SCALE HOUSE AND SCALES		$ 247,101
IV.	BUILDINGS		$ 6,456,100
V.	PROCESSING EQUIPMENT		$ -
VI.	MOBILE EQUIPMENT		$ 699,900
VII.	POWER BLOCK EQUIPMENT		$ 19,916,224
	SUBTOTAL CONSTRUCTION AND EQUIPMENT		$ 30,058,726
	CONTINGENCY	25%	$ 7,514,700
	SALES TAX	4%	$ 1,502,900
	DESIGN/ENGINEERING	8%	$ 3,005,900
	PERMITTING		$ 450,000
	SURVEYING AND SOILS REPORT		$ 75,000
	CONSTRUCTION INSPECTION	5%	$ 1,878,700
	START UP AND TESTING	4%	$ 1,502,900
	TOTAL CAPITAL COST (FACILITY IMPLEMENTATION)		$ 45,988,826

Project:	**Guam Modular WTE Feasibility Study**	
Technology:	**Modular Mass Burn Facility**	**120 tpd-7 days per week**
Date:	**02/12/08**	
Estimate Basis:	**Conceptual Layout (Average 120tpd)**	
Costs:	**2008$**	
Location:	**Guam**	

NOTES:

(1) All costs rounded to 1000's

(2) All costs in 2008 $.

I. SITE AQUISITION

Subtotal I	$0

II. SITE DEVELOPMENT

Item	Quantity	Units	Unit Price	Item Cost		Total
Site Preparation					$	367,400
Excavation - foundations(1)	9,400	cy	$17	$159,300		
General Earthwork (2)	15,100	cy	$14	$204,700		
Finishing Grassing & Grading	1	acres	$3,390	$3,400		
Demolition	0	cy material	$339	$0		
Site Improvements					$	1,312,700
Approach /Roadways Concrete (3)	4,000	sy	$102	$406,800		
Asphalt Roadways & Parking	5,000	sy	$68	$339,000		
Retaining Walls	400	cy	$847	$339,000		
Site Drainage	1	L.S.	$127,110	$127,100		
Fencing(4)	2,000	lf	$25	$50,800		
Landscaping (Minimal)	1	L.S.	$50,000	$50,000		
Site Utilities (5)					$	1,059,300
Fire Protection	2,000	lf	$42	$84,700		
Water Supply	1,500	lf	$42	$63,600		
Well Field	0	LS	$50,000	$0		
Sewer System	1,500	lf	$42	$63,600		
Electrical Substation	1	L.S.	$847,399	$847,400		
Subtotal II					$	2,739,400

Notes:

(1) Based on estimated building square footages. Demolition calculated separately below

(2) General Earthwork includes moving soil, backfill, embankment, loadout tunnel excav, etc.

(3) Roadway unit price includes curbs, gutters, etc.

(4) Assumes perimeter fencing at 6' (w/ barbed wire) with gates and litter fencing around maneuvering area of 15' height.

(5) Utilities unit price includes excavation, bedding material, piping installed, backfill, etc.

III. SCALE HOUSE AND SCALES

Item	**Quantity**	**Units**	**Unit Price**	**Item Cost**	**Total**
Metal Building (1)	400	sf	$153	$61,013	
Concrete Slabwork(2)	15	cy	$339	$5,084	
Concrete Footings	10	cy	$678	$6,779	
Interior Treatments(3)	400	sf	$85	$33,896	
Motor Truck Scales & Foundations	2	LS	$93,214	$186,428	
Mechanical(4)	400	sf	$17	$6,779	
Electrical(5)	400	sf	$20	$8,135	
Subtotal III					$247,101

Notes:

(1) No additional facilities for waste delivery truck drivers or admintration activities areas, are included.

(2) Assumes stable soil with good load bearing capacity. Slab floor is 6" reinforced concrete.

(3) Includes tile, painting, window covers and funiture

(4) Building mechanical includes drains, plumbing, air handling, fire protection, etc.

(5) Electrical includes lighting, power, communications, etc.

Project:	**Guam Modular WTE Feasibility Study**	
Technology:	**Modular Mass Burn Facility**	**120 tpd-7 days per week**
Date:	**02/12/08**	
Estimate Basis:	**Conceptual Layout (Average 120tpd)**	
Costs:	**2008$**	
Location:	**Guam**	

IV. BUILDINGS

Item	Quantity	Units	Unit Price	Item Cost	Total
Metal Buildings - Preengineered (1) (2)	13,000	sf	$ 153	$1,982,900	
Ash Concrete Push Walls(3)	100	cy	$ 678	$67,800	
Metal Buildings - Engineered	672,000	cf	$ 6	$3,986,200	
Concrete Pit (3)	0	cy	$ 400	$0	
Overhead Doors	4	ea	$ 16,948	$67,800	
Admin. Area	1,728	sf	$ 203	$351,400	
Subtotal IV					$6,456,100

Notes:

(1) Metal bldg. includes structural steel, column free bldg. (long span), 30 ft. clear height, & 20 yr roofing warranty with mechanical and electrical.

(2) Assumes stable soil with good load bearing capacity. Slab floor is 10" reinforced concrete on grade;
12" on structural slabs

(3) 4 ft thick wall with 10 ft thick mat

V. PROCESSING EQUIPMENT

Item	Quantity	Type	Units	Unit Price	Item Cost	Total
Overhead Cranes NOT USED		Hydraulic Grapple	0	$ 259,560	$ -	
Subtotal V						$0

Notes:

VI. MOBILE EQUIPMENT

Item	Quantity	Units	Unit Price	Item Cost	Total
Ash Trucks and Trailers	1	ea	$211,850	$211,800	
Loader	1	ea	$254,220	$254,200	
Back up Loader	1	ea	$200,000	$200,000	
Pick-up/Utility Truck	1	ea	$33,896	$33,900	
Subtotal VI					$699,900

Notes:

(1) Loader used for fuel handling

Project:	**Guam Modular WTE Feasibility Study**
Technology:	**Modular Mass Burn Facility** **120 tpd-7 days per week**
Date:	**02/12/08**
Estimate Basis:	**Conceptual Layout (Average 120tpd)**
Costs:	**2008$**
Location:	**Guam**

VII. POWER BLOCK EQUIPMENT

Item	Quantity	Unit	Unit Price	Item Cost	Total
Modular Mass Burn Incinerator (1)	3	ls	$956,712	$2,870,100	
Heat Recovery Boiler(1)	3	ls	$260,073	$780,200	
SNCR (NOx Control)	0	ls	$89,598	$0	
Air Pollution Control Equipment(1)	3	ls	$673,425	$2,020,300	
Continuous Emissions Monitoring	3	ls	$288,541	$865,624	
Bottom Ash Quench(1)	3	ls	$54,048	$162,100	
Bottom Ash Conveying	1	ls	$400,000	$400,000	
Flyash Handling/Conditioning	3	ls	$299,799	$899,400	
Aux Cooling Water System	1	ls	$46,448	$46,400	
Condensate System	1	ls	$160,456	$160,500	
Chem Feed	1	ls	$87,265	$87,300	
Circulating Water System	1	ls	$137,232	$137,200	
Waste Water System	1	ls	$161,863	$161,900	
Water Treatment	1	ls	$157,641	$157,600	
Fire Protection	1	ls	$135,825	$135,800	
Feedwater System(1)	1	ls	$125,370	$125,400	
Compressed Air System	1	ls	$34,484	$34,500	
Service Water System	1	ls	$33,076	$33,100	
Steam Piping	1	ls	$46,448	$46,400	
Steam Turbine (2)	1	ls	$557,200	$557,200	
Electrical System	1	ls	$2,060,591	$2,060,600	
Equipment Subtotal					$11,741,624
Boiler Erection (Labor)	1	ls	$2,835,300	$2,835,300	
Steam Turbine Installation(2)	1	ls	$390,040	$390,000	
Mechanical Systems Installation (Labor)	1	ls	$2,375,906	$2,375,900	
Electrical Installation (Labor)	1	ls	$1,556,783	$1,556,800	
Ocean Freight	3	ls	$200,000	$600,000	
Installation Subtotal					$7,758,000
Shop Tools & Equip.	1	Allowance	$122,531	$122,500	
Control Room Furnishings	1	Allowance	$49,012	$49,000	
Spare Parts	1	Allowance	$245,061	$245,100	
Miscellaneous Items					$416,600
Subtotal VII					**$19,916,224**

Notes:

(1) Based on equipment quote from Pennram

(2) Based on equipment qoute and installation estimate from Turbosteam

Subtotal I through VII	**$30,058,726**

Project:	**Guam Modular WTE Feasibility Study**
Technology:	**Modular Mass Burn Facility** **120 tpd-7 days per week**
Date:	**02/12/08**
Estimate Basis:	**Conceptual Layout (Average 120tpd)**
Costs:	**2008$**
Location:	**Guam**

ALTERNATIVE 4a
MODULAR MASS BURN FACILITY
OPERATIONS AND MAINTENANCE COST SUMMARY [1]
Conceptual Layout (Average 120tpd)

			Estimated Costs[2]
I.	LABOR		$ 1,778,000
II.	FACILITY MAINTENANCE		$ 844,000
III.	UTILITIES		$ 932,928
IV.	PROCESS RESIDUE HAUL & DISPOSAL		$ 419,226
V.	ROLLING STOCK O&M COSTS		$ 126,900
VI.	MISCELLANEOUS COSTS		$ 91,100
	SUBTOTAL OPERATION & MAINTENANCE		$ 4,192,154
	CONTINGENCY	25%	$ 1,048,000
	OVERHEAD AND PROFIT	15%	$ 786,000
	ACCOUNTING, SUPPLIES, MISC.	5%	$ 262,000
	ADMINISTRATION	3%	$ 157,000
TOTAL ANNUAL OPERATION & MAINTENANCE COST			$ 6,445,154
VII.	MINUS	SALES REVENUES[3]	$ 489,194
NET ANNUAL OPERATION & MAINTENANCE COST			$ 5,955,960

NOTES:
(1) All costs rounded to 1000
(2) All costs in 2008$
(3) Doesn't include ferrous revenues

Project:	**Guam Modular WTE Feasibility Study**		
Technology:	**Modular Mass Burn Facility**	**120**	**tpd-7 days per week**
Date:	**02/12/08**		
Estimate Basis:	**Conceptual Layout (Average 120tpd)**		
Costs:	**2008$**		
Location:	**Guam**		

I. LABOR

Job Classification	Personnel(1)	$/hr(2)	hrs/yr (3)	Over-time Hrs	Annual Cost	% OT	Total
Facility Manager	1	$54	2,080	0	$112,000	0%	
Operating Engineer	1	$47	2,080	0	$98,000	0%	
Administrative/Clerical	1	$20	2,080	208	$48,000	10%	
Scale Attendant	2	$24	2,080	208	$116,000	10%	
Lead Equipment Operator	4	$41	2,080	312	$413,000	15%	
Equipment Operators	8	$30	2,080	312	$605,000	15%	
Mechanic	1	$34	2,080	208	$81,000	10%	
Electrician/Electronics Specialis	1	$34	2,080	208	$81,000	10%	
Welders	1	$34	2,080	208	$81,000	10%	
Helper	0	$20	2,080	208	$0	10%	
Residue Disposal Drivers	1	$27	2,080	208	$65,000	10%	
Spotters/Laborers	2	$16	2,080	208	$78,000	10%	
Subtotal	23						$1,778,000

Notes:

(1) Based on a 24-hour, seven day per week operation.

(2) Includes fringe benefits (retirement, ss, workers comp, health & life insurance, vacation/sick leave) at 35%
and overtime rate is at 1.5 times straight time

(3) Assumes standard working shift hours 5 Days/Wk 8 Hr/Day

II. FACILITY MAINTENANCE

Item	% of Capital Value	Quantity	Unit	Unit Price	Annual Cost	Total
Site Maintenance(1)	1.5%	1	Lump	$ 35,580	$35,580	
Building Repair & Replacement	3.3%	1	Lump	$ 221,000	$221,000	
Equipment Maintenance (3)	2.0%	1	Lump	$ 234,832	$234,832	
Equipment Replacement (4)	3.0%	1	Lump	$ 352,249	$352,249	
Subtotal						$ 844,000

Notes:

(1) Percentage of capital value is based on empirical data from operating plants in the U.S.

(2) Site maintenance is estimated as % capital construction cost for site improvements and site utilities.

(3) Buidling repair base on a 30 year depreciation of the original capital cost with escalation.

(4) Equipment maintenance (annual needs) and replacement (periodic needs) estimated based on assumed 20 life.

Project:	Guam Modular WTE Feasibility Study	
Technology:	Modular Mass Burn Facility	120 tpd-7 days per week
Date:	02/12/08	
Estimate Basis:	Conceptual Layout (Average 120tpd)	
Costs:	2008$	
Location:	Guam	

III. UTILITIES

Item	Quantity	Unit	Unit Price	Annual Cost	Total
Electricity Purchase (1)	127	MWh/yr	$ 200	$ 25,316	
Propane(2)	308	Gal/Yr	$ 3.39	$ 1,043	
Diesel (3)	206,361	Gal/Yr	$ 3.75	$ 773,852	
Telephone (Mobile/Fixed) (4)	20	Phones	$ 480	$ 9,600	
Water	32,830,965	Gal/Yr	$ 0.003	$ 98,493	
Sewer (5)	8,207,741	Gal/Yr	$ 0.003	$ 24,623	
Subtotal					$ 932,928

Notes:

(1) Electricity purchase accounts for energy use during downtimes only; inhouse power provided by the system otherwise.

(2) Propane used for burner ignition 2008 price ratioed according with diesel prices plus 10%

(3) Diesel used for start-up and shutdown and to maintain "good combustion control" in secondary chamber

(4) Based on mobile phones for entire staff except drivers, helpers and laborers.

(5) Sewer use based on 25% of water use; evaporation and ash quench account for rest.

IV. PROCESS RESIDUE HAUL & DISPOSAL

Item	Cost /Load(1)	Quantity	Unit	Unit Price	Annual Cost	Total
Process Residue Haul	$ 75	503	Tons	$ 3.75	$ 1,886	
Ash Haul	$ 75	14,079	Tons	$ 3.75	$ 52,796	
Landfill Disposal Fees		14,582	Tons	$ 25.00	$ 364,545	
Subtotal						$ 419,226

Notes:

(1) Cost assumes truck operating costs per 20-ton load

V. ROLLING STOCK O&M COSTS

Fuel	Weeks	Unit Rate	Units	Unit Price	Annual Cost	Total
Loader	52	200	gal/wk	$ 3.75	$39,000	
Back up Loader	52	100	gal/wk	$ 3.75	$19,500	
Pick-up Truck	52	30	gal/wk	$ 3.75	$5,900	
Maintenance	**# Vehicles**	**Quantity**	**Units**	**Unit Price**	**Annual Cost**	**Total**
Loader	1	1	L.S.	$13,982	$14,000	
Pick-up Truck	1	12,000	Miles/Yr	$0.50	$6,000	
General O&M		1	L.S.	$42,500	$42,500	
Subtotal						$126,900

Notes:

(1) Based on Owning and Operationg Cost Methodology in the Catepillar Performance Handbook.

Project:	Guam Modular WTE Feasibility Study	
Technology:	Modular Mass Burn Facility	120 tpd-7 days per week
Date:	02/12/08	
Estimate Basis:	Conceptual Layout (Average 120tpd)	
Costs:	2008$	
Location:	Guam	

VI. MISCELLANEOUS COSTS

Item	Useage (1)	Quantity	Unit	Unit Price	Annual Cost	Total
Property Insurance (2)	1	0.3%			$88,100	
Flood Insurance (2)	0	1.2%			$0	
Property Taxes (3)	1	3,252	m2	$0.78	$3,000	
Subtotal						$ 91,100

Notes:

(1) Multiplier used to adjust costs for various potential sites. Zero means expense not appicalbe to this site.

(2) Based on % of capital construction costs.

(3) Based on area of developed property.

Subtotal I through VI	$4,192,154

VII. SALES REVENUES(3)

Material	Units	Unit	Unit Value	Annual Revenues	Total
Net Electric Generation	4,447	MWh	$110	$489,194	Addressed in Pro Forma
Net Steam Generation	176,843	Mlbs.	$0	$0	Addressed in Pro Forma
Aluminum	-	Tons	$800	$0	No recovery provided
Ferrous Metals	-	Tons	$25	$0	
Subtotal VII					$489,194

Water Usage Estimates — 120 TPD

		Conversion factor =	3.785412	
Domestic	**Assumptions**	**Gallons/Yr**	**Liters/Year**	
Average People/Day	5.48			
gpd/person	25			
gallons per day	137			
days/week	7			
weeks/year	52			
gallons per year		49,833	188,640	
Blowdown/Spray Dryer	4%	947,482		
Spray Dryer(Lb/hr Water/tpd Fuel)	212.00	2,950,564		
Ash Quench(15% moisture)	5.80	423,529		
Cooling Tower (blowdown 20% evap.)		28,424,448		
Washdown		35,100	132,868	
Total Water Usage		32,830,957	124,278,698	
Evaporation/Ash Quench	75%	24,623,218	93,209,023	
Total Sewer Usage		8,207,739	31,069,674	

Reagent Usage Estimates

	Qty/Ton
Lime (Lbs/Ton)	20
Ammonia (lbs/Ton)	NA
Carbon (Lbs/Ton)	0.66

Energy Generation Assumptions

	Gross Generation Amount/Ton	**In-House Power Amount/Ton**	**Net Generation Amount/Ton**		**Net Annual Generation**	
Steam Production (mlb)	5.41	0.66	4.75	=	176,843	Mlbs.
Electricity Production (kWh)	136	16.55	119	=	4,447	MWh
Single stage condensing turbine	0.68	MW at	27,040	lbs/hr	0%	Margin

Energy Consumption Assumptions

Item	**mmBtu/Ton**	**Btu/Gal**	**MMBTU**	**Gal/yr**
Propane (mmBtu)	0.000757	91600	28	308
Diesel (mmBtu)	0.776	140000	28,890	206,361

Item	**Qty/Ton**	**hp**	**load factor**	**kw**	**hrs/year**	**kwh/yr**
Power Purchase Req. (kWh/Ton)	3.4					126,582
Total Purchase						126,582

MSW Quanitites and Characteristics

Waste Quantity	40,000	tpy		
Daily Delivery	110	tpd - 7 days per weeks		
Capacity Factor	85%			
Delivery Capacity	129	tpd - 5 days per week		
Annual Throughput	37,230	tpy		
MSW HHV (B&W)	5,200	Btu/lb		
Boiler Efficiency (B&W)	65%			
Fuel Feed Rate (B&W)	10,000	Lbs/Hr at	120	tons/day
Gross Steam Production (B&W)	27,040	Lb/Hr	5408	lbs(steam)/ton

MSW Storage Calculations

Floor Storage Days	3	Days		
Floor Storage Tons	387	tons		
MSW Density	17	lb/cf		
MSW Volume Capacity	46,414	cu. ft.		
Pit Area - NOT USED	900	SF	35	ft deep plus 50% of vol. up to charging level
Pit length - NOT USED	26	ft at	35	feet wide

Residue Disposal

Assumes 5% unburned and combined fly ash and bottom ash with scrubber residue.

Residue Disposal	1.5%	2	tpd5	0.1	Truckloads/Day5
Ash Disposal	30%	38.7	tpd7	2	Truckloads/Day7
Truck Payload (Tons)	20			2.0	Truckloads/Day
		28	HRS/week	4	HRs/day
				2	Round Trip Haul

Basic Conceptual Layout Dimensions

		Length	Span	Area	Height	Number of Stories	Size
Conversion Factor	**M to Ft**	**3.28084**	**3.28084**	**10.76391111**	**3.28084**		**Adjustment**
Exterior Maneuvering	Feet	150.0	60.0	9,000			
	Meters	45.7	18.3	836			
MSW Tipping Floor	Feet	75.0	150.0	11,250	40.0	1.0	
	Meters	22.9	45.7	1,045	12.2		
Boiler Bldg	Feet	35.0	150.0	5,250	115.0	1.0	
	Meters	10.7	45.7	488	35.1		
Turbine Building	Feet	50.0	45.0	4,500	15.0	2.0	
	Meters	15.2	13.7	209	4.6		
Maintenance/Storage	Feet	48.0	36.0	1,728	16.4	1.0	0.8
	Meters	14.6	11.0	161	5		
Admin/ Control Room	Feet	48.0	36.0	1,728	16.4	1.0	0.8
	Meters	14.6	11.0	161	5		
Refuse Storage Bldg (Pit)	Feet		35.0	-	115.0	1.0	
	Meters	0.0	10.7	-	31		
Ash Storage Bldg	Feet	35.0	30.0	1,050	30.0	1.0	0.75
	Meters	10.7	9.1	98	9.1		
Site Development	Feet	350.0	100.0	35,000			
	Meters	106.7	30.5	3,252			
		Total Bldg Floor Area		14,256			

Modular Mass Burn Facility

Capital Cost	$	45,989,000	
Life Extension Measures	$	32,315,424	Capital cost less site work, scalehouse and scales, buildings, mobile equipment, engineering, permitting, survey
Operating Cost	$	6,445,000	
Energy Revenue	$	489,000	

2008 Dollars

Capital Cost Breakdown			
Year 0	$	2,629,000	Permitting, survey, and 70% engineering work
Year 1	$	17,284,000	40% of total less start up, permitting, survey, 70% of engineering
Year 2	$	26,076,000	60% of total plus startup less permitting, survey and engineering
Total	$	45,989,000	

Life Extension			
Year 15	$	8,079,000	25%
Year 20	$	16,158,000	50%
Year 25	$	8,079,000	25%

Project:	**Guam Field Erected WTE Feasibility Study**
Technology:	**Mass Burn Facility** 150 tpd-7 days per week
Date:	**04/09/08**
Estimate Basis:	**Conceptual Layout (Average 150tpd)**
Costs:	**2008$**
Location:	**Guam**

ALTERNATIVE 4b

COST SUMMARY[1]

MASS BURN FACILITY

Conceptual Layout (Average 150tpd)

TOTAL CAPITAL COST	$88,401,000	to	$108,046,000
ANNUAL OPERATION & MAINTENANCE COST	$6,795,174	to	$7,475,000
ANNUAL COST	$15,799,174	to	$18,480,000
YEAR 2003 ANNUAL TONNAGE	37,230	Short tons	
COST PER TON (Before Energy Revenues)	$424	to	$496

Notes

(1) All costs are presented in 2008 Dollars

Project:	**Guam Field Erected WTE Feasibility Study**	
Technology:	**Mass Burn Facility**	**150 tpd-7 days per week**
Date:	**04/09/08**	
Estimate Basis:	**Conceptual Layout (Average 150tpd)**	
Costs:	**2008$**	
Location:	**Guam**	

ALTERNATIVE 4b
MASS BURN FACILITY
CAPITAL COST SUMMARY [(1)]
Conceptual Layout (Average 150tpd)

				Estimated Costs[(2)]
I.	SITE AQUISITION			$ -
II.	SITE DEVELOPMENT			$ 2,491,900.00
III.	SCALE HOUSE AND SCALES			$ 247,101
IV.	BUILDINGS			$ 6,320,500
V.	PROCESSING EQUIPMENT			$ 879,803
VI.	MOBILE EQUIPMENT			$ 499,900
VII.	POWER BLOCK EQUIPMENT			$ 54,155,041
		SUBTOTAL CONSTRUCTION AND EQUIPMENT		$ 64,594,246
		CONTINGENCY	25%	$ 16,148,600
		SALES TAX	4%	$ 3,229,700
		DESIGN/ENGINEERING	8%	$ 6,459,400
		PERMITTING		$ 450,000
		SURVEYING AND SOILS REPORT		$ 75,000
		CONSTRUCTION INSPECTION	5%	$ 4,037,100
		START UP AND TESTING	4%	$ 3,229,700
		TOTAL CAPITAL COST (FACILITY IMPLEMENTATION)		$ 98,223,746

NOTES:
(1) All costs rounded to 1000's
(2) All costs in 2008 $.

Project:	**Guam Field Erected WTE Feasibility Study**	
Technology:	**Mass Burn Facility**	**150 tpd-7 days per week**
Date:	**04/09/08**	
Estimate Basis:	**Conceptual Layout (Average 150tpd)**	
Costs:	**2008$**	
Location:	**Guam**	

I. SITE AQUISITION

Subtotal I	$0

II. SITE DEVELOPMENT

Item	Quantity	Units	Unit Price	Item Cost		Total
Site Preparation					$	194,600
Excavation - foundations(1)	7,600	cy	$17	$128,800		
General Earthwork (2)	4,600	cy	$14	$62,400		
Finishing Grassing & Grading	1	acres	$3,390	$3,400		
Demolition	0	cy material	$339	$0		
Site Improvements					$	1,238,000
Approach /Roadways Concrete (3)	3,500	sy	$102	$355,900		
Asphalt Roadways & Parking	3,400	sy	$68	$230,500		
Retaining Walls	500	cy	$847	$423,700		
Site Drainage	1	L.S.	$127,110	$127,100		
Fencing(4)	2,000	lf	$25	$50,800		
Landscaping (Minimal)	1	L.S.	$50,000	$50,000		
Site Utilities (5)					$	1,059,300
Fire Protection	2,000	lf	$42	$84,700		
Water Supply	1,500	lf	$42	$63,600		
Well Field	0	LS	$50,000	$0		
Sewer System	1,500	lf	$42	$63,600		
Electrical Substation	1	L.S.	$847,399	$847,400		
Subtotal II					$	2,491,900

Notes:

(1) Based on estimated building square footages. Demolition calculated separately below

(2) General Earthwork includes moving soil, backfill, embankment, loadout tunnel excav, etc.

(3) Roadway unit price includes curbs, gutters, etc.

(4) Assumes perimeter fencing at 6' (w/ barbed wire) with gates and litter fencing around maneuvering area of 15' height.

(5) Utilities unit price includes excavation, bedding material, piping installed, backfill, etc.

III. SCALE HOUSE AND SCALES

Item	Quantity	Units	Unit Price	Item Cost	Total
Metal Building (1)	400	sf	$153	$61,013	
Concrete Slabwork(2)	15	cy	$339	$5,084	
Concrete Footings	10	cy	$678	$6,779	
Interior Treatments(3)	400	sf	$85	$33,896	
Motor Truck Scales & Foundations	2	LS	$93,214	$186,428	
Mechanical(4)	400	sf	$17	$6,779	
Electrical(5)	400	sf	$20	$8,135	
Subtotal III					$247,101

Notes:

(1) No additional facilities for waste delivery truck drivers or admintration activities areas, are included.

(2) Assumes stable soil with good load bearing capacity. Slab floor is 6" reinforced concrete.

(3) Includes tile, painting, window covers and funiture

(4) Building mechanical includes drains, plumbing, air handling, fire protection, etc.

(5) Electrical includes lighting, power, communications, etc.

Project:	**Guam Field Erected WTE Feasibility Study**		
Technology:	**Mass Burn Facility**	**150**	**tpd-7 days per week**
Date:	**04/09/08**		
Estimate Basis:	**Conceptual Layout (Average 150tpd)**		
Costs:	**2008$**		
Location:	**Guam**		

IV. BUILDINGS

Item	Quantity	Units	Unit Price	Item Cost	Total
Metal Buildings - Preengineered (1) (2)	3,000	sf	$ 153	$457,600	
Ash Concrete Push Walls(3)	100	cy	$ 678	$67,800	
Metal Buildings - Engineered	792,000	cf	$ 6	$4,698,000	
Concrete Pit (3)	1,000	cy	$ 678	$677,900	
Overhead Doors	4	ea	$ 16,948	$67,800	
Admin. Area	1,728	sf	$ 203	$351,400	
Subtotal IV					$6,320,500

Notes:

(1) Metal bldg. includes structural steel, column free bldg. (long span), 30 ft. clear height, & 20 yr roofing warranty with mechanical and electrical.

(2) Assumes stable soil with good load bearing capacity. Slab floor is 10" reinforced concrete on grade;
12" on structural slabs

(3) 4 ft thick wall with 10 ft thick mat

V. PROCESSING EQUIPMENT

Item	Quantity	Type	Units	Unit Price	Item Cost	Total
Overhead Cranes		Hydraulic Grapple	2	$ 439,902	$ 879,803	
Subtotal V						$879,803

Notes:

VI. MOBILE EQUIPMENT

Item	Quantity	Units	Unit Price	Item Cost	Total
Ash Trucks and Trailers	1	ea	$211,850	$211,800	
Loader	1	ea	$254,220	$254,200	
Pick-up/Utility Truck	1	ea	$33,896	$33,900	
Subtotal VI					$499,900

Notes:

(1) Loader used for ash loading and general maintenance activities

Project:	Guam Field Erected WTE Feasibility Study		
Technology:	Mass Burn Facility	150	tpd-7 days per week
Date:	04/09/08		
Estimate Basis:	Conceptual Layout (Average 150tpd)		
Costs:	2008$		
Location:	Guam		

VII. POWER BLOCK EQUIPMENT

Item	Quantity	Unit	Unit Price	Item Cost	Total
Mass Burn Boiler (1)	1	ls	$19,921,027	$19,921,000	
SNCR (NOx Control)	1	ls	$264,388	$264,400	
Continuous Emissions Monitoring	1	ls	$288,541	$288,541	
Bottom Ash Handling	1	ls	$377,742	$377,700	
Flyash Handling/Conditioning	1	ls	$358,392	$358,400	
Aux Cooling Water System	1	ls	$55,526	$55,500	
Condensate System	1	ls	$191,815	$191,800	
Chem Feed	1	ls	$104,321	$104,300	
Circulating Water System	1	ls	$164,053	$164,100	
Waste Water System	1	ls	$193,498	$193,500	
Water Treatment	1	ls	$188,450	$188,500	
Fire Protection	1	ls	$162,370	$162,400	
Feedwater System	1	ls	$147,227	$147,200	
Compressed Air System	1	ls	$41,224	$41,200	
Service Water System	1	ls	$39,541	$39,500	
Steam Piping	1	ls	$55,526	$55,500	
Steam Turbine	1	ls	$2,563,367	$2,563,400	
Electrical System	1	ls	$2,463,315	$2,463,300	
Equipment Subtotal					$27,580,241
Boiler Erection (Labor)	1	ls	$17,928,924	$17,928,900	
Steam Turbine Installation	1	ls	$1,794,357	$1,794,400	
Mechanical Systems Installation (Labor)	1	ls	$3,250,136	$3,250,100	
Electrical Installation (Labor)	1	ls	$1,724,320	$1,724,300	
Ocean Freight	1	ls	$1,379,012	$1,379,000	
Installation Subtotal					$24,697,700
Shop Tools & Equip.	1	Allowance	$146,478	$146,500	
Control Room Furnishings	1	Allowance	$58,591	$58,600	
Spare Parts	1	Allowance	$292,956	$293,000	
Miscellaneous Items					$498,100
Subtotal VII					**$54,155,041**

Notes:

(1) Based on equipment quote from Babcock and Wilcox

Subtotal I through VII	**$64,594,246**

Project:	**Guam Field Erected WTE Feasibility Study**
Technology:	**Mass Burn Facility** **150 tpd-7 days per week**
Date:	**04/09/08**
Estimate Basis:	**Conceptual Layout (Average 150tpd)**
Costs:	**2008$**
Location:	**Guam**

ALTERNATIVE 4b
MASS BURN FACILITY
OPERATIONS AND MAINTENANCE COST SUMMARY [1]
Conceptual Layout (Average 150tpd)

			Estimated Costs[2]
I.	LABOR		$ 1,778,000
II.	FACILITY MAINTENANCE		$ 1,674,000
III.	UTILITIES		$ 295,426
IV.	PROCESS RESIDUE HAUL & DISPOSAL		$ 369,048
V.	ROLLING STOCK O&M COSTS		$ 107,400
VI.	MISCELLANEOUS COSTS		$ 195,300
	SUBTOTAL OPERATION & MAINTENANCE		$ 4,419,174
	CONTINGENCY	25%	$ 1,105,000
	OVERHEAD AND PROFIT	15%	$ 829,000
	ACCOUNTING, SUPPLIES, MISC.	5%	$ 276,000
	ADMINISTRATION	3%	$ 166,000
TOTAL ANNUAL OPERATION & MAINTENANCE COST			$ 6,795,174
VII.	MINUS	SALES REVENUES[3]	$ 1,732,627
NET ANNUAL OPERATION & MAINTENANCE COST			$ 5,062,547

NOTES:
(1) All costs rounded to 1000
(2) All costs in 2008$
(3) Doesn't include ferrous revenues

Project:	**Guam Field Erected WTE Feasibility Study**
Technology:	**Mass Burn Facility** **150 tpd-7 days per week**
Date:	**04/09/08**
Estimate Basis:	**Conceptual Layout (Average 150tpd)**
Costs:	**2008$**
Location:	**Guam**

I. LABOR

Job Classification	Personnel(1)	$/hr(2)	hrs/yr (3)	Over-time Hrs	Annual Cost	% OT	Total
Facility Manager	1	$54	2,080	0	$112,000	0%	
Operating Engineer	1	$47	2,080	0	$98,000	0%	
Administrative/Clerical	1	$20	2,080	208	$48,000	10%	
Scale Attendant	2	$24	2,080	208	$116,000	10%	
Lead Equipment Operator	4	$41	2,080	312	$413,000	15%	
Equipment Operators	8	$30	2,080	312	$605,000	15%	
Mechanic	1	$34	2,080	208	$81,000	10%	
Electrician/Electronics Specialist	1	$34	2,080	208	$81,000	10%	
Welders	1	$34	2,080	208	$81,000	10%	
Helper	0	$20	2,080	208	$0	10%	
Residue Disposal Drivers	1	$27	2,080	208	$65,000	10%	
Spotters/Laborers	2	$16	2,080	208	$78,000	10%	
Subtotal	23						$1,778,000

Notes:

(1) Based on a 24-hour, seven day per week operation.

(2) Includes fringe benefits (retirement, ss, workers comp, health & life insurance, vacation/sick leave) 35%

and overtime rate is at 1.5 times straight time

(3) Assumes standard working shift hours 5 Days/Wk 8 Hr/Day

II. FACILITY MAINTENANCE

Item	% of Capital Value	Quantity	Unit	Unit Price	Annual Cost	Total
Site Maintenance (1) (2)	1.5%	1	Lump	$ 34,460	$34,460	
Building Repair & Replacement (2)	3.3%	1	Lump	$ 217,000	$217,000	
Equipment Maintenance (3)	2.0%	1	Lump	$ 569,201	$569,201	
Equipment Replacement (4)	3.0%	1	Lump	$ 853,801	$853,801	
Subtotal						$ 1,674,000

Notes:

(1) Percentage of capital value is based on empirical data from operating plants in the U.S.

(2) Site maintenance is estimated as % capital construction cost for site improvements and site utilities.

(3) Buidling repair based on a 30 year depreciation of the original capital cost with escalation.

(4) Equipment maintenance (annual needs) and replacement (periodic needs) estimated based on assumed 20 year life.

III. UTILITIES

Item	Quantity	Unit	Unit Price	Annual Cost	Total
Electricity Purchase (1)	139	MWh/yr	$ 200.00	$ 27,796	
Diesel (2)	26,593	Gal/Yr	$ 3.75	$ 99,723	
Telephone (Mobile/Fixed) (3)	20	Phones	$ 480	$ 9,600	
Water	42,215,078	Gal/Yr	$ 0.003	$ 126,645	
Sewer (4)	10,553,770	Gal/Yr	$ 0.003	$ 31,661	
Subtotal					$ 295,426

Notes:

(1) Electricity purchase accounts for energy use during downtimes only; inhouse power provided by the system otherwise.

(2) Diesel used for start-up and shutdown only to maintain "good combustion control"

(3) Based on mobile phones for entire staff except drivers, helpers and laborers.

(4) Sewer use based on 25% of water use; evaporation and ash quench account for rest.

Project:	Guam Field Erected WTE Feasibility Study	
Technology:	Mass Burn Facility	150 tpd-7 days per week
Date:	04/09/08	
Estimate Basis:	Conceptual Layout (Average 150tpd)	
Costs:	2008$	
Location:	Guam	

IV. PROCESS RESIDUE HAUL & DISPOSAL

Item	Cost /Load(1)	Quantity	Unit	Unit Price	Annual Cost	Total
Process Residue Haul	$ 75	503	Tons	$ 3.75	$ 1,886	
Ash Haul	$ 75	13,140	Tons	$ 3.75	$ 49,276	
Landfill Disposal Fees		13,643	Tons	$ 23.30	$ 317,886	
Subtotal						$ 369,048

Notes:

(1) Cost assumes truck operating costs per 20-ton load

V. ROLLING STOCK O&M COSTS

Fuel	Weeks	Unit Rate	Units	Unit Price	Annual Cost	Total
Loader	52	200	gal/wk	$ 3.75	$39,000	
Pick-up Truck	52	30	gal/wk	$ 3.75	$5,900	
Maintenance	**# Vehicles**	**Quantity**	**Units**	**Unit Price**	**Annual Cost**	**Total**
Loader	1	1	L.S.	$13,982	$14,000	
Pick-up Truck	1	12,000	Miles/Yr	$0.50	$6,000	
General O&M		1	L.S.	$42,500	$42,500	
Subtotal						$107,400

Notes:

(1) Based on Owning and Operationg Cost Methodology in the Catepillar Performance Handbook.

VI. MISCELLANEOUS COSTS

Item	Useage (1)	Quantity	Unit	Unit Price	Annual Cost	Total
Property Insurance (2)	1	0.3%			$192,300	
Flood Insurance (2)	0	1.2%			$0	
Property Taxes (3)	1	3,252	m2	$0.78	$3,000	
Subtotal						$ 195,300

Notes:

(1) Multiplier used to adjust costs for various potential sites. Zero means expense not appicalbe to this site.

(2) Based on % of capital construction costs.

(3) Based on area of developed property.

Subtotal I through VI	$4,419,174

VII. SALES REVENUES(3)

Material	Units	Unit	Unit Value	Annual Revenues	Total
Net Electric Generation	15,751	MWh	$110	$1,732,627	Addressed in Pro Forma
Net Steam Generation	223,380	Mlbs.	$0	$0	Addressed in Pro Forma
Aluminum	-	Tons	$800	$0	No recovery provided
Ferrous Metals	-	Tons	$25	$0	
Subtotal VII					$1,732,627

Water Usage Estimates

150 TPD

	Conversion factor =		3.785412
Domestic	**Assumptions**	**Gallons/Yr**	**Liters/Year**
Average People/Day	5.48		
gpd/person	25		
gallons per day	137		
days/week	7		
weeks/year	52		
gallons per year		49,833	188,640
Blowdown/Spray Dryer	4%	1,226,400	
Spray Dryer(Lb/hr Water/tpd Fuel)	212.00	3,688,206	
Ash Quench(15% moisture)	5.80	423,529	
Cooling Tower (blowdown 20% evap.)		36,792,000	
Washdown		35,100	132,868
Total Water Usage		42,215,068	159,801,426
Evaporation/Ash Quench	75%	31,661,301	119,851,070
Total Sewer Usage		10,553,767	39,950,357

Reagent Usage Estimates

	Qty/Ton
Lime (Lbs/Ton)	20
Ammonia (lbs/Ton)	7.5
Carbon (Lbs/Ton)	0.66

Energy Generation Assumptions

	Gross Generation Amount/Ton	**In-House Power Amount/Ton**	**Net Generation Amount/Ton**		**Net Annual Generation**	
Steam Production (mlb)	7.00	1.00	6	=	223,380	Mlbs.
Electricity Production (kWh)	494	70.51	423	=	15,751	MWh
Assumes condensing turbine	2.75	MW at	39,000	lbs/hr	0%	Margin

Energy Consumption Assumptions

Item	**mmBtu/Ton**	**Btu/Gal**	**MMBTU**	**Gal/yr**
Diesel (mmBtu)	0.1	140000	3,723	26,593

Item	**Qty/Ton**	**hp**	**load factor**	**kw**	**hrs/year**	**kwh/yr**
Power Purchase Req. (kWh/Ton)	3.73					138,981
Total Purchase						138,981

MSW Quanitites and Characteristics

Waste Quantity	40,000	tpy		Note system is slightly derated to allow for outages		
Daily Delivery	110	tpd - 7 days per weeks				
Capacity Factor	85%					
Delivery Capacity	129	tpd - 5 days per week				
Annual Throughput	37,230	tpy				
MSW HHV (B&W)	5,200	Btu/lb				
Boiler Efficiency (B&W)	71%					
Fuel Feed Rate (B&W)	10,000	Lbs/Hr at	120	tons/day	650degF/650psig	
Gross Steam Production (B&W)	35,000	Lb/Hr	7000	lbs(steam)/ton	3.5	lbstm/lb MSW

MSW Storage Calculations

Pit Storage	5	Days		
Pit Storage	645	tons		
MSW Density	20	lb/cf		
MSW Pit Capacity	63,292	cu. ft.		
Pit Area	1,300	SF	30	ft deep plus 50% of vol. up to charging level
Pit length	33	ft at	40	feet wide

Residue Disposal

Assumes cofiring RDF w/ coal and disposing both residues

Residue Disposal	1.5%	2	tpd5	0	Truckloads/Day5
Ash Disposal	28%	36.1	tpd7	2	Truckloads/Day7
Truck Payload (Tons)	20			2.0	Truckloads/Day
		24	HRS/week	4	HRs/day
				2	Round Trip Haul

Basic Conceptual Layout Dimensions

		Length	Span	Area	Height	Number of Stories	Size Adjustment
Conversion Factor	**M to Ft**	**3.28084**	**3.28084**	**10.7639111**	**3.28084**		
Exterior Maneuvering	Feet	55.0	60.0	3,300			
	Meters	16.8	18.3	307			
MSW Tipping Floor	Feet	55.0	35.0	1,925	40.0	1.0	
	Meters	16.8	10.7	179	12.2		
Boiler Bldg	Feet	60.0	85.0	5,100	115.0	1.0	
	Meters	18.3	25.9	474	35.1		
Turbine Building	Feet	50.0	45.0	4,500	15.0	2.0	
	Meters	15.2	13.7	209	4.6		
Maintenance/Storage	Feet	48.0	36.0	1,728	16.4	1.0	0.8
	Meters	14.6	11.0	161	5		
Admin/ Control Room	Feet	48.0	36.0	1,728	16.4	1.0	0.8
	Meters	14.6	11.0	161	5		
Refuse Storage Bldg (Pit)	Feet	30.0	40.0	1,200	115.0	1.0	
	Meters	9.1	12.2	111	31		
Ash Storage Bldg	Feet	35.0	30.0	1,050	30.0	1.0	0.75
	Meters	10.7	9.1	98	9.1		
Site Development	Feet	350.0	100.0	35,000			
	Meters	106.7	30.5	3,252			
		Total Bldg Floor Area		15,306			

Mass Burn Facility

Capital Cost	$	98,224,000
Life Extension Measures	$	5,250,000
Operating Cost	$	6,795,000
Energy Revenue	$	1,733,000

2008 Dollars

Capital Cost Breakdown			
Year 0	$	5,047,000	Permitting, survey, and 70% engineering work
Year 1	$	37,142,000	40% of total less start up, permitting, survey, 70% of engineering
Year 2	$	56,035,000	60% of total plus startup less permitting, survey and engineering
Total	$	98,224,000	

Life Extension			
Year 15	$	1,312,500	25%
Year 20	$	2,625,000	50%
Year 25	$	1,312,500	25%

Appendix D.2

Cost Data – Private Entity Funding

PV Analysis	Alternative 1-1[b] Apra Harbor LF (54MSL)	Alternative 1-2[c] Apra Harbor LF (100MSL)	Alternative 2[d,e] GovGuam Landfill	Alternative 3[f] New Navy Landfill	Alternative 4a[g] Modular WTE Facility	Alternative 4b[g] Erected WTE Facility
25 -Year	Inadequate Service Life	60,000,000	123,000,000	153,000,000	184,000,000	217,000,000
		39%	80%	100%	120%	142%
50 - Year	Inadequate Service Life	Inadequate Service Life	189,000,000	176,000,000	270,000,000	283,000,000
			107%	100%	153%	161%

Notes

General
1. Capital projects over the study period were assumed to be financed or funded through a sinking fund, except for Alternative 2, planned GovGuam Landfill costs.
2. Capital projects financings assumed were for 20-year periods except for Alternative 1-1 which used a 15 year period.
3. Capital project financings assumed origination fees of 1.00% and an interest rate of 2.5%.
3. Capital project sinking funds were for varied periods in consideration of cash flow and included earned interest at an annual percentage rate of 1.0%.
4. Equal annual landfill closure fund deposits were considered over the alternative landfill life including earned interest at an annual percentage rate of 1.0%.

a Present Value Analysis uses a real discount rate of 2.8 percent, with inflation premium removed per OMB Circular No. A-94; Appendix C, rev January 2008

b Estimated service life is limited to the year 2023 and would be exhausted prior to 25 and 50 year analysis periods.

c Estimated service life is limited to the year 2036 and would be exhausted prior to 50 year analysis periods.

d Assumed a tip fee at the Gov Guam landfill of $95/ton over the analysis period, which is discounted over the analysis period.

e Includes estimated 40% increase in collection driver/truck costs to use GovGuam LF Vs current system (80 % waste from northern Guam after troop relocation).

f Includes estimated 15% increase in collection driver/truck costs to use Central Guam LF Vs current system (80 % waste from northern Guam after troop relocation).

g Assumes WTE would extend Apra Harbor Landfill site life to 65 years for landfilling of unburnable waste and residual ash.

CURRENT DOLLARS ANALYSIS

	Alternative 1-1 (54 MSL)		Alternative 1-2 (100 MSL)		Alternative 2		Alternative 3		Alternative 4a			Alternative 4b		
	Apra Harbor Landfill		Apra Harbor Landfill		Gov Guam Landfill		New Navy Landfill		Modular Waste-to-Energy Facility			Erected Waste-to-Energy Facility		
Year	Capital/*Finance*	Operating	Capital/*Finance*	Operating	AHLF Closure	Service Fee	Capital/*Finance*	Operating	Capital/*Finance*	Operating	Revenue	Capital/*Finance*	Operating	Revenue
2008														
2009	$ 1,562,664	$ 873,908	$ 1,841,399	$ 873,908		$ 1,228,470	$ 1,437,281	$ 873,908	$ 1,687,866	$ 873,908		$ 1,687,866	$ 873,908	
2010	$ 1,562,664	$ 994,824	$ 1,841,399	$ 994,824	$ 466,411	$ 3,159,235	$ 1,437,281	$ 994,824	$ 1,687,866	$ 994,824		$ 1,687,866	$ 994,824	
2011	$ 1,562,664	$ 1,003,782	$ 1,841,399	$ 1,003,782	$ 466,411	$ 3,771,600	$ 1,437,281	$ 1,003,782	$ 4,909,114	$ 1,003,782		$ 8,118,576	$ 1,003,782	
2012	$ 1,562,664	$ 1,066,791	$ 1,841,399	$ 1,066,791	$ 466,411	$ 4,009,271	$ 5,901,739	$ 1,066,791	$ 4,909,114	$ 1,066,791		$ 8,118,576	$ 1,066,791	
2013	$ 1,562,664	$ 1,331,541	$ 1,841,399	$ 1,331,541	$ 466,411	$ 4,951,764	$ 5,901,739	$ 2,245,264	$ 4,909,114	$ 1,331,541		$ 8,118,576	$ 1,371,541	
2014	$ 1,562,664	$ 1,557,676	$ 1,841,399	$ 1,557,676	$ 466,411	$ 5,900,808	$ 5,901,739	$ 2,475,092	$ 4,909,114	$ 8,460,586	$ (489,000)	$ 8,118,576	$ 8,810,586	$ (1,733,000)
2015	$ 1,562,664	$ 1,900,734	$ 1,841,399	$ 1,900,734	$ 466,411	$ 7,403,083	$ 5,901,739	$ 2,838,896	$ 4,909,114	$ 8,460,586	$ (489,000)	$ 8,118,576	$ 8,810,586	$ (1,733,000)
2016	$ 1,562,664	$ 2,090,584	$ 1,841,399	$ 2,090,584	$ 466,411	$ 7,706,450	$ 5,901,739	$ 2,912,362	$ 4,909,114	$ 8,460,586	$ (489,000)	$ 8,118,576	$ 8,810,586	$ (1,733,000)
2017	$ 1,562,664	$ 2,090,584	$ 1,841,399	$ 2,090,584	$ 466,411	$ 7,706,450	$ 6,572,186	$ 2,912,362	$ 4,909,114	$ 8,460,586	$ (489,000)	$ 8,118,576	$ 8,810,586	$ (1,733,000)
2018	$ 1,562,664	$ 2,090,584	$ 1,841,399	$ 2,090,584	$ 466,411	$ 7,706,450	$ 6,572,186	$ 2,912,362	$ 4,909,114	$ 8,460,586	$ (489,000)	$ 8,118,576	$ 8,810,586	$ (1,733,000)
2019	$ 1,562,664	$ 2,090,584	$ 1,841,399	$ 2,090,584	$ 466,411	$ 7,779,243	$ 6,572,186	$ 2,929,990	$ 4,909,114	$ 8,460,586	$ (489,000)	$ 8,118,576	$ 8,810,586	$ (1,733,000)
2020	$ 1,562,664	$ 2,090,584	$ 1,841,399	$ 2,090,584	$ 466,411	$ 7,779,243	$ 6,572,186	$ 2,929,990	$ 4,909,114	$ 8,460,586	$ (489,000)	$ 8,118,576	$ 8,810,586	$ (1,733,000)
2021	$ 1,562,664	$ 2,090,584	$ 1,841,399	$ 2,090,584	$ 466,411	$ 7,779,243	$ 6,572,186	$ 2,929,990	$ 4,909,114	$ 8,460,586	$ (489,000)	$ 8,118,576	$ 8,810,586	$ (1,733,000)
2022	$ 1,562,664	$ 2,090,584	$ 1,841,399	$ 2,090,584	$ 466,411	$ 7,779,243	$ 6,186,230	$ 2,929,990	$ 4,909,114	$ 8,460,586	$ (489,000)	$ 8,118,576	$ 8,810,586	$ (1,733,000)
2023	$ 1,562,664	$ 2,090,584	$ 1,841,399	$ 2,090,584	$ 466,411	$ 7,779,243	$ 6,507,860	$ 2,929,990	$ 4,909,114	$ 8,460,586	$ (489,000)	$ 8,118,576	$ 8,810,586	$ (1,733,000)
2024			$ 1,841,399	$ 2,090,584	$ 466,411	$ 7,779,243	$ 6,507,860	$ 2,929,990	$ 4,909,114	$ 8,460,586	$ (489,000)	$ 8,118,576	$ 8,810,586	$ (1,733,000)
2025			$ 1,841,399	$ 2,090,584	$ 466,411	$ 7,779,243	$ 6,507,860	$ 2,929,990	$ 4,909,114	$ 8,460,586	$ (489,000)	$ 8,118,576	$ 8,810,586	$ (1,733,000)
2026			$ 1,841,399	$ 2,090,584	$ 466,411	$ 7,779,243	$ 6,507,860	$ 2,929,990	$ 4,909,114	$ 8,460,586	$ (489,000)	$ 8,118,576	$ 8,810,586	$ (1,733,000)
2027			$ 1,841,399	$ 2,090,584	$ 466,411	$ 7,779,243	$ 6,186,230	$ 2,929,990	$ 4,909,114	$ 8,460,586	$ (489,000)	$ 8,118,576	$ 8,810,586	$ (1,733,000)
2028			$ 1,841,399	$ 2,090,584	$ 466,411	$ 7,779,243	$ 6,186,230	$ 2,929,990	$ 4,909,114	$ 8,460,586	$ (489,000)	$ 8,118,576	$ 8,810,586	$ (1,733,000)
2029			$ 246,565	$ 2,090,584	$ 466,411	$ 7,779,243	$ 5,375,166	$ 2,929,990	$ 3,674,604	$ 8,460,586	$ (489,000)	$ 6,582,279	$ 8,810,586	$ (1,733,000)
2030			$ 246,565	$ 2,090,584		$ 7,779,243	$ 5,375,166	$ 2,929,990	$ 3,674,604	$ 8,460,586	$ (489,000)	$ 6,582,279	$ 8,810,586	$ (1,733,000)
2031			$ 246,565	$ 2,090,584		$ 7,779,243	$ 5,375,166	$ 2,929,990	$ 865,240	$ 8,460,586	$ (489,000)	$ 218,484	$ 8,810,586	$ (1,733,000)
2032			$ 246,565	$ 2,090,584		$ 7,779,243	$ 1,132,101	$ 2,929,990	$ 865,240	$ 8,460,586	$ (489,000)	$ 218,484	$ 8,810,586	$ (1,733,000)
2033			$ 246,565	$ 2,090,584		$ 7,779,243	$ 810,471	$ 2,929,990	$ 865,240	$ 8,460,586	$ (489,000)	$ 218,484	$ 8,810,586	$ (1,733,000)
2034			$ 246,565	$ 2,090,584		$ 7,779,243	$ 810,471	$ 2,929,990	$ 1,912,094	$ 8,460,586	$ (489,000)	$ 388,554	$ 8,810,586	$ (1,733,000)
2035			$ 246,565	$ 2,090,584		$ 7,779,243	$ 810,471	$ 2,929,990	$ 1,912,094	$ 8,460,586	$ (489,000)	$ 388,554	$ 8,810,586	$ (1,733,000)
2036			$ -	$ 2,090,584		$ 7,779,243	$ 1,132,101	$ 2,929,990	$ 1,912,094	$ 8,460,586	$ (489,000)	$ 388,554	$ 8,810,586	$ (1,733,000)
2037						$ 7,779,243	$ 783,283	$ 2,929,990	$ 1,912,094	$ 8,460,586	$ (489,000)	$ 388,554	$ 8,810,586	$ (1,733,000)
2038						$ 7,779,243	$ 721,504	$ 2,929,990	$ 1,912,094	$ 8,460,586	$ (489,000)	$ 388,554	$ 8,810,586	$ (1,733,000)
2039						$ 7,779,243	$ 399,874	$ 2,929,990	$ 1,912,094	$ 8,460,586	$ (489,000)	$ 388,554	$ 8,810,586	$ (1,733,000)
2040						$ 7,779,243	$ 721,504	$ 2,929,990	$ 1,912,094	$ 8,460,586	$ (489,000)	$ 388,554	$ 8,810,586	$ (1,733,000)
2041						$ 7,779,243	$ 721,504	$ 2,929,990	$ 1,912,094	$ 8,460,586	$ (489,000)	$ 388,554	$ 8,810,586	$ (1,733,000)
2042						$ 7,185,076	$ 721,504	$ 2,929,990	$ 1,912,094	$ 8,460,586	$ (489,000)	$ 388,554	$ 8,810,586	$ (1,733,000)
2043						$ 7,185,076	$ 721,504	$ 2,929,990	$ 1,912,094	$ 8,460,586	$ (489,000)	$ 388,554	$ 8,810,586	$ (1,733,000)
2044						$ 7,185,076	$ 1,043,134	$ 2,114,990	$ 1,912,094	$ 8,460,586	$ (489,000)	$ 388,554	$ 8,810,586	$ (1,733,000)
2045						$ 7,185,076	$ 1,010,718	$ 2,114,990	$ 1,912,094	$ 8,460,586	$ (489,000)	$ 388,554	$ 8,810,586	$ (1,733,000)
2046						$ 7,185,076	$ 689,088	$ 2,114,990	$ 1,912,094	$ 8,460,586	$ (489,000)	$ 388,554	$ 8,810,586	$ (1,733,000)
2047						$ 7,185,076	$ 1,010,718	$ 2,114,990	$ 1,912,094	$ 8,460,586	$ (489,000)	$ 388,554	$ 8,810,586	$ (1,733,000)
2048						$ 7,185,076	$ 1,010,718	$ 2,114,990	$ 1,912,094	$ 8,460,586	$ (489,000)	$ 388,554	$ 8,810,586	$ (1,733,000)
2049						$ 7,185,076	$ 1,010,718	$ 2,114,990	$ 1,139,886	$ 8,460,586	$ (489,000)	$ 263,102	$ 8,810,586	$ (1,733,000)
2050						$ 7,185,076	$ 689,088	$ 2,114,990	$ 1,139,886	$ 8,460,586	$ (489,000)	$ 263,102	$ 8,810,586	$ (1,733,000)
2051						$ 7,185,076	$ 689,088	$ 2,114,990	$ 1,139,886	$ 8,460,586	$ (489,000)	$ 263,102	$ 8,810,586	$ (1,733,000)
2052						$ 7,185,076	$ 689,088	$ 2,114,990	$ 1,139,886	$ 8,460,586	$ (489,000)	$ 263,102	$ 8,810,586	$ (1,733,000)
2053						$ 7,185,076	$ 689,088	$ 2,114,990	$ 1,139,886	$ 8,460,586	$ (489,000)	$ 263,102	$ 8,810,586	$ (1,733,000)
2054						$ 7,185,076	$ 440,957	$ 2,114,990	$ 1,139,886	$ 8,460,586	$ (489,000)	$ 263,102	$ 8,810,586	$ (1,733,000)
2055						$ 7,185,076	$ 440,957	$ 2,114,990	$ 1,139,886	$ 8,460,586	$ (489,000)	$ 263,102	$ 8,810,586	$ (1,733,000)
2056						$ 7,185,076	$ 440,957	$ 2,114,990	$ 1,139,886	$ 8,460,586	$ (489,000)	$ 263,102	$ 8,810,586	$ (1,733,000)
2057						$ 7,185,076	$ 440,957	$ 2,114,990	$ 1,139,886	$ 8,460,586	$ (489,000)	$ 263,102	$ 8,810,586	$ (1,733,000)
2058						$ 7,185,076		$ 2,114,990	$ 1,139,886	$ 8,460,586	$ (489,000)	$ 263,102	$ 8,810,586	$ (1,733,000)
					$ 9,328,227	$ 354,612,474	$ 147,178,660	$ 125,210,242	$ 141,764,988	$ 385,997,217		$ 171,789,431	$ 401,787,217	
ste volume, cy						$ 363,940,701		$ 272,388,902		$ 527,762,205			$ 573,576,648	

PRESENT VALUE ANALYSIS

	Alternative 1-1 (54 MSL) Apra Harbor Landfill		Alternative 1-2 (100 MSL) Apra Harbor Landfill		Alternative 2 Gov Guam Landfill		Alternative 3 New Navy Landfill		Alternative 4a Modular Waste-to-Energy Facility			Alternative 4b Erected Waste-to-Energy Facility		
Year	Capital/Finance	Operating	Capital/Finance	Operating	AHLF Closure	Service Fee	Capital/Finance	Operating	Capital/Finance	Operating	Revenue	Capital/Finance	Operating	Revenue
2009	$ 1,520,101	$ 248,609	$ 1,791,244	$ 850,105	$ -	$ 1,195,009	$ 1,398,134	$ 850,105	$ 1,641,893	$ 850,105	$ -	$ 1,641,893	$ 850,105	$ -
2010	$ 1,478,697	$ 941,370	$ 1,742,456	$ 941,370	$ 441,350	$ 2,989,481	$ 1,360,052	$ 941,370	$ 1,597,172	$ 941,370	$ -	$ 1,597,172	$ 941,370	$ -
2011	$ 1,438,422	$ 923,975	$ 1,694,996	$ 923,975	$ 429,329	$ 3,471,733	$ 1,323,008	$ 923,975	$ 4,518,807	$ 923,975	$ -	$ 7,473,095	$ 923,975	$ -
2012	$ 1,399,243	$ 955,228	$ 1,648,829	$ 955,228	$ 417,635	$ 3,589,988	$ 6,852,026	$ 955,228	$ 4,395,727	$ 955,228	$ -	$ 7,269,548	$ 955,228	$ -
2013	$ 1,361,131	$ 1,159,816	$ 1,603,919	$ 1,159,816	$ 406,260	$ 4,313,148	$ 6,665,395	$ 1,955,698	$ 4,275,999	$ 1,159,816	$ -	$ 7,071,544	$ 1,194,657	$ -
2014	$ 1,324,057	$ 1,319,831	$ 1,560,232	$ 1,319,831	$ 395,194	$ 4,999,802	$ 6,483,848	$ 2,097,166	$ 4,159,532	$ 7,168,722	$ (414,334)	$ 6,878,934	$ 7,465,280	$ (1,468,385)
2015	$ 1,287,994	$ 1,566,641	$ 1,517,736	$ 1,566,641	$ 384,430	$ 6,101,840	$ 6,307,245	$ 2,339,902	$ 4,046,237	$ 6,973,465	$ (403,048)	$ 6,691,570	$ 7,261,946	$ (1,428,390)
2016	$ 1,252,912	$ 1,676,188	$ 1,476,397	$ 1,676,188	$ 373,959	$ 6,178,875	$ 6,135,452	$ 2,335,073	$ 3,936,028	$ 6,783,527	$ (392,070)	$ 6,509,310	$ 7,064,149	$ (1,389,484)
2017	$ 1,218,786	$ 1,630,533	$ 1,436,184	$ 1,630,533	$ 363,774	$ 6,010,579	$ 5,968,339	$ 2,271,471	$ 3,828,821	$ 6,598,761	$ (381,391)	$ 6,332,013	$ 6,871,741	$ (1,351,638)
2018	$ 1,185,590	$ 1,586,122	$ 1,397,066	$ 1,586,122	$ 353,865	$ 5,846,867	$ 5,805,777	$ 2,209,603	$ 3,724,534	$ 6,419,028	$ (371,003)	$ 6,159,546	$ 6,684,573	$ (1,314,823)
2019	$ 1,153,297	$ 1,542,920	$ 1,359,013	$ 1,542,920	$ 344,227	$ 5,741,338	$ 5,647,643	$ 2,162,429	$ 3,623,088	$ 6,244,191	$ (360,898)	$ 5,991,776	$ 6,502,503	$ (1,279,011)
2020	$ 1,121,884	$ 1,500,895	$ 1,321,997	$ 1,500,895	$ 334,851	$ 5,584,959	$ 5,493,816	$ 2,103,530	$ 3,524,405	$ 6,074,116	$ (351,068)	$ 5,828,576	$ 6,325,392	$ (1,244,174)
2021	$ 1,091,327	$ 1,460,015	$ 1,285,990	$ 1,460,015	$ 325,731	$ 5,432,839	$ 5,344,179	$ 2,046,236	$ 3,428,409	$ 5,908,673	$ (341,506)	$ 5,669,821	$ 6,153,105	$ (1,210,286)
2022	$ 1,061,602	$ 1,420,248	$ 1,250,963	$ 1,420,248	$ 316,859	$ 5,284,863	$ 5,198,618	$ 1,990,502	$ 3,335,028	$ 5,747,736	$ (332,204)	$ 5,515,390	$ 5,985,510	$ (1,177,321)
2023	$ 1,032,687	$ 1,381,564	$ 1,216,890	$ 1,381,564	$ 308,228	$ 5,140,917	$ 5,057,021	$ 1,936,286	$ 3,244,191	$ 5,591,183	$ (323,156)	$ 5,365,166	$ 5,822,481	$ (1,145,254)
2024	$ -	#VALUE!	$ 1,183,745	$ 1,343,934	$ 299,833	$ 5,000,892	$ 4,919,281	$ 1,883,546	$ 3,155,828	$ 5,438,894	$ (314,354)	$ 5,219,033	$ 5,663,892	$ (1,114,060)
2025	$ -	#VALUE!	$ 1,151,503	$ 1,307,329	$ 291,666	$ 4,864,681	$ 4,785,293	$ 1,832,243	$ 3,069,871	$ 5,290,753	$ (305,792)	$ 5,076,880	$ 5,509,623	$ (1,083,716)
2026	$ -	#VALUE!	$ 1,120,139	$ 1,271,720	$ 283,722	$ 4,732,180	$ 4,654,954	$ 1,782,338	$ 2,986,256	$ 5,146,647	$ (297,463)	$ 4,938,599	$ 5,359,555	$ (1,054,199)
2027	$ -	#VALUE!	$ 1,089,629	$ 1,237,082	$ 275,994	$ 4,603,288	$ 4,528,166	$ 1,733,792	$ 2,904,919	$ 5,006,466	$ (289,361)	$ 4,804,085	$ 5,213,575	$ (1,025,485)
2028	$ -	#VALUE!	$ 1,059,951	$ 1,203,387	$ 268,477	$ 4,477,907	$ 4,404,830	$ 1,686,568	$ 2,825,796	$ 4,870,103	$ (281,479)	$ 4,673,234	$ 5,071,571	$ (997,554)
2029	$ -	#VALUE!	$ 138,063	$ 1,170,610	$ 261,164	$ 4,355,940	$ 3,540,311	$ 1,640,630	$ 2,057,572	$ 4,737,454	$ (273,813)	$ 3,685,708	$ 4,933,435	$ (970,383)
2030	$ -	#VALUE!	$ 134,302	$ 1,138,726	$ -	$ 4,237,296	$ 3,443,882	$ 1,595,944	$ 2,001,529	$ 4,608,419	$ (266,355)	$ 3,585,319	$ 4,799,061	$ (943,952)
2031	$ -	#VALUE!	$ 130,644	$ 1,107,710	$ -	$ 4,121,883	$ 3,350,080	$ 1,552,475	$ 458,453	$ 4,482,897	$ (259,100)	$ 115,765	$ 4,668,347	$ (918,242)
2032	$ -	#VALUE!	$ 127,086	$ 1,077,539	$ -	$ 4,009,614	$ 55,463	$ 1,510,189	$ 445,966	$ 4,360,795	$ (252,043)	$ 112,612	$ 4,541,194	$ (893,231)
2033	$ -	#VALUE!	$ 123,624	$ 1,048,190	$ -	$ 3,900,403	$ 53,952	$ 1,469,056	$ 433,819	$ 4,242,019	$ (245,178)	$ 109,545	$ 4,417,504	$ (868,902)
2034	$ -	#VALUE!	$ 120,257	$ 1,019,640	$ -	$ 3,794,166	$ 52,483	$ 1,429,043	$ 932,585	$ 4,126,477	$ (238,500)	$ 189,509	$ 4,297,183	$ (845,235)
2035	$ -	#VALUE!	$ 116,982	$ 991,867	$ -	$ 3,690,823	$ 51,053	$ 1,390,119	$ 907,183	$ 4,014,083	$ (232,004)	$ 184,347	$ 4,180,139	$ (822,213)
2036	$ -	#VALUE!	$ -	$ 964,851	$ -	$ 3,590,295	$ 49,663	$ 1,352,256	$ 882,474	$ 3,904,750	$ (225,684)	$ 179,326	$ 4,066,283	$ (799,818)
2037	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 3,492,505	$ 48,310	$ 1,315,424	$ 858,438	$ 3,798,395	$ (219,537)	$ 174,442	$ 3,955,528	$ (778,033)
2038	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 3,397,378	$ 20,014	$ 1,279,595	$ 835,056	$ 3,694,937	$ (213,558)	$ 169,691	$ 3,847,790	$ (756,842)
2039	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 3,304,843	$ 19,469	$ 1,244,743	$ 812,312	$ 3,594,296	$ (207,741)	$ 165,069	$ 3,742,986	$ (736,227)
2040	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 3,214,828	$ 18,939	$ 1,210,839	$ 790,186	$ 3,496,397	$ (202,083)	$ 160,573	$ 3,641,037	$ (716,175)
2041	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 3,127,264	$ 18,423	$ 1,177,859	$ 768,664	$ 3,401,165	$ (196,579)	$ 156,199	$ 3,541,865	$ (696,668)
2042	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,809,736	$ 17,921	$ 1,145,777	$ 747,727	$ 3,308,526	$ (191,224)	$ 151,945	$ 3,445,394	$ (677,692)
2043	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,733,206	$ 17,433	$ 1,114,569	$ 727,361	$ 3,218,410	$ (186,016)	$ 147,806	$ 3,351,551	$ (659,234)
2044	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,658,761	$ 16,958	$ 782,629	$ 707,550	$ 3,130,749	$ (180,949)	$ 143,780	$ 3,260,263	$ (641,278)
2045	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,586,343	$ 16,496	$ 761,313	$ 688,278	$ 3,045,476	$ (176,021)	$ 139,864	$ 3,171,462	$ (623,811)
2046	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,515,898	$ 16,047	$ 740,577	$ 669,531	$ 2,962,525	$ (171,226)	$ 136,054	$ 3,085,080	$ (606,820)
2047	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,447,372	$ 15,610	$ 720,405	$ 651,295	$ 2,881,834	$ (166,563)	$ 132,349	$ 3,001,051	$ (590,292)
2048	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,380,712	$ 15,185	$ 700,783	$ 633,555	$ 2,803,341	$ (162,026)	$ 128,744	$ 2,919,310	$ (574,214)
2049	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,315,867	$ 14,771	$ 681,696	$ 367,404	$ 2,726,985	$ (157,613)	$ 84,802	$ 2,839,796	$ (558,574)
2050	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,252,789	$ 14,369	$ 663,128	$ 357,397	$ 2,652,709	$ (153,320)	$ 82,492	$ 2,762,447	$ (543,360)
2051	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,191,429	$ 13,977	$ 645,066	$ 347,662	$ 2,580,456	$ (149,144)	$ 80,245	$ 2,687,205	$ (528,560)
2052	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,131,741	$ 13,597	$ 627,496	$ 338,193	$ 2,510,172	$ (145,081)	$ 78,060	$ 2,614,013	$ (514,164)
2053	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,073,678	$ 13,226	$ 610,405	$ 328,981	$ 2,441,801	$ (141,130)	$ 75,934	$ 2,542,814	$ (500,159)
2054	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 2,017,196	$ 12,866	$ 593,779	$ 320,021	$ 2,375,293	$ (137,286)	$ 73,865	$ 2,473,555	$ (486,536)
2055	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 1,962,253	$ 12,516	$ 577,606	$ 311,304	$ 2,310,596	$ (133,546)	$ 71,854	$ 2,406,182	$ (473,284)
2056	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 1,908,806	$ 12,175	$ 561,874	$ 302,825	$ 2,247,662	$ (129,909)	$ 69,896	$ 2,340,644	$ (460,393)
2057	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 1,856,816	$ 11,843	$ 546,570	$ 294,577	$ 2,186,441	$ (126,371)	$ 67,993	$ 2,276,891	$ (447,853)
2058	$ -	#VALUE!	$ -	#VALUE!	$ -	$ 1,806,241	$ 11,521	$ 531,683	$ 286,554	$ 2,126,888	$ (122,929)	$ 66,141	$ 2,214,874	$ (435,655)
Sum 25 Year	$ 18,927,731	#VALUE!	$ 28,562,597	$ 31,821,676	$ 6,876,547	$ 116,186,325	$ 108,776,765	$ 43,805,353	$ 73,619,883	$ 116,524,344	$ (6,455,616)	$ 118,316,134	$ 121,179,769	$ (22,878,491)
25 Year PV	#VALUE!		60,384,272		123,062,872		152,582,118		183,688,611			216,617,411		
Sum 50 Year	$ 18,927,731	#VALUE!	$ 28,799,835	#VALUE!	$ 6,876,547	$ 182,447,271	$ 109,301,630	$ 66,210,589	$ 88,486,998	$ 192,064,710	$ (10,821,654)	$ 121,427,113	$ 199,845,111	$ (38,351,587)
50 Year PV	#VALUE!		#VALUE!		189,323,818		175,512,219		269,730,054			282,920,637		

COST ESTIMATING AND ECONOMIC ASSUMPTIONS

General Cost factors

Costs shown below have been adjusted for Guam in detail sheets or use the following factors, applied as noted in line item description.

For Construction projects - PAX Newsletter No 3.2.1, 30 April 2007 - Area Cost Factors (ACF) - (See example factors used)

1.15	California
2.64	Guam
2.296	Use Factor

For Primarily Labor or O&M Projects

May 2006 State Occupational Employment and Wage Estimates
Installation, Maintenance and Repair Occupations - 49-0000

Guam	49-0000	$	27,970	
California	49-0000	$	42,760	
Labor	Conversion		0.65	Guam/CA

Given that material factor in Means is 1.4 use below:
0.8 Use Factor

Financing and Interest Earned Assumptions		
Bank Financing		
	Interest Rate	**Amortization Period***
BOJ Bank Rate	2.50%	20 yrs
OriginationFees	1.00%	Capitalized
* Deviations for other terms are noted		
Interest Earned- Sinking/Closure Fund		
	Interest Rate	**Amortization Period**
	1.00%	varies

ALTERNATIVE 1-1: Landfill Improvements and Liner "Untouched Area" in 2009; LFG Control in 2013; Closure in 2024

Capital Costs			
2009	$	11,133,317	Scale, Control Building, Line Untouched, LCRS, Site Work
2013	$	1,790,609	LFG Control System and Flare for 60 Acres @$10k/acre & $150,000 Flare + tax- (x Guam/CA ACF)
Finance	$	1,054,258	Annual pmt for financing of above 2 items (2023-2009/approx use 15 years finance period assumed)
2023	$	7,599,356	Closure Cap (assumes 7.4ppd and revised filling practices yielding 14 years site life)
Fund		$508,405.81	Annual closure fund contribution (2009 to year shown- includes fund interest)
Oper Costs			
Reference	$	717,802	Annual Landfill Operating and Collection Cost 2007 (Includes Refuse Trucks and Drivers - tonnage prorated to 2012)
	$	2,050,584	Annual Landfill Operating Cost 2015 - future tonnage (Includes Refuse Trucks and Drivers)
2013	$	40,000	Additional Annual LFG Control Operating Cost - $50,000 (Guam/CA O&M Factor, above)
	$	775,000	Annual PC Care w/o LFG/GW items (Rounded $765,230 from Pre-final Landfill Management Plan, November 2007)
	$	*40,000*	*Additional O&M for LFG in PCM period - $50,000 X O&M Guam factor*
2024 to 2054	*$*	*815,000*	*Total Annual PCM Costs; 30 years (does not in include GW monitoring Assumed needed under All).*

ALTERNATIVE 1-2: Landfill Improvements and Liner in 2009; LFG Control in 2013; Closure in 2036

Capital Costs			
2009	$	22,825,361	Scale, Control Building, Line entire acreage, LCRS, Site Work
2013	$	1,790,609	LFG Control System and Flare for 60 Acres @$10k/acre & $150,000 Flare- (x Guam/CA ACF)
Finance	$	1,594,834	Annual pmt for financing of above 2 items
2036	$	7,599,356	Closure Cap (assumes 7.4ppd and revised filling practices yielding 27 years site life)
Fund		$246,565	Annual closure fund contribution (2009 up to closure year shown- includes fund interest)
Oper Costs			
Reference	$	717,802	Reference Annual Landfill Operating & Collection Cost 2007 (Includes Refuse Trucks and Drivers - prorated to 2015)
2015 to future	$	2,050,584	Annual Landfill Operating Cost 2015 - future tonnage (Includes Refuse Trucks and Drivers)
2015 to future	$	40,000	Additional Annual LFG Control Operating Cost - $50,000 (Guam/CA O&M Factor, above)
2036	$	775,000	Annual PC Care w/o LFG/GW items (Rounded $765,230 from Pre-final Landfill Management Plan, November 2007)
	$	*40,000*	*Additional O&M for LFG in PCM period - $50,000 X O&M Guam factor*
2036 to 2066	*$*	*815,000*	*Total Annual PCM Costs; 30 years (does not in include GW monitoring Assumed needed under All).*

ALTERNATIVE 2: GovGuam Landfill Operational in 2010; tip fee (shown as annual "operating" cost) as shown.

2010 to future	$	95.00	Assumed Tip Fee for use of GovGuam Landfill
2010 to future		140%	Comparative Collection Cost over Alternative 1 due to greater off-route collection costs
Capital Cost			Includes Closure costs for 46 acres (assumed untouched area not included) below:
2010	$	7,198,973	Closure (Cap and LFG venting) of 46 acres (prorated from 60 acres); NO LINER
Finance	$	466,411	Annual pmt for financing of above item
2011 to 2041	$	594,167	Total Annual PCM Costs (46 acres); 30 years; LFG venting, no LFG control system (not including GW monitoring).

ALTERNATIVE 3: AHLF/New Navy LF (line untouched only) to 2013; Close AHLF in 2013; Construct new LF 2012; Operations 2013.

Apra Harbor Landfill in interim

Capital Costs (Apra Harbor interim)			
2009	$	11,133,317	Scale, Control Building, Site Work (Liner for untouched area only - 14 acres)
2013	$	1,790,609	LFG Control System and Flare for 60 Acres @$10k/acre & $150,000 Flare- (x Guam/CA ACF)
2013	$	7,599,356	Closure Cap for 60 acres
Finance	$	1,329,675	Annual pmt for financing of above 3 items
Oper Costs			
to 2015	$	717,802	Reference Annual Landfill Operating & Collection Cost 2007 (Includes Refuse Trucks and Drivers - prorated to 2015)
	$	775,000	Annual PC Care w/o LFG/GW items (Rounded $765,230 from Pre-final Landfill Management Plan, November 2007)
	$	40,000	Additional O&M for LFG in PCM period - $50,000 X O&M Guam factor
2013 to 2043	*$*	*815,000*	*Total Annual PCM Costs; 30 years (does not in include GW monitoring Assumed needed under All).*

New Navy Landfill In Central Guam

Capital Costs

$			28,379,520	Total Liner and LCRS
$			12,000,000	Total Landfill Earthwork (included in phased module financings, below)
$			55,548,000	Other Initial Site Capital Development Costs minus total earthwork
$			95,927,520	Total site Development Costs
	2012		62,950,912	Initial Site Development and Module 1
Finance		$	4,078,501	Annual pmt for financing of above item
	2017	$	5,383,936	Liner/LCRS Module 2
Finance		$	348,818	Annual pmt for financing of above item
	2022	$	4,037,952	Liner/LCRS Module 3
Fund			$385,956	Sinking Fund Annual payment (2012 to year shown)
	2027	$	3,364,960	Liner/LCRS Module 4
Fund			$321,630	Sinking Fund Annual payment (2017 to year shown)
	2033	$	3,364,960	Liner/LCRS Module 5
Fund			$321,630	Sinking Fund Annual payment (2023 to year shown)
	2039	$	3,364,960	Liner/LCRS Module 6
Fund			$321,630	Sinking Fund Annual payment (2029 to year shown)
	2046	$	3,364,960	Liner/LCRS Module 7
Fund			$321,630	Sinking Fund Annual payment (2036 to year shown)
	2050	$	3,364,960	Liner/LCRS Module 8
Fund			$321,630	Sinking Fund Annual payment (2040 to year shown)
	2054	$	3,364,960	Liner/LCRS Module 9
Fund			$321,630	Sinking Fund Annual payment (2044 to year shown)
	2057	$	3,364,960	Liner/LCRS Module 10
Fund			$321,630	Sinking Fund Annual payment (2047 to year shown)
CHECK			95,927,520	Total Liner and LCRS Capital Cost
	2032	$	596,870	Initial Portion [20 year] of LFG Control and Flare for 20 Acres @$10k/acre & $150,000 Flare- (x Guam/CA ACF)
Fund			$196,980	Sinking Fund Annual payment (2029 to year shown)
	2045	$	447,652	Add to LFG Control System 15 Acres ($10k/acre CA x factor adjust to Guam)
Fund			$32,417	Sinking Fund Annual payment (2032 to year shown)
	2058	$	298,435	Add to LFG Control System 10 Acres (15 acres to be completed at closure beyond 2058)
Fund			$73,499	Sinking Fund Annual payment (2054 to year shown)
Reference		$	7,198,973	Closure Cap -60 acres (Apply in 2038 [25 year of life] and prorated in 2058 for 20/25 years of remaining life)
	2038	$	3,599,486	1/2 of closure cap cost prorated for first 25 years of site life
Fund			$107,607	Annual closure fund contribution (2009 to closure year shown- includes fund interest)
	2058	$	2,879,589	portion of closure cap cost prorated for years 26 to year 2058; or 20 years
Fund			$45,828	Annual closure fund contribution (2038 to year shown- includes fund interest)

Oper Costs

2015	$	374,991	New Landfill Operating Cost - Minus Collection Costs
2015 to 2063		115%	Apply Comparative Collection Cost over Alternative 1 due to greater off-route collection costs

ALTERNATIVE 4a: Modular WTE Facility

Capital Costs

	2011	$	2,629,000	Permitting, survey, and 70% engineering work
	2012	$	17,284,000	40% of Total Construction Cost less Start up, permitting, survey, 70% of engineering costs
	2013	$	26,076,000	60% of Total Construction Cost plus Startup; less permitting, survey and engineering
Finance		$	2,809,364	Annual pmt for financing of above 3 items
	2029	$	8,079,000	Minor Life Extension Measures (replacement of system components)
Fund			$411,884	Sinking Fund Annual payment (2011 to year shown)
	2034	$	16,158,000	Major Life Extension Measures (replacement of combustion units and major boiler components)
Finance		$	1,046,854	Annual pmt for financing of above item)
	2039	$	8,079,000	Minor Life Extension Measures (replacement of system components)
Fund			$772,208	Sinking Fund Annual payment (2029 to year shown)
	2049	$	8,079,000	Minor Life Extension Measures (replacement of system components)
Fund			$772,208	Sinking Fund Annual payment (2039 to year shown)
	2054	$	16,158,000	Major Life Extension Measures (replacement of combustion units and major boiler components)
Finance		$	1,046,854	Annual pmt for financing of above item (Assumed sinking fund not used since near end of study period)

WTE Operating Costs

2014 to Future	$	6,445,000	Annual Operating Cost
2014 to Future	$	489,000	Annual Electrical Sales Revenue

Residual Waste and Ash Landfill Costs (46% of waste stream - Based on adjustments of Alt 1-2 landfill costs)

Capital Costs				
	2009	$	22,825,361	Scale, Control Building, Line entire acreage, LCRS, Site Work
	2013	$	1,790,609	LFG Control System and Flare for 60 Acres @$10k/acre & $150,000 Flare- (x Guam/CA ACF)
Finance		$	1,594,834	Annual pmt for financing of above 2 items (PMT(rate,nper,pv,fv,type))
	2058	$	5,845,658	Prorate closure cap to end of 50 year period (50 of 65 year site life [See Table 4-1])
Fund			$93,032	Annual closure fund contribution (2009 to year shown- includes fund interest)
LF Oper Costs				
Ref to 2014		$	717,802	Reference Annual Landfill Operating & Collection Cost 2007 (Includes Refuse Trucks and Drivers - prorated to 2015)
2014 to future		$	299,993	Annual Landfill Operating Cost 2014 - 80% of landfill only cost for Alt 1-2)
2014 to future		$	1,675,593	Collection Cost for Refuse trucks and Drivers
2015 to future		$	40,000	Additional Annual LFG Control Operating Cost - $50,000 (Guam/CA O&M Factor, above)

ALTERNATIVE 4b - Field Erected WTE

	2011	$	5,047,000	Permitting, survey, and 70% engineering work
	2012	$	37,142,000	40% of Total Construction Cost less Start up, permitting, survey, 70% of engineering costs
	2013	$	56,035,000	60% of Total Construction Cost plus Startup; less permitting, survey and engineering
Finance		$	6,363,795	Annual pmt for financing of above 3 items (PMT(rate,nper,pv,fv,type))
	2029	$	1,312,500	Minor Life Extension Measures (replacement of system components)
Fund			$66,914	Sinking Fund Annual payment (2011 to year shown)
	2034	$	2,625,000	Major Life Extension Measures (replacement of combustion units and major boiler components)
Finance		$	170,070	Annual pmt for financing of above item
	2039	$	1,312,500	Minor Life Extension Measures (replacement of system components)
Fund			$125,451	Sinking Fund Annual payment (2029 to year shown)
	2049	$	1,312,500	Minor Life Extension Measures (replacement of system components)
Fund			$125,451	Sinking Fund Annual payment (2039 to year shown)
	2054	$	2,625,000	Major Life Extension Measures (replacement of combustion units and major boiler components)
Finance		$	170,070	Annual pmt for financing of above item
WTE Operating Costs				
	2014 to future	$	6,795,000	Annual Operating Cost
	2014 to future	$	1,733,000	Annual Electrical Sales Revenue

Residual Waste and Ash Landfill Costs (46% of waste stream - Based on adjustments of Alt 1-2 landfill costs)

	2009	$	22,825,361	Scale, Control Building, Line entire acreage, LCRS, Site Work
	2013	$	1,790,609	LFG Control System and Flare for 60 Acres @$10k/acre & $150,000 Flare- (x Guam/CA ACF)
Finance		$	1,594,834	Annual pmt for financing of above 2 items (PMT(rate,nper,pv,fv,type))
	2058	$	5,845,658	Prorate closure cap to end of 50 year period (50 of 65 y
Fund			$93,032	Annual closure fund contribution (2009 to year shown- includes fund interest)
LF Oper Costs				
Ref to 2014		$	717,802	Reference Annual Landfill Operating & Collection Cost
2014 to future		$	299,993	Annual Landfill Operating Cost 2014 - 80% of landfill only cost for Alt 1-2)
2014 to future		$	1,675,593	Collection Cost for Refuse trucks and Drivers
2015 to future		$	40,000	Additional Annual LFG Control Operating Cost - $50,000 (Guam/CA O&M Factor, above)

COMPARISON OF COLLECTION COST INCREASE USING VARIOUS ALTERNATIVE LANDFILLS
(ASSUMED AFTER FULL TROOP RELOCATION - 80% GENERATED IN NORTHERN GUAM)
Cost factor of 100% set for Apra harbor landfill based on 2 full load basis, below - variables in bold

ALT 1,4,6 **ASSUMED EXISTING CASE USING APRA HARBOR LANDFILL**

	Route time assumptions		Collection cycle		Cumul min	Cum hrs.
	15	yard to route	15	yard to route	15	0.25
	120	Assumed on-route	120	On route first load	135	2.25
Note 1	**40**	Route to LF or back	40	Route to LF	175	2.92
	15	Unload at LF	15	Unload at LF	190	3.17
	40	Break time/day	40	LF to Route	230	3.83
	40	LF to yard	120	On-route second	350	5.83
			15	Route to LF	365	6.08
			15	Unload at LF	380	6.33
			40	LF to yard	420	7.00
			40	Breaks	460	*7.67*

Notes:

1	Assumes 80 percent of waste from AF and Marines located in north - 20 miles one way
100%	% full last load using minutes deduction to get 8 hours total
100%	Total Daily Efficiency prorated over 2 loads
100%	Cost Factor

ALT 2 **ASSUMED USING NEW GOV GUAM LANDFILL**

	Route time assumptions		Collection cycle		Cumul min	Cum hrs.
	15	yard to route	15	yard to route	15	0.25
	120	Assumed on-route	120	On route first load	135	2.25
Note 2	**70**	Route to LF or back	70	Route to LF	205	3.42
	15	Unload at LF	15	Unload at LF	220	3.67
	40	Break time/day	70	LF to Route	290	4.83
	40	LF to yard	**25**	On-route second	315	5.25
			70	Route to LF	385	6.42
			15	Unload at LF	400	6.67
			40	LF to yard	440	7.33
			40	Breaks	480	*8.00*

Notes:

2	Assumes 80 percent of waste from AF and Marines located in north - 35 miles one way
21%	% full last load using minutes deduction to get 8 hours total
60%	Total Daily Efficiency prorated over 2 loads
140%	Increase Cost Factor

ALT 3 **ASSUMED USING NEW NAVY CENTRAL GUAM LANDFILL**

	Route time assumptions		Collection cycle		Cumul min	Cum hrs.
	15	yard to route	15	yard to route	15	0.25
	120	Assumed on-route	120	On route first load	135	2.25
Note 3	**50**	Route to LF or back	50	Route to LF	185	3.08
	15	Unload at LF	15	Unload at LF	200	3.33
	40	Break time/day	50	LF to Route	250	4.17
	40	LF to yard	**85**	On-route second	335	5.58
			50	Route to LF	385	6.42
			15	Unload at LF	400	6.67
			40	LF to yard	440	7.33
			40	Breaks	480	*8.00*

Notes:

3	Assumes 80 percent of waste from AF and Marines located in north - 25 miles one way
71%	% full last load using minutes deduction to get 8 hours total
85%	Total Daily Efficiency prorated over 2 loads
115%	Increase Cost Factor

LANDFILL OPERATION COST (current) - Refuse Trucks for Apra Harbor Landfill Location

Description	Quantity	Hours/Day	Wage $/Hour	Equipment Cost, $/Hour	Daily Cost $	Annual Cost $
Personnel						
Manager/Supervisor	1	8	$ 25.00	-	$ 200	$ 50,400
Operator/Equipment Operator (On-site)	1	8	$ 16.12	-	$ 129	$ 32,503
Equipment Operator (On-site)	1	8	$ 16.12	-	$ 129	$ 32,503
Drivers/Operators for Refuse Collection Trucks	8	8	$ 9.50	-	$ 608	$ 153,216
Laborers	3	8	$ 10.29	-	$ 247	$ 62,225
Environmental Specialist	1	2	$ 21.10	-	$ 42	$ 10,634
Equipment						
Dozer Operation	1	4	-	$ 66.77	$ 267	$ 67,304
Refuse Trucks Operation	8	6	-	$ 25.55	$ 1,226	$ 309,017
TOTALS					$ 2,848	$ 717,802
Collection Drivers and Trucks Only						$ 462,233

LANDFILL OPERATION COST (2015 and beyond @ approx 55,000 TPY) - Refuse Trucks (Apra Harbor Landfill Location)

Description	Quantity	Hours/Day	Wage $/Hour	Equipment Cost, $/Hour	Daily Cost, $	Annual Cost, $
Personnel						
Manager/Supervisor	1	8	$ 25.00	-	$ 200	$ 50,400
Operator/Equipment Operator (On-site)	1	8	$ 16.12	-	$ 129	$ 32,503
Equipment Operator (On-site)	1	8	$ 16.12	-	$ 129	$ 32,503
Drivers/Operators for Refuse Collection Trucks	**29**	8	$ 9.50	-	$ 2,204	$ 555,408
Laborers	**5**	8	$ 10.29	-	$ 412	$ 103,708
Environmental Specialist	1	**4**	$ 21.10	-	$ 84	$ 21,269
Equipment						
Dozer Operation	1	**8**	-	$ 66.77	$ 534	$ 134,608
Refuse Trucks Operation	**29**	6	-	$ 25.55	$ 4,445	$ 1,120,185
TOTALS					$ 8,137	$ 2,050,584
Collection Drivers and Trucks Only						$ 1,675,593

ALTERNATIVE 1-1 - LINE INACTIVE AREA OF LANDFILL							
ITEMS OF WORK		QUANTITIES		LABOR COST		TOTAL COST	
		NO OF UNITS	UN-IT	UNIT COST	COST	UNIT COST	COST
	REVISED						
001	**Landfill Control Building**						
	Landfill Control Building	600	SF	725	435,000	725	435,000
	SUBTOTAL						435,000
	TAX					4%	17,400
	TOTAL						452,400
002	**Truck Scale Facility**						
	Truck Scale Structure	780	CF	25	19,500	25	19,500
	Truck Scale	1	EA	70,000	70,000	70,000	70,000
	SUBTOTAL						89,500
	TAX					4%	3,580
	TOTAL						93,080
003	**Closure Cap**						
	Closure Cap (60 Acres)	1	LS	7,307,073	7,307,073	7,307,073	7,307,073
	SUBTOTAL						7,307,073
	TAX					4%	292,283
	TOTAL						7,599,356
004	**Landfill Gas Control System**						
	LFG Control System (60 Acres)	1	LS	1,721,739	1,721,739	1,721,739	1,721,739
	SUBTOTAL						1,721,739
	TAX					4%	68,870
	TOTAL						1,790,609
005	**Leachate Treatment System**						
	Leachate Treatment System (14.4 Acres)	1	LS	719,924	719,924	719,924	719,924
	Mechanical for Leachate Treatment System (14.4 Acres)	1	LS	15,566	15,566	15,566	15,566
	Electrical for Leachate Pumps (14.4 Acres)	1	LS	31,132	31,132	31,132	31,132
	SUBTOTAL						766,622
	TAX					4%	30,665
	TOTAL						797,287
006	**Site Work**						
	Chain Link Fence	1100	LF	64	70,683	64	70,683
	Gate	1	EA	3,753	3,753	3,753	3,753
	SUBTOTAL						74,436
	TAX					4%	2,977
	TOTAL						77,414
007	**Liner and Leachate Collection System**						
	Liner and Leachate Collection System (14.4 Acres)	1	LS	9,339,554	9,339,554	9,339,554	9,339,554
	SUBTOTAL						9,339,554
	TAX					4%	373,582
	TOTAL						9,713,136

COST MODEL SUMMARY SHEET

PROJECT TITLE			CONTRACT NO. N62742-06-D-1881
ACTIVITY Apra Harbor Naval Complex	LOCATION Guam		AMENDMENT NO.
PREPARED BY (Name)	TITLE OR ORGANIZATION HDR|Hawaii Pacific Engineers, Inc.	DATE	TYPE OF ESTIMATE
ACF / FY	FER	CATEGORY CODE	COST ESCALATED TO

	$/SYS	SYS QUAN (UM)	TOTAL	BUILDING	BUILT-IN EQUIPMENT
ALTERNATIVE 1-1 - LINE INACTIVE AREA OF LANDFILL					
PRIMARY FACILITIES					
001 Landfill Control Building	$ 452,400	1	$ 452,400.0		
002 Truck Scale Facility	$ 93,080	1	$ 93,080.0		
003 Closure Cap	$ 7,599,356	1	$ 7,599,355.9		
004 LFG Control System (60 Acres)	$ 1,790,609	1	$ 1,790,609		
005 Leachate Treatment System	$ 797,287	1	$ 797,286.9		
006 Site Work	$ 77,414	1	$ 77,413.6		
007 Liner and Leachate Collection System	$ 9,713,136	1	$ 9,713,136.2		
			$ 20,523,281.2		

ALTERNATIVE 1-2 - LINE EXIST AND INACTIVE AREA OF LANDFILL

	ITEMS OF WORK	QUANTITIES		LABOR COST		TOTAL COST	
	REVISED	NO OF UNITS	UN-IT	UNIT COST	COST	UNIT COST	COST
001	**Landfill Control Building**						
	Landfill Control Building	600	SF	725	435,000	725	435,000
	SUBTOTAL						435,000
	TAX					4%	17,400
	TOTAL						452,400
002	**Truck Scale Facility**						
	Truck Scale Structure	780	CF	25	19,500	25	19,500
	Truck Scale	1	EA	70,000	70,000	70,000	70,000
	SUBTOTAL						89,500
	TAX					4%	3,580
	TOTAL						93,080
003	**Closure Cap**						
	Closure Cap (60 Acres)	1	LS	7,307,073	7,307,073	7,307,073	7,307,073
	SUBTOTAL						7,307,073
	TAX					4%	292,283
	TOTAL						7,599,356
004	**Landfill Control System**						
	LFG Control System (60 Acres)	1	LS	1,721,739	1,721,739	1,721,739	1,721,739
	SUBTOTAL						1,721,739
	TAX					4%	68,870
	TOTAL						1,790,609
005	**Leachate Treatment System**						
	Leachate Treatment System (60 Acres)	1	LS	1,520,784	1,520,784	1,520,784	1,520,784
	Mechanical for Leachate Treatment System (60 Acres)	1	LS	32,882	32,882	32,882	32,882
	Electrical for Leachate Pumps (60 Acres)	1	LS	65,764	65,764	65,764	65,764
	SUBTOTAL						1,619,430
	TAX					4%	64,777
	TOTAL						1,684,207
006	**Site Work**						
	Chain Link Fence	1100	LF	64	70,683	64	70,683
	Gate	1	EA	3,753	3,753	3,753	3,753
	SUBTOTAL						74,436
	TAX					4%	2,977
	TOTAL						77,414
006	**Liner and Leachate Collection System**						
	Liner and Leachate Collection System (60 Acres)	1	LS	19,729,096	19,729,096	19,729,096	19,729,096
	SUBTOTAL						19,729,096
	TAX					4%	789,164
	TOTAL						20,518,260

COST MODEL SUMMARY SHEET

PROJECT TITLE				CONTRACT NO. N62742-06-D-1881
ACTIVITY Apra Harbor Naval Complex		LOCATION Guam		AMENDMENT NO.
PREPARED BY (Name)	TITLE OR ORGANIZATION HDR|Hawaii Pacific Engineers, Inc.		DATE	TYPE OF ESTIMATE
ACF	FY	FER	CATEGORY CODE	COST ESCALATED TO

	$/SYS	SYS QUAN (UM)	TOTAL	BUILDING	BUILT-IN EQUIPMENT
ALTERNATIVE 1-2 - LINE EXIST AND INACTIVE AREA OF LANDFILL					
PRIMARY FACILITIES					
001 Landfill Control Building	$ 452,400	1	$ 452,400		
002 Truck Scale Facility	$ 93,080	1	$ 93,080		
003 Closure Cap	$ 7,599,356	1	$ 7,599,356		
004 Landfill Control System	$ 1,790,609	1	$ 1,790,609		
005 Leachate Treatment System	$ 1,684,207	1	$ 1,684,207		
006 Site Work	$ 77,414	1	$ 77,414		
007 Liner and Leachate Collection System	$20,518,260	1	$ 20,518,260		
			$ 32,215,325		

ALTERNATIVE 2 - USE GOVGUAM LANDFILL CLOSE EXISTING UNLINED LANDFILL							
	ITEMS OF WORK	QUANTITIES		COST		TOTAL COST	
	REVISED	NO OF UNITS	UN-IT	UNIT COST	COST	UNIT COST	COST
001	**Landfill Control Building**						
	Landfill Control Building	600	SF	725	435,000	725	435,000
	SUBTOTAL						435,000
	TAX					4%	17,400
	TOTAL						452,400
002	**Truck Scale Facility**						
	Truck Scale Structure	780	CF	25	19,500	25	19,500
	Truck Scale	1	EA	70,000	70,000	70,000	70,000
	SUBTOTAL						89,500
	TAX					4%	3,580
	TOTAL						93,080
003	**Closure Cap**						
	Closure Cap (60 Acres)	1	LS	7,307,073	7,307,073	7,307,073	7,307,073
	SUBTOTAL						7,307,073
	TAX					4%	292,283
	TOTAL						7,599,356
004	**Landfill Gas Venting System**						
	LFG Venting System (60 Acres)	1	LS	182,677	182,677	182,677	182,677
	SUBTOTAL						182,677
	TAX					4%	7,307
	TOTAL						189,984
005	**Site Work**						
	Chain Link Fence	1100	LF	64	70,683	64	70,683
	Gate	1	EA	3,753	3,753	3,753	3,753
	SUBTOTAL						74,436
	TAX					4%	2,977
	TOTAL						77,414

COST MODEL SUMMARY SHEET

PROJECT TITLE				CONTRACT NO. N62742-06-D-1881
ACTIVITY Apra Harbor Naval Complex		LOCATION Guam		AMENDMENT NO.
PREPARED BY (Name)	TITLE OR ORGANIZATION HDR|Hawaii Pacific Engineers, Inc.		DATE	TYPE OF ESTIMATE
ACF	FY	FER	CATEGORY CODE	COST ESCALATED TO

	$/SYS	SYS QUAN (UM)	TOTAL	BUILDING	BUILT-IN EQUIPMENT
ALTERNATIVE 2 - USE GOVGUAM LANDFILL CLOSE UNLINED LANDFILL					
PRIMARY FACILITIES					
001 Landfill Control Building	452,400	1	452,400		
002 Truck Scale Facility	93,080	1	93,080		
003 Closure Cap	7,599,356	1	7,599,356		
004 Landfill Gas Venting System	189,984	1	189,984		
005 Site Work	77,414	1	77,414		
			8,412,234		

ALTERNATIVE 3 - NEW LANDFILL						
ITEMS OF WORK	QUANTITIES		LABOR COST		TOTAL COST	
REVISED	NO OF UNITS	UN-IT	UNIT COST	COST	UNIT COST	COST
001 Landfill Control Building						
Landfill Control Building	600	SF			1,102	661,000
SUBTOTAL						661,000
TAX					4%	26,440
TOTAL						687,440
002 Truck Scale Facility						
Truck Scale Structure	780	CF			37	29,000
Truck Scale	1	EA			106,000	106,000
SUBTOTAL						135,000
TAX					4%	5,400
TOTAL						140,400
003 Leachate Treatment System						
Leachate Treatment System (60 Acres)	1	LS			2,103,000	2,103,000
Mechanical for Leachate Treatment System (60 Acres)	1	LS			45,000	45,000
Electrical for Leachate Pumps (60 Acres)	1	LS			91,000	91,000
SUBTOTAL						2,239,000
TAX					4%	89,560
TOTAL						2,328,560
004 Site Work						
Clearing and Grubbing	1	LS			101,000	101,000
Chain Link Fence	6000	LF			97	583,000
Gate	1	EA			6,000	6,000
Earthwork	1200000	CY			10	12,000,000
Gunite Lining, fiber reinforced, 4-in thick	2000000	SF			23	46,000,000
Potable Water	1	LS			21,000	21,000
Septic Tank and Subsurface Disposal	1	LS			168,000	168,000
Groundwater Monitoring Wells	1	LS			1,885,000	1,885,000
Electrical	1	LS			402,000	402,000
Mechanical	1	LS			749,000	749,000
SUBTOTAL						61,915,000
TAX					4%	2,476,600
TOTAL						64,391,600
005 Liner and Leachate Collection System						
Liner and Leachate Collection System (60 Acres)	1	LS			27,288,000	27,288,000
SUBTOTAL						27,288,000
TAX					4%	1,091,520
TOTAL						28,379,520

COST MODEL SUMMARY SHEET

PROJECT TITLE				CONTRACT NO. N62742-06-D-1881
ACTIVITY Apra Harbor Naval Complex		LOCATION Guam		AMENDMENT NO.
PREPARED BY (Name)	TITLE OR ORGANIZATION HDR|Hawaii Pacific Engineers, Inc.		DATE	TYPE OF ESTIMATE
ACF	FY	FER	CATEGORY CODE	COST ESCALATED TO

	$/SYS	SYS QUAN (UM)	TOTAL	BUILDING	BUILT-IN EQUIPMENT
ALTERNATIVE 3 - NEW LANDFILL					
PRIMARY FACILITIES					
001 Landfill Control Building	$ 687,440	1	$ 687,440		
002 Truck Scale Facility	$ 140,400	1	$ 140,400		
003 Leachate Treatment System	$ 2,328,560	1	$ 2,328,560		
004 Site Work	$ 64,391,600	1	$ 64,391,600		
005 Liner and Leachate Collection System	$ 28,379,520	1	$ 28,379,520		
			$ 95,927,520		

Project:	**Guam Modular WTE Feasibility Study**
Technology:	**Modular Mass Burn Facility 120 tpd-7 days per week**
Date:	**02/12/08**
Estimate Basis:	**Conceptual Layout (Average 120tpd)**
Costs:	**2008$**
Location:	**Guam**

ALTERNATIVE 4a
COST SUMMARY(1)
MODULAR MASS BURN FACILITY
Conceptual Layout (Average 120tpd)

TOTAL CAPITAL COST	$41,390,000	to	$50,588,000
ANNUAL OPERATION & MAINTENANCE COST	$6,445,154	to	$7,090,000
ANNUAL COST	$10,661,154	to	$12,242,000
YEAR 2008 ANNUAL TONNAGE	37,230	Short tons	
COST PER TON (Before Energy Revenues)	$286	to	$329

Notes
(1) All costs are presented in 2008 Dollars

Project:	**Guam Modular WTE Feasibility Study**	
Technology:	**Modular Mass Burn Facility**	**120 tpd-7 days per week**
Date:	**02/12/08**	
Estimate Basis:	**Conceptual Layout (Average 120tpd)**	
Costs:	**2008$**	
Location:	**Guam**	

ALTERNATIVE 4a
MODULAR MASS BURN FACILITY
CAPITAL COST SUMMARY [1]
Conceptual Layout (Average 120tpd)

			Estimated Costs[2]
I.	SITE AQUISITION		$ -
II.	SITE DEVELOPMENT		$ 2,739,400
III.	SCALE HOUSE AND SCALES		$ 247,101
IV.	BUILDINGS		$ 6,456,100
V.	PROCESSING EQUIPMENT		$ -
VI.	MOBILE EQUIPMENT		$ 699,900
VII.	POWER BLOCK EQUIPMENT		$ 19,916,224
	SUBTOTAL CONSTRUCTION AND EQUIPMENT		$ 30,058,726
	CONTINGENCY	25%	$ 7,514,700
	SALES TAX	4%	$ 1,502,900
	DESIGN/ENGINEERING	8%	$ 3,005,900
	PERMITTING		$ 450,000
	SURVEYING AND SOILS REPORT		$ 75,000
	CONSTRUCTION INSPECTION	5%	$ 1,878,700
	START UP AND TESTING	4%	$ 1,502,900
	TOTAL CAPITAL COST (FACILITY IMPLEMENTATION)		$ 45,988,826

Project:	**Guam Modular WTE Feasibility Study**	
Technology:	**Modular Mass Burn Facility**	**120 tpd-7 days per week**
Date:	**02/12/08**	
Estimate Basis:	**Conceptual Layout (Average 120tpd)**	
Costs:	**2008$**	
Location:	**Guam**	

NOTES:

(1) All costs rounded to 1000's

(2) All costs in 2008 $.

I. SITE AQUISITION

Subtotal I	$0

II. SITE DEVELOPMENT

Item	Quantity	Units	Unit Price	Item Cost		Total
Site Preparation					$	367,400
Excavation - foundations(1)	9,400	cy	$17	$159,300		
General Earthwork (2)	15,100	cy	$14	$204,700		
Finishing Grassing & Grading	1	acres	$3,390	$3,400		
Demolition	0	cy material	$339	$0		
Site Improvements					$	1,312,700
Approach /Roadways Concrete (3)	4,000	sy	$102	$406,800		
Asphalt Roadways & Parking	5,000	sy	$68	$339,000		
Retaining Walls	400	cy	$847	$339,000		
Site Drainage	1	L.S.	$127,110	$127,100		
Fencing(4)	2,000	lf	$25	$50,800		
Landscaping (Minimal)	1	L.S.	$50,000	$50,000		
Site Utilities (5)					$	1,059,300
Fire Protection	2,000	lf	$42	$84,700		
Water Supply	1,500	lf	$42	$63,600		
Well Field	0	LS	$50,000	$0		
Sewer System	1,500	lf	$42	$63,600		
Electrical Substation	1	L.S.	$847,399	$847,400		
Subtotal II					$	2,739,400

Notes:

(1) Based on estimated building square footages. Demolition calculated separately below

(2) General Earthwork includes moving soil, backfill, embankment, loadout tunnel excav, etc.

(3) Roadway unit price includes curbs, gutters, etc.

(4) Assumes perimeter fencing at 6' (w/ barbed wire) with gates and litter fencing around maneuvering area of 15' height.

(5) Utilities unit price includes excavation, bedding material, piping installed, backfill, etc.

III. SCALE HOUSE AND SCALES

Item	**Quantity**	**Units**	**Unit Price**	**Item Cost**	**Total**
Metal Building (1)	400	sf	$153	$61,013	
Concrete Slabwork(2)	15	cy	$339	$5,084	
Concrete Footings	10	cy	$678	$6,779	
Interior Treatments(3)	400	sf	$85	$33,896	
Motor Truck Scales & Foundations	2	LS	$93,214	$186,428	
Mechanical(4)	400	sf	$17	$6,779	
Electrical(5)	400	sf	$20	$8,135	
Subtotal III					$247,101

Notes:

(1) No additional facilities for waste delivery truck drivers or admintration activities areas, are included.

(2) Assumes stable soil with good load bearing capacity. Slab floor is 6" reinforced concrete.

(3) Includes tile, painting, window covers and funiture

(4) Building mechanical includes drains, plumbing, air handling, fire protection, etc.

(5) Electrical includes lighting, power, communications, etc.

Project:	**Guam Modular WTE Feasibility Study**	
Technology:	**Modular Mass Burn Facility**	**120 tpd-7 days per week**
Date:	**02/12/08**	
Estimate Basis:	**Conceptual Layout (Average 120tpd)**	
Costs:	**2008$**	
Location:	**Guam**	

IV. BUILDINGS

Item	Quantity	Units	Unit Price	Item Cost	Total
Metal Buildings - Preengineered (1) (2)	13,000	sf	$ 153	$1,982,900	
Ash Concrete Push Walls(3)	100	cy	$ 678	$67,800	
Metal Buildings - Engineered	672,000	cf	$ 6	$3,986,200	
Concrete Pit (3)	0	cy	$ 400	$0	
Overhead Doors	4	ea	$ 16,948	$67,800	
Admin. Area	1,728	sf	$ 203	$351,400	
Subtotal IV					$6,456,100

Notes:

(1) Metal bldg. includes structural steel, column free bldg. (long span), 30 ft. clear height, & 20 yr roofing warranty with mechanical and electrical.

(2) Assumes stable soil with good load bearing capacity. Slab floor is 10" reinforced concrete on grade;
12" on structural slabs

(3) 4 ft thick wall with 10 ft thick mat

V. PROCESSING EQUIPMENT

Item	Quantity	Type	Units	Unit Price	Item Cost	Total
Overhead Cranes NOT USED		Hydraulic Grapple	0	$ 259,560	$ -	
Subtotal V						$0

Notes:

VI. MOBILE EQUIPMENT

Item	Quantity	Units	Unit Price	Item Cost	Total
Ash Trucks and Trailers	1	ea	$211,850	$211,800	
Loader	1	ea	$254,220	$254,200	
Back up Loader	1	ea	$200,000	$200,000	
Pick-up/Utility Truck	1	ea	$33,896	$33,900	
Subtotal VI					$699,900

Notes:

(1) Loader used for fuel handling

Project:	**Guam Modular WTE Feasibility Study**	
Technology:	**Modular Mass Burn Facility**	**120 tpd-7 days per week**
Date:	**02/12/08**	
Estimate Basis:	**Conceptual Layout (Average 120tpd)**	
Costs:	**2008$**	
Location:	**Guam**	

VII. POWER BLOCK EQUIPMENT

Item	Quantity	Unit	Unit Price	Item Cost	Total
Modular Mass Burn Incinerator (1)	3	ls	$956,712	$2,870,100	
Heat Recovery Boiler(1)	3	ls	$260,073	$780,200	
SNCR (NOx Control)	0	ls	$89,598	$0	
Air Pollution Control Equipment(1)	3	ls	$673,425	$2,020,300	
Continuous Emissions Monitoring	3	ls	$288,541	$865,624	
Bottom Ash Quench(1)	3	ls	$54,048	$162,100	
Bottom Ash Conveying	1	ls	$400,000	$400,000	
Flyash Handling/Conditioning	3	ls	$299,799	$899,400	
Aux Cooling Water System	1	ls	$46,448	$46,400	
Condensate System	1	ls	$160,456	$160,500	
Chem Feed	1	ls	$87,265	$87,300	
Circulating Water System	1	ls	$137,232	$137,200	
Waste Water System	1	ls	$161,863	$161,900	
Water Treatment	1	ls	$157,641	$157,600	
Fire Protection	1	ls	$135,825	$135,800	
Feedwater System(1)	1	ls	$125,370	$125,400	
Compressed Air System	1	ls	$34,484	$34,500	
Service Water System	1	ls	$33,076	$33,100	
Steam Piping	1	ls	$46,448	$46,400	
Steam Turbine (2)	1	ls	$557,200	$557,200	
Electrical System	1	ls	$2,060,591	$2,060,600	
Equipment Subtotal					$11,741,624
Boiler Erection (Labor)	1	ls	$2,835,300	$2,835,300	
Steam Turbine Installation(2)	1	ls	$390,040	$390,000	
Mechanical Systems Installation (Labor)	1	ls	$2,375,906	$2,375,900	
Electrical Installation (Labor)	1	ls	$1,556,783	$1,556,800	
Ocean Freight	3	ls	$200,000	$600,000	
Installation Subtotal					$7,758,000
Shop Tools & Equip.	1	Allowance	$122,531	$122,500	
Control Room Furnishings	1	Allowance	$49,012	$49,000	
Spare Parts	1	Allowance	$245,061	$245,100	
Miscellaneous Items					$416,600
Subtotal VII					**$19,916,224**

Notes:

(1) Based on equipment quote from Pennram

(2) Based on equipment qoute and installation estimate from Turbosteam

Subtotal I through VII	**$30,058,726**

Project:	**Guam Modular WTE Feasibility Study**	
Technology:	**Modular Mass Burn Facility**	**120 tpd-7 days per week**
Date:	**02/12/08**	
Estimate Basis:	**Conceptual Layout (Average 120tpd)**	
Costs:	**2008$**	
Location:	**Guam**	

ALTERNATIVE 4a
MODULAR MASS BURN FACILITY
OPERATIONS AND MAINTENANCE COST SUMMARY [1]
Conceptual Layout (Average 120tpd)

			Estimated Costs[2]
I.	LABOR		$ 1,778,000
II.	FACILITY MAINTENANCE		$ 844,000
III.	UTILITIES		$ 932,928
IV.	PROCESS RESIDUE HAUL & DISPOSAL		$ 419,226
V.	ROLLING STOCK O&M COSTS		$ 126,900
VI.	MISCELLANEOUS COSTS		$ 91,100
	SUBTOTAL OPERATION & MAINTENANCE		$ 4,192,154
	CONTINGENCY	25%	$ 1,048,000
	OVERHEAD AND PROFIT	15%	$ 786,000
	ACCOUNTING, SUPPLIES, MISC.	5%	$ 262,000
	ADMINISTRATION	3%	$ 157,000
TOTAL ANNUAL OPERATION & MAINTENANCE COST			$ 6,445,154
VII.	MINUS	SALES REVENUES[3]	$ 489,194
NET ANNUAL OPERATION & MAINTENANCE COST			$ 5,955,960

NOTES:
(1) All costs rounded to 1000
(2) All costs in 2008$
(3) Doesn't include ferrous revenues

Project:	**Guam Modular WTE Feasibility Study**	
Technology:	**Modular Mass Burn Facility**	**120 tpd-7 days per week**
Date:	**02/12/08**	
Estimate Basis:	**Conceptual Layout (Average 120tpd)**	
Costs:	**2008$**	
Location:	**Guam**	

I. LABOR

Job Classification	Personnel(1)	$/hr(2)	hrs/yr (3)	Over-time Hrs	Annual Cost	% OT	Total
Facility Manager	1	$54	2,080	0	$112,000	0%	
Operating Engineer	1	$47	2,080	0	$98,000	0%	
Administrative/Clerical	1	$20	2,080	208	$48,000	10%	
Scale Attendant	2	$24	2,080	208	$116,000	10%	
Lead Equipment Operator	4	$41	2,080	312	$413,000	15%	
Equipment Operators	8	$30	2,080	312	$605,000	15%	
Mechanic	1	$34	2,080	208	$81,000	10%	
Electrician/Electronics Specialis	1	$34	2,080	208	$81,000	10%	
Welders	1	$34	2,080	208	$81,000	10%	
Helper	0	$20	2,080	208	$0	10%	
Residue Disposal Drivers	1	$27	2,080	208	$65,000	10%	
Spotters/Laborers	2	$16	2,080	208	$78,000	10%	
Subtotal	23						$1,778,000

Notes:

(1) Based on a 24-hour, seven day per week operation.
(2) Includes fringe benefits (retirement, ss, workers comp, health & life insurance, vacation/sick leave) at 35%
and overtime rate is at 1.5 times straight time
(3) Assumes standard working shift hours 5 Days/Wk 8 Hr/Day

II. FACILITY MAINTENANCE

Item	% of Capital Value	Quantity	Unit	Unit Price	Annual Cost		Total
Site Maintenance(1)	1.5%	1	Lump	$ 35,580	$35,580		
Building Repair & Replacement	3.3%	1	Lump	$ 221,000	$221,000		
Equipment Maintenance (3)	2.0%	1	Lump	$ 234,832	$234,832		
Equipment Replacement (4)	3.0%	1	Lump	$ 352,249	$352,249		
Subtotal						$	844,000

Notes:

(1) Percentage of capital value is based on empirical data from operating plants in the U.S.
(2) Site maintenance is estimated as % capital construction cost for site improvements and site utilities.
(3) Buidling repair base on a 30 year depreciation of the original capital cost with escalation.
(4) Equipment maintenance (annual needs) and replacement (periodic needs) estimated based on assumed 20 life.

Project:	Guam Modular WTE Feasibility Study		
Technology:	Modular Mass Burn Facility	120	tpd-7 days per week
Date:	02/12/08		
Estimate Basis:	Conceptual Layout (Average 120tpd)		
Costs:	2008$		
Location:	Guam		

III. UTILITIES

Item	Quantity	Unit	Unit Price	Annual Cost	Total
Electricity Purchase (1)	127	MWh/yr	$ 200	$ 25,316	
Propane(2)	308	Gal/Yr	$ 3.39	$ 1,043	
Diesel (3)	206,361	Gal/Yr	$ 3.75	$ 773,852	
Telephone (Mobile/Fixed) (4)	20	Phones	$ 480	$ 9,600	
Water	32,830,965	Gal/Yr	$ 0.003	$ 98,493	
Sewer (5)	8,207,741	Gal/Yr	$ 0.003	$ 24,623	
Subtotal					$ 932,928

Notes:

(1) Electricity purchase accounts for energy use during downtimes only; inhouse power provided by the system otherwise.

(2) Propane used for burner ignition 2008 price ratioed according with diesel prices plus 10%

(3) Diesel used for start-up and shutdown and to maintain "good combustion control" in secondary chamber

(4) Based on mobile phones for entire staff except drivers, helpers and laborers.

(5) Sewer use based on 25% of water use; evaporation and ash quench account for rest.

IV. PROCESS RESIDUE HAUL & DISPOSAL

Item	Cost /Load(1)	Quantity	Unit	Unit Price	Annual Cost	Total
Process Residue Haul	$ 75	503	Tons	$ 3.75	$ 1,886	
Ash Haul	$ 75	14,079	Tons	$ 3.75	$ 52,796	
Landfill Disposal Fees		14,582	Tons	$ 25.00	$ 364,545	
Subtotal						$ 419,226

Notes:

(1) Cost assumes truck operating costs per 20-ton load

V. ROLLING STOCK O&M COSTS

Fuel	Weeks	Unit Rate	Units	Unit Price	Annual Cost	Total
Loader	52	200	gal/wk	$ 3.75	$39,000	
Back up Loader	52	100	gal/wk	$ 3.75	$19,500	
Pick-up Truck	52	30	gal/wk	$ 3.75	$5,900	
Maintenance	**# Vehicles**	**Quantity**	**Units**	**Unit Price**	**Annual Cost**	**Total**
Loader	1	1	L.S.	$13,982	$14,000	
Pick-up Truck	1	12,000	Miles/Yr	$0.50	$6,000	
General O&M		1	L.S.	$42,500	$42,500	
Subtotal						$126,900

Notes:

(1) Based on Owning and Operationg Cost Methodology in the Catepillar Performance Handbook.

Project:	Guam Modular WTE Feasibility Study	
Technology:	Modular Mass Burn Facility	120 tpd-7 days per week
Date:	02/12/08	
Estimate Basis:	Conceptual Layout (Average 120tpd)	
Costs:	2008$	
Location:	Guam	

VI. MISCELLANEOUS COSTS

Item	Useage (1)	Quantity	Unit	Unit Price	Annual Cost	Total
Property Insurance (2)	1	0.3%			$88,100	
Flood Insurance (2)	0	1.2%			$0	
Property Taxes (3)	1	3,252	m2	$0.78	$3,000	
Subtotal						$ 91,100

Notes:

(1) Multiplier used to adjust costs for various potential sites. Zero means expense not appicalbe to this site.

(2) Based on % of capital construction costs.

(3) Based on area of developed property.

Subtotal I through VI	$4,192,154

VII. SALES REVENUES(3)

Material	Units	Unit	Unit Value	Annual Revenues	Total
Net Electric Generation	4,447	MWh	$110	$489,194	Addressed in Pro Forma
Net Steam Generation	176,843	Mlbs.	$0	$0	Addressed in Pro Forma
Aluminum	-	Tons	$800	$0	No recovery provided
Ferrous Metals	-	Tons	$25	$0	
Subtotal VII					$489,194

Water Usage Estimates 120 TPD

	Assumptions	Gallons/Yr	Liters/Year
		Conversion factor =	3.785412
Domestic	**Assumptions**	**Gallons/Yr**	**Liters/Year**
Average People/Day	5.48		
gpd/person	25		
gallons per day	137		
days/week	7		
weeks/year	52		
gallons per year		49,833	188,640
Blowdown/Spray Dryer	4%	947,482	
Spray Dryer(Lb/hr Water/tpd Fuel)	212.00	2,950,564	
Ash Quench(15% moisture)	5.80	423,529	
Cooling Tower (blowdown 20% evap.)		28,424,448	
Washdown		35,100	132,868
Total Water Usage		32,830,957	124,278,698
Evaporation/Ash Quench	75%	24,623,218	93,209,023
Total Sewer Usage		8,207,739	31,069,674

Reagent Usage Estimates

	Qty/Ton
Lime (Lbs/Ton)	20
Ammonia (lbs/Ton)	NA
Carbon (Lbs/Ton)	0.66

Energy Generation Assumptions

	Gross Generation Amount/Ton	In-House Power Amount/Ton	Net Generation Amount/Ton		Net Annual Generation	
Steam Production (mlb)	5.41	0.66	4.75	=	176,843	Mlbs.
Electricity Production (kWh)	136	16.55	119	=	4,447	MWh
Single stage condensing turbine	0.68	MW at	27,040	lbs/hr	0%	Margin

Energy Consumption Assumptions

Item	mmBtu/Ton	Btu/Gal	MMBTU	Gal/yr
Propane (mmBtu)	0.000757	91600	28	308
Diesel (mmBtu)	0.776	140000	28,890	206,361

Item	Qty/Ton	hp	load factor	kw	hrs/year	kwh/yr
Power Purchase Req. (kWh/Ton)	3.4					126,582
Total Purchase						126,582

MSW Quanitites and Characteristics

Waste Quantity	40,000	tpy		
Daily Delivery	110	tpd - 7 days per weeks		
Capacity Factor	85%			
Delivery Capacity	129	tpd - 5 days per week		
Annual Throughput	37,230	tpy		
MSW HHV (B&W)	5,200	Btu/lb		
Boiler Efficiency (B&W)	65%			
Fuel Feed Rate (B&W)	10,000	Lbs/Hr at	120	tons/day
Gross Steam Production (B&W)	27,040	Lb/Hr	5408	lbs(steam)/ton

MSW Storage Calculations

Floor Storage Days	3	Days		
Floor Storage Tons	387	tons		
MSW Density	17	lb/cf		
MSW Volume Capacity	46,414	cu. ft.		
Pit Area - NOT USED	900	SF	35	ft deep plus 50% of vol. up to charging level
Pit length - NOT USED	26	ft at	35	feet wide

Residue Disposal

Assumes 5% unburned and combined fly ash and bottom ash with scrubber residue.

Residue Disposal	1.5%	2	tpd5	0.1	Truckloads/Day5
Ash Disposal	30%	38.7	tpd7	2	Truckloads/Day7
Truck Payload (Tons)	20			2.0	Truckloads/Day
		28	HRS/week	4	HRs/day
				2	Round Trip Haul

Basic Conceptual Layout Dimensions

		Length	Span	Area	Height	Number of Stories	Size Adjustment
Conversion Factor	**M to Ft**	**3.28084**	**3.28084**	**10.76391111**	**3.28084**		
Exterior Maneuvering	Feet	150.0	60.0	9,000			
	Meters	45.7	18.3	836			
MSW Tipping Floor	Feet	75.0	150.0	11,250	40.0	1.0	
	Meters	22.9	45.7	1,045	12.2		
Boiler Bldg	Feet	35.0	150.0	5,250	115.0	1.0	
	Meters	10.7	45.7	488	35.1		
Turbine Building	Feet	50.0	45.0	4,500	15.0	2.0	
	Meters	15.2	13.7	209	4.6		
Maintenance/Storage	Feet	48.0	36.0	1,728	16.4	1.0	0.8
	Meters	14.6	11.0	161	5		
Admin/ Control Room	Feet	48.0	36.0	1,728	16.4	1.0	0.8
	Meters	14.6	11.0	161	5		
Refuse Storage Bldg (Pit)	Feet		35.0	-	115.0	1.0	
	Meters	0.0	10.7	-	31		
Ash Storage Bldg	Feet	35.0	30.0	1,050	30.0	1.0	0.75
	Meters	10.7	9.1	98	9.1		
Site Development	Feet	350.0	100.0	35,000			
	Meters	106.7	30.5	3,252			
		Total Bldg Floor Area		14,256			

Modular Mass Burn Facility

Capital Cost	$	45,989,000	
Life Extension Measures	$	32,315,424	Capital cost less site work, scalehouse and scales, buildings, mobile equipment, engineering, permitting, survey
Operating Cost	$	6,445,000	
Energy Revenue	$	489,000	

2008 Dollars

Capital Cost Breakdown			
Year 0	$	2,629,000	Permitting, survey, and 70% engineering work
Year 1	$	17,284,000	40% of total less start up, permitting, survey, 70% of engineering
Year 2	$	26,076,000	60% of total plus startup less permitting, survey and engineering
Total	$	45,989,000	

Life Extension			
Year 15	$	8,079,000	25%
Year 20	$	16,158,000	50%
Year 25	$	8,079,000	25%

Project:	**Guam Field Erected WTE Feasibility Study**	
Technology:	**Mass Burn Facility**	**150 tpd-7 days per week**
Date:	**04/09/08**	
Estimate Basis:	**Conceptual Layout (Average 150tpd)**	
Costs:	**2008$**	
Location:	**Guam**	

ALTERNATIVE 4b
COST SUMMARY(1)
MASS BURN FACILITY
Conceptual Layout (Average 150tpd)

TOTAL CAPITAL COST	$88,401,000	to	$108,046,000
ANNUAL OPERATION & MAINTENANCE COST	$6,795,174	to	$7,475,000
ANNUAL COST	$15,799,174	to	$18,480,000
YEAR 2003 ANNUAL TONNAGE	37,230	Short tons	
COST PER TON (Before Energy Revenues)	$424	to	$496

Notes
(1) All costs are presented in 2008 Dollars

Project:	**Guam Field Erected WTE Feasibility Study**	
Technology:	**Mass Burn Facility**	**150 tpd-7 days per week**
Date:	**04/09/08**	
Estimate Basis:	**Conceptual Layout (Average 150tpd)**	
Costs:	**2008$**	
Location:	**Guam**	

ALTERNATIVE 4b
MASS BURN FACILITY
CAPITAL COST SUMMARY (1)
Conceptual Layout (Average 150tpd)

				Estimated Costs(2)
I.	SITE AQUISITION		$	-
II.	SITE DEVELOPMENT		$	2,491,900.00
III.	SCALE HOUSE AND SCALES		$	247,101
IV.	BUILDINGS		$	6,320,500
V.	PROCESSING EQUIPMENT		$	879,803
VI.	MOBILE EQUIPMENT		$	499,900
VII.	POWER BLOCK EQUIPMENT		$	54,155,041
	SUBTOTAL CONSTRUCTION AND EQUIPMENT		$	64,594,246
	CONTINGENCY	25%	$	16,148,600
	SALES TAX	4%	$	3,229,700
	DESIGN/ENGINEERING	8%	$	6,459,400
	PERMITTING		$	450,000
	SURVEYING AND SOILS REPORT		$	75,000
	CONSTRUCTION INSPECTION	5%	$	4,037,100
	START UP AND TESTING	4%	$	3,229,700
	TOTAL CAPITAL COST (FACILITY IMPLEMENTATION)		$	98,223,746

NOTES:
(1) All costs rounded to 1000's
(2) All costs in 2008 $.

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Date:	**04/09/08**		
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Costs:	**2008$**		
Location:	**Guam**		

I. SITE AQUISITION

Subtotal I	$0

II. SITE DEVELOPMENT

Item	Quantity	Units	Unit Price	Item Cost		Total
Site Preparation					$	194,600
Excavation - foundations(1)	7,600	cy	$17	$128,800		
General Earthwork (2)	4,600	cy	$14	$62,400		
Finishing Grassing & Grading	1	acres	$3,390	$3,400		
Demolition	0	cy material	$339	$0		
Site Improvements					$	1,238,000
Approach /Roadways Concrete (3)	3,500	sy	$102	$355,900		
Asphalt Roadways & Parking	3,400	sy	$68	$230,500		
Retaining Walls	500	cy	$847	$423,700		
Site Drainage	1	L.S.	$127,110	$127,100		
Fencing(4)	2,000	lf	$25	$50,800		
Landscaping (Minimal)	1	L.S.	$50,000	$50,000		
Site Utilities (5)					$	1,059,300
Fire Protection	2,000	lf	$42	$84,700		
Water Supply	1,500	lf	$42	$63,600		
Well Field	0	LS	$50,000	$0		
Sewer System	1,500	lf	$42	$63,600		
Electrical Substation	1	L.S.	$847,399	$847,400		
Subtotal II					$	2,491,900

Notes:

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(2) General Earthwork includes moving soil, backfill, embankment, loadout tunnel excav, etc.

(3) Roadway unit price includes curbs, gutters, etc.

(4) Assumes perimeter fencing at 6' (w/ barbed wire) with gates and litter fencing around maneuvering area of 15' height.

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Metal Building (1)	400	sf	$153	$61,013	
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Subtotal III					$247,101

Notes:

(1) No additional facilities for waste delivery truck drivers or admintration activities areas, are included.

(2) Assumes stable soil with good load bearing capacity. Slab floor is 6" reinforced concrete.

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Project:	**Guam Field Erected WTE Feasibility Study**	
Technology:	**Mass Burn Facility**	**150 tpd-7 days per week**
Date:	**04/09/08**	
Estimate Basis:	**Conceptual Layout (Average 150tpd)**	
Costs:	**2008$**	
Location:	**Guam**	

IV. BUILDINGS

Item	Quantity	Units	Unit Price	Item Cost	Total
Metal Buildings - Preengineered (1) (2)	3,000	sf	$ 153	$457,600	
Ash Concrete Push Walls(3)	100	cy	$ 678	$67,800	
Metal Buildings - Engineered	792,000	cf	$ 6	$4,698,000	
Concrete Pit (3)	1,000	cy	$ 678	$677,900	
Overhead Doors	4	ea	$ 16,948	$67,800	
Admin. Area	1,728	sf	$ 203	$351,400	
Subtotal IV					$6,320,500

Notes:

(1) Metal bldg. includes structural steel, column free bldg. (long span), 30 ft. clear height, & 20 yr roofing warranty with mechanical and electrical.

(2) Assumes stable soil with good load bearing capacity. Slab floor is 10" reinforced concrete on grade;
12" on structural slabs

(3) 4 ft thick wall with 10 ft thick mat

V. PROCESSING EQUIPMENT

Item	Quantity	Type	Units	Unit Price	Item Cost	Total
Overhead Cranes		Hydraulic Grapple	2	$ 439,902	$ 879,803	
Subtotal V						$879,803

Notes:

VI. MOBILE EQUIPMENT

Item	Quantity	Units	Unit Price	Item Cost	Total
Ash Trucks and Trailers	1	ea	$211,850	$211,800	
Loader	1	ea	$254,220	$254,200	
Pick-up/Utility Truck	1	ea	$33,896	$33,900	
Subtotal VI					$499,900

Notes:

(1) Loader used for ash loading and general maintenance activities

Project:	**Guam Field Erected WTE Feasibility Study**		
Technology:	**Mass Burn Facility**	**150**	**tpd-7 days per week**
Date:	**04/09/08**		
Estimate Basis:	**Conceptual Layout (Average 150tpd)**		
Costs:	**2008$**		
Location:	**Guam**		

VII. POWER BLOCK EQUIPMENT

Item	Quantity	Unit	Unit Price	Item Cost	Total
Mass Burn Boiler (1)	1	ls	$19,921,027	$19,921,000	
SNCR (NOx Control)	1	ls	$264,388	$264,400	
Continuous Emissions Monitoring	1	ls	$288,541	$288,541	
Bottom Ash Handling	1	ls	$377,742	$377,700	
Flyash Handling/Conditioning	1	ls	$358,392	$358,400	
Aux Cooling Water System	1	ls	$55,526	$55,500	
Condensate System	1	ls	$191,815	$191,800	
Chem Feed	1	ls	$104,321	$104,300	
Circulating Water System	1	ls	$164,053	$164,100	
Waste Water System	1	ls	$193,498	$193,500	
Water Treatment	1	ls	$188,450	$188,500	
Fire Protection	1	ls	$162,370	$162,400	
Feedwater System	1	ls	$147,227	$147,200	
Compressed Air System	1	ls	$41,224	$41,200	
Service Water System	1	ls	$39,541	$39,500	
Steam Piping	1	ls	$55,526	$55,500	
Steam Turbine	1	ls	$2,563,367	$2,563,400	
Electrical System	1	ls	$2,463,315	$2,463,300	
Equipment Subtotal					$27,580,241
Boiler Erection (Labor)	1	ls	$17,928,924	$17,928,900	
Steam Turbine Installation	1	ls	$1,794,357	$1,794,400	
Mechanical Systems Installation (Labor)	1	ls	$3,250,136	$3,250,100	
Electrical Installation (Labor)	1	ls	$1,724,320	$1,724,300	
Ocean Freight	1	ls	$1,379,012	$1,379,000	
Installation Subtotal					$24,697,700
Shop Tools & Equip.	1	Allowance	$146,478	$146,500	
Control Room Furnishings	1	Allowance	$58,591	$58,600	
Spare Parts	1	Allowance	$292,956	$293,000	
Miscellaneous Items					$498,100
Subtotal VII					**$54,155,041**

Notes:

(1) Based on equipment quote from Babcock and Wilcox

Subtotal I through VII	**$64,594,246**

Project:	**Guam Field Erected WTE Feasibility Study**	
Technology:	**Mass Burn Facility**	**150 tpd-7 days per week**
Date:	**04/09/08**	
Estimate Basis:	**Conceptual Layout (Average 150tpd)**	
Costs:	**2008$**	
Location:	**Guam**	

ALTERNATIVE 4b
MASS BURN FACILITY
OPERATIONS AND MAINTENANCE COST SUMMARY [1]
Conceptual Layout (Average 150tpd)

				Estimated Costs[2]
I.	LABOR			$ 1,778,000
II.	FACILITY MAINTENANCE			$ 1,674,000
III.	UTILITIES			$ 295,426
IV.	PROCESS RESIDUE HAUL & DISPOSAL			$ 369,048
V.	ROLLING STOCK O&M COSTS			$ 107,400
VI.	MISCELLANEOUS COSTS			$ 195,300
		SUBTOTAL OPERATION & MAINTENANCE		$ 4,419,174
		CONTINGENCY	25%	$ 1,105,000
		OVERHEAD AND PROFIT	15%	$ 829,000
		ACCOUNTING, SUPPLIES, MISC.	5%	$ 276,000
		ADMINISTRATION	3%	$ 166,000
TOTAL ANNUAL OPERATION & MAINTENANCE COST				$ 6,795,174
VII.	MINUS		SALES REVENUES[3]	$ 1,732,627
NET ANNUAL OPERATION & MAINTENANCE COST				$ 5,062,547

NOTES:
(1) All costs rounded to 1000
(2) All costs in 2008$
(3) Doesn't include ferrous revenues

Project:	**Guam Field Erected WTE Feasibility Study**
Technology:	**Mass Burn Facility** **150 tpd-7 days per week**
Date:	**04/09/08**
Estimate Basis:	**Conceptual Layout (Average 150tpd)**
Costs:	**2008$**
Location:	**Guam**

I. LABOR

Job Classification	Personnel(1)	$/hr(2)	hrs/yr (3)	Over-time Hrs	Annual Cost	% OT	Total
Facility Manager	1	$54	2,080	0	$112,000	0%	
Operating Engineer	1	$47	2,080	0	$98,000	0%	
Administrative/Clerical	1	$20	2,080	208	$48,000	10%	
Scale Attendant	2	$24	2,080	208	$116,000	10%	
Lead Equipment Operator	4	$41	2,080	312	$413,000	15%	
Equipment Operators	8	$30	2,080	312	$605,000	15%	
Mechanic	1	$34	2,080	208	$81,000	10%	
Electrician/Electronics Specialist	1	$34	2,080	208	$81,000	10%	
Welders	1	$34	2,080	208	$81,000	10%	
Helper	0	$20	2,080	208	$0	10%	
Residue Disposal Drivers	1	$27	2,080	208	$65,000	10%	
Spotters/Laborers	2	$16	2,080	208	$78,000	10%	
Subtotal	23						$1,778,000

Notes:

(1) Based on a 24-hour, seven day per week operation.

(2) Includes fringe benefits (retirement, ss, workers comp, health & life insurance, vacation/sick leave) 35%

and overtime rate is at 1.5 times straight time

(3) Assumes standard working shift hours 5 Days/Wk 8 Hr/Day

II. FACILITY MAINTENANCE

Item	% of Capital Value	Quantity	Unit	Unit Price	Annual Cost	Total
Site Maintenance (1) (2)	1.5%	1	Lump	$ 34,460	$34,460	
Building Repair & Replacement (2)	3.3%	1	Lump	$ 217,000	$217,000	
Equipment Maintenance (3)	2.0%	1	Lump	$ 569,201	$569,201	
Equipment Replacement (4)	3.0%	1	Lump	$ 853,801	$853,801	
Subtotal						$ 1,674,000

Notes:

(1) Percentage of capital value is based on empirical data from operating plants in the U.S.

(2) Site maintenance is estimated as % capital construction cost for site improvements and site utilities.

(3) Buidling repair based on a 30 year depreciation of the original capital cost with escalation.

(4) Equipment maintenance (annual needs) and replacement (periodic needs) estimated based on assumed 20 year life.

III. UTILITIES

Item	Quantity	Unit	Unit Price	Annual Cost	Total
Electricity Purchase (1)	139	MWh/yr	$ 200.00	$ 27,796	
Diesel (2)	26,593	Gal/Yr	$ 3.75	$ 99,723	
Telephone (Mobile/Fixed) (3)	20	Phones	$ 480	$ 9,600	
Water	42,215,078	Gal/Yr	$ 0.003	$ 126,645	
Sewer (4)	10,553,770	Gal/Yr	$ 0.003	$ 31,661	
Subtotal					$ 295,426

Notes:

(1) Electricity purchase accounts for energy use during downtimes only; inhouse power provided by the system otherwise.

(2) Diesel used for start-up and shutdown only to maintain "good combustion control"

(3) Based on mobile phones for entire staff except drivers, helpers and laborers.

(4) Sewer use based on 25% of water use; evaporation and ash quench account for rest.

Project:	**Guam Field Erected WTE Feasibility Study**
Technology:	**Mass Burn Facility** **150 tpd-7 days per week**
Date:	**04/09/08**
Estimate Basis:	**Conceptual Layout (Average 150tpd)**
Costs:	**2008$**
Location:	**Guam**

IV. PROCESS RESIDUE HAUL & DISPOSAL

Item	Cost /Load(1)	Quantity	Unit	Unit Price	Annual Cost	Total
Process Residue Haul	$ 75	503	Tons	$ 3.75	$ 1,886	
Ash Haul	$ 75	13,140	Tons	$ 3.75	$ 49,276	
Landfill Disposal Fees		13,643	Tons	$ 23.30	$ 317,886	
Subtotal						$ 369,048

Notes:

(1) Cost assumes truck operating costs per 20-ton load

V. ROLLING STOCK O&M COSTS

Fuel	Weeks	Unit Rate	Units	Unit Price	Annual Cost	Total
Loader	52	200	gal/wk	$ 3.75	$39,000	
Pick-up Truck	52	30	gal/wk	$ 3.75	$5,900	
Maintenance	**# Vehicles**	**Quantity**	**Units**	**Unit Price**	**Annual Cost**	**Total**
Loader	1	1	L.S.	$13,982	$14,000	
Pick-up Truck	1	12,000	Miles/Yr	$0.50	$6,000	
General O&M		1	L.S.	$42,500	$42,500	
Subtotal						$107,400

Notes:

(1) Based on Owning and Operationg Cost Methodology in the Catepillar Performance Handbook.

VI. MISCELLANEOUS COSTS

Item	Useage (1)	Quantity	Unit	Unit Price	Annual Cost	Total
Property Insurance (2)	1	0.3%			$192,300	
Flood Insurance (2)	0	1.2%			$0	
Property Taxes (3)	1	3,252	m2	$0.78	$3,000	
Subtotal						$ 195,300

Notes:

(1) Multiplier used to adjust costs for various potential sites. Zero means expense not appicalbe to this site.

(2) Based on % of capital construction costs.

(3) Based on area of developed property.

Subtotal I through VI	$4,419,174

VII. SALES REVENUES(3)

Material	Units	Unit	Unit Value	Annual Revenues	Total
Net Electric Generation	15,751	MWh	$110	$1,732,627	Addressed in Pro Forma
Net Steam Generation	223,380	Mlbs.	$0	$0	Addressed in Pro Forma
Aluminum	-	Tons	$800	$0	No recovery provided
Ferrous Metals	-	Tons	$25	$0	
Subtotal VII					$1,732,627

Water Usage Estimates — 150 TPD

	Conversion factor =	3.785412	
Domestic	**Assumptions**	**Gallons/Yr**	**Liters/Year**
Average People/Day	5.48		
gpd/person	25		
gallons per day	137		
days/week	7		
weeks/year	52		
gallons per year		49,833	188,640
Blowdown/Spray Dryer	4%	1,226,400	
Spray Dryer(Lb/hr Water/tpd Fuel)	212.00	3,688,206	
Ash Quench(15% moisture)	5.80	423,529	
Cooling Tower (blowdown 20% evap.)		36,792,000	
Washdown		35,100	132,868
Total Water Usage		42,215,068	159,801,426
Evaporation/Ash Quench	75%	31,661,301	119,851,070
Total Sewer Usage		10,553,767	39,950,357

Reagent Usage Estimates

	Qty/Ton
Lime (Lbs/Ton)	20
Ammonia (lbs/Ton)	7.5
Carbon (Lbs/Ton)	0.66

Energy Generation Assumptions

	Gross Generation Amount/Ton	**In-House Power Amount/Ton**	**Net Generation Amount/Ton**		**Net Annual Generation**	
Steam Production (mlb)	7.00	1.00	6	=	223,380	Mlbs.
Electricity Production (kWh)	494	70.51	423	=	15,751	MWh
Assumes condensing turbine	2.75	MW at	39,000	lbs/hr	0%	Margin

Energy Consumption Assumptions

Item	**mmBtu/Ton**	**Btu/Gal**	**MMBTU**	**Gal/yr**
Diesel (mmBtu)	0.1	140000	3,723	26,593

Item	**Qty/Ton**	**hp**	**load factor**	**kw**	**hrs/year**	**kwh/yr**
Power Purchase Req. (kWh/Ton)	3.73					138,981
Total Purchase						138,981

MSW Quanitites and Characteristics

Waste Quantity	40,000	tpy	Note system is slightly derated to allow for outages		
Daily Delivery	110	tpd - 7 days per weeks			
Capacity Factor	85%				
Delivery Capacity	129	tpd - 5 days per week			
Annual Throughput	37,230	tpy			
MSW HHV (B&W)	5,200	Btu/lb			
Boiler Efficiency (B&W)	71%				
Fuel Feed Rate (B&W)	10,000	Lbs/Hr at	120	tons/day	650degF/650psig
Gross Steam Production (B&W)	35,000	Lb/Hr	7000	lbs(steam)/ton	3.5 lbstm/lb MSW

MSW Storage Calculations

Pit Storage	5	Days		
Pit Storage	645	tons		
MSW Density	20	lb/cf		
MSW Pit Capacity	63,292	cu. ft.		
Pit Area	1,300	SF	30	ft deep plus 50% of vol. up to charging level
Pit length	33	ft at	40	feet wide

Residue Disposal

Assumes cofiring RDF w/ coal and disposing both residues

Residue Disposal	1.5%	2 tpd5	0	Truckloads/Day5
Ash Disposal	28%	36.1 tpd7	2	Truckloads/Day7
Truck Payload (Tons)	20		2.0	Truckloads/Day
		24 HRS/week	4	HRs/day
			2	Round Trip Haul

Basic Conceptual Layout Dimensions

		Length	Span	Area	Height	Number of Stories	Size Adjustment
Conversion Factor	**M to Ft**	**3.28084**	**3.28084**	**10.7639111**	**3.28084**		
Exterior Maneuvering	Feet	55.0	60.0	3,300			
	Meters	16.8	18.3	307			
MSW Tipping Floor	Feet	55.0	35.0	1,925	40.0	1.0	
	Meters	16.8	10.7	179	12.2		
Boiler Bldg	Feet	60.0	85.0	5,100	115.0	1.0	
	Meters	18.3	25.9	474	35.1		
Turbine Building	Feet	50.0	45.0	4,500	15.0	2.0	
	Meters	15.2	13.7	209	4.6		
Maintenance/Storage	Feet	48.0	36.0	1,728	16.4	1.0	0.8
	Meters	14.6	11.0	161	5		
Admin/ Control Room	Feet	48.0	36.0	1,728	16.4	1.0	0.8
	Meters	14.6	11.0	161	5		
Refuse Storage Bldg (Pit)	Feet	30.0	40.0	1,200	115.0	1.0	
	Meters	9.1	12.2	111	31		
Ash Storage Bldg	Feet	35.0	30.0	1,050	30.0	1.0	0.75
	Meters	10.7	9.1	98	9.1		
Site Development	Feet	350.0	100.0	35,000			
	Meters	106.7	30.5	3,252			
		Total Bldg Floor Area		15,306			

Mass Burn Facility

Capital Cost	$	98,224,000
Life Extension Measures	$	5,250,000
Operating Cost	$	6,795,000
Energy Revenue	$	1,733,000

2008 Dollars

Capital Cost Breakdown			
Year 0	$	5,047,000	Permitting, survey, and 70% engineering work
Year 1	$	37,142,000	40% of total less start up, permitting, survey, 70% of engineering
Year 2	$	56,035,000	60% of total plus startup less permitting, survey and engineering
Total	$	98,224,000	

Life Extension			
Year 15	$	1,312,500	25%
Year 20	$	2,625,000	50%
Year 25	$	1,312,500	25%

Final Report

Construction and Demolition Debris Reuse and Diversion Study for DOD Bases, Guam

Prepared For:

Naval Facilities Engineering Command Pacific
Pearl Harbor, Hawaii

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Prepared by:

HDR|Hawaii Pacific Engineers

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14 May 2010
HDR 0123998 HPE 2009017

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Executive Summary

Background

The Guam Joint Military Master Plan (GJMMP), formerly the Guam Integrated Military Development Plan (GIMDP), provides for the planned increase in military population on Guam. The northern Guam bases, Naval Computer and Telecommunications Station (NCTS) Finegayan, South Finegayan, Andersen Air Force Base (AAFB), AAFB Northwest Field, and AAFB South are expected to experience most of the military personnel increase.

This study evaluates construction and demolition (C&D) debris reuse and diversion alternatives for the Department of Defense (DoD) to service the Defense Policy Review Initiative (DPRI) construction projects associated with the increase in military population on Guam. This study provides planning for projects representing the best value alternatives for processing construction and demolition debris, which would enable the DoD on Guam to meet the defined requirements.

Executive Order 13514

Executive Order 13514 Federal Leadership in Environmental, Energy, and Economic Performance builds on and expands upon the energy reduction and environmental requirements of Executive Order 13423 Strengthening Federal Environmental, Energy, and Transportation Management. Executive Order 13514 indicates that the Federal Government must lead by example in safeguarding the health of the environment.

To comply with Executive Order 13514, DoD agencies shall “promote pollution prevention and eliminate waste by”:

i. Minimizing the generation of waste and pollutants through source reduction;
ii. Diverting at least 50 percent of non-hazardous solid waste, excluding construction and demolition materials and debris by the end of fiscal year 2015;
iii. Diverting at least 50 percent of construction and demolition materials and debris by the end of fiscal year 2015; and
iv. Increasing diversion of compostable and organic material from the waste stream.

Construction and Demolition Debris and Green Waste Quantities

The Master Plans for DPRI construction projects at Finegayan, AAFB, Naval Base, Apra Harbor, and the Ordnance Annex were referenced to determine the areas expected to generate construction and demolition debris. The DPRI Master Plans for Finegayan and AAFB North Ramp were dated August 2009; the DPRI Master Plan for Naval Base, Apra Harbor and Ordnance Annex was dated March 2009. Construction and demolition debris quantities were calculated based on record drawings and base development maps that were readily available. Paint samples from existing facilities were tested for lead to determine the quantity of demolition debris containing lead-based paint. Materials containing lead-based paint must be mitigated prior to diversion or disposed according to applicable regulations. Existing asbestos surveys were referenced to determine the type and quantities of existing building components comprised of asbestos-containing materials, which would require proper removal and disposal prior to demolition. The estimated quantity projected for C&D debris generated by the DPRI construction projects identified in this study is approximately 470,000 tons.

Processing of Construction and Demolition Debris and Green Waste

Based on a review of the estimated quantity of C&D debris, the following alternatives for processing C&D debris for reuse and diversion were identified for evaluation:

- Alternative 1: Contractor continues to process all C&D debris. Construct a composting facility to process a portion of green waste.
- Alternative 2: Construct a C&D debris central processing facility that recovers concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.
- Alternative 3: Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard and untreated wood. Construct a composting facility to process a portion of green waste.
- Alternative 4: Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard, untreated wood, concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.
- Alternative 5: Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard, untreated wood, concrete without lead-based paint, asphalt and glass. Construct a composting facility to process a portion of green waste.

A preliminary screening analysis was conducted for the five alternatives. Alternatives were screened based on environmental, regulatory, and implementation considerations. Based on the screening analysis, Alternative 5 was considered to be nonviable and was removed from further consideration.

Alternatives 1, 2, 3, and 4 were developed in further detail for evaluation. The evaluation included regulatory and implementation considerations, and an economic and life cycle cost analysis. Based on the finite time frame of the DPRI construction projects' schedule, the period selected for the life cycle cost analysis was five and 10 years. The life cycle cost analysis for each period is summarized in Table ES-1 and Table ES-2, which is included at the end of this section. The results of the comparative evaluation are summarized in Table ES-3, which is also included at the end of this section.

Summary of Findings

The major findings of the study are summarized below.

- Based on the expected characteristics of the C&D debris generated by the projected DPRI construction projects identified in this study, diversion of concrete without lead-based paint, asphalt concrete, and scrap metal would meet the DoD goal of 50 percent diversion of C&D debris by the end of fiscal year 2015.
- Green waste generated by land clearing activities would not contribute towards meeting the diversion goal. However, green waste should be reused on-site as mulch or compost.
- The Guam Environmental Protection Agency (GEPA) has regulatory primacy for enforcing United States (U.S.) Environmental Protection Agency (EPA) solid waste regulations on Guam. GEPA would require multiple solid waste permits and Air Pollution Control Permits to crush concrete and asphalt debris at construction sites or processing facilities.
- Requiring the contractor to continue processing all C&D debris and providing a composting facility with the capability to accept a portion of the green waste generated is the most cost-effective solution for processing C&D debris and green waste generated by the DPRI construction projects identified in this study.
- Currently, there are recycling companies on Guam who accept scrap metal at no charge.
- Currently, there are recycling companies on Guam who accept old corrugated cardboard for a fee.

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Table ES-1

Summary of 5-Year Present Value Life Cycle Analysis

Alternative	Initial Capital Cost of Facility, Equipment and Trucks	Labor Cost	Operations and Maintenance Cost for Trucks	Operations and Maintenance Cost for Facilities and Equipment	Hardfill Disposal Cost	Present Value Life Cycle Analysis 5 years
Alternative 1 – Contractor continues to process all C&D debris. Construct a composting facility to process a portion of green waste.	$10,000,000	$36,800,000	$15,900,000	$3,800,000	$1,800,000	$68,200,000
Alternative 2 – Construct a C&D debris central processing facility that recovers concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.	$11,300,000	$40,400,000	$15,200,000	$7,300,000	$600,000	$74,800,000
Alternative 3 – Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard and untreated wood. Construct a composting facility to process a portion of green waste.	$15,700,000	$38,700,000	$14,600,000	$5,600,000	$600,000	$75,200,000
Alternative 4 – Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard, untreated wood, concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.	$17,400,000	$45,800,000	$18,300,000	$4,600,000	$600,000	$86,700,000

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Table ES-2

Summary of 10-Year Present Value Life Cycle Analysis

Alternative	Initial Capital Cost of Facility, Equipment and Trucks	Labor Cost	Operations and Maintenance Cost for Trucks	Operations and Maintenance Cost for Facilities and Equipment	Hardfill Disposal Cost	Present Value Life Cycle Analysis 10 years
Alternative 1 – Contractor continues to process all C&D debris. Construct a composting facility to process a portion of green waste.	$9,800,000	$39,200,000	$16,100,000	$4,800,000	$1,700,000	$71,600,000
Alternative 2 – Construct a C&D debris central processing facility that recovers concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.	$11,700,000	$47,100,000	$14,500,000	$9,800,000	$600,000	$83,700,000
Alternative 3 – Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard and untreated wood. Construct a composting facility to process a portion of green waste.	$16,300,000	$44,400,000	$15,200,000	$7,300,000	$600,000	$83,800,000
Alternative 4 – Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard, untreated wood, concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.	$17,500,000	$49,600,000	$18,400,000	$7,400,000	$600,000	$93,500,000

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TABLE ES-3
SUMMARY MATRIX OF COMPARATIVE ADVANTAGES (A) AND DISADVANTAGES (D)

Alt.	Option	Regulations	Operations	Implementation	Economics	Schedule
1	Contractor continues to process all C&D debris. Construct composting facility.	D – GEPA permits would be required for processing C&D debris at each project site. A – GEPA permits would not be required for a central processing facility.	A – No C&D debris central processing facility to maintain.	A – No C&D debris central processing facility.	A – Lowest Present Value cost for all alternatives based on a 5-year life cycle analysis.	D – Composting facility would not be constructed before the first set of DPRI construction projects begin.
2	Construct a C&D debris central processing facility that recovers concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.	D – GEPA permits would be required for a C&D central processing facility and composting facility in addition to operations on each project site. D – An Air Pollution Control Permit for a central processing facility requires a minimum of 12 months to process.	A –Two types of C&D debris must be recovered at the facility. A – Excess crushed concrete and asphalt may be stockpiled at this facility for reuse on other construction projects.	A – Siting and construction of the smallest central processing facility.	A –Lowest present value cost for alternatives with C&D debris central processing facility based on a 5-year life cycle analysis.	D – Composting facility would not be constructed before the first set of DPRI construction projects begin.
3	Construct C&D debris central processing facility that recovers scrap metal, old corrugated cardboard and untreated wood. Construct composting facility.	D – GEPA permits would be required for a C&D central processing facility and composting facility in addition to operations on each project site.	D – Three types of C&D debris must be recovered at the facility.	D – Siting and construction of the second largest central processing facility.	D– Second highest present value cost for alternatives with C&D debris central processing facility based on a 5-year life cycle analysis.	D – Central processing facility would not be constructed before the first set of DPRI construction projects begins.
4	Construct C&D debris central processing facility that recovers scrap metal, old corrugated cardboard, untreated wood, concrete without lead-based paint and asphalt. Construct composting facility	D – GEPA permits would be required for a C&D central processing facility and composting facility in addition to operations on each project site. D – An Air Pollution Control Permit for a central processing facility requires a minimum of 12 months to process.	D – Five types of C&D debris must be recovered at the facility. A – Excess crushed concrete and asphalt may be stockpiled at this facility for reuse on other construction projects.	D – Siting and construction of the largest central processing facility.	D –Highest present value cost for alternatives with C&D central processing facility based on a 5-year life cycle analysis.	D – Central processing facility would not be constructed before the first set of DPRI construction projects begins.

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Tables

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Appendices

ACRONYMS

AAFB	Andersen Air Force Base
ACM	Asbestos-Containing Material
AHERA	Asbestos Hazard Emergency Response Act
C&D	Construction and Demolition
CAP	Consumer Awareness Program
CCA	Chromated Copper Arsenate
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFCs	Chlorofluorocarbons
CFR	Code of Federal Regulations
CRB	Coconut Rhinoceros Beetle
CY	cubic yards
DEHP	Bis(2-ethylhexyl) phthalate
DIY	Do-It-Yourself
DoD	Department of Defense
DOT	Department of Transportation
DPRI	Defense Policy Review Initiative
DPW	Department of Public Works, Government of Guam
DRMO	Defense Reutilization and Marketing Office
DRMS	Defense Reutilization and Marketing Service
ECM	Earth covered magazine
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
EPS	Expanded polystyrene
FAA	Federal Aviation Administration
FEAD	Facility Engineering & Acquisition Division
GBB	Gershman, Bricker, and Bratton, Inc.
GCA	Guam Code Annotated
GEPA	Guam Environmental Protection Agency
GJMMP	Guam Joint Military Master Plan
GIMDP	Guam Integrated Military Development Plan
GovGuam	Government of Guam
HAP	Hazardous Air Pollutant

HCFCs	Hydrochlorofluorocarbons
HVAC	Heating, Ventilating, and Air Conditioning
ISWMP	Integrated Solid Waste Management Plan
JP	Jet Propellant
LBP	Lead-Based Paint
LEED	Leadership in Energy and Environmental Design
MCB	Marine Corps Base
mg/L	milligrams per liter
MOU	Memorandum of Understanding
MR	Materials and Resources
MSW	Municipal Solid Waste
NAVFAC	Naval Facilities Engineering Command
NCTS	Naval Computer and Telecommunications Station
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NGLA	Northern Guam Lens Aquifer
NPL	National Priorities List
O&M	Operation and maintenance
OCC	Old Corrugated Cardboard
OSHA	Occupational Safety and Health Administration
PCBs	Polychlorinated biphenyls
PCP	Pentachlorophenol
ppm	parts per million
PVC	Polyvinyl chloride
RAP	Recycled Asphalt Pavement
RCRA	Resource Conservation and Recovery Act
SWMD	Solid Waste Management Division
SWMP	Solid Waste Management Program
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TSCA	Toxic Substances Control Act
tph	tons per hour
tpy	tons per year
UFGS	United Facilities Guide Specifications
U.S.	United States
USC	US Code

USMC	United States Marine Corps
VOCs	Volatile Organic Compounds
VCP	Vitrified Clay Pipe

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1.0 Introduction

1.1 Purpose

The Guam Joint Military Master Plan, formerly the Guam Integrated Military Development Plan, provides for the planned increase in military population on Guam. NCTS Finegayan, South Finegayan, AAFB, AAFB Northwest Field, and AAFB South are expected to experience most of the military personnel increase on Guam. Solid waste disposal facilities for these installations and all other DoD installations on Guam are currently provided by separate Navy and Air Force landfills.

Based on the projected increase of military personnel, substantial quantities of C&D debris are expected to be generated.

The purpose of this study is to identify reasonable cost-effective alternatives to divert C&D debris to meet existing and known future DoD requirements.

1.2 Background Information

The island of Guam is part of the Mariana Island chain. Guam is a U.S. territory and is located approximately 3,800 miles west of Hawaii and 1,500 miles south of Japan. The island is approximately 30 miles long and ranges from four to 11 miles wide. The total land area is approximately 212 square miles. The 2010 population of Guam is estimated to be approximately 180,000. A vicinity map of Guam is shown on Figure 1-1.

The solid waste management system on Guam includes the Navy Sanitary Landfill and hardfill located at Apra Harbor, a landfill and recycling center located at Andersen Air Force Base, Ordot Dump, and two private hardfills.

The Navy and Air Force disposal sites are operated by the DoD and provide service to military personnel and residents of the bases and commercial waste streams from base activities. The remaining waste stream of Guam is serviced by Gershman, Bricker, and Bratton, Inc. (GBB) using Ordot Dump and citizen drop-off convenience stations.

Ordot Dump was previously operated by the Guam Department of Public Works (DPW) but is now under a federal receivership. Under a Consent Decree with the United States Environmental Protection Agency, Ordot Dump was directed to achieve complete closure by October 23, 2007. In response to the mandate, the DPW advertised Requests for Letters of Interest for projects in January 2006 and prepared procurement packages for the design and construction of Ordot Dump's closure, the design, construction and operation of a new landfill at Layon, and the design, construction and operation of other solid waste operations and activities.

The DoD anticipates disposing a portion of the DoD's non-hazardous solid waste at the Government of Guam (GovGuam) Layon landfill in the future. The Navy

Sanitary Landfill is expected to remain open for disposal of solid waste not accepted at the Layon landfill. The tipping fee at the Layon landfill is expected to be $156 per ton. Existing landfill operations at AAFB include a municipal solid waste landfill area and a C&D debris disposal area. At the time of permitting for the AAFB landfill, the GovGuam landfill was scheduled to be operational by the year 2008. However, when it became apparent that the GovGuam landfill would not be ready for use as originally anticipated, AAFB planned a further incremental expansion of their lined expanded landfill to provide a limited amount of additional volume. The 2-acre lined landfill expansion implemented by AAFB is an interim measure. The AAFB landfill is expected to close upon reaching its permitted capacity or when the GovGuam Layon landfill becomes operational.

Additionally, there are two private hardfills in Yigo, Guam. The Eddie Cruz Hardfill accepts construction and demolition debris. Northern Hardfill accepts green debris and construction and demolition debris. Both private hardfills do not accept combustible materials.

1.3 Proposed U.S. Marine Corps Relocation and Other DoD Growth

The DoD is planning to increase the military population on the island of Guam. The official military loading is expected to increase by approximately 9,632 military personnel over the current baseline population of 6,668 military personnel stationed on Guam. This includes military personnel from the Air Force, Army, Coast Guard, United States Marine Corps (USMC), and Navy. The number of dependents associated with accompanied personnel is expected to increase by about 10,240 dependents over the current baseline dependent population of 8,412 dependents. The total population increase is expected to be approximately 19,872 military and dependent personnel, which is approximately 11 percent on the current population of Guam. It is expected that approximately 11,002 transient military personnel would be added to the military loading on Guam, including personnel from the Air Force, USMC, and Navy. Of the total DoD population increase, about 17,552 military personnel and dependents are associated with the proposed USMC relocation from Okinawa to Guam. The proposed USMC relocation is anticipated to begin in 2012 and be completed by 2016.

1.4 Construction and Demolition Debris

1.4.1 Background

Based on the projected military developments, substantial amounts of C&D debris are expected to be generated.

C&D debris is a type of solid waste which is subject to regulatory and permitting requirements. Proper handling, processing, and disposal procedures for hazardous materials and materials which require special handling must be practiced in accordance with federal and local regulations.

To address the generation and proper management of C&D debris including hazardous materials, alternatives were developed to meet the DoD's diversion goals while complying with applicable regulations.

1.4.2 Processing of Construction and Demolition Debris and Green Waste

Based on a preliminary review of the estimated quantity of DoD-generated C&D debris, the following alternatives for processing C&D debris for reuse and diversion were identified for evaluation:

- Alternative 1: Contractor continues to process all C&D debris. Construct a composting facility to process a portion of green waste.
- Alternative 2: Construct a C&D debris central processing facility that recovers concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.
- Alternative 3 Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard and untreated wood. Construct a composting facility to process a portion of green waste.
- Alternative 4: Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard, untreated wood, concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.
- Alternative 5: Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard, untreated wood, concrete without lead-based paint, asphalt and glass. Construct a composting facility to process a portion of green waste.

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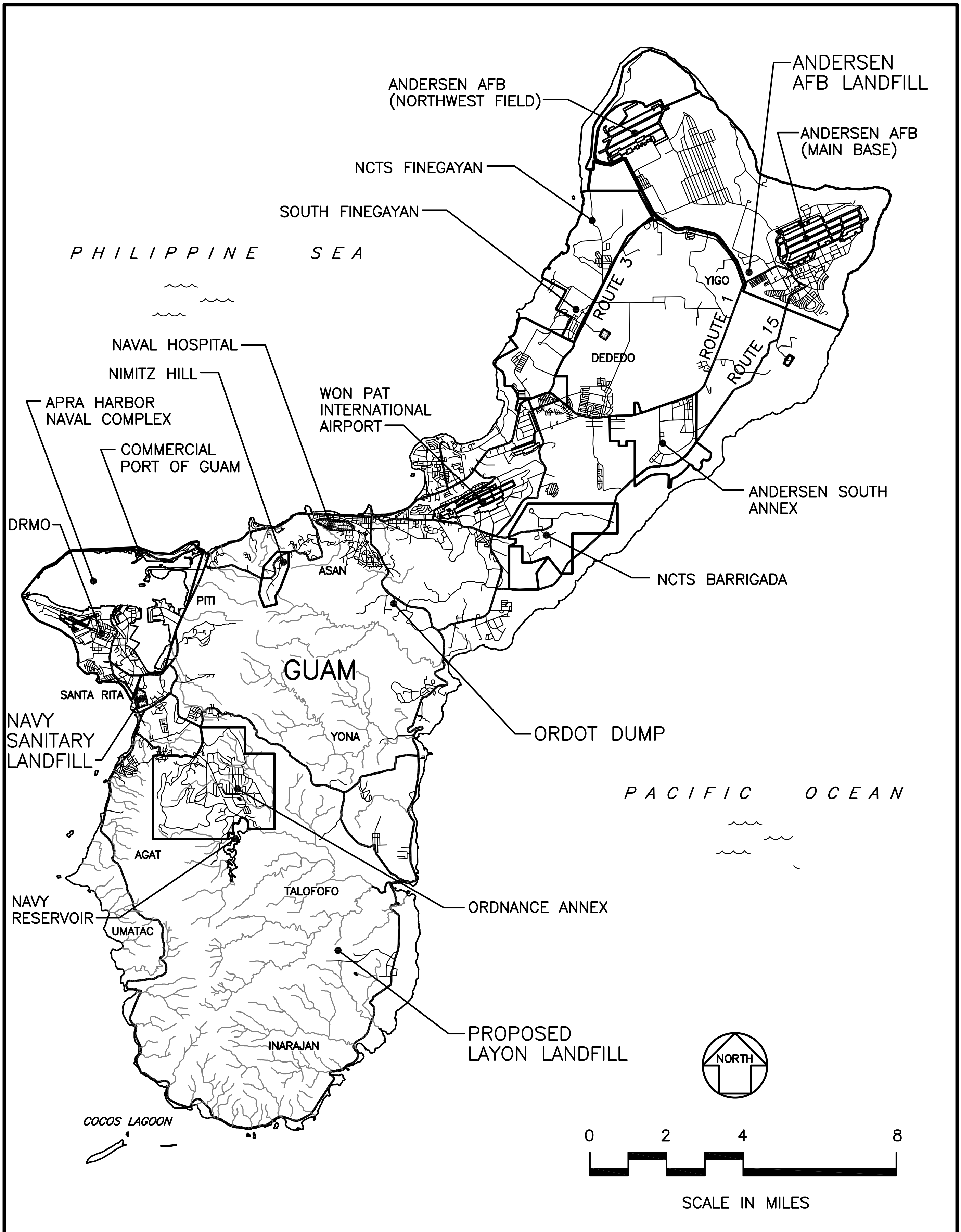

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HDR HPE Hawaii Pacific Engineers, Inc.	CONSTRUCTION AND DEMOLITION DEBRIS STUDY FOR DOD GUAM	VICINITY MAP	FIGURE 1–1

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2.0 Regulations and Guidance Documents for Construction and Demolition Debris Reuse and Diversion

2.1 Regulations Overview

This section summarizes the regulations and guidance documents applicable to construction and demolition debris processing and diversion on Guam.

2.1.1 Executive Order 13423

Executive Order 13423 Strengthening Federal, Environmental, Energy, and Transportation Management states "it is the policy of the United States that Federal agencies conduct their environmental, transportation, and energy-related activities under the law in support of their respective missions, in an environmentally, economically, and fiscally sound, integrated, continuously improving, efficient, and sustainable manner." Implementing this policy as it relates to solid waste, the head of each agency should ensure that the agency increases diversion of solid waste as appropriate, and maintains cost-effective waste prevention and recycling programs in its facilities.

2.1.2 Memorandum of Understanding (MOU)

The Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding dated 24 January 2006 is referenced under Executive Order 13423. The MOU is applicable to new construction and major renovation of federal agency buildings. The MOU provides principles to reduce the environmental impact of materials. These principles encourage the use of recycled content in products and recycling or salvaging at least 50 percent of construction, demolition, and land clearing waste, excluding soil.

2.1.3 Executive Order 13514

Executive Order 13514 Federal Leadership in Environmental, Energy, and Economic Performance enacted on 5 October 2009 builds on and expands upon the energy reduction and environmental requirements of Executive Order 13423. Executive Order 13514 indicates that the federal government must lead by example in safeguarding the health of the environment.

To comply with Executive Order 13514, DoD agencies shall "promote pollution prevention and eliminate waste by":

i. Minimizing the generation of waste and pollutants through source reduction;
ii. Diverting at least 50 percent of non-hazardous solid waste, excluding construction and demolition debris, by the end of fiscal year 2015;
iii. Diverting at least 50 percent of construction and demolition materials and debris by the end of fiscal year 2015; and

iv. Increasing diversion of compostable and organic material from the waste stream.

Under the Executive Order, “construction and demolition materials and debris” is defined as “materials and debris generated during construction, renovation, demolition, or dismantling of all structures and buildings and associated infrastructure.” Based on the definition of construction and demolition materials and debris, this study focuses on materials generated during construction and demolition of buildings and infrastructure. Green waste generated by land clearing activities would not be included in the construction and demolition debris quantities and would therefore not contribute towards meeting the diversion goal.

2.1.4 DoD Integrated (Non-Hazardous) Solid Waste Management Policy

To implement and maintain cost-effective waste prevention and recycling programs, a DoD memo dated 1 February 2008 by Acting Deputy Under Secretary of Defense indicates managers should seek out waste diversion practices with the guidance of the Integrated Solid Waste Management Plan (ISWMP). The ISWMP promotes reuse or recycling as an effective method towards disposal deterrence and is discussed further in this study.

2.1.5 LEED

Potential Leadership in Energy and Environmental Design (LEED) points related to construction and demolition debris activities are contained in the LEED Materials and Resources (MR) category. To earn points, a prerequisite must be fulfilled.

MR Prerequisite 1 describes the storage and collection of recyclables. The prerequisite indicates that an easily-accessible area for collection and recycling should be provided to facilitate the reduction of waste disposed at the landfill. After this requirement has been met, MR credits may be granted. MR credits applicable to construction and demolition debris include the MR Credit 2 Construction Waste Management.

Requirements listed under the MR Credit 2 include recycling and/or salvaging non-hazardous construction and demolition debris, and implementing a plan identifying the recovery and sorting of certain materials. Up to two points may be earned under this credit. One point may be earned if a minimum of 50 percent of C&D waste is recycled and/or salvaged; two points may be earned if a minimum of 75 percent of C&D waste is recycled and/or salvaged.

2.1.6 Construction and Demolition Debris Regulations

Construction and demolition debris is classified as solid waste under federal and local regulations. Federal regulations pertinent to solid waste are contained in Title 40 of the Code of Federal Regulations (CFR), Parts 239 through 259. These parts pertain to non-hazardous solid waste. For this study, 40 CFR Parts 243, 246, 256, and 257 are applicable. Local regulations are provided under Title 10 Guam Code Annotated (10 GCA), Division 2 and Guam Administrative

Rules and Regulations; Title 22, Division 4, Chapters 20 through 23. The Guam Environmental Protection Agency is responsible for implementing the local regulations.

2.1.6.1 Federal Regulations

Federal regulations governing solid waste management are contained in 40 CFR Parts 239 through 259. The regulations applicable to construction and demolition debris include 40 CFR Parts 243, 246, 256, and 257.

The regulations applicable to this study contain guidelines and policies pertaining to the following areas of solid waste management:

- Storage and collection of residential, commercial, and institutional solid waste;
- Source separation for materials recovery;
- Development and implementation of state solid waste management plans; and
- Criteria for classification of solid waste disposal facilities and practices.

The purpose of these regulations is to establish minimum standards for solid waste management and to ensure the protection of human health and the environment. The regulations contain methods for resource conservation, maximizing utilization of valuable resources, achieving the objectives of environmentally sound management, and properly disposing solid and hazardous waste.

2.1.6.2 Local Regulations

Solid waste is regulated on Guam under 10 GCA 33 Solid Waste and 10 GCA Chapter 51 Solid Waste Management and Litter Control. Title 22 of the Guam Administrative Rules and Regulations transfers regulatory power to GEPA for the implementation of solid waste regulations contained in Chapter 20 through 23. The responsibilities of GEPA are outlined in Section 2.2.1. The local regulations contain policies regarding solid waste collection and disposal.

2.1.7 Composting and Mulching Regulations

Federal and local regulations extend to composting and mulching operations. The U.S. EPA indicates that the management of organic materials is not enforced at the federal level except in cases where biosolids and animal manures are involved. Generally, local regulators are responsible for regulation of composting and mulching facilities.

2.1.7.1 Federal Regulations

The U.S. EPA has established a list of recommended compostable materials, which include the following:

- Clean paper
- Eggshells

- Fruits and vegetables
- Grass clippings
- Houseplants
- Leaves
- Wood chips
- Yard trimmings.

Waste not recommended for composting includes:

- Black walnut tree leaves or twigs
- Meat or fish bones and scraps
- Diseased or insect-ridden plants
- Yard trimmings treated with chemical pesticides.

Mulching is generally regulated at the state or local level. Under the Resource Conservation and Recovery Act (RCRA), wood treated with chromated copper arsenate (CCA) may not be used for mulch.

Based on an EPA Office of Solid Waste memorandum dated January 4, 2004, wood mulch derived from CCA-treated lumber would not be considered exempt from regulation as a hazardous waste under RCRA. The memorandum indicated that the use of CCA-treated wood to produce mulch is not the intended end use of the treated wood and would not be exempt from hazardous waste regulations under 40 CFR 261.4(b)(9).

The memo concurs with instructions by the EPA Consumer Awareness Program (CAP), which indicates that treated wood may not be used where a preservative may become a component of food or animal food. CAP indicates that mulching from recycled arsenic-treated wood is an example of this usage.

2.1.7.2 Local Regulations

Rules and Regulations for the GEPA Solid Waste Disposal, Title 22, Division 4, Chapter 23, Article 1 defines composting as a controlled degradation of organic solid waste.

Backyard or home composting is a non-permit required operation where food and/or yard waste may be composted into nutrient-rich soil. A more complex composting operation would require a GEPA solid waste processing permit for the approved operation of a composting facility or composting operations.

A large pest eradication program is currently in effect for the coconut rhinoceros beetle. The Guam Department of Agriculture established quarantine on October 5, 2007, through a “Declaration of Quarantine.” The quarantine prohibits coconut rhinoceros beetle host material from being transported except under a limited permit issued by the Guam Department of Agriculture. The quarantine in northern Guam restricts the movement of green waste and live plants across the quarantine boundary without inspection and/or treatment. Green waste recycled into mulch or compost would be subject to these restrictions.

2.1.8 Hazardous Waste Regulations

Hazardous waste is regulated by both Federal and local restrictions.

Federal regulations pertinent to hazardous waste are contained in Title 40 CFR Parts 260 through 279. Construction and demolition debris is generally non-hazardous and is not regulated by the EPA. However, any entity that generates hazardous waste is subject to federal regulations. Hazardous waste considered in this study includes polychlorinated biphenyls (PCBs) and is discussed further in Section 2.1.15 PCBs Regulations.

Hazardous waste regulations are provided under RCRA, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Universal Waste Program, Toxic Substances Control Act (TSCA), and 40 CFR Part 761.

Transportation of hazardous material or hazardous waste over a public highway requires the carrier to comply with the Department of Transportation (DOT) 49 CFR Part 177 Carriage By Public Highway. Provisions include, but are not limited to, appropriate training, responsible driving, and proper segregation of hazardous materials.

2.1.9 Wastes Requiring Special Handling

Wastes requiring special handling include low-level radioactive waste, lead-based paint (LBP), fluorescent lamps, pesticide-contaminated soils, asbestos-containing materials, and ozone-depleting substances. Regulations for wastes requiring special handling are discussed in the following sections.

2.1.10 Low-Level Radioactive Waste

Low-level radioactive wastes are items contaminated with radioactive material or have become radioactive through exposure to neutron radiation. Wastes typically consist of tritium exit signs, smoke detectors, gauges, and other materials exposed to radioactivity. Low-level radioactive waste is typically stored on-site by licensees until quantities are large enough for shipment to a low-level waste disposal site in containers approved by the Department of Transportation. Some low-level radioactive wastes including smoke detectors may be returned to the manufacturer for disposal.

Under the Low-Level Radioactive Waste Policy Act of 1980, Congress established the policy that each state is responsible for disposing low-level radioactive waste generated within its borders. To accomplish this, states may enter into compacts. Section 102 of the 1986 amendments to the Act provided that each state, either by itself or in cooperation with other states, be responsible for disposal of low-level radioactive wastes generated within the state.

Currently, there are three active licensed low-level waste disposal facilities located in the U.S. However, only one site would accept wastes from Guam. Located in Clive, Utah, EnergySolutions Clive Operations accepts waste from all regions of the United States. The facility is licensed by the State of Utah and accepts Class A waste only. Class A waste is characterized as containing the lowest concentration of short-lived and long-lived radionuclides. A new disposal facility has been licensed but is not yet operating. The facility is located in Andrews County, Texas, and is expected to begin operating in 2010. The facility will accept Classes A, B, and C low-level radioactive wastes from Texas and Vermont, as well as the federal government.

2.1.11 Lead-based Paint Regulations

Lead is a toxic, heavy metal used for providing pigment, increasing durability, and resisting moisture. In the U.S., lead-based paint is defined as paint containing lead in concentrations of a minimum of 5000 parts per million (ppm) or 0.5 percent lead by weight. Prior to 1978, lead-based paint was commonly used in residential and commercial buildings. In 1978, the Consumer Product Safety Commission banned the sale and distribution of lead-based paint for use in residential buildings.

Federal regulations for lead-based paint applicable to this study include RCRA and TSCA. Lead is also regulated under the Occupational Safety and Health Administration (OSHA). Local regulations are included in the Hazardous Waste Management Program. GEPA is responsible for implementing the Hazardous Waste Management Program on Guam.

2.1.11.1Federal Regulations

2.1.11.1.1 RCRA

The RCRA is a federal law, which encourages “environmentally sound methods” for managing solid and hazardous waste. The EPA considers waste to be hazardous if it meets or exhibits one of four characteristics, defined in 40 CFR Parts 260 through 279: ignitability, corrosivity, reactivity, and toxicity.

A final rule pertaining to disposal of residential lead-based paint waste in 40 CFR Parts 257 and 258 allows contractors working to abate lead-based paint in housing units to dispose lead-based paint waste as household waste and are not required to determine its toxicity characteristic under RCRA. However, the demolition of DoD facilities would not be eligible for the household hazardous waste exemption.

Lead-based paint is considered a hazardous waste if a representative sample meets or exceeds a specific toxicity concentration of 5 ppm, as determined by the Toxicity Characteristics Leaching Procedure (TCLP).

40 CFR Part 745 indicates that beginning on April 22, 2010, only EPA-certified personnel are authorized to abate hazardous lead-based paint, dust-lead hazards, or soil-lead hazards. The EPA Region 9 Lead Program provides a list of personnel and businesses, certified or accredited to perform lead-based paint abatement on Guam.

2.1.11.1.2 TSCA

The TSCA is a federal law, which grants EPA the authority to regulate chemical substances. The Act indicates that EPA may evaluate, assess, mitigate, and control the risks that may be posed by the chemical's production, processing, or use. If an unreasonable risk to public health or the environment is determined by EPA, TSCA regulations may apply. Lead-based paint may be regulated during production, importation, use, and disposal under this act.

2.1.11.2 Local Regulations

GEPA administers the Hazardous Waste Management Program on Guam. The Program is responsible for permitting hazardous waste collection and treatment, storage, and disposal facilities.

An RCRA Subtitle C Site Identification Form must be completed for lead-based paint determined to be a hazardous waste. Activities involving the generation, transportation, recycling, treatment, storage, or disposal of hazardous waste would require an RCRA Subtitle C Site Identification Form. After an identification number has been assigned, a Hazardous Waste Report should be submitted to the GEPA Hazardous Waste Management Program.

2.1.12 Fluorescent Lamp Regulations

A fluorescent lamp is the bulb or tube of an electric lighting device, which emits visible light after the excitation of mercury vapor. Disposal of fluorescent lamps is regulated by the Universal Waste Program under RCRA. The Universal Waste Program is included in 40 CFR Part 273 Standards for Universal Waste Management. Proper handling and disposal regulations for fluorescent lamps are included in 40 CFR Part 273. Local regulations are included under the Hazardous Waste Management Program on Guam. GEPA is responsible for implementing the Hazardous Waste Management Program.

All fluorescent lamps require a ballast to operate. Ballasts provide a high initial voltage to initiate the discharge of mercury vapor; then current is limited to safely sustain the discharge. The disposal of fluorescent lamp ballasts is federally regulated. The ballasts may be regulated depending on the substance contained within the ballast. Lighting ballasts manufactured prior to 1979 commonly incorporated PCBs into the capacitors. Ballasts manufactured after 1979 should contain a label indicating “No PCBs.” EPA indicates that ballasts manufactured prior to 1979 or do not contain the label indicating “No PCBs” should be assumed to contain PCBs.

PCB regulations are discussed in Section 2.1.14.

2.1.12.1 Federal Regulations

2.1.12.1.1 Universal Waste Program

The Universal Waste Program was established under RCRA to alleviate management burden and encourage the collection and recycling of commonly generated wastes. Through the program, once-identified *hazardous* waste may be classified as a *universal* waste provided that the waste is classified as battery, mercury-containing equipment, pesticide, or lamp, as defined in 40 CFR Part 273.

Lamps must be tested using the TCLP to determine whether the lamp is considered non-hazardous, otherwise it must be treated as a hazardous waste. Lamps often exhibit the toxicity characteristic for mercury or lead, which classifies them as a hazardous waste when they are discarded. Under the Universal Waste Program, fluorescent lamps must be handled properly and disposed or recycled according to regulations. An exemption exists for a conditionally exempt small quantity generator who disposes 100 kilograms or less of hazardous wastes during one month.

2.1.12.1.2 CERCLA

CERCLA, commonly known as the Superfund, provides federal authority to act upon the release of hazardous material that may endanger public health. CERCLA established prohibitions and requirements regarding closed and abandoned hazardous sites; provided for liability of persons responsible for release of hazardous wastes at these sites; and established a trust fund to provide cleanup when a responsible party could not be identified.

Andersen Air Force Base, located in Yigo, Guam, is one of two Guam sites listed on the EPA's National Priorities List (NPL). The other Guam site listed on the NPL is Ordot Dump. The NPL narrative for Andersen Air Force Base describes sources of on-site hazardous substances to include unlined landfills, drum storage and disposal areas, chemical storage areas, fire training areas, waste storage areas, and industrial and flight line operations. Substances include trichloroethene (TCE) and paint thinner solvents, dry cleaning fluids and laundry products, Jet Propellant JP-4 and gasoline fuels, pesticides; aircraft cleaning compounds and PCBs.

The Air Force indicates that there is a presence of lead, chromium, TCE, toluene, and tetrachloroethene in the Northern Guam Lens groundwater site.

In addition to considering the status of AAFB on the NPL, any construction and demolition debris collection, handling, and disposal must not disrupt or interfere with the on-going remediation process. Further contamination of a Superfund site may result in financial liability.

Fluorescent lamps contain a small quantity of mercury that may be harmful to the environment and human health when improperly managed. The law requires waste generators to notify the National Response Center under certain conditions when disposing mercury-containing lamps. All generators may be held liable in any subsequent Superfund cleanup. Fluorescent bulbs should be handled carefully to prevent breakage, which would potentially release mercury vapor or elemental mercury into the environment.

The disposal of fluorescent light ballasts is regulated. Prior to 1979, light ballasts contained PCBs. In 1979, PCBs were banned for use in fluorescent light ballasts and replaced by Bis(2-ethylhexyl)phthalate (DEHP), a dielectric fluid. DEHP is classified as a probable human carcinogen by the EPA and is characterized as a hazardous and toxic substance under various environmental regulations. The disposal of DEHP requires notification of the National Response Center when a “Reportable Quantity” of 100 pounds is to be disposed. A “Reportable Quantity” is estimated to be contained in approximately 1,600 light ballasts. The same precautions used for the handling of PCB-containing ballasts should also be applied to the disposal of DEHP ballasts.

DEHP is listed as a hazardous waste under RCRA when discarded in its pure form. However, DEHP is not considered hazardous waste if it is “used.” For example, a drum of DEHP found at the loading dock of a DEHP manufacturing facility would be considered hazardous waste if disposed, but a spent ballast capacitor filled with the chemical is not considered hazardous under RCRA because the DEHP has been used.

2.1.12.2 Local Regulations

GEPA administers the Hazardous Waste Management Program on Guam. The Program is responsible for permitting hazardous waste collection and treatment, storage, and disposal facilities.

An RCRA Subtitle C Site Identification Form must be completed for large quantity generators of lamp wastes. Activities involving the generation, transportation, recycling, treatment, storage, or disposal of universal waste require an RCRA Subtitle C Site Identification Form. After an identification number has been assigned, a Hazardous Waste Report must be submitted to the GEPA Hazardous Waste Management Program.

2.1.13 Pesticide-Contaminated Soil Regulations

The pesticide chlordane and other organochlorine pesticides listed under EPA Test Method 8081 are expected to be found in soil under the foundation of existing buildings because they were commonly used for prevention of ground termites. GEPA’s Pesticides Control Program indicates chlordane is listed on EPA’s list of suspended and canceled pesticides.

2.1.13.1 Federal Regulations

The EPA indicates that the TCLP threshold characteristic value for chlordane is 0.03 milligrams per liter (mg/L). After the threshold value is met, chlordane must be regulated as a hazardous waste.

2.1.13.2 Local Regulations

GEPA indicated that pesticide-contaminated soils are not under the jurisdiction of the Pesticides Enforcement Program, but managed under the Hazardous Waste Management Program. Based on an agreement between GEPA and Naval

Facilities Engineering Command (NAVFAC) Marianas, chlordane-contaminated soil may remain on-site if placed under concrete, asphalt or encapsulated with a minimum of 18 inches of uncontaminated soil and seeded with grass.

2.1.14 PCBs Regulations

PCBs are mixtures of synthetic organic chemical substances sharing similar basic chemical structure and physical properties. PCBs were valued for their non-flammability, chemical stability, high boiling point and electrical insulating properties. Due to these properties, PCBs were used in many industrial and commercial applications including caulk and light ballasts.

Caulk is any flexible sealing compounds used to seal joints or fill crevices in buildings against water, air, dust, or insects. EPA has learned in recent years that PCB-containing caulk was used in many buildings in the 1950s through the 1970s. Generally, buildings built after 1978 do not contain PCBs in caulk. Buildings built between 1950 and 1978 require testing for PCBs in caulk prior to demolition and disposal. EPA has developed test methods to determine the concentration of PCBs in buildings.

Upon release, PCBs remain persistent in the environment and can accumulate in organisms. As organisms are consumed in the food chain, PCBs undergo "biomagnification". As PCBs bioaccumulate in organisms and are magnified in the food chain, they present substantial ecological and human health effects, including carcinogenicity, neurotoxicity, reproductive and developmental toxicity, immune system suppression, liver damage, and endocrine disruption.

Based on the health implications associated with PCB exposure, PCBs are heavily regulated by Federal and local agencies. Federal regulations are included under TSCA and 40 CFR Part 761. Local regulations are administered under the Hazardous Waste Management Program on Guam. GEPA is responsible for implementing the Hazardous Waste Management Program.

2.1.14.1Federal Regulations

2.1.14.1.1 TSCA

Section 2.1.11 Lead-based Paint Regulations discusses TSCA regulations. Specific chemical substances, including polychlorinated biphenyls, asbestos, and lead-based paint, may be regulated under TSCA during production, importation, use, and disposal. Although TSCA contains asbestos and lead-based paint requirements, PCBs are specifically regulated under TSCA through Title 15 US Code (USC) §2605(e).

TSCA disposal requirements for light ballasts are dependent on the condition and concentration of the light ballasts. Ballasts with capacitors labeled "No PCBs" are not regulated under TSCA. If a capacitor ruptures, PCBs would leak into a surrounding tar-like substance referred to as potting material. Ballasts with intact and non-leaking capacitors with PCB potting material concentrations greater than or equal to 50 ppm are considered PCB bulk product waste. Section 2.1.14.1.2

discusses PCB bulk product waste requirements. Intact and non-leaking capacitors with potting material concentrations less than 50 ppm may be disposed as municipal solid waste. Leaking capacitors with any concentration of PCBs in the potting material must be disposed as PCB bulk product waste.

2.1.14.1.2 40 CFR Part 761

Upon the enactment of the TSCA, PCB regulations were published under 40 CFR Part 761 Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions. EPA is the administrator for PCB regulations. The PCB regulations include proper disposal and removal practices.

40 CFR Part 761 establishes prohibitions and requirements for the manufacture, processing, distribution in commerce, use, disposal, storage, and marking of PCBs and PCB items.

To determine the presence of PCBs in the air or caulk, EPA has two approved test methods for air and the PCB regulations provide test methods for evaluating PCB concentrations in caulk. The two EPA approved air testing methods are:

- Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air - Compendium Method TO-4A (high air volume)
- Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air - Compendium Method TO-10A (low air volume)

Procedures provided in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846* may be used for PCB testing in caulk. EPA provides additional PCB test methods for caulk contained in their recommended wipe sampling procedures.

Caulk containing PCBs at levels of 50 ppm or greater is considered *PCB bulk product waste* and is subject to applicable cleanup and disposal requirements included in 40 CFR Part 761. PCB-containing caulk is known to contaminate adjacent materials in buildings including masonry, wood, and concrete. Building materials and soil contaminated through leaching of PCBs at levels of 50 ppm or greater are considered *PCB remediation waste* and must be cleaned up in accordance with 40 CFR §761.61.

The PCB regulations contain disposal requirements for each category of PCB waste. The categories most applicable to this study include bulk product waste and remediation waste. 40 CFR §761.3 define PCB bulk product waste and PCB remediation waste as follows:

- *PCB bulk product waste* means waste derived from manufactured products containing PCBs in a non-liquid state, at any concentration where the concentration at the time of designation for disposal was ≥50 ppm PCBs.

- *PCB remediation waste* means waste containing PCBs as a result of a spill, release, or other unauthorized disposal, at the following concentration: ≥50 ppm PCBs and materials which are currently at any concentration if the PCBs are spilled or released from a source not authorized for use under this part. PCB remediation waste means soil, rags, and other debris generated as a result of any PCB spill cleanup, including building materials.

Building materials coated with PCB-containing caulk at concentrations of 50 ppm or greater should be managed and disposed as PCB bulk product waste.

Disposal of PCB bulk product waste is regulated under 40 CFR §761.62. There are three disposal options under this provision: performance based disposal; disposal in solid waste landfills; or risk-based disposal approval.

Disposal of PCB remediation waste is regulated under 40 CFR §761.61. There are three disposal options for PCB remediation waste: self-implementing cleanup and disposal; performance-based disposal; and risk-based cleanup and disposal.

2.1.14.2 Local Regulations

GEPA administers the Hazardous Waste Management Program on Guam. The Program is responsible for permitting hazardous waste collection and treatment, storage, and disposal facilities. The Hazardous Waste Management Program is also responsible for the inspection, compliance monitoring, enforcement, corrective action on all hazardous waste related activities, CERCLA, and TSCA.

2.1.15 Asbestos Regulations

Asbestos refers to several naturally occurring fibrous minerals with high tensile strength, the ability to be woven, and resistance to heat and many chemicals. Due to these properties, asbestos was widely used in building materials including vinyl floor tiles, ceiling tiles, and caulk.

Asbestos is not classified as an RCRA hazardous waste. However, based on the health implications associated with asbestos exposure, asbestos is regulated by both the EPA and OSHA. Federal asbestos regulations applicable to this study include the National Emissions Standards for Hazardous Air Pollutants (NESHAP) and TSCA. Local regulations are administered through GEPA.

2.1.15.1 Federal Regulations

2.1.15.1.1 NESHAP

The regulation most commonly applied to the construction industry is the Asbestos National Emissions Standards for Hazardous Air Pollutants. The NESHAP standards for asbestos are included in 40 CFR Part 61, Subpart M. NESHAP standards are authorized under the Clean Air Act and classify asbestos-containing materials (ACM) into three categories: Friable ACM, Category 1 Non-Friable ACM, and Category 2 Non-Friable ACM.

Friable ACM crumble under hand pressure and are regulated under NESHAP when disturbed during demolition. Category 1 Non-Friable ACM are non-regulated ACM and do not require removal prior to demolition. However, if the Category 1 ACM is subjected to abrading, ACM is considered regulated and must be removed prior to demolition. Category 2 Non-Friable ACM includes asbestos cement. Non-Friable ACM that may be crushed becomes regulated. Regulated ACM should be properly packaged and disposed at an appropriate site, as approved by the local agency. Contractors must submit a written notice to the local control agency or the EPA regional office prior to handling asbestos. Building sites must also be inspected by a certified asbestos inspector.

2.1.15.1.2 TSCA

The Asbestos Hazard Emergency Response Act (AHERA) is an asbestos program implemented under Title II of the Toxic Substances Control Act. AHERA regulates asbestos contained in schools and public and commercial buildings. This Act requires the development of management plans; specifies work practices and engineering controls for removing and handling asbestos; and establishes emissions standards in schools after abatement has occurred.

2.1.15.2 Local Regulations

NESHAP and TSCA regulations indicate that GEPA’s Air Pollution Control Program oversees asbestos demolition, renovation, and disposal activities.

For facilities handling asbestos-containing materials, the GEPA Air Pollution Control Standards and Regulations are applicable. Relevant sections from the Air Pollution Control Standards and Regulations pertaining to proper asbestos handling include Section 1103.9 Process Industries, Section 1103.13 Asbestos, and Section 1104.6 Air Pollution Control Permit Application.

GEPA indicates that most sources of air pollution should apply for an Air Pollution Control Permit. Asbestos is classified under Federal Oversight Sources as defined by Section 1107 of the Guam Air Pollution Standards and Regulations or Section 112 of the federal Clean Air Act. Air Pollution Controls Permits for these sources must also be reviewed by U.S. EPA Region 9.

2.1.16 Ozone-Depleting Substances Regulations

Ozone-depleting substances commonly refer to chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), and other chemical substances which contribute to ozone depletion. CFCs and HCFCs were commonly used in applications for refrigeration and air conditioning.

EPA has established regulations under Section 608 of the Clean Air Act (40 CFR Part 82), which require the following:

- Minimizing refrigerant emissions by maximizing the recovery and recycling of ozone-depleting substances during the service, repair, or disposal of refrigeration and air conditioning equipment.

- Setting certification requirements for refrigerant recycling and recovery equipment, technicians, and refrigerant reclaimers.
- Restricting the sale of refrigerant to certified technicians.
- Requiring persons servicing or disposing of air-conditioning and refrigeration equipment to certify to EPA that they have acquired refrigerant recovery and/or recycling equipment and are complying with the requirements of the rule.
- Requiring the repair of substantial leaks in air conditioning and refrigeration equipment with a refrigerant charge greater than 50 pounds.
- Establishing safe disposal requirements to ensure removal of refrigerant from goods that enter the waste stream with the charge intact.

2.1.17 Regulations Summary for Wastes Requiring Special Handling

A summary of federal regulations applicable to wastes requiring special handling is provided in Table 2-1.

Table 2-1
Federal Regulations Summary
Wastes Requiring Special Handling

Federal Regulation	Material
RCRA	• Lead-Based Paint
Universal Waste Program (under RCRA)	• Fluorescent Lamps
CERCLA	• Fluorescent Lamps • DEHP Light Ballasts
TSCA	• Lead-Based Paint • PCBs (ballasts, caulk) • Asbestos-Containing Materials
40 CFR 761	• PCBs (ballasts, caulk)
NESHAP	• Asbestos-Containing Materials

2.2 Regulatory Involvement

2.2.1 GEPA

GEPA was created in March 1973 and is responsible for establishing and maintaining the quality of the air, land and water of Guam. In December 1998, Public Law 24-304 created the Solid Waste Management Program (SWMP). The SWMP is responsible for permitting solid waste collection and treatment, storage, and disposal facilities. Additionally, the SWMP is responsible for inspection, compliance monitoring, enforcement, and corrective action on all solid waste-related activities. Other activities include beverage container inspections, public education, and pollution prevention incentives.

In 1996, the Solid Waste Management and Litter Control Act (Act) was revised giving Guam EPA the authority to impose administrative penalties for solid and hazardous waste management violations and defined civil versus criminal penalties. The revised Act provided provisions for citizen suits, established permit fees for certain solid waste activities, and created a Solid Waste Management Fund (Fund) to support activities to effectuate the Act, which includes paying for full-time employees and related expenses. Aside from the Fund, the Program's activities are supported by the Litter Revolving Fund, which was created to be used primarily for anti-littering campaigns. At its meeting on September 27, 2006, the Guam EPA Board of Directors approved the *Guam 2006 Integrated Solid Waste Management Plan* (2006 ISWMP), which updated the previous *Guam 2000 Integrated Solid Waste Management Plan* as required by Chapter 51, of Title 10 Guam Code Annotated. The 2006 ISWMP is described in more detail in Section 2.3 Guidance Documents.

The GEPA Rules and Regulations for Solid Waste Disposal; Title 22, Division 4, Chapter 23 establishes minimum standards governing the design, construction, installation, operation and maintenance of solid waste disposal facilities on Guam. Chapter 23 establishes permit requirements for solid waste management facilities, which include solid waste processing facilities. Prohibited wastes include hazardous, commercial, government and military solid wastes (unless approved by the administrator); inert material; biological, pathological, radioactive, medical, and infectious wastes, free liquids, asbestos, animal carcasses, ashes, putrescible animal waste, sewage sludge, and other sludge and petroleum products.

2.2.1.1 Permits

Guam's Solid Waste Management Act under 10 GCA Section 51, authorizes the GEPA to issue permits for all collectors, operators and solid waste management facilities, their design, operation, maintenance, substantial alteration, modification or enlargement.

10 GCA Section 51002(25) defines solid waste management facilities as "any machinery, equipment, vehicles, structures or any part of accessories thereof installed or acquired for the primary purpose of: collection, transportation, storage, recycling, processing, or disposal of any solid waste."

Solid waste management facilities relevant to this study include central processing facilities and composting facilities.

GEPA requires permits for the following facilities and activities applicable to this study:

- Solid Waste Disposal Facility
- Solid Waste Processing
- Solid Waste Storage
- Solid Waste Collection
- Solid Waste Transfer
- Air Pollution Control Permit

Solid Waste Disposal Facility Permit

All solid waste including municipal, commercial, industrial, land clearing debris, and demolition debris must be disposed at a GEPA permitted solid waste disposal facility. The facilities requiring a solid waste disposal permit generally include landfills, hardfills, and transfer facilities. The permit application for a solid waste disposal facility must specify the facility location, mode of operation, a detailed description illustrating compliance with applicable laws and regulations, and proposed closure requirements.

Solid Waste Processing Permit

GEPA requires a solid waste processing permit for facilities that *process* solid waste. Processing is defined by 10 GCA Section 51102(16) as “any method, system or other treatment designed to change the physical, chemical or biological character or composition of any solid waste.” A processing permit would be required for facilities processing solid waste in central processing facilities, solid waste composting facilities, or for contractors processing materials on-site for reuse.

The permit application for solid waste processing contains the following requirements:

- Provide detailed plans and specifications for the facility;
- Submit relevant zoning compliance certifications and permits;
- Include a detailed operational plan; and
- Provide proof of financial assurance.

Solid Waste Storage Permit

GEPA requires a solid waste storage permit for both individuals and businesses that temporarily store solid waste. Storage is defined by 10 GCA Section 51102(50) as “the interim containment of solid waste in accordance with Federal and local regulations.”

The permit application for solid waste storage contains requirements similar to a solid waste processing permit with the exception of providing proof of financial assurance. In addition, GEPA provides public notice of the Agency’s intention to issue a permit and may provide a public hearing if opposition is received.

Solid Waste Collection Permit

A solid waste collection permit is required for any business that transports solid waste over Guam roadways. The permit application requires collection information including route and vehicle identification.

Solid Waste Transfer Permit

GEPA requires a solid waste transfer permit for any business that accepts solid waste, which is temporarily deposited and stored *awaiting transportation* to another permitted solid waste management facility such as a landfill, materials resource recovery facility, or a recycling center. The transfer permit allows temporary storage of residential waste and yard waste. The permit application requirements for solid waste transfer are similar to a solid waste processing permit with the exception of providing proof of financial assurance.

Air Pollution Control Permit

Most sources of air pollution on Guam must apply for an air pollution control permit from GEPA. The permit must be obtained prior to construction or operations activities. The following sources are required to have an air pollution control permit:

- Major Sources: Includes all facilities or group of adjacent facilities under the same ownership that emit a minimum of ten tons per year of any single hazardous air pollutant (HAP) or a minimum of 25 tons per year of any combination of hazardous pollutants. Major sources also include those that emit 100 tons per year of any other regulated air pollutant.
- Federal Oversight Sources: The U.S. EPA must also review Air Pollution Control Permits for these sources. Federal Oversight Sources include Major Sources, sources subject to standards of performance for air pollution emission sources as established in 40 CFR Part 60, and sources subject to requirements for hazardous air pollutants pursuant to 40 CFR Part 61 or Part 63, or Section 112 of the federal Clean Air Act.
- Minor Sources:
  - Sources that exceed the parameters of Insignificant Sources – Type I and Type II. GEPA's Air Pollution Control Regulations and Standards include a list of Type I and Type II insignificant sources.
  - Sources that are not Major Sources but have the potential to emit a minimum of one ton per year of each criteria or hazardous air pollutant.
  - Some minor sources may be federal oversight sources.

Although the GEPA website indicates that Air Pollution Source Construction Permits and Air Pollution Source Operating Permits may be required, discussion with a manager of the Air Pollution Control Program indicated that construction and operating permits are combined into a single Air Pollution Control Permit.

All air pollution sources or facilities to be constructed must obtain an Air Pollution Control Permit. Air pollution permits are issued according to the dry weight pollutant per year anticipated to be emitted from a facility classified as either a major or minor source. Permits are issued to ensure that facilities are constructed utilizing best available technologies to minimize, treat or eliminate specified quantities of pollutants. Many types of air pollution sources or land use activities require Air Pollution Control Permits. Sources include rock quarrying and processing facilities.

Major and minor sources are defined by threshold limits for new and existing air pollution sources.

Criteria for *Major Stationary Sources* include the following:

- >100 tons per year of Criteria Pollutant
- >250 tons per year of Criteria Pollutant*
- >10 tons per year of any Hazardous Air Pollutant*
- >25 tons per year of any combination of two or more Hazardous Air Pollutant*

*Indicates both GEPA and U.S. EPA review and approval are required.

Minor Stationary Sources

All other facility sources, which fall below the Major Source threshold, are considered minor sources. There are six Criteria Pollutants:

- Carbon Monoxide
- Particulate Matter
- Sulfur Dioxide
- Nitrogen Oxides
- Ozone, volatile organic compounds (VOCs)
- Lead

Section 112 of the Clean Air Act lists 189 Hazardous Air Pollutants.

GEPA Air Pollution Control Standards and Regulations define Insignificant Activity – Type I and Insignificant Activity – Type II sources as applicable to this study:

Insignificant Activity – Type I:

- Any emission activity or equipment with potential emissions of less than 2.0 tons per year (tpy) of each air pollutant (excluding HAPs) and less than 0.5 tpy of each hazardous air pollutant.
- Portable diesel or gasoline fired industrial equipment less than two hundred horsepower in size which are used during power outages or intermittently for maintenance and repair purposes (if there are more than five at the facility).

Insignificant Activity – Type II:

- Mobile internal combustion engines.
- Portable diesel or gasoline fired industrial equipment less than two hundred horsepower in size which are used during power outages or intermittently for maintenance and repair purposes (if there are five or less at the facility).

2.2.2 Government of Guam Department of Public Works

Guam Department of Public Works is one of several agencies of the Government of Guam and consists of several divisions including the Solid Waste Management Division (SWMD). The operation of the DPW is supported by the revenues derived from the services that it renders, fines and penalties that it collects, grants, and appropriations from the Guam General Fund (General Fund).

The Guam DPW and other non-DoD entities must comply with the Guam laws and regulations as codified under the Guam Code Annotated. Although all of the Guam laws and regulations are not directly applicable to DoD solid waste activities that involve only DoD installations, they may have an indirect impact. The most notable indirect impact is the non-compliant status of the Ordot Dump and the delayed construction of the new GovGuam landfill. The Guam laws and regulations would be applicable to any facility, including regional facilities, that manage both DoD and non-DoD solid waste.

The SWMD currently has five sections: administration, customer service, residential solid waste collection, transfer station drop-off locations and landfill operations. Support for SWMD's operations comes from revenues derived from solid waste services charges and occasional cash infusions from the Federal grants, Compact Impact funds and the General Fund. Until recently, there was no separate monthly financial reporting for SWMD's operations. DPW is responsible for complying with the tasks and deadlines mandated by the EPA Consent Decree.

Due to the delays in meeting the Consent Decree deadlines for the closure of the Ordot Dump and completion of the new landfill, the US District Court has placed the SWMD in federal receivership.

2.2.2.1 Layon Landfill Requirements

The Federal regulations pertinent to landfills on Guam are contained in Title 40 of the Code of Federal Regulations, Part 258. Local regulations are included in the GEPA Rules and Regulations for Solid Waste Disposal. The GEPA Rules and Regulations for Solid Waste Disposal are based on the Federal regulations contained in 40 CFR Part 258.

The Federal regulations contain guidance and policies on the purpose, scope and applicability of the regulations, location restrictions, operating criteria, design criteria, groundwater monitoring and corrective actions, closure and post-closure care, and financial assurance criteria.

The purpose of the regulations is to establish minimum standards for all municipal solid waste landfills to ensure the protection of human health and the environment. The regulations apply to all new municipal solid waste (MSW) landfills, existing MSW landfills and lateral expansions of existing landfills.

The GEPA requirements for a landfill permit are similar to the Federal regulations except for a few differences:

- Permit requirements for the operation of a solid waste management facility, including landfill are included.
- List of solid wastes that are prohibited for disposal at the landfill is included.
- Health and safety requirements for the protection of all personnel associated with the operation of the landfill disposal site are included.

In addition to local and Federal regulations, a materials ban has been imposed by the Receiver. These restrictions have been applied to the Ordot Dump and Layon Landfill is expected to implement a similar ban. Under this ban, the following materials are prohibited: old corrugated cardboard (OCC), green waste, construction waste, wooden pallets, and inert materials.

The Layon Landfill is expected to exclude the following waste for disposal: junk vehicles, appliances, construction and demolition debris, PCB wastes, contaminated soils (petroleum), E-wastes, DIY used motor oil, batteries, radioactive wastes, solvents, paints, oily wastes, acids, corrosives, green wastes, industrial wastes, explosives, asbestos, sludge, and asbestos-containing materials. There are provisions for acceptance of special wastes, which include infectious wastes, dead animals and offal, and sewage sludge,

The Layon Landfill has a projected tipping fee of $156 per ton for July 2010. The increase in tipping fees was established by the Receiver to ensure that the SWMD would be able to meet the debt service covenants of its borrowing obligations and to provide sufficient ongoing equity in the solid waste system.

2.3 Guidance Documents

The Guam 2006 ISWMP is a guidance document, which identifies and describes key elements of the integrated solid waste management system on Guam. Chapter 7 of the Guam 2006 ISWMP establishes minimum standards governing recycling, composting, and special wastes. Under these standards, recycling facilities and operations should be able to accomplish the stated objectives pertaining to the functional, operational, and legal/regulatory criteria for each facility. The legal and regulatory criteria are subject to applicable local and Federal laws and include the following provisions:

- Operations of recycling facilities must not violate applicable air, water quality, and other environmental standards or regulations;
- Issuance of permits by the Guam EPA for the design, operation, maintenance, and modification of all solid waste management facilities, including recycling facilities;
- Efforts should be made by all Government of Guam departments, agencies, and instrumentalities to reduce and recycle solid waste;

- Establishment of a promotional program for recycling by Guam EPA and the Solid Waste Management Division;
- Requirement for Government purchase and usage of products manufactured from recycled glass to promote recycling by the October 1997 provision in PL 24-100; and
- Insurance and maintenance of the regular collection of recyclable materials and recorded data forwarded to Guam EPA.

GEPA's Guam 2006 ISWMP provides additional performance standard requirements for processing operations. On the basis that processing and composting facilities and landfills share similar functional concerns – including odor and vector control – facilities must meet requirements in terms of location (e.g., flood plains, wetlands, housing developments). Further, the Guam 2006 ISWMP indicates that, in order to achieve effective facility design, construction, management and operation, operating rules and regulations are to be in place against which the performance of the system may be evaluated.

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3.0 Construction and Demolition Debris and Green Waste Generation

3.1 Projected DoD Development

Development of additional facilities is planned for DoD operations and the proposed relocation of the U.S. Marine Corps on Guam. Activity at the DoD installations is expected to increase. The proposed USMC relocation is anticipated to begin in 2012 and be completed by 2016. The generation of construction and demolition debris during the DoD installations' projected growth is expected to occur in several areas including:

- NCTS Finegayan
- Former Federal Aviation Administration (FAA) Parcel
- South Finegayan
- Andersen Air Force Base
- Naval Base, Apra Harbor
- Ordnance Annex (Naval Magazine)
- Andersen Air Force Base South

NCTS Finegayan is expected to experience development throughout the entire base with several areas being retained. Development of NCTS Finegayan is expected to include demolition of existing facilities and clearing and grubbing of existing vegetation prior to new construction. Directly south of NCTS Finegayan is the former FAA land parcel. The former FAA parcel would require obtainment from the current owners, which include private individuals and GovGuam. Base maps and location maps are provided on Figure A-1 through Figure A-8 in Appendix A and include the anticipated demolition areas.

A complete redevelopment of South Finegayan is anticipated. All existing facilities are expected to be demolished. Clearing and grubbing is expected to occur in areas of existing vegetation. Base maps and location maps are provided on Figure A-9 through Figure A-11 in Appendix A and include the expected demolition areas.

Development of Andersen Air Force Base is planned for the North Ramp portion of the base. Demolition of existing buildings and clearing and grubbing of existing vegetation is expected. Base maps and location maps are provided on Figure A-12 and Figure A-13 in Appendix A and include the anticipated demolition areas during the planned development.

Development of the Naval Base, Apra Harbor is expected to include several construction projects located at the Main Base, Camp Covington, and Polaris Point within Apra Harbor. Demolition of existing buildings and clearing and grubbing of existing vegetation in these areas is planned. Base maps and location maps are provided on Figure A-14 through Figure A-16 in Appendix A and include the expected areas of demolition.

Construction of new earth covered magazines (ECM) is planned for the Ordnance Annex. Development is planned for a site located near the Fena Valley Reservoir and another site beside Parsons Road. Clearing and grubbing of these areas is expected to occur in preparation for the development. Base maps and location maps are provided on Figure A-17 and Figure A-18 in Appendix A and include the expected areas of demolition.

Andersen Air Force Base South is expected to be developed as a non-firing range training complex. The area is expected to be used for maneuvers training. The existing facilities are expected to be utilized for training and clearing and grubbing is not expected to occur. A base map for Andersen Air Force Base South is provided on Figure A-19 in Appendix A.

The Master Plans for DPRI construction projects at the current NCTS Finegayan, former FAA parcel, South Finegayan, AAFB, Naval Base, Apra Harbor and the Ordnance Annex were referenced to determine the areas expected to generate construction and demolition debris. The DPRI Master Plan for the future Marine Corps Base (MCB) Guam Main Cantonment, which is currently NCTS Finegayan, South Finegayan, and the former FAA parcel was dated August 2009; DPRI Master Plan for AAFB North Ramp was dated August 2009; and DPRI Master Plan for Naval Base, Apra Harbor and the Ordnance Annex was dated March 2009. The Master Plan for Naval Base, Apra Harbor includes construction projects at the Main Base, Camp Covington, and Polaris Point. The following projects at Naval Base, Apra Harbor are included for this study:

Main Base Area:

- P-1002 USCG Berthing & Crew Support
- P-1003 Relocate Military Working Dogs
- P-1005 Apra Harbor Wharf Improvements
- P-1008 USMC Embarkation Operations
- P-564 NECC Consolidation
- MCH-006 Apra Harbor Medical Clinic
- Port Operations Group Facility

Camp Covington:

- P-564 NECC Consolidation

Polaris Point:

- P-465 Consolidated SLC and CSS-15 Facility
- P-528 Torpedo Exercise Support Facility
- P-583 CVN Capable Wharf
- P-1004 AAV/LCAC Operations

The generation of substantial quantities of C&D debris is expected to support the military buildup. In this study, C&D debris includes solid waste generated during construction and demolition activities from the DPRI projects identified. The C&D

debris quantities do not include those generated during wharf improvements and dredging operations at Naval Base, Apra Harbor.

3.2 Projected Construction and Demolition Debris and Green Waste Generation

3.2.1 Introduction

To meet the Federal and DoD non-hazardous solid waste requirements of 50 percent diversion of C&D debris by 2015, C&D debris quantities were estimated and reuse and recycling options are identified in the following sections. Current reuse and recycling capabilities available on Guam at the time of this study were assessed for each material.

It is expected that during demolition activities, wastes requiring special handling may be encountered. Waste determined to be hazardous must be managed and disposed in accordance with local and federal regulations. Wastes requiring special handling are anticipated to be generated during demolition and include fluorescent lamps and ballasts, PCBs, low-level radioactive waste, and asbestos-containing materials.

Wastes requiring special handling must be removed prior to demolition of facilities and managed in accordance with the applicable removal and disposal procedures.

Construction debris expected include wood, gypsum board, scrap metal, plastics, cardboard, and miscellaneous construction debris.

Demolition debris expected include concrete, asphalt concrete, glass, wood, scrap metal, polyvinyl chloride (PVC), vitrified clay pipe (VCP), gypsum board, porcelain plumbing fixtures, white goods, and other demolition debris. White goods should be removed prior to demolition and would not contribute towards the C&D waste stream to meet the diversion goal. The generation of green waste and soil are expected during construction and demolition activities.

Based on the Executive Order definition of construction and demolition materials and debris, this study focuses on materials generated during construction and demolition of buildings and infrastructure. Green waste generated by land clearing activities is not included in the quantities for construction and demolition debris and would therefore not contribute towards meeting the diversion goal. However, it is expected that green waste would be reused on-site.

The following sections discuss reuse, recycling, and disposal options for each type of material expected to be generated.

3.2.2 Wastes Requiring Special Handling

3.2.2.1 Fluorescent Lamps and Ballasts

Fluorescent lamps are commonly found in administrative and industrial buildings. Section 2.1.12 of this study discusses regulations including disposal requirements for fluorescent lamps.

Currently, light ballasts are removed during routine building maintenance and prior to demolition. The light ballasts are disposed through the Defense Reutilization and Marketing Office (DRMO) on Guam. DRMO is also referred to as the Defense Reutilization and Marketing Service (DRMS). DRMO is part of the Defense Logistics Agency. Their mission is "to provide the DoD's best value services and deliver great performance" to customers for the reuse, transfer, donation, sale or disposal of excess/surplus property. DRMO manages the disposal of hazardous property for DoD activities, maximizing the use of each item and minimizing environmental risks and costs. Light ballasts are currently shipped directly off-island as non-hazardous waste.

3.2.2.2 PCBs

PCBs were used in caulk in many industrial and commercial buildings between 1950 and 1978.

Caulk is any flexible sealing compounds used to seal joints or fill crevices in buildings against water, air, dust, or insects. Caulk is expected to be found during the demolition of DoD facilities.

Based on the health implications associated with PCB exposure, PCBs are heavily regulated by Federal and local agencies. Section 2.1.14 discusses PCB regulations. Removal and disposal of PCB-containing caulk are subject to applicable Federal and local regulations.

3.2.2.3 Low-Level Radioactive Waste

Low-level radioactive wastes are items contaminated with radioactive material or have become radioactive and typically consist of tritium exit signs, smoke detectors, gauges, and other materials. It is expected that low-level radioactive wastes may be encountered during demolition. Removal and disposal procedures must be in compliance with Federal and local regulations. Section 2.1.10 discusses low-level radioactive waste regulations.

3.2.2.4 Asbestos-Containing Materials

Asbestos is a mineral fiber which was commonly used in building materials as insulation or a fire retardant. Based on two Guam asbestos surveys: *Asbestos Inventory and Assessment U.S. Naval Computer and Telecommunications Area Master Station WESPAC Guam* and *Final Inspection Report, Asbestos Inventory Naval Activities, Guam, Volumes 1 through 5*, asbestos-containing materials were found to be present on Guam naval bases. Common types of ACM that may be of concern during demolition include: ceiling and floor tiles, roofing materials, insulation, transite pipe, and asbestos cement products.

Asbestos floor tiles subjected to sanding, grinding, cutting, or abrading activities expected during demolition would be considered regulated ACM and would require removal prior to demolition. The other ACM expected during demolition are regulated ACM and would be subject to applicable regulations. Regulated ACM requires special handling and must be disposed in accordance with NESHAP.

At the time of this study, none of the hardfills on Guam accept asbestos. The Layon Landfill will not accept asbestos waste. The Navy Sanitary Landfill accepts asbestos waste on a case-by-case basis. The landfill must be notified at least 24 hours prior to the receipt of incoming asbestos waste. After receiving approval for disposal, certified asbestos contractors arrive with asbestos waste pre-bagged and sealed. DZSP-21 Environmental Operations personnel inspect asbestos bag seals for integrity and certify asbestos waste for disposal. The landfill operations staff directs the driver to the disposal site. The Waste Shipment Record must be signed by the landfill supervisor as the disposer and retained on site. The active asbestos disposal area is located in the central-west portion of the landfill site.

3.3 Construction Debris

3.3.1 Wood

Wood is a commonly generated material during new construction. Wood is often used for forming and framing lumber, doors, and engineered wood. It is expected that new construction would generate large quantities of wood from concrete formwork and wood pallets. The recycling and disposal of wood are dependent on whether wood is comprised of treated or painted wood. Wood debris comprised of wood pressure-treated with CCA, creosote, pentachlorophenol (PCP), or other hazardous wood preservatives, must not be ground, chipped, reused, or recycled.

On Guam, untreated wood is currently taken to a private hardfill, where it is mulched or chipped.

The wood waste generated during new construction is expected to be “clean:” untreated, unpainted, and recyclable. Generation of “clean” wood in construction debris may be achieved by specifying the use of untreated and unpainted wood for all formwork lumber and wood packaging in contract documents.

Common recycling options for clean, untreated wood include remilling, chipping, or grinding into the following products:

- Wood chips or mulch
- Animal bedding
- Compost
- Feed stock for engineered wood

- Boiler fuel

Contractors can use clean wood for wood chips or mulch for erosion control on construction sites. Wood chips may also be combined with green waste to generate compost.

Recycling of untreated wood for boiler fuel would not be permitted on Guam. Boilers are commonly a part of a waste-to-energy facility. Chapter 73, Fire Prevention, Division 3 of Title 10 of the Guam Code Annotated Code prohibits construction or operation of a municipal solid waste incinerator or waste-to-energy facility. Although the DoD is generally not subject to Guam laws and regulations, the DoD should comply with certain U.S. federal laws that are administered by the Government of Guam.

3.3.2 Gypsum Board

Drywall is a common method used for constructing interior walls and ceilings using panels known as gypsum board, wallboard, or plasterboard. The panels are made of gypsum plaster, usually pressed between two thick sheets of paper or fiberboard and kiln dried. On Guam, gypsum board is used for internal walls and dropped ceilings for residential and commercial buildings.

Gypsum board from new construction is often recycled through the recovery of gypsum by grinding wallboard, removing any metals, screening out paper, and drying and bagging the resulting gypsum powder. Common products made with recovered gypsum include:

- Gypsum wallboard
- Soil amendment
- Cat litter
- Cement

Currently, there is no recycling market on Guam for gypsum board. California has recycled gypsum board for use as a soil amendment. However, due to the location of the Northern Guam Lens Aquifer (NGLA), a sole source aquifer for Guam's potable water supply, the use of gypsum as a soil amendment may raise environmental concerns. Therefore, disposal at the hardfill at the Navy Sanitary Landfill may be a possible option. Landfill disposal of gypsum board is discouraged due to the possible production of hydrogen sulfide. Another option is to ship the clean gypsum board directly to off-island recyclers.

3.3.3 Scrap Metal

Scrap metal generally refers to both ferrous and non-ferrous metals, which are recyclable materials. Scrap metal is generated as a residual of product consumption during new construction. Steel comprises the largest category of metals in construction. During construction, the most commonly used steel products include structural beams, steel plates, and reinforcement bars. Other scrap metal is generated as construction debris from siding, wiring, and framing.

Steel is a commonly recycled metal and is often combined with steel scrap and melted in a furnace to produce new steel. The steel industry uses scrap to produce new steel, which ensures all steel products contain 25 to 100 percent recycled content. Steel recycling reduces costs and energy consumption compared with mining and using virgin materials to produce new steel. The production of recycled steel reduces greenhouse gases released during the processing and manufacturing of steel from virgin materials. Scrap metal is accepted for recycling into various end uses. Recycling of scrap metal typically involves sorting, shredding, and remelting in a blast furnace for use in new products.

Currently there are seven recyclers on Guam who accept scrap metal for recycling. The seven recyclers are: Bali Steel, Formosa, FSM Recycling, Global Recycling Center, Inc., Pyramid Recycling, Triple Star Recycling, and Xiong's Family Recycling, Inc. The recyclers accepting the scrap metal ship the metals to Asia for sale in the available markets. Sorted scrap metal typically has higher value than mixed scrap metal. Sorting the metals would require higher capital and labor costs for sorting and storage requirements. Currently, one recycler on Guam ships mixed scrap metal to a facility in China where metals are sorted by type. The labor costs in China are substantially lower than those on Guam. The lower cost of labor in China would allow recyclers with an affiliate in China to ship mixed scrap metals regardless of market prices. Currently, the Navy Sanitary Landfill and GovGuam Ordot Dump prohibit the disposal of scrap metal.

3.3.4 Plastics

Plastics are commonly used in packaging materials during new construction to protect materials, components, and finishes during transportation and storage. Plastics used in packaging include plastic wrap and expanded polystyrene (EPS).

Plastic wrap is used to protect construction materials from dust and moisture. Although some mixed plastics are not easily recycled, plastic packaging may be recycled into various materials and products, including plastic lumber, composite lumber, injection molded materials, construction materials, and home-use items. Plastic wrap and shrink wrap generated during construction typically consist of plastics with resin identification codes Type 3 and Type 4. Currently, Pyramid Recycling on Guam accepts plastic shrink wrap. Plastics can also be shipped directly to off-island recyclers.

EPS is lightweight, transport packaging generated during construction. Expanded polystyrene is commonly referred to as Styrofoam. The volume of EPS is a concern in landfills because it does not biodegrade. EPS can be identified by the #6 plastic resin identification code. EPS is a recyclable plastic and may be recycled into new products including new EPS, plastic lumber, clothes hangers, park benches, toys, and other plastic products. However, currently, none of the recyclers on Guam accept EPS plastic for recycling. EPS can be disposed at the hardfill at the Navy Sanitary Landfill. Another option is to ship the material directly to off-island recyclers.

3.3.5 ***Cardboard***

Cardboard is expected to be generated during new construction as packaging material. Cardboard is typically used in boxes, packaging and protective covers. Old corrugated cardboard is commonly recycled in many communities. Cardboard can easily be flattened for recycling. Recycled cardboard is remade into paper products including: new cardboard, paper towels, and fiber board. Currently, two recyclers on Guam, Mr. Rubbishman and Dewitt Moving and Storage, accept OCC for a fee of $3.00 to $3.50 per cubic yard. The recyclers on Guam bale and ship the cardboard to an available market. The AAFB Recycling Center also recycles cardboard through a local vendor. Currently, OCC is prohibited at Ordot Dump. Other options for recycling cardboard include baling and shipping OCC off Guam directly to OCC recyclers. The capability to ship directly off-island can provide a more reliable means of diversion that is not subject to the financial viability of business decisions of a local recycler.

3.3.6 ***Miscellaneous Construction Debris***

During construction of DoD facilities, it is expected that additional miscellaneous materials besides those previously identified would be generated in smaller quantities. Miscellaneous materials anticipated include but are not limited to carpeting, insulation, roofing, and tile.

Miscellaneous construction debris may contain materials, which can be recycled or reused. In general, the miscellaneous construction debris available is not expected to contribute towards meeting the diversion goal due to the limited recycling opportunities for those materials.

3.4 Demolition Debris

3.4.1 ***Concrete***

Concrete is a construction material composed of cement, coarse aggregates, fine aggregates, cementitious materials, and water. Reinforced concrete uses reinforcement bars composed of iron or steel to provide strength in tension. Concrete is one of the most commonly used materials in new construction. By weight, concrete comprises the single largest category of demolition wastes. In the construction industry, concrete is used in the formation of foundations, driveways, sidewalks, floors, road surfaces, buildings, and other structures. Many buildings on Guam are constructed of reinforced concrete due to the frequent occurrence of typhoons and earthquakes.

The planned development is expected to generate large quantities of concrete. Concrete debris would be generated during demolition of existing structural and site concrete. Concrete is expected to be generated from the demolition of DoD facilities from the following sources:

- Foundations
- Walls
- Building roofs
- Driveways
- Slabs
- Sidewalks and covered walkways

Common practices for concrete recycling involve crushing, screening, and removing steel reinforcement before use as aggregate in various applications. The aggregate produced from recycled concrete can be used for the following products:

- Aggregate for new concrete or pavement
- Road base under new roadways or parking areas
- General fill
- Drainage media
- Bank protection
- Noise barriers or embankments
- Vegetated swale
- Rip rap

Recycling opportunities may be limited in some areas and disposal may be the only option. Concrete generated during demolition activities are often taken to a construction and demolition landfill or a hardfill facility.

Currently, there are no recyclers on Guam who accept concrete nor is there a central processing facility accepting construction and demolition debris. Concrete from construction and demolition debris can be disposed at the hardfill at the Navy Sanitary Landfill for a fee. Contractors have the option of crushing concrete from construction and demolition projects on-site after obtaining the required permits. Concrete crushers capable of removing reinforcing steel are available on Guam for purchase or rental.

A significant quantity of structural concrete is painted. One concern during demolition of older structures is lead-based paint. Lead-based paint is commonly found on walls, woodwork, siding, windows, and doors of older structures. Walls containing lead-based paint may have been covered using drywall or gypsum board as a temporary measure to mitigate the hazard until the lead-based paint is removed or the facility is demolished.

Lead-based paint waste from removal activities including debris, paint chips, or dust exhibiting the toxicity characteristic must be managed and disposed as RCRA hazardous waste.

Lead-based paint surveys on concrete structures conducted at NCTS Finegayan, South Finegayan, AAFB, and Naval Base, Apra Harbor have identified lead-based paint in a few of the buildings sampled. Based on the lead testing results, a similar ratio of buildings was assumed to contain lead-based paint. Lead-based paint testing results are included in Appendix B.

Concrete without lead-based paint can be crushed for reuse as general fill material.

Concrete containing lead-based paint may not be recycled unless the paint has been abated. Without abatement, the concrete requires disposal at the hardfill at the Navy Sanitary Landfill. Concrete containing lead-based paint must pass a TCLP test before it can be disposed at the hardfill at the Navy Sanitary Landfill. The cost to dispose concrete in the hardfill is based on the volume of concrete disposed. Disposal of concrete in the hardfill would not contribute towards meeting the 50 percent diversion goal.

Abatement costs are estimated by surface area requiring abatement. Lead-based paint chips from abatement must be handled and disposed properly, as defined by federal and local regulations. Abatement of hazardous lead-based paint must be performed by EPA-certified personnel.

3.4.2 ***Asphalt Concrete***

Asphalt concrete or asphalt pavement is a composite material used in the construction of pavement, highways, and parking lots. Asphalt concrete is comprised of asphalt binder and mineral aggregate. The asphalt concrete is placed in layers and compacted.

On Guam, asphalt concrete is typically found in roadways, parking lots, and other paved areas. A large amount of asphalt concrete is expected to be removed during the construction of DPRI projects identified in this study.

Asphalt concrete is a commonly recycled material. Recycling practices for asphalt concrete involve crushing, grinding, and screening for use in products such as recycled asphalt pavement (RAP), recycled asphalt concrete, structural fill, and aggregate for road base or subbase. While asphalt pavement is typically recycled at a central processing facility, asphalt concrete can be pulverized on-site and incorporated into an aggregate base course after obtaining the applicable permits and meeting gradation requirements.

Currently, a central processing facility is not available on Guam. None of the recyclers on Guam accept asphalt concrete. Asphalt concrete can be disposed at the hardfill at the Navy Sanitary Landfill. Equipment for crushing and pulverizing asphalt is available for rent or purchase on Guam and material can be processed on the construction site for use as general fill. Currently, crushed asphalt does not meet the DoD gradation requirements for use in base course or recycled asphalt.

3.4.3 ***Glass***

Glass generated during demolition is typically derived from windows, mirrors, and lighting. Construction glass is separated from container glass and other glass types. It is expected that glass would be generated from the demolition of windows in commercial and residential buildings. Glass from lighting would not contribute towards meeting the diversion goal due to the special handling requirements of fluorescent light bulbs.

Windows are composed of plate glass; a type of glass cast in a solid plate. This type of glass is flat and generally has few distortions. Common recycling practices for plate glass include crushing or grinding the glass for use in the following products:

- Aggregate for glasphalt
- Flat glass
- Fiberglass
- Sand for utility bedding

At the time of the study, none of the recyclers on Guam accept plate glass. Currently, the AAFB Recycling Center accepts glass containers for recycling and crushes the glass into a one-quarter inch aggregate and sand. The recycled glass from the AAFB Recycling Center is ground into sand for use as utility bedding material and the one-quarter inch aggregate is used as cover at the landfill. Utility bedding material composed of sand from recycled glass does not meet DoD gradation requirements, but can be used for non-military construction.

Glasphalt has not been used previously and is currently not in use on Guam. Glass recycling considerations include contamination, laminated or fire resistant glass, and tinted or colored glass. Currently, there are no resources on Guam for recycling plate glass into fiberglass or flat glass. Recycling glass into these products requires shipping the glass directly to off-island recyclers. Other options for plate glass are disposal at a landfill or the hardfill at the Navy Sanitary Landfill, which would not contribute towards meeting the diversion goal.

3.4.4 *Wood*

Demolition of structures at DoD installations is expected to generate wood debris from forming and framing lumber, doors, and utility poles.

Currently, a central processing facility is not available on Guam. Untreated wood is currently taken to a private hardfill, where it is mulched or chipped. Demolition of facilities during the planned development of DoD installations is expected to generate wood from doors and drywall framing. Based on the wood sources expected, it is assumed that a majority of the wood would be treated or painted. Wood debris containing lead-based paint would require disposal at the hardfill at the Navy Sanitary Landfill. Drywall framing lumber is expected to be treated and must not be used for mulching, chipping, or composting. Treated or painted wood may not be recycled or reused and must be disposed at the hardfill at the Navy Landfill.

3.4.5 *Scrap Metal*

Scrap metal is expected to be generated during the demolition of pipes, rebar, flashing, wiring, plumbing, framing, and heating, ventilating, and air conditioning

(HVAC). Common types of scrap metal encountered during demolition include steel, aluminum, copper, brass, and alloys.

Steel comprises the largest category of metals in construction. On Guam, it is expected that steel debris would be generated in the form of reinforcing bars during concrete demolition. To remove steel from concrete, a concrete crusher is required. Concrete crushers are available on Guam for purchase or rent and can be used on-site with proper permitting.

It is expected that scrap metal would be generated from metal shutters, pipe railings, fluorescent light fixtures, chain link fencing, and HVAC. Currently, scrap metal is accepted by seven recyclers on Guam. Section 3.3.3 discusses scrap metal recycling options.

3.4.6 PVC

PVC pipe is widely used due to its versatile properties. PVC pipe is commonly used in water distribution and sewage collection system piping, plumbing, and electrical conduits. Although the use of PVC is widespread, recycling practices are not as common. PVC has a plastic resin identification code of #3. Although PVC is recyclable, few recyclers accept PVC. Currently, none of the recyclers on Guam accept PVC for recycling. PVC pipe is likely to be disposed at the hardfill at the Navy Sanitary Landfill. Another option is to ship the material directly to off-island recyclers.

3.4.7 VCP

VCP is pipe made from clay, which has undergone vitrification, a process transforming a substance into a glass-like state. According to a technical note from the National Clay Pipe Institute, clay pipe can be recycled to form new pipe, brick, and roofing tile. Clay pipe can be used for road base and landscaping. On Guam, clay pipe is not likely to be permitted for use in road base on DoD projects due to gradation requirements, but can be used as general fill. Clay pipe is accepted for disposal at the hardfill at the Navy Sanitary Landfill but would not contribute towards meeting the diversion goal.

3.4.8 Porcelain Plumbing Fixtures

Plumbing refers to a system of pipes and fixtures installed in a building for the distribution of potable water or the removal of wastes. Plumbing is generally distinguished from water and sewage systems; a plumbing system serves one building, while water and sewage systems serve a group of buildings or a municipality. Porcelain plumbing fixtures, which include toilets and wash basins, are expected to be generated from DoD bases during demolition. Toilet recycling programs are available in some communities in the United States. The seat cover and any metal or plastic parts must be removed prior to recycling. Toilet recycling programs crush the porcelain and use the material as aggregate in concrete for roads, sidewalks, and road base. Currently, toilet recycling programs are not available on Guam. Currently, crushed porcelain does not meet the DoD gradation requirements for aggregate base course or use in concrete but may be used as general fill. Porcelain plumbing fixtures are accepted for disposal at the Navy Sanitary Landfill.

3.4.9 Gypsum Board

Gypsum board is expected to be encountered during the demolition of existing DoD facilities. Gypsum board is typically used on Guam for internal walls and dropped ceilings for residential and commercial buildings. Gypsum board resulting from demolition must be free of nails and finishes prior to being recycled. Based on lead-based paint surveys for NCTS Finegayan, South Finegayan, AAFB, and Naval Base, Apra Harbor, it is assumed that some building walls and ceilings may contain lead-based paint. This may result in additional recycling and disposal concerns. Section 3.3.2 discusses reuse options for gypsum board.

3.4.10 White Goods

A white good is a term used to describe major or domestic appliances. White goods are used in household, institutional, commercial, and industrial settings. On DoD bases, white goods are expected to be generated from residential and commercial buildings. The anticipated white goods are refrigerators, stoves, washers, and dryers.

Appliances are manufactured from a combination of materials, such as metals, polymers, foam, and fiberglass. Based on weight, metals account for a large percentage of materials in appliances. The U.S. EPA indicates typical large appliances including washers and refrigerators are comprised of approximately 65 percent steel. The metals contained in white goods can be recycled as scrap metal after being dismantled.

Recyclers on Guam currently accept white goods for recycling. White goods and appliances are prohibited from disposal at a hardfill or landfill. Although local recyclers are available on Guam, white goods owned by the federal government are required to be submitted to DRMO. DRMO is responsible for the disposal or distribution of white goods through an appropriate vendor or recipient for the items received. White goods should be removed by the user activity prior to demolition but do not contribute towards the construction and demolition waste stream when managed by DRMO. DRMO does not track items after they have been declared scrap. Therefore, the end use of the item cannot be determined.

DRMO accepts refrigerators both in serviceable and non-serviceable condition. Serviceable refrigerators are operable or may be fixed for reuse. Submittal of serviceable refrigerators to DRMO does not require refrigerant to be removed. Many refrigerants contain CFCs, which is commonly referred to as Freon. Non-serviceable refrigerators require refrigerant to be removed prior to submitting to DRMO. Section 2.1.16 discusses regulations applicable to CFCs and ozone depleting substances.

Privately owned white goods can be recycled through local recyclers for a disposal fee. Some local recyclers do not require refrigerant from refrigerators to be removed prior to disposal. Contractors who encounter privately owned white goods should dispose of white goods through local recyclers and in accordance with applicable regulations.

During the development of DoD facilities, none of the white goods generated are expected to be privately owned.

3.4.11 Other Demolition Debris

During the demolition of existing DoD facilities, it is expected that additional materials besides those previously identified may be generated in smaller quantities. Other materials anticipated include carpeting, insulation, and additional miscellaneous materials within a building.

Carpet is used as a textile floor covering composed of an upper layer of “pile” attached to a backing. Although carpet is typically used in residential and commercial buildings, the quantity of carpet at DoD facilities is expected to be minimal. Carpet is a reusable and recyclable material. Reusing carpet involves cleaning, rejuvenating, restyling, and reinstallation as fresh carpet. Used carpet may also be recycled as a component to produce other products such as auto parts, carpet pad, plastic lumber, and parking stops. Currently, none of the recyclers on Guam accept carpet. Carpet is likely to be disposed at the hardfill at the Navy Sanitary Landfill.

Other items generated during demolition include insulation and miscellaneous fixtures in a building. These items would generally not be recyclable and comprise a small percentage of the demolition debris waste stream.

3.5 Green Waste

3.5.1 Introduction

Green waste is a biodegradable waste composed of brush, limbs, leaves, grass, tree trimmings, and other organic materials. Clearing and grubbing during development is expected to produce large quantities of green waste.

Clearing activities generally consist of cutting, removing, and disposing of all vegetation and debris. Grubbing usually involves removal and disposal of stumps, large roots, and matted roots from the grubbing area. It was estimated that grubbing of heavily vegetated areas would require removal to a depth of 18 inches to remove debris not suitable for foundation purposes. Lightly vegetated areas are expected to be primarily grassed areas containing shallow roots and trees dispersed throughout the grubbing areas. It was estimated that clearing grassed areas would generate a half pound of green waste per square foot of area cleared.

Green waste is commonly recycled into compost and landscaping mulch. The use of green waste for composting and landscaping is regulated at the local and federal level. Section 2.1.7 discusses the applicable composting and mulching requirements.

Recycling green waste into compost and mulch would require separation of the “woody” material from the “leafy” material. The “woody” material includes tree trunks, branches, and large roots, which would be suitable for mulch; the leafy materials can be combined with grass for composting.

It was estimated that approximately 10-percent of a square foot of forest area consists of green waste. In heavily vegetated areas where vegetation ranges from 10 to 15 feet in height, it is estimated that approximately 150 square feet of area would produce one cubic yard of “woody” material. In medium vegetated areas in which vegetation ranges from five to ten feet in height, it is estimated that approximately 300 square feet of area would produce one cubic yard of “woody” material. The remaining quantity of green waste would consist of the “leafy” material.

Mulch is any material placed on top of the soil that protects plants and soil. Mulch shields the soil from the sun, wind erosion, extreme temperature changes, and moisture loss. Mulch also suppresses weeds and increases water infiltration from rainfall. As mulch decomposes, it can add organic matter and nutrients to the soil. Examples of mulch are wood chips, bark, rocks, shredded paper, straw, ground yard wastes and partially composted material.

Compost is a chemically and thermally stable decomposed organic matter that looks and feels like dark, crumbly soil. Compost is a finished product that is typically mixed with soil as a conditioner. The addition of compost to soil may help lighten dense, clay soils, improve water retention in sandy soils, physically stabilize the soil against erosion, and provide nutrients for plant growth.

Composting is the biological process of converting organic waste matter under controlled conditions to a product that may be used to enhance soil texture and fertility. Composting reduces the weight and volume of organic matter, plant, and animal waste through biological decomposition. The composting process typically involves the placement of biodegradable waste in a pile at a designated location where decomposition is accelerated through human intervention and by the creation of a suitable environment.

3.5.2 Composting Factors

Many factors contribute to the success of the composting process. Composting incorporates biological, chemical, and physical processes.

Microorganisms are essential to the composting process. For composting to occur rapidly, all conditions must be ideal for a given microbial population to perform at its maximum potential. Therefore, the composting process should be adapted to the needs of the microorganisms and promote conditions that would lead to rapid stabilization of the organic materials.

Composting methods incorporate chemical processes which must be controlled during composting. The main variables include:

- Presence of an adequate supply of carbon, energy source, or feedstock
- Balanced amount of nutrients, e.g., nitrogen
- Proper moisture content
- Adequate oxygen
- Appropriate pH
- Absence of toxic constituents that may inhibit microbial activity

Microorganisms in compost rely on the carbon in organic material as their carbon source. Most tree trimmings contain adequate amounts of biodegradable forms of carbon. Carbon is commonly found in brown waste materials including dried leaves, tree stumps, and branches. Wood chips may also be used as a carbon source in composting.

Nitrogen is the most important plant nutrient for composting. Nitrogen is found in "green" waste such as fresh leaves and grass clippings. The ratio of carbon to nitrogen is considered critical in determining the decomposition rate.

Water is an essential component for composting. A moisture content of 50 to 60 percent of total weight is considered ideal. However, excessive moisture content may cause the formation of leachate or runoff, which is undesirable during composting.

Composting is an aerobic process, which requires oxygen. The compost pile should contain adequate voids to allow oxygen from the atmosphere to enter the pile.

An appropriate pH between 6 and 8 is considered optimum. The pH affects the amount of nutrients available to microorganisms, the solubility of heavy metals, and the overall metabolic activity of the microorganisms.

Physical processes affecting composting include the following factors:

- Temperature
- Particle size
- Mixing

Microorganisms in compost have an optimum temperature range between 32 degrees Centigrade and 60 degrees Centigrade. Temperature is critical for the destruction of pathogens and promoting rapid composting.

Particle size of the material being composted is critical. Smaller particles generally have larger surface areas per unit weight. The larger surface areas facilitate higher microbial activity on the surface, which leads to rapid decomposition.

Mixing of feedstock and water is important for composting. Mixing of piles distributes moisture and air evenly and promotes the breakdown of clumps in the compost.

3.5.3 *Composting Methods*

Composting methods vary and range from simple and inexpensive backyard and on-site methods to more expensive and involved technologies such as in-vessel composting. According to the EPA, the most common methods of composting include: backyard or on-site, including grasscycling; vermicomposting; aerated windrow; aerated static pile; and in-vessel.

The composting methods most applicable to green waste include aerated windrow and aerated static pile.

3.5.3.1 *Aerated Windrow*

The most common composting method for green waste is the windrow. A windrow is a pile with a triangular cross section. A windrow's length exceeds its width and height. The ideal pile height allows for a pile to generate sufficient heat, yet allows oxygen to diffuse to the center of the pile. Typically, an ideal height is four to eight feet with a width of 14 to 16 feet. Windrow composting works well with leaves, which break down more slowly than grass clippings. The combination of dry leaves and grass clippings in a 1:1 weight ratio provide an optimum carbon-to-nitrogen ratio. Composting only leaves may require supplemental nutrients. This method is suitable for large quantities, such as those generated by communities and local governments, but only with frequent turning and careful monitoring.

Windrow composting is a large-scale operation and may be subject to regulatory involvement. Machines equipped with augers, paddles, or tines are used to turn piles. Operations with large volumes may use front-end loaders to turn the compost. Piles may be covered or uncovered outdoors. Outdoor piles are exposed to precipitation, which may result in runoff or leachate. Additional moisture from precipitation increases the potential for producing leachate. Any leachate or runoff should be collected and treated or added to new feedstock. Windrow composting usually requires large areas of land, heavy equipment, and a continual supply of labor to maintain and operate the facility. An EPA document indicated the composting time required using windrows may vary depending on the frequency of turning and the factors discussed in Section 3.5.2. The EPA document indicated that seasons are a factor in the composting time. A large scale commercial composting operation on Oahu, Hawaii employing the windrow method requires approximately three months to complete the composting process. The composting operation in Hawaii turns piles every three to seven days based on temperature readings. Based on Guam's tropical climate, which is similar to Hawaii's, it is expected that the composting time required may be similar.

3.5.3.2 *Aerated static pile*

Aerated static pile composting is another possible option for composting green waste. This method involves placing compost mixture in piles that are mechanically aerated. To aerate the piles, the pile may be placed over a network of pipes connected to a blower that delivers air into or draws air out of the pile. Aerated static piles are suitable for relatively homogeneous mixtures of organic waste and work well for larger quantity generators of yard trimmings and compostable municipal solid waste. Aerated static piles require careful monitoring to ensure the outside of piles heat evenly through the core because there is no physical turning of the pile. This method generally requires less land than the windrow method, but requires equipment such as blowers, pipes, and monitoring equipment. Aerated static piles typically produce compost relatively quickly. An EPA document indicated the composting time required using this method usually requires six to 12 weeks.

3.5.4 Current Conditions

Currently, Guam does not have a composting or mulching facility. At the time of this study, Ordot Dump prohibits the disposal of green waste, which should be taken to a private hardfill where it is mulched. The University of Guam has submitted a proposal for the development of a large scale composting operation for green waste on Guam. Their proposal outlines the reasons a large-scale composting operation on Guam is needed. These reasons are listed below.

- Ordot Dump currently prohibits the disposal of green waste and users are asked to deliver the green waste to Primo's Hardfill in Northern Guam for a fee of four dollars per cubic yard. There is a need to minimize cost and undesirable environmental effects of legal and illegal dump sites and to enable utilization of green waste as a resource.
- Guam law prohibits importation of soil, except in small quantities for research purposes. However, the law is not enforced and nurseries and hardware stores import large quantities of packaged soil and amendments containing invasive species. Therefore, a source of cheap, locally produced compost would reduce the need to import some of this material, thereby reducing the risk of accidental pest introduction.
- A large pest eradication project has been launched on Guam for the coconut rhinoceros beetle. This has resulted in removal of decaying coconut logs, the rhinoceros beetle breeding sites. There is a materials handling problem faced by the Guam Coconut Rhinoceros Beetle (CRB) Eradication project. The establishment of a large-scale composting operation would assist in the chipping and transformation of coconut logs into compost, which would prevent infestation by insects.

In the proposal, a three-acre parcel of property has been selected for the processing site in the Northern Guam Soil and Water Conservation District. Although there are many methods of composting organic materials, the proposal has selected to use active windrow. Currently, a compost turner is available at the Yigo Agricultural Experiment Station. Two chippers are locally available. A large, general purpose chipper is owned by the experiment station. The Eradication Project has also purchased its own chipper designed to process damp, fibrous wood such as coconut.

There is currently quarantine in northern Guam by the Guam Department of Agriculture restricting the transport of green waste and live plants across a quarantine boundary without inspection and/or treatment. At the time of this study, NCTS Finegayan, South Finegayan, AAFB, and the former FAA parcel were within the quarantine boundary. Recycling green waste into mulch or compost would require the mulch or compost be reused on-site after obtaining proper permits. The green waste recycling site in Dededo was not intended for the large quantities of green waste generated during the Guam military buildup. Therefore, contractors would be responsible for managing the green waste generated during construction in accordance with the CRB management procedures. CRB management procedures were prepared by NAVFAC Marianas for the development of the future MCB Guam Main Cantonment. The procedure was prepared in coordination with Guam Department of Agriculture and NAVFAC Pacific Environmental. A copy of the procedure is included in Appendix C.

Recycling green waste under the CRB restriction would be a contract requirement for the contractor to use the mulch on site for landscaping after mass grading. This mulch can be used as landscaping or erosion control. Mulching for erosion control can help stabilize exposed or recently planted soil surfaces. In addition to soil stabilization, mulch may reduce storm water velocity and improve the infiltration of runoff. The same requirement may be applied to compost use on site after clearing and grubbing. Mulch is used to aid plant growth and compost acts as a soil amendment.

3.6 Soil

The DPRI projects identified in this study are expected to include extensive grading work. Currently, the contractors on Guam are responsible for handling excess soil, rock, and coral. One option for reusing excess soil is to designate a location for contractors to stockpile soil from their construction projects for reuse by other contractors or in future construction projects as fill material. A stockpile of excess soil would likely be used primarily by contractors involved in future construction projects. .

Soil would be available without charge. However, the DoD must ensure that it would be able to provide a specific quantity of material to a future contractor during the project bidding phase. The DoD is likely to accept some risk if they are not able to provide the amount of soil stated in the bidding documents.

Designating a location to stockpile excess soil would require higher capital costs for additional storage area. The DoD would manage the site. The DoD would be required to impose minimum restrictions on the characteristics of the soil accepted to ensure that it would meet the requirements of future projects.

Previously, contractors on Guam were known to provide excess fill material to other contractors who required fill material rather than pay to dispose the excess fill material at a hardfill. The practice of working together with other contractors despite competing for the same projects is believed to be due to Guam's isolated geographic location and the limited number of contractors on Guam.

Based on Guam's history of contractors working together, the probability of excess fill material requiring disposal at a hardfill is decreased. Based on the increase in capital costs for additional storage area for a soil stockpile area and the additional risk to the DoD for managing the stockpile area, it is recommended that the contractor continue to be held responsible for the management of excess soil.

The pesticide chlordane and other organochlorine pesticides are expected to be found in soil under the foundation of existing buildings because they were commonly used for prevention of ground termites. Contractors must manage the pesticide-contaminated soil in accordance with the NAVFAC Marianas Pesticide Soil Management Plan.

3.7 Projected Diversion of Construction and Demolition Debris

The C&D debris expected to be generated from the DPRI projects identified in this study was quantified with available development information. Based on reuse and recycling opportunities available on Guam, the percentage of C&D debris projected as available for diversion is approximately 80 percent. The estimated diversion for C&D debris does not include green waste generated during clearing and grubbing activities or excess soil associated with the anticipated development.

Types of construction debris evaluated for reuse and recycling included: wood, gypsum board, scrap metal, plastics, cardboard, and miscellaneous debris. Types of demolition debris evaluated for reuse and recycling included: concrete, asphalt concrete, glass, wood, scrap metal, PVC, VCP, porcelain plumbing fixtures, gypsum board, white goods, and other demolition debris.

A summary of reuse and recycling options is provided for each type of material previously identified.

Wood generated during new construction from concrete formwork and pallets is expected to be "clean." The untreated and unpainted wood may be recycled into wood chips, mulch, compost, or other uses.

Clean gypsum board generated during construction activities is not likely to be recycled. Due to environmental concerns, the gypsum board is likely to be disposed at the hardfill at the Navy Sanitary Landfill.

Scrap metal generated during construction activities is expected to be a residual of metal building materials. Items including reinforcing steel, metal from siding, wiring, or framing can be recycled through a recycler on Guam. There are seven recyclers for scrap metal on Guam. Scrap metal would generally be accepted by local recyclers at no charge.

Plastics generated during construction include plastic wrap, packaging, and expanded polystyrene. Other plastics may be generated. Plastic shrinkwrap can be recycled on Guam, but the other plastics would require shipping directly to off-island recyclers.

Cardboard is generated during construction as packaging for construction materials. Two recyclers on Guam accept cardboard for recycling.

Miscellaneous construction debris is expected to be generated in smaller quantities and include carpeting, insulation, roofing, tile, and other items. Most of the miscellaneous items are not expected to be recyclable and would likely be disposed at the hardfill at the Navy Sanitary Landfill.

Concrete recycling was separated into two categories: concrete with lead-based paint and concrete without lead-based paint. Concrete with lead-based paint is expected to be generated by the demolition of commercial and industrial buildings. A few buildings are expected to contain lead-based paint. Demolition of site-based concrete, which includes concrete utilities, sidewalks, driveways, and other concrete on-site are not expected to contain lead-based paint. Concrete containing lead-based paint may not be recycled without proper abatement. Concrete containing lead-based paint would be permitted for disposal at the hardfill at the Navy Sanitary Landfill after determination that the concrete is not considered hazardous using the TCLP. Concrete without lead-based paint can be recycled by crushing for reuse on-site by contractors upon meeting gradation requirements for each application.

Asphalt concrete is typically found in roads, parking lots, and other paved areas. Asphalt concrete can be crushed and pulverized using equipment available on Guam and material can be recycled on-site for use as fill. Asphalt is unlikely to be recycled as aggregate or new asphalt pavement due to gradation requirements.

Glass generated during demolition is expected to contain mostly plate glass from windows. Recycling glass for use as aggregate or sand would not meet DoD gradation requirements, but may be used for non-DoD developments. Glass crushed into aggregate can be used as landfill cover. Other recycling options are not available on Guam and would require shipping directly to off-island recyclers.

It is expected that wood generated during demolition is likely to be comprised of treated or painted wood. Wood from doors and framing lumber are expected to be treated with preservatives, painted, or possibly contain lead-based paint. Treated or painted wood may not be reused or recycled and would require disposal at the hardfill at the Navy Sanitary Landfill.

Most lumber is pressure-treated with chromated copper arsenate, which gives the wood a green tinge. However, as the treated wood weathers, it becomes difficult to distinguish the treated wood from the untreated wood.

Scrap metal is generated in multiple forms during demolition. Both ferrous and non-ferrous metals are expected to be generated. Scrap metal sources include reinforcing steel, piping, shutters, railings, and HVAC systems. Scrap metal is accepted by recyclers on Guam.

PVC piping and other plastic piping is encountered in utilities and plumbing applications. Recycling of PVC may be challenging because none of the recyclers on Guam accept PVC plastic. Although PVC may be recycled outside of Guam, the PVC pipe would require shipment directly to off-island recyclers. Therefore, it is likely that PVC would be disposed at the hardfill at the Navy Sanitary Landfill.

VCP is primarily used in sewage collection systems on Guam. Although clay pipe can be recycled as aggregate in base course, it would not meet gradation standards for DoD projects and could be used as general fill. VCP is accepted for disposal at the hardfill at the Navy Sanitary Landfill.

Gypsum board used for interior walls and ceilings are expected to be generated as demolition debris. Recycling options for gypsum board are the same as those previously identified for gypsum board from construction activities. Gypsum from demolition activities is likely to be disposed at the hardfill at the Navy Sanitary Landfill.

Porcelain plumbing fixtures are expected to be generated during the demolition of buildings and include toilets and sinks. Plumbing fixtures are commonly made with porcelain, which may be crushed and used as general fill. Although some communities participate in toilet recycling programs, a program is not available on Guam. Porcelain plumbing fixtures are accepted for disposal at the hardfill at the Navy Sanitary Landfill.

Miscellaneous demolition materials are expected in smaller quantities and include insulation, roofing, and other building supplies. Miscellaneous items are assumed to be non-recyclable and would be disposed at the hardfill at the Navy Sanitary Landfill.

White goods including refrigerators, stoves, washers, and dryers are expected to be generated during demolition. All white goods are expected to be owned by the federal government and must be submitted to DRMO. White goods do not contribute towards the C&D waste stream when diverted through DRMO.

A summary of the projected diversion for each type of material expected during the planned development of all DoD bases on Guam is provided in Table 3-1. A summary of projected diversion rates for NCTS Finegayan, the former FAA parcel, South Finegayan, AAFB, Naval Base, Apra Harbor, and Ordnance Annex, Naval Magazine, are provided in Table 3-2 through Table 3-7, respectively. Quantities for construction and demolition materials are included in Appendix D. A summary of diversion options for each type of C&D material is provided in Table 3-8.

Table 3-1
Projected Diversion of Construction and Demolition Debris and Green Waste Generation
All DoD Bases

Material	Estimated Volume (CY)	Estimated Weight (Tons)	Estimated Percent (%)	Percent Diverted (%)
Construction Debris				
Wood (untreated)	146,445	69,195	14.7	14.7
Gypsum Board	57,998	39,540	8.5	0.0
Scrap Metal	14,278	4,284	0.9	0.9
Plastics	3,630	4,284	0.9	0.0
Cardboard	659,003	16,475	3.5	3.5
Miscellaneous	192,758	38,552	8.2	0.0
Demolition Debris				
Concrete				
Concrete w/LBP	3,200	6,479	1.4	0.0
Concrete w/o LBP	107,077	216,831	46.2	46.2
Asphalt concrete	49,837	59,804	12.8	12.8
Glass	132	280	0.1	0.1
Wood (treated)	2,248	1,062	0.2	0.0
Scrap Metal	7,804	8,427	1.8	1.8
PVC	750	879	0.2	0.0
VCP	17,008	597	0.1	0.1
Gypsum Board	911	621	0.1	0.0
Porcelain Plumbing Fixtures	185	94	0.0	0.0
Miscellaneous	9,543	1,909	0.4	0.0
Total	**1,272,808**	**469,311**	**100.0**	**80.1**
Green Waste				
Woody Material	453,069	113,267	21.2	21.2
Leafy Material	3,322,505	415,313	77.7	77.7
Grass	31,700	6,404	1.1	1.1
Total	**3,807,273**	**534,984**	**100.0**	**100.0**

Notes:

a) Concrete w/LBP contains a concentration of lead above the EPA LBP criterion of 0.5% lead by weight, concrete w/o LBP may contain lead in concentrations below 0.5%

b) Woody material conversion rate of 4 CY per ton, leafy material conversion rate of 8 CY per ton, and grass conversion rate of 4.95 CY per ton originated from Table 2.3 Volume to Weight Conversions from User's Guide UG-2062-ENV Fiscal Year 2004 Solid Waste Pollution Prevention Annual Data Summary (SW P2ADS) Guide dated September 2004.

Table 3-2
Projected Diversion of Construction and Demolition Debris and Green Waste Generation
NCTS Finegayan

Material	Estimated Volume (CY)	Estimated Weight (Tons)	Estimated Percent (%)	Percent Diverted (%)
Construction Debris				
Wood (untreated)	11,982	5,661	4.5	4.5
Gypsum Board	4,745	3,235	2.6	0.0
Scrap Metal	1,168	350	0.3	0.3
Plastics	297	350	0.3	0.0
Cardboard	53,917	1,348	1.1	1.1
Miscellaneous	15,771	3,154	2.5	0.0
Demolition Debris				
Concrete				
Concrete w/LBP	956	1,936	1.5	0.0
Concrete w/o LBP	38,881	78,735	62.9	62.9
Asphalt concrete	21,095	25,314	20.2	20.2
Glass	51	108	0.1	0.1
Wood (treated)	852	403	0.3	0.0
Scrap Metal	4,428	3,326	2.7	2.7
PVC	253	292	0.2	0.0
VCP	2,365	83	0.1	0.1
Gypsum Board	311	212	0.2	0.0
Porcelain Plumbing Fixtures	56	29	0.0	0.0
Miscellaneous	3,161	632	0.5	0.0
Total	**160,289**	**125,169**	**100.0**	**91.9**
Green Waste				
Woody Material	253,887	63,472	21.2	21.2
Leafy Material	1,861,840	232,730	77.6	77.6
Grass	18,250	3,687	1.2	1.2
Total	**2,133,977**	**299,889**	**100.0**	**100.0**

Notes:

a) Concrete w/LBP contains a concentration of lead above the EPA LBP criterion of 0.5% lead by weight; concrete w/o LBP may contain lead in concentrations below 0.5%.

b) Woody material conversion rate of 4 CY per ton, leafy material conversion rate of 8 CY per ton, and grass conversion rate of 4.95 CY per ton originated from Table 2.3 Volume to Weight Conversions from User's Guide UG-2062-ENV Fiscal Year 2004 Solid Waste Pollution Prevention Annual Data Summary (SW P2ADS) Guide dated September 2004.

Table 3-3
Projected Diversion of Construction and Demolition Debris and Green Waste Generation
Former FAA Parcel

Material	Estimated Volume (CY)	Estimated Weight (Tons)	Estimated Percent (%)	Percent Diverted (%)
Construction Debris				
Wood (untreated)	84,400	39,879	37.9	37.9
Gypsum Board	33,426	22,788	21.6	0.0
Scrap Metal	8,229	2,469	2.4	2.4
Plastics	2,092	2,469	2.4	0.0
Cardboard	379,800	9,495	9.0	9.0
Miscellaneous	111,091	22,218	21.1	0.0
Demolition Debris				
Concrete				
Concrete w/LBP	0	0	0.0	0.0
Concrete w/o LBP	2,932	5,937	5.6	5.6
Asphalt concrete	0	0	0.0	0.0
Glass	0	0	0.0	0.0
Wood (treated)	45	21	0.0	0.0
Scrap Metal	0	0	0.0	0.0
PVC	34	40	0.0	0.0
VCP	0	0	0.0	0.0
Gypsum Board	0	0	0.0	0.0
Porcelain Plumbing Fixtures	0	0	0.0	0.0
Miscellaneous	0	0	0.0	0.0
Total	**622,049**	**105,316**	**100.0**	**54.9**
Green Waste				
Woody Material	175,977	43,999	21.4	21.4
Leafy Material	1,290,646	161,331	78.6	78.6
Grass	0	0	0.0	0.0
Total	**1,466,643**	**205,330**	**100.0**	**100.0**

Notes:

a) Concrete w/LBP contains a concentration of lead above the EPA LBP criterion of 0.5% lead by weight, concrete w/o LBP may contain lead in concentrations below 0.5%

b) Woody material conversion rate of 4 CY per ton, leafy material conversion rate of 8 CY per ton, and grass conversion rate of 4.95 CY per ton originated from Table 2.3 Volume to Weight Conversions from User's Guide UG-2062-ENV Fiscal Year 2004 Solid Waste Pollution Prevention Annual Data Summary (SW P2ADS) Guide dated September 2004.

Table 3-4
Projected Diversion of Construction and Demolition Debris and Green Waste Generation
South Finegayan

Material	Estimated Volume (CY)	Estimated Weight (Tons)	Estimated Percent (%)	Percent Diverted (%)
Construction Debris				
Wood (untreated)	45,932	21,703	11.7	11.7
Gypsum Board	18,191	12,402	6.7	0.0
Scrap Metal	4,478	1,343	0.7	0.7
Plastics	1,139	1,343	0.7	0.0
Cardboard	206,692	5,167	2.8	2.8
Miscellaneous	60,457	12,091	6.5	0.0
Demolition Debris				
Concrete				
Concrete w/LBP	1,481	2,998	1.6	0.0
Concrete w/o LBP	54,563	110,490	59.4	59.4
Asphalt concrete	9,487	11,384	6.1	6.1
Glass	57	121	0.1	0.1
Wood (treated)	1,248	590	0.3	0.0
Scrap Metal	1,480	3,907	2.1	2.1
PVC	406	479	0.3	0.0
VCP	14,530	510	0.3	0.3
Gypsum Board	365	249	0.1	0.0
Porcelain Plumbing Fixtures	107	54	0.0	0.0
Miscellaneous	5,405	1,081	0.6	0.0
Total	**426,017**	**185,914**	**100.0**	**83.2**
Green Waste				
Woody Material	14,725	3,681	19.3	19.3
Leafy Material	107,981	13,498	70.9	70.9
Grass	9,250	1,869	9.8	9.8
Total	**131,955**	**19,047**	**100.0**	**100.0**

Notes:

a) Concrete w/LBP contains a concentration of lead above the EPA LBP criterion of 0.5% lead by weight, concrete w/o LBP may contain lead in concentrations below 0.5%

b) Woody material conversion rate of 4 CY per ton, leafy material conversion rate of 8 CY per ton, and grass conversion rate of 4.95 CY per ton originated from Table 2.3 Volume to Weight Conversions from User's Guide UG-2062-ENV Fiscal Year 2004 Solid Waste Pollution Prevention Annual Data Summary (SW P2ADS) Guide dated September 2004.

Table 3-5
Projected Diversion of Construction and Demolition Debris and Green Waste Generation
Andersen Air Force Base

Material	Estimated Volume (CY)	Estimated Weight (Tons)	Estimated Percent (%)	Percent Diverted (%)
Construction Debris				
Wood (untreated)	3,300	1,559	4.4	4.4
Gypsum Board	1,307	891	2.5	0.0
Scrap Metal	322	97	0.3	0.3
Plastics	82	97	0.3	0.0
Cardboard	14,850	371	1.0	1.0
Miscellaneous	4,344	869	2.4	0.0
Demolition Debris				
Concrete				
Concrete w/LBP	181	367	1.0	0.0
Concrete w/o LBP	4,804	9,727	27.3	27.3
Asphalt concrete	17,338	20,806	58.4	58.4
Glass	8	16	0.0	0.0
Wood (treated)	45	21	0.0	0.0
Scrap Metal	1,715	696	2.0	2.0
PVC	47	55	0.2	0.0
VCP	114	4	0.0	0.0
Gypsum Board	11	8	0.0	0.0
Porcelain Plumbing Fixtures	3	1	0.0	0.0
Miscellaneous	277	55	0.2	0.0
Total	**48,747**	**35,641**	**100.0**	**93.4**
Green Waste				
Woody Material	2,305	577	17.8	17.8
Leafy Material	16,906	2,113	65.1	65.1
Grass	2,750	556	17.1	17.1
Total	**21,961**	**3,245**	**100.0**	**100.0**

Notes:

a) Concrete w/LBP contains a concentration of lead above the EPA LBP criterion of 0.5% lead by weight, concrete w/o LBP may contain lead in concentrations below 0.5%

b) Woody material conversion rate of 4 CY per ton, leafy material conversion rate of 8 CY per ton, and grass conversion rate of 4.95 CY per ton originated from Table 2.3 Volume to Weight Conversions from User's Guide UG-2062-ENV Fiscal Year 2004 Solid Waste Pollution Prevention Annual Data Summary (SW P2ADS) Guide dated September 2004.

Table 3-6
Projected Diversion of Construction and Demolition Debris and Green Waste Generation
Naval Base, Apra Harbor

Material	Estimated Volume (CY)	Estimated Weight (Tons)	Estimated Percent (%)	Percent Diverted (%)
Construction Debris				
Wood (untreated)	832	393	2.3	2.3
Gypsum Board	329	225	1.3	0.0
Scrap Metal	81	24	0.1	0.1
Plastics	21	24	0.1	0.0
Cardboard	3,744	94	0.5	0.5
Miscellaneous	1,095	219	1.3	0.0
Demolition Debris				
Concrete				
Concrete w/LBP	582	1,178	6.8	0.0
Concrete w/o LBP	5,897	11,942	69.1	69.1
Asphalt concrete	1,917	2,300	13.3	13.3
Glass	16	35	0.2	0.2
Wood (treated)	57	27	0.2	0.0
Scrap Metal	182	497	2.9	2.9
PVC	11	13	0.1	0.0
VCP	0	0	0.0	0.0
Gypsum Board	223	152	0.9	0.0
Porcelain Plumbing Fixtures	19	10	0.1	0.1
Miscellaneous	700	140	0.8	0.0
Total	**15,706**	**17,273**	**100.0**	**88.5**
Green Waste				
Woody Material	6,154	1,539	20.9	20.9
Leafy Material	45,133	5,642	76.5	76.5
Grass	950	192	2.6	2.6
Total	**52,237**	**7,373**	**100.0**	**100.0**

Notes:

a) Concrete w/LBP contains a concentration of lead above the EPA LBP criterion of 0.5% lead by weight, concrete w/o LBP may contain lead in concentrations below 0.5%

b) Woody material conversion rate of 4 CY per ton, leafy material conversion rate of 8 CY per ton, and grass conversion rate of 4.95 CY per ton originated from Table 2.3 Volume to Weight Conversions from User's Guide UG-2062-ENV Fiscal Year 2004 Solid Waste Pollution Prevention Annual Data Summary (SW P2ADS) Guide dated September 2004.

Table 3-7
Projected Green Waste Generation
Ordnance Annex, Naval Magazine

Material	Estimated Volume (CY)	Estimated Weight (Tons)	Estimated Percent (%)	Percent Diverted (%)
Green Waste				
Woody Material	0	0	0.0	0.0
Leafy Material	0	0	0.0	0.0
Grass	500	101	100.0	100.0
Total	**500**	**101**	**100.0**	**100.0**

Note:

a) Grass conversion rate of 4.95 CY per ton originated from Table 2.3 Volume to Weight Conversions from User's Guide UG-2062-ENV Fiscal Year 2004 Solid Waste Pollution Prevention Annual Data Summary (SW P2ADS) Guide dated September 2004.

Table 3-8
Summary of Diversion Options for C&D Debris and Green Waste
All DoD Bases

Material	Estimated Weight (Tons)	Material can be reused on-site	Material can be recycled on Guam	Material disposed at the hardfill at Navy Sanitary Landfill
Construction Debris				
Wood (untreated)	69,195	X		
Gypsum Board	39,540			X
Scrap Metal	4,284		X	
Plastics	4,284		X	
Cardboard	16,475		X	
Miscellaneous	38,552			X
Demolition Debris				
Concrete				
Concrete w/LBP	6,479			X
Concrete w/o LBP	216,831	X		
Asphalt concrete	59,804	X		
Glass	280		X	
Wood (treated)	1,062			X
Scrap Metal	8,427		X	
PVC	879			X
VCP	597			X
Gypsum Board	621			X
Porcelain Plumbing Fixtures	94			X
Miscellaneous	1,909			X
Total	**469,311**			
Green Waste				
Woody Material	113,267	X		
Leafy Material	415,313	X		
Grass	6,404	X		
Total	**534,984**			

Notes:

a) Wastes requiring special handling do not contribute towards the C&D waste stream and are not included in this summary.
b) Diverting green waste does not count towards 50-percent diversion goal for C&D debris. Diverting green waste does count towards 50-percent diversion goal for non-hazardous solid waste excluding C&D debris.

4.0 Assessment of Construction and Demolition Debris and Green Waste Processing Alternatives

4.1 Overview

The purpose of this study is to estimate quantities of C&D debris that would be generated by the planned military increase on Guam and to identify reuse and recycling options to meet diversion requirements indicated in Executive Order 13514.

To meet the diversion goal, Section 4.0 summarizes alternatives for processing, reuse and recycling of C&D debris.

4.1.1 Current Practices for Processing Construction and Demolition Debris on Guam

Specifications for Military Construction contracts on Guam generally originate from the Unified Facilities Guide Specifications (UFGS). Construction projects are required to include an edited version of UFGS Section 01 74 19 Construction and Demolition Waste Management. This specification section requires the construction contractor to divert a specified amount of total project solid waste from a landfill and to develop and implement a waste management plan prior to the start of demolition work. Construction and demolition waste management would vary depending on the type and size of project and the types of equipment required for the project. The waste management plan is reviewed and approved by the Contracting Officer.

The waste management plan details the contractor's plan for meeting the project diversion goal. The plan should include a characterization and estimated quantity of waste expected to be generated; a list of specific materials that may be salvaged; and identification of materials that cannot be recycled or reused. An explanation or justification for the materials not being diverted is required for approval by the Contracting Officer.

UFGS Section 02 41 00 Demolition and Deconstruction indicates that demolition debris that cannot be salvaged, reused or recycled becomes the property of the contractor and the contractor must dispose the debris outside of DoD property. For Navy construction projects on Guam, the contractor is required to dispose C&D debris at the hardfill at the Navy Sanitary Landfill at the Naval Base in Apra Harbor. For Air Force construction projects on Guam, the contractor must dispose C&D debris outside of Andersen Air Force Base.

UFGS Section 02 41 00 Demolition and Deconstruction also provides guidance for deconstruction of a facility. The deconstruction procedures include instructions for sorting debris to be salvaged or reused.

The length of time required for a contractor to deconstruct and demolish a facility is generally longer than required for demolition. If contractors working on the DPRI projects previously identified in Section 3.0 are given the opportunity to haul construction and demolition debris to a central facility for processing, contractor efforts for sorting salvageable materials and disposal of the remaining waste would be minimal.

Based on the large number of DPRI projects expected, a central processing facility for C&D debris may streamline the process of sorting salvageable and reusable materials.

Demand for reusable C&D debris may vary by project. A central processing facility would also serve as a storage facility for reusable material generated during construction and demolition activities that may not be reused immediately.

To address the management of non-hazardous C&D debris, alternatives were developed to service the DoD's diversion goals while complying with applicable regulations. Five alternatives for processing C&D debris were considered:

- Alternative 1: Contractor continues to process all C&D debris. Construct a composting facility to process a portion of green waste.
- Alternative 2: Construct a C&D debris central processing facility that recovers concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.
- Alternative 3: Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard and untreated wood. Construct a composting facility to process a portion of green waste.
- Alternative 4: Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard, untreated wood, concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.
- Alternative 5: Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard, untreated wood, concrete without lead-based paint, asphalt and glass. Construct a composting facility to process a portion of green waste.

4.2 Assessment of Construction and Demolition Debris and Green Waste Processing Alternatives

4.2.1 Alternative 1 – Contractor continues to process all C&D debris. Construct a composting facility to process a portion of green waste.

4.2.1.1 Description

For Alternative 1, the construction contractors would continue to be responsible for diverting the minimum amount of C&D debris and green waste specified in the construction contract documents. All C&D debris would become the property of the contractor. The contractor would be required to dispose the remaining C&D debris from the DPRI projects identified in this study that are not reused or recycled at the hardfill at the Navy Sanitary Landfill.

Green waste would be mulched by the contractor or delivered to a new composting facility. Mulch would be comprised of the "woody" portion of the green waste. The remaining "leafy" and grassy portion of the green waste would be used for compost.

The "woody" material would be comprised of tree trunks, branches and large roots from clearing activities. Most of the "woody" green waste would originate from the heavily vegetated forest areas. The contractor would be required to separate the "woody" material from the "leafy" material at the project site. The "woody" material would be chipped down to a size of two inches and used as mulch for erosion control at the project site.

The "leafy" material and grass would be delivered to a composting facility. Additional materials must be added to the green waste for the composting process as described in Section 3.5. Contractors would be required to use compost generated at the composting facility as a soil amendment.

A separate area would be available for contractors to stockpile excess crushed concrete without lead-based paint and asphalt. The crushed concrete and asphalt would be available for contractors to use in future construction projects.

4.2.1.2 Viability

<u>Environmental/Regulatory Considerations</u>

As indicated in Section 2.2.1, GEPA's Rules and Regulations for Solid Waste Disposal: Title 22, Division 4, Chapter 23 establishes a solid waste management permit system for all solid waste management facilities. The following GEPA permits would be required for each C&D recycling operation:

Contractor processing C&D materials on-site:

- Solid waste processing permit
- Solid waste storage permit
- Solid waste collection permit
- Solid waste transfer permit
- Air Pollution Control Permit

The following GEPA permits would be required for each composting facility:

- Solid waste processing permit
- Solid waste storage permit
- Air Pollution Control Permit

All GEPA permit applications would be filed electronically through the Facility Engineering & Acquisition Division (FEAD) office with the Joint Region Marianas Permit Application Tracking System. The process time for each solid waste processing permit, solid waste storage permit, and solid waste transfer permit is expected to be a maximum of 120 days. Each solid waste collection permit is expected to require a maximum of 30 days to process.

Air Pollution Control Permits may require a minimum of 12 months to process. If a contractor has an existing Air Pollution Control Permit for equipment operations at one location, a permit for a new location using existing equipment may require a process time of six months.

Alternative 1 may require an Air Pollution Control Permit. At the time of this study, it was assumed that a processing facility capable of crushing concrete and asphalt would have a maximum throughput of 150 tons per hour (tph). This throughput is estimated to generate 25 tpy of particulate matter. A contractor performing crushing operations on-site is not expected to exceed a throughput of 150 tph. Permit applications should include maximum total emissions rates typically provided by the equipment manufacturer. A composting facility may generate VOCs, which is a criteria pollutant, during mulching and composting operations.

Use of stationary reciprocating internal combustion engines for operations would subject the equipment to 40 CFR Part 63, which includes a NESHAP for reciprocating internal combustion engines. Sources subject to 40 CFR Part 63 would be considered a Federal Oversight Source, which would require the U.S. EPA to review the Air Pollution Control Permit. This may result in a longer permit process time.

A potential advantage of requiring the contractor to process C&D materials on-site may be a reduction in permit processing time if the contractor has an existing Air Pollution Control Permit.

Siting Considerations

GEPA may have concerns about noise, air pollution and heavy vehicle traffic generated by the composting facility and their effect on surrounding areas. Most of the green waste from the DPRI projects identified in this study is expected to be generated from NCTS Finegayan, the former FAA parcel, South Finegayan and AAFB. Because most of the green waste would be generated in northern Guam, it is assumed that the proposed composting facility would be located in northern Guam. Areas considered for preliminary composting sites include the future MCB Guam Main Cantonment, Potts Junction, and AAFB Northwest Field.

The composting facility should be located in an area adjacent to similar industrial-type facilities and distanced from GovGuam roadways to minimize noise, air pollution and heavy vehicle traffic in civilian and military residential areas. Potts Junction is directly adjacent to residential areas and a private golf course. Potts Junction was considered to be the least suitable for a composting facility as compared to MCB Guam and AAFB Northwest Field. Therefore, Potts Junction was not considered a viable location for a composting facility.

This alternative may have impacts on traffic, air quality, and other off-base facilities. Impacts to traffic and air quality are expected to be similar for each alternative.

4.2.2 Alternative 2 – Construct a C&D debris central processing facility that recovers concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.

4.2.2.1 Description

For Alternative 2, the construction contractors would pre-sort concrete with lead-based paint from concrete without lead-based paint before delivering the concrete without lead-based paint and asphalt to the central processing facility. Contractors would dispose concrete with lead-based paint at the hardfill at the Navy Sanitary Landfill. The contractor would be responsible for recycling scrap metal, old corrugated cardboard and untreated wood. The contractor would transport all remaining C&D debris to the hardfill at the Navy Sanitary Landfill.

The central processing facility would process the concrete without lead-based paint and asphalt. Crushing equipment would be required at the central processing facility to process the concrete without lead-based paint and asphalt. Crushed concrete and asphalt would be stored at the central processing facility for reuse in future construction projects.

Scrap metal would be transported to a local recycler as described in Section 3.3.3.

Old corrugated cardboard would be transported to a local recycler or recycling center as described in Section 3.3.5.

Untreated wood would be chipped by the contractor on-site. The chipped wood would be used as mulch as described in Section 3.3.1.

Green waste would be mulched by the contractor on-site or delivered to a new composting facility. Mulch would be comprised of the “woody” portion of the green waste. The remaining “leafy” and grassy portion of the green waste would be used for compost.

The contractor would be required to separate the “woody” material from the “leafy” material at the project site. The “woody” material would be chipped down to a size of two inches and used as mulch for erosion control at the project site.

The “leafy” material and grass would be delivered to the composting facility. Additional materials must be added to the green waste for the composting process as described in Section 3.5. Contractors would be required to use compost generated at the composting facility as a soil amendment.

4.2.2.2 Viability

Environmental/Regulatory Considerations

As indicated in Section 2.2.1, GEPA's Rules and Regulations for Solid Waste Disposal: Title 22, Division 4, Chapter 23 establishes a solid waste management permit system for all solid waste management facilities. The following GEPA permits would be required for each C&D recycling operation:

Contractor processing C&D materials on-site:

- Solid waste processing permit
- Solid waste storage permit
- Solid waste collection permit
- Solid waste transfer permit

The following GEPA permits would be required for each C&D debris central processing facility:

- Solid waste disposal facility
- Solid waste processing permit
- Solid waste storage permit
- Solid waste transfer permit
- Air Pollution Control Permit

The following GEPA permits would be required for each composting facility:

- Solid waste processing permit
- Solid waste storage permit
- Air Pollution Control Permit

All GEPA permit applications would be filed electronically through the Facility Engineering & Acquisition Division (FEAD) office with the Joint Region Marianas Permit Application Tracking System. The process time for each solid waste processing permit, solid waste storage permit, solid waste transfer permit, and solid waste disposal facility permit is expected to be a maximum of 120 days. Each solid waste collection permit is expected to require a maximum of 30 days to process.

Air Pollution Control Permits may require a minimum of 12 months to process.

Alternative 2 would require an Air Pollution Control Permit. At the time of this study, it was assumed that a processing facility capable of crushing concrete and asphalt would have a maximum throughput of 150 tph. This throughput is estimated to generate 25 tpy of particulate matter. A contractor performing crushing operations on-site is not expected to exceed a throughput of 150 tph. Permit applications should include maximum total emissions rates typically provided by the equipment manufacturer. A composting facility may generate VOCs, which is a criteria pollutant, during mulching and composting operations.

Use of stationary reciprocating internal combustion engines for operations would subject the equipment to 40 CFR Part 63, which includes a NESHAP for reciprocating internal combustion engines. Sources subject to 40 CFR Part 63 would be considered a Federal Oversight Source, which would require the U.S. EPA to review the Air Pollution Control Permit. This may result in a longer permit process time.

Siting Considerations

GEPA may have concerns about noise, air pollution and heavy vehicle traffic generated by the composting facility and their effect on surrounding areas. Most of the green waste from the DPRI projects identified in this study is expected to be generated from NCTS Finegayan, the former FAA parcel, South Finegayan and AAFB. Because most of the green waste would be generated in northern Guam, it is assumed that the proposed composting facility would be located in northern Guam. Areas considered for preliminary composting sites include the future MCB Guam Main Cantonment, Potts Junction, and AAFB Northwest Field.

The composting facility should be located in an area adjacent to similar industrial-type facilities and distanced from GovGuam roadways to minimize noise, air pollution and heavy vehicle traffic in civilian and military residential areas. Potts Junction is directly adjacent to residential areas and a private golf course. Potts Junction was considered to be the least suitable for a composting facility as compared to MCB Guam and AAFB Northwest Field. Therefore, Potts Junction was not considered a viable location for a composting facility.

GEPA may have concerns about noise, air pollution and heavy vehicle traffic generated by a central processing facility and their effect on surrounding areas similar to those for a composting facility.

Most of the C&D debris generated from the DPRI projects identified in this study is expected to originate from NCTS Finegayan, the former FAA parcel, South Finegayan and AAFB. Because the majority of C&D debris would be generated in northern Guam, it is assumed that the proposed central processing facility would be situated in northern Guam

Similar to a composting facility, the C&D debris central processing facility should be located in an area adjacent to similar industrial-type facilities and distanced from GovGuam roadways to minimize noise, air pollution and heavy vehicle traffic in civilian and military residential areas.

This alternative may have impacts on traffic, air quality, and other off-base facilities. Impacts to traffic and air quality are expected to be similar for each alternative.

4.2.3 Alternative 3 – Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard and untreated wood. Construct a composting facility to process a portion of green waste.

4.2.3.1 Description

For Alternative 3, the construction contractor would be responsible for crushing and recycling concrete without lead-based paint and asphalt. Contractors would dispose concrete with lead-based paint at the hardfill at the Navy Sanitary Landfill. The contractor would transport all remaining C&D debris to a new central processing facility.

The central processing facility would recover scrap metal, old corrugated cardboard and untreated wood from the mixed C&D debris and process those materials for recycling or reuse. The operators of the central processing facility would dispose the remaining C&D debris at the hardfill at the Navy Sanitary Landfill.

Scrap metal would be transported to a local recycler as described in Section 3.3.3.

Old corrugated cardboard would be baled at the central processing facility. The bales would be transported to a local recycler or recycling center as described in Section 3.3.5.

Untreated wood would be chipped at the central processing facility. The chipped wood would be used as mulch as described in Section 3.3.1.

Asphalt and concrete without lead-based paint would be crushed by the contractor at the project site. The contractor would be required to ensure that the crushed asphalt and concrete are recycled and not disposed at the hardfill.

Green waste would be mulched by the contractor or delivered to a new composting facility. Mulch would be comprised of the "woody" portion of the green waste. The remaining "leafy" and grassy portion of the green waste would be used for compost.

The contractor would be required to separate the "woody" material from the "leafy" material at the project site. The "woody" material would be chipped down to a size of two inches and used as mulch for erosion control at the project site.

The "leafy" material and grass would be delivered to the composting facility. Additional materials must be added to the green waste for the composting process as described in Section 3.5. Contractors would be required to use compost generated at the composting facility as a soil amendment.

A separate area would be available for contractors to stockpile excess crushed concrete without lead-based paint. The crushed concrete would be available for contractors to use in future construction projects.

4.2.3.2 Viability

Environmental/Regulatory Considerations

As indicated in Section 2.2.1, GEPA's Rules and Regulations for Solid Waste Disposal: Title 22, Division 4, Chapter 23 establishes a solid waste management permit system for all solid waste management facilities. The following GEPA permits would be required for each C&D recycling operation:

Contractor processing C&D materials on-site:

- Solid waste processing permit
- Solid waste storage permit
- Solid waste collection permit
- Solid waste transfer permit
- Air Pollution Control Permit

The following GEPA permits would be required for each C&D debris central processing facility:

- Solid waste disposal facility
- Solid waste processing permit
- Solid waste storage permit
- Solid waste transfer permit

The following GEPA permits would be required for each composting facility:

- Solid waste processing permit
- Solid waste storage permit
- Air Pollution Control Permit

All GEPA permit applications would be filed electronically through the Facility Engineering & Acquisition Division (FEAD) office with the Joint Region Marianas Permit Application Tracking System. The process time for each solid waste processing permit, solid waste storage permit, solid waste transfer permit, and solid waste disposal facility permit is expected to be a maximum of 120 days. Each solid waste collection permit is expected to require a maximum of 30 days to process.

Air Pollution Control Permits may require a minimum of 12 months to process. If a contractor has an existing Air Pollution Control Permit for equipment operations at one location, a permit for a new location using existing equipment may require a process time of six months.

Alternative 3 may require an Air Pollution Control Permit. At the time of this study, it was assumed that a processing facility capable of crushing concrete and asphalt would have a maximum throughput of 150 tph. This throughput is estimated to generate 25 tpy of particulate matter. A contractor performing crushing operations on-site is not expected to exceed a throughput of 150 tph. Permit applications should include maximum total emissions rates typically provided by the equipment manufacturer. A composting facility may generate VOCs, which is a criteria pollutant, during mulching and composting operations.

Use of stationary reciprocating internal combustion engines for operations would subject the equipment to 40 CFR Part 63, which includes a NESHAP for reciprocating internal combustion engines. Sources subject to 40 CFR Part 63 would be considered a Federal Oversight Source, which would require the U.S. EPA to review the Air Pollution Control Permit. This may result in a longer permit process time.

A potential advantage of requiring the contractor to process concrete and asphalt on-site may be a reduction in permit processing time if the contractor has an existing Air Pollution Control Permit.

Siting Considerations

GEPA may have concerns about noise, air pollution and heavy vehicle traffic generated by the composting facility and their effect on surrounding areas. Most of the green waste from the DPRI projects identified in this study is expected to be generated from NCTS Finegayan, the former FAA parcel, South Finegayan and AAFB. Because most of the green waste would be generated in northern Guam, it is assumed that the proposed composting facility would be located in northern Guam. Areas considered for preliminary composting sites include the future MCB Guam Main Cantonment, Potts Junction, and AAFB Northwest Field.

The composting facility should be located in an area adjacent to similar industrial-type facilities and distanced from GovGuam roadways to minimize noise, air pollution and heavy vehicle traffic in civilian and military residential areas. Potts Junction is directly adjacent to residential areas and a private golf course. Potts Junction was considered to be the least suitable for a composting facility as compared to MCB Guam and AAFB Northwest Field. Therefore, Potts Junction was not considered a viable location for a composting facility.

GEPA may have concerns about noise, air pollution and heavy vehicle traffic generated by a central processing facility and their effect on surrounding areas similar to those for a composting facility.

Most of the C&D debris generated from the DPRI projects identified in this study is expected to originate from NCTS Finegayan, the former FAA parcel, South Finegayan and Andersen AFB. Because most C&D debris would be generated in northern Guam, it is assumed that the proposed central processing facility would be situated in northern Guam

Similar to a composting facility, the C&D debris central processing facility should be located in an area adjacent to similar industrial-type facilities and distanced from GovGuam roadways to minimize noise, air pollution and heavy vehicle traffic in civilian and military residential areas.

This alternative may have impacts on traffic, air quality, and other off-base facilities. Impacts to traffic and air quality are expected to be similar for each alternative.

4.2.4 Alternative 4 – Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard, untreated wood, concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.

4.2.4.1 Description

For Alternative 4, the construction contractors would transport all C&D debris from the project sites to the new central processing facility. The contractor would pre-sort concrete with lead-based paint from concrete without lead-based paint before delivering the concrete without lead-based paint to the central processing facility. Contractors would dispose concrete with lead-based paint at the hardfill at the Navy Sanitary Landfill. The contractor would transport all remaining C&D debris to the new central processing facility.

The central processing facility would recover scrap metal, old corrugated cardboard, and untreated wood from the mixed C&D debris and process those materials for recycling or reuse. The central processing facility would also crush the concrete without lead-based paint and asphalt. The operators of the central processing facility would dispose the remaining C&D debris at the hardfill at the Navy Sanitary Landfill.

Crushing equipment would be required at the central processing facility to crush the concrete without lead-based paint and asphalt. Crushed concrete and asphalt would be stored at the central processing facility for reuse on future construction projects. Additional area at the central processing facility would be required to process and store the crushed concrete and asphalt.

Scrap metal would be transported to a local recycler as described in Section 3.3.3.

Old corrugated cardboard would be baled at the central processing facility. The bales would be transported to a local recycler or recycling center as described in Section 3.3.5.

Untreated wood would be chipped at the central processing facility. The chipped wood would be used as mulch as described in Section 3.3.1.

Green waste would be mulched by the contractor or delivered to a new composting facility. Mulch would be comprised of the “woody” portion of the green waste. The remaining “leafy” and grassy portion of the green waste would be used for compost.

The contractor would be required to separate the “woody” material from the “leafy” material at the project site. The “woody” material would be chipped down to a size of two inches and used as mulch for erosion control at the project site.

The “leafy” material and grass would be delivered to the composting facility. Additional materials must be added to the green waste for the composting process as described in Section 3.5. Contractors would be required to use compost generated at the composting facility as a soil amendment.

4.2.4.2 Viability

Environmental/Regulatory Considerations

As indicated in Section 2.2.1, GEPA’s Rules and Regulations for Solid Waste Disposal: Title 22, Division 4, Chapter 23 establishes a solid waste management permit system for all solid waste management facilities. The following GEPA permits would be required for each C&D recycling operation:

Contractor processing C&D materials on-site:

- Solid waste storage permit
- Solid waste collection permit
- Solid waste transfer permit

The following GEPA permits would be required for each C&D debris central processing facility:

- Solid waste disposal facility
- Solid waste processing permit
- Solid waste storage permit
- Solid waste transfer permit
- Air Pollution Control Permit

The following GEPA permits would be required for each composting facility:

- Solid waste processing permit
- Solid waste storage permit
- Air Pollution Control Permit

All GEPA permit applications would be filed electronically through the Facility Engineering & Acquisition Division (FEAD) office with the Joint Region Marianas Permit Application Tracking System. The process time for each solid waste processing permit, solid waste storage permit, solid waste transfer permit, and solid waste disposal facility permit is expected to be a maximum of 120 days. Each solid waste collection permit is expected to require a maximum of 30 days to process.

Air Pollution Control Permits may require a minimum of 12 months to process.

Alternative 4 would require an Air Pollution Control Permit. At the time of this study, it was assumed that a processing facility capable of crushing concrete and asphalt would have a maximum throughput of 150 tph. This throughput is estimated to generate 25 tpy of particulate matter. Permit applications should include maximum total emissions rates typically provided by the equipment manufacturer. A composting facility may generate VOCs, which is a criteria pollutant, during mulching and composting operations.

Use of stationary reciprocating internal combustion engines for operations would subject the equipment to 40 CFR Part 63, which includes a NESHAP for reciprocating internal combustion engines. Sources subject to 40 CFR Part 63 would be considered a Federal Oversight Source, which would require the U.S. EPA to review the Air Pollution Control Permit. This may result in a longer permit process time.

<u>Siting Considerations</u>

GEPA may have concerns about noise, air pollution and heavy vehicle traffic generated by the composting facility and their effect on surrounding areas. Most of the green waste from the DPRI projects identified in this study is expected to be generated from NCTS Finegayan, the former FAA parcel, South Finegayan and AAFB. Because most of the green waste would be generated in northern Guam, it is assumed that the proposed composting facility would be located in northern Guam. Areas considered for preliminary composting sites include the future MCB Guam Main Cantonment, Potts Junction, and AAFB Northwest Field.

The composting facility should be located in an area adjacent to similar industrial-type facilities and distanced from GovGuam roadways to minimize noise, air pollution and heavy vehicle traffic in civilian and military residential areas. Potts Junction is directly adjacent to residential areas and a private golf course. Potts Junction was considered to be the least suitable for a composting facility as compared to MCB Guam and AAFB Northwest Field. Therefore, Potts Junction was not considered a viable location for a composting facility.

GEPA may have concerns about noise, air pollution and heavy vehicle traffic generated by a central processing facility and their effect on surrounding areas similar to those for a composting facility.

Most of the C&D debris generated from the DPRI projects identified in this study is expected to originate from NCTS Finegayan, the former FAA parcel, South Finegayan and Andersen AFB. Because most C&D debris would be generated in northern Guam, it is assumed that the proposed central processing facility would be situated in northern Guam

Similar to a composting facility, the C&D debris central processing facility should be located in an area adjacent to similar industrial-type facilities and distanced from GovGuam roadways to minimize noise, air pollution and heavy vehicle traffic in civilian and military residential areas.

This alternative may have impacts on traffic, air quality, and other off-base facilities. Impacts to traffic and air quality are expected to be similar for each alternative.

4.2.5 Alternative 5 – Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard, untreated wood, concrete without lead-based paint, asphalt and glass. Construct a composting facility to process a portion of green waste.

4.2.5.1 Description

For Alternative 5, the construction contractors would transport all C&D debris from the project sites to the new central processing facility. The contractor would pre-sort concrete with lead-based paint from concrete without lead-based paint before delivering the concrete without lead-based paint to the central processing facility. Contractors would dispose concrete with lead-based paint at the hardfill at the Navy Sanitary Landfill. The contractor would transport all remaining C&D debris to the new central processing facility.

The central processing facility would recover scrap metal, old corrugated cardboard, untreated wood, and glass from the mixed C&D debris and process those recovered materials for recycling or reuse. The central processing facility would also crush the concrete without lead-based paint and asphalt. The operators of the central processing facility would dispose the remaining C&D debris at the hardfill at the Navy Sanitary Landfill.

Glass was considered for diversion based on the estimated quantity and percentage of the C&D debris waste stream.

Crushing equipment would be required at the central processing facility to crush the concrete without lead-based paint, asphalt, and glass. Crushed concrete, asphalt, and glass would be stored at the central processing facility for reuse in future construction projects. Crushed glass would be available for reuse on construction projects as general fill material. Additional area at the central processing facility would be required to process and store the crushed concrete, asphalt, and glass.

Scrap metal would be transported to a local recycler as described in Section 3.3.3.

Old corrugated cardboard would be baled at the central processing facility. The bales would be transported to a local recycler or recycling center as described in Section 3.3.5.

Untreated wood would be chipped at the central processing facility. The chipped wood would be used as mulch as described in Section 3.3.1.

Green waste would be mulched by the contractor or delivered to a new composting facility. Mulch would be comprised of the "woody" portion of the green waste. The remaining "leafy" and grassy portion of the green waste would be used for compost.

The contractor would be required to separate the "woody" material from the "leafy" material at the project site. The "woody" material would be chipped down to a size of two inches and used as mulch for erosion control at the project site.

The "leafy" material and grass would be delivered to the composting facility. Additional materials must be added to the green waste for the composting process as described in Section 3.5. Contractors would be required to use compost generated at the composting facility as a soil amendment.

4.2.5.2 Viability

Environmental/Regulatory Considerations

As indicated in Section 2.2.1, GEPA's Rules and Regulations for Solid Waste Disposal: Title 22, Division 4, Chapter 23 establishes a solid waste management permit system for all solid waste management facilities. The following GEPA permits would be required for each C&D recycling operation:

Contractor processing C&D materials on-site:

- Solid waste storage permit
- Solid waste collection permit
- Solid waste transfer permit

The following GEPA permits would be required for each C&D debris central processing facility:

- Solid waste disposal facility
- Solid waste processing permit
- Solid waste storage permit
- Solid waste transfer permit
- Air Pollution Control Permit

The following GEPA permits would be required for each composting facility:

- Solid waste processing permit
- Solid waste storage permit
- Air Pollution Control Permit

All GEPA permit applications would be filed electronically through the Facility Engineering & Acquisition Division (FEAD) office with the Joint Region Marianas Permit Application Tracking System. The process time for each solid waste processing permit, solid waste storage permit, solid waste transfer permit, and solid waste disposal facility permit is expected to be a maximum of 120 days.

Each solid waste collection permit is expected to require a maximum of 30 days to process.

Air Pollution Control Permits may require a minimum of 12 months to process.

Alternative 5 would require an Air Pollution Control Permit. At the time of this study, it was assumed that a processing facility capable of crushing concrete and asphalt would have a maximum throughput of 150 tph. This throughput is estimated to generate 25 tpy of particulate matter. Permit applications should include maximum total emissions rates typically provided by the equipment manufacturer. A composting facility may generate VOCs, which is a criteria pollutant, during mulching and composting operations.

Use of stationary reciprocating internal combustion engines for operations would subject the equipment to 40 CFR Part 63, which includes a NESHAP for reciprocating internal combustion engines. Sources subject to 40 CFR Part 63 would be considered a Federal Oversight Source, which would require the U.S. EPA to review the Air Pollution Control Permit. This may result in a longer permit process time.

Siting Considerations

GEPA may have concerns about noise, air pollution and heavy vehicle traffic generated by the composting facility and their effect on surrounding areas. Most of the green waste from the DPRI projects identified in this study is expected to be generated from NCTS Finegayan, the former FAA parcel, South Finegayan and AAFB. Because most of the green waste would be generated in northern Guam, it is assumed that the proposed composting facility would be located in northern Guam. Areas considered for preliminary composting sites include the future MCB Guam Main Cantonment, Potts Junction, and AAFB Northwest Field.

The composting facility should be located in an area adjacent to similar industrial-type facilities and distanced from GovGuam roadways to minimize noise, air pollution and heavy vehicle traffic in civilian and military residential areas. Potts Junction is directly adjacent to residential areas and a private golf course. Potts Junction was considered to be the least suitable for a composting facility as compared to MCB Guam and AAFB Northwest Field. Therefore, Potts Junction was not considered a viable location for a composting facility.

GEPA may have concerns about noise, air pollution and heavy vehicle traffic generated by a central processing facility and their effect on surrounding areas similar to those for a composting facility.

Most of the C&D debris generated from the DPRI projects identified in this study is expected to originate from NCTS Finegayan, the former FAA parcel, South Finegayan and Andersen AFB. Because most C&D debris would be generated in northern Guam, it is assumed that the proposed central processing facility would be situated in northern Guam

Similar to a composting facility, the C&D debris central processing facility should be located in an area adjacent to similar industrial-type facilities and distanced from GovGuam roadways to minimize noise, air pollution and heavy vehicle traffic in civilian and military residential areas.

This alternative may have impacts on traffic, air quality, and other off-base facilities. Impacts to traffic and air quality are expected to be similar for each alternative.

Implementation Considerations

A minimal amount of glass is expected to be recovered during construction and demolition activities. If glass is not recycled, it is anticipated that diversion goals for C&D debris would be met. Based on the relatively low quantity of glass anticipated in the C&D debris waste stream, it may not be economically feasible to purchase and operate glass crushing equipment at the central processing facility.

Based on the indicated implementation considerations, this alternative is not considered viable and is not considered further in Section 5.0.

4.3 Summary of Viability of Alternatives

Alternatives 1, 2, 3, and 4 are considered to be viable and are analyzed in further detail in Section 5.0. Although Alternative 5 would increase the percentage of C&D debris that may be reused or recycled, the amount of additional debris that would be diverted from the hardfill is minimal.

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5.0 Viable Construction and Demolition Debris and Green Waste Processing Alternatives

5.1 Alternative 1 – Contractor continues to process all C&D debris. Construct a composting facility to process a portion of green waste.

5.1.1 Analysis

As described in Section 4.2.1, the contractor would continue to be responsible for processing and diverting the minimum amount of C&D debris and green waste specified in the construction contract documents. A central processing facility would not be required in this alternative. However, a contractor would be required to purchase or rent equipment necessary for processing all C&D debris.

A stockpile facility would be available for contractors to deposit excess crushed concrete without lead-based paint for reuse on future construction projects.

Most of the C&D debris from the DPRI projects identified in Section 3.0 is expected to be generated in northern Guam. Therefore, the location of the stockpile facility and composting facility is likely to be in northern Guam. The stockpile facility and composting facility are intended to receive concrete and green waste from all DPRI projects identified in this study and would not be limited to the projects in northern Guam.

There is currently quarantine in northern Guam by the Guam Department of Agriculture restricting the transport of green waste and live plants across a quarantine boundary without inspection and/or treatment. At the time of this study, NCTS Finegayan, South Finegayan, AAFB, and the former FAA parcel were within the quarantine boundary. The contractor must follow the CRB management procedures prepared by NAVFAC Marianas.

Assuming that the green waste generated would be evenly distributed over a five-year period, the minimum area required for a composting facility is approximately 15 acres.

5.1.2 Cost

Because specific sites have not been selected, site development costs are based on a generic site and may vary depending on the site characteristics. However, it is assumed that site roadway, utilities, and other improvements are required. Assumptions regarding demolition of existing structures were not included. It is assumed that water and sewer service would be obtained from existing nearby water distribution systems and sewage collection systems.

For the purpose of this analysis, it is assumed that the stockpile area and composting facility would be located at the current NCTS Finegayan.

Estimated capital costs for the contractor to process the C&D debris includes operations and transport vehicles. It is assumed in the cost analysis the contractor would be required to purchase or rent equipment to process the C&D debris.

Estimated capital costs for the composting facility include a wood chipper, truck scale facility, site work, utility work, and operation vehicles.

Estimated annual operational costs for Alternative 1 include the cost for the contractor to process C&D debris and for the DoD to manage the composting facility. The annual operating cost for a contractor to process C&D debris at the project site include hauling and tipping fees for disposal of C&D debris at the hardfill at the Navy Sanitary Landfill. C&D debris that is not reused or recycled would be disposed at the hardfill at the Navy Sanitary Landfill. The tipping fee for the hardfill at the Navy Sanitary Landfill is $1.65 per cubic yard.

Section 5.5 provides an economic analysis, which assumes that the C&D debris waste stream would be limited to the DPRI construction projects identified in this study. The economic analysis assumes that the first phase of construction projects would start in 2010 and the last phase of construction projects would start by 2014 as indicated in the Draft Environmental Impact Statement (EIS).

Alternative 1 was assessed over a 5-year and 10-year life cycle. The 5-year present value life cycle cost of Alternative 1 is estimated to be $68,200,000. The 10-year present value life cycle cost of Alternative 1 is estimated to be $71,600,000.

Present value life cycle cost analyses for Alternative 1 are included in Appendix E. A 5-year life cycle cost analysis is provided in Appendix E.1. A 10-year life cycle cost analysis is provided in Appendix E.2. Assumptions and calculations are also provided with each analysis.

5.2 Alternative 2 – Construct a C&D debris central processing facility that recovers concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.

5.2.1 Analysis

As described in Section 4.2.2, the construction contractors would pre-sort concrete on-site before delivering the concrete without lead-based paint and asphalt to the central processing facility. The contractor would be responsible for recycling scrap metal, old corrugated cardboard and untreated wood. Green waste would be mulched by the contractor on-site or delivered to the composting facility.

The central processing facility would crush the concrete without lead-based paint and asphalt. Crushed concrete and asphalt would be stored at the central processing facility for reuse in future construction projects.

Most of the C&D debris from the DPRI projects identified in Section 3.0 is expected to be generated in northern Guam. Therefore, the location of the central processing facility and composting facility is likely to be in northern Guam. The central processing facility and composting facility are intended to receive concrete, asphalt, and green waste from all DPRI projects identified in this study and would not be limited to the projects in northern Guam.

There is currently quarantine in northern Guam by the Guam Department of Agriculture restricting the transport of green waste and live plants across a quarantine boundary without inspection and/or treatment. At the time of this study, NCTS Finegayan, South Finegayan, AAFB, and the former FAA parcel were within the quarantine boundary. The contractor must follow the CRB management procedures prepared by NAVFAC Marianas.

Assuming that the C&D debris generated would be evenly distributed over a five-year period, the minimum area required for a central processing facility for Alternative 2 is approximately 200,000 square feet. The estimated area includes storage for processed materials that can be recycled. A conceptual layout of the central processing facility is shown on Figure 5-1.

Assuming that the green waste generated would be evenly distributed over a five-year period, the minimum area required for a composting facility is approximately 15 acres.

5.2.2 Cost

Because specific sites have not been designated, site development costs are based on generic sites and may vary depending on actual site characteristics. It is assumed that site roadway, utilities, and other improvements are required. Assumptions regarding demolition of existing structures were not included. It is assumed that water and sewer service would be obtained from existing nearby water distribution systems and sewage collection systems.

For the purpose of this analysis, it is assumed that the central processing facility and composting facility would be located at the current NCTS Finegayan.

Estimated capital costs for the central processing facility in Alternative 2 include crushers and grinders for concrete and asphalt, a truck scale facility, storage bins, site work, roadways, utility work, and operation and transport vehicles. Estimated capital costs for the composting facility in Alternative 2 include a wood chipper, truck scale facility, site work, utility work, and operation vehicles.

C&D debris that is not reused or recycled would be disposed at the hardfill at the Navy Sanitary Landfill. The tipping fee for the hardfill at the Navy Sanitary Landfill is $1.65 per cubic yard.

Alternative 2 was assessed over a 5-year and 10-year life cycle. The 5-year present value life cycle cost of Alternative 2 is estimated to be $74,800,000. The 10-year present value life cycle cost of Alternative 1 is estimated to be $83,700,000.

Present value life cycle cost analyses for Alternative 2 are included in Appendix E. A 5-year life cycle cost analysis is provided in Appendix E.1. A 10-year life cycle cost analysis is provided in Appendix E.2. Assumptions and calculations are also provided with each analysis.

5.3 Alternative 3 – Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard and untreated wood. Construct a composting facility to process a portion of green waste.

5.3.1 Analysis

As described in Section 4.2.3, the construction contractor would be responsible for crushing and recycling concrete without lead-based paint and asphalt on-site. The contractor would transport all remaining C&D debris to the central processing facility. The central processing facility would recover scrap metal, old corrugated cardboard and untreated wood and process those materials for recycling. The operators of the central processing facility would dispose the remaining C&D debris at the hardfill at the Navy Sanitary Landfill.

The hardfill at the Navy Sanitary Landfill has sufficient capacity for disposal of C&D debris that is not recycled. Although private hardfills are available, the quantity of C&D debris expected during the DPRI projects identified in Section 3.0 would have a substantial impact on the private hardfills. Therefore, the hardfill at the Navy Sanitary Landfill would be used for disposal of all C&D debris that is not recycled.

Most of the C&D debris from the DPRI projects identified in this is expected to be generated in northern Guam. Therefore, the location of the central processing facility and composting facility is likely to be in northern Guam. The central processing facility and composting facility are intended to receive C&D debris and green waste from all DPRI projects identified in this study and would not be limited to the projects in northern Guam.

There is currently quarantine in northern Guam by the Guam Department of Agriculture restricting the transport of green waste and live plants across a quarantine boundary without inspection and/or treatment. At the time of this study, NCTS Finegayan, South Finegayan, AAFB, and the former FAA parcel were within the quarantine boundary. The contractor must follow the CRB management procedures prepared by NAVFAC Marianas.

Assuming that the C&D debris generated would be evenly distributed over a five-year period, the minimum area required for a central processing facility for Alternative 3 is approximately 350,000 square feet. The estimated area includes storage for processed material that can be recycled. A conceptual layout of the central processing facility is shown on Figure 5-2.

Assuming that the green waste generated would be evenly distributed over a five year period, the minimum area required for a composting facility is approximately 15 acres.

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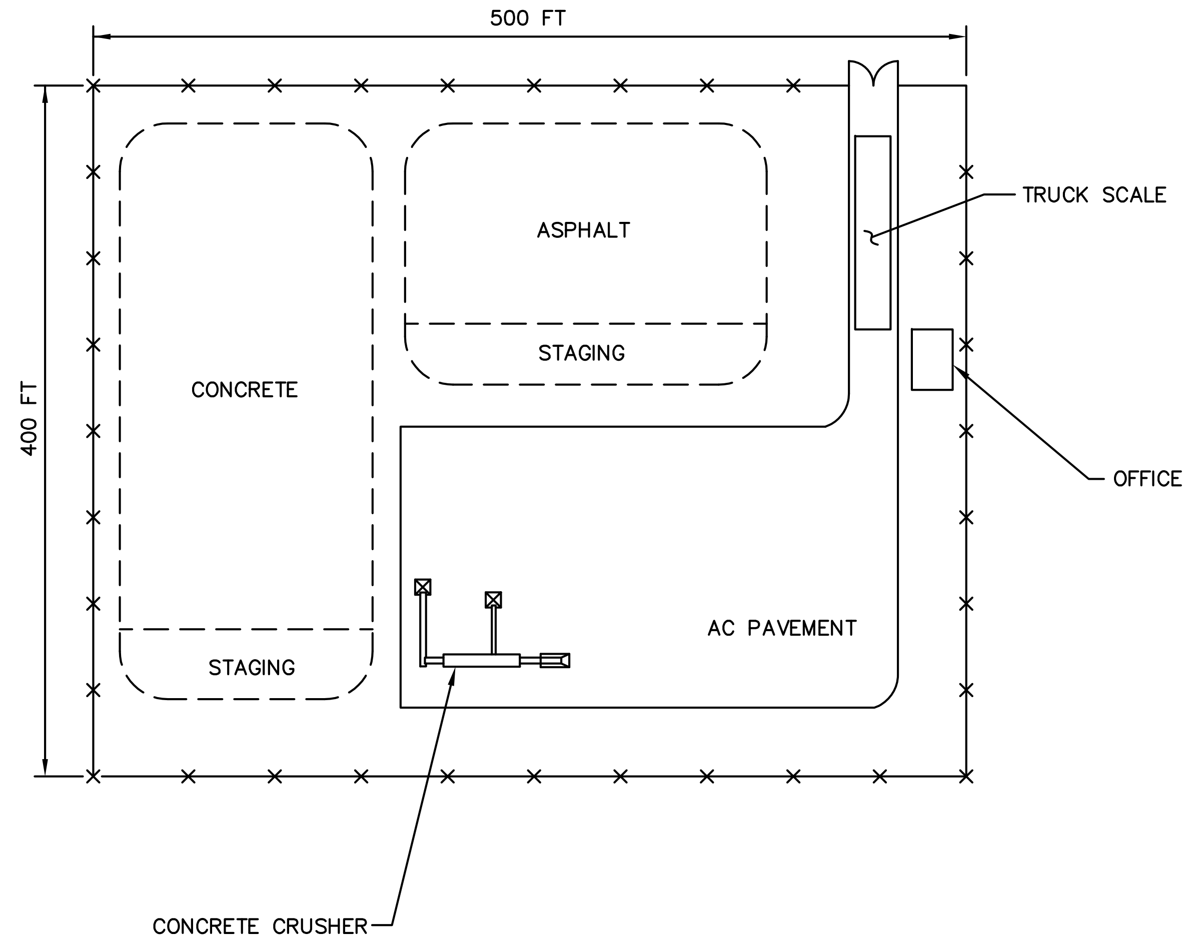

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CONSTRUCTION AND DEMOLITION DEBRIS REUSE AND DIVERSION STUDY

CONCEPTUAL LAYOUT OF C&D DEBRIS CENTRAL PROCESSING FACILITY, ALTERNATIVE 2

FIGURE 5–1

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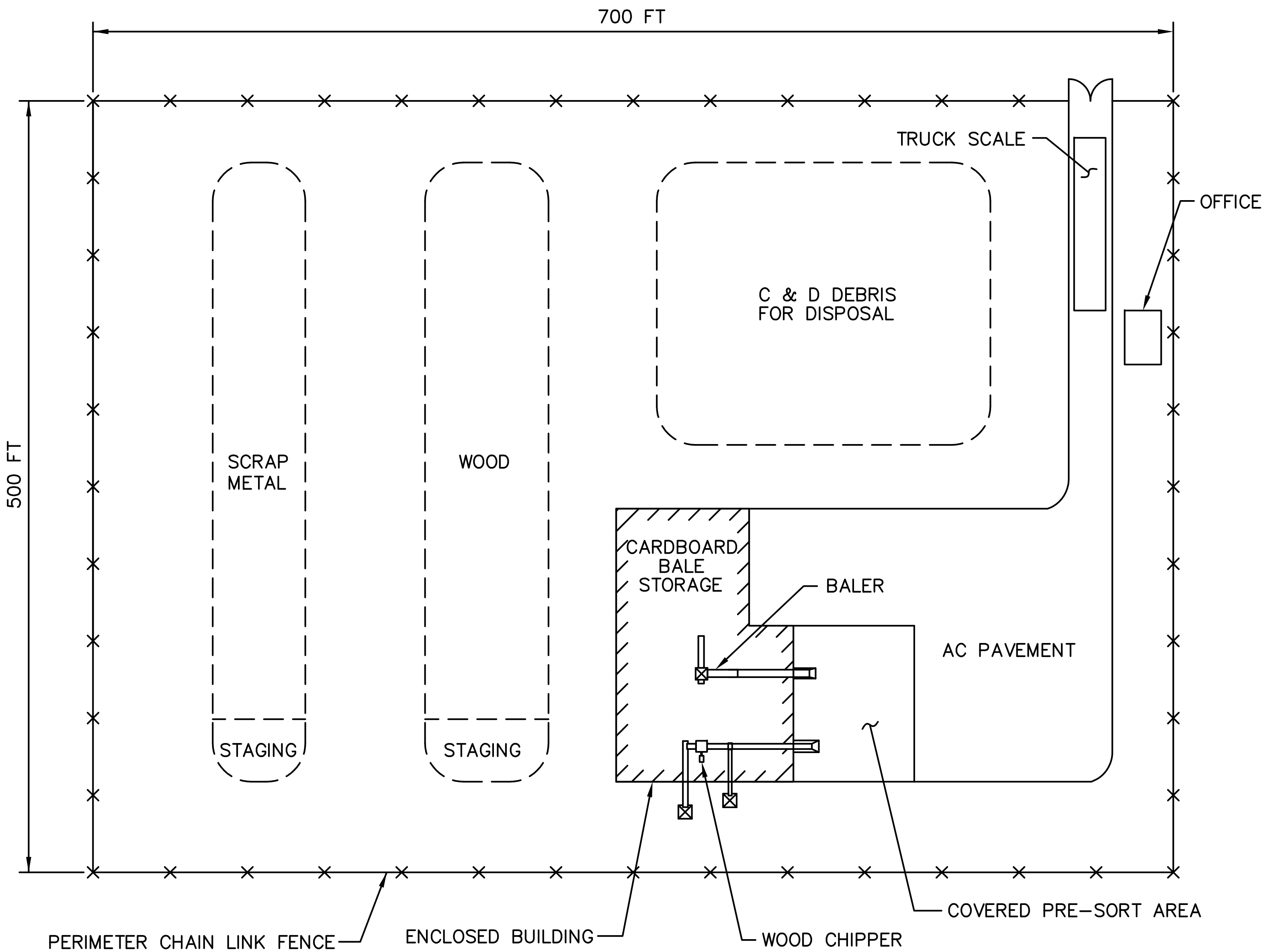

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CONSTRUCTION AND DEMOLITION DEBRIS REUSE AND DIVERSION STUDY

CONCEPTUAL LAYOUT OF C&D DEBRIS CENTRAL PROCESSING FACILITY, ALTERNATIVE 3

FIGURE 5–2

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5.3.2 Cost

Because specific sites have not been designated, site development costs are based on generic sites and may vary depending on actual site characteristics. It is assumed that site roadway, utilities, and other improvements are required. Assumptions regarding demolition of existing structures were not included. It is assumed that water and sewer service would be obtained from existing nearby water distribution systems and sewage collection systems.

For the purpose of this analysis, it is assumed that the central processing facility, composting facility, and stockpile area would be located at the current NCTS Finegayan.

Estimated capital costs for the central processing facility in Alternative 3 include a truck scale facility, enclosed pre-engineered processing building, wood chipper, baler, storage bins, covered pre-sorting area, site work, roadways, utility work, and operation and transport vehicles.

Estimated capital costs for the composting facility in Alternative 3 include a wood chipper, truck scale facility, site work, utility work, and operation vehicles.

C&D debris that is not recycled would be disposed at the hardfill at the Navy Sanitary Landfill. The tipping fee for the hardfill at the Navy Sanitary Landfill is $1.65 per cubic yard.

The annual operational costs include hauling and tipping fees for disposal of C&D debris that is not recycled. Operational costs for the contractors to process concrete without lead-based paint and asphalt at each project site are included.

Alternative 3 was assessed over a 5-year and 10-year life cycle. The 5-year present value life cycle cost of Alternative 3 is estimated to be $75,200,000. The 10-year present value life cycle cost of Alternative 1 is estimated to be $83,800,000.

Present value life cycle cost analyses for Alternative 3 are included in Appendix E. A 5-year life cycle cost analysis is provided in Appendix E.1. A 10-year life cycle cost analysis is provided in Appendix E.2. Assumptions and calculations are also provided with each analysis.

5.4 Alternative 4 – Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard, untreated wood, concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.

5.4.1 Analysis

As described in Section 4.2.4, the construction contractors would transport all C&D debris from the project sites to the new central processing facility. The contractor would pre-sort concrete before delivering the concrete without lead-based paint to the central processing facility. The contractor would transport the remaining C&D debris to the central processing facility.

The central processing facility would recover scrap metal, old corrugated cardboard and untreated wood from the mixed C&D debris and process those materials for recycling. The central processing facility would crush and grind the concrete and asphalt The operators of the central processing facility would dispose the remaining C&D debris at the hardfill at the Navy Sanitary Landfill.

In Alternative 4, crushers and grinders would be added to the central processing facility to process concrete and asphalt. Crushed concrete and asphalt would be stored at the central processing facility for reuse in future construction projects.

Most of the C&D debris from the DPRI projects identified in Section 3.0 is expected to be generated in northern Guam. Therefore, the location of the central processing facility and composting facility is likely to be in northern Guam. The central processing facility and composting facility are intended to receive C&D debris and green waste from all DPRI projects identified in this study and would not be limited to the projects in northern Guam.

There is currently quarantine in northern Guam by the Guam Department of Agriculture restricting the transport of green waste and live plants across a quarantine boundary without inspection and/or treatment. At the time of this study, NCTS Finegayan, South Finegayan, AAFB, and the former FAA parcel were within the quarantine boundary. The contractor must follow the CRB management procedures prepared by NAVFAC Marianas.

Assuming that the C&D debris generated would be evenly distributed over a five-year period, the minimum area required for a central processing facility for Alternative 4 is approximately 600,000 square feet. The estimated area includes storage for processed materials that can be recycled. A conceptual layout of the central processing facility is shown on Figure 5-3.

Assuming that the green waste generated would be evenly distributed over a five-year period, the minimum area required for a composting facility is approximately 15 acres.

5.4.2 Cost

Because specific sites have not been designated, site development costs are based on generic sites and may vary depending on actual site characteristics. It is assumed that site roadway, utilities, and other improvements are required. Assumptions regarding demolition of existing structures were not included. It is assumed that water and sewer service would be obtained from existing nearby water distribution systems and sewage collection systems.

For the purpose of this analysis, it is assumed that the central processing facility and composting facility would be located at the current NCTS Finegayan.

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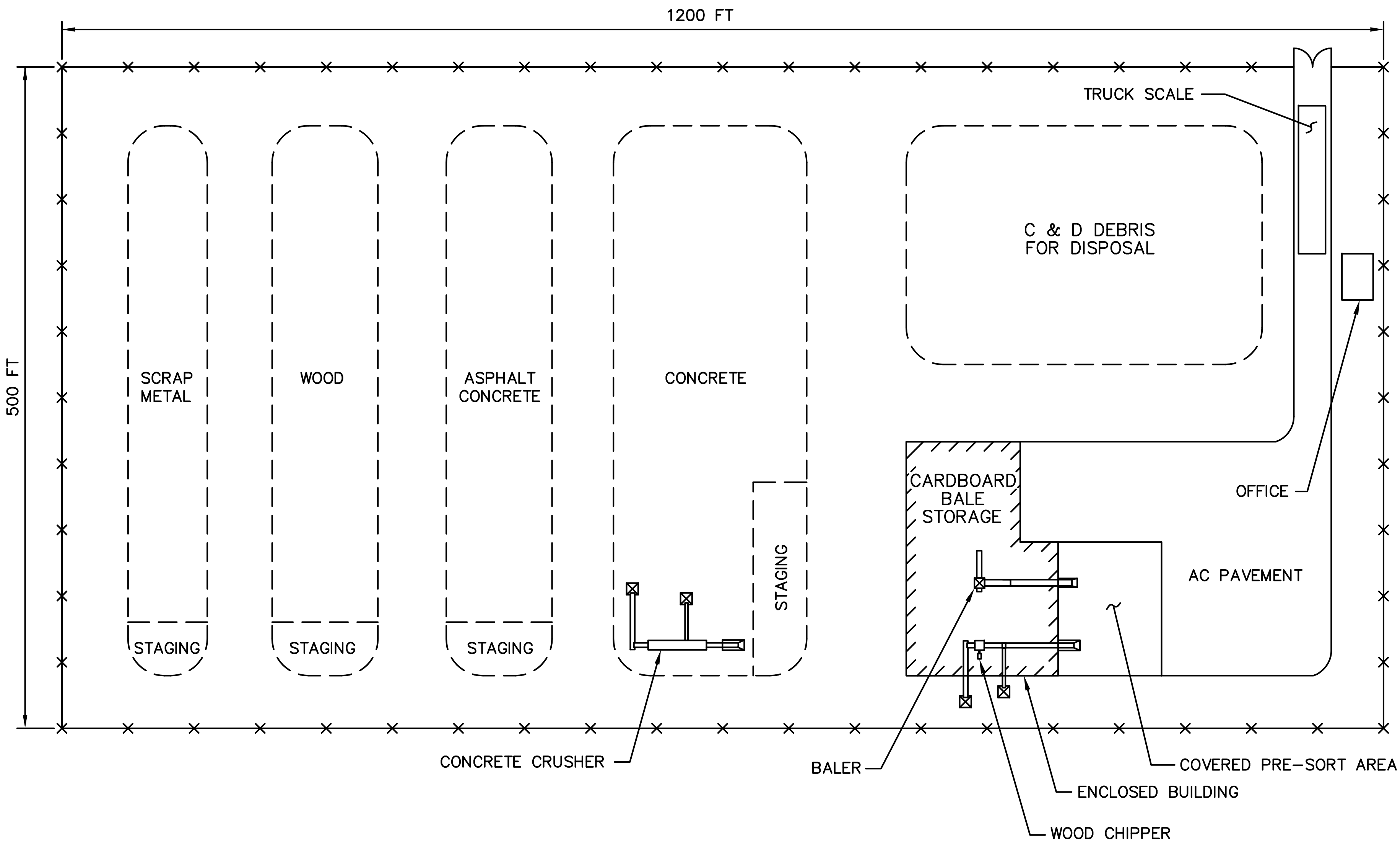

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CONSTRUCTION AND DEMOLITION DEBRIS
REUSE AND DIVERSION STUDY

CONCEPTUAL LAYOUT OF C&D DEBRIS
CENTRAL PROCESSING FACILITY, ALTERNATIVE 4

FIGURE
5-3

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C&D debris that is not reused or recycled would be disposed at the hardfill at the Navy Sanitary Landfill. The tipping fee for the hardfill at the Navy Sanitary Landfill is $1.65 per cubic yard. Capital costs for the central processing facility in Alternative 4 include crushers and grinders for concrete and asphalt, a truck scale facility, enclosed pre-engineered processing building, wood chipper, baler, storage bins, covered pre- sorting area, site work, roadways, utility work, and operation and transport vehicles.

Capital costs for the composting facility in Alternative 4 include a wood chipper, truck scale facility, site work, utility work, and operation vehicles.

Annual operational costs for Alternative 4 include hauling and tipping fees for disposal of C&D debris that is not recycled. It is assumed that C&D debris that is not recycled would be disposed at the hardfill at the Navy Sanitary Landfill.

Alternative 4 was assessed over a 5-year and 10-year life cycle. The 5-year present value life cycle cost of Alternative 4 is estimated to be $86,700,000. The 10-year present value life cycle cost of Alternative 1 is estimated to be $93,500,000.

Present value life cycle cost analyses for Alternative 4 are included in Appendix E. A 5-year life cycle cost analysis is provided in Appendix E.1. A 10-year life cycle cost analysis is provided in Appendix E.2. Assumptions and calculations are also provided with each analysis.

5.5 Alternative Comparisons

5.5.1 Cost Comparison

The present value life cycle costs based on a 5-year period for the evaluation of C&D debris and green waste processing alternatives are summarized in Table 5-1. A present value life cycle cost analysis for each alternative is included in Appendix E.1. Assumptions and calculations are also provided in Appendix E.1.

Alternative 1, requiring the contractor to continue processing all C&D debris and constructing a composting facility to process a portion of green waste provides the most cost-effective alternative over the 5-year analysis period.

The present value life cycle costs based on a 10-year period for the evaluation of C&D debris and green waste processing alternatives are summarized in Table 5-2. A present value life cycle cost analysis for each alternative is included in Appendix E.2. Assumptions and calculations are also provided in Appendix E.2.

Alternative 1, requiring the contractor to continue processing all C&D debris and constructing a composting facility to process a portion of green waste provides the most cost-effective alternative over the five and 10-year analysis period.

5.5.2 Advantages and Disadvantages

Table 5-3 is a matrix of the four viable alternatives analyzed in this section. Each alternative was developed to meet the DoD goal of 50 percent diversion of construction and demolition debris by 2015. The table lists the advantages and disadvantages of the alternatives in terms of regulatory, operational, implementation and economical considerations.

All four alternatives include construction of a composting facility to process a portion of the green waste.

Alternative 1 has the lowest present value cost over a 5-year period among the four alternatives. The contractor would be responsible for processing all C&D debris. Therefore, a C&D debris central processing facility is not required. Contractor efficiency may decrease during demolition due to an increase in presorting efforts to meet the diversion requirements. Contractors are likely to divert the minimum amount of C&D debris required by the contract documents. As a result, there may be reusable or recyclable materials taken to the hardfill. A potential advantage of requiring the contractor to process C&D materials on-site may be a reduction in permit processing time if the contractor has an existing Air Pollution Control Permit.

Alternative 2 has the smallest area requirement for the C&D debris central processing facility. Crushed concrete and asphalt would be stockpiled at this facility and readily available for reuse in other construction projects. Contractors would be required to process all other C&D debris besides concrete without lead-based paint and asphalt.

Alternative 3 has the second largest area requirement for the C&D debris central processing facility. Contractors are likely to process the concrete without lead-based paint and asphalt at the project site to avoid handling the material twice. On-site processing operations would require contractors to obtain applicable permits from GEPA, which may affect construction project schedules. A potential advantage of requiring the contractor to process concrete and asphalt on-site may be a reduction in permit processing time if the contractor has an existing Air Pollution Control Permit.

Alternative 4 has the highest present value cost over a 5 and 10-year period. This alternative also requires the largest area for the C&D debris central processing facility because the concrete without lead-based paint and asphalt would be hauled to this facility for processing in addition to the mixed C&D debris. Crushed concrete and asphalt would be stockpiled at this facility and readily available for reuse in other construction projects.

Table 5-1

Summary of 5-Year Present Value Life Cycle Analysis

Alternative	Initial Capital Cost of Facility, Equipment and Trucks	Labor Cost	Operations and Maintenance Cost for Trucks	Operations and Maintenance Cost for Facilities and Equipment	Hardfill Disposal Cost	Present Value Life Cycle Analysis 5 years
Alternative 1 – Contractor continues to process all C&D debris. Construct a composting facility to process a portion of green waste.	$10,000,000	$36,800,000	$15,900,000	$3,800,000	$1,800,000	$68,200,000
Alternative 2 – Construct a C&D debris central processing facility that recovers concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.	$11,300,000	$40,400,000	$15,200,000	$7,300,000	$600,000	$74,800,000
Alternative 3 – Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard and untreated wood. Construct a composting facility to process a portion of green waste.	$15,700,000	$38,700,000	$14,600,000	$5,600,000	$600,000	$75,200,000
Alternative 4 – Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard, untreated wood, concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.	$17,400,000	$45,800,000	$18,300,000	$4,600,000	$600,000	$86,700,000

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Table 5-2

Summary of 10-Year Present Value Life Cycle Analysis

Alternative	Initial Capital Cost of Facility, Equipment and Trucks	Labor Cost	Operations and Maintenance Cost for Trucks	Operations and Maintenance Cost for Facilities and Equipment	Hardfill Disposal Cost	Present Value Life Cycle Analysis 10 years
Alternative 1 – Contractor continues to process all C&D debris. Construct a composting facility to process a portion of green waste.	$9,800,000	$39,200,000	$16,100,000	$4,800,000	$1,700,000	$71,600,000
Alternative 2 – Construct a C&D debris central processing facility that recovers concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.	$11,700,000	$47,100,000	$14,500,000	$9,800,000	$600,000	$83,700,000
Alternative 3 – Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard and untreated wood. Construct a composting facility to process a portion of green waste.	$16,300,000	$44,400,000	$15,200,000	$7,300,000	$600,000	$83,800,000
Alternative 4 – Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard, untreated wood, concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.	$17,500,000	$49,600,000	$18,400,000	$7,400,000	$600,000	$93,500,000

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TABLE 5-3
SUMMARY MATRIX OF COMPARATIVE ADVANTAGES (A) AND DISADVANTAGES (D)

Alt.	Option	Regulations	Operations	Implementation	Economics	Schedule
1	Contractor continues to process all C&D debris. Construct composting facility.	D – GEPA permits would be required for processing C&D debris at each project site. A – GEPA permits would not be required for a central processing facility.	A – No C&D debris central processing facility to maintain.	A – No C&D debris central processing facility.	A – Lowest Present Value cost for all alternatives based on a 5-year life cycle analysis.	D – Composting facility would not be constructed before the first set of DPRI construction projects begin.
2	Construct a C&D debris central processing facility that recovers concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.	D – GEPA permits would be required for a C&D central processing facility and composting facility in addition to operations on each project site. D – An Air Pollution Control Permit for a central processing facility requires a minimum of 12 months to process.	A – Two types of C&D debris must be recovered at the facility. A – Excess crushed concrete and asphalt may be stockpiled at this facility for reuse on other construction projects.	A – Siting and construction of the smallest central processing facility.	A –Lowest present value cost for alternatives with C&D debris central processing facility based on a 5-year life cycle analysis.	D – Composting facility would not be constructed before the first set of DPRI construction projects begin.
3	Construct C&D debris central processing facility that recovers scrap metal, old corrugated cardboard and untreated wood. Construct composting facility.	D – GEPA permits would be required for a C&D central processing facility and composting facility in addition to operations on each project site.	D – Three types of C&D debris must be recovered at the facility.	D – Siting and construction of the second largest central processing facility.	D– Second highest present value cost for alternatives with C&D debris central processing facility based on a 5-year life cycle analysis.	D – Central processing facility would not be constructed before the first set of DPRI construction projects begins.
4	Construct C&D debris central processing facility that recovers scrap metal, old corrugated cardboard, untreated wood, concrete without lead-based paint and asphalt. Construct composting facility	D – GEPA permits would be required for a C&D central processing facility and composting facility in addition to operations on each project site. D – An Air Pollution Control Permit for a central processing facility requires a minimum of 12 months to process.	D –Five types of C&D debris must be recovered at the facility. A – Excess crushed concrete and asphalt may be stockpiled at this facility for reuse on other construction projects.	D – Siting and construction of the largest central processing facility.	D –Highest present value cost for alternatives with C&D central processing facility based on a 5-year life cycle analysis.	D – Central processing facility would not be constructed before the first set of DPRI construction projects begins.

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6.0 Summary of Findings

The major findings of the study are summarized below.

- Based on the expected characteristics of the C&D debris generated by the projected DPRI construction projects identified in this study, diversion of concrete without lead-based paint, asphalt concrete, and scrap metal would meet the DoD goal of 50 percent diversion of C&D debris by the end of fiscal year 2015.
- Green waste generated by land clearing activities would not contribute towards meeting the diversion goal. However, green waste should be reused on-site as mulch or compost.
- The Guam Environmental Protection Agency has regulatory primacy for enforcing U.S. EPA solid waste regulations on Guam. GEPA would require multiple solid waste permits and Air Pollution Control Permits to crush concrete and asphalt debris at construction sites or processing facilities.
- Requiring the contractor to continue processing all C&D debris and providing a composting facility with the capability to accept a portion of the green waste generated is the most cost-effective solution for processing C&D debris and green waste generated by the DPRI construction projects identified in this study.
- Currently, there are recycling companies on Guam who accept scrap metal at no charge.
- Currently, there are recycling companies on Guam who accept old corrugated cardboard for a fee.

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Appendices

Appendix A

Proposed Demolition Figures

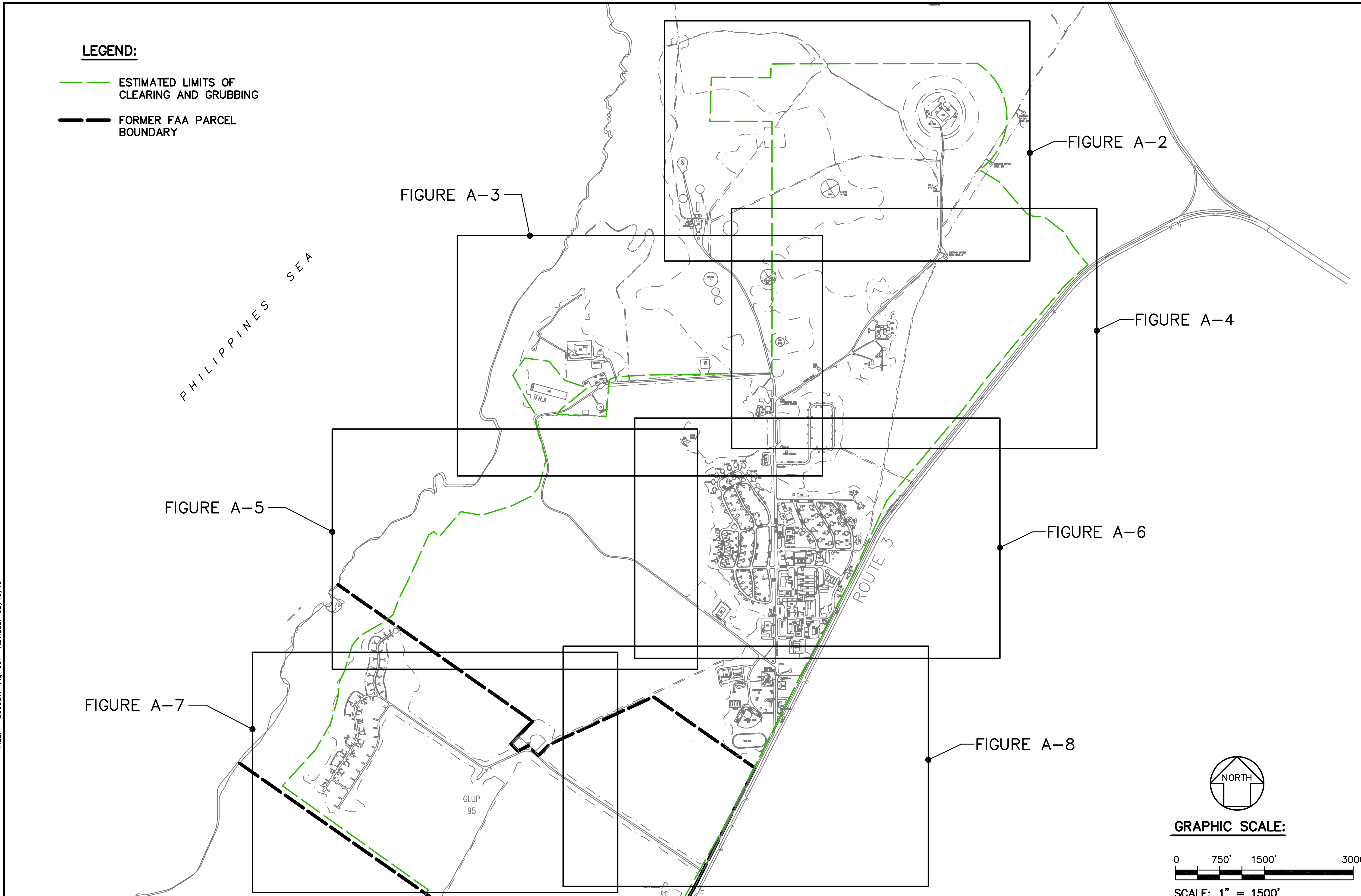

FIGURE A-1

BASE MAP FOR PROPOSED DEMOLITION – NCTS FINEGAYAN AND FORMER FAA PARCEL

CONSTRUCTION AND DEMOLITION DEBRIS REUSE AND DIVERSION STUDY

NCTS FINEGAYAN, GUAM

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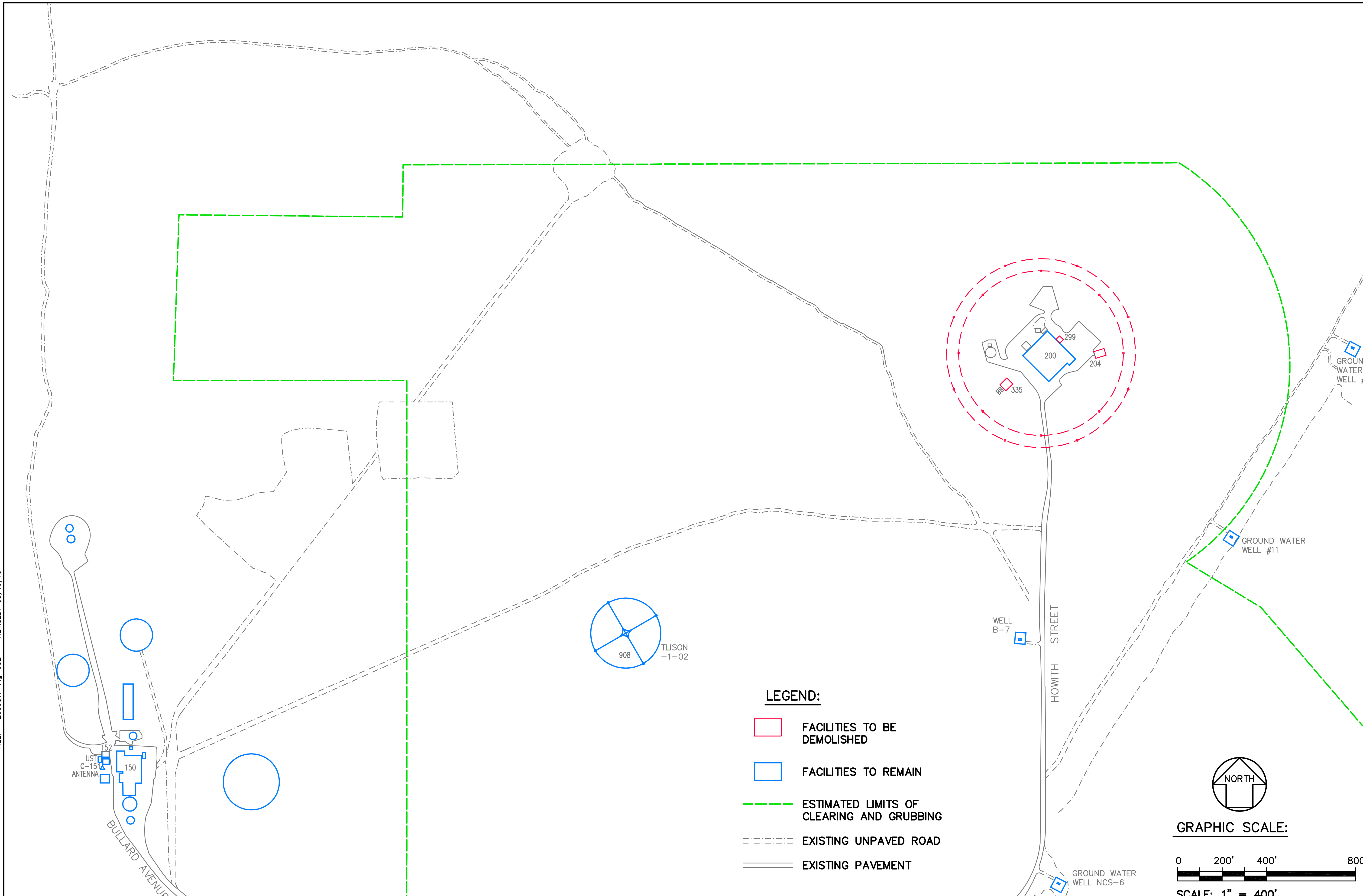

FIGURE A-2

LOCATION MAP FOR PROPOSED DEMOLITION – NCTS FINEGAYAN

CONSTRUCTION AND DEMOLITION DEBRIS REUSE AND DIVERSION STUDY

NCTS FINEGAYAN, GUAM

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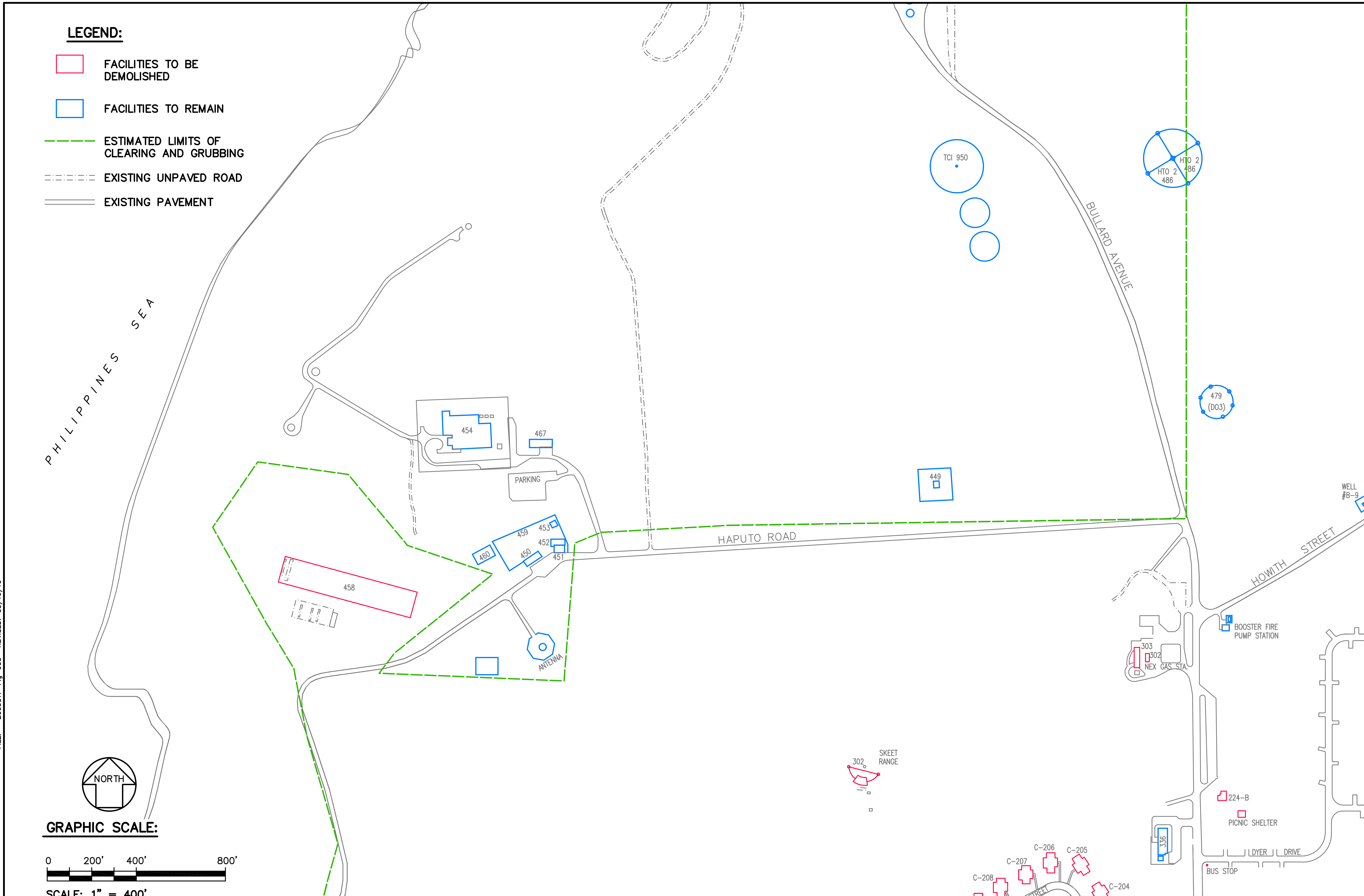

FIGURE A-3

LOCATION MAP FOR PROPOSED DEMOLITION – NCTS FINEGAYAN

CONSTRUCTION AND DEMOLITION DEBRIS REUSE AND DIVERSION STUDY

NCTS FINEGAYAN, GUAM

HDR Hawaii Pacific Engineers, Inc.

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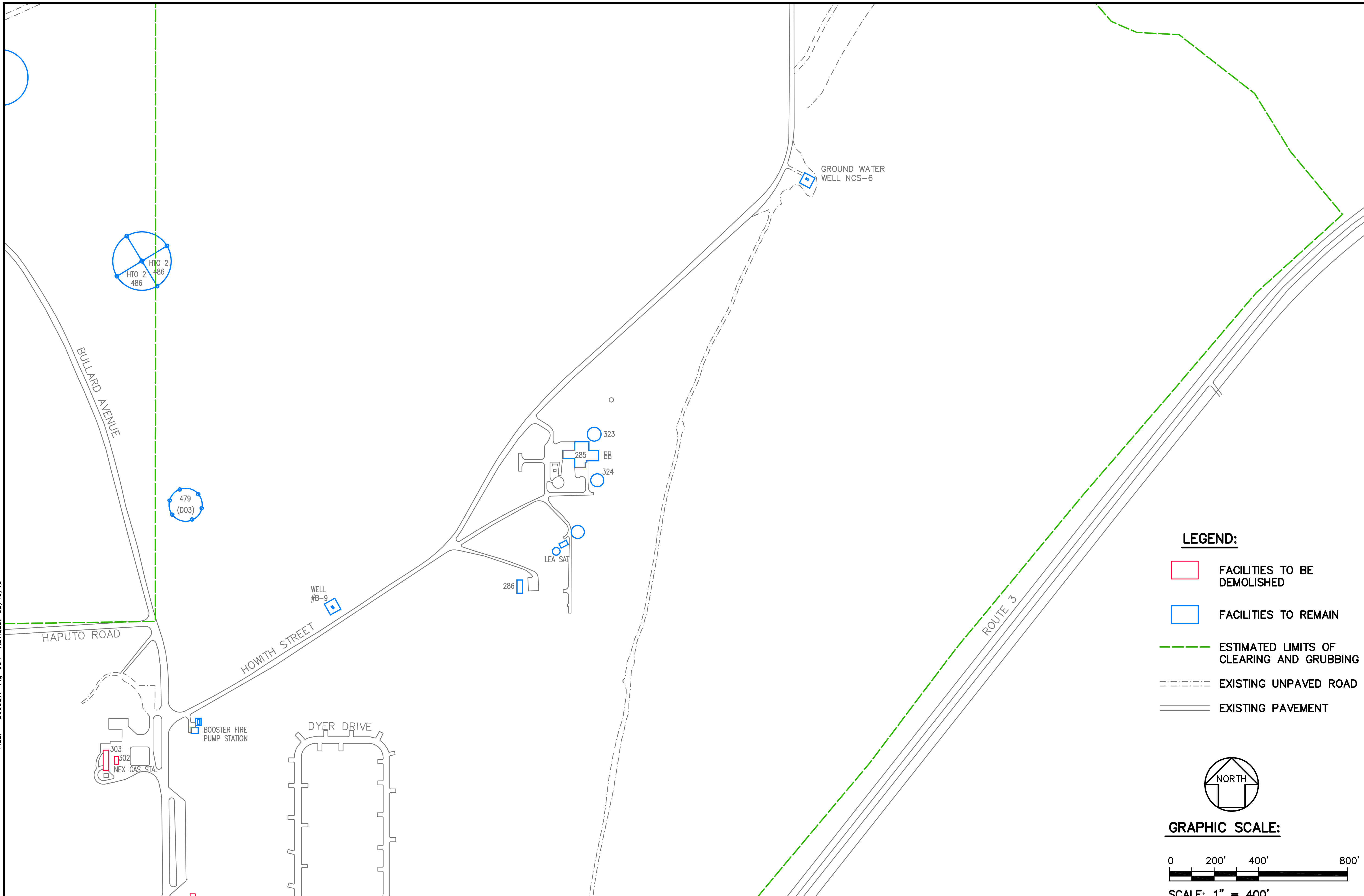

FIGURE A-4

LOCATION MAP FOR PROPOSED DEMOLITION – NCTS FINEGAYAN

CONSTRUCTION AND DEMOLITION DEBRIS REUSE AND DIVERSION STUDY

NCTS FINEGAYAN, GUAM

HDR Hawaii Pacific Engineers, Inc.

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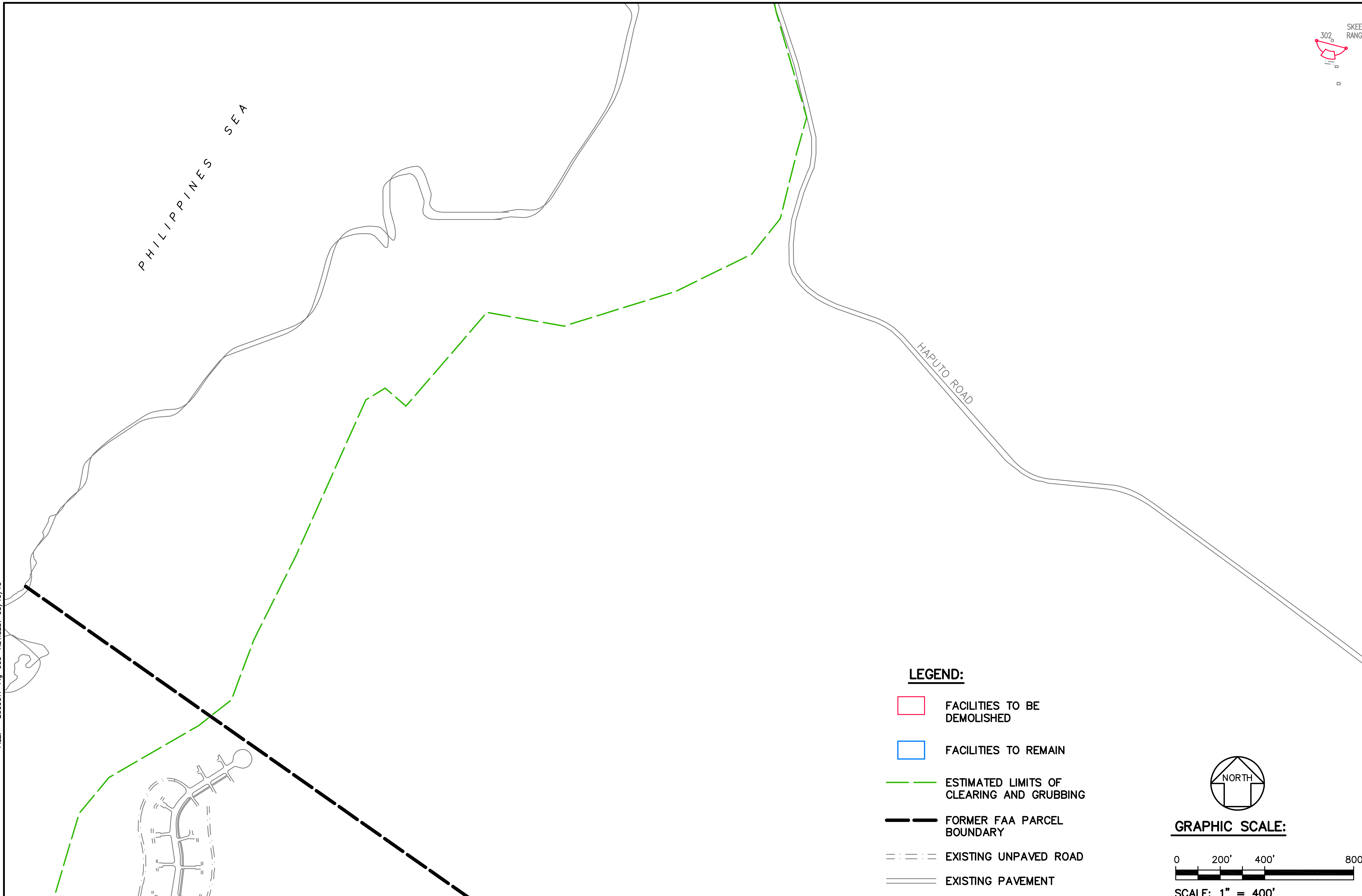

FIGURE A–5

LOCATION MAP FOR PROPOSED DEMOLITION – NCTS FINEGAYAN AND FORMER FAA PARCEL

CONSTRUCTION AND DEMOLITION DEBRIS REUSE AND DIVERSION STUDY

NCTS FINEGAYAN, GUAM

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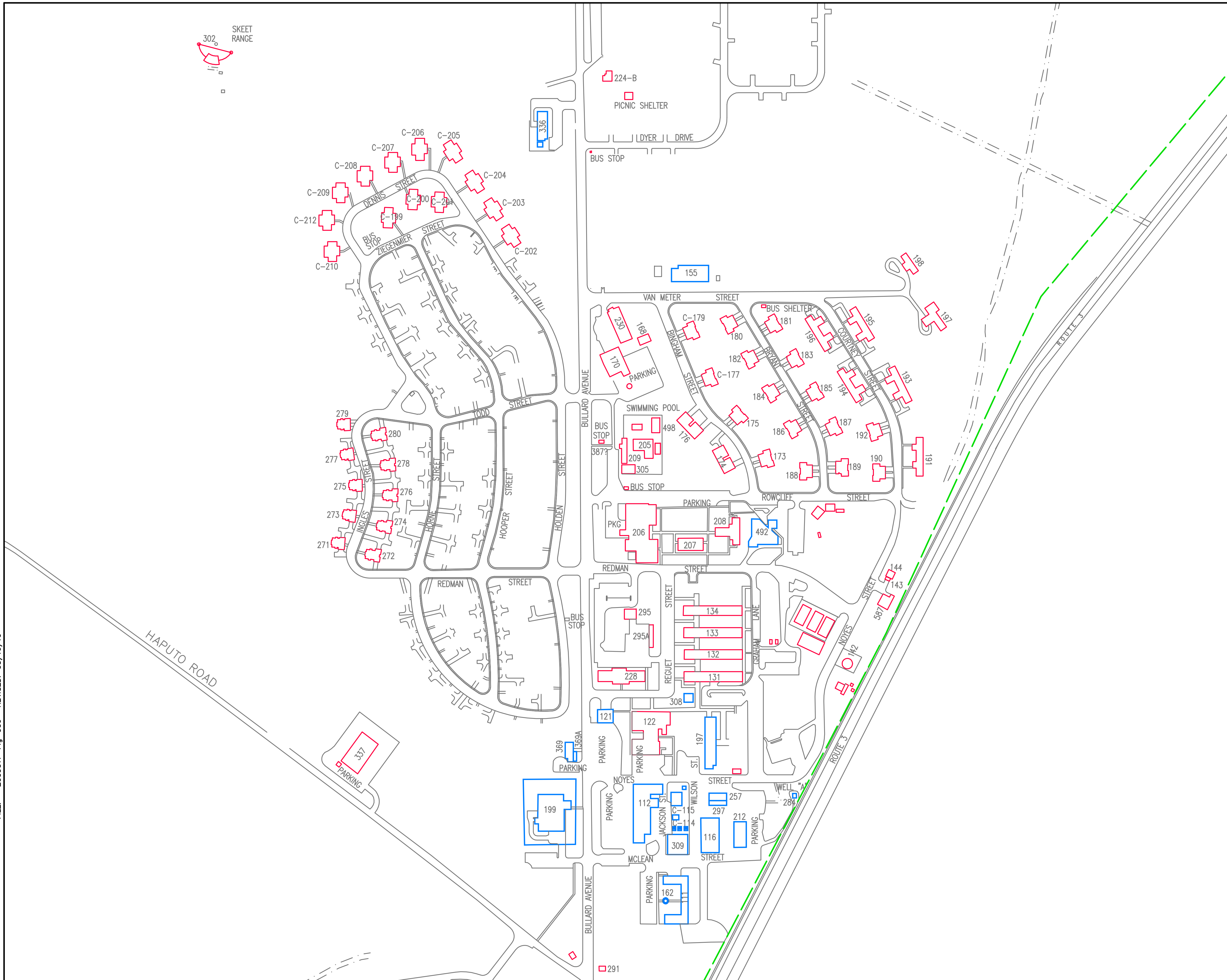
REVISED: 03/16/10



LEGEND:

FACILITIES TO BE DEMOLISHED

FACILITIES TO REMAIN

ESTIMATED LIMITS OF CLEARING AND GRUBBING

EXISTING UNPAVED ROAD

EXISTING PAVEMENT

NORTH

GRAPHIC SCALE:

0 200' 400' 800'

SCALE: 1" = 400'

FIGURE A–6

LOCATION MAP FOR PROPOSED DEMOLITION – NCTS FINEGAYAN

CONSTRUCTION AND DEMOLITION DEBRIS REUSE AND DIVERSION STUDY

NCTS FINEGAYAN, GUAM

HDR | Hawaii Pacific Engineers, Inc.

DATE: 01/09/10
SCALE: 1 = 1
FILE: 2009017-Fig-006
PM: TCL
OPER: *FAI
REVISED: 03/16/10

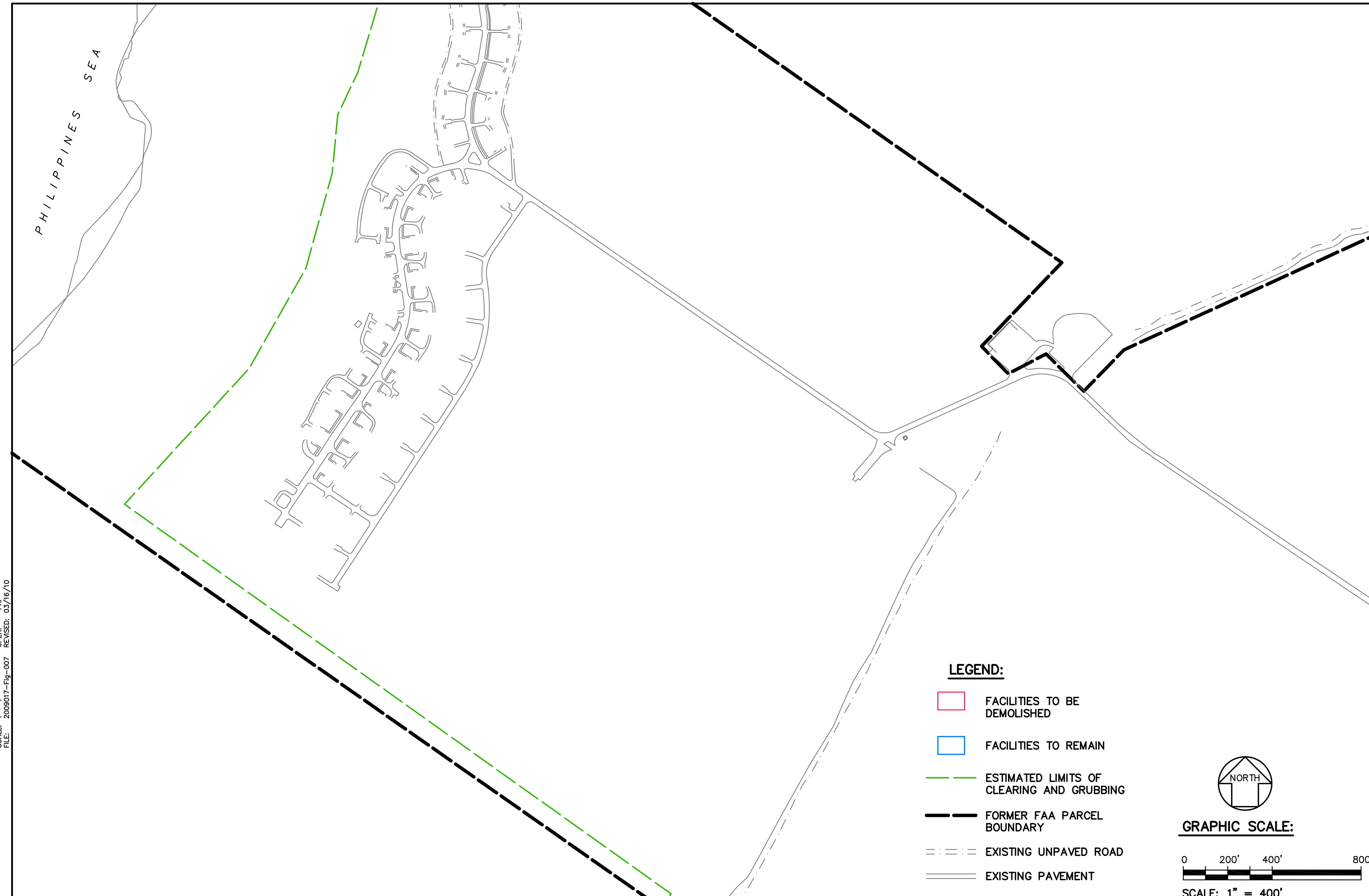


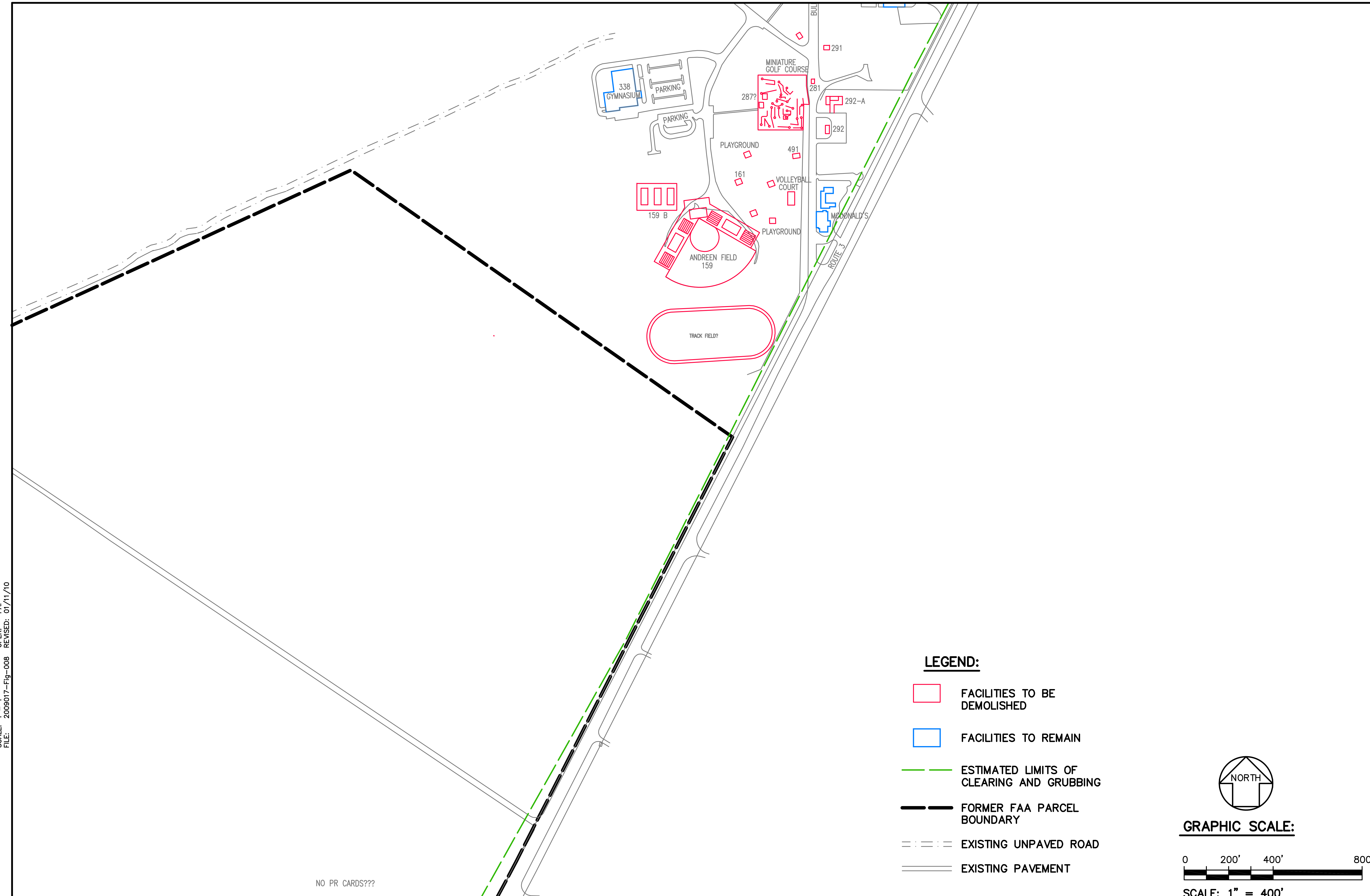
FIGURE A-7

LOCATION MAP FOR PROPOSED DEMOLITION – NCTS FINEGAYAN AND FORMER FAA PARCEL

CONSTRUCTION AND DEMOLITION DEBRIS REUSE AND DIVERSION STUDY
NCTS FINEGAYAN, GUAM

HDR Hawaii Pacific Engineers, Inc.

DATE: 01/16/10
SCALE: 1 = 1
FILE: 2009017-Fig-007
PM: TCL
OPER: *FAI
REVISED: 03/16/10



DATE: 01/16/10
SCALE: 1 = 1
FILE: 2009017-Fig-008
PM: TCL
OPER: FAI
REVISED: 01/11/10

FIGURE A-8

LOCATION MAP FOR PROPOSED DEMOLITION – NCTS FINEGAYAN AND FORMER FAA PARCEL

CONSTRUCTION AND DEMOLITION DEBRIS REUSE AND DIVERSION STUDY
NCTS FINEGAYAN, GUAM

HDR | HPE Hawaii Pacific Engineers, Inc.

FIGURE A-9

BASE MAP FOR SOUTH FINEGAYAN AND FORMER FAA PARCEL

CONSTRUCTION AND DEMOLITION DEBRIS REUSE AND DIVERSION STUDY
SOUTH FINEGAYAN, GUAM

HDR | HPE Hawaii Pacific Engineers, Inc.

DATE: 01/09/10
SCALE: 1 = 1
FILE: 2009017-Fig-009
PM: TCL
OPER: *FAI
REVISED: 03/16/10

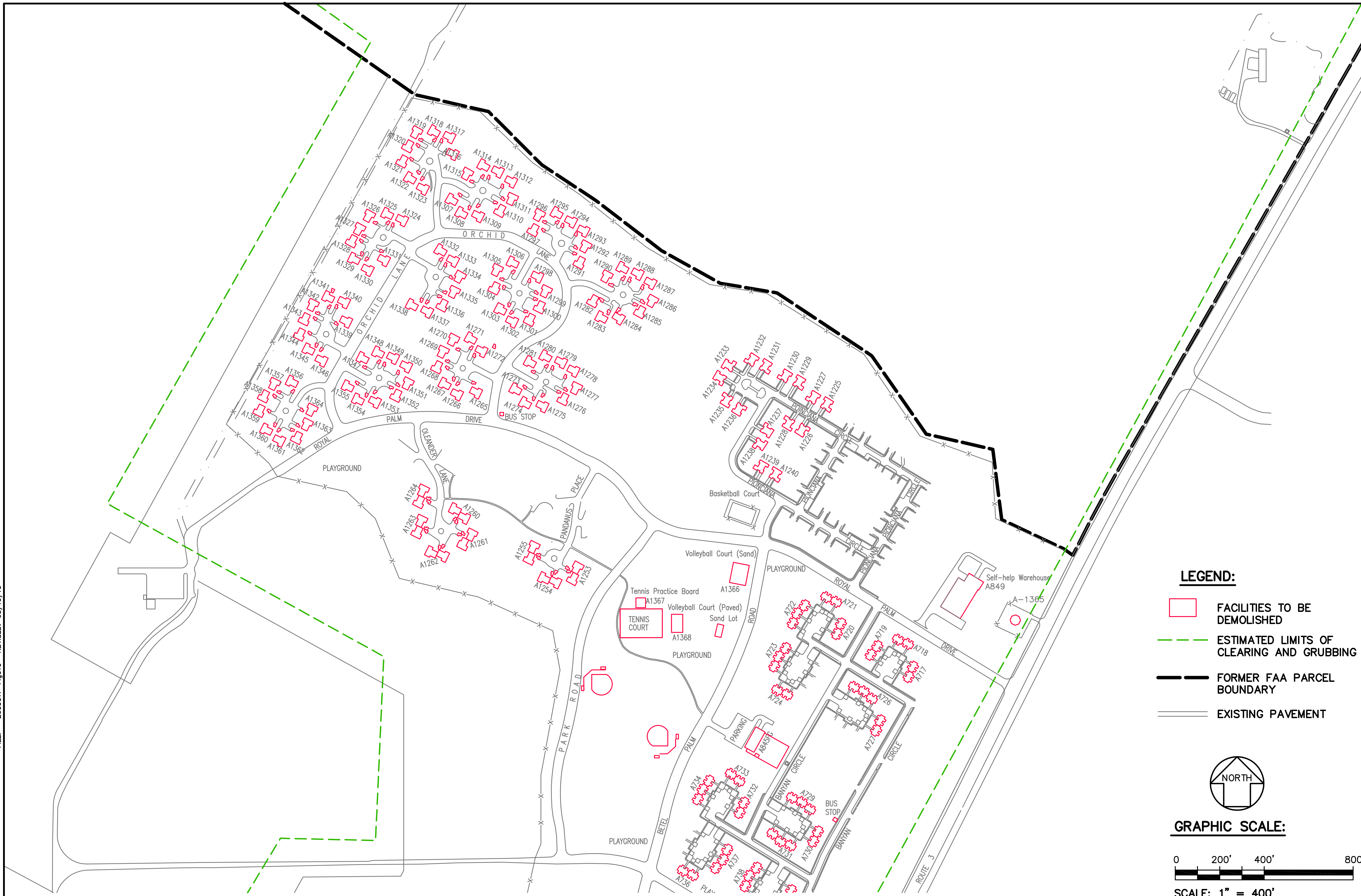


FIGURE A-10

LOCATION MAP FOR PROPOSED DEMOLITION – SOUTH FINEGAYAN AND FORMER FAA PARCEL

CONSTRUCTION AND DEMOLITION DEBRIS REUSE AND DIVERSION STUDY

SOUTH FINEGAYAN, GUAM

HDR Hawaii Pacific Engineers, Inc.

DATE: 01/09/10
SCALE: 1 = 1
FILE: 2009017-Fig010
PM: TCL
OPER: *FAI
REVISED: 03/16/10

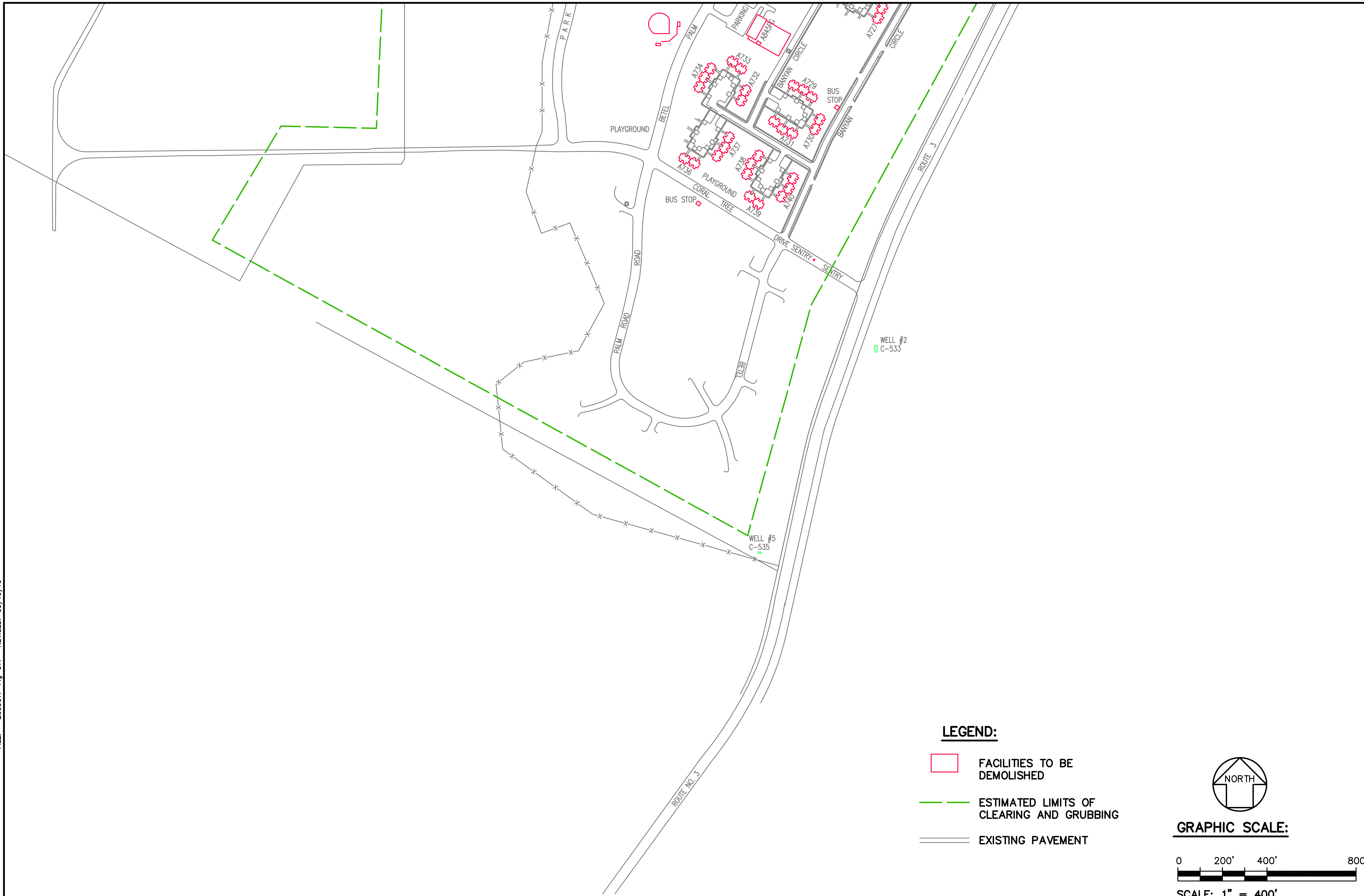


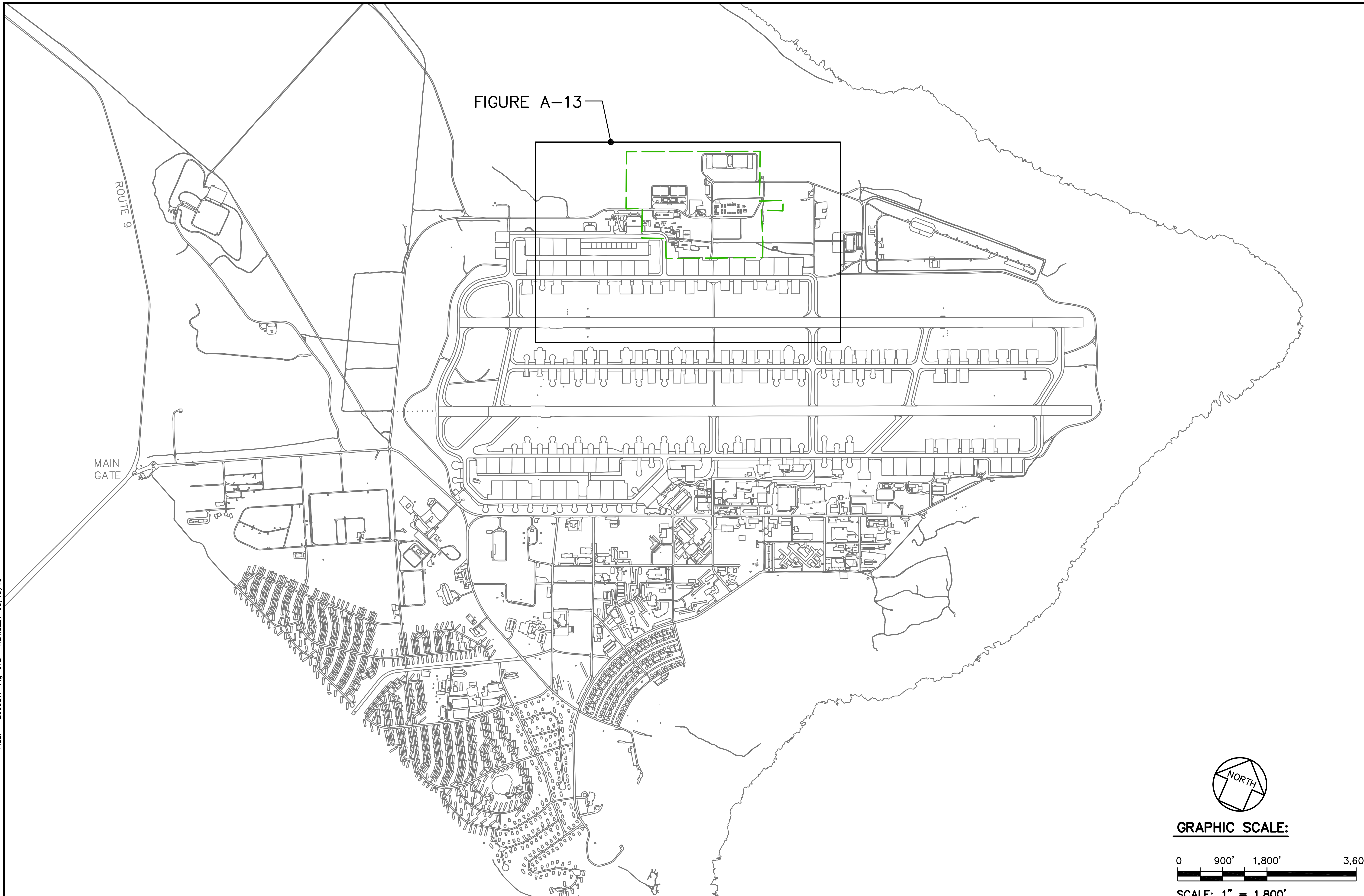
FIGURE A-11

LOCATION MAP FOR PROPOSED DEMOLITION – SOUTH FINEGAYAN

CONSTRUCTION AND DEMOLITION DEBRIS REUSE AND DIVERSION STUDY
SOUTH FINEGAYAN, GUAM

HDR HPE Hawaii Pacific Engineers, Inc.

DATE: 01/09/10
SCALE: 1 = 1
FILE: 2009017-Fig-011
PM: TCL
OPER: *FAI
REVISED: 03/16/10



BASE MAP FOR PROPOSED DEMOLITION – ANDERSEN AIR FORCE BASE

FIGURE A-12

CONSTRUCTION AND DEMOLITION DEBRIS REUSE AND DIVERSION STUDY
ANDERSEN AIR FORCE BASE, GUAM

HDR | HPE Hawaii Pacific Engineers, Inc.

DATE: 01/09/10
SCALE: 1 = 1
FILE: 2009017–Fig–012
PM: TCL
OPER: *FAI
REVISED: 03/16/10

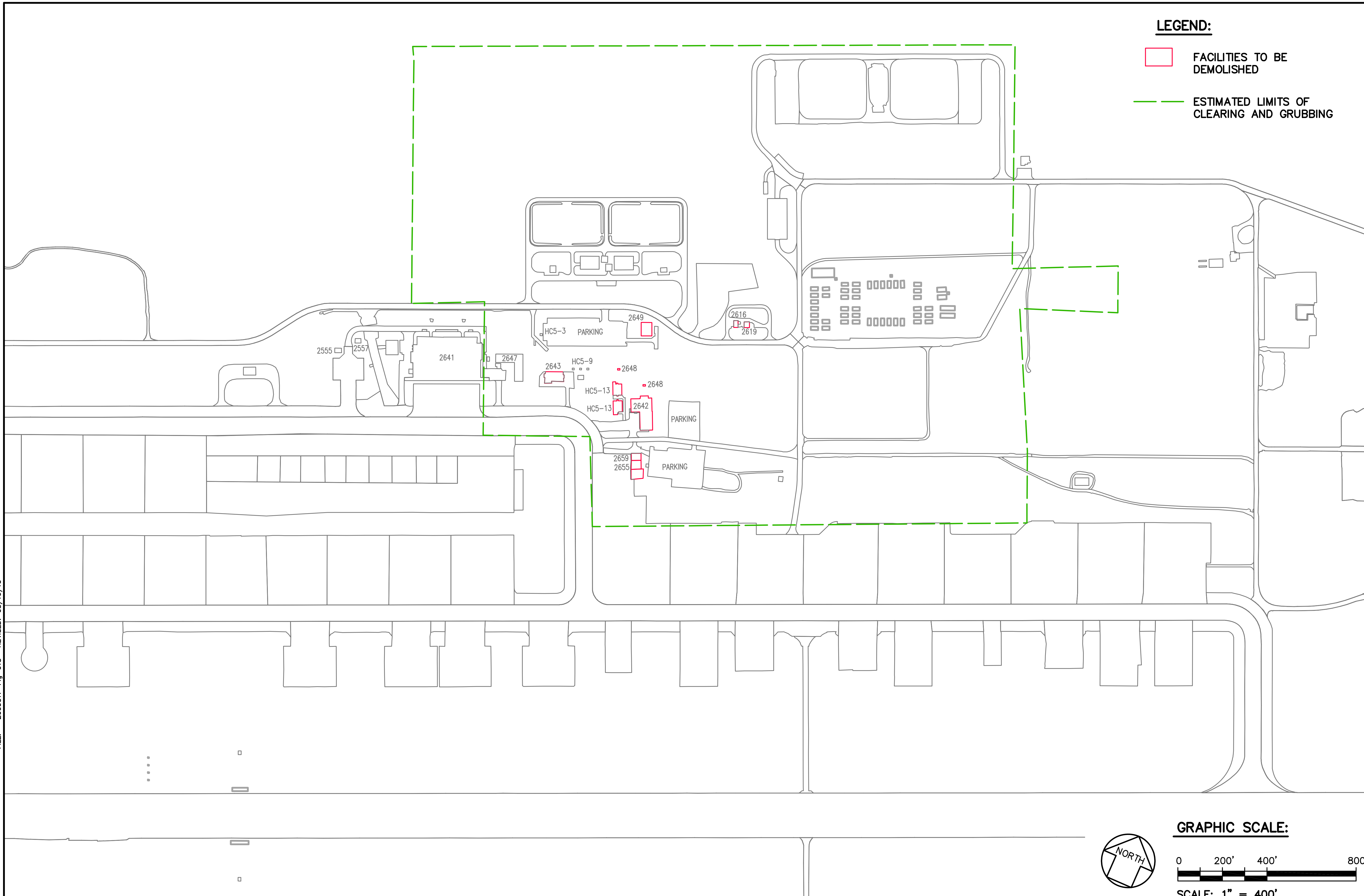


FIGURE A–13

LOCATION MAP FOR PROPOSED DEMOLITION – ANDERSEN AIR FORCE BASE

CONSTRUCTION AND DEMOLITION DEBRIS REUSE AND DIVERSION STUDY

ANDERSEN AIR FORCE BASE, GUAM

HDR Hawaii Pacific Engineers, Inc.

DATE: 01/09/10
SCALE: 1 = 1
FILE: 2009017–Fig–013

PM: TCL
OPER: *FAI
REVISED: 03/16/10

DATE: 01/09/10
SCALE: 1 = 1
FILE: 2009017-Fig-014

PM: TCL
OPER: *FAI
REVISED: 03/16/10

FIGURE A-14

BASE MAP FOR PROPOSED DEMOLITION — NAVAL BASE, APRA HARBOR

CONSTRUCTION AND DEMOLITION DEBRIS REUSE AND DIVERSION STUDY
NAVAL BASE, APRA HARBOR, GUAM

HDR | HPE Hawaii Pacific Engineers, Inc.

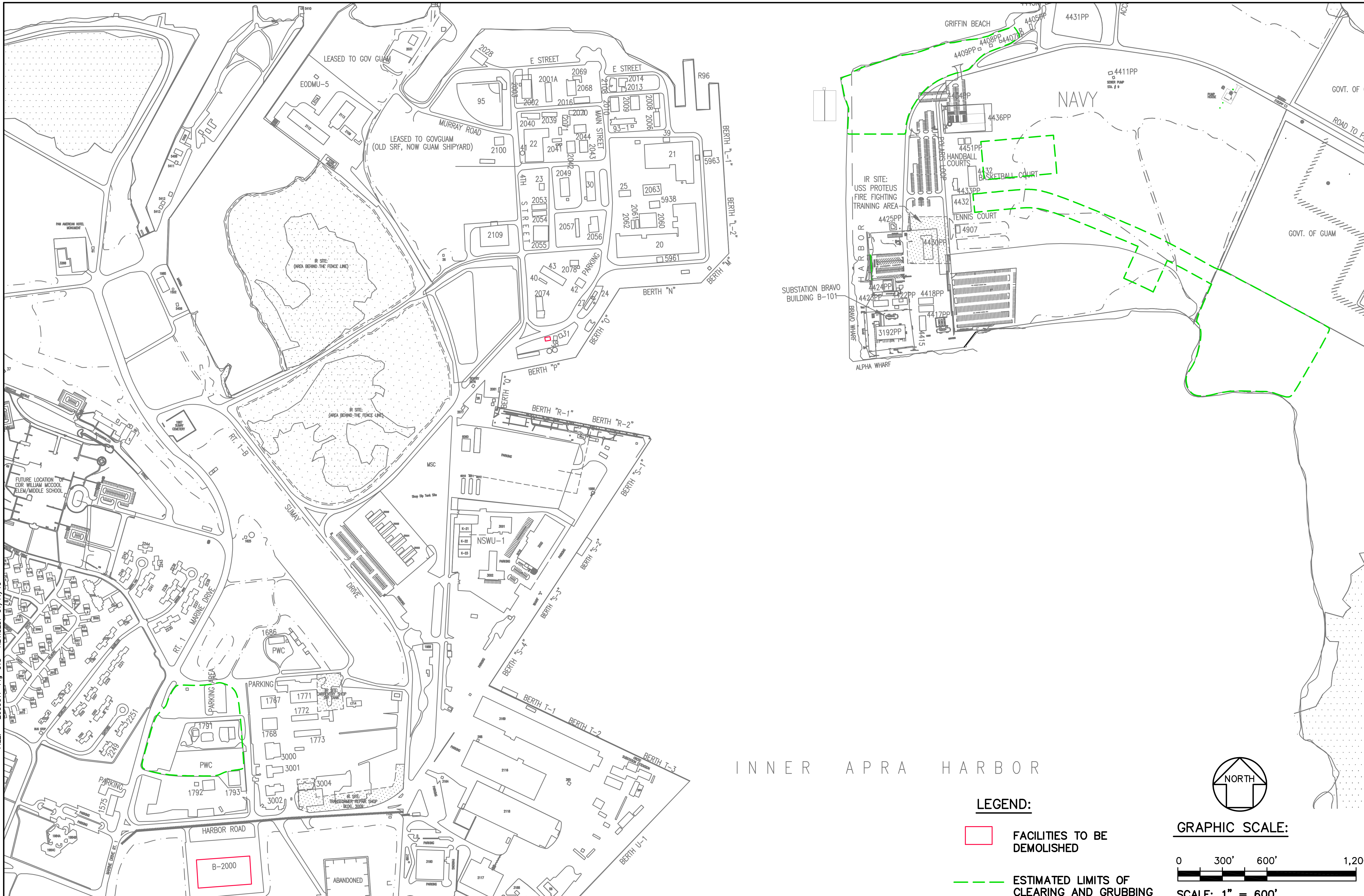


FIGURE A-15

LOCATION MAP FOR PROPOSED DEMOLITION – NAVAL BASE, APRA HARBOR

CONSTRUCTION AND DEMOLITION DEBRIS REUSE AND DIVERSION STUDY

NAVAL BASE, APRA HARBOR, GUAM

HDR Hawaii Pacific Engineers, Inc.

DATE: 01/09/10
SCALE: 1"=1'
FILE: 2009017-Fig-015
PM: TCL
OPER: FAI
REVISED: 01/11/10

DATE: 01/09/10
SCALE: 1=1
FILE: 2009017-Fig-016

PM: TCL
OPER: *FAI
REVISED: 03/16/10

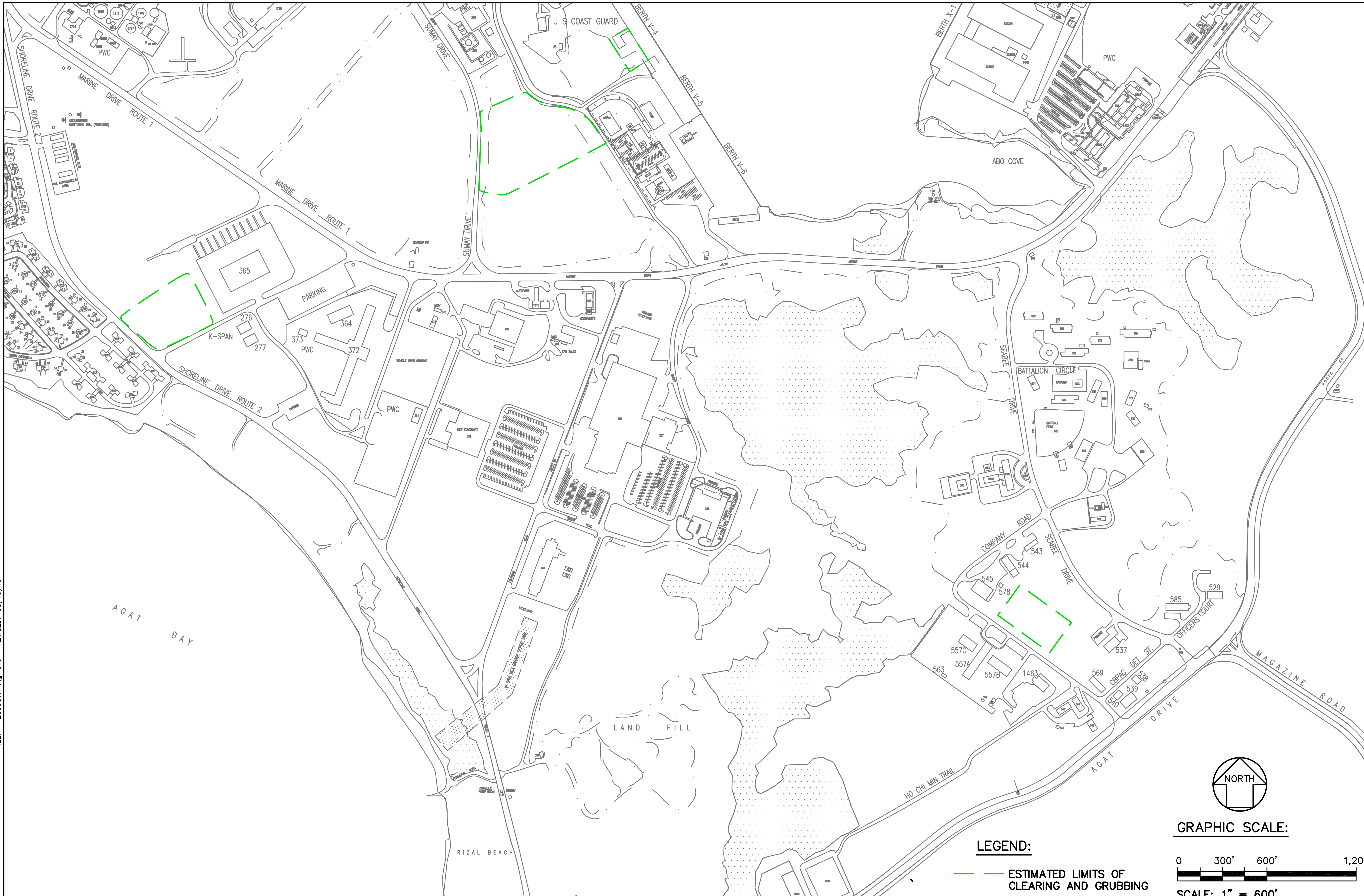


FIGURE A-16

LOCATION MAP FOR PROPOSED DEMOLITION – NAVAL BASE, APRA HARBOR

CONSTRUCTION AND DEMOLITION DEBRIS REUSE AND DIVERSION STUDY
NAVAL BASE, APRA HARBOR, GUAM

HDR Hawaii Pacific Engineers, Inc.

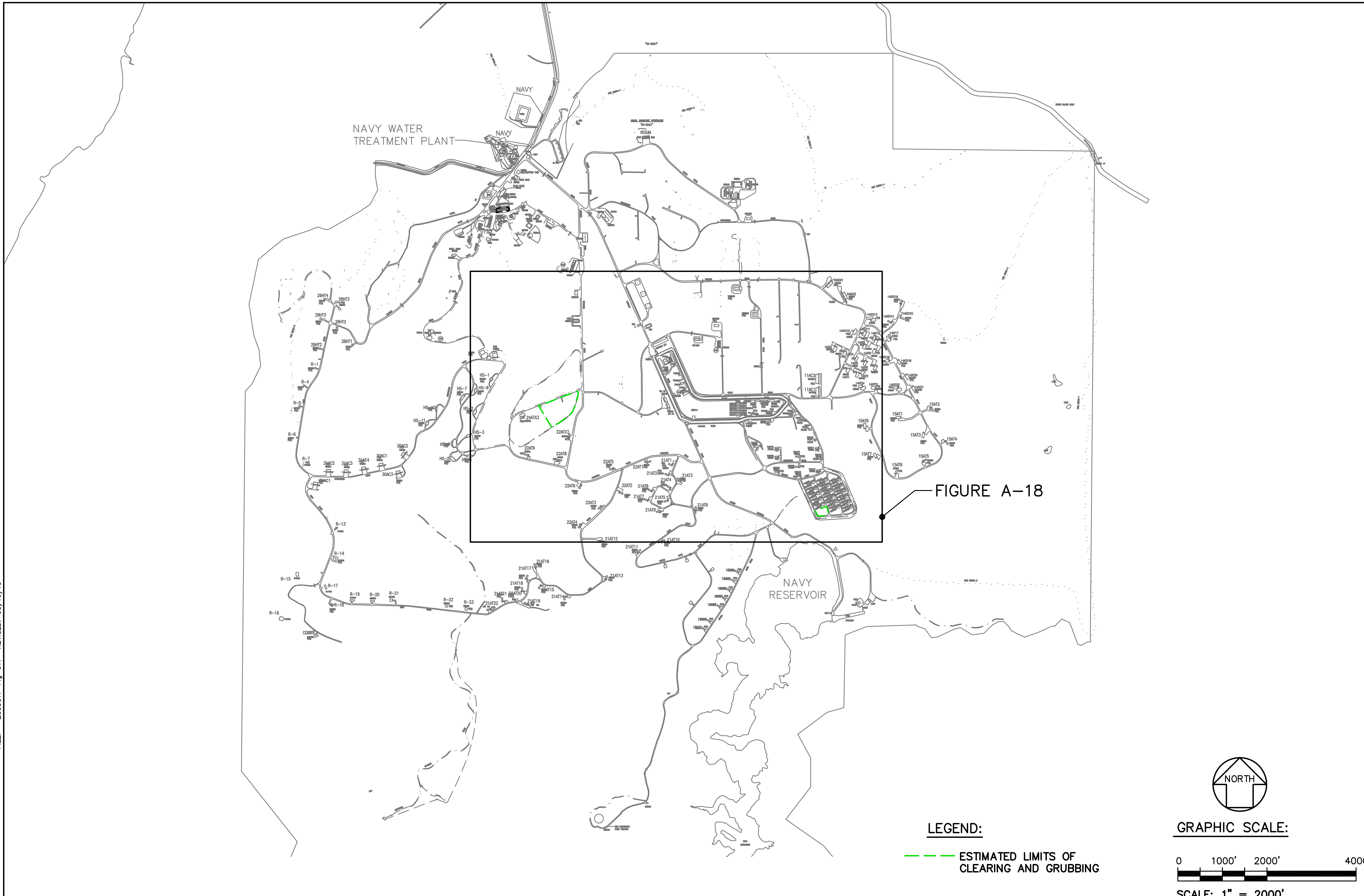


FIGURE A-17

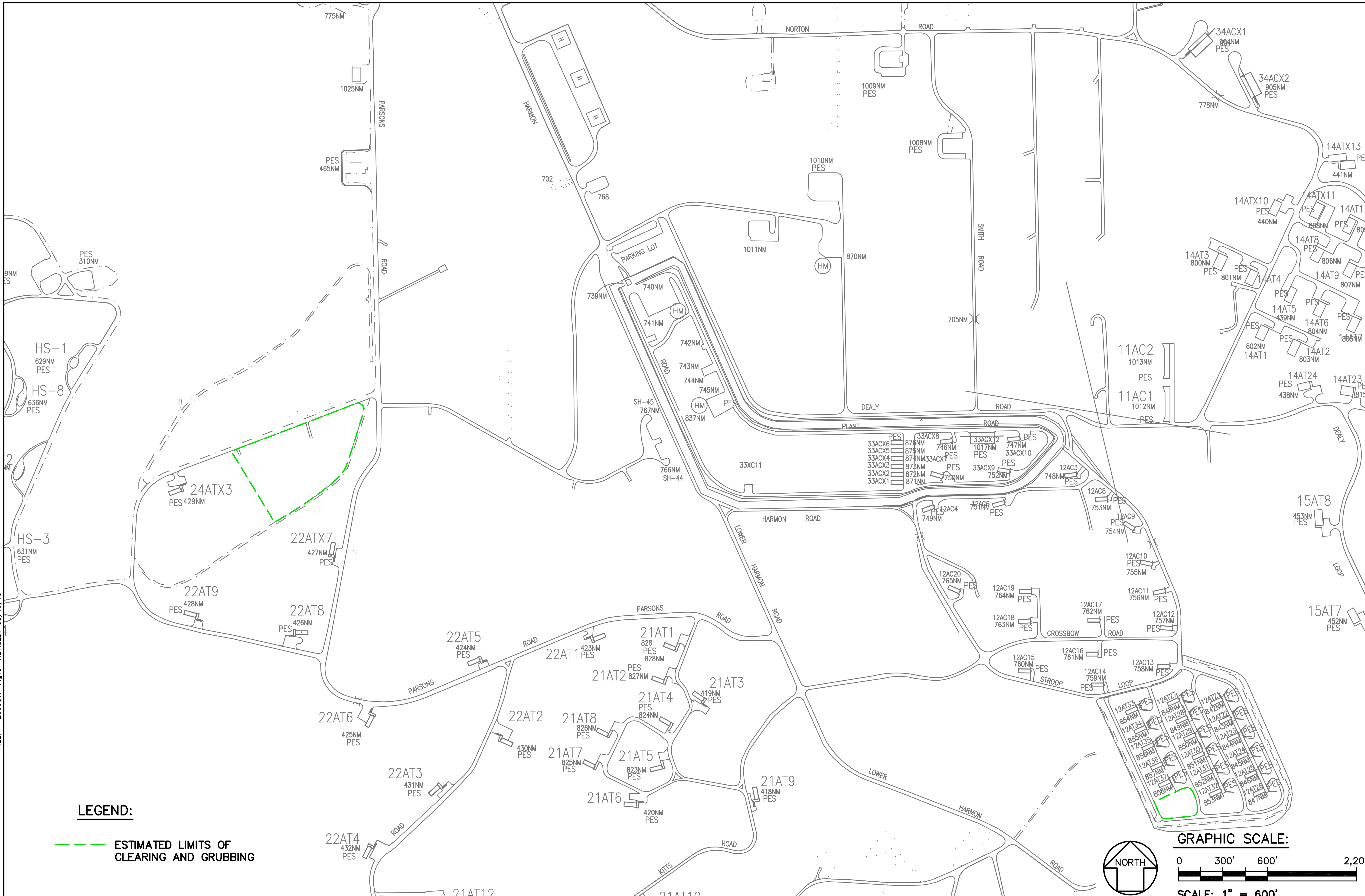
BASE MAP FOR PROPOSED DEMOLITION – ORDNANCE ANNEX

CONSTRUCTION AND DEMOLITION DEBRIS REUSE AND DIVERSION STUDY

ORDNANCE ANNEX, GUAM

HDR Hawaii Pacific Engineers, Inc.

DATE: 01/09/10
SCALE: 1=1
FILE: 2009017-Fig-017
PM: TCL
OPER: FAI
REVISED: 03/16/10



DATE: 01/09/10
SCALE: 1 = 1
FILE: 2009017-Fig18
PM: TCL
OPER: *FAI
REVISED: 03/16/10

FIGURE A-18

LOCATION MAP FOR PROPOSED DEMOLITION – ORDNANCE ANNEX

CONSTRUCTION AND DEMOLITION DEBRIS REUSE AND DIVERSION STUDY

ORDNANCE ANNEX, GUAM

HDR Hawaii Pacific Engineers, Inc.

DATE: 01/20/10
SCALE: 1 = 1
FILE: 2009017-Fig-019

PM: TCL
OPER: *FAI
REVISED: 03/16/10

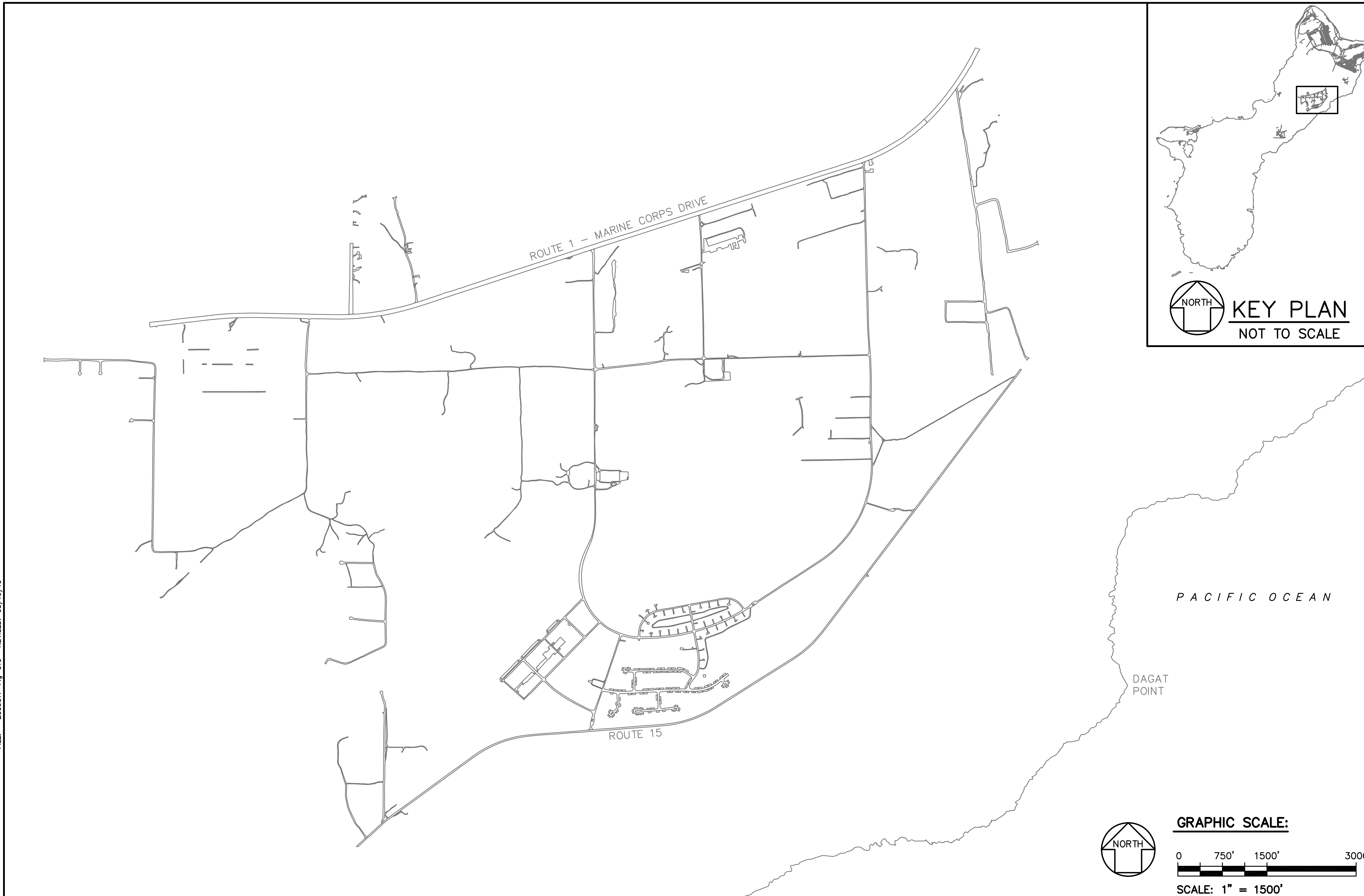


FIGURE A-19

LOCATION MAP FOR PROPOSED DEMOLITION – ANDERSEN AIR FORCE BASE SOUTH

CONSTRUCTION AND DEMOLITION DEBRIS REUSE AND DIVERSION STUDY

ANDERSEN AIR FORCE BASE SOUTH, GUAM

HDR Hawaii Pacific Engineers, Inc.

Appendix B

Lead-Based Paint Sampling and Testing Results

Lead-Based Sampling and Testing Results

Sample Number	Surface Color	Substrate	Building Location	Structure	Sample Location	Condition	Approximate Quantity	Lead Content (% by weight)
L1	Brown	Concrete	NCTS Finegayan	Exterior Window Sill	West Facing	Fair	NA	0.0076
L2	Tan	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Fair	NA	ND (0.0043)
L3	Tan	Concrete	NCTS Finegayan	Interior Wall	East Facing	Fair	NA	0.3100
L4	Tan	Concrete	NCTS Finegayan	Interior Wall	South Facing, 2nd floor	Fair	NA	0.0930
L5	Gray	Concrete	NCTS Finegayan	Ground Surface	Garage	Fair	NA	ND (<0.0045)
L6	Light Brown	Concrete	NCTS Finegayan	Exterior Window Sill	South Facing	Fair	NA	ND (<0.0045)
L7	Gray	Concrete	NCTS Finegayan	Ground Surface	West Facing	Fair	NA	0.0075
L8	Tan	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Fair	NA	0.0200
L9	Light Brown	Concrete	NCTS Finegayan	Exterior Window Sill	North Facing	Fair	NA	ND (<0.0041)
L10	Tan	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Fair	NA	ND (<0.0044)
L11	Tan	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Fair	NA	ND (<0.0045)
L12	Brown	Concrete	NCTS Finegayan	Exterior Window Sill	West Facing	Fair	NA	ND (<0.0046)
L13	Tan	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Fair	NA	0.0290
L14	Brown	Concrete	NCTS Finegayan	Exterior Window Sill	East Facing	Fair	NA	ND (<0.0042)
L15	Tan	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Fair	NA	ND (<0.0046)
L16	Tan	Concrete	NCTS Finegayan	Interior Wall	North Facing	Fair	NA	0.1200
L17	Tan	Concrete	NCTS Finegayan	Interior Wall	East Facing, 2nd floor	Fair	NA	0.3700
L18	Tan	Concrete	NCTS Finegayan	Interior Wall	West Facing, 2nd floor	Fair	NA	0.0570
L19	Tan	Concrete	NCTS Finegayan	Interior Wall	South Facing	Fair	NA	0.0860
L20	Tan	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Fair	NA	ND (<0.0042)
L21	Brown	Concrete	NCTS Finegayan	Exterior Window Sill	South Facing	Fair	NA	0.0053
L22	Tan	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Fair	NA	0.0490
L23	Gray	Concrete	NCTS Finegayan	Ground Surface	West Facing	Fair	NA	0.0044
L24	Brown	Concrete	NCTS Finegayan	Exterior Window Sill	North Facing	Fair	NA	0.0041
L25	Tan	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Fair	NA	ND (<0.0047)
L26	Tan	Concrete	NCTS Finegayan	Exterior Wall	South Facing	Fair	NA	0.0240
L27	Tan	Concrete	NCTS Finegayan	Exterior Window Sill	East Facing	Fair	NA	0.0087
L28	Brown	Concrete	NCTS Finegayan	Exterior Window Sill	West Facing	Fair	NA	ND (<0.0041)
L29	Tan	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Fair	NA	ND (<0.0047)
L30	Gray	Concrete	NCTS Finegayan	Ground Surface	West Facing	Fair	NA	ND (<0.0042)
L31	Tan	Concrete	NCTS Finegayan	Interior Wall	East Facing	Fair	NA	0.0380
L32	Tan	Concrete	NCTS Finegayan	Interior Wall	South Facing	Fair	NA	0.0420
L33	Tan	Concrete	NCTS Finegayan	Interior Wall	East Facing	Fair	NA	0.1100
L34	Tan	Concrete	NCTS Finegayan	Interior Wall	North Facing	Fair	NA	0.0570
L35	Tan	Concrete	NCTS Finegayan	Interior Wall	North Facing	Fair	NA	0.0660
L36	Tan	Concrete	NCTS Finegayan	Interior Wall	West Facing	Fair	NA	0.0250
L37	Tan	Concrete	NCTS Finegayan	Interior Wall	South Facing	Fair	NA	0.0760
L38	Tan	Concrete	NCTS Finegayan	Interior Wall	West Facing	Fair	NA	0.0210
L39	Tan	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Fair	NA	ND (<0.0042)
L40	Brown	Concrete	NCTS Finegayan	Exterior Window Sill	East Facing	Fair	NA	ND (<0.0048)
L41	Tan	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Fair	NA	ND (<0.0047)
L42	Tan	Concrete	NCTS Finegayan	Exterior Wall	South Facing	Fair	NA	0.0067
L43	Gray	Concrete	NCTS Finegayan	Ground Surface	West Facing	Fair	NA	ND (<0.0043)
L44	Brown	Concrete	NCTS Finegayan	Exterior Window Sill	West Facing	Fair	NA	ND (<0.0039)
L45	Tan	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Fair	NA	0.0310
L46	Tan	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Fair	NA	0.0220
L47	Brown	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Fair	NA	0.0099

Lead-Based Sampling and Testing Results

Sample Number	Surface Color	Substrate	Building Location	Structure	Sample Location	Condition	Approximate Quantity	Lead Content (% by weight)
L48	Tan	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Fair	NA	0.0180
L49	Tan	Concrete	NCTS Finegayan	Interior Wall	South Facing	Fair	NA	0.0250
L50	Tan	Concrete	NCTS Finegayan	Interior Wall	North Facing	Fair	NA	0.0490
L51	Tan	Concrete	NCTS Finegayan	Interior Wall	East Facing	Fair	NA	0.0570
L52	Tan	Concrete	NCTS Finegayan	Interior Wall	South Facing	Fair	NA	0.0800
L53	Tan	Concrete	NCTS Finegayan	Interior Wall	West Facing	Fair	NA	0.0760
L55	Tan	Concrete	NCTS Finegayan	Interior Wall	West Facing	Fair	NA	0.0870
L56	Tan	Concrete	NCTS Finegayan	Interior Wall	North Facing	Fair	NA	0.0530
L57	Tan	Concrete	NCTS Finegayan	Interior Wall	South Facing	Fair	NA	0.0390
L58	Tan	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Fair	NA	ND (<0.0040)
L59	Gray	Concrete	NCTS Finegayan	Ground Surface	West Facing	Fair	NA	ND (<0.0040)
L60	Brown	Concrete	NCTS Finegayan	Exterior Window Sill	West Facing	Fair	NA	ND (<0.0041)
L61	Brown	Concrete	NCTS Finegayan	Exterior Window Sill	North Facing	Fair	NA	ND (<0.0045)
L62	Tan	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Fair	NA	ND (<0.0045)
L63	Brown	Concrete	NCTS Finegayan	Exterior Window Sill	South Facing	Fair	NA	ND (<0.0059)
L64	Tan	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Fair	NA	0.0100
L65	Tan	Concrete	NCTS Finegayan	Exterior Wall	South Facing	Fair	NA	ND (<0.0053)
L66	Tan	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Fair	NA	0.0390
L67	Brown	Concrete	NCTS Finegayan	Exterior Window Sill	East Facing	Fair	NA	ND (<0.0045)
L68	Black	Concrete	NCTS Finegayan	Ground Surface	East Facing	Fair	NA	ND (<0.0041)
L69	Tan	Concrete	NCTS Finegayan	Interior Wall	North Facing	Fair	NA	ND (<0.0049)
L70	Tan	Concrete	NCTS Finegayan	Interior Wall	West Facing	Fair	NA	ND (<0.0046)
L71	Tan	Concrete	NCTS Finegayan	Interior Wall	South Facing	Fair	NA	0.0400
L72	Tan	Concrete	NCTS Finegayan	Interior Wall	East Facing	Fair	NA	0.0290
L73	Tan	Concrete	NCTS Finegayan	Interior Wall	North Facing	Fair	NA	0.0500
L74	Tan	Concrete	NCTS Finegayan	Interior Wall	South Facing	Fair	NA	0.0880
L75	Tan	Concrete	NCTS Finegayan	Exterior Wall	NE Facing	Fair	NA	ND (<0.0040)
L76	Tan	Concrete	NCTS Finegayan	Exterior Wall	NW Facing	Fair	NA	ND (<0.0046)
L77	Brown	Concrete	NCTS Finegayan	Exterior Wall	NE Facing	Fair	NA	ND (<0.0041)
L78	Brown	Concrete	NCTS Finegayan	Ground Surface	NE Facing	Fair	NA	0.1300
L79	**Black**	**Concrete**	**NCTS Finegayan**	**Ground Surface**	**NE Facing**	**Fair**	**200**	**3.3000**
L80	**Yellow**	**Concrete**	**NCTS Finegayan**	**Curb**	**SE Facing**	**Fair**	**15**	**13.0000**
L81	Brown	Concrete	NCTS Finegayan	Exterior Wall	NW Facing	Fair	NA	ND (<0.0050)
L82	**Blue**	**Concrete**	**NCTS Finegayan**	**Curb**	**NW Facing**	**Fair**	**230**	**4.0000**
L83	Brown	Concrete	NCTS Finegayan	Exterior Wall	SW Facing	Fair	NA	ND (<0.0045)
L84	**Yellow**	**Concrete**	**NCTS Finegayan**	**Interior Wall**	**SW Facing**	**Fair**	**50**	**10.0000**
L85	Red	Concrete	NCTS Finegayan	Interior Wall	SW Facing	Fair	NA	0.0210
L86	White	Concrete	NCTS Finegayan	Interior Wall	NW Facing	Fair	NA	ND (<0.0048)
L87	Pink	Concrete	NCTS Finegayan	Interior Wall	NE Facing	Fair	NA	0.0790
L88	Tan	Concrete	NCTS Finegayan	Exterior Wall	South Facing	Fair	NA	ND (0.0048)
L89	Brown	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Fair	NA	ND (<0.0043)
L90	Red	Concrete	NCTS Finegayan	Interior Wall	South Facing	Fair	NA	0.1100
L91	Tan	Concrete	NCTS Finegayan	Exterior Wall	NE Facing	Fair	NA	ND (<0.0060)
L92	Brown	Concrete	NCTS Finegayan	Exterior Wall	SW Facing	Fair	NA	ND (<0.0050)
L93	**Yellow**	**Concrete**	**NCTS Finegayan**	**Canopy Support**	**South Facing**	**Fair**	**60**	**0.7800**
L94	Black	Concrete	NCTS Finegayan	Ground Surface	North Facing	Fair	NA	ND (<0.0047)
L95	Tan	Concrete	NCTS Finegayan	Exterior Wall	South Facing	Fair	NA	ND (<0.0048)
L96	Brown	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Fair	NA	ND (<0.0042)
L97	Black	Concrete	NCTS Finegayan	Ground Surface	East Facing	Fair	NA	ND (<0.0050)

Lead-Based Sampling and Testing Results

Sample Number	Surface Color	Substrate	Building Location	Structure	Sample Location	Condition	Approximate Quantity	Lead Content (% by weight)
L98	Tan	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Fair	NA	ND (<0.0051)
L99	Brown	Concrete	NCTS Finegayan	Exterior Wall	South Facing	Fair	NA	ND (<0.0050)
L100	White	Concrete	NCTS Finegayan	Curb	East Facing	Fair	NA	0.0680
L101	Black	Concrete	NCTS Finegayan	Ground Surface	North Facing	Fair	NA	0.0400
L102	Brown	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Fair	NA	ND (<0.0050)
L103	Tan	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Fair	NA	ND (<0.0044)
L104	Yellow	Concrete	NCTS Finegayan	Curb	West Facing	Fair	NA	0.0280
L105	Gray	Concrete	NCTS Finegayan	Ground Surface	Interior Floor	Fair	NA	0.0060
L106	Black	Concrete	NCTS Finegayan	Ground Surface	Exterior, West of building	Fair	NA	0.2000
L107	Tan	Concrete	NCTS Finegayan	Exterior Wall	Exterior, West of building	Fair	NA	ND (<0.0048)
L108	Yellow	Concrete	NCTS Finegayan	Ground Surface	Exterior, West of building	Fair	NA	ND (<0.0042)
L109	Brown	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Fair	NA	ND (<0.0043)
L110	White	Concrete	NCTS Finegayan	Interior Wall	East Facing	Fair	NA	ND (<0.0043)
L111	Tan	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Fair	NA	0.1700
L112	**Black**	**Concrete**	**NCTS Finegayan**	**Ground Surface**	**West Facing**	**Fair**	**200**	**5.9000**
L113	**Yellow**	**Concrete**	**NCTS Finegayan**	**Curb**	**West Facing**	**Fair**	**20**	**9.5000**
L114	**Red**	**Concrete**	**NCTS Finegayan**	**Curb**	**West Facing**	**Fair**	**250**	**3.8000**
L115	Brown	Concrete	NCTS Finegayan	Edge of Stairs	North Facing	Fair	NA	0.0290
L116	Red	Concrete	NCTS Finegayan	Interior Wall	East Facing	Fair	NA	0.2100
L117	Tan	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Fair	NA	0.0820
L118	Brown	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Fair	NA	0.4000
L119	Brown	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Fair	NA	0.0710
L120	Tan	Concrete	NCTS Finegayan	Interior Wall	South Facing	Fair	NA	ND (<0.0045)
L121	Tan	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Fair	NA	ND (<0.0048)
L122	Brown	Concrete	NCTS Finegayan	Exterior Wall	West of building, south facing column	Fair	NA	ND (<0.0044)
L123	Tan	Concrete	NCTS Finegayan	Interior Wall	North Facing, under stairs	Fair	NA	0.0660
L124	Tan	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Fair	NA	ND (<0.0041)
L125	Brown	Concrete	NCTS Finegayan	Exterior edge of stair landing	East Facing, stair landing	Fair	NA	0.0520
L126	Black	Concrete	NCTS Finegayan	Ground Surface	East Facing	Fair	NA	ND (<0.0047)
L127	Gray	Concrete	NCTS Finegayan	Exterior Stair Surface	West Facing	Fair	NA	0.0300
L128	Tan	Concrete	NCTS Finegayan	Exterior Wall	South Facing	Fair	NA	ND (<0.0043)
L129	Brown	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Fair	NA	ND (<0.0043)
L130	Black	Concrete	NCTS Finegayan	Ground Surface	Exterior Floor	Fair	NA	ND (<0.0044)
L131	Yellow	Concrete	NCTS Finegayan	Curb	North Facing	Fair	NA	0.0350
L132	Tan	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Fair	NA	0.0058
L133	Tan	Concrete	NCTS Finegayan	Exterior Wall	South Facing	Fair	NA	ND (<0.0042)
L134	**Tan**	**Concrete**	**NCTS Finegayan**	**Exterior Wall**	**South Facing**	**Fair**	**100**	**3.1000**
L135	**Brown**	**Concrete**	**NCTS Finegayan**	**Exterior wall of sampling vault**	**East Facing**	**Fair**	**25**	**1.4000**
L136	Gray	Concrete	NCTS Finegayan	Ground Surface	South Facing	Fair	NA	ND (<0.0045)
L137	Brown	Concrete	NCTS Finegayan	Exterior Window Sill	South Facing	Fair	NA	ND (<0.0046)
L138	Tan	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Fair	NA	ND (<0.0045)
L139	Tan	Concrete	Andersen Air Force Base	Exterior Wall	SW Facing	Fair	NA	ND (<0.0043)
L140	Tan	Concrete	Andersen Air Force Base	Exterior Wall	SW Facing	Fair	NA	ND (<0.0047)

Lead-Based Sampling and Testing Results

Sample Number	Surface Color	Substrate	Building Location	Structure	Sample Location	Condition	Approximate Quantity	Lead Content (% by weight)
L141	Tan	Concrete	Andersen Air Force Base	Exterior Wall	NE Facing	Fair	NA	0.0084
L142	Gray	Concrete	Andersen Air Force Base	Exterior Stair Surface	SW Facing	Fair	NA	0.0064
L143	Yellow	Concrete	Andersen Air Force Base	Exterior Wall	SW Facing	Fair	NA	ND (<0.0051)
L144	Yellow	Concrete	Andersen Air Force Base	Exterior Wall	SW Facing	Fair	NA	ND (0.0044)
L145	Tan	Concrete	Andersen Air Force Base	Exterior Wall	SW Facing	Fair	NA	ND (<0.0041)
L146	Tan	Concrete	Andersen Air Force Base	Exterior Wall	NW Facing	Fair	NA	ND (<0.0066)
L147	Tan	Concrete	Andersen Air Force Base	Exterior Wall	SW Facing	Fair	NA	ND (<0.0045)
L148	Tan	Concrete	Andersen Air Force Base	Exterior Wall	NW Facing	Fair	NA	ND (<0.0042)
L149	White	Concrete	Andersen Air Force Base	Interior Wall	NE Facing	Fair	NA	ND (<0.0044)
L150	Gray	Concrete	Andersen Air Force Base	Ground Surface	SW of building	Fair	NA	ND (<0.0045)
L151	Red	Concrete	Andersen Air Force Base	Interior Wall	NW Facing	Fair	NA	0.0660
L152	White	Concrete	Andersen Air Force Base	Ground Surface	Interior Floor	Fair	NA	ND (<0.0045)
L153	Tan	Concrete	Andersen Air Force Base	Ground Surface	SW of building	Fair	NA	ND (<0.0044)
L154	Yellow	Concrete	Andersen Air Force Base	Interior Wall	NE Facing	Fair	NA	ND (<0.0070)
L155	Blue	Concrete	Andersen Air Force Base	Interior Wall	NW Facing	Fair	NA	ND (<0.0059)
L156	Tan	Concrete	Andersen Air Force Base	Interior Wall	NE Facing	Fair	NA	ND (<0.0054)
L157	Tan	Concrete	Andersen Air Force Base	Interior Wall	NW Facing	Fair	NA	ND (<0.0044)
L158	Tan	Concrete	Andersen Air Force Base	Exterior Wall	SW Facing	Fair	NA	ND (<0.0041)
L159	Yellow	Concrete	Andersen Air Force Base	Interior Wall	SE Facing	Fair	NA	ND (<0.0044)
L160	Tan	Concrete	Andersen Air Force Base	Interior Wall	NW Facing	Fair	NA	ND (<0.0046)
L161	Tan	Concrete	Andersen Air Force Base	Exterior Wall	SW Facing	Fair	NA	ND (<0.0042)
L162	Tan	Concrete	Andersen Air Force Base	Exterior Wall	NE Facing	Fair	NA	ND (<0.0047)
L163	Tan	Concrete	Andersen Air Force Base	Exterior Wall	SW Facing	Fair	NA	0.1500
L164	Tan	Concrete	Andersen Air Force Base	Exterior Wall	NW Facing	Fair	NA	ND (<0.0046)

Lead-Based Sampling and Testing Results

Sample Number	Surface Color	Substrate	Building Location	Structure	Sample Location	Condition	Approximate Quantity	Lead Content (% by weight)
L165	Brown	Concrete	Andersen Air Force Base	Exterior Wall	South Facing	Fair	NA	ND (<0.0051)
L166	Tan	Concrete	Andersen Air Force Base	Exterior Wall	North Facing	Fair	NA	ND (<0.0047)
L167	Blue	Concrete	Andersen Air Force Base	Interior Wall	South Facing	Fair	NA	ND (<0.0048)
L168	**White**	**Concrete**	**NCTS Finegayan**	**Interior Wall**	**East Facing**	**Fair**	**10000**	**0.5400**
L169	**Red**	**Concrete**	**NCTS Finegayan**	**Interior Wall**	**NE Facing**	**Fair**	**10**	**0.8200**
L170	Black	Concrete	NCTS Finegayan	Ground Surface	West of building	Fair	NA	0.0150
L171	**Blue**	**Concrete**	**NCTS Finegayan**	**Curb**	**West of building**	**Fair**	**150**	**1.6000**
L172	**Red**	**Concrete**	**NCTS Finegayan**	**Curb**	**West of building**	**Fair**	**100**	**3.8000**
L173	Yellow	Concrete	NCTS Finegayan	Curb	West of building	Fair	NA	0.3000
L174	Tan	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Fair	NA	ND (<0.0054)
L175	Brown	Concrete	NCTS Finegayan	Exterior Wall	South Facing	Fair	NA	ND (<0.0044)
L176	Gray	Concrete	NCTS Finegayan	Ground Surface	East of building	Fair	NA	ND (<0.0050)
L177	**Yellow**	**Concrete**	**NCTS Finegayan**	**Ground Surface**	**East of building**	**Fair**	**20**	**2.4000**
L178	Tan	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Fair	NA	0.0130
L179	Yellow	Concrete	NCTS Finegayan	Curb	Parking Lot	Fair	NA	ND (<0.0045)
L180	Blue	Concrete	NCTS Finegayan	Curb	Parking Lot	Fair	NA	ND (<0.0047)
L181	Black	Concrete	NCTS Finegayan	Ground Surface	South of building	Fair	NA	ND (<0.0046)
L182	Brown	Concrete	NCTS Finegayan	Exterior Wall	South Facing	Fair	NA	ND (<0.0039)
L183	White	Concrete	NCTS Finegayan	Interior Wall	East Facing	Fair	NA	0.2200
L184	**Red**	**Concrete**	**NCTS Finegayan**	**Interior Wall**	**South Facing**	**Fair**	**10**	**0.5700**
L185	Black	Concrete	NCTS Finegayan	Ground Surface	East of building	Fair	NA	0.2400
L186	Tan	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Fair	NA	0.0150
L187	Brown	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Fair	NA	0.0061
L188	Tan	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Fair	NA	ND (<0.0043)
L189	Tan	Concrete	NCTS Finegayan	Interior Wall	West Facing	Fair	NA	ND (<0.0046)
L190	Brown	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Fair	NA	ND (<0.0045)
L191	Tan	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Fair	NA	ND (<0.0046)
L192	White	Concrete	NCTS Finegayan	Interior Wall	North Facing	Fair	NA	ND (<0.0043)
L193	White	Concrete	NCTS Finegayan	Interior Wall	East Facing	Fair	NA	0.0130
L194	Black	Concrete	NCTS Finegayan	Ground Surface	East of building	Fair	NA	ND (<0.0048)
L195	Tan	Concrete	NCTS Finegayan	Exterior Wall	South Facing	Fair	NA	0.0050
L196	Brown	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Fair	NA	ND (<0.0042)
L197	White	Concrete	NCTS Finegayan	Interior Wall	South Facing	Fair	NA	0.0910
L198	White	Concrete	NCTS Finegayan	Interior Wall	Norht Facing	Good	NA	0.0410
L199	Black	Concrete	NCTS Finegayan	Ground Surface	South Facing	Good	NA	0.0360
L200	Tan	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Good	NA	0.0170
L201	Brown	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Good	NA	ND (<0.0044)
L202	Tan	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Good	NA	ND (<0.0044)
L203	Brown	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Good	NA	ND (<0.0041)
L204	**Black**	**Concrete**	**NCTS Finegayan**	**Ground Surface**	**East Facing**	**Good**	**60**	**2.1000**
L205	White	Concrete	NCTS Finegayan	Interior Wall	East Facing	Good	NA	0.1900
L206	Red	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Good	NA	ND (<0.0076)
L207	Red	Concrete	NCTS Finegayan	Interior Wall	North Facing	Fair	NA	0.0045
L208	Brown	Concrete	NCTS Finegayan	Interior Wall	West Facing	Fair	NA	ND (<0.0042)
L209	White	Concrete	NCTS Finegayan	Interior Wall	East Facing	Fair	NA	0.0058
L210	Tan	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Fair	NA	0.0052

Lead-Based Sampling and Testing Results

Sample Number	Surface Color	Substrate	Building Location	Structure	Sample Location	Condition	Approximate Quantity	Lead Content (% by weight)
L211	Brown	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Fair	NA	ND (<0.0052)
L212	Tan	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Fair	NA	ND (<0.0047)
L213	Brown	Concrete	NCTS Finegayan	Exterior Wall	South Facing	Fair	NA	0.0053
L214	Tan	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Fair	NA	ND (<0.0044)
L215	Brown	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Fair	NA	ND (<0.0043)
L216	Black	Concrete	NCTS Finegayan	Ground Surface	East Facing	Fair	NA	ND (<0.0045)
L217	**Red**	**Concrete**	**NCTS Finegayan**	**Ground Surface**	**Interior Floor**	**Fair**	**3200**	**0.7400**
L218	**Yellow**	**Concrete**	**NCTS Finegayan**	**Interior Wall**	**Pillar in the middle of the building**	**Fair**	**100**	**5.5000**
L219	**Black**	**Concrete**	**NCTS Finegayan**	**Interior Wall**	**Pillar South of building**	**Fair**	**60**	**3.1000**
L220	**Red**	**Concrete**	**NCTS Finegayan**	**Interior Wall**	**East Facing**	**Fair**	**10**	**3.0000**
L221	White	Concrete	NCTS Finegayan	Interior Wall	East Facing	Fair	NA	0.0043
L222	Tan	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Fair	NA	ND (<0.0051)
L223	Black	Concrete	NCTS Finegayan	Ground Surface	East of building	Fair	NA	ND (<0.00452)
L224	Red	Concrete	NCTS Finegayan	Ground Surface	East of building	Fair	NA	ND (<0.0058)
L225	Brown	Concrete	NCTS Finegayan	Exterior Wall	North stair way, south Facing	Fair	NA	ND (<0.0048)
L226	Tan	Concrete	NCTS Finegayan	Interior Wall	Laundry room, north facing wall	Fair	NA	ND (<0.0053)
L227	Brown	Concrete	NCTS Finegayan	Interior Wall	North Facing	Good	NA	ND (<0.0061)
L228	Yellow	Concrete	NCTS Finegayan	Interior Wall	North Facing	Good	NA	ND (<0.0045)
L229	**Red**	**Concrete**	**NCTS Finegayan**	**Interior Wall**	**East Facing**	**Good**	**25**	**0.5000**
L230	White	Concrete	NCTS Finegayan	Interior Wall	South Facing	Good	NA	0.0015
L231	**Black**	**Concrete**	**NCTS Finegayan**	**Ground Surface**	**Staircase on the north side of the building**	**Good**	**500**	**2.4000**
L232	Tan	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Good	NA	ND (<0.0042)
L233	Brown	Concrete	NCTS Finegayan	Exterior Wall	South of the building	Good	NA	ND (<0.0049)
L234	**Yellow**	**Concrete**	**NCTS Finegayan**	**Curb**	**South of the building**	**Good**	**100**	**7.1000**
L235	Black	Concrete	NCTS Finegayan	Ground Surface	South of the building	Good	NA	0.0063
L236	Brown	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Good	NA	ND (<0.0049)
L237	Tan	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Fair	NA	ND (<0.0050)
L238	White	Concrete	NCTS Finegayan	Interior Wall	North Facing	Fair	NA	0.0240
L239	Gray	Concrete	NCTS Finegayan	Ground Surface	North side of building	Fair	NA	ND (<0.0047)
L240	**Yellow**	**Concrete**	**NCTS Finegayan**	**Ground Surface**	**North side of building**	**Fair**	**250**	**0.6500**
L241	White	Concrete	NCTS Finegayan	Interior Wall	North Facing	Fair	NA	ND (<0.0046)
L242	Black	Concrete	NCTS Finegayan	Ground Surface	West side of building	Fair	NA	ND (<0.0047)
L243	**Yellow**	**Concrete**	**NCTS Finegayan**	**Ground Surface**	**West side of building**	**Fair**	**30**	**2.7000**
L244	Tan	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Fair	NA	ND (<0.0040)
L245	Brown	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Fair	NA	ND (<0.0044)
L246	**Black**	**Concrete**	**NCTS Finegayan**	**Ground Surface**	**North side of building**	**Fair**	**2000**	**8.0000**
L247	Tan	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Fair	NA	0.0950
L248	Brown	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Fair	NA	ND (<0.0048)
L249	Tan	Concrete	NCTS Finegayan	Exterior Wall	West of building	Fair	NA	0.0660
L250	Tan	Concrete	NCTS Finegayan	Interior Wall	SE corner of building	Fair	NA	0.1300
L251	Gray	Concrete	NCTS Finegayan	Interior Wall	SE corner of mechancial room 1	Fair	NA	0.0830
L252	White	Concrete	NCTS Finegayan	Interior Wall	SE corner of mechancial room 1	Fair	NA	0.0480

Lead-Based Sampling and Testing Results

Sample Number	Surface Color	Substrate	Building Location	Structure	Sample Location	Condition	Approximate Quantity	Lead Content (% by weight)
L253	**Yellow**	**Concrete**	**NCTS Finegayan**	**Ground Surface**	**SE corner of mechancial room 1**	**Fair**	**100**	**29.0000**
L254	Red	Concrete	NCTS Finegayan	Ground Surface	East of building	Fair	NA	0.0160
L255	Tan	Concrete	NCTS Finegayan	Interior Wall	West of building	Good	NA	0.1400
L256	Black	Concrete	NCTS Finegayan	Ground Surface	West of building	Good	NA	0.0760
L257	Yellow	Concrete	NCTS Finegayan	Ground Surface	West of building	Good	NA	0.0580
L258	Tan	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Good	NA	ND (<0.0044)
L259	Brown	Concrete	NCTS Finegayan	Exterior Wall	East of building	Good	NA	ND (<0.0045)
L260	Red	Concrete	NCTS Finegayan	Curb	SE of building	Good	NA	ND (<0.0040)
L261	Black	Concrete	NCTS Finegayan	Ground Surface	SW of building	Good	NA	ND (<0.0041)
L262	Brown	Concrete	NCTS Finegayan	Exterior Wall	NW Facing	Good	NA	ND (<0.0044)
L263	Tan	Concrete	NCTS Finegayan	Exterior Wall	SE Facing	Good	NA	ND (<0.0047)
L264	Gray	Concrete	NCTS Finegayan	Ground Surface	SE of building	Good	NA	0.1000
L265	White	Concrete	NCTS Finegayan	Interior Wall	NW Facing	Fair	NA	ND (<0.0046)
L266	Light Yellow	Concrete	NCTS Finegayan	Interior Wall	NW Facing	Fair	NA	0.0410
L267	**Yellow**	**Concrete**	**NCTS Finegayan**	**Ground Surface**	**Interior Floor**	**Fair**	**200**	**1.6000**
L268	Black	Concrete	NCTS Finegayan	Ground Surface	Interior Floor	Fair	NA	0.0190
L269	Gray	Concrete	NCTS Finegayan	Interior Wall	SW Facing	Fair	NA	0.0580
L270	Red	Concrete	NCTS Finegayan	Interior Wall	SW Facing	Fair	NA	0.2100
L271	Baby Blue	Concrete	NCTS Finegayan	Interior Wall	SW Facing	Fair	NA	ND (<0.0044)
L274	White	Concrete	NCTS Finegayan	Exterior Wall	SW Facing	Fair	NA	ND (<0.0046)
L275	Black	Concrete	NCTS Finegayan	Ground Surface	NE in pavillion	Fair	NA	0.0084
L276	**Yellow**	**Concrete**	**NCTS Finegayan**	**Ground Surface**	**SE in pavillion**	**Fair**	**25**	**0.6700**
L277	**Black**	**Concrete**	**NCTS Finegayan**	**Ground Surface**	**East of building**	**Fair**	**40**	**0.6700**
L278	**Red**	**Concrete**	**NCTS Finegayan**	**Curb**	**East of building**	**Fair**	**200**	**0.7200**
L279	White	Concrete	NCTS Finegayan	Interior Wall	West Facing	Fair	NA	0.0970
L280	Tan	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Fair	NA	0.0120
L281	Brown	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Fair	NA	ND (<0.0045)
L282	Tan	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Fair	NA	ND (<0.0046)
L283	Brown	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Fair	NA	ND (<0.0043)
L284	White	Concrete	NCTS Finegayan	Interior Wall	South Facing	Fair	NA	ND (<0.0045)
L285	Tan	Concrete	NCTS Finegayan	Interior Wall	East Facing	Fair	NA	ND (<0.0041)
L286	Tan	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Fair	NA	ND (<0.0049)
L287	Brown	Concrete	NCTS Finegayan	Exterior Wall	South Facing	Fair	NA	ND (<0.0053)
L288	Tan	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Fair	NA	ND (<0.0075)
L289	Gray	Concrete	NCTS Finegayan	Ground Surface	South of building	Fair	NA	ND (<0.0046)
L290	Brown	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Fair	NA	ND (<0.0065)
L291	Tan	Concrete	NCTS Finegayan	Interior Wall	NE Facing	Fair	NA	0.0850
L292	Tan	Concrete	NCTS Finegayan	Interior Wall	North Facing	Fair	NA	ND (<0.0042)
L293	Brown	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Fair	NA	ND (<0.0041)
L294	Gray	Concrete	NCTS Finegayan	Ground Surface	East of building	Good	NA	ND (<0.0052)
L295	Tan	Concrete	NCTS Finegayan	Exterior Wall	South Facing	Good	NA	ND (<0.0048)
L296	Brown	Concrete	NCTS Finegayan	Exterior Window Sill	East Facing	Good	NA	ND (<0.0042)
L297	Gray	Concrete	NCTS Finegayan	Ground Surface	East of building	Good	NA	ND (<0.0067)
L298	Tan	Concrete	NCTS Finegayan	Interior Wall	North Facing	Good	NA	ND (<0.0047)
L299	Red	Concrete	Naval Base, Apra Harbor	Interior Wall	East Facing	Fair	NA	0.0520

Lead-Based Sampling and Testing Results

Sample Number	Surface Color	Substrate	Building Location	Structure	Sample Location	Condition	Approximate Quantity	Lead Content (% by weight)
L300	White	Concrete	Naval Base, Apra Harbor	Interior Wall	East Facing	Fair	NA	ND (<0.0045)
L301	Gray	Concrete	Naval Base, Apra Harbor	Ground Surface	NW of building	Fair	NA	ND (<0.0050)
L302	White	Concrete	Naval Base, Apra Harbor	Interior Wall	West Facing	Fair	NA	ND (<0.0058)
L303	Tan	Concrete	Naval Base, Apra Harbor	Exterior Wall	West Facing	Fair	NA	ND (<0.0048)
L304	Brown	Concrete	Naval Base, Apra Harbor	Exterior Wall	West Facing	Fair	NA	ND (<0.0051)
L305	Brown	Concrete	Naval Base, Apra Harbor	Exterior Wall	South Facing	Fair	NA	ND (<0.0048)
L306	Tan	Concrete	Naval Base, Apra Harbor	Exterior Wall	South Facing	Fair	NA	ND (<0.0040)
L307	Tan	Concrete	Naval Base, Apra Harbor	Exterior Wall	East Facing	Fair	NA	ND (<0.0047)
L308	Tan	Concrete	Naval Base, Apra Harbor	Exterior Wall	North Facing	Fair	NA	ND (<0.0041)
L309	Brown	Concrete	Naval Base, Apra Harbor	Exterior Wall	Norht Facing	Fair	NA	ND (<0.0044)
L310	Yellow	Concrete	Naval Base, Apra Harbor	Ground Surface	West of building	Fair	NA	ND (<0.0048)
L311	Black	Concrete	Naval Base, Apra Harbor	Ground Surface	West of building	Fair	NA	ND (<0.0043)
L312	White	Concrete	Naval Base, Apra Harbor	Interior Wall	South Facing	Fair	NA	ND (<0.0044)
L313	Gray	Concrete	Naval Base, Apra Harbor	Exterior Wall	West Facing	Fair	NA	ND (<0.0043)
L314	White	Concrete	Naval Base, Apra Harbor	Exterior Wall	East Facing	Fair	NA	ND (<0.0047)
L315	Blue	Concrete	Naval Base, Apra Harbor	Curb	East of building	Fair	NA	0.0240
L316	**Red**	**Concrete**	**Naval Base, Apra Harbor**	**Curb**	**East of building**	**Fair**	**500**	**1.8000**
L317	Black	Concrete	Naval Base, Apra Harbor	Ground Surface	North of building	Fair	NA	ND (<0.0047)
L318	Tan	Concrete	Naval Base, Apra Harbor	Exterior Wall	North Facing	Fair	NA	ND (<0.0048)
L319	Brown	Concrete	Naval Base, Apra Harbor	Exterior Wall	North Facing	Fair	NA	ND (<0.0044)
L320	Tan	Concrete	Naval Base, Apra Harbor	Exterior Wall	West Facing	Fair	NA	ND (<0.0045)
L321	Black	Concrete	Naval Base, Apra Harbor	Ground Surface	South of building	Fair	NA	ND (<0.0048)
L322	Brown	Concrete	Naval Base, Apra Harbor	Exterior Wall	East Facing	Fair	NA	ND (<0.0049)
L323	Red	Concrete	Naval Base, Apra Harbor	Interior Wall	South Facing	Fair	NA	ND (<0.0057)

Lead-Based Sampling and Testing Results

Sample Number	Surface Color	Substrate	Building Location	Structure	Sample Location	Condition	Approximate Quantity	Lead Content (% by weight)
L324	White	Concrete	Naval Base, Apra Harbor	Interior Wall	West Facing	Fair	NA	ND (<0.0048)
L325	Light Orange	Concrete	Naval Base, Apra Harbor	Interior Wall	East Facing	Fair	NA	ND (<0.0046)
L326	Blue	Concrete	Naval Base, Apra Harbor	Interior Wall	West Facing	Fair	NA	ND (<0.0048)
L327	Gray	Concrete	Naval Base, Apra Harbor	Ground Surface	North of men's locker room	Fair	NA	ND (<0.0047)
L328	Brown	Concrete	Naval Base, Apra Harbor	Interior Wall	West Facing	Fair	NA	ND (<0.0044)
L329	Light Brown	Concrete	Naval Base, Apra Harbor	Interior Wall	South Facing	Fair	NA	ND (<0.0054)
L330	Gray	Concrete	South Finegayan	Exterior Wall	North of building	Fair	NA	ND (<0.0044)
L331	White	Concrete	South Finegayan	Interior Wall	Garage, South Facing	Fair	NA	0.0350
L332	Brown	Concrete	South Finegayan	Exterior Wall	North Facing	Fair	NA	ND (0.0062)
L333	Tan	Concrete	South Finegayan	Exterior Wall	North Facing	Fair	NA	ND (<0.0041)
L334	Tan	Concrete	South Finegayan	Exterior Wall	Garage, South Facing	Fair	NA	ND (<0.0048)
L335	Brown	Concrete	South Finegayan	Exterior Wall	Norht Facing	Fair	NA	ND (<0.0045)
L336	White	Concrete	South Finegayan	Interior Wall	West Facing	Fair	NA	ND (0.0045)
L337	Gray	Concrete	South Finegayan	Ground Surface	West of building	Fair	NA	ND (<0.0045)
L338	Gray	Concrete	South Finegayan	Ground Surface	East of building	Fair	NA	ND (<0.0071)
L339	White	Concrete	South Finegayan	Interior Wall	Bedroom, East Facing	Good	NA	0.0560
L340	Tan	Concrete	South Finegayan	Exterior Wall	South Facing	Good	NA	ND (<0.0043)
L341	Brown	Concrete	South Finegayan	Exterior Wall	North Facing	Good	NA	ND (<0.0042)
L342	Brown	Concrete	South Finegayan	Ground Surface	West of building	Good	NA	ND (<0.0054)
L343	White	Concrete	South Finegayan	Interior Wall	West Facing	Good	NA	0.0320
L344	Tan	Concrete	South Finegayan	Exterior Wall	North Facing	Good	NA	ND (<0.0046)
L345	White	Concrete	South Finegayan	Interior Wall	Bedroom, South Facing	Good	NA	0.0350
L346	Gray	Concrete	South Finegayan	Ground Surface	West of building	Good	NA	ND (<0.0063)
L347	Tan	Concrete	South Finegayan	Exterior Wall	South Facing	Good	NA	ND (<0.0045)
L348	Brown	Concrete	South Finegayan	Exterior Wall	East Facing	Good	NA	ND (<0.0044)
L349	White	Concrete	South Finegayan	Interior Wall	East Facing	Good	NA	0.0250
L350	Gray	Concrete	South Finegayan	Ground Surface	East of building	Good	NA	ND (<0.0066)
L351	Tan	Concrete	South Finegayan	Exterior Wall	North Facing	Good	NA	ND (<0.0039)
L352	Brown	Concrete	South Finegayan	Exterior Wall	West Facing	Good	NA	ND (<0.0046)
L353	Gray	Concrete	South Finegayan	Ground Surface	North of building	Good	NA	ND (<0.0040)
L354	White	Concrete	South Finegayan	Interior Wall	South Facing	Good	NA	0.0170
L355	Tan	Concrete	South Finegayan	Exterior Wall	East Facing	Good	NA	ND (<0.0045)
L356	Brown	Concrete	South Finegayan	Exterior Wall	South Facing	Good	NA	ND (<0.0045)
L357	White	Concrete	South Finegayan	Interior Wall	South Facing	Good	NA	0.0460
L358	Brown	Concrete	South Finegayan	Exterior Wall	South Facing	Good	NA	ND (<0.0053)
L359	Tan	Concrete	South Finegayan	Exterior Wall	North Facing	Good	NA	ND (<0.0049)
L360	Tan	Concrete	South Finegayan	Exterior Wall	East Facing	Good	NA	ND (<0.0043)
L361	White	Concrete	South Finegayan	Interior Wall	Living room, West Facing	Good	NA	0.0230
L362	Brown	Concrete	South Finegayan	Exterior Wall	West Facing	Good	NA	ND (<0.0044)
L363	Gray	Concrete	South Finegayan	Ground Surface	SW of building	Good	NA	ND (<0.0049)
L364	White	Concrete	South Finegayan	Interior Wall	SW Facing	Good	NA	ND (<0.0045)
L365	Tan	Concrete	South Finegayan	Exterior Wall	NW Facing	Good	NA	ND (<0.0047)
L366	Brown	Concrete	South Finegayan	Exterior Wall	NE Facing	Good	NA	ND (<0.0040)

Lead-Based Sampling and Testing Results

Sample Number	Surface Color	Substrate	Building Location	Structure	Sample Location	Condition	Approximate Quantity	Lead Content (% by weight)
L367	Brown	Concrete	NCTS Finegayan	Interior Wall	Lounge, East Facing	Good	NA	ND (<0.0049)
L368	Tan	Concrete	NCTS Finegayan	Interior Wall	Lounge,West Facing	Good	NA	ND (<0.0044)
L369	**Yellow**	**Concrete**	**NCTS Finegayan**	**Exterior Wall**	**North Facing**	**Good**	**100**	**5.4000**
L370	Brown	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Good	NA	0.0046
L371	Tan	Concrete	NCTS Finegayan	Exterior Wall	South Facing	Good	NA	0.0240
L372	Black	Concrete	NCTS Finegayan	Ground Surface	South of building	Good	NA	0.0130
L373	Tan	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Good	NA	ND (<0.0044)
L374	Yellow	Concrete	NCTS Finegayan	Curb	North of building	Good	NA	ND (<0.0098)
L375	Tan	Concrete	NCTS Finegayan	Interior Wall	South Facing	Good	NA	ND (<0.0043)
L376	Brown	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Good	NA	ND (<0.0044)
L377	Black	Concrete	NCTS Finegayan	Ground Surface	South of bus stop	Good	NA	0.0140
L378	Red	Concrete	NCTS Finegayan	Ground Surface	South Corner	Fair	NA	0.0160
L379	Green	Concrete	NCTS Finegayan	Ground Surface	Southern area of middle court	Fair	NA	0.4300
L380	White	Concrete	NCTS Finegayan	Ground Surface	Northern area of west court	Fair	NA	0.0310
L381	Red	Concrete	NCTS Finegayan	Ground Surface	Northern area between west and middle courts	Good	NA	0.0059
L382	Tan	Concrete	NCTS Finegayan	Exterior Wall	NW Facing	Good	NA	ND (<0.0042)
L383	Brown	Concrete	NCTS Finegayan	Exterior Wall	SE Facing	Good	NA	ND (<0.0046)
L384	Tan	Concrete	NCTS Finegayan	Exterior Wall	SW Facing	Good	NA	ND (<0.0044)
L385	Brown	Concrete	NCTS Finegayan	Exterior Wall	NW Facing	Good	NA	ND (<0.0042)
L386	Tan	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Good	NA	ND (<0.0045)
L387	Black	Concrete	NCTS Finegayan	Ground Surface	Staircase on the north side of the building	Good	NA	ND (<0.0059)
L388	Brown	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Good	NA	0.0110
L389	White	Concrete	NCTS Finegayan	Interior Wall	East Facing	Good	NA	0.3100
L390	Tan	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Good	NA	0.0850
L391	Gray	Concrete	NCTS Finegayan	Ground Surface	South of building	Good	NA	ND (<0.0042)
L392	Brown	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Good	NA	0.1200
L393	Black	Concrete	NCTS Finegayan	Ground Surface	West of building	Good	NA	ND (<0.0045)
L394	Tan	Concrete	NCTS Finegayan	Exterior Wall	South Facing	Good	NA	ND (<0.0044)
L395	Brown	Concrete	NCTS Finegayan	Exterior Wall	North Facing	Good	NA	ND (<0.0047)
L396	Tan	Concrete	NCTS Finegayan	Pavillion	Ceiling	Good	NA	0.0071
L397	Tan	Concrete	NCTS Finegayan	Interior Wall	East Facing	Fair	NA	ND (<0.0046)
L398	Blue	Concrete	NCTS Finegayan	Interior Wall	West Facing	Fair	NA	ND (<0.0053)
L399	Light Green	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Fair	NA	ND (<0.0046)
L400	Green	Concrete	NCTS Finegayan	Exterior Wall	East Facing	Fair	NA	ND (<0.0046)
L401	Dark Orange	Concrete	NCTS Finegayan	Exterior Wall	West Facing	Fair	NA	0.0056
L402	Light Orange	Concrete	NCTS Finegayan	Interior Wall	SW of building	Fair	NA	ND (0.0045)
L403	Purple	Concrete	NCTS Finegayan	Mini Golf Shelter	Bench	Fair	NA	0.0044
L404	Pink	Concrete	NCTS Finegayan	Exterior Wall	SW Facing	Fair	NA	ND (<0.0044)
L405	Yellow	Concrete	NCTS Finegayan	Mini Golf Hole #14	NW Facing	Fair	NA	ND (<0.0044)
L406	Tan	Concrete	South Finegayan	Exterior Wall	West Facing	Poor	NA	0.0110
L407	Tan	Concrete	South Finegayan	Exterior Wall	West Facing	Poor	NA	ND (<0.0043)

Lead-Based Sampling and Testing Results

Sample Number	Surface Color	Substrate	Building Location	Structure	Sample Location	Condition	Approximate Quantity	Lead Content (% by weight)
L408	Light Green	Concrete	South Finegayan	Interior Wall	East Facing	Poor	NA	ND (<0.0043)
L409	Tan	Concrete	South Finegayan	Exterior Wall	South Facing	Poor	NA	ND (<0.0044)
L410	White	Concrete	South Finegayan	Ground Surface	North Facing	Poor	NA	ND (<0.0041)
L411	Red	Concrete	South Finegayan	Ground Surface	South of west court	Good	NA	0.0099
L412	Green	Concrete	South Finegayan	Ground Surface	West of middle court	Good	NA	ND (<0.0042)
L413	White	Concrete	South Finegayan	Ground Surface	East court	Good	NA	ND (<0.0043)
L414	Red	Concrete	South Finegayan	Ground Surface	Between east and middle court	Good	NA	0.0046
L415	Green	Concrete	South Finegayan	Exterior Wall	South Facing	Good	NA	ND (<0.0040)
L416	Gray	Concrete	South Finegayan	Ground Surface	West of building	Good	NA	ND (<0.0042)
L417	Brown	Concrete	South Finegayan	Exterior Wall	West Facing	Good	NA	ND (<0.0049)
L418	**Brown**	**Concrete**	**South Finegayan**	**Exterior Wall**	**South Facing**	**Good**	**250**	**0.6100**
L419	Tan	Concrete	South Finegayan	Exterior Wall	West Facing	Good	NA	0.0075
L420	Black	Concrete	South Finegayan	Ground Surface	West of building	Good	NA	ND (<0.0053)
L421	Tan	Concrete	South Finegayan	Exterior Wall	North Facing	Good	NA	0.0130
L422	Red	Concrete	South Finegayan	Curb	West of building	Good	NA	0.3200
L423	Yellow	Concrete	South Finegayan	Curb	West of building	Good	NA	0.0460
L424	Brown	Concrete	South Finegayan	Exterior Wall	South side of building, west facing	Good	NA	0.0330
L425	Red	Concrete	South Finegayan	Ground Surface	SE corner of basketball court	Good	NA	ND (<0.0047)
L426	White	Concrete	South Finegayan	Ground Surface	Top of the key, east side of basketball court	Good	NA	ND (<0.0042)
L427	Green	Concrete	South Finegayan	Ground Surface	Middle of the basketball court	Good	NA	ND (<0.0041)
L428	White	Concrete	South Finegayan	Interior Wall	South Facing	Good	NA	0.0260
L429	Gray	Concrete	South Finegayan	Ground Surface	West of building	Good	NA	ND (<0.0048)
L430	Tan	Concrete	South Finegayan	Exterior Wall	South Facing	Good	NA	ND (<0.0043)
L431	Brown	Concrete	South Finegayan	Exterior Wall	East Facing	Good	NA	ND (<0.0044)
L432	Gray	Concrete	South Finegayan	Ground Surface	West of building	Good	NA	ND (<0.0089)
L433	Brown	Concrete	South Finegayan	Exterior Wall	East Facing	Good	NA	ND (<0.0049)
L434	Tan	Concrete	South Finegayan	Exterior Wall	East Facing	Good	NA	ND (<0.0042)
L435	White	Concrete	South Finegayan	Interior Wall	North Facing	Good	NA	ND (<0.0046)
L436	Gray	Concrete	South Finegayan	Ground Surface	North of building	Good	NA	ND (<0.0059)
L437	Tan	Concrete	South Finegayan	Exterior Wall	South Facing	Good	NA	ND (<0.0044)
L438	Brown	Concrete	South Finegayan	Exterior Wall	West Facing	Good	NA	ND (<).0044)
L439	White	Concrete	South Finegayan	Interior Wall	South Facing	Good	NA	0.0680
L440	Brown	Concrete	South Finegayan	Exterior Wall	South Facing	Good	NA	ND (<0.0041)
L441	Gray	Concrete	South Finegayan	Ground Surface	South of building	Good	NA	ND (<0.0046)
L442	Tan	Concrete	South Finegayan	Exterior Wall	North Facing	Good	NA	ND (<0.0041)
L443	White	Concrete	South Finegayan	Exterior Wall	South Facing	Good	NA	ND (<0.0045)
L444	Gray	Concrete	South Finegayan	Ground Surface	East of building	Good	NA	ND (<0.0042)
L445	Tan	Concrete	South Finegayan	Exterior Wall	South Facing	Good	NA	ND (<0.0046)
L446	Brown	Concrete	South Finegayan	Exterior Wall	West Facing	Good	NA	ND (<0.0046)
L447	White	Concrete	South Finegayan	Interior Wall	South Facing	Good	NA	0.0390
L448	Tan	Concrete	South Finegayan	Exterior Wall	West Facing	Good	NA	ND (<0.0045)
L449	Gray	Concrete	South Finegayan	Ground Surface	North of building	Good	NA	ND (<0.0046)
L450	Brown	Concrete	South Finegayan	Exterior Wall	West Facing	Good	NA	ND (<0.0045)

Lead-Based Sampling and Testing Results

Sample Number	Surface Color	Substrate	Building Location	Structure	Sample Location	Condition	Approximate Quantity	Lead Content (% by weight)
L451	White	Concrete	South Finegayan	Interior Wall	South Facing	Good	NA	0.0530
L452	Brown	Concrete	South Finegayan	Exterior Wall	East Facing	Good	NA	ND (<0.0046)
L453	Tan	Concrete	South Finegayan	Exterior Wall	West Facing	Good	NA	ND (<0.0046)
L454	Gray	Concrete	South Finegayan	Ground Surface	Exterior Floor	Good	NA	ND (<0.0046)
L455	White	Concrete	South Finegayan	Interior Wall	NW Facing	Good	NA	0.0420
L456	Tan	Concrete	South Finegayan	Exterior Wall	NE Facing	Good	NA	ND (<0.0046)
L457	Gray	Concrete	South Finegayan	Ground Surface	NE of building	Good	NA	ND (<0.0068)
L458	Brown	Concrete	South Finegayan	Exterior Wall	SE Facing	Good	NA	ND (<0.0050)
L459	White	Concrete	South Finegayan	Interior Wall	East Facing	Good	NA	0.0180
L460	Gray	Concrete	South Finegayan	Ground Surface	West of building	Good	NA	ND (<0.0050)
L461	Tan	Concrete	South Finegayan	Exterior Wall	South Facing	Good	NA	ND (<0.0046)
L462	Brown	Concrete	South Finegayan	Exterior Wall	East Facing	Good	NA	ND (<0.0039)
L463	White	Concrete	South Finegayan	Interior Wall	West Facing	Good	NA	0.0460
L464	Tan	Concrete	South Finegayan	Ground Surface	South Facing	Good	NA	ND (<0.0053)
L465	Gray	Concrete	South Finegayan	Ground Surface	North of building	Good	NA	ND (<0.0096)
L466	Brown	Concrete	South Finegayan	Exterior Wall	East Facing	Good	NA	ND (<0.0049)
L467	White	Concrete	South Finegayan	Interior Wall	East Facing	Good	NA	0.0130
L468	Tan	Concrete	South Finegayan	Exterior Wall	East Facing	Good	NA	ND (<0.0042)
L469	Brown	Concrete	South Finegayan	Exterior Wall	South Facing	Good	NA	ND (<0.0047)
L470	Gray	Concrete	South Finegayan	Ground Surface	Exterior Floor	Good	NA	ND (<0.0043)

Notes:
% = percent
Boldface = concentration detected above the EPA lead-based paint criterion of 0.5% lead by weight
NA - not applicable
NCTS = Naval Computer and Telecommunications Station
ND (<0.0001) = not detected above reporting limit of 0.0001% or 1 mg/kg
sf = square feet

Appendix C

Coconut Rhinoceros Beetle Management Procedures

Coconut Rhinoceros Beetles (CRB) Management Procedures

GENERAL PREVENTATIVE & MAINTENANCE PROCEDURES

1) The Contractor's Hazard Analysis and Critical Control Point (HACCP) Plan will include CRB.
2) The Contractor will maintain a clean worksite to the maximum extent possible and subject to review of the Biological Monitor. Debris left on site that is not mulched or managed properly could facilitate infestations of CRB and other species.

GENERAL CLEARING APPROVALS

1) The Contractor shall notify the Construction Management Engineer (CME) *at least two weeks prior to* scheduled vegetation removal. No vegetation removal / clearing will be conducted without prior government approval. Prior to vegetation removal the Government (Govt) Biological Monitor will visually inspect the area for evidence of CRB infestation (i.e. vegetation damage and/or breeding sites).

AREAS IDENTIFIED WITH CRB INFESTATION

1) The Govt will identify and clearly mark specific areas within the vegetation that show evidence of CRB infestation. The Contractor will manage the CRB infested vegetation/material separately from all other green waste. All CRB infested vegetation/material will be mulched immediately after removal. The mulching area utilized for the CRB infested vegetation/material will be a separate area from non-CRB infested vegetation. This is to prevent potential spread of CRB into other vegetation waste piles.

2) The Contractor will provide for the proper fumigation services for all CRB infested mulch material as approved by the Govt. Fumigation should occur within one month of infested vegetation removal.

3) After fumigation is completed (~26 HOUR PROCESS), the fumigated mulched material will be inspected by the Govt Biological Monitor. Upon approval by the Govt, the fumigated mulched material will be reused on site or delivered to the Govt approved facility as soon as the fumigation process has been completed. Alternatively, upon approval by the Govt, the fumigated material can remain stored on site but MUST be sealed to prevent re-infestation and left sealed until it is ready to be reused on site or delivered to the Govt approved facility.

AREAS INDENTIFIED WITH NO EVIDENCE OF CRB INFESTATION

PALM WASTE

1) The Govt will identify and clearly mark all palm vegetation. All palm vegetation will be managed separately from other non-infested vegetation. All palm vegetation will be mulched and inspected for CRB infestation by the Govt. Upon approval by the Govt, the mulched palm material will be reused on site or delivered to the Govt approved facility. Palm material should be handled separately because it is the host material for the CRB

so the potential for infestation is greater. In the event the palm waste pile becomes infested during processing it should be fumigated following the same procedures as for infested vegetation/material.

NON-PALM WASTE

2) Upon approval by the Govt, non-infested vegetation/material can be removed/cleared. All non-infested vegetation/material will be managed separately from the CRB infested green waste and palm waste. All non-infested vegetation/material will be mulched and reused on site or delivered to the Govt approved facility.

REMOVAL OF NON-INFESTED VEGETATION/MATERIAL OFF-SITE

1) In the event, any non-infested vegetation needs to be moved off-site from NCTS Finegayan (CRB quarantine area) an inspection by Guam Dept of Agriculture will be required prior to removal. The Contractor shall notify the Govt at least 1 week prior to removal.

PERFORMANCE STANDARD

1) Ensure that CRB infested vegetation/material is mulched, fumigated, inspected and approved as CRB free and reused on site or delivered to the Govt approved facility within the specified time frames.

2) Ensure that all non-infested palm vegetation/material is mulched and inspected prior to reusing or delivering to the Govt approved facility.

3) Ensure that all other (non-palm) non-infested material is mulched and reused on site or delivered to the Govt approved facility.

Appendix D

Construction and Demolition Debris Quantities

NCTS Finegayan - Construction Quantities

HDR | Hawaii Pacific Engineers, Inc.
1132 Bishop Street, Suite 1003
Honolulu, HI 96813-2830
Phone: (808) 697-6200 Fax: (808) 697-6201

Project: Construction and Demolition Debris Diversion
Job No.: 2009017
Date: 12 February 2010
Prepared by: SK Checked by:

NCTS Finegayan
Construction Quantities by Weight

NR = Non-Residential
R = Residential

Type	Building/Facility	Building Footprint (sf)	Construction Waste Generated (tons)	Wood Generated (tons)	Gypsum Board Generated (tons)	Scrap Metal Generated (tons)	Plastics Generated (tons)	Concrete Generated (tons)	Glass Generated (tons)	Cardboard Generated (tons)	Miscellaneous Waste Generated (tons)
NR	Brig	18,719	49	20	11	1	1	0	0	5	11
NR	Rehab Center	22,617	59	24	14	1	1	0	0	6	13
NR	Kennel	5,101	13	5	3	0	0	0	0	1	3
NR	CRSP Warehouse	198,051	518	208	119	13	13	0	0	50	116
NR	Haz Flam Storage	1,226	3	1	1	0	0	0	0	0	1
NR	Paint & Other Related Ops Facility	35,202	92	37	21	2	2	0	0	9	21
NR	9th ESB Vehicle Garage	22,624	59	24	14	1	1	0	0	6	13
NR	9th ESB Auto Shop	17,905	47	19	11	1	1	0	0	4	10
NR	Haz Flam Storage	3,090	8	3	2	0	0	0	0	1	2
NR	9th ESB Elec Comm Shop	7,666	20	8	5	0	0	0	0	2	4
NR	Wood Working Shop	6,544	17	7	4	0	0	0	0	2	4
NR	9th ESB Headquarters	11,513	30	12	7	1	1	0	0	3	7
NR	9th ESB BN Warehouse	202,771	530	213	122	13	13	0	0	51	119
NR	Gas Chamber	4,692	12	5	3	0	0	0	0	1	3
NR	Photographic Building	14,023	37	15	8	1	1	0	0	4	8
NR	AV SIM Trainer	47,888	125	50	29	3	3	0	0	12	28
NR	Mistic Op Trainer	22,363	58	23	13	1	1	0	0	6	13
NR	Motor Vehicle Trainer	14,410	38	15	9	1	1	0	0	4	8
NR	Combat Trn Tank	16,098	42	17	10	1	1	0	0	4	9
NR	Indoor Arms Range	12,317	32	13	7	1	1	0	0	3	7
NR	3D MED BN WHSE/Storage	31,733	83	33	19	2	2	0	0	8	19
NR	PMO TMO Storage	118,896	311	125	71	8	8	0	0	30	70
NR	Base DSSA Warehouse	157,614	412	165	95	10	10	0	0	39	92
NR	MCB Storage	199,076	521	209	119	13	13	0	0	50	116
NR	MLG Warehouse	180,987	473	190	109	12	12	0	0	45	106
NR	Haz Flam Storage	2,423	6	3	1	0	0	0	0	1	1
NR	CLR-37 Field Maintenance Shop/Whse	56,981	149	60	34	4	4	0	0	14	33
NR	CLR-37 Auto Shop	18,369	48	19	11	1	1	0	0	5	11
NR	CLR-37 Elec-Comm Shop	39,763	104	42	24	3	3	0	0	10	23
NR	MLG Armory	10,977	29	12	7	1	1	0	0	3	6
NR	CLR-35 Auto Shop	17,889	47	19	11	1	1	0	0	4	10
NR	CLR-35 Field Maintenance Shop	96,617	253	101	58	6	6	0	0	24	57
NR	CLC Organic Storage	29,316	77	31	18	2	2	0	0	7	17
NR	CLC Elec Shop	7,089	19	7	4	0	0	0	0	2	4
NR	CLC Auto Shop	3,423	9	4	2	0	0	0	0	1	2
NR	Haz Flam Storage	382	1	0	0	0	0	0	0	0	0

NCTS Finegayan - Construction Quantities

Type	Building/Facility	Building Footprint (sf)	Construction Waste Generated (tons)	Wood Generated (tons)	Gypsum Board Generated (tons)	Scrap Metal Generated (tons)	Plastics Generated (tons)	Concrete Generated (tons)	Glass Generated (tons)	Cardboard Generated (tons)	Miscellaneous Waste Generated (tons)
NR	III MEF MP CO HQ	24,926	65	26	15	2	2	0	0	6	15
NR	MHG Auto Shop	13,441	35	14	8	1	1	0	0	3	8
NR	III MEF Organic Storage	37,076	97	39	22	2	2	0	0	9	22
NR	5th Elec Comm Shop	3,183	8	3	2	0	0	0	0	1	2
NR	5th Anglico HQ	23,032	60	24	14	1	1	0	0	6	13
NR	7th Comm CO HQ	17,683	46	19	11	1	1	0	0	4	10
NR	7th Comm Elec-Comm Shop	8,221	21	9	5	1	1	0	0	2	5
NR	III MEF	2,791	7	3	2	0	0	0	0	1	2
NR	7th Comm Auto Shop	10,300	27	11	6	1	1	0	0	3	6
NR	3rd Truck Co Auto Shop	7,566	20	8	5	0	0	0	0	2	4
NR	3rd Intel BN CO HQ	25,459	67	27	15	2	2	0	0	6	15
NR	3rd Intel Elec Comm Shop	3,096	8	3	2	0	0	0	0	1	2
NR	MARDIV CO HQ	25,627	67	27	15	2	2	0	0	6	15
NR	Division Elec Comm Shop	11,188	29	12	7	1	1	0	0	3	7
NR	Division Armory	8,513	22	9	5	1	1	0	0	2	5
NR	MARDIV HQ CO Auto Shop	12,044	31	13	7	1	1	0	0	3	7
NR	Division Organic Storage	32,488	85	34	19	2	2	0	0	8	19
NR	Organic Storage	3,186	8	3	2	0	0	0	0	1	2
NR	Division Haz Flam	5,163	14	5	3	0	0	0	0	1	3
NR	3rd Region Parachute Loft	13,189	34	14	8	1	1	0	0	3	8
NR	3rd RECON CO HQ	28,041	73	29	17	2	2	0	0	7	16
NR	3rd RECON Auto Shop	3,004	8	3	2	0	0	0	0	1	2
NR	12th REGT HQ	16,291	43	17	10	1	1	0	0	4	10
NR	12th REGT Elec Comm Shop	6,153	16	6	4	0	0	0	0	2	4
NR	12th REGT Heavy Gun Shop	11,231	29	12	7	1	1	0	0	3	7
NR	12th REGT Auto Shop	10,407	27	11	6	1	1	0	0	3	6
NR	III MEF Armory	8,475	22	9	5	1	1	0	0	2	5
NR	5th Anglico Auto Shop	6,050	16	6	4	0	0	0	0	2	4
NR	Central Issue Facility	42,060	110	44	25	3	3	0	0	11	25
NR	Recycling Center	17,218	45	18	10	1	1	0	0	4	10
NR	Exchange Warehouse & Maint Facility	19,663	51	21	12	1	1	0	0	5	12
NR	General Storage Shed	18,359	48	19	11	1	1	0	0	5	11
NR	Facilities & Env Eng Office	6,667	17	7	4	0	0	0	0	2	4
NR	MWR Auto Skills Center	20,700	54	22	12	1	1	0	0	5	12
NR	Public Works Facility	74,666	195	78	45	5	5	0	0	19	44
NR	Vehicle Holding Shed	5,492	14	6	3	0	0	0	0	1	3
NR	Base Auto Shop	24,986	65	26	15	2	2	0	0	6	15
NR	Org Storage Building	7,289	19	8	4	0	0	0	0	2	4
NR	Oil Storage Building	1,899	5	2	1	0	0	0	0	0	1
NR	Technical Equipment Maintenance Facility	46,666	122	49	28	3	3	0	0	12	27

NCTS Finegayan - Construction Quantities

Type	Building/Facility	Building Footprint (sf)	Construction Waste Generated (tons)	Wood Generated (tons)	Gypsum Board Generated (tons)	Scrap Metal Generated (tons)	Plastics Generated (tons)	Concrete Generated (tons)	Glass Generated (tons)	Cardboard Generated (tons)	Miscellaneous Waste Generated (tons)
NR	Company Operations Facility Readiness/COF Admin/Battalion HQ	60,538	158	64	36	4	4	0	0	15	35
NR	MLG HQ	25,412	66	27	15	2	2	0	0	6	15
NR	3rd MED BN Surgical COHO	12,099	32	13	7	1	1	0	0	3	7
NR	CLR-37 CO HQ	27,742	73	29	17	2	2	0	0	7	16
NR	Location Gas Station	1,976	5	2	1	0	0	0	0	0	1
NR	Location Exchange	9,751	25	10	6	1	1	0	0	2	6
NR	Enlisted Dining Facility	43,957	115	46	26	3	3	0	0	11	26
NR	MAW HQ	22,534	59	24	14	1	1	0	0	6	13
NR	MAW GRP SQDN HQ	25,234	66	26	15	2	2	0	0	6	15
NR	MAW Armory	4,904	13	5	3	0	0	0	0	1	3
NR	MAW Elec Comm Shop	9,048	24	10	5	1	1	0	0	2	5
NR	MAW Organic Storage	26,958	70	28	16	2	2	0	0	7	16
NR	MAW Auto Shop	22,473	59	24	13	1	1	0	0	6	13
NR	Transient BN HQ	15,076	39	16	9	1	1	0	0	4	9
NR	Transient Armory	5,885	15	6	4	0	0	0	0	1	3
NR	Transient BN Auto Shop	14,334	37	15	9	1	1	0	0	4	8
NR	Transient BN Organic Storage	66,477	174	70	40	4	4	0	0	17	39
NR	Transient Heavy Gun Shop	10,572	28	11	6	1	1	0	0	3	6
NR	Transient BN Elec-Comm Shop	11,817	31	12	7	1	1	0	0	3	7
NR	Storage	1,501	4	2	1	0	0	0	0	0	1
NR	Proposed Substation	37,405	98	39	22	2	2	0	0	9	22
NR	Comm Center	11,104	29	12	7	1	1	0	0	3	6
NR	Welcome Center & Marine & Family Support Center	16,669	44	18	10	1	1	0	0	4	10
NR	Office	2,799	7	3	2	0	0	0	0	1	2
NR	Building function was not legible on development map	24,327	64	26	15	2	2	0	0	6	14
NR	MCCS Office	19,060	50	20	11	1	1	0	0	5	11
NR	Legal Services Facility	7,979	21	8	5	1	1	0	0	2	5
NR	Security (Police) Building	29,459	77	31	18	2	2	0	0	7	17
NR	Commissary	88,336	231	93	53	6	6	0	0	22	52
NR	Exchange	109,367	286	115	66	7	7	0	0	27	64
NR	Fast Food	4,410	12	5	3	0	0	0	0	1	3
NR	Auto Parts Store	5,625	15	6	3	0	0	0	0	1	3
NR	Main Service Station	3,827	10	4	2	0	0	0	0	1	2
NR	Car Wash	2,664	7	3	2	0	0	0	0	1	2
NR	Theater w/restaurant and ticket office	23,466	61	25	14	2	2	0	0	6	14
NR	Bowling Alley, Skating Rink, Restaurant, Thrift Shop	40,976	107	43	25	3	3	0	0	10	24
NR	Bank, Restaurant, Package Store, Credit Union	36,353	95	38	22	2	2	0	0	9	21
NR	Pool Bath House	8,376	22	9	5	1	1	0	0	2	5
NR	Indoor Fitness Center	29,815	78	31	18	2	2	0	0	7	17

NCTS Finegayan - Construction Quantities

Type	Building/Facility	Building Footprint (sf)	Construction Waste Generated (tons)	Wood Generated (tons)	Gypsum Board Generated (tons)	Scrap Metal Generated (tons)	Plastics Generated (tons)	Concrete Generated (tons)	Glass Generated (tons)	Cardboard Generated (tons)	Miscellaneous Waste Generated (tons)
NR	Rec Center	12,814	34	13	8	1	1	0	0	3	7
NR	Enlisted Dining Facility	41,736	109	44	25	3	3	0	0	10	24
NR	Base HQ	38,530	101	40	23	3	3	0	0	10	23
NR	Location Exchange	10,738	28	11	6	1	1	0	0	3	6
NR	Division HQ	19,580	51	21	12	1	1	0	0	5	11
NR	MAGTF OP Trainer	41,650	109	44	25	3	3	0	0	10	24
NR	III MEF HQ	35,073	92	37	21	2	2	0	0	9	21
NR	Indoor Fitness Center	30,123	79	32	18	2	2	0	0	8	18
NR	Pool Bath House	8,226	22	9	5	1	1	0	0	2	5
NR	MWR Supply	8,756	23	9	5	1	1	0	0	2	5
NR	Medical & Dental Clinic	58,680	153	62	35	4	4	0	0	15	34
NR	RMF Library & Ed Center	37,920	99	40	23	2	2	0	0	9	22
NR	Band Auditorium	31,522	82	33	19	2	2	0	0	8	18
NR	Conference Center	14,992	39	16	9	1	1	0	0	4	9
NR	All Hands Club	21,229	56	22	13	1	1	0	0	5	12
NR	Elec Bldg	1,696	4	2	1	0	0	0	0	0	1
R	BEQ 100 Unit	35,275	92	37	21	2	2	0	0	9	21
R	BEQ 100 Unit	35,275	92	37	21	2	2	0	0	9	21
R	BEQ 100 Unit	35,275	92	37	21	2	2	0	0	9	21
R	BEQ 100 Unit	35,275	92	37	21	2	2	0	0	9	21
R	BEQ 100 Unit	35,275	92	37	21	2	2	0	0	9	21
R	BEQ 100 Unit	35,275	92	37	21	2	2	0	0	9	21
NR	Small Bldg	997	3	1	1	0	0	0	0	0	1
R	BEQ 200 Unit	59,078	154	62	35	4	4	0	0	15	35
NR	Small Bldg	2,364	6	2	1	0	0	0	0	1	1
R	BEQ 200 Unit	59,078	154	62	35	4	4	0	0	15	35
R	BEQ 200 Unit	59,078	154	62	35	4	4	0	0	15	35
NR	Small Bldg	1,112	3	1	1	0	0	0	0	0	1
R	BEQ 200 Unit	59,078	154	62	35	4	4	0	0	15	35
R	BEQ 200 Unit	59,078	154	62	35	4	4	0	0	15	35
R	BEQ 200 Unit	59,078	154	62	35	4	4	0	0	15	35
R	BEQ 200 Unit	59,078	154	62	35	4	4	0	0	15	35
NR	Small Bldg	2,500	7	3	2	0	0	0	0	1	1
NR	Small Bldg	2,319	6	2	1	0	0	0	0	1	1
R	BEQ 200 Unit	59,078	154	62	35	4	4	0	0	15	35
R	BEQ 200 Unit	59,078	154	62	35	4	4	0	0	15	35
R	BEQ 200 Unit	59,078	154	62	35	4	4	0	0	15	35
NR	Small Bldg	1,090	3	1	1	0	0	0	0	0	1
NR	Small Bldg	875	2	1	1	0	0	0	0	0	1
R	BEQ 200 Unit	59,078	154	62	35	4	4	0	0	15	35
NR	Small Bldg	1,978	5	2	1	0	0	0	0	0	1
R	BEQ 100 Unit	35,275	92	37	21	2	2	0	0	9	21
R	BEQ 200 Unit	59,078	154	62	35	4	4	0	0	15	35

NCTS Finegayan - Construction Quantities

Type	Building/Facility	Building Footprint (sf)	Construction Waste Generated (tons)	Wood Generated (tons)	Gypsum Board Generated (tons)	Scrap Metal Generated (tons)	Plastics Generated (tons)	Concrete Generated (tons)	Glass Generated (tons)	Cardboard Generated (tons)	Miscellaneous Waste Generated (tons)
R	BEQ 200 Unit	59,078	154	62	35	4	4	0	0	15	35
R	BEQ 200 Unit	59,078	154	62	35	4	4	0	0	15	35
R	BEQ 200 Unit	59,078	154	62	35	4	4	0	0	15	35
NR	Small Bldg	2,381	6	2	1	0	0	0	0	1	1
NR	Small Bldg	1,303	3	1	1	0	0	0	0	0	1
NR	Small Bldg	1,273	3	1	1	0	0	0	0	0	1
R	BEQ 200 Unit	59,078	154	62	35	4	4	0	0	15	35
R	BEQ 200 Unit	59,078	154	62	35	4	4	0	0	15	35
R	BEQ 200 Unit	59,078	154	62	35	4	4	0	0	15	35
R	BEQ 100 Unit	35,275	92	37	21	2	2	0	0	9	21
NR	Small Bldg	1,185	3	1	1	0	0	0	0	0	1
NR	Small Bldg	937	2	1	1	0	0	0	0	0	1
NR	Small Bldg	2,597	7	3	2	0	0	0	0	1	2
R	Temporary Lodging Facility	74,059	194	78	44	5	5	0	0	19	43
R	BEQ 200 Unit	59,140	155	62	35	4	4	0	0	15	35
R	BEQ 200 Unit	59,140	155	62	35	4	4	0	0	15	35
R	BEQ 200 Unit	59,140	155	62	35	4	4	0	0	15	35
R	BEQ 200 Unit	59,140	155	62	35	4	4	0	0	15	35
R	BEQ 200 Unit	59,140	155	62	35	4	4	0	0	15	35
	Total		**14,099**	5,661	3,235	350	350	0	0	1,348	3,154

Note: Building footprint areas were taken from development map, all buildings are assumed to be one story except for BEQs/BOQs and duplex housing
Assumption: BEQ and Duplex Housing were assumed to be 2 story buildings with area twice the footprint

Summary

Material	**Weight (tons)**
Wood	5,661
Gypsum Board	3,235
Scrap Metal	350
Plastics/PVC	350
Concrete	0
Glass	0
Cardboard	1,348
Misc. Waste	3,154
TOTAL	14,099

Former FAA Parcel - Construction Quantities

HDR | Hawaii Pacific Engineers, Inc.
1132 Bishop Street, Suite 1003
Honolulu, HI 96813-2830
Phone: (808) 697-6200 Fax: (808) 697-6201

Project: Construction and Demolition Debris Diversion
Job No.: 2009017
Date: 5 May 2010
Prepared by: SK Checked by:

Former FAA Parcel
Construction Quantities by Weight

NR = Non-Residential
R = Residential

Type	Building/Facility	Building Footprint (sf)	Construction Waste Generated (tons)	Wood Generated (tons)	Gypsum Board Generated (tons)	Scrap Metal Generated (tons)	Plastics Generated (tons)	Concrete Generated (tons)	Glass Generated (tons)	Cardboard Generated (tons)	Miscellaneous Waste Generated (tons)
R	O5-O7 Single Family	1,424,412	3,725	1,496	855	93	93	0	0	356	833
R	O1-O3 W2 Duplex	4,687,056	12,257	4,921	2,812	305	305	0	0	1,172	2,742
R	O-5-O7 Single Family	278,784	729	293	167	18	18	0	0	70	163
R	O4 Duplex	3,397,680	8,885	3,568	2,039	221	221	0	0	849	1,988
R	O-5-O7 Single Family	121,968	319	128	73	8	8	0	0	30	71
R	E6-E8 Duplex/4-plex	5,532,120	14,466	5,809	3,319	360	360	0	0	1,383	3,236
R	E1-E5 4/6 Plex	2,787,840	7,290	2,927	1,673	181	181	0	0	697	1,631
R	E1-E5 Duplex 4-Plex	10,707,048	27,999	11,242	6,424	696	696	0	0	2,677	6,264
R	O1-O3 W2 Duplex	4,582,512	11,983	4,812	2,750	298	298	0	0	1,146	2,681
NR	Religious Ministry Facility/Youth Center	326,700	854	343	196	21	21	0	0	82	191
NR	Middle School	657,756	1,720	691	395	43	43	0	0	164	385
NR	Village Center	426,888	1,116	448	256	28	28	0	0	107	250
NR	Religious Ministry Facility	169,884	444	178	102	11	11	0	0	42	99
NR	CDC	283,140	740	297	170	18	18	0	0	71	166
NR	Primary School	522,720	1,367	549	314	34	34	0	0	131	306
NR	Primary School	522,720	1,367	549	314	34	34	0	0	131	306
NR	CDC	278,784	729	293	167	18	18	0	0	70	163
NR	Intermediate School	553,212	1,447	581	332	36	36	0	0	138	324
NR	High School	718,740	1,880	755	431	47	47	0	0	180	420
	Total		**99,318**	39,879	22,788	2,469	2,469	0	0	9,495	22,218

Note: Building footprint areas were taken from development map, all buildings are assumed to be one story except for BEQs/BOQs and duplex housing
Assumption: BEQ and Duplex Housing were assumed to be 2 story buildings with area twice the footprint

Summary

Material	Weight (tons)
Wood	39,879
Gypsum Board	22,788
Scrap Metal	2,469
Plastics/PVC	2,469
Concrete	0
Glass	0
Cardboard	9,495
Misc. Waste	22,218
TOTAL	99,318

South Finegayan - Construction Quantities

HDR | Hawaii Pacific Engineers, Inc.
1132 Bishop Street, Suite 1003
Honolulu, HI 96813-2830
Phone: (808) 697-6200 Fax: (808) 697-6201

Project: Construction and Demolition Debris Diversion
Job No.: 2009017
Date: 27 January 2010
Prepared by: SK Checked by:

South Finegayan
Construction Quantities by Weight

NR = Non-Residential
R = Residential

Type	Building/Facility	Building Footprint (sf)	Construction Waste Generated (tons)	Wood Generated (tons)	Gypsum Board Generated (tons)	Scrap Metal Generated (tons)	Plastics Generated (tons)	Concrete Generated (tons)	Glass Generated (tons)	Cardboard Generated (tons)	Miscellaneous Waste Generated (tons)
R	E9 Duplex	1,280,664	3,349	1,345	768	83	83	0	0	320	749
R	O1-O3 W2 Duplex	906,048	2,369	951	544	59	59	0	0	227	530
R	E6-E8 Duplex/4-Plex	5,445,000	14,239	5,717	3,267	354	354	0	0	1,361	3,185
R	E6-E8 Duplex/4-Plex	1,428,768	3,736	1,500	857	93	93	0	0	357	836
R	E9 Duplex	2,134,440	5,582	2,241	1,281	139	139	0	0	534	1,249
R	E1-E5 Duplex/4-Plex	8,067,312	21,096	8,471	4,840	524	524	0	0	2,017	4,719
NR	CDC	317,988	832	334	191	21	21	0	0	79	186
NR	Primary School	522,720	1,367	549	314	34	34	0	0	131	306
NR	Youth Center	566,280	1,481	595	340	37	37	0	0	142	331
	Total		**54,050**	21,703	12,402	1,343	1,343	0	0	5,167	12,091

Note: Building footprint areas were taken from development map, all buildings are assumed to be one story except for BEQs/BOQs and duplex housing
Assumption: BEQ and Duplex Housing were assumed to be 2 story buildings with area twice the footprint

Summary

Material	**Weight (tons)**
Wood	21,703
Gypsum Board	12,402
Scrap Metal	1,343
Plastics/PVC	1,343
Concrete	0
Glass	0
Cardboard	5,167
Misc. Waste	12,091
TOTAL	54,050

Andersen Air Force Base - Construction Quantities

HDR | Hawaii Pacific Engineers, Inc.
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Project: Construction and Demolition Debris Diversion
Job No.: 2009017
Date: 27 January 2010
Prepared by: SK Checked by:

Andersen Air Force Base
Quantities by Weight

NR = Non-Residential
R = Residential

Type	Building/Facility	Building Footprint (sf)	Construction Waste Generated (tons)	Wood Generated (tons)	Gypsum Board Generated (tons)	Scrap Metal Generated (tons)	Plastics Generated (tons)	Concrete Generated (tons)	Glass Generated (tons)	Cardboard Generated (tons)	Miscellaneous Waste Generated (tons)
NR	Organizational Vehicle Parking	273,833	716	288	164	18	18	0	0	68	160
NR	Organic Unit Storage	30,122	79	32	18	2	2	0	0	8	18
NR	Engine Test Cell	1,181	3	1	1	0	0	0	0	0	1
NR	MWSS-172 Auto Shop	20,562	54	22	12	1	1	0	0	5	12
NR	MSSS-172 Electronic Communicatior	4,094	11	4	2	0	0	0	0	1	2
NR	Flightline Small Arms Armory	584	2	1	0	0	0	0	0	0	0
NR	Non-organizational vehicle parking	193,263	505	203	116	13	13	0	0	48	113
NR	Organizational Vehicle Parking	168,598	441	177	101	11	11	0	0	42	99
NR	Aviation Trainer Facility	36,015	94	38	22	2	2	0	0	9	21
NR	Corrision Control Hangar	19,413	51	20	12	1	1	0	0	5	11
NR	VMM Hangar #1 and #2	113,386	297	119	68	7	7	0	0	28	66
NR	Non-organizational vehicle parking	118,867	311	125	71	8	8	0	0	30	70
NR	Aircraft Wash Rack	25,701	67	27	15	2	2	0	0	6	15
NR	Aircraft Operations Building	9,712	25	10	6	1	1	0	0	2	6
NR	HMH & HMLA Hangar	55,452	145	58	33	4	4	0	0	14	32
NR	MALS Hangar	55,439	145	58	33	4	4	0	0	14	32
NR	Organizational Vehicle Parking	114,253	299	120	69	7	7	0	0	29	67
NR	Non-organizational vehicle parking	47,866	125	50	29	3	3	0	0	12	28
NR	Non-organizational vehicle parking	75,974	199	80	46	5	5	0	0	19	44
NR	MCAF HQ	20,660	54	22	12	1	1	0	0	5	12
NR	Dining Facility/Fitness Center	24,711	65	26	15	2	2	0	0	6	14
NR	GSE Shed, GSE Shop	15,075	39	16	9	1	1	0	0	4	9
NR	MALS Spares/Stores Warehouse	35,771	94	38	21	2	2	0	0	9	21
NR	USMC EOD Facility	8,403	22	9	5	1	1	0	0	2	5
NR	AF EOD Facility	16,111	42	17	10	1	1	0	0	4	9
			3,883	1,559	891	97	97	0	0	371	869

Note: Building footprint areas were taken from development map, all buildings are assumed to be one story except for BEQs/BOQs and duplex housing

Andersen Air Force Base - Construction Quantities

Summary

Material	Weight (tons)
Wood	1,559
Gypsum Board	891
Scrap Metal	97
Plastics/PVC	97
Concrete	0
Glass	0
Cardboard	371
Misc. Waste	869
TOTAL	3,883

Naval Base, Apra Harbor - Construction Quantities

HDR | Hawaii Pacific Engineers, Inc.
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Honolulu, HI 96813-2830
Phone: (808) 697-6200 Fax: (808) 697-6201

Project: Construction and Demolition Debris Diversion
Job No.: 2009017
Date: 27 January 2010
Prepared by: SK Checked by:

Naval Base, Apra Harbor
Quantities by Weight

NR = Non-Residential
R = Residential

Type	Building/Facility	Building Footprint (sf)	Construction Waste Generated (tons)	Gypsum Board Generated (tons)	Scrap Metal Generated (tons)	Plastics Generated (tons)	Concrete Generated (tons)	Glass Generated (tons)	Cardboard Generated (tons)	Misc. Waste Generated (tons)
NR	Port Operations Group Facility	31,531	82	19	2	2	0	0	8	18
NR	P-1008 USMC Embarkation Ops	17,680	46	11	1	1	0	0	4	10
NR	P-1003 Relocate Military Working Dogs	31,153	81	19	2	2	0	0	8	18
NR	P-564 NECC Consolidation	77,401	202	46	5	5	0	0	19	45
NR	P-583 CNV Capable Wharf	32,651	85	20	2	2	0	0	8	19
NR	P-528 Torpedo Exercise Support Facility	7,761	20	5	1	1	0	0	2	5
NR	P-465 Consolidated SLC and CSS-15 Facility	29,291	77	18	2	2	0	0	7	17
NR	Expand ERF	11,951	31	7	1	1	0	0	3	7
NR	P-1002 USCG Berthing & Crew Support	10,638	28	6	1	1	0	0	3	6
NR	MCH-006 Apra Harbor Medical Clinic	43,516	114	26	3	3	0	0	11	25
NR	P-564 NECC Consolidation	80,784	211	48	5	5	0	0	20	47
	Total		979	225	24	24	0	0	94	219

Note: Building footprint areas were taken from development map, all buildings are assumed to be one story except for BEQs/BOQs and duplex housing

Summary

Material	**Weight (tons)**
Wood	393
Gypsum Board	225
Scrap Metal	24
Plastics/PVC	24
Concrete	0
Glass	0
Cardboard	94
Misc. Waste	219
TOTAL	979

Construction Generation Rates

HDR | Hawaii Pacific Engineers, Inc.
1132 Bishop Street, Suite 1003
Honolulu, HI 96813-2830
Phone: (808) 697-6200 Fax: (808) 697-6201

Project: Construction and Demolition Debris Diversion
Job No.: 2009017
Date: 1 March 2010
Prepared by: SK Checked by:

Description	Code	Total Generation Rate (lb/sf)	Wood (lb/sf)	Drywall (lb/sf)	Metals (lb/sf)	Plastics (lb/sf)	Masonry/ Concrete (lb/sf)	Glass (lb/sf)	Cardboard (lb/sf)	Miscellaneous (lb/sf)
Non-Residential Construction	NR	5.23	2.10	1.20	0.13	0.13	0.00	0.00	0.50	1.17
Residential Construction	R	5.23	2.10	1.20	0.13	0.13	0.00	0.00	0.50	1.17
Percent of total		100%	40%	23%	2%	2%	0%	0%	10%	22%

Notes:
Rates are based on typical waste generation rates from the National Association of Homebuilders for typical residential construction
Wood Generation is estimated to be on the higher end of the spectrum due to Guam construction using wood forms for concrete buildings
Residential and Non-residential construction is expected to be very similar in Guam, therefore rates are the same for both types of construction
Plastics are estimated from total waste generated in other wastes (total other wastes = 1.3 lb/sf)
Masonry/Concrete are estimated to be used during construction without any debris remaining

NCTS Finegayan - Demolition Quantities

HDR | Hawaii Pacific Engineers, Inc.
1132 Bishop Street, Suite 1003
Honolulu, HI 96813-2830
Phone: (808) 697-6200 Fax: (808) 697-6201

Project: Construction and Demolition Debris Diversion
Job No.: 2009017
Date: 1 March 2010
Prepared by: SK Checked by:

NCTS FINEGAYAN

Bldg. No.	Building	Building Category	Building Floor Area	Concrete w/LBP tons	Concrete w/o LBP tons	Glass tons	Wood tons	Scrap Metal tons	Gypsum Wall Board tons	Plastic plumbing (sewer) tons	Reinf. Steel tons	Bathroom Fixtures tons	Misc. tons
122	NCTS Add. Facilites (Meal Hall)	C	20,450	247	3,281	11	14	5	5	3	128	1	
131	BEQ NCTS (Barracks)	B	5,040	78	791	2	2	2	10	1	31	1	
	single story building connected to barracks	C	366	4	59	0	0	0	0	0	2	0	
132	BEQ NCTS (Barracks)	B	5,040	78	791	2	2	2	10	1	31	1	
	single story building connected to barracks	C	366	4	59	0	0	0	0	0	2	0	
133	BEQ NCTS (Barracks)	B	5,040	78	791	2	2	2	10	1	31	1	
	single story building connected to barracks	C	366	4	59	0	0	0	0	0	2	0	
134	BEQ NCTS (Barracks)	B	5,040	78	791	2	2	2	10	1	31	1	
	single story building connected to barracks	C	366	4	59	0	0	0	0	0	2	0	
142	Elevated Water Storage Tank (not concrete)	C	0	0	0	0	0	7	0	0	0	0	
143	Water treatment facility	C	236	3	38	0	0	0	0	0	1	0	
144	Water storage tank	C	874	11	140	0	0	0	0	0	5	0	
159	Softball field with two story announcer building and 2 dugouts	C	950	11	152	0	0	0	0	0	6	0	
159B	Tennis courts w/fence and lights	C	18,840	33	438	0	0	0	0	0	17	1	
161	Men and women's restroom facility	C	225	3	36	0	0	0	0	0	1	0	
162	Flagpole in front of 111 (not concrete)	C	0	0	0	0	0	0	0	0	0	0	
168	Power/Maintenance Building next to BOQ	C	1,666	20	267	1	1	0	0	0	10	0	
	BBQ Pavilion next to BOQ	C	540	7	87	0	0	0	0	0	3	0	
170	Officer's Mess (closed)	C	6,777	82	1,087	4	5	2	2	1	42	0	
C-173	Family Housing (two story duplex)	A	4,700	0	952	1	5	3	2	1	34	1	
C-174	Family Housing (one story abandoned duplex)	A	4,840	0	980	1	5	3	2	1	35	1	
C-175	Family Housing (two story duplex)	A	4,700	0	952	1	5	3	2	1	34	1	
C-176	Family Housing (one story abandoned duplex)	A	4,840	0	980	1	5	3	2	1	35	1	
C-177	Family Housing (two story duplex)	A	4,700	0	952	1	5	3	2	1	34	1	
C-181	Family Housing (two story duplex)	A	4,700	0	952	1	5	3	2	1	34	1	
C-183	Family Housing (two story duplex)	A	4,700	0	952	1	5	3	2	1	34	1	
C-185	Family Housing (two story duplex)	A	4,700	0	952	1	5	3	2	1	34	1	
C-187	Family Housing (two story duplex)	A	4,700	0	952	1	5	3	2	1	34	1	
C-188	Family Housing (two story duplex)	A	4,700	0	952	1	5	3	2	1	34	1	
C-189	Family Housing (two story duplex)	A	4,700	0	952	1	5	3	2	1	34	1	
C-190	Family Housing (two story duplex)	A	4,700	0	952	1	5	3	2	1	34	1	
C-191	Family Housing (single story duplex)	A	5,660	0	1,146	1	6	3	3	1	41	1	
C-192	Family Housing (two story duplex)	A	4,700	0	952	1	5	3	2	1	34	1	
C-193	Family Housing (single story duplex)	A	5,660	0	1,146	1	6	3	3	1	41	1	
C-194	Family Housing (single story duplex)	A	5,660	0	1,146	1	6	3	3	1	41	1	
C-195	Family Housing (single story duplex)	A	5,660	0	1,146	1	6	3	3	1	41	1	
C-196	Family Housing (single story duplex)	A	5,660	0	1,146	1	6	3	3	1	41	1	
C-197	Family Housing (single story house)	A	3,583	0	726	1	4	2	2	1	26	0	
C-198	Family Housing (single story house)	A	2,560	0	518	1	3	1	1	1	18	0	

NCTS Finegayan - Demolition Quantities

HDR | Hawaii Pacific Engineers, Inc.
1132 Bishop Street, Suite 1003
Honolulu, HI 96813-2830
Phone: (808) 697-6200 Fax: (808) 697-6201

Project: Construction and Demolition Debris Diversion
Job No.: 2009017
Date: 1 March 2010
Prepared by: SK Checked by:

NCTS FINEGAYAN

Bldg. No.	Building	Building Category	Building Floor Area	Concrete w/LBP tons	Concrete w/o LBP tons	Glass tons	Wood tons	Scrap Metal tons	Gypsum Wall Board tons	Plastic plumbing (sewer) tons	Reinf. Steel tons	Bathroom Fixtures tons	Misc. tons
C-199	Family Housing (single story house, duplex)	A	3,525	0	714	1	4	2	2	1	25	0	
C-200	Family Housing (single story house, duplex)	A	3,525	0	714	1	4	2	2	1	25	0	
C-201	Family Housing (single story house, duplex)	A	3,525	0	714	1	4	2	2	1	25	0	
C-202	Family Housing (single story house, duplex)	A	3,510	0	711	1	4	2	2	1	25	0	
C-203	Family Housing (single story house, duplex)	A	3,510	0	711	1	4	2	2	1	25	0	
C-204	Family Housing (single story house, duplex)	A	3,510	0	711	1	4	2	2	1	25	0	
C-205	Family Housing (single story house, duplex)	A	3,510	0	711	1	4	2	2	1	25	0	
C-206	Family Housing (single story house, duplex)	A	3,510	0	711	1	4	2	2	1	25	0	
C-207	Family Housing (single story house, duplex)	A	3,525	0	714	1	4	2	2	1	25	0	
C-208	Family Housing (single story house, duplex)	A	3,525	0	714	1	4	2	2	1	25	0	
C-209	Family Housing (single story house, duplex)	A	3,525	0	714	1	4	2	2	1	25	0	
C-210	Family Housing (single story house, duplex)	A	3,525	0	714	1	4	2	2	1	25	0	
C-212	Family Housing (single story house, duplex)	A	3,525	0	714	1	4	2	2	1	25	0	
204	Storage building near 200	C	1,615	20	259	1	1	0	0	0	10	0	
205	Swimming Pool with attached building	C	1,260	15	202	1	1	0	0	0	8	0	
206	NEX	C	20,000	242	3,209	10	14	4	5	3	125	1	
207	Barber's shop/empty (originally a library and education center)	C	3,886	47	623	2	3	1	1	1	24	0	
208	Chapel	C	4,408	53	707	2	3	1	1	1	28	0	
228	Enlisted Men's Barracks	B	17,430	271	2,736	8	6	8	35	3	106	2	
230	BOQ	B	11,013	171	1,729	5	4	5	22	2	67	1	
281	Sentry House	C	292	4	47	0	0	0	0	0	2	0	
291	Sentry Hut	C	20	0	3	0	0	0	0	0	0	0	
292	Sentry Gate House	C	392	5	63	0	0	0	0	0	2	0	
292A	NCTAMS Security	C	1,600	19	257	1	1	0	0	0	10	0	
295	Single story office building	B	1,810	28	284	1	1	1	4	0	11	0	
299	Building attached to 200	C	690	8	111	0	0	0	0	0	4	0	
302	gas pumps (roofing over gas pumps)	C	628	8	101	0	0	0	0	0	4	0	
303	AUTOPORT gas station mini mart	C	1,405	17	225	1	1	0	0	0	9	0	

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Job No.: 2009017
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Prepared by: SK Checked by:

NCTS FINEGAYAN

Bldg. No.	Building	Building Category	Building Floor Area	Concrete w/LBP tons	Concrete w/o LBP tons	Glass tons	Wood tons	Scrap Metal tons	Gypsum Wall Board tons	Plastic plumbing (sewer) tons	Reinf. Steel tons	Bathroom Fixtures tons	Misc. tons
305	Office building	B	1,615	25	254	1	1	1	3	0	10	0	
335	Storage facility near 200	C	1,550	19	249	1	1	0	0	0	10	0	
	Power station building near 200 (x 2)	C	108	1	17	0	0	0	0	0	1	0	
337	Hobby Shop replacement (unsure of current use) - 2 story high	C	13,200	159	2,118	7	9	3	3	2	83	1	
387	Bus stop (x 2)	C	520	6	83	0	0	0	0	0	3	0	
458	Firing range shelter	C	540	7	87	0	0	0	0	0	3	0	
491	Pavilion with storage	C	30	0	5	0	0	0	0	0	0	0	
495	Pump building for swimming pool	C	1,550	19	249	1	1	0	0	0	10	0	
498	BBQ pavilion outside of pool	C	540	7	87	0	0	0	0	0	3	0	
587	Water treatment facility	C	2,420	29	388	1	2	1	1	0	15	0	
	Bus stop	C	260	3	42	0	0	0	0	0	2	0	
None	Storage area for sentry	C	90	1	14	0	0	0	0	0	1	0	
160/287	Mini golf course buildings	C	100	1	16	0	0	0	0	0	1	0	
	picnic pavilions (4)	C	400	5	64	0	0	0	0	0	3	0	
	75 Circular Antenna arrays (metal, not concrete)		0	0	0	0	0	38	0	0	0	0	
Unit 224/226	2 story duplex not shown on map, but located in field	A	2,750	0	557	1	3	2	1	1	20	0	
Unit 218/220	2 story duplex not shown on map, but located in field	A	2,750	0	557	1	3	2	1	1	20	0	
Unit 212/214	2 story duplex not shown on map, but located in field	A	2,750	0	557	1	3	2	1	1	20	0	
Unit 208/210	2 story duplex not shown on map, but located in field	A	2,750	0	557	1	3	2	1	1	20	0	
Unit 202/204	2 story duplex not shown on map, but located in field	A	2,750	0	557	1	3	2	1	1	20	0	
Unit 201/203	2 story duplex not shown on map, but located in field	A	2,750	0	557	1	3	2	1	1	20	0	
Unit 205/207	2 story duplex not shown on map, but located in field	A	2,750	0	557	1	3	2	1	1	20	0	
Unit 209/211	2 story duplex not shown on map, but located in field	A	2,750	0	557	1	3	2	1	1	20	0	
Unit 215/217	2 story duplex not shown on map, but located in field	A	2,750	0	557	1	3	2	1	1	20	0	

NCTS Finegayan - Demolition Quantities

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Project: Construction and Demolition Debris Diversion
Job No.: 2009017
Date: 1 March 2010
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NCTS FINEGAYAN

Bldg. No.	Building	Building Category	Building Floor Area	Concrete w/LBP tons	Concrete w/o LBP tons	Glass tons	Wood tons	Scrap Metal tons	Gypsum Wall Board tons	Plastic plumbing (sewer) tons	Reinf. Steel tons	Bathroom Fixtures tons	Misc. tons
Unit 221/223	2 story duplex not shown on map, but located in field	A	2,750	0	557	1	3	2	1	1	20	0	
2	Playgrounds		12,000	0	300	0	0	0	0	0	4	0	
	TOTAL (TONS)			**1,936**	**57,690**	**108**	**256**	**182**	**212**	**57**	**2,118**	**29**	**632**

ONSITE DEMOLITION MATERIALS	Weight (tons)	Volume (CY)
Concrete		
w/LBP	0	
w/o LBP	21,045	
Wood (treated)	147	
Miscellaneous Scrap Metal	1,027	3,423
PVC	235	199
VCP	83	
Asphalt	25,314	
TOTAL	47,850	

Former FAA Parcel - Demolition Quantities

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Date: 5 May 2010
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FORMER FAA PARCEL

ONSITE DEMOLITION MATERIALS	Weight (tons)
Concrete	
w/LBP	0
w/o LBP	5,937
Wood (treated)	21
Miscellaneous Scrap Metal	0
PVC	40
VCP	0
Asphalt	0
TOTAL	5,998

South Finegayan - Demolition Quantities

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Project: Construction and Demolition Debris Diversion
Job No.: 2009017
Date: 1 March 2010
Prepared by: SK Checked by:

SOUTH FINEGAYAN

Bldg. No.	Building	Building Category	Building Floor Area (sf)	Concrete w/LBP	Concrete w/o LBP	Glass	Wood	Scrap Metal	Gypsum Wall Board	Plastic Plumbing (sewer)	Reinf. Steel	Bathroom Fixtures	Misc.
				tons	tons	tons	tons	tons	tons	tons	tons	tons	tons
845	Community Center	C	4,066	49	652	2	3	1	1	1	25	0.2	
846	Bus stop	C	260	3	42	0	0	0	0	0	2	0.0	
847	Bus stop	C	260	3	42	0	0	0	0	0	2	0.0	
848	Bus stop	C	260	3	42	0	0	0	0	0	2	0.0	
	Self Help Warehouse (corrugated metal	C	16,000	42	558	8	11	4	4	2	22	0.7	
A717	Family Housing - 4-Plex	A	6,432	0	1,302	1	7	4	3	1	46	0.7	
A718	Family Housing - 4-Plex	A	6,432	0	1,302	1	7	4	3	1	46	0.7	
A719	Family Housing - 4-Plex	A	6,432	0	1,302	1	7	4	3	1	46	0.7	
A720	Family Housing - 4-Plex	A	6,432	0	1,302	1	7	4	3	1	46	0.7	
A721	Family Housing - 4-Plex	A	6,432	0	1,302	1	7	4	3	1	46	0.7	
A722	Family Housing - 4-Plex	A	9,648	0	1,954	2	10	5	5	2	69	1.1	
A723	Family Housing - 4-Plex	A	9,648	0	1,954	2	10	5	5	2	69	1.1	
A724	Family Housing - 4-Plex	A	6,432	0	1,302	1	7	4	3	1	46	0.7	
A726	Family Housing - 4-Plex	A	9,648	0	1,954	2	10	5	5	2	69	1.1	
A727	Family Housing - 4-Plex	A	6,432	0	1,302	1	7	4	3	1	46	0.7	
A729	Family Housing - 4-Plex	A	9,648	0	1,954	2	10	5	5	2	69	1.1	
A730	Family Housing - 4-Plex	A	6,432	0	1,302	1	7	4	3	1	46	0.7	
A731	Family Housing - 4-Plex	A	9,648	0	1,954	2	10	5	5	2	69	1.1	
A732	Family Housing - 4-Plex	A	6,432	0	1,302	1	7	4	3	1	46	0.7	
A733	Family Housing - 4-Plex	A	6,432	0	1,302	1	7	4	3	1	46	0.7	
A734	Family Housing - 6-Plex	A	9,648	0	1,954	2	10	5	5	2	69	1.1	
A736	Family Housing - 4-Plex	A	6,432	0	1,302	1	7	4	3	1	46	0.7	
A737	Family Housing - 6-Plex	A	9,648	0	1,954	2	10	5	5	2	69	1.1	
A738	Family Housing - 6-Plex	A	9,648	0	1,954	2	10	5	5	2	69	1.1	
A739	Family Housing - 4-Plex	A	6,432	0	1,302	1	7	4	3	1	46	0.7	
A740	Family Housing - 6-Plex	A	9,648	0	1,954	2	10	5	5	2	69	1.1	
A1225	Family Housing	A	2,024	0	410	0	2	1	1	0	15	0.2	
A1226	Family Housing	A	2,024	0	410	0	2	1	1	0	15	0.2	
A1227	Family Housing	A	2,024	0	410	0	2	1	1	0	15	0.2	
A1228	Family Housing	A	2,024	0	410	0	2	1	1	0	15	0.2	
A1229	Family Housing	A	2,024	0	410	0	2	1	1	0	15	0.2	
A1230	Family Housing	A	2,024	0	410	0	2	1	1	0	15	0.2	
A1231	Family Housing	A	2,024	0	410	0	2	1	1	0	15	0.2	
A1232	Family Housing	A	2,024	0	410	0	2	1	1	0	15	0.2	
A1233	Family Housing	A	2,024	0	410	0	2	1	1	0	15	0.2	
A1234	Family Housing	A	2,024	0	410	0	2	1	1	0	15	0.2	
A1235	Family Housing	A	2,024	0	410	0	2	1	1	0	15	0.2	

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Job No.: 2009017
Date: 1 March 2010
Prepared by: SK Checked by:

SOUTH FINEGAYAN

Bldg. No.	Building	Building Category	Building Floor Area (sf)	Concrete w/LBP tons	Concrete w/o LBP tons	Glass tons	Wood tons	Scrap Metal tons	Gypsum Wall Board tons	Plastic Plumbing (sewer) tons	Reinf. Steel tons	Bathroom Fixtures tons	Misc. tons
A1236	Family Housing	A	2,024	0	410	0	2	1	1	0	15	0.2	
A1237	Family Housing	A	2,024	0	410	0	2	1	1	0	15	0.2	
A1238	Family Housing	A	2,024	0	410	0	2	1	1	0	15	0.2	
A1239	Family Housing	A	2,024	0	410	0	2	1	1	0	15	0.2	
A1240	Family Housing	A	2,024	0	410	0	2	1	1	0	15	0.2	
A1253	Family Housing	A	4,934	0	999	1	5	3	2	1	35	0.5	
A1254	Family Housing	A	4,934	0	999	1	5	3	2	1	35	0.5	
A1255	Family Housing	A	4,934	0	999	1	5	3	2	1	35	0.5	
A1260	Family Housing	A	4,934	0	999	1	5	3	2	1	35	0.5	
A1261	Family Housing	A	4,934	0	999	1	5	3	2	1	35	0.5	
A1262	Family Housing	A	4,934	0	999	1	5	3	2	1	35	0.5	
A1263	Family Housing	A	4,934	0	999	1	5	3	2	1	35	0.5	
A1264	Family Housing	A	4,934	0	999	1	5	3	2	1	35	0.5	
A1265	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1266	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1267	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1268	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1269	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1270	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1271	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1272	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1273	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1274	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1275	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1276	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1277	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1278	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1279	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1280	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1281	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1282	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1283	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1284	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1285	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1286	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1287	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1288	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1289	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1290	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	

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SOUTH FINEGAYAN

Bldg. No.	Building	Building Category	Building Floor Area (sf)	Concrete w/LBP tons	Concrete w/o LBP tons	Glass tons	Wood tons	Scrap Metal tons	Gypsum Wall Board tons	Plastic Plumbing (sewer) tons	Reinf. Steel tons	Bathroom Fixtures tons	Misc. tons
A1291	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1292	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1293	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1294	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1295	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1296	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1297	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1298	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1299	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1300	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1301	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1302	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1303	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1304	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1305	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1306	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1307	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1308	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1309	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1310	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1311	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1312	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1313	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1314	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1315	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1316	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1317	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1318	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1319	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1320	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1321	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1322	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1323	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1324	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1325	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1326	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1327	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1328	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1329	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	

South Finegayan - Demolition Quantities

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Project: Construction and Demolition Debris Diversion
Job No.: 2009017
Date: 1 March 2010
Prepared by: SK Checked by:

SOUTH FINEGAYAN

Bldg. No.	Building	Building Category	Building Floor Area (sf)	Concrete w/LBP tons	Concrete w/o LBP tons	Glass tons	Wood tons	Scrap Metal tons	Gypsum Wall Board tons	Plastic Plumbing (sewer) tons	Reinf. Steel tons	Bathroom Fixtures tons	Misc. tons
A1330	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1331	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1332	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1333	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1334	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1335	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1336	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1337	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1338	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1339	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1340	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1341	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1342	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1343	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1344	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1345	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1346	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1347	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1348	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1349	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1350	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1351	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1352	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1353	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1354	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1355	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1356	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1357	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1358	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1359	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1360	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1361	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1362	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
A1363	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	

South Finegayan - Demolition Quantities

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SOUTH FINEGAYAN

Bldg. No.	Building	Building Category	Building Floor Area (sf)	Concrete w/LBP tons	Concrete w/o LBP tons	Glass tons	Wood tons	Scrap Metal tons	Gypsum Wall Board tons	Plastic Plumbing (sewer) tons	Reinf. Steel tons	Bathroom Fixtures tons	Misc. tons
A1364	Family Housing	A	2,467	0	500	1	3	1	1	1	18	0.3	
#14	Playgrounds		84,000	2,098	0	0	0	0	0	0	84	0.0	
	Basketball Court		7,462	186	0	0	0	0	0	0	7	0.0	
	Tennis Court		24,496	612	0	0	0	0	0	0	24	0.0	
	Concrete enclosure for photovoltaic panels		150	2	2	0	0	0	0	0	0	0.0	
	Elevated water tank (metal)		0	0	0	0	0	7	0	0	0	0.0	
	TOTAL (tons)			**2,998**	**99,058**	**121**	**521**	**280**	**249**	**108**	**3,628**	**54**	**1,081**

ONSITE DEMOLITION MATERIALS	Weight (tons)
Concrete	
w/LBP	0
w/o LBP	11,432
Wood (treated)	69
Miscellaneous Scrap Metal	0
PVC	371
VCP	510
Asphalt	11,384
TOTAL	23,766

Andersen Air Force Base - Demolition Quantities

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Job No.: 2009017
Date: 1 March 2010
Prepared by: SK Checked by:

ANDERSEN AIR FORCE BASE

Bldg. No.	Building	Building Category	Building Floor Area (ft^2)	Concrete w/LBP	Concrete w/o LBP	Glass	Wood	Scrap Metal	Gypsum Wall Board	Plastic plumbing (sewer)	Reinf. Steel	Bathroom Fixtures	Misc.
				tons	tons	tons	tons	tons	tons	tons	tons	tons	tons
?	AAFB Unknown Facility	C	78	1	13	0	0	0	0	0	0	0.00	
?	AAFB Unknown Facility	C	78	1	13	0	0	0	0	0	0	0.00	
2548	Navy GSE Equipment Shop	C	3,985	48	639	2	3	1	1	1	25	0.18	
2616	Comm Facility	C	603	7	97	0	0	0	0	0	4	0.03	
2619	Elect Power Station Bldg	C	732	9	117	0	1	0	0	0	5	0.03	
2642	Navy HC-5 AIMD	C	10,729	130	1,721	6	8	2	3	1	67	0.48	
HC5-13 (2642-B)	Navy Wheel & Tire/Hydraulics	C	2,209	27	354	1	2	0	1	0	14	0.10	
HC5-14 (2642-A)	Navy Metal Fabrication Shop	C	2,288	28	367	1	2	1	1	0	14	0.10	
2643	SE Building	C	1,000	12	160	1	1	0	0	0	6	0.05	
2648	GSE locker and batter locker (2 buildings with same	C	144	2	23	0	0	0	0	0	1	0.01	
2649	Navy Fitness Center	C	2,879	35	462	2	2	1	1	0	18	0.13	
2655	Navy GSE Holding Shed	C	178	2	29	0	0	0	0	0	1	0.01	
2659	AAFB Fire Station II	C	5,511	67	884	3	4	1	1	1	34	0.25	
	TOTAL (TONS)			**367**	**4,879**	**16**	**21**	**7**	**8**	**4**	**190**	**1.37**	**55**

ONSITE DEMOLITION MATERIALS	Weight (tons)
Concrete	
w/o LBP	4,848
w/LBP	0
Wood (treated)	0
Miscellaneous Scrap Metal	499
PVC	51
VCP	4
Asphalt	20,806
TOTAL	26,208

Naval Base, Apra Harbor - Demolition Quantities

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Job No.: 2009017
Date: 1 March 2010
Prepared by: SK Checked by:

NAVAL BASE, APRA HARBOR

Bldg. No.	Building	Building Category	Building Floor Area (ft^2)	Concrete w/ LBP tons	Concrete w/o LBP tons	Glass tons	Wood tons	Scrap Metal tons	Gypsum Wall Board tons	Plastic plumbing (sewer) tons	Reinf. Steel tons	Bathroom Fixtures tons	Misc. tons
642	Assumed office bldg (2 or 3 story bldg)	B	75,200	1,167	11,805	35	26	33	152	13	458	8	
#	generator building	C	855	10	137	0	1	0	0	0	5	2	
	TOTAL (TONS)			**1,178**	**11,942**	**35**	**27**	**34**	**152**	**13**	**464**	**10**	**140**

TOTAL VOLUME (CF)	188,150
TOTAL VOLUME (CY)	6,969

ONSITE DEMOLITION MATERIALS	**Weight (tons)**
Asphalt	2,300
TOTAL	2,300

Demolition Generation Rates

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Code	Category	Concrete Ratio (cf/sf)	LBP Concrete Ratio (cf/cf concrete)	Wood Ratio (cf/sf)	Gypsum Wallboard Ratio (cf/sf)	Steel Reinforcement Ratio (lb/cf concrete)	Glass Ratio (sf/sf)	Scrap Metal Ratio (cf/sf)	Plastic Plumbing Ratio (cf/sf)	Porcelain Bathroom Fixtures Ratio (lb/sf)
A	Housing - Single family housing, duplex	2.7	0	0.06	0.02	5.31	0.07	0.05	0.005	0.22
B	BEQ/BOQ/Office	2.3	0.09	0.02	0.08	5.3	0.14	0.04	0.004	0.20
C	Commercial/Industrial Buildings	2.3	0.07	0.04	0.01	5.44	0.16	0.02	0.003	0.09

Green Waste Generation Quantities

Green Waste Quantities

Location	Areas of Clearing		Woody Waste				Leafy Waste				Total Waste			
	Quantity	Units	Quantity	Units	Quantity	Units	Quantity	Units	Quantity	Units	Quantity	Units	Quantity	Units
Andersen Air Force Base – Heavy Vegetated	345,796	SF	2,305.31	CY	576.33	TONS	16,905.58	CY	2113.20	TONS	19,210.89	CY	2,689.52	TONS
Andersen Air Force Base – Light Vegetated	2,217,972	SF									2,750.00	CY	555.56	TONS
Total Andersen Air Force Base											21,961	CY	3,245	TONS
Naval Base, Apra Harbor – Heavy Vegetated	923,168	SF	6,154.45	CY	1,538.61	TONS	45,132.66	CY	5,641.58	TONS	51,287.11	CY	7,180.20	TONS
Naval Base, Apra Harbor – Light Vegetated	750,052	SF									950.00	CY	191.92	TONS
Total Naval Base, Apra Harbor											52,237	CY	7,372	TONS
NCTS Finegayan – Heavy Vegetated	35,078,022	SF	233,853.48	CY	58,463.37	TONS	1,714,925.52	CY	214,365.69	TONS	1,948,779.00	CY	272,829.06	TONS
NCTS Finegayan - Medium Vegetated	6,010,131	SF	20,033.77	CY	5,008.44	TONS	146,914.31	CY	18,364.29	TONS	166,948.08	CY	23,372.73	TONS
NCTS Finegayan – Light Vegetated	11,029,071	SF									18,250.00	CY	3,686.87	TONS
Total NCTS Finegayan											2,133,977	CY	299,889	TONS
Former FAA Parcel – Heavy Vegetated	0	SF	0.00	CY	0.00	TONS	0.00	CY	0.00	TONS	0.00	CY	0.00	TONS
Former FAA Parcel - Medium Vegetated	26,399,573	SF	175,997.15	CY	43,999.29	TONS	1,290,645.79	CY	161,330.72	TONS	1,466,642.94	CY	205,330.01	TONS
Former FAA Parcel – Light Vegetated	0	SF									0.00	CY	0.00	TONS
Total Former FAA Parcel											1,466,643	CY	205,330	TONS
South Finegayan – Heavy Vegetated	0	SF	0.00	CY	0.00	TONS	0.00	CY	0.00	TONS	0.00	CY	0.00	TONS
South Finegayan - Medium Vegetated	2,208,698	SF	14,724.65	CY	3,681.16	TONS	107,980.79	CY	13,497.60	TONS	122,705.44	CY	17,178.76	TONS
South Finegayan – Light Vegetated	7,385,888	SF									9,250.00	CY	1,868.69	TONS
Total South Finegayan											131,955	CY	19,047	TONS
Ordnance Annex – Heavy Vegetated	0	SF	0.00	CY	0.00	TONS	0.00	CY	0.00	TONS	0.00	CY	0.00	TONS
Ordnance Annex – Light Vegetated	407,827	SF									500.00	CY	101.01	TONS
Total Ordnance Annex											500	CY	101	TONS
Andersen Air Force Base South – Heavy Vegetated	0	SF	0.00	CY	0.00	TONS	0.00	CY	0.00	TONS	0.00	CY	0.00	TONS
Andersen Air Force Base South – Light Vegetated	0	SF									0.00	CY	0.00	TONS
Total Andersen Air Force Base South											0	CY	0	TONS
	Total Heavy Vegetated		242,313	CY	60,578	TONS	1,776,964	CY	222,120	TONS	2,019,277	CY	282,699	TONS
	Total Med Vegetated		210,756	CY	52,689	TONS	1,545,541	CY	193,193	TONS	1,756,296	CY	245,882	TONS
	Total Light Vegetated										31,700	CY	6,404	TONS
	Total		453,069	CY	113,267	TONS	3,322,505	CY	415,313	TONS	3,807,273	CY	534,984	TONS

Note:

1. Woody waste conversion rate of 4 cy per ton, leafy waste conversion rate of 8 cy per ton and grass waste conversion rate of 4.95 cy per ton originated from Table 2.3 Volume to Weight Conversions from User's Guide UG-2062-ENV Fiscal Year 2004 Solid Waste Pollution Prevention Annual Data Summary (SW P2ADS) Guide prepared by Environmental Information Systems Branch, Naval Facilities Engineering Service Center, Port Hueneme, CA 93043-4370 dated September 2004.

Green Waste Generation Quantities

Assumptions:

One cubic yard of woody waste (branches, trunk) generated from	150.00	square feet of area.	300.00	square feet of area.
One cubic yard of leafy (leaves) waste generated from	20.45	square feet of area.	40.91	square feet of area.

HEAVY VEGETATED			MEDIUM VEGETATED		
Woody Waste			Woody Waste		
27	cf	woody waste	27	cf	woody waste
150	sf	per total area	300	sf	per total area
0.18		cf per sf of area	0.09		cf per sf of area
Total Plant Matter (Woody + Leafy)			Total Plant Matter (Woody + Leafy)		
15	ft	vegetation height	7.5	ft	vegetation height
1	sf	per total area	1	sf	per total area
15	cf	plant matter	7.5	cf	plant matter
10%		percent of volume occupied by plant matter	10%		percent of volume occupied by plant matter
1.5		cf per sf of area	0.75		cf per sf of area
Leafy Waste			Leafy Waste		
1.32		cf per sf of area	0.66		cf per sf of area
0.0489		cy per sf of area	0.0244		cy per sf of area

Appendix E

Cost Data

Appendix E.1

Cost Data – 5-Year Life Cycle Analysis

5-Year Life Cycle Analysis

NET PRESENT VALUE SUMMARY

Alternative	Life Cycle Years	Net Present Value	Description
1	5	$68,200,000	Contractor continues to process all C&D debris. Construct a composting facility to process a portion of green waste.
2	5	$74,800,000	Construct a C&D debris central processing facility that recovers concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.
3	5	$75,200,000	Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard and untreated wood. Construct a composting facility to process a portion of green waste.
4	5	$86,700,000	Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard, untreated wood, concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.

PRESENT VALUE ANALYSIS

Calendar	ALTERNATIVE 1			ALTERNATIVE 2			ALTERNATIVE 3			ALTERNATIVE 4		
	Total Capital		**NPV**	**Total Capital**		**NPV**	**Total Capital**		**NPV**	**Total Capital**		**NPV**
	$9,747,529		$68,221,707	$11,128,865		$74,806,620	$15,546,073		$75,185,620	$17,153,696		$86,725,947
		Rounded NPV	$68,200,000		Rounded NPV	$74,800,000		Rounded NPV	$75,200,000		Rounded NPV	$86,700,000
	Capital	**Operating**	**Total**	**Capital**	**Operating**	**Total**	**Capital**	**Operating**	**Total**	**Capital**	**Operating**	**Total**
2011	14,877,625	12,639,617	27,517,242	16,180,581	13,779,261	29,959,843	21,410,385	12,910,703	34,321,088	24,020,513	15,054,549	39,075,062
2012		12,639,617	12,639,617		13,779,261	13,779,261		12,910,703	12,910,703		15,054,549	15,054,549
2013		12,639,617	12,639,617		13,779,261	13,779,261		12,910,703	12,910,703		15,054,549	15,054,549
2014		12,639,617	12,639,617		13,779,261	13,779,261		12,910,703	12,910,703		15,054,549	15,054,549
2015	(5,130,096)	12,639,617	7,509,521	(5,051,716)	13,779,261	8,727,545	(5,864,312)	12,910,703	7,046,391	(6,866,817)	15,054,549	8,187,732

COST SUMMARY

Description	Cost	Remarks
Discount Factor	2.800%	
Capital Costs		
Alternative 1		
Capital Costs - 2011	$14,877,625	Initial capital cost
Capital Costs - 2015	$5,130,096	Equipment Salvage Value
Alternative 2		
Capital Costs - 2011	$16,180,581	Initial capital cost
Capital Costs - 2015	$5,051,716	Equipment Salvage Value
Alternative 3		
Capital Costs - 2011	$21,410,385	Initial capital cost
Capital Costs - 2015	$5,864,312	Equipment Salvage Value
Alternative 4		
Capital Costs - 2011	$24,020,513	Initial capital cost
Capital Costs - 2015	$6,866,817	Equipment Salvage Value
Annual Operating Costs		
Alternative 1		
Operating Costs 2011 to 2015	$12,639,617	The building will only be operating for the first 5 years.
Alternative 2		
Operating Costs 2011 to 2015	$13,779,261	The building will only be operating for the first 5 years.
Alternative 3		
Operating Costs 2011 to 2015	$12,910,703	The building will only be operating for the first 5 years.
Alternative 4		
Operating Costs 2011 to 2015	$15,054,549	The building will only be operating for the first 5 years.

OPERATION AND MAINTENANCE COSTS

ALTERNATIVE 1

Building Maintenance	Quantity	Hours/Day	Equipment $/hour	Daily Cost		Annual Cost
Composting Facility Maintenance Cost 2011 - 2015						**$9,351**

Contractor Processing O&M (2011-2015)	Quantity	Hours/Day	Cost $/hour	Daily Cost		Annual Cost
Concrete Crusher Maintenance	1					$25,967
Concrete Crusher Operation	1	6	$21.00	$126.00		$21,840
Wood Chipper Maintenance	1					$17,311
Wood Chipper Operation	1	8	$52.70	$421.60		$109,616
Front End Loader Maintenance	1					$54,098
Front End Loader Operation	1	6	$75.00	$450.00		$78,000
Total Contract Work Cost						$306,833
Contractor Overhead					30%	$92,050
Subtotal						$398,883
Profit					10%	$39,888
Subtotal						$438,771
Bid Bond					2%	$8,775
Subtotal						$447,547
Guam Tax					4%	$18,649
Total Contractor Processing Fee (2011-2015)						**$466,196**

(a) Concrete and asphalt crushing operations occur 8 months out of the year.
(b) Equipment maintenance costs are based on 10% of the initial capital cost.

Contractor Transportation O&M (2011-2015)	Quantity	Hours/Day	Cost $/hour	Daily Cost		Annual Cost
Transfer Trailer Maintenance	32					$666,947
Transfer Trailer Operation	32	6	$13.00	$2,496.00		$648,960
Total Contract Work Cost						$1,315,907
Contractor Overhead					30%	$394,772
Subtotal						$1,710,680
Profit					10%	$171,068
Subtotal						$1,881,748
Bid Bond					2%	$37,635
Subtotal						$1,919,382
Guam Tax					4%	$79,981
Total Contractor Transportation Fee (2011-2015)						**$1,999,363**

Contractor Labor (2011-2015)	Quantity	Hours/Day	Wage $/hour	Daily Cost		Annual Cost
Operator for Concrete Crusher	1	8	$39.54	$316.31		$54,827
Operator for Front End Loader	1	8	$39.54	$316.31		$54,827
Operator for Wood Chipper	1	8	$39.54	$316.31		$82,241
Drivers/Operators for 40 CY Transfer Trailers	32	8	$39.51	$10,115.48		$2,630,025
Total Contract Work Cost						$2,821,920
Contractor Overhead					30%	$846,576
Subtotal						$3,668,496
Profit					10%	$366,850
Subtotal						$4,035,346
Bid Bond					2%	$80,707
Subtotal						$4,116,053
Guam Tax					4%	$171,516
Total Contractor Labor Fee (2011-2015)						**$4,287,569**

Composting Facility (2011-2015)		Cost
Facility and Processing O&M		$336,977
Transportation O&M		$1,437,042
Labor		$3,703,894
Total Composting Facility Cost		**$5,477,913**
Navy Sanitary Landfill Hardfill Disposal Cost	$1.65/CY	**$399,226**
Alternative 1 Total Operating Cost	**2011 to 2015**	**$12,639,617**

(a) Vehicle maintenance cost is 10% of capital costs on annual basis.
(b) Contractor on-site processing of concrete and asphalt occurs an average of 8 months out of the year
(c) Receiving and processing at transfer station occurs 312 days a year, 8 hours a day

OPERATION AND MAINTENANCE COSTS

ALTERNATIVE 2						
Building Maintenance	**Quantity**	**Hours/Day**	**Equipment $/hour**	**Daily Cost**		**Annual Cost**
Total Building Maintenance Cost 2011 - 2015						**$9,351**
Composting Facility Maintenance Cost 2011 - 2015						**$9,351**
Facility and Processing O&M (2011-2015)	**Quantity**	**Hours/Day**	**Equipment $/hour**	**Daily Cost**		**Annual Cost**
Front End Loader Maintenance	1					$54,098
Front End Loader Maintenance (used-backup)	1					$21,639
Front End Loader Operation	1	6	$75.00	$450.00		$78,000
Concrete Crusher Maintenance	1					$25,967
Concrete Crusher Operation	1	6	$21.00	$126.00		$21,840
Bobcat Maintenance	1					$6,492
Utility Pick-Up Truck Maintenance	1					$6,492
Truck Scale Maintenance	1					$10,820
Total O&M Cost						**$225,348**
PERSONNEL (2011-2015)	**Quantity**	**Hours/Day**	**Wage $/hour**	**Daily Cost**		**Annual Cost**
Operators for Concrete Crusher	1	8	$39.54	$316.31		$54,827
Operators for Front End Loader	1	8	$39.54	$316.31		$54,827
General laborers/spotters/floor sort	4	8	$35.46	$1,134.60		$294,997
Vehicle and Equipment Maintenance						
Mechanics	1	8	$43.18	$345.48		$89,824
Mechanics helper	1	8	$35.46	$283.65		$73,749
Administration						
Facility Manager	0.5	8	$68.56	$274.24		$71,303
Accounting/Personnel Manager	0.5	8	$35.46	$141.83		$36,875
Secretary/Receptionist	0.5	8	$35.46	$141.83		$36,875
Total Personnel Cost						**$1,096,953**
Contractor Processing O&M (2011-2015)	**Quantity**	**Hours/Day**	**Cost $/hour**	**Daily Cost**		**Annual Cost**
Wood Chipper Maintenance	1					$17,311
Wood Chipper Operation	1	8	$52.70	$421.60		$109,616
Front End Loader Maintenance	1					$54,098
Front End Loader Operation	1	6	$75.00	$450.00		$78,000
Disposal						
Cardboard Disposal[a]						$393,812
Total Contract Work Cost						$652,838
Extra Effort to Sort C&D Debris					15%	$97,926
Total Contract Work Cost						$750,764
Contractor Overhead					30%	$195,851
Subtotal						$848,689
Profit					10%	$84,869
Subtotal						$933,558
Bid Bond					2%	$18,671
Subtotal						$952,229
Guam Tax					4%	$39,679
Total Contractor Processing Fee (2011-2015)						**$991,909**

(a) Disposal of cardboard at $3.00/CY
(b) Concrete and asphalt crushing operations occur 8 months out of the year.
(c) Equipment maintenance costs are based on 10% of the initial capital cost.

OPERATION AND MAINTENANCE COSTS

Contractor Transportation O&M (2011-2015)	Quantity	Hours/Day	Cost $/hour	Daily Cost		Annual Cost
40 CY Transfer Trailer Maintenance	26					$541,895
40 CY Transfer Trailer Operation	26	6	$13.00	$2,028.00		$527,280
Total Contract Work Cost						$1,069,175
Extra Effort to Sort C&D Debris					15%	$160,376
Total Contract Work Cost						$1,229,551
Contractor Overhead					30%	$368,865
Subtotal						$1,598,416
Profit					10%	$159,842
Subtotal						$1,758,258
Bid Bond					2%	$35,165
Subtotal						$1,793,423
Guam Tax					4%	$74,732
Total Contractor Transportation Fee (2011-2015)						**$1,868,155**

Contractor Labor (2011-2015)	Quantity	Hours/Day	Wage $/hour	Daily Cost		Annual Cost
Drivers/Operators for Transfer Trailers	26	8	$39.51	$8,218.83		$2,136,895
Operator for Front End Loader	1	8	$39.54	$316.31		$54,827
Operator for Wood Chipper	1	8	$39.54	$316.31		$82,241
Total Contract Work Cost						$2,273,963
Extra Effort to Sort C&D Debris					15%	$341,094
Subtotal						$2,615,058
Contractor Overhead					30%	$784,517
Subtotal						$3,399,575
Profit					10%	$339,958
Subtotal						$3,739,533
Bid Bond					2%	$74,791
Subtotal						$3,814,323
Guam Tax					4%	$158,943
Total Contractor Labor Fee (2011-2015)						**$3,973,266**

Composting Facility (2011-2015)	Cost
Facility and Processing O&M	$336,977
Transportation O&M	$1,437,042
Labor	$3,703,894
Total Composting Facility Cost	**$5,477,913**

Navy Sanitary Landfill Hardfill Disposal Cost		$1.65/CY	**$127,015**
Alternative 2 Total Operating Cost	**2011 to 2015**		**$13,779,261**

(a) Vehicle maintenance cost is 10% of capital costs on annual basis.
(b) Administration staff works 260 days a year, 8 hours a day
(c) Receiving and processing at transfer station occurs 312 days a year, 8 hours a day

OPERATION AND MAINTENANCE COSTS

ALTERNATIVE 3

Building Maintenance	Quantity	Hours/Day	Equipment $/hour	Daily Cost		Annual Cost
Total Building Maintenance Cost 2011 - 2015						**$60,280**
Composting Facility Maintenance Cost 2011 - 2015						**$9,351**

Transportation O&M (2011-2015)	Quantity	Hours/Day	Equipment $/hour	Daily Cost		Annual Cost
Transfer Trailer Operation	10	6	$13.00	$780.00		$202,800
Transfer Trailer Maintenance	10	6				$208,421
Total O&M Cost						**$411,221**

Facility and Processing O&M (2011-2015)	Quantity	Hours/Day	Equipment $/hour	Daily Cost		Annual Cost
Front End Loader Maintenance	1					$54,098
Front End Loader Maintenance (used-backup)	1					$21,639
Front End Loader Operation	1	6	$75.00	$450.00		$78,000
Wood Chipper Maintenance	1					$17,311
Wood Chipper Operation	1	8	$52.70	$421.60		$109,616
Bobcat Maintenance	1					$6,492
Truck Scale Maintenance	1					$10,820
Forklift Maintenance	1					$10,820
Mini-Sweeper Maintenance	1					$10,820
Baler Maintenance	1					$23,158
Utility Pick-Up Truck Maintenance	1					$6,492
Total O&M Cost						**$349,266**

PERSONNEL (2011-2015)	Quantity	Hours/Day	Wage $/hour	Daily Cost		Annual Cost
Drivers/Operators for Transfer Trailers	10	8	$39.54	$3,163.10		$822,407
Operator for Front End Loader	1	8	$39.54	$316.31		$54,827
Operator for Wood Chipper	1	8	$39.54	$316.31		$82,241
Receiving/Transfer/Processing						
Supervisors	0.5	8	$52.71	$210.84		$54,818
Rolling stock operators	2	8	$39.51	$632.22		$164,377
General laborers/spotters/floor sort	4	8	$35.46	$1,134.60		$294,997
Vehicle and Equipment Maintenance						
Mechanics	1	8	$43.18	$345.48		$89,824
Mechanics helper	1	8	$35.46	$283.65		$73,749
Administration						
Facility Manager	0.5	8	$68.56	$274.24		$71,303
Accounting/Personnel Manager	0.5	8	$35.46	$141.83		$36,875
Secretary/Receptionist	0.5	8	$35.46	$141.83		$36,875
Total Personnel Cost						**$1,782,293**

Contractor Processing O&M (2011-2015)	Quantity	Hours/Day	Cost $/hour	Daily Cost		Annual Cost
Concrete Crusher Maintenance	1					$25,967
Concrete Crusher Operation	1	6	$21.00	$126.00		$21,840
Wood Chipper Maintenance	1					$17,311
Wood Chipper Operation	1	8	$52.70	$421.60		$109,616
Front End Loader Maintenance	1					$54,098
Front End Loader Operation	1	6	$75.00	$450.00		$78,000
Total Contract Work Cost						$306,833
Contractor Overhead					30%	$92,050
Subtotal						$398,883
Profit					10%	$39,888
Subtotal						$438,771
Bid Bond					2%	$8,775
Subtotal						$447,547
Guam Tax					4%	$18,649
Total Contractor Processing Fee (2011-2015)						**$466,196**

(a) Cardboard is assumed to be delivered to a DoD recycling center.
(b) Concrete and asphalt crushing operations occur 8 months out of the year.
(c) Equipment maintenance costs are based on 10% of the initial capital cost.

OPERATION AND MAINTENANCE COSTS

Contractor Transportation O&M (2011-2015)	Quantity	Hours/Day	Cost $/hour	Daily Cost		Annual Cost
Transfer Trailer Maintenance	21					$437,684
Transfer Trailer Operation	21	6	$13.00	$1,638.00		$425,880
Total Contract Work Cost						$863,564
Contractor Overhead					30%	$259,069
Subtotal						$1,122,633
Profit					10%	$112,263
Subtotal						$1,234,897
Bid Bond					2%	$24,698
Subtotal						$1,259,595
Guam Tax					4%	$52,487
Total Contractor Transportation Fee (2011-2015)						**$1,312,082**

Contractor Labor (2011-2015)	Quantity	Hours/Day	Wage $/hour	Daily Cost		Annual Cost
Drivers/Operators for 40 CY Transfer Trailers	21	8	$39.51	$6,638.28		$1,725,954
Operator for Front End Loader	1	8	$39.54	$316.31		$54,827
Operator for Wood Chipper	1	8	$39.54	$316.31		$82,241
Operator for Concrete Crusher	1	8	$39.54	$316.31		$54,827
Total Contract Work Cost						$1,917,849
Contractor Overhead					30%	$575,355
Subtotal						$2,493,204
Profit					10%	$249,320
Subtotal						$2,742,524
Bid Bond					2%	$54,850
Subtotal						$2,797,375
Guam Tax					4%	$116,567
Total Contractor Labor Fee (2011-2015)						**$2,913,941**

Composting Facility (2011-2015)		Cost
Facility and Processing O&M		$336,977
Transportation O&M		$1,437,042
Labor		$3,703,894
Total Composting Facility Cost		**$5,477,913**
Navy Sanitary Landfill Hardfill Disposal Cost	$1.65/CY	**$128,160**
Alternative 3 Total Operating Cost — **2011 to 2015**		**$12,910,703**

(a) Vehicle maintenance cost is 10% of capital costs on annual basis.
(b) Receiving and processing at transfer station occurs 312 days a year, 8 hours a day

OPERATION AND MAINTENANCE COSTS

ALTERNATIVE 4

Building Maintenance	Quantity	Hours/Day	Equipment $/hour	Daily Cost		Annual Cost
Total Building Maintenance Cost 2011 - 2015						**$59,586**
Composting Facility Maintenance Cost 2011 - 2015						**$9,351**

Transportation O&M (2011-2015)	Quantity	Hours/Day	Equipment $/hour	Daily Cost		Annual Cost
Transfer Trailer Operation	10	6	$13.00	$780.00		$202,800
Transfer Trailer Maintenance	10	6				$208,421
Total O&M Cost						**$411,221**

Facility and Processing O&M (2011-2015)	Quantity	Hours/Day	Equipment $/hour	Daily Cost		Annual Cost
Front End Loader Maintenance	1					$54,098
Front End Loader Maintenance (used-backup)	1					$21,639
Front End Loader Operation	1	6	$75.00	$450.00		$78,000
Concrete Crusher Maintenance	1					$25,967
Concrete Crusher Operation	1	6	$21.00	$126.00		$21,840
Wood Chipper Maintenance	1					$17,311
Wood Chipper Operation	1	8	$52.70	$421.60		$109,616
Bobcat Maintenance	1					$6,492
Truck Scale Maintenance	1					$10,820
Forklift Maintenance	1					$10,820
Mini-Sweeper Maintenance	1					$10,820
Baler Maintenance	1					$23,158
Utility Pick-Up Truck Maintenance	1					$6,492
Total O&M Cost						**$397,073**

PERSONNEL (2011-2015)	Quantity	Hours/Day	Wage $/hour	Daily Cost		Annual Cost
Drivers/Operators for Transfer Trailers	10	8	$39.54	$3,163.10		$822,407
Operator for Front End Loader	1	8	$39.54	$316.31		$54,827
Operator for Concrete Crusher	1	8	$39.54	$316.31		$54,827
Operator for Wood Chipper	1	8	$39.54	$316.31		$82,241
General laborers/spotters/floor sort	4	8	$35.46	$1,134.60		$294,997
Vehicle and Equipment Maintenance						
Mechanics	1	8	$43.18	$345.48		$89,824
Mechanics helper	1	8	$35.46	$283.65		$73,749
Administration						
Facility Manager	0.5	8	$68.56	$274.24		$71,303
Accounting/Personnel Manager	0.5	8	$35.46	$141.83		$36,875
Secretary/Receptionist	0.5	8	$35.46	$141.83		$36,875
Total Personnel Cost						**$2,001,601**

Contractor Processing O&M (2011-2015)	Quantity	Hours/Day	Cost $/hour	Daily Cost		Annual Cost
Front End Loader Maintenance	1					$54,098
Front End Loader Operation	1	6	$75.00	$450.00		$78,000
Wood Chipper Maintenance	1					$17,311
Wood Chipper Operation	1	8	$52.70	$421.60		$109,616
Total Contract Work Cost						$132,098
Contractor Overhead					30%	$39,630
Subtotal						$171,728
Profit					10%	$17,173
Subtotal						$188,901
Bid Bond					2%	$3,778
Subtotal						$192,679
Guam Tax					4%	$8,029
Total Contractor Processing Fee (2011-2015)						**$200,708**

Contractor Transportation O&M (2011-2015)	Quantity	Hours/Day	Cost $/hour	Daily Cost		Annual Cost
Transportation						
Transfer Trailer Maintenance	34					$708,632
Transfer Trailer Operation	34	6	$13.00	$2,652.00		$689,520
Total Contract Work Cost						$1,398,152
Contractor Overhead					30%	$419,445
Subtotal						$1,817,597
Profit					10%	$181,760
Subtotal						$1,999,357
Bid Bond					2%	$39,987
Subtotal						$2,039,344
Guam Tax					4%	$84,979
Total Contractor Transportation Fee (2011-2015)						**$2,124,323**

OPERATION AND MAINTENANCE COSTS

Contractor Labor (2011-2015)	Quantity	Hours/Day	Wage $/hour	Daily Cost		Annual Cost
Drivers/Operators for Transfer Trailers	34	8	$39.51	$10,747.70		$2,794,402
Operator for Wood Chipper	1	8	$39.54	$316.31		$82,241
Operator for Front End Loader	1	8	$39.54	$316.31		$54,827
Total Contract Work Cost						$2,794,402
Contractor Overhead					30%	$838,321
Subtotal						$3,632,722
Profit					10%	$363,272
Subtotal						$3,995,995
Bid Bond					2%	$79,920
Subtotal						$4,075,914
Guam Tax					4%	$169,843
Total Contractor Labor Fee (2011-2015)						**$4,245,758**

Composting Facility (2011-2015)	Cost
Facility and Processing O&M	$336,977
Transportation O&M	$1,437,042
Labor	$3,703,894
Total Composting Facility Cost	**$5,477,913**

Navy Sanitary Landfill Hardfill Disposal Cost	$1.65/CY	**$127,015**
Alternative 4 Total Operating Cost **2011 to 2015**		**$15,054,549**

(a) Vehicle maintenance cost is 10% of capital costs on annual basis.
(b) Administration staff works 260 days a year, 8 hours a day
(c) Receiving and processing at transfer station occurs 312 days a year, 8 hours a day
(d) Cardboard is assumed to be delivered to a DoD recycling center.
(e) Concrete and asphalt crushing operations occur 8 months out of the year.
(f) Equipment maintenance costs are based on 10% of the initial capital cost.

CAPITAL COSTS

ALTERNATIVE 1			
Composting Facility Capital Costs			**$7,234,381**
Composting Facility Salvage Value		37%	$2,302,096
Contractor Capital Costs	**Unit Cost**	**Quantity**	**Total Cost**
Equipment			
Concrete Crusher	$259,672.13	1	$259,672
Front End Loader	$540,983.61	1	$540,984
Wood Chipper	$173,114.75	1	$173,115
Transfer Trailer	$208,421	32	$6,669,474
Total			**$7,643,244**
Contractor Equipment Salvage Value		37%	$2,828,000
Alternative 1 Total Equipment Salvage Value		37%	$5,130,096
Alternative 1 Total Capital Costs			**$14,877,625**

CAPITAL COSTS

ALTERNATIVE 2			
C&D Debris Central Processing Facility	**Unit Cost**	**Quantity**	**Total Cost**
Central Processing Facility		1	
Admin office/scale operations	$935,100	1	$935,100
Asphalt Roadway	$556,174	1	$556,174
Equipment			
Concrete Crusher	$259,672.13	1	$259,672
Truck Scales	$108,196.72	1	$108,197
Truck Scale Installation	$16,800.00	1	$16,800
Bins (Misc LS)	$10,820	4	$43,279
Bin Installation	$1,680	4	$6,720
Rolling Stock			
Front End Loader	$540,983.61	1	$540,984
Front End Loader (used-backup)	$216,393.44	1	$216,393
Bobcat	$64,918.03	1	$64,918
Utility pick-up Truck	$64,918.03	1	$64,918
Total C&D Cental Processing Facility Cost			**$2,813,155**
Central Processing Facility Capital Costs			**$2,813,155**
Central Processing Facility Salvage Value		37%	$6,557,542
Composting Facility Capital Costs			**$7,234,381**
Composting Facility Salvage Value		37%	$2,302,096
Contractor Capital Costs	**Unit Cost**	**Quantity**	**Total Cost**
Equipment			
Wood Chipper	$173,114.75	1	$173,115
Front End Loader	$540,983.61	1	$540,984
Transfer Trailer	$208,421	26	$5,418,947
Total			**$6,133,046**
Contractor Equipment Salvage Value		37%	$2,269,227
Alternative 2 Total Equipment Salvage Value		37%	$5,051,716
Alternative 2 Total Capital Costs			**$16,180,581**

CAPITAL COSTS

ALTERNATIVE 3			
C&D Debris Central Processing Facility	**Unit Cost**	**Quantity**	**Total Cost**
Central Processing Facility		1	
Building	$3,000,000	1	$3,000,000
Admin office/scale operations	$935,100	1	$935,100
Asphalt Roadway	$556,174	1	$556,174
Equipment			
Wood Chipper	$173,114.75	1	$173,115
Wood Chipper Processing Line	$324,590.16	1	$324,590
Baler	$231,578.95	1	$231,579
Baler Installation	$33,600.00	1	$33,600
Truck Scales	$108,196.72	1	$108,197
Truck Scale Installation	$16,800.00	1	$16,800
Bins (Misc LS)	$10,820	4	$43,279
Bin Installation	$1,680	4	$6,720
Rolling Stock			
Front End Loader	$540,983.61	1	$540,984
Front End Loader (used-backup)	$216,393.44	1	$216,393
Forklift	$108,196.72	1	$108,197
Bobcat	$64,918.03	1	$64,918
Utility pick-up Truck	$64,918.03	1	$64,918
Mini-Sweeper	$108,196.72	1	$108,197
Total C&D Debris Central Processing Facility Cost			**$6,532,760**
C&D Transportation	**Unit Cost**	**Quantity**	**Total Cost**
Transfer Trailer	$208,421	10	$2,084,211
Spare Transfer Trailer	$208,421	1	$208,421
Total Collection and Transportation Cost			**$2,292,632**
Central Processing Facility Capital Costs			**$8,825,391**
Central Processing Facility Salvage Value		37%	$1,582,489
Composting Facility Capital Costs			**$7,234,381**
Composting Facility Salvage Value		37%	$2,302,096
Contractor Capital Costs	**Unit Cost**	**Quantity**	**Total Cost**
Equipment			
Concrete Crusher	$259,672.13	1	$259,672
Wood Chipper	$173,114.75	1	$173,115
Front End Loader	$540,983.61	1	$540,984
Transfer Trailer	$208,421	21	$4,376,842
Total			**$5,350,613**
Contractor Equipment Salvage Value		37%	$1,979,727
Alternative 3 Total Equipment Salvage Value		37%	$5,864,312
Alternative 3 Total Capital Costs			**$21,410,385**

CAPITAL COSTS

ALTERNATIVE 4			
C&D Debris Central Processing Facility	**Unit Cost**	**Quantity**	**Total Cost**
Central Processing Facility		1	
Building	$3,000,000	1	$3,000,000
Admin office/scale operations	$935,100	1	$935,100
Asphalt Roadway	$456,828	1	$456,828
Equipment			
Wood Chipper	$173,114.75	1	$173,115
Wood Chipper Processing Line	$324,590.16	1	$324,590
Concrete Crusher	$259,672.13	1	$259,672
Baler	$231,578.95	1	$231,579
Baler Installation	$33,600.00	1	$33,600
Truck Scales	$108,196.72	1	$108,197
Truck Scale Installation	$16,800.00	1	$16,800
Bins (Misc LS)	$10,820	4	$43,279
Bin Installation	$1,680	4	$6,720
Rolling Stock			
Front End Loader	$540,983.61	1	$540,984
Front End Loader (used-backup)	$216,393.44	1	$216,393
Forklift	$108,196.72	1	$108,197
Bobcat	$64,918.03	1	$64,918
Utility pick-up Truck	$64,918.03	1	$64,918
Mini-Sweeper	$108,196.72	1	$108,197
Total C&D Cental Processing Facility Cost			**$6,693,086**

Transportation and On-Site Processing	**Unit Cost**	**Quantity**	**Total Cost**
Transfer Trailer	$208,421	10	$2,084,211
Spare Transfer Trailer	$208,421	1	$208,421
Total Transportation and On-Site Processing Cost			**$2,292,632**
Central Processing Facility Capital Costs			**$8,985,718**
Central Processing Facility Salvage Value		37%	$11,965,447
Composting Facility Capital Costs			**$7,234,381**
Composting Facility Salvage Value		37%	$2,302,096

Contractor Capital Costs	**Unit Cost**	**Quantity**	**Total Cost**
Equipment			
Transfer Trailer	$208,421	34	$7,086,316
Wood Chipper	$173,114.75	1	$173,115
Front End Loader	$540,983.61	1	$540,984
Total			**$7,800,414**
Contractor Equipment Salvage Value		37%	$2,886,153
Alternative 4 Total Equipment Salvage Value		37%	$6,866,817
Alternative 4 Total Capital Costs			**$24,020,513**

Central Processing Facility	Unit Cost
Facility	
Processing Facility Alt II	$670,290.72
Processing Facility Alt III	$6,028,024.32
Processing Facility Alt IV	$5,958,616.08
Admin office/scale operations	$935,100.00
Stationary Equipment	
Truck scales	$108,196.72
Truck scales installation	$43,278.69
Baler	$216,393.44
Baler Install	$86,557.38
Scalehouse equipment	$32,459.02
Scalehouse equipment installation	$12,983.61
Wood Chipper	$173,114.75
Wood Chipper Installation	$69,245.90
Concrete Grinder	$259,672.13
Concrete Grinder Installation	$103,868.85
Wood Chipper Processing Line	$324,590.16
Wood Chipper Process Line Installation	$129,836.07
Bins	$10,819.67
Bin Installation	$4,327.87
Office Equipment (LS)	$75,737.70
Rolling Stock	
Concrete Crusher	$223,361.31
Excavator	$649,180.33
Front End Loader	$540,983.61
Front End Loader (used-backup)	$216,393.44
Forklift	$108,196.72
Bobcat	$64,918.03
Utility pick-up truck	$64,918.03
Mini-Sweeper	$108,196.72

Solid Waste Collection & Transportation	Unit Cost
Transfer Trailer	$90,000
Transfer Trailer Rental per day	$1,625
Total Collection and Transportation Cost	

PERSONNEL	Wage $/hour
Drivers/Operators for Transfer Trailers	$39.54
Scalehouse	
Weigh masters/load check per shift	$35.46
Receiving/Transfer/Processing	
Supervisors	$52.71
Rolling stock operators	$39.51
Equipment operators	$39.54
General laborers/spotters/floor sort	$35.46
Curbside Recyclables Transf Equip	$39.51
Curbside Recyclables Transf labor	$35.46
HHW	
Operators	$35.46
Buy Back and Retail	
Buy Back operators	$35.46
Retail (assumed volunteer)	
Vehicle and Equipment Maintenance	
Mechanics	$43.18
Mechanics helper	$35.46
Administration	
Facility Manager	$68.56
Accounting/personnel manager	$35.46
Secretary/receptionist	$35.46

Alternative 1

Status quo: Contractor to process concrete and asphalt concrete on-site; Contractor to haul remaining construction and demolition debris materials to the hardfill at the Navy Sanitary Landfill. The C&D debris will be transported and processed over a period of 5 years.

Construction and Demolition Debris Distribution

Location	Materials Disposed at Hardfill at Navy Sanitary Landfill (CY/yr)
Andersen Air Force Base	5,321
Naval Base - Apra Harbor	1,049
NCTS Finegayan	287,118
South Finegayan	72,291
Total	489,602

Transportation to Hardfill at the Navy Sanitary Landfill

Origin	Material to be Transported (CY/yr)	Truck Load (CY)	Truck Loads	Truck Loads/Day	Truck Cycles (b)
Andersen Air Force Base	5,321	22	242	2	128
Naval Base - Apra Harbor	1,049	22	48	3	16
NCTS Finegayan	287,118	22	13,051	2	6,526
South Finegayan	72,291	22	3,286	2	1,494
Total Truck Cycles Per Year					8,164

(a) Assume 40 CY transfer trailer capacity; maximum payload is 22 tons; mixed C&D debris density is 2000 lbs/cy.
(b) A daily truck cycle is the amount of production from one truck in one day.
(c) Quantities for the former FAA parcel are included with NCTS Finegayan quantities.

Trucks Required

Transportation of C&D Debris to Hardfill at Navy Sanitary Landfill for Disposal

Destination	Handled By	Daily Truck Cycles	Operating Days/Year (a)	Quantity of Trucks
Hardfill at Navy Sanitary Landfill	Contractor	8,164	260	32

Alternative 2

A C&D Debris Central Processing Facility will be constructed in NCTS Finegayan. Recoverable concrete and asphalt will be transported to the facility by the contractor. The contractor would presort the remaining C&D materials. All corrugated cardboard, wood pallets and scrap metal will be recycled by the contractor and all other construction and demolition debris, not intended for recovery, will then be transported to the hardfill at the Navy Sanitary Landfill by the contractor. The C&D debris will be transported and processed over a period of 5 years.

Construction and Demolition Materials Distribution

Location	Materials Transported to Local Recyclers (CY/yr)	Materials Disposed at Hardfill at Navy Sanitary Landfill (CY/yr)	Materials Sent to Central Processing Facility (CY/yr)
Andersen Air Force Base	3,377	1,284	4,428
Naval Base - Apra Harbor	272	611	1,563
NCTS Finegayan	167,114	83,847	13,779
South Finegayan	42,530	20,575	12,810
Total	213,293	106,317	32,580

Transportion of Cardboard and Scrap Metal to Local Recycling Centers

Origin	Material to be Transported (CY/yr)	Truck Load (CY)	Truck Loads	Truck Loads/Day	Truck Cycles (b)
Andersen Air Force Base	3,377	22	154	3	60
Naval Base - Apra Harbor	272	22	13	3	5
NCTS Finegayan	167,114	22	7,597	3	2,451
South Finegayan	42,530	22	1934	3	624
Total Truck Cycles Per Year					3,140

(a) Assume 40 CY transfer trailer capacity; maximum payload is 22 tons; C&D debris density is 2000 lbs/cy.
(b) A daily truck cycle is the amount of production from one truck in one day.
(c) Quantities for the former FAA parcel are included with NCTS Finegayan quantities.

Transportation to Central Processing Facility

Origin	Material to be Transported (CY/yr)	Truck Load (CY)	Truck Loads	Truck Loads/Day	Truck Cycles (b)
Andersen Air Force Base	4,428	11	403	3	144
Naval Base - Apra Harbor	1,563	11	143	2	72
NCTS Finegayan	13,779	11	1253	3	405
South Finegayan	12,810	11	1165	3	376
Total Truck Cycles Per Year					997

(a) Assume 40 CY transfer trailer capacity; maximum payload is 22 tons; concrete and asphalt density is 4000 lbs/cy.
(b) A daily truck cycle is the amount of production from one truck in one day.
(c) Quantities for the former FAA parcel are included with NCTS Finegayan quantities.

Transportation of C&D Debris to Hardfill at Navy Sanitary Landfill for Disposal

Origin	Material to be Transported (CY/yr)	Truck Load (CY)	Truck Loads	Truck Loads/Day	Daily Truck Cycles (b)
Andersen Air Force Base	1,284	22	59	2	32
Naval Base - Apra Harbor	611	22	28	3	10
NCTS Finegayan	83,847	22	3,812	2	1,906
South Finegayan	20,575	22	936	2	426
Total Truck Cycles Per Year					2,374

(a) Assume 40 CY transfer trailer capacity; maximum payload is 22 tons; mixed C&D debris density is 2000 lbs/cy.
(b) A daily truck cycle is the amount of production from one truck in one day.
(c) Quantities for the former FAA parcel are included with NCTS Finegayan quantities.

Trucks Required

Destination	Handled By	Daily Truck Cycles	Operating Days/Year (a)	Quantity of Trucks
Local Recyclers	Contractor	3,140	260	
Central Processing Facility	Contractor	997	260	
Hardfill at Navy Sanitary Landfill	Contractor	2,374	260	
Total	Contractor	6,511	260	26

(a) Number of operating days in a year, assuming 5 work days a week.

Alternative 3

A C&D Debris Central Processing Facility will be constructed in NCTS Finegayan. Concrete without lead-based paint and asphalt will be processed at the construction site; concrete with lead-based paint will be transported to the hardfill at the Navy Sanitary Landfill; and all other construction and demolition debris will be transported to the central processing facility by the contractor. Corrugated cardboard, wood pallets and scrap metal will be processed at the facility and all other construction and demolition debris, not intended for recycling, will then be transported to the hardfill at the Navy Sanitary Landfill by the DOD. The C&D debris will be transported and processed over a period of 5 years.

Construction and Demolition Materials Distribution

Location	Concrete with LBP (CY/yr)	Materials Disposed at Hardfill at Navy Sanitary Landfill (CY/yr)	Materials Sent to Central Processing Facility (CY/yr)
Andersen Air Force Base	36	1,284	5,321
Naval Base - Apra Harbor	116	611	1,049
NCTS Finegayan	245	83,847	287,118
South Finegayan	296	20,575	72,291
Total	694	106,317	365,779

Transportation of Concrete with LBP to Hardfill at the Navy Sanitary Landfill

Origin	Material to be Transported (CY/yr)	Truck Load (CY)	Truck Loads	Truck Loads per Day	Truck Cycles (b)
Andersen Air Force Base	36	11	4	2	3
Naval Base - Apra Harbor	116	11	11	3	4
NCTS Finegayan	245	11	23	2	12
South Finegayan	296	11	27	2	13
Ordnance Annex, Naval Magazine	0	11	0	3	0
Total Truck Cycles Per Year					32

(a) Assume 40 CY transfer trailer capacity; maximum payload is 22 tons; concrete density is 4000 lbs/cy.
(b) A daily truck cycle is the amount of production from one truck in one day.
(c) Quantities for the former FAA parcel are included with NCTS Finegayan quantities.

Transportation to Central Processing Facility

Origin	Material to be Transported (CY/yr)	Truck Load (CY)	Truck Loads	Truck Loads per Day	Truck Cycles (b)
Andersen Air Force Base	5,321	22	242	3	87
Naval Base - Apra Harbor	1,049	22	48	2	24
NCTS Finegayan	287,118	22	13,051	3	4,210
South Finegayan	72,291	22	3,286	3	1,060
Ordnance Annex, Naval Magazine	0	22	0	2	0
Total Truck Cycles Per Year					5,381

(a) Assume 40 CY transfer trailer capacity; maximum payload is 22 tons; C&D debris density is 2000 lbs/cy.
(b) A daily truck cycle is the amount of production from one truck in one day.
(c) Quantities for the former FAA parcel are included with NCTS Finegayan quantities.

Transportation from Central Processing Facility to Hardfill at the Navy Sanitary Landfill

Origin	Material to be Transported (CY/yr)	Truck Load (CY)	Truck Loads	Truck Loads/Day	Daily Truck Cycles (b)
Andersen Air Force Base	1,284	22	59	2	30
Naval Base - Apra Harbor	611	22	28	2	14
NCTS Finegayan	83,847	22	3,812	2	1,906
South Finegayan	20,575	22	936	2	468
Total Truck Cycles Per Year					2,418

(a) Assume 40 CY transfer trailer capacity; maximum payload is 22 tons; C&D debris density is 2000 lbs/cy.
(b) A daily truck cycle is the amount of production from one truck in one day.
(c) Quantities for the former FAA parcel are included with NCTS Finegayan quantities.

Trucks Required

Transportation by Contractor

Destination	Handled By	Daily Truck Cycles	Operating Days/Year (a)	Quantity of Trucks
Hardfill at Navy Sanitary Landfill	Contractor	32	260	
Central Processing Facility	Contractor	5,381	260	
Total	Contractor	5,413	260	21

(a) Number of operating days in a year, assuming 5 work days a week.

Transportation by DOD

Destination	Handled By	Daily Truck Cycles	Operating Days/Year (a)	Quantity of Trucks
Hardfill at Navy Sanitary Landfill	DOD	2,418	260	10

(a) Number of operating days in a year, assuming 5 work days a week.

Alternative 4

A C&D Debris Central Processing Facility will be constructed in NCTS Finegayan. All construction and demolition debris will be transported to the facility by the contractor. Corrugated cardboard, wood pallets, scrap metal, concrete and asphalt will be processed and all other construction and demolition debris, not intended for recycling, will then be transported to the hardfill at the Navy Sanitary Landfill by the DOD. The C&D debris will be transported and processed over a period of 5 years.

Construction and Demolition Debris Distribution

Location	Concrete with LBP (CY/yr)	Materials Disposed at Hardfill at Navy Sanitary Landfill (CY/yr)	Materials Sent to Central Processing Facility (CY/yr)
Andersen Air Force Base	36	1,248	9,713
Naval Base - Apra Harbor	116	494	2,495
NCTS Finegayan	245	83,602	300,651
South Finegayan	296	20,279	84,805
Total	694	105,623	397,665

Transportation of Concrete with LBP to Hardfill at the Navy Sanitary Landfill

Origin	Material to be Transported (CY/yr)	Truck Load (CY)	Truck Loads	Truck Loads per Day	Truck Cycles (b)
Andersen Air Force Base	36	11	4	2	3
Naval Base - Apra Harbor	116	11	11	3	4
NCTS Finegayan	245	11	23	2	12
South Finegayan	296	11	27	2	13
Ordnance Annex, Naval Magazine	0	11	0	3	0
Total Truck Cycles Per Year					32

(a) Assume 40 CY transfer trailer capacity; maximum payload is 22 tons; concrete density is 4000 lbs/cy.
(b) A daily truck cycle is the amount of production from one truck in one day.
(c) Quantities for the former FAA parcel are included with NCTS Finegayan quantities.

Transportation to Central Processing Facility

Origin	Material to be Transported (CY/yr)	Truck Load (CY)	Truck Loads	Truck Loads per Day	Daily Truck Cycles (b)
Andersen Air Force Base	9,713	15	648	3	232
Naval Base - Apra Harbor	2,495	15	167	2	84
NCTS Finegayan	300,651	15	20,044	3	6,466
South Finegayan	84,805	15	5,654	3	1,824
Ordnance Annex, Naval Magazine	0	15	0	2	0
Total Truck Cycles Per Year					8,606

(a) Assume 40 CY transfer trailer capacity; maximum payload is 22 tons; mixed C&D debris density is 3000 lbs/cy.
(b) A daily truck cycle is the amount of production from one truck in one day.
(c) Quantities for the former FAA parcel are included with NCTS Finegayan quantities.

Transportation from Central Processing Facility to Hardfill at the Navy Sanitary Landfill

Origin	Material to be Transported (CY/yr)	Truck Load (CY)	Truck Loads	Truck Loads/Day	Truck Cycles (b)
Andersen Air Force Base	1,248	22	57	2	29
Naval Base - Apra Harbor	494	22	23	2	12
NCTS Finegayan	83,602	22	3,801	2	1,901
South Finegayan	20,279	22	922	2	461
Total Truck Cycles Per Year					2,403

(a) Assume 40 CY transfer trailer capacity; maximum payload is 22 tons; C&D debris density is 2000 lbs/cy.
(b) A daily truck cycle is the amount of production from one truck in one day.
(c) Quantities for the former FAA parcel are included with NCTS Finegayan quantities.

Trucks Required

Transportation by Contractor

Destination	Handled By	Daily Truck Cycles	Operating Days/Year (a)	Quantity of Trucks
Hardfill at Navy Sanitary Landfill	Contractor	32	260	
Central Processing Facility	Contractor	8,606	260	
Total	Contractor	8,638	260	34

Transportation by DOD

Destination	Handled By	Daily Truck Cycles	Operating Days/Year (a)	Quantitiy of Trucks
Hardfill at Navy Sanitary Landfill	DOD	2,403	260	10

Daily Dump Truck Cycles

Central Processing Facility

Origin	Two-Way Travel Time (hrs) (a)	Addional Time Per Trip (hrs) (b)	Hours in Operation (c)	Trips/Day
Andersen Air Force Base	0.60	1.50	6.0	3
Naval Base - Apra Harbor	1.40	1.50	6.0	2
NCTS Finegayan	0.40	1.50	6.0	3
South Finegayan	0.40	1.50	6.0	3
Ordnance Annex, Naval Magazine	2.00	1.50	6.0	2

(a) Estimated vehicular speed of 30 miles per hour.
(b) Includes 45 min loading & unloading and 45 min washdown and inspection per trip.
(c) Estimated 6 hours of vehicle operation and 2 hours for start up and shut down time.

Hardfill at Navy Sanitary Landfill

Origin	Two-Way Travel Time (hrs) (a)	Additional Time Per Trip (hrs) (b)	Hours in Operation (c)	Trips/Day
Andersen Air Force Base	1.60	1.50	6.0	2
Naval Base - Apra Harbor	0.40	1.50	6.0	3
NCTS Finegayan	1.40	1.50	6.0	2
South Finegayan	1.20	1.50	6.0	2
Ordnance Annex, Naval Magazine	0.40	1.50	6.0	3

(a) Estimated vehicular speed of 30 miles per hour.
(b) Includes 45 min loading & unloading and 45 min washdown and inspection per trip.
(c) Estimated 6 hours of vehicle operation and 2 hours for start up and shut down time.

C&D Debris Central Processing Facility to Hardfill at the Navy Sanitary Landfill

C&D debris to be disposed will be transported from the central processing facility to the hardfill at the Navy Sanitary Landfill.

Destination	Two-Way Travel Time (hrs) (a)	Additional Time Per Trip (hrs) (b)	Hours in Operation (c)	Trips/Day
Hardfill at Navy Sanitary Landfill	1.40	1.50	6.0	2

(a) Estimated vehicular speed of 30 miles per hour.
(b) Includes 45 min loading & unloading and 45 min washdown and inspection per trip.
(c) Estimated 6 hours of vehicle operation and 2 hours for start up and shut down time.

Local Recyclers

Origin	Two-Way Travel Time (hrs) (a)	Additional Time Per Trip (hrs) (b)	Hours in Operation (c)	Trips/Day
Andersen Air Force Base	0.80	1.50	6.0	3
Naval Base - Apra Harbor	0.80	1.50	6.0	3
NCTS Finegayan	0.40	1.50	6.0	3
South Finegayan	0.40	1.50	6.0	3

(a) Estimated vehicular speed of 30 miles per hour.
(b) Includes 45 min loading & unloading and 45 min washdown and inspection per trip.
(c) Estimated 6 hours of vehicle operation and 2 hours for start up and shut down time.

Composting Facility

Origin	Two-Way Travel Time (hrs) (a)	Additional Time Per Trip (hrs) (b)	Hours in Operation (c)	Trips/Day
Andersen Air Force Base	0.60	1.50	6.0	3
Naval Base - Apra Harbor	2.00	1.50	6.0	2
NCTS Finegayan	0.40	1.50	6.0	3
South Finegayan	0.40	1.50	6.0	3
Ordnance Annex, Naval Magazine	2.00	1.50	6.0	2

(a) Estimated vehicular speed of 30 miles per hour.
(b) Includes 45 min loading & unloading and 45 min washdown and inspection per trip.
(c) Estimated 6 hours of vehicle operation and 2 hours for start up and shut down time.

Distances and Travel Times

	Hardfill at Navy Sanitary Landfill		
Origin	**Distance (km)**	**Distance (mi)**	**RT Time (hours)**
Andersen Air Force Base	40.5	25.2	1.60
Naval Base - Apra Harbor	3.5	2.2	0.40
NCTS Finegayan	32.7	20.3	1.40
South Finegayan	29.0	18.0	1.20
Ordnance Annex, Naval Magazine	8.1	5.0	0.40
Central Processing Facility	35.0	21.7	1.40

	C&D Debris Central Processing Facility		
Origin	**Distance (km)**	**Distance (mi)**	**RT Time (hours)**
Andersen Air Force Base	16.3	10.1	0.60
Naval Base - Apra Harbor	34.9	21.7	1.40
NCTS Finegayan	2.9	1.8	0.40
South Finegayan	5.4	3.4	0.40
Ordnance Annex, Naval Magazine	46.7	29.0	2.00

	Local Recycling Centers		
Origin	**Distance (km)**	**Distance (mi)**	**RT Time (hours)**
Andersen Air Force Base	19.4	12.1	0.80
Naval Base - Apra Harbor	21.7	13.5	0.80
NCTS Finegayan	11.6	7.2	0.40
South Finegayan	7.9	4.9	0.40

	Composting Facility		
Origin	**Distance (km)**	**Distance (mi)**	**RT Time (hours)**
Andersen Air Force Base	16.3	10.1	0.60
Naval Base - Apra Harbor	46.7	29.0	2.00
NCTS Finegayan	2.9	1.8	0.40
South Finegayan	5.4	3.4	0.40
Ordnance Annex, Naval Magazine	46.7	29.0	2.00

(a) Estimated vehicular speed of 30 miles per hour.

(b) RT = Round Trip

Alternative 1: Concrete and Asphalt On-Site Material Processing

Concrete and asphalt will be processed at the construction and demolition site using concrete crushers and an excavator to load it.

Quantity of Material to be Crushed

Location	Concrete (CY/Year)	Asphalt (CY/Year)
Andersen Air Force Base	961	3,468
Naval Base - Apra Harbor	1,179	383
NCTS Finegayan	9,118	4,219
South Finegayan	10,912	1,897
Ordnance Annex, Naval Magazine	0	0

Concrete and Asphalt Crushing

Location	Material to be crushed (CY/Year)	Crusher Capacity (CY/Month)	Concrete Crushers	Months Per Year (a)
Andersen Air Force Base	4,429	5,200	1	1
Naval Base - Apra Harbor	1,562	5,200	1	1
NCTS Finegayan	13,337	5,200	1	3
South Finegayan	12,809	5,200	1	3
Ordnance Annex, Naval Magazine	0	5,200	1	0
Total				8

(a) Months per year that the specified number of conrete crushers will be needed at each location.
(b) Quantities for the former FAA parcel are included with NCTS Finegayan quantities.

Concrete Crushing Equipment Summary	No.	Months
Total Number of Concrete Crusher Attachments	1	8
Total Number of 25 Ton Excavators	1	8

Concrete Crushing Personnel Summary	No.	Months
Heavy Equipment Operators	1	8
General Laborers	1	8

Alternative 2: Untreated Wood On-Site Material Processing

Untreated wood will be processed at the construction and demolition site using wood chippers and a front end loader to load it.

Quantity of Material to be Chipped

Location	Wood (CY/Year)
Andersen Air Force Base	660
Naval Base - Apra Harbor	166
NCTS Finegayan	19,276
South Finegayan	9,186
Ordnance Annex, Naval Magazine	0

Untreated Wood to be Chipped

Location	Material to be Chipped (CY/Year)	Wood Chipper Capacity (CY/Month)	Wood Chippers	Months Per Year (a)
Andersen Air Force Base	660	7,800	1	1
Naval Base - Apra Harbor	166	7,800	1	1
NCTS Finegayan	19,276	7,800	1	3
South Finegayan	9,186	7,800	1	2
Ordnance Annex, Naval Magazine	0	7,800	1	0
Total				7

(a) Months per year that the specified number of wood chippers will be needed at each location.
(b) Quantities for the former FAA parcel are included with NCTS Finegayan quantities.

Wood Chipping Equipment Summary	No.	Months
Total Number of Wood Chippers	1	7
Total Number of Front End Loaders	1	7

Wood Chippers Personnel Summary	No.	Months
Heavy Equipment Operators	1	7
General Laborers	1	7

Alternative 3: Concrete and Asphalt On-Site Material Processing

Concrete and asphalt will be processed at the construction and demolition site using concrete crushers and an excavator to load it.

Quantity of Material to be Crushed

Location	Concrete (CY/Year)	Asphalt (CY/Year)
Andersen Air Force Base	961	3,468
Naval Base - Apra Harbor	1,179	383
NCTS Finegayan	9,118	4,219
South Finegayan	10,913	1,897
Ordnance Annex, Naval Magazine	0	0

Concrete and Asphalt Crushing

Location	Material to be crushed (CY/Year)	Crusher Capacity (CY/Month)	Concrete Crushers	Months Per Year (a)
Andersen Air Force Base	4,428	5,200	1	1
Naval Base - Apra Harbor	1,563	5,200	1	1
NCTS Finegayan	13,337	5,200	1	3
South Finegayan	12,810	5,200	1	3
Ordnance Annex, Naval Magazine	0	5,200	1	0
Total				8

(a) Months per year that the specified number of conrete crushers will be needed at each location.

Concrete Crushing Equipment Summary	No.	Months
Total Number of Concrete Crusher Attachments	1	8
Total Number of 25 Ton Excavators	1	8

Concrete Crushing Personnel Summary	No.	Months
Heavy Equipment Operators	1	8
General Laborers	1	8

NET PRESENT VALUE SUMMARY

Life Cycle Years	Net Present Value	Description
5	$30,300,000	Composting Facility

PRESENT VALUE ANALYSIS

Calendar Year	Composting Facility		
	Total Capital		**NPV**
	$4,932,285		$30,306,346
		Rounded NPV	$30,300,000
	Capital	**Operating**	**Total**
2011	7,234,381	5,487,264	12,721,644
2012		5,487,264	5,487,264
2013		5,487,264	5,487,264
2014		5,487,264	5,487,264
2015	(2,302,096)	5,487,264	3,185,168

COST SUMMARY-COMPOSTING FACILITY

Description	Cost	Remarks
Discount Factor	2.800%	
Capital Costs		
Capital Costs - 2011	$7,234,381	Initial capital cost
Capital Costs - 2015	$2,302,096	Equipment Salvage Value
Annual Operating Costs		
Operating Costs 2011 to 2015	$5,487,264	The building will only be operating for the first 5 years.

OPERATION AND MAINTENANCE COSTS

COMPOSTING						
Building Maintenance	**Quantity**	**Hours/Day**	**Equipment $/hour**	**Daily Cost**		**Annual Cost**
Total Building Maintenance Cost 2011 - 2015						**$9,351**
Operations and Maintenance (2011-2015)	**Quantity**	**Hours/Day**	**Equipment $/hour**	**Daily Cost**		**Annual Cost**
Front End Loader Maintenance	1					$54,098
Front End Loader Maintenance (used-backup)	1					$21,639
Front End Loader Operation	1	6	$75.00	$450.00		$117,000
Wood Chipper Maintenance	1					$17,311
Wood Chipper Operation	1	8	$52.70	$421.60		$109,616
Truck Scale Maintenance	1					$10,820
Bobcat Maintenance	1					$6,492
Total O&M Cost						**$336,977**
PERSONNEL (2011-2015)	**Quantity**	**Hours/Day**	**Wage $/hour**	**Daily Cost**		**Annual Cost**
Operator for Front End Loader	1	8	$39.54	$316.31		$82,241
Operator for Wood Chipper	1	8	$39.54	$316.31		$82,241
Receiving/Transfer/Processing						
Supervisors	0.5	8	$52.71	$210.84		$54,818
Rolling stock operators	2	8	$39.51	$632.22		$164,377
General laborers/spotters/floor sort	3	8	$35.46	$850.95		$221,248
Vehicle and Equipment Maintenance						
Mechanics	0.5	8	$43.18	$172.74		$44,912
Mechanics helper	0.5	8	$35.46	$141.83		$36,875
Administration						
Facility Manager	0.5	8	$68.56	$274.24		$71,303
Accounting/Personnel Manager	0.5	8	$35.46	$141.83		$36,875
Secretary/Receptionist	0.5	8	$35.46	$141.83		$36,875
Total Personnel Cost						**$831,763**
Contractor Transportation O&M (2011-2015)	**Quantity**	**Hours/Day**	**Cost $/hour**	**Daily Cost**		**Annual Cost**
40 CY Transfer Trailer Operation	23	6	$13.00	$1,794.00		$466,440
40 CY Transfer Trailer Maintenance	23					$479,368
Total Contract Work Cost						$945,808
Contractor Overhead					30%	$283,743
Subtotal						$1,229,551
Profit					10%	$122,955
Subtotal						$1,352,506
Bid Bond					2%	$27,050
Subtotal						$1,379,556
Guam Tax					4%	$57,486
Total Contractor Transportation Fee (2011-2015)						**$1,437,042**

OPERATION AND MAINTENANCE COSTS

Contractor Labor (2011-2015)	Quantity	Hours/Day	Wage $/hour	Daily Cost		Annual Cost
Drivers/Operators for Transfer Trailers	23	8	$39.51	$7,270.50		$1,890,331
Total Contract Work Cost						$1,890,331
Contractor Overhead					30%	$567,099
Subtotal						$2,457,430
Profit					10%	$245,743
Subtotal						$2,703,173
Bid Bond					2%	$54,063
Subtotal						$2,757,236
Guam Tax					4%	$114,894
Total Contractor Labor Fee (2011-2015)						**$2,872,130**

Total Operating Cost	**2011 to 2015**	**$5,487,264**

(a) Vehicle and equipment maintenance cost is 10% of capital costs on annual basis.

CAPITAL COSTS

COMPOSTING FACILITY			
Item	**Unit Cost**	**Quantity**	**Total Cost**
Building		1	
Admin office/scale operations	$935,100	1	$935,100.00
Stationary Equipment			
Wood Chipper	$173,114.75	1	$173,114.75
Wood Chipper Processing Line	$324,590.16	1	$324,590.16
Truck Scales	$108,196.72	1	$108,196.72
Truck Scale Installation	$16,800.00	1	$16,800.00
Chain Link Fence (per LF)	$30	2020	$60,600.00
Rolling Stock			
Front End Loader	$540,983.61	1	$540,983.61
Front End Loader (used-backup)	$216,393.44	1	$216,393.44
Bobcat	$64,918.03	1	$64,918.03
Total Composting Facility Cost			**$2,440,696.72**

Contractor Capital Costs	**Unit Cost**	**Quantity**	**Total Cost**
Equipment			
Transfer Trailer	$208,421	23	$4,793,684.21
Total Contractor Capital Costs			**$4,793,684.21**
Contractor Equipment Salvage Value		37%	$1,773,663.16
Total Equipment Salvage Value		37%	$2,302,095.94
Total Capital Costs			**$7,234,380.93**

Green Waste

Green Waste Composting

Green Waste Distribution

Location	To Composting Facility (CY/yr)
Andersen Air Force Base	3,931
Naval Base - Apra Harbor	9,217
NCTS Finegayan	376,018
South Finegayan	23,446
Ordnance Annex, Naval Magazine	100
Former FAA Parcel	258,129
Total	670,841

Transportation to Composting Facility

Origin	Material to be Transported (CY/yr)	Truck Load (CY)	Truck Loads	Truck Loads per Day	Truck Cycles (b)
Andersen Air Force Base	3,931	40	99	2	50
Naval Base - Apra Harbor	9,217	40	231	1	231
NCTS Finegayan	376,018	40	9,401	3	3,134
South Finegayan	23,446	40	587	3	196
Ordnance Annex, Naval Magazine	100	40	3	2	2
Former FAA Parcel	258,129	40	6,454	3	2,152
Total					5,765

(a) Assume 40 CY transfer trailer capacity; maximum payload is 22 tons; green waste density is 1000 lbs/cy.
(b) A daily truck cycle is the amount of production from one truck in one day.

Trucks Required

Transport Green Waste to Composting Facility

Destination	Daily Truck Cycles	Operating Days/Year	Quantity of Trucks
Composting Facility	5,765	260	23

Daily Dump Truck Cycles

Composting Facility

Origin	Two-Way Travel Time (hrs) (a)	Downtime Time Per Trip (hrs) (b)	Hours in Operation (c)	Trips/Day
Andersen Air Force Base	0.60	1.50	6.0	2
Naval Base - Apra Harbor	2.00	1.50	6.0	1
NCTS Finegayan	0.40	1.50	6.0	3
South Finegayan	0.40	1.50	6.0	3
Ordnance Annex, Naval Magazine	1.40	1.50	6.0	2
Former FAA Parcel	0.40	1.50	6.0	3

(a) Estimated vehicular speed of 30 miles per hour.
(b) Includes 45 min loading & unloading and 45 min washdown and inspection per trip.
(c) Estimated 6 hour of vehicle operation and 2 hours of start up and shut down time.

Distances and Travel Times

	Hardfill at Navy Sanitary Landfill		
Origin	Distance (km)	Distance (mi)	RT Time (hours)
Andersen Air Force Base	40.5	25.2	1.60
Naval Base - Apra Harbor	3.5	2.2	0.40
NCTS Finegayan	32.7	20.3	1.40
South Finegayan	29.0	18.0	1.20
Ordnance Annex, Naval Magazine	8.1	5.0	0.40
Processing Center	35.0	21.7	1.40

	Composting Facility		
Origin	Distance (km)	Distance (mi)	RT Time (hours)
Andersen Air Force Base	16.3	10.1	0.60
Naval Base - Apra Harbor	46.7	29.0	2.00
NCTS Finegayan	2.9	1.8	0.40
South Finegayan	5.4	3.4	0.40
Ordnance Annex, Naval Magazine	35.0	21.7	1.40
Former FAA Parcel	4.2	2.6	0.40

(a) Estimated vehicular speed of 30 miles per hour.

	C&D Debris Central Processing Facility		
Origin	Distance (km)	Distance (mi)	RT Time (hours)
Andersen Air Force Base	16.3	10.1	0.60
Naval Base - Apra Harbor	46.7	29.0	2.00
NCTS Finegayan	2.9	1.8	0.40
South Finegayan	5.4	3.4	0.40
Ordnance Annex, Naval Magazine	35.0	21.7	1.40

(a) Estimated vehicular speed of 30 miles per hour.

(b) RT = Round Trip

Woody Green Waste On-Site Material Processing

Woody green waste will be processed at the construction and demolition site using wood chippers and a front end loader to load it.

Quantity of Material to be Chipped

Location	Woody Green Waste (CY/Year)
Andersen Air Force Base	461
Naval Base - Apra Harbor	1,231
NCTS Finegayan	50,777
South Finegayan	2,945
Ordnance Annex, Naval Magazine	0
Former FAA Parcel	35,199

Woody Green Waste Chipping

Location	Material to be Chipped (CY/Year)	Wood Chipper Capacity (CY/Month)	Wood Chippers	Months Per Year (a)
Andersen Air Force Base	461	7,800	1	1
Naval Base - Apra Harbor	1,231	7,800	1	1
NCTS Finegayan	50,777	7,800	1	7
South Finegayan	2,945	7,800	1	1
Ordnance Annex, Naval Magazine	0	7,800	1	0
Former FAA Parcel	35,199	7,800	1	5
Total				15

(a) Months per year that the specified number of wood chippers will be needed at each location.
(b) Wood chipper capacity is based on operations 8 hrs per day.

Wood Chipper Equipment Summary	**No.**	**Months**
Total Number of Wood Chippers	2	7.5
Total Number of Front End Loaders	2	7.5

Wood Chipper Personnel Summary	**No.**	**Months**
Heavy Equipment Operators	2	7.5
General Laborers	2	7.5

Appendix E.2

Cost Data – 10-Year Life Cycle Analysis

10-Year Life Cycle Analysis

NET PRESENT VALUE SUMMARY

Alternative	Life Cycle Years	Net Present Value	Description
1	10	$71,600,000	Contractor continues to process all C&D debris. Construct a composting facility to process a portion of green waste.
2	10	$83,700,000	Construct a C&D debris central processing facility that recovers concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.
3	10	$83,800,000	Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard and untreated wood. Construct a composting facility to process a portion of green waste.
4	10	$93,500,000	Construct a C&D debris central processing facility that recovers scrap metal, old corrugated cardboard, untreated wood, concrete without lead-based paint and asphalt. Construct a composting facility to process a portion of green waste.

PRESENT VALUE ANALYSIS

Calendar	ALTERNATIVE 1			ALTERNATIVE 2			ALTERNATIVE 3			ALTERNATIVE 4		
	Total Capital		**NPV**	**Total Capital**		**NPV**	**Total Capital**		**NPV**	**Total Capital**		**NPV**
	$10,051,705		$71,561,044	$11,979,925		$83,628,519	$16,792,886		$83,788,558	$17,984,387		$93,473,827
		Rounded NPV	$71,600,000		Rounded NPV	$83,700,000		Rounded NPV	$83,800,000		Rounded NPV	$93,500,000
	Capital	**Operating**	**Total**	**Capital**	**Operating**	**Total**	**Capital**	**Operating**	**Total**	**Capital**	**Operating**	**Total**
2011	10,051,705	7,169,134	17,220,839	11,979,925	8,351,758	20,331,682	16,792,886	7,827,058	24,619,944	17,984,387	8,816,416	26,800,802
2012		7,169,134	7,169,134		8,351,758	8,351,758		7,827,058	7,827,058		8,816,416	8,816,416
2013		7,169,134	7,169,134		8,351,758	8,351,758		7,827,058	7,827,058		8,816,416	8,816,416
2014		7,169,134	7,169,134		8,351,758	8,351,758		7,827,058	7,827,058		8,816,416	8,816,416
2015		7,169,134	7,169,134		8,351,758	8,351,758		7,827,058	7,827,058		8,816,416	8,816,416
2016		7,169,134	7,169,134		8,351,758	8,351,758		7,827,058	7,827,058		8,816,416	8,816,416
2017		7,169,134	7,169,134		8,351,758	8,351,758		7,827,058	7,827,058		8,816,416	8,816,416
2018		7,169,134	7,169,134		8,351,758	8,351,758		7,827,058	7,827,058		8,816,416	8,816,416
2019		7,169,134	7,169,134		8,351,758	8,351,758		7,827,058	7,827,058		8,816,416	8,816,416
2020		7,169,134	7,169,134		8,351,758	8,351,758		7,827,058	7,827,058		8,816,416	8,816,416

COST SUMMARY

Description	Cost	Remarks
Discount Factor	2.800%	
Capital Costs		
Alternative 1		
Capital Costs - 2011	$10,051,705	Initial capital cost
Alternative 2		
Capital Costs - 2011	$11,979,925	Initial capital cost
Alternative 3		
Capital Costs - 2011	$16,792,886	Initial capital cost
Alternative 4		
Capital Costs - 2011	$17,984,387	Initial capital cost
Annual Operating Costs		
Alternative 1		
Operating Costs 2011 to 2020	$7,169,134	The building will only be operating for the first 10 years.
Alternative 2		
Operating Costs 2011 to 2020	$8,351,758	The building will only be operating for the first 10 years.
Alternative 3		
Operating Costs 2011 to 2020	$7,827,058	The building will only be operating for the first 10 years.
Alternative 4		
Operating Costs 2011 to 2020	$8,816,416	The building will only be operating for the first 10 years.

OPERATION AND MAINTENANCE COSTS

ALTERNATIVE 1

Building Maintenance	Quantity	Hours/Day	Equipment $/hour	Daily Cost		Annual Cost
Composting Facility Maintenance Cost 2011 - 2020						**$9,351**

Contractor Processing O&M (2011-2020)	Quantity	Hours/Day	Cost $/hour	Daily Cost		Annual Cost
Concrete Crusher Maintenance	1					$25,967
Concrete Crusher Operation	1	6	$21.00	$126.00		$16,380
Front End Loader Maintenance	1					$54,098
Front End Loader Operation	1	6	$75.00	$450.00		$58,500
Wood Chipper Maintenance	1					$17,311
Wood Chipper Operation	1	8	$52.70	$421.60		$91,347
Total Contract Work Cost						$154,946
Contractor Overhead					30%	$46,484
Subtotal						$201,429
Profit					10%	$20,143
Subtotal						$221,572
Bid Bond					2%	$4,431
Subtotal						$226,004
Guam Tax					4%	$9,418
Total Contractor Processing Fee (2011-2020)						**$235,421**

(a) Concrete and asphalt crushing operations occur 6 months out of the year.
(b) Equipment maintenance costs are based on 10% of the initial capital cost.

Contractor Transportation O&M (2011-2020)	Quantity	Hours/Day	Cost $/hour	Daily Cost		Annual Cost
Transfer Trailer Maintenance	16					$333,474
Transfer Trailer Operation	16	6	$13.00	$1,248.00		$324,480
Total Contract Work Cost						$657,954
Contractor Overhead					30%	$197,386
Subtotal						$855,340
Profit					10%	$85,534
Subtotal						$940,874
Bid Bond					2%	$18,817
Subtotal						$959,691
Guam Tax					4%	$39,990
Total Contractor Transportation Fee (2011-2020)						**$999,682**

Contractor Labor (2011-2015)	Quantity	Hours/Day	Wage $/hour	Daily Cost		Annual Cost
Operator for Concrete Crusher	1	8	$39.54	$316.31		$41,120
Operator for Front End Loader	1	8	$39.54	$316.31		$41,120
Operator for Wood Chipper	1	8	$39.54	$316.31		$68,534
Drivers/Operators for 40 CY Transfer Trailers	16	8	$39.51	$5,057.74		$1,315,013
Total Contract Work Cost						$1,465,787
Contractor Overhead					30%	$439,736
Subtotal						$1,905,523
Profit					10%	$190,552
Subtotal						$2,096,076
Bid Bond					2%	$41,922
Subtotal						$2,137,997
Guam Tax					4%	$89,090
Total Contractor Labor Fee (2011-2020)						**$2,227,088**

Composting Facility (2011-2020)		Cost
Facility and Processing O&M		$309,573
Transportation O&M		$871,532
Labor		$2,316,559
Total Composting Facility Cost		**$3,497,664**
Navy Sanitary Landfill Tipping Fee	$1.65/CY	**$199,929**
Alternative 1 Total Operating Cost — **2011 to 2020**		**$7,169,134**

(a) Vehicle maintenance cost is 10% of capital costs on annual basis.
(b) Contractor on-site processing of concrete and asphalt occurs an average of 6 months out of the year
(c) Receiving and processing at transfer station occurs 312 days a year, 8 hours a day
(d) Contractor on-site processing of woody green waste occurs an average of 10 months out of the year

OPERATION AND MAINTENANCE COSTS

ALTERNATIVE 2						
Building Maintenance	**Quantity**	**Hours/Day**	**Equipment $/hour**	**Daily Cost**		**Annual Cost**
Total Building Maintenance Cost 2011 - 2020						**$9,351**
Composting Facility Maintenance Cost 2011 - 2020						**$9,351**
Operations and Maintenance (2011-2020)	**Quantity**	**Hours/Day**	**Equipment $/hour**	**Daily Cost**		**Annual Cost**
Front End Loader Maintenance	1					$54,098
Front End Loader Maintenance (used-backup)	1					$21,639
Front End Loader Operation	1	6	$75.00	$450.00		$58,500
Concrete Crusher Maintenance	1					$25,967
Concrete Crusher Operation	1	6	$21.00	$126.00		$16,380
Truck Scale Maintenance	1					$10,820
Bobcat Maintenance	1					$6,492
Utility Pick-Up Truck Maintenance	1					$6,492
Total O&M Cost						**$200,388**
PERSONNEL (2011-2020)	**Quantity**	**Hours/Day**	**Wage $/hour**	**Daily Cost**		**Annual Cost**
Operators for Concrete Crushers	1	8	$39.54	$316.31		$41,120
Operators for Front End Loaders	1	8	$39.54	$316.31		$41,120
General laborers/spotters/floor sort	4	8	$35.46	$1,134.60		$294,997
Vehicle and Equipment Maintenance						
Mechanics	1	8	$43.18	$345.48		$89,824
Mechanics helper	1	8	$35.46	$283.65		$73,749
Administration						
Facility Manager	0.5	8	$68.56	$274.24		$71,303
Accounting/Personnel Manager	0.5	8	$35.46	$141.83		$36,875
Secretary/Receptionist	0.5	8	$35.46	$141.83		$36,875
Total Personnel Cost						**$1,069,540**
Contractor Processing O&M (2011-2020)	**Quantity**	**Hours/Day**	**Cost $/hour**	**Daily Cost**		**Annual Cost**
Wood Chipper Maintenance	1					$17,311
Wood Chipper Operation	1	8	$52.70	$421.60		$109,616
Front End Loader Maintenance	1					$54,098
Front End Loader Operation	1	6	$27.65	$165.90		$21,567
Cardboard Disposal[a]						$196,906
Total Contract Work Cost						$399,499
Contractor Overhead					30%	$119,850
Subtotal						$519,348
Profit					10%	$51,935
Subtotal						$571,283
Bid Bond					2%	$11,426
Subtotal						$582,709
Guam Tax					4%	$24,281
Total Contractor Processing Fee (2011-2020)						**$606,990**
Contractor Transportation O&M (2011-2020)	**Quantity**	**Hours/Day**	**Cost $/hour**	**Daily Cost**		**Annual Cost**
40 CY Transfer Trailer Maintenance	13					$270,947
40 CY Transfer Trailer Operation	13	6	$13.00	$1,014.00		$263,640
Total Contract Work Cost						$534,587
Contractor Overhead					30%	$160,376
Subtotal						$694,964
Profit					10%	$69,496
Subtotal						$764,460
Bid Bond					2%	$15,289
Subtotal						$779,749
Guam Tax					4%	$32,492
Total Contractor Transportation Fee (2011-2020)						**$812,241**

OPERATION AND MAINTENANCE COSTS

Contractor Labor (2011-2015)	Quantity	Hours/Day	Wage $/hour	Daily Cost		Annual Cost
Drivers/Operators for Transfer Trailers	13	8	$39.51	$4,109.41		$1,068,448
Operators for Front End Loader	1	8	$39.54	$316.31		$41,120
Operators for Wood Chipper	1	8	$39.54	$316.31		$82,241
Total Contract Work Cost						$1,191,809
Extra Effort to Sort C&D Debris					15%	$178,771
Subtotal						$1,370,580
Contractor Overhead					30%	$411,174
Subtotal						$1,781,754
Profit					10%	$178,175
Subtotal						$1,959,930
Bid Bond					2%	$39,199
Subtotal						$1,999,128
Guam Tax					4%	$83,304
Total Contractor Labor Fee (2011-2020)						**$2,082,432**

(a) Disposal of cardboard at $3.00/CY
(b) Wood chipping operations include woody green waste and untreated wood.
(c) Concrete and asphalt crushing operations occur 6 months out of the year.
(d) Equipment maintenance costs are based on 10% of the initial capital cost.

Composting Facility (2011-2020)	Cost
Facility and Processing O&M	$309,573
Transportation O&M	$871,532
Labor	$2,316,559
Total Composting Facility Cost	**$3,497,664**

Navy Sanitary Landfill Tipping Fee		$1.65/CY	**$63,801**
Alternative 2 Total Operating Cost	**2011 to 2020**		**$8,351,758**

(a) Vehicle maintenance cost is 10% of capital costs on annual basis.
(b) Administration staff works 260 days a year, 8 hours a day
(c) Receiving and processing at transfer station occurs 312 days a year, 8 hours a day

OPERATION AND MAINTENANCE COSTS

ALTERNATIVE 3

Building Maintenance	Quantity	Hours/Day	Equipment $/hour	Daily Cost	Annual Cost
Total Building Maintenance Cost 2011 - 2020					**$60,280**
Composting Facility Maintenance Cost 2011 - 2020					**$9,351**

Transportation O&M (2011-2020)	Quantity	Hours/Day	Equipment $/hour	Daily Cost	Annual Cost
Transfer Trailer Operation	5	6	$13.00	$390.00	$101,400
Transfer Trailer Maintenance	5	6			$104,211
Facility and Processing O&M Cost					**$205,611**

Facility and Processing O&M (2011-2020)	Quantity	Hours/Day	Equipment $/hour	Daily Cost	Annual Cost
Front End Loader Maintenance	1				$54,098
Front End Loader Maintenance (used-backup)	1				$21,639
Front End Loader Operation	1	6	$27.65	$165.90	$21,567
Wood Chipper Maintenance	1				$17,311
Wood Chipper Operation	1	8	$52.70	$421.60	$45,673
Truck Scale Maintenance	1				$10,820
Forklift Maintenance	1				$10,820
Mini-Sweeper Maintenance	1				$10,820
Baler Maintenance	1				$23,158
Bobcat Maintenance	1				$6,492
Utility Pick-Up Truck Maintenance	1				$6,492
Facility and Processing O&M Cost					**$228,890**

(a) Wood chipping operations occur 5 months out of the year at the central processing facility for untreated wood.

PERSONNEL (2011-2020)	Quantity	Hours/Day	Wage $/hour	Daily Cost	Annual Cost
Drivers/Operators for Transfer Trailers	5	8	$39.51	$1,580.54	$410,941
Operators for Front End Loader	1	8	$39.54	$316.31	$41,120
Operators for Wood Chipper	1	8	$39.54	$316.31	$34,267
Receiving/Transfer/Processing					
Supervisors	0.5	8	$52.71	$210.84	$54,818
Rolling stock operators	2	8	$39.51	$632.22	$164,377
General laborers/spotters/floor sort	3	8	$35.46	$850.95	$221,248
Vehicle and Equipment Maintenance					
Mechanics	1	8	$43.18	$345.48	$89,824
Mechanics helper	1	8	$35.46	$283.65	$73,749
Administration					
Facility Manager	0.5	8	$68.56	$274.24	$71,303
Accounting/Personnel Manager	0.5	8	$35.46	$141.83	$36,875
Secretary/Receptionist	0.5	8	$35.46	$141.83	$36,875
Total Personnel Cost					**$1,235,397**

OPERATION AND MAINTENANCE COSTS

Contractor Processing O&M (2011-2020)	Quantity	Hours/Day	Cost $/hour	Daily Cost		Annual Cost
Concrete Crusher Maintenance	1					$25,967
Concrete Crusher Operation	1	6	$21.00	$126.00		$16,380
Front End Loader Maintenance	1					$54,098
Front End Loader Operation	1	6	$75.00	$450.00		$58,500
Wood Chipper Maintenance	1					$17,311
Wood Chipper Operation	1	8	$52.70	$421.60		$91,347
Total Contract Work Cost						$154,946
Contractor Overhead					30%	$46,484
Subtotal						$201,429
Profit					10%	$20,143
Subtotal						$221,572
Bid Bond					2%	$4,431
Subtotal						$226,004
Guam Tax					4%	$9,418
Total Contractor Processing Fee (2011-2020)						**$235,421**

(a) Cardboard is assumed to be delivered to a DoD recycling center.
(b) Wood chipping operations occur 10 months out of the year for contractors processing woody green waste on-site.
(c) Concrete and asphalt crushing operations occur 6 months out of the year.
(d) Equipment maintenance costs are based on 10% of the initial capital cost.

Contractor Transportation O&M (2011-2020)	Quantity	Hours/Day	Cost $/hour	Daily Cost		Annual Cost
Transfer Trailer Maintenance	11					$229,263
Transfer Trailer Operation	11	6	$13.00	$858.00		$223,080
Total Contract Work Cost						$452,343
Contractor Overhead					30%	$135,703
Subtotal						$588,046
Profit					10%	$58,805
Subtotal						$646,851
Bid Bond					2%	$12,937
Subtotal						$659,788
Guam Tax					4%	$27,493
Total Contractor Transportation Fee (2011-2020)						**$687,281**

Contractor Labor (2011-2015)	Quantity	Hours/Day	Wage $/hour	Daily Cost		Annual Cost
Drivers/Operators for 40 CY Transfer Trailers	11	8	$39.51	$3,477.20		$904,071
Operator for Front End Loader	1	8	$39.54	$316.31		$41,120
Operator for Wood Chipper	1	8	$39.54	$316.31		$68,534
Operator for Concrete Crusher	1	8	$39.54	$316.31		$41,120
Total Contract Work Cost						$1,054,846
Contractor Overhead					30%	$316,454
Subtotal						$1,371,300
Profit					10%	$137,130
Subtotal						$1,508,429
Bid Bond					2%	$30,169
Subtotal						$1,538,598
Guam Tax					4%	$64,113
Total Contractor Labor Fee (2011-2020)						**$1,602,711**

(a) Concrete and asphalt crushing operations occur 6 months out of the year.

Composting Facility (2011-2020)		Cost
Facility and Processing O&M		$309,573
Transportation O&M		$871,532
Labor		$2,316,559
Total Composting Facility Cost		**$3,497,664**
Navy Sanitary Landfill Tipping Fee	$1.65/CY	**$64,451**
Alternative 3 Total Operating Cost — **2011 to 2020**		**$7,827,058**

(a) Vehicle maintenance cost is 10% of capital costs on annual basis.
(b) Contractor on-site processing of concrete and asphalt occurs an average of 6 months out of the year
(c) Receiving and processing at transfer station occurs 312 days a year, 8 hours a day

OPERATION AND MAINTENANCE COSTS

ALTERNATIVE 4						
Building Maintenance	**Quantity**	**Hours/Day**	**Equipment $/hour**	**Daily Cost**		**Annual Cost**
Total Building Maintenance Cost 2010 - 2019						**$59,586**
Composting Facility Maintenance Cost 2011 - 2020						**$9,351**
Transportation O&M (2011-2020)	**Quantity**	**Hours/Day**	**Equipment $/hour**	**Daily Cost**		**Annual Cost**
Transfer Trailer Operation	5	6	$13.00	$390.00		$101,400
Transfer Trailer Maintenance	5	6				$104,211
Transportation O&M Cost						**$205,611**
Facility and Processing O&M (2011-2020)	**Quantity**	**Hours/Day**	**Equipment $/hour**	**Daily Cost**		**Annual Cost**
Front End Loader Maintenance	1					$54,098
Front End Loader Maintenance (used-backup)	1					$21,639
Front End Loader Operation	1	6	$75.00	$450.00		$58,500
Concrete Crusher Maintenance	1					$25,967
Concrete Crusher Operation	1	6	$21.00	$126.00		$16,380
Wood Chipper Maintenance	1					$17,311
Wood Chipper Operation	1	8	$52.70	$421.60		$45,673
Truck Scale Maintenance	1					$10,820
Forklift Maintenance	1					$10,820
Mini-Sweeper Maintenance	1					$10,820
Baler Maintenance	1					$23,158
Bobcat Maintenance	1					$6,492
Utility Pick-Up Truck Maintenance	1					$6,492
Facility and Processing O&M Cost						**$308,170**
PERSONNEL (2011-2020)	**Quantity**	**Hours/Day**	**Wage $/hour**	**Daily Cost**		**Annual Cost**
Drivers/Operators for Transfer Trailers	5	8	$39.51	$1,580.54		$410,941
Operator for Front End Loaders	1	8	$39.54	$316.31		$41,120
Operator for Concrete Crusher	1	8	$39.54	$316.31		$41,120
Operator for Wood Chipper	1	8	$39.54	$316.31		$34,267
General laborers/spotters/floor sort	4	8	$35.46	$1,134.60		$294,997
Vehicle and Equipment Maintenance						
Mechanics	1	8	$43.18	$345.48		$89,824
Mechanics helper	1	8	$35.46	$283.65		$73,749
Administration						
Facility Manager	0.5	8	$68.56	$274.24		$71,303
Accounting/personnel Manager	0.5	8	$35.46	$141.83		$36,875
Secretary/Receptionist	0.5	8	$35.46	$141.83		$36,875
Total Personnel Cost						**$1,316,113**

(a) Wood chipping operations occur 5 months out of the year at the central processing facility for untreated wood.

Contractor Transportation O&M (2011-2020)	**Quantity**	**Hours/Day**	**Cost $/hour**	**Daily Cost**		**Annual Cost**
Transfer Trailer Maintenance	17					$354,316
Transfer Trailer Operation	17	6	$13.00	$1,326.00		$344,760
Total Contract Work Cost						$699,076
Contractor Overhead					30%	$209,723
Subtotal						$908,799
Profit					10%	$90,880
Subtotal						$999,678
Bid Bond					2%	$19,994
Subtotal						$1,019,672
Guam Tax					4%	$42,490
Total Contractor Transportation Fee (2011-2020)						**$1,062,162**

Contractor Processing O&M (2011-2020)	**Quantity**	**Hours/Day**	**Cost $/hour**	**Daily Cost**		**Annual Cost**
Front End Loader Maintenance	1					$54,098
Front End Loader Operation	1	6	$75.00	$450.00		$58,500
Wood Chipper Maintenance	1					$17,311
Wood Chipper Operation	1	8	$52.70	$421.60		$91,347
Total Contract Work Cost						$112,598
Contractor Overhead					30%	$33,780
Subtotal						$146,378
Profit					10%	$14,638
Subtotal						$161,016
Bid Bond					2%	$3,220
Subtotal						$164,236
Guam Tax					4%	$6,844
Total Contractor Processing Fee (2011-2020)						**$171,080**

OPERATION AND MAINTENANCE COSTS

Contractor Labor (2011-2015)	Quantity	Hours/Day	Wage $/hour	Daily Cost		Annual Cost
Drivers/Operators for Transfer Trailers	17	8	$39.51	$5,373.85		$1,397,201
Operator for Wood Chipper	1	8	$39.54	$316.31		$68,534
Operator for Front End Loader	1	8	$39.54	$316.31		$41,120
Total Contract Work Cost						$1,397,201
Contractor Overhead					30%	$419,160
Subtotal						$1,816,361
Profit					10%	$181,636
Subtotal						$1,997,997
Bid Bond					2%	$39,960
Subtotal						$2,037,957
Guam Tax					4%	$84,922
Total Contractor Labor Fee (2011-2020)						**$2,122,879**

Composting Facility (2011-2020)	Cost
Facility and Processing O&M	$309,573
Transportation O&M	$871,532
Labor	$2,316,559
Total Composting Facility Cost	**$3,497,664**

Navy Sanitary Landfill Tipping Fee	$1.65/CY	**$63,801**
Alternative 4 Total Operating Cost	**2011 to 2020**	**$8,816,416**

(a) Vehicle maintenance cost is 10% of capital costs on annual basis.
(b) Administration staff works 260 days a year, 8 hours a day
(c) Receiving and processing at transfer station occurs 312 days a year, 8 hours a day
(d) Wood chipping operations occur 10 months out of the year for contractors processing woody green waste on-site.

CAPITAL COSTS

ALTERNATIVE 1			
Composting Facility Capital Costs			**$5,743,198**
Contractor Capital Costs	**Unit Cost**	**Quantity**	**Total Cost**
Equipment			
Concrete Crusher	$259,672.13	1	$259,672
Front End Loader	$540,983.61	1	$540,984
Wood Chipper	$173,114.75	1	$173,115
Transfer Trailer	$208,421	16	$3,334,737
Total			**$4,308,507**
Alternative 1 Total Capital Costs			**$10,051,705**

CAPITAL COSTS

ALTERNATIVE 2			
C&D Debris Central Processing Facility	**Unit Cost**	**Quantity**	**Total Cost**
Central Processing Facility		1	
Admin office/scale operations	$935,100.00	1	$935,100
Asphalt Roadway	$556,174.08	1	$556,174
Equipment			
Concrete Crusher	$259,672.13	1	$259,672
Truck Scales	$108,196.72	1	$108,197
Truck Scale Installation	$16,800.00	1	$16,800
Bins (Misc LS)	$10,819.67	4	$43,279
Bin Installation	$1,680.00	4	$6,720
Rolling Stock			
Front End Loader	$540,983.61	1	$540,984
Front End Loader (used-backup)	$216,393.44	1	$216,393
Bobcat	$64,918.03	1	$64,918
Utility pick-up Truck	$64,918.03	1	$64,918
Total C&D Cental Processing Facility Cost			**$2,813,155**
Composting Facility Capital Costs			**$5,743,198**

Contractor Capital Costs	**Unit Cost**	**Quantity**	**Total Cost**
Equipment			
Wood Chipper	$173,114.75	1	$173,115
Front End Loader	$540,983.61	1	$540,984
Transfer Trailer	$208,421.05	13	$2,709,474
Total			**$3,423,572**
Alternative 2 Total Capital Costs			**$11,979,925**

CAPITAL COSTS

ALTERNATIVE 3			
C&D Debris Central Processing Facility	**Unit Cost**	**Quantity**	**Total Cost**
Central Processing Facility		1	
Building	$3,000,000	1	$3,000,000
Admin office/scale operations	$935,100	1	$935,100
Asphalt Roadway	$556,174	1	$556,174
Equipment			
Wood Chipper	$173,114.75	1	$173,115
Wood Chipper Processing Line	$324,590.16	1	$324,590
Baler	$231,578.95	1	$231,579
Baler Installation	$33,600.00	1	$33,600
Truck Scales	$108,196.72	1	$108,197
Truck Scale Installation	$16,800.00	1	$16,800
Bins (Misc LS)	$10,819.67	4	$43,279
Bin Installation	$1,680.00	4	$6,720
Rolling Stock			
Front End Loader	$540,983.61	1	$540,984
Front End Loader (used-backup)	$216,393.44	1	$216,393
Forklift	$108,196.72	1	$108,197
Bobcat	$64,918.03	1	$64,918
Utility pick-up Truck	$64,918.03	1	$64,918
Mini-Sweeper	$108,196.72	1	$108,197
Total C&D Debris Central Processing Facility Cost			**$6,532,760**

C&D Transportation and On-Site Processing	**Unit Cost**	**Quantity**	**Total Cost**
Transfer Trailer	$208,421	5	$1,042,105
Spare Transfer Trailer	$208,421	1	$208,421
Total Collection and Transportation Cost			**$1,250,526**
Composting Facility Capital Costs			**$5,743,198**

Contractor Capital Costs	**Unit Cost**	**Quantity**	**Total Cost**
Equipment			
Concrete Crusher	$259,672.13	1	$259,672
Front End Loader	$540,983.61	1	$540,984
Wood Chipper	$173,114.75	1	$173,115
Transfer Trailer	$208,421.05	11	$2,292,632
Total			**$3,266,402**
Alternative 3 Total Capital Costs			**$16,792,886**

CAPITAL COSTS

ALTERNATIVE 4			
C&D Debris Central Processing Facility	**Unit Cost**	**Quantity**	**Total Cost**
Central Processing Facility		1	
Building	$3,000,000	1	$3,000,000
Admin office/scale operations	$935,100.00	1	$935,100
Asphalt Roadway	$456,828.24	1	$456,828
Equipment			
Wood Chipper	$173,114.75	1	$173,115
Wood Chipper Processing Line	$324,590.16	1	$324,590
Concrete Crusher	$259,672.13	1	$259,672
Concrete Crusher Installation	$40,320.00	1	$40,320
Baler	$231,578.95	1	$231,579
Baler Installation	$33,600.00	1	$33,600
Truck Scales	$108,196.72	1	$108,197
Truck Scale Installation	$16,800.00	1	$16,800
Bins (Misc LS)	$10,819.67	4	$43,279
Bin Installation	$1,680.00	4	$6,720
Rolling Stock			
Front End Loader	$540,983.61	1	$540,984
Front End Loader (used-backup)	$216,393.44	1	$216,393
Forklift	$108,196.72	1	$108,197
Bobcat	$64,918.03	1	$64,918
Utility pick-up Truck	$64,918.03	1	$64,918
Mini-Sweeper	$108,196.72	1	$108,197
Total C&D Cental Processing Facility Cost			**$6,733,406**

Transportation and On-Site Processing	**Unit Cost**	**Quantity**	**Total Cost**
Transfer Trailer	$208,421	5	$1,042,105
Spare Transfer Trailer	$208,421	1	$208,421
Total Transportation and On-Site Processing Cost			**$1,250,526**

Composting Facility Capital Costs			**$5,743,198**

Contractor Capital Costs	**Unit Cost**	**Quantity**	**Total Cost**
Equipment			
Transfer Trailer	$208,421	17	$3,543,158
Wood Chipper	$173,114.75	1	$173,115
Front End Loader	$540,983.61	1	$540,984
Total			**$4,257,256**

Alternative 4 Total Capital Costs			**$17,984,387**

Central Processing Facility	Unit Cost
Facility	
Processing Facility Alt II	$670,290.72
Processing Facility Alt III	$6,028,024.32
Processing Facility Alt IV	$5,958,616.08
Admin office/scale operations	$935,100.00
Stationary Equipment	
Truck scales	$108,196.72
Truck scales installation	$43,278.69
Baler	$216,393.44
Baler Install	$86,557.38
Scalehouse equipment	$32,459.02
Scalehouse equipment installation	$12,983.61
Wood Chipper	$173,114.75
Wood Chipper Installation	$69,245.90
Concrete Grinder	$259,672.13
Concrete Grinder Installation	$103,868.85
Wood Chipper Processing Line	$324,590.16
WCPL Installation	$129,836.07
Bins	$10,819.67
Bin Installation	$4,327.87
Office Equipment (LS)	$75,737.70
Rolling Stock	
Concrete Crusher	$223,361.31
Excavator	$649,180.33
Front End Loader	$540,983.61
Front End Loader (used-backup)	$216,393.44
Forklift	$108,196.72
Bobcat	$64,918.03
Utility pick-up truck	$64,918.03
Mini-Sweeper	$108,196.72

Solid Waste Collection & Transportation	Unit Cost
Transfer Trailer	$90,000
Transfer Trailer Rental per day	$1,625
Total Collection and Transportation Cost	

PERSONNEL	Wage $/hour
Drivers/Operators for Transfer Trailers	$39.54
Scalehouse	
Weigh masters/load check per shift	$35.46
Receiving/Transfer/Processing	
Supervisors	$52.71
Rolling stock operators	$39.51
Equipment operators	$39.54
General laborers/spotters/floor sort	$35.46
Curbside Recyclables Transf Equip	$39.51
Curbside Recyclables Transf labor	$35.46
HHW	$0.00
Operators	$35.46
Buy Back and Retail	
Buy Back operators	$35.46
Retail (assumed volunteer)	
Vehicle and Equipment Maintenance	
Mechanics	$43.18
Mechanics helper	$35.46
Administration	
Facility Manager	$68.56
Accounting/personnel manager	$35.46
Secretary/receptionist	$35.46

Alternative 1

Status quo: Contractor to process concrete and asphalt concrete on-site; Contractor to haul remaining construction and demolition debris materials to the hardfill at the Navy Sanitary Landfill. The C&D debris will be transported and processed over a period of 10 years.

Construction and Demolition Debris Distribution

Location	Materials Disposed at Hardfill at Navy Sanitary Landfill (CY/yr)
Andersen Air Force Base	2,661
Naval Base - Apra Harbor	524
NCTS Finegayan	143,559
South Finegayan	36,146
Total	182,889

Transportation to Hardfill at the Navy Sanitary Landfill

Origin	Material to be Transported (CY/yr)	Truck Load (CY)	Truck Loads	Truck Loads/Day	Truck Cycles (b)
Andersen Air Force Base	2,661	22	121	2	64
Naval Base - Apra Harbor	524	22	24	3	8
NCTS Finegayan	143,559	22	6,526	2	3,263
South Finegayan	36,146	22	1,643	2	747
Total Truck Cycles Per Year					4,082

(a) Assume 40 CY transfer trailer capacity; maximum payload is 22 tons; C&D debris density is 2000 lbs/cy.
(b) A daily truck cycle is the amount of production from one truck in one day.
(c) Quantities for the former FAA parcel are included with NCTS Finegayan quantities.

Trucks Required

Transport C&D Debris to Hardfill at the Navy Sanitary Landfill for Disposal

Destination	Handled By	Daily Truck Cycles	Operating Days/Year (a)	Quantity of Trucks
Hardfill at Navy Sanitary Landfill	Contractor	4,082	260	16

Alternative 2

A C&D Debris Central Processing Facility will be constructed in NCTS Finegayan. Recoverable concrete and asphalt will be transported to the facility by the contractor. The contractor would presort the remaining C&D materials. All corrugated cardboard, wood pallets and scrap metal will be recycled by the contractor and all other construction and demolition debris, not intended for recovery, will then be transported to the hardfill at the Navy Sanitary Landfill by the contractor. The C&D debris will be transported and processed over a period of 10 years.

Construction and Demolition Materials Distribution

Location	Materials Sent to Local Recyclers (CY/yr)	Materials Disposed at Hardfill at Navy Sanitary Landfill (CY/yr)	Materials Sent to Central Processing Facility (CY/yr)
Andersen Air Force Base	1,689	642	2,214
Naval Base - Apra Harbor	136	305	781
NCTS Finegayan	83,557	41,924	6,889
South Finegayan	21,265	10,287	6,405
Total	106,647	53,158	16,290

Transportion of Cardboard and Scrap Metal to Local Recycling Centers

Origin	Material to be Transported (CY/yr)	Truck Load (CY)	Truck Loads	Truck Loads/Day	Truck Cycles (b)
Andersen Air Force Base	1,689	22	77	3	30
Naval Base - Apra Harbor	136	22	7	3	3
NCTS Finegayan	83,557	22	3,799	3	1,226
South Finegayan	21,265	22	967	3	312
Total Truck Cycles Per Year					1,571

(a) Assume 40 CY transfer trailer capacity; maximum payload is 22 tons; C&D debris density is 2000 lbs/cy.
(b) A daily truck cycle is the amount of production from one truck in one day.
(c) Quantities for the former FAA parcel are included with NCTS Finegayan quantities.

Transportation to Central Processing Facility

Origin	Material to be Transported (CY/yr)	Truck Load (CY)	Truck Loads	Truck Loads/Day	Truck Cycles (b)
Andersen Air Force Base	2,214	11	202	3	73
Naval Base - Apra Harbor	781	11	72	2	36
NCTS Finegayan	6,889	11	627	3	203
South Finegayan	6,405	11	583	3	189
Total Truck Cycles Per Year					501

(a) Assume 40 CY transfer trailer capacity; maximum payload is 22 tons; concrete and asphalt density is 4000 lbs/cy.
(b) A daily truck cycle is the amount of production from one truck in one day.
(c) Quantities for the former FAA parcel are included with NCTS Finegayan quantities.

Transportation of C&D Debris to Hardfill at the Navy Sanitary Landfill for Disposal

Origin	Material to be Transported (CY/yr)	Truck Load (CY)	Truck Loads	Truck Loads/Day	Daily Truck Cycles (b)
Andersen Air Force Base	642	22	30	2	16
Naval Base - Apra Harbor	305	22	14	3	5
NCTS Finegayan	41,924	22	1,906	2	953
South Finegayan	10,287	22	468	2	213
Total Truck Cycles Per Year					1187

(a) Assume 40 CY transfer trailer capacity; maximum payload is 22 tons; C&D debris density is 2000 lbs/cy.
(b) A daily truck cycle is the amount of production from one truck in one day.
(c) Quantities for the former FAA parcel are included with NCTS Finegayan quantities.

Trucks Required

Destination	Handled By	Daily Truck Cycles	Operating Days/Year (a)	Quantity of Trucks
Local Recyclers	Contractor	1571	260	
Central Processing Facility	Contractor	501	260	
Hardfull at Navy Sanitary Landfill	Contractor	1187	260	
Total	Contractor	3259	260	13

(a) Number of operating days in a year, assuming 5 work days a week.

Alternative 3

A C&D Debris Central Processing Facility will be constructed in NCTS Finegayan. Concrete without lead-based paint and asphalt will be processed at the construction site; concrete with lead-based paint will be transported to the hardfill at the Navy Sanitary Landfill; and all other construction and demolition debris will be transported to the central processing facility by the contractor. Corrugated cardboard, wood pallets and scrap metal will be processed at the facility and all other construction and demolition debris, not intended for recycling, will then be transported to the hardfill at the Navy Sanitary Landfill by the DOD. The C&D debris will be transported and processed over a period of 10 years.

Construction and Demolition Materials Distribution

Location	Concrete with LBP (CY/yr)	Materials Disposed at Hardfill at Navy Sanitary Landfill (CY/yr)	Materials Sent to Central Processing Facility (CY/yr)
Andersen Air Force Base	18	642	2,661
Naval Base - Apra Harbor	58	305	524
NCTS Finegayan	123	41,924	143,559
South Finegayan	148	10,287	36,146
Total	347	53,158	182,889

Transportation of Concrete with LBP to Hardfill at the Navy Sanitary Landfill

Origin	Material to be Transported (CY/yr)	Truck Load (CY)	Truck Loads	Truck Loads per Day	Truck Cycles (b)
Andersen Air Force Base	18	11	2	2	2
Naval Base - Apra Harbor	58	11	6	3	2
NCTS Finegayan	123	11	12	2	6
South Finegayan	148	11	14	2	7
Ordnance Annex, Naval Magazine	0	11	0	3	0
Total Truck Cycles Per Year					17

(a) Assume 40 CY transfer trailer capacity; maximum payload is 22 tons; concrete density is 4000 lbs/cy.
(b) A daily truck cycle is the amount of production from one truck in one day.
(c) Quantities for the former FAA parcel are included with NCTS Finegayan quantities.

Transportation to Central Processing Facility

Origin	Material to be Transported (CY/yr)	Truck Load (CY)	Truck Loads	Truck Loads per Day	Truck Cycles (b)
Andersen Air Force Base	2,661	22	121	3	44
Naval Base - Apra Harbor	524	22	24	2	12
NCTS Finegayan	143,559	22	6,526	3	2,106
South Finegayan	36,146	22	1,643	3	530
Ordnance Annex, Naval Magazine	0	22	0	2	0
Total Truck Cycles Per Year					2,692

(a) Assume 40 CY transfer trailer capacity; maximum payload is 22 tons; C&D debris density is 2000 lbs/cy.
(b) A daily truck cycle is the amount of production from one truck in one day.
(c) Quantities for the former FAA parcel are included with NCTS Finegayan quantities.

Transportation from Central Processing Facility to Hardfill at the Navy Sanitary Landfill

Origin	Material to be Transported (CY/yr)	Truck Load (CY)	Truck Loads	Truck Loads/Day	Daily Truck Cycles (b)
Andersen Air Force Base	642	22	30	2	15
Naval Base - Apra Harbor	305	22	14	2	7
NCTS Finegayan	41,924	22	1,906	2	953
South Finegayan	10,287	22	468	2	234
Total Truck Cycles Per Year					1,209

(a) Assume 40 CY transfer trailer capacity; maximum payload is 22 tons; C&D debris density is 2000 lbs/cy.
(b) A daily truck cycle is the amount of production from one truck in one day.
(c) Quantities for the former FAA parcel are included with NCTS Finegayan quantities.

Trucks Required

Transportation by Contractor

Destination	Handled By	Daily Truck Cycles	Operating Days/Year (a)	Quantity of Trucks
Hardfill at Navy Sanitary Landfill	Contractor	17	260	
Central Processing Facility	Contractor	2,692	260	
Total	Contractor	2,709	260	11

(a) Number of operating days in a year, assuming 5 work days a week.

Transportation by DOD

Destination	Handled By	Daily Truck Cycles	Operating Days/Year (a)	Quantity of Trucks
Hardfill at Navy Sanitary Landfill	DOD	1209	260	5

(a) Number of operating days in a year, assuming 5 work days a week.

Alternative 4

A C&D Debris Central Processing Facility will be constructed in NCTS Finegayan. All construction and demolition debris will be transported to the facility by the contractor. Corrugated cardboard, wood pallets, scrap metal, concrete and asphalt will be processed and all other construction and demolition debris, not intended for recycling, will then be transported to the hardfill at the Navy Sanitary Landfill by the DOD. The C&D debris will be transported and processed over a period of 10 years.

Construction and Demolition Debris Distribution

Location	Concrete with LBP (CY/yr)	Materials Disposed at Hardfill at Navy Sanitary Landfill (CY/yr)	Materials Sent to Central Processing Facility (CY/yr)
Andersen Air Force Base	18	624	4,857
Naval Base - Apra Harbor	58	247	1,248
NCTS Finegayan	123	41,801	150,326
South Finegayan	148	10,139	42,403
Total	347	52,811	198,832

Transportation of Concrete with LBP to Hardfill at the Navy Sanitary Landfill

Origin	Material to be Transported (CY/yr)	Truck Load (CY)	Truck Loads	Truck Loads per Day	Truck Cycles (b)
Andersen Air Force Base	18	11	2	2	2
Naval Base - Apra Harbor	58	11	6	3	2
NCTS Finegayan	123	11	12	2	6
South Finegayan	148	11	14	2	7
Ordnance Annex, Naval Magazine	0	11	0	3	0
Total Truck Cycles Per Year					17

(a) Assume 40 CY transfer trailer capacity; maximum payload is 22 tons; concrete density is 4000 lbs/cy.
(b) A daily truck cycle is the amount of production from one truck in one day.
(c) Quantities for the former FAA parcel are included with NCTS Finegayan quantities.

Transportation to Central Processing Facility

Origin	Material to be Transported (CY/yr)	Truck Load (CY)	Truck Loads	Truck Loads per Day	Daily Truck Cycles (b)
Andersen Air Force Base	4,857	15	324	3	116
Naval Base - Apra Harbor	1,248	15	84	2	42
NCTS Finegayan	150,326	15	10,022	3	3,233
South Finegayan	42,403	15	2,827	3	912
Ordnance Annex, Naval Magazine	0	15	0	2	0
Total Truck Cycles Per Year					4,303

(a) Assume 40 CY transfer trailer capacity; maximum payload is 22 tons; mixed C&D debris density is 3000 lbs/cy.
(b) A daily truck cycle is the amount of production from one truck in one day.
(c) Quantities for the former FAA parcel are included with NCTS Finegayan quantities.

Transportation from Central Processing Facility to Hardfill at the Navy Sanitary Landfill

Origin	Material to be Transported (CY/yr)	Truck Load (CY)	Truck Loads	Truck Loads/Day	Truck Cycles (b)
Andersen Air Force Base	624	22	29	2	15
Naval Base - Apra Harbor	247	22	12	2	6
NCTS Finegayan	41,801	22	1,901	2	951
South Finegayan	10,139	22	461	2	231
Total Truck Cycles Per Year					1203

(a) Assume 40 CY transfer trailer capacity; maximum payload is 22 tons; C&D debris density is 2000 lbs/cy.
(b) A daily truck cycle is the amount of production from one truck in one day.
(c) Quantities for the former FAA parcel are included with NCTS Finegayan quantities.

Trucks Required

Transportation by Contractor

Destination	Handled By	Daily Truck Cycles	Operating Days/Year (a)	Quantity of Trucks
Hardfill at Navy Sanitary Landfill	Contractor	17	260	
Central Processing Facility	Contractor	4303	260	
Total	Contractor	4320	260	17

Transportation by DOD

Destination	Handled By	Daily Truck Cycles	Operating Days/Year (a)	Quantitiy of Trucks
Hardfill at Navy Sanitary Landfill	DOD	1203	260	5

Daily Dump Truck Cycles

Central Processing Facility

Origin	Two-Way Travel Time (hrs) (a)	Additional Time Per Trip (hrs) (b)	Hours in Operation (c)	Trips/Day
Andersen Air Force Base	0.60	1.50	6.0	3
Naval Base - Apra Harbor	1.40	1.50	6.0	2
NCTS Finegayan	0.40	1.50	6.0	3
South Finegayan	0.40	1.50	6.0	3
Ordnance Annex, Naval Magazine	2.00	1.50	6.0	2

(a) Estimated vehicular speed of 30 miles per hour.
(b) Includes 45 min loading & unloading and 45 min washdown and inspection per trip.
(c) Estimated 6 hours of vehicle operation and 2 hours for start up and shut down time.

Hardfill at Navy Sanitary Landfill

Origin	Two-Way Travel Time (hrs) (a)	Additional Time Per Trip (hrs) (b)	Hours in Operation (c)	Trips/Day
Andersen Air Force Base	1.60	1.50	6.0	2
Naval Base - Apra Harbor	0.40	1.50	6.0	3
NCTS Finegayan	1.40	1.50	6.0	2
South Finegayan	1.20	1.50	6.0	2
Ordnance Annex, Naval Magazine	0.40	1.50	6.0	3

(a) Estimated vehicular speed of 30 miles per hour.
(b) Includes 45 min loading & unloading and 45 min washdown and inspection per trip.
(c) Estimated 6 hours of vehicle operation and 2 hours for start up and shut down time.

C&D Debris Central Processing Facility to Hardfill at the Navy Sanitary Landfill

C&D debris to be disposed will be transported from the central processing facility to the hardfill at the Navy Sanitary Landfill.

Destination	Two-Way Travel Time (hrs) (a)	Additional Time Per Trip (hrs) (b)	Hours in Operation (c)	Trips/Day
Hardfill at Navy Sanitary Landfill	1.40	1.50	6.0	2

(a) Estimated vehicular speed of 30 miles per hour.
(b) Includes 45 min loading & unloading and 45 min washdown and inspection per trip.
(c) Estimated 6 hours of vehicle operation and 2 hours for start up and shut down time.

Local Recyclers

Origin	Two-Way Travel Time (hrs) (a)	Additional Time Per Trip (hrs) (b)	Hours in Operation (c)	Trips/Day
Andersen Air Force Base	0.80	1.50	6.0	3
Naval Base - Apra Harbor	0.80	1.50	6.0	3
NCTS Finegayan	0.40	1.50	6.0	3
South Finegayan	0.40	1.50	6.0	3

(a) Estimated vehicular speed of 30 miles per hour.
(b) Includes 45 min loading & unloading and 45 min washdown and inspection per trip.
(c) Estimated 6 hours of vehicle operation and 2 hours for start up and shut down time.

Composting Facility

Origin	Two-Way Travel Time (hrs) (a)	Additional Time Per Trip (hrs) (b)	Hours in Operation (c)	Trips/Day
Andersen Air Force Base	0.60	1.50	6.0	3
Naval Base - Apra Harbor	2.00	1.50	6.0	2
NCTS Finegayan	0.40	1.50	6.0	3
South Finegayan	0.40	1.50	6.0	3
Ordnance Annex, Naval Magazine	1.40	1.50	6.0	2

(a) Estimated vehicular speed of 30 miles per hour.
(b) Includes 45 min loading & unloading and 45 min washdown and inspection per trip.
(c) Estimated 6 hours of vehicle operation and 2 hours for start up and shut down time.

Distances and Travel Times

	Hardfill at Navy Sanitary Landfill		
Origin	**Distance (km)**	**Distance (mi)**	**RT Time (hours)**
Andersen Air Force Base	40.5	25.2	1.60
Naval Base - Apra Harbor	3.5	2.2	0.40
NCTS Finegayan	32.7	20.3	1.40
South Finegayan	29.0	18.0	1.20
Ordnance Annex, Naval Magazine	8.1	5.0	0.40
Central Processing Facility	35.0	21.7	1.40

	C&D Debris Central Processing Facility		
Origin	**Distance (km)**	**Distance (mi)**	**RT Time (hours)**
Andersen Air Force Base	16.3	10.1	0.60
Naval Base - Apra Harbor	34.9	21.7	1.40
NCTS Finegayan	2.9	1.8	0.40
South Finegayan	5.4	3.4	0.40
Ordnance Annex, Naval Magazine	46.7	29.0	2.00

	Local Recycling Centers		
Origin	**Distance (km)**	**Distance (mi)**	**RT Time (hours)**
Andersen Air Force Base	19.4	12.1	0.80
Naval Base - Apra Harbor	21.7	13.5	0.80
NCTS Finegayan	11.6	7.2	0.40
South Finegayan	7.9	4.9	0.40

	Composting Facility		
Origin	**Distance (km)**	**Distance (mi)**	**RT Time (hours)**
Andersen Air Force Base	16.3	10.1	0.60
Naval Base - Apra Harbor	46.7	29.0	2.00
NCTS Finegayan	2.9	1.8	0.40
South Finegayan	5.4	3.4	0.40
Ordnance Annex, Naval Magazine	35.0	21.7	1.40

(a) Estimated vehicular speed of 30 miles per hour.

(b) RT = Round Trip

Alternative 1: Concrete and Asphalt On-Site Material Processing

Concrete and asphalt will be processed at the construction and demolition site using concrete crushers and an excavator to load it.

Quantity of Material to be Crushed

Location	Concrete (CY/Year)	Asphalt (CY/Year)
Andersen Air Force Base	480	1,734
Naval Base - Apra Harbor	590	192
NCTS Finegayan	4,559	2,110
South Finegayan	5,456	949
Ordnance Annex, Naval Magazine	0	0

Concrete and Asphalt Crushing

Location	Material to be crushed (CY/Year)	Crusher Capacity (CY/Month)	Concrete Crushers	Months Per Year (a)
Andersen Air Force Base	2,214	5,200	1	1
Naval Base - Apra Harbor	782	5,200	1	1
NCTS Finegayan	6,669	5,200	1	2
South Finegayan	6,405	5,200	1	2
Ordnance Annex, Naval Magazine	0	5,200	1	0
Total				6

(a) Months per year that the specified number of conrete crushers will be needed at each location.

Concrete Crushing Equipment Summary	No.	Months
Total Number of Concrete Crusher Attachments	1	6
Total Number of 25 Ton Excavators	1	6

Concrete Crushing Personnel Summary	No.	Months
Heavy Equipment Operators	1	6
General Laborers	1	6

Alternative 2: Untreated Wood On-Site Material Processing

Untreated wood will be processed at the construction and demolition site using wood chippers and a front end loader to load it.

Quantity of Material to be Chipped

Location	Wood (CY/Year)
Andersen Air Force Base	330
Naval Base - Apra Harbor	83
NCTS Finegayan	9,638
South Finegayan	4,593
Ordnance Annex, Naval Magazine	0

Untreated Wood to be Chipped

Location	Material to be chipped (CY/Year)	Wood Chipper Capacity (CY/Month)	Wood Chippers	Months Per Year (a)
Andersen Air Force Base	330	7,800	1	1
Naval Base - Apra Harbor	83	7,800	1	1
NCTS Finegayan	9,638	7,800	1	2
South Finegayan	4,593	7,800	1	1
Ordnance Annex, Naval Magazine	0	7,800	1	0
Total				5

(a) Months per year that the specified number of wood chippers will be needed at each location.

Wood Chipping Equipment Summary	No.	Months
Total Number of Wood Chippers	1	5
Total Number of Front End Loaders	1	5

Wood Chippers Personnel Summary	No.	Months
Heavy Equipment Operators	1	5
General Laborers	1	5

Alternative 3: Concrete and Asphalt On-Site Material Processing

Concrete and asphalt will be processed at the construction and demolition site using concrete crushers and an excavator to load it.

Quantity of Material to be Crushed

Location	Concrete (CY/Year)	Asphalt (CY/Year)
Andersen Air Force Base	480	1,734
Naval Base - Apra Harbor	590	192
NCTS Finegayan	4,559	2,110
South Finegayan	5,456	949
Ordnance Annex, Naval Magazine	0	0

Concrete and Asphalt Crushing

Location	Material to be crushed (CY/Year)	Crusher Capacity (CY/Month)	Concrete Crushers	Months Per Year (a)
Andersen Air Force Base	2,214	5200	1	1
Naval Base - Apra Harbor	782	5200	1	1
NCTS Finegayan	6,669	5200	1	2
South Finegayan	6,405	5200	1	2
Ordnance Annex, Naval Magazine	0	5200	1	0
Total				6

(a) Months per year that the specified number of conrete crushers will be needed at each location.

Concrete Crushing Equipment Summary	No.	Months
Total Number of Concrete Crusher Attachments	1	6
Total Number of 25 Ton Excavators	1	6

Concrete Crushing Personnel Summary	No.	Months
Heavy Equipment Operators	1	6
General Laborers	1	6

NET PRESENT VALUE SUMMARY

Life Cycle Years	Net Present Value	Description
10	$21,700,000	Composting Facility

PRESENT VALUE ANALYSIS

Calendar Year	Composting Facility		
	Total Capital		**NPV**
	$5,743,198		$21,739,998
		Rounded NPV	$21,700,000
	Capital	**Operating**	**Total**
2011	5,743,198	3,507,015	9,250,212
2012		3,507,015	3,507,015
2013		3,507,015	3,507,015
2014		3,507,015	3,507,015
2015		3,507,015	3,507,015
2016		3,507,015	3,507,015
2017		3,507,015	3,507,015
2018		3,507,015	3,507,015
2019		3,507,015	3,507,015
2020		3,507,015	3,507,015

COST SUMMARY - COMPOSTING FACILITY

Description	Cost	Remarks
Discount Factor	2.800%	
Capital Costs		
Capital Costs - 2011	$5,743,198	Initial capital cost
Annual Operating Costs		
Operating Costs 2011 to 2020	$3,507,015	The building will only be operating for the first 10 years.

OPERATION AND MAINTENANCE COSTS

COMPOSTING					
Building Maintenance	**Quantity**	**Hours/Day**	**Equipment $/hour**	**Daily Cost**	**Annual Cost**
Total Building Maintenance Cost 2011 - 2020					**$9,351.00**
Operations and Maintenance (2011-2020)	**Quantity**	**Hours/Day**	**Equipment $/hour**	**Daily Cost**	**Annual Cost**
Front End Loader Maintenance	1				$54,098.36
Front End Loader Maintenance (used-backup)	1				$21,639.34
Front End Loader Operation	1	6	$75.00	$450.00	$117,000
Wood Chipper Maintenance	1				$17,311
Wood Chipper Operation	1	6	$52.70	$316.20	$82,212
Truck Scale Maintenance	1				$10,820
Bobcat Maintenance	1				$6,491.80
Total O&M Cost					**$309,572.66**
PERSONNEL (2011-2020)	**Quantity**	**Hours/Day**	**Wage $/hour**	**Daily Cost**	**Annual Cost**
Operator for Front End Loader	1	8	$39.54	$316.31	$82,240.70
Operator for Wood Chipper	1	8	$39.54	$316.31	$68,533.92
Receiving/Transfer/Processing					
Supervisors	0.5	8	$52.71	$210.84	$54,818.40
Rolling stock operators	2	8	$39.51	$632.22	$164,376.58
General laborers/spotters/floor sort	3	8	$35.46	$850.95	$221,247.94
Vehicle and Equipment Maintenance					
Mechanics	0.5	8	$43.18	$172.74	$44,911.78
Mechanics helper	0.5	8	$35.46	$141.83	$36,874.66
Administration					
Facility Manager	0.5	8	$68.56	$274.24	$71,303.23
Accounting/personnel Manager	0.5	8	$35.46	$141.83	$36,874.66
Secretary/Receptionist	0.5	8	$35.46	$141.83	$36,874.66
Total Personnel Cost					**$818,056.51**

OPERATION AND MAINTENANCE COSTS

Contractor Transportation O&M (2011-2020)	Quantity	Hours/Day	Wage $/hour	Daily Cost		Annual Cost
Transfer Trailer Operation	12	6	$13.00	$936.00		$243,360.00
Transfer Trailer Maintenance	12					$330,250.11
Total Contract Work Cost						$573,610.11
Contractor Overhead					30%	$172,083.03
Subtotal						$745,693.14
Profit					10%	$74,569.31
Subtotal						$820,262.45
Bid Bond					2%	$16,405.25
Subtotal						$836,667.70
Guam Tax					4%	$34,863.94
Total Contractor Transportation Fee (2011-2020)						**$871,531.64**

Contractor Labor (2011-2020)	Quantity	Hours/Day	Wage $/hour	Daily Cost		Annual Cost
Drivers/Operators for 40 CY Transfer Trailers	12	8	$39.51	$3,793.31		$986,259.46
Total Contract Work Cost						$986,259.46
Contractor Overhead					30%	$295,877.84
Subtotal						$1,282,137.29
Profit					10%	$128,213.73
Subtotal						$1,410,351.02
Bid Bond					2%	$28,207.02
Subtotal						$1,438,558.04
Guam Tax					4%	$59,944.71
Total Contractor Labor Fee (2011-2020)						**$1,498,502.76**

Total Operating Cost	**2011 to 2020**	**$3,507,014.57**

(a) Vehicle maintenance cost is 10% of capital costs on annual basis.

CAPITAL COSTS

COMPOSTING FACILITY			
Item	**Unit Cost**	**Quantity**	**Total Cost**
Building		1	
Admin office/scale operations	$935,100	1	$935,100.00
Stationary Equipment			
Wood Chipper	$173,114.75	1	$173,114.75
Wood Chipper Processing Line	$324,590.16	1	$324,590.16
Truck Scales	$108,196.72	1	$108,196.72
Truck Scale Installation	$16,800.00	1	$16,800.00
Chain Link Fence (per LF)	$30	2020	$60,600.00
Rolling Stock			
Front End Loader	$540,983.61	1	$540,983.61
Front End Loader (used-backup)	$216,393.44	1	$216,393.44
Bobcat	$64,918.03	1	$64,918.03
Total Composting Facility Cost			**$2,440,696.72**

Contractor Capital Costs	**Unit Cost**	**Quantity**	**Total Cost**
Transfer Trailer	$275,208.42	12	$3,302,501.05
Total Contractor Capital Costs			**$3,302,501.05**
Total Capital Costs			**$5,743,197.77**

Green Waste

Green Waste Composting

Green Waste Distribution

Location	To Composting Facility (CY)
Andersen Air Force Base	1,966
Naval Base - Apra Harbor	4,608
NCTS Finegayan	188,009
South Finegayan	11,723
Ordnance Annex, Naval Magazine	50
Former FAA Parcel	129,065
Total	335,420

Transportation to Composting Facility

Origin	Material to be Transported (CY)	Truck Load (CY)	Truck Loads	Truck Loads per Day	Truck Cycles (b)
Andersen Air Force Base	1,966	40	50	2	25
Naval Base - Apra Harbor	4,608	40	116	1	116
NCTS Finegayan	188,009	40	4,701	3	1,567
South Finegayan	11,723	40	294	3	98
Ordnance Annex, Naval Magazine	50	40	2	2	1
Former FAA Parcel	129,065	40	3,227	3	1,076
Total					2,883

(a) Assume 40 CY transfer trailer capacity; maximum payload is 22 tons; green waste density is 1000 lbs/cy.
(b) A daily truck cycle is the amount of production from one truck in one day.

Trucks Required

Transport Green Waste to Composting Facility

Destination	Daily Truck Cycles	Operating Days/Year	Quantity of Trucks
Composting Facility	2,883	260	12

Daily Dump Truck Cycles

Composting Facility

Origin	Two-Way Travel Time (hrs) (a)	Additional Time Per Trip (hrs) (b)	Hours in Operation (c)	Trips/Day
Andersen Air Force Base	0.60	1.50	6.0	2
Naval Base - Apra Harbor	2.00	1.50	6.0	1
NCTS Finegayan	0.40	1.50	6.0	3
South Finegayan	0.40	1.50	6.0	3
Ordnance Annex, Naval Magazine	1.40	1.50	6.0	2
Former FAA Parcel	0.40	1.50	6.0	3

(a) Estimated vehicular speed of 30 miles per hour.

(b) Includes 45 min loading & unloading and 45 min washdown and inspection per trip.

(c) Estimated 6 hours of vehicle operation and 2 hours for start up and shut down time.

Distances and Travel Times

Origin	Hardfill at Navy Sanitary Landfill Distance (km)	Distance (mi)	RT Time (hours)
Andersen Air Force Base	40.5	25.2	1.60
Naval Base - Apra Harbor	3.5	2.2	0.40
NCTS Finegayan	32.7	20.3	1.40
South Finegayan	29.0	18.0	1.20
Ordnance Annex, Naval Magazine	8.1	5.0	0.40
Processing Center	35.0	21.7	1.40

Origin	Composting Facility Distance (km)	Distance (mi)	RT Time (hours)
Andersen Air Force Base	16.3	10.1	0.60
Naval Base - Apra Harbor	46.7	29.0	2.00
NCTS Finegayan	2.9	1.8	0.40
South Finegayan	5.4	3.4	0.40
Ordnance Annex, Naval Magazine	35.0	21.7	1.40
Former FAA Parcel	4.2	2.6	0.40

(a) Estimated vehicular speed of 30 miles per hour.

Origin	C&D Debris Central Processing Facility Distance (km)	Distance (mi)	RT Time (hours)
Andersen Air Force Base	16.3	10.1	0.60
Naval Base - Apra Harbor	46.7	29.0	2.00
NCTS Finegayan	2.9	1.8	0.40
South Finegayan	5.4	3.4	0.40
Ordnance Annex, Naval Magazine	35.0	21.7	1.40

(a) Estimated vehicular speed of 30 miles per hour.

(b) RT = Round Trip

Woody Green Waste On-Site Material Processing

Woody green waste will be processed at the construction and demolition site using wood chippers and a front end loader to load it.

Quantity of Material to be Chipped

Location	Woody Green Waste (CY/Year)
Andersen Air Force Base	231
Naval Base - Apra Harbor	615
NCTS Finegayan	25,389
South Finegayan	1,472
Ordnance Annex, Naval Magazine	0
Former FAA Parcel	17,600

Woody Green Waste Chipping

Location	Material to be Chipped (CY/Year)	Wood Chipper Capacity (CY/Month)	Wood Chippers	Months Per Year (a)
Andersen Air Force Base	231	7,800	1	1
Naval Base - Apra Harbor	615	7,800	1	1
NCTS Finegayan	25,389	7,800	1	4
South Finegayan	1,472	7,800	1	1
Ordnance Annex, Naval Magazine	0	7,800	1	0
Former FAA Parcel	17,600	7,800	1	3
Total				10

(a) Months per year that the specified number of wood chippers will be needed at each location.

Wood Chipper Equipment Summary	**No.**	**Months**
Total Number of Wood Chippers	1	10
Total Number of Front End Loaders	1	10

Wood Chipper Personnel Summary	**No.**	**Months**
Heavy Equipment Operators	2	10
General Laborers	1	10

Final Report

Recycling and Solid Waste Diversion Study for DOD Bases, Guam

Prepared For:

Naval Facilities Engineering Command Pacific
Pearl Harbor, Hawaii

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Executive Summary

Background

The Guam Integrated Military Development Plan (GIMDP), formerly the Joint Guam Military Master Plan (JGMMP), provides for the planned increase in military population on Guam. The Northern Guam bases, Naval Computer and Telecommunications Station (NCTS) Finegayan, South Finegayan, Andersen Air Force Base (AAFB), AAFB Northwest Field, and AAFB South would experience most of the military personnel increase.

This study evaluates materials recovery alternatives for the Department of Defense (DoD) to service its current and proposed future Marine Corps solid waste diversion needs and to meet future regulatory requirements. This study focuses on developing facilities that would divert non-hazardous solid waste generated by DoD activities. It includes planning for projects that represent the best value alternative for solid waste diversion. Recycling and materials resource recovery facilities are considered to enable the DoD on Guam to meet defined future requirements.

Executive Order 13423

Executive Order 13423, Strengthening Federal, Environmental, Energy, and Transportation Management states that "it is the policy of the United States that Federal agencies conduct their environmental, transportation, and energy-related activities under the law in support of their respective missions, in an environmentally, economically, and fiscally sound, integrated, continuously improving, efficient, and sustainable manner." Implementing this policy, as it relates to DoD solid waste, the head of each agency should ensure that the agency increases diversion of solid waste as appropriate, and maintains cost-effective waste prevention and recycling programs in its facilities.

Executive Order 13514

Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance builds on and expands upon the energy reduction and environmental requirements of Executive Order 13423. Executive Order 13514 indicates that the federal government must lead by example in safeguarding the health of the environment.

To comply with Executive Order 13514, DoD agencies should promote pollution prevention and eliminate waste by:

i. Minimizing the generation of waste and pollutants through source reduction;
ii. Diverting at least 50 percent of non-hazardous solid waste, excluding construction and demolition materials and debris by the end of fiscal year 2015;

iii. Diverting at least 50 percent of construction and demolition materials and debris by the end of fiscal year 2015; and
iv. Increasing diversion of compostable and organic material from the waste stream.

Solid Waste Quantities

The military personnel and dependent population on Guam is projected to increase from the current baseline population of approximately 15,080 persons to an estimated 46,000 persons in the year 2019 when the proposed United States Marine Corps (USMC) relocation to Guam is scheduled to be complete. The total projected additional military and dependent population associated with the proposed USMC relocation to Guam is about 17,552 persons. The total projected additional military and dependent population associated with other services is approximately 17,395 persons. It is expected that approximately 11,002 transient military personnel would be added to the military loading on Guam, including personnel from the Air Force, USMC, and Navy. DoD solid waste quantities are correspondingly projected to increase from current design capacity levels of approximately 20,366 tons per year to approximately 53,993 tons per year in the year 2019. The projected solid waste quantity associated with the proposed USMC relocation is approximately 26,414 tons per year.

Recovered Materials

Based on the existing conditions and projected waste streams, the following materials were targeted for recovery: cardboard, aluminum cans, plastic containers, glass, mixed paper, brass, scrap metal, wood pallets, green waste, and food waste. Construction and demolition materials are not included in this study. Reuse and diversion of construction and demolition waste will be included in a separate study.

Diversion Alternatives

To meet the DoD diversion goal of 50 percent of non-hazardous waste without C&D waste by 2015, alternatives for diversion were investigated. Items targeted for diversion were commonly recycled materials and items that would not be accepted at the GovGuam Layon landfill.

Refuse transfer stations would provide a cost-effective method of collecting solid waste for disposal at the GovGuam Layon landfill. Refuse transfer stations would also enable the removal of bulky recyclable materials such as old corrugated cardboard, scrap metal and wooden pallets.

Establishing a source separation program would increase diversion of commonly recycled material from the solid waste stream. Recycling centers would provide locations to collect and process the recycled materials. However, based on the estimated characterization of the solid waste stream, all of the targeted material for diversion must be recovered from the solid waste stream to meet the DoD diversion goal. Therefore, a materials recovery facility would be needed to recover nearly all of the targeted material for diversion.

Materials Resource Recovery Facilities

A materials resource recovery facility (MRRF) would recover and segregate targeted recyclable materials from the solid waste stream prior to the solid waste being disposed at the Layon landfill or Navy Sanitary Landfill. The following alternatives for construction of materials resource recovery facilities, refuse transfer stations, and recycling centers were identified for evaluation:

- Alternative 1: Construct MRRF with refuse transfer stations and recycling centers in northern and southern Guam.
- Alternative 2: Construct MRRF with refuse transfer station and recycling center in southern Guam and construct refuse transfer station and recycling center in northern Guam.
- Alternative 3: Construct MRRF with refuse transfer station and recycling center in northern Guam and construct refuse transfer station and recycling center in southern Guam.
- Alternative 4: Construct MRRF with refuse transfer station in Barrigada and construct recycling center in northern Guam and construct recycling center in southern Guam.

The evaluation included regulatory considerations, implementation considerations, and an economic and life cycle cost analysis. Each life cycle cost analysis for materials resource recovery facilities was assessed over 50 years. A summary of the life cycle cost analyses is included in Table ES-1. The results of the comparative evaluation are summarized in Table ES-2.

Summary of Findings

The major findings of the study are summarized below.

- Construction of two DoD refuse transfer stations, one in northern Guam and one in southern Guam, is the most cost-effective solution for collection and disposal of DoD solid waste at the GovGuam Layon landfill or Apra Harbor landfill.
- Expansion of existing source separation recycling programs at all DoD facilities is essential towards meeting the DoD diversion goals.
- Construction of two DoD recycling centers, one in northern Guam and one in southern Guam, is needed to process recyclable materials collected by the source separation recycling program and to serve as a drop-off facility for recyclable materials generated by residential, commercial, and industrial sectors. The existing AAFB Recycling Center should continue to serve as a satellite recycling center for AAFB.
- Based on the characterization of the projected DoD solid waste stream, a materials resource recovery facility is necessary to achieve the DoD goal

of 50-percent diversion of non-hazardous solid waste excluding construction and demolition waste by 2015.

- Construction of a materials resource recovery facility with refuse transfer station and recycling center in southern Guam and construction of a refuse transfer station and recycling center in northern Guam is the most cost-effective alternative.
- Existing recycling vendors on Guam are not able to accept all types of recyclable materials that DoD would need to divert from its solid waste stream to meet its diversion goal. In addition, with the possible exception of scrap metal, existing recycling vendors on Guam cannot reasonably ensure that they will accept all the types of materials that they do handle at all times.
- The capability to directly ship recyclable materials to off-island recyclers is essential to ensure a reliable means of moving the collected materials out of the DoD facilities.

Summary of Recommendations

Based on the results of the analysis and evaluations performed for this study, the following recommendations are offered.

- Conduct a solid waste characterization study for DoD facilities on Guam.
- Construct two DoD refuse transfer stations, one in northern Guam and one in southern Guam.
- Implement a source separation recycling program at all DoD facilities.
- Construct two DoD recycling centers, one in northern Guam and one in southern Guam.
- Construct a minimum of one DoD materials resource recovery facility.
- Evaluate the feasibility of establishing a comprehensive program for Guam that includes the Defense Commissary Agency, the Navy Exchange Service Command, the Army & Air Force Exchange Service, and other agencies and commands to implement source controls for the types of materials brought to Guam, to implement a consistent approach for recovery and diversion of recyclable materials, and to develop back shipment container capacity.

TABLE ES-1

SUMMARY OF PRESENT VALUE ANALYSIS

Alternative	Initial Capital Cost of Facility, Equipment and Trucks	Recurring Replacement Cost of Trucks	Recurring Replacement Cost of Major Equipment	Operating Cost of Labor	Operation and Maintenance Cost for Trucks	Operation and Maintenance Cost for Facilities and Equipment	Container Shipping Costs	Total Present Value Analysis 50 years
Alternative 1 – Construct MRRFs with refuse transfer stations and recycling centers in northern and southern Guam	$82,900,000	$44,300,000	$600,000	$173,700,000	$61,300,000	$90,500,000	$4,500,000	$457,800,000
Alternative 2 – Construct MRRF with refuse transfer station and recycling center in southern Guam and construct refuse transfer facility and recycling center in northern Guam	$69,300,000	$45,100,000	$600,000	$156,200,000	$61,800,000	$83,000,000	$1,400,000	$417,400,000
Alternative 3 – Construct MRRF with refuse transfer station and recycling center in northern Guam and construct refuse transfer facility and recycling center in southern Guam	$69,300,000	$45,100,000	$600,000	$154,500,000	$64,400,000	$83,000,000	$2,500,000	$419,400,000
Alternative 4 – Construct MRRF with refuse transfer station in Barrigada and construct recycling centers in northern Guam and southern Guam	$67,700,000	$46,700,000	$300,000	$198,000,000	$80,100,000	$83,000,000	$2,500,000	$478,300,000

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TABLE ES-2
SUMMARY MATRIX OF COMPARATIVE ADVANTAGES (A) AND DISADVANTAGES (D)

Alt.	Option	Regulations	Operations	Implementation	Economics
1	Construct MRRFs with refuse transfer stations and recycling centers in northern and southern Guam	D – GEPA permits for two MRRFs, two refuse transfer stations and two recycling centers.	A – Two materials resource recovery facilities provide operational flexibility. A – Unprocessed solid waste would not be transported between northern and southern Guam. D – Recyclable material processed at four facilities.	D – Siting and construction of two MRRFs with refuse transfer stations.	A – Second highest Present Value cost based on a 50-year lifecycle analysis.
2	Construct MRRF with refuse transfer station and recycling center in southern Guam and construct refuse transfer station and recycling center in northern Guam	A – GEPA permits required for one MRRF, two transfer stations and two recycling centers.	D – Relatively longer total distance for transfer vehicles to transport unprocessed solid waste. A – Relatively shorter total distance for transfer vehicles to transport processed solid waste. A – Recyclable material processed at three facilities.	A – Siting and construction of one MRRF with refuse transfer station.	A – Lowest Present Value cost based on a 50-year lifecycle analysis.
3	Construct MRRF with refuse transfer station and recycling center in northern Guam and construct refuse transfer station and recycling center in southern Guam	A– GEPA permits required for one MRRF, two transfer stations and two recycling centers.	A – Relatively shorter total distance for transfer vehicles to transport unprocessed solid waste. D – Relatively longer total distance for transfer vehicles to transport processed solid waste. A – Recyclable material processed at three facilities.	A – Siting and construction of one MRRF with refuse transfer station. A – Planning for a facility in northern Guam may be less difficult than for a facility in southern Guam.	D – Third Highest Present Value cost based on a 50-year lifecycle analysis.
4	Construct MRRF with refuse transfer station in Barrigada, and construct recycling center in northern Guam and construct recycling center in southern Guam	A – GEPA permits required for one MRRF and two recycling centers. D – Processing of GEPA permits for a MRRF with refuse transfer station site in Barrigada.	D – Relatively longer total distance for collection vehicles to transport unprocessed solid waste. A – Relatively shorter total transportation distance for processed solid waste. A – Recyclable material processed at three facilities.	A – Siting and construction of one MRRF with refuse transfer station.	D– Highest Present Value cost based on a 50-year lifecycle analysis.

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ACRONYMS

AAFB	Andersen Air Force Base
AFB	Air Force Base
C&D	Construction and Demolition
CAP	Consumer Awareness Program
CCA	Chromated Copper Arsenate
CFR	Code of Federal Regulations
CNY	Chinese Yuan
cpd	capita per day
CY	Cubic Yard
DIY	Do-It-Yourself
DoD	Department of Defense
DPW	Department of Public Works
DRMO	Defense Reutilization Marketing Offices
DRMS	Defense Reutilization Marketing Service
EA	Each
EPA	Environmental Protection Agency
GCA	Guam Code Annotated
GEPA	Guam Environmental Protection Agency
GIMDP	Guam Integrated Military Development Plan
GBPR	Guam Business Partners for Recycling, Inc.
GovGuam	Government of Guam
HDPE	High Density Polyethylene
HMS	Heavy Metal Scrap or Heavy Melting Scrap
ISWMP	Integrated Solid Waste Management Plan
JGMMP	Joint Guam Military Master Plan
KG	Kilogram
LB	Pound
MCB	Marine Corps Base
MELL	Mariana Express Lines, Ltd.
MRRF	Materials Resource Recovery Facility
MSW	Municipal Solid Waste
MT	Metric Tons
MOU	Memorandum of Understanding

N/A	Not Applicable
NCTS	Naval Computer and Telecommunications Station
NFESC	Naval Facilities Engineering Service Center
O&M	Operation and maintenance
OCC	Old Corrugated Cardboard
OUSD	Office of the Under Secretary of Defense
PCP	Pentachlorophenol
PET	Polyethylene Terephthalate
PL	Public Law
QRP	Qualified Recycling Program
RCRA	Resource Conservation and Recovery Act
RMB	Renminbi or CNY, Chinese yuan
SWMD	Solid Waste Management Division
tpd	tons per day
tpy	tons per year
U.S.	United States
U.S.C.	United States Code
USCG	United States Coast Guard
USD	United States Dollar
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
USMC	United States Marine Corps
Yr	Year

1.0 Introduction

1.1 Purpose

The Guam Integrated Military Development Plan (GIMDP), formerly the Joint Guam Military Master Plan (JGMMP), describes the planned increase in military population on Guam. NCTS Finegayan, South Finegayan, Andersen Air Force Base (AAFB), AAFB Northwest Field, and AAFB South would experience most of the military personnel increase on Guam. Solid waste disposal facilities for these installations and all other Department of Defense (DoD) installations on Guam are currently provided by separate Navy and Air Force landfills.

The purpose of this study is to identify reasonable cost-effective alternatives for diverting non-hazardous solid waste in support of existing and known future DoD requirements.

1.2 Background Information

The island of Guam is part of the Mariana Island chain. Guam is a U.S. territory and is located approximately 3,800 miles west of Hawaii and 1,500 miles south of Japan. The island is approximately 30 miles long and ranges from four to 11 miles wide. The total land area is approximately 212 square miles. The 2010 population of Guam is estimated at approximately 180,000. A vicinity map of Guam is shown In Figure 1-1.

The solid waste management system on Guam includes the Navy Sanitary Landfill located at Apra Harbor, a landfill and recycling center located at Andersen Air Force Base, and Ordot Dump owned and operated by the Government of Guam (GovGuam). The Navy and Air Force disposal sites are operated by the DoD and provide service to military personnel and residents of the bases as well as commercial waste streams from base activities. The remaining waste stream of Guam is serviced by GovGuam using Ordot Dump and citizen drop-off convenience stations.

The Guam Department of Public Works (DPW) was operating Ordot Dump, which is now under federal receivership. Under a Consent Decree with the United States Environmental Protection Agency (USEPA) Ordot Dump was directed to achieve complete closure by October 23, 2007. In response to this requirement, the DPW advertised Requests for Letters of Interest for these projects in January 2006 and prepared procurement packages for the design and construction for closure of the Ordot Dump, the design, construction and operation of a new landfill at Layon, and the design, construction and operation of other solid waste operations and activities.

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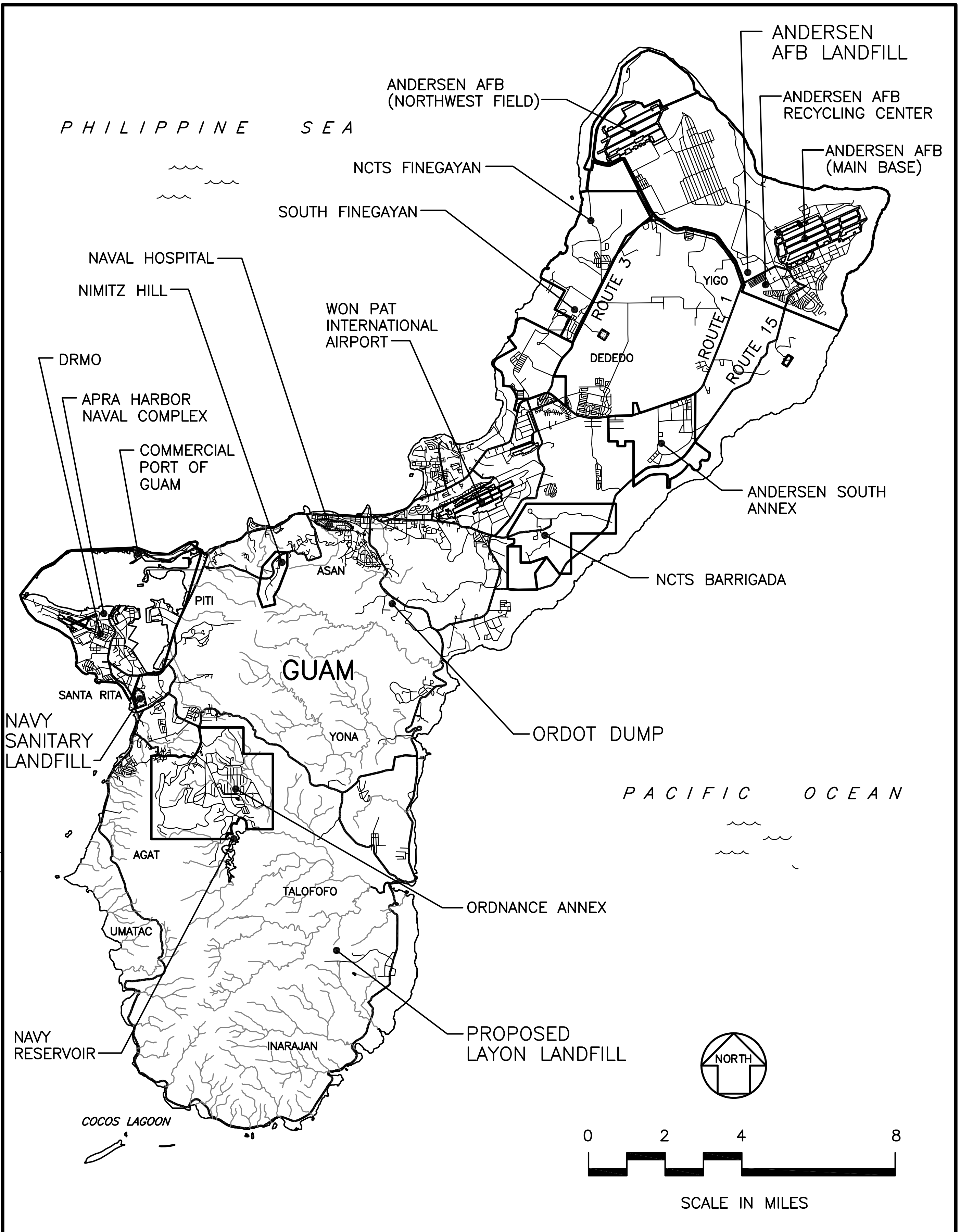

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HDR HPE Hawaii Pacific Engineers, Inc.	RECYCLING AND SOLID WASTE DIVERSION STUDY FOR DOD GUAM	VICINITY MAP	FIGURE 1–1

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The DoD anticipates disposing a portion of their non-hazardous solid waste at the GovGuam Layon landfill in the future. The Navy Sanitary Landfill is expected to remain open for disposal of solid waste that is not accepted at the Layon landfill. The landfill at Andersen Air Force Base is expected to close upon reaching its permitted capacity or when the GovGuam Layon landfill becomes operational. The tipping fee at the Layon landfill is expected to be $156 per ton.

This study evaluates materials diversion, recycling, and resource recovery alternatives for the DoD to service its current and proposed future solid waste diversion needs and to meet regulatory requirements. This study focuses on developing facilities that would divert non-hazardous solid waste generated from DoD activities. It includes planning for projects that represent cost effective alternatives for solid waste diversion, recycling, and materials resource recovery facilities that would enable the DoD on Guam to meet the expected future DoD requirements.

1.3 Proposed U.S. Marine Corps Relocation and Other DoD Growth

The DoD is planning to increase the military population on the island of Guam. The official military loading is expected to increase by approximately 9,632 military personnel over the current baseline population of 6,668 military personnel stationed on Guam. This includes military personnel from the Air Force, Army, United States Coast Guard (USCG), USMC, and Navy. The number of dependents associated with accompanied personnel is expected to increase by about 10,240 over the current baseline dependent population of 8,412 dependents. The total population increase is expected to be approximately 19,872 military and dependent personnel, approximately 11 percent of the current population of Guam. It is expected that approximately 11,002 transient military personnel would be added to the military loading on Guam, including personnel from the Air Force, USMC, and Navy. Of the total DoD population increase, about 17,552 military personnel and dependents are associated with the proposed USMC relocation from Okinawa to Guam. The proposed USMC relocation is anticipated to begin in 2012 and be completed by 2016.

1.4 Solid Waste Collection

It is anticipated that DoD-generated non-hazardous solid waste would be disposed at the Layon landfill. Based on the relatively long travel distances from DoD installations to the Layon landfill, refuse transfer facilities should be considered for DoD solid waste collection operations.

Based on the projected DoD growth, the installations that are expected to have the highest DoD populations are Andersen Air Force Base, NCTS Finegayan, South Finegayan in northern Guam and Apra Harbor Naval Complex in southern Guam. The location of the future Marine Corps Base (MCB) Guam Main Cantonment includes the current NCTS Finegayan and South Finegayan areas.

1.5 Solid Waste Diversion Alternatives

Based on a preliminary review of the projected DoD solid waste stream characteristics, the following considerations for solid waste diversion were identified for evaluation:

- Establishing a source separation recycling program;
- Constructing a recycling center;
- Constructing a materials resource recovery facility (MRRF); and
- Evaluating a Status Quo scenario where the DoD does not divert any recyclable materials.

Upon evaluation, the following alternatives are proposed:

- Alternative 1: Construct MRRFs with refuse transfer stations and recycling centers in northern and southern Guam.
- Alternative 2: Construct MRRF with refuse transfer station and recycling center in southern Guam and construct refuse transfer station and recycling center in northern Guam.
- Alternative 3: Construct MRRF with refuse transfer station and recycling center in northern Guam and construct refuse transfer station and recycling center in southern Guam.
- Alternative 4: Construct MRRF with refuse transfer station in Barrigada and construct recycling center in northern and southern Guam.

2.0 Regulations and Guidance Documents for Recycling and Solid Waste Diversion

2.1 Regulations Overview

This chapter summarizes the regulations and guidance documents applicable to recycling and solid waste diversion on Guam.

2.1.1 Executive Order 13423

Executive Order 13423 Strengthening Federal, Environmental, Energy, and Transportation Management states that "it is the policy of the United States that Federal agencies conduct their environmental, transportation, and energy-related activities under the law in support of their respective missions, in an environmentally, economically, and fiscally sound, integrated, continuously improving, efficient, and sustainable manner." Implementing this policy as it relates to DoD solid waste, the head of each agency should ensure that the agency increases diversion of solid waste as appropriate, and maintains cost-effective waste prevention and recycling programs in its facilities.

2.1.2 Memorandum of Understanding (MOU)

The Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding dated 24 January 2006 is referenced under Executive Order 13423. The MOU is applicable to new construction and major renovation of federal agency buildings. The MOU includes principles to reduce the environmental impact of building materials. These principles encourage the use of recycled content in products as well as recycling or salvaging at least 50 percent of construction, demolition, and land clearing waste, excluding soil. Although construction, demolition, and land clearing waste account for a significant portion of the solid waste stream, this study focuses on recycling and diversion of non-hazardous solid waste excluding construction and demolition (C&D) debris. The reuse and diversion of construction and demolition debris will be included in a separate study.

2.1.3 OUSD Memorandum

A memorandum from the Office of the Under Secretary of Defense (OUSD) dated 1 February 2008 implements the solid waste and recycling requirements of Executive Order 13423. The memo incorporates a diversion goal into the DoD Integrated (Non-Hazardous) Solid Waste Management Policy. The diversion goal for non-hazardous solid waste without C&D waste was 40 percent by 2010. The diversion goal for C&D waste was 50 percent by 2010. The memo indicates that managers must seek out waste diversion practices with the guidance of the Integrated Solid Waste Management Plan (ISWMP). Under this guide, recycling is an effective method towards disposal deterrence, and is further discussed in this study.

2.1.4 Executive Order 13514

Executive Order 13514 Federal Leadership in Environmental, Energy, and Economic Performance enacted on 5 October 2009 builds on and expands upon the energy reduction and environmental requirements of Executive Order 13423. Executive Order 13514 indicates that the federal government must lead by example in safeguarding the health of the environment.

To comply with Executive Order 13514, DoD agencies shall “promote pollution prevention and eliminate waste by”:

i. Minimizing the generation of waste and pollutants through source reduction;
ii. Diverting at least 50 percent of non-hazardous solid waste, excluding construction and demolition debris, by the end of fiscal year 2015;
iii. Diverting at least 50 percent of construction and demolition materials and debris by the end of fiscal year 2015; and
iv. Increasing diversion of compostable and organic material from the waste stream.

2.1.5 Solid Waste Regulations

Federal regulations pertinent to solid waste are contained in Title 40 of the Code of Federal Regulations (CFR), Parts 239 through 259. These parts pertain to non-hazardous solid waste. For this study, 40 CFR Parts 243, 246, 247, 256, and 257 are applicable. Local regulations are included under Title 10 Guam Code Annotated (10 GCA), Division 2 and Guam Administrative Rules and Regulations; Title 22, Division 4, Chapters 20 through 23. The Guam Environmental Protection Agency (GEPA) is responsible for implementing the local regulations.

2.1.5.1 *Federal Regulations*

Federal regulations governing solid waste management are contained in 40 CFR Parts 239 through 259. The regulations applicable to this study include 40 CFR Parts 243, 246, 247, 256, and 257.

The regulations applicable to this study contain guidelines and policies pertaining to the following areas of solid waste management:

- Storage and collection of residential, commercial, and institutional solid waste;
- Source separation for materials recovery;
- Procurement guidelines for products containing recovered materials;
- Development and implementation of state solid waste management plans; and
- Criteria for classification of solid waste disposal facilities and practices.

The purpose of these regulations is to establish minimum standards for solid waste management and to ensure the protection of human health and the environment. The regulations contain methods for resource conservation, maximizing utilization of valuable resources, achieving the objectives of environmentally sound management, and properly disposing solid and hazardous waste.

2.1.5.2 *Local Regulations*

Solid waste is regulated on Guam under 10 GCA 33 Solid Waste and 10 GCA Chapter 51 Solid Waste Management and Litter Control. Title 22 of the Guam Administrative Rules and Regulations transfers regulatory power to GEPA for the implementation of solid waste regulations contained in Chapter 20 through 23. The responsibilities of GEPA are outlined in Section 2.2.1. The local regulations contain policies regarding solid waste collection and disposal and include provisions for beverage containers.

2.1.6 Composting and Mulching Regulations

Federal and local regulations extend to composting and mulching operations. The U.S. EPA indicates that the management of organic materials is not enforced at the federal level unless biosolids and animal manures are involved. Generally, local regulators are responsible for the regulation of composting and mulching facilities.

2.1.6.1 *Federal Regulations*

The U.S. EPA has established a list of recommended compostable materials, which include the following:

- Cardboard rolls
- Clean paper
- Eggshells
- Fruits and vegetables
- Shredded newspaper
- Grass clippings
- Houseplants
- Leaves
- Wood chips
- Yard trimmings.

Waste not recommended for composting includes:

- Black walnut tree leaves or twigs
- Meat or fish bones and scraps
- Diseased or insect-ridden plants
- Yard trimmings treated with chemical pesticides.

Mulching is generally regulated at the state or local level. Under the Resource Conservation and Recovery Act (RCRA), wood treated with chromated copper arsenate (CCA) may not be used for mulch.

Based on an EPA Office of Solid Waste memorandum dated 4 January 2004, wood mulch derived from CCA-treated lumber would not be considered exempt from regulation as a hazardous waste under RCRA. The memorandum indicated that the use of CCA-treated wood to produce mulch is not the intended end use of the treated wood and would not be exempt from hazardous waste regulations under 40 CFR 261.4(b)(9).

The memo concurs with instructions by the EPA Consumer Awareness Program (CAP), which indicates that treated wood may not be used where a preservative may become a component of food or animal food. CAP indicates that mulching recycled arsenic-treated wood is an example of this usage.

2.1.6.2 *Local Regulations*

Rules and Regulations for the GEPA Solid Waste Disposal, Title 22, Division 4, Chapter 23, Article 1 defines composting as a controlled degradation of organic solid waste.

Backyard or home composting is a non-permit required operation where food and/or yard waste may be composted into nutrient-rich soil. A more complex composting facility would require GEPA permits for the approved operation of the processing facility.

A large pest eradication program is currently in effect for the coconut rhinoceros beetle. The Guam Department of Agriculture established quarantine on October 5, 2007, through a “Declaration of Quarantine.” The quarantine prohibits coconut rhinoceros beetle host material from being transported except under a limited permit issued by the Guam Department of Agriculture. The quarantine in northern Guam restricts the movement of green waste and live plants across the quarantine boundary without inspection and/or treatment. Green waste recycled into mulch or compost would be subject to these restrictions.

2.2 Regulatory Involvement

2.2.1 GEPA

GEPA was created in March 1973 and is responsible for establishing and maintaining the quality of the air, land and water of Guam. In December 1998, Public Law 24-304 created the Solid Waste Management Program. The Program is responsible for permitting solid waste collection and treatment, storage, and disposal facilities. In addition, the Program is responsible for inspection, compliance monitoring, enforcement, and corrective action on all solid waste-related activities. Other activities include beverage container inspections, public education, and pollution prevention incentives.

In 1996, the Solid Waste Management and Litter Control Act was revised giving Guam EPA the authority to impose administrative penalties for solid and hazardous waste management violations and defined civil versus criminal penalties. The revised Act provided provisions for citizen suits, established permit fees for certain solid waste activities, and created a Solid Waste

Management Fund to support activities to effectuate the Act, which includes paying for full-time employees and related expenses. Aside from the Fund, the Program's activities are supported by the Litter Revolving Fund, which was created to be used primarily for anti-littering campaigns. At its meeting on September 27, 2006, the Guam EPA Board of Directors approved the *Guam 2006 Integrated Solid Waste Management Plan* (2006 ISWMP), which updated the previous *Guam 2000 Integrated Solid Waste Management Plan* as required by Chapter 51, of Title 10 Guam Code Annotated. The 2006 ISWMP is described in more detail in Section 2.3 Guidance Documents.

The GEPA Rules and Regulations for Solid Waste Disposal; Title 22, Division 4, Chapter 23 establishes minimum standards governing the design, construction, installation, operation and maintenance of solid waste disposal facilities on Guam. Chapter 23 establishes permit requirements for solid waste management facilities, which include solid waste transfer facilities and solid waste processing facilities. Prohibited wastes include hazardous, commercial, government and military solid wastes (unless approved by the administrator); inert material; biological, pathological, radioactive, medical, and infectious wastes, free liquids, asbestos, animal carcasses, ashes, putrescible animal waste, sewage sludge, and other sludge and petroleum products.

2.2.1.1 *Permits*

Guam's Solid Waste Management Act under 10 GCA Section 51, authorizes the GEPA to issue permits for all collectors, operators and solid waste management facilities, their design, operation, maintenance, substantial alteration, modification or enlargement.

10 GCA Section 51002(25) defines solid waste management facilities as "any machinery, equipment, vehicles, structures or any part of accessories thereof installed or acquired for the primary purpose of: collection, transportation, storage, recycling, processing, or disposal of any solid waste."

Solid waste management facilities relevant to this study include recycling facilities, transfer facilities, and materials resource recovery facilities.

GEPA requires permits for the following facilities and activities applicable to this study:

- Solid waste disposal facility
- Solid waste processing
- Solid waste storage
- Solid waste collection
- Solid waste transfer

Solid Waste Disposal Facility Permit

All solid waste including municipal, commercial, industrial, land clearing debris, and demolition debris must be disposed at a GEPA permitted solid waste disposal facility. The facilities requiring a solid waste disposal permit generally include landfills, hardfills, and transfer facilities. The permit application for a solid waste disposal facility must specify the facility location, mode of operation, a detailed description illustrating compliance with applicable laws and regulations, and proposed closure requirements.

Solid Waste Processing Permit

GEPA requires a solid waste processing permit for facilities that *process* solid waste. Processing is defined by 10 GCA Section 51102(16) as "any method, system or other treatment designed to change the physical, chemical or biological character or composition of any solid waste." A processing permit would be required for facilities processing solid waste in materials resource recovery facilities, composting facilities, and recycling facilities with processing capabilities.

The permit application for solid waste processing contains the following requirements:

- Provide detailed plans and specifications for the facility;
- Submit relevant zoning compliance certifications and permits;
- Include a detailed operational plan; and
- Provide proof of financial assurance.

Solid Waste Storage Permit

GEPA requires a solid waste storage permit for both individuals and businesses that *temporarily* store solid waste. Storage is defined by 10 GCA Section 51102(50) as "the interim containment of solid waste in accordance with Federal and local regulations."

The permit application for solid waste storage contains requirements similar to a solid waste processing permit with the exception of providing proof of financial assurance. In addition, GEPA provides public notice of the Agency's intention to issue a permit and may provide a public hearing if opposition is received.

Solid Waste Collection Permit

A solid waste collection permit is required for any business that transports solid waste over Guam roadways. The permit application requires collection information including route and vehicle identification.

Solid Waste Transfer Permit

GEPA requires a solid waste transfer permit for any business that accepts solid waste, which is temporarily deposited and stored *awaiting transportation* to another permitted solid waste management facility such as a landfill, materials resource recovery facility, or a recycling center. The transfer permit allows temporary storage of residential waste and yard waste. The permit application requirements for solid waste transfer are similar to a solid waste processing permit with the exception of providing proof of financial assurance.

2.2.2 Government of Guam Department of Public Works

Guam Department of Public Works is one of several agencies of the Government of Guam and consists of several divisions including the Solid Waste Management Division (SWMD). The operation of the DPW is supported by the revenues derived from the services that it renders, fines and penalties that it collects, grants, and appropriations from the Guam General Fund (General Fund).

The Guam DPW and other non-DoD entities must comply with the Guam laws and regulations as codified under the Guam Code Annotated. Although all of the Guam laws and regulations are not directly applicable to DoD solid waste activities that involve only DoD installations, they may have an indirect impact. The most notable indirect impact is the non-compliant status of the Ordot Dump and the delayed construction of the new GovGuam landfill. The Guam laws and regulations would be applicable to any facility, including regional facilities, that handle both DoD and non-DoD solid waste.

The SWMD currently has five sections: administration, customer service, residential solid waste collection, transfer station drop-off locations and landfill operations. Support for SWMD's operations comes from revenues derived from solid waste services charges and occasional cash infusions from Federal grants, Compact Impact funds and the General Fund. Until recently, there was no separate monthly financial reporting for SWMD's operations. DPW is responsible for complying with the tasks and deadlines mandated by the EPA Consent Decree.

Due to the delays in meeting the Consent Decree deadlines for the closure of the Ordot Dump and completion of the new landfill, the US District Court has placed the SWMD in federal receivership.

2.2.2.1 Layon Landfill Requirements

The Federal regulations pertinent to landfills on Guam are contained in Title 40 of the Code of Federal Regulations, Part 258. Local regulations are included in the GEPA Rules and Regulations for Solid Waste Disposal. The GEPA Rules and Regulations for Solid Waste Disposal are based on the Federal regulations contained in 40 CFR Part 258.

The Federal regulations contain guidance and policies on the purpose, scope and applicability of the regulations, location restrictions, operating criteria, design criteria, groundwater monitoring and corrective actions, closure and post-closure care, and financial assurance criteria. The regulations apply to all new municipal solid waste (MSW) landfills, existing MSW landfills and lateral expansions of existing landfills.

The GEPA requirements for a landfill permit are similar to the Federal regulations except for a few differences:

- Permit requirements for the operation of a solid waste management facility, including landfill are included.
- List of solid wastes that are prohibited for disposal at the landfill is included. These wastes include waste oil, regulated hazardous wastes, whole or partially whole vehicles, vehicle parts, tires, batteries, septic tank pumping, appliances, sewage sludge, and other petroleum based products and oil based paints.
- Health and safety requirements for the protection of all personnel associated with the operation of the landfill disposal site are included.

In addition to local and Federal regulations, a materials ban has been imposed by the Receiver. These restrictions have been applied to the Ordot Dump and many restrictions would be applied to the new Layon Landfill. Under this ban, the following materials are prohibited: old corrugated cardboard (OCC), green waste, construction waste, wooden pallets, and inert materials.

The Layon Landfill is expected to exclude the following waste for disposal: junk vehicles, appliances, construction and demolition debris, PCB wastes, contaminated soils (petroleum), E-wastes, DIY used motor oil, batteries, radioactive wastes, solvents, paints, oily wastes, acids, corrosives, green wastes, industrial wastes, explosives, asbestos, sludge, and asbestos-containing materials. There are provisions for acceptance of special wastes, which include infectious wastes, dead animals and offal, and sewage sludge.

The Layon Landfill has a projected tipping fee of $156 per ton for July 2010. The increase in tipping fees was established by the Receiver to ensure that the SWMD would be able to meet the debt service covenants of its borrowing obligations and to provide sufficient ongoing equity in the solid waste system.

2.3 Guidance Documents

2.3.1 Guam 2006 Integrated Solid Waste Management Plan

The Guam 2006 ISWMP is a guidance document, which identifies and describes key elements of the integrated solid waste management system on Guam. Chapter 7 of the Guam 2006 ISWMP establishes minimum standards governing recycling, composting, and special wastes. Under these standards, recycling facilities and operations should be able to accomplish the objectives pertaining to the functional, operational, and legal/regulatory criteria for each facility. Standards for a materials resource recovery facility are included in this chapter. The legal and regulatory criteria are subject to applicable local and Federal laws and include the following provisions:

- Operations of recycling facilities must not violate applicable air, water quality, and other environmental standards or regulations;

- Issuance of permits by Guam EPA for the design, operation, maintenance, and modification of all solid waste management facilities, including recycling facilities;
- Efforts should be made by all Government of Guam departments, agencies, and instrumentalities to reduce and recycle solid waste;
- Establishment of a promotional program for recycling by Guam EPA and the Solid Waste Management Division;
- Requirement for Government purchase and usage of products manufactured from recycled glass to promote recycling by the October 1997 provision in PL 24-100; and
- Insurance and maintenance of the regular collection of recyclable materials and recorded data forwarded to Guam EPA.

The Guam 2006 ISWMP provides additional performance standard requirements for processing operations. On the basis that processing and composting facilities and landfills share similar functional concerns – such as odor and vector control – facilities must meet siting requirements in terms of location (e.g. flood plains, wetlands, housing developments). Further, the Guam 2006 ISWMP indicates that in order to achieve effective facility design, construction, management and operation, operating rules and regulations are to be in place against which the performance of the system may be evaluated.

2.3.1.1 *Materials Resource Recovery Facility*

The performance standards for a materials resource recovery facility are outlined in the 2006 ISWMP, Chapter 7. Under this document, the following functional and operational provisions are applicable:

- Recycling should incorporate a MRRF to achieve necessary recovery rates.
- Recycling operations should allow for the convenient collection and/or drop-off of appropriate commodities to encourage widespread participation.
- Recycling collection and drop-off facilities provided at a minimum, at transfer stations and village community centers.
- MRRF design based upon an appropriate waste stream analysis.
- MRRF provisions for recovery of the following materials: paper, ferrous and non-ferrous metals, white goods, plastics, batteries, glass, tires, and used motor oil.
- Provide incentives for operations of recycling-based industries.
- Obtaining subsidy and financial support of recycling operations when the marketing of certain recyclables are non-existent or is not profitable.

- MRRF and transfer stations locations based upon maximum usage and participation studies.
- MRRF designed to accommodate drop-offs from self-haulers and commercial haulers.
- MRRF designed to accept all types of recyclable materials for processing and marketing.
- MRRF designed to determine weight and volume of each type of recyclable material received, processed and transported.
- Coordination with the Office of Recycling and Guam EPA by the facility operator in the promulgation and execution of a public education strategy.

2.3.2 OPNAVINST 5090.1C, Navy Environmental Readiness Program Manual

In October 2007, the Office of the Chief of Naval Operations implemented OPNAVINST 5090.1C, the Navy Environmental Readiness Program Manual. This Manual is a significant revision to OPNAVINST 5090.1B, the Environmental and Natural Resources Program Manual. The Environmental Readiness Program Manual provides Navy policy and procedure, identifies key statutory and regulatory requirements, and assigns responsibility for the planning and execution of Navy programs including:

- Programs for compliance with current laws, regulations and Executive Orders relative to the protection of the environment; pollution prevention, and the conservation of natural, cultural and historic resources.
- Programs that enable the planning and execution of Navy, joint and combined operations and training that fully meet operational readiness requirements and Navy environmental objectives.

The mission of the Navy's Environmental Readiness Program is to ensure the ability of United States Navy forces to effectively operate worldwide in an environmentally responsible manner. In Chapter 16 of the Program Manual, policies regarding solid waste management and resource recovery are provided. All Navy installations worldwide that generate one or more tons of solid waste per day would follow the solid waste reporting, solid waste management planning, recycling requirements, and affirmative procurement requirements outlined in this chapter. These Navy installations are required to develop and implement integrated solid waste management programs (ISWMPs) and Qualified Recycling Programs (QRPs).

A QRP is an organized recycling operation in which an installation is qualified to retain the proceeds from the sale of recyclable materials if specific criteria are met.

2.3.3 NFESC UG-2039-ENV, Qualified Recycling Program Guide

The guidance document compiled by Naval Facilities Engineering Service Center (NFESC), UG-2039-ENV, Qualified Recycling Program Guide; July 2000, provides instruction pertaining to the development and operation of both regional and installation QRPs for naval shore activities.

The enactment of 10 U.S.C. §2577 enabled “qualified recycling programs” to retain revenue from the sale of certain recyclable revenue. This law contains provisions that form the basis for QRPs.

The Defense Reutilization Marketing Offices (DRMO) should be informed that the installation has a QRP.

After the establishment of an organized QRP or concurrent with such program development, the installation should coordinate with DRMO to determine whether the specific materials to be sold are QRP recyclable materials. The QRP may not retain sales proceeds from excluded items. The managing activity may sell recyclable materials through DRMO or by direct sales if authority is granted. DRMO would return net proceeds to the QRP. Commonly sold QRP materials include: cardboard, aluminum cans, scrap paper, office paper, glass bottles, lead acid batteries, used oil, metal scrap from Resource Management System Activities, expended range brass properly certified as safe or inert, scrap wood and plastic bottles. A partial list of excluded materials is included below:

- Government material furnished to a contractor
- Precious metals
- Hazardous wastes
- Ozone depleting substances
- Materials requiring demilitarization and scrap resulting from demilitarization
- Scrap without market value
- Metal scrap originally purchased with working capital funds
- Property owned by non-appropriated fund activities

A complete list of excluded materials may be found in Chapter 3 of the Qualified Recycling Program Guide. Sales proceeds from excluded materials may not be retained by the QRP.

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3.0 Solid Waste Generation and Disposal Conditions

3.1 Existing Conditions

3.1.1 Waste Collection System

The Navy Sanitary Landfill currently receives all DoD non-hazardous solid waste generated on Navy installations. This section presents a brief overview of DoD solid waste generation and focuses on the existing solid waste stream entering the landfill. Field investigations and review of landfill records were conducted to quantify and characterize the solid waste stream entering the landfill. Projected base loadings were then used to develop future solid waste stream quantities and characteristics.

Solid wastes generated by the Navy installations and their tenants were categorized into four general source categories:

- Family housing;
- Commercial and industrial activities;
- Construction activities; and
- Other wastes.

Housing waste is collected in 90-gallon refuse containers emptied by 40-cubic yard capacity, side-loading, compacting refuse trucks. Commercial and industrial waste is collected in 3-, 6- and 8-cubic yard “front-loader” containers placed near various facilities at the Naval installations. The containers are emptied by 40-cubic yard capacity, front-loading, compacting refuse collection trucks. Selected Naval facilities have 20- and 40-cubic yard “dinosaur” containers that are collected by roll-on/roll-off, rear-loading tractors. Refuse from ships is collected in special containers located along the berthing pier. The containers are picked up from the pier and transported to the steam sterilization facility for decontamination of the ship refuse. After the ship refuse is decontaminated, the steam-sterilized waste is transported to the Navy Sanitary Landfill for disposal.

A curbside recycling program was recently implemented throughout Naval neighborhoods on Guam. The recycling program allows residents to sort their recyclables into three specific categories: aluminum, plastic, and glass. Families are assigned a 92-gallon recycling bin for the recyclables. The recyclables are currently picked up from the family housing areas and taken to the AAFB recycling center for sorting and processing.

The Andersen Air Force Base landfill currently accepts waste generated from Andersen Air Force Base, Andersen South, and Northwest Field. The existing landfill operations at AAFB include a municipal solid waste landfill area and a construction and demolition debris disposal area. The landfill was planned to have sufficient capacity for AAFB solid waste until the opening of the new

GovGuam landfill. Currently, a horizontal landfill expansion project at AAFB is in the design process, which would provide an additional limited capacity. The horizontal expansion is anticipated to provide AAFB with significant disposal capacity until the completion of the GovGuam landfill. Beyond the expansion, Andersen Air Force Base is expected to dispose solid waste in the new GovGuam landfill upon the landfill's completion or when the expanded capacity of the AAFB landfill has been reached.

Currently, a contractor collects solid waste at AAFB. Housing waste at AAFB is collected in designated 95-gallon green refuse containers using a compaction vehicle for curbside collection. Industrial, administrative, and commercial waste are collected in 8-cubic yard containers located throughout the base. The contractor collects recyclable materials in designated 95-gallon blue curbside recycling bins in housing areas and 8-cubic yard containers located throughout the base.

A contractor operates a recycling center at AAFB. The recycling center primarily serves as an accumulation point for cardboard, paper, plastic bottles, aluminum cans, and glass. Covered storage area is limited, and the majority of the accumulated materials are stored in uncovered open areas at the recycling center site. The recycling center operator is responsible for arranging transport of the materials off AAFB through a recycler.

3.1.2 Assessment of Existing Waste Generation

Field investigations and data collection were performed to assess the quantity of solid waste entering the Navy Sanitary Landfill to develop projected solid waste stream quantities and characteristics and to allow subsequent analysis of remaining landfill life and potential future disposal alternatives. Field investigations were conducted between 11 December 2006 and 18 December 2006. Data was analyzed for the landfill airspace volume utilization using topographic mapping and related to the volume of material added to the landfill.

The following parameters were estimated based on volumetric calculations and visual observations of the landfilling operations:

- The annual landfilling rate was calculated to be 49,580 cubic yards per year, based on a total landfill volume change of 529,000 cubic yards between February 1996 and October 2006.
- An observed in-place density of 625 pounds per cubic yard and in-place solid waste to cover material ratio of 1:1 were used to calculate a daily solid waste generation rate of 21 tons per day.
- The Guam Water Quality Management Plan, 1979 indicated a military per capita generation rate of 7.4 pounds per day.

Annual solid waste volumes for 2006 were estimated based on the reported volumes, refuse collection schedule, trip tickets and disposal logs.

- The total solid waste generated based on the reported volumes to GEPA was calculated to be 309,400 cubic yards. It should be noted that the volume of the housing waste appears to be a compacted volume.
- The calculated annual solid waste generated based on the refuse collection schedule is 187,300 cubic yards. It should be noted that this value includes only the waste from commercial and industrial activities collected in the 3-, 6-, 8-, 20- and 40-cubic yard containers and assumes that the refuse container is full.
- The estimated solid waste volume generated based on the trip tickets is 134,300 cubic yards. It should be noted that this total includes only commercial and industrial waste. Housing and customer-hauled waste is not included. It was also assumed that the containers were full.
- The total solid waste volume generated based on the disposal logs was calculated to be 135,600 cubic yards. It should be noted that the volumes recorded for housing and some of the commercial and industrial waste volumes appears to be a compacted volume.

It appeared that the solid waste volumes recorded on the reports to GEPA and disposal logs were overestimated. Because the estimated volumes based on the solid waste records did not appear to be sufficiently accurate, the calculated change in landfill volume based on the available topographic survey maps and information and observations of landfill placement practices were used to develop the basic solid waste data to project quantities of future solid waste stream entering the landfill.

Basic solid waste data for the existing solid waste stream based on the analyses and investigations described above and per capita parameters used for projection of solid waste quantities are summarized in Table 3-1.

Table 3-1

Basic Solid Waste Stream Data

Parameter	Value	Unit
Total landfilled volume, solid waste and cover material	49,580	cy/yr
Cover material to solid waste ratio	1.0	
In-place solid waste volume	24,790	cy/yr
Cover material volume	24,790	cy/yr
In-place solid waste density	625	lbs/cy
Total solid waste entering landfill	21	tons/day
Current population served by landfill	7,000	
Per capita unit waste generation used for this report	7.4	lbs/day

3.1.3 Recycling Facilities Field Observations

Field observations were conducted on 20 May 2009 and 21 May 2009 to assess current practices at recycling facilities, view recycling equipment, and gain general operational and management advice. Facilities visited included recycling centers at the Marine Corps Base Hawaii (MCB Hawaii), Hickam Air Force Base, Naval Base Pearl Harbor, Naval Base Guam, and Andersen Air Force Base, Guam to assess current recycling practices.

Recommendations for facility implementation, operation, and feasibility were provided and included methods for handling materials and selecting equipment for the facility.

The waste stream is an important consideration for appropriately sizing and equipping a MRRF or recycling center. Conducting a waste stream analysis was suggested for better assessment of incoming materials and targeted recyclables.

Solid waste source segregation was also encouraged to help instill more responsibility and ownership within the recycling program.

The type of equipment needed for a recycling facility was discussed. In the separation process, optical sorters and other mechanical means were strongly recommended to minimize the need for onsite labor. Facility personnel should possess the appropriate skills for the duties they would perform.

During processing, dense, uniform bales are desired. These bales have higher value than loose, contaminated bales. A high compression, export quality baler was recommended to produce bales weighing 1,200 to 1,500 pounds each. Contamination should be prevented to produce high quality bales.

For each facility, the recycling manager or coordinator should have broad authority over adjustments and operating decisions. An example of broad authority includes partnering, bidding, and price moderating decisions.

3.2 Projected Conditions

Activity at DoD installations is expected to increase due to planned development of additional facilities for DoD operations and the proposed relocation of USMC operations. The proposed USMC relocation is anticipated to begin in 2012 and be completed by 2016. Based on the projected allocation of military personnel on Guam, it is estimated the majority of DoD solid waste would be generated in northern Guam. Furthermore, the existing Andersen Air Force Base Landfill is currently near capacity. The current GovGuam Ordot Dump is scheduled to close. The new GovGuam landfill is currently behind schedule and its completion date is uncertain. There is potential for disposing solid waste from the Air Force facilities at the Navy Sanitary Landfill until GovGuam opens its new landfill. Updated projected population data is summarized in Table 3-2.

Table 3-2

Military Population

Year	USMC	Air Force	Navy	Army	USCG	Total
2009	5	5,095	9,580	80	320	15,080
2010	1,052	6,193	9,580	80	320	17,225
2011	2,806	6,193	9,580	130	320	19,029
2012	2,806	6,549	9,580	130	320	19,385
2013	2,806	6,549	9,580	130	400	19,465
2014	19,557	6,681	9,580	130	400	36,348
2015	19,557	6,681	16,932	1,660	400	45,230
2016	19,557	6,681	16,932	1,660	400	45,230
2017	19,557	6,681	16,932	1,660	400	45,230
2018	19,557	6,681	16,932	1,660	400	45,230
2019	19,557	7,205	17,132	1,660	400	45,954
2020	19,557	7,205	17,132	1,660	400	45,954
Percent of Total	42.6%	15.7%	37.3%	3.6%	0.9%	100.0%

Notes:

a) The civilian work force population is not included in the military population. The solid waste generated by the civilian work force is factored into the military per capita solid waste generation rate of 7.4 lbs/cpd.
b) The military population for the USMC, Air Force, and Army include the full time equivalent for transient personnel stationed on Guam. However, the Navy population includes transient personnel stationed on Guam up to three times per year at 21 days per visit.

The solid waste alternatives included in this study were developed to serve the entire DoD population. The DoD solid waste data was combined with projected base loading for all military installations on Guam to derive the projected quantities of the future solid waste stream entering the landfill. The estimated DoD solid waste quantity distribution between the Navy, Air Force, USMC, Army, and USCG relocation for year 2016 is as follows:

	Solid Waste Quantity at 7.4 lbs/cpd
Navy	14,797 tons/year
Air Force	9,023 tons/year
USMC	26,414 tons/year
Army	2,242 tons/year
USCG	540 tons/year
Total	53,016 tons/year

The estimated quantities for the DoD solid waste stream entering the Navy Sanitary Landfill are summarized in Table 3-3. The DoD solid waste quantities projected are based on a military solid waste generation rate of 7.4 pounds per capita per day.

Table 3-3

Projected Solid Waste Quantities

Year	Population	Projected Solid Waste (tons/year)	Remarks
2009	15,080	20,366	Baseline
2010	17,225	23,265	
2011	19,019	25,701	
2012	19,385	26,182	Proposed USMC relocation begins
2013	19,465	26,290	
2014	36,348	49,090	
2015	45,230	50,016	
2016	45,230	53,016	Proposed USMC relocation complete
2017	45,230	53,016	
2018	45,230	53,016	
2019	45,954	53,993	
2020	45,954	53,993	

A solid waste characterization analysis was not conducted as part of this study. A solid waste characterization study was conducted for MCB Hawaii. Solid waste generation activities for military installations on Guam and MCB Hawaii are similar. Both military installations on Guam and MCB Hawaii have similar facilities including maintenance shops, administrative offices, commissary and exchange facilities, fast-food establishments, club operations, family housing and unaccompanied personnel housing. Furthermore, both military installations on

Guam and MCB Hawaii are located on an island with similar climate and weather conditions. Due to the lack of solid waste characterization data for military installations on Guam, it was assumed that the solid waste characterization for MCB Hawaii would best represent the solid waste characteristics for military installations on Guam.

Selected waste stream data taken from the Qualified Recycling Program Business Plan prepared for Andersen Air Force Base by engineering-environmental Management (e^2M), Inc. was used to estimate the wooden pallet production in the waste stream.

For purposes of this study it was assumed that the residential and commercial/ industrial per capita solid waste generation for military installations on Guam would be 7.4 lbs/day based on the 1979 Guam Water Quality Management Plan. This value is higher than the calculated present per capita solid waste generation for Naval facilities on Guam. However, it is considered a conservative assumption for planning purposes.

The projected average daily solid waste quantities and composition for all DoD military installations on Guam are summarized in Table 3-4. The projected average daily solid waste quantities are based on the total projected annual solid waste stream. The projected average daily solid waste quantities and composition for northern and southern military installations on Guam are summarized in Table 3-5 and Table 3-6, respectively. Table 3-7 summarizes the projected solid waste stream quantities by source category.

Table 3-4

Projected Average Daily Solid Waste Quantities and Composition, Total

	Residential		Commercial/ Industrial		Composite	
Per Capita Waste Generation (lbs/day)						7.4
2009 Military Population						15,080
Total Weight (lbs/day)						111,592
Projected Military Population						45,954
Total Projected Weight (lbs/day)						295,852
Residential/Commercial/Industrial Waste						
Percent of Total		19.7		42.6		
Total 2009 Computed Weight (lbs/day)		21,984		47,538		69,522
Total Projected Weight (lbs/day)		58,283		126,033		184,316
Composition	percent	lbs/day	percent	lbs/day	percent	lbs/day
Aluminum Cans	3.4	1,981.6	1.2	1,512.4	1.9	3,494.0
Glass (Brown)	4.0	2,331.3	0.5	630.2	1.6	2,961.5
Glass (Clear)	3.0	1,748.5	1.8	2,268.6	2.2	4,017.1
Glass (Green)	0.8	466.3	0.2	252.1	0.4	718.3
Ferrous Metals	0.8	466.3	5.0	6,301.6	3.7	6,767.9
Non-Ferrous Metals	1.4	816.0	1.4	1,764.5	1.4	2,580.4
Newspaper	1.3	757.7	0.9	1,134.3	1.0	1,892.0
Mixed Paper	1.9	1,107.4	4.0	5,041.3	3.3	6,148.7
Office Paper	0.3	174.8	3.0	3,781.0	2.1	3,955.8
Cardboard	6.6	3,846.7	2.3	2,898.8	3.7	6,745.4
Plastics	1.7	990.8	1.2	1,512.4	1.4	2,503.2
Compostable Material	6.2	3,613.5	15.7	19,787.2	12.7	23,400.7
Wood Pallets	11.3	6,586.0	11.3	14,241.7	11.3	20,827.7
Miscellaneous Waste[a]	57.3	33,396.1	51.5	64,907.0	53.3	98,303.1
Total Collected Waste	100.0	58,282.9	100.0	126,033.0	100.0	184,315.8
Construction Waste						
Percent of Total						37.7
2009 Total Weight (lbs/day)						42,070
Total Projected Weight (lbs/day)						111,536

Note [a]: Miscellaneous waste includes discarded items such as clothing, shoes, small appliances, small furniture, and carpet. It is believed that miscellaneous waste may contain additional recyclable materials.

Table 3-5

Projected Average Daily Solid Waste Quantities and Composition, North

	Residential		Commercial/ Industrial		Composite	
Per Capita Waste Generation (lbs/day)						7.4
2009 Military Population						5,180
Total Weight (lbs/day)						38,334
Projected Military Population						28,422
Total Projected Weight (lbs/day)						210,334
Residential/Commercial/Industrial Waste						
Percent of Total		19.7		42.6		
Total Weight (lbs/day)		7,552		16,330		23,882
Total Projected Weight (lbs/day)		41,436		89,602		131,038
Composition	percent	lbs/day	percent	lbs/day	percent	lbs/day
Aluminum Cans	3.4	1,408.8	1.2	1,075.2	1.9	2,484.0
Glass (Brown)	4.0	1,657.4	0.5	448.0	1.6	2,105.4
Glass (Clear)	3.0	1,243.1	1.8	1,612.8	2.2	2,855.9
Glass (Green)	0.8	331.5	0.2	179.2	0.4	510.7
Ferrous Metals	0.8	331.5	5.0	4,480.1	3.7	4,811.6
Non-Ferrous Metals	1.4	580.1	1.4	1,254.4	1.4	1,834.5
Newspaper	1.3	538.7	0.9	806.4	1.0	1,345.1
Mixed Paper	1.9	787.3	4.0	3,584.1	3.3	4,374.1
Office Paper	0.3	124.3	3.0	2,688.1	2.1	2,812.4
Cardboard	6.6	2,734.8	2.3	2,060.9	3.7	4,795.6
Plastics	1.7	704.4	1.2	1,075.2	1.4	1,779.6
Compostable Material	6.2	2,569.0	15.7	14,067.6	12.7	16,636.6
Wood Pallets	11.3	4,682.2	11.3	10,125.1	11.3	14,807.3
Miscellaneous Waste[a]	57.3	23,742.7	51.5	46,145.2	53.3	69,887.9
Total Collected Waste	100.0	41,435.8	100.0	89,602.3	100.0	131,038.1
Construction Waste						
Percent of Total						37.7
2009 Total Weight (lbs/day)						14,452
Total Projected Weight (lbs/day)						79,296

Note [a]: Miscellaneous waste includes discarded items such as clothing, shoes, small appliances, small furniture, and carpet. It is believed that miscellaneous waste may contain additional recyclable materials.

Table 3-6

Projected Average Daily Solid Waste Quantities and Composition, South

	Residential		Commercial/ Industrial		Composite	
Per Capita Waste Generation (lbs/day)						7.4
2009 Military Population						9,900
Total Weight (lbs/day)						73,260
Projected Military Population						17,532
Total Projected Weight (lbs/day)						85,518
Residential/Commercial/Industrial Waste						
Percent of Total		19.7		42.6		
Total Weight (lbs/day)		14,432		31,209		45,641
Total Projected Weight (lbs/day)		16,847		36,431		53,278
Composition	percent	lbs/day	percent	lbs/day	percent	lbs/day
Aluminum Cans	3.4	572.8	1.2	437.2	1.9	1,010.0
Glass (Brown)	4.0	673.9	0.5	182.2	1.6	856.0
Glass (Clear)	3.0	505.4	1.8	655.8	2.2	1,161.2
Glass (Green)	0.8	134.8	0.2	72.9	0.4	207.6
Ferrous Metals	0.8	134.8	5.0	1,821.5	3.7	1,956.3
Non-Ferrous Metals	1.4	235.9	1.4	510.0	1.4	745.9
Newspaper	1.3	219.0	0.9	327.9	1.0	546.9
Mixed Paper	1.9	320.1	4.0	1,457.2	3.3	1,777.3
Office Paper	0.3	50.5	3.0	1,092.9	2.1	1,143.5
Cardboard	6.6	1,111.9	2.3	837.9	3.7	1,949.8
Plastics	1.7	286.4	1.2	437.2	1.4	723.6
Compostable Material	6.2	1,044.5	15.7	5,719.6	12.7	6,764.1
Wood Pallets	11.3	1,903.7	11.3	4,116.7	11.3	6,020.4
Miscellaneous Waste[a]	57.3	9,653.4	51.5	18,761.8	53.3	28,415.2
Total Collected Waste	100.0	16,847.0	100.0	36,430.7	100.0	53,277.7
Construction Waste						
Percent of Total						37.7
2009 Total Weight (lbs/day)						27,619
Total Projected Weight (lbs/day)						32,240

Note [a]: Miscellaneous waste includes discarded items such as clothing, shoes, small appliances, small furniture, and carpet. It is believed that miscellaneous waste may contain additional recyclable materials.

Table 3-7

Projected Average Daily Solid Waste Quantities by Source Category

	Residential	Commercial/ Industrial	Construction	Total
Per Capita Waste Generation (lbs/day)				7.4
2009 Military Population				15,080
2009 Total Weight (lbs/day)				111,592
Baseline Military Population				15,080
Total Baseline Weight (lbs/day)				111,592
Projected Military Population				45,954
Total Projected Weight (lbs/day)	58,283	126,033	111,536	295,852
North Projected Weight (lbs/day)	41,436	89,602	79,296	210,334
South Projected Weight (lbs/day)	16,847	36,431	53,278	85,518

3.3 Waste Characterization

The projected average daily DoD solid waste quantities and composition for all DoD installations on Guam are summarized in Table 3-4. DoD solid waste quantities and composition for northern and southern Guam are summarized in Table 3-5 and Table 3-6, respectively.

Tables 3-4 through 3-6 provide a percentage composition of selected waste categories: aluminum cans, glass (brown), glass (clear), glass (green), ferrous metals, non-ferrous metals, newspaper, mixed paper, office paper, cardboard, plastics, compostable material, wood pallets, and miscellaneous waste. For example, aluminum cans account for 1.9 percent of the DoD solid waste stream.

Given this waste characterization, if 100 percent of the recyclables are recovered, only 46.7 percent diversion would be achieved. While the estimated 46.7 percent does not meet the Executive Order 13514 diversion goal of 50 percent, the percentage is based on MCB Hawaii's waste characterization study.

MCB Hawaii's waste characterization study indicated miscellaneous waste accounted for 53.3 percent of the solid waste stream. It is believed that miscellaneous waste may contain additional recyclable materials. The MCB Hawaii's waste characterization study indicated that miscellaneous waste included material that was not segregated from solid waste during sorting. The miscellaneous waste category included discarded items such as clothing, shoes, small appliances, small furniture and carpet. If an additional 3.3 percent of the 53.3 percent miscellaneous waste contains recyclable materials, the diversion goal can be met.

Therefore, it is recommended that a solid waste characterization study for DoD installations on Guam be conducted to adequately model its waste generation and to better estimate the characteristics of the miscellaneous waste.

3.4 Defense Reutilization and Marketing Office (DRMO)

DRMO is the office of the Defense Reutilization and Marketing Service (DRMS). DRMO is part of the Defense Logistics Agency. Their mission is to provide the DoD with the best value services and deliver great performance to customers for the reuse, transfer, donation, sale or disposal of excess/surplus property. Currently, the main purpose of Guam DRMO is to oversee the field level receipt, storage, accountability, issuance, and ultimate disposition of DoD excess and surplus property.

If an item received is not reusable, DRMO declares it to be scrap material. Scrap material is put up for sale. If the scrap material cannot be sold, it is designated for donation to a recycler. If the scrap material cannot be sold or donated, it is disposed as solid waste.

The recyclable portion of scrap material that is processed through DRMO may be counted towards the installation's diversion quantity if there is adequate documentation. The documentation must ensure that the recyclable portion of the scrap material is diverted from disposal. Guam DRMO indicated that after scrap material is sold or donated on Guam, there is no documentation tracking the destination of the recyclable portion of the scrap material. Therefore, due to current practices at Guam DRMO, recyclable materials diverted by Guam DRMO may not be counted towards the quantity of recyclable materials at DoD bases on Guam.

4.0 Recovered Materials

4.1 Introduction

Based on the existing conditions and projected waste streams, the following materials have been targeted for recovery:

- Cardboard
- Aluminum cans
- Plastic containers
- Glass
- Mixed paper
- Brass
- Scrap metal
- Wood pallets
- Green waste
- Food waste.

These items were selected because they are commonly recycled materials or may be prohibited at the GovGuam Ordot Dump or landfill.

Construction and demolition materials have not been included in this study. A separate study will be completed for the diversion of construction and demolition debris. A brief description, common recycling methods, and local recycling and diversion alternatives are included for each targeted recyclable material.

To achieve the diversion goal of 50 percent of all non-hazardous solid waste, the recovery and diversion of all identified recyclable materials would be required. Although recyclable materials as quantified for this study account for 46.7 percent of the projected waste stream, it is believed that miscellaneous waste may contain additional recyclable materials. Additionally, the projected waste stream was based upon a waste characterization for a study where the limited time available between incoming loads did not allow full characterization of each load. The remaining unsorted materials were generally categorized as miscellaneous and may have contained additional recyclable material. Therefore, all recyclables should be targeted for recovery to help achieve the diversion goal of 50 percent.

Table 4-1 summarizes the projected weight of recyclables generated per year based on the total projected annual solid waste stream.

The following sections describe options available for the diversion of each targeted recyclable material. The market value of many recyclable materials has decreased considerably, increasing the difficulty for diversion of the materials.

Table 4-1

Annual Projected Recyclable Materials

Material	Projected Weight (lbs/yr)[a]
Cardboard	2,462,081
Aluminum Cans	1,275,315
Plastic Containers	913,670
Glass	2,809,364
Mixed Paper	4,378,724
Expended Brass[b]	31,832
Scrap Metal	3,380,309
Wood Pallets	7,602,106
Green Waste/Food Waste	8,541,261

Notes:

a. Annual projected weights of materials are based upon the projected average daily solid waste quantities and composition for total military installation on Guam. One year is based upon 365 days in a calendar year.

b. The projected expended brass quantities are based on estimated annual brass usage at the Marine Corps Base Hawaii. The expended brass must be recycled through DRMO. See Appendix A.1.

One option for diversion includes shipping the recyclables off-island. The two major shipping agents servicing Guam, Asia, and the Continental U.S. are Matson and Horizon Lines. A map of their major shipping routes through Guam is shown in Figure 4-1. Guam also has smaller shipping agents available for shipping worldwide. Mariana Express Lines, Ltd. (MELL) is a local shipping agent that also services Guam and Asia. Asia is considered to have the larger and more viable markets for recyclables. China has a considerable demand for scrap materials and recyclables as compared to other countries in Asia. A smaller market exists for some materials in the United States. However, the higher cost of shipping to the United States as compared to shipping to Asia affects the economic viability of such operations.

Shipping costs were obtained in September 2009 for transporting recyclables directly off-island. Shipping costs for a 40-foot container of recyclables to China typically range from $1,425 to $2,764. Shipping a 40-foot container to the U.S. West Coast is approximately $4,750. Shipping costs for a 20-foot container of recyclables to China typically range from $1,225 to $2,564. Shipping a 20-foot container to the West Coast is approximately $3,612.

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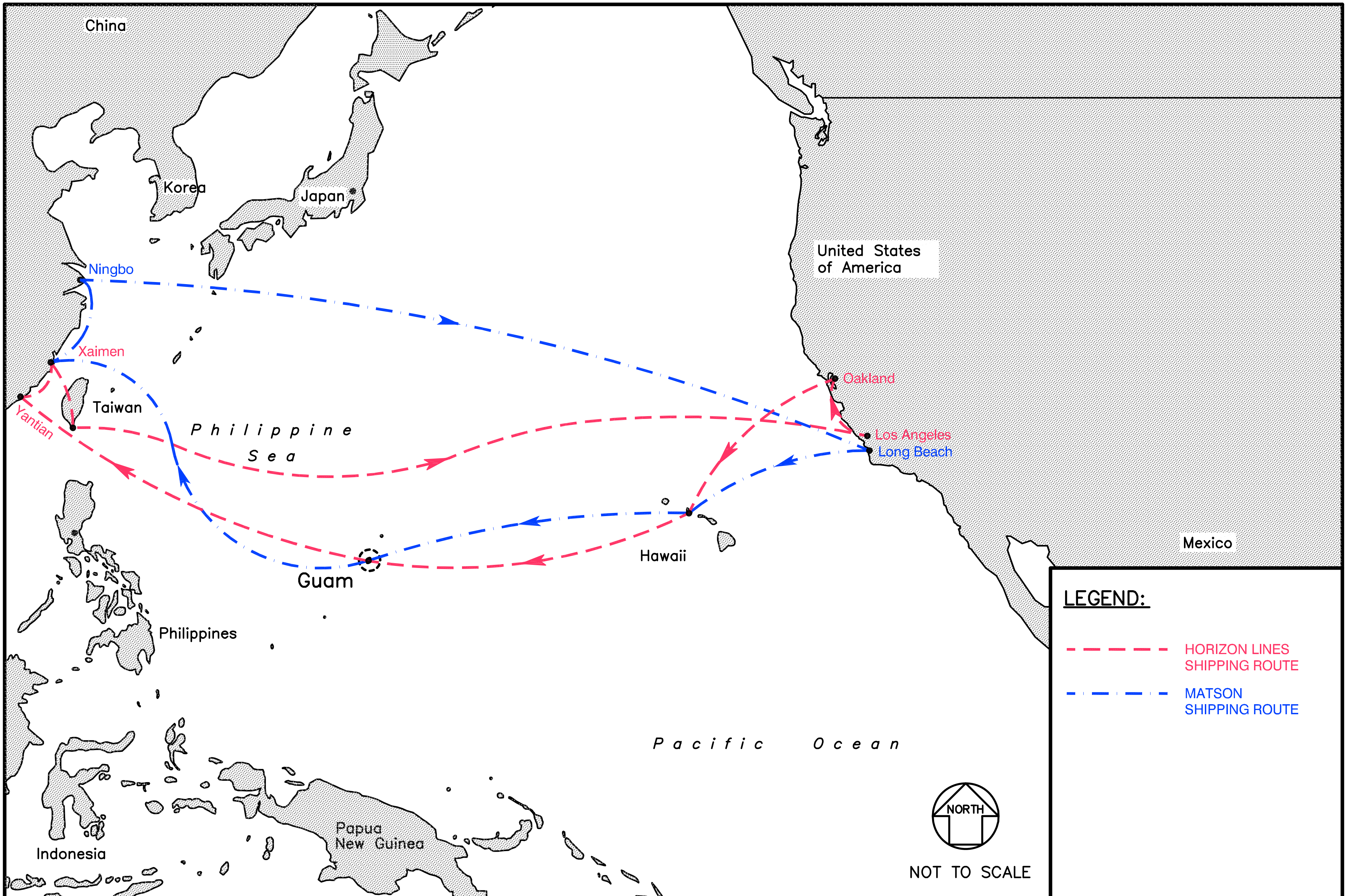

HDR HPE Hawaii Pacific Engineers, Inc.

RECYCLING AND SOLID WASTE DIVERSION STUDY FOR DOD GUAM

MAJOR SHIPPING ROUTES

FIGURE 4–1

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Large volume shippers can negotiate return shipment rights into their agreements with the shipping company. One example on Guam is Pepsi Co. Pepsi Co. uses a shipping agreement for the shipment of their pallets back to the United States.

4.2 Cardboard

Old Corrugated Cardboard (OCC) comprises a significant portion of the solid waste stream on Guam. OCC is currently prohibited at GovGuam Ordot Dump. Cardboard is used in boxes, packaging and protective covers. These products are easily flattened for recycling. Recycled cardboard is remade into paper products including: new cardboard, paper towels, and fiber board.

On Guam, two local recyclers currently accept OCC for a fee. The local recyclers bale and ship the cardboard to an available market. Currently, Guahan Waste Control, Inc., doing business as Mr. Rubbishman, and Dewitt Moving and Storage accept cardboard for a fee of $3.00 to $3.50 per cubic yard.

Naval bases on Guam currently have recycling bins for cardboard located at various Navy locations. Dewitt Moving and Storage and Mr. Rubbishman are contracted by the Navy to collect cardboard from the recycling bins. A contractor operates the AAFB Recycling Center where cardboard is recycled through a vendor.

Other options for recycling cardboard include baling and shipping OCC off Guam directly to OCC recyclers. The capability to ship directly off-island can provide a more reliable means of diversion that is not subject to the financial viability or business decisions of a local recycler.

The cost of shipping the baled cardboard to China ranges from $1,425 to $2,764 per 40-foot container. September 2009 spot market prices for China showed OCC with a value between 372.70 RMB to 993.88 RMB per metric ton depending on the quantities available. This converts to approximately $54.41 to $145.11 per metric ton or $49.37 to $131.68 per U.S. ton.

4.3 Aluminum Cans

Aluminum cans are lightweight and convenient. According to the EPA, aluminum accounts for nearly all beverage packaging for some products. Recycling aluminum cans conserves natural resources and may lower overall costs by reducing the amount of virgin materials required for manufacturing new cans. EPA indicates that an average aluminum can may contain 40 percent postconsumer recycled aluminum.

Residents may recycle aluminum cans, aluminum food containers, baking trays and foil with their curbside recycling bin. The recyclables are currently collected from the Navy housing areas and taken to the AAFB recycling center for sorting and processing. The AAFB recycling center later transports the aluminum to a vendor.

“I Recycle” Program

Guam's "I Recycle" Program provides an option for diverting aluminum cans from Guam’s landfills. The “I Recycle” Program is an aluminum recycling program created to benefit Guam’s schools. It is sponsored by the Guam Business Partners for Recycling, Inc (GBPR). GBPR is a non-profit organization dedicated to promoting aluminum recycling island-wide to help schools, clean up the island, and to keep aluminum cans out of Ordot Dump. Through this program, aluminum cans may be donated to individual schools by depositing cans in storage bins at the schools or by taking cans directly to Pyramid Recycling and donating the cans in the school’s name. Pyramid Recycling bales the cans. Ambros, Inc. transports the bales to the GovGuam port for shipment to the West Coast. In Los Angeles, California, the aluminum bales are purchased by Anheuser-Busch Recycling Corporation at the current market value and proceeds are disbursed to the individual schools based on the quantity of aluminum they collected.

On Guam, there are currently three local recyclers buying aluminum cans: Triple Star Recycling, Pyramid Recycling, and Xiong’s Family, Inc. These recyclers eventually ship the cans to Asia for sale in the available markets. The August 2009 price for aluminum cans was found to be $0.40 to $0.50 per kg.

Another option for recycling aluminum cans is shipping the cans directly off-island. Currently, the cost of shipping baled aluminum cans to China ranges from $1,425 to $2,764 for each 40-foot container. The cost of shipping to the West Coast of the United States is approximately $4,750 for a 40-foot container. September 2009 spot market prices for China showed aluminum cans with a value between 3312.92 RMB to 4367.04 RMB per metric ton depending on quantities provided, which is approximately equal to $483.69 to $637.58 per metric ton or $0.22 to $0.29 per pound. A U.S. spot market price for baled used beverage cans ranges from $0.57 to $0.72 per pound.

4.4 Plastic Containers

Plastics are commonly used for packaging. The plastics in the projected waste stream are expected to be generated as mixed plastics and plastic beverage containers.

Most plastic containers have an imprinted symbol that indicates the resin identification code. The number code indicates the type of plastic resin used to manufacture the container. The resin identification codes are intended to help consumers understand whether or how to recycle various plastic products and packages. The two most commonly recycled plastics are Type 1 and Type 2. Type 1 is commonly known as PET and is made up of polyethylene terephthalate. PET is commonly found in beverage bottles and is often accepted by many recyclers. Type 2 is known as HDPE or high density polyethylene and is commonly found in detergent bottles and milk jugs.

Local recyclers in Guam typically do not accept mixed plastics. Currently, there are two recyclers on Guam who accept only plastic resin identification codes Type 1 and Type 2. Pyramid Recycling accepts plastics at no charge, while Xiong's Family, Inc. accepts and pays for beverage and detergent bottles.

Plastic containers with resin codes Type 1 and 2 are currently accepted for recycling in the curbside recycling program for Navy housing. Bins for recycling plastic bottles are also located at various Navy locations. Currently, the plastic bottles collected from the bins are accepted by Pyramid Recycling at no cost to the Navy. In addition, the AAFB Recycling Center accepts Type 1 and Type 2 plastics for transport to local vendors. Other types of plastics are disposed in a landfill.

Plastics may also be shipped directly off-island. Currently, the cost of shipping bales of mixed plastic to China ranges from $1,425 to $2,764 for a 40-foot container. Plastic prices vary depending on resin type. In China, September 2009 prices for Mixed PET scrap were found to range between 1054.11 RMB to 3614.10 RMB per metric ton, which is approximately equal to $153.90 to $527.66 per metric ton or $139.66 to $478.82 per U.S. ton. Prices for Mixed HDPE scrap ranged between 602.35 RMB and 2710.57 RMB per metric ton depending on quantities available, which is approximately equal to $87.94 to $395.74 per metric ton or $79.80 to $359.11 per U.S. ton. A market price for mixed plastics in China could not be determined, but a U.S. market price for mixed sortable plastic scrap was found to be $0.06 per pound. Due to the high cost of equipment and labor for separating plastics and the low amount of plastic containers generated, the analysis for diverting plastic containers did not involve the separation of plastic containers by type. The lower cost of labor in China would allow recyclers with an affiliate in China to ship mixed plastics. The labor costs in China are significantly lower than those incurred on Guam. One recycler on Guam currently ships unsorted materials to a sorting facility in China to reduce the impact of labor costs.

Plastics may also be disposed at the GovGuam landfill, which is projected to have a tipping fee of $156 per ton. The Navy Sanitary Landfill accepts solid waste for a fee of $1.65 per cubic yard. Disposal in a landfill would not contribute towards meeting the 50 percent diversion goal.

4.5 Glass

Glass beverage bottles are generally found in three colors; brown, clear, and green. The bottles must not be mixed with other types of glass such as window glass, light bulbs, glass dishware, Pyrex, mirrors and automobile glass. The glass must be sorted by color to be sold as recyclable glass. Clear glass is the most valuable. Green and broken mixed color glass sometimes have no market value. Broken glass is difficult to sort and has little to no market value. Due to the extensive costs of equipment required for sorting glass by color, the analysis for this study focused on mixed glass.

Although there is very little market for mixed glass, one company in the United States with various locations in California presently buys scrap glass for processing into cullet. Cullet is a raw material used in glass production processes. The cost of shipping mixed glass to the West Coast is approximately $4,750 for a 40-foot container. The market value of the mixed glass is extremely low and one September 2009 spot price found for mixed glass was $3.75 per ton, which is less than $0.01 per pound.

At the time of this study, none of the local recyclers on Guam accepted glass.

Another option for recycling glass without shipping off-island is to use the glass as an aggregate for construction backfill. Glass must be properly crushed and processed to remove sharp edges for use as aggregate. Due to the relatively high projected amount of glass, this alternative may be viable to avoid excessive shipping costs for diversion off-island.

Recycled glass may also be used as an aggregate in glasphalt. Glasphalt has not been used previously on Guam. Special considerations for recycling glass include contaminated glass, laminated or fire resistant glass, and tinted or colored glass.

The curbside recycling program recently implemented by the Navy includes glass bottles and jars as one type of recyclable collected. The Andersen Air Force Base Recycling Center accepts glass containers for recycling and crushes or grinds the glass into a one-quarter inch aggregate or sand. The recycled glass from the AAFB Recycling Center is ground into sand for use as utility bedding material and the one-quarter inch aggregate is used as cover at the landfill.

Glass is also accepted for disposal at landfills and hardfills for a disposal fee. Tipping fees for the GovGuam landfill are expected to be $156 per ton. The Navy Sanitary Landfill disposal fee is $1.65 per cubic yard and the hardfill disposal fee is $5 per cubic yard. Disposal of glass in landfills or hardfills would not contribute towards meeting the diversion goal.

4.6 Mixed Paper

For this study, mixed paper is considered to be an assortment of newspaper, office paper, and other types of recyclable paper. Most types of paper can be recycled. Recycled paper can be used as feedstock to produce new paper products. Recovered paper is generally combined with water in a pulper, which blends and separates fibers from paper sheets. The paper slurry is then passed through screens and other separation processes to remove contaminants. The acceptable level of contaminants is dependent on the type of paper being produced. The recovered fiber may be used to produce paper products made entirely with recovered fiber or may be blended with virgin materials.

Clean, well-sorted, uncontaminated, dry paper generally has a higher market value. The factors affecting market value for paper include the quantity available, grade of paper, and degree of contamination. Contaminants such as food, plastic, metal or other refuse make the paper difficult to recycle. As a result, contaminated paper is more likely to be composted or disposed in a landfill. Paper is currently accepted at the GovGuam Ordot Dump. The GovGuam Layon Landfill is expected to charge a tipping fee of $156 per ton. The Navy Sanitary Landfill would accept paper for $1.65 per cubic yard. Disposal of paper in landfills would not contribute towards meeting the diversion goal.

Currently, local recyclers on Guam do not accept mixed paper. The recently implemented Navy curbside recycling program does not accept paper, newspapers, magazines, or catalogs in the recycling bins. The recycling center at AAFB currently processes paper for recycling through another vendor.

Paper may also be shipped directly off island. White sorted office paper is one of the more valuable types of paper to recycle. However, the market for recycled paper is currently very low. Shipment of a 40-foot container to China ranges from $1,425 to $2,764. September 2009 spot market prices for China indicated mixed paper prices from 90.80 RMB to 256.90 RMB per metric ton depending on quantities available. The market price is approximately equivalent to $13.26 to $37.51 per metric ton or $12.03 to $34.04 per U.S. ton. A 40-foot container of baled mixed paper contains approximately 12.7 metric tons.

4.7 Brass

Brass is an alloy of copper and zinc. With the relocation of the USMC, it is expected that brass would be generated during training exercises.

Firing range expended brass is defined by the NFESC QRP Guide as expended brass of any caliber and material without the primer, propellant and projectile. This brass may be sold as scrap metal after it has been properly deformed and certified as safe and inert. Although local recyclers are available on Guam, expended brass generated by a DoD base on Guam must be disposed by DRMO. DRMO is responsible for the disposal or distribution through an appropriate vendor or recipient for the items received.

Brass generated by other sources may be recycled through local vendors. Several of the local recyclers in Guam accept or buy brass for recycling. Pyramid Recycling, Formosa, Triple Star Recycling, and Xiong's Family, Inc. purchase brass and ship the materials to Asia for recycling. One buyer for brass listed a price of $1.60 per kilogram which is approximately $0.726 per pound.

Brass may also be recycled directly off island. Brass is a valuable recyclable material and market prices indicated that its resale value as scrap is greater than the container shipping costs. Shipment of a 20-foot container to China ranges from $1,225 to $2,564. Shipping a 20-foot container to the West Coast of the United States was found to cost approximately $3,612. September 2009 market prices in China were listed to range from 12799.93 RMB to 21383.42 RMB per metric ton depending on quantities available. These market prices are equivalent to approximately $1,868.79 to $3,121.98 per metric ton or $0.85 to $1.42 per pound.

4.8 Scrap Metal

Scrap metal generally refers to both ferrous and non-ferrous metals, which are recyclable materials. Scrap metal is generated as a residual of product consumption and may be found in commercial and residential wastes. Common types of scrap metal include steel, aluminum, copper, brass, and alloys.

Scrap metal is commonly accepted for recycling into various products. Recycling of scrap metal typically involves sorting, shredding, and remelting in a blast furnace for use in new products.

There are currently seven known local recyclers on Guam who accept scrap metal for recycling. The recyclers ship the materials to Asia for sale in the available markets. The seven local recyclers include Bali Steel, Formosa, FSM Recycling, Global Recycling Center, Inc., Pyramid Recycling, Triple Star Recycling and Xiong's Family, Inc.

The Navy Sanitary Landfill and GovGuam Ordot Dump currently prohibit scrap metal from being disposed. Local hardfills on Guam accept scrap metal; however, disposal in a hardfill would not be considered recycling.

Scrap metal may also be recycled directly off-island. Shipment of a 20-foot container to China ranges from $1,225 to $2,564. Shipping a 20-foot container to the West Coast of the United States was found to be approximately $3,612. Scrap metals in this study are considered to be unsorted and would consist of a mixture of ferrous and non-ferrous metals. Although market prices for sorted metal are typically higher than prices for mixed scrap metals, sorting of scrap metals would require higher capital and labor costs for sorting and storage requirements. Based on the estimated waste stream, quantities of individual metal types could not be determined and feasibility of additional costs for sorting on Guam could not be justified. The lower cost of labor in China would allow recyclers with an affiliate in China to ship mixed scrap metals regardless of market prices. The labor costs in China are significantly lower than those incurred on Guam. One recycler on Guam currently ships mixed scrap metal to a facility in China where metals are separated by type.

Market prices for mixed scrap metal could not be directly determined. Therefore, our estimate of market prices was based on the mixed scrap metals being valued at a lower price than other sorted scrap metals. September 2009 market prices in China for old mixed aluminum, HMS No. 2 steel, stainless scrap, and old mixed zinc scrap were compared to determine a reasonable estimate of scrap metal prices. Prices in China ranged from 1,085.01 RMB to 1,736.03 RMB per metric ton. This is approximately $158.41 to $253.46 per metric ton. A U.S. price for mixed scrap iron and steel was found to be $230 per ton for a truck load quantity, while bundled steel can scrap was worth $143.75 per ton. A value of $150 per ton was used as an estimate to determine revenue from scrap metals.

4.9 Wood Pallets

Wood pallets are a common packaging material generated in commercial settings. The recycling and disposal of wood from pallets are dependent on whether the pallets are comprised of treated or painted wood. Wood pallets comprised of wood pressure-treated with chromated copper arsenate, creosote, pentachlorophenol (PCP), or other hazardous wood preservatives, must not be ground, chipped, reused, or recycled. Section 2.1.6 includes a discussion of mulching and composting regulations.

Common recycling options for clean, untreated wood include remilling, chipping, or grinding into the following products:

- Wood chips or mulch
- Animal bedding
- Compost
- Feed stock for engineered wood
- Boiler fuel

On Guam, there are currently no processing facilities that recycle wood pallets. Wood pallets are currently banned at Ordot Dump. The large projected quantity of wood pallets makes diversion of this material particularly important. Currently, there are few options for the diversion of wood pallets off Guam. Untreated wood is taken to the hardfills, where it is mulched or chipped. Some wood pallets are painted or comprised of treated wood. Treated wood may require disposal in a hardfill or the Navy Sanitary Landfill. Disposal costs for the hardfill are $5 per cubic yard and $1.65 per cubic yard at the Navy Sanitary Landfill. Disposal at the hardfill or landfill would not contribute towards meeting the diversion goal.

Recycling of untreated wood for boiler fuel is not permitted on Guam. Boilers are commonly a part of a waste-to-energy facility. Chapter 73, Fire Prevention, Division 3 of Title 10 of the Guam Code Annotated Code prohibits construction or operation of a municipal solid waste incinerator or waste-to-energy facility. Although the DoD is generally not subject to Guam laws and regulations, the DoD should comply with certain U.S. federal laws that are administered by the Government of Guam.

Wood pallets may also be repaired and made into new pallets. Although, there are no local recyclers for wood pallets on Guam, a California company buys pallets for repair and reuse.

A company in San Diego, California accepts wood pallets at a fee to mulch or recycle at a construction and demolition facility. Wood pallets accepted for mulching are required to be constructed of untreated wood. Treated wood pallets are accepted for construction and demolition recycling. Costs for transport of pallets from the Port of San Diego to the mulching or construction and demolition facility range from $155 to $175 per 40 cubic yard disposal bin for pick-up/drop off with an additional charge of $30 to $75 per ton based on whether wood has been treated. Additional ground transport is required from the Long

Beach or Los Angeles port to the San Diego port. This would contribute an additional cost of approximately $520 per container shipped.

Another company, which has locations nationwide and a facility in Riverside, California, buys pallets for repair and recycling into new pallets. This company is a large pallet recycling company and offers $0.75 to $1.25 per pallet depending on the pallet condition. The company accepts 40-inch by 48-inch pallets for recycling and requires a minimum quantity of one truckload, which is approximately 400 pallets. Pallets must be delivered to their facility for recycling. Ground transport costs from the Long Beach port to the recycling facility are approximately $371 per container.

Wood pallets typically weigh between 40 to 70 lbs. A cost comparison for the range of weights for wood pallets is included in Appendix A.1.

Wood pallets may be chipped and converted to mulch, repaired and made into new pallets, or diverted to a construction and demolition facility for recycling. Shipping costs for wood pallets to the West Coast range from $3,524 to $3,634 for a 40-foot container.

4.10 Green Waste

Green waste is a biodegradable waste composed of brush, limbs, leaves, grass, tree trimmings, and other organic materials. Green waste often refers to waste containing high nitrogen content, as opposed to brown waste, containing high carbon content. Landscaping debris and yard trimmings are expected to contribute to green waste quantities.

Ordot Dump currently bans disposal of green waste and the Layon Landfill is expected to also implement a similar ban. Northern Hardfill and Global Recycling Center, Inc. on Guam currently charge a disposal fee for mulching of green waste. Green waste can be processed into two types of usable products; compost and mulch.

The use of green waste for composting and landscaping is regulated at the local and federal level. Section 2.1.6 discusses the applicable composting and mulching requirements.

Mulch is any material placed on top of the soil that protects plants and soil. Mulch shields the soil from the sun, wind erosion, extreme temperature changes, and moisture loss. Mulch also suppresses weeds and increases water infiltration from rainfall. As mulch decomposes, it can add organic matter and nutrients to the soil. Examples of mulch are wood chips, bark, rocks, shredded paper, straw, ground yard wastes and partially composted material.

Compost is chemically and thermally stable decomposed organic matter that looks and feels like dark, crumbly soil. Compost is a finished product that is typically mixed with the soil as a conditioner. The addition of compost to soil would help lighten dense, clay soils, improve water retention in sandy soils, physically stabilize the soil against erosion, and provide nutrients for plant growth.

Composting is the biological process of converting organic waste matter under controlled conditions to a product that may be used to enhance soil texture and fertility. Composting reduces the weight and volume of organic matter, plant, and animal waste through biological decomposition. The composting process typically involves the placement of biodegradable waste in a pile at a designated location where decomposition is accelerated through human intervention and by the creation of a suitable environment.

4.10.1 Composting Factors

Many factors contribute to the success of the composting process. Composting incorporates biological, chemical, and physical processes.

Microorganisms are essential to the composting process. For composting to occur rapidly, all conditions must be ideal for a given microbial population to perform at its maximum potential. Therefore, the composting process should be adapted to the needs of the microorganisms and promote conditions that would lead to rapid stabilization of the organic materials.

Composting methods incorporate chemical processes which must be controlled during composting. The main variables include:

- Presence of an adequate supply of carbon, energy source, or feedstock
- Balanced amount of nutrients
- Proper moisture content
- Adequate oxygen
- Appropriate pH
- Absence of toxic constituents that may inhibit microbial activity

Microorganisms in compost rely on the carbon in organic material as their carbon source. Most tree trimmings contain adequate amounts of biodegradable forms of carbon. Carbon is commonly found in brown waste materials including dried leaves, tree stumps, and branches. Wood chips may also be used as a carbon source in composting.

Nitrogen is the most important plant nutrient for composting. Nitrogen is found in “green” waste such as fresh leaves and grass clippings. The ratio of carbon to nitrogen is considered critical in determining the decomposition rate.

Water is an essential component for composting. A moisture content of 50 to 60 percent of total weight is considered ideal. However, excessive moisture content may cause the formation of leachate or runoff, which is undesirable during composting.

Composting is an aerobic process, which requires oxygen. The compost pile should contain adequate voids to allow oxygen from the atmosphere to enter the pile.

An appropriate pH between 6 and 8 is considered optimum. The pH affects the amount of nutrients available to microorganisms, the solubility of heavy metals, and the overall metabolic activity of the microorganisms.

Physical processes affecting composting include the following factors:

- Temperature
- Particle size
- Mixing

Microorganisms in compost have an optimum temperature range between 32-degrees Centigrade and 60-degrees Centigrade. Temperature is critical for the destruction of pathogens and promoting rapid composting.

Particle size of the material being composted is critical. Smaller particles generally have larger surface areas per unit weight. The larger surface areas facilitate higher microbial activity on the surface, which leads to rapid decomposition.

Mixing of feedstock and water is important for composting. Mixing of piles distributes moisture and air evenly and promotes the breakdown of clumps in the compost.

4.10.2 Composting Methods

Composting methods vary and range from simple and inexpensive backyard and onsite methods to more expensive and involved technologies such as in-vessel composting. According to the EPA, the most common methods of composting include: backyard or onsite, including grasscycling; vermicomposting; aerated windrow; aerated static pile; and in-vessel.

The composting methods most applicable to green waste include aerated windrow and aerated static pile.

4.10.2.1 *Aerated Windrow*

The most common composting method for green waste and yard trimmings is the windrow. A windrow is a pile with a triangular cross section. A windrow's length exceeds its width and height. The ideal pile height allows for a pile to generate sufficient heat, yet allows oxygen to diffuse to the center of the pile. Typically, an ideal height is four to eight feet with a width of 14 to 16 feet. Windrow composting works well with leaves, which break down more slowly than grass clippings. The combination of dry leaves and grass clippings in a 1:1 weight ratio provide an optimum carbon-to-nitrogen ratio. Composting only leaves may require supplemental nutrients. This method is suitable for large quantities, such as those generated by communities and local governments, but only with frequent turning and careful monitoring.

Windrow composting is a large-scale operation and may be subject to regulatory involvement. Machines equipped with augers, paddles, or tines are used to turn piles. Operations with large volumes may use front-end loaders to turn the compost. Piles may be covered or uncovered outdoors. Outdoor piles are exposed to precipitation, which may result in runoff or leachate. Additional moisture from precipitation increases the potential for producing leachate. Any leachate or runoff should be collected and treated or added to new feedstock. Windrow composting usually requires large areas of land, heavy equipment, and a continual supply of labor to maintain and operate the facility. An EPA document indicated the composting time required using windrows may vary depending on the frequency of turning and the factors discussed in Section 4.10.1. The EPA document indicated that seasons are a factor in the composting time. A large scale commercial composting operation in Hawaii employing the windrow method requires approximately three months to complete the composting process. The composting operation in Hawaii turns piles every three to seven days based on temperature readings. Based on Guam's tropical climate, which is similar to Hawaii's, it is expected that the composting time required may be similar.

4.10.2.2 *Aerated Static Pile*

Aerated static pile composting is another possible option for composting green waste. This method involves placing compost mixtures in piles that are mechanically aerated. To aerate the piles, the pile may be placed over a network of pipes connected to a blower that delivers air into or draws air out of the pile. Aerated static piles are suitable for relatively homogeneous mixtures of organic waste and work well for larger quantity generators of yard trimmings and compostable municipal solid waste. Aerated static piles require careful monitoring to ensure the outside of piles heat evenly through the core because there is no physical turning of the pile. This method generally requires less land than the windrow method, but requires equipment such as blowers, pipes, and monitoring equipment. Aerated static piles typically produce compost relatively quickly, within three to six months.

On Guam, there is currently quarantine in Northern Guam by the Department of Agriculture restricting the transport of green waste and live plants across a quarantine boundary without inspection and/or treatment. The quarantine is due to eradication efforts against the coconut rhinoceros beetle found in Northern Guam. The recycling of green waste into mulch or compost would require the mulch or compost to be reused on-site or green waste may be donated to the GovGuam green waste recycling site in Dededo after compliance with the necessary coconut rhinoceros beetle eradication program procedures.

4.11 Food Waste

Food waste is generated by many sources: food manufacturing and process facilities; supermarkets; institutions; restaurants and food courts; and households. The EPA indicates that food waste may be categorized as either pre-consumer or post-consumer food waste. EPA and the United States Department of Agriculture (USDA) both recommend following the "food waste recovery hierarchy" as the preferred options for recovering and recycling food waste. The tiers of the food waste recovery hierarchy are detailed below:

Source reduction:	Reduce the amount of food generated.
Feed people:	Donate excess food to food banks, soup kitchens and shelters.
Feed animals:	Provide food scraps to farmers.
Industrial uses:	Provide fats for rendering or fuel and food discards for animal feed production.
Composting:	Recycle food scraps into a nutrient rich soil amendment.

Disposal of food into a landfill is considered the least desirable option and would be placed at the bottom of the hierarchy.

Currently, food waste on Guam is disposed in a landfill. The projected waste stream contains food waste and green waste under compostable materials. There are a few opportunities for recycling food waste on Guam.

One of the options for recycling food waste is a machine, which processes food waste using grinding and high heat to break down the food. This machine converts the food waste into water and an organic material, which may be used as fertilizer. Restaurant models currently cost approximately $27,000 but may process up to 220 pounds of food waste each day.

Another study on Guam found that food waste may be converted into swine feed using dry extrusion technology. High moisture contents were reduced by adding dry ingredients, and nutrient deficiencies were adjusted by adding supplements prior to extrusion. Based on the added costs of transportation, labor, electricity, machinery parts and maintenance, the study concluded that the process for converting the food waste using dry extrusion technology was not economically feasible at the time. However, for food refuse recycling to become economically feasible, an island-wide educational program with incentives would be beneficial to demonstrate the importance of recycling. In addition, technologies to increase processing efficiency should be explored.

Composting of food waste is another option. Food waste may be a more putrescible material than yard trimmings and must be handled appropriately. Many of the composting methods mentioned previously in the green waste discussion contain limitations for the types of food waste that may be composted. Food waste may also be subject to health and sanitation regulations when composting. Section 2.1.6 of this study discusses composting regulations. These limitations mainly apply to food waste containing meats, fats, and dairy products due to odor concerns. One composting method, in-vessel, is suitable for composting virtually any type of organic waste. Most in-vessel systems are proprietary and may require technical assistance to operate properly. The benefits of using in-vessel composting for food waste include the minimal production of odors and leachate.

Anaerobic processing is another option for diverting food waste. Anaerobic processes have been used for biologically stabilizing biosolids from municipal sewage treatment plants for many years. During anaerobic processes, bacteria break down organic material in the absence of oxygen and produce methane gas and carbon dioxide. Anaerobic systems may generate sufficient energy in the form of methane to operate the process and provide a surplus to market as a gas or convert into electricity. Upon the completion of digestion processes, a residue chemically similar to compost remains. With further drying, the stabilized residue may be handled as a solid and treated similarly to compost.

4.12 Summary of Recovered Materials

This section described materials targeted for recycling and possible diversion alternatives available for each material. Table 4-2 summarizes the types of materials accepted by local vendors on Guam.

Table 4-2

Potential Vendors for Recyclables[a]

Vendor Name	Cardboard	Aluminum cans	Plastic Containers	Glass	Mixed Paper	Brass	Scrap Metal	Wood Pallets	Green Waste
Bali Steel							X		
Dewitt Moving and Storage	X								
Formosa						X	X		
FSM Recycling							X		
Global Recycling Center, Inc.							X		X
Guahan Waste Recycling, LLC	X								
Northern Hardfill Facility (Primo's Heavy Equipment)									X
Pyramid Recycling		X	X			X	X		
Triple Star Recycling		X				X	X		
Xiong's Family Recycling, Inc.		X	X			X	X		

Note:

a. The local recyclers listed do not include all possible vendors. The listed recyclers were visited and interviewed during a site visit in August 2009. Note that for some recyclable categories checked; only certain materials within that category may be recycled by the identified vendor.

Current market prices on Guam are included in Table 4-3 for each recyclable.

Table 4-3

Current* Market Prices for Local Recyclers by Material

Material	Units	Price (USD)	Cost (USD)
Cardboard	CY	N/A	3.00 – 3.50
Aluminum Cans	KG	0.40 – 0.50	N/A
Plastic Containers	N/A	0	0
Glass	N/A	N/A	N/A
Mixed Paper	N/A	N/A	N/A
Brass	KG	1.60	N/A
Scrap Metal	KG	0 – 2.50	N/A
Wood Pallets	N/A	N/A	N/A
Green Waste	CY	N/A	5.00

*Note: Local market prices were obtained in August 2009.

Table 4-4 provides market prices for recycling materials off island. Appendix A.1 provides the cost of recycling materials if shipped off island.

Table 4-4

Current[d] Off-Island Market Prices by Material

Material	Units[a]	Price (foreign currency)[b]	Funds[c]	Price (USD)
Cardboard	MT	372.70-993.88	RMB	54.41 - 145.11
Aluminum Cans	LB	N/A		0.57-0.72
Plastic Containers	MT	602.35 – 1,054.11	RMB	87.94-153.90
Glass	TON	N/A		1.88-3.75
Mixed Paper	MT	90.80 – 256.90	RMB	13.26 – 37.51
Brass	MT	12,799.93 – 21,383.42	RMB	1,868.79-3,121.98
Scrap Metal	MT	1,085.01 – 1,736.03	RMB	158.41-253.46
Wood Pallets	EA	N/A		0.75-1.25
Green Waste	N/A	N/A	N/A	N/A

Notes:

a Units are based upon MT = metric ton = 1000 kg = 2204 lbs, which is the unit used in China and LB = pound is used in the U.S.

b Price ranges are based upon less than truckload and truckload quantities.

c Funds are based upon renminbi (RMB) or currency in China, whose principle unit is the yuan. Current exchange rate: 1 Chinese yuan (CNY) = 0.146 U.S. dollars (USD)

d Market prices were obtained in September 2009.

Table 4-5 contains a summary of the available diversion alternatives available for each material.

Table 4-5

Summary of Diversion Options by Material

Material	Diversion Alternatives
Cardboard	• Local recyclers • Direct shipment to off-island recyclers
Aluminum Cans	• "I Recycle" Program • Local recyclers • Direct shipment to off-island recyclers
Plastic Containers	• Local recyclers accept Type 1 and 2 only • Direct shipment to off-island recyclers • Disposal in landfill
Glass	• No local recyclers • AAFB recycles glass for aggregate and sand • Glasphalt • Direct shipment to off-island recyclers • Disposal in landfill or hardfill
Mixed Paper	• No local recyclers • Direct shipment to off-island recyclers • Disposal in landfill
Brass	• Divert to DRMO • Local recyclers • Direct shipment to off-island recyclers
Scrap Metal	• Local recyclers • Direct shipment to off-island recyclers
Wood Pallets	• Mulch or compost • Direct shipment to off-island recyclers • Disposal in hardfill
Green Waste	• Mulch or compost
Food Waste	• Conversion into compost • Animal feed • Anaerobic processing

Based on the materials targeted for recovery, an assessment of the collection and diversion methods and alternatives is included in the following section.

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5.0 Assessment of Collection and Diversion Alternatives

5.1 Introduction

The purpose of this study is to identify reasonable cost-effective alternatives for diverting non-hazardous solid waste in support of existing and known future DoD requirements. This study investigates solid waste collection and diversion alternatives, which include the use of refuse transfer stations, a source separation program, recycling centers, and materials resource recovery facilities. Currently, the Navy Sanitary landfill receives all DoD non-hazardous solid waste generated on Navy installations. Ordot Dump, located in central Guam, is currently operating under a federal receiver until closure. A materials ban on old corrugated cardboard, green waste, construction waste, wooden pallets, and inert materials is in effect at the Ordot Dump. A GovGuam landfill at Layon is currently under construction. The Layon landfill is expected to have a similar materials ban as Ordot Dump.

Field investigations were conducted to assess the quantity of solid waste entering the Navy Sanitary Landfill on Guam. The investigations were used to develop projected solid waste stream quantities and characteristics. Additionally, field observations were conducted at the Marine Corps Base Hawaii, Hickam Air Force Base, Naval Base Pearl Harbor, Naval Base Guam, and Andersen Air Force Base, Guam to assess current recycling practices.

A diversion goal of 50 percent of non-hazardous solid waste excluding construction and demolition debris was established under Executive Order 13514. To comply with the Executive Order, alternatives for diversion were investigated. Items targeted for diversion are commonly recycled materials and items that would not be accepted at the GovGuam Layon landfill.

5.2 Collection Alternatives

5.2.1 Transfer Facilities

Waste transfer facilities play an important role in the solid waste management system. Transfer facilities serve as a link between solid waste collection programs and the final waste disposal facility. In general, transfer facilities consolidate waste from multiple collection vehicles into larger, high-volume transfer vehicles before being delivered to distant disposal sites. Typically, local waste collection vehicles deposit waste in a designated receiving area within the transfer facility. Waste is often compacted prior to being loaded into larger transfer vehicles. Transfer vehicles are used to transport solid waste to the landfill for disposal. No long-term storage of waste occurs at a transfer station. Waste is consolidated quickly and removed from the site.

A 2002 EPA manual, *Waste Transfer Stations: A Manual for Decision-Making,* acknowledged a nationwide trend in solid waste disposal toward the construction of larger, more remote landfills. The manual indicated that rural and urban communities alike are finding the most economically viable solution to waste disposal is transporting waste to transfer facilities. Under these conditions, a transfer facility provides the critical link for making cost-effective shipments to remote landfills.

The primary reason for utilizing a transfer facility is to reduce the cost of transporting waste to disposal facilities. Consolidation of smaller loads from collection vehicles into larger transfer vehicles reduces the hauling costs by enabling collection crews to spend less time traveling to distant sites and more time collecting waste. Overall, using a transfer facility reduces fuel consumption and vehicle maintenance while producing less traffic, air emissions, and road wear.

The use of transfer facilities also provides an opportunity to screen waste prior to disposal. Waste collection vehicles would unload waste cargo onto a tipping floor in the transfer facility for inspection. Large, bulky recyclable materials such as wood pallets, large pieces of scrap metal, and corrugated cardboard may be removed before refuse is moved into the transfer vehicles. Bulky recyclables would then be delivered to a nearby recycling center. Lastly, transfer facilities often serve self-haulers who may use a transfer facility to deposit solid waste if collection services are not provided.

Various factors should be considered prior to the planning and development of a transfer facility. Issues for consideration include:

- Types of waste accepted
- Facility siting
- Service area
- Volume of waste generated
- Types of vehicles used for collection and transfer
- Maximum distance traveled to landfill
- Impacts on the surrounding area, which include air quality, noise, and traffic
- Costs to build and operate each facility

On Guam, permits are required for a transfer facility. Requirements for each type of permit are listed in Section 2.2.1.1 of this study.

GEPA requires the following permits for a transfer facility:

- Solid waste disposal facility permit
- Solid waste storage permit
- Solid waste collection permit

- Solid waste transfer permit.

Based on the anticipated distribution of the military population on Guam, it is estimated the majority of DoD solid waste would be generated in northern Guam. The Layon Landfill is located in southern Guam. The distance between the Layon Landfill and DoD bases in northern Guam is approximately 29 miles. The distance between the Layon Landfill and DoD bases in southern Guam is approximately 19 miles. Finally, the EPA manual concludes that although cost effectiveness of transfer facilities vary, transfer facilities generally become economically viable when the hauling distance to the disposal facility is greater than 15 to 20 miles. Therefore, transfer facilities were considered at three locations for this study.

In addition to the use of transfer facilities, other methods of diversion should be considered to meet the 50 percent diversion goal required by the Executive Order. Diversion methods such as the use of source separation, recycling centers, and materials resource recovery facilities should be considered.

5.3 Diversion Alternatives

5.3.1 Source Separation of Recyclables

Source separation is one common method used to divert and recover recyclables. Source separation is defined as the segregation of recyclable materials from the solid waste stream at the point of generation. Collection of source separated recyclables falls into two general categories: curbside and drop-off.

A Qualified Recycling Program is a prominent part of solid waste management and incorporates a source separation program. Previously, QRPs only recycled profitable materials. However, compliance with DoD, Navy, Marine Corps, Federal, state and local recycling laws and goals is currently the compelling factor.

A 1994 EPA report, *Waste Prevention, Recycling, and Composting Options: Lessons from 30 Communities,* analyzed recycling programs of 30 diverse communities. The communities ranged from rural towns to metropolitan areas and were selected based on their location, population density, instructive program characteristics, including public or private collection, segregated or commingled set-out, sorting en route versus sorting at an intermediate processing center, curbside versus drop-off, bottle bill, mandatory or voluntary participation, and volume based or flat refuse collection rates. The study determined that factors contributing to high materials recovery rates included:

- Targeting a wide range of materials for recovery;
- Offering convenient service such as curbside and drop-off collection;
- Employing collection and processing techniques that encourage resident participation as well as yield high-quality materials;

- Establishing strong economic incentives such as higher tipping fees;
- Collecting source-separated yard waste for composting; and
- Extending programs beyond the residential sector to the commercial and institutional sector.

The EPA study found that suburban and rural areas had higher rates of recovery due to the area's homogeneous nature where most residents lived in single-family homes. Urban areas were more likely to have a diverse socioeconomic mix with residents living in multi-unit buildings and generally included a higher proportion of commercial and institutional waste.

The EPA report indicated that material recovery rates for suburban areas and small cities were between nine and 24 percent, while commercial and institutional facilities recovered zero to 70 percent of their waste stream. Communities achieving high recovery rates were generally found to employ the strategies mentioned earlier. These strategies may provide insight into developing a recycling program.

Collection strategies are an important part of the recycling program. Residents were more likely to participate in a recycling program if it was as convenient as disposing their other refuse. Therefore, the following items had the greatest impact on the success of the program:

- Providing weekly curbside collection of recyclables if weekly curbside collection of refuse is provided.
- Offering service to all households.
- Utilizing set-out and collection methods that encourage resident participation as well as yield high-quality, readily marketable materials.
- Providing adequate containers for storage and set-out of residential recyclables.
- Establishing recycling drop-off sites at disposal facilities if residents self-haul refuse.

Items typically recovered through drop-off sites or curbside collection included newspaper, corrugated cardboard, paper, aluminum cans, scrap metal, glass, plastic bottles, and tires. Yard waste and compost were also collected in the same manner.

In the commercial sector, it was determined that successful recycling programs implemented the following initiatives in their communities:

- Institution of economic incentives such as high tipping fees at refuse disposal sites and reduced or no tipping fees at recycling drop-off sites and material processing facilities
- Recycling start-up funds

- Targeting a wide range of materials for recovery
- Mandating that businesses and institutions recover a wide range of recyclable and compostable materials or prohibiting disposal of specific materials such as green waste
- Requirement of businesses to write and submit recycling plans
- Providing technical assistance such as waste audits and listings of drop-off sites and private recycling services
- Assisting businesses and haulers with marketing of recovered materials by informing them of different marketing options, allowing them to bring materials to public processing facilities
- Providing municipal pick up of commercial/institutional recyclables and/or convenient drop off sites that accept materials generated by the commercial and institutional sector

Some of the methods mentioned in the EPA report are currently being practiced on Guam. Section 3.1 of this study provides a discussion of the Navy's recently implemented curbside recycling program. Other strategies mentioned in the EPA report may be implemented on Guam. Existing recycling programs may also be expanded. The following methods should be considered to provide further diversion of solid waste:

- Target a wide range of materials for recovery;
- Collect source separated yard waste for composting; and
- Extend programs beyond the residential sector.

Although source separation provides some diversion of solid wastes, it alone cannot achieve the 50 percent diversion goal required by the DoD. Therefore, further diversion alternatives such as recycling centers and materials resource recovery facilities should be considered.

5.3.2 Recycling Centers

A recycling center is another method of increasing diversion of recyclable materials. Recycling centers are often used to support a source separation recycling program. Typically, a recycling center serves as a final collection, processing and storage facility for recyclable materials before materials are transported to available markets. A recycling center may also function as a drop-off area for recyclables generated by residents, commercial and industrial sources.

Recyclable materials commonly collected at a recycling center include corrugated cardboard, newspaper, office paper, aluminum cans, glass, scrap metal, plastic bottles, and tires. Recyclable materials primarily generated from the commercial sector, such as wooden pallets and green waste from public areas may also be collected. The recycling center should have the capacity and equipment to store and process all of the materials collected.

Although curbside collection of recyclables is generally more effective in recovering recyclable materials, a recycling center would augment curbside recycling programs. Recycling centers enable the collection of materials that would not be recovered through curbside programs. Based on the EPA report, establishment of a recycling drop-off would increase the amount of materials collected if these sites were conveniently placed. In addition, a recycling center facilitates baling and storage of collected materials before being transported to available markets.

Factors to consider before the establishment of a recycling facility include: location, sizing of facility, materials collected, estimated volume of recyclables, and distribution of the population serviced. A recycling center would also require permits for operation. On Guam, GEPA would require solid waste processing, storage, collection, and transfer permits for recycling centers.

The military population on the island of Guam is expected to be concentrated in two geographical areas; northern and southern Guam. The location of a recycling center is critical. The EPA report found that users of drop-off collection sites were more likely to use these sites if they were conveniently placed. Therefore, the construction of two recycling centers, one in northern Guam and one in southern Guam, would increase the efficiency of the recycling program and provide greater convenience to achieve higher recovery rates.

Andersen Air Force Base currently operates what is referred to as a recycling center. A recycling center serves as a final collection, processing and storage facility for all recyclable materials for shipment or recycling. The AAFB facility provides some of these functions for a limited set of materials, and therefore is not considered a full-scale recycling center. The AAFB facility sorts the source segregated recyclable materials into limited material categories handled at the facility and packages the material for transport to local establishments for recycling or disposal. The AAFB facility may be expanded for future operations or continue to operate as a satellite recycling center to service AAFB.

Based on the estimated solid waste stream for the military population on Guam and the local and off-island markets for recyclables, a recycling facility should have sufficient capability to accept an adequate amount of materials to meet the 50 percent diversion goal. The recyclables selected for recovery are: cardboard, aluminum cans, plastic containers, glass, mixed paper, brass, scrap metal, wood pallets, green waste, and food waste. To meet the 50 percent diversion goal, all recyclables identified above would need to be recovered.

An economic analysis of a source separation program with recycling facilities is included in Appendix A.2.

The establishment of a source separation program, usage of recycling centers as recyclable material drop-off facilities, and diversion of recyclables at transfer facilities would not achieve 100 percent diversion of the recyclable materials. Therefore, a materials resource recovery facility should be considered to increase the diversion of the remaining recyclables.

5.3.3 Materials Resource Recovery Facility

A materials resource recovery facility (MRRF) is a central operation, which accepts and processes commingled materials for recycling, shipment, or disposal. Materials separation may be accomplished through manual labor or advanced mechanical and optical sorting equipment. The magnitude of consolidation and baling equipment is dependent on the facility capacity, targeted materials, and overall marketability of recyclables.

Diversion of recyclable materials through source separation programs, recycling centers, and transfer facilities alone would not meet the required waste diversion goal of 50 percent. Therefore, a MRRF would be necessary to further recover and segregate targeted recyclable materials from the solid waste stream prior to disposal in Layon landfill.

Factors to consider prior to the development of a materials resource recovery facility include:

- Location and size of facility
- Type of materials available for recovery in the waste stream
- Volume of recyclables in the waste stream

GEPA requires the following permits for a MRRF:

- Solid waste processing permit
- Solid waste storage permit
- Solid waste collection permit
- Solid waste transfer permit.

Based on the projected allocation of military personnel on Guam, it is estimated the majority of DoD solid waste would be generated in northern Guam. A MRRF should be conveniently located and take into consideration the location of transfer facilities and recycling centers. The Port of Guam is located near the DoD bases in southern Guam. Shipment of recyclables from Guam would be processed through the Port of Guam.

Based on the analysis for the estimated solid waste stream for the military population on Guam, a MRRF should target most of the recyclables in the waste stream for recovery. The recyclables targeted for recovery are: cardboard, aluminum cans, plastic containers, glass, mixed paper, brass, scrap metal, wood pallets, green waste, and food waste.

A variety of separation methods is available to sort recyclables. To optimize efficiency for the handling of DoD solid waste on Guam, recovery and segregation of recyclable materials should be accomplished through the use of mechanical and optical sorting equipment and some manual labor.

After recyclable materials have been recovered and segregated from the solid waste stream, the recyclable materials may be combined and processed with the materials collected from the recycling center. Depending on the alternative chosen, processing would take place either within the MRRF or at the recycling center. The remaining refuse would then be transferred to the Layon landfill. The MRRF is intended to process the solid waste delivered primarily by collection vehicles.

The sizing of the MRRF would not vary among alternatives. However, staffing would depend on whether a MRRF would be provided both in northern and southern Guam or if a MRRF would be provided in northern Guam, southern Guam, or Barrigada. The following four alternatives are proposed in this study:

- Alternative 1: Construct MRRFs with refuse transfer stations and recycling centers in northern and southern Guam.
- Alternative 2: Construct MRRF with refuse transfer station and recycling center in southern Guam and construct refuse transfer station and recycling center in northern Guam.
- Alternative 3: Construct MRRF with refuse transfer station and recycling center in northern Guam and construct refuse transfer station and recycling center in southern Guam.
- Alternative 4: Construct MRRF with refuse transfer station in Barrigada and construct recycling centers in northern and southern Guam.

These alternatives are further investigated in Section 5.4.

5.3.4 Status Quo – No Diversion

5.3.4.1 Description and Viability

This option assumes that the DoD would dispose of all solid waste at the Layon landfill without waste diversion after the Layon landfill is constructed and operational. The exception would be the recyclable materials that are diverted to local recyclers through the source separation recycling program.

The tipping fee at the Layon landfill is expected to be $156 per ton and would be applied to most wastes generated. Certain wastes are expected to be prohibited at the Layon landfill and would require disposal at the Navy hardfill at the Navy Sanitary Landfill. The current Navy hardfill tipping fee is $1.65 per cubic yard. Materials that would be disposed at the Layon landfill include aluminum cans, various types of glass, ferrous and non-ferrous metals, newspaper, mixed paper, office paper, plastics, food waste, and miscellaneous waste. Materials that would require disposal at a hardfill include green waste and wood pallets. Cardboard cannot be disposed at the Layon landfill but can be handled by local cardboard recyclers for a current disposal fee of $3.00 to $3.50 per cubic yard.

The total solid waste disposal cost is expected to be approximately $4,603,000 per year. Calculations are included in Appendix A.3.

This option would not enable the DoD to meet the Executive Order waste diversion goal. Therefore, this option is not considered viable and is not considered further in Section 6.

5.4 Assessment of Alternatives

5.4.1 Alternative 1 – Construct MRRFs with Refuse Transfer Stations and Recycling Centers in Northern and Southern Guam

5.4.1.1 Description

For Alternative 1, a MRRF with refuse transfer station would be constructed within the Andersen Air Force Base landfill in northern Guam. The MRRF with refuse transfer station would process solid waste generated from DoD facilities in northern Guam. A recycling center located at the future Marine Corps Base (MCB) Guam Main Cantonment, which includes NCTS Finegayan and South Finegayan would be constructed to service DoD facilities in northern Guam. The existing AAFB recycling center would continue to operate as a satellite recycling center to service AAFB. A second MRRF with refuse transfer station located at the Navy Sanitary landfill would be constructed in southern Guam to process solid waste generated from DoD facilities in southern Guam. A recycling center located at the Navy Sanitary landfill would be constructed to service DoD facilities in southern Guam.

Source segregated DoD solid waste from northern and southern Guam would be taken directly to their respective recycling center locations where the materials would be processed. All recyclable materials recovered at each MRRF would be processed and recycled independently of the other MRRF. Processed recyclables would then be taken to either local recyclers or the GovGuam port for shipment directly to off-island recyclers. Refuse would be taken to the GovGuam Layon landfill or the Navy Sanitary landfill for disposal.

A flow chart for Alternative 1 is shown on Figure 5-1.

Providing a MRRF with refuse transfer station in both northern and southern Guam would reduce the travel distance and time for solid waste collection by local collector trucks to the Layon landfill.

5.4.1.2 Viability

Environmental/Regulatory Considerations

As indicated in Section 2.2.1, GEPA's Rules and Regulations for Solid Waste Disposal: Title 22, Division 4, Chapter 23 establishes a solid waste management permit system for all solid waste management facilities.

The following GEPA permits would be required for each MRRF with refuse transfer station:

- Solid waste disposal facility permit
- Solid waste processing permit
- Solid waste storage permit
- Solid waste collection permit
- Solid waste transfer permit

The following GEPA permits would be required for each recycling center:

- Solid waste processing permit
- Solid waste storage permit
- Solid waste collection permit
- Solid waste transfer permit

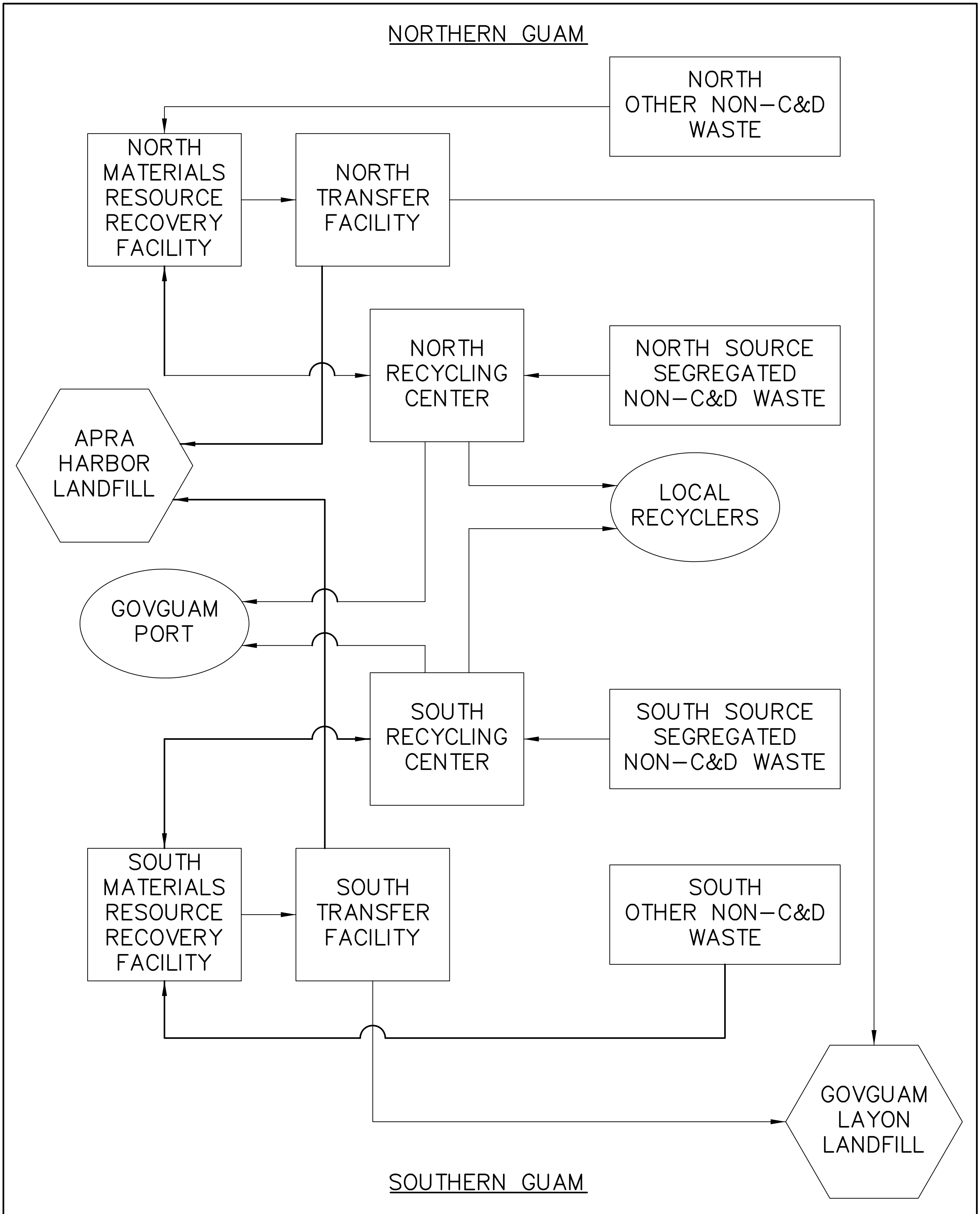
Siting Considerations

Guam EPA may have concerns about noise, air pollution, and heavy vehicle traffic generated by the solid waste processing facilities and their effect on surrounding areas. Therefore, the solid waste processing facilities should be located near similar industrial-type facilities and away from residential and commercial areas to minimize noise, air pollution, and heavy vehicle traffic impact to civilian and military residential areas.

In northern Guam, locations initially considered for a MRRF with refuse transfer station included the future MCB Guam area, AAFB landfill, AAFB Northwest Field, and a DoD parcel near Potts Junction. The DoD parcel near Potts Junction is adjacent to civilian residential areas and a private golf course. This location was considered to be the least suitable for solid waste processing facilities as compared to MCB Guam, AAFB landfill, and AAFB Northwest Field locations. Therefore, Potts Junction was not considered a viable location for solid waste processing facilities.

Locating a northern Guam DoD MRRF with refuse transfer station at the existing AAFB landfill area would be advantageous because of the similarity to the operations already occurring at the existing landfill. Because similar operations occur at the landfill, environmental impacts of the future facility would be similar to existing permitted conditions. Considerations include, but are not limited to, traffic, noise pollution, and public nuisance. The existing AAFB landfill site is already isolated from public and residential areas, and completion of the Andersen AFB commercial gate would decrease the impacts of vehicle traffic.

Locating a southern Guam DoD MRRF with refuse transfer station and recycling center at the existing Navy Sanitary landfill would be advantageous because of the similarity to the operations already occurring at the existing landfill. Because similar operations occur at the landfill, environmental impacts of the future facilities would be similar to existing permitted conditions. Considerations include, but are not limited to, traffic, noise pollution, and public nuisance.



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HDR | HPE Hawaii Pacific Engineers, Inc.	RECYCLING AND SOLID WASTE DIVERSION STUDY FOR DOD GUAM	ALTERNATIVE 1 FLOWCHART	FIGURE 5-1

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The existing Navy Sanitary landfill site is already isolated from public and residential areas.

5.4.2 Alternative 2 – Construct MRRF with Refuse Transfer Station and Recycling Center in Southern Guam and Construct Refuse Transfer Station and Recycling Center in Northern Guam

5.4.2.1 Description

For Alternative 2, a MRRF with refuse transfer station would be constructed at the Navy Sanitary Landfill in southern Guam to process solid waste generated from all DoD facilities on Guam. A recycling center located at the Navy Sanitary landfill would be constructed to service DoD facilities in southern Guam. A refuse transfer station would be constructed within the AAFB landfill in northern Guam. The refuse transfer station would serve as an intermediate collection point for solid waste generated from DoD facilities in northern Guam. A recycling center located at the future MCB Guam Main Cantonment would be constructed to service DoD facilities in northern Guam. The existing AAFB recycling center would continue to operate as a satellite recycling center to service AAFB.

Non-source segregated solid waste from northern Guam would be taken to the refuse transfer station at the AAFB landfill in northern Guam for consolidation and transport to the MRRF in southern Guam for processing. Non-source segregated solid waste from southern Guam would be taken directly to the MRRF for processing.

Source segregated DoD solid waste from northern and southern Guam would be taken directly to their respective recycling center locations where the materials would be processed. Processed recyclables would then be taken to either local recyclers or the GovGuam port for shipment directly to off-island recyclers.

Recyclable materials from non-source segregated waste recovered at the MRRF would be processed. Processed recyclables would then be taken to either local recyclers or the GovGuam port for shipment directly to off-island recyclers. The MRRF would be located reasonably close to the GovGuam port where the shipping vessels dock. Refuse from the MRRF would be taken to the GovGuam Layon landfill or Navy Sanitary Landfill for disposal.

A flow chart for Alternative 2 is shown on Figure 5-2.

5.4.2.2 Viability

Environmental/Regulatory Considerations

As indicated in Section 2.2.1, GEPA's Rules and Regulations for Solid Waste Disposal: Title 22, Division 4, Chapter 23 establishes a solid waste management permit system for all solid waste management facilities.

The following GEPA permits would be required for the MRRF with refuse transfer station:

- Solid waste disposal facility permit
- Solid waste processing permit
- Solid waste storage permit
- Solid waste collection permit
- Solid waste transfer permit

The following GEPA permits would be required for the refuse transfer station:

- Solid waste disposal facility permit
- Solid waste storage permit
- Solid waste collection permit
- Solid waste transfer permit

The following GEPA permits would be required for each recycling center:

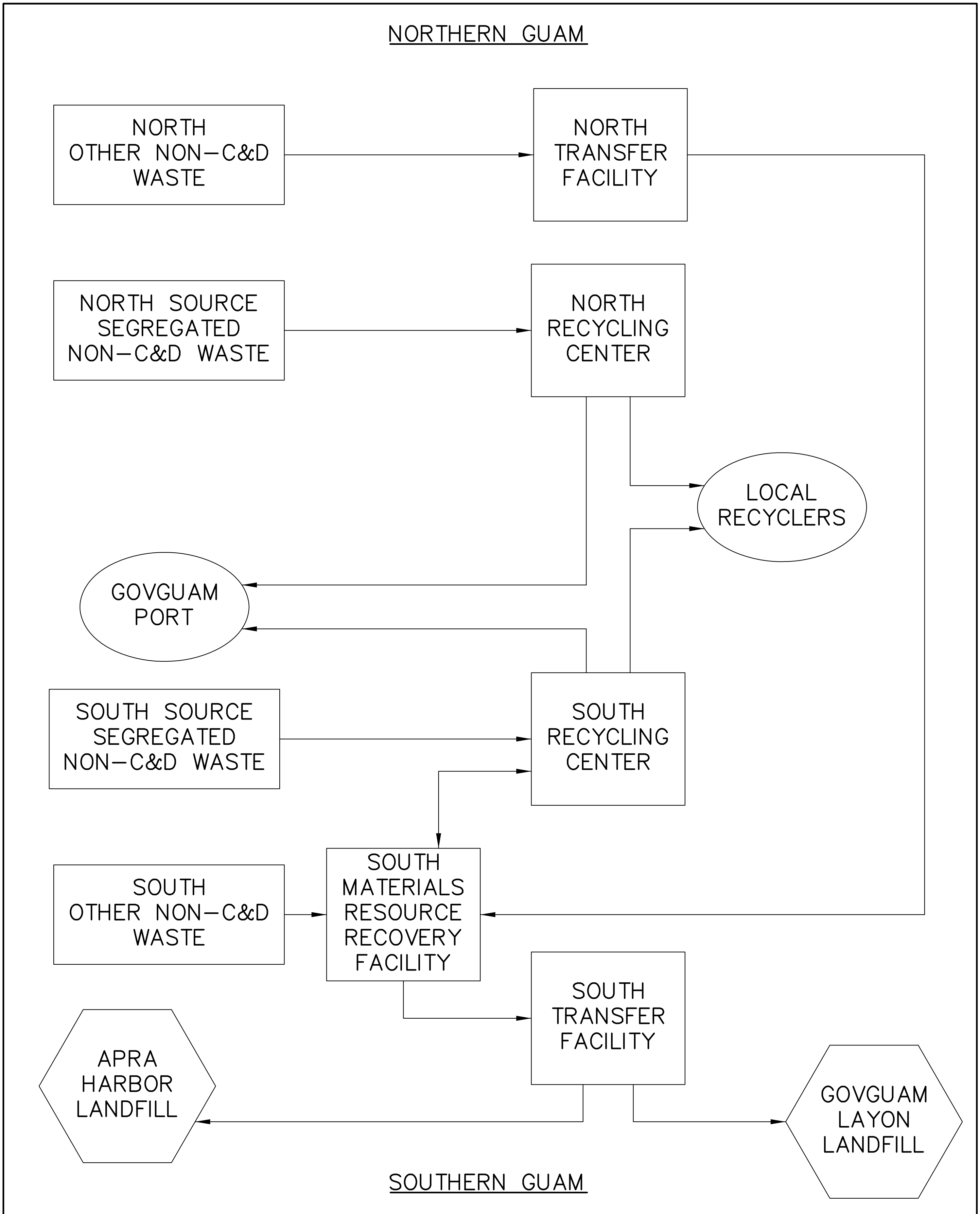
- Solid waste processing permit
- Solid waste storage permit
- Solid waste collection permit
- Solid waste transfer permit

Siting Considerations

Guam EPA may have concerns about noise, air pollution, and heavy vehicle traffic generated by the solid waste processing facilities and their effect on surrounding areas. Therefore, the solid waste processing facilities should be located near similar industrial-type facilities and away from residential and commercial areas to minimize noise, air pollution, and heavy vehicle traffic impact to civilian and military residential areas.

Locating a northern Guam refuse transfer station at the existing AAFB landfill area would be advantageous because of the similarity to the operations already occurring at the existing landfill. Because similar operations occur at the landfill, environmental impacts of the future facility would be similar to existing permitted conditions. Considerations include, but are not limited to, traffic, noise pollution, and public nuisance. The existing AAFB landfill site is already isolated from public and residential areas, and completion of the Andersen AFB commercial gate would decrease the impacts of vehicle traffic.

Locating a southern Guam DoD MRRF with refuse transfer station and a recycling center at the existing Navy Sanitary landfill would be advantageous because of the similarity to the operations already occurring at the existing landfill. Because similar operations occur at the landfill, environmental impacts of the future facilities would be similar to existing permitted conditions. Considerations include, but are not limited to, traffic, noise pollution, and public nuisance. The existing Navy Sanitary landfill site is already isolated from public and residential areas.



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RECYCLING AND SOLID WASTE DIVERSION STUDY FOR DOD GUAM

ALTERNATIVE 2 FLOWCHART

FIGURE 5–2

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5.4.3 Alternative 3 – Construct MRRF with Refuse Transfer Station and Recycling Center in Northern Guam and Construct Refuse Transfer Station and Recycling Center in Southern Guam

5.4.3.1 Description

For Alternative 3, a MRRF with refuse transfer station would be constructed at Andersen Air Force Base landfill in northern Guam to process solid waste generated from all DoD facilities on Guam. A recycling center located at the future MCB Guam Main Cantonment would be constructed to service DoD facilities in northern Guam. The existing AAFB recycling center would continue to operate as a satellite recycling center to service AAFB. A refuse transfer station would be constructed at the Navy Sanitary Landfill in southern Guam to collect solid waste generated from DoD facilities in southern Guam. The refuse transfer station would serve as an intermediate collection point for solid waste generated from DoD facilities in southern Guam. A recycling center located at the Navy Sanitary Landfill would be constructed to service DoD facilities in southern Guam.

Non-source segregated solid waste from southern Guam would be taken to the refuse transfer station at the Navy Sanitary landfill in southern Guam for consolidation and transport to the MRRF in northern Guam for processing. Solid waste generated from northern Guam would be taken directly to the MRRF for processing.

Source segregated DoD solid waste from northern and southern Guam would be taken directly to their respective recycling center locations where the materials would be processed. Processed recyclables would then be taken to either local recyclers or the GovGuam port for shipment directly to off-site recyclers.

Recyclable materials from non-source segregated waste recovered at the MRRF would be processed. Processed recyclables would then be taken to either local recyclers or the GovGuam port for shipment directly to off-island recyclers. The MRRF would be located relatively far from the GovGuam port where the shipping vessels dock. Refuse from the MRRF would be taken to the Layon landfill or Navy Sanitary landfill for disposal. The MRRF would be located relatively far from the Layon landfill.

A flow chart for Alternative 3 is shown on Figure 5-3.

5.4.3.2 Viability

Environmental/Regulatory Considerations

As indicated in Section 2.2.1, GEPA's Rules and Regulations for Solid Waste Disposal: Title 22, Division 4, Chapter 23 establishes a solid waste management permit system for all solid waste management facilities.

The following GEPA permits would be required for the MRRF with refuse transfer station:

- Solid waste disposal facility permit
- Solid waste processing permit
- Solid waste storage permit
- Solid waste collection permit
- Solid waste transfer permit

The following GEPA permits would be required for the refuse transfer station:

- Solid waste disposal facility permit
- Solid waste storage permit
- Solid waste collection permit
- Solid waste transfer permit

The following GEPA permits would be required for each recycling center:

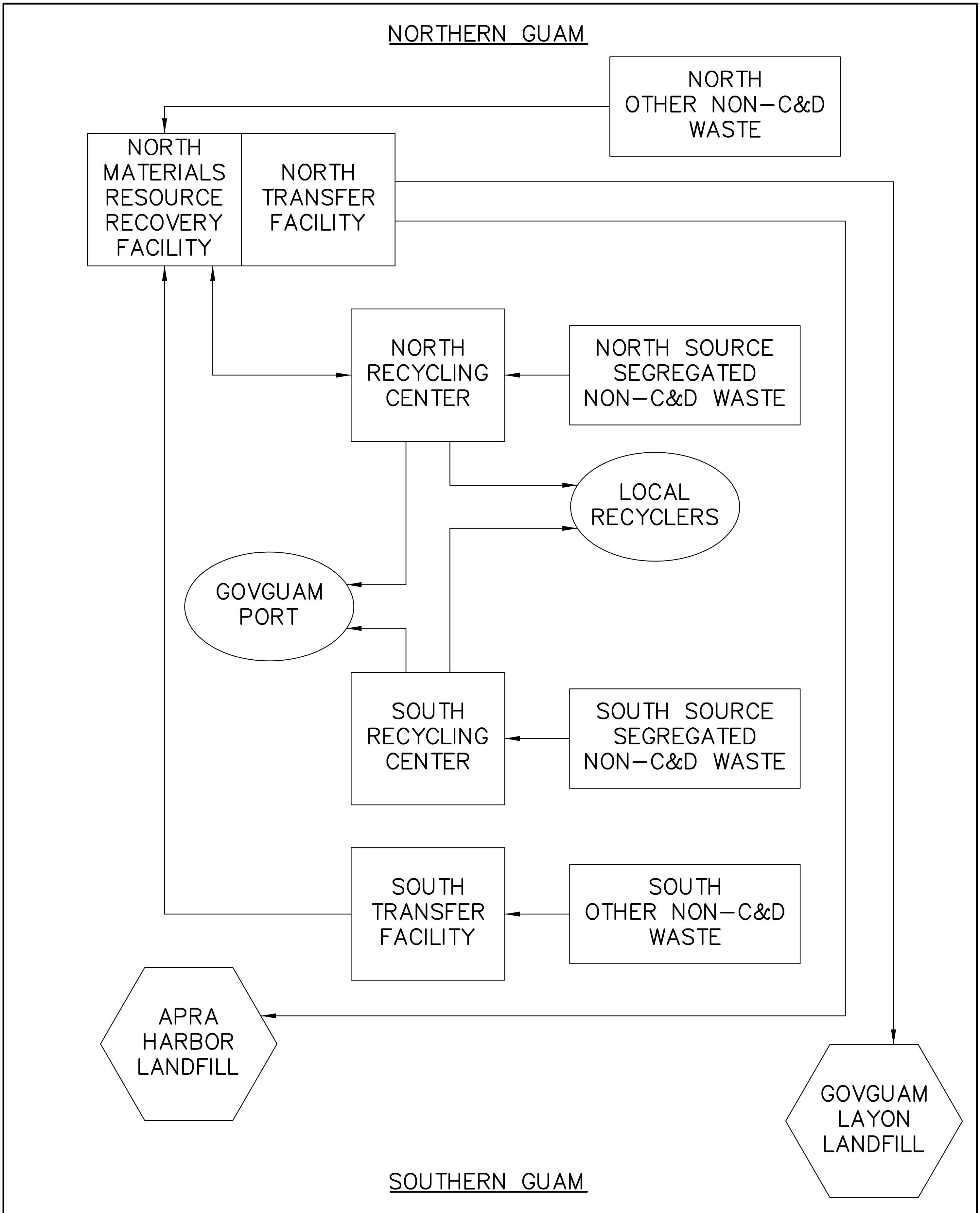
- Solid waste processing permit
- Solid waste storage permit
- Solid waste collection permit
- Solid waste transfer permit

Siting Considerations

Guam EPA may have concerns about noise, air pollution, and heavy vehicle traffic generated by the solid waste processing facilities and their effect on surrounding areas. Therefore, the solid waste processing facilities should be located near similar industrial-type facilities and away from residential and commercial areas to minimize noise, air pollution, and heavy vehicle traffic impact to civilian and military residential areas.

Locating a northern Guam DoD MRRF with refuse transfer station at the existing AAFB landfill area would be advantageous because of the similarity to the operations already occurring at the existing landfill. Because similar operations occur at the landfill, environmental impacts of the future facility would be similar to existing permitted conditions. Considerations include, but are not limited to, traffic, noise pollution, and public nuisance. The existing AAFB landfill site is already isolated from public and residential areas, and completion of the Andersen AFB commercial gate would decrease the impacts of vehicle traffic.

Locating a southern Guam DoD refuse transfer station and a recycling center at the existing Navy Sanitary landfill would be advantageous because of the similarity to the operations already occurring at the existing landfill. Because similar operations occur at the landfill, environmental impacts of the future facilities would be similar to existing permitted conditions. Considerations include, but are not limited to, traffic, noise pollution, and public nuisance. The existing Navy Sanitary landfill site is already isolated from public and residential areas.



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RECYCLING AND SOLID WASTE DIVERSION STUDY FOR DOD GUAM

ALTERNATIVE 3 FLOWCHART

FIGURE 5–3

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5.4.4 Alternative 4 – Construct MRRF with Refuse Transfer Station at Barrigada and Construct Recycling Center in Northern and Southern Guam

5.4.4.1 Description

For Alternative 4, a MRRF with refuse transfer station would be constructed in Barrigada to process solid waste generated from all DoD facilities on Guam. A recycling center located at the future MCB Guam Main Cantonment would be constructed to service DoD facilities in northern Guam. The existing AAFB recycling center would continue to operate as a satellite recycling center to service AAFB. A recycling center located at the Navy Sanitary Landfill would be constructed to service DoD facilities in southern Guam.

Non-source segregated solid waste from northern and southern Guam would be taken directly to the MRRF at Barrigada for processing. While the collection vehicles would need to travel a longer distance to the MRRF, transfer vehicles transporting refuse for disposal at Layon landfill would have a shorter travel distance.

Source segregated DoD solid waste from northern and southern Guam would be taken directly to their respective recycling center locations where the materials would be processed. Processed recyclables would then be taken to either local recyclers or the GovGuam port for shipment directly to off-island recyclers.

Recyclable materials from non-source segregated waste recovered at the MRRF would be processed. Processed recyclables would then be taken to either local recyclers or the GovGuam port for shipment directly to off-island recyclers. Refuse from the MRRF would be taken to the Layon landfill or Navy Sanitary landfill for disposal.

A flow chart for Alternative 4 is shown on Figure 5-4.

5.4.4.2 Viability

Environmental/Regulatory Considerations

As indicated in Section 2.2.1, GEPA's Rules and Regulations for Solid Waste Disposal: Title 22, Division 4, Chapter 23 establishes a solid waste management permit system for all solid waste management facilities. A MRRF with refuse transfer station is classified under the permit system as a solid waste processing facility.

The following GEPA permits would be required for the MRRF with refuse transfer station:

- Solid waste disposal facility permit
- Solid waste processing permit
- Solid waste storage permit
- Solid waste collection permit
- Solid waste transfer permit

The following GEPA permits would be required for each recycling center:

- Solid waste processing permit
- Solid waste storage permit
- Solid waste collection permit
- Solid waste transfer permit

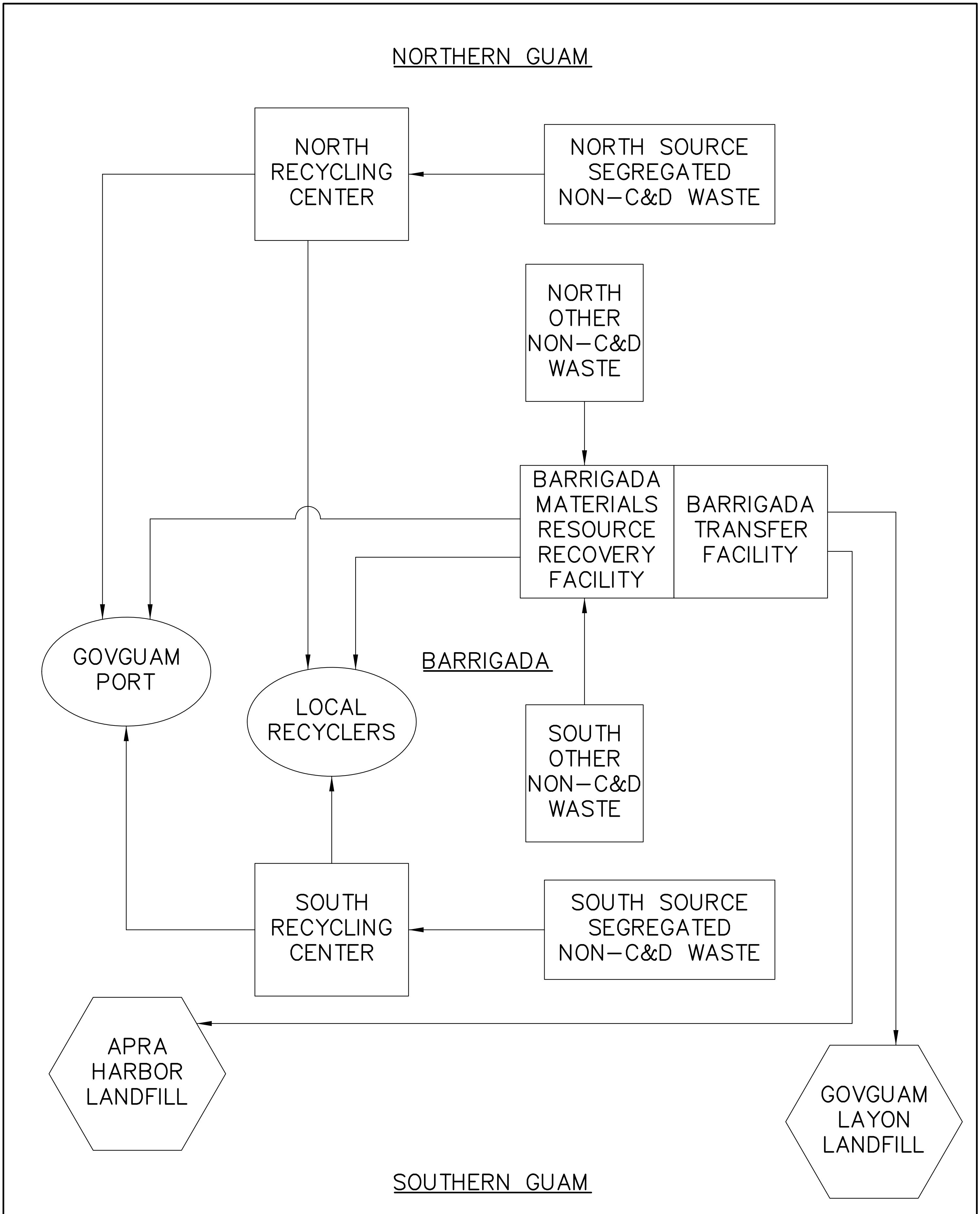
Siting Considerations

Presently, a site for a MRRF in Barrigada is not included in the master plans for any of the DoD bases in Barrigada Guam.

Unlike Alternatives 1 through 3, Barrigada does not currently have operations similar to those necessary for a MRRF or transfer station. Therefore, the environmental impacts of a MRFF and transfer station facility at Barrigada would be greater than the impacts generated under Alternative1, Alternative 2, and Alternative 3.

5.5 Viability of Alternatives

Based on a preliminary comparative assessment of the MRRF locations alternatives, none of the alternatives are considered to be substantially more advantageous than the others for successful implementation of the DoD diversion goal. Therefore, Alternatives 1 through 4 are analyzed in further detail in Section 6.



HDR | HPE Hawaii Pacific Engineers, Inc.	RECYCLING AND SOLID WASTE DIVERSION STUDY FOR DOD GUAM	ALTERNATIVE 4 FLOWCHART	FIGURE 5–4

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6.0 Viable Alternatives

6.1 Alternative 1 – Construct MRRFs with Refuse Transfer Stations and Recycling Centers in Northern and Southern Guam

6.1.1 Analysis

As described in Section 5.4.1, a MRRF in northern Guam would process solid waste generated by DoD facilities in northern Guam while a MRRF in southern Guam would process solid waste generated by DoD facilities in southern Guam. Recyclable materials recovered at each MRRF and recycling center would be processed and recycled independently.

Duplicate facilities in northern and southern Guam would provide DoD with redundancy. Redundancy would allow continued operation in the event that a facility was temporarily unavailable.

Although the amount of solid waste generated in northern Guam is projected to exceed the amount of solid waste generated in southern Guam, the size of the solid waste processing facilities would be similar. The minimum estimated area for a MRRF with refuse transfer station is 260,000 square feet. The minimum estimated area for a recycling center is 200,000 square feet. Figure 6-1 shows a conceptual layout of a MRRF with refuse transfer station facility. Figure 6-2 shows a conceptual floor plan of a MRRF with refuse transfer station building. Figure 6-3 shows a conceptual layout of a recycling center facility. Figure 6-4 shows a conceptual floor plan of a recycling center building.

The preliminary site selected for the MRRF with refuse transfer station in northern Guam is located at the AAFB landfill. The preliminary site selected for the recycling center in northern Guam is located at the future MCB Guam Main Cantonment.

The majority of DoD operations in southern Guam are located at the Apra Harbor Naval Base. Therefore, solid waste processing facilities should be located within the Naval Base. The preliminary site selected for the MRRF with refuse transfer station in southern Guam is located at the Navy Sanitary Landfill. The preliminary site selected for the recycling center in southern Guam would be located near the MRRF with refuse transfer station.

6.1.2 Cost

Because specific sites have not been designated, site development costs are based on generic sites and may vary depending on actual site characteristics. However, it is assumed that site roadway, utilities, and other improvements are required. Assumptions regarding demolition of existing structures were not included. It is assumed that water and sewer service would be obtained from existing nearby water distribution systems and sewage collection systems.

For the purpose of this analysis, it is assumed that the MRRF with refuse transfer station for northern Guam would be located at AAFB landfill and the recycling center for northern Guam would be located at the future MCB Guam Main Cantonment. The MRRF with refuse transfer for southern Guam would be located at the Navy Sanitary Landfill with the recycling center nearby.

Alternative 1 was assessed over a 50-year life cycle. The present worth life cycle cost of Alternative 1 was estimated to be $457,800,000. The costs include a MRRF with refuse transfer station and recycling center in northern and southern Guam. The detailed life cycle cost analysis is included in Appendix A.4.

6.2 Alternative 2 – Construct MRRF with Refuse Transfer Station and Recycling Center in Southern Guam and Construct Refuse Transfer Station and Recycling Center in Northern Guam

6.2.1 Analysis

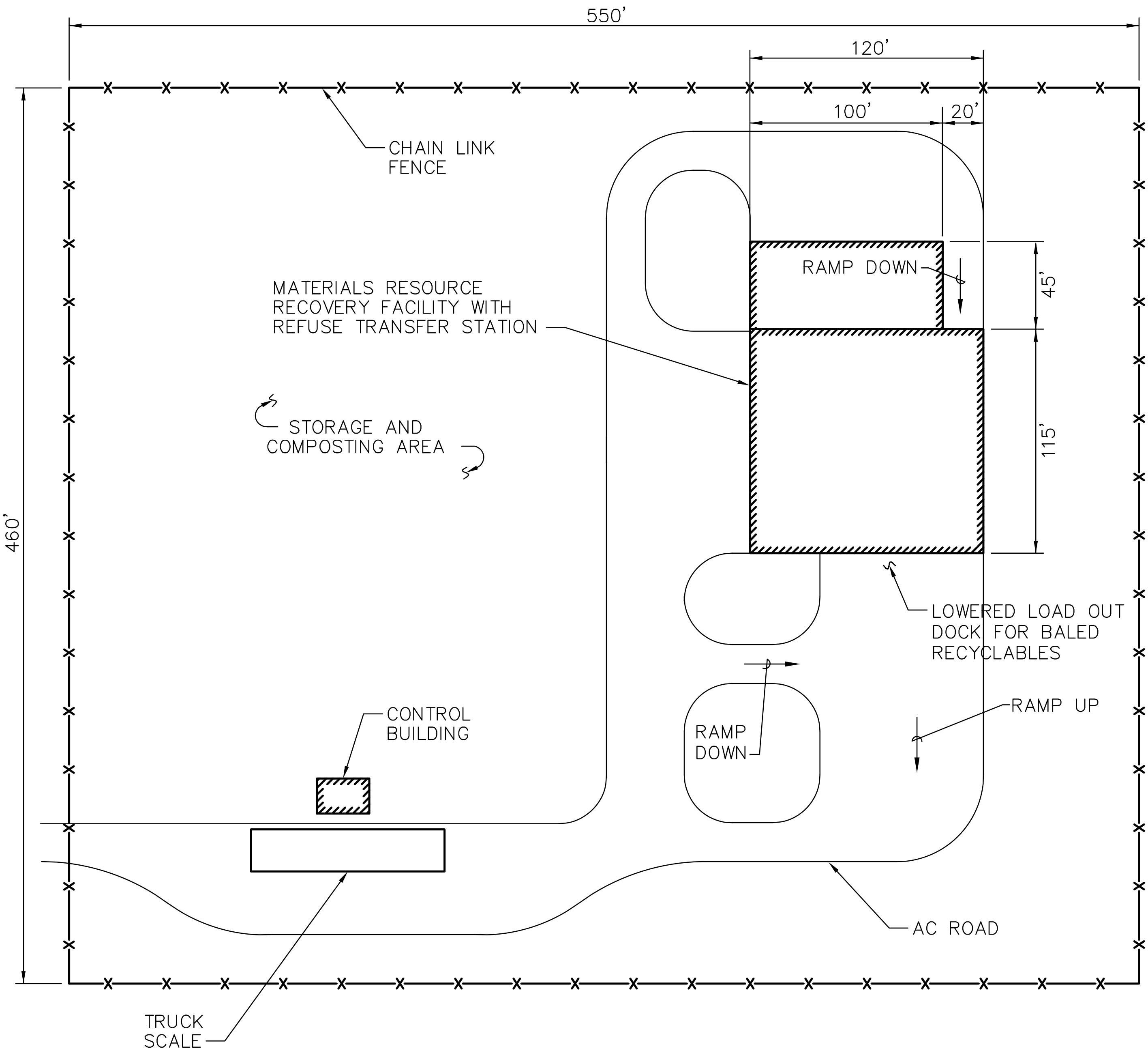
As described in Section 5.4.2, a MRRF with refuse transfer station in southern Guam would process the solid waste generated from all DoD facilities on Guam. Solid waste would be transported from a refuse transfer station in northern Guam to the MRRF with refuse transfer station in southern Guam for processing.

Because the Layon landfill, Navy Sanitary landfill and GovGuam Port are located in southern Guam, locating the MRRF with refuse transfer station in southern Guam would result in shorter travel distances for the vehicles transporting processed solid waste to the Layon landfill or Navy Sanitary Landfill and shorter distances for the vehicles transporting recyclables to the GovGuam Port. However, because a majority of the projected solid waste would be generated in northern Guam, the number of trips required for vehicles to transport unprocessed solid waste between northern and southern Guam would increase.

The minimum estimated area for a MRRF with refuse transfer station is 260,000 square feet. The minimum estimated area for a recycling center is 200,000 square feet. The minimum estimated area for a refuse transfer station is 150,000 square feet. Figure 6-1 shows a conceptual layout of a MRRF with refuse transfer station facility. Figure 6-2 shows a conceptual floor plan of a MRRF with refuse transfer station building. Figure 6-3 shows a conceptual layout of a recycling center facility. Figure 6-4 shows a conceptual floor plan of a recycling center building. Figure 6-5 shows a conceptual layout of a refuse transfer station facility. Figure 6-6 shows a conceptual floor plan of a refuse transfer station building.

The preliminary site selected for a refuse transfer station in northern Guam is located at the AAFB landfill. The preliminary site selected for the recycling center in northern Guam is located at the future MCB Guam Main Cantonment.

The preliminary site selected for the MRRF with refuse transfer station in southern Guam is located at the Navy Sanitary Landfill. The preliminary site



SITE PLAN
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HDR | HPE Hawaii Pacific Engineers, Inc.	RECYCLING AND SOLID WASTE DIVERSION STUDY FOR DOD GUAM	CONCEPTUAL MATERIALS RESOURCE RECOVERY FACILITY WITH REFUSE TRANSFER STATION SITE PLAN	FIGURE 6–1

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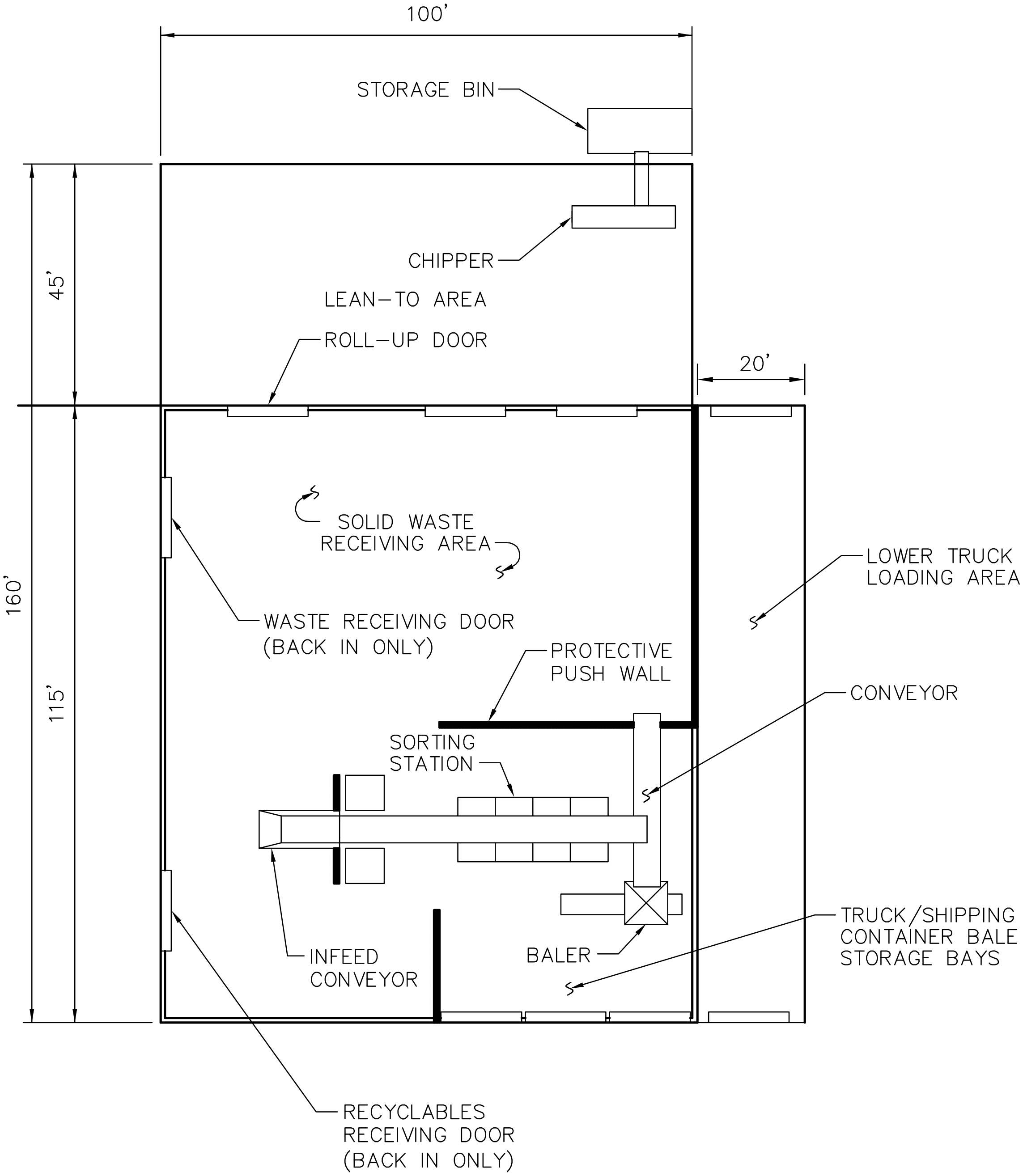

FLOOR PLAN

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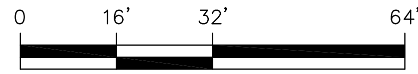

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HDR / HPE Hawaii Pacific Engineers, Inc.	RECYCLING AND SOLID WASTE DIVERSION STUDY FOR DOD GUAM	CONCEPTUAL MATERIALS RESOURCE RECOVERY FACILITY WITH REFUSE TRANSFER STATION FLOOR PLAN	FIGURE 6-2

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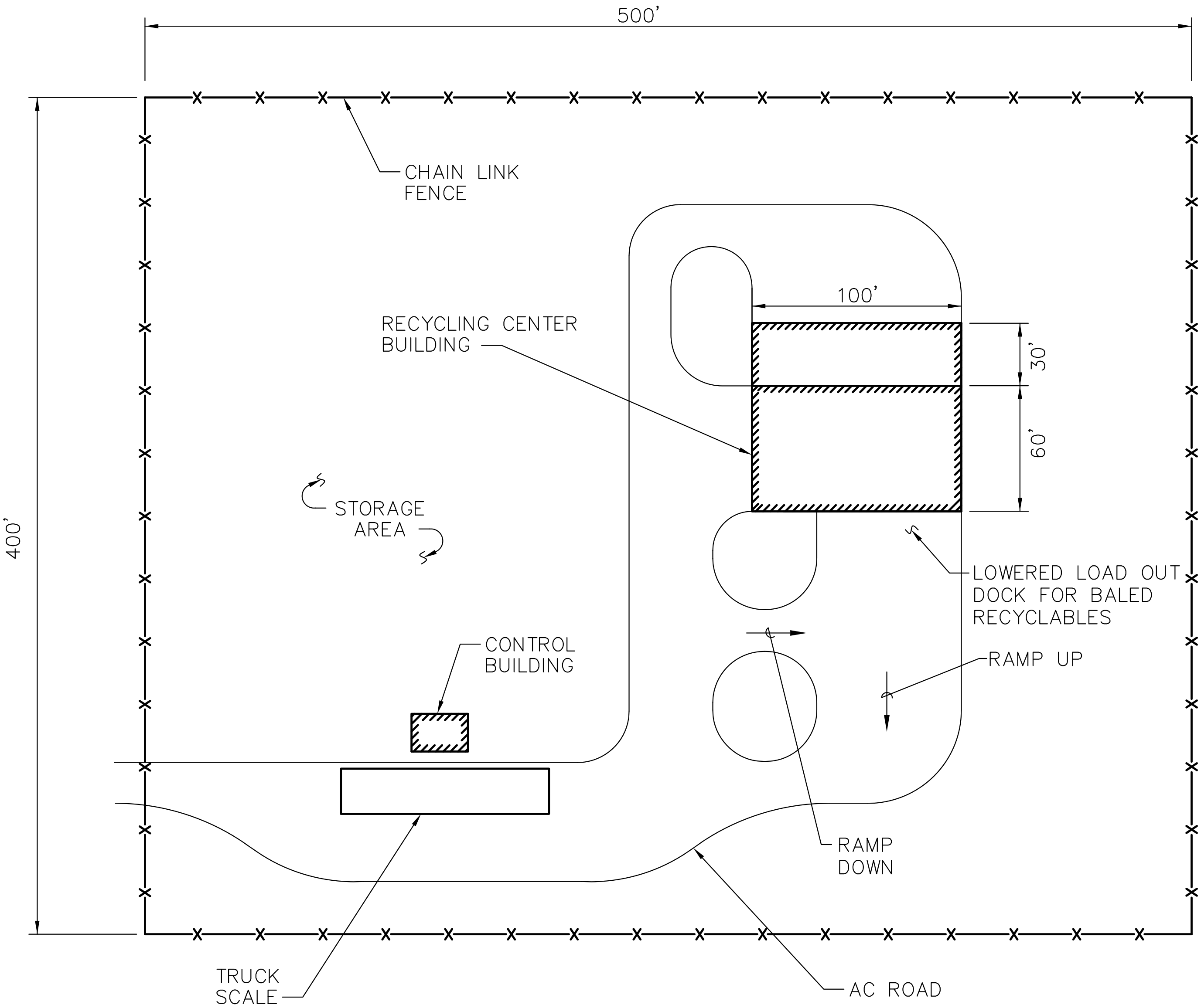

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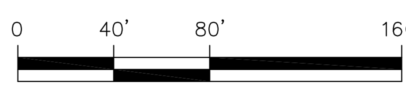

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RECYCLING AND SOLID WASTE DIVERSION STUDY FOR DOD GUAM	CONCEPTUAL RECYCLING CENTER SITE PLAN	FIGURE 6-3

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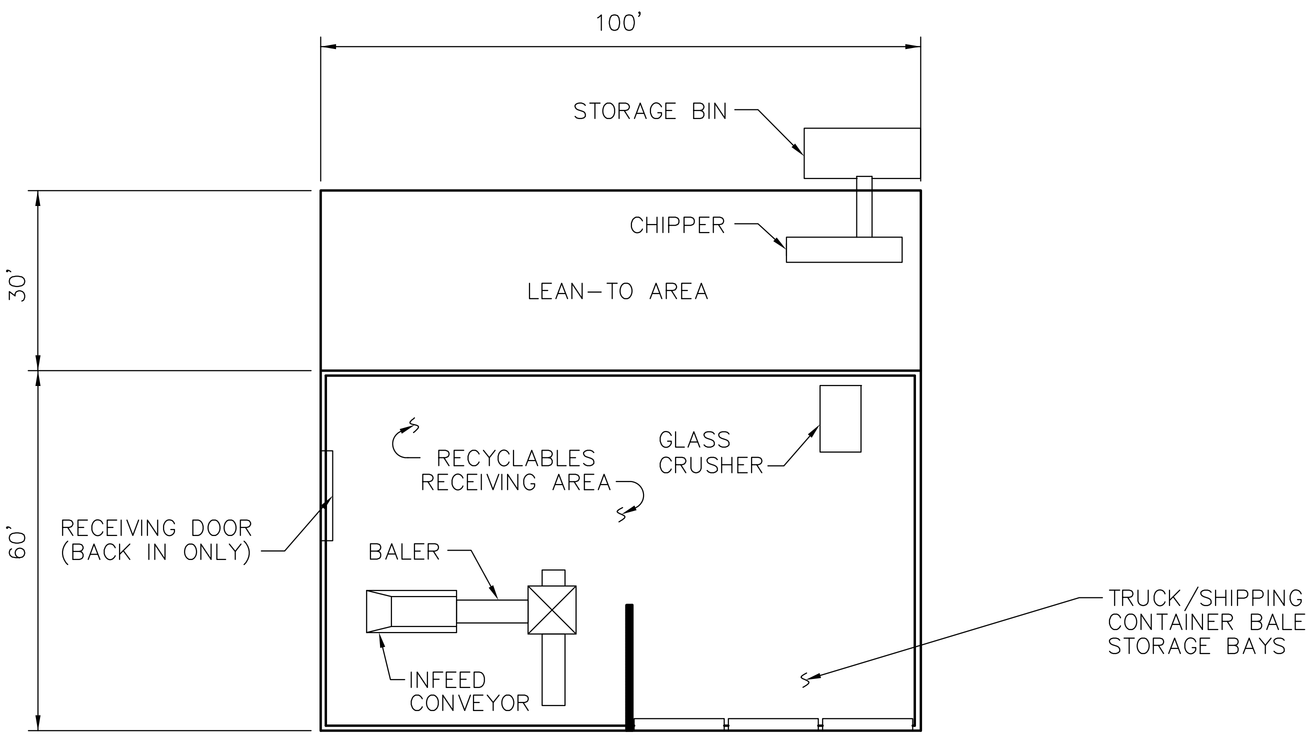

FLOOR PLAN

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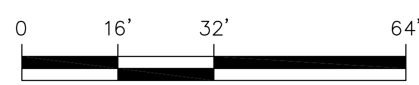

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Hawaii Pacific Engineers, Inc.	RECYCLING AND SOLID WASTE DIVERSION STUDY FOR DOD GUAM	CONCEPTUAL RECYCLING CENTER FLOOR PLAN	FIGURE 6-4

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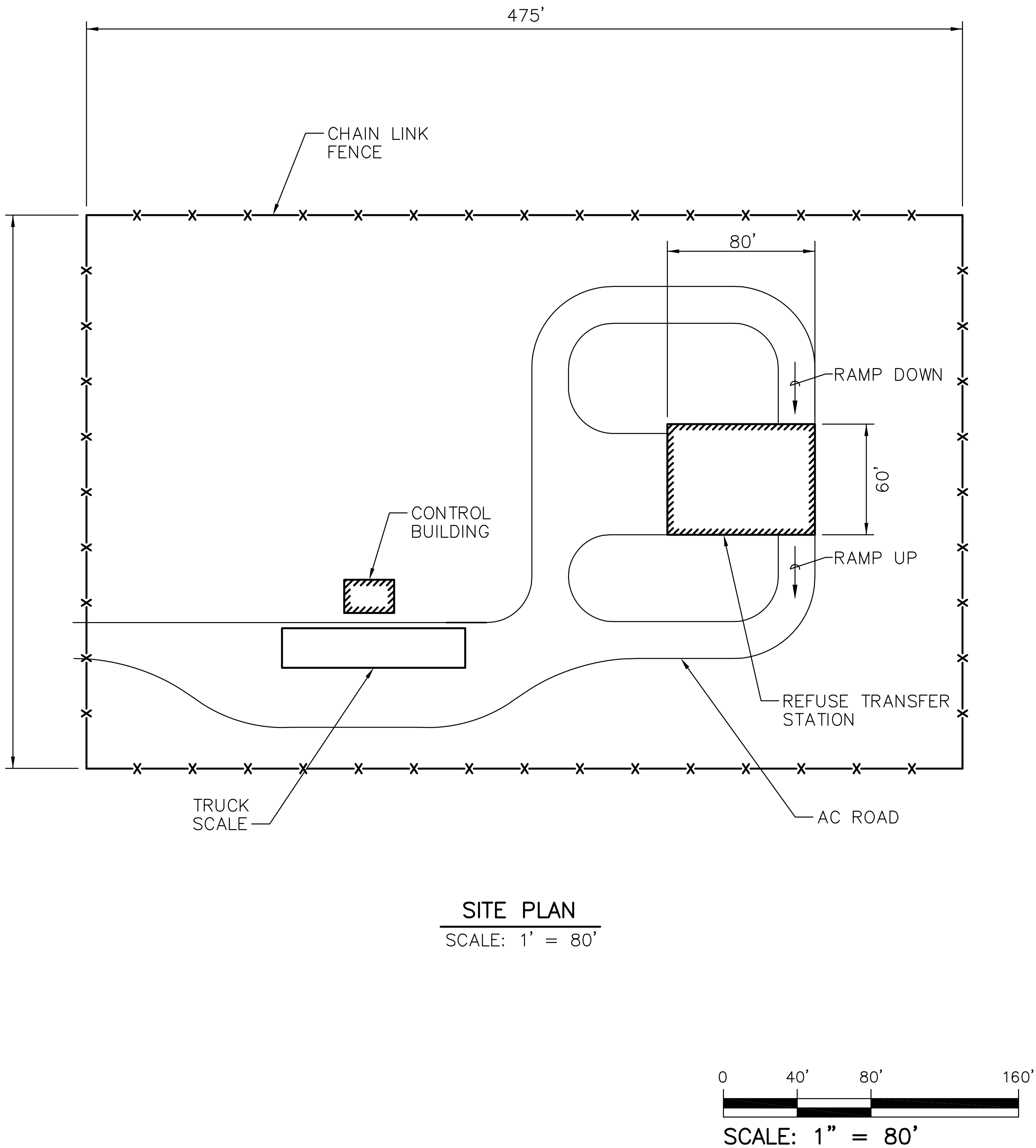

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RECYCLING AND SOLID WASTE
DIVERSION STUDY FOR DOD GUAM

CONCEPTUAL REFUSE TRANSFER STATION
SITE PLAN

FIGURE
6–5

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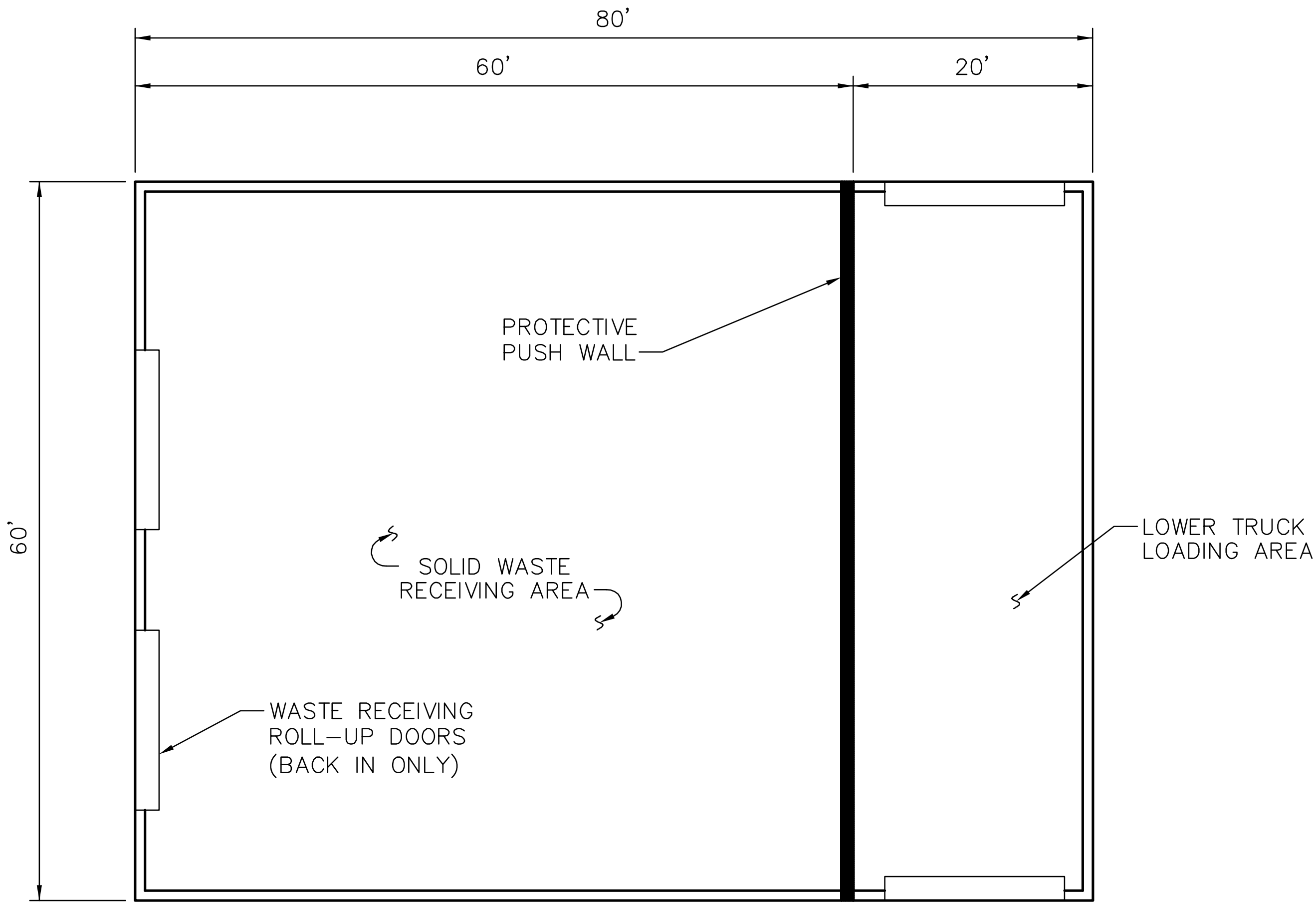

FLOOR PLAN
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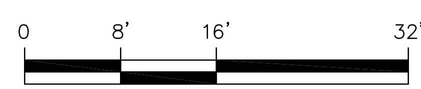

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RECYCLING AND SOLID WASTE DIVERSION STUDY FOR DOD GUAM

CONCEPTUAL REFUSE TRANSFER STATION FLOOR PLAN

FIGURE 6-6

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selected for the recycling center in southern Guam would be located near the MRRF with refuse transfer station.

6.2.2 Cost

Because specific sites have not been designated, site development costs are based on generic sites and may vary depending on actual site characteristics. However, it is assumed that site roadway, utilities, and other improvements are required. Assumptions regarding demolition of existing structures were not included. It is assumed that water and sewer service would be obtained from existing nearby water distribution systems and sewage collection systems.

For the purpose of this analysis, it is assumed that the MRRF with refuse transfer station would be located at the Navy Sanitary Landfill with the recycling center. The refuse transfer in the north would be located at AAFB landfill and the recycling center for northern Guam would be located at the future MCB Guam Main Cantonment.

Alternative 2 was assessed over a 50-year life cycle. The present worth life cycle cost of Alternative 2 was estimated to be $417,400,000. The costs include a refuse transfer station and recycling center in northern Guam and a MRRF with refuse transfer station and recycling center in southern Guam. The detailed life cycle cost analysis is included in Appendix A.4.

6.3 Alternative 3 – Construct MRRF with Refuse Transfer Station and Recycling Center in Northern Guam and Construct Refuse Transfer Station and Recycling Center in Southern Guam

6.3.1 Analysis

As described in Section 5.4.3, a MRRF with refuse transfer station in northern Guam would process solid waste generated from all DoD facilities on Guam. Solid waste would be transported from a refuse transfer station in southern Guam to the MRRF with refuse transfer station in northern Guam for processing.

Construction of a MRRF with refuse transfer station in northern Guam would result in fewer trips by vehicles transporting unprocessed solid waste between solid waste processing facilities in northern and southern Guam. The decrease in trips would be a result of the majority of projected solid waste being generated in northern Guam. However, the travel distances to the Layon landfill or the Navy Sanitary Landfill and the GovGuam Port would increase.

The minimum estimated area for a MRRF with refuse transfer station is 260,000 square feet. The minimum estimated area for a recycling center is 200,000 square feet. The minimum estimated area for a refuse transfer station is 150,000 square feet. Figure 6-1 shows a conceptual layout of a MRRF with refuse transfer station facility. Figure 6-2 shows a conceptual floor plan of a MRRF with refuse transfer station building. Figure 6-3 shows a conceptual layout of a recycling center facility. Figure 6-4 shows a conceptual floor plan of a recycling center building. Figure 6-5 shows a conceptual layout of a refuse transfer station facility. Figure 6-6 shows a conceptual floor plan of a refuse transfer station building. The preliminary site selected for a MRRF with refuse transfer station in northern Guam is located at the AAFB landfill. The preliminary site selected for the recycling center in northern Guam is located at the future MCB Guam Main Cantonment at Finegayan.

The preliminary site selected for the refuse transfer station in southern Guam is located at the Navy Sanitary Landfill. The preliminary site selected for the recycling center in southern Guam would be located near the refuse transfer station.

6.3.2 Cost

Because specific sites have not been designated, site development costs are based on generic sites and may vary depending on actual site characteristics. However, it is assumed that site roadway, utilities, and other improvements are required. Assumptions regarding demolition of existing structures were not included. It is assumed that water and sewer service would be obtained from an existing nearby water distribution system and sewage collection system.

For the purpose of this analysis, it is assumed that the MRRF with refuse transfer station would be located at AAFB landfill and the recycling center for northern Guam would be located at the future MCB Guam Main Cantonment at Finegayan. The refuse transfer in the south would be located at the Navy Sanitary Landfill with the recycling center nearby.

Alternative 3 was assessed over a 50-year life cycle. The present worth life cycle cost of Alternative 3 was estimated to be $419,400,000. The costs include a refuse transfer station and recycling center in southern Guam and a MRRF with refuse transfer station and recycling center in northern Guam. The detailed life cycle cost analysis is included in Appendix A.4.

6.4 Alternative 4 – Construct MRRF with Refuse Transfer Station in Barrigada and Construct Recycling Center in Northern and Southern Guam

6.4.1 Analysis

As described in Section 5.4.4, a MRRF with refuse transfer station in Barrigada would process the solid waste generated from all DoD facilities on Guam. Solid waste collection vehicles would transport solid waste from northern and southern Guam to the MRRF with refuse transfer station in Barrigada for processing.

Locating the MRRF with refuse transfer station in Barrigada would reduce the travel distance for vehicles transporting processed solid waste to the Layon landfill and Apra Harbor landfill. However, it would increase the travel distance for vehicles collecting solid waste in northern and southern Guam.

The minimum estimated area for a MRRF with refuse transfer station is 260,000 square feet. The minimum estimated area for a recycling center is 200,000 square feet. Figure 6-1 shows a conceptual layout of a MRRF with refuse transfer station facility. Figure 6-2 shows a conceptual floor plan of a MRRF with refuse transfer station building. Figure 6-3 shows a conceptual layout of a recycling center facility. Figure 6-4 shows a conceptual floor plan of a recycling center building.

The preliminary site selected for the MRRF with refuse transfer station is located at NCTAMS Barrigada.

The preliminary site selected for the recycling center in northern Guam is located at the future MCB Guam Main Cantonment at Finegayan.

The preliminary site selected for the recycling center in southern Guam is located near the Navy Sanitary Landfill.

6.4.2 Cost

Because specific sites have not been designated, site development costs are based on generic sites and may vary depending on actual site characteristics. However, it is assumed that site roadway, utilities, and other improvements are required. Assumptions regarding demolition of existing structures were not included. It is assumed that water and sewer service would be obtained from an existing nearby water distribution system and sewage collection system.

For the purpose of this analysis, it is assumed that the MRRF with refuse transfer station would be in Barrigada, the recycling center for northern Guam would be located at the future MCB Guam Main Cantonment at Finegayan, and the recycling center for southern Guam would be located near the Navy Sanitary Landfill.

This alternative was assessed over a 50-year life cycle. The present worth life cycle cost of Alternative 4 was estimated to be $478,300,000. The costs include a recycling center in northern and southern Guam and a MRRF with refuse transfer station and recycling center in Barrigada. The detailed life cycle cost analysis is included in Appendix A.4.

6.5 Alternative Comparison

6.5.1 Cost Comparison

The total net present value life cycle costs based on a 50-year period for the detailed evaluation of material resource recovery facility alternatives are summarized in Table 6-1. Appendix A.4 contains tables showing the annual current dollars and present value analysis for the capital and operating costs for the alternatives. Appendix A.4 also contains the detailed cost assumptions and calculations used for the analysis.

Constructing a MRRF with refuse transfer facility and recycling center in southern Guam and constructing a refuse transfer facility and recycling center in northern

Guam provides the most cost effective alternative over the 50-year analysis period.

6.5.2 Advantages and Disadvantages

Table 6-2 is a matrix of the four viable alternatives analyzed in this section. Each alternative was developed to achieve the DoD goal of 50-percent diversion of non-hazardous solid waste excluding construction and demolition waste by 2015. The table lists the advantages and disadvantages of the alternatives in terms of regulatory, operational, implementation and economical considerations.

Alternative 1 would allow operational redundancy with recyclable material recovery operations occurring both in northern Guam and southern Guam. Alternative 1 has the second highest present value cost over a 50-year period.

Alternative 2 has the lowest present value cost over a 50-year period. With the MRRF sited in southern Guam, it would be closer to the Layon landfill and Navy Sanitary Landfill than a facility in northern Guam. Therefore, the trips to dispose the processed solid waste would be shorter. Recyclables recovered from the MRRF for shipment off of Guam would be closer to the GovGuam port.

Alternative 3 would provide a MRRF in northern Guam, where a majority of the projected DoD solid waste would be generated. Planning for a MRRF in northern Guam may be less difficult than a MRRF in southern Guam because master plans for the Marine Corps Base in northern Guam are still under development.

Alternative 4 would provide a MRRF in Barrigada and recycling centers in northern and southern Guam. While Barrigada is a junction point on the travel routes that refuse transfer vehicles would take from northern and southern Guam to the Layon landfill, this alternative has the highest present value cost over a 50-year period.

Table 6-1

Summary of Present Value Analysis

Alternative	Initial Capital Cost of Facility, Equipment and Trucks	Recurring Replacement Cost of Trucks	Recurring Replacement Cost of Major Equipment	Operating Cost of Labor	Operation and Maintenance Cost for Trucks	Operation and Maintenance Cost for Facilities and Equipment	Container Shipping Costs	Total Present Value Analysis 50 years
Alternative 1 – Construct MRRFs with refuse transfer stations and recycling centers in northern and southern Guam	$82,900,000	$44,300,000	$600,000	$173,700,000	$61,300,000	$90,500,000	$4,500,000	$457,800,000
Alternative 2 – Construct MRRF with refuse transfer station and recycling center in southern Guam and construct refuse transfer facility and recycling center in northern Guam	$69,300,000	$45,100,000	$600,000	$156,200,000	$61,800,000	$83,000,000	$1,400,000	$417,400,000
Alternative 3 – Construct MRRF with refuse transfer station and recycling center in northern Guam and construct refuse transfer facility and recycling center in southern Guam	$69,300,000	$45,100,000	$600,000	$154,500,000	$64,400,000	$83,000,000	$2,500,000	$419,400,000
Alternative 4 – Construct MRRF with refuse transfer station in Barrigada and construct recycling centers in northern Guam and southern Guam	$67,700,000	$46,700,000	$300,000	$198,000,000	$80,100,000	$83,000,000	$2,500,000	$478,300,000

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TABLE 6-2
SUMMARY MATRIX OF COMPARATIVE ADVANTAGES (A) AND DISADVANTAGES (D)

Alt.	Option	Regulations	Operations	Implementation	Economics
1	Construct MRRFs with refuse transfer stations and recycling centers in northern and southern Guam	D – GEPA permits for two MRRFs, two refuse transfer stations and two recycling centers.	A – Two materials resource recovery facilities provide operational flexibility. A – Unprocessed solid waste would not be transported between northern and southern Guam. D – Recyclable material processed at four facilities.	D – Siting and construction of two MRRFs with refuse transfer stations.	A – Second highest Present Value cost based on a 50-year lifecycle analysis.
2	Construct MRRF with refuse transfer station and recycling center in southern Guam and construct refuse transfer station and recycling center in northern Guam	A – GEPA permits required for one MRRF, two transfer stations and two recycling centers.	D – Relatively longer total distance for transfer vehicles to transport unprocessed solid waste. A – Relatively shorter total distance for transfer vehicles to transport processed solid waste. A – Recyclable material processed at three facilities.	A – Siting and construction of one MRRF with refuse transfer station.	A – Lowest Present Value cost based on a 50-year lifecycle analysis.
3	Construct MRRF with refuse transfer station and recycling center in northern Guam and construct refuse transfer station and recycling center in southern Guam	A – GEPA permits required for one MRRF, two transfer stations and two recycling centers.	A – Relatively shorter total distance for transfer vehicles to transport unprocessed solid waste. D – Relatively longer total distance for transfer vehicles to transport processed solid waste. A – Recyclable material processed at three facilities.	A – Siting and construction of one MRRF with refuse transfer station. A – Planning for a facility in northern Guam may be less difficult than for a facility in southern Guam.	D – Third Highest Present Value cost based on a 50-year lifecycle analysis.
4	Construct MRRF with refuse transfer station in Barrigada and construct recycling center in northern Guam and construct recycling center in southern Guam	A – GEPA permits required for one MRRF and two recycling centers. D – Processing of GEPA permits for a MRRF with refuse transfer station site in Barrigada.	D – Relatively longer total distance for collection vehicles to transport unprocessed solid waste. A – Relatively shorter total transportation distance for processed solid waste. A – Recyclable material processed at three facilities.	A – Siting and construction of one MRRF with refuse transfer station.	D– Highest Present Value cost based on a 50-year lifecycle analysis.

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7.0 Summary of Findings

The major findings of the study are summarized below.

- Construction of two DoD refuse transfer stations, one in northern Guam and one in southern Guam, is the most cost-effective solution for collection and disposal of DoD solid waste at the GovGuam Layon landfill or Apra Harbor landfill.
- Expansion of existing source separation recycling programs at all DoD facilities is essential towards meeting the DoD diversion goals.
- Construction of two DoD recycling centers, one in northern Guam and one in southern Guam, is needed to process recyclable materials collected by the source separation recycling program and to serve as a drop-off facility for recyclable materials generated by residential, commercial, and industrial sectors. The existing AAFB Recycling Center should continue to serve as a satellite recycling center for AAFB.
- Based on the characterization of the projected DoD solid waste stream, a materials resource recovery facility is necessary to achieve the DoD goal of 50-percent diversion of non-hazardous solid waste excluding construction and demolition waste by 2015.
- Construction of a materials resource recovery facility with refuse transfer station and recycling center in southern Guam and construction of a refuse transfer station and recycling center in northern Guam is the most cost-effective alternative.
- Existing recycling vendors on Guam are not able to accept all types of recyclable materials that DoD would need to divert from its solid waste stream to meet its diversion goal. In addition, with the possible exception of scrap metal, existing recycling vendors on Guam cannot reasonably ensure that they will accept all the types of materials that they do handle at all times.
- The capability to directly ship recyclable materials to off-island recyclers is essential to ensure a reliable means of moving the collected materials out of the DoD facilities.

Based on the results of the analysis and evaluations performed for this study, the following recommendations are offered.

- Conduct a solid waste characterization study for DoD facilities on Guam.
- Construct two DoD refuse transfer stations, one in northern Guam and one in southern Guam.
- Expand existing source separation recycling programs at all DoD facilities.

- Construct two DoD recycling centers, one in northern Guam and one in southern Guam.
- Construct a minimum of one DoD materials resource recovery facility.
- Evaluate the feasibility of establishing a comprehensive program for Guam that includes the Defense Commissary Agency, the Navy Exchange Service Command, the Army & Air Force Exchange Service, and other agencies and commands to implement source controls for the types of materials brought to Guam, to implement a consistent approach for recovery and diversion of recyclable materials, and to develop back shipment container capacity.

8.0 References

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Appendices

Appendix A

Cost Data

Appendix A.1

Cost Data – Diversion of Recyclable Materials

RECYCLING - COST ESTIMATING AND ECONOMIC ASSUMPTIONS

Current Exchange Rates

September 2009: 1 CNY = 0.146497 U.S. Dollar (CNY = Chinese Yuan)

Conversion Factors

1 metric tonne (MT) = 1000 kg = 2204 lbs

Shipping Calculations

Destination for shipped materials: The two main locations considered for shipment of recyclables were the West Coast of the United States (includes Los Angeles/Long Beach, CA, Oakland, CA, and Tacoma, WA) and Xiamen, China.

Recyclable Materials Shipping Destination

Material	Destination	Container Size[a]
Cardboard	Xiamen	40' Dry HC
Aluminum Cans	West Coast	40' Dry HC
Plastic Containers	Xiamen	40' Dry HC
Glass	West Coast	20' Dry
Mixed Paper	Xiamen	40' Dry HC
Brass	N/A	N/A
Scrap Metal	Xiamen	20' Dry
Wood Pallets	Long Beach, CA	40' Dry HC

Notes:

a A 40' Dry High Cube was chosen for each recyclable unless the weight of the material exceeded the weight limits of the container. In the case of the weight exceeding the maximum capacity, a 20' Dry container was used.

Number of bales expected to fit in each shipping container:

Based on Matson 40' Dry High Cube container dimensions:

Inside: 39’6” L x 7’9” W x 7’10” H

Outside: 40’ L x 8’ W x 8’6” H

Bale size: 30” x 45” x 60”

Bales are double-stacked and can fit 28 bales per 40’ container.

Maximum weight:

40’ container: 44,000 lbs; 20’ container: 36,000 lbs

Number of wood pallets expected to fit in a 40’ container:

Pallet size: 40” x 45” x 5”

Pallets stacked 19 high, 2 stacks wide, 9 stacks deep: 342 pallets per 40’ container

Wood pallets weigh between 40-70 lbs.

Estimate of Brass Quantities

Quantities of brass casings are dependent on the type and number of Marines that will be stationed in Guam. Our estimate of brass quantities produced is based on the quantities of brass generated at the Marine Corps Base Hawaii (MCB Hawaii). MCB Hawaii generates between 60,000-200,000 lbs/year of brass depending on the training required. Based on the current function of the Marines at MCB Hawaii and the anticipated function of the Marines in Guam, it is estimated that approximately 50% of the MCB Hawaii brass quantities will be generated in Guam.

PROJECTED BRASS QUANTITIES (2019)

Military Location	Population	Brass Quantities (lbs/yr)	50% of Brass Quantities (lbs/yr)
MCB Hawaii	18,414	60,000	30,000
Guam (projected)	19,557	63,724.3	31,832.2
Ratio	1.06		

MATERIALS RECOVERY FACILITY IN NORTHERN AND SOUTHERN GUAM - NORTHERN PORTION													
Material	**Production**		**Weight per bale (lbs)**		**No. bales per year**	**Weight of container**	**No. containers**	**Unit Price**	**Containers shipped**	**Annual revenue**	**Additional Transport Costs***	**Annual Shipping Costs**	**Net profit (loss)**
	lbs/day	**lbs/yr**	**Min.**	**Max.**	**(Min. Wt)**	**lbs**	**per year**	**$/lb**	**per year**	**$/yr**	**$/yr**	**$/yr**	**$/yr**
Cardboard	4,795.6	1,750,399.5	1,200	1,500	1,458.7	33,600	52.1	$0.065	52	$113,568		$143,744	($30,176)
Aluminum Cans	2,484.0	906,676.3	900	1,125	1,007.4	25,200	36.0	$0.720	35	$635,040		$166,223	$468,817
Plastic Containers	1,779.6	649,567.1	1,200	1,400	541.3	33,600	19.3	$0.060	19	$38,304		$52,522	($14,218)
Glass	5,472.0	1,997,298.0	N/A	N/A	N/A	36,000	55.5	$3.75/ton	55	$3,713		$209,666	($205,954)
Mixed Paper	8,528.8	3,113,024.2	1,000	1,690	3,113.0	28,000	111.2	$0.017	111	$52,836		$306,837	($254,001)
Expended Brass[a]	87.2	28,603.8	N/A	N/A	N/A	N/A	N/A	$1.416	N/A	N/A		N/A	N/A
Scrap Metal	6,558.9	2,394,006.6	N/A	N/A	N/A	36,000	66.5	$150/ton	66	$178,200		$166,604	$11,596
Treated Wood Pallets (40lb)	14,807.3	5,404,665.7	N/A	N/A	N/A	13,680	395.1	$0.000	395	$0	$571,984	$1,435,497	($2,007,481)
Treated Wood Pallets (70lbs)	14,807.3	5,404,665.7	N/A	N/A	N/A	18,760	288.1	$0.000	288	$0	$424,388	$1,046,641	($1,471,029)
Untreated Wood Pallets (40lb)	14,807.3	5,404,665.7	N/A	N/A	N/A	13,680	395.1	$0.000	395	$0	$459,346	$1,435,497	($1,894,843)
Untreated Wood Pallets (70lbs)	14,807.3	5,404,665.7	N/A	N/A	N/A	18,760	288.1	$0.000	288	$0	$299,909	$1,046,641	($1,346,550)
Recycling Wood Pallets (40 lbs)	14,807.3	5,404,665.7	N/A	N/A	N/A	13,680	395.1	$0.75/pallet	395	$50,659	$146,545	$1,435,497	($1,531,383)
Green Waste/Food Waste	16,636.6	6,072,351.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total (40 lb Treated Pallets to C&D facility)										$1,021,661	$571,984	$2,481,092	($2,031,416)
Total (70 lb Treated Pallets to C&D facility)										$1,021,661	$424,388	$2,092,236	($1,494,964)
Total (40 lb Untreated Pallets - Mulching)										$1,021,661	$459,346	$2,481,092	($1,918,777)
Total (70 lb Untreated Pallets - Mulching)										$1,021,661	$299,909	$2,092,236	($1,370,484)
Total (40 lb Pallets for Repair/Recycling)										$1,072,319	$146,545	$2,481,092	($1,555,318)

Notes:

[a] Expended Brass must be recycled through DRMO and may not be shipped off of Guam for recycling

***Additional trucking transport cost added for wooden pallets for mulching and C&D recycling ($520.20)**

Additional trucking transport cost added for wooden pallets for recycling (Riverside) ($370.96)

Shipping costs - Wooden pallets	**20' container**	**40' container**
West Coast - rate for wooden pallets		$3,634.17

Treated Pallets sent to Construction and Demolition facility for recycling, transport costs:	$155 - dropoff/pickup	$79/ton
Untreated Pallets sent to Mulching facility, transport costs:	$175 - dropoff/pickup	$30/ton

Shipping Cost - Mixed Recyclables	**20' container**	**40' container**
Guam to Xiamen, China	$2,524.30	$2,764.30
Guam to West Coast	$3,812.11	$4,749.22

Assumptions:

Brass density = 543 PCF

Scrap metal density (estimated) = 480 PCF

Glass density = 1000 - 2000 lbs/CY

MATERIALS RECOVERY FACILITY IN NORTHERN AND SOUTHERN GUAM - SOUTHERN PORTION													
Material	Production		Weight per bale (lbs)		No. bales per year	Weight of container	No. containers	Unit Price	Containers shipped	Annual revenue	Additional Transport Costs*	Annual Shipping Costs	Net profit (loss)
	lbs/day	lbs/yr	Min.	Max.	(Min. Wt)	lbs	per year	$/lb	per year	$/yr	$/yr	$/yr	$/yr
Cardboard	1,949.8	711,680.8	1,200	1,500	593.1	33,600	21.2	$0.065	21	$45,864		$55,740	($9,876)
Aluminum Cans	1,010.0	368,638.2	900	1,125	409.6	25,200	14.6	$0.720	14	$254,016		$64,949	$189,067
Plastic Containers	723.6	264,102.2	1,200	1,400	220.1	33,600	7.9	$0.060	7	$14,112		$18,580	($4,468)
Glass	2,224.8	812,065.2	N/A	N/A	N/A	36,000	22.6	$3.75/ton	22	$1,485		$81,446	($79,961)
Mixed Paper	3,467.7	1,265,699.3	1,000	1,690	1,265.7	28,000	45.2	$0.017	45	$21,420		$119,444	($98,024)
Expended Brass[a]	0.0	0.0	N/A	N/A	N/A	N/A	N/A	$1.416	N/A	N/A		N/A	N/A
Scrap Metal	2,702.2	986,302.2	N/A	N/A	N/A	36,000	27.4	$150/ton	27	$72,900		$65,186	$7,714
Treated Wood Pallets (40lb)	6,020.4	2,197,439.3	N/A	N/A	N/A	13,680	160.6	$0.000	160	$0	$231,690	$563,867	($795,557)
Treated Wood Pallets (70lbs)	6,020.4	2,197,439.3	N/A	N/A	N/A	18,760	117.1	$0.000	117	$0	$172,408	$412,328	($584,736)
Untreated Wood Pallets (40lb)	6,020.4	2,197,439.3	N/A	N/A	N/A	13,680	160.6	$0.000	160	$0	$186,064	$563,867	($749,931)
Untreated Wood Pallets (70lbs)	6,020.4	2,197,439.3	N/A	N/A	N/A	18,760	117.1	$0.000	117	$0	$121,838	$412,328	($534,166)
Recycling Wood Pallets (40 lbs)	6,020.4	2,197,439.3	N/A	N/A	N/A	13,680	160.6	$0.75/pallet	160	$20,520	$59,360	$563,867	($602,707)
Green Waste/Food Waste	6,764.1	2,468,908.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total (40 lb Treated Pallets to C&D facility)										$409,797	$231,690	$969,213	($791,105)
Total (70 lb Treated Pallets to C&D facility)										$409,797	$172,408	$817,673	($580,284)
Total (40 lb Untreated Pallets - Mulching)										$409,797	$186,064	$969,213	($745,480)
Total (70 lb Untreated Pallets - Mulching)										$409,797	$121,838	$817,673	($529,714)
Total (40 lb Pallets for Repair/Recycling)										$430,317	$59,360	$969,213	($598,256)

Notes:

[a] Expended Brass must be recycled through DRMO and may not be shipped off of Guam for recycling

***Additional trucking cost added for wooden pallets for mulching and C&D recycling ($520.20)**

Additional trucking cost added for wooden pallets for recycling (Riverside) ($370.96)

Shipping costs - Wooden Pallets	**20' container**	**40' container**
West Coast - rate for wooden pallets		$3,524.17

Treated Pallets sent to Construction and Demolition facility for recycling, transport costs:	$155 - dropoff/pickup	$79/ton
Untreated Pallets sent to Mulching facility, transport costs:	$175 - dropoff/pickup	$30/ton

Shipping Cost - Mixed Recyclables	**20' container**	**40' container**
Guam to Xiamen, China	$2,414.30	$2,654.30
Guam to West Coast	$3,702.11	$4,639.22

Assumptions:

Brass density = 543 PCF
Scrap metal density (estimated) = 480 PCF
Glass density = 1000 - 2000 lbs/CY
50% of wood pallets for recycling will receive $0.75 ea.
All brass is generated in Northern Guam

MATERIALS RECOVERY FACILITY IN NORTHERN AND SOUTHERN GUAM - TOTAL												
	NORTHERN GUAM PORTION				SOUTHERN GUAM PORTION				TOTAL			
Material	**Annual revenue**	**Additional Transport Costs**	**Annual Shipping Costs**	**Net profit (loss)**	**Annual revenue**	**Additional Transport Costs**	**Annual Shipping Costs**	**Net profit (loss)**	**Annual revenue**	**Additional Transport Costs**	**Annual Shipping Costs**	**Net profit (loss)**
	$/yr	**$/yr**	**$/yr**	**$/yr**	**$/yr**	**$/yr**	**$/yr**	**$/yr**	**$/yr**	**$/yr**	**$/yr**	**$/yr**
Cardboard	$113,568		$143,744	($30,176)	$45,864		$55,740	($9,876)	$159,432	$0	$199,484	($40,052)
Aluminum Cans	$635,040		$166,223	$468,817	$254,016		$64,949	$189,067	$889,056	$0	$231,172	$657,884
Plastic Containers	$38,304		$52,522	($14,218)	$14,112		$18,580	($4,468)	$52,416	$0	$71,102	($18,686)
Glass	$3,713		$209,666	($205,954)	$1,485		$81,446	($79,961)	$5,198	$0	$291,112	($285,915)
Mixed Paper	$52,836		$306,837	($254,001)	$21,420		$119,444	($98,024)	$74,256	$0	$426,281	($352,025)
Expended Brass[a]	N/A		N/A	N/A	N/A		N/A	N/A	N/A	$0	N/A	N/A
Scrap Metal	$178,200		$166,604	$11,596	$67,500		$65,186	$2,314	$245,700	$0	$231,790	$13,910
Treated Wood Pallets (40lb)	$0	$571,984	$1,435,497	($2,007,481)	$0	$231,690	$563,867	($795,557)	$0	$803,673	$1,999,364	($2,803,038)
Treated Wood Pallets (70lbs)	$0	$424,388	$1,046,641	($1,471,029)	$0	$172,408	$412,328	($584,736)	$0	$596,796	$1,458,969	($2,055,765)
Untreated Wood Pallets (40lb)	$0	$459,346	$1,435,497	($1,894,843)	$0	$186,064	$563,867	($749,931)	$0	$645,410	$1,999,364	($2,644,774)
Untreated Wood Pallets (70lbs)	$0	$299,909	$1,046,641	($1,346,550)	$0	$121,838	$412,328	($534,166)	$0	$421,747	$1,458,969	($1,880,716)
Recycling Wood Pallets (40 lbs)	$50,659	$146,545	$1,435,497	($1,531,383)	$20,520	$59,360	$563,867	($602,707)	$71,179	$205,905	$1,999,364	($2,134,091)
Green Waste/Food Waste	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total (40 lb Treated Pallets to C&D facility)	$1,021,661	$571,984	$2,481,092	($2,031,416)	$409,797	$231,690	$969,213	($791,105)	$1,431,458	$803,673	$3,450,305	($2,822,521)
Total (70 lb Treated Pallets to C&D facility)	$1,021,661	$424,388	$2,092,236	($1,494,964)	$409,797	$172,408	$817,673	($580,284)	$1,431,458	$596,796	$2,909,910	($2,075,248)
Total (40 lb Untreated Pallets - Mulching)	$1,021,661	$459,346	$2,481,092	($1,918,777)	$409,797	$186,064	$969,213	($745,480)	$1,431,458	$645,410	$3,450,305	($2,664,257)
Total (70 lb Untreated Pallets - Mulching)	$1,021,661	$299,909	$2,092,236	($1,370,484)	$409,797	$121,838	$817,673	($529,714)	$1,431,458	$421,747	$2,909,910	($1,900,199)
Total (40 lb Pallets for Repair/Recycling)	$1,072,319	$146,545	$2,481,092	($1,555,318)	$430,317	$59,360	$969,213	($598,256)	$1,502,636	$205,905	$3,450,305	($2,153,574)

Notes:

[a] Expended Brass must be recycled through DRMO and may not be shipped off of Guam for recycling

MATERIALS RECOVERY FACILITY IN SOUTHERN GUAM													
Material	Production		Weight per bale (lbs)		No. bales per year	Weight of container	No. containers	Unit Price	Containers shipped	Annual revenue	Additional Transport Costs*	Annual Shipping Costs	Net profit (loss)
	lbs/day	lbs/yr	Min.	Max.	(Min. Wt)	lbs	per year	$/lb	per year	$/yr	$/yr	$/yr	$/yr
Cardboard	6,745.4	2,462,080.8	1,200	1,500	2,051.7	33,600	73.3	$0.065	73	$159,432		$193,764	($34,332)
Aluminum Cans	3,494.0	1,275,314.7	900	1,125	1,417.0	25,200	50.6	$0.720	50	$907,200		$231,960	$675,240
Plastic Containers	2,503.2	913,669.5	1,200	1,400	761.4	33,600	27.2	$0.060	27	$54,432		$71,666	($17,234)
Glass	7,696.9	2,809,363.8	N/A	N/A	N/A	36,000	78.0	$3.75/ton	78	$5,265		$288,765	($283,500)
Mixed Paper	11,996.5	4,378,724.3	1,000	1,690	4,378.7	28,000	156.4	$0.017	156	$74,256		$414,071	($339,815)
Expended Brass[a]	87.2	28,603.8	N/A	N/A	N/A	N/A	N/A	$1.416	N/A	N/A		N/A	N/A
Scrap Metal	9,261.1	3,380,309.4	N/A	N/A	N/A	36,000	93.9	$150/ton	93	$251,100		$224,530	$26,570
Treated Wood Pallets (40lb)	20,827.7	7,602,106.4	N/A	N/A	N/A	13,680	555.7	$0.000	555	$0	$797,178	$1,955,914	($2,753,093)
Treated Wood Pallets (70lbs)	20,827.7	7,602,106.4	N/A	N/A	N/A	18,760	405.2	$0.000	405	$0	$719,148	$1,427,289	($2,146,437)
Untreated Wood Pallets (40lb)	20,827.7	7,602,106.4	N/A	N/A	N/A	13,680	555.7	$0.000	555	$0	$797,178	$1,955,914	($2,753,093)
Untreated Wood Pallets (70lbs)	20,827.7	7,602,106.4	N/A	N/A	N/A	18,760	405.2	$0.000	405	$0	$719,148	$1,427,289	($2,146,437)
Recycling Wood Pallets (40 lbs)	20,827.7	7,602,106.4	N/A	N/A	N/A	13,680	555.7	$0.75/pallet	555	$71,179	$205,905	$1,955,914	($2,090,641)
Green Waste	23,400.7	8,541,260.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total (40 lb Treated Pallets to C&D facility)										$1,451,685	$797,178	$3,380,670	($2,726,163)
Total (70 lb Treated Pallets to C&D facility)										$1,451,685	$719,148	$2,852,044	($2,119,507)
Total (40 lb Untreated Pallets - Mulching)										$1,451,685	$797,178	$3,380,670	($2,726,163)
Total (70 lb Untreated Pallets - Mulching)										$1,451,685	$719,148	$2,852,044	($2,119,507)
Total (40 lb Pallets for Repair/Recycling)										$1,522,864	$205,905	$3,380,670	($2,063,711)

Notes:

[a] Expended Brass must be recycled through DRMO and may not be shipped off of Guam for recycling

***Additional trucking cost added for wooden pallets for mulching and C&D recycling ($520.20)**

Additional trucking cost added for wooden pallets for recycling (Riverside) ($370.96)

Shipping Costs - Wooden Pallets	20' container	40' container
West Coast - rate for wooden pallets		$3,524.17

Shipping Costs - Mixed Recyclables	20' container	40' container
Guam to Xiamen, China	$2,414.30	$2,654.30
Guam to West Coast	$3,702.11	$4,639.20

Treated Pallets sent to Construction and Demolition facility for recycling, transport costs:	$155 - dropoff/pickup	$79/ton
Untreated Pallets sent to Mulching facility, transport costs:	$175 - dropoff/pickup	$30/ton

Assumptions:

Brass density = 543 PCF
Scrap metal density (estimated) = 480 PCF
Glass density = 1000 - 2000 lbs/CY
50% of wood pallets for recycling will receive $0.75 ea.

MATERIALS RECOVERY FACILITY IN NORTHERN GUAM/BARRIGADA													
Material	**Production**		**Weight per bale (lbs)**		**No. bales per year**	**Weight of container**	**No. containers**	**Unit Price**	**Containers shipped**	**Annual revenue**	**Additional Transport Costs***	**Annual Shipping Costs**	**Net profit (loss)**
	lbs/day	**lbs/yr**	**Min.**	**Max.**	**(Min. Wt)**	**lbs**	**per year**	**$/lb**	**per year**	**$/yr**	**$/yr**	**$/yr**	**$/yr**
Cardboard	6,745.4	2,462,080.8	1,200	1,500	2,051.7	33,600	73.3	$0.065	73	$159,432		$201,794	($42,362)
Aluminum Cans	3,494.0	1,275,314.7	900	1,125	1,417.0	25,200	50.6	$0.720	50	$907,200		$237,461	$669,739
Plastic Containers	2,503.2	913,669.5	1,200	1,400	761.4	33,600	27.2	$0.060	27	$54,432		$74,636	($20,204)
Glass	7,696.9	2,809,363.8	N/A	N/A	N/A	36,000	78.0	$3.75/ton	78	$5,265		$297,345	($292,080)
Mixed Paper	11,996.5	4,378,724.3	1,000	1,690	4,378.7	28,000	156.4	$0.017	156	$74,256		$431,231	($356,975)
Expended Brass[a]	87.2	28,603.8	N/A	N/A	N/A	N/A	N/A	$1.416	N/A	N/A		N/A	N/A
Scrap Metal	9,261.1	3,380,309.4	N/A	N/A	N/A	36,000	93.9	$150/ton	93	$251,100		$234,760	$16,340
Treated Wood Pallets (40lb)	20,827.7	7,602,106.4	N/A	N/A	N/A	13,680	555.7	$0.000	555	$0	$797,178	$2,016,964	($2,814,143)
Treated Wood Pallets (70lbs)	20,827.7	7,602,106.4	N/A	N/A	N/A	18,760	405.2	$0.000	405	$0	$592,029	$1,471,839	($2,063,868)
Untreated Wood Pallets (40lb)	20,827.7	7,602,106.4	N/A	N/A	N/A	13,680	555.7	$0.000	555	$0	$640,911	$2,016,964	($2,657,875)
Untreated Wood Pallets (70lbs)	20,827.7	7,602,106.4	N/A	N/A	N/A	18,760	405.2	$0.000	405	$0	$419,081	$1,471,839	($1,890,920)
Recycling Wood Pallets (40 lbs)	20,827.7	7,602,106.4	N/A	N/A	N/A	13,680	555.7	$0.75/pallet	555	$71,179	$205,905	$2,016,964	($2,151,691)
Green Waste	23,400.7	8,541,260.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total (40 lb Treated Pallets to C&D facility)										$1,451,685	$797,178	$3,494,191	($2,839,684)
Total (70 lb Treated Pallets to C&D facility)										$1,451,685	$592,029	$2,949,065	($2,089,409)
Total (40 lb Untreated Pallets - Mulching)										$1,451,685	$640,911	$3,494,191	($2,683,416)
Total (70 lb Untreated Pallets - Mulching)										$1,451,685	$419,081	$2,949,065	($1,916,461)
Total (40 lb Pallets for Repair/Recycling)										$1,522,864	$205,905	$3,494,191	($2,177,232)

Notes:

[a] Expended Brass must be recycled through DRMO and may not be shipped off of Guam for recycling

***Additional trucking cost added for wooden pallets for mulching and C&D recycling ($520.20)**

Additional trucking cost added for wooden pallets for recycling (Riverside) ($370.96)

Shipping Costs - Wooden Pallets	**20' container**	**40' container**
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Untreated Pallets sent to Mulching facility, transport costs:	$175 - dropoff/pickup	$30/ton

Shipping Costs - Mixed Recyclables	**20' container**	**40' container**
Guam to Xiamen, China	$2,524.30	$2,764.30
Guam to West Coast	$3,812.11	$4,749.22

Assumptions:

Brass density = 543 PCF

Scrap metal density (estimated) = 480 PCF

Glass density = 1000 - 2000 lbs/CY

50% of wood pallets for recycling will receive $0.75 ea.

LOCAL RECYCLERS ON GUAM PROFITS/COSTS				
Material	**Production**		**Unit**	**Profit/(loss)**
	lbs/day	**lbs/yr**	**Price/(Cost)**	**$**
Cardboard	6,745.4	2,462,080.8	($3.50/CY)	($86,173)
Aluminum Cans	3,494.0	1,275,314.7	$0.18/lb	$229,557
Plastic Containers	2,503.2	913,669.5		N/A
Glass	7,696.9	2,809,363.8		N/A
Mixed Paper	11,996.5	4,378,724.3		N/A
Expended Brass[a]	87.2	31,832.2	$0.726/lb	N/A
Scrap Metal	9,261.1	3,380,309.4		N/A
Treated Wood Pallets (40lb)	20,827.7	7,602,106.4		N/A
Treated Wood Pallets (70lbs)	20,827.7	7,602,106.4		N/A
UntreatedWood Pallets (40lb)	20,827.7	7,602,106.4		N/A
Untreated Wood Pallets (70lbs)	20,827.7	7,602,106.4		N/A
Green Waste/Food Waste	23,400.7	8,541,260.7		N/A

Notes:

[a]Expended Brass must be recycled through DRMO and may not be shipped off of Guam for recycling

Appendix A.2

Cost Data – Source Segregation and Recycling Center

NET PRESENT VALUE SUMMARY

Alternative	Net Present Value	Description
1	$161,160,000	Two recycling centers (one in North, one in South)
2	$142,872,000	One Facility in North Only
3	$142,482,000	One Facility in South Only

Assumption: 15% of identified recyclable materials would be recovered through a source separation and curbside recycling program

PRESENT VALUE ANALYSIS

Calendar Year	ALTERNATIVE 1			ALTERNATIVE 2			ALTERNATIVE 3		
	Total Capital		**NPV**	**Total Capital**		**NPV**	**Total Capital**		**NPV**
	$80,750,555		$161,159,319	$72,395,338		$142,871,486	$72,395,338		$142,481,353
		Rounded NPV	$161,160,000		Rounded NPV	$142,872,000		Rounded NPV	$142,482,000
	Capital	**Operating**	**Total**	**Capital**	**Operating**	**Total**	**Capital**	**Operating**	**Total**
2010	33,639,997	3,816,830	37,456,826	23,224,010	3,515,425	26,739,435	23,224,010	3,500,833	26,724,843
2011		3,816,830	3,816,830		3,515,425	3,515,425		3,500,833	3,500,833
2012		3,816,830	3,816,830		3,515,425	3,515,425		3,500,833	3,500,833
2013		3,816,830	3,816,830		3,515,425	3,515,425		3,500,833	3,500,833
2014		3,816,830	3,816,830		3,515,425	3,515,425		3,500,833	3,500,833
2015		3,816,830	3,816,830		3,515,425	3,515,425		3,500,833	3,500,833
2016		3,816,830	3,816,830		3,515,425	3,515,425		3,500,833	3,500,833
2017		3,816,830	3,816,830		3,515,425	3,515,425		3,500,833	3,500,833
2018		3,816,830	3,816,830		3,515,425	3,515,425		3,500,833	3,500,833
2019		3,816,830	3,816,830		3,515,425	3,515,425		3,500,833	3,500,833
2020	10,631,182	3,888,830	14,520,012	11,719,603	3,551,425	15,271,028	11,719,603	3,536,833	15,256,436
2021		3,888,830	3,888,830		3,551,425	3,551,425		3,536,833	3,536,833
2022		3,888,830	3,888,830		3,551,425	3,551,425		3,536,833	3,536,833
2023		3,888,830	3,888,830		3,551,425	3,551,425		3,536,833	3,536,833
2024		3,888,830	3,888,830		3,551,425	3,551,425		3,536,833	3,536,833
2025	1,528,610	3,888,830	5,417,440	764,305	3,551,425	4,315,730	764,305	3,536,833	4,301,138
2026		3,888,830	3,888,830		3,551,425	3,551,425		3,536,833	3,536,833
2027		3,888,830	3,888,830		3,551,425	3,551,425		3,536,833	3,536,833
2028		3,888,830	3,888,830		3,551,425	3,551,425		3,536,833	3,536,833
2029		3,888,830	3,888,830		3,551,425	3,551,425		3,536,833	3,536,833
2030	10,631,182	3,978,830	14,610,012	11,719,603	3,596,425	15,316,028	11,719,603	3,581,833	15,301,436
2031		3,978,830	3,978,830		3,596,425	3,596,425		3,581,833	3,581,833
2032		3,978,830	3,978,830		3,596,425	3,596,425		3,581,833	3,581,833
2033		3,978,830	3,978,830		3,596,425	3,596,425		3,581,833	3,581,833
2034		3,978,830	3,978,830		3,596,425	3,596,425		3,581,833	3,581,833
2035		3,978,830	3,978,830		3,596,425	3,596,425		3,581,833	3,581,833
2036		3,978,830	3,978,830		3,596,425	3,596,425		3,581,833	3,581,833
2037		3,978,830	3,978,830		3,596,425	3,596,425		3,581,833	3,581,833
2038		3,978,830	3,978,830		3,596,425	3,596,425		3,581,833	3,581,833
2039		3,978,830	3,978,830		3,596,425	3,596,425		3,581,833	3,581,833
2040	12,159,792	4,014,830	16,174,622	12,483,908	3,614,425	16,098,333	12,483,908	3,599,833	16,083,741
2041		4,014,830	4,014,830		3,614,425	3,614,425		3,599,833	3,599,833
2042		4,014,830	4,014,830		3,614,425	3,614,425		3,599,833	3,599,833
2043		4,014,830	4,014,830		3,614,425	3,614,425		3,599,833	3,599,833
2044		4,014,830	4,014,830		3,614,425	3,614,425		3,599,833	3,599,833
2045		4,014,830	4,014,830		3,614,425	3,614,425		3,599,833	3,599,833
2046		4,014,830	4,014,830		3,614,425	3,614,425		3,599,833	3,599,833
2047		4,014,830	4,014,830		3,614,425	3,614,425		3,599,833	3,599,833
2048		4,014,830	4,014,830		3,614,425	3,614,425		3,599,833	3,599,833
2049		4,014,830	4,014,830		3,614,425	3,614,425		3,599,833	3,599,833
2050	10,631,182.09	4,014,830	14,646,012	11,719,603	3,614,425	15,334,028	11,719,603	3,599,833	15,319,436
2051		4,014,830	4,014,830		3,614,425	3,614,425		3,599,833	3,599,833
2052		4,014,830	4,014,830		3,614,425	3,614,425		3,599,833	3,599,833
2053		4,014,830	4,014,830		3,614,425	3,614,425		3,599,833	3,599,833
2054		4,014,830	4,014,830		3,614,425	3,614,425		3,599,833	3,599,833
2055	1528610.09	4,014,830	5,543,440	764,305	3,614,425	4,378,730	764,305	3,599,833	4,364,138
2056		4,014,830	4,014,830		3,614,425	3,614,425		3,599,833	3,599,833
2057		4,014,830	4,014,830		3,614,425	3,614,425		3,599,833	3,599,833
2058		4,014,830	4,014,830		3,614,425	3,614,425		3,599,833	3,599,833
2059		4,014,830	4,014,830		3,614,425	3,614,425		3,599,833	3,599,833

COST SUMMARY

Description	Cost	Remarks
Discount Factor	2.800%	
Capital Costs		
Alternative 1		
Capital Costs - 2010	$33,639,997	Initial capital cost
Capital Costs - 2020	$10,631,182	Repurchasing of trucks and recycling bins (10 year life span)
Capital Costs - 2025	$1,528,610	Repurchasing equipment in recycling facility (15 year life span)
Capital Costs - 2030	$10,631,182	Repurchasing of trucks and recycling bins (10 year life span)
Capital Costs - 2040	$12,159,792	Repurchasing of trucks and recycling bins (10 year life span), recycling equipment
Capital Costs - 2050	$10,631,182	Repurchasing of trucks and recycling bins (10 year life span)
Capital Costs - 2055	$1,528,610	Repurchasing equipment in recycling facility (15 year life span)
Alternative 2		
Capital Costs - 2010	$23,224,010	Initial capital cost
Capital Costs - 2020	$11,719,603	Repurchasing of trucks and recycling bins (10 year life span)
Capital Costs - 2025	$764,305	Repurchasing equipment in recycling facility (15 year life span)
Capital Costs - 2030	$11,719,603	Repurchasing of trucks and recycling bins (10 year life span)
Capital Costs - 2040	$12,483,908	Repurchasing of trucks and recycling bins (10 year life span), recycling equipment
Capital Costs - 2050	$11,719,603	Repurchasing of trucks and recycling bins (10 year life span)
Capital Costs - 2055	$764,305	Repurchasing equipment in recycling facility (15 year life span)
Alternative 3		
Capital Costs - 2010	$23,224,010	Initial capital cost
Capital Costs - 2020	$11,719,603	Repurchasing of trucks and recycling bins (10 year life span)
Capital Costs - 2025	$764,305	Repurchasing equipment in recycling facility (15 year life span)
Capital Costs - 2030	$11,719,603	Repurchasing of trucks and recycling bins (10 year life span)
Capital Costs - 2040	$12,483,908	Repurchasing of trucks and recycling bins (10 year life span), recycling equipment
Capital Costs - 2050	$11,719,603	Repurchasing of trucks and recycling bins (10 year life span)
Capital Costs - 2055	$764,305	Repurchasing equipment in recycling facility (15 year life span)
Annual Operating Costs		
Alternative 1		
Operating Costs 2010 to 2019	$3,816,830	
Operating Costs 2020 to 2029	$3,888,830	
Operating Costs 2030 to 2039	$3,978,830	
Operating Costs 2040 to 2060	$4,014,830	
Alternative 2		
Operating Costs 2010 to 2019	$3,515,425	
Operating Costs 2020 to 2029	$3,551,425	
Operating Costs 2030 to 2039	$3,596,425	
Operating Costs 2040 to 2060	$3,614,425	
Alternative 3		
Operating Costs 2010 to 2019	$3,500,833	
Operating Costs 2020 to 2029	$3,536,833	
Operating Costs 2030 to 2039	$3,581,833	
Operating Costs 2040 to 2060	$3,599,833	

OPERATION AND MAINTENANCE COSTS

Item	Quantity	Hours/Day	Wage $/hour	Equipment $/hour	Daily Cost $	Annual Cost $
Alternative 1						
BUILDING MAINTENANCE						
Recycling Facility Maintenance 2010 to 2019	2					$180,000.00
Recycling Facility Maintenance 2020 to 2029	2					$252,000.00
Recycling Facility Maintenance 2030 to 2039	2					$342,000.00
Recycling Facility Maintenance 2040 to 2060	2					$378,000.00
Total Building Maintenance Cost 2010 - 2019						**$180,000.00**
Total Building Maintenance Cost 2020 - 2029						**$252,000.00**
Total Building Maintenance Cost 2030 - 2039						**$342,000.00**
Total Building Maintenance Cost 2040 - 2060						**$378,000.00**
MR & GW TRUCK O&M						
Automated Side Loading Collection Truck Operation	6	6		$25.55	$919.80	$239,148.00
Automated Side Loading Collection Truck Maintenance	6					$326,526.32
Automated Front Loading Collection Truck Operation	8	6		$25.55	$1,226.40	$318,864.00
Automated Front Loading Collection Truck Maintenance	8					$435,368.42
Transport Costs for Shipping Containers to/from Port						$28,056.00
Total O & M Cost						**$1,347,962.74**
PERSONNEL						
Supervisor	2	8	$52.71		$843.36	$219,273.60
Drivers/Operators for Collection Trucks	14	8	$39.51		$4,425.52	$1,150,636.03
Buyback Operator	2	8	$35.46		$567.30	$147,498.62
Rolling Stock Operators	4	8	$39.54		$1,265.24	$328,962.82
General laborers/spotters/floor sort	4	8	$35.46		$1,134.60	$294,997.25
Curbside Recyclables Transf labor	2	8	$35.46		$567.30	$147,498.62
Total Personnel Cost						**$2,288,866.94**
Alternative 1 Total Operating Cost	**2010 to 2019**					**$3,816,829.68**
Alternative 1 Total Operating Cost	**2020 to 2029**					**$3,888,829.68**
Alternative 1 Total Operating Cost	**2030 to 2039**					**$3,978,829.68**
Alternative 1 Total Operating Cost	**2040 to 2060**					**$4,014,829.68**

OPERATION AND MAINTENANCE COSTS

Item	Quantity	Hours/Day	Wage $/hour	Equipment $/hour	Daily Cost $	Annual Cost $
Alternative 2						
BUILDING MAINTENANCE						
Recycling Facility Maintenance 2010 to 2019	1					$90,000.00
Recycling Facility Maintenance 2020 to 2029	1					$126,000.00
Recycling Facility Maintenance 2030 to 2039	1					$171,000.00
Recycling Facility Maintenance 2040 to 2060	1					$189,000.00
Total Building Maintenance Cost 2010 - 2019						**$90,000.00**
Total Building Maintenance Cost 2020 - 2029						**$126,000.00**
Total Building Maintenance Cost 2030 - 2039						**$171,000.00**
Total Building Maintenance Cost 2040 - 2060						**$189,000.00**
MR & GW TRUCK O&M						
Automated Side Loading Collection Truck Operation	7	6		$25.55	$1,073.10	$279,006.00
Automated Side Loading Collection Truck Maintenance	7					$380,947.37
Automated Front Loading Collection Truck Operation	9	6		$25.55	$1,379.70	$358,722.00
Automated Front Loading Collection Truck Maintenance	9					$489,789.47
Transport Costs for Shipping Containers to/from Port						$32,832.00
Total O & M Cost						**$1,541,296.84**
PERSONNEL						
Supervisor	1	8	$52.71		$421.68	$109,636.80
Drivers/Operators for Collection Trucks	16	8	$39.51		$5,057.74	$1,315,012.61
Buyback Operator	1	8	$35.46		$283.65	$73,749.31
Rolling Stock Operators	2	8	$39.54		$632.62	$164,481.41
General laborers/spotters/floor sort	2	8	$35.46		$567.30	$147,498.62
Curbside Recyclables Transf labor	1	8	$35.46		$283.65	$73,749.31
Total Personnel Cost						**$1,884,128.06**
Alternative 2 Total Operating Cost	**2010 to 2019**					**$3,515,424.91**
Alternative 2 Total Operating Cost	**2020 to 2029**					**$3,551,424.91**
Alternative 2 Total Operating Cost	**2030 to 2039**					**$3,596,424.91**
Alternative 2 Total Operating Cost	**2040 to 2060**					**$3,614,424.91**

OPERATION AND MAINTENANCE COSTS

Item	Quantity	Hours/Day	Wage $/hour	Equipment $/hour	Daily Cost $	Annual Cost $
Alternative 3						
<u>BUILDING MAINTENANCE</u>						
Recycling Facility Maintenance 2010 to 2019	1					$90,000.00
Recycling Facility Maintenance 2020 to 2029	1					$126,000.00
Recycling Facility Maintenance 2030 to 2039	1					$171,000.00
Recycling Facility Maintenance 2040 to 2060	1					$189,000.00
Total Building Maintenance Cost 2010 - 2019						**$90,000.00**
Total Building Maintenance Cost 2020 - 2029						**$126,000.00**
Total Building Maintenance Cost 2030 - 2039						**$171,000.00**
Total Building Maintenance Cost 2040 - 2060						**$189,000.00**
<u>MR & GW TRUCK O&M</u>						
Automated Side Loading Collection Truck Operation	7	6		$25.55	$1,073.10	$279,006.00
Automated Side Loading Collection Truck Maintenance	7					$380,947.37
Automated Front Loading Collection Truck Operation	9	6		$25.55	$1,379.70	$358,722.00
Automated Front Loading Collection Truck Maintenance	9					$489,789.47
Transport Costs for Shipping Containers to/from Port						$18,240.00
Total O & M Cost						**$1,526,704.84**
<u>PERSONNEL</u>						
Supervisor	1	8	$52.71		$421.68	$109,636.80
Drivers/Operators for Collection Trucks	16	8	$39.51		$5,057.74	$1,315,012.61
Buyback Operator	1	8	$35.46		$283.65	$73,749.31
Rolling Stock Operators	2	8	$39.54		$632.62	$164,481.41
General laborers/spotters/floor sort	2	8	$35.46		$567.30	$147,498.62
Curbside Recyclables Transf labor	1	8	$35.46		$283.65	$73,749.31
Total Personnel Cost						**$1,884,128.06**
Alternative 3 Total Operating Cost	**2010 to 2019**					**$3,500,832.91**
Alternative 3 Total Operating Cost	**2020 to 2029**					**$3,536,832.91**
Alternative 3 Total Operating Cost	**2030 to 2039**					**$3,581,832.91**
Alternative 3 Total Operating Cost	**2040 to 2060**					**$3,599,832.91**

CAPITAL COST

Item	Unit Cost	Quantity	Total Cost
Alternative 1			
Recycling Center	$9,000,000.00	2	$18,000,000.00
Administrative Office	$435,000.00	2	$870,000.00
Asphalt Roadway	$39,000.00	2	$78,000.00
Baler w/ Infeed	$302,950.82	2	$605,901.64
Glass Crusher - 1 ton/hr	$158,403.41	2	$316,806.81
Wood Chipper	$242,360.66	2	$484,721.31
Bins	$15,147.54	8	$121,180.33
Side Loading Collection Truck (40cy)	$544,210.53	6	$3,265,263.16
Front Loading Collection Truck (40cy)	$544,210.53	8	$4,353,684.21
Truck Scales	$108,196.72	2	$216,393.44
Truck Scale Installation	$16,800.00	2	$33,600.00
Scalehouse Equipment	$32,459.02	2	$64,918.03
Scalehouse Equipment Installation	$5,040.00	2	$10,080.00
Front End Loader	$540,984	2	$1,081,967.21
Front End Loader (used-backup)	$216,393	2	$432,786.89
Forklift	$108,197	2	$216,393.44
Bobcat	$64,918	2	$129,836.07
Utility pick-up truck	$64,918	2	$129,836.07
Mini-Sweeper	$108,197	2	$216,393.44
92 Gallon Roll Out Bins	$129.36	14427	$1,866,276.72
3 Cubic Yard Front Loaded Bins	$2,362.80	485	$1,145,958.00
Total Capital Costs			**$33,639,996.77**

Assumptions:

(a) Guam DOD area cost factor of 2.64 used.

(b) Bins Life Span - 10 years

(c) Truck Life Span- 10 years

CAPITAL COST

Item	Unit Cost	Quantity	Total Cost
Alternative 2			
Recycling Center	$9,000,000.00	1	$9,000,000.00
Administrative Office	$435,000.00	1	$435,000.00
Asphalt Roadway	$39,000.00	1	$39,000.00
Baler w/ Infeed	$302,950.82	1	$302,950.82
Glass Crusher - 1 ton/hr	$158,403.41	1	$158,403.41
Wood Chipper	$242,360.66	1	$242,360.66
Bins	$15,147.54	4	$60,590.16
Side Loading Collection Truck (40cy)	$544,210.53	7	$3,809,473.68
Front Loading Collection Truck (40cy)	$544,210.53	9	$4,897,894.74
Truck Scales	$108,196.72	1	$108,196.72
Truck Scale Installation	$16,800.00	1	$16,800.00
Scalehouse Equipment	$32,459.02	1	$32,459.02
Scalehouse Equipment Installation	$5,040.00	1	$5,040.00
Front End Loader	$540,984	1	$540,983.61
Front End Loader (used-backup)	$216,393	1	$216,393.44
Forklift	$108,197	1	$108,196.72
Bobcat	$64,918	1	$64,918.03
Utility pick-up truck	$64,918	1	$64,918.03
Mini-Sweeper	$108,197	1	$108,196.72
92 Gallon Roll Out Bins	$129.36	14427	$1,866,276.72
3 Cubic Yard Front Loaded Bins	$2,362.80	485	$1,145,958.00
Total Capital Costs			**$23,224,010.48**

Assumptions:

(a) Guam DOD area cost factor of 2.64 used.
(b) Bins Life Span - 10 years
(c) Truck Life Span- 10 years

CAPITAL COST

Item	Unit Cost	Quantity	Total Cost
Alternative 3			
Recycling Center	$9,000,000.00	1	$9,000,000.00
Administrative Office	$435,000.00	1	$435,000.00
Asphalt Roadway	$39,000.00	1	$39,000.00
Baler w/ Infeed	$302,950.82	1	$302,950.82
Glass Crusher - 1 ton/hr	$158,403.41	1	$158,403.41
Wood Chipper	$242,360.66	1	$242,360.66
Bins	$15,147.54	4	$60,590.16
Side Loading Collection Truck (40cy)	$544,210.53	7	$3,809,473.68
Front Loading Collection Truck (40cy)	$544,210.53	9	$4,897,894.74
Truck Scales	$108,196.72	1	$108,196.72
Truck Scale Installation	$16,800.00	1	$16,800.00
Scalehouse Equipment	$32,459.02	1	$32,459.02
Scalehouse Equipment Installation	$5,040.00	1	$5,040.00
Front End Loader	$540,984	1	$540,983.61
Front End Loader (used-backup)	$216,393	1	$216,393.44
Forklift	$108,197	1	$108,196.72
Bobcat	$64,918	1	$64,918.03
Utility pick-up truck	$64,918	1	$64,918.03
Mini-Sweeper	$108,197	1	$108,196.72
92 Gallon Roll Out Bins	$129.36	14427	$1,866,276.72
3 Cubic Yard Front Loaded Bins	$2,362.80	485	$1,145,958.00
Total Capital Costs			**$23,224,010.48**

Assumptions:

(a) Guam DOD area cost factor of 2.64 used.

(b) Bins Life Span - 10 years

(c) Truck Life Span- 10 years

ALTERNATIVE 1

NORTHERN RECYCLABLES TRANSPORTED TO PORT

Material	Production		Weight per bale (lbs)		No. bales per year	Weight of container	Containers shipped
	lbs/day	lbs/yr	Min.	Max.	(Min. Wt)	lbs	per year
Cardboard	719.3	262,559.9	1,200	1,500	218.8	33,600	7
Aluminum Cans	372.6	136,001.4	900	1,125	151.1	25,200	5
Plastic Containers	266.9	97,435.1	1,200	1,400	81.2	33,600	2
Glass	820.8	299,594.7	N/A	N/A	N/A	36,000	8
Mixed Paper	1,279.3	466,953.6	1,000	1,690	467.0	28,000	16
Expended Brass[a]	0.0	28,603.8	N/A	N/A	N/A	N/A	N/A
Scrap Metal	983.8	359,101.6	N/A	N/A	N/A	36,000	9
Wood Pallets (40lb)	2,221.1	810,699.9	N/A	N/A	N/A	13,680	59
Compostable Material	2,495.5	910,852.6	N/A	N/A	N/A	N/A	N/A
Total Containers Shipped Per Year							106

Notes:

[a] Expended Brass must be recycled through DRMO and may not be shipped off of Guam for recycling
Compostable Material will not be shipped

Assumptions:

Brass density = 543 PCF
Scrap metal density (estimated) = 480 PCF
Glass density = 1000 - 2000 lbs/CY

Number of containers shipped per year		106	containers
Transport Costs (From NCTS Finegayan)	$108 each way	$216	round trip
Total transport cost for recyclables to port		$22,896	total annual cost

SOUTHERN RECYCLABLES TRANSPORTED TO PORT

Material	Production		Weight per bale (lbs)		No. bales per year	Weight of container	Containers shipped
	lbs/day	lbs/yr	Min.	Max.	(Min. Wt)	lbs	per year
Cardboard	292.5	106,752.1	1,200	1,500	89.0	33,600	3
Aluminum Cans	151.5	55,295.7	900	1,125	61.4	25,200	2
Plastic Containers	108.5	39,615.3	1,200	1,400	33.0	33,600	1
Glass	333.7	121,809.8	N/A	N/A	N/A	36,000	3
Mixed Paper	520.2	189,854.9	1,000	1,690	189.9	28,000	6
Expended Brass[a]	0.0	0.0	N/A	N/A	N/A	N/A	N/A
Scrap Metal	405.3	147,945.3	N/A	N/A	N/A	36,000	4
Wood Pallets (40lb)	903.1	329,615.9	N/A	N/A	N/A	13,680	24
Compostable Material	1,014.6	370,336.2	N/A	N/A	N/A	N/A	N/A
Total Containers Shipped Per Year							43

Notes:

[a] Expended Brass must be recycled through DRMO and may not be shipped off of Guam for recycling
Compostable Material will not be shipped

Assumptions:

Brass density = 543 PCF
Scrap metal density (estimated) = 480 PCF
Glass density = 1000 - 2000 lbs/CY
All brass is generated in Northern Guam

Number of containers shipped per year		43	containers
Transport Costs (From Naval Base)	$60 each way	$120	round trip
Total transport cost for recyclables to port		$5,160	total annual cost
Total containers shipped per year		149	containers
Container transport cost per year		**$28,056**	

ALTERNATIVE 2

RECYCLABLES TRANSPORTED TO PORT FROM NORTHERN GUAM

Material	Production		Weight per bale (lbs)		No. bales per year	Weight of container	Containers shipped
	lbs/day	lbs/yr	Min.	Max.	(Min. Wt)	lbs	per year
Cardboard	1,011.8	369,312.1	1,200	1,500	307.8	33,600	10
Aluminum Cans	524.1	191,297.2	900	1,125	212.6	25,200	7
Plastic Containers	375.5	137,050.4	1,200	1,400	114.2	33,600	4
Glass	1,154.5	421,404.6	N/A	N/A	N/A	36,000	11
Mixed Paper	1,799.5	656,808.6	1,000	1,690	656.8	28,000	23
Expended Brass[a]	0.0	0.0	N/A	N/A	N/A	N/A	N/A
Scrap Metal	1,389.2	507,047.0	N/A	N/A	N/A	36,000	14
Wood Pallets (40lb)	3,124.2	1,140,316.0	N/A	N/A	N/A	13,680	83
Compostable Material	3,510.1	1,281,189.1	N/A	N/A	N/A	N/A	N/A
Total Containers Shipped Per Year							152

Notes:

[a] Expended Brass must be recycled through DRMO and may not be shipped off of Guam for recycling

Compostable Material will not be shipped

Assumptions:

Brass density = 543 PCF
Scrap metal density (estimated) = 480 PCF
Glass density = 1000 - 2000 lbs/CY
All brass is generated in Northern Guam

Number of containers shipped per year		152	containers
Transport Costs (From NCTS Finegayan)	$108 each way	$216	round trip
Total transport cost for recyclables to port		**$32,832**	total annual cost

ALTERNATIVE 3

RECYCLABLES TRANSPORTED TO PORT FROM SOUTHERN GUAM

Material	Production		Weight per bale (lbs)		No. bales per year	Weight of container	Containers shipped
	lbs/day	lbs/yr	Min.	Max.	(Min. Wt)	lbs	per year
Cardboard	1,011.8	369,312.1	1,200	1,500	307.8	33,600	10
Aluminum Cans	524.1	191,297.2	900	1,125	212.6	25,200	7
Plastic Containers	375.5	137,050.4	1,200	1,400	114.2	33,600	4
Glass	1,154.5	421,404.6	N/A	N/A	N/A	36,000	11
Mixed Paper	1,799.5	656,808.6	1,000	1,690	656.8	28,000	23
Expended Brass[a]	0.0	0.0	N/A	N/A	N/A	N/A	N/A
Scrap Metal	1,389.2	507,047.0	N/A	N/A	N/A	36,000	14
Wood Pallets (40lb)	3,124.2	1,140,316.0	N/A	N/A	N/A	13,680	83
Compostable Material	3,510.1	1,281,189.1	N/A	N/A	N/A	N/A	N/A
Total Containers Shipped Per Year							152

Notes:

[a] Expended Brass must be recycled through DRMO and may not be shipped off of Guam for recycling

Compostable Material will not be shipped

Assumptions:

Brass density = 543 PCF
Scrap metal density (estimated) = 480 PCF
Glass density = 1000 - 2000 lbs/CY
All brass is generated in Northern Guam

Number of containers shipped per year		152	containers
Transport Costs (From Naval Base)	$60 each way	$120	round trip
Total transport cost for recyclables to port		**$18,240**	total annual cost

100% Relative Efficiency Bin Collection

The condition of 100% efficiency occurs when recycling centers are located in both northern (NCTS) and southern (Apra Harbor) Guam.

	Automated Side-Loading Trucks Needed	Automated Front-Loading Trucks Needed	Efficiency Relative to Existing
Total	6	8	100%
Northern Guam	4	4	100%
Southern Guam	2	4	100%

Alternatives For Solid Waste Collection

Mixed recyclables and green waste will be collected on a bi-weekly basis in residential communities and on a weekly basis in commercial sectors. 92 gallon side-loaded bins and 3-cy front loaded bins will be distributed just as the refuse bins are for these areas. The transportation and processing of these recyclables will fall into one of three alternatives:

Alternative 1

Alternative 1 - Two recycling centers are constructed, one in northern and one in the southern Guam.

Northern Guam Increased Operations %	0%
Southern Guam Increased Operations %	0%

	Automated Side-Loading Trucks Needed	Automated Front-Loading
Total	6	8
Northern Guam	4	4
Southern Guam	2	4

Alternative 2

Alternative 2 - One recycling center is constructed in the southern Guam. All northern Guam recyclables are directly delivered to southern Guam recycling center.

Northern Guam Increased Operations %	19%
Southern Guam Increased Operations %	0%

	Automated Side-Loading Trucks Needed	Automated Front-Loading
Total	7	9
Northern Guam	5	5
Southern Guam	2	4

Alternative 3

Alternative 3 - One recycling center is constructed in northern Guam. All southern Guam recyclables are directly delivered to the northern Guam recycling center.

Northern Guam Increased Operations %	0%
Southern Guam Increased Operations %	19%

	Automated Side-Loading Trucks Needed	Automated Front-Loading
Total	7	9
Northern Guam	4	4
Southern Guam	3	5

Existing Bin Collection (92-Gallon)

Currently bins are being collected twice a week for recyclables.

Existing Automated Side-Loading Trucks in Operation	2
Frequency of Bin Collection	2
Existing Number of Collected 92-gal Bins	1,624
Existing Number of Pick Ups for Collected 92-gal Bins	3,248
92-gal Bin Collection Capacity Per Truck	1,624

Projected Bin Collection

If northern and southern Guam recycling centers are provided, then the projected collection capacity will remain the same as the existing condition.

Mixed Recyclables

Northern Guam Automated Side-Loading Trucks Required

Projected Number of 92-gal Bins	4,014
Frequency of Bin Collection	0.5
92-gal Bin Collection Capacity Per Truck	1,624
Number of Automated Side-Loading Trucks Required	**2**

Southern Guam Automated Side-Loading Trucks Required

Projected Number of 92-gal Bins	3,199
Frequency of Bin Collection	0.5
92-gal Bin Collection Capacity Per Truck	1,624
Number of Automated Side-Loading Trucks Required	**1**

Green Waste

Northern Guam Automated Side-Loading Trucks Required

Projected Number of 92-gal Bins	4,014
Frequency of Bin Collection	0.5
92-gal Bin Collection Capacity Per Truck	1,624
Number of Automated Side-Loading Trucks Required	**2**

Southern Guam Automated Side-Loading Trucks Required

Projected Number of 92-gal Bins	3,199
Frequency of Bin Collection	0.5
92-gal Bin Collection Capacity Per Truck	1,624
Number of Automated Side-Loading Trucks Required	**1**

Total Number of Trucks Required in Northern Guam	**4**
Total Number of Trucks Required in Southern Guam	**2**

Existing Bin Collection (3, 6, 8 CY)

Recycling bins are assumed to be collected in the same manner as refuse bins. Refuse bins are collected primarily in the southern Guam region on a weekly basis.

Existing Automated Front-Loading Trucks in Operation	2
Existing Number of Collected 3, 6 & 8 cy Bins	121
3, 6 & 8 cy Bin Collection Capacity Per Truck	60.5

Projected Bin Collection

If a northern and southern Guam recycling centers are provided, then the projected collection rate will remain the same as the existing condition. The recyclables will be transported to the recycling centers in northern and/or southern Guam.

Northern Guam Automated Front-Loading Trucks Required

Projected Number of 3, 6 & 8 cy Bins	221
6 cy Bin Collection Capacity Per Truck	60.5
Number of Automated Front-Loading Trucks Required	**4**

Southern Guam Automated Front-Loading Trucks Required

Projected Number of 3, 6 & 8 cy Bins	183
6 cy Bin Collection Capacity Per Truck	60.5
Number of Automated Front-Loading Trucks Required	**4**

Alternative 1 Bin Collection

Northern Guam and southern Guam bins will be delivered to the nearby recycling centers at NCTS and Apra Harbor.
The efficiency of bin collection will not be affected.

Mixed Recyclable and Green Waste Transport - Between northern and southern Guam

Location	Travel Distance NCTS (km)	Travel Distance NCTS (mi)	Travel Time NCTS (min)	Travel Distance Apra Harbor (km)	Travel Distance Apra Harbor (mi)	Travel Time Apra Harbor (min)
NCTS	0.0	0.0	0	31.5	19.5	39
Apra Harbor Naval Base	31.5	19.5	39	0.0	0.0	0

(a) Estimated vehicular speed of 30 miles per hour

Northern Guam Bin Collection

Additional Travel Time (min)	0
Additional Travel Time (hrs)	0.00
Existing Route Time (hrs)	8
New Route Time (hrs)	8.00
Efficiency (%)	100%
Increased operation to meet 100% efficiency condition (%)	**0%**

Southern Guam Bin Collection

Additional Travel Time (min)	0
Additional Travel Time (hrs)	0.00
Existing Route Time (hrs)	8
New Route Time (hrs)	8.00
Efficiency (%)	100%
Increased operation to meet 100% efficiency condition (%)	**0%**

Alternative 2 Bin Collection

Northern Guam and southern Guam bins will be taken to the recycling center at Apra Harbor Naval Base. The efficiency of bin collection decreases and more trucks will be required to make up the difference. The decrease in efficiency is from the time lost for northern trucks driving to and from the Apra Harbor Recycling Center.

Mixed Recyclable and Green Waste Transport - Between northern and southern Guam

Location	Travel Distance NCTS (km)	Travel Distance NCTS (mi)	Travel Time NCTS (min)	Travel Distance Apra Harbor (km)	Travel Distance Apra Harbor (mi)	Travel Time Apra Harbor (min)
NCTS	0.0	0.0	0	31.5	19.5	39
Apra Harbor Naval Base	31.5	19.5	39	0.0	0.0	0

(a) Estimated vehicular speed of 30 miles per hour

Northern Guam Bin Collection

Increase in Travel Time per Trip (min)	78
Increase in Travel Time per Trip (hrs)	1.30
Existing Collection Hours per Day (hrs)	8
New Collection Hours per Day (hrs)[a]	6.70
Efficiency (%)	84%
Increased operation to meet 100% efficiency condition (%)	**19%**

Southern Guam Bin Collection

Increase in Travel Time per Trip (min)	0
Increase in Travel Time per Trip (hrs)	0.00
Existing Collection Hours per Day (hrs)	8
New Collection Hours per Day (hrs)[a]	8.00
Efficiency (%)	100%
Increased operation to meet 100% efficiency condition (%)	**0%**

(a) The existing number of collection hours per day is decreased by the additional travel and processing time associated with driving to the recycling center in the south. This decrease in efficiency requires an increase in the number of trucks in operation to make up the difference.

Alternative 3 Bin Collection

Northern Guam and southern Guam bins will be taken to the recycling center at NCTS Recycling Center. The efficiency of bin collection decreases and more trucks will be required to make up the difference. The decrease in efficiency is from the time lost for southern trucks driving to and from the NCTS Recycling Center.

Mixed Recyclable and Green Waste Transport - Between northern and southern Guam

Location	Travel Distance NCTS (km)	Travel Distance NCTS (mi)	Travel Distance NCTS (min)	Travel Distance Apra Harbor (km)	Travel Distance Apra Harbor (mi)	Travel Distance Apra Harbor (min)
NCTS	0.0	0.0	0	31.5	19.5	39
Apra Harbor Naval Base	31.5	19.5	39	0.0	0.0	0

(a) Estimated vehicular speed of 30 miles per hour

Northern Guam Bin Collection

Additional Travel Time (min)	0
Additional Travel Time (hrs)	0.00
Existing Route Time (hrs)	8
New Route Time (hrs)	8.00
Efficiency (%)	100%
Increased operation to meet 100% efficiency condition (%)	**0%**

Southern Guam Bin Collection

Additional Travel Time (min)	78
Additional Travel Time (hrs)	1.30
Existing Route Time (hrs)	8
New Route Time (hrs)	6.70
Efficiency (%)	84%
Increased operation to meet 100% efficiency condition (%)	**19%**

(a) The existing number of collection hours per day is decreased by the additional travel and processing time associated with driving to the recycling center in the north. This decrease in efficiency requires an increase in the number of trucks in operation to make up the difference.

Mixed Recyclable and Green Waste Collection Distribution

	Accompanied Personnel	Population (Total)	Curb Side[b] Bins	Front Loaded Bins	DINO Bins
Total[a]	8,438	38,749	14,426	404	58
Northern Guam[a]	4,014	21,217	8,028	221	0
Andersen Air Force Base	1,225	7,205	2,450	75	0
Southern Guam	3,199	17,532	6,398	183	58

(a) Does not include Andersen Air Force Base, whose source segregated recycling will be handled separately.

(b) Curb side bin number accounts for mixed recyclables bins and green waste bins.

Assumptions:

The number of 2006 unaccompanied military personnel is about 1,624. They occupy residential housing. Each accompanied military personnel is assumed to have a family that will be living in residential housing and will require two 92-gallon bins (one for mixed recyclables and one for green waste). The number of 2006 military population is about 11,613. They produce the commercial waste. An increase in military population is assumed to proportionally increase the number of front loaded bins required. Andersen Air Force Base currently has an operational recycling center. This recycling center will continue to service the base, so the source segregated recyclables from Andersen Air Force Base is not included in this study.

Upscaling Number of Bins Required For Projected Population

2006 Guam Military Population	11,613
2006 number of front loader bins	121
Number of people per bin	95.98
Projected Guam Military Population	38,749
Number of front loader bins needed	**404**

Breakdown of Bin Location

North Population	21,217
North Population %	54.80%
North Bins	**221**
South Population	17,532
South Population %	45.20%
South Bins	**183**

Appendix A.3

Cost Data – Status Quo Disposal Cost

Status Quo - No Diversion

MATERIAL	DISPOSAL METHOD	DAILY GENERATION	UNITS	ANNUAL GENERATION	UNITS	DISPOSAL UNIT COST	UNITS	ANNUAL DISPOSAL COST
Aluminum Cans	Landfill	3,494	lbs/day	637.7	tons/yr	156.00	$/ton	$99,475
Glass (Brown)	Landfill	2,961	lbs/day	540.5	tons/yr	156.00	$/ton	$84,313
Glass (Clear)	Landfill	4,017	lbs/day	733.1	tons/yr	156.00	$/ton	$114,366
Glass (Green)	Landfill	718	lbs/day	131.1	tons/yr	156.00	$/ton	$20,451
Ferrous Metals	Landfill	6,768	lbs/day	1,235.1	tons/yr	156.00	$/ton	$192,682
Non-Ferrous Metals	Landfill	2,580	lbs/day	470.9	tons/yr	156.00	$/ton	$73,465
Newspaper	Landfill	1,892	lbs/day	345.3	tons/yr	156.00	$/ton	$53,864
Mixed Paper	Landfill	6,149	lbs/day	1,122.1	tons/yr	156.00	$/ton	$175,053
Office Paper	Landfill	3,956	lbs/day	721.9	tons/yr	156.00	$/ton	$112,623
Cardboard	Other*	6,745	lbs/day	24,620.8	CY/yr	3.00	$/CY	$73,862
Plastics	Landfill	2,503	lbs/day	456.8	tons/yr	156.00	$/ton	$71,266
Compostable Material**	-	23,401	lbs/day	4,270.6	tons/yr	-	N/A	-
Green Waste	Hardfill	7,020	lbs/day	7,321.1	CY/yr	5.00	$/CY	$36,605
Food Waste	Landfill	16,380	lbs/day	2,989.4	tons/yr	156.00	$/ton	$466,353
Wood Pallets	Hardfill	20,828	lbs/day	46,073.4	CY/yr	5.00	$/CY	$230,367
Miscellaneous Wastes	Landfill	98,303	lbs/day	17,940.3	tons/yr	156.00	$/ton	$2,798,688
Total								**$4,603,434**

Notes:

*Cardboard would not be accepted for disposal in the landfill or hardfill and would be taken to cardboard recyclers

**Assumption: Green Waste accounts for 30 percent of compostable material; Food Waste accounts for 70 percent

Conversions

Material	Weight (lbs)	Units
Green Waste	350	CY
Wood Pallets	165	CY
Cardboard	100	CY

Appendix A.4

Cost Data – Viable Alternatives – Life Cycle Analysis

NET PRESENT VALUE SUMMARY

Alternative	Life Cycle Years	Net Present Value	Description
1	50	$457,480,000	MRRF in northern Guam and southern Guam
2	50	$416,967,000	MRRF in southern Guam
3	50	$419,002,000	MRRF in northern Guam
4	50	$477,787,000	MRRF in Barrigada, Guam

PRESENT VALUE ANALYSIS

Calendar Year	ALTERNATIVE 1			ALTERNATIVE 2			ALTERNATIVE 3			ALTERNATIVE 4		
	Total Capital		NPV	Total Capital		NPV	Total Capital		NPV	Total Capital		NPV
	$107,138,005		$457,480,036	$93,489,751		$416,966,842	$93,489,751		$419,002,440	$92,501,208		$477,787,186
		Rounded NPV	$457,480,000		Rounded NPV	$416,967,000		Rounded NPV	$419,002,000		Rounded NPV	$477,787,000
	Capital	Operating	Total	Capital	Operating	Total	Capital	Operating	Total	Capital	Operating	Total
2010	85,185,408	12,040,164	97,225,572	71,147,646	11,079,408	82,227,054	71,147,646	11,155,544	82,303,190	69,521,324	13,388,785	82,910,108
2011		12,040,164	12,040,164		11,079,408	11,079,408		11,155,544	11,155,544		13,388,785	13,388,785
2012		12,040,164	12,040,164		11,079,408	11,079,408		11,155,544	11,155,544		13,388,785	13,388,785
2013		12,040,164	12,040,164		11,079,408	11,079,408		11,155,544	11,155,544		13,388,785	13,388,785
2014		12,040,164	12,040,164		11,079,408	11,079,408		11,155,544	11,155,544		13,388,785	13,388,785
2015	324,991	12,040,164	12,365,155	324,991	11,079,408	11,404,399	324,991	11,155,544	11,480,536	162,496	13,388,785	13,551,280
2016		12,040,164	12,040,164		11,079,408	11,079,408		11,155,544	11,155,544		13,388,785	13,388,785
2017		12,040,164	12,040,164		11,079,408	11,079,408		11,155,544	11,155,544		13,388,785	13,388,785
2018		12,040,164	12,040,164		11,079,408	11,079,408		11,155,544	11,155,544		13,388,785	13,388,785
2019		12,040,164	12,040,164		11,079,408	11,079,408		11,155,544	11,155,544		13,388,785	13,388,785
2020	21,627,606	12,260,164	33,887,770	22,017,114	11,244,608	33,261,722	22,017,114	11,320,744	33,337,858	22,817,389	13,534,785	36,352,174
2021		12,260,164	12,260,164		11,244,608	11,244,608		11,320,744	11,320,744		13,534,785	13,534,785
2022		12,260,164	12,260,164		11,244,608	11,244,608		11,320,744	11,320,744		13,534,785	13,534,785
2023		12,260,164	12,260,164		11,244,608	11,244,608		11,320,744	11,320,744		13,534,785	13,534,785
2024		12,260,164	12,260,164		11,244,608	11,244,608		11,320,744	11,320,744		13,534,785	13,534,785
2025		12,260,164	12,260,164		11,244,608	11,244,608		11,320,744	11,320,744		13,534,785	13,534,785
2026		12,260,164	12,260,164		11,244,608	11,244,608		11,320,744	11,320,744		13,534,785	13,534,785
2027		12,260,164	12,260,164		11,244,608	11,244,608		11,320,744	11,320,744		13,534,785	13,534,785
2028		12,260,164	12,260,164		11,244,608	11,244,608		11,320,744	11,320,744		13,534,785	13,534,785
2029		12,260,164	12,260,164		11,244,608	11,244,608		11,320,744	11,320,744		13,534,785	13,534,785
2030	21,952,597	12,535,164	34,487,761	22,342,106	11,451,108	33,793,213	22,342,106	11,527,244	33,869,350	22,979,885	13,717,285	36,697,169
2031		12,535,164	12,535,164		11,451,108	11,451,108		11,527,244	11,527,244		13,717,285	13,717,285
2032		12,535,164	12,535,164		11,451,108	11,451,108		11,527,244	11,527,244		13,717,285	13,717,285
2033		12,535,164	12,535,164		11,451,108	11,451,108		11,527,244	11,527,244		13,717,285	13,717,285
2034		12,535,164	12,535,164		11,451,108	11,451,108		11,527,244	11,527,244		13,717,285	13,717,285
2035		12,535,164	12,535,164		11,451,108	11,451,108		11,527,244	11,527,244		13,717,285	13,717,285
2036		12,535,164	12,535,164		11,451,108	11,451,108		11,527,244	11,527,244		13,717,285	13,717,285
2037		12,535,164	12,535,164		11,451,108	11,451,108		11,527,244	11,527,244		13,717,285	13,717,285
2038		12,535,164	12,535,164		11,451,108	11,451,108		11,527,244	11,527,244		13,717,285	13,717,285
2039		12,535,164	12,535,164		11,451,108	11,451,108		11,527,244	11,527,244		13,717,285	13,717,285
2040	21,627,606	12,645,164	34,272,770	22,017,114	11,533,708	33,550,822	22,017,114	11,609,844	33,626,958	22,817,389	13,790,285	36,607,674
2041		12,645,164	12,645,164		11,533,708	11,533,708		11,609,844	11,609,844		13,790,285	13,790,285
2042		12,645,164	12,645,164		11,533,708	11,533,708		11,609,844	11,609,844		13,790,285	13,790,285
2043		12,645,164	12,645,164		11,533,708	11,533,708		11,609,844	11,609,844		13,790,285	13,790,285
2044		12,645,164	12,645,164		11,533,708	11,533,708		11,609,844	11,609,844		13,790,285	13,790,285
2045	324,991	12,645,164	12,970,155	324,991	11,533,708	11,858,699	324,991	11,609,844	11,934,836	162,496	13,790,285	13,952,780
2046		12,645,164	12,645,164		11,533,708	11,533,708		11,609,844	11,609,844		13,790,285	13,790,285
2047		12,645,164	12,645,164		11,533,708	11,533,708		11,609,844	11,609,844		13,790,285	13,790,285
2048		12,645,164	12,645,164		11,533,708	11,533,708		11,609,844	11,609,844		13,790,285	13,790,285
2049		12,645,164	12,645,164		11,533,708	11,533,708		11,609,844	11,609,844		13,790,285	13,790,285
2050	21,627,606	12,645,164	34,272,770	22,017,114	11,533,708	33,550,822	22,017,114	11,609,844	33,626,958	22,817,389	13,790,285	36,607,674
2051		12,645,164	12,645,164		11,533,708	11,533,708		11,609,844	11,609,844		13,790,285	13,790,285
2052		12,645,164	12,645,164		11,533,708	11,533,708		11,609,844	11,609,844		13,790,285	13,790,285
2053		12,645,164	12,645,164		11,533,708	11,533,708		11,609,844	11,609,844		13,790,285	13,790,285
2054		12,645,164	12,645,164		11,533,708	11,533,708		11,609,844	11,609,844		13,790,285	13,790,285
2055		12,645,164	12,645,164		11,533,708	11,533,708		11,609,844	11,609,844		13,790,285	13,790,285
2056		12,645,164	12,645,164		11,533,708	11,533,708		11,609,844	11,609,844		13,790,285	13,790,285
2057		12,645,164	12,645,164		11,533,708	11,533,708		11,609,844	11,609,844		13,790,285	13,790,285
2058		12,645,164	12,645,164		11,533,708	11,533,708		11,609,844	11,609,844		13,790,285	13,790,285
2059		12,645,164	12,645,164		11,533,708	11,533,708		11,609,844	11,609,844		13,790,285	13,790,285

COST SUMMARY

Description	Cost	Remarks
Discount Factor	2.800%	
Capital Costs		
Alternative 1		
Capital Costs - 2010	$85,185,408	Initial capital cost
Capital Costs - 2015	$324,991	Repurchasing of truck scale equipment (15 year life span)
Capital Costs - 2020	$21,627,606	Repurchasing of trucks (10 year life span)
Capital Costs - 2030	$21,952,597	Repurchasing of trucks (10 year life span) and truck scale equipment (15 year life span)
Capital Costs - 2040	$21,627,606	Repurchasing of trucks (10 year life span)
Capital Costs - 2045	$324,991	Repurchasing of truck scale equipment (15 year life span)
Capital Costs - 2050	$21,627,606	Repurchasing of trucks (10 year life span)
Alternative 2		
Capital Costs - 2010	$71,147,646	Initial capital cost
Capital Costs - 2015	$324,991	Repurchasing of truck scale equipment (15 year life span)
Capital Costs - 2020	$22,017,114	Repurchasing of trucks (10 year life span)
Capital Costs - 2030	$22,342,106	Repurchasing of trucks (10 year life span) and truck scale equipment (15 year life span)
Capital Costs - 2040	$22,017,114	Repurchasing of trucks (10 year life span)
Capital Costs - 2045	$324,991	Repurchasing of truck scale equipment (15 year life span)
Capital Costs - 2050	$22,017,114	Repurchasing of trucks (10 year life span)
Alternative 3		
Capital Costs - 2010	$71,147,646	Initial capital cost
Capital Costs - 2015	$324,991	Repurchasing of truck scale equipment (15 year life span)
Capital Costs - 2020	$22,017,114	Repurchasing of trucks (10 year life span)
Capital Costs - 2030	$22,342,106	Repurchasing of trucks (10 year life span) and truck scale equipment (15 year life span)
Capital Costs - 2040	$22,017,114	Repurchasing of trucks (10 year life span)
Capital Costs - 2045	$324,991	Repurchasing of truck scale equipment (15 year life span)
Capital Costs - 2050	$22,017,114	Repurchasing of trucks (10 year life span)
Alternative 4		
Capital Costs - 2010	$69,521,324	Initial capital cost
Capital Costs - 2015	$162,496	Repurchasing of truck scale equipment (15 year life span)
Capital Costs - 2020	$22,817,389	Repurchasing of trucks (10 year life span)
Capital Costs - 2030	$22,979,885	Repurchasing of trucks (10 year life span) and truck scale equipment (15 year life span)
Capital Costs - 2040	$22,817,389	Repurchasing of trucks (10 year life span)
Capital Costs - 2045	$162,496	Repurchasing of truck scale equipment (15 year life span)
Capital Costs - 2050	$22,817,389	Repurchasing of trucks (10 year life span)

Description	Cost
Annual Operating Costs	
Alternative 1	
Operating Costs 2010 to 2019	$12,040,164
Operating Costs 2020 to 2029	$12,260,164
Operating Costs 2030 to 2039	$12,535,164
Operating Costs 2040 to 2059	$12,645,164
Alternative 2	
Operating Costs 2010 to 2019	$11,079,408
Operating Costs 2020 to 2029	$11,244,608
Operating Costs 2030 to 2039	$11,451,108
Operating Costs 2040 to 2059	$11,533,708
Alternative 3	
Operating Costs 2010 to 2019	$11,155,544
Operating Costs 2020 to 2029	$11,320,744
Operating Costs 2030 to 2039	$11,527,244
Operating Costs 2040 to 2059	$11,609,844
Alternative 4	
Operating Costs 2010 to 2019	$13,388,785
Operating Costs 2020 to 2029	$13,534,785
Operating Costs 2030 to 2039	$13,717,285
Operating Costs 2040 to 2059	$13,790,285

OPERATION AND MAINTENANCE COSTS

ALTERNATIVE 1

Building Maintenance	Quantity	Hours/Day	Equipment $/hour	Daily Cost	Annual Cost
Northern MRRF Maintenance 2010 to 2019	1				$185,000
Northern MRRF Maintenance 2020 to 2029	1				$259,000
Northern MRRF Maintenance 2030 to 2039	1				$351,500
Northern MRRF Maintenance 2040 to 2059	1				$388,500
Southern MRRF Maintenance 2010 to 2019	1				$185,000
Southern MRRF Maintenance 2020 to 2029	1				$259,000
Southern MRRF Maintenance 2030 to 2039	1				$351,500
Southern MRRF Maintenance 2040 to 2059	1				$388,500
Recycling Center Maintenance 2010 to 2019	2				$180,000
Recycling Center Maintenance 2020 to 2029	2				$252,000
Recycling Center Maintenance 2030 to 2039	2				$342,000
Recycling Center Maintenance 2040 to 2059	2				$378,000
Total Building Maintenance Cost 2010 - 2019					**$550,000**
Total Building Maintenance Cost 2020 - 2029					**$770,000**
Total Building Maintenance Cost 2030 - 2039					**$1,045,000**
Total Building Maintenance Cost 2040 - 2059					**$1,155,000**

Operations and Maintenance	Quantity	Hours/Day	Equipment $/hour	Daily Cost	Annual Cost
Solid Waste Collection and Transportation					
Automated Side Loading Collection Truck Operation	18	6	$5.15	$556.20	$144,612
Automated Side Loading Collection Truck Maintenance	18				$979,579
Automated Front Loading Collection Truck Operation	17	6	$5.15	$525.30	$136,578
Automated Front Loading Collection Truck Maintenance	17				$925,158
Roll-Off Truck Operation	6	6	$5.15	$185.40	$48,204
Roll-Off Truck Maintenance	6				$58,426
Transport Costs for Shipping Containers to/from Port					$164,592
Northern MRRF Equipment Maintenance	1				$131,400
Southern MRRF Equipment Maintenance	1				$131,400
Total O&M Cost					**$2,719,949**

PERSONNEL	Quantity	Hours/Day	Wage $/hour	Daily Cost	Annual Cost
Drivers/Operators for Collection Trucks	35	8	$39.51	$11,063.81	$2,876,590
Drivers/Operators for Roll-Off Collection Trucks	6	8	$39.51	$1,896.65	$493,130
Drivers for Roll-Off Transport Trucks					$237,086
Northern MRRF Personnel	1				$1,443,474
Southern MRRF Personnel	1				$1,443,474
Total Personnel Cost					**$6,493,753**

Total Recycling Center Operation and Maintenance Cost **$2,276,462**

Alternative 1 Total Operating Cost	**2010 to 2019**	**$12,040,164**
Alternative 1 Total Operating Cost	**2020 to 2029**	**$12,260,164**
Alternative 1 Total Operating Cost	**2030 to 2039**	**$12,535,164**
Alternative 1 Total Operating Cost	**2040 to 2059**	**$12,645,164**

(a) Vehicle maintenance cost is 10% of capital costs on annual basis.
(b) Administration staff works 260 days a year, 8 hours a day
(c) Receiving and processing at transfer station occurs 312 days a year, 8 hours a day

OPERATION AND MAINTENANCE COSTS

ALTERNATIVE 2

Building Maintenance	**Quantity**	**Hours/Day**	**Equipment $/hour**	**Daily Cost**	**Annual Cost**
MRRF Maintenance 2010 to 2019	1				$185,000
MRRF Maintenance 2020 to 2029	1				$259,000
MRRF Maintenance 2030 to 2039	1				$351,500
MRRF Maintenance 2040 to 2059	1				$388,500
Transfer Station Maintenance 2010 to 2019	1				$48,000
Transfer Station Maintenance 2020 to 2029	1				$67,200
Transfer Station Maintenance 2030 to 2039	1				$91,200
Transfer Station Maintenance 2040 to 2059	1				$100,800
Recycling Center Maintenance 2010 to 2019	2				$180,000
Recycling Center Maintenance 2020 to 2029	2				$252,000
Recycling Center Maintenance 2030 to 2039	2				$342,000
Recycling Center Maintenance 2040 to 2059	2				$378,000
Total Building Maintenance Cost 2010 - 2019					**$413,000**
Total Building Maintenance Cost 2020 - 2029					**$578,200**
Total Building Maintenance Cost 2030 - 2039					**$784,700**
Total Building Maintenance Cost 2040 - 2059					**$867,300**

Operations and Maintenance	**Quantity**	**Hours/Day**	**Equipment $/hour**	**Daily Cost**	**Annual Cost**
Solid Waste Collection and Transportation					
Automated Side Loading Collection Truck Operation	18	6	$5.15	$556.20	$144,612
Automated Side Loading Collection Truck Maintenance	18				$979,579
Automated Front Loading Collection Truck Operation	17	6	$5.15	$525.30	$136,578
Automated Front Loading Collection Truck Maintenance	17				$925,158
Roll-Off Truck Operation	8	6	$5.15	$247.20	$64,272
Roll-Off Truck Maintenance	8				$58,426
Transport Costs for Shipping Containers to/from Port					$50,760
MRRF Building Equipment Maintenance	1				$131,400
Transfer Station Building Equipment Maintenance	1				$59,100
Total O&M Cost					**$2,549,885**

PERSONNEL	**Quantity**	**Hours/Day**	**Wage $/hour**	**Daily Cost**	**Annual Cost**
Drivers/Operators for Collection Trucks	35	8	$39.51	$11,063.81	$2,876,590
Drivers/Operators for Roll-Off Collection Trucks	8	8	$39.51	$2,528.87	$657,506
Drivers for Roll-Off Transport Trucks					$371,091
MRRF Personnel	1				$1,443,474
Transfer Station Personnel	1				$491,400
Total Personnel Cost					**$5,840,061**

Total Recycling Center Operation and Maintenance Cost		**$2,276,462**
Alternative 2 Total Operating Cost	**2010 to 2019**	**$11,079,408**
Alternative 2 Total Operating Cost	**2020 to 2029**	**$11,244,608**
Alternative 2 Total Operating Cost	**2030 to 2039**	**$11,451,108**
Alternative 2 Total Operating Cost	**2040 to 2059**	**$11,533,708**

(a) Vehicle maintenance cost is 10% of capital costs on annual basis.
(b) Administration staff works 260 days a year, 8 hours a day
(c) Receiving and processing at transfer station occurs 312 days a year, 8 hours a day

OPERATION AND MAINTENANCE COSTS

ALTERNATIVE 3

Building Maintenance	Quantity	Hours/Day	Equipment $/hour	Daily Cost	Annual Cost
MRRF Maintenance 2010 to 2019	1				$185,000
MRRF Maintenance 2020 to 2029	1				$259,000
MRRF Maintenance 2030 to 2039	1				$351,500
MRRF Maintenance 2040 to 2059	1				$388,500
Transfer Station Maintenance 2010 to 2019	1				$48,000
Transfer Station Maintenance 2020 to 2029	1				$67,200
Transfer Station Maintenance 2030 to 2039	1				$91,200
Transfer Station Maintenance 2040 to 2059	1				$100,800
Recycling Center Maintenance 2010 to 2019	2				$180,000
Recycling Center Maintenance 2020 to 2029	2				$252,000
Recycling Center Maintenance 2030 to 2039	2				$342,000
Recycling Center Maintenance 2040 to 2059	2				$378,000
Total Building Maintenance Cost 2010 - 2019					**$413,000**
Total Building Maintenance Cost 2020 - 2029					**$578,200**
Total Building Maintenance Cost 2030 - 2039					**$784,700**
Total Building Maintenance Cost 2040 - 2059					**$867,300**

Operations and Maintenance	Quantity	Hours/Day	Equipment $/hour	Daily Cost	Annual Cost
Solid Waste Collection and Transportation					
Automated Side Loading Collection Truck Operation	18	6	$5.15	$556.20	$144,612
Automated Side Loading Collection Truck Maintenance	18				$979,579
Automated Front Loading Collection Truck Operation	17	6	$5.15	$525.30	$136,578
Automated Front Loading Collection Truck Maintenance	17				$925,158
Roll-Off Truck Operation	8	6	$5.15	$247.20	$64,272
Roll-Off Truck Maintenance	8				$155,803
Transport Costs for Shipping Containers to/from Port					$91,368
MRRF Building Equipment Maintenance	1				$131,400
Transfer Station Building Equipment Maintenance	1				$59,100
Total O&M Cost					**$2,687,870**

PERSONNEL	Quantity	Hours/Day	Wage $/hour	Daily Cost	Annual Cost
Drivers/Operators for Collection Trucks	35	8	$39.51	$11,063.81	$2,876,590
Drivers/Operators for Roll-Off Collection Trucks	8	8	$39.51	$2,528.87	$657,506
Drivers for Roll-Off Transport Trucks					$309,242
MRRF Personnel	1				$1,443,474
Transfer Station Personnel	1				$491,400
Total Personnel Cost					**$5,778,212**

Total Recycling Center Operation and Maintenance Cost		**$2,276,462**
Alternative 3 Total Operating Cost	**2010 to 2019**	**$11,155,544**
Alternative 3 Total Operating Cost	**2020 to 2029**	**$11,320,744**
Alternative 3 Total Operating Cost	**2030 to 2039**	**$11,527,244**
Alternative 3 Total Operating Cost	**2040 to 2059**	**$11,609,844**

(a) Vehicle maintenance cost is 10% of capital costs on annual basis.
(b) Administration staff works 260 days a year, 8 hours a day
(c) Receiving and processing at transfer station occurs 312 days a year, 8 hours a day

OPERATION AND MAINTENANCE COSTS

ALTERNATIVE 4

Building Maintenance	Quantity	Hours/Day	Equipment $/hour	Daily Cost	Annual Cost
MRRF Maintenance 2010 to 2019	1				$185,000
MRRF Maintenance 2020 to 2029	1				$259,000
MRRF Maintenance 2030 to 2039	1				$351,500
MRRF Maintenance 2040 to 2059	1				$388,500
Recycling Center Maintenance 2010 to 2019	2				$180,000
Recycling Center Maintenance 2020 to 2029	2				$252,000
Recycling Center Maintenance 2030 to 2039	2				$342,000
Recycling Center Maintenance 2040 to 2059	2				$378,000
Total Building Maintenance Cost 2010 - 2019					**$365,000**
Total Building Maintenance Cost 2020 - 2029					**$511,000**
Total Building Maintenance Cost 2030 - 2039					**$693,500**
Total Building Maintenance Cost 2040 - 2059					**$766,500**

Operations and Maintenance	Quantity	Hours/Day	Equipment $/hour	Daily Cost	Annual Cost
Automated Side Loading Collection Truck Operation	24	6	$5.15	$741.60	$192,816
Automated Side Loading Collection Truck Maintenance	24				$1,306,105
Automated Front Loading Collection Truck Operation	20	6	$5.15	$618.00	$160,680
Automated Front Loading Collection Truck Maintenance	20				$1,088,421
Roll-Off Truck Operation	9	6	$5.15	$278.10	$72,306
Roll-Off Truck Maintenance	9				$175,279
Transport Costs for Shipping Containers to/from Port					$91,368
MRRF Building Equipment Maintenance	2				$262,800
Total O&M Cost					**$3,349,775**

PERSONNEL	Quantity	Hours/Day	Wage $/hour	Daily Cost	Annual Cost
Drivers/Operators for Collection Trucks	44	8	$39.51	$13,908.79	$3,616,285
Drivers/Operators for Roll-Off Collection Trucks	9	8	$39.51	$2,844.98	$739,695
Drivers for Roll-Off Transport Trucks					$154,621
MRRF Personnel	2				$2,886,947
Total Personnel Cost					**$7,397,548**

Total Recycling Center Operation and Maintenance Cost		**$2,276,462**
Alternative 4 Total Operating Cost	**2010 to 2019**	**$13,388,785**
Alternative 4 Total Operating Cost	**2020 to 2029**	**$13,534,785**
Alternative 4 Total Operating Cost	**2030 to 2039**	**$13,717,285**
Alternative 4 Total Operating Cost	**2040 to 2059**	**$13,790,285**

(a) Vehicle maintenance cost is 10% of capital costs on annual basis.
(b) Administration staff works 260 days a year, 8 hours a day
(c) Receiving and processing at transfer station occurs 312 days a year, 8 hours a day

CAPITAL COSTS

ALTERNATIVE 1			
MRRF (Including Transfer Station)	**Unit Cost**	**Quantity**	**Total Cost**
Facility			
North MRRF Building (Includes Transfer Station)	$18,500,000	1	$18,500,000
South MRRF Building (Includes Transfer Station)	$18,500,000	1	$18,500,000
Administrative Office	$435,000	2	$870,000
Asphalt Roadway	$333,210	2	$666,420
Stationary Equipment			
Baler w/ infeed	$216,393	2	$346,230
Baler Installation	$33,600	2	$67,200
Grinder/Chipper	$173,115	2	$346,230
Grinder/Chipper Installation	$26,880	2	$53,760
MRF Processing Line	$432,787	2	$216,393
MRF Processing Line Installation	$67,200	2	$134,400
Truck Scales	$108,197	2	$216,393
Truck Scale Installation	$16,800	2	$33,600
Bins	$10,820	16	$173,115
Bin Installation	$1,680	16	$64,918
Office Equipment	$75,738	2	$151,475
Scalehouse Equipment	$32,459	2	$64,918
Scalehouse Equipment Installation	$5,040	2	$10,080
Rolling Stock			
Front End Loader	$540,984	2	$1,081,967
Front End Loader (used-backup)	$216,393	2	$432,787
Forklift	$108,197	2	$216,393
Bobcat	$64,918	2	$129,836
Utility pick-up truck	$64,918	2	$129,836
Mini-Sweeper	$108,197	2	$216,393
Total MRRF Cost			**$42,622,345**

Recycling Center	**Unit Cost**	**Quantity**	**Total Cost**
Facility			
Recycling Center Building	$9,000,000	2	$18,000,000
Administrative Office	$435,000	2	$870,000
Asphalt Roadway	$39,000	2	$78,000
Stationary Equipment and Rolling Stock			
Total Cost (From Recycling Center Life Cycle Analysis)			$1,987,457
Total Recycling Center Cost			**$20,935,457**

Solid Waste Collection	**Unit Cost**	**Quantity**	**Total Cost**
Side Loading Collection Truck (40cy) - Refuse	$544,211	12	$6,530,526
Side Loading Collection Truck (40 cy) - Recycling	$544,211	6	$3,265,263
Spare Side Loading Collection Truck (40cy) - Refuse	$544,211	1	$544,211
Front Loading Collection Truck (40cy) - Refuse	$544,211	9	$4,897,895
Front Loading Collection Truck (40 cy) - Recycling	$544,211	8	$4,353,684
Spare Front Loading Collection Truck (40cy) - Refuse	$544,211	1	$544,211
Roll-off truck & trailer (new)	$194,754	3	$584,262
Spare Roll-Off Truck	$194,754	1	$194,754
Total Collection Cost			**$20,914,806**

Solid Waste Transportation	**Unit Cost**	**Quantity**	**Total Cost**
Transfer Trailer	$64,269	2	$128,538
Roll-off truck & trailer (new)	$194,754	3	$584,262
Total Transportation Cost			**$712,800**
Total Capital Costs			**$85,185,408**

CAPITAL COSTS

ALTERNATIVE 2			
MRRF (Including Transfer Station)	**Unit Cost**	**Quantity**	**Total Cost**
Facility			
MRRF Building (Includes Transfer Station)	$18,500,000	1	$18,500,000
Administrative Office	$435,000	1	$435,000
Asphalt Roadway	$333,210	1	$333,210
Stationary Equipment			
Baler w/ infeed	$216,393	1	$173,115
Baler Installation	$33,600	1	$33,600
Grinder/Chipper	$173,115	1	$173,115
Grinder/Chipper Installation	$26,880	1	$26,880
MRF Processing Line	$432,787	1	$108,197
MRF Processing Line Installation	$67,200	1	$67,200
Truck Scales	$108,197	1	$108,197
Truck Scale Installation	$16,800	1	$16,800
Bins	$10,820	8	$86,557
Bin Installation	$1,680	8	$32,459
Office Equipment	$75,738	1	$75,738
Scalehouse Equipment	$32,459	1	$32,459
Scalehouse Equipment Installation	$5,040	1	$5,040
Rolling Stock			
Front End Loader	$540,984	1	$540,984
Front End Loader (used-backup)	$216,393	1	$216,393
Forklift	$108,197	1	$108,197
Bobcat	$64,918	1	$64,918
Utility pick-up truck	$64,918	1	$64,918
Mini-Sweeper	$108,197	1	$108,197
Total MRRF Cost			**$21,311,173**

Transfer Station	**Unit Cost**	**Quantity**	**Total Cost**
Facility			
Transfer Station	$4,800,000	1	$4,800,000
Administrative Office	$435,000	1	$435,000
Asphalt Roadway	$153,600	1	$153,600
Stationary Equipment			
Truck Scales	$108,197	1	$108,197
Truck Scale Installation	$16,800	1	$16,800
Scalehouse Equipment	$32,459	1	$32,459
Scalehouse Equipment Installation	$5,040	1	$5,040
Rolling Stock			
Front End Loader	$540,984	1	$540,984
Front End Loader (used-backup)	$216,393	1	$216,393
Forklift	$108,197	1	$108,197
Bobcat	$64,918	1	$64,918
Utility pick-up truck	$64,918	1	$64,918
Mini-Sweeper	$108,197	1	$108,197
Total Transfer Station			**$6,654,702**

Recycling Center	**Unit Cost**	**Quantity**	**Total Cost**
Facility			
Recycling Center Building	$9,000,000	2	$18,000,000
Administrative Office	$435,000	2	$870,000
Asphalt Roadway	$153,600	2	$307,200
Stationary Equipment and Rolling Stock			
Total Cost (From Recycling Center Life Cycle Analysis)			$1,987,457
Total Recycling Center Cost			**$21,164,657**

CAPITAL COSTS

Solid Waste Collection	Unit Cost	Quantity	Total Cost
Side Loading Collection Truck (40cy) - Refuse	$544,211	12	$6,530,526
Side Loading Collection Truck (40 cy) - Recycling	$544,211	6	$3,265,263
Spare Side Loading Collection Truck (40cy) - Refuse	$544,211	1	$544,211
Front Loading Collection Truck (40cy) - Refuse	$544,211	9	$4,897,895
Front Loading Collection Truck (40 cy) - Recycling	$544,211	8	$4,353,684
Spare Front Loading Collection Truck (40cy) - Refuse	$544,211	1	$544,211
Roll-off truck & trailer (new)	$194,754	3	$584,262
Spare Roll-Off Truck	$194,754	1	$194,754
Total Collection Cost			**$20,914,806**

Solid Waste Transportation	Unit Cost	Quantity	Total Cost
Transfer Trailer	$64,269	2	$128,538
Roll-off truck & trailer (new)	$194,754	5	$973,770
Total Transportation Cost			**$1,102,308**
Total Capital Costs			**$71,147,646**

CAPITAL COSTS

ALTERNATIVE 3			
MRRF (Including Transfer Station)	**Unit Cost**	**Quantity**	**Total Cost**
Facility			
MRRF Building (Includes Transfer Station)	$18,500,000	1	$18,500,000
Administrative Office	$435,000	1	$435,000
Asphalt Roadway	$333,210	1	$333,210
Stationary Equipment			
Baler w/ infeed	$216,393	1	$173,115
Baler Installation	$33,600	1	$33,600
Grinder/Chipper	$173,115	1	$173,115
Grinder/Chipper Installation	$26,880	1	$26,880
MRF Processing Line	$432,787	1	$108,197
MRF Processing Line Installation	$67,200	1	$67,200
Truck Scales	$108,197	1	$108,197
Truck Scale Installation	$16,800	1	$16,800
Bins	$10,820	8	$86,557
Bin Installation	$1,680	8	$32,459
Office Equipment	$75,738	1	$75,738
Scalehouse Equipment	$32,459	1	$32,459
Scalehouse Equipment Installation	$5,040	1	$5,040
Rolling Stock			
Front End Loader	$540,984	1	$540,984
Front End Loader (used-backup)	$216,393	1	$216,393
Forklift	$108,197	1	$108,197
Bobcat	$64,918	1	$64,918
Utility pick-up truck	$64,918	1	$64,918
Mini-Sweeper	$108,197	1	$108,197
Total MRRF Cost			**$21,311,173**

Transfer Station	**Unit Cost**	**Quantity**	**Total Cost**
Facility			
Transfer Station	$4,800,000	1	$4,800,000
Administrative Office	$435,000	1	$435,000
Asphalt Roadway	$153,600	1	$153,600
Stationary Equipment			
Truck Scales	$108,197	1	$108,197
Truck Scale Installation	$16,800	1	$16,800
Scalehouse Equipment	$32,459	1	$32,459
Scalehouse Equipment Installation	$5,040	1	$5,040
Rolling Stock			
Front End Loader	$540,984	1	$540,984
Front End Loader (used-backup)	$216,393	1	$216,393
Forklift	$108,197	1	$108,197
Bobcat	$64,918	1	$64,918
Utility pick-up truck	$64,918	1	$64,918
Mini-Sweeper	$108,197	1	$108,197
Total Transfer Station			**$6,654,702**

Recycling Center	**Unit Cost**	**Quantity**	**Total Cost**
Facility			
Recycling Center Building	$9,000,000	2	$18,000,000
Administrative Office	$435,000	2	$870,000
Asphalt Roadway	$153,600	2	$307,200
Stationary Equipment and Rolling Stock			
Total Cost (From Recycling Center Life Cycle Analysis)			$1,987,457
Total Recycling Center Cost			**$21,164,657**

CAPITAL COSTS

Solid Waste Collection	Unit Cost	Quantity	Total Cost
Side Loading Collection Truck (40cy) - Refuse	$544,211	12	$6,530,526
Side Loading Collection Truck (40 cy) - Recycling	$544,211	6	$3,265,263
Spare Side Loading Collection Truck (40cy) - Refuse	$544,211	1	$544,211
Front Loading Collection Truck (40cy) - Refuse	$544,211	9	$4,897,895
Front Loading Collection Truck (40 cy) - Recycling	$544,211	8	$4,353,684
Spare Front Loading Collection Truck (40cy) - Refuse	$544,211	1	$544,211
Roll-off truck & trailer (new)	$194,754	3	$584,262
Spare Roll-Off Truck	$194,754	1	$194,754
Total Collection Cost			**$20,914,806**

Solid Waste Transportation	Unit Cost	Quantity	Total Cost
Transfer Trailer	$64,269	2	$128,538
Roll-off truck & trailer (new)	$194,754	5	$973,770
Total Transportation Cost			**$1,102,308**
Total Capital Costs			**$71,147,646**

CAPITAL COSTS

ALTERNATIVE 4			
MRRF (Including Transfer Station)	**Unit Cost**	**Quantity**	**Total Cost**
Facility			
MRRF Building (Includes Transfer Station)	$18,500,000	1	$18,500,000
Administrative Office	$435,000	1	$435,000
Asphalt Roadway	$333,210	1	$333,210
Stationary Equipment			
Baler w/ infeed	$216,393	1	$173,115
Baler Installation	$33,600	1	$33,600
Grinder/Chipper	$173,115	1	$173,115
Grinder/Chipper Installation	$26,880	1	$26,880
MRF Processing Line	$432,787	1	$108,197
MRF Processing Line Installation	$67,200	1	$67,200
Truck Scales	$108,197	1	$108,197
Truck Scale Installation	$16,800	1	$16,800
Bins	$10,820	8	$86,557
Bin Installation	$1,680	8	$32,459
Office Equipment	$75,738	1	$75,738
Scalehouse Equipment	$32,459	1	$32,459
Scalehouse Equipment Installation	$5,040	1	$5,040
Rolling Stock			
Front End Loader	$540,984	1	$540,984
Front End Loader (used-backup)	$216,393	1	$216,393
Forklift	$108,197	1	$108,197
Bobcat	$64,918	1	$64,918
Utility pick-up truck	$64,918	1	$64,918
Mini-Sweeper	$108,197	1	$108,197
Total MRRF Cost			**$21,311,173**

Recycling Center	**Unit Cost**	**Quantity**	**Total Cost**
Recycling Center Building	$9,000,000	2	$18,000,000
Administrative Office	$435,000	2	$870,000
Asphalt Roadway	$153,600	2	$307,200
Stationary Equipment and Rolling Stock			
Total Cost (From Recycling Center Life Cycle Analysis)			$1,987,457
Total Recycling Center Cost			**$21,164,657**

Solid Waste Collection	**Unit Cost**	**Quantity**	**Total Cost**
Side Loading Collection Truck (40cy) - Refuse	$544,211	18	$9,795,789
Side Loading Collection Truck (40 cy) - Recycling	$544,211	6	$3,265,263
Spare Side Loading Collection Truck (40cy) - Refuse	$544,211	1	$544,211
Front Loading Collection Truck (40cy) - Refuse	$544,211	12	$6,530,526
Front Loading Collection Truck (40 cy) - Recycling	$544,211	8	$4,353,684
Spare Front Loading Collection Truck (40cy) - Refuse	$544,211	1	$544,211
Roll-off truck & trailer (new)	$194,754	7	$1,363,279
Spare Roll-Off Truck	$194,754	1	$194,754
Total Collection Cost			**$26,591,717**

Solid Waste Transportation	**Unit Cost**	**Quantity**	**Total Cost**
Transfer Trailer	$64,269	1	$64,269
Roll-off truck & trailer (new)	$194,754	2	$389,508
Total Transportation Cost			**$453,777**

Total Capital Costs **$69,521,324**

MATERIALS RESOURCE RECOVERY FACILITY ANNUAL TRANSPORTATION COST

Alternative	Annual Cost (labor)	Description
1	$402,000	MRRF in northern Guam and MRRF in southern Guam
2	$422,000	MRRF in southern Guam
3	$401,000	MRRF in northern Guam
4	$246,000	MRRF in Barrigada, Guam

ALTERNATIVE 1: MRRF IN NORTHERN GUAM AND MRRF IN SOUTHERN GUAM

NORTHERN WASTE TO LANDFILL

Travel Distance			
Northern Waste (sorted/processed at northern MRRF):			
Andersen AFB to Layon Landfill, roundtrip		58.8	miles/round trip
Northern Waste Characterization			
Known Recyclables		30.58	tons/day
Misc waste		34.94	tons/day
Total northern waste		65.52	tons/day
Northern Source Segregated Characterization			
Known Recyclables, 15% source segregated		4.59	tons/day
Misc waste + 85% non-source segregated		60.93	tons/day
Total northern waste		65.52	tons/day
Northern Waste Destination Characterization			
Known Recyclables, 15% source segregated		4.59	tons/day
Non-recyclables (to landfill)		34.94	tons/day
Recyclables recovered from MRRF, removal efficiency:	100.00%	25.99	tons/day
Total northern waste		65.52	tons/day
Non-recyclables (to landfill) per working day, 5 days a week		48.92	tons/working day
Container Weight Capacity:	15 ton/container	4	round trips/day
Hours per roundtrip	25 miles/hour	2.40	hours/round trip
A truck will need to travel		235.09	miles/working day
		9.60	travel hours
Allowance:	1 hour start up per vehicle	2	startup hour
	1 washdown/inspection per roundtrip	4	wash/inspect hours
Required hours		16	total labor hours
Therefore, two trucks to run concurrently:		16.00	travel hours
Include one additional trailer to remain at MRRF for loading		2	trucks
		1	trailer

SOUTHERN WASTE TO LANDFILL

Travel Distance			
Southern Waste (sorted/processed at southern MRF):			
Apra Harbor to Layon Landfill, roundtrip		38.8	miles/round trip
Southern Waste Characterization			
Known Recyclables		12.43	tons/day
Misc waste		14.21	tons/day
Total southern waste		26.64	tons/day
Southern Source Segregated Characterization			
Known Recyclables, 15% source segregated		1.86	tons/day
Misc waste + 85% non-source segregated		24.77	tons/day
Total southern waste		26.64	tons/day
Southern Waste Destination Characterization			
Known Recyclables, 15% source segregated		1.86	tons/day
Non-recyclables (to landfill)		14.21	tons/day
Recyclables recovered from MRRF, removal efficiency:	100.00%	10.57	tons/day
Total southern waste		26.64	tons/day
Non-recyclables (to landfill) per working day, 5 days a week		19.89	tons/working day

Container Weight Capacity:	15 ton/container	2 roundtrips/day
Hours per roundtrip	25 miles/hour	1.60 hours/roundtrip
A truck will need to travel		77.60 miles/working day
		3.20 travel hours
Allowance:	1 hour start up per vehicle	1 startup hour
	1 washdown/inspection per roundtrip	2 wash/inspect hours
Required hours		7 total labor hours
Therefore, one truck to run:		7.00 total labor hours
Include one additional trailer to remain at MRRF for loading		1 truck
		1 trailer

NORTHERN RECYCLABLES TO PORT

Material	Production		Weight per bale (lbs)		No. bales per year	Weight of container	Containers shipped
	lbs/day	lbs/yr	Min.	Max.	(Min. Wt)	lbs	per year
Cardboard	4,076.3	1,487,839.6	1,200	1,500	1,239.9	33,600	44
Aluminum Cans	2,111.4	770,674.8	900	1,125	856.3	25,200	30
Plastic Containers	1,512.7	552,132.1	1,200	1,400	460.1	33,600	16
Glass	4,651.2	1,697,703.3	N/A	N/A	N/A	36,000	47
Mixed Paper	7,249.5	2,646,070.6	1,000	1,690	2,646.1	28,000	94
Expended Brass[a]	87.2	28,603.8	N/A	N/A	N/A	N/A	N/A
Scrap Metal	5,575.1	2,034,905.6	N/A	N/A	N/A	36,000	56
Wood Pallets (40lb)	12,586.2	4,593,965.8	N/A	N/A	N/A	13,680	335
Compostable Material	14,141.1	5,161,498.3	N/A	N/A	N/A	N/A	N/A
Total Containers Shipped Per Year							622

Notes:

[a] Expended Brass must be recycled through DRMO and may not be shipped off of Guam for recycling

Compostable Material will not be shipped

Assumptions:

Brass density = 543 PCF

Scrap metal density (estimated) = 480 PCF

Glass density = 1000 - 2000 lbs/CY

Number of containers shipped per year		622 containers
Transport Costs (From AAFB)	$108 each way	$216 round trip
Total transport cost for recyclables to port		$134,352 total annual cost

SOUTHERN RECYCLABLES TO PORT

Material	Production		Weight per bale (lbs)		No. bales per year	Weight of container	Containers shipped
	lbs/day	lbs/yr	Min.	Max.	(Min. Wt)	lbs	per year
Cardboard	1,657.3	604,928.7	1,200	1,500	504.1	33,600	18
Aluminum Cans	858.5	313,342.4	900	1,125	348.2	25,200	12
Plastic Containers	615.0	224,486.9	1,200	1,400	187.1	33,600	6
Glass	1,891.1	690,255.5	N/A	N/A	N/A	36,000	19
Mixed Paper	2,947.5	1,075,844.4	1,000	1,690	1,075.8	28,000	38
Expended Brass[a]	0.0	0.0	N/A	N/A	N/A	N/A	N/A
Scrap Metal	2,296.9	838,356.9	N/A	N/A	N/A	36,000	23
Wood Pallets (40lb)	5,117.3	1,867,823.4	N/A	N/A	N/A	13,680	136
Compostable Material	5,749.5	2,098,571.9	N/A	N/A	N/A	N/A	N/A
Total Containers Shipped Per Year							252

Notes:

[a] Expended Brass must be recycled through DRMO and may not be shipped off of Guam for recycling
Compostable Material will not be shipped

Assumptions:

Brass density = 543 PCF
Scrap metal density (estimated) = 480 PCF
Glass density = 1000 - 2000 lbs/CY
All brass is generated in Northern Guam

Number of containers shipped per year		252	containers
Transport Costs (From Naval Base)	$60 each way	$120	round trip
Total transport cost for recyclables to port		$30,240	total annual cost

Total trucks for operation		3	trucks
Total trailers for operation		2	trailers
Total hours per day		23.00	hours
Total hours per year		5996.10	hours
Labor cost per year	$39.54 per hour	**$237,086**	
Total containers shipped per year		874	containers
Container transport cost per year		**$164,592**	
Total labor and transport cost per year		**$402,000**	

ALTERNATIVE 2: MRRF IN SOUTHERN GUAM

Travel Distance			
Northern Waste (northern transfer station to southern MRRF):			
Andersen AFB to Apra Harbor Naval Base, roundtrip		45.5	miles/roundtrip
Northern Waste (sorted/processed at southern MRRF):			
Apra Harbor to Layon Landfill, roundtrip		38.8	miles/roundtrip

NORTHERN WASTE (Transfer station to MRRF/TS)

Northern Waste Characterization			
Known Recyclables		30.58	tons/day
Misc waste		34.94	tons/day
Total northern waste		65.52	tons/day
Northern Source Segregated Characterization			
Known Recyclables, 15% source segregated		4.59	tons/day
Misc waste + 85% non-source segregated		60.93	tons/day
Total northern waste		65.52	tons/day
Non-recyclables from transfer station to MRRF/working day, 5 days/week		85.31	tons/working day
Container Weight Capacity:	15 ton/container	6	roundtrips/day
Hours per roundtrip	25 miles/hour	1.90	hours/roundtrip
A truck will need to travel		273.25	miles/working day
		11.40	travel hours
Allowance:	1 hour start up per vehicle	3	startup hour
	1 washdown/inspection per roundtrip	6	wash/inspect hours
Required hours		21	total labor hours
Therefore, three trucks to run:		21.00	travel hours
Include one additional trailer to remain at transfer station for loading		3	trucks
		1	trailer

TOTAL WASTE (MRRF/TS to LANDFILL)

Northern Waste Destination Characterization			
Non-recyclables (to landfill)		34.94	tons/day
Recyclables recovered from MRRF, removal efficiency:	100.00%	25.99	tons/day
Total northern waste		60.93	tons/day
Travel Distance			
Southern Waste (sorted/processed at southern MRRF):			
Apra Harbor to Layon Landfill, roundtrip		38.8	miles/roundtrip
Southern Waste Characterization			
Known Recyclables		12.43	tons/day
Misc waste		14.21	tons/day
Total southern waste		26.64	tons/day
Southern Source Segregated Characterization			
Known Recyclables, 15% source segregated		1.86	tons/day
Misc waste + 85% non-source segregated		24.77	tons/day
Total southern waste		26.64	tons/day
Southern Waste Destination Characterization			
Non-recyclables (to landfill)		14.21	tons/day
Recyclables recovered from MRRF, removal efficiency:	100.00%	10.57	tons/day
Total southern waste		24.77	tons/day
Total non-recyclables (to landfill)		49.15	tons/day
Non-recyclables (to landfill) per working day, 5 days a week		68.81	tons/working day
Container Weight Capacity:	15 ton/container	5	roundtrips/day
Hours per roundtrip	25 miles/hour	1.55	hours/roundtrip

A truck will need to travel		194.00	miles/working day
		8.00	travel hours
Allowance:	1 hour start up per vehicle	2	startup hour
	1 washdown/inspection per roundtrip	5	wash/inspect hours
Required hours		15	total labor hours
Therefore, two trucks to run:		15.00	travel hours
Include one additional trailer to remain at MRRF for loading		2	trucks
		1	trailer

RECYCLABLES TO PORT

Material	Production		Weight per bale (lbs)		No. bales per year	Weight of container	Containers shipped
	lbs/day	lbs/yr	Min.	Max.	(Min. Wt)	lbs	per year
Cardboard	5,733.6	2,092,768.7	1,200	1,500	1,744.0	33,600	62
Aluminum Cans	2,969.9	1,084,017.5	900	1,125	1,204.5	25,200	43
Plastic Containers	2,127.7	776,619.1	1,200	1,400	647.2	33,600	23
Glass	6,542.4	2,387,959.2	N/A	N/A	N/A	36,000	66
Mixed Paper	10,197.0	3,721,915.7	1,000	1,690	3,721.9	28,000	132
Expended Brass[a]	87.2	31,828.0	N/A	N/A	N/A	N/A	N/A
Scrap Metal	1,389.2	507,047.0	N/A	N/A	N/A	36,000	14
Wood Pallets (40lb)	3,124.2	1,140,316.0	N/A	N/A	N/A	13,680	83
Compostable Material	3,510.1	1,281,189.1	N/A	N/A	N/A	N/A	N/A
Total Containers Shipped Per Year							423

Notes:

[a] Expended Brass must be recycled through DRMO and may not be shipped off of Guam for recycling

Compostable Material will not be shipped

Assumptions:

Brass density = 543 PCF

Scrap metal density (estimated) = 480 PCF

Glass density = 1000 - 2000 lbs/CY

All brass is generated in Northern Guam

Number of containers shipped per year		423	containers
Transport Costs (From Naval Base)	$60 each way	$120	round trip
Total transport cost for recyclables to port		$50,760	total annual cost

Total trucks for operation		5	trucks
Total trailers for operation		2	trailers
Total hours per day		36.00	hours
Total hours per year		9385.20	hours
Labor cost per year	$39.54 per hour	**$371,091**	
Total containers shipped per year		423	containers
Container transport cost per year		**$50,760**	
Total labor and transport cost per year		**$422,000**	

ALTERNATIVE 3: ONE MRRF IN NORTHERN GUAM

SOUTHERN WASTE

Travel Distances			
Southern Waste (travel to northern MRRF):			
Apra Harbor Naval Base to Andersen AFB		45.5	miles/unit
Southern Waste (sorted/processed at northern MRRF):			
Andersen AFB to Layon Landfill		58.8	miles/unit

SOUTHERN WASTE (Transfer station to MRRF/TS)

Southern Waste Characterization			
Known Recyclables		12.43	tons/day
Misc waste		14.21	tons/day
Total southern waste		26.64	tons/day
Southern Source Segregated Characterization			
Known Recyclables, 15% source segregated		1.86	tons/day
Misc waste + 85% non-source segregated		24.77	tons/day
Total southern waste		26.64	tons/day
Southern Waste to MRRF per working day, 5 days a week		34.68	tons/working day
Container Weight Capacity:	15 ton/container	3	roundtrips/day
Hours per roundtrip	25 miles/hour	1.90	hours/roundtrip
A truck will need to travel		136.63	miles/working day
		5.70	travel hours
Allowance:	1 hour start up per vehicle	2	startup hour
	1 washdown/inspection per roundtrip	3	wash/inspect hours
Required hours		11	total labor hours
Therefore, two trucks to run concurrently:		11.00	travel hours
Include one additional trailer to remain at transfer station for loading		2	trucks
		1	trailer

TOTAL WASTE (MRRF/TS to Landfill)

Travel Distances			
Northern Waste (sorted/processed at northern MRRF):			
Andersen AFB to Layon Landfill, roundtrip		58.8	miles/round trip
Northern Waste Characterization			
Known Recyclables		30.58	tons/day
Misc waste		34.94	tons/day
Total northern waste		65.52	tons/day
Northern Source Segregated Characterization			
Known Recyclables, 15% source segregated		4.59	tons/day
Misc waste + 85% non-source segregated		60.93	tons/day
Total northern waste		65.52	tons/day
Northern Waste Destination Characterization			
Known Recyclables, 15% source segregated		4.59	tons/day
Non-recyclables (to landfill)		34.94	tons/day
Recyclables recovered from MRRF, removal efficiency:	100.00%	25.99	tons/day
Total northern waste		65.52	tons/day
Southern Waste Destination Characterization			
Known Recyclables, 15% source segregated		1.86	tons/day
Non-recyclables (to landfill)		14.21	tons/day
Recyclables recovered from MRRF, removal efficiency:	100.00%	10.57	tons/day
Total southern waste		26.64	tons/day

Total non-recyclables (to landfill)		49.15	tons/day
Total Non-recyclables (to landfill) per working day, 5 days a week		68.81	tons/working day
Container Weight Capacity:	15 ton/container	5	roundtrips/day
Hours per roundtrip	25 miles/hour	2.40	hours/roundtrip
A truck will need to travel		293.86	miles/working day
		12.00	travel hours
Allowance:	1 hour start up per vehicle	2	startup hour
	1 washdown/inspection per roundtrip	5	wash/inspect hours
Required hours		19	total labor hours
Therefore, three trucks to run concurrently:		19.00	travel hours
Include one additional trailer to remain at MRRF for loading		3	trucks
		1	trailer

RECYCLABLES TO PORT

Material	Production		Weight per bale (lbs)		No. bales per year	Weight of container	Containers shipped
	lbs/day	lbs/yr	Min.	Max.	(Min. Wt)	lbs	per year
Cardboard	5,733.6	2,092,768.7	1,200	1,500	1,744.0	33,600	62
Aluminum Cans	2,969.9	1,084,017.5	900	1,125	1,204.5	25,200	43
Plastic Containers	2,127.7	776,619.1	1,200	1,400	647.2	33,600	23
Glass	6,542.4	2,387,959.2	N/A	N/A	N/A	36,000	66
Mixed Paper	10,197.0	3,721,915.7	1,000	1,690	3,721.9	28,000	132
Expended Brass[a]	87.2	31,828.0	N/A	N/A	N/A	N/A	N/A
Scrap Metal	1,389.2	507,047.0	N/A	N/A	N/A	36,000	14
Wood Pallets (40lb)	3,124.2	1,140,316.0	N/A	N/A	N/A	13,680	83
Compostable Material	3,510.1	1,281,189.1	N/A	N/A	N/A	N/A	N/A
Total Containers Shipped Per Year							423

Notes:

[a] Expended Brass must be recycled through DRMO and may not be shipped off of Guam for recycling

Compostable Material will not be shipped

Assumptions:

Brass density = 543 PCF
Scrap metal density (estimated) = 480 PCF
Glass density = 1000 - 2000 lbs/CY
All brass is generated in Northern Guam

Number of containers shipped per year		423	containers
Transport Costs (From AAFB)	$108 each way	$216	round trip
Total transport cost for recyclables to port		$91,368	total annual cost
Total trucks for operation		5	trucks
Total trailers for operation		2	trailers
Total hours per day		30.00	hours
Total hours per year		7821.00	hours
Labor cost per year	$39.54 per hour	**$309,242**	
Total containers shipped per year		423	containers
Container transport cost per year		**$91,368**	
Total labor and transport cost per year		**$401,000**	

ALTERNATIVE 4: MRRF IN BARRIGADA, GUAM

TOTAL WASTE (MRRF/TS TO LANDFILL)

Travel Distance

Northern Waste (sorted/processed at central MRRF):			
Central MRRF at Barrigada to Layon Landfill, roundtrip		37.0	miles/round trip
Northern Waste Characterization			
Known Recyclables		30.58	tons/day
Misc waste		34.94	tons/day
Total northern waste		65.52	tons/day
Northern Source Segregated Characterization			
Known Recyclables, 15% source segregated	=	4.59	tons/day
Misc waste + 85% non-source segregated	=	60.93	tons/day
Total northern waste	=	65.52	tons/day
Northern Waste Destination Characterization			
Known Recyclables, 15% source segregated	=	4.59	tons/day
Non-recyclables (to landfill)		34.94	tons/day
Recyclables recovered from MRRF, removal efficiency:	100.00%	25.99	tons/day
Total northern waste		65.52	tons/day
Travel Distance			
Southern Waste (sorted/processed at central MRRF):			
Central MRRF at Barrigada to Layon Landfill, roundtrip		37.0	miles/unit
Southern Waste Characterization			
Known Recyclables		12.43	tons/day
Misc waste		14.21	tons/day
Total southern waste		26.64	tons/day
Southern Source Segregated Characterization			
Known Recyclables, 15% source segregated		1.86	tons/day
Misc waste + 85% non-source segregated		24.77	tons/day
Total southern waste		26.64	tons/day
Southern Waste Destination Characterization			
Non-recyclables (to landfill)		14.21	tons/day
Recyclables recovered from MRRF, removal efficiency:	100.00%	10.57	tons/day
Total southern waste		24.77	tons/day
Total non-recyclables (to landfill)		49.15	tons/day
Non-recyclables (to landfill) per working day, 5 days a week		68.81	tons/working day
Container Weight Capacity:	15 ton/container	5	roundtrips/day
Hours per roundtrip	25 miles/hour	1.50	hours/roundtrip
A truck will need to travel		185.20	miles/working day
		7.50	travel hours
Allowance:	1 hour start up per vehicle	2	startup hour
	1 washdown/inspection per roundtrip	5	wash/inspect hours
Required hours		15	total labor hours
Therefore, two trucks to run:		$\boxed{15.00}$	total labor hours
Include one additional trailer to remain at MRRF for loading		2	trucks
		1	trailer

RECYCLABLES TO PORT

Material	Production		Weight per bale (lbs)		No. bales per year	Weight of container	Containers shipped
	lbs/day	lbs/yr	Min.	Max.	(Min. Wt)	lbs	per year
Cardboard	5,733.6	2,092,768.7	1,200	1,500	1,744.0	33,600	62
Aluminum Cans	2,969.9	1,084,017.5	900	1,125	1,204.5	25,200	43
Plastic Containers	2,127.7	776,619.1	1,200	1,400	647.2	33,600	23
Glass	6,542.4	2,387,959.2	N/A	N/A	N/A	36,000	66
Mixed Paper	10,197.0	3,721,915.7	1,000	1,690	3,721.9	28,000	132
Expended Brass[a]	87.2	31,828.0	N/A	N/A	N/A	N/A	N/A
Scrap Metal	1,389.2	507,047.0	N/A	N/A	N/A	36,000	14
Wood Pallets (40lb)	3,124.2	1,140,316.0	N/A	N/A	N/A	13,680	83
Compostable Material	3,510.1	1,281,189.1	N/A	N/A	N/A	N/A	N/A
Total Containers Shipped Per Year							423

Notes:

[a] Expended Brass must be recycled through DRMO and may not be shipped off of Guam for recycling
Compostable Material will not be shipped

Assumptions:

Brass density = 543 PCF
Scrap metal density (estimated) = 480 PCF
Glass density = 1000 - 2000 lbs/CY
All brass is generated in Northern Guam

Number of containers shipped per year		423	containers
Transport Costs (From Barrigada)	$108 each way	$216	round trip
Total transport cost for recyclables to port		$91,368	total annual cost

Total trucks for operation		2	trucks
Total trailers for operation		1	trailer
Total hours per day		15.00	hours
Total hours per year		3910.50	hours
Labor cost per year	$39.54 per hour	**$154,621**	
Total containers shipped per year		423	containers
Container transport cost per year		**$91,368**	
Total labor and transport cost per year		**$246,000**	

100% Relative Efficiency Bin Collection

	Automated Side-Loading Trucks	Automated Front-Loading	Automated Roll-Off Trucks Needed	Efficiency Relative to Existing
Total	11	9	3	100%
Northern Guam	7	5	0	100%
Southern Guam	4	4	3	100%

Alternatives For Solid Waste Collection

Currently refuse bins are collected primarily in the southern Guam region and delivered to the Apra Harbor Landfill, which is nearby. Projected bins of solid waste will need to be transported to a transfer station, which is in northern or southern Guam, under one of four alternatives:

Alternatives 1-3

Alternatives 1-3 - Two transfer stations are constructed, one in the north and one in the south. All solid waste is taken to the nearest MRRF/transfer station, then transported to the Layon Landfill in roll-off transfer trailers after processing at the MRRF.

	Commercial	Residential	Roll Off
North Increased Operations %	0%	6%	0%
South Increased Operations %	0%	0%	0%

	Automated Side-Loading Trucks	Automated Front-Loading	Automated Roll-Off Trucks Needed
Total	12	9	3
Northern Guam	8	5	0
Southern Guam	4	4	3

Alternative 4

Alternative 4 - One MRRF/transfer station is constructed in Barrigada. All solid waste in northern Guam is taken to the MRRF/transfer station. Solid waste in southern Guam is taken to the MRRF/transfer station in Barrigada. Solid waste is later transported from the MRRF/transfer station to the Layon Landfill in roll-off transfer trailers.

	Front Loader	Side Loader	Roll Off
North Increased Operations %	22%	55%	0%
South Increased Operations %	24%	62%	102%

	Automated Side-Loading Trucks	**Automated Front-Loading**	**Automated Roll-Off Trucks Needed**
Total	18	12	7
Northern Guam	11	7	0
Southern Guam	7	5	7

Existing 90-gallon Bin Collection

Currently refuse bins are being collected primarily in the southern Guam region and being delivered to the Apra Harbor Landfill, which is nearby.

Existing Automated Side-Loading Trucks in Operation	2
Existing Number of Collected 90-gal Bins	1624
90-gal Bin Collection Capacity Per Truck	812

Projected Bin Collection

If a northern and southern Guam transfer station is provided, then the projected collection capacity will remain the same as the existing condition. The solid waste will later be transported to the Layon Landfill.

Northern Guam Automated Side-Loading Trucks Required

Projected Number of 90-gal Bins	5239
90-gal Bin Collection Capacity Per Truck	812
Number of Automated Side-Loading Trucks Required	**7.0**

Southern Guam Automated Side-Loading Trucks Required

Projected Number of 90-gal Bins	3199
90-gal Bin Collection Capacity Per Truck	812
Number of Automated Side-Loading Trucks Required	**4.0**

Existing 3, 6, & 8 CY Bin Collection

Currently refuse bins are being collected primarily in the southern Guam region and being delivered to the Apra Harbor Landfill, which is nearby.

Existing Automated Front-Loading Trucks in Operation	2
Existing Number of Collected 3, 6 & 8 cy Bins	121
3, 6 & 8 cy Bin Collection Capacity Per Truck	60.5

Projected Bin Collection

If a northern and southern Guam transfer station is provided, then the projected collection capacity will remain the same as the existing condition. The solid waste will later be transported to the Layon Landfill.

Northern Guam Automated Front-Loading Trucks Required

Projected Number of 3, 6 & 8 cy Bins	296
3, 6 & 8 cy Bin Collection Capacity Per Truck	60.5
Number of Automated Front-Loading Trucks Required	**5**

Southern Guam Automated Front-Loading Trucks Required

Projected Number of 3, 6 & 8 cy Bins	183
3, 6 & 8 cy Bin Collection Capacity Per Truck	60.5
Number of Automated Front-Loading Trucks Required	**4**

Existing 20 & 40 CY "DINO" Bin Collection

Currently "DINO" bins are being collected primarily in the southern Guam region and being delivered to the Apra Harbor Landfill, which is nearby.

Existing Automated Roll-Off Trucks in Operation	3
Existing Number of Collected 20 & 40 cy Bins	58
20 & 40 cy Bin Collection Capacity Per Truck	19

Projected Bin Collection

If a southern Guam transfer station is provided, then the projected collection capacity will remain the same as the existing condition. The solid waste will later be transported to the Layon Landfill. Number of bins and collection trucks remain the same.

Northern Guam Automated Roll-Off Trucks Required

Projected Number of 20 & 40 cy Bins	0
20 & 40 cy Bin Collection Capacity Per Truck	19
Number of Automated Roll-Off Trucks Required	**0**

Southern Guam Automated Roll-Off Trucks Required

Projected Number of 20 & 40 cy Bins	58
20 & 40 cy Bin Collection Capacity Per Truck	19
Number of Automated Roll-Off Trucks Required	**3**

Alternatives 1-3 Bin Collection

Northern Guam and southern Guam refuse bins will be delivered to transfer stations. The efficiency of bin collection in southern Guam will not be affected. The efficiency of residential 90-gal bin collection in northern Guam will decrease slightly due to travel time to the AAFB Transfer Station, which is located away from a majority of the side loaders' 90-gallon refuse bin collection sites.

Solid Waste Transport - From Northern Collection Routes to AAFB Transfer Station

Location	Travel Distance to MRRF/transfer station(km)	Travel Distance to MRRF/transfer station (mi)	Travel Time to MRRF/transfer station(min)
Andersen Air Force Base	12	7	14

(a) Estimated vehicular speed of 30 miles per hour

Northern Guam Bin Collection	**Front Loader**	**Side Loader**
Number of Trips to Transfer Station[a]	1.00	2.00
Increase in Travel Time per Trip (min)	0	29
Increase in Travel Time per Trip (hrs)	0.00	0.48
Waiting Time per trip due to traffic (hrs)	0.00	0.00
Increase in Time Per Trip (hrs)	0.00	0.48
Total Increase in Time (hrs)	0.00	0.96
Existing Collection Hours per Day (hrs)	8	8
New Collection Hours per Day (hrs)[b]	8.00	7.52
Efficiency (%)	100%	94%
Increase in operation needed to meet 100% efficiency condition (%)	**0%**	**6%**

Southern Guam Bin Collection	**Front Loader**	**Side Loader**	**Roll Off**
Number of Trips to Transfer Station[a]	1.00	2.00	2.00
Increase in Travel Time per Trip (min)	0	0	0
Increase in Travel Time per Trip (hrs)	0.00	0.00	0.00
Increase in Processing Time per trip (hrs)	0.00	0.00	0.00
Increase in Time Per Trip (hrs)	0.00	0.00	0.00
Total Increase in Time (hrs)	0.00	0.00	0.00
Existing Collection Hours per Day (hrs)	8	8	8
New Collection Hours per Day (hrs)[b]	8.00	8.00	8.00
Efficiency (%)	100%	100%	100%
Increase in operation needed to meet 100% efficiency condition (%)	**0%**	**0%**	**0%**

(a) Busiest side loader pick up days require 3 trips for 2 trucks in a day, which is rounded up to 2 trips.

(b) The existing number of collection hours per day is decreased by the additional travel and processing time associated with direct trips to the transfer station. This decreases efficiency and requires an increase in the number of trucks in operation to make up the difference.

Alternative 4 Bin Collection

Northern Guam and southern Guam refuse bins will be delivered to a central MRRF/transfer station located at Barrigada. The efficiency of bin collection will be decreased. The decrease in efficiency will be caused by increased travel time from the immediate areas (NCTS and Apra Harbor) to the MRRF/transfer station at Barrigada and back.

Solid Waste Transport - From Collection Routes to MRRF/Transfer Station

Location	Travel Distance MRRF/Transfer Station (km)	Travel Distance MRRF/Transfer Station (mi)	Travel Time MRRF/Transfer Station (min)
Andersen Air Force Base	22	14	28
Apra Harbor Naval Base	25	15	31

(a) Estimated vehicular speed of 30 miles per hour

Northern Guam Bin Collection	**Front Loader**	**Side Loader**
Number of Trips to Transfer Station[a]	1.00	2.00
Increase in Travel Time per Trip (min)	56	56
Increase in Travel Time per Trip (hrs)	0.93	0.93
Waiting Time per trip due to traffic (hrs)	0.50	0.50
Increase in Time Per Trip (hrs)	1.43	1.43
Total Increase in Time (hrs)	1.43	2.85
Existing Collection Hours per Day (hrs)	8	8
New Collection Hours per Day (hrs)[b]	6.57	5.15
Efficiency (%)	82%	64%
Increase in operation needed to meet 100% efficiency condition (%)	**22%**	**55%**

Southern Guam Bin Collection	**Front Loader**	**Side Loader**	**Roll Off**
Number of Trips to Transfer Station[a]	1.00	2.00	2.00
Increase in Travel Time per Trip (min)	61	61	61
Increase in Travel Time per Trip (hrs)	1.02	1.02	1.02
Waiting Time per trip due to traffic (hrs)	0.50	0.50	1.00
Increase in Time Per Trip (hrs)	1.52	1.52	2.02
Total Increase in Time (hrs)	1.52	3.05	4.05
Existing Collection Hours per Day (hrs)	8	8	8
New Collection Hours per Day (hrs)[b]	6.48	4.95	3.95
Efficiency (%)	81%	62%	49%
Increase in operation needed to meet 100% efficiency condition (%)	**24%**	**62%**	**102%**

(a) Busiest side loader pick up days require 3 trips for 2 trucks in a day, which is rounded up to 2 trips.

(b) The existing number of collection hours per day is decreased by the additional travel and processing time associated with direct trips to the transfer station. This decreases efficiency and requires an increase in the number of trucks in operation to make up the difference.

Solid Waste Collection Distribution

	Accompanied Personnel	Population (Total)	Curb Side Bins	Front Loaded Bins	DINO Bins
Total	8,438	45,954	8,438	479	58
Northern Guam	5,239	28,422	5,239	296	0
Southern Guam	3,199	17,532	3,199	183	58

Assumptions:

The number of 2006 accompanied military personnel is about 1,624. These personnel occupy residential housing. Each accompanied military personnel is assumed to have a family that will be living in residential housing and will require a 90-gallon refuse bin.

The number of 2006 military population on Guam is about 11,613. Military personnel are assumed to produce the commercial waste. An increase in military population is assumed to proportionally increase the number of front loaded bins required.

Upscaling Number of Bins Required For Projected Population

Current Guam Military Population	11,613
Current number of front loader bins	121
Number of people per bin	95.98
Projected Guam Military Population	45,954
Number of front loader bins needed	**479**

Breakdown of Bin Location

North Population	28,422
North Population %	61.85%
North Bins	296

South Population	17,532
South Population %	38.15%
South Bins	183

DINO bin usage will not be extended to northern Guam. Existing DINO bins will remain in service, and will continue to be picked up, but no additional bins will be added.

Existing 20 & 40 cy (DINO) Bins

Current Guam Military Population	11,613
Current number of DINO bins	58

Projected 20 & 40 cy (DINO) Bins

Northern Guam	0
Southern Guam	58

100% Relative Efficiency Recyclable Bin Collection

The condition of 100% efficiency occurs when recycling centers are constructed in both northern (NCTS Finegayan) and southern (Apra Harbor) Guam.

	Automated Side-Loading Trucks Needed	Automated Front-Loading Trucks	Efficiency Relative to Existing
Total	6	8	100%
Northern Guam	4	4	100%
Southern Guam	2	4	100%

Alternatives For Recyclable Collection

Mixed recyclables and green waste will be collected on a bi-weekly basis in residential communities and on a weekly basis in commercial sectors. 92 gallon side-loaded bins and 3 cy front loaded bins will be distributed just as the refuse bins are for these areas. The transportation and processing of these recyclables will occur as follows:

Two recycling centers are constructed, one in northern Guam and one in southern Guam.

Northern Guam Increased Operations %	0%
Southern Guam Increased Operations %	0%

	Automated Side-Loading Trucks Needed	Automated Front-Loading Trucks
Total	6	8
Northern Guam	4	4
Southern Guam	2	4

Existing Bin Collection (92 Gallons)

Currently bins are being collected twice a week for recyclables.

Existing Automated Side-Loading Trucks in Operation	2
Frequency of Bin Collection	2
Existing Number of Collected 92-gal Bins	1,624
Existing Number of Pick Ups for Collected 92-gal Bins	3,248
92-gal Bin Collection Capacity Per Truck	1,624

Projected Bin Collection

If northern and southern Guam recycling centers are provided, then the projected collection capacity will remain the same as the existing condition.

Mixed Recyclables

Northern Guam Automated Side-Loading Trucks Required

Projected Number of 92-gal Bins	4,014
Frequency of Bin Collection	0.5
92-gal Bin Collection Capacity Per Truck	1,624
Number of Automated Side-Loading Trucks Required	**2**

Southern Guam Automated Side-Loading Trucks Required

Projected Number of 92-gal Bins	3,199
Frequency of Bin Collection	0.5
92-gal Bin Collection Capacity Per Truck	1,624
Number of Automated Side-Loading Trucks Required	**1**

Green Waste

Northern Guam Automated Side-Loading Trucks Required (GW)

Projected Number of 92-gal Bins	4,808
Frequency of Bin Collection	0.5
92-gal Bin Collection Capacity Per Truck	1,624
Number of Automated Side-Loading Trucks Required	**2**

Southern Guam Automated Side-Loading Trucks Required (GW)

Projected Number of 92-gal Bins	2,324
Frequency of Bin Collection	0.5
92-gal Bin Collection Capacity Per Truck	1,624
Number of Automated Side-Loading Trucks Required	**1**

Total Number of Trucks Required in Northern Guam	**4**
Total Number of Trucks Required in Southern Guam	**2**

Existing Bin Collection (3, 6, 8 CY)

Recycling bins are being collected primarily in the Southern Guam region on a weekly basis.

Existing Automated Front-Loading Trucks in Operation	2
Existing Number of Collected 3, 6 & 8 cy Bins	121
3, 6 & 8 cy Bin Collection Capacity Per Truck	60.5

Projected Bin Collection

If northern and southern Guam recycling centers are provided, then the projected collection capacity will remain the same as the existing condition.

Northern Guam Automated Front-Loading Trucks Required

Projected Number of 3, 6 & 8 cy Bins	221
6 cy Bin Collection Capacity Per Truck	60.5
Number of Automated Front-Loading Trucks Required	**4**

Southern Guam Automated Front-Loading Trucks Required

Projected Number of 3, 6 & 8 cy Bins	183
6 cy Bin Collection Capacity Per Truck	60.5
Number of Automated Front-Loading Trucks Required	**4**

Bin Collection

Northern Guam and Southern Guam recycling bins will be delivered to the nearby recycling centers. The efficiency of bin collection will not be affected.

Mixed Recyclable and Green Waste Transport - Between Northern Guam and Southern Guam

Location	Travel Distance NCTS (km)	Travel Distance NCTS (mi)	Travel Time NCTS (min)	Travel Distance Apra Harbor (km)	Travel Distance Apra Harbor (mi)	Travel Time Apra Harbor (min)
NCTS	0.0	0.0	0	31.5	19.5	39
Apra Harbor Naval Base	31.5	19.5	39	0.0	0.0	0

(a) Estimated vehicular speed of 30 miles per hour

Northern Guam Bin Collection

Additional Travel Time (min)	0
Additional Travel Time (hrs)	0.00
Existing Route Time (hrs)	8
New Route Time (hrs)	8.00
Efficiency (%)	100%
Increased operation to meet 100% efficiency condition (%)	**0%**

Southern Guam Bin Collection

Additional Travel Time (min)	0
Additional Travel Time (hrs)	0.00
Existing Route Time (hrs)	8
New Route Time (hrs)	8.00
Efficiency (%)	100%
Increased operation to meet 100% efficiency condition (%)	**0%**

Revised Final

Barrigada Utility Study to Support USMC Off-Base Housing Facilities Requirements

June 2010

Department of the Navy
Naval Facilities Engineering Command, Pacific
258 Makalapa Drive, Suite 100
Pearl Harbor, HI 96860-3134

Contract Number N62742-06-D-1870, TO 0035

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Prepared for:

Department of the Navy
Naval Facilities Engineering Command, Pacific
258 Makalapa Drive, Suite 100
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Contract Number N62742-06-D-1870, TO 0035

EXECUTIVE SUMMARY

The *Guam Joint Military Master Plan* (GJMMP) (JGPO 2009) identifies a planned increase in military population and activity on Guam. The Environmental Impact Statement (EIS) for this action presents several EIS Cantonment alternatives for the United States Marine Corps (USMC). Potential sites for EIS Cantonment Alternative 3 and 8 include Department of Defense (DoD) land at Barrigada, Guam, specifically Navy Barrigada and Air Force (AF) Barrigada.

The Naval Facilities Engineering Command, Pacific, under Master Contract Number (no.) N62742-06-D-1870 issued Task Order no. 35 to the TEC, Inc. Joint Venture to study the electrical power, potable water, and wastewater utilities for EIS Cantonment Alternatives 3 and 8 at Barrigada, Guam. The Barrigada Utility Study will support the preparation of the EIS for the USMC relocation to Guam with sufficient and detailed information for EIS Cantonment Alternatives 3 and 8, including the interim and long-term alternatives for each of the three utilities; the study includes site plans, cost estimates, and schedule schemes. The status of existing utilities will be considered in preparing the required alternatives. The EIS Cantonment Alternatives 3 and 8 from the May 2009 in-progress EIS were used for this analysis.

The Barrigada Utility Study uses the projected military relocation populations provided from the Navy on 9 February 2009 (NAVFAC Pacific 2009) that are consistent with the populations used in the in-progress EIS for Guam. Housing locations for construction workers and increased civilian population on Guam required certain assumptions to assess the impact on existing utilities. An overview of the population data assumptions used in this study is provided below:

- Assumptions for distribution of the military, dependents, and civilian transient worker populations are derived from the Parsons Brinckerhoff Inc. model assumptions report (PB 2008) and are the same as used in the 28 January 2009 Traffic Analysis.
- Assumptions for family housing in Navy Barrigada (33 percent) and in AF Barrigada (33 percent) are derived from the Parsons Brinckerhoff Inc. model assumptions report (PB 2008) and the same as used in the 28 January 2009 Traffic Analysis.
- Assumptions for the on-base civilian work force are 40 percent of the active duty military population with 33 percent living in Navy Barrigada, 33 percent in AF Barrigada, and 33 percent in USMC Finegayan Base.

An overview of the utility findings and options that would be required to support EIS Cantonment Alternatives 3 and 8 are presented below. Because the impacted areas for Cantonment Alternative 3 are larger and inclusive of Alternative 8, Alternative 3 will be analyzed as representative of both alternatives. This approach will present the alternative with the maximum potential adverse effect and is consistent with the approach used in the 28 January 2009 Traffic Analysis.

Electrical Power Utility Overview

In the Guam Power Generation Study (ATS 2010a), electrical generation and distribution system improvements were recommended to serve the Finegayan Base (for EIS Cantonment Alternatives 1 and 2). The Guam Power Authority generation system would require additional power generation capacity to serve the USMC relocation and other DoD planned loads. The power generation requirements for Cantonment Alternative 3 would be similar to the Cantonment Alternatives 1 and 2, but the transmission and distribution requirements would be different.

EIS Cantonment Alternative 3 differs from the previously considered EIS Cantonment Alternatives 1 and 2 in that a portion of the accompanied service members is housed on Navy Barrigada and AF Barrigada. It is assumed that the overall conclusions documented in the Guam Power Generation Study

(ATS 2010a) would be the same for EIS Cantonment Alternative 3. Therefore, this report provides a detailed analysis of power distribution options to support Navy Barrigada and AF Barrigada facilities.

The electrical systems in both Navy and AF Barrigada areas would require extensive upgrades due to existing electrical distribution systems being inadequate to support requirements for the proposed housing. Those upgrades would include the following major components:

- New substation at AF Barrigada (Eagle Field area)
- Upgraded distribution between Highway 16 and the new AF Barrigada substation
- Upgrades to existing Navy Barrigada substation
- Upgrades to distribution between Highway 16 and Navy Barrigada substation

The upgrades would support the planned housing developments at Navy and AF Barrigada based on information available. Table ES-1 provides a summary of the options considered for upgrades to the electrical system.

Table ES-1: Cost Summary of Electrical Options Considered

Option	Option 1: Replace existing substation with new serving all loads	Option 2: Install new substation in both areas	Option 3: Upgrade existing Navy Barrigada substation and install new AF Barrigada substation	Option 4: Upgrade existing Navy Barrigada substation and feed AF Barrigada from GPA substation at 13.8kV
Capital Costs				
Total Capital Cost	$36,500,000	$45,000,000	$38,341,000	$33,000,000
Amortized Capital Cost	$2,686,000	$3,311,000	$2,821,000	$2,428,000
O&M Costs				
Total Annual Cost	$557,000	$686,000	$585,000	$503,000
Annual Life Cycle Costs	$3,243,000	$3,997,000	$3,406,000	$2,931,000
Estimated Construction Duration	*2.0 to 2.5 years*	*2.5 to 3.0 years*	*2.0 to 2.5 years*	*2.5 to 3.0 years*

O&M operations and maintenance

The options considered do not have widely varying costs; however, they do offer higher or lower reliability and have less direct impacts to long-term operation of each option. Option 3 was selected as the option that provides the best balance between reliability (reasonable circuit lengths) and costs. While Options 1 and 4 offer lower cost, they also have lower reliability due to long circuit lengths to serve Navy and AF Barrigada areas from locations that are further from the facilities. Option 2 has the highest cost but also provides new substations for each new housing area while not providing additional reliability or significant benefits to justify the higher cost.

Potable Water Utility Overview

In the Guam Water Utility Study (ATS 2010), development of groundwater resources was recommended as the primary source to serve the USMC Finegayan Base (Alternatives 1 and 2). The supply from rehabilitated wells and purchase of water from Guam Waterworks Authority (GWA) alone are not sufficient to meet USMC relocation water demand. Review of the available yield indicates that the water supply from the Northern Guam Lens Aquifer is sufficient to meet the projected demand based on the 1992 sustainable yield estimates.

EIS Cantonment Alternative 3 differs from the previously considered EIS Cantonment Alternatives 1 and 2 in that a portion of the accompanied service members is housed on Navy Barrigada and AF Barrigada. It is assumed that the overall conclusions documented in the Guam Water Utility Study (ATS 2010) would be the same for EIS Cantonment Alternative 3. Therefore, this report provides a detailed analysis of groundwater resource development as the primary source for Navy Barrigada and AF Barrigada.

Summary of Findings for Potable Water

The current and future water demands for the USMC relocation areas are shown in Table ES-2. Components of the proposed water system are shown in Table ES-3.

For EIS Cantonment Alternative 3, it was determined that the USMC Finegayan Base water supply would have capacity to serve Navy Barrigada demand. It is estimated that the wells installed on Navy Barrigada would be sufficient to supply AF Barrigada. The capacities for water system components, sized according to the Unified Facilities Criteria guidance, are presented in Table ES-4. Twenty (20) wells on Andersen Air Force Base (AFB) would meet the supply requirements for the USMC Finegayan Base water system. Eleven (11) wells on Navy Barrigada would meet the supply for AF Barrigada. Groundwater would be treated prior to distribution to USMC bases. Additional storage capacity is required at USMC Finegayan Base and AF Barrigada. Partial replacement of the NIW water system mains is needed to transport water from USMC Finegayan Base to the facilities in Barrigada. This study includes the cost of the transmission mains, excluding distribution from water storage to users.

Life cycle costs for EIS Cantonment Alternative 3 are shown in Table ES-5. Costs are based on year 2008 dollars and escalated to the mid-point year of construction. The costs of the alternatives presented in this study do not include components for DoD that do not relate to the USMC relocation. The present worth cost is $401 million (M).

Table ES-2: DoD Water Demands in USMC Relocation Areas

Projected Potable Water Demands	Baseline (2009)	Estimated Increase (2019)	Total Future Loading (2019)
Average Daily Demand (mgd)			
USMC Finegayan Base	0.1	3.7	3.9
Barrigada (Navy and Air Force)	0.0	2.2	2.2
Maximum Daily Demand (mgd)			
USMC Finegayan Base	0.2	6.2	6.7
Barrigada (Navy and Air Force)	0.0	4.4	4.4

mgd million gallons per day

Table ES-3: Proposed Water System Components

Component	Description
Water Supply	• Development of up to 20 new water supply wells (including one contingency well) at Andersen AFB • Development of up to 11 new water supply wells (including one contingency well) at Navy Barrigada • Continued use of existing Navy wells at USMC Finegayan Base
Water Treatment	• Disinfection and fluoridation prior to transmission to the new base from the 20 new water supply wells on Andersen AFB and the 11 new water supply wells on Navy Barrigada
Water Storage	• Continued use of existing Navy Barrigada storage tank • Construction of up to three new storage tanks at USMC Finegayan Base • Construction of a new storage tank at AF Barrigada • Abandonment of existing Navy storage tanks at USMC Finegayan Base
Distribution System	• Waterlines to transport the water from supply wells to storage tanks (ground level tank on USMC Finegayan Base, Barrigada tank and the ground level storage tank on AF Barrigada)
	• An interconnect with the NIW water system • Improvements to the NIW water system between AF Barrigada and USMC Finegayan Base (i.e., extend system to AF Barrigada, size pipes appropriately, replace corroded pipes, transport water to the south as well as north) • Pumping stations

Table ES-4: Facility Capacities for Water

<table>
<tr><th rowspan="2"></th><th colspan="3">USMC Relocation Areas</th></tr>
<tr><th>Finegayan Base [a]</th><th>Navy Barrigada</th><th>AF Barrigada</th></tr>
<tr><td colspan="4">Water Supply (mgd)</td></tr>
<tr><td>Existing Supply</td><td colspan="2">0.0</td><td>0.0</td></tr>
<tr><td>Additional Required</td><td colspan="2">9.5</td><td>2.5</td></tr>
<tr><td>Additional Planned Capacity</td><td colspan="2">9.5</td><td>2.5</td></tr>
<tr><td>Total Future Capacity</td><td colspan="2">9.5</td><td>2.5</td></tr>
<tr><td colspan="4">Water Storage (MG)</td></tr>
<tr><td>Existing Storage</td><td>0</td><td>3.0</td><td>0</td></tr>
<tr><td>Additional Required</td><td>3.3</td><td>0</td><td>1</td></tr>
<tr><td>Future Planned Capacity</td><td>3.3</td><td>0</td><td>1</td></tr>
<tr><td>Total Future Capacity</td><td>3.3</td><td>3.0</td><td>1.0</td></tr>
</table>

[a] It is assumed that all existing storage facilities on Finegayan would be demolished.

Table ES-5: Cantonment Alternative 3 Life Cycle Costs

Capital Costs	Cost ($000)
Total Construction Cost	$161,337
Contingencies (20%)	$32,267
Engineering (15%)	$24,201
Total Capital Cost	**$217,805**
Present Worth Guam Capital Costs	**$219,513**
Annual O&M Costs	
Total Annual O&M Cost	$6,350
Contingency (20%)	$1,270
Total Annual O&M Cost	**$7,620**
Present Worth of O&M Costs (25 year life)	**$181,867**
Present Worth of Total Costs	**$401,380**

% percent

Wastewater Utility Overview

To identify reasonable wastewater treatment options to support the potential EIS Cantonment alternatives, four wastewater options were analyzed in detail in this study:

- Expand and upgrade the Government of Guam (GovGuam) Northern District WWTP to secondary treatment and convey wastewater generated at Barrigada housing site to the NDWWTP.
- Expand and upgrade the GovGuam Hagatna WWTP to secondary treatment.
- Build new secondary treatment plant near the proposed development on DoD land and construct new outfall.
- Build new separate secondary treatment plant at GovGuam Hagatna WWTP site to treat DoD load only.

The current and projected increased average daily wastewater flows in the central Guam wastewater basin related to the Barrigada housing alternatives of USMC relocation to Guam are summarized in Table ES-6. Military flow is generated from the military activities in Navy Barrigada and AF Barrigada, while outside base civilian flow includes the flows generated from Guam population and its natural growth, and induced population due to military relocation in the region.

Table ES-7 presents total present capital costs and annual life cycle costs of the four viable options based on year 2009 cost.

Table ES-6: Current and Future Average Wastewater Flow in Central Guam for USMC Relocation Main Cantonment Alternative 3

Projected Wastewater Flows	Baseline (Y2009)	Estimated Increase (Y2019)	Total Future Loading (Y2019)
Outside-base Civilian, mgd	4.38	1.76	6.14
Military, mgd	0.34	1.05	1.40
Total Central Guam Flow, mgd	**4.72**	**2.82**	**7.54**

Assumptions:
1. No Navy, AF, Coast Guard, and Guam National Guard population increase in Barrigada area.
2. Number of USMC and Army personnel and dependents in Barrigada obtained from Guam Traffic Analysis Data spreadsheet (01-28-09).
3. Navy Barrigada existing flow (Y2009) estimated 80% of water demand data (total - irrigation) supplied by Jack Brown of NAFM.
4. Off-base civilian existing flow (2009) estimated by deducting DoD flow from Hagatna WWTP flow data provided by GWA.
5. Off-base civilian future flow (Y2019) calculated by 38% north, 43% central, and 19% south of island-wide civilian natural population growth data from US Census Bureau, International Data Base (IBD), and 15 Dec 2008: http://www.census.gov/ipc/www/ibd/.

Table ES-7: Cost Summary of Wastewater Viable Options

Option	Option 1: Expand and upgrade the GovGuam Northern District WWTP to secondary treatment	Option 2: Expand & Upgrade Hagatna WWTP to Secondary Treatment	Option 3: DoD Secondary Treatment on DoD Land	Option 4: Separate Secondary Treatment at Hagatna WWTP Site to Treat DoD Load Only
Capital Costs				
Total Capital Cost	$225,173,000	$90,319,000	$158,220,000	$65,237,000
Amortized Capital Cost	$16,569,000	$6,646,000	$11,642,000	$4,800,000
USMC Barrigada Housing Related Treatment Capital Cost	*$40,383,000*	*$29,773,000*	*$81,961,000*	*$49,280,000*
O&M Costs				
Total Annual Cost	$3,096,000	$2,722,000	$1,396,000	$995,000
Annual Life Cycle Costs	$19,665,000	$9,368,000	$13,038,000	$5,795,000
Estimated Construction Duration	*4.0 to 5.5 years*	*3.5 to 4.5 years*	*4.0 to 5.5 years*	*4.0 to 5.5 years*

Option 1's annual life cycle cost of $19,665,000 (includes amortized construction cost and estimated annual operations and maintenance [O&M] cost) and total construction cost of $225,173,000 are the highest of the available options. However, this is the recommended option because of factors related to NPDES permit requirements. According to the EPA Region 9:

- the increased discharge from DoD activities on Guam would have an impact on the existing NPDES permit requirements, water quality standards, and NPDES requirements for current and any future effluent discharge, and
- NPDES requirements for current and any future effluent discharge would be based on EPA secondary treatment technology based requirements.

This requirement means that all wastewater treatment facilities on Guam would need to meet secondary treatment standards. Option 1 allows the Navy to focus on funding only one treatment facility that is closer to the region with USMC main activities. Also, the DoD has committed to arrange a third-party funding using a private entity to finance the necessary upgrades to NDWWTP. Based on the funding and water quality issues, Option 1 is the recommended option.

To further support the selection of Option 1, both Option 1 and Option 3 have one wastewater treatment facility for both USMC main base and off-base housing. The USMC's capital cost share of $40,383,000 based on wastewater flow contribution for Option 1 is lower than the cost of $81,961,000 for Option 3. The proposed upgrades in Option 1 could be implemented in phased construction. With restoring primary treatment capacity in the NDWWTP, the plant is able to handle additional wastewater generated from the construction workforce and the proposed project induced population in northern Guam during the interim period for primary treatment. After the remaining proposed expansions and upgrades are complete, the NDWWTP could treat proposed future flow from both civilian population and military activities with secondary biological treatment to fulfill EPA requirements.

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FIGURES

TABLES

ACRONYMS AND ABBREVIATIONS

%	percent
$	United States dollar
ACP	asbestos cement pipes
AF	Air Force
AFB	Air Force Base
AMD	Air and Missile Defense
amp	ampere
BOD	biochemical oxygen demand
DoD	Department of Defense
EIS	Environmental Impact Statement
EO	Executive Order
EPA	Environmental Protection Agency, United States
ESQD	Explosive Safety Quantity Distance
ESS	Explosives Safety Submission
ft	foot/feet
gal	gallon
GEPA	Guam Environmental Protection Agency
GJMMP	Guam Joint Military Master Plan
GovGuam	Government of Guam
GPA	Guam Power Authority
gpcd	gallons per capita per day
gpd	gallons per day
gpm	gallons per minute
GWA	Guam Waterworks Authority
GWRMP	Guam Water Resources Master Plan
GWUDI	groundwater under the direct influence of surface water
HDBK	handbook
HP	horsepower
IBD	inhabited building distance
kV	kilovolt
M	million
MARBO	Marianas Bonins Command
MEC	munition and explosive of concern
MG	million gallons
mg/L	milligram per liter
mgd	million gallons per day
MIL	military
msl	mean sea level
MVA	million volt-ampere
MW	megawatt
NAVCOMM	Naval Communications
NAVFAC	Naval Facilities Engineering Command
NCTS	Naval Computer and Telecommunications Station
NEXRAD	Next Generation Radar
NGLA	Northern Guam Lens Aquifer
NIW	Navy Island-Wide
no.	number

NOSSA	Naval Ordnance Safety and Security Activity
NPDES	National Pollutant Discharge Elimination System
NWF	Northwest Field
O&M	operations and maintenance
PVC	polyvinyl chloride
SPS	sewage pump station
T&D	transmission and distribution
TSS	total suspended solids
U.S.	United States
UFC	Unified Facilities Criteria
UFW	unaccounted for water
USCG	United States Coast Guard
USMC	United States Marine Corps
UV	ultra violet
UXO	unexploded ordnance
VCP	vitrified clay pipes
WWTP	wastewater treatment plant

1. Introduction

The *Guam Joint Military Master Plan* (GJMMP) (JGPO 2009) identifies a planned increase in military population and activity on Guam. The Environmental Impact Statement (EIS) for this action presents several EIS Cantonment alternatives for the United States (U.S.) Marine Corps (USMC). Potential sites for EIS Cantonment Alternatives 3 and 8 include Department of Defense (DoD) land at Barrigada, Guam, specifically Navy Barrigada and Air Force (AF) Barrigada.

The Naval Facilities Engineering Command (NAVFAC), Pacific, under Master Contract Number (no.) N62742-06-D-1870 issued Task Order no. 35 to the TEC, Inc Joint Venture to study the electrical power, potable water, and wastewater utilities for EIS Cantonment Alternatives 3 and 8 at Barrigada, Guam. The Barrigada Utility Study will support the preparation of the EIS for the USMC relocation to Guam with sufficient and detailed information for EIS Cantonment Alternatives 3 and 8, including the interim and long-term alternatives for each of the three utilities; the study includes site plans, cost estimates, and schedule schemes. The status of existing utilities will be considered in preparing the required alternatives. The EIS Cantonment Alternatives 3 and 8 from the May 2009 in-progress EIS are shown on Figure 1-1 and Figure 1-2.

The Barrigada Utility Study uses the military relocation populations presented in Table 1-1 through Table 1-6, which are the projected populations provided from the Navy on 9 February 2009 (NAVFAC Pacific 2009) and are consistent with the populations used in the in-progress EIS for Guam. Housing locations for construction workers and increased civilian population on Guam required certain assumptions in order to assess the impact on existing utilities. An overview of the population data assumptions used in this study is provided below:

- Assumptions for distribution of the military, dependents, and civilian transient worker populations are derived from the Parsons Brinckerhoff Inc. model assumptions report (PB 2008) and are the same as used in the 28 January 2009 Traffic Analysis.
- Assumptions for family housing in Navy Barrigada (33 percent) and in AF Barrigada (33 percent) are derived from the Parsons Brinckerhoff Inc. model assumptions report (PB 2008) and the same as used in the 28 January 2009 Traffic Analysis.
- Assumptions for the on-base civilian work force are 40 percent of the active duty military population with 33 percent living in Navy Barrigada, 33 percent in AF Barrigada, and 33 percent in Finegayan.

Because the impacted areas for Cantonment Alternative 3 are larger and inclusive of Alternative 8, Alternative 3 will be analyzed as representative of both alternatives. This approach will present the alternative with the maximum potential adverse effect and is consistent with the approach used in the Traffic Analysis (01-28-09). The following sections will cover each of the three utilities studied for EIS Cantonment Alternatives 3 at DoD land at Barrigada.

- Section 2: Electrical Power
- Section 3: Potable Water
- Section 4: Wastewater

Figure 1-1: USMC Main Cantonment Alternative 3

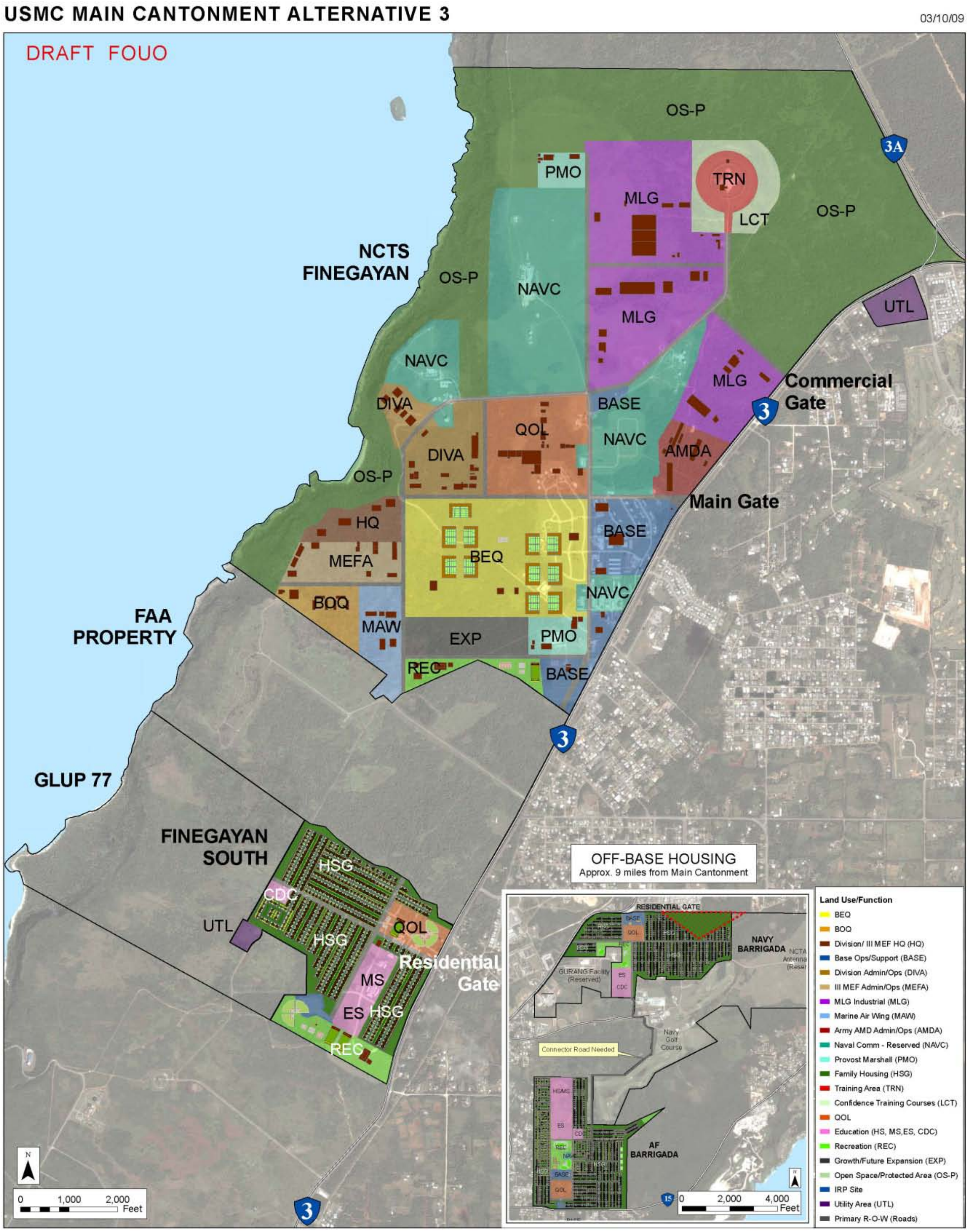


Figure 1-2: USMC Main Cantonment Alternative 8

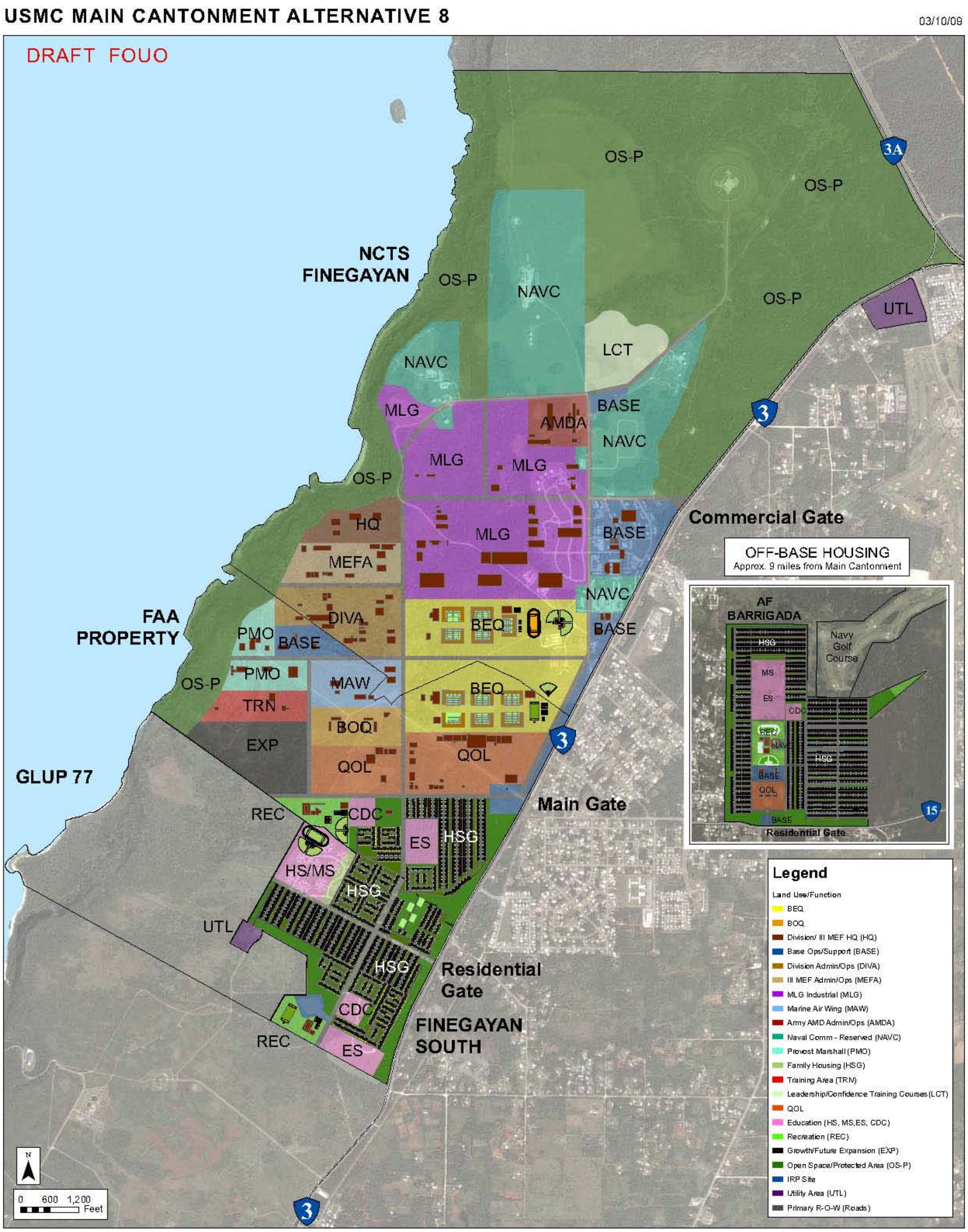


Table 1-1: Projected Population Associated with the Proposed Military Relocation Project on Guam

Summary Table	Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019		Total at 2019 (incl. baseline)
Project-Related (with Transient Personnel from Carrier Strike Group [CSG] and Expeditionary Strike Group [ESG])													
DoD													
Active	33	510	1,220	1,220	1,220	8,602	9,182	9,182	9,182	9,182	9,182	0	9,215
Dependents	52	537	1,231	1,231	1,231	9,000	9,950	9,950	9,950	9,950	9,950	0	10,002
Transient	0	0	400	400	400	2,000	9,222	9,222	9,222	9,222	9,222	0	9,222
Civilian Work Force (on-base)	12	102	244	244	244	1,720	1,836	1,836	1,836	1,836	1,836	0	1,848
Non-Military													
Construction Jobs (direct, on-site)	0	3,238	8,202	14,217	17,834	18,374	12,140	3,785	0	0	0	0	0
Full-Time Equivalent Jobs (direct, from purchases)	0	1,640	4,029	6,659	8,074	9,657	7,538	3,889	2,254	2,254	2,356	0	2,356
Full-Time Equivalent Jobs (indirect and induced)	0	1,126	3,009	5,114	6,003	7,330	5,402	2,457	2,092	2,092	2,126	0	2,126
Dependents	0	3,886	9,500	15,216	17,569	22,494	16,869	8,820	6,116	6,116	6,157	0	6,157
Project-Related Subtotal	97	11,038	27,835	44,301	52,575	79,178	72,140	49,141	40,653	40,653	40,830	0	40,927
Non-Project Related													
DoD													
Active	6,635	80	80	80	130	170	250	250	250	250	450	0	7,085
Dependents	8,360	118	118	118	148	240	290	290	290	290	290	0	8,650
Transient	0	900	900	1,256	1,256	1,256	1,256	1,256	1,256	1,256	1,780	0	1,780
Civilian Work Force (on-base)	2,489	17	17	17	27	35	38	38	38	38	45	0	2,534
Non-Project Related Subtotal	17,484	1,115	1,115	1,471	1,561	1,701	1,834	1,834	1,834	1,834	2,565	0	20,049
Grand Total Population Total (Op.'s + Construction)	17,581	12,153	28,950	45,772	54,136	80,879	73,974	50,975	42,487	42,487	43,395	0	60,976
Guam Population (general)		180,692	183,081	185,435	187,754	190,042	192,302	194,541	196,757	198,942	201,095	0	201,095
Guam Population Increase (general)			2,389	4,743	7,062	9,350	11,610	13,849	16,065	18,250	20,403		
ISLAND POPULATION TOTAL (Op.'s + Construction + Guam Pop.)		192,845	212,031	231,207	241,890	270,921	266,276	245,516	239,244	241,429	244,490	0	244,490

Notes:

1. Data from Projected Population Associated with the Proposed Military Relocation Project on Guam supplied by Peer's population (02-09-09).

Table 1-2: Project-Related Population Distribution Associated with the Proposed Military Relocation Project on Guam in 2019 (Alternative 3)

	Islandwide	Finegayan (NCTS+South)	Navy Barrigada	AF Barrigada
Option 3 & 8				
Active-Duty	9,182			
Transient	2,000			
Military personnel subtotal	11,182	8659	1262	1261
Dependents	9,950	3317	3317	3316
Civilian Work Force (on base)	1,836	612	612	612

Notes:

1. Military population, dependents and civilian transient workforce from Traffic Analysis (01-28-09).
2. Alt. 3 is representative of Alt.3 & 8 same as assumed in Traffic Analysis.
3. 100% BEQ/BOQ housing in Finegayan NCTS same as assumed in Traffic Analysis.
4. Project-related population includes USMC and Army AMD only for distribution between Finegayan and Barrigada.
5. 33% family housing in Navy Barrigada and 33% in AF Barrigada same as assumed in Traffic Analysis.
6. Transient doesn't include 7222 CVN Navy transients for the study only in Barrigada Cantonment Option.
7. Civilian Work Force on base is 40% of Active Duty same as assumed in 02-09-09 population data, and 33% in Navy Barrigada and 33% in AF Barrigada.

Table 1-3: Projected Population Associated with the Proposed Military Relocation Project in Barrigada Area (Alternative 3)

Summary Table	Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total at 2019 (incl. baseline)
Project-Related												
Military personnel	0	140	335	335	335	2,364	2,523	2,523	2,523	2,523	2,523	2,523
Dependents	0	358	821	821	821	6,000	6,633	6,633	6,633	6,633	6,633	6,633
Civilian Work Force (on base)	0	68	163	163	163	1,147	1,224	1,224	1,224	1,224	1,224	1,224
On Base Population	0	566	1,319	1,319	1,319	9,510	10,380	10,380	10,380	10,380	10,380	10,380

Notes:

1. Same population distribution ratio in Traffic Analysis for military personnel in Barrigada is used.
2. Same population distribution ratio in Traffic Analysis for dependent in Barrigada is used.
3. On base civilian population is 50% of 40% active duty, same as assumed in 02-09-09 population data, and 66% (33%+33%) in Barrigada area.

Table 1-4: Projected Population Associated with the Proposed Military Relocation Project in Northern Guam (Alternative 3)

Summary Table	Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019		Total at 2019 (incl. baseline)
Project-Related													
Military personnel	33	395	1,254	1,254	1,254	8,210	8,659	8,659	8,659	8,659	8,659		8,692
Dependents	52	179	410	410	410	3,000	3,317	3,317	3,317	3,317	3,317		3,369
Civilian Work Force (on base)	12	34	81	81	81	573	612	612	612	612	612		624
On Base Population (NCTS Finegayan + South Finegayan)	97	608	1,746	1,746	1,746	11,784	12,588	12,588	12,588	12,588	12,588		12,685
Non Project-Related													
AF active duty	2,145	2,145	2,145	2,145	2,145	2,145	2,145	2,145	2,145	2,145	2,145	#	2,145
Dependents	2,950	2,950	2,950	2,950	2,950	2,950	2,950	2,950	2,950	2,950	2,950	#	2,950
Transient	0	900	900	1,256	1,256	1,256	1,256	1,256	1,256	1,256	1,780	0	1,780
Civilian Work Force (on base)	805	805	805	805	805	805	805	805	805	805	805	#	805
On Base Population (Andersen AFB)	5,900	1,115	1,115	1,471	1,471	1,611	1,611	1,611	1,611	1,611	2,135	0	8,035

Table 1-5: Projected Population Associated with the Proposed Military Relocation Project in Apra Harbor (Alternative 3)

Summary Table	Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019		Total at 2019 (incl. baseline)
Non Project-Related													
Navy active duty	4,350	0	0	0	0	0	80	80	80	80	280	0	4,630
Dependents	5,230	0	0	0	0	0	50	50	50	50	50	0	5,280
Transient	0	0	0	0	0	0	7,222	7,222	7,222	7,222	7,222	0	7,222
Civilian Work Force (on base)	1,631	0	0	0	0	0	3	3	3	3	10	0	1,641
Coast Guard active duty	140	0	0	0	50	50	50	50	50	50	50	0	190
Dependents	180	0	0	0	30	30	30	30	30	30	30	0	210
Transient	0	0	0	0	0	0	0	0	0	0	0	0	0
Civilian Work Force (on base)	53	0	0	0	10	10	10	10	10	10	10	0	63
On Base Population (Apra Harbor Naval Main Base)	11,584	0	0	0	90	90	7,445	7,445	7,445	7,445	7,652	0	19,236

Table 1-6: Projected Off-Base Non-Military Population Associated with the Proposed Military Relocation Project ion Guam (Alternative 3)

Summary Table	Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019		Total at 2019 (incl. baseline)
Northern Guam													
Construction Jobs (direct, on-site)	0	2,158	5,467	9,477	11,889	12,249	8,093	2,523	0	0	0	0	0
Indirect and induced population	0	2,217	5,513	8,996	10,549	13,160	9,936	5,055	3,487	3,487	3,546	0	3,546
Population Increase (general)			796	1,581	2,354	3,116	3,870	4,616	5,355	6,083	6,801	0	
Central Guam													
Construction Jobs (direct, on-site)	0	1,079	2,733	4,738	5,944	6,124	4,046	1,261	0	0	0	0	0
Indirect and induced population	0	2,217	5,513	8,996	10,549	13,160	9,936	5,055	3,487	3,487	3,546	0	3,546
Population Increase (general)			796	1,581	2,354	3,116	3,870	4,616	5,355	6,083	6,801	0	
Southern Guam													
Indirect and induced population	0	2,217	5,513	8,996	10,549	13,160	9,936	5,055	3,487	3,487	3,546		3,546
Population Increase (general)			796	1,581	2,354	3,116	3,870	4,616	5,355	6,083	6,801		

Notes:

1. Construction workforce is 2/3 of total island project related construction force in Northern Guam, 1/3 in Central Guam same as the assumption used in Break Point Analysis (July, 2008).
2. Induced population is 1/3 of total island project related induced population in each of Northern, Central and Southern Guam same as the assumption used in PEIS
3. Guam general population increase is 1/3 of total island civilian general population increase in Table I for each Guam region.

2. Electrical Power Utility

The military relocation populations projected in the EIS for Guam that were used as a basis for this utility study are presented in Table 1-1 through Table 1-6. Certain assumptions were required regarding the housing locations for construction workers and increased civilian population of Guam in order to assess the impact on existing utilities operated by the Government of Guam (GovGuam). The assumptions are footnoted in the population worksheets.

This study provides conceptual level planning for power distribution to the Navy and AF Barrigada area. This planning information identifies impacts to substation and electrical lines to facilitate assessment of impacts in the EIS.

2.1 Analysis of Electrical Power Demand – Current and Future

The existing conditions were evaluated with input from NAVFAC Marianas staff to establish existing demands in the area. Guam Power Authority (GPA) provided additional input regarding impacts to the island-wide power system transmission (see Appendix B), distribution, and substation systems. Areas considered in this report are Navy Barrigada and AF Barrigada. Navy Barrigada is somewhat developed in that there are existing electrical distribution facilities and a substation that serve the area. AF Barrigada is less developed and the limited power needs in the area are served by the substation located at Navy Barrigada.

The Navy and GPA terms used for the area are described to clarify terms used in this report. GPA refers to a substation that serves the general area as "Barrigada Substation," whereas "Radio Barrigada" is used in referring to the Navy substation located near the golf course, which is also referred to as "Navy Barrigada." This report will refer to the Radio Barrigada area as Navy Barrigada and the area to the south (Barrigada Substation) as AF Barrigada.

The existing Navy Barrigada substation is located near the entrance to the golf course and is rated at 9.375 million volt-ampere (MVA) (two transformers connected to provide redundancy for the substation). The existing substation transformers are being rebuilt under a contract that is under construction. Existing demand loads on this substation amount to approximately 3.5 megawatts (MW) of peak demand or about 40 percent of the substation capacity. This information was provided by the Navy from historical electrical demand information for the substation. The existing GPA Barrigada substation has a capacity of 22 MVA and is currently loaded to 12.4 MW based on information provided by GPA and summarized in Table 2-1.

Table 2-1: Existing Loads

Area	Substation	Existing Load	Planned Load
Navy Barrigada	Transformer 23/24	3.5MW	16.27MW
AF Barrigada	Existing served from Navy Barrigada	0.5MW included in Navy Barrigada	12.52MW
GPA Barrigada	22MVA (19.8MW) GPA Substation	12.4MW	13.02MW (AF Barrigada)

The additional load at AF Barrigada would exceed the capacity of the GPA substation if connected to the GPA Barrigada Substation. Discussions with Navy and GPA staff indicated that a new substation (Navy/GPA) should be located near the planned AF Barrigada housing under EIS Cantonment Alternative 3 to serve those loads. This option would allow a joint facility to be built near the housing area at AF Barrigada (South housing area) and provide the ability to use the substation to house the Navy switchgear and GPA service equipment.

Planned future demand is expected to be 16.3 MW at Navy Barrigada and 12.5 MW at AF Barrigada. Each of these load increases would require expansion or upgrade of the existing distribution system.

The basis for power demand at the EIS Cantonment Alternative 3 housing areas is the facilities list provided with the planning layouts for facilities. The demand calculations can be found in Appendix B.2.

Both housing areas planned in EIS Cantonment Alternative 3 results in approximately 29 MW of additional demand to the Barrigada area.

2.2 EVALUATION OF EXISTING CONDITIONS AND FUTURE REQUIREMENTS

2.2.1 Existing Conditions

The existing DoD loads in the Barrigada area affected by planned housing under EIS Cantonment Alternative 3 are currently served through the Navy Barrigada substation. This substation had operational problems that necessitated a project to repair/rebuild these units in place. While this would restore the transformers to reliable service, the capacity of this substation is not sufficient to provide power to the planned housing and existing loads.

The Navy Barrigada substation supplies power to DoD facilities nearby as well as south to the area surrounding the golf course (near AF Barrigada). Addition of the substantial housing planned for the AF Barrigada area would overload the existing distribution and require major portions to be replaced. Minimal distribution exists in the AF Barrigada area (Southern portion of the planned housing for EIS Cantonment Alternative 3) to support the radio facilities in that area (Transmitter building 81 and U.S. Coast Guard (USCG) LORAN building based on Navy electrical distribution system maps). This distribution is also insufficient and would require replacement if the new housing were served from Navy Barrigada.

The proposed option would need to re-connect existing loads to provide power from any of the options. The existing circuits would need to be picked up near the existing Navy Barrigada Substation to cause minimal disruption in service and limit that amount of work required to serve the existing loads.

There is no known reliability or regulatory issue in the area relative to electrical distribution. Some conditions exist in the high power antenna areas (Navy Barrigada) that may impact facility planning to maintain minimum separation from radio equipment.

2.3 ELECTRICAL POWER OPTIONS

2.3.1 Interim Options Considered

The interim options available are limited due to the location of the planned facilities and existing infrastructure. Options considered are based on using two substation transformers that provide redundant capacity should one circuit or transformer fail. The remaining transformer would be capable of supporting the facility load. This configuration provides an economical level of redundancy with limited complexity.

Additional options could involve adding a transformer to the existing Navy Barrigada Substation to provide additional capacity. This arrangement does not provide the additional capacity that the switchgear requires, adds complexity to the switching required for the added transformer, and does not provide redundancy simply by adding a transformer as the existing transformers are not sized to support the planned loads. These reasons limited options to the more conventional two transformer arrangement that provides an economical level of redundancy for the substation.

The existing GPA distribution must be upgraded at the same time that the Navy and AF Barrigada Substations are installed to provide the necessary load capacity for the planned facilities. This is because the existing circuits are not capable of reliably handling the additional loads, and a partial upgrade would not be cost effective and may result in spending nearly double the cost of upgrading the circuits to the required capacity with the other interim projects. The options considered are listed below:

- Option 1 – Replace existing Navy Barrigada substation with new substation sized to support planned Cantonment Alternative 3 facilities in both areas.
- Option 2 – Install new substation at each planned housing area.
- Option 3 – Upgrade existing Navy Barrigada substation and install new substation for the AF Barrigada housing area (GPA refers to this area as Eagle Field).
- Option 4 – Upgrade existing Navy Barrigada substation to support nearby planned housing and feed AF Barrigada housing from the existing GPA substation (would require upgrading due to inadequate capacity).

The options were evaluated and ranked based on cost, increase or decrease in reliability to the system, and implementation difficulty as described in Table 2-2. The results are presented below in descending order by rank:

1. Option 3 – This option takes advantage of as much existing distribution as possible from the substation and upgrades existing facilities to provide improved reliability. While upgrading the existing substation would require outage to implement, they should be reasonable and existing facilities have standby generators were deemed necessary. Installing a new substation at the AF Barrigada area would require minimal interruptions to existing systems.
2. Option 2 – While this option would be the simplest to implement (no existing facilities to work around), it does not use the opportunity to improve the existing substation or switchgear by upgrading for additional capacity and is potentially more costly than Option 3.
3. Options 1 and 4 – These options are similar in that each proposes to upgrade the existing Navy Barrigada substation and serve the AF Barrigada from some distance away. This option avoids the cost of a substation for the southern housing area but would require extensive underground distribution from either the existing Navy Barrigada location or the GPA Barrigada substation. The long distances present voltage drop challenges at the lower distribution voltage (13.8 kilovolts [kV] versus 34.5 kV) and would be a concern for reliability.

Table 2-2: Electrical Power Option Analysis

Option	Cost	Implementation	Reliability Impact
1. Replace existing substation and serve all planned facilities.	Lowest	Difficult due to long distance between Navy and AF Barrigada and upgrading existing substation.	Lowest
2. Install new substation and new distribution for all planned facilities. Existing substation to remain.	Highest	Simple due to all new construction but higher cost to re-feed existing facility circuits and coordination required.	Medium
3. Install new substation at AF Barrigada and upgrade existing Navy Barrigada substation.	Medium	Medium due to upgrade of existing substation work.	Highest
4. Upgrade existing Navy Barrigada substation and GPA substation in Barrigada for AF Barrigada area.	Medium	Medium to difficult due to need to upgrade existing GPA substation and distance to new housing.	Medium

It should be noted that distribution and substation improvements to meet interim requirements and long-term power requirements are the same for Cantonment Alternative 3. The housing construction is anticipated by 2015 and is before the long-term generation is anticipated to be available. No additional identified system improvements are required during the long-term period of 2015 and later.

2.3.2 Recommendation

The recommended option is Option 3 – *Upgrade the existing Barrigada Substation and install a new substation near the planned housing in AF Barrigada* (GPA Eagle Field substation). The option would also require new distribution feeders from GPA substations (Barrigada and Pulantat substations) to serve the AF Barrigada Switchgear. This option is recommended to avoid placing all of the new facilities on one substation, running excessively long distribution loops from the Navy area to the AF area, and reworking existing distribution at Navy Barrigada by upgrading the existing substation rather than installing a new substation. This option also improves reliability by distributing substation facilities and avoiding overly long distribution lines.

The Option 3 modifications and additional loads in the Navy and AF Barrigada areas require additional GPA transmission and distribution (T&D) improvements to support the additional load and provide two sources of power for reliability. These improvements require the following upgrades to the T&D system:

- AF Barrigada (Eagle Field) Substation located at AF Barrigada
- Barrigada to AF Barrigada (Eagle Field) 34.5 kV Line
- AF Barrigada (Eagle Field) to Pulantat 34.5 kV Line (essentially re-routing Barrigada to Pulantat 34.5 kV line to go through Eagle Field Substation first)
- Apra to Talofofo 34.5 kV Line
- 12 MVAR capacitor bank at AF Barrigada (Eagle Field) for voltage support
- 6 MVAR capacitor bank at Navy Barrigada for voltage support

These improvements are in addition to the distribution inside DoD property to support the additional facilities.

Each of the planned housing areas would require a substation that is connected to 34.5 kV lines from GPA and provides distribution voltage at 13.8 kV. The sizing of those units would need to support existing, planned, and possible future loads for the area. The substation sizes are selected based on the load requirements described in Table 2-1 and below in Table 2-3.

Table 2-3: Navy and AF Barrigada Substation

Load Description	Load (MW)	Notes
Navy Barrigada Existing	3.0 MW	0.5 MW would be transferred to AF Barrigada loads
Navy Barrigada Planned Loads	16.3 MW	
Navy Barrigada Substation	19.3 MW (24 MVA using 0.8 power factor for demand load)	Represents anticipated coincident demand load
AF Barrigada Existing	0.5 MW	
AF Barrigada Planned Loads	12 MW	
AF Barrigada Substation	12.5 MW (15.6 MVA using 0.8 power factor for demand load)	Represents anticipated coincident demand load

The substation capacity for Navy Barrigada should be planned for 30 MVA. This provides for the anticipated 24 MVA of load with the next largest substation size. The substation capacity for AF Barrigada should be planned for 20 MVA. This supports the anticipated 15.6 MVA of load and uses the next largest substation size.

3. Potable Water Utility

The military relocation populations projected in the EIS for Guam that were used as a basis for this utility study are presented in Table 1-1 through Table 1-6. Certain assumptions were required regarding the housing locations for construction workers and increased civilian population of Guam in order to assess the impact on existing utilities operated by the GovGuam. The military relocation populations were provided by the Navy on 9 February 2009 (NAVFAC Pacific 2009). The population distribution ratios for military personnel and dependents are the same as the Traffic Analysis. The on-base civilian population is 50 percent of 40 percent active duty to be consistent with the February 9, 2009 population estimate. The project related population for USMC Finegayan Base includes the USMC and Army Air and Missile Defense (AMD). The family housing in the Barrigada area would be 66 percent of the total family housing. It is assumed that the 2000 USMC transients are housed on USMC Finegayan Base. It is assumed that the construction workers would be housed off base and that all construction related water would be provided by the contractor through the Guam Waterworks Authority (GWA).

This study provides conceptual level planning for potable water supply to Navy Barrigada and AF Barrigada areas. The planning information identifies impacts to water storage, future additional water supply wells, water treatment, and distribution systems to facilitate assessment of impacts in the EIS. In this study, the water supply for USMC Finegayan Base would be from new proposed wells located primarily on the Andersen Air Force Base (AFB). Water would be supplied to Navy Barrigada and AF Barrigada partially from wells located on Navy Barrigada and from the USMC Finegayan Base water system through upgrades to the Navy Island-Wide (NIW) system water mains.

3.1 Analysis of Water System Demands – Current and Future

3.1.1 Water System Demands Based on UFC

The following section presents the water demand calculation for the proposed facilities for the Marine relocation and improvement to the existing DoD facilities (Andersen AFB and the Naval Base). The water demand for the USMC relocation was calculated using the Unified Facilities Criteria (UFC) 3-230-19N "Design: Water Supply Systems." Total requirements are calculated for domestic, industrial, fire protection and unaccounted for water (UFW) demands.

The DoD population data presented in Section 1 is the basis for the USMC domestic demand. The Navy and Air Force domestic demand was calculated from monthly average water measurements provided by the bases. The *Final Report Water, Wastewater, and Solid Waste Management Impact Assessment for JGMMP, Guam* (HPE 2006) for Alternative 1 and the *Final U.S. Marine Corps Facility Requirements and Initial Concept Plan* (HHF 2007) provides the basis for the measured water losses at Navy bases and the industrial demands. Water demands for visiting ships are from the Draft EIS and UFC 4-150-02 (DoD 2003). All DoD water demands are considered, because (1) water may be supplied to the Barrigada bases from either the Navy or the planned USMC Finegayan Base water supply; and (2) the availability of water from the Northern Guam Lens Aquifer (NGLA) would be assessed considering all DoD and GWA wells current and planned.

3.1.1.1 Domestic Uses

Domestic uses include drinking water, household uses, and household lawn irrigation. Per capita requirements are shown in Table 3-1 for permanent and temporary installation in the tropics. The per capita requirement for transients is based on the hotel domestic water allowance from Table 2-1 UFC 3-230-03A 16 January 2004 for Water Supply (DoD 2004a). When on base, the transients would be housed in officers or enlisted quarters, which would not require all of the water demands of a home (e.g., household lawn irrigation).

Table 3-1: Average Potable Domestic Water Requirements Gallons Per Capita Per Day

Use Category	Tropic (gpcd)
Unaccompanied Personnel Housing	155
Family Housing	180
Transients	70
Workers (per shift)	45

Source: DOD 2004a; DoD 2005
gpcd gallons per capita per day

The average demand for each use category shown Table 3-1, in gallons per day (gpd), is calculated by Equation 1:

Equation 1

Average daily domestic demand in gpd = gallons per capita per day (gpcd) × design population × growth factor

The following growth factors are used in Equation 1:

a) Large systems (5,000 population or greater), 1.25.

b) Small systems (populations less than 5,000), 1.50.

Total average demand is the sum of averages for unaccompanied personnel housing, family housing and workers.

Other controlling demands are calculated by Equation 2:

Equation 2

Maximum Daily Domestic Demand = average daily domestic demand in gpd × K

Table 3-2 provides the data for the coefficient, K.

Table 3-2: Controlling Demand Coefficients for Water

Demand	Units of Demand	Coefficient K	
		Population <5,000	Population >5,000
Maximum Day Flow	gpd	2.25	2

Source: DoD 2005
gpd gallons per day

Visiting ships docked at Apra Harbor would be connected to the NIW water system for potable water. Estimated potable water requirements are included in the domestic demand based on UFC 4-150-02 (DoD 2003). The type and number of visiting ships with the potable water requirements is shown in Table 3-3.Table 3-4 presents the future domestic demand. The number of accompanied service members was estimated assuming 2.5 dependents per accompanied service member. It is assumed that the active service members housed at Navy Barrigada and AF Barrigada would travel to USMC Finegayan Base for work each day.

The average production rate for the Navy water system is currently 11.7 million gallons per day (mgd). Current average domestic demand is estimated at 1.4 mgd by subtracting water transfer to

GWA (3.6 mgd), UFW assuming 25 percent (2.9 mgd), and industrial demands (3.8 mgd) from the average production rate. Future average domestic demand is estimated by adding the water demand for the additional population based on UFC requirements to the current average domestic demand.

The average amount of water billed in the Andersen AFB water system was 1.4 mgd between October 2009 and April 2010. Current average domestic demand is estimated at 0.67 by subtracting the industrial demand (0.76 mgd). Future average domestic demand is estimated by adding the water demand for the additional population based on UFC requirements to the current average domestic demand.

Table 3-3: Visiting Ship Demand

	No. of Ships	Demand per ship (gpd)	Total (gpd)
CVN	1	235,000	235,000
LHD	1	90,000	90,000
LSD	1	24,000	24,000
LPD	1	40,000	40,000
CG-47	2	16,000	32,000
DDG	2	11,400	22,800
			443,800

Source: Draft EIS Volume 2 Table 2.5-1 and Volume 4; DoD 2003

The future USMC relocation-related maximum daily domestic demands are 5.2 mgd for the USMC Finegayan Base and 4.1 mgd for Navy and AF Barrigada. For existing bases, the future maximum daily domestic demands are 4.7 mgd for the remaining Navy Bases (not including USMC housed on Barrigada) and 2.3 mgd for Andersen AFB.

Table 3-4: DoD Future Domestic Demand for Water

	USMC Relocation Areas			
	Finegayan Base	Navy and AF Barrigada	Remaining Navy Bases	Andersen AFB
Average Daily Domestic Demand (mgd)	2.6	2.1	2.3	1.1
Maximum Daily Domestic Demand (mgd)	5.2	4.1	4.7	2.3

3.1.1.2 INDUSTRIAL USES

Industrial uses include air conditioning, irrigation, swimming pools, shops, laundries, dining, processing, flushing, and boiler makeup water. Demands were assigned according to the values in Table 3-4 from UFC 3-230-19N (DoD 2005) for air conditioning.

Table 3-5: Industrial Water Requirements Potable Water - Permanent Installations

		Requirements		
	Unit	Min	Avg	Max
Air conditioning:	gpm/ton	—	0.05	0.10

Source: UFC 3-230-19N

Additionally, UFC 3-230-19N (DoD 2005) requires that water demand data from other activities having uses similar to those anticipated be used. The industrial demands for the facilities not covered in DoD (2005) were assigned a demand based on the measured demands for similar facilities within the existing Navy bases. The average daily industrial use is 1.17 mgd at the USMC Finegayan Base. This demand includes 225 gallons per minute (gpm) for use in a power generation. Details of the demand calculation are present in Appendix C.2. The USMC Finegayan Base facility list is from the Facilities Requirement and Initial Concept Plan (HHF 2007). The industrial facilities planned for Navy Barrigada and AF Barrigada are from the TEC, Inc. descriptions for Alternative 3. The future DoD industrial demands are listed in Table 3-6. The current industrial demand estimate is included in the future industrial demand estimate for USMC Finegayan Base.

The future USMC relocation-related industrial demands are 1.17 mgd for the USMC Finegayan Base, 0.002 mgd for Navy Barrigada and 0.05 mgd for AF Barrigada. For existing bases, the future industrial demands are 4.55 mgd for the remaining Navy Bases (including industrial demands at Navy Barrigada not related to the USMC relocation) and 1.00 mgd for Andersen AFB. There is an additional water demand on the Navy bases of 0.05 mgd for Marine Expeditionary Unit ship washdowns.

Table 3-6: Future DoD Industrial Demands for Water

	USMC Relocation Areas				
Daily Industrial Demands (mgd)	USMC Finegayan Base	Navy Barrigada	AF Barrigada	Remaining Navy Bases	Andersen AFB
Existing [a]	0.1	0.89	0	2.91	0.76
Additional from Projects In Progress [a]	0	0.28	0.00	0.45	0.17
USMC Relocation	0.75	0.0018	0.05	0.02	0.07
225 gpm for power in north Guam	0.32				
Marine Expeditionary Unit Washdown				0.05	
Total Industrial/Commercial	1.17	1.17	0.05	3.43	1.00

[a] From JGPO 2009

3.1.1.3 *FIRE PROTECTION DEMANDS*

Fire protection demand includes water required for maintaining the fire protection system within the facility and is designed based on the criteria outlined under the Military Handbook Fire Protection for Facilities Engineering, Design, and Construction (MIL HDBK 1008C [DoD 1994]). Requirements for fire protection water storage are based on the assumption that there would be only one fire at a time. The quantity of water required is equal to the product of the fire protection water demand and the required duration, and must be available at all times. Water supply for the domestic, industrial, and other demands is added to these requirements to determine the total amount of water required in the facility. The fire flow requirements under MIL HDBK 1008C (DoD 1994) vary greatly based on hazard classification of the activity in the facility.

The 2007 conceptual plan for relocation indicates four commands and 19 permanently based organizations, which include facilities such as family housing, aviation operation (including hangars, maintenance shops, training facilities), command centers (including administrative offices) and facilities housing various base support operations. The fire flow requirement for each facility is determined by the hazard classification for each facility structure and operation. For the USMC Finegayan Base design, a maximum fire flow demand of 7,500 gpm for a minimum duration of 150 minutes is assumed. This value is referenced from Table C-1, in UFC Fire Protection Engineering for Facilities (UFC 3-600-01 [DoD 2006]), and classifies the facility as "extra hazard," which includes facilities such as hangars, ordnance plants, and warehouses. While some of the facilities listed in the 2007 plan would fall under light or ordinary hazard category, the "extra hazard" designation is selected for the conceptual fire protection demand, assuming all the facilities listed in the relocation plan are a single unit. For Navy Barrigada and AF Barrigada, the facilities are assumed to be light hazard with a maximum fire demand of 1,125 gpm for 90 minutes. Details of the calculation are presented in Appendix C.2.

3.1.1.4 UNACCOUNTED FOR WATER

UFW is water that is not metered, such as water lost in leakages. UFW is derived by subtracting the amount of water measured by meters from the water that is produced from the treatment plants and wells and net changes in water storage tank inventories. Most water utilities, policymakers, and associations such as the American Water Works Association deem a 10 percent to 15 percent UFW loss as acceptable. However, the utility reports for the DoD facilities indicate that the Navy system currently has a higher loss rate. The GJMMP 2006 Report provided estimates for the existing UFW demand for most of the Navy facilities. It is assumed that the UFW for Navy bases is 25 percent for existing water demands. The UFW for the Andersen AFB water system is 50 percent according a study conducted at the base. The DoD water systems UFW daily demands and the loss rates are listed in Table 3-7.

Table 3-7: Existing Unaccounted for Water from the JGMMP 2006 Report

Facility	Existing UFW	Source
Navy Finegayan	15%	Assumed high end of acceptable range
Apra Harbor	1.67 mgd	GJMMP Report
Ordnance Annex	0.072 mgd	GJMMP Report
Nimitz Hill	0.072 mgd	GJMMP Report
Naval Hospital	10%	GJMMP Report
Barrigada	0.072 mgd	GJMMP Report
Andersen AFB	50%	Information provided by Pacific Air Forces

% percent

Based on state standards summarized in the 2005 utility technical study report (Engineering Concepts 2005), a UFW of 15 percent is assumed for additional demands at the NIW System and Andersen AFB from projects in progress, and future expansions including the USMC relocation. A UFW of 5 percent is assumed for USMC relocation areas at USMC Finegayan Base and Barrigada because conservation and sustainability concepts would be integrated into the design.

The future UFW demands for the USMC relocation are shown in Table 3-8.

Table 3-8: Future DoD UFW

	USMC Relocation Areas			
	USMC Finegayan Base	Navy and AF Barrigada	Remaining Navy Bases	Andersen AFB
Average Daily UFW (mgd)	0.19	0.11	3.2	1.1
Maximum Daily UFW (mgd)	0.32	0.21	3.7	1.6

Note: The water demands for Navy Barrigada exclude the demand not related to USMC Relocation.

3.1.1.5 SUMMARY OF CALCULATED DEMANDS

The average and maximum daily demands are calculated as the sum of domestic, industrial, and UFW demands. Current demands are presented in Table 3-9. The DoD future average and maximum daily demands are summarized in Table 3-10. The USMC relocation-related future maximum daily demands are 6.7 mgd for the USMC Finegayan Base and 4.4 mgd for Navy and AF Barrigada. For existing bases, the future maximum daily demands are 13.0 mgd for the remaining Navy Bases and 4.9 mgd for Andersen AFB.

Table 3-9: DoD Current Daily Demands for Water

	USMC Relocation Areas			
	USMC Finegayan Base	Navy and AF Barrigada	Remaining Navy Bases	Andersen AFB
Average Daily Demand (mgd)	0.1	0.0	8.1	2.1
Maximum Daily Demand (mgd)	0.2	0.0	9.8	3.1

Table 3-10: DoD Future Daily Demands for Water

	USMC Relocation Areas			
	USMC Finegayan Base	Navy and AF Barrigada	Remaining Navy Bases	Andersen AFB
Average Daily Demand (mgd)	3.9	2.2	10.1	3.2
Maximum Daily Demand (mgd)	6.7	4.4	13.0	4.9

Note: The maximum daily demand for Barrigada excludes the demand not related to USMC Relocation. These demands are included in the remaining Navy demands.

3.1.2 Water System Demands Including Water Conservation and Sustainability

3.1.2.1 DEMAND ADJUSTED TO REFLECT FEDERAL MANDATES TO REDUCE CONSUMPTION

The potable water demand assumptions presented in Section 3.1.1 are based on the UFC-3-230-19N dated 8 June 2005 that provides a conservative estimate for potable water source demands in a standalone system serving the long-term needs of a generic military base located anywhere in the world. Construction on military bases is standardized and dictated by UFC documents that provide planning, design, construction, sustainment, restoration, and modernization criteria. They are applicable to Military Departments, Defense Agencies, and DoD Field Activities. The documents were/will be used to develop project designs, construction documents, permits, operations activities, and maintenance activities and address issues, such as design standards for water systems based primarily on installation population. There is little flexibility in minimal design standards, but there is flexibility in site planning. Congressional appropriations require the incorporation of all relevant UFCs in design.

Unfortunately, UFC-3-230-19N addresses the criteria to be used to define the source of water, but does not account for several federal mandates (Executive Order [EO] 13423, EPAct 2005, EISA 2007, EO 13514) that have been issued since the last release of UFC-3-230-19N. These federal mandates require the use of water conservation technology to achieve significant reductions in water usage. EO l3514 dated 5 October 2009 requires federal agencies to reduce their water consumption by 26 percent by 2020 as compared to the federal agency's water consumption in 2007. The disconnection between the mandated reductions in usage and the UFC results in a design for the water source (compliant with UFC) is that the amount is greater than the actual need (based on the mandated reductions). To address this situation, prior to an update in UFC-3-230-19N and to factor in a more realistic scenario based on Guam, it was decided to incorporate sustainability and water conservation into the water demand calculation. This approach has been endorsed by the Navy Criteria team that is responsible for updating the UFCs and is considered consistent with the spirit and intent of the UFCs. It is essential to start with UFC-3-230-19N and apply sound engineering judgment to adjust requirements to preclude the construction of a more costly system that would constrain a limited water resource and ultimately be underutilized, potentially resulting in long-term operating issues.

The reduction in on-base water demand for the new Marine Corps Base is expected to be 22 percent for average daily demand and 40 percent for maximum daily demand if conservation measures, sustainability principles, and Guam site-specific conditions are applied.

3.1.2.2 Sustainability Principles

The following directives and guidance documents address water conservation:

- EO 12902, *Energy Efficiency and Water Conservation at Federal Facilities*
- EO 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*
- Energy Policy Act of 2005; Energy Independence and Security Act of 2007
- 10 U.S. Code (USC) 2866, *Water Conservation at Military Installations*
- 10 USC 2915, *New Construction: Use of Renewable Forms of Energy and Energy Efficient Products*
- Military Handbook 1165, *Water Conservation*, MIL-HDBK-1165 (DoD 1996)
- *Navy Water Conservation Guide For Shore Activities* (Hoffard, Magro, and Zendijas 1996)
- EO 13514, Federal Leadership In Environmental, Energy, And Economic Performance (5 October 2009)
- LEED 2009 for New Construction and Major Renovation (USGBC 2008)

Additionally, the existing Navy and Air Force bases are subject to water conservation goals, such as those in EO 13423. Implementation of this order would require a reduction in water usage of 16 percent by 2015 on the existing bases. This percent reduction is included in the modified potable water demand estimates presented in the Draft EIS. The water conserved on the existing bases would either reduce the stress on the NGLA or be made available via interconnects to support off-base developments related to the relocation via a formal request by GWA to the Navy (NAVFAC Marianas).

The DoD is in the process of developing and approving water conservation measures for the Marine Corps Base through equipment selection and management practices. Water consumption at the Marine Corps Base would differ from consumption at the existing bases because, as part of the proposed action, the design and construction of the new base at Finegayan would implement low-flow equipment and other improvements to the extent practical. Examples include the following:

- Low-flow faucets
- Ultra-low-consumption toilets/urinals with electric flush sensors
- Low-flow showerheads

- Lower flow commercial-type "Energy Star" washing machines in housing units
- Energy- and water-saving dishwashers (Energy Star)
- Water conservation education
- Wastewater recycling in industrial washing and rinsing of aircrafts and vehicles
  - Water-efficient cooling systems
  - Minimal landscape irrigation
  - Rainwater collection and reuse
  - Air conditioning condensate recycling

Water management practices would be implemented at the Finegayan Base to better control water consumption and prevent water loss. The amount of water used to water lawns and landscapes would be minimized or eliminated through sustainable design. Meters would be installed at all facilities and at key locations within the water distribution system; thus, significantly improving the ability to quickly identify leaks and take corrective action. Water management operation procedures would be reviewed periodically and revised as needed. Base residents would be educated about living responsibly on a sustainable base to create a sustainable culture through responsible actions by residents. Education programs on proper use of water would include: watering lawns sparingly or not at all, installing low-flow fixtures, full-load clothes washing, etc. Metering would allow water users to have full awareness of their water usage. For housing residents, meters would support billing of water usage directly to the residents. Water conservation would be a key program that would receive command level attention and follow up.

3.1.2.3 Site Specific Water Conservation Measures

Because the proposed Marine Corps Base is located on Guam, some of the assumptions behind the development of the UFC guidance are not relevant. Notably, the water needed for lawn irrigation would be minimal because of Guam's climate, particularly in the rainy season. As described above, the facility design is expected to implement water conservation equipment that is likely to produce at least a 22 percent water savings compared to conventional equipment. This water savings is mandated by regulation (EO 13514). No irrigation would be used for housing and would be used minimally elsewhere on the base. Landscaping throughout the base would use plants that can survive with little watering. A common components manual to guide the development of the new base at Finegayan would address which local plants can be utilized in landscaping. Improved leak detection, extensive metering, and management systems are expected to reduce the amount of UFW to a rate of 5 percent based on engineering judgment. It is noted that the UFC-3-230-19N does not address the issue of UFW. The controlling demand factor used to estimate the maximum daily demand and to size water system components would be lower for Guam because there are limited climatic changes on Guam as compared the mainland and other locations.

Incorporating these assumptions, the daily demand for the Finegayan Base is estimated to be reduced by approximately 22 percent of the UFC estimated average daily demand and 40 percent of the maximum daily demand.

3.2 EVALUATION OF EXISTING CONDITIONS/CAPACITY & PROJECTED FUTURE REQUIRED CAPACITY

3.2.1 Service Areas and Water Systems Overview

The existing water supply on Guam is comprised of the following three separate, but partially interconnected water systems:

- Navy Water System
- Andersen AFB Water System
- GWA Water System

The first two of the above systems are the DoD systems, while the GWA system is the primary source of water to the general public on Guam.

Navy Water System – The Navy system and service areas are Naval Computer and Telecommunications Station (NCTS) Finegayan, South Finegayan, Navy (NCTS) Barrigada, Nimitz Hill, Naval Hospital, Ordnance Annex, and the Apra Harbor Complex.

The NCTS Finegayan is situated on the northwest coast of Guam, about 9 miles north of the capital city of Hagatna, and occupies approximately 3,000 acres. NCTS Finegayan is bounded by the Andersen AFB to the north, Route 3 to the east, and the FAA parcel to the south. NCTS Finegayan includes residential units for family and unaccompanied personnel, community service facilities, administrative buildings, medical and dental clinics, support communication facilities, and mechanical shops.

South Finegayan is located on the northwest coast of Guam, approximately 8 miles northeast of Hagatna and occupies approximately 270 acres. South Finegayan is bounded by NCTS Finegayan to the north and the Philippine Sea to the west. The area comprises family housing, an unaccompanied personnel housing unit, and a youth center.

Navy Barrigada is located to the east central part of Guam, approximately 3 miles east of Hagatna and occupies approximately 1,850 acres. Navy Barrigada is bounded by the former Naval Air Station Hagatna to the west, Mount Barrigada to the north and Andersen AFB Communication Annex to the south. Photos of the existing water system components are provided in Appendix C.4.

Nimitz Hill is located along the west central coast of Guam, approximately 1.5 miles south of Hagatna. It occupies about 95 acres and is bounded by Naval Hospital to the northeast and by Piti Village to the west. Naval Hospital is located northeast of Nimitz Hill along the west central coast of Guam, directly east of Hagatna. Facilities at Nimitz Hill include operations facilities, officers club, thrift shop, a federal fire station, and a high school. The main facility at Naval Hospital is a 57-bed hospital at Hagatna Heights. Other facilities include family and unaccompanied personnel housing, medical facilities, fire station, convenience stores, recreational facilities, utility plants, and a chapel.

The Apra Harbor Naval Base Complex is located on the west-central coast of Guam, approximately eight miles southwest of Hagatna. The site encompasses a land area of 4,500 acres and a harbor of 650 acres. The Ordnance Annex is located approximately 2.5 miles southeast of Apra Harbor Naval Base Complex and encompasses approximately 8,840 acres of land most of which is used as buffer land or as watershed for the Navy Reservoir. The Apra Harbor Naval Base Complex and additional Navy areas include Orote Peninsula, Guam Economic Development Authority, Camp Covington, both new and old Apra Heights Housing Areas, Tenjo Vista, Sasa Valley, and Dry Dock Island. The

Ordnance Annex has an ammunition wharf at Orote Peninsula with headquarters in the highlands above Apra Harbor Naval Base Complex along Route 5.

The existing Navy water system is an island-wide system extending from the Navy Reservoir in Southern Guam to NCTS Finegayan near the northern tip of Guam. Water for the system is primarily supplied from the Navy Water Treatment Plant (WTP). Water is distributed from the treatment plant to reservoirs designed to serve different service zones and transfer water to other Navy installations across the island. Most of the transmission mains from the reservoirs to the distribution systems are 24-inch pipelines. The Navy system is interconnected to supply water to GWA and for emergency service capability. The connection with the Andersen AFB system is out of service.

In most of the service areas, water is supplied either from onsite groundwater wells, through the NIW water system, or by interconnection with the GWA water system. The NIW water system comprises three primary sources, which are located at the southern region of Guam: Almagosa Springs, Bona Springs, and the Navy Reservoir surface water impoundment. Water from the above three sources are treated at the Navy WTP and distributed through a network of reservoirs, transmission mains, and booster pump stations. A brief description of the water supply sources in each of the Navy service areas is provided below.

- At the NCTS Finegayan, water is primarily supplied by groundwater wells located on site and at South Finegayan. If necessary, water can also be supplied by interconnections with the GWA system or the NIW system. Groundwater wells are the primary source of potable water for this area.
- At the South Finegayan Housing area, water is primarily supplied by the groundwater wells on site and at NCTS Finegayan. If necessary, water can be supplied by interconnections with the GWA system or the NIW system.
- At the Navy Barrigada, water is primarily supplied by groundwater wells or through a connection to the NIW systems.
- At the Naval Hospital, water can be provided from either the NIW water system or onsite groundwater wells.
- At the Apra Harbor Naval Base Complex and other Navy areas south of the Piti Power Plant, potable water is supplied entirely by the Navy WTP.

Andersen AFB Water System – Andersen AFB is located in northern Guam and covers approximately 24.5 square miles. The base consists of two major areas and several smaller areas called annexes. The major areas collectively known as the “main base” are North Field containing the base’s active operations and Northwest Field (NWF) containing abandoned runways and landing fields. The annexes are scattered throughout northern Guam and contain base housing, communications services, and water and petroleum storage facilities. The annexes include the Marianas Bonins Command (MARBO) Annex (also known as Andersen South), the Harmon Annex, and AF Barrigada.

The Andersen AFB water system includes an off-base water supply, treatment, storage and transmission systems, and an on-base water distribution system. The off-base water supply and transmission system includes nine water production wells, two booster pump stations, three reservoirs, chlorination facilities, a fluoridation facility, and approximately 80,000 feet of water lines. The existing on-base water distribution system includes a pump station, three water storage tanks, and approximately 700,000 ft of water lines.

Water is currently supplied from wells located in the MARBO Annex, stored, disinfected and fluoridated, and then pumped to the main base. The nine off-base production wells are located at Andersen South Annex and the Tumon area and draw water from the NGLA. Water is currently supplied to Andersen AFB from seven of the nine off-base water production wells. Andersen AFB prepared plans to install 10 wells with a total capacity of 3.3 mgd on the NW Field. Distribution lines and electrical components have been installed for the 10 wells. Permits were granted for all wells. To date, five of the wells have been installed and activated. Currently there are no plans to install the remaining five wells.

There are no known existing water supply facilities on AF Barrigada. It is assumed that the existing and planned Andersen AFB water system would serve Air Force water demands only.

GWA Water System – The GWA water system comprises three public water systems known as the Northern, Central, and Southern Public Water Systems, serving the respective areas of the island with some overlaps. The Northern and Central systems are designated as 'Large' and the Southern System is designated as 'Small.' A schematic of the GWA water system is provided in Figure 3-1.

The Northern Public Water System is the largest system serving all public areas in the north and central parts of the island south of Andersen AFB and serves an approximate population of 146,050. This system consists of 119 groundwater wells, 14 reservoirs (11 in use) and 10 booster pump stations (9 in use). It is the GWA Northern Public Water System that is of importance with respect to the USMC relocation due to its proximity to the relocation areas and since this system is primarily supplied by the same aquifer that serves the DoD systems.

The Central Public Water System consists of one spring, eight reservoirs (five in use) and nine booster stations (six in use). The main source of water for this system is the NIW water system and water is purchased through 54 metered interconnections, of which 15 are reported to be inactive. Water from the Northern System can also be fed to the Central System in the areas of Mongmong-Toto-Maite, Sinjana, Hagatna Heights, Asan, and parts of Piti. Northern water can also be supplied to Apra Heights, Santa Rita, and Agat through water mains that run along Routes 17, 5, 12, and 2.

The Southern Public Water System supplying the southern and southeastern parts of the island consists of 2 groundwater wells, 4 springs, 14 reservoirs, 16 booster stations (14 in use), and the Ugum WTP.

3.2.2 Design Capacity of System Components for the USMC Relocation

3.2.2.1 Water Supply Sources

The water supply source would be designed to meet the military activity's quantity demands. Where there is inadequate storage between the source and the treatment plant or distribution system, the supply would provide maximum day domestic demand plus industrial use demand.

For supply wells, sufficient capacity would be included to meet the maximum day domestic demand plus industrial use demand, with the largest well out of service.

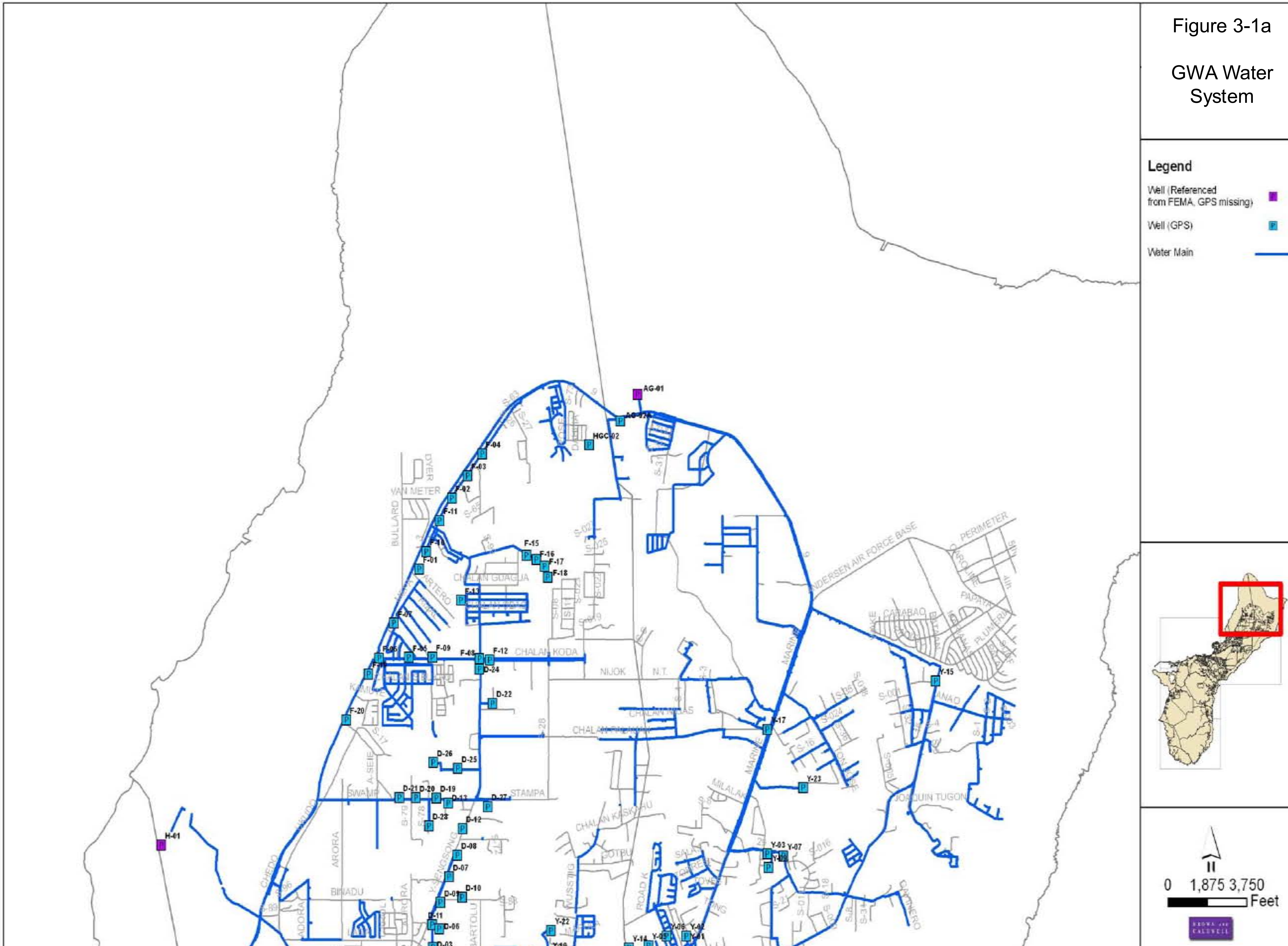


Figure 3-1a

GWA Water System

Reference: Adapted from Guam Water Authority. Water Resources Master Plan Volume 2, Chapter 1 Water System Description. 2007.

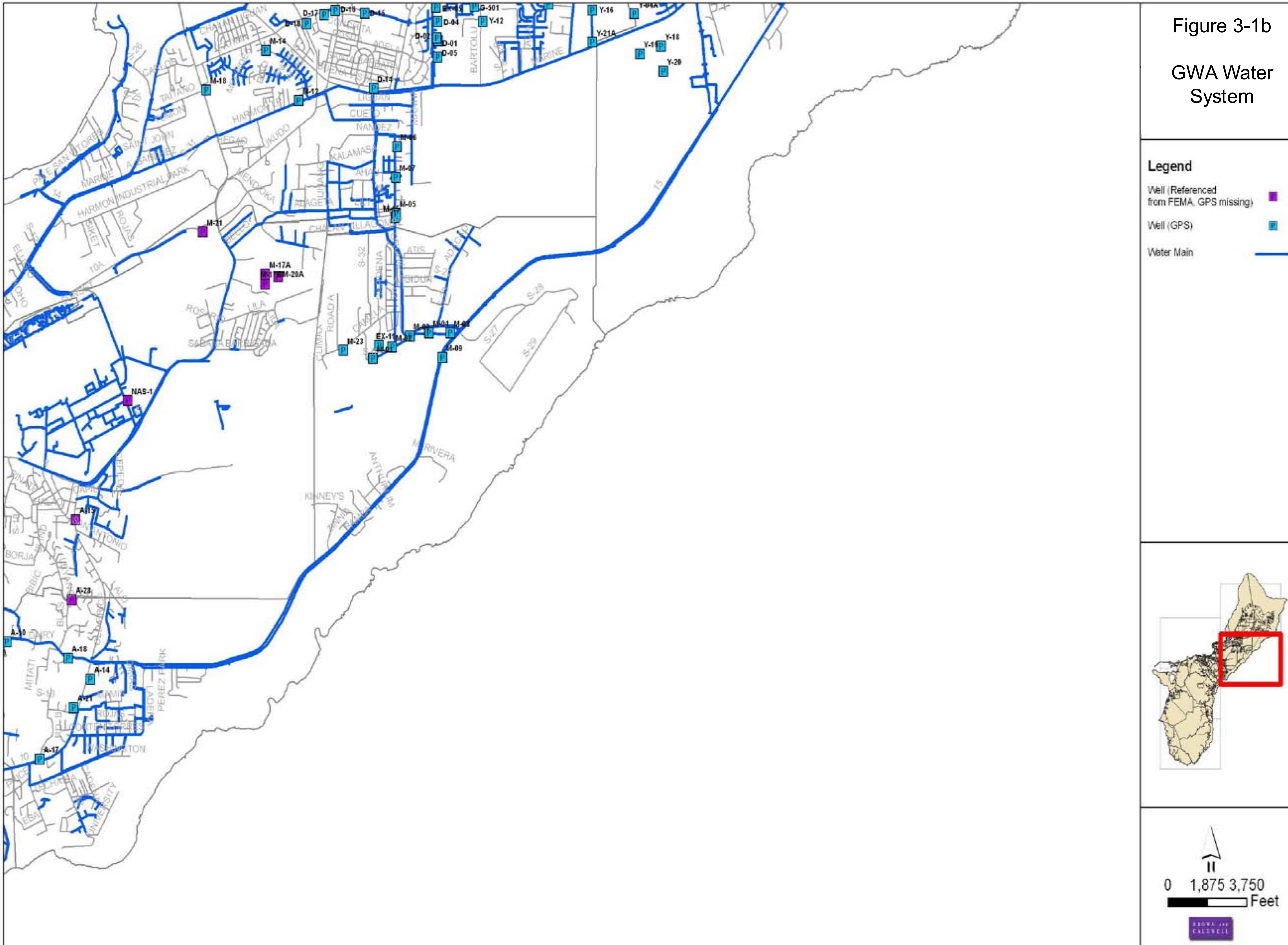


Figure 3-1b

GWA Water System

Reference: Adapted from Guam Water Authority. Water Resources Master Plan Volume 2, Chapter 1 Water System Description. 2007.

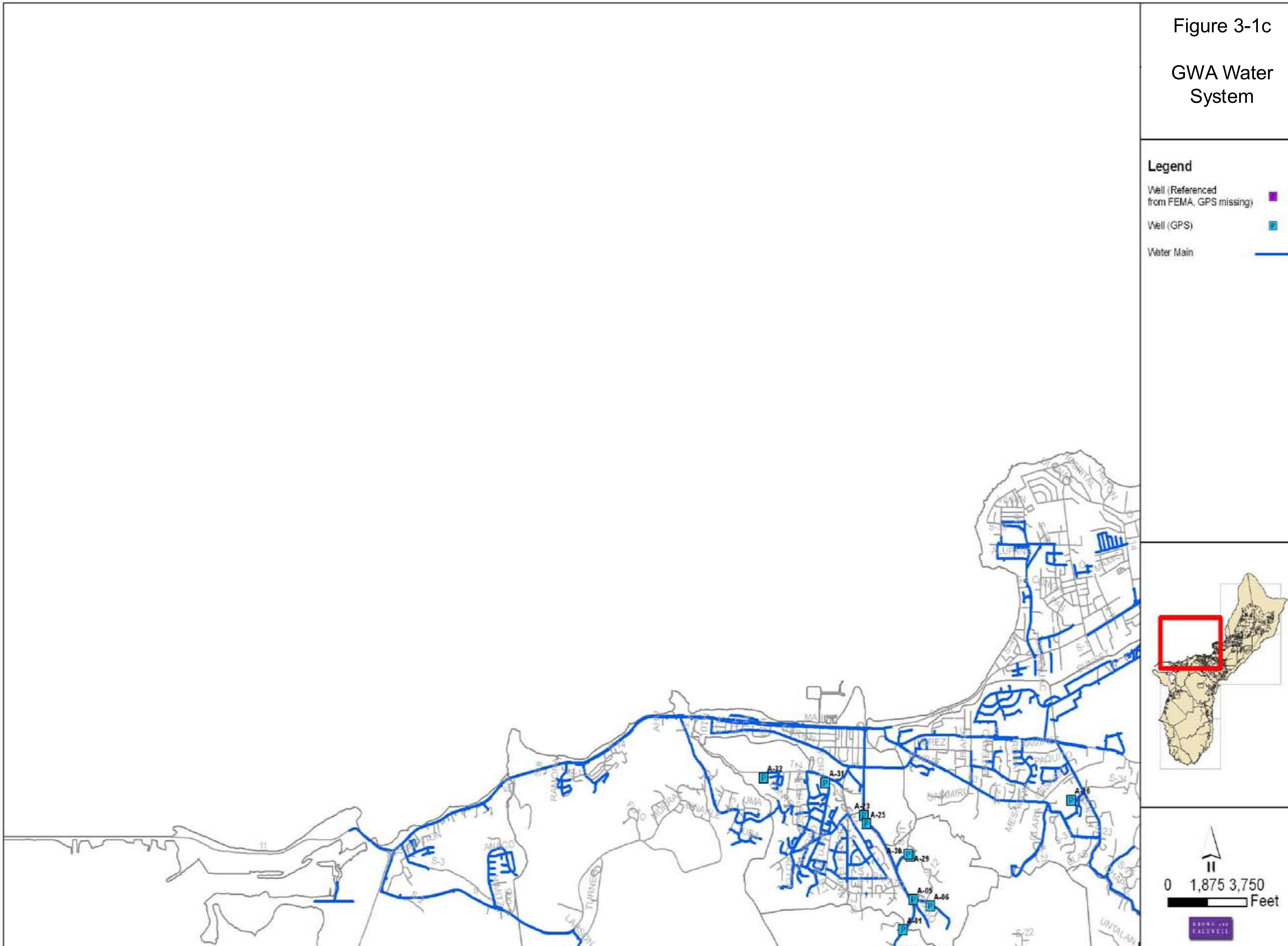


Figure 3-1c

GWA Water System

Reference: Adapted from Guam Water Authority. Water Resources Master Plan Volume 2, Chapter 1 Water System Description. 2007.

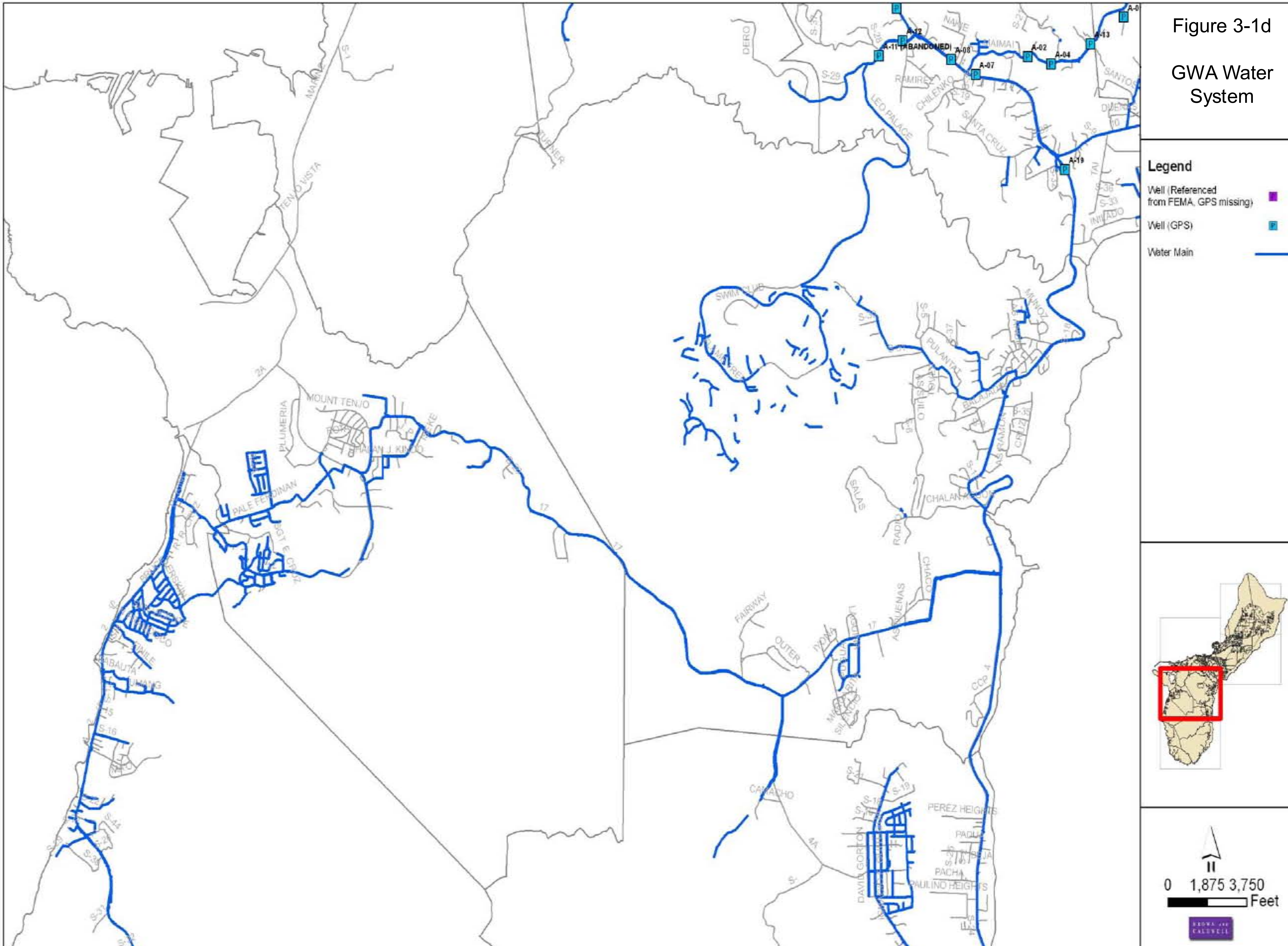


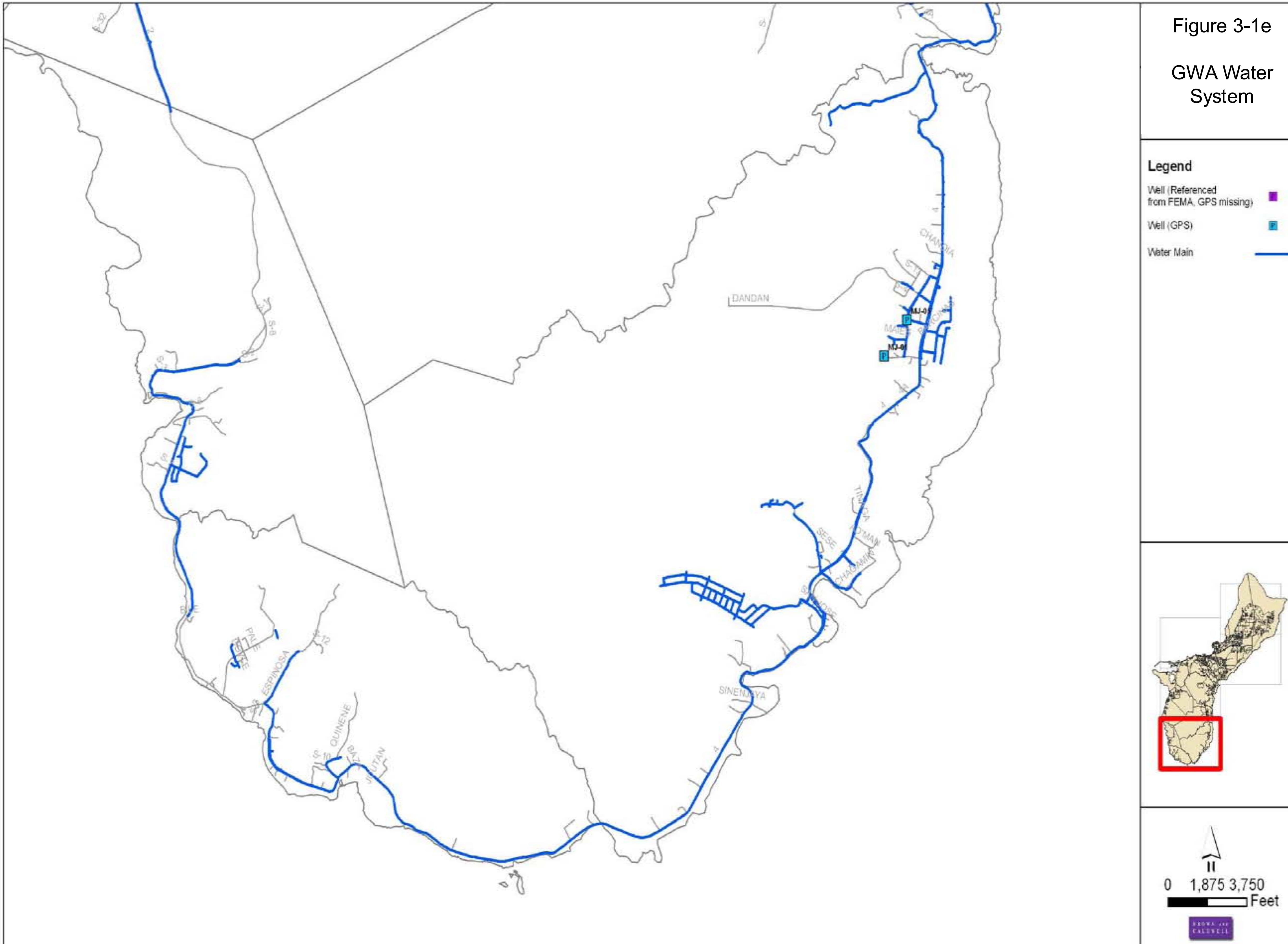
Figure 3-1d

GWA Water System

Reference: Adapted from Guam Water Authority. Water Resources Master Plan Volume 2, Chapter 1 Water System Description. 2007.

Figure 3-1e

GWA Water System



Reference: Adapted from Guam Water Authority. Water Resources Master Plan Volume 2, Chapter 1 Water System Description. 2007.

Existing or planned rehabilitation water supplies in Finegayan and Navy Barrigada are listed in Table 3-11. There is no existing water supply at AF Barrigada. The Navy has eight active wells and one well requiring rehabilitation at Finegayan with a total capacity of 2.2 mgd, and two wells at Navy Barrigada that are currently out of service but are being rehabilitated by the Navy. Other Navy water supplies having a total capacity of 11.9 mgd are listed in Table 3-12. Water supply from the existing Navy wells is accessible through the NIW system.

Table 3-11: DoD Water Supplies Current or Planned Rehabilitation in USMC Relocation Areas

	Capacity (gpm)	Planned (gpm)	Total (mgd)
Navy Wells on Finegayan [a]	**1,300**	**225**	**2.2**
NCTS #2		225	
NCTS #6	125		
NCTS #7	235		
NCTS #9	200		
NCTS #10	180		
NCTS #11	180		
NCTS #12	180		
NCTS B1	200		
Navy Wells on Barrigada [b]	**0**	**250**	**0.36**
NCTS #3		50	
NCTS #8		200	

[a] The Navy will abandon wells NCTS A and NCTS #5.
[b] There are no existing wells on AF Barrigada.

Table 3-12: Other Navy Water Supplies in NIW Water System

	Capacity (gpm)	Planned (gpm)	Total (mgd)
Navy S. Guam	**7,614**	**0**	**11.0**
Almagosa Spring	928		
Bona Spring	426		
Fena Reservoir	6,260		
Naval Hospital Supply	**234**	**378**	**0.88**
NRMC #1	234		
NRMC #2 Rehabilitation		200	
NRMC #3 Rehabilitation		178	

The required future water supply for the DoD facilities is shown in Table 3-13 using the UFC requirements described in Section 3.1.1. It is assumed that the supply for Navy Barrigada would be met by the USMC Finegayan Base water supply transported through the NIW water main. The supply required for AF Barrigada is 2.5 mgd for Alternative 3. The supply necessary to meet the demand at the USMC Finegayan Base and Navy Barrigada is 9.5 mgd for Alternative 3. This supply does not address the demand from Navy industrial facilities on Navy Barrigada, which would be met through the NIW system. The 2.3 mgd from existing wells on the USMC Finegayan Base is included in the total supply for the Navy. At Navy bases, the required supply is 17.0 mgd. Including the existing supply of 13.2 mgd and well rehabilitation totaling 1.2 mgd, there is a deficit of 2.6 mgd. It is assumed that the DoD would consider long-term alternatives (Section 3.3.2), rehabilitate wells (e.g., Tumon Maui and Marbo #2), or use excess water from the USMC Finegayan Base water supply to meet the projected deficit.

The USMC relocation-related required water supplies are 9.5 mgd for the USMC Finegayan Base (including Navy Barrigada) and 2.5 mgd for AF Barrigada. For existing bases, the required water supplies are 17.0 mgd for the remaining Navy Bases (not including domestic demands from Navy Barrigada) and 5.6 mgd for Andersen AFB.

Table 3-13: Required Future Water Supply (mgd)

	USMC Relocation Areas			
Units: mgd	USMC Finegayan Base + Navy Barrigada	AF Barrigada	Remaining Navy Bases	Andersen AFB
Minimum Required (maximum daily demand +largest well)	9.5	2.5	13.0	5.6
GWA Allotment			4	
Total Supply Required (Sum Minimum Required and GWA Allotment)	9.5	2.5	17.0	5.6
Existing Supply	0.0	0.0	13.2	4.7
Additional Required	9.5	2.5	3.8	0.9
Additional Planned Capacity	9.5	2.5	1.2	0
Total Future Capacity	9.5	2.5	14.4	4.7

Notes:
1. The maximum daily demand for Navy Barrigada excludes the demand not related to USMC relocation. These demands are included in the remaining Navy demands.
2. The maximum daily demand for the USMC Finegayan Base and Navy Barrigada are combined to estimate the water system capacities.
3. A "Largest Well" size is not included for the remaining Navy bases since the primary water source is Navy Reservoir.
4. The future water supply for the USMC relocation does not include the supply from existing Navy wells on base. The supply from these wells would be used by the Navy through the NIW system.

An estimate of the future available yield is presented in Table 3-14. Current and future well production estimates are summed for GWA and DoD. It is assumed that all DoD wells would be put in production at a rate which would supply the average daily demand to the water systems. The DoD has determined that up to 1.7 mgd is currently available from the Andersen AFB water system for transfer to GWA. It is assumed that 1.3 mgd would be supplied to GWA in 2019 from Andersen AFB wells in addition to the Navy transfer from Fena Reservoir to assist GWA in meeting the demand from the induced population and civilian workers resulting from the USMC relocation. GWA current well production is based on a recent communication with the Navy. The production rate for GWA was reduced by 2 mgd because a lower production rate is planned for wells in the Agana subbasin with consistently elevated chloride levels. GWA planned well production of 2.8 mgd is consistent with baseline growth in 2019 assuming no induced or military civilian worker increases. For the NGLA, the total future well production is 52.6 mgd. The total well production is subtracted from the 1992 sustainable yield estimates by subbasin to estimate the available yield, 27.9 mgd. As shown in Table 3-14, the NGLA has adequate available yield to accommodate the full capacity of the current, planned, and required future supply to meet DoD demand for Cantonment Alternative 3.

Sustainable yield is defined as the rate at which groundwater can be continuously withdrawn from an aquifer without impairing the quality or the quantity of the pumped water. In order to achieve the hypothetically available sustainable yield, the means of water withdrawal has to be optimized, which is usually not the case. Therefore, the full capacity of the aquifer is not available. Additionally, sustainable yield is not equal to recharge. In the case of the NGLA, leakage at the edges of the lens along the coastline must be taken into account.

Table 3-14: Future Available Yield Estimate Based on Total Well Production (mgd)

Subbasin (mgd)	Agafa-Gumas	Agana	Andersen	Finegayan	Mangilao	Yigo	Total
Well Production							
GWA Current Wells	0.0	8.0	0.7	6.7	2.5	18.0	36.0
GWA Future Wells	2.8	0.0	0.0	0.0	0.0	0.0	2.8
DoD Future Average Daily Demand	2.5	2.7	1.3	3.1	1.3	3.0	13.8
Total Well Production	5.3	10.7	2.0	9.7	3.8	21.0	52.6
Yield							
1992 Sustainable Yield Estimate	12.0	20.5	9.8	11.6	6.6	20.0	80.5
Available Yield	6.7	9.8	7.8	1.9	2.8	-1.0	27.9

There have been two published estimates of the NGLA: one by Camp Dresser & McKee Inc. (CDM) (CDM 1982), and one by Barrett Consulting with John Mink (cited herein as Barrett 1992). The CDM estimates were based on a steady-state condition and relied on conservative assumptions such that future development and groundwater management programs could be easily implemented. The CDM was the first to divide the aquifer into a series of six subbasins and 47 management zones. The subbasin division is based primarily on the basement topography forming effective hydrological divides in the subsurface. Based on the position of the freshwater lens, the subbasins can be either basal (freshwater lens floating on top of salt water), or parabasal (freshwater lens bottom in contact with basement rock, where the basement surface rises above the freshwater-saltwater interface). Management zones are a construct to optimally manage well fields within the basin.

The second estimate of sustainable yield was prepared by Barrett (1992), which revised the simulation to a transient system rather than steady-state. Barrett argued that the NGLA is best described as a transient system; as the majority of the recharge comes during the wet season and that transient conditions best represent seasonal variations in recharge. The revised estimate of using transient conditions increased sustainable yield to approximately 70 to 80 mgd.

The University of Guam Water and Environmental Research Institute provided an expert technical review of the two sustainable yield estimates for the NGLA in 2009. The study concluded that the approach and methodology used in Barrett 1992 to estimate the sustainable yield are still valid and are appropriate for initial planning. The Barrett 1992 sustainable-yield estimates should be used instead of the earlier 1982 sustainable-yield estimates (CDM 1982) because the later values are based on an additional decade of field data. The 1982 sustainable-yield estimates are excessively conservative.

3.2.2.2 Treatment Plant

Groundwater under the direct influence of surface water (GWUDI) is groundwater with inadequate natural filtration when surface water filters through soils into the groundwater table (called "recharge"). This inadequate filtration may lead to contamination of the groundwater from bacteria or contaminants in the soils. GEPA is currently conducting a study to determine if wells extracting water from the NGLA are GWUDI. Soils in northern Guam are highly porous, and past sampling has indicated that contaminants may enter the aquifer during sewer pump station spills and rain events. If portions of the aquifer subbasins are identified as GWUDI, then treatment requirements may be imposed on individual wells that include filtration and/or disinfection.

The results of the GEPA study are expected in late 2010. Preliminary results of the study indicate that the NGLA would not be characterized as GWUDI, but individual wells may be designated GWUDI and require supplemental treatment. This study is developed assuming that the proposed and existing DoD wells are not subject to GWUDI.

No treatment plants are planned. Groundwater would be chlorinated and fluorinated prior to transmission to the new base.

3.2.2.3 Transmission Mains

The NIW system would transport a portion of the water required to meet the demand at Navy Barrigada from the USMC Finegayan Base water supply. Given the age of the water mains in the NIW system, it is assumed that the water mains would require replacement between the USMC Finegayan Base and a point on the existing main near AF Barrigada. An extension would be required between the existing water main and AF Barrigada.

3.2.2.4 Distribution System

The distribution system within the facility is not included in the conceptual design.

3.2.2.5 Storage Facilities

Reservoir capacity for the USMC relocation would be adequate to satisfy the total of the following requirements:

- Peak fire flow demand
- 50 percent of average daily consumption (domestic and industrial)
- Minimum working volume of 1 hour at average demand (domestic and industrial) for scheduling of treatment plant equipment and service pumps maintenance

The storage capacity for the facility is referenced from Section 2.3.5 of MIL HDBK 1005/7A and is based on Equation 3:

Equation 3

$$\text{Storage} = \text{Peak Fire Flow Demand} + 50 \text{ percent Average Daily Use} + 1 \text{ hour of Average Daily Use} \quad (3)$$

In the above equation, the average daily use includes both domestic and industrial.

The minimum required storage capacity for the USMC relocation areas is shown in Table 3-15. It is assumed that all Navy existing reservoirs on Finegayan would be demolished. No storage facilities are currently present on AF Barrigada. New storage facilities would be required for USMC Finegayan Base and AF Barrigada. An existing 3-million gallon (MG) concrete reinforced Navy reservoir can address the required storage requirements at Navy Barrigada. The reservoir is leaking. The extent of the damage is not known. It is assumed that the tank would require inspection and repair.

Table 3-15: Water Storage Capacity in USMC Relocation Areas (mgd)

Units: mgd	USMC Relocation Areas		
	USMC Finegayan Base [a]	Navy Barrigada (USMC Only)	AF Barrigada
Minimum Required	3.3	1.4	0.7
Existing Supply	0	3.0	0
Additional Required	3.3	0	0.7
Future Planned Capacity	3.3	0	1
Total Future Capacity	3.3	3.0	1.0

[a] It is assumed that all existing storage facilities on Finegayan would be demolished.

3.2.3 Regulatory Involvement for Water Systems Options

The regulatory requirements for the proposed water treatment options were discussed with the following regulatory agencies during the field investigations:

- Guam Environmental Protection Agency (GEPA)
- U.S. Environmental Protection Agency (EPA) Region 9
- GWA
- Department of Public Works
- Department of Parks and Recreation (Historic Preservation)
- Guam Division of Aquatic and Wildlife Resources
- Bureau of Statistics and Planning (Coastal Management)

In June 2009, ATS met with representatives of GEPA and GWA. Minutes of these meetings are provided in Appendix C.3. Guam recently passed legislation that gives additional authority over water resources to Guam regulatory agencies. According to GEPA, well permits would not be reviewed by GEPA until GWA has approved the location of the wells. During the meeting with GWA, the GWA representative for water supply acknowledged the separate water supply wells for the DoD and expressed concern over placement of the DoD wells and sharing of the NGLA resource. At the time of the meeting, GWA had not considered placement of additional GWA wells to meet the requirements of the construction workers and induced population. The DoD and GWA have had additional meetings to discuss cooperatively managing groundwater resources moving forward.

GEPA noted that the area of influence for a well is considered to be 1,000 ft. Wells should be separated by 2,000 ft, but GEPA would consider well specific data to allow closer spacing. Wells should also be 1,000 ft from possible contaminant sources such as sewers, but GEPA would consider closer spacing if the water is treated at a WTP.

3.2.3.1 GEPA Permitting Requirements

A list of the well requirements for GEPA permitting is provided in Table 3-16 with information on due dates and regulatory response times. Additional permit requirements for system construction are provided in Table 3-17. The Navy and GEPA have established a liaison position staffed by a Navy service member who is the contact for all USMC relocation permitting inquiries going forward.

The permit required for drilling, exploratory drilling, pump testing and water quality testing is the "Application for Well Drilling Permit". (The GEPA "Test Boring Application" is only applicable for test boring, test pitting, percolation testing or simply, for geotechnical investigations only.) The well drilling permit application would be reviewed by GWA prior to submittal to GEPA. Once the exploratory wells are ready for development, detailed well construction plans that are approved and signed by the owner (DoD) are submitted for agency review. GEPA would review and approve the plans with comments to be incorporated with the final drawings. Response times are listed in Table 3-16. However, GEPA may require at least one month to review and approve the permit applications. GEPA would conduct a site visit before issuance of permits. A notice to proceed would be issued by GEPA to proceed with the well development. No separate permit would be issued during this time.

After the wells are fully developed, the "Application for Well Operating Permit" would be filed with GEPA by the owner to run the wells. The well coordinates and elevations are surveyed after construction. Coordinates and elevations are not needed during the exploratory phase.

3.3 WATER SYSTEM OPTIONS

3.3.1 Review of Technical Options

A summary of the options reviewed for the USMC relocation, included in an appendix to the Guam Water Utility Study (ATS 2010), is provided in Table 3-18. ATS provided a detailed review of the following four options:

- Option 1 – Optimize groundwater resource development within DoD property.
- Option 2 – Determine the requirements for rehabilitation, treatment of well water, or replacement of existing wells not currently in production due to contamination, structural and/or mechanical problems.
- Option 3 – Purchase water from GWA.
- Option 8 – Desalination.

For EIS Cantonment Alternatives 1 and 2, ATS recommended development of groundwater resources (Option 1) as the primary source to serve the USMC Finegayan Base. The supply from rehabilitated wells (Option 2) and purchase of water from GWA (Option 3) are not sufficient to meet USMC relocation water demand. Desalination (Option 8) is a viable means of meeting the USMC demand, but is significantly more costly and energy intensive. Implementation of this option is recommended as a long-term alternative if freshwater resources are insufficient to meet the combined DoD and GWA water demand. However, review of the available yield, indicates that the water supply from the NGLA is sufficient to meet the peak projected demand.

Cantonment Alternative 3 differs from the previously considered Cantonment Alternatives 1 and 2 in that a portion of the accompanied service members is housed on Navy Barrigada or AF Barrigada. It is assumed that the conclusions documented in the Guam Water Utility Study (ATS 2010) would be the same for Alternative 3. Therefore, this report would provide a detailed analysis of groundwater resource development as the primary source for Navy Barrigada and AF Barrigada.

Table 3-16: Well Permitting Requirements for Water

Well	Submittal Requirements	Due Date	Response Time
Well drilling permit application	Submit complete application package to GEPA Administrator cc: Water Resources Program Manager	At least 15 days prior to drilling operations	Permit issuance within 15 days following complete submittal of well drilling permit application package
Application fee	Remit payment for application fee ($250 per well) by check or electronic transfer documents	Due with permit application	No GEPA action
Inspection of proposed site	GEPA must schedule the inspection of proposed site	At least 24 hrs prior to desired inspection date	Within 15 day review and approval period
Performance bond	Submit copy of performance bond for each well to Administrator cc: Water Resources Program	Due with permit application	No GEPA Action
Maximum pumping capacity - not to exceed pumping rates identified in Northern Guam Lens Study	Provide information on permit application	Due with permit application	GEPA comments / RFI within 1 week application submittal
Notification prior to drilling and after drilling complete	Submit written notification advising Administrator of anticipated drilling start and completion dates cc: Water Resources Program. Provide verbal and email notification to Water Resources program prior to initiating drilling and following completion of drilling work, installation of well casing, and installation of equipment or appurtenances in well. University of Guam Water & Energy Research Institute must be notified before well drilling takes place.	Written notification at least 2 weeks prior to anticipated drilling start date. Verbal and email notification 48 hours prior to and following completion of work	
Preliminary report	Submit preliminary report with drilling permit application to Administrator cc: Water Resource Program	Due with permit application	GEPA comments / RFI within 1 week application submittal

The following information is also required:
Physical / chemical analysis
- Well blow-off line
- if provided, slope downward and terminate at a point not subject to flooding

Secured facility
- provide perimeter fence and lockable gates or enclosed ventilated lockable well house

All weather access road proper drainage
- fine grade well site in such a manner to assure proper surface water drainage away from well

Drilling information
- drilling operation records
- well driller's log
- representative samples of rock materials penetrated during drilling
- results of pumping tests conducted
- map showing location of test site, pumped well, piezometers, recharge and impervious boundaries
- lithological cross-section of the pumping test site

Yield and drawdown report
- yield and drawdown report
- water samples, pump tests for each well and where well(s) are located less than 1,000 ft away from the new well
- yield and drawdown report during long-term and recovery tests simultaneously

Table 3-17: System Installation Permitting Requirements for Water

Requirement Description (What is it?)	Submittal Requirements	Due Date	GEPA Response Time
Siting approval Seek approval from GEPA notifying of intent to initiate construction of PWS or to increase capacity of existing PWS	Submit letter to Water Division providing • Narrative project description, e.g. purpose, population served, estimated cost, raw source water data (surface water only) • Location map • Applicant responsible for setting up meeting to present proposed project (Groundwater - Water Resources Program, Surface Water - Safe Drinking Water Program)		Water Division approval within 2 weeks of Siting meeting with GEPA, EPA (if needed) and military staff, additional time may be needed to address issues.
Construction design approval Seek approval to initiate construction	Submit 2 sets of plan documents (paper or electronic) of proposed construction to GEPA Administrator cc: Safe Drinking Water/Water Resource Program Managers. Plan documents would include: • Engineering plans and specifications, i.e. schedule of materials and equipment, • Proposed treatment process, and • Permit application for well drilling (see well requirements sheet). A meeting and presentation would be required for 30% design submittal.	At 30-60-90% design completion prior to proceeding with next design stage and At 100% design completion prior to commencement of construction	Administrator signature of approval at 100% design stage. At 30-60-90%, Water Division written approval (i.e. approval of meeting proceedings) to proceed to next design stage within 30 days of construction design review meetings at 30%, and 15 days at each 60% and 90% designs.
Inspections during construction GEPA would inspect to verify that construction conforms to approved plans and specifications before system is put into operation.	GEPA may request specific documentation prior to an inspection that includes but is not limited to: procedure for proper disinfection and sanitation of the plumbing system and a timeline for these activities to take place, MSDSs, chemical product data, specifications of drinking water plumbing materials, etc.	Before system is put into operation	Written inspection results due within 5 business days of inspection.
Operations approval Seek approval to place system into operation	Submit letter to GEPA Administrator cc: Safe Drinking Water Program Manager requesting approval and providing proposed operation date. Submittal requirements vary from system to system and are specified in the approved construction design. They can include but are not limited to: • Equipment O&M manuals • As-built plans • Manufacturer required operator training • SOPs • Emergency shutdown and startup • Treatment-specific SOPs • Water quality testing results • Hydrostatic testing results	At least 30 days prior to operating new or altered water system	GEPA shall provide operations approval or comments and request for more information within 2 weeks from receiving letter requesting operations approval.

O&M operation and maintenance

Table 3-18: Summary of Option Evaluation for Water

Water System Alternative	Evaluation Considerations	Recommendation
Option 1 – Optimize Groundwater Resource Development within DoD Property	Salt water intrusion/ Excessive aquifer draw down. Managed fully by DoD/ Reliable and secure. Integrated System with GWA. Sustainable yield considerations.	Detailed review. Included in DoD recommended alternative.
Option 2 – Determine the Requirements for Rehabilitation, Treatment of Well Water, or Replacement of Existing Wells	Salt water intrusion/ Excessive aquifer draw down. Reduced stress on aquifer from installation of new wells. Managed fully by DoD/ Reliable and secure. Sustainable yield considerations.	Detailed review. Included in DoD recommended alternative. Insufficient supply from rehabilitated wells to meet full demand from USMC Relocation.
Option 3 – Purchase Water from GWA	New connections with DoD water systems. Upgrading systems/ energy savings. No excess supply available for DoD.	Detailed review. Included in DoD recommended alternative.
Option 4 – Sediment Dredging at Navy Reservoir	Current storage capacity reduced due to sedimentation. Need to dredge to sustain long-term supply Managed fully by DoD.	Potentially viable. Additional analysis is necessary to fully evaluate.
Option 5 – Expand Naval Reservoir Storage Capacity by Raising Dam Crest	Technical complexity of design and implementation. Relative advantages compared to other viable alternatives. Overall cost.	Eliminated
Option 6 – Potable Water Reclamation through Effluent Reuse	Negative connotations/ public perception. Relative advantages compared to other viable alternatives.	Eliminated
Option 7 – Non-Potable Water Reclamation through Effluent Reuse	Require separate distribution system. Relative advantages compared to other viable alternatives.	Eliminated
Option 8 – Desalination	Construction of desalination plant/Effluent discharge. High energy demands. Overall cost.	Detailed review. Viable if freshwater resources are not sufficiently abundant to meet demand.
Option 9 – Develop a New Surface Water Source	Complexity in identification, design and implementation. Relative advantages compared to other viable alternatives. Overall cost.	Reviewed rehabilitation of Lost River cofferdam in October 2008 letter report to meet DoD demand in southern Guam.

3.3.2 Long-term Options

This section provides a description of the water supply system components. The main components are the wells, distribution system, and storage. For Alternative 3, it is assumed that the water would be supplied from wells installed on Andersen AFB and Navy Barrigada. Improvements to the Navy or Andersen AFB water systems are not considered, except to the extent the components would be used to support Alternative 3.

3.3.2.1 Water Resources

Well locations are identified on Andersen AFB and Navy Barrigada to support Alternative 3. Wells were not located on AF Barrigada because there is no parabasal zone in the area and the Agana subbasins can contain dirty limestone (containing clay) that limits production. Using the 1992 estimates of sustainable yield, sufficient groundwater is available within military reservation boundaries to meet the new required supply resulting from the transfer of USMC and other assets to Guam. Potential water supply well locations were initially sited with consideration of the following land ownership and constraints:

- Limiting well production within subbasins so that the sustainable yield would not be exceeded.
- Preferentially locating wells in parabasal zones (as opposed to basal zones) to achieve higher yield with lower chloride levels; thereby, reducing the number of wells and associated costs.
- Maintaining a 1,000-foot distance from the shoreline to avoid saltwater intrusion.
- Maintaining an approximately 800- to 1,000-foot distance from other supply wells.

The parabasal zones (areas where the freshwater lens bottom is in contact with basement rock) are roughly drawn in Figure 3-2. It is assumed that the parabasal zone extends seaward to a point where the top of the impermeable volcanic basement underlies the limestone aquifer at depth of approximately 131 feet below mean sea level (msl). A transitional parabasal/basal zone is assumed to exist in the area where the top of the impermeable volcanic basement underlies the limestone aquifer at depths between 131 and 196 feet below msl. These assumptions are based on existing GWA well locations described as parabasal or transitional that appear to meet these characteristics, according to available volcanic basement contour maps.

The proposed well locations are clustered in the region of the parabasal zones because the wells are expected to have a higher capacity than wells in the basal zone and are less likely to have saltwater intrusion. Some considerations for the proposed locations include:

- According to volcanic-bedrock contour mapping, a substantial portion of the available potential high-yield parabasal zone exists on or near the military reservation boundary.
- If the parabasal zone were to yield less than the proposed well production, some of the wells may need to be relocated to the basal zone on DoD property, farther from the DoD boundary, and additional wells may need to be installed. A notional alternative layout is presented in Appendix C.2. Approximately twice the number of wells would be required if wells were to be located in the basal zone.
- One of the proposed well locations falls within the inhabited building distance (IBD) explosive safety quantity distance (ESQD) arc. The planned Andersen AFB wells are located within the IBD EQSD arc. Because of the spatial limitations, some proposed well locations are near or within residential zones. The Air Force would review and approve facility locations at Andersen AFB. Facility design would incorporate Andersen AFB requirements. For instance, wells located near the runways would be frangible or flush mounted.
- A significant portion of the available potential high yield parabasal zone exists on or near the military reservation boundary. Wells located along the boundary are less secure. To compensate for this, the wells would have added security, be provided with pitless adaptors, and be located within a locked structure.
- Wells near the approach to runways may need to be frangible or flush mounted. Wells located near the main base would be constructed to minimize noise and visual impact.
- Wells sited on Andersen AFB along the parabasal zone avoiding the installation restoration sites and Andersen AFB facilities. Wells are placed in and near the main base housing to supply water from the Andersen subbasin. This area may be subject to impacts from the sewer lines or dry wells. Spacing between wells is approximately 1,000 feet.

- Wells on Navy Barrigada are placed along the parabasal zone avoiding existing Navy structures, including the communication towers on the eastern side of the base. The wells follow the existing roadways. Several GWA are located immediately to the northeast of the site. The GWA wells are approximately 1,000 feet from the nearest planned well and should not impact production from the planned wells.

- Additional constraints are listed in Table 3-19.

Table 3-19: Well Location Constraints

Location Constraint	Comments/Approach to Well Placement
DoD Property	• Wells are located on DoD property.
Sustainable Yield	• The combined capacity of the existing and planned wells is less than the 1992 sustainable yield estimate.
Parabasal/Basal Zones	• Wells are clustered in the parabasal zone to maximize production of the aquifer. Lower chloride levels and higher production are anticipated for parabasal zone wells. Wells are located more than 1,000 ft from the shoreline to avoid saltwater intrusion.
Proximity to Existing and Proposed Air Force and GWA wells	• Maintain about 800- to 1,000-ft from other supply wells. • Monitor for saltwater intrusion. • Coordinate with GWA.
Current and Future Land Usage: - Impact on Air Force Mission and Quality of Life - Future Construction in Residential Area - Future Paving of the Utility Corridor	• All facility locations would be reviewed by and require the approval of the Air Force.
ESQD	• Wells are located outside all ESQD arcs, except one well that falls inside the IBD arc.
Potential Contaminant Sources: - Fuel Pipeline in the Utility Corridor - Fuel Storage - Dry Cleaners - 78 IRP Sites including Active and Inactive Landfills - Areas of past hazardous substance activities - Landfills and target ranges on the USMC Finegayan Base - UIC Wells in the Main Base Area -Unsewered properties	• Maintain approximately 800- to 1,000-ft (244- to 305-m) distance from contaminant sources, where possible. • Water quality would be evaluated during the pilot hole testing and periodically during well use.
Chlorinated VOC Plumes in the Main Base Area	• Monitoring wells with elevated levels of chlorinated VOCs are downgradient from the proposed well locations. • Water quality would be evaluated during the pilot hole testing.
UXO/MEC	• Precautions would be taken during construction for UXO/MEC.
Sewer Main along Route 9	• If wells are proposed along Route 9, DoD would conduct a study to evaluate the integrity of the sewer main.
Runway Approach	• DoD/Air Force requirements for design would be observed. • Well heads would be flush with the ground or frangible.
Cultural Resources Sensitive Habitat	• Location specific studies are being conducted by DoD. Facility locations would be adjusted as required.

ft feet or foot

Potential sources of contamination exist on or near Andersen AFB. These include the installation restoration sites, a utility corridor including a sewer line, and storm water injection wells. The proposed wells would be located away from these sites, where possible. All well locations would be tested for water quality before installation. The DoD would comply with all necessary stormwater requirements. Because the primary military relocation area would not be at Andersen AFB, impacts on stormwater resulting from the relocation would be minimal. If elevated contaminant levels were detected, the wells would be relocated or the design would be revised to include the appropriate treatment processes. The Main Cantonment area is within the Finegayan subbasin. Design of the Marine Corps Base will implement Low Impact Development to manage stormwater in a manner which is similar to the predevelopment hydrology at the site. A chlorinated-solvent plume containing trichloroethylene and perchlorethylene levels greater than the maximum contaminant levels is identified in groundwater on Andersen AFB. Monitoring wells with elevated levels of chlorinated solvents are shown on Figure 3-2. This plume is downgradient from the wells and is not expected to affect the proposed well locations.

Unexploded ordnance (UXO) and munitions and explosives of concern (MEC) may be found at Andersen AFB. In accordance with Naval Ordnance Safety and Security Activity (NOSSA) Instruction 8020.15B, Explosives Safety Submission (ESS) documentation must be prepared that details how explosive safety standards are applied to munitions responses. The ESS also addresses how a project will comply with applicable environmental requirements related to managing MEC and material potentially presenting an explosive hazard. At munitions response sites, no site operations may begin unless NOSSA and the DoD Explosive Safety Board have reviewed and approved the ESS. An ESS is prepared for onsite construction support where the likelihood of encountering UXO is determined to be moderate or high and where ground-disturbing or other intrusive activities, including dredging may occur in areas known or suspected to contain UXO. The ESS outlines specific measures to be taken to ensure the safety of workers and the public.

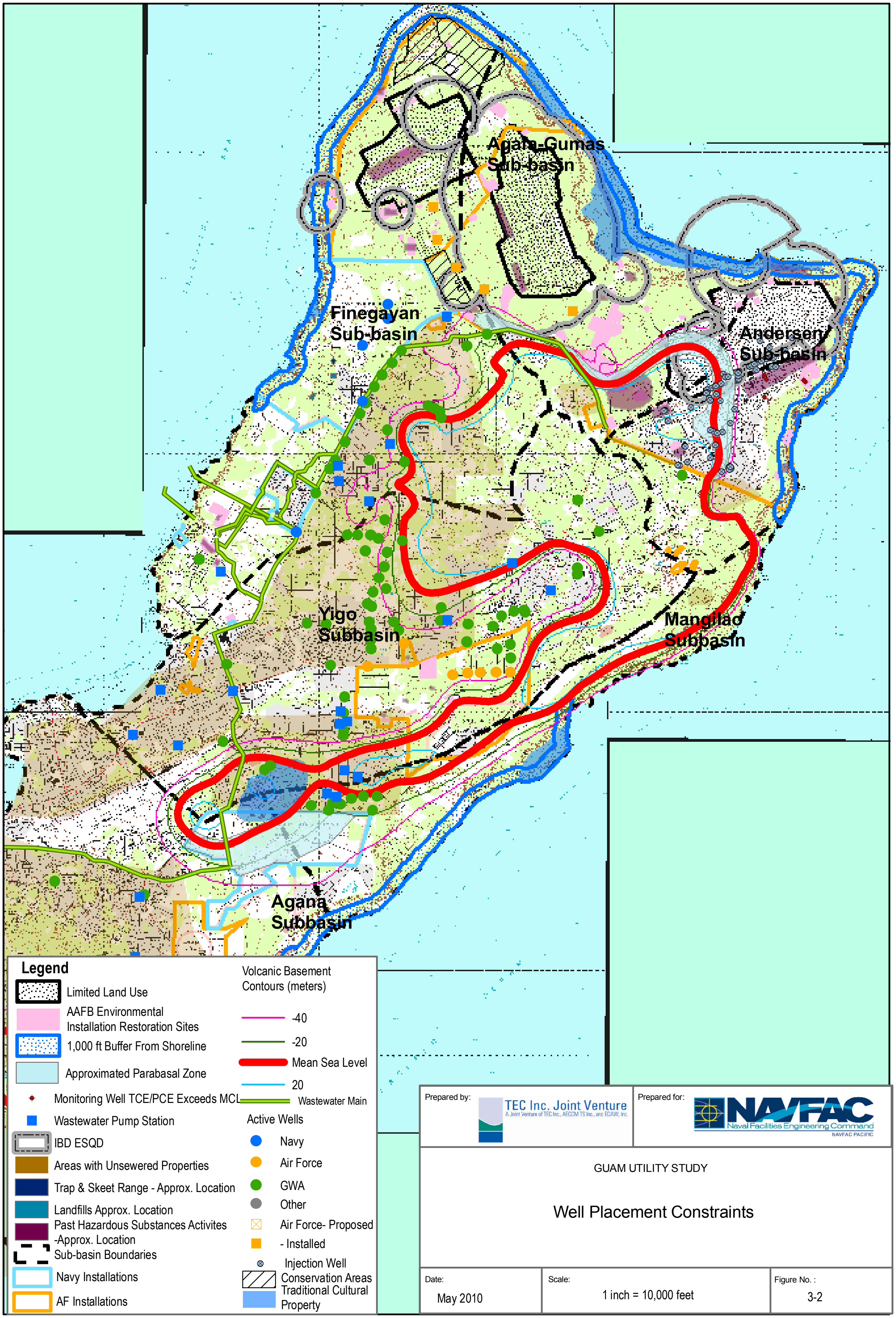
Studies of cultural resources and sensitive habitat are ongoing. Well locations may be modified as a result of these studies.

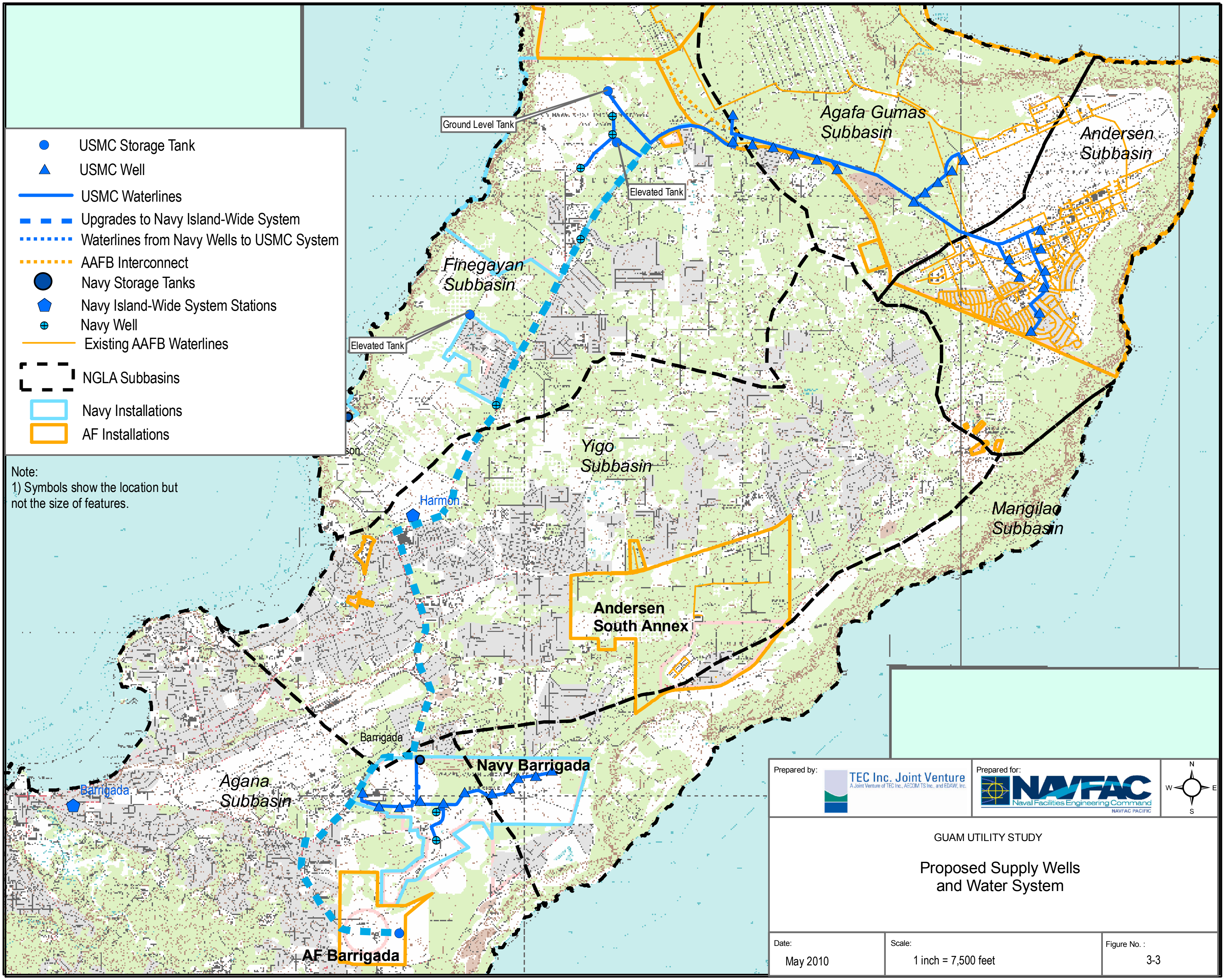
As part of the well permitting process, GEPA would conduct a review of each well location and review site-specific data. Additionally, all federal projects proposed over the Northern Aquifer are subject to an aquifer protection review. Projects are reviewed for potential direct or indirect impacts on groundwater. Submittal of detailed site plans, plumbing plans, engineering studies, and calculations may be required.

Well production rates were assigned assuming up to 450 gpm for parabasal wells and 100–300 gpm for transitional wells. Based on these assumptions, a minimum of 31 additional wells would be needed to meet the required supply for Cantonment Alternative 3 (20 wells on Andersen AFB and 11 newly installed wells on Navy Barrigada including the required contingency wells). These limits are consistent with the recommendations for supply wells presented in the 1982 NGLA study (CDM 1982). The sustainable yield estimates presented in the 1992 report (Barrett 1992) are included in this study for an assessment of well capacities by subbasin. These values are an update to the analysis presented in the 1982 NGLA study. However, the 1982 study included recommendations on the installation of supply wells that were not updated in the 1992 report. The Navy is currently implementing a study consisting of installing test wells on Andersen AFB and Barrigada to confirm the desired pumping capacities can be achieved.

If the well production rate is significantly lower than estimated for the parabasal zone on Andersen AFB and the USMC Finegayan Base, the number of wells could approximately double (e.g., 48 wells in the USMC Finegayan Base water system). A notional figure assuming seven 450 gpm wells are replaced with 21 lower capacity wells is provided in Appendix C.2. Lower well capacities were assigned to the Navy Barrigada wells (100 mgd to 200 mgd).

Table 3-20 presents the well capacity and subbasin location for potential wells needed to meet new demands resulting from transfer of DoD assets to Guam. Water system components are shown on Figure 3-3.


Agafa-Gumas Sub-basin
Finegayan Sub-basin
Andersen Sub-basin
Yigo Subbasin
Mangilao Subbasin
Agana Subbasin
Legend
Limited Land Use
AAFB Environmental Installation Restoration Sites
1,000 ft Buffer From Shoreline
Approximated Parabasal Zone
Monitoring Well TCE/PCE Exceeds MCL
Wastewater Pump Station
IBD ESQD
Areas with Unsewered Properties
Trap & Skeet Range - Approx. Location
Landfills Approx. Location
Past Hazardous Substances Activites -Approx. Location
Sub-basin Boundaries
Navy Installations
AF Installations
Volcanic Basement Contours (meters)
-40
-20
Mean Sea Level
20
Wastewater Main
Active Wells
Navy
Air Force
GWA
Other
Air Force- Proposed
- Installed
Injection Well
Conservation Areas
Traditional Cultural Property
Prepared by:
TEC Inc. Joint Venture
Prepared for:
NAVFAC
Naval Facilities Engineering Command
NAVFAC PACIFIC
GUAM UTILITY STUDY
Well Placement Constraints
Date:
May 2010
Scale:
1 inch = 10,000 feet
Figure No. :
3-2



Prepared by: TEC Inc. Joint Venture
A Joint Venture of TEC Inc., AECOM TS Inc. and EDAW, Inc.

Prepared for: NAVFAC Naval Facilities Engineering Command NAVFAC PACIFIC

GUAM UTILITY STUDY

Proposed Supply Wells and Water System

Date: May 2010

Scale: 1 inch = 7,500 feet

Figure No.: 3-3

Table 3-20: Proposed Well Details

Well Number	Proposed Capacity (gpm)	Sub-Basin
Located on Andersen AFB	**6,605 gpm (9.5 mgd)**	
1	450	Agafa-Gumas
2	350	Andersen
3	150	Andersen
4	200	Agafa-Gumas
5	400	Agafa-Gumas
6	400	Agafa-Gumas
7	400	Agafa-Gumas
8	100	Finegayan
9	350	Agafa-Gumas
10	350	Andersen
11	350	Andersen
12	350	Agafa-Gumas
13	355	Andersen
14	400	Agafa-Gumas
15	350	Agafa-Gumas
16	350	Andersen
17	350	Andersen
18	350	Andersen
19	350	Agafa-Gumas
20	250	Agafa-Gumas
Located on Navy Barrigada	**1,750 gpm (2.5 mgd)**	
1	200	Mangilao
2	200	Mangilao
3	150	Mangilao
4	150	Mangilao
5	150	Mangilao
6	100	Agana
7	100	Agana
8	100	Agana
9	150	Agana
10	100	Agana
11	100	Agana
NCTS #3 *(to be rehabilitated)*	50	Agana
NCTS #8 *(to be rehabilitated)*	200	Agana

The existing two Navy wells on Navy Barrigada, which are being rehabilitated by the Navy, would also be included in the water supply for Alternative 3. The Navy wells on the USMC Finegayan Base are not included in the water supply allotted for the USMC relocation. These wells are periodically down because of high chloride levels, the presence of coliform, or structural problems.

Periodic monitoring of the aquifer following implementation of the water supply wells is recommended to optimize the system and adjust pumping rates if chloride levels are shown to be increasing. The monitoring program should be coordinated with GWA.

Proper operations and maintenance (O&M) of the supply wells is necessary so that the wells consistently meet the design capacity and achieve the design life span. Deterioration of the well system starts as soon as the well is constructed and generally occurs slowly. Given time, a critical point is reached and deterioration accelerates, resulting in substantially decreased yield, or worse yet, total failure.

3.3.2.2 WATER TREATMENT

Groundwater would be extracted, disinfected, and fluorinated prior to transmission to the new base.

3.3.2.3 WATER STORAGE

For Navy Barrigada, it is assumed that the existing 3-MG Barrigada reservoir can be used to meet the 1.4-MG minimum required storage for Alternative 3. Some expense for inspection and repair to the leaking structure would be required.

For AF Barrigada, a 1-MG ground level tank is planned to meet the 0.7-MG minimum required storage for Alternative 3. There is no existing storage in this area.

For the USMC Finegayan Base, the minimum storage required for Alternative 3 is 3.3-MG. A 5-MG ground tank is planned. At least one additional tank is recommended to account for extra hazard fire demand storage and peak daily demand in total storage. The additional tank may be elevated. The cost estimate for this study only includes the minimum storage requirement.

3.3.2.4 DISTRIBUTION SYSTEM

Pumps at each well station would pump water from the wells through water transmission mains to the water storage tanks on the USMC Finegayan Base, Navy Barrigada, and AF Barrigada.

For Alternative 3, the well supply from Navy Barrigada wells is sufficient to meet the demand at AF Barrigada. The water from these wells is transported from the reservoir on Navy Barrigada to the storage tank on AF Barrigada through the NIW (30-inch main) and a planned connection from the NIW to a planned reservoir on AF Barrigada (24-inch main). The cost includes replacement of the NIW water main in sections, which are planned for use in Alternative 3 since the water mains are over 50 years old and significant water loss is expected in these water lines from leakage. The minimum required water demand at Navy Barrigada from the USMC relocation is supplied through the NIW 24-inch water main from the USMC Finegayan water system to the Navy Barrigada reservoir.

Pumping Stations

Well houses would be constructed to meet typhoon and local building code requirements. Sufficient standby power would be provided to ensure that the average daily demand at the new base could be met during power outages. Each well station would include a submersible well pump with an aboveground discharge pipe that would need to be protected. Wells would be installed with pitless adapters for security. The discharge pipe would have an air/vacuum relief valve, check valve, surge relief valve, and flow meter. The land area requirement for each well station is estimated to be a minimum of 1,000 square feet (93 square meters).

Water Transmission Mains

The water transmission mains would convey water from the wells to storage. The mains range from 8 to 30 inches in diameter, and are sized to provide velocities less than 6 feet per second to minimize friction head losses. There is a water interconnection from Andersen AFB wells on the NWF to water mains connecting the USMC wells on Andersen AFB. Water mains are included to transport water from the existing Navy wells on the USMC Finegayan Base to the new base water mains. For Alternative 3, replacement NIW mains are planned. Distribution of treated water to users within the bases is not included in this plan. AF Barrigada would receive water from the existing Barrigada ground storage tank through the NIW water mains and a planned extension.

Prior to constructing these water mains, additional study and hydraulic modeling is needed to confirm the feasibility and operating conditions. Improvements to the Navy's existing water mains can be implemented over time.

3.3.2.5 *COSTS*

The costs estimated for Alternative 3 are provided in Table 3-21. Costs are based on year 2008 dollars and escalated to the mid-point year of construction. Details of the cost estimate are provided in Appendix C.1. The present worth cost is $401 million (M).

Table 3-21: Cantonment Alternative 3 Life Cycle Costs for Water

Capital Costs	Cost ($000)
1) Water Resources Development	$26,385
2) Water Treatment	$3,653
3) Distribution	$131,299
Total Construction Cost	$161,337
Contingencies (20%)	$32,267
Engineering (15%)	$24,201
Total Capital Cost	**$217,805**
Present Worth Guam Capital Costs	**$219,513**
1) Water Resources Development	$487
2) Water Treatment	$775
3) Distribution	$5,089
Total Annual O&M Cost	$6,350
Contingency (20%)	$1,270
Total Annual O&M Cost	**$7,620**
Present Worth of O&M Costs (25 year life)	**$181,867**
Present Worth of Total Costs	**$401,380**

3.3.2.6 *PRELIMINARY CONSTRUCTION SCHEDULE*

ATS anticipates that implementation of the recommended water system would require about 12 to 18 months to design, 5 to 6 months to bid and award, and 25 to 30 months to construct the water supply facilities. It is assumed that the regulatory agency permitting work would be done concurrently with the design. Therefore, the total time required is approximately 5 years. Scheduling and planning the water system improvements would be important so drinking water and fire protection water would be available when and where it is needed. Prior to constructing any water system improvements, detailed water system master planning and hydraulic modeling would be necessary. Master planning and modeling would assure that the water improvements are in the right location and of the right size for the proposed developments.

3.3.3 Interim Alternative

For potable water, no distinction is made between interim and long-term alternatives. It is assumed that 10 wells on Andersen AFB would be installed to meet the interim DoD demand with housing on the USMC Finegayan Base only.

4. Wastewater Utility

The military relocation populations projected in the EIS for Guam that were used as a basis for this utility study are presented in Table 1-1 through Table 1-6. Certain assumptions were required regarding the housing locations for construction workers and increased civilian population of Guam in order to assess the impact on existing utilities operated by the GovGuam. The assumptions are footnoted in the population worksheets.

This study provides conceptual level planning for wastewater flow and treatment from the Navy and AF Barrigada area. This planning information identifies impacts to wastewater treatment and collection systems to facilitate assessment of impacts in the EIS.

4.1 Analysis of Wastewater Flows and Treatment Capacity Requirements

4.1.1 Basis of Wastewater Flows and Treatment Capacity Requirements Calculations

In order to identify wastewater treatment capacity requirements for USMC relocation, it is essential to determine the quantity and source of wastewater flow. Wastewater normally consists of domestic sanitary sewage and industrial wastewater. The sanitary sewage could be estimated by population and the industrial wastewater could be determined based on type of industry and its activities. This study addresses wastewater generated in Barrigada area of Guam for EIS Cantonment Alternative 3.

In EIS Cantonment Alternative 3, relocated USMC personnel would have a main base at Finegayan area in Northern Guam and an off-base housing area for family housing and associated base operations, educational facilities, and recreation and quality of life in DoD properties at Barrigada. Military personnel living at Barrigada area would commute to Finegayan main base for day activities. As a result, wastewater generated from USMC relocation activities at Barrigada is assumed to be sanitary sewage that can be estimated by number of USMC personnel.

Population growth related to the Barrigada housing alternatives for Marine relocation to Guam included accompanied military personnel, their dependents and on-base civilian workforce and off-base civilian workforce; construction workforce; induced population growth, and Guam local civilian natural growth in the region. Based on assumptions of the alternatives, only accompanied military personnel from both Marine and Army would be located at Barrigada, while unaccompanied personnel and transient personnel would be located at Finegayan main base. Based on the Traffic Analysis assumptions, the proposed family housing would equally split among Finegayan main base, Navy Barrigada and AF Barrigada. As a result, two thirds of accompanied military personnel, and their dependents would live at Barrigada area. The USMC relocation related population increases in Barrigada DoD properties by 2019 are shown in Table 4-1.

Table 4-1: Proposed On-Base Population Distribution for USMC Relocation to Guam Alternative 3

Projected Related Population Category	Island-wide	Finegayan (NCTS+South)	Navy Barrigada	AF Barrigada
Alternative 3				
Active-Duty	9,182			
Transient	2,000			
Military personnel subtotal	11,182	8,659	1,262	1,261
Dependents	9,950	3,317	3,317	3,316
Civilian Work Force (on base)	1,836	612	612	612

According to the draft GJMMP, Army AMD housing would be located in AF Barrigada, with a total 342 units. The study assumed that a total of 342 Army personnel and 950 dependents would stay in AF Barrigada.

Barrigada area is located inside of central Guam wastewater basin defined by GWA in GWRMP. The off-base central Guam civilian population growths are considered for evaluating wastewater treatment options that utilize GWA treatment facilities.

Off-base population growths, such as USMC relocation project construction workforce, USMC relocation project induced population, and Guam local civilian population are estimated only for central Guam in this study. It is assumed that 38 percent of the Guam natural population growth and project induced population on the island are distributed in the north, 43 percent in the central, and 19 percent in the south. The distribution is based on a socio-economic analysis of the proposed Guam military relocation. Two thirds of the project related construction workforce would be located in northern Guam and the rest in central Guam. The projected Barrigada on-base and off-base populations associated with the proposed military relocation project on Guam are presented in Table 1-3.

4.1.2 Wastewater Flows and Treatment Capacity Requirements Calculations

Domestic wastewater flow generated from Marine relocation was calculated per UFC 3-240-02N, Wastewater Treatment Systems Augmenting Handbook, 16 January 2004. The following unit flow information is considered for the wastewater flow generation:

120 gpcd for resident personnel
35 gpcd per for transient personnel

Marine relocation related population increase consists of accompanied military personnel, and their dependents who live on-base were counted as resident personnel, while transient population included military personnel who come to the island for training and civilian personnel working in housing area but living outside were counted as non-resident personnel. Based on GJMMP, Marine relocation related military transient population were planned to use Finegayan Main base and would not contribute wastewater flow in Barrigada. As discussed earlier, the Barrigada study area would not contribute industrial wastewater; hence, only domestic wastewater was considered for the analysis.

A unit value of 120 gpcd is considered for estimating wastewater flow generated by off-base non-military population that includes local Guam population and induced population. A unit value of 70 gpcd is considered for estimating wastewater generated by project related construction workforce. The unit value is in line with on-base bachelor officer criteria listed in UFC 3-240-02.

4.1.3 Barrigada Projected Wastewater Flow Requirements

Total wastewater flow generated from Barrigada Base is summary of current baseline flow and future Marine relocation generated flow.

The planned on-base housing would be located in Navy and AF Barrigada. The current wastewater flow from Navy Barrigada discharges to GWA sewer for treatment at Hagatna Wastewater Treatment Plant (WWTP). Currently there is no wastewater flow from AF Barrigada. There is no sewer flow data available for Navy Barrigada area. Neither Navy nor GWA has wastewater flow records. The water consumption data from May 2008 through May 2009 was provided by NAVFAC Marianas. As recommended by NAVFAC Marianas, our analysis considered 80 percent water consumption as wastewater flow. Based on this analysis the current wastewater flow from Navy Barrigada is 0.34 mgd.

Based on the wastewater flow data from March 2008 through March 2009, the current average flow at Hagatna WWTP is 4.72 mgd. Current and projected increased average daily wastewater flow in central Guam wastewater basin related to the Barrigada housing alternatives of Marine relocation to Guam was summarized in Table 4-2. As presented from the table, military flow is generated from the military activities in Navy Barrigada and AF Barrigada, while outside base civilian flow includes the flows generated from Guam population and its natural growth, and induced population due to military relocation in the region.

Table 4-2: Current and Future Average Wastewater Flow in Central Guam for USMC Relocation Alternative 3

Scenario	Service	DoD Active Duty	DoD Dependents	On-base Civilian	Total Population	Unit Flow (gpcpd)	Total Flow (mgd)
Baseline (Y2009)	**Outside-base Civilian**						**4.38**
	Military at Barrigada	-	-	-	-	-	**0.34**
	USMC	0	0	0	0	120 (35)	0.00
	Navy	-	-	-	-	-	0.34
	Army	0	0	0	0	120 (35)	0.00
	Total Central Guam Flow						**4.72**
Proposed Increase (Y2019)	**Outside-base Civilian**				14,667	120	**1.76**
	Guam Natural Growth				10,834	120	1.30
	Induced Population				3,833	120	0.46
	Military at Barrigada	2,523	6,633	1,224	10,380	120 (35)	**1.05**
	USMC	2,181	5,683	1,058	8,922	120 (35)	0.91
	Army	342	950	166	1,458	120 (35)	0.14
	Total Central Guam Flow						**2.82**
Total Future Loading (Y2019)	**Outside-base Civilian**				-	-	**6.14**
	Guam Civilian Population				-	-	5.68
	Induced Population				3,833	120	0.46
	Military at Barrigada	2,523	6,633	1,224	10,380	120 (35)	**1.40**
	USMC	2,181	5,683	1,058	8,922	120 (35)	0.91
	Navy	-	-	-	-	-	034
	Army	342	950	166	1,458	120 (35)	0.15
	Total Central Guam Flow						**7.54**

Notes: 1: No Navy, AF, Coast Guard, and Guam National Guard population increase in Barrigada area.
2: Assume Cantonment Alt. 3 and Alt. 8 with same population distribution in Barrigada.
3: Assume Army stays in AF Barrigada and army active duty with family # from GJMMP April 2008.
4: Number of USMC and Army personnel and dependents in Barrigada obtained from Guam Traffic Analysis Data spreadsheet (01-28-09).
5: No industrial flow in Barrigada residential base.
6: Navy Barrigada existing flow (Y2009) estimated 80% of water demand data (total - irrigation) supplied by Jack Brown of NA FM.
7: Off-base civilian existing flow (2009) estimated by deducting DoD flow from Hagatna WWTP flow data provided in Julie Shane's email.
8: Off-base civilian future flow (Y2019) calculated by 43% island wide civilian natural population growth data from US Census Bureau, International Data Base (IBD), and 15 Dec 2008: http://www.census.gov/ipc/www/ibd/.
9: Current baseline year: 2009; Planning future year: 2019.

From the above Table 4-2, the projected 2019 average daily wastewater flow generated from DoD Barrigada properties is 1.40 mgd. The peak factor was calculated using Babbit's curve in Water Pollution Control Federation Manual of Practice No. FD-5. The peak flow as presented in Table 4-3 from DoD Barrigada area in 2019 would be 4.76 mgd.

Table 4-3: Projected Y2019 Wastewater Flow Generated from DoD Barrigada Properties

Flows	Flow rate (mgd)
Average daily flow	1.40
Peak wet weather flow	4.76

From Table 4-2, the projected wastewater flow at the Hagatna WWTP by year 2019 from regional Guam natural population growth, Marine Corps future expansion and associated induced population is 7.54 mgd. In this evaluation, it was assumed that the future combined civilian and military wastewater flow would have peak characteristics similar to the wastewater flow discharging to the existing Hagatna WWTP. Hence the same peaking factor of 1.75 was used in the evaluation. The wastewater flows to Hagatna WWTP in year 2019 are presented in the Table 4-4.

Table 4-4: Projected Wastewater Treatment Flow at Hagatna WWTP in 2019

Flows	Flow rate (mgd)
Average daily flow	7.54
Peak wet weather flow	13.20

4.2 EXISTING WASTEWATER SYSTEM FOR BARRIGADA AREA

Two of the four cantonments alternatives proposed for relocation of the USMC to Guam are included in Barrigada area in Central Guam. The proposed housing associated base operations, educational facilities, and recreation and quality of life facilities would be located in Navy and AF Barrigada areas.

Navy land (approximately 300 acres) at Barrigada is located east of Route 16, west of Route 15, and north of Route 8. The eastern portion of the property contains the electronic antenna farm for Naval Communications (NAVCOMM) emitters and receivers. The west portion includes Navy Fleet Hospital Facility, Guam National Guard Facility, and Navy Golf Course.

Air Force land (approximately 445 acres) at Barrigada is located south of Route 8, north of Route 15, and east of Route 10. It is currently used only for Air Force Next Generation Radar (NEXRAD) weather satellite receiver.

Currently, only Navy Barrigada has sewer service that conveys wastewater to GWA central sewer basin with treatment at GWA Hagatna WWTP at the coast of Hagatna, Guam. Air Force NEXRAD weather satellite receiver in AF Barrigada does not generate wastewater flow.

4.2.1 Existing Sewer System in Navy Barrigada

Current sewer collection system in Navy Barrigada is comprised of approximately 13,000 ft gravity sewer lines with size ranging from 6 to 8 inches in diameter. Most of the lines were built in the 1950s, 1960s and 1980s with vitrified clay pipes (VCP) and asbestos cement pipes (ACP). The collection system connects buildings of Fleet Hospital Facility, Guam National Guard Facility, and Navy Reserves Facilities at west part of the property, flowing from north down into an 8 inch sewer trunk along Route 8 at south. The sewer trunk, built in 1982, conveys wastewater in a southwest direction and connects to a GWA manhole just before the intersection of Route 8 and Route 16. Figure 4-1 shows the existing sewer system in Navy Barrigada.

In addition, isolated areas such as Navy Golf Course Clubhouse and NAVCOMM operation facility in the east of the property are served by septic tanks and leaching fields.

There are no generated sewer flow data available for Navy Barrigada area. Neither Navy nor GWA has measurements on this part of wastewater flow. Based on current water consumption (May 2008 – May 2009) provided by NAVFAC Marianas, and assuming 80 percent of water is converted to wastewater (per recommendation by NAVFAC Marianas), current wastewater flow from Navy Barrigada is estimated at 0.34 mgd.

4.2.2 Existing GWA Wastewater System Associated to Navy Barrigada Property

Navy Barrigada property is located inside GWA central wastewater basin and currently wastewater generated from the property is conveyed though the central GWA sewage system to GWA Hagatna WWTP for treatment and disposal to the Philippine Sea.

4.2.2.1 Existing GWA Sewer Line from Navy Barrigada to Hagatna WWTP

Wastewater generated from Navy Barrigada discharges into GWA central sewer basin system at intersection of Route 8 and Route 16. The trunk sewer runs along Route 8 toward the west, and then connects to trunk sewer that runs under Route 1 Marine Corps Drive flowing west to GWA Agana Main Sewer Pump Station (SPS). The main SPS pumps sewage to Hagatna WWTP for treatment. All the sewers from northeast under Marine Corps Drive for the area as far as west part of Tumon Bay, from southeast under Route 8 from Barrigada, from south under Route 4, and from west under Marine Corps Drive for Asan Piti area in the central Guam discharges to the Agana Main SPS.

The sewer trunk from Navy Barrigada to the treatment plant consists of sewer lines with diameter ranging from 8-inch to 38-inch of VCP, ACP, and polyvinyl chloride (PVC) pipes. Most of the trunks were built between 1975 and 1990; some were even built in 1950s. GWA does not have as-built sewer information available for this segment of the sewer trunk. There are no records available on flow rates or sewer conditions for this section of sewer line. Figure 4-2 shows the existing GWA sewer system.

4.2.2.2 Existing GWA Hagatna WWTP

Hagatna WWTP was built on a man-made island located in the west of Hagatna Bay and treats wastewater flows from all central Guam. It was commissioned in 1979 and has a designed capacity of 12 mgd average flow and 21 mgd peak flow for a primary treatment level. The plant was refurbished in 2007 in order to restore its operation by refurbishing or replacing its major unit processes and components with upgraded and more modern equipment and facilities.

The plant liquid process stream includes a flow division structure, and a Parshall flume followed by three rectangular primary clarifiers, and treated effluent discharged into Philippine Sea though a newly extended 1,200-ft ocean outlet. Its solid process stream consists of four square aerobic digesters and a centrifuge dewatering system with solid handling capability of 9,800 to 15,300 pounds per day, and dewatered solid is disposed of to a Guam sanitary landfill. The primary clarifiers remove suspended solids from the raw wastewater and aerobic digesters stabilize the solids removed by the primary clarifiers. The design criteria of Hagatna WWTP in GWRMP are provided in Table 4-5.

Based on the discussion with GWA personnel during the field visit, the plant is in compliance with all requirements of current National Pollutant Discharge Elimination System (NPDES) discharge permit. However, when treated effluent is over 6 mgd, backflow could potentially occur during high tide with existing gravity ocean outfall design. GWA personnel recommended an upgrade with an effluent pumping station for discharging treated flow.

Table 4-5: Existing WWTP Design Summary

Item	Design Value
Influent Metering	
Type	Parshall Flume
Number	1
Primary Clarifiers	
Type	Rectangular
Number	3
Length (ft)	120
Width (ft)	34
Side water depth (ft) (shallowest)	11.6
Side water depth (ft) (deepest)	12
Surface area (ft^2)	4,080
Weir length (ft)	204
Total surface area (ft^2)	12,240
Total volume (ft^3)	122,400
Total design flow (mgd)	12
Design surface overflow rate (gpd/ft^2)	980
Design weir overflow rate (gpd/ft^2)	58,824
Primary sludge inline grinders	
Type	Inline Grinder
Number	4
Capacity (gpm)	80-500
Primary sludge cavity pumps	
Type	Progressive Cavity Pump
Number	4
Capacity (gpm)	100
Head (ft)	40
Scum pit scum removal pumps	
Type	Chopper Pumps
Number	2
Capacity (gpm)	200
Head (ft)	40
Pump gallery sump pumps	
Type	Submersible/Non-clog
Number	2
Capacity (gpm)	60
Head (ft)	20
Pump gallery booster pumps	
Type	Submersible/Non-clog
Number	2
Capacity (gpm)	60
Head (ft)	20
Aerobic Digester	
Type	Coated Concrete Square Tank
Number	4
Length (ft)	32

Item	Design Value
Width (ft)	32
Water depth (ft)	18
Active sludge waste depth (ft)	15
Total Active volume (ft^3)	61,440
Aerators	
Type	Low Speed Surface Aerator
Number	4
Output Speed (RPM)	37
Motor (HP)	40
Sludge Decant Tank	
Type	Coated Concrete Rectangular Tank
Number	1
Length (ft)	32
Width (ft)	9
Side water depth (ft)	11.5
Digester dewatering pumps	
Type	Torque Flow Pump
Number	2
Capacity (gpm)	700
Head (ft)	35
Centrifuge sludge Feed Pumps	
Type	Progressive Cavity Pump
Number	2
Capacity (gpm)	120
Head (ft)	150
Centrifuges	
Type	Centrifuge
Number	2
Capacity (gpm)	150
T Motor (HP)	60
Effluent Pump Station	
Pumps	NA
Outfall to Philippine Sea	
Pipeline Size, each (inches)	30
Peak Hour Capacity	27 mgd
Length of the outfall from the shore	2,100 ft
Depth at which wastewater is discharged	150 ft

ft^3 cubic ft
ft^3/min cubic ft per minute
gpd/ft^2 gallons per day per square ft
gpm gallons per minute
HP horse power
lb/day/ft^2 pounds per day per square ft
RPM revolutions per minute

The treated effluent discharge to the ocean is regulated under NPDES Permit No. GU0020087 issued June 30, 1986 with 301 (h) waiver that exempts the plant from full secondary treatment requirements. The NPDES permit requirements on effluent of Hagatna WWTP are listed in Table 4-6. The permit has not been renewed since it expired in 1991, and in January 2009 the EPA Region 9 tentatively denied a renewal of 301 (h) exemption and required Hagatna WWTP upgraded to secondary treatment. GovGuam is asking the EPA to delay its decision until the GWA completes additional studies to test the performance capability of the newly installed outfall.

Table 4-6: Hagatna WWTP NPDES Permit Requirements

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	lb/day		Other Units (specify)			
	Average Monthly	Daily Max	Average Monthly	Daily Max	Measurement Frequency	Sample type
Flow (mgd)	—	—	—	12	Continuous	—
BOD_5 [a]	8,011	16,022	80 mg/L	160 mg/L	Once/week	Composite
Suspended Solids [a]	6,008	12,016	60 mg/L	120 mg/L	Once/week	Composite
Settleable Solids	—	—	1 ml/L	2 ml/L	Once/week	Discrete
Oil and Grease [b]	—	—	—	—	Once/month	Discrete
pH [c]	Not less than 7.0 standard units nor greater than 9.0 standard units				Once/month	Discrete

BOD biochemical oxygen demand
mg/L milligram per liter
ml/L milliliter per liter
[a] Both the influent and effluent shall be monitored.
[b] Oil and grease shall be monitored in the effluent on a monthly basis over a six-month period since toxic organic pollutants partition into this fraction. If the level of oil and grease is found to be unacceptable, this permit shall be modified to include an effluent limitation and monitoring requirement for this parameter.
[c] The discharge shall not cause the pH of the receiving water to deviate more than 0.5 pH units of that which would occur naturally.

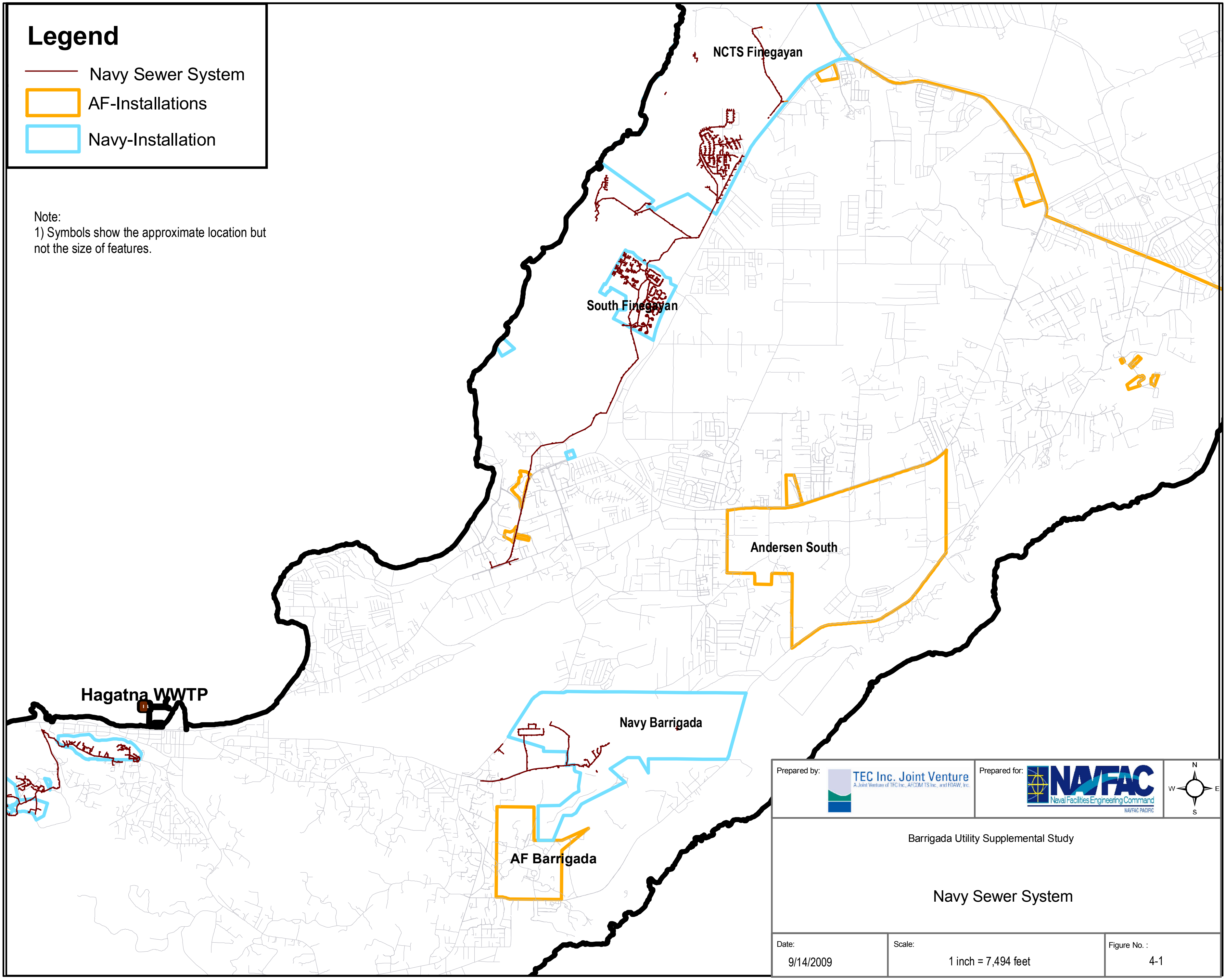
4.2.2.3 GWA Moratorium Sewer Improvement Project

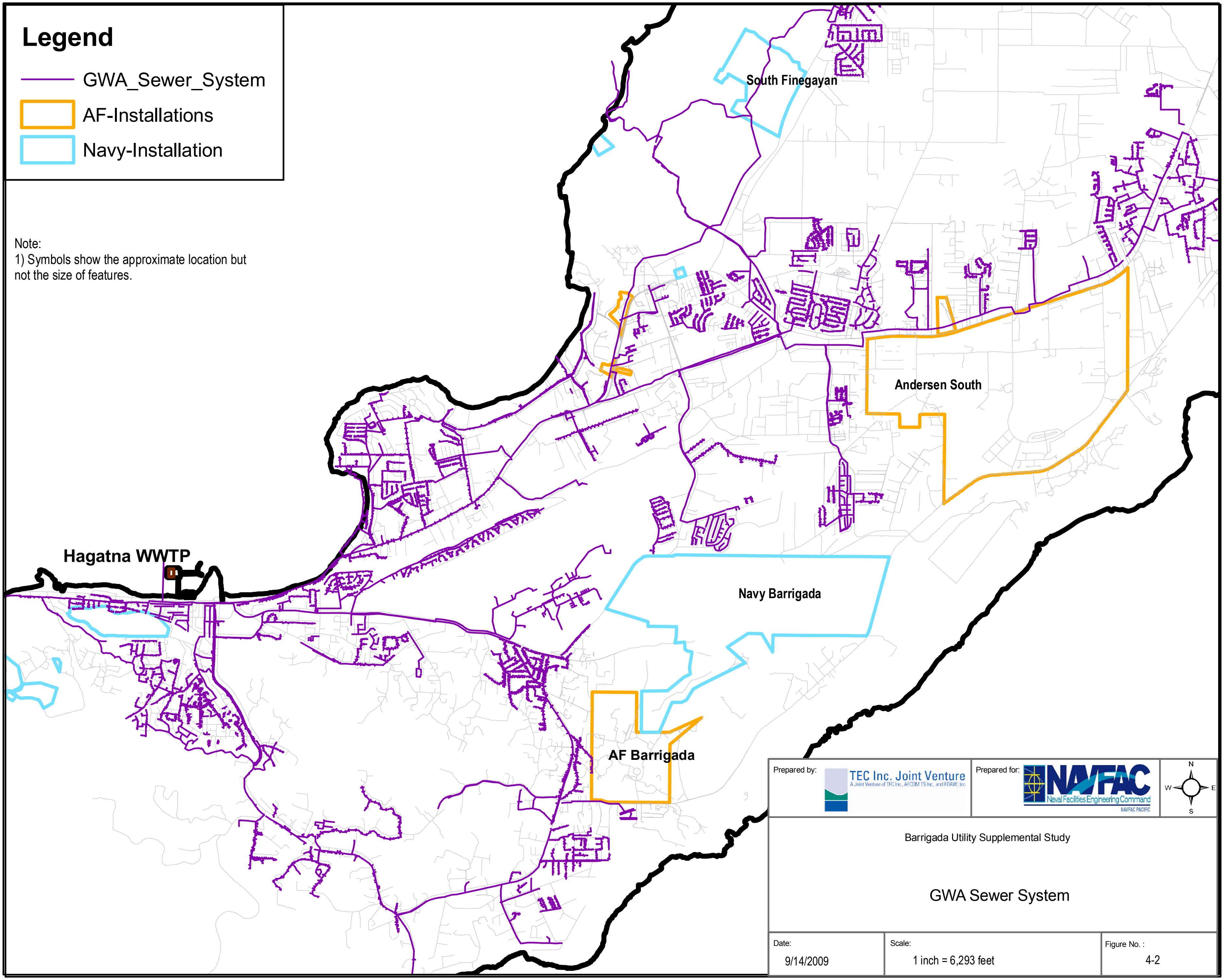
Central Guam sewer collection system that conveys sewage to Hagatna WWTP has several limitations, which, because the system are all interconnected, created overflows during high flow conditions. To alleviate the problems, GWA proposed a design build finance project, the Moratorium Project, to improve central Guam sewer system to allow it in its entirety and to operate satisfactorily. Besides upgrading, the project proposed to include:

- Blocking connection between northern and central sewage systems at Route 16 SPS.
- A new 24-inch force main from Tamuning SPS directly to Hagatna WWTP.
- A new 24-inch pressure line from New Chaot SPS directly down to Hagatna WWTP.
- Refurbishing Agana Main SPS to support the proposed modification to the sewerage system.
- A new vortex grit removal system in Hagatna WWTP for reducing sedimentation and FOG going to the plant.

Agana Main SPS would be refurbished to a design normal operation flow of 12 mgd and peak flow of 27.11 mgd. With proposed relief sewer lines from Tamuning and Chaot running directly to the treatment plant, Agana Main SPS would have an attenuated flow and improved pumping efficiency.

With the improvement project, a new vortex grit removal system at Hagatna WWTP and a new grit removal system at Tamuning SPS would be installed to provide preliminary treatment for all influent wastewater to the Hagatna WWTP. The project was originally planned to bid in September 2009 and scheduled to complete in 24 months. However, as per GWA the proposed project has not started. GWA will start the design phase as soon as the funding is in place.


Legend
Navy Sewer System
AF-Installations
Navy-Installation
Note:
1) Symbols show the approximate location but not the size of features.
NCTS Finegayan
South Finegayan
Andersen South
Hagatna WWTP
Navy Barrigada
AF Barrigada
Prepared by:
TEC Inc. Joint Venture
Prepared for:
NAVFAC
Naval Facilities Engineering Command
N
W
E
S
Barrigada Utility Supplemental Study
Navy Sewer System
Date:
9/14/2009
Scale:
1 inch = 7,494 feet
Figure No. :
4-1



Prepared by: TEC Inc. Joint Venture

Prepared for: NAVFAC Naval Facilities Engineering Command NAVFAC PACIFIC

Barrigada Utility Supplemental Study

GWA Sewer System

Date:	Scale:	Figure No. :
9/14/2009	1 inch = 6,293 feet	4-2

4.3 EVALUATION OF WASTEWATER TREATMENT OPTIONS

Construction of Marine Corps and the Army AMD housing at DoD Barrigada properties would increase wastewater flows to the Hagatna WWTP. The wastewater flow from Barrigada is currently conveyed to the Hagatna WWTP in central Guam for treatment and disposal. Projected wastewater flows to the Hagatna WWTP as if military Barrigada wastewater still goes to the plant are summarized in Table 4-4.

As a result of the proposed military relocation, the average daily flow to the Hagatna WWTP from military sources is projected to increase to 1.40 mgd by year 2019 and the total flow from military and civilian sources would increase to 7.54 mgd by year 2019.

A socio-economic analysis of the proposed military build-up has estimated that induced civilian growth as a result of the military build-up could increase the island-wide population on Guam by up to 40,000 in year 2014. The total wastewater flow to Hagatna WWTP would reach its peak in year 2014 due to the construction workforce and induced population growth. Table 4-7 summarizes existing Guam civilian and DoD flows, projected increases civilian flows due to natural population growth, projected DoD increases associated with the military build-up, increases associated with the imported construction workforce, and civilian increases that would result from induced growth.

Table 4-7: Projected Interim Wastewater Flows to the Hagatna WWTP

	Year									
Source of Wastewater Flow	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Existing Guam Civilian	4.38	4.38	4.38	4.38	4.38	4.38	4.38	4.38	4.38	4.38
Existing DoD	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
Guam Civilian Increase	0.25	0.37	0.50	0.62	0.73	0.85	0.97	1.08	1.19	1.30
DoD Increase	0.06	0.13	0.13	0.13	0.96	1.05	1.05	1.05	1.05	1.05
Construction Workforce	0.14	0.33	0.55	0.66	0.70	0.45	0.15	0.00	0.00	0.00
Subtotal Direct DoD and Guam Civilian	**5.17**	**5.56**	**5.90**	**6.13**	**7.12**	**7.08**	**6.89**	**6.86**	**6.97**	**7.08**
Induced Civilian Increase	0.28	0.71	1.18	1.42	1.71	1.30	0.64	0.45	0.45	0.46
Total Flow –all sources	**5.45**	**6.27**	**7.08**	**7.54**	**8.83**	**8.38**	**7.53**	**7.31**	**7.42**	**7.54**

Notes: all units are mgd

The total average daily flow in year 2019 and the interim peak average daily flow in year 2014 are less than the plant design capacity of 12 mgd. The projected peak daily flow of 15.5 mgd in year 2014 and 13.2 mgd in year 2019 exceed the current EPA permitted maximum daily flow of 12 mgd for the plant based on the plant peak flow calculation using originally designed peak to average flow ratio. As a result, the existing permit limit is required to be modified to reflect the plant maximum daily treatment capacity of 21 mgd.

Both interim and long-term wastewater treatment options are considered to meet the increased demand of the proposed military relocation in Barrigada area of central Guam. The interim options are developed to meet projected interim wastewater demands and long-term options are developed to meet the wastewater flows in year 2019.

4.3.1 Interim Option

Interim Option would refurbish and upgrade the primary treatment facilities of the Hagatna WWTP to accept the additional DoD and its relocation related flows. The existing NPDES permit of the Hagatna WWTP is based on maximum daily flow of 12 mgd. The projected average daily and peak daily flow to the WWTP during interim period would be 8.83 mgd and 15.5 mgd respectively. The existing permit limit would require modification to reflect the plant maximum daily treatment capacity of 21 mgd.

The GWA plant personnel indicated that during high tide periods the plant has backflow problem with its gravity ocean outfall when treated effluent is over 6 mgd. To accommodate interim anticipated flow and loadings, the Hagatna WWTP would have to be refurbished and upgraded the following existing facilities:

- Refurbishing existing effluent pumping station with new pumps.
- Modifying sewer(s) based on the induced and construction population distribution in central Guam.

Significant upgrades and improvements to the current condition of the plant and associated central Guam collection system are being performed. The interim option solution should be reevalauted at the time of impelementation as the plant and collection system are being upgraded. To incorporate the interim option, the Navy would need to coordinate with GWA to modify the NPDES permit to increase the effluent discharge limitation from 12.0 mgd to 21.0 mgd.

4.3.2 Long-Term Options

Four long-term viable wastewater treatment conceptual options were reviewed:

1. Expand and upgrade the GovGuam NDWWTP to secondary treatment and convey wastewater generated at Barrigada housing site to the NDWWTP.
2. Expand and upgrade the GovGuam Hagatna WWTP to secondary treatment.
3. Build new secondary treatment plant near the proposed development to DoD land and construct new outfall.
4. Build new separate secondary treatment plant at GovGuam Hagatna WWTP site to treat DoD load only.

4.3.2.1 EXPAND AND UPGRADE THE GOVGUAM NDWWTP TO SECONDARY TREATMENT AND CONVEY WASTEWATER GENERATED AT BARRIGADA HOUSING SITE TO THE NDWWTP – OPTION 1

Under this option, DoD-generated wastewater from Andersen AFB, the proposed USMC base at Finegayan, and its off-base housing at Barrigada would be conveyed to the NDWWTP for treatment. The NDWWTP would treat the aformentioned DoD flows and northern Guam off-base civilian wastewater flows that includes Guam on-island population, construction workers, and induced population associated with USMC relocation. The NDWWTP would be refurbished and the plant's primary treatment capacity would be upgraded to accept the additional DoD flows and military relocation–related flows and loads.

A wastewater treatment facility performs primary and sometimes secondary treatments. Primary wastewater treatment removes a portion of the suspended solids and associated organic matter from wastewater by settling and skimming. A primary clarifier enhances solid liquid separation utilizing gravitational settling to remove suspended solids, and it normally removes 60 percent suspended solids as total suspended solids (TSS) and 30 percent organic matter presented as biochemical oxygen demand (BOD_5) from municipal wastewater. A secondary treatment enhances removal of biodegradable organic matter (in solution or suspension) and suspended solids. Secondary treatment normally refers to a biological treatment process that utilizes microorganisms to consume organic pollutants. It can be either a suspended growth activated sludge treatment or an aerobic attached growth treatment system (such as trickling filter).

The EPA Region 9 recently issued a decision to deny GWA's secondary treatment 301(h) variance, effectively requiring GWA to upgrade its NDWWTP to secondary treatment. Additionally, GWA projected a future capacity of 18 mgd is needed at the NDWWTP to meet future flows. The analysis considered future flow of 18 mgd for upgrades and improvements at the NDWWTP. Refurbishment of the primary system, upgrade of the primary system, and installation of a secondary system at the NDWWTP would be constructed in separate phases.

Based on the plant's current capacity to accommodate anticipated interim flow and loadings while still achieving the existing primary-treatment requirement, the following existing components of the NDWWTP would have to be refurbished and upgraded:

- Headworks with odor control
- Two primary clarifiers
- Two anaerobic digesters
- Two centrifuge solids-dewatering systems with odor control
- Two chlorine contact tanks
- Effluent monitoring

This option would also upgrade the refurbished primary treatment system at the NDWWTP to secondary treatment of 18 mgd, to treat projected future flows from both civilian and military sources. A trickling filter system is proposed as the secondary treatment process. The following new process components and upgrades would be required at the NDWWTP for this alternative:

- Four trickling filters
- Four secondary clarifiers
- Two additional anaerobic digesters (the same size as existing ones)
- One additional centrifuge solids-dewatering system and odor control

The ocean outfall at the NDWWTP that was put into service in December 2008 was designed to discharge a peak-hour treated flow of 27 mgd to the Philippine Sea. It would not have enough disposal capacity to handle the predicted future flow during the peak period, therefore, extra outfall discharge capacity would be required.

All flows from the current and proposed future military relocation at Andersen AFB would be conveyed through the existing GWA sewer to the NDWWTP, while wastewater flow generated from the proposed USMC base at Finegayan and its off-base housing at Barrigada would be conveyed respectively via different new sewer lines to the NDWWTP. Figure 4-3 indicates the most likely routing of the proposed sewer lines and locations of the proposed pump stations that would need to be installed to convey wastewater generated at Barrigada housing to the NDWWTP for treatment.

4.3.2.2 *EXPAND AND UPGRADE GOVGUAM HAGATNA WWTP TO SECONDARY TREATMENT – OPTION 2*

As described in Section 4.2, the Hagatna WWTP is a major wastewater treatment facility in the central region on Guam. Hagatna WWTP is a primary treatment facility with primary clarifiers mainly for removal of settleable organics and suspended solids. The plant has aerobic digesters and a sludge dewatering system for stabilizing primary sludge and reducing its volume before landfill disposal.

In this option, it is assumed that wastewater generated from USMC off-base housing at Barrigada would be conveyed to the Hagatna WWTP for treatment. The Hagatna WWTP was designed for treating an average daily flow of 12.0 mgd and a peak flow of 21.0 mgd. The projected 2019 wastewater flow to Hagatna WWTP due to central Guam natural population growth, USMC off-base housing, and military relocation associated with central Guam induced population growth is 7.54 mgd. In this evaluation, it is assumed that the future civilian and military wastewater flow would have characteristics similar to the wastewater flow discharging to the existing Hagatna WWTP. A new relief sewer from Navy Barrigada to the Hagatna WWTP needs to be constructed and the proposed sewer layout is shown on Figure 4-4. As a result, Hagatna WWTP influent flow and loading are presented in Table 4-8.

Table 4-8: Projected Hagatna WWTP Influent Flow and Loading in 2019

Flows	Flow rate (mgd)	
Average daily flow	7.54	
Peak wet weather flow	13.20	
Parameters	Concentration (mg/L)	Loading (lbs/day)
BOD_5	184	11,600
Suspended solids	207	13,100

lbs pounds

The projected Hagatna WWTP influent average flow of 7.54 mgd and peak daily flow of 13.2 mgd in 2019 are about 63 percent of the Hagatna WWTP's designed treatment capacity. The plant is not required to be expanded to meet the future flows. However, the projected 2019 peak daily flow of 13.2 mgd exceeds the current EPA permit flow of 12 mgd for the plant. Hence, the NPDES permit of the plant has to be updated.

In January 2009, the EPA Region 9, upon review of the Hagatna WWTP information from GWA, again issued a tentative decision to deny its 301 (h) secondary treatment variance, followed by a final decision to deny the variance on 30 September 2009. This final decision effectively requires the GWA to install full secondary treatment at the Hagnata WWTP.

The national minimum secondary treatment requirements are presented in Figure 4-9. The objective of this option is to expand and upgrade the existing primary treatment system at the Hagatna WWTP to secondary treatment with capacity of average daily flow of 12.0 mgd and peak daily flow of 21.0 mgd and to treat current wastewater flow, as well as additional predicted future flow from both civilian and military sources in central Guam.

Table 4-9: Minimum National Standards for Secondary Wastewater Treatment

Characteristic of discharge	Unit of measurement	Average 30-day concentration	Average 7-day concentration
BOD_5	mg/L	30	45
Suspended solids	mg/L	30	45
pH	pH	6.0 – 9.0	

By expanding and upgrading the existing primary system, the Hagatna WWTP can be converted to a new secondary treatment process as shown in the schematic process diagram on Figure 4-5. A trickling filter system was selected as the secondary treatment process not only because of its lower power requirement and less sludge production compared with a suspended growth system (such as Activated Sludge System) but also because of its simple and reliable operational nature. It is desirable to have a simple process to minimize future O&M requirements.

The existing Hagatna WWTP is built on a man-made coral island and has limited space for future expansion. To utilize available land at the plant more efficiently, chemicals would be added to existing primary clarifiers to enhance coagulation and flocculation process and improve precipitation to remove more solids and organic matter from the influent wastewater. It is proposed that 0.75 milligram per liter (mg/L) polymer and 20 mg/L Ferric Chloride would be added to the primary clarifiers and improve removal rate of BOD to 45 percent, and TSS to 80 percent. As a result, less solids and organic matter require treatment by the new secondary process; hence, requiring less space for the secondary treatment facility components. After preliminary and primary treatments, the primary effluent is pumped to the top of the three new circular trickling filters for secondary biological treatment. Trickling filter flow is conveyed into three new rectangular secondary clarifiers for solid liquid separation. Each circular trickling filter is 85-ft in diameter and 24-ft water depth. Each secondary clarifier is 220-ft long, 60-ft wide, and 18-ft water depth. Clarified final effluent flows into an ultra violet (UV) disinfection system. Though UV consumes more electricity, the UV system was chosen for effluent disinfection because it does not require using chemicals; hence, there will be no shipping costs and no delays of getting chemicals to the island from mainland. The UV disinfection system has three contact channels, each with two UV banks. The UV system has an overall tee shape with one tee containing channels of 30-ft long, 12-ft wide, and 6-ft depth and an outlet weir structure of 14-ft long, 56-ft wide, and 6-ft depth. After all, the refurbished effluent pumping station pumps UV disinfected effluent through the plant 30-inch ocean outfall into the Philippine for final disposal.

The secondary clarifiers generated humus sludge are collected and pumped back to the primary clarifiers for co-settling and producing a thicker settled sludge. The co-settled sludge of the primary clarifiers is pumped by sludge transfer pumps to an aerobic digestion system for sludge stabilization. Aerobic digestion system includes four existing aerobic digesters with surface aerators and five new ones with air diffuser aeration. Air diffuser aeration is recommended for the new digesters because they can operate in a deeper tank; thus, reducing the total foot print of the structure. Each new digester is 44-ft long, 23-ft wide, and 21-ft liquid depth. A blower room would be constructed on the top of the digesters to reduce the foot print of the structure. Digested solids are pumped to the existing centrifuge dewatering system for volume reduction. Dewatered cake is hauled out as Class B solids for offsite disposal.

These new process components and upgrades are required at the Hagatna WWTP for this option:

- Three trickling filters
- Three rectangular secondary clarifiers

- One UV disinfection system
- Five new rectangular aerobic digesters
- Refurbishing effluent pumping station

The sizes of the new process components and upgrades required at the Hagatna WWTP for expanding and upgrading to secondary treatment are listed in Table 4-10.

Table 4-10: Components for Expanding and Upgrading the Hagatna WWTP to Secondary Treatment

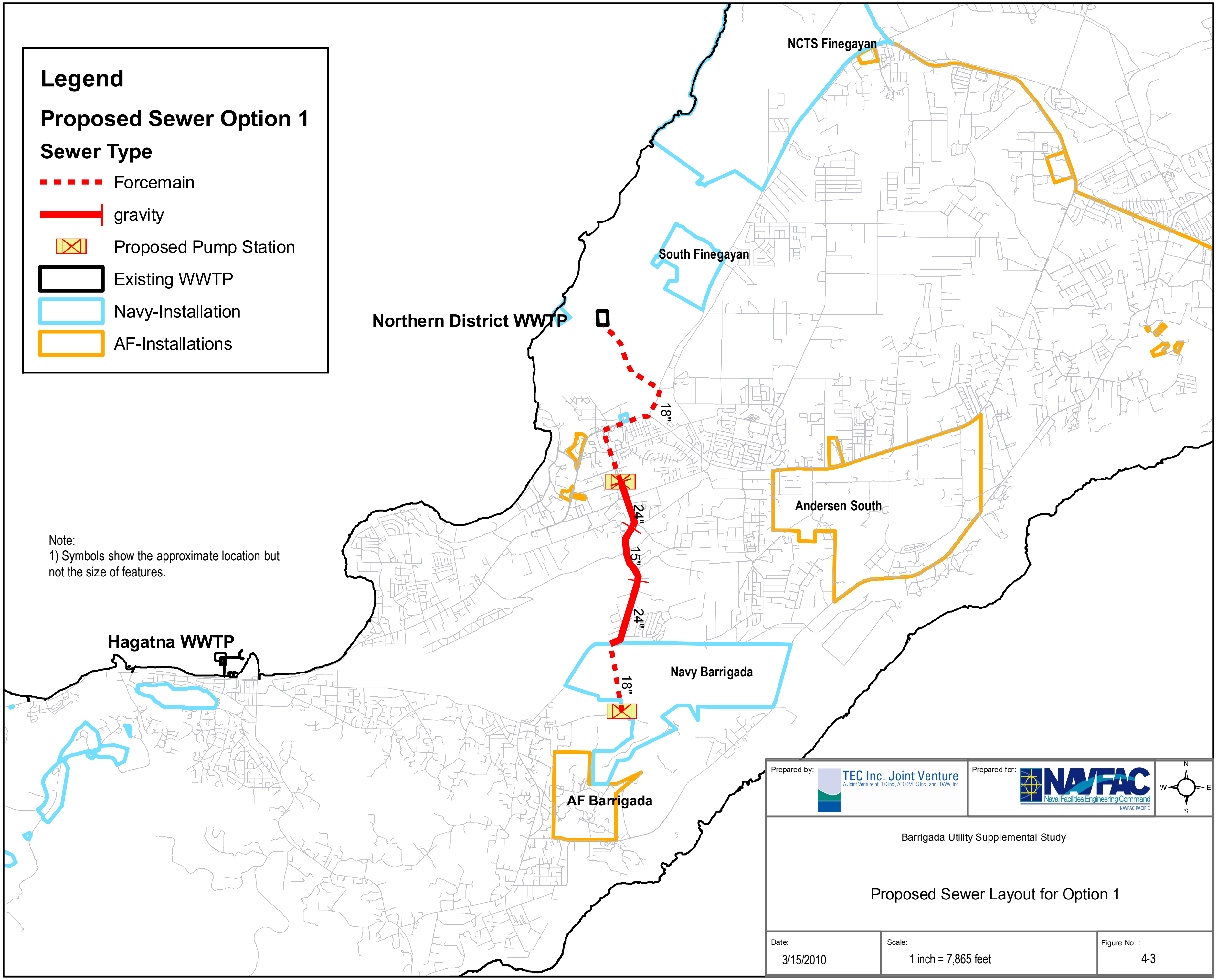
Construction Components	Expand (E)/ Upgrade (U)/NEW (N)/Refurbish (R)	Unit	Dimensions/Description
Chemical enhanced precipitation system	N	1	1 x 8,000 gallons chemical storage tanks, dosing pumps, and control
Trickling filter pumping station	N	1	40-ft long x 25-ft wide x 16-ft high
Trickling filter	N	3	85-ft diameter x 24-ft SWD
Secondary clarifier	N	3	220-ft long x 60-ft wide x 12-ft SWD
UV disinfection system	N	1	Three UV channels of 30' L x 12' W, one outlet weir structure 56' L x 14' W
Effluent pumping station	R	1	3 x 60 HP pumps
Aerobic digester	N	5	44-ft long x 18-ft wide x 21-ft SWD

4.3.2.3 BUILD NEW SECONDARY TREATMENT PLANT NEAR THE PROPOSED DEVELOPMENT ON DOD LAND AND CONSTRUCT NEW OUTFALL – OPTION 3

This option considers construction of a secondary treatment plant that would be owned and operated by the DoD for the relocated USMC, rather than upgrading the existing GWA-owned treatment plants to secondary treatment. In this option, newly constructed independent sewer mains are required to convey all military generated wastewater in the northern Guam region and Barrigada housing area to a DoD secondary treatment plant near the proposed USMC Finegayan development on DoD land (as shown on Figure 4-6). A new sewer main and two new pump stations carrying a total average daily wastewater flow of 1.4 mgd from Barrigada housing bases to the proposed new DoD treatment facility at South Finegayan is required to be constructed for this option. The proposed DoD treatment facility is designed to treat total of 2.9 mgd average daily flow generated from planned Finegayan main base (1.5 mgd) and Barrigada housings (1.4 mgd). The treated effluent from this secondary WWTP would be discharged via a new DoD ocean outfall into the Philippine Sea. The future peak flow for the DoD secondary plant is estimated to be 7.05 mgd and its peak factor is estimated based on the served population from Babbit's curve in Water Pollution Control Federation Manual of Practice No. FD-5. It is assumed that the future military wastewater flow would have characteristics similar to the wastewater flow discharging to the nearby North District WWTP. Future influent wastewater flow and its characteristics and loadings to the DoD secondary plant are presented in Table 4-11.

Table 4-11: Projected Influent Flow and Loading in 2019 for DoD Secondary Wastewater Treatment on DoD Land

Flows	Flow rate (mgd)	
Average daily flow	2.9	
Peak wet weather flow	7.05	
Parameters	Concentration (mg/L)	Loading (lbs/day)
BOD_5	206	4,983
Suspended solids	202	4,886


Legend
Proposed Sewer Option 1
Sewer Type
Forcemain
gravity
Proposed Pump Station
Existing WWTP
Navy-Installation
AF-Installations
Note:
1) Symbols show the approximate location but not the size of features.
NCTS Finegayan
South Finegayan
Northern District WWTP
18"
24"
15"
24"
18"
Andersen South
Hagatna WWTP
Navy Barrigada
AF Barrigada
Prepared by:
TEC Inc. Joint Venture
Prepared for:
NAVFAC
Naval Facilities Engineering Command
N
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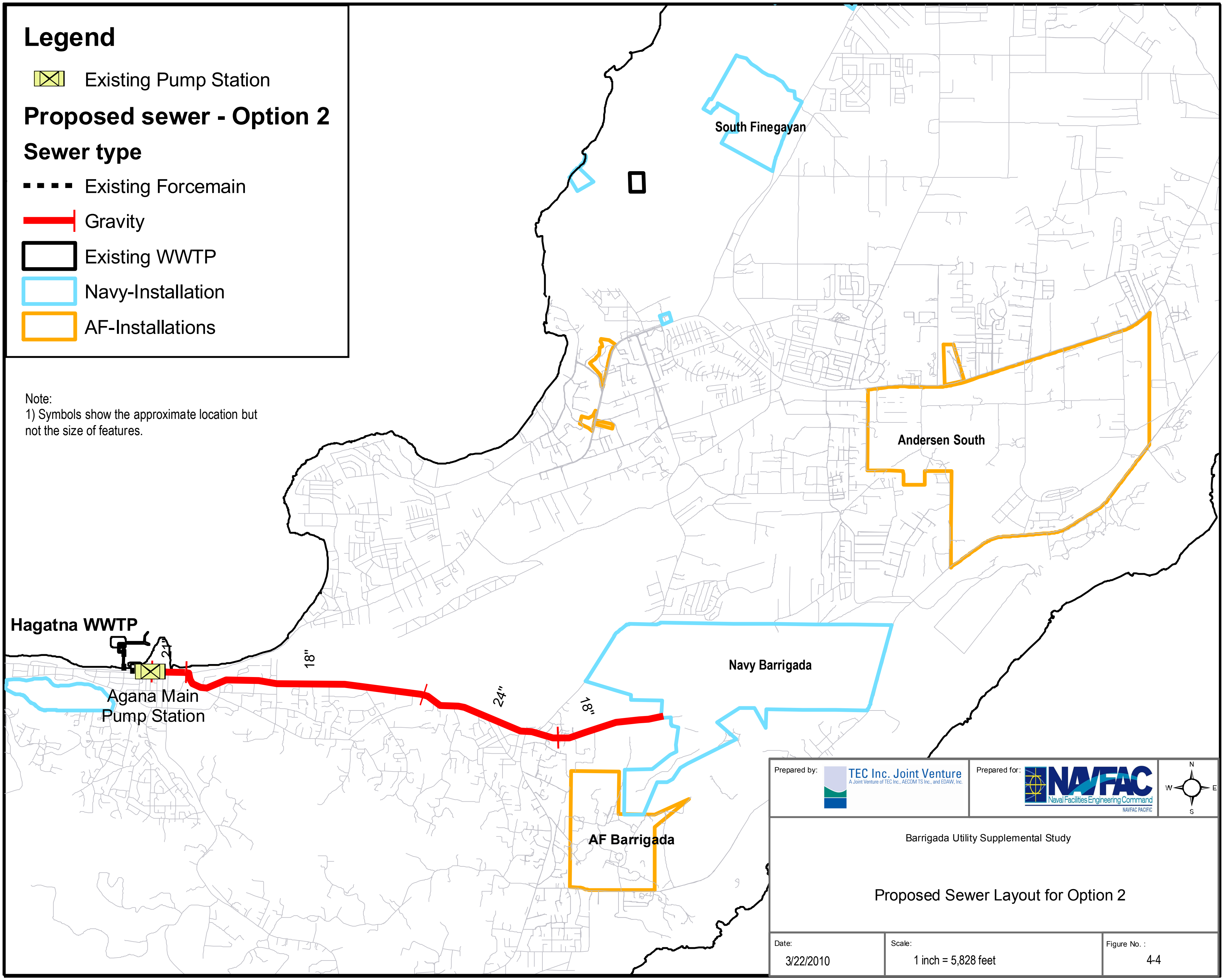
Barrigada Utility Supplemental Study
Proposed Sewer Layout for Option 1
Date:
3/15/2010
Scale:
1 inch = 7,865 feet
Figure No. :
4-3



Legend
Existing Pump Station
Proposed sewer - Option 2
Sewer type
Existing Forcemain
Gravity
Existing WWTP
Navy-Installation
AF-Installations
Note:
1) Symbols show the approximate location but not the size of features.
South Finegayan
Andersen South
Hagatna WWTP
Agana Main Pump Station
18"
24"
18"
Navy Barrigada
AF Barrigada
Prepared by:
TEC Inc. Joint Venture
Prepared for:
NAVFAC
Naval Facilities Engineering Command
N
W
E
S
Barrigada Utility Supplemental Study
Proposed Sewer Layout for Option 2
Date:
3/22/2010
Scale:
1 inch = 5,828 feet
Figure No. :
4-4

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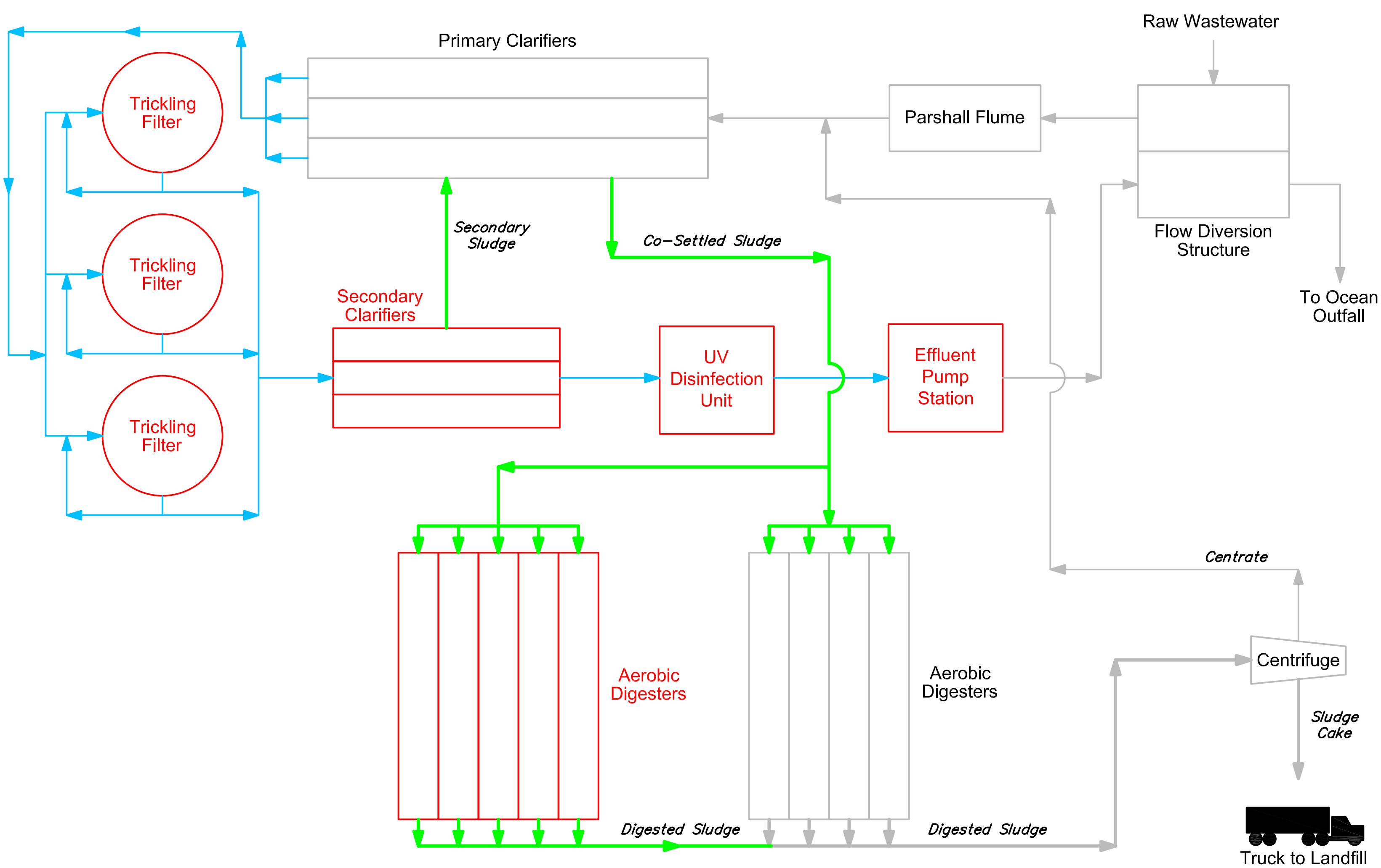


LEGEND

Existing Liquid Stream

Proposed Liquid Stream

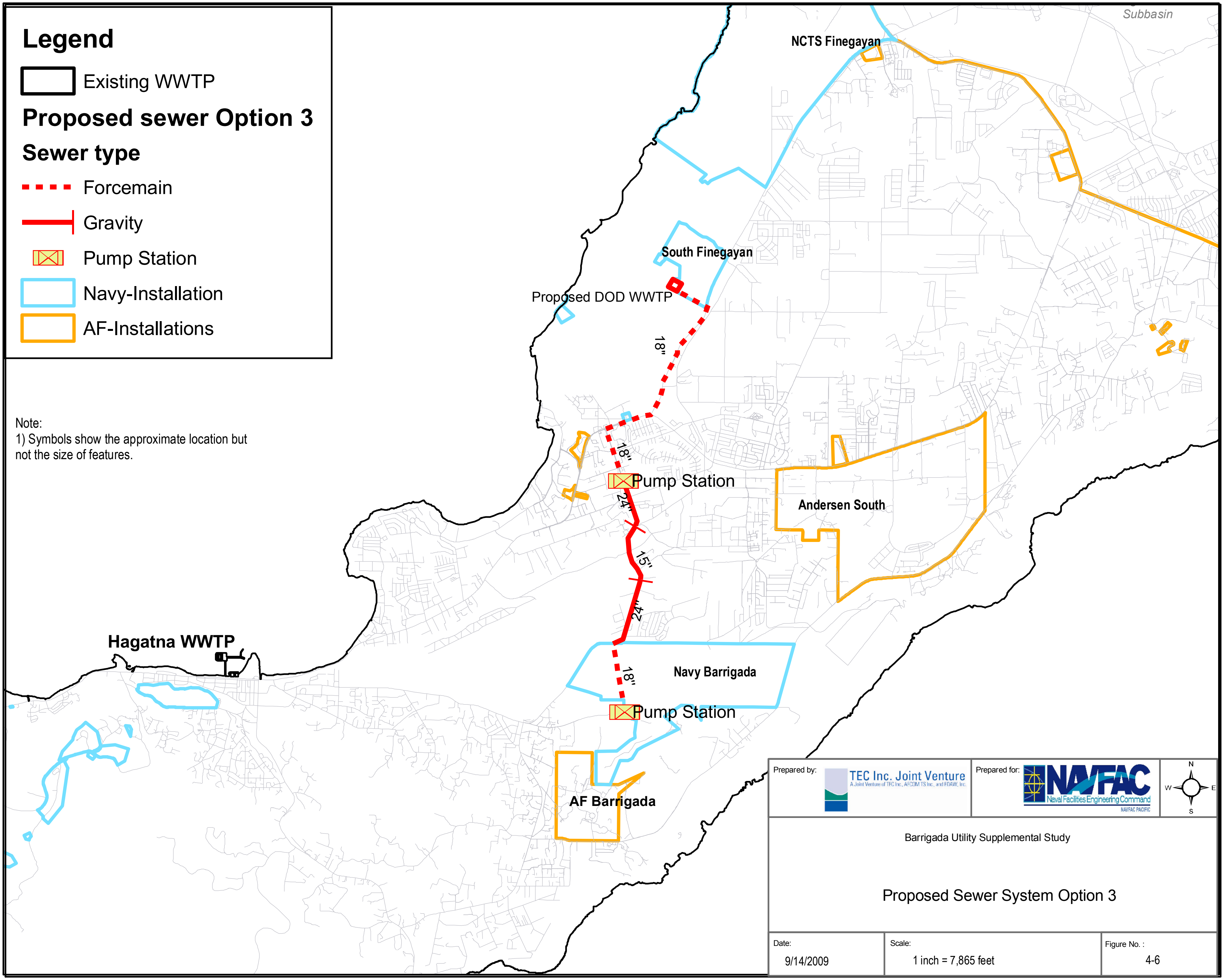
Existing Solid Stream

Proposed Solid Stream

Draft

Option 2:
Expand and Upgrade
Hagatna WWTP to Secondary Treatment

Date: 8-09	Barrigada Wastewater Study	Figure
Project No. 113128	TEC Inc. Joint Venture A Joint Venture of TEC Inc., AECOM TS Inc., and EDAW, Inc.	4-5



Legend
Existing WWTP
Proposed sewer Option 3
Sewer type
Forcemain
Gravity
Pump Station
Navy-Installation
AF-Installations
Note:
1) Symbols show the approximate location but not the size of features.
Subbasin
NCTS Finegayan
South Finegayan
Proposed DOD WWTP
18"
18"
Pump Station
24"
15"
24"
Andersen South
Hagatna WWTP
Navy Barrigada
18"
Pump Station
AF Barrigada
Prepared by:
TEC Inc. Joint Venture
Prepared for:
NAVFAC
Naval Facilities Engineering Command
N
W
E
S
Barrigada Utility Supplemental Study
Proposed Sewer System Option 3
Date:
9/14/2009
Scale:
1 inch = 7,865 feet
Figure No. :
4-6

The new DoD secondary WWTP would consist of following components:

- Headworks (two screens and two aerated grit chambers with odor control)
- Three primary clarifiers
- Three trickling filters
- Three secondary clarifiers
- Two chlorine contact tanks
- Three anaerobic digesters
- Two centrifuge solids dewatering systems with odor control
- Effluent monitoring and measurement
- Ocean outfall

Figure 4-7 shows a process flow diagram of the new DoD secondary treatment. Preliminary treatment for this option includes bar racks and 3/8-inch to 1/2-inch mechanical fine screens at the headworks structure, followed by two aerated grit removal chambers. Each chamber has a 40-ft length and 12-ft width and 7-ft water depth. Grit and screenings removed are disposed of in a sanitary landfill.

Primary treatment includes three primary clarifiers, each 55-ft diameter and 10-ft water depth. Secondary treatment system includes three trickling filters and three secondary clarifiers. Each circular trickling filter is 60 ft in diameter and 24-ft water depth. Each secondary clarifier is 75 ft in diameter and 13-ft water depth. Subsequently a disinfection system with two chlorine contact tanks, each 50 ft long by 20 ft wide with water depth of 14 ft, provides chlorination and dechlorination to the secondary clarifier effluent, and its effluent flows into the 30-inch ocean outfall for final discharge at Philippine Sea, west of the plant. A new ocean outfall about 5,000 ft long 30-inch effluent transmission pipe and 2,400-ft long 30-inch outfall is required for the treated effluent disposal in this option.

Solids treatment for both primary sludge and secondary sludge includes three anaerobic digesters and two solids dewatering centrifuges for sludge digestion and dewatering. Each digester is 65 ft in diameter and 18-ft liquid depth. Two first stage anaerobic digesters are operated for stabilization, and one second stage anaerobic digester provides liquid solids separation and thickening. The digesters are designed for a hydraulic detention time over 15 days to meet EPA Class B standards, and would operate to handle planned future sludge loadings with one digester out of service for maintenance. Anaerobic digested sludge is then pumped to two centrifuges with a capacity of 125 gpm each for the solids dewatering to reduce the volume of final disposed sludge. Dewatered cake is hauled as Class B solids for offsite disposal.

4.3.2.4 BUILD NEW SECONDARY TREATMENT PLANT AT GOVGUAM HAGATNA WWTP SITE TO TREAT DOD LOAD ONLY

This option would build a new secondary treatment plant at the Hagatna WWTP site, and treat the DoD wastewater from the DoD Barrigada properties including proposed USMC housings. The existing Hagatna WWTP would be upgraded to have two separate and independent treatment process trains. The existing primary treatment would continue to treat flow from civilian population in Central Guam. The new process train consists of primary and secondary treatment, as well as UV disinfection, and solids treatment. The new treatment plant would have separate headworks, primary treatment, secondary treatment, UV disinfection, and sludge handling facilities to treat the load from DoD Barrigada properties. The new process train, including both liquid treatment and solids treatment, is a self-contained and complete secondary treatment system from the start to the end, and it would require jointly utilizing the existing Hagatna WWTP ocean outfall for its secondary treated effluent disposal. This alternative requires constructing a new independent sewer main to convey all military generated wastewater in the DoD Barrigada properties to the Hagatna WWTP site as shown on Figure 4-8. The independent sewer connects the proposed Barrigada housing collection system near Navy Barrigada main gate, runs west along the Route 8 then Route 16, and carries wastewater into the newly constructed secondary treatment plant located inside the Hagatna WWTP fence at Agana Bay. Projected wastewater flow from Barrigada area is presented in Table 4-3. The projected wastewater loadings are estimated based on 0.20 lb/cap/d of BOD and 0.23 lb/cap/d of TSS with the served population in WEF Manual of Practice 8 (MOP8). The projected influent wastewater flow and its characteristics and loadings to the DoD secondary plant at the Hagatna WWTP site are presented in Table 4-12.

Table 4-12: Projected Influent Flow and Loading in 2019 for DoD Secondary Wastewater Treatment at Hagatna WWTP site

Flows	Flow rate (mgd)	
Average daily flow	1.4	
Peak wet weather flow	4.38	
Parameters	Concentration (mg/L)	Loading (lbs/day)
BOD_5	200	2,336
Suspended solids	230	2,686

The new secondary WWTP would consist of following components:

- Headworks (two screens and two aerated grit chambers with odor control)
- Three primary clarifiers
- Three trickling filters
- Three rectangular secondary clarifiers
- One UV disinfection system
- Three anaerobic digesters
- Two centrifuge solids dewatering systems with odor control
- Effluent monitoring and measurement

Figure 4-9 shows a process flow diagram of the new secondary treatment plant inside the Hagatna WWTP site. Preliminary treatment for this option includes bar racks and 3/8-inch to 1/2-inch mechanical fine screens at the headworks structure, followed by two vortex grit removal chambers.

Grit and screenings removed are disposed of in a sanitary landfill. Primary treatment includes three rectangular primary clarifiers, each 60-ft long by 20-ft wide with 12-ft water depth. Chemical enhanced precipitation is incorporated into the primary settlement design to reduce the size of proposed subsequent secondary treatment process. It is proposed that 0.75 mg/L polymer and 20 mg/L ferric chloride would be added to the proposed primary clarifiers to improve removal rate of BOD to 45 percent, and TSS to 80 percent.

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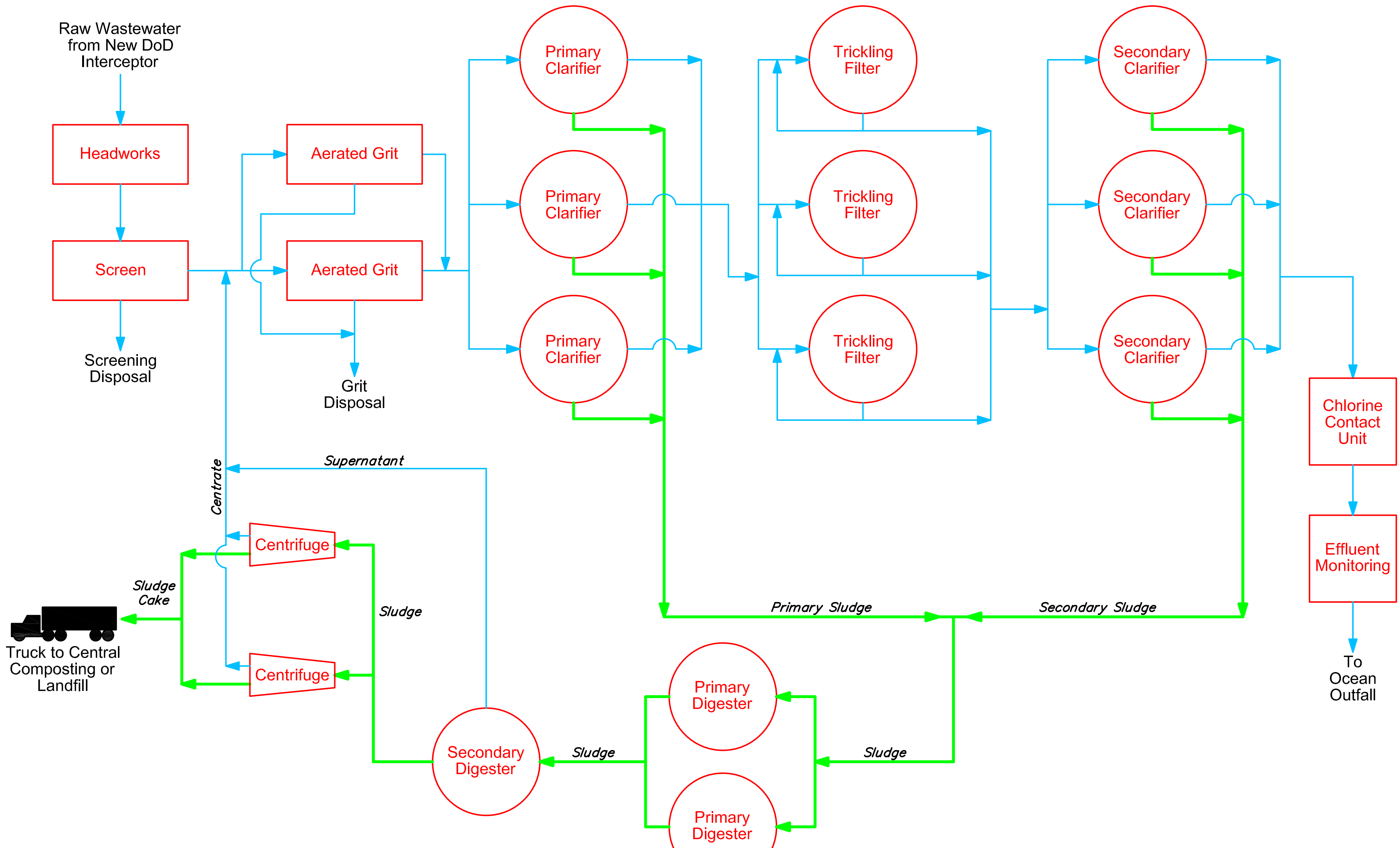


LEGEND

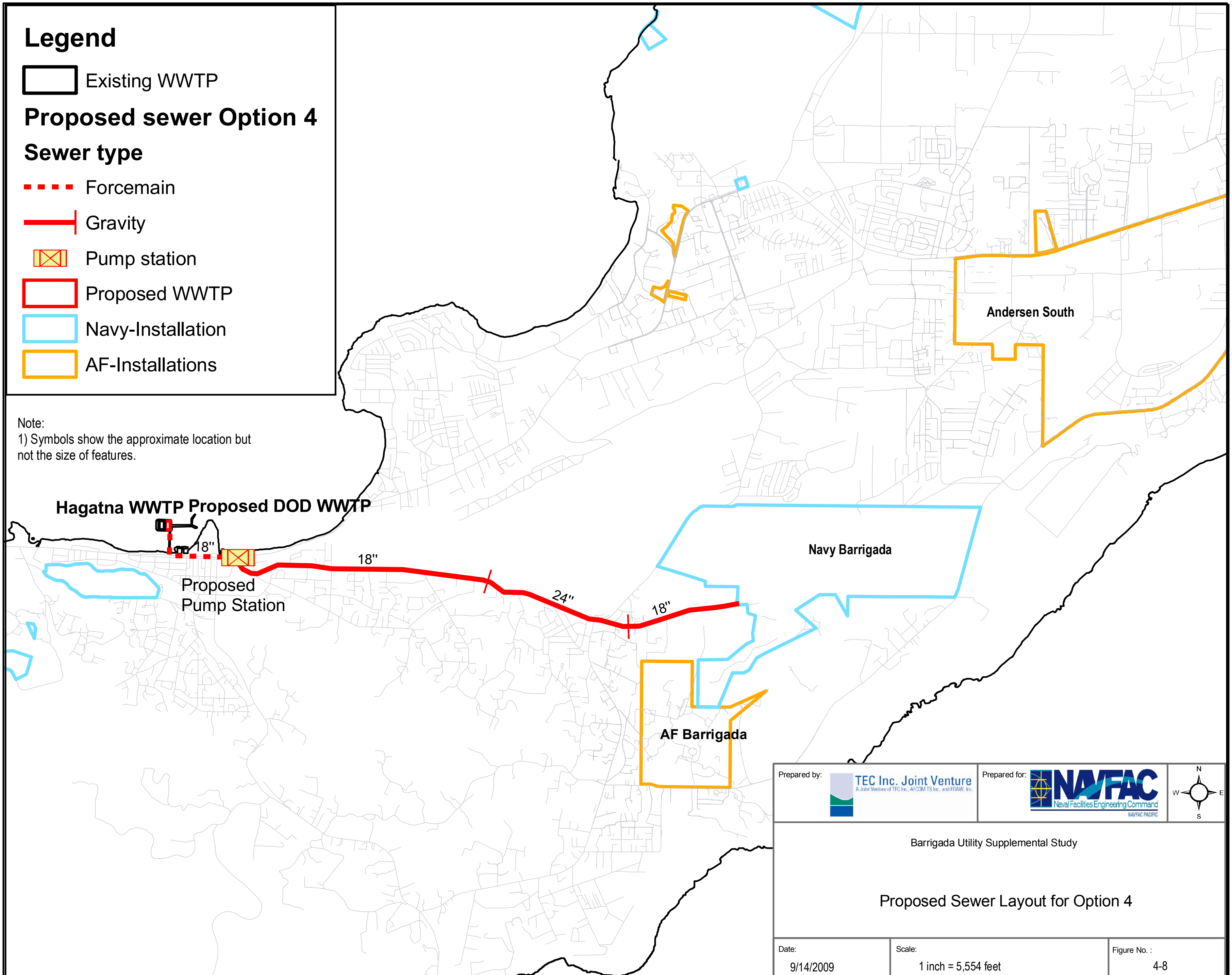
Proposed Liquid Stream

Proposed Solid Stream

Draft

Option 3: Build New DoD Secondary Treatment Facility on DoD Land

Date: 8-09	Barrigada Wastewater Study	Figure
Project No. 113128	TEC Inc. Joint Venture A Joint Venture of TEC Inc., AECOM TS Inc., and EDAW, Inc.	4-7



Prepared by: TEC Inc. Joint Venture

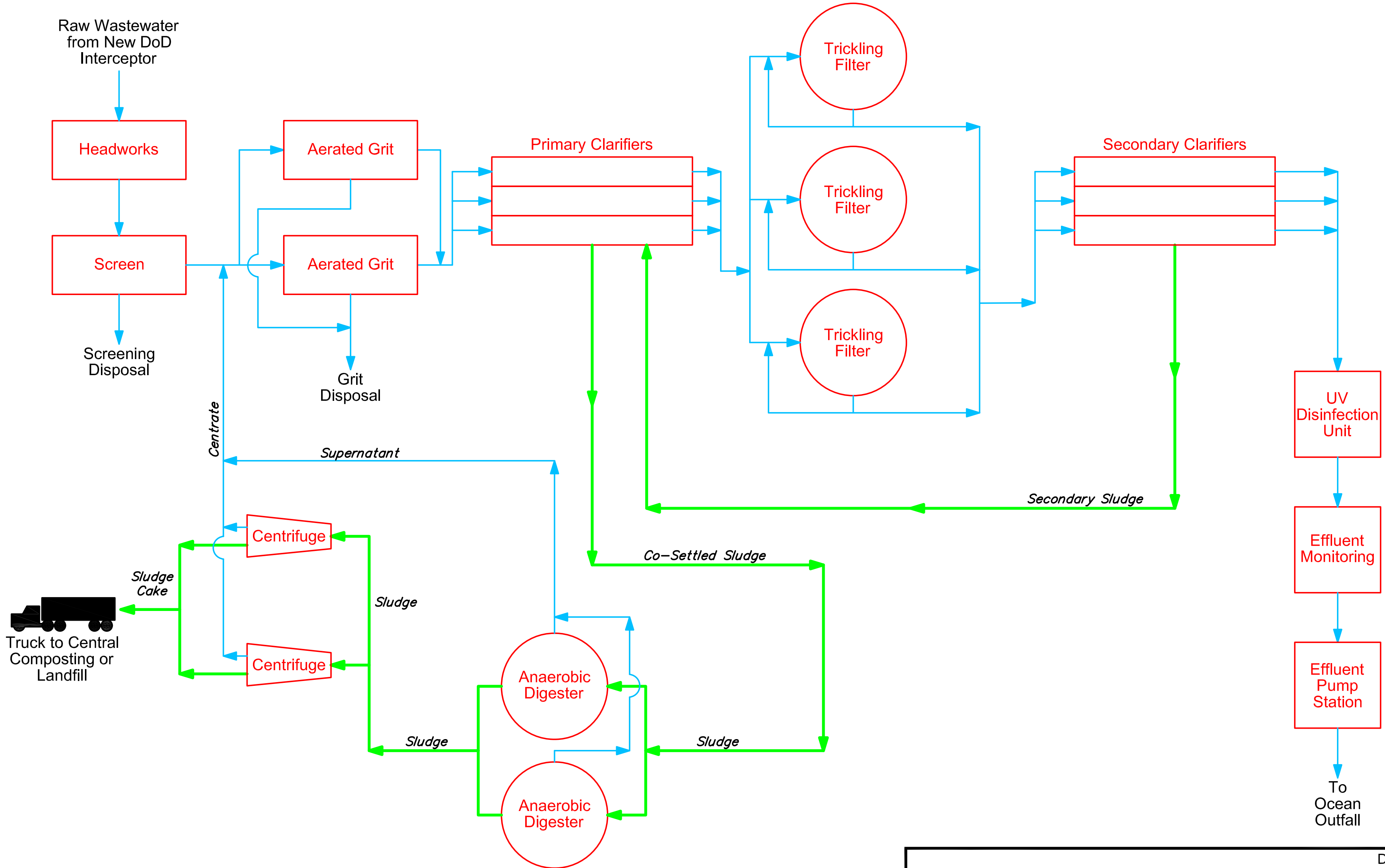
Prepared for: NAVFAC Naval Facilities Engineering Command

Barrigada Utility Supplemental Study

Proposed Sewer Layout for Option 4

Date:	Scale:	Figure No.:
9/14/2009	1 inch = 5,554 feet	4-8

File: Y:\Guam\XXXXX.XX\CAD\Design\Figure 4-9.dwg Time: Sep 14, 2009 – 3:30pm



LEGEND

Proposed Liquid Stream

Proposed Solid Sream

Draft

Option 4:
Build New DoD Secondary Treatment Facility at Hagatna WWTP to Treat DoD Load Only

Date: 8-09	Barrigada Wastewater Study	Figure
Project No. 113128	TEC Inc. Joint Venture A Joint Venture of TEC Inc., AECOM TS Inc., and EDAW, Inc.	4-9

Secondary treatment system includes three trickling filters and three secondary clarifiers. Each circular trickling filter is 35-ft in diameter and 24-ft water depth. Each secondary clarifier is 100-ft long by 20-ft wide with 12-ft water depth. Subsequently a disinfection system with two UV channels, each 20 ft long by 2.5 ft wide with water depth of 3 ft, containing two banks of UV lamps provides disinfection to the secondary clarifier effluent, and its effluent flows into the Hagatna WWTP existing 30-inch ocean outfall for final discharge at Philippine Sea, west of the plant.

The secondary clarifiers generate humus sludge that are collected and pumped back to the primary clarifiers for co-settling and producing a thicker settled sludge. The co-settled sludge of the primary clarifiers is then pumped by sludge transfer pumps to an aerobic digestion system for sludge stabilization. The sludge digestion system includes two anaerobic digesters and two solids dewatering centrifuges for sludge digestion and dewatering. Each digester is 30-ft in diameter and 30-ft liquid depth. One anaerobic digester is operated for stabilization, and another provides liquid solids separation and thickening. When one digester is offline for cleaning, another digester operates for stabilization and liquid solids separation. The anaerobic digesters are designed for a hydraulic detention time over 15 days to meet EPA Class B standards. Anaerobic digested sludge is then pumped to two centrifuges with a capacity of 60 gpm each for the solids dewatering to reduce the volume of final disposed sludge. Dewatered cake is hauled as Class B solids for offsite disposal.

All the above described treatment facilities are sized for treating DoD load only. A summary of the major process components for a new secondary treatment plant at Hagatna WWTP site to treat DoD load only are listed in Table 4-13.

Table 4-13: Major Process Components for Building a New Secondary Treatment Plant at the Hagatna WWTP Site to Treat DoD Load Only

Construction Components	Unit	Dimensions/Description
Headwork	1	Two mechanical fine screens and Two (2) vortex grit chambers, each 14 ft long x 2 ft wide straight channel and 7 ft diameter chamber
Primary clarifier	3	60 ft long x 20 ft wide x 12 ft SWD
Trickling filter pumping station	1	25 ft long x 25 ft wide x 16 ft high
Trickling filter	3	35 ft diameter x 24 ft SWD
Secondary clarifier	3	100 ft long x 20 ft wide x 12 ft SWD
UV disinfection channel	2	20 ft long x 2.5 ft wide channel and 14 ft long x 12 ft wide weir
Effluent pumping station	1	3 x 60 HP pumps
Effluent measurement	1	Automatic sampler
Anaerobic digesters	2	30 ft diameter x 30 ft SWD
Solids dewatering centrifuges	2	60 gpm each

in inch

4.3.2.5 *Description of Collection System Modifications*

The existing sewer maps and topography maps were examined to convey wastewater from proposed facilities, identified in Section 4.2, to the Hagatna WWTP. Wastewater generated in Navy Barrigada discharges to GWA central sewer basin system at intersection of Route 8 and Route 16. First the sewer trunk is followed along Route 16 toward west, and then connected to trunk runs under Route 1 Marine Corps Drive flowing west to GWA Agana Main SPS. After that, the main SPS pumps wastewater to Hagatna WWTP for treatment. There is no sewer service to AF Barrigada. Based on our discussions with GWA, it was recognized that sewer records are not available for sewer from Barrigada to the Agana Main SPS. Some segments of the sewer were constructed with VCP and may be as old as 40 to 50 years. The sewer has not been surveyed and does not have flow meters either.

As a result, a relief sewer is recommended to collect wastewater generated from proposed USMC housing at both Navy and AF Barrigada and other military activities in the area and convey it to the proposed treatment facilities either in northern or central Guam as presented in the long-term wastewater treatment options. The recommended relief sewer is sized based on the following criteria:

- Minimum pipe size 8 inches
- At peak dry weather flow, maximum flow depth over diameter (d/D) is less than 0.8
- Minimum flow velocity 2.5 ft per second for gravity sewer pipe
- Maximum flow velocity is 5 ft per second for force mains
- Pipe diameter determined using Manning's pipe friction formula
- Coefficient of roughness "n" equal to 0.013

It is sized to carry projected flow at DoD Barrigada properties that is described in Table 4-3. Following natural grade, sewage generated in Navy Barrigada is drained toward south and finally collected at southwest corner of the property near the exiting base gate. Sewage generated from proposed AF Barrigada housing area is drained down toward north and finally intersect Navy Barrigada sewer trunk near Navy Barrigada base gate.

Option 1 and 3 require almost the same set of collection system modifications; whereas, Option 2 and 4 require another set of collection system modifications. Option 1 and 3 propose carrying the wastewater to northern Guam. Option 1 conveys wastewater to the upgraded NDWWTP and Option 3 coveys wastewater to the proposed new secondary treatment facility located within DoD land at the southeast corner of the proposed USMC Finegayan main base. While Option 2 and 4 convey the wastewater generated from the DoD Barrigada properties to the Hagatna WWTP site for treatment.

Construct a Separate Sewer for Military Activities in Barrigada to the Upgraded NDWWTP

As discussed in the previous sections, Option 1 would treat all military generated wastewater in northern Guam and USMC off-base housing at Barrigada area. It requires the DoD to construct its own independent sewage interceptor to collect wastewater generated from proposed USMC housing at Barrigada. The interceptor would connect proposed Barrigada housing collection system at proposed sewage pumping station at Navy Barrigada gate. The proposed pump station would have three 100-horsepower (HP) dry pit pumps, two duty, and one standby. Wastewater would be pumped north up to Route 16 to the west of Barrigada Hill and then run down along Route 16 north until it intersects with Route 3. Another new proposed SPS has three 75-HP pumps (two duty and one standby) that pump wastewater northeast to the new proposed DoD treatment plant at south Finegayan.

As shown on Figure 4-3, the proposed sewer consisting of 17,500-ft 18-inch force main, 3,650-ft 15-inch gravity sewer, and 4,700-ft 24-inch gravity sewer would be required to convey flow from the Barrigada area to the NDWWTP. The sewer is designed with average flow and peak daily flow provided in Table 4-3.

Construct a New Relief Sewer to Accommodate USMC Relocation Wastewater Flow Generated from Barrigada Area to the Hagatna WWTP

The proposed Option 2 would treat all wastewater flows generated within the central Guam wastewater basin, including both civilian flow and proposed USMC housing at Barrigada in the Hagatna WWTP. The total projected wastewater would be treated by a secondary process as proposed in Option 2. The DoD wastewater flows generated in Barrigada would be conveyed through a new gravity relief sewer from Navy Barrigada gate first along Route 8 and then along Route 16 west all the way down to the GWA Agana main SPS.

As shown on Figure 4-4, the proposed relief sewer consisting of 15,300-ft 18-inch sewer, 1,500-ft 21-inch sewer, and 6,900-ft 24-inch sewer would be required to convey flow from the Barrigada area to the GWA Agana main SPS. The relief sewer is sized with average flow and peak daily flow provided in Table 4-3.

Construct a New Separate Sewer for All Military Activities in Barrigada Area to DoD Secondary Treatment Facility Inside DoD Land

In Option 3, a newly constructed DoD-owned wastewater facility located at the southwest corner of the USMC Finegayan area requires the DoD to construct its own independent sewage interceptor to collect wastewater generated from proposed USMC housing at Barrigada area. The interceptor would connect proposed Barrigada housing collection system at proposed sewage pumping station at Navy Barrigada gate. The proposed pump station would have three 125 HP dry pit pumps, two duty and one standby. Wastewater would be pumped north up to Route 16 to the west of Barrigada Hill and then run down along Route 16 north until intersecting Route 3. Another new proposed SPS has three 75 HP pumps—two duty and one standby—that pump wastewater northeast to the new proposed DoD treatment plant at south Finegayan.

As shown on Figure 4-6, the proposed sewer consisting of 18,710-ft 18-inch force main, 3,650-ft 15-inch gravity sewer, and 4,700-ft 24-inch gravity sewer would be required to convey flow from the Barrigada area to the new proposed DoD plant at south Finegayan. The sewer is designed with average flow and peak daily flow provided in Table 4-3.

This option would also require construction of 5,000 ft of 30-inch effluent transmission line and 2,400 ft of 30-inch outfall to discharge effluent to the Philippine Sea.

Construct a New Separate Sewer for All Military Activities in Barrigada Area to Secondary Treatment Facility at the Hagatna WWTP Site to Treat DoD Load Only

In Option 4, a DoD constructed secondary wastewater facility is proposed at the Hagatna WWTP site to treat Barrigada DoD load only. The sewer layout is similar to the one for Option 1 and 2 except a proposed sewage pumping station by the Marine Drive in front of the Hagatna WWTP to pump wastewater flow to the proposed DoD secondary treatment plant (as shown on Figure 4-9). The proposed new sewage pump station has three 25 HP pumps, two on duty and one on standby. The sewer is designed with average flow and peak daily flow provided in Table 4-3.

As shown on Figure 4-8, the proposed relief sewer consisting of 3,500-ft 18-inch force main, 15,300-ft 18-inch sewer, and 6,900-ft 24-inch sewer would be required to convey flow from the Barrigada area to the proposed DoD secondary treatment tactility at the Hagatna WWTP site.

4.3.3 Preliminary Opinion of Probable Construction Cost

A summary of the preliminary opinion of probable construction cost (the construction cost estimate) is outlined in this section. The quantities shown are estimates based on descriptions in this study and vendor proposals. The estimates are intended to be as comprehensive as possible at the study stage where much of the work is still at a conceptual level.

The quantities for all work items shall be reviewed and updated during the Detailed Design. A project level allowance of 35 percent is added to the estimated construction cost for project services to establish the total estimated project cost. Project services include the following:

- Environmental Impact Report/Other Documents
- Design Engineering
- Construction Engineering and Contract Administration
- General and Administrative Expenses
- Contingencies

The current construction cost estimate is based on July 2008 prices (ENR_{LA} = 9,335). A summary of the preliminary construction cost for each option is shown in Appendix D.1. A detailed construction cost allocation among the GWA, the USMC and other project related partners is presented in Table 4-14. The cost allocation is determined based on the flow contribution from the GWA, USMC, and other DoD units.

Table 4-14: Capital Cost Allocations between USMC and Other Project Related Partners

Cost Allocation	Option 1: Expand and upgrade the GovGuam Northern District WWTP to secondary treatment t	Option 2: Expand & Upgrade Hagatna WWTP to Secondary Treatment	Option 3: DoD Secondary Treatment on DoD Land	Option 4: Separate Secondary Treatment at Hagatna WWTP Site to Treat DoD Load Only
GWA	$138,008,000	$50,905,000	—	—
USMC Housing	$40,383,000	$29,773,000	$81,961,000	$49,280,000
USMC Main Base	$33,527,000	—	$54,652,000	—
Other DoD Units	$13,255,000	$9,641,000	$21,607,000	$15,957,000
Total Cost	**$225,173,000**	**$90,319,000**	**$158,220,000**	**$65,237,000**

As shown in Table 4-14, Option 4 has the lowest construction cost, Option 1 has the highest construction cost, and Option 3 has the second highest construction cost. The high capital costs of Option 1 and 3 include proposed sewer line and pumping stations to convey USMC generated wastewater from its Barrigada housing to the NDWWTP, proposed DoD treatment facility at south Finegayan, and treatment for wastewater generated from USMC Main Base at Finegayan. If comparing the capital costs for treating only USMC Barrigada housing generated wastewater, then Option 2 is the lowest among the four secondary options.

An estimate of the O&M costs for viable options has been developed and a detailed cost spreadsheet is provided in Appendix D.1. The assumptions and criteria that form the basis for this estimate are presented below:

- Staffing of two expansion and upgrade options (Options 1 and 2) at the NDWWTP and Hagatna WWTP would be by the GWA.
- Staffing of two expansion and upgrade options (Options 1 and 2) at the NDWWTP and Hagatna WWTP would be similar (in terms of shift and time of day coverage by operators and sharing of maintenance with other facilities) to the current staffing at the existing Hagatna WWTP.
- Staffing of DoD operating option (Option 3) would be by the DoD.
- Staffing of treating DoD load only option (Option 4) at the Hagatna WWTP site would be negotiated between the GWA and DoD, but assumed similar (in terms of shift and time of day coverage by operators and sharing of maintenance with other facilities) to the DoD operating option (Option 3) for conservative estimation.
- Staff labor of manager at $75,000 per year including fringe benefits, operator/mechanic at $45,000 per year including fringe benefits, and administrative assistant at $30,000 per year including fringe benefits.
- Flow based on projected future value of 18.0 mgd for expansion and upgrade option (Options 1) at the NDWWTP.
- Flow based on projected future value of 7.54 mgd for expansion and upgrade option (Options 2) at the Hagatna WWTP.
- Flow based on projected future value of 2.9 mgd for Option 3 USMC loads at both proposed Finegayan and Barrigada areas only.
- Flow based on projected future value of 1.4 mgd for Option 4 DoD Barrigada load only.
- Power cost based on $0.20 per kilowatt hour.
- Polymer cost based on $3.00 per pound.
- Sodium hypochlorite cost based on $0.85 per gallon.
- Citric acid cost based on $6.50 per gallon.
- Ferric Chloride cost based on $14.0 per gallon.
- General repair and maintenance based on $0.15 percent of estimated construction costs.
- Sewer line maintenance based on 0.15 per ft.
- Solids hauling and disposal based on $25 per cubic yard (cy) processing/land application fee and $285 per 20 cy truck trip for transportation.

The above viable options would require a life cycle comparison for a recommended selection. An annual 4 percent interest was used to compare 20-year net present worth for each option. Table 4-15 presents an outline of annual costs for each option. Revenues from sewer connection fee and sale of reuse water are not included in the annual costs analysis.

In addition, this study also provided a separate O&M cost estimate showing distribution of O&M costs between the DoD and the GWA for Option 2. In Option 2, the costs are distributed in proportion to the flow contribution to the Hagatna WWTP, which is 1.40 mgd of 7.54 mgd for the DoD and 6.14 mgd of 7.54 mgd for the GWA. Table 4-16 presents total O&M cost and respective cost distribution to the GWA and the DoD for Option 2.

Table 4-15: Life Cycle Cost Comparison of Wastewater Treatment Options

Item	Description	Option 1: Expand and upgrade the GovGuam Northern District WWTP to secondary treatment	Option 2: Expand & Upgrade Hagatna WWTP to Secondary Treatment	Option 3: DoD Secondary Treatment on DoD Land	Option 4: Separate Secondary Treatment at Hagatna WWTP Site to Treat DoD Load Only
A.	**Estimated Capital Cost**				
1	Headworks	$4,910,000	—	$3,458,000	$2,812,000
2	Primary Clarifiers	$11,277,000	—	$6,098,000	$4,465,000
3	Chemical Enhanced Settlement System	—	$323,000	—	$118,000
4	Pumping Stations	$3,237,000	$2,025,000	$1,687,000	$1,404,000
5	Trickling Filters	$26,067,000	$14,793,000	$8,380,000	$4,014,000
6	Secondary Clarifiers	$31,650,000	$22,079,000	$10,458,000	$5,459,000
7	Disinfection System	$5,564,000	$2,856,000	$2,729,000	$925,000
8	Effluent Pump Station	—	$488,000	—	$585,000
9	Sludge Digesters	$47,057,000	$10,002,000	$23,247,000	$4,287,000
10	Sludge Thickening & Dewatering System	$8,340,000	—	$10,518,000	$10,093,000
11	Influent & Effluent Samplers	$982,000	—	$159,000	—
12	Site Work & Utilities	$9,509,000	$3,680,000	$4,671,000	$2,392,000
13	Sewer System	$14,752,000	$10,657,000	$35,998,000	$11,770,000
14	Effluent Transmission Line	—	—	$2,788,000	—
15	Ocean Out Fall & Piping	$3,450,000	—	$7,009,000	—
16	Project Services	$58,378,000	$23,416,000	$41,020,000	$16,913,000
	TOTAL	**$225,173,000**	**$90,319,000**	**$158,220,000**	**$65,237,000**
B.	**Estimated Annual O&M Cost**				
1	Labor & Benefits	$135,000	$135,000	$465,000	$375,000
2	Chemicals	$201,000	$975,000	$51,000	$37,000
3	Collection	$8,000	$4,000	$8,000	$3,000
4	Contract Services	$622,000	$598,000	$227,000	$155,000
5	Maintenance	$200,000	$200,000	$251,000	$251,000
6	Utilities	$1,930,000	$810,000	$394,000	$174,000
	TOTAL	**$3,096,000**	**$2,722,000**	**$1,396,000**	**$995,000**
C.	**Annual Costs**				
1	Amortized Capital Cost	$16,569,000	$6,646,000	$11,642,000	$4,800,000
2	Estimated Annual O&M Cost	$3,096,000	$2,722,000	$1,396,000	$995,000
	TOTAL	**$19,665,000**	**$9,368,000**	**$13,038,000**	**$5,795,000**

4.3.4 Preliminary Construction Schedule

It is anticipated that for Option 1 and Option 2, constructing secondary treatment and upgrading existing primary treatment at GovGuam NDWWTP or Hagatna WWTP would require about 12 to 18 months to design, 5 to 6 months to bid and award, and 25 to 30 months to construct the wastewater collection and treatment facilities. It is assumed that the wastewater treatment regulatory agency permitting work would be done concurrently with the design. Therefore, a total time required is 3.5 to 4.5 years.

Table 4-16: Annual O&M Cost and Cost Distribution between GWA and DoD for Option 2 – Expand and Upgrade the GovGuam Hagatna WWTP to Secondary Treatment

Cost Categories	Quantity	O& M Cost	GWA's O&M Cost Share	DoD's O&M Cost Share
Labor & Benefits	LS	$135,000	$106,000	$29,000
Chemicals	LS	$975,000	$766,000	$209,000
Collection	LS	$4,000	$0	$4,000
Contract Services	LS	$598,000	$470,000	$128,000
Maintenance	LS	$200,000	$157,000	$43,000
Utilities	LS	$810,000	$636,000	$174,000
Total Annual Operation Cost		**$2,722,000**	**$2,135,000**	**$587,000**

For Option 3 and 4, constructing secondary treatment plant at DoD land or GovGuam Hagatna WWTP site would require about 18 to 24 months to design, 5 to 6 months to bid and award, and 30 to 36 months to construct the wastewater collection and treatment facilities. It is assumed that the wastewater treatment regulatory agency permitting work would be done concurrently with the design. Therefore, a total time required is 4.0 to 5.5 years.

4.4 RECOMMENDED WASTEWATER TREATMENT OPTION

Based on the cost analysis discussed in Section 4.3.3, the total present capital costs and annual life cycle costs of the four viable options are presented in Table 4-17.

Table 4-17: Cost Summary of Viable Options for Wastewater

Option:	Option 1: Expand and upgrade the GovGuam Northern District WWTP to secondary treatment	Option 2: Expand & Upgrade Hagatna WWTP to Secondary Treatment	Option 3: DoD Secondary Treatment on DoD Land	Option 4: Separate Secondary Treatment at Hagatna WWTP Site to Treat DoD Load Only
Capital Costs				
Total Capital Cost	$225,173,000	$90,319,000	$158,220,000	$65,237,000
Amortized Capital Cost	$16,569,000	$6,646,000	$11,642,000	$4,800,000
O&M Costs				
Total Annual Cost	$3,096,000	$2,722,000	$1,396,000	$995,000
Annual Life Cycle Costs	$19,665,000	$9,368,000	$13,038,000	$5,795,000
USMC Barrigada Housing Related Treatment Capital Cost	*$40,383,000*	*$29,773,000*	*$81,961,000*	*$49,280,000*

Option 1's annual life cycle cost of $19,665,000 (includes amortized construction cost and estimated annual operations and maintenance [O&M] cost) and total construction cost of $225,173,000 are the highest of the available options. However, this is the recommended option because of factors related to NPDES permit requirements. According to the EPA Region 9:

- The increased discharge from DoD activities on Guam would have an impact on the existing NPDES permit requirements, water quality standards, and NPDES requirements for current and any future effluent discharge, and
- NPDES requirements for current and any future effluent discharge would be based on EPA secondary treatment technology based requirements.

This requirement means that all wastewater treatment facilities on Guam would need to meet secondary treatment standards. Option 1 allows the Navy to focus on funding only one treatment facility that is closer to the region with USMC main activities. Also, the DoD has committed to arrange a third-party funding using a private entity to finance the necessary upgrades to NDWWTP. Based on the funding and water quality issues, Option 1 is the recommended option.

To further support the selection of Option 1, both Option 1 and Option 3 have one wastewater treatment facility for both USMC main base and off-base housing. The USMC's capital cost share of \$40,383,000 based on wastewater flow contribution for Option 1 is lower than the cost of \$81,961,000 for Option 3. The proposed upgrades in Option 1 could be implemented in phased construction. With restoring primary treatment capacity in the NDWWTP, the plant is able to handle additional wastewater generated from the construction workforce and the proposed project induced population in northern Guam during the interim period for primary treatment. After the remaining proposed expansions and upgrades are complete, the NDWWTP could treat proposed future flow from both civilian population and military activities with secondary biological treatment to fulfill EPA requirements.

4.4.1 Description of Recommended Option

In this option, the NDWWTP facility would be expanded and upgraded to a secondary treatment plant and wastewater generated at the Barrigada Housing site would be conveyed to the NDWWTP for treatment. The secondary treatment train would include facilities to enhance removal of biodegradable organic matters (in solution or suspension) and suspended solids found in wastewater. Figure 4-10 shows the schematic process diagram of the recommended option. The following restoration, new process components and expansion are required at the NDWWTP site for this option:

The following existing components of the NDWWTP are required to be refurbished and upgraded:

- Headworks with odor control
- Two primary clarifiers
- Two anaerobic digesters
- Two centrifuge solids-dewatering systems with odor control
- Two chlorine contact tanks
- Effluent monitoring

The following new process components and upgrades would be required at the NDWWTP for expanding and upgrading to secondary treatment:

- Four trickling filters
- Four secondary clarifiers

- Two additional anaerobic digesters (the same size as existing ones)
- One additional centrifuge solids-dewatering system and odor control

The sizes of the new process components and upgrades required at the Hagatna WWTP for expanding and upgrading to secondary treatment are listed in Table 4-18.

Table 4-18: Components for Recommended Option - Expanding and Upgrading the NDWWTP to Secondary Treatment and Conveying Wastewater Generated at USMC Housing at Barrigada to the NDWWTP

Construction Components	Refurbish (R)/Expand (E)/Upgrade (U)/ New (N)	Unit	Dimensions/Description
The short-term improvements for restoring primary treatment			
Septage Receiving Station	N	1	Septage storage tank, screen, two blowers, diffusers, two grinder pumps, and truck unloading area
FOG Receiving Station	N	1	Headed grease holding tank, heat trace system, two grinder pumps, and grease truck unloading area
Headworks	R	1	Two (2) 6-mm fine screens, grit chamber retrofit, new grit pump station, grit wash and separation, and flow metering
Primary Clarifier	R	2	New Sludge Collectors, electrical, pumps, and coatings, concrete repair 130-ft dia ×7-ft swd
Anaerobic Digester	R	2	New sludge mixing, heat exchangers, electrical, controls, coatings, piping and valves, concrete repair 80-ft dia × 18-ft swd
Solids Dewatering Building (replace)	N	1	Structure replacement, one centrifuge, one feed pump, polymer dosing system, electrical, controls, coatings, piping and valves
Influent and Effluent Samplers	N	2	Automatic samplers
Sludge Drying Bed (refurbish)	R	1	Concrete repair, valves
Standby Diesel Generator	N	1	300 KW diesel generator
The long-term improvements for restoring primary treatment			
Chlorine Contact Tank	R	2	New mixers, chemical feed pumps, effluent flow metering, electrical, coatings, concrete repair, buffer wall reconfiguration, and effluent measure flume 60-ft L × 40-ft W × 7.5-ft swd
Anaerobic Digester	N	1	New sludge mixing, heat exhangers, electrical, controls, coatings, piping and valves, and one digester tank 80-ft dia × 18–ft swd
Digester Gas Utilization	N	1	Engine generator, gas purification, and compressor
Sludge Dewatering Centrifuge	N	1	2,000 lb/hr centrifuge
Plant Odor Control System	N	1	Odor control system
Adm/Lab, Workshop, Storage	R	1	Adm/Lab, workshop, and storage
Secondary treatment expansion and upgrade, and sewer convey system			
Primary Clarifier	N	1	130' dia x 7'swd
Pumping Station	N	1	40-ft L x 25-ft W x 16-ft H
Trickling Filters	N	3	120-ft dia x 24-ft swd
Secondary Clarifiers	N	4	125-ft dia x 14-ft swd
Chlorine Contact Tank	N	1	60-ft L x 40-ft W x 8-ft swd
Anaerobic Digesters	N	2	80-ft dia x 18-ft swd

Construction Components	Refurbish (R)/Expand (E)/Upgrade (U)/ New (N)	Unit	Dimensions/Description
Solids Dewatering Building Expansion	E	1	One 2,000 lb/hr centrifuge
Influent and Effluent Samplers	N	2	
Relief Sewer	N	1	Gravity sewer: 3,650-ft dia 15-in, 4,700-ft dia 24-in; Force main:17,500-ft dia 18-in; 2 × Pumping station
Outfall Upgrade	U	1	40 diffusers w/ 400-ft long

4.4.2 Description of Collection System Modifications

The recommended Option 1 would treat all wastewater flows generated within proposed USMC off-base housing in Barrigada at the upgraded NDWWTP. The interceptor would connect proposed Barrigada housing collection system at proposed sewage pumping station at Navy Barrigada gate. The proposed pump station would have three 100-HP dry pit pumps, two duty, and one standby. Wastewater would be pumped north up to Route 16 to the west of Barrigada Hill and then run down along Route 16 north until it intersects with Route 3. Another new proposed SPS has three 75-HP pumps (two duty and one standby) that pump wastewater northeast to the new proposed DoD treatment plant at south Finegayan.

As shown on Figure 4-3, the proposed sewer consisting of 17,500-ft 18-inch force main, 3,650-ft 15-inch gravity sewer, and 4,700-ft 24-inch gravity sewer would be required to convey flow from the Barrigada area to the NDWWTP. The sewer is designed to have capacity for conveying 5 mgd.

4.4.3 Preliminary Construction Cost

The estimated project cost for expanding and upgrading the NDWWTP to secondary treatment and conveying wastewater generated at USMC housing at Barrigada to the NDWWTP is $225,173,000. A summary of preliminary project cost for the recommended option is shown in Table 4-19.

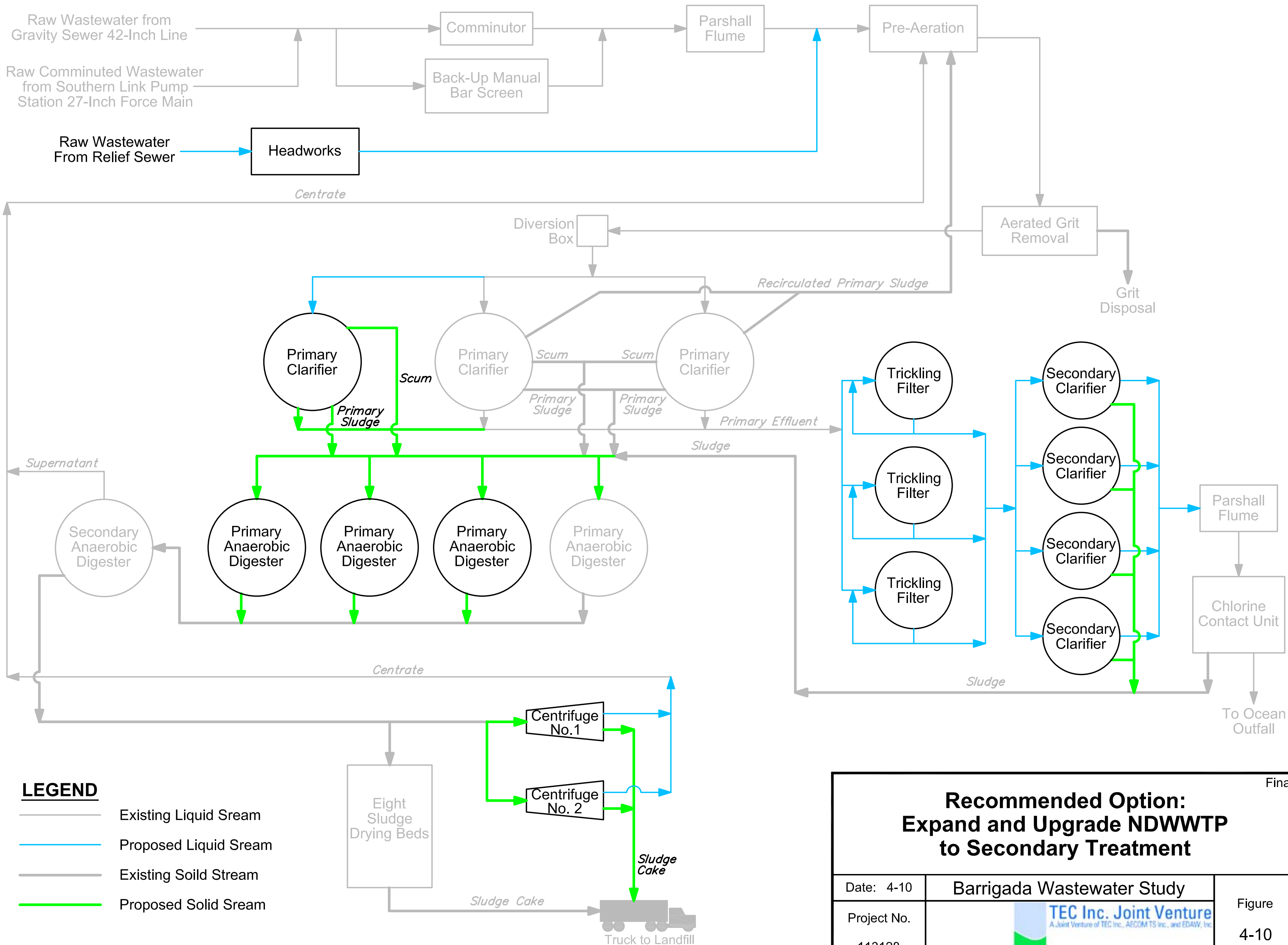
4.4.4 Preliminary Construction Schedule

It is anticipated that Option 1 would take about 12 to 18 months to design, 5 to 6 months to bid and award, and 30 to 42 months to construct the wastewater collection and treatment facilities. It is assumed that the wastewater treatment regulatory agency permitting work would be done concurrently with the design. Therefore, the total time required to complete the project is 4.0 to 5.5 years. The schedule may be compressed by 6 months to 1 year if “design build” or “fast track” construction methodologies are used.

Table 4-19: Preliminary Construction Cost for Recommended Option– Expanding and Upgrading the NDWWTP to Secondary Treatment

Construction Categories	Cost Opinion
Headworks	$4,910,000
Primary Clarifiers	$11,277,000
Pumping Stations	$3,237,000
Trickling Filters	$26,067,000
Secondary Clarifiers	$31,650,000
Disinfection System	$5,564,000
Effluent Pump Station	—
Sludge Digesters	$47,057,000
Sludge Thickening & Dewatering System	$8,340,000
Influent & Effluent Samplers	$982,000
Ocean Outfall & Piping	$3,450,000
Site Work & Utilities	$9,509,000
Sewer System	$14,752,000
TREATMENT SUBTOTAL COST	$148,595,000
SEWER SUBTOTAL COST	$18,200,000
TOTAL COST	$166,795,000
PROJECT SERVICES	$58,378,000
TOTAL ESTIMATED PROJECT COST (ROUNDED)	**$225,173,000**
TOTAL ESTIMATED PROJECT COST FOR USMC OFF-BASE HOUSING	**$40,383,000**

File: Y:\Guam\Barrigada\Final Report & Support Material\Figures\Figure 4-10 Recommended Layout.dwg Time: May 26, 2010 - 1:22pm



Final

Recommended Option: Expand and Upgrade NDWWTP to Secondary Treatment

Date: 4-10	Barrigada Wastewater Study	Figure
Project No. 113128	TEC Inc. Joint Venture A Joint Venture of TEC Inc., AECOM TS Inc., and EDAW, Inc.	4-10

5. References

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Appendix A
General

Appendix A.1
Statement of Work

AMENDMENT NO. 41 **REVISION 1** TO THE STATEMENT OF ARCHITECT-ENGINEER SERVICES FOR ENVIRONMENTAL STRATEGIC PLANNING TO SUPPORT FORWARD BASING INITIATIVES AND SERVICES RELATED TECHNICAL FOR PROJECTS AND ACTIVITIES AT VARIOUS LOCATIONS

N62742-06-D-1870
T.O. 0035
01 April 2010

The basic Statement of Architect-Engineer Services of 12 May 06) is amended as follows:

1. Project Title/Location: BARRIGADA UTILITY STUDY - POWER, POTABLE WATER, AND WASTEWATER UTILITY SUPPLEMENTAL STUDY TO SUPPORT EIS FOR MARINE CORPS CANTONMENT

References:

(a) Unified Facilities Criteria UFC 3-240-02N, Wastewater Treatment Systems Augmenting Handbook, 16 January, 2004
(b) Water Environment Federation Manual of Practice No FD-5, Gravity Sanitary Sewer Design and Construction
(c) UFC 3-230-19n Water Supply Systems
(d) UFC 3-600-01 Fire Protection Engineering for Facilities
(e) UFC 3-230-02, Operation and Maintenance: Water Supply Systems, July 2001
(f) UFC 3-230-03a Water Supply Systems
(g) Applicable DoD Unified Facilities Criteria (UFC) Technical Publications
(h) Revision 1: Draft Environmental Impact Statement (DEIS), GUAM AND CNMI MILITARY RELOCATION, Relocating Marines from Okinawa, Visiting Aircraft Carrier Berthing, and Army Air and Missile Defense Task Force, Volume 6: Related Actions – Utilities and Roadway Projects, dated November 2009.

Attachments:

2. Project Budget / Estimated Construction Cost (ECC): NA

3. Project Points of Contact (POC):

a. Project Contract Specialist (PCS). The PCS assigned to this project is Ms. Valerie Mito, telephone 471-7130, email address valerie.mito@navy.mil.

b. Contracting Officer’s Representative (COR). The COR assigned to this contract is Ms. **Connie Chang** (EV21) telephone (808) 472-1**395**, or email address liane.rosen@navy.mil. The COR will coordinate all technical matters of the contract. Keep the COR informed of contract/amendment progress and problems involved.

c. Navy Technical Representative (NTR). The NTRs who serves as the technical representative in the administration of this project are:

Mr. Sonny Rasay/Alan Oshiro, Electrical Power and Lead
(808) 473-5943/(808) 473-1445
Mr. Kevin Oshiro/**Scot Urada**, Water
(808) 472-1390/(808) 472-**1435**
Mr. Gerald Akai/Travis Hylton, Wastewater
(808) 472-1412/(808) 472-1385

Keep the NTRs informed of the progress and problems encountered.

All contacts and conferences concerning work shall be made through the NTR. The PCS shall designate an individual who will be directly responsible for, and be contacted on all matters pertaining to this project. Direct contact with other departments within NAVFAC Pacific or other commands and/or military activities may be made by the PCS only with prior notification and approval by the NTR.

4. Project Scope and General Information:

The Guam Integrated Military Development Plan (GIMDP), formerly the Joint Guam Military Master Plan (JGMMP), provides the planned increase in Marine Corps cantonment facilities on the island of Guam.

Objective. This project addresses power generation, water demand, and wastewater generation for potential cantonments in Barrigada, Guam. There are two main cantonment alternatives to be considered for the project from the USMC Main Cantonment EIS; Barrigada (Alternatives #3 and #8). The alternatives involve Navy and Air Force lands at Barrigada to be considered for off-base housing, including related land uses such as base operations, educational facilities, and recreation and quality of life areas.

This engineering study will evaluate existing utility capacities and identify all reasonable conceptual and interim alternatives for electrical power, potable water, and wastewater improvements to support the USMC Barrigada cantonment facilities with sufficient and detailed information to support the EIS process.

Revision 1: The purpose of this revised Amendment is to update the Barrigada Utility Study dated September 2009 to support the DEIS consistent with the utilities alternatives presented, including all of the items covered in the summary letter reports and applicable supporting studies.

General Work Requirements. This study is currently Business Sensitive, “For Official Use Only” and will not be released or discussed outside of DoD without the consent of Naval Facilities Engineering Command Pacific (NAVFAC Pacific).

The A-E shall conduct a study that will identify all reasonable conceptual and interim alternatives for electrical power, potable water, and wastewater improvements to support the USMC Main Cantonment Alternatives #3 and #8 at Barrigada with sufficient and detailed information to support the EIS process.

The A-E shall take into consideration in their study that the Barrigada cantonment alternatives encompass an off-base housing area of up to approximately 810 acres.

The A-E shall conduct a study that will determine what is needed to provide the best power generation (source, transmission, and distribution), potable water supply (source, treatment, storage, and distribution), and wastewater service (collection, treatment, and disposal) to the planned DoD housing facilities alternatives in Barrigada. The A-E shall identify and develop conceptual and interim alternatives to support the planned DoD development. The A-E shall provide a comparative analysis and provide recommendations for electrical power service, potable water supply, and wastewater service. The A-E shall provide environmental impact analysis (for use in the EIS) on the most feasible alternatives. Identify and develop planning documents for projects that represent the best value alternative for electrical power, potable water, and wastewater systems. References (a) and (b) contain pertinent design and planning guidelines for DOD wastewater systems. References (c), (d), (e), and (f) contain pertinent design and planning guidelines for DoD water supply systems.

The study shall address the utilities requirement to support development of the alternatives. The report shall be developed in such a way that the alternatives are easily distinguished (i.e. cost estimates, implementation and schedule schemes).

The latest Development Plans shall be used to develop the utility alternatives. The A-E should consult and gather the necessary Development Plans with NAVFAC Pacific Base Development or the appropriate A-E who is responsible in developing the cantonment alternatives for any future planning issues related to the cantonments at Barrigada.

This tasks order shall also include the necessary efforts to support meetings with GoJ, GovGuam, NAVFAC, future utilities summits, and other meetings in support of the Guam DPRI effort. This may involve attending meetings, summits, preparing briefs, and answering questions that may come out during these meetings and summits.

5. Services:

The electrical power, potable water, and wastewater utility study encompasses main cantonment alternatives #3 and #8 at Barrigada. The services to be performed are as follows:

a. The A/E shall participate in meetings at NAVFAC Marianas. These meetings may involve briefings to the Commanding Officer of NAVFAC Marianas or their designated representatives and personnel on the work to be performed. Upon completion of the field work, exit briefings shall be provided to the NAVFAC Marianas on the findings and recommendations that are known at the time of the out-brief.

(1) Develop itinerary for site visit, including briefs, meetings, interviews and facility site visits.
(2) Develop power point in-brief.
(3) Coordinate briefs, meetings, interviews, and facility site visits.
(4) Conduct In-brief to NAVFAC Marianas and other interested parties.

(5) Conduct Out-brief to NAVFAC Marianas and other interested parties.
(6) Upon return from Guam visit, set up a telecon to conduct a back-brief to NAVFAC Pacific and other interested parties regarding the findings during the site visit.

b. Search for previous studies, as-built drawings, planned power, water, and wastewater improvement projects, National Pollutant Discharge Elimination System (NPDES), and any other records on electrical power, water, and wastewater systems owned by Guam Water Authority (GWA) Guam Power Authority (GPA), Consolidated Commission on Utilities (CCU), Department of Public Works (DPW) or DoD. Gather and review all applicable documents. Calculate the estimated demand load and capacity requirements based on applicable documents that are gathered.

c. Conduct onsite field investigations in Barrigada to include, but not be limited to, the following tasks:
(1) Meet with GWA and GPA personnel to discuss the proposed base camp development and its requirements for electrical power, water and wastewater utility services, possibility of tie-in to the existing electrical power grid, water, and wastewater utility systems, and to gather other pertinent information from GWA and CUC.
(2) Meet with other Guam government agencies as appropriate.
(3) For existing electrical power, water and wastewater systems that may provide utility service to the cantonment alternatives, verify existing system capacity, condition, and reliability and ability to support current and future loadings.
(4) If new power generation is necessary, provide several alternatives that would describe type, proposed sites, and verify viability of those sites. Identify any necessary upgrade to existing transmission and distribution (T & D), substation, and if new T & D is necessary to support the cantonment.
(5) For new potable water well sites, verify the viability of those sites to provide long-term average day and maximum day requirements based on existing hydro-geologic information. If there is inadequate existing information, provide a proposal to develop pilot well studies.
(6) For alternative potable water resources, such as desalination, locate sources and disposal options.
(7) For alternative wastewater treatment facilities, identify locations for treatment and disposal facilities.

d. Develop alternatives for electrical power, water, and wastewater systems to meet the interim and conceptual (long term) requirements of cantonment alternatives at Barrigada.

e. Provide a site plan, project description, estimates for capital cost and life cycle cost for each alternative.

f. Prepare draft and final engineering reports detailing the field work performed, plans, all pertinent data, and evaluation analyses.

g. This tasks order shall also include the necessary efforts to support meetings with GoJ, GovGuam, NAVFAC, future utilities summits, and other meetings in support of the Guam DPRI effort. This may involve attending meetings, summits, preparing briefs, and answering questions that may come out during these meetings and summits.

h. Revision 1: This revision shall update the Barrigada Utility Study dated September 2009 to support the DEIS consistent with respect to the wastewater facilities alternatives presented, including all of the items covered in the summary letter reports and applicable supporting studies. Sections of the Barrigada Utility Study affected by this update includes the Executive Summary, Section 4, and other applicable sections, figures, references, or tables. The following updates shall be reflected in this revision to the Barrigada Utility Study:

(1) Updates will be limited to recommend the preferred alternative presented in the DEIS. Costs for that alternative will be estimated from existing data (force main from Barrigada to NDWWTP cost is essentially already available in the stand alone DoD WWTP alternative) with the intent to minimize changes to the study.

(2) The current option 1 in this study, Expand and Upgrade Hagatna WWTP Primary Treatment, will be replaced by the preferred alternative from the DEIS. The current option 2, Expand and Upgrade Hagatna WWTP to secondary treatment, will include the primary upgrades required.

6. Schedule of Fees: (To be filled in at conclusion of negotiations) N/A

7. Submittal Due Dates:
The contractor shall submit to the contracting officer copies of the engineering study report in accordance with the following schedule. The time allowed for each task along with government report review periods shall be as follows. The number of days for each task indicated shall be construed as calendar days. The A-E shall develop a plan of action and milestones for this study. The time periods in the "Time Period" column are for planning purposes only.

Task No.	Task Description	Time Period	Hypothetical Due Dates
A	Project Development Gather and review all applicable documents Preplan and prepare for site visit/field work	4 weeks	
B	Guam/Barrigada site visit and field work Hawaii back-brief teleconference	2 weeks 1 day	
C	Technical Analysis	6 weeks	
D	Draft Report	2 weeks	1 June 2009
E	Government review period	3 weeks	22 June 2009
F	Final Report	2 weeks	6 July 2009

Rev. 1	**Draft Updated Report**	**3 weeks**	**26 April 2010**
Rev. 1	**Final Updated Report**	**2 weeks upon receipt of NTR's review comments**	**24 May 2010**

8. Project Submittal Requirements and Distribution:

a. The study shall be consolidated in one report with a common part for all of the three utilities and the specific for each utility shall be by sections:

Section 1 Electrical Power
Section 2 Potable Water
Section 3 Wastewater

b. Report Content. "Barrigada Utilities Study To Support USMC Off-Base Housing Facilities Requirements"

The report shall include, but not be limited to, the following:

Introduction
- Goals and Objectives
- Background

1. Analysis of Load and Capacity Requirements
   - Bases of Load and Capacity Requirements Calculations
   - Load and Capacity Requirements Calculations
   - Barrigada Projected Load Requirements
2. Evaluation of Existing Utilities
   - Existing Condition
   - Present and Projected Capacity
   - Quality and Reliability
3. Recommendations
   - Interim Alternatives
   - Long-Term Alternatives
4. Supporting Information
   - Cost Estimates
   - Minutes of Meetings
   - Site Visit Out-brief
   - Photographs

c. The load or capacity requirements computations and cost estimates shall be in MS Excel format.

d. Report submittals shall be made at the Draft and Final delivery points in study development. The final report submittal shall include all review comments of the Draft Report submittals with annotations of actions taken by the A-E. The number of copies required for the study report shall be as follows. In addition, all originals, including all electronic source files, shall be submitted at the Final Report stage.

e. Revision 1: Updated Report submittals shall be made at the Draft and Final delivery stages. The Final Updated Report submittal shall include all review comments of the Draft Updated Report submittals with annotations of actions taken by the A-E. The number of copies required for the Draft and Final Updated Reports shall be as shown below.

Item	Number of Copies
Draft Report	20
Final Report	20
CD of electronic PDF and source files	20
Revision 1:	
Draft Updated Report (hard copies, plus electronic PDF)	**5**
Final Updated Report (hard copies)	**5**
CDs of electronic PDF and source files	**5**

e. Hard copy format – Text of the study report shall be prepared on 8-1/2 inch by 11 inch portrait format sheets. Drawings, sketches, and maps shall be ANSI D size. Photographs, sketches and other charts shall be sized as required such that the product is legible.

f. Electronic format – The format and content of electronic data shall be as follows:

(1) Operating system platform – All deliverables shall be compatible with MS Windows NT/Microsoft Office 2003 with the latest service pack.

(2) Reports - All Draft and Final submittals of studies and documents, including appendices and attachments shall be delivered in an editable and indexed PDF format with all source files. Two copies shall be provided for every submittal, one optimized for printer output, and the other optimized for screen output. All source text files shall be delivered in Microsoft Office format. All source material shall be delivered with proper citation.

(3) Graphics, GIF or compressed JPG file formats - All graphics for non-map related charts, illustrations and diagrams, shall be in GIF or compressed JPG formats and have adequate pixel resolution to clearly convey the subject matter. Source files shall be delivered in the highest resolution available in a digital format. Acceptable formats for source graphics include uncompressed JPEG, BMP, TIFF and Adobe PSD and AI formats. Multi-media deliverables shall be provided in a format that can be viewed through an NMCI approved media player (e.g. Windows Media Player).

(4) Photographs - Source files shall be delivered in the highest resolution available in a digital format. Acceptable formats for source photographs include uncompressed JPEG or TIFF formats. If source files are not in a compressed JPG format, they shall also be converted and delivered in a compressed JPG

format with a minimum pixel resolution of 640 x 480. Progressive JPEG files are not allowed.

(5) Drawings, Maps and Sketches - Source files shall be delivered in GIS Format, same version as Master Plan GIS Version (EDAW).

g. Briefs - Briefs shall be delivered in an Adobe Acrobat PDF format. Two copies shall be provided, one optimized for printer output and the other optimized for screen output. Each brief shall be a single document in letter size portrait mode. Source files shall be delivered in a Microsoft Power Point format and any source graphic/photographs used in the Briefs shall be delivered as specified above. Source files for charts that are spreadsheet-based shall be delivered in a Microsoft Excel format.

h. Estimate Submittals – estimates shall be delivered in Excel format.

i. Electronic Submittals - Provide five (20) organized sets of all final electronic submittals on standard recordable compact discs (CD-R). Transmittal sheet listing all deliverables shall be provided. Transmittal sheet shall identify both draft and final submittals as well as an inventory of source files and accompanying metadata provided on a given submission date.

As stated in Section 3, the PCS shall designate an individual who will be directly responsible for, and be contacted on all matters pertaining to this project. This responsibility will include receipt and distribution of submittals.

Appendix A.2
Site Visit Outbrief

OUT-BRIEF

Guam Site Visit 08 June – 12 June 2009
Contract #: N62742-06-D-1870
Task Order #: 35
Barrigada Utility Study – Power, Potable Water, and Wastewater Utility Supplemental Study to Support EIS for Marine Corps Cantonment
Contractor: TEC JV

12 June 2009

In-Brief: Guam Site Visit 8 June – 12 June 2009
Team Introduction

- **NAVFACPAC:**

LEAD & ELECTRICAL SME	**SONNY RASAY**
WATER/WASTEWATER SME	**KEVIN OSHIRO**

- **TEC JV (EARTH TECH AECOM)**

LEAD & ELECTRICAL	**GENE MOE**
WASTEWATER	**YANG MA**
WATER	**CLAIRE HUNT**

DELIBERATIVE PROCESS – FOR OFFICIAL USE ONLY

Task & Purpose of Visit

- **Task: Study Barrigada area utilities to develop interim and long-term alternatives to support cantonment alternatives 3 & 8 in the EIS, including project specific data and cost estimates for interim alternatives**

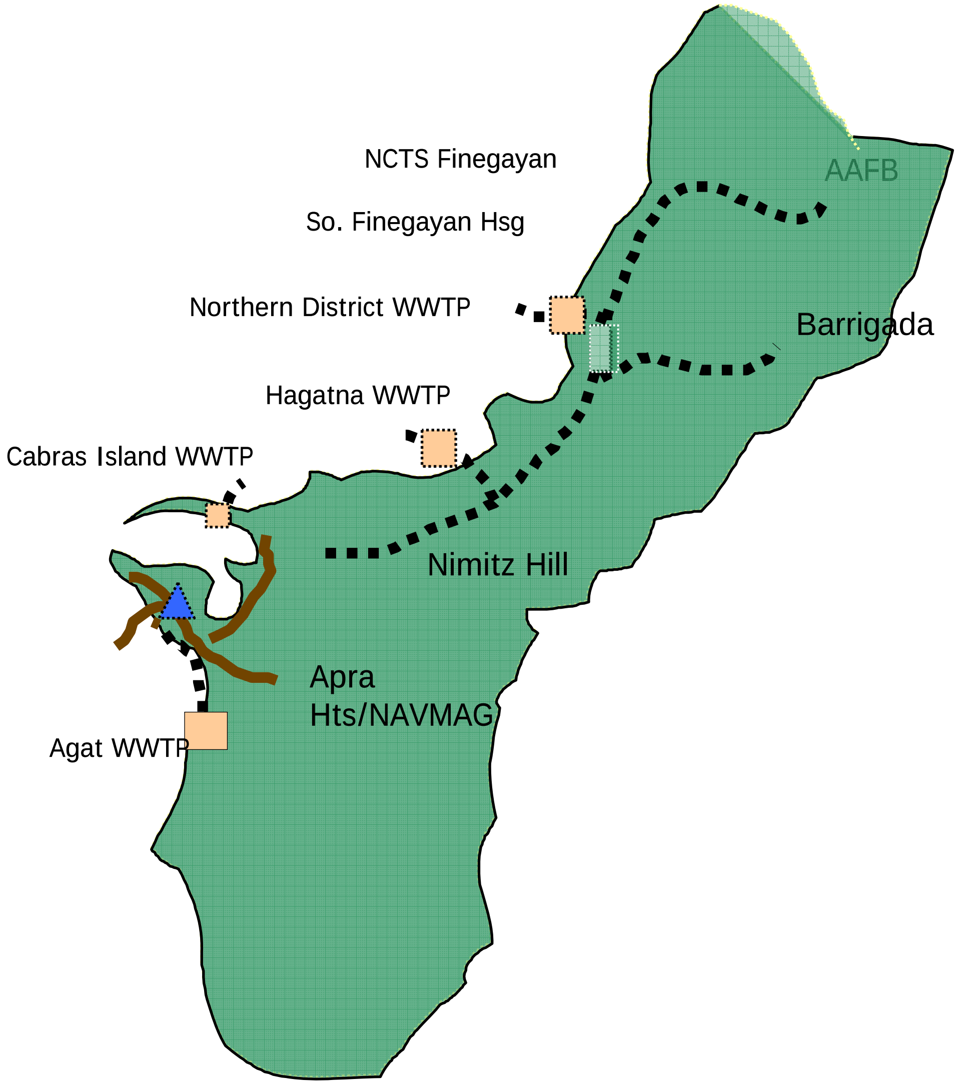
- **Purpose of visit is to gather information on existing utilities and tour proposed sites**
  - **- As-Builts**
  - **- Capacities, both design and current based on condition**
  - **- Current regional demand**
  - **- Potential non-DoD future demand increases**
  - **- Potential tie-in points with existing utilities**
  - **- Coordination with GWA and GPA**
  - **- Current MOUs, permit issues, etc. that might impact Barrigada**

In-Brief: Guam Site Visit 8 June – 12 June 2009
Visit Agenda

- 8 June
  - Sonny Rasay & Gene Moe start their site visit
  - tour areas outside of base properties focusing on power
- 9 June – 12 June
  - Balance of team start their site visit
  - Conducted In-Brief at COMNAV Marianas
  - Concentrate/tour on base properties
  - Meet with base engineering for as-builts & other information
  - Meet with GPA & GWA for coordination & information

- **Electrical Power**
  - **Transmission and Distribution**
    - **Met with GPA to present cantonment 3 and 8 load projections**
    - **Met with Ron Rogers to identify any restrictions in Radio Barrigada not currently known (forwarded comments to master planning group)**
    - **Existing distribution has some capacity but not sufficient for planned facilities under alternatives 3 and 8**
    - **Met with utilities staff at COMNAV Marianas to obtain existing demand load information for recent 12 month period**
  - **Power Generation**
    - **No changes anticipated**

- **Wastewater**
  - **Met with GWA**
    - Request for existing documentation expected to be complete week of 15Jun09
    - Drawings for recent upgrades at Hagatna WWTP expected week of 15Jun09
    - Impact to NDWWTP from cantonment alternatives 3 and 8 expected to lower projected flow demands
  - **Existing Navy & Air Force Sewers were discussed with utility staff**
  - **As-builts for Hagatna WWTP expected from GPA**
  - **Current planned GWA projects are expected to relieve plant interceptor capacity to Hagatna and allow additional flow from the North**
  - **Expected impact to North District WWTP will result in reduced demand for cantonment alternatives 3 and 8**



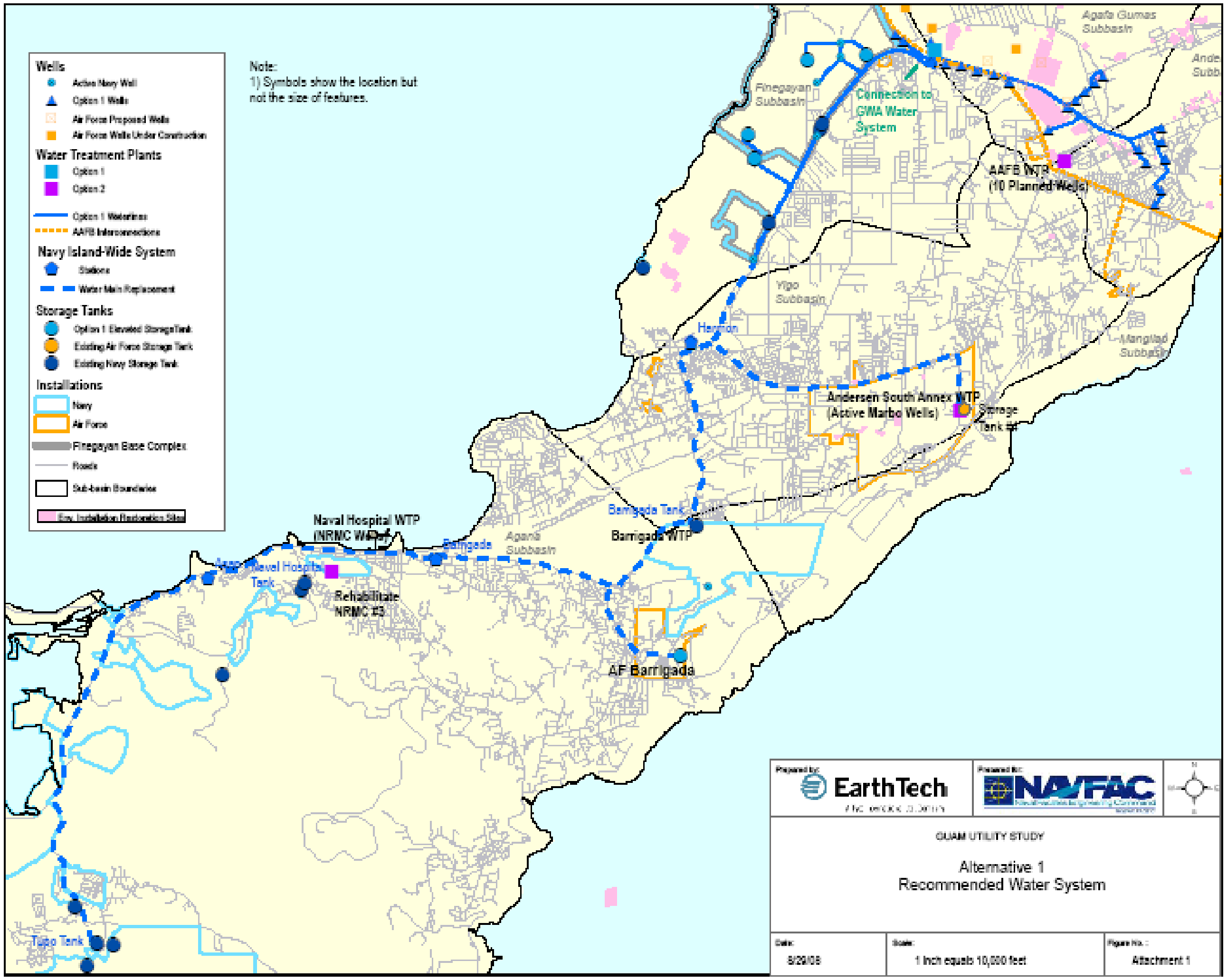
Navy Wastewater and tie-in to GWA

Sewer System

- Navy Main Sewer Lines
- GWA Main Sewer Lines
- Navy Treatment Plant
- GWA Treatment Plant

- **Potable Water**
  - **Site visit to Barrigada**
  - **Most current As-built information for all existing potable water utilities is in hand**
  - **Current demand on system provided during meeting at the Navy Base**
  - **Met with GWA**
    - GWA's plans for new wells has not changed (anticipate 10 wells but no definite plan for location
    - Information on other planned projects in this area (GWA)
    - GPA provided information regarding permitting requirements that potentially include GPA approval before review/approval by GEPA, well locations must be at least 1000 feet from septic tanks, sewer lines, etc.
    - Met with Dr. Jensen with the general expectation that past well performance is a reasonable indication of anticipated performance in Barrigada

Utility Specifics – Potable Water



DELIBERATIVE PROCESS – FOR OFFICIAL USE ONLY

QUESTIONS / DISCUSSION

Appendix B
Electrical Power

Appendix B.1
Cost Estimates

1. Component SUMMARY OF COSTS	**FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA**			2. Date JUL 2009
3. Installation And Location/UIC N62813 MARINE CORPS BASE GUAM		4. Project Title Utility Development Plans to Support DOD Build-Up on Guam (Power)		
5. Program Element	6. Category Code	7. Project Number	8. Project Cost ($000) $33,601	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
SUMMARY OF COSTS				
CAPITAL COSTS				
Electrical Distribution - Navy Barrigada				$14,041
Total Construction Cost				$14,041
Contingencies (20%)				$2,808
Engineering (15%)				$2,106
Total Capital Cost				**$18,955**
Present Worth Guam Capital Costs				**$19,104**
Annual O&M Costs				
Electrical Distribution - Navy Barrigada				$506
Total Annual O&M Cost				$506
Contingency (20%)				$101
Total Annual O&M Cost				**$607**
Present Worth of O&M Costs (25 year life)				**$14,498**
Present Worth of Total Costs				**$33,601**
Guidance Cost Analysis				

10. Description of Proposed Construction:
Extend new underground primary circuit to existing substation location, upgrade substation and provide primary and secondary switchgear.

Notes:
1. The area construction cost factor for Guam is based on Navy guidance.
2. The escalation factor for construction costs is 2.5% from ENR (May 2008).
3. The discount factor from Circular-94 Jan 2008 ranged from 2.3% (5-year) to 2.8% (30+years).
4. The construction period is assumed to be from 2010 to 2014.
5. The costs include substation cost that may be shared with GPA depending on ownership

1. Component CAPITAL COSTS	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date JUL 2009
3. Installation And Location/UIC N62813 MARINE CORPS BASE GUAM		4. Project Title Utility Development Plans to Support DOD Build-Up on Guam (Powerr)		
5. Program Element	6. Category Code	7. Project Number	8. Project Cost ($000) $33,601	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
COST DETAILS				
CAPITAL COSTS				
Navy Barrigada Electrical T&D Improvements				
1) Distribution Network				
From Take off sheet (Appendix II.3)	ft			$14,041
Total Distribution Cost				**$14,041**
Total Construction Cost				$14,041
Contingencies (20%)				$2,808
Engineering (15%)				$2,106
2008 Construction Costs				**$18,955**
2012 Construction Costs (2.5% Escalation)				**$20,923**
Present Worth Guam Construction Costs (2.3% discount)				**$19,104**

1. Component O&M COSTS	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date JUL 2009
3. Installation And Location/UIC N62813 MARINE CORPS BASE GUAM		4. Project Title Utility Development Plans to Support DOD Build-Up on Guam (Power)		
5. Program Element	6. Category Code	7. Project Number	8. Project Cost ($000) $33,601	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Navy Barrigada Improvements				
3% of the construction cost?				
Annual Maintenance (3% of key equipment)	LS	0.03	14,040,666	$421
Yearly electrical system testing	ea	1	85,000	$85
Annual Electric costs				
Transformer losses	kw-h		0.20	$0
Total Electrical Distribution O&M				**$506**
Total Annual Cost				$506
Contingency (20%)				$101
Total Annual O&M Cost				$607
2008 O&M Cost (25 year life)				**$15,187**
Future O&M Costs (2015 to 2039)				**$24,665**
Present Worth of O&M Costs (2.4 to 2.8% Discounts)				**$14,498**

1. Component SUMMARY OF COSTS	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date JUL 2009
3. Installation And Location/UIC N62813 MARINE CORPS BASE GUAM		4. Project Title Utility Development Plans to Support DOD Build-Up on Guam (Power)		
5. Program Element	6. Category Code	7. Project Number	8. Project Cost ($000) $33,819	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
SUMMARY OF COSTS				
CAPITAL COSTS				
Electrical T&D - AF Barrigada				$14,139
Total Construction Cost				$14,139
Contingencies (20%)				$2,828
Engineering (15%)				$2,121
Total Capital Cost				**$19,088**
Present Worth Guam Capital Costs				**$19,237**
Annual O&M Costs				
Electrical T&D - AF Barrigada				$509
Total Annual O&M Cost				$509
Contingency (20%)				$102
Total Annual O&M Cost				**$611**
Present Worth of O&M Costs (25 year life)				**$14,582**
Present Worth of Total Costs				**$33,819**

Guidance Cost Analysis

10. Description of Proposed Construction:
Extend new underground primary to potential substation location, install new substation, install primary and secondary switchgear.

Notes:
1. The area construction cost factor for Guam is based on Navy guidance.
2. The escalation factor for construction costs is 2.5% from ENR (May 2008).
3. The discount factor from Circular-94 Jan 2008 ranged from 2.3% (5-year) to 2.8% (30+years).
4. The construction period is assumed to be from 2010 to 2014.

1. Component CAPITAL COSTS	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date JUL 2009
3. Installation And Location/UIC N62813 MARINE CORPS BASE GUAM		4. Project Title Utility Development Plans to Support DOD Build-Up on Guam (Powerr)		
5. Program Element	6. Category Code	7. Project Number	8. Project Cost ($000) $33,819	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
COST DETAILS				
CAPITAL COSTS				
AF Barrigada Electrical Improvements				
1) Distribution Network				
From Take off sheet (Appendix II.3)	ft			$14,139
Total T&D Cost				**$14,139**
Total Construction Cost				$14,139
Contingencies (20%)				$2,828
Engineering (15%)				$2,121
2008 Construction Costs				**$19,088**
2012 Construction Costs (2.5% Escalation)				**$21,069**
Present Worth Guam Construction Costs (2.3% discount)				**$19,237**

1. Component O&M COSTS	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date JUL 2009
3. Installation And Location/UIC N62813 MARINE CORPS BASE GUAM		4. Project Title Utility Development Plans to Support DOD Build-Up on Guam (Power)		
5. Program Element	6. Category Code	7. Project Number	8. Project Cost ($000) $33,819	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
AF Barrigada Distribution Improvements				
3% of the construction cost?				
Annual Maintenance (3% of key equipment)	LS	0.03	14,139,008	$424
Yearly electrical system testing	ea	1	85,000	$85
Annual Electric costs				
Transformer losses	kw-h		0.20	$0
Total Water Distribution O&M				**$509**
Total Annual Cost				$509
Contingency (20%)				$102
Total Annual O&M Cost				$611
2008 O&M Cost (25 year life)				**$15,275**
Future O&M Costs (2015 to 2039)				**$24,809**
Present Worth of O&M Costs (2.4 to 2.8% Discounts)				**$14,582**

Description	Unit	Price	Qty	
Ductbank materials				
Concrete	CY	$ 236		0
Reinforcing #4-#7	ton	$ 2,750		0
Excavation/backfill (2'Wx6'D) Means doubled for rocky conditions	LF	$ 11		0
Composite concrete, excavation and reinforcing	LF			0
Liquid filled pad mounted service transformers (15kV primary, 480 v, 3ph secondary)				
150 kvs	each	$ 15,000		0
225 kva	each	$ 17,400		0
300 kva	each	$ 20,800		0
500 kva	each	$ 25,700		0
750 kva	each	$ 32,300		0
1000 kva	each	$ 38,700		0
1500 kva	each	$ 45,000		0
2000 kva	each	$ 55,000		0
2500 kva	each	$ 64,500		0
3000 kva	each	$ 77,000		0
3750 kva	each	$ 97,000		0
5000 kva	each	$ 125,000		0
Station transformers (2-30mva units)	MVA	$ 63,000	0	0
Pad Mounted Swtiches				
2 switches	each			0
3 switches	each	$ 20,000		0
4 switches	each	$ 25,000		0
Medium Voltage cable - 15kV				
#1/0 cable	LF	$ 8		0
#2/0 cable	LF	$ 9		0
#4/0 cable	LF	$ 11		0
#250kcmil	LF	$ 12		0
#350kcmil	LF	$ 14		0
#500kcmil	LF	$ 17		0
Medium Voltage cable - 35kV				
#1/0 cable	LF	$ 10		0
#2/0 cable	LF	$ 12		0
#4/0 cable	LF	$ 14		0
#250kcmil	LF	$ 16		0
#350kcmil	LF	$ 20		0
#500kcmil	LF	$ 23		0
Electrical Manholes				
4'x7'x7' deep	each	$ 4,000		0
6'x8'x7' deep	each	$ 4,575		0

6'x10'x7' deep	each	$	5,000	0
Handholes				
2'x2'x3' deep	each	$	1,050	0
3'x3'x3' deep	each	$	1,350	0
4'x4'x4' deep	each	$	2,175	0
Underground ductbank				
1-4inch PVC type EB	LF	$	29	0
2-4inch PVC type EB	LF	$	34	0
3-4inch PVC type EB	LF	$	39	0
4-4inch PVC type EB	LF	$	50	0
5-4inch PVC type EB	LF	$	57	0
6-4inch PVC type EB	LF	$	68	0
Medium Voltage switchgear (recent quotes)				
5 kV section	each	$	25,000	0
15 kV section	each	$	35,000	0
35 kV section	each	$	50,000	0
480 volt switchgear				
Section	each	$	7,500	0
Breaker - 400 amp	each		4550	0
Breaker - 800 amp	each		8650	0
Breaker - 1200 amp	each		11200	0
Breaker - 1600 amp	each		17200	0
Breaker - 2000 amp	each		18300	0
Breaker - 3000 amp	each		25000	0
Breaker - 4000 amp	each		30000	0
Breaker - 5000 amp	each		35000	0
Total				0
		Contingency	30 percent	0
		Guam Cost		0

Description	Unit	Price	Qty	Extended
Ductbank materials				
Concrete	CY	$ 236		0
Reinforcing #4-#7	ton	$ 2,750	10	27500
Excavation/backfill (2'Wx6'D) Means doubled for rocky conditions	LF	$ 11	5000	52500
Composite concrete, excavation and reinforcing	LF			0
Liquid filled pad mounted service transformers (15kV primary, 480 v, 3ph secondary)				
150 kvs	each	$ 15,000		0
225 kva	each	$ 17,400		0
300 kva	each	$ 20,800		0
500 kva	each	$ 25,700	1	25700
750 kva	each	$ 32,300		0
1000 kva	each	$ 38,700		0
1500 kva	each	$ 45,000		0
2000 kva	each	$ 55,000		0
2500 kva	each	$ 64,500		0
3000 kva	each	$ 77,000		0
3750 kva	each	$ 97,000		0
5000 kva	each	$ 125,000		0
Station transformers (2-30mva units)	MVA	$ 63,000	50	3150000
Pad Mounted Swtiches				
2 switches	each			0
3 switches	each	$ 20,000		0
4 switches	each	$ 25,000		0
Pole Mounted Gand operated switch	each	$ 16,700		0
Medium Voltage cable - 15kV				
#1/0 cable	LF	$ 8		0
#2/0 cable	LF	$ 9		0
#4/0 cable	LF	$ 11		0
#250kcmil	LF	$ 12		0
#350kcmil	LF	$ 14		0
#500kcmil	LF	$ 17	3000	51000
Station transformers	MVA	$ 24,000	0	0
Medium Voltage cable - 35kV				
#1/0 cable	LF	$ 10		0
#2/0 cable	LF	$ 12		0
#4/0 cable	LF	$ 14		0
#250kcmil	LF	$ 16		0
#350kcmil	LF	$ 20		0
#500kcmil	LF	$ 23	15000	337500
Electrical Manholes				
4'x7'x7' deep	each	$ 4,000		0
6'x8'x7' deep	each	$ 4,575		0

6'x10'x7' deep	each	$	5,000		0
Handholes					
2'x2'x3' deep	each	$	1,050		0
3'x3'x3' deep	each	$	1,350		0
4'x4'x4' deep	each	$	2,175		0
Underground ductbank					
1-4inch PVC type EB	LF	$	29		0
2-4inch PVC type EB	LF	$	34		0
3-4inch PVC type EB	LF	$	39		0
4-4inch PVC type EB	LF	$	50	500	24750
5-4inch PVC type EB	LF	$	57		0
6-4inch PVC type EB	LF	$	68		0
Medium Voltage switchgear (recent quotes)					
5 kV section	each	$	25,000		0
15 kV section	each	$	35,000	10	350000
35 kV section	each	$	50,000	4	200000
480 volt switchgear					
Section	each	$	7,500		0
Breaker - 400 amp	each		4550		0
Breaker - 800 amp	each		8650		0
Breaker - 1200 amp	each		11200		0
Breaker - 1600 amp	each		17200		0
Breaker - 2000 amp	each		18300		0
Breaker - 3000 amp	each		25000		0
Breaker - 4000 amp	each		30000		0
Breaker - 5000 amp	each		35000		0
Total					4218950
		Contingency		30 percent	5484635
		Guam Cost			14040666

Appendix B.2
Calculations

Barrigada Load Calculations

Navy Barrigada Area

No.	Building/Facility Name & Purpose	# Floors	Approx Height	Footprint Area (SF)	Gross Building (SF	CCN
B33	Sattelite Fire Station	1	20	8,485	8,485	73010
B50	Location Exchange #3	1	20	10,033	10,033	74002
B89	Religious Ministry Facility #2	1	20	17,190	17,190	73083
B94	Security (Police) Substation	1	12	880	880	73020

# Units	Residential Dwelling Unit Type
1566	3 BDRM- 2 STORY UNITS

# Fac	Recreational Facility
1	Volleyball Courts
2	Basketball Full Courts
2	Baseball Fields

AF Barrigada Area

No.	Building/Facility Name & Purpose	# Floors	Approx Height	Footprint Area (SF)	Gross Building (SF)	CCN
B49	Location Exchange #2	1	20	10,033	10,033	74002
B105	Swimming Pool #3 - Pool	0	0	12,136	0	75030
B106	Swimming Pool #3- Pool Deck	0	0	24,260	0	75030
B104	Swimming Pool #3 - Bath House	1	12	8,620	8,620	75030
B112	Youth Center #1	2	24	21,115	42,231	74055

# Units	Residential Dwelling Unit Type
8	4 BDRM DUPLEX - 2 STORY
1	4 BDRM UNIT - 2 STORY
4	1/2 acre - Generals Lot
42	3 BDRM - 5000 sf lot
1284	3 BDRM- 2 STORY UNITS
6	3 BDRM DUPLEX
1	4 BDRM - 2 STORY
31	4 BDRM - 5000 SF LOT
287	4 BDRM DUPLEX - 2 STORY
1	4 BDRM UNIT - 2 STORY
1	5 BDRM
11	5 BDRM - 1/5 ACRE LOT

133	5 BDRM DUPLEX

# Fac	Recreational Facility
2	Baseball Fields
1	Track and Field

Units	Demand/ Unit (kW)	25 percent spare	Coincident Demand (0.27 demand)	
SF	0.007	0.00875	20.05	
SF	0.007	0.00875	23.70	
SF	0.007	0.00875	40.61	
SF	0.007	0.00875	2.08	
			86.44	**kW**
Each	6	7.5	**12684.60**	**kW**

	New Facilities	**12.77**	**MW**
	Existing Facilities	**3.5**	**MW**
	Total	**16.27**	**MW**

Units	Demand/ Unit (kW)	25 percent spare	Coincident Demand (0.27 demand)	
SF	0.007	0.00875	23.70	
SF	0.006	0.0075	24.58	
SF	0.006	0.0075	49.13	
SF	0.007	0.00875	20.36	
SF	0.007	0.00875	99.77	
			217.54	**kW**
Each	12	15	64.80	
Each	6	7.5	2.03	
Each	6	7.5	8.10	
Each	6	7.5	85.05	
Each	6	7.5	5200.20	
Each	12	15	48.60	
Each	6	7.5	2.03	
Each	6	7.5	62.78	
Each	12	15	4649.40	
Each	6	7.5	2.03	
Each	6	7.5	2.03	
Each	6	7.5	22.28	

Each	12	15	2154.60	
			12303.90	**kW**
	Total		**12.52**	**MW**

Appendix B.3
Meeting Minutes

GPA/NAVFAC Meetings of 1/27/09 and 1/28/09

1/28/09

June 10, 2009
Meeting Attendees:
Joaquin “Kin” Flores – GPA General Manager
Joven Acosta – GPA Electrical Engineering (Systems engineer)
Melinda Camacho - GPA
Joe Torre – NAVFAC MAR Utilities Specialist
Jack Brown – NAVFAC MAR Utilities Manager
Arlene Aromin – NAVFAC MAR electrical engineer
Gene Moe – Earth Tech AECOM electrical engineer
Sonny Rasay – NAVFAC Pac UEM Electrical Engineer

Goal: The goal of the meeting was to present load information to GPA that represents the worst case option for cantonment alternatives 3 and 8 to allow preliminary T&D evaluation for providing power to the housing areas in Navy and AF Barrigada.

1. The load requirements for Navy Barrigada are expected to be 9.5MW plus the existing load of about 2MW.
2. The load requirements for AF Barrigada are expected to be about 11.5MW with no existing loads in the area.
3. Potential substation options discussed include locating one at Navy Barrigada near the SE corner of the proposed development. This area would be closest to RF energy caused by high power antenna located to the East.
4. Potential substation for AF Barrigada could be in the SE corner of the property as well to be located near the Hwy15 easement or in the triangle area to the East/Central of the proposed development provided an easement for utilities could be provided to get service from Hwy15.
5. Other discussion included the following:
    a. Planned substations would be supplied by GPA at 34.5 kV.
    b. The Navy would plan to distribute at 13.8 kV.
    c. Substations would require separate space to keep GPA equipment isolated from Navy equipment.
    d. GPA provided a table of planned loads and upgrades for Andersen AFB and Navy P-494 project areas.

e. GPA asked for additional clarification regarding load requirements they have received from the AF and those from NAVFAC. Specifically, what overlaps exist to avoid double counting planning requirements.
f. Planning data was discussed and GPA suggested that they may be able to put the folks they have develop their planning load projections with our population planners to determine what if any overlap exists in that planning. NAVFAC needs to identify who that person would be to open that line of communications.
g. GPA will provide a preliminary substation layout for planning purposes in the new development areas (how much space should be allocated for the substation).
h. GPA indicated that substations need to be a minimum of 1000 feet from schools (there is an existing Barrigada substation that will not be able to be expanded to accommodate planned loads due to proximity with a school. This is a relatively new ordinance in Guam.
i. GPA asked if land would be provided for the substation and their use. This was not answered at the time and would need to be resolved at a later date in the detailed design of facilities.

6. GPA will use the information provided and provide impact information for their T&D system.

Appendix B.4
Photographs

First photograph is Navy Barrigada substation and second is AF Barrigada (Eagle Field) area.

Photo 1. Navy Barrigada Substation

Photo 2. AF Barrigada (Eagle Field)

Appendix C
Potable Water

Appendix C.1
Cost Estimates

1. Component SUMMARY OF COSTS	**FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA**			2. Date APR 2010
3. Installation And Location/UIC N62813 MARINE CORPS BASE GUAM		4. Project Title GUAM POTABLE WATER STUDY		
5. Program Element OPTION 1 - OPTIMIZE GROUNDWATER RESOURCE DEVELOPMENT WITHIN DoD-ALT. 3	6. Category Code	7. Project Number	8. Project Cost ($000) $401,380	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
SUMMARY OF COSTS				
CAPITAL COSTS				
1) Water Resources Development				$26,385
2) Water Treatment				$3,653
3) Distribution				$131,299
Total Construction Cost				$161,337
Contingencies (20%)				$32,267
Engineering (15%)				$24,201
Total Capital Cost				**$217,805**
Present Worth Guam Capital Costs				**$219,513**
Annual O&M Costs				
1) Water Resources Development				$487
2) Water Treatment				$775
3) Distribution				$5,089
Total Annual O&M Cost				$6,350
Contingency (20%)				$1,270
Total Annual O&M Cost				**$7,620**
Present Worth of O&M Costs (25 year life)				**$181,867**
Present Worth of Total Costs				**$401,380**

Guidance Cost Analysis

10. Description of Proposed Construction:
Option 1: USMC housed at Finegayan Base, Navy Barrigada and AF Barrigada. Development of groundwater resources on DoD property. This option includes installation of 31 water supply wells; disinfection and flourination at well heads; a distribution system from the water supply wells to storage facilities, and an interconnect with the AAFB system.

Notes:
1. The area construction cost factor for Guam is based on Navy guidance.
2. The escalation factor for construction costs is 2.5% from ENR (May 2008).
3. The discount factor from Circular-94 Jan 2008 ranged from 2.3% (5-year) to 2.8% (30+years).
4. The construction period is assumed to be from 2010 to 2014.
5. Details are provided in Appendix E.

1. Component CAPITAL COSTS	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date APR 2010
3. Installation And Location/UIC N62813 MARINE CORPS BASE GUAM		4. Project Title GUAM POTABLE WATER STUDY		
5. Program Element OPTION 1 - OPTIMIZE GROUNDWATER RESOURCE DEVELOPMENT WITHIN DoD-ALT. 3	6. Category Code	7. Project Number	8. Project Cost ($000) $401,380	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
COST DETAILS				
CAPITAL COSTS				
1) Water Resources Development				
Well Installation/Construction Costs - 150-300 GPM Wells,				
Mobilization/Demobilization	LS	1	64,000	$64
Drill min. 17.25 in. dia. hole in unlithified and set outer temp. casing	ft	20	704	$14
Drill min. 17.25 in. dia. hole in bedrock	ft	490	512	$251
Furnish and install stainless steel, wire-wrapped screen, 10-in. pipe-size dia.	ft	40	512	$20
Furnish and install steel casing, 10-in. dia.	1	472	128	$60
Furnish and install gravel pack and sand seal	LS	1	25,600	$26
Set-up grouting equipment	LS	1	12,800	$13
Circulate bentonite	bags	200	64	$13
Grout annular space between 10.75-in. OD casing and 17.25-in. dia. borehole	bags	504	77	$39
Furnish and install development/test pump and appurtenances	LS	1	19,200	$19
Perform well development by pumping and surging	hr	24	768	$18
Perform step-drawdown well test	hr	8	576	$5
Perform aquifer performance test	hr	24	576	$14
Perform plumbness and alignment test	hr	1	3,840	$4
Televise well	LS	1	3,328	$3
Cost of seismic reflection study at wellsite	ea	1	25,600	$26
Total cost per well				$589
Total number of wells				16
Total cost of wells				$9,418
Well Installation/Construction Costs - 450 GPM Wells, 12"				
Mobilization/Demobilization	LS	1	76,800	$77
Drill min. 18-in. dia. hole in unlithified and set outer temp. casing	ft	20	704	$14
Drill min. 18-in. dia. hole in bedrock	ft	557	512	$285
Furnish and install stainless steel, wire-wrapped screen, 12-in. pipe-size dia.	ft	40	614	$25
Furnish and install steel casing, 12-in. dia.	1	539	166	$90
Furnish and install gravel pack and sand seal	LS	1	30,720	$31
Set-up grouting equipment	LS	1	12,800	$13
Circulate bentonite	bags	180	64	$12
Grout annular space between 12-in. dia. casing and 18-in. dia. borehole	bags	450	77	$35
Furnish and install development/test pump and appurtenances	LS	1	20,480	$20
Perform well development by pumping and surging	hr	24	768	$18
Perform step-drawdown well test	hr	8	640	$5
Perform aquifer performance test	hr	24	640	$15
Perform plumbness and alignment test	LS	1	4,480	$4
Televise well	LS	1	3,840	$4
Cost of seismic reflection study at wellsite	ea	1	25,600	$26

1. Component CAPITAL COSTS	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA				2. Date APR 2010
3. Installation And Location/UIC N62813 MARINE CORPS BASE GUAM		4. Project Title GUAM POTABLE WATER STUDY			
5. Program Element OPTION 1 - OPTIMIZE GROUNDWATER RESOURCE DEVELOPMENT WITHIN DoD-ALT. 3	6. Category Code	7. Project Number	8. Project Cost ($000) $401,380		

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Total cost per 450 GPM well				$673
Total number of 450 GPM wells				15
Total cost of 450 GPM wells				$10,099
Test Borings	ea.	22	276,480	$6,083
Monitoring Wells, 400 ft at $64/ft	ea	12	65,536	$786
Total Water Resources Development				**$26,385**
2) Water Treatment				
Chlorination and Flourination Equipment and Installation	ea.	1	3,653,186	$3,653
Total Water Treatment Cost				**$3,653**
3) Distribution				
Well Facilities				
250 gpm submersible pump with 50 hp motor	ea	16	153,600	$2,458
Discharge piping, valves, flow meter	ea	16	64,000	$1,024
Pump house	ea	16	512,000	$8,192
Security fence	ea	16	38,400	$614
Telemetry	ea	16	51,200	$819
Electrical service to site	ea	16	12,800	$205
300 gpm submersible pump with 75 hp motor	ea	0	179,200	$0
Discharge piping, valves, flow meter	ea	0	64,000	$0
Pump house	ea	0	512,000	$0
Security fence	ea	0	38,400	$0
Telemetry	ea	0	51,200	$0
Electrical service to site	ea	0	12,800	$0
450 gpm submersible pump with 100 hp motor	ea	15	192,000	$2,880
Discharge piping, valves, flow meter	ea	15	76,800	$1,152
Pump house	ea	15	512,000	$7,680
Security fence	ea	15	38,400	$576
Telemetry	ea	15	51,200	$768
Electrical service to site	ea	15	12,800	$192
Water Mains for New Wells				
At Finegayan				
8 inch Transmission Main				
Pipe and installation	ft	4700	154	$722
Restoration	ft	4700	26	$120

1. Component CAPITAL COSTS	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date APR 2010
3. Installation And Location/UIC N62813 MARINE CORPS BASE GUAM		4. Project Title GUAM POTABLE WATER STUDY		
5. Program Element OPTION 1 - OPTIMIZE GROUNDWATER RESOURCE DEVELOPMENT WITHIN DoD-ALT. 3	6. Category Code	7. Project Number	8. Project Cost ($000) $401,380	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Valves spaced at 500 ft	ea	9	16,640	$150
Hydrants spaced at 1,000 ft	ea	5	16,896	$84
12 inch Transmission Main				
Pipe and installation	ft	11100	179	$1,989
Restoration	ft	11100	26	$284
Valves spaced at 500 ft	ea	22	25,600	$563
Hydrants spaced at 1,000 ft	ea	11	16,896	$186
16 inch Transmission Main				
Pipe and installation	ft	5600	205	$1,147
Restoration	ft	5600	26	$143
Valves spaced at 500 ft	ea	11	46,080	$507
Hydrants spaced at 1,000 ft	ea	6	16,896	$101
20 inch Transmission Main				
Pipe and installation	ft	7000	256	$1,792
Restoration	ft	7000	38	$269
Valves spaced at 500 ft	ea	14	51,200	$717
Hydrants spaced at 1,000 ft	ea	7	16,896	$118
24 inch Transmission Main				
Pipe and installation	ft	14600	307	$4,485
Restoration	ft	14600	38	$561
Valves spaced at 500 ft	ea	29	56,320	$1,633
Hydrants spaced at 1,000 ft	ea	15	16,896	$253
30 inch Transmission Main				
Pipe and installation	ft	26600	384	$10,214
Restoration	ft	26600	38	$1,021
Valves spaced at 500 ft	ea	53	64,000	$3,392
Hydrants spaced at 1,000 ft	ea	27	16,896	$456
At Barrigada				
12 inch Transmission Main				
Pipe and installation	ft	14100	179	$2,527
Restoration	ft	14100	26	$361
Valves spaced at 500 ft	ea	28	25,600	$717
Hydrants spaced at 1,000 ft	ea	14	16,896	$237
16 inch Transmission Main				
Pipe and installation	ft	7900	205	$1,618

1. Component CAPITAL COSTS	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date APR 2010
3. Installation And Location/UIC N62813 MARINE CORPS BASE GUAM		4. Project Title GUAM POTABLE WATER STUDY		
5. Program Element OPTION 1 - OPTIMIZE GROUNDWATER RESOURCE DEVELOPMENT WITHIN DoD-ALT. 3	6. Category Code	7. Project Number	8. Project Cost ($000) $401,380	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Restoration	ft	7900	26	$202
Valves spaced at 500 ft	ea	16	46,080	$737
Hydrants spaced at 1,000 ft	ea	8	16,896	$135
24 inch Transmission Main to Barrigada Tank				
Pipe and installation	ft	2000	307	$614
Restoration	ft	2000	38	$77
Valves spaced at 500 ft	ea	4	56,320	$225
Hydrants spaced at 1,000 ft	ea	2	16,896	$34
Water Mains for connecting existing Navy wells at Finegayan to MCB System				
8 inch Transmission Main				
Pipe and installation	ft	21000	154	$3,226
Restoration	ft	21000	26	$538
Valves spaced at 500 ft	ea	42	16,640	$699
Hydrants spaced at 1,000 ft	ea	21	16,896	$355
12 inch Transmission Main				
Pipe and installation	ft	8500	179	$1,523
Restoration	ft	8500	26	$218
Valves spaced at 500 ft	ea	17	25,600	$435
Hydrants spaced at 1,000 ft	ea	9	16,896	$152
Standby Power - Generators -Central	ea	1	11,825,216	$11,825
Water Mains to AF Barrigada Tank				
NIW Between Barrigada Reservoir and Transmission Main to AF Barrigada				
30 inch Transmission Main				
Pipe and installation	ft	9100	384	$3,494
Restoration	ft	9100	38	$349
Valves spaced at 500 ft	ea	18	64,000	$1,152
Hydrants spaced at 1,000 ft	ea	9	16,896	$152
Flow control valve station	LS	1	512,000	$512
Transmission Main From Finegayan to Barrigada Tank				
24 inch Transmission Main				
Pipe and installation	ft	31000	307	$9,523
Restoration	ft	31000	38	$1,190
Valves spaced at 500 ft	ea	62	56,320	$3,492
Hydrants spaced at 1,000 ft	ea	31	16,896	$524

1. Component CAPITAL COSTS	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date APR 2010
3. Installation And Location/UIC N62813 MARINE CORPS BASE GUAM		4. Project Title GUAM POTABLE WATER STUDY		
5. Program Element OPTION 1 - OPTIMIZE GROUNDWATER RESOURCE DEVELOPMENT WITHIN DoD-ALT. 3	6. Category Code	7. Project Number	8. Project Cost ($000) $401,380	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Flow control valve station	LS	1	512,000	$512
Transmission Main from NIW to Housing Area				
24 inch Transmission Main				
Pipe and installation	ft	10000	307	$3,072
Restoration	ft	10000	38	$384
Valves spaced at 500 ft	ea	20	56,320	$1,126
Hydrants spaced at 1,000 ft	ea	10	16,896	$169
Flow control valve station	LS	1	512,000	$512
Water Storage				
At Finegayan				
Reinforce concrete reservoir	ea	1	13,926,400	$13,926
Telemetry	ea	1	58,027	$58
Site work	ea	1	290,133	$290
Electrical service to site	ea	1	14,507	$15
At AF Barrigada Housing				
Water Tank - 1 MG				
Water tower	ea	1	4,864,000	$4,864
Telemetry	ea	1	51,200	$51
Site work	ea	1	51,200	$51
Electrical service to site	ea	1	12,800	$13
Repair to Leaking Barrigada 3 MG Reservoir (extent of damage unknown)	ls	1	128,000	$128
AAFB Interconnect (Raw water to MCB WTP)				
16- inch Transmission Main				
Pipe and installation	ft	6000	205	$1,229
Restoration	ft	6000	51	$307
Valves	ea	3	46,080	$138
Hydrants spaced at 1,000 ft	ea	6	16,896	$101
Connection to existing pipe	ea	1	12,800	$13
Flow meter at WTP	ea	1	25,600	$26
Total Distribution Cost				**$131,299**

1. Component CAPITAL COSTS	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date APR 2010
3. Installation And Location/UIC N62813 MARINE CORPS BASE GUAM		4. Project Title GUAM POTABLE WATER STUDY		
5. Program Element OPTION 1 - OPTIMIZE GROUNDWATER RESOURCE DEVELOPMENT WITHIN DoD-ALT. 3	6. Category Code	7. Project Number	8. Project Cost ($000) $401,380	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Total Construction Cost				$161,337
Contingencies (20%)				$32,267
Engineering (15%)				$24,201
2008 Construction Costs				**$217,805**
2012 Construction Costs (2.5% Escalation)				**$240,416**
Present Worth Guam Construction Costs (2.3% discount)				**$219,513**

1. Component O&M COSTS	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date APR 2010
3. Installation And Location/UIC N62813 MARINE CORPS BASE GUAM		4. Project Title GUAM POTABLE WATER STUDY		
5. Program Element OPTION 1 - OPTIMIZE GROUNDWATER RESOURCE DEVELOPMENT WITHIN DoD-ALT. 3	6. Category Code	7. Project Number	8. Project Cost ($000) $401,380	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
O&M COSTS				
1) Water Resources Development				
Annual Maintenance Cost for Supply Wells (well cleaning)	ea	33	12,000	$396
Annual Labor Cost for Sampling MW ($25/hr with a 2.7 multiplier)	hr	1344	68	$91
Total Water Resources Development				**$487**
2) Water Treatment				
Power, Chemicals and Maintenance	yr	1	774,700.00	$774.7
Total Water Treatment				**$775**
3) Distribution				
Annual Electric costs				
Water pumps	kw-h	10924777	0.20	$2,185
Annual Pump replacement costs				
Replace Well pumps				
Pull pump from well every 10 years	ea	33	5,000	$165
Inspect and replace every 10 years	ea	33	75,000	$2,475
Annual Cost Replace Well pumps	ea	33	8,000	$264
Total Water Distribution				**$5,089**
Total Annual Cost				$6,350
Contingency (20%)				$1,270
Total Annual O&M Cost				$7,620
2008 O&M Cost (25 year life)				**$190,511**
Future O&M Costs (2015 to 2039)				**$309,412**
Present Worth of O&M Costs (2.4 to 2.8% Discounts)				**$181,867**

Appendix C.2
Calculations

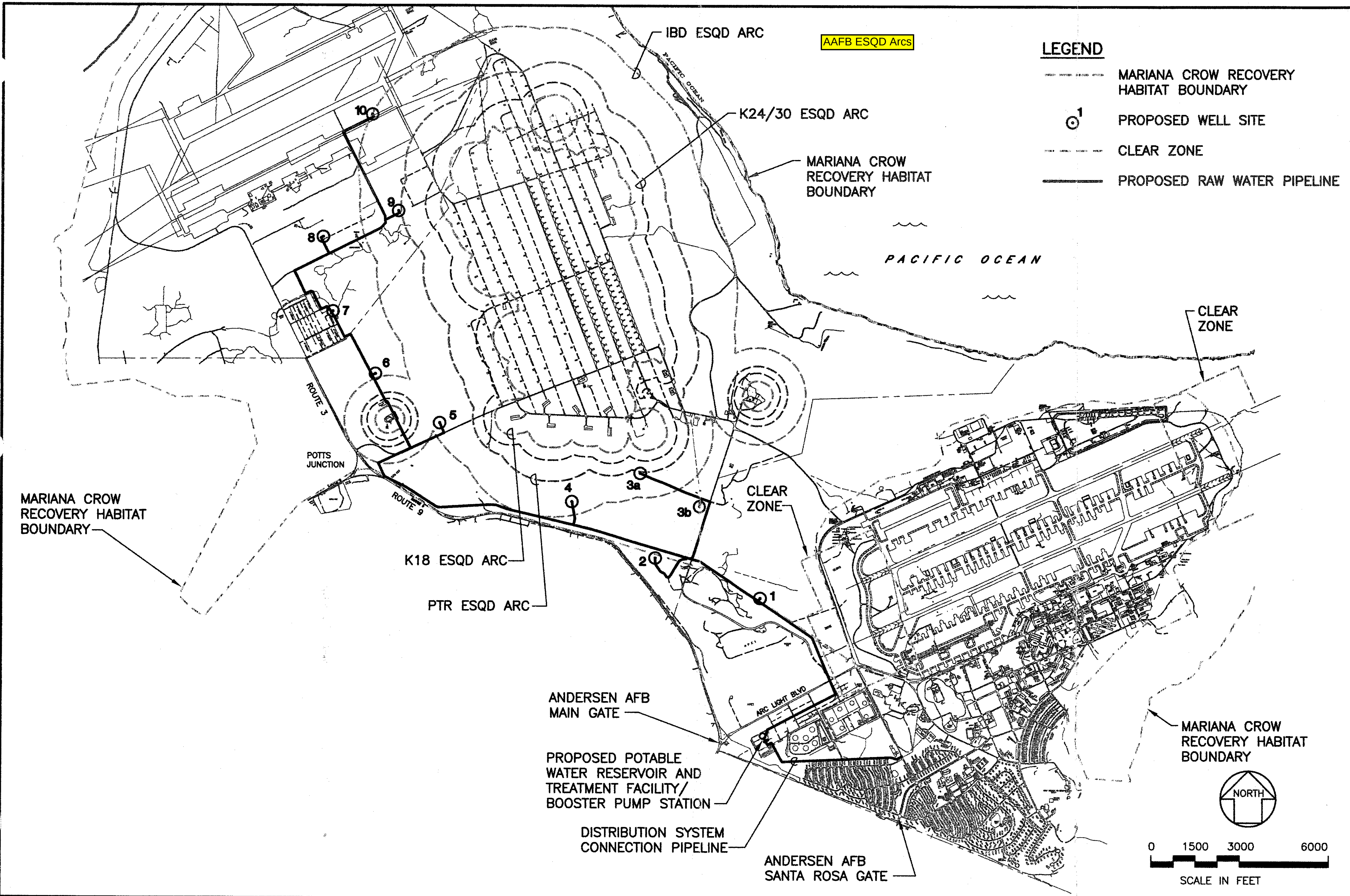


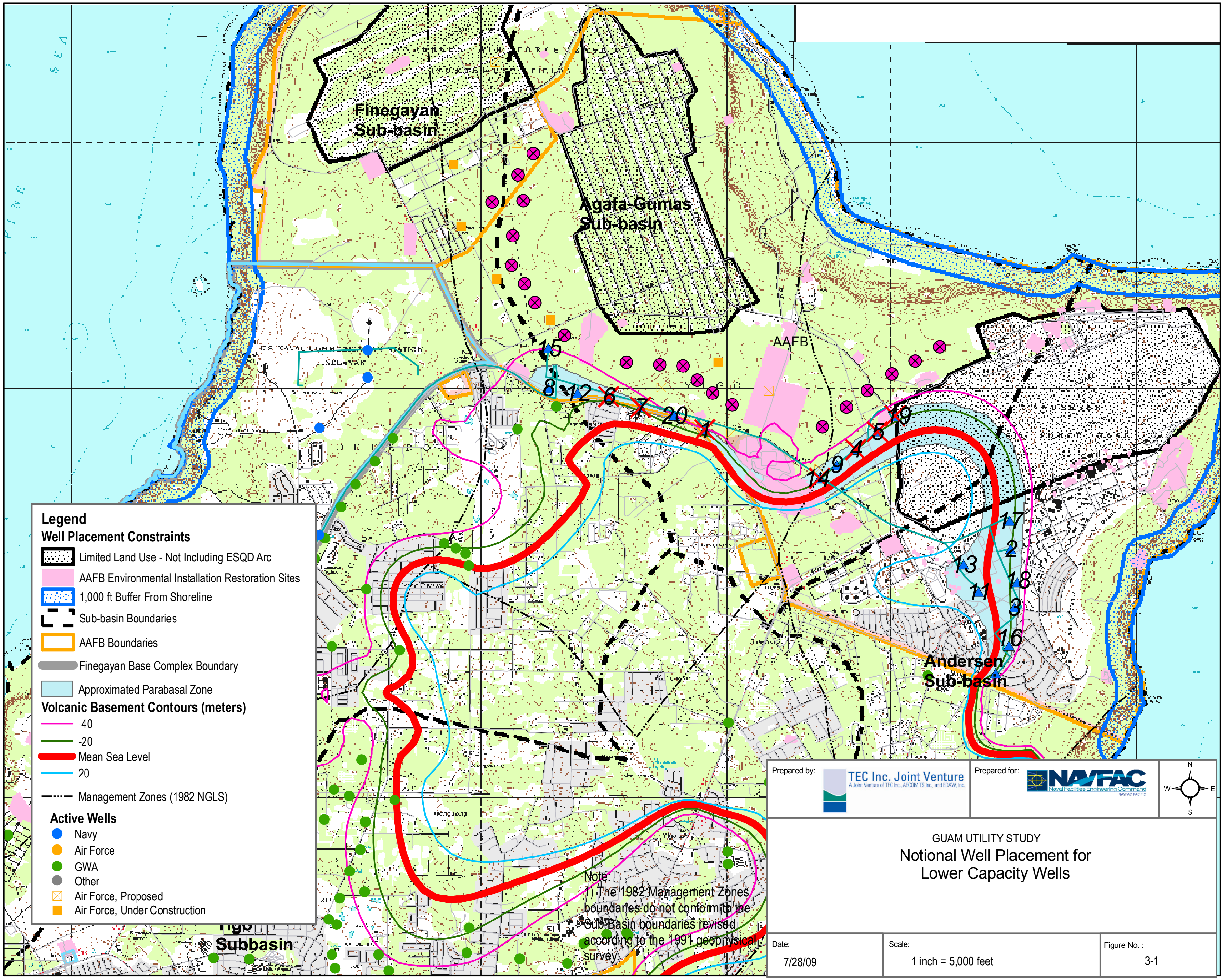
FIGURE 4-6

PROPOSED AAFB WATER SUPPLY, TRANSMISSION, AND STORAGE SITE PLAN

FY03 MCAF REPLACE OFF-BASE WATER SUPPLY SYSTEM
GUAM
ANDERSEN AIR FORCE BASE

Hawaii Pacific Engineers

DATE: 7/16/03
SCALE: 1 = 1 (1"=3000')
FILE: 2002004-46
PM: FTH
OPER: AK
REVISED: 7/28/03


Finegayan Sub-basin
Agafa-Gumas Sub-basin
AAFB
Andersen Sub-basin
Subbasin
15
8
12
6
7
20
1
5
4
9
14
19
17
2
13
11
18
3
16
Legend
Well Placement Constraints
Limited Land Use - Not Including ESQD Arc
AAFB Environmental Installation Restoration Sites
1,000 ft Buffer From Shoreline
Sub-basin Boundaries
AAFB Boundaries
Finegayan Base Complex Boundary
Approximated Parabasal Zone
Volcanic Basement Contours (meters)
-40
-20
Mean Sea Level
20
Management Zones (1982 NGLS)
Active Wells
Navy
Air Force
GWA
Other
Air Force, Proposed
Air Force, Under Construction
Note:
1) The 1982 Management Zones boundaries do not conform to the Sub-Basin boundaries revised according to the 1991 geophysical survey.
Prepared by:
TEC Inc. Joint Venture
Prepared for:
NAVFAC
Naval Facilities Engineering Command
N
E
S
W
GUAM UTILITY STUDY
Notional Well Placement for Lower Capacity Wells
Date:
7/28/09
Scale:
1 inch = 5,000 feet
Figure No. :
3-1

								Feb. 2008 Population Increases						*Total 2019*
Project Relation	**Location**	**Population Type**	**Baseline**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**Total**
USMC Relocation Alt 1	Finegayan	Active duty	33	535	1,220	1,220	1,220	8,602	9,182	9,182	9,182	9,182	9,182	9,215
USMC Relocation Alt 1	Finegayan	Dependents	52	537	1,231	1,231	1,231	9,000	9,950	9,950	9,950	9,950	9,950	10,002
USMC Relocation Alt 1	Finegayan	Transient	0	0	400	400	400	2,000	2,000	2,000	2,000	2,000	2,000	2,000
USMC Relocation Alt 1	Finegayan	Civilian Work Force	12	102	244	244	244	1,720	1,836	1,836	1,836	1,836	1,836	1,848
		Finegayan Total	**97**	**1,174**	**3,095**	**3,095**	**3,095**	**21,322**	**22,968**	**22,968**	**22,968**	**22,968**	**22,968**	**23,065**
USMC Relocation Alt 3/8	Finegayan	Active duty	33	395	884	884	884	6,239	6,659	6,659	6,659	6,659	6,659	6,692
USMC Relocation Alt 3/8	Finegayan	Dependents	52	179	410	410	410	3,000	3,317	3,317	3,317	3,317	3,317	3,369
USMC Relocation Alt 3/8	Finegayan	Commuters from Barrigada	0	140	335	335	335	2,364	2,523	2,523	2,523	2,523	2,523	2,523
USMC Relocation Alt 3/8	Finegayan	Transient	0	0	400	400	400	2,000	2,000	2,000	2,000	2,000	2,000	2,000
USMC Relocation Alt 3/8	Finegayan	Civilian Work Force	12	92	220	220	220	1,548	1,653	1,653	1,653	1,653	1,653	1,665
		Finegayan Total	**97**	**806**	**2,249**	**2,249**	**2,249**	**15,151**	**16,152**	**16,152**	**16,152**	**16,152**	**16,152**	**16,249**
USMC Relocation Alt 3/8	Barrigada	Active duty	0	140	335	335	335	2,364	2,523	2,523	2,523	2,523	2,523	2,523
USMC Relocation Alt 3/8	Barrigada	Dependents	0	358	821	821	821	6,000	6,633	6,633	6,633	6,633	6,633	6,633
USMC Relocation Alt 3/8	Barrigada	Transient	0	0	0	0	0	0	0	0	0	0	0	0
USMC Relocation Alt 3/8	Barrigada	Civilian Work Force	0	10	24	24	24	172	184	184	184	184	184	184
		Barrigada Total	**0**	**508**	**1,180**	**1,180**	**1,180**	**8,536**	**9,340**	**9,340**	**9,340**	**9,340**	**9,340**	**9,340**
non-USMC Relocation	Andersen AFB	Active duty	2,145	80	80	80	80	120	120	120	120	120	120	2,265
non-USMC Relocation	Andersen AFB	Dependents	2,950	118	118	118	118	210	210	210	210	210	210	3,160
non-USMC Relocation	Andersen AFB	Transient	0	900	900	1,256	1,256	1,256	1,256	1,256	1,256	1,256	1,780	1,780
non-USMC Relocation	Andersen AFB	Civilian Work Force	805	17	17	17	17	25	25	25	25	25	25	830
		Andersen AFB Total	**5,900**	**1,115**	**1,115**	**1,471**	**1,471**	**1,611**	**1,611**	**1,611**	**1,611**	**1,611**	**2,135**	**8,035**
non-USMC Relocation	Remaining Navy	Active duty	4,490	0	0	0	50	50	130	130	130	130	330	4,820
non-USMC Relocation	Remaining Navy	Dependents	5,410	0	0	0	30	30	80	80	80	80	80	5,490
non-USMC Relocation	Remaining Navy	Transient	0	0	0	0	0	0	0	0	0	0	0	0
non-USMC Relocation	Remaining Navy	Civilian Work Force	1,684	0	0	0	10	10	13	13	13	13	20	1,704
		Remaining Navy Total	**11,584**	**0**	**0**	**0**	**90**	**90**	**223**	**223**	**223**	**223**	**430**	**12,014**

Notes:

1. CVN 7222 transients not included in water demand since housed on ships.
2. Civilian Work Force does not include construction workers
3. Finegayan transients for Alternative 3/8 include USMC commuting from Barrigada.

		Population Increases Re-organized													*Total 2019*
Project Relation	**Location**	**Population Type**	**Baseline**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**		**Total**
USMC Relocation Alt 1	Finegayan	Family Housing	73	752	1,723	1,723	1,723	12,600	13,930	13,930	13,930	13,930	13,930		14,003
USMC Relocation Alt 1	Finegayan	Unaccompanied Resident	12	320	728	728	728	5,002	5,202	5,202	5,202	5,202	5,202		5,214
USMC Relocation Alt 1	Finegayan	Transient	0	0	400	400	400	2,000	2,000	2,000	2,000	2,000	2,000		2,000
USMC Relocation Alt 1	Finegayan	Civilian Work Force	12	102	244	244	244	1,720	1,836	1,836	1,836	1,836	1,836		1,848
		Finegayan Total	**97**	**1,174**	**3,095**	**3,095**	**3,095**	**21,322**	**22,968**	**22,968**	**22,968**	**22,968**	**22,968**		**23,065**
USMC Relocation Alt 3/8	Finegayan	Family Housing	73	251	574	574	574	4,200	4,644	4,644	4,644	4,644	4,644		4,717
USMC Relocation Alt 3/8	Finegayan	Unaccompanied Resident	12	323	720	720	720	5,039	5,332	5,332	5,332	5,332	5,332		5,344
USMC Relocation Alt 3/8	Finegayan	Transient	0	140	735	735	735	4,364	4,523	4,523	4,523	4,523	4,523		4,523
USMC Relocation Alt 3/8	Finegayan	Civilian Work Force	12	92	220	220	220	1,548	1,653	1,653	1,653	1,653	1,653		1,665
		Finegayan Total	**97**	**806**	**2,249**	**2,249**	**2,249**	**15,151**	**16,152**	**16,152**	**16,152**	**16,152**	**16,152**		**16,249**
USMC Relocation Alt 3/8	Barrigada	Family Housing	0	498	1,156	1,156	1,156	8,364	9,156	9,156	9,156	9,156	9,156		9,156
USMC Relocation Alt 3/8	Barrigada	Unaccompanied Resident	0	0	0	0	0	0	0	0	0	0	0		0
USMC Relocation Alt 3/8	Barrigada	Transient	0	0	0	0	0	0	0	0	0	0	0		0
USMC Relocation Alt 3/8	Barrigada	Civilian Work Force	0	10	24	24	24	172	184	184	184	184	184		184
		Barrigada Total	**0**	**508**	**1,180**	**1,180**	**1,180**	**8,536**	**9,340**	**9,340**	**9,340**	**9,340**	**9,340**		**9,340**
non-USMC Relocation	Andersen AFB	Family Housing	4,130	165	165	165	165	294	294	294	294	294	294		4,424
non-USMC Relocation	Andersen AFB	Unaccompanied Resident	965	33	33	33	33	36	36	36	36	36	36		1,001
non-USMC Relocation	Andersen AFB	Transient	0	900	900	1,256	1,256	1,256	1,256	1,256	1,256	1,256	1,780		1,780
non-USMC Relocation	Andersen AFB	Civilian Work Force	805	17	17	17	17	25	25	25	25	25	25		830
		Andersen AFB Total	**5,900**	**1,115**	**1,115**	**1,471**	**1,471**	**1,611**	**1,611**	**1,611**	**1,611**	**1,611**	**2,135**		**8,035**
non-USMC Relocation	Remaining Navy	Family Housing	7,574	0	0	0	42	42	112	112	112	112	112		7,686
non-USMC Relocation	Remaining Navy	Unaccompanied Resident	2,326	0	0	0	38	38	98	98	98	98	298		2,624
non-USMC Relocation	Remaining Navy	Transient	0	0	0	0	0	0	0	0	0	0	0		0
non-USMC Relocation	Remaining Navy	Civilian Work Force	1,684	0	0	0	10	10	13	13	13	13	20		1,704
		Remaining Navy Total	**11,584**	**0**	**0**	**0**	**90**	**90**	**223**	**223**	**223**	**223**	**430**		**12,014**

Total Populations

Project Relation	Location	Population Type	Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
USMC Relocation Alt 1	Finegayan	Family Housing	73	825	1,796	1,796	1,796	12,673	14,003	14,003	14,003	14,003	14,003
USMC Relocation Alt 1	Finegayan	Unaccompanied Resident	12	332	740	740	740	5,014	5,214	5,214	5,214	5,214	5,214
USMC Relocation Alt 1	Finegayan	Transient	0	0	400	400	400	2,000	2,000	2,000	2,000	2,000	2,000
USMC Relocation Alt 1	Finegayan	Civilian Work Force (on base)	12	114	256	256	256	1,732	1,848	1,848	1,848	1,848	1,848
		Finegayan Total	**97**	**1,271**	**3,192**	**3,192**	**3,192**	**21,419**	**23,065**	**23,065**	**23,065**	**23,065**	**23,065**
USMC Relocation Alt 3/8	Finegayan	Family Housing	73	323	647	647	647	4,273	4,717	4,717	4,717	4,717	4,717
USMC Relocation Alt 3/8	Finegayan	Unaccompanied Resident	12	336	732	732	732	5,051	5,344	5,344	5,344	5,344	5,344
USMC Relocation Alt 3/8	Finegayan	Transient	0	140	735	735	735	4,364	4,523	4,523	4,523	4,523	4,523
USMC Relocation Alt 3/8	Finegayan	Civilian Work Force	12	104	232	232	232	1,560	1,665	1,665	1,665	1,665	1,665
		Finegayan Total	**97**	**903**	**2,346**	**2,346**	**2,346**	**15,248**	**16,249**	**16,249**	**16,249**	**16,249**	**16,249**
USMC Relocation Alt 3/8	Barrigada	Family Housing	0	498	1,156	1,156	1,156	8,364	9,156	9,156	9,156	9,156	9,156
USMC Relocation Alt 3/8	Barrigada	Unaccompanied Resident	0	0	0	0	0	0	0	0	0	0	0
USMC Relocation Alt 3/8	Barrigada	Transient	0	0	0	0	0	0	0	0	0	0	0
USMC Relocation Alt 3/8	Barrigada	Civilian Work Force	0	10	24	24	24	172	184	184	184	184	184
		Barrigada Total	**0**	**508**	**1,180**	**1,180**	**1,180**	**8,536**	**9,340**	**9,340**	**9,340**	**9,340**	**9,340**
non-USMC Relocation	Andersen AFB	Family Housing	4,130	4,295	4,295	4,295	4,295	4,424	4,424	4,424	4,424	4,424	4,424
non-USMC Relocation	Andersen AFB	Unaccompanied Resident	965	998	998	998	998	1,001	1,001	1,001	1,001	1,001	1,001
non-USMC Relocation	Andersen AFB	Transient	0	900	900	1,256	1,256	1,256	1,256	1,256	1,256	1,256	1,780
non-USMC Relocation	Andersen AFB	Civilian Work Force	805	822	822	822	822	830	830	830	830	830	830
		Andersen AFB Total	**5,900**	**7,015**	**7,015**	**7,371**	**7,371**	**7,511**	**7,511**	**7,511**	**7,511**	**7,511**	**8,035**
non-USMC Relocation	Remaining Navy	Family Housing	7,574	7,574	7,574	7,574	7,616	7,616	7,686	7,686	7,686	7,686	7,686
non-USMC Relocation	Remaining Navy	Unaccompanied Resident	2,326	2,326	2,326	2,326	2,364	2,364	2,424	2,424	2,424	2,424	2,624
non-USMC Relocation	Remaining Navy	Transient	0	0	0	0	0	0	0	0	0	0	0
non-USMC Relocation	Remaining Navy	Civilian Work Force	1,684	1,684	1,684	1,684	1,694	1,694	1,697	1,697	1,697	1,697	1,704
		Remaining Navy Total	**11,584**	**11,584**	**11,584**	**11,584**	**11,674**	**11,674**	**11,807**	**11,807**	**11,807**	**11,807**	**12,014**

Average Daily Domestic Demand (gpd)

Location	Population Type	Require-ments (gpcd)	Additional for CVN et al (gpd)	Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019 Growth Factor	Sustain-abilty Factor	2019
Alt. 1 Finegayan	Family Housing	180		13,104	148,428	323,316	323,316	323,316	2,281,104	2,520,504	2,520,504	2,520,504	2,520,504			3,150,630
Alt. 1 Finegayan	Unaccompanied Resident	155		1,891	51,522	114,669	114,669	114,669	777,201	808,201	808,201	808,201	808,201			1,010,251
Alt. 1 Finegayan	Transient	70		0	0	28,000	28,000	28,000	140,000	140,000	140,000	140,000	140,000			175,000
Alt. 1 Finegayan	Civilian Work Force	45		540	5,130	11,520	11,520	11,520	77,940	83,160	83,160	83,160	83,160			103,950
	Finegayan Total			**15,535**	**205,080**	**477,505**	**477,505**	**477,505**	**3,276,245**	**3,551,865**	**3,551,865**	**3,551,865**	**3,551,865**	**1.25**	**0%**	**4,439,831**
Alt. 3/8 Finegayan	Family Housing	180		13,104	58,212	116,424	116,424	116,424	769,104	848,988	848,988	848,988	848,988			1,061,235
Alt. 3/8 Finegayan	Unaccompanied Resident	155		1,891	52,018	113,491	113,491	113,491	782,936	828,382	828,382	828,382	828,382			1,035,478
Alt. 3/8 Finegayan	Transient	70		0	9,800	51,450	51,450	51,450	305,480	316,610	316,610	316,610	316,610			395,763
Alt. 3/8 Finegayan	Civilian Work Force	45		540	4,680	10,440	10,440	10,440	70,200	74,925	74,925	74,925	74,925			93,656
	Finegayan Total			**15,535**	**124,710**	**291,805**	**291,805**	**291,805**	**1,927,720**	**2,068,905**	**2,068,905**	**2,068,905**	**2,068,905**	**1.25**	**0%**	**2,586,131**
Alt. 3/8 Barrigada	Family Housing	180		0	89,640	208,080	208,080	208,080	1,505,520	1,648,080	1,648,080	1,648,080	1,648,080			2,060,100
Alt. 3/8 Barrigada	Unaccompanied Resident	155		0	0	0	0	0	0	0	0	0	0			0
Alt. 3/8 Barrigada	Transient	70		0	0	0	0	0	0	0	0	0	0			0
Alt. 3/8 Barrigada	Civilian Work Force	45		0	450	1,080	1,080	1,080	7,740	8,280	8,280	8,280	8,280			10,350
	Barrigada Total			**0**	**90,090**	**209,160**	**209,160**	**209,160**	**1,513,260**	**1,656,360**	**1,656,360**	**1,656,360**	**1,656,360**	**1.25**	**0%**	**2,070,450**
Andersen AFB	Family Housing	180		743,400	773,136	773,136	773,136	773,136	796,320	796,320	796,320	796,320	796,320			995,400
Andersen AFB	Unaccompanied Resident	155		149,575	154,659	154,659	154,659	154,659	155,155	155,155	155,155	155,155	155,155			193,944
Andersen AFB	Transient	70		0	63,000	63,000	87,920	87,920	87,920	87,920	87,920	87,920	87,920			155,750
Andersen AFB	Civilian Work Force	45		36,225	36,990	36,990	36,990	36,990	37,350	37,350	37,350	37,350	37,350			46,688
	Andersen AFB Total			**929,200**	**1,027,785**	**1,027,785**	**1,052,705**	**1,052,705**	**1,076,745**	**1,076,745**	**1,076,745**	**1,076,745**	**1,076,745**	**1.25**	**0%**	**1,391,781**
Remaining Navy	Family Housing	180		1,363,320	1,363,320	1,363,320	1,363,320	1,370,880	1,370,880	1,383,480	1,383,480	1,383,480	1,383,480			1,729,350
Remaining Navy	Unaccompanied Resident	155		360,530	360,530	360,530	360,530	366,420	366,420	375,720	375,720	375,720	375,720			508,400
Remaining Navy	Transient	70	443,800	0	0	0	0	0	0	443,800	443,800	443,800	443,800			443,800
Remaining Navy	Civilian Work Force	45		75,780	75,780	75,780	75,780	76,230	76,230	76,359	76,359	76,359	76,359			95,850
	Apra Harbor Total			**1,799,630**	**1,799,630**	**1,799,630**	**1,799,630**	**1,813,530**	**1,813,530**	**2,279,359**	**2,279,359**	**2,279,359**	**2,279,359**	**1.25**	**0%**	**2,777,400**

Notes:

1. Growth Factor is only applied for 2019

Average Daily Domestic Demand (mgd)

Population Type		Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Project Alt 1	Finegayan	0.02	0.21	0.48	0.48	0.48	3.28	3.55	3.55	3.55	3.55	4.44
Project Alt 3/8	Finegayan	0.02	0.12	0.29	0.29	0.29	1.93	2.07	2.07	2.07	2.07	2.59
Project Alt 3/8	Barrigada	0.00	0.09	0.21	0.21	0.21	1.51	1.66	1.66	1.66	1.66	2.07
Non-Project	Andersen AFB	0.93	1.03	1.03	1.05	1.05	1.08	1.08	1.08	1.08	1.08	1.39
Non-Project	Remaining Navy	1.80	1.80	1.80	1.80	1.81	1.81	2.28	2.28	2.28	2.28	2.78

Industrial Daily Demands (mgd)

Population Type		Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Project Alt 1	Finegayan	0.10	0.10	0.48	0.85	1.23	1.23	1.23	1.23	1.23	1.23	1.23
Project Alt 3/8	Finegayan	0.10	0.10	0.46	0.82	1.17	1.17	1.17	1.17	1.17	1.17	1.17
Project Alt 3/8	Barrigada	0.00	0.00	0.02	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Non-Project	Andersen AFB	0.76	0.76	0.84	0.92	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Non-Project	Remaining Navy	3.80	3.80	4.06	4.33	4.60	4.60	4.60	4.60	4.60	4.60	4.60

Notes:

1. Barrigada industrial demands unrelated to the USMC relocation are included in the Remaining Navy estimates.

Average Daily Unaccounted For Water - UFW (mgd)

Population Type		Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Project Alt 1	Finegayan	0.02	0.02	0.05	0.07	0.09	0.23	0.24	0.24	0.24	0.24	0.28
Project Alt 3/8	Finegayan	0.02	0.01	0.04	0.06	0.07	0.16	0.16	0.16	0.16	0.16	0.19
Project Alt 3/8	Barrigada	0.00	0.00	0.01	0.01	0.01	0.08	0.09	0.09	0.09	0.09	0.11
Non-Project	Andersen AFB	0.84	0.89	0.93	0.98	1.02	1.04	1.04	1.04	1.04	1.04	1.19
Non-Project	Remaining Navy	1.95	1.95	1.99	2.03	2.07	2.07	2.14	2.14	2.14	2.14	2.21

Notes:

1. New systems with extensive metering and new technology are expected to reduce system leakage losses from standard 15% to 5% at USMC Relocation Areas
2. Improvements to the current systems are expected to reduce system leakage losses on new sources to the standard 15%.
3. Existing UFW from Barrigada are included in the Remaining Navy estimates.

Average Daily Demand (mgd)

Population Type		Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Project Alt 1	Finegayan	0.13	0.32	1.00	1.40	1.79	4.73	5.02	5.02	5.02	5.02	5.95
Project Alt 3/8	Finegayan	0.13	0.24	0.79	1.16	1.54	3.26	3.40	3.40	3.40	3.40	3.95
Project Alt 3/8	Barrigada	0.00	0.09	0.24	0.26	0.28	1.65	1.80	1.80	1.80	1.80	2.23
Non-Project	Andersen AFB	2.14	2.29	2.41	2.56	2.68	2.71	2.71	2.71	2.71	2.71	3.19
Non-Project	Remaining Navy	8.10	8.10	8.41	8.71	9.03	9.03	9.57	9.57	9.57	9.57	10.14

UFC Based Average Daily Demand (mgd)

Non-Project	Andersen AFB	2.53	2.68	2.80	2.95	3.07	3.11	3.11	3.11	3.11	3.11	3.58
Non-Project	Remaining Navy	7.55	7.55	7.85	8.16	8.48	8.48	9.01	9.01	9.01	9.01	9.59

UFC Based Average Daily Demand (mgd) Addition over Baseline

Non-Project	Andersen AFB	0.00	0.15	0.27	0.42	0.54	0.57	0.57	0.57	0.57	0.57	1.05
Non-Project	Remaining Navy	0.00	0.00	0.31	0.61	0.93	0.93	1.47	1.47	1.47	1.47	2.04

Maximum Day Factor - Coefficient K (mgd)

Population Type		Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Project Alt 1	Finegayan	2.25	2.25	2.25	2.25	2.25	2.00	2.00	2.00	2.00	2.00	2.00
Project Alt 3/8	Finegayan	2.25	2.25	2.25	2.25	2.25	2.00	2.00	2.00	2.00	2.00	2.00
Project Alt 3/8	Barrigada	2.25	2.25	2.25	2.25	2.25	2.00	2.00	2.00	2.00	2.00	2.00
Non-Project	Andersen AFB	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Non-Project	Apra Harbor	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00

Maximum Daily Domestic Demand (mgd)

Population Type		Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Project Alt 1	Finegayan	0.03	0.46	1.07	1.07	1.07	6.55	7.10	7.10	7.10	7.10	8.88
Project Alt 3/8	Finegayan	0.03	0.28	0.66	0.66	0.66	3.86	4.14	4.14	4.14	4.14	5.17
Project Alt 3/8	Barrigada	0.00	0.20	0.47	0.47	0.47	3.03	3.31	3.31	3.31	3.31	4.14
Non-Project	Andersen AFB	1.86	2.06	2.06	2.11	2.11	2.15	2.15	2.15	2.15	2.15	2.78
Non-Project	Remaining Navy	3.60	3.60	3.60	3.60	3.63	3.63	4.56	4.56	4.56	4.56	5.55

Maximum Daily UFW (mgd)

Population Type		Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Project Alt 1	Finegayan	0.02	0.03	0.08	0.10	0.12	0.39	0.42	0.42	0.42	0.42	0.51
Project Alt 3/8	Finegayan	0.02	0.02	0.06	0.07	0.09	0.25	0.27	0.27	0.27	0.27	0.32
Project Alt 3/8	Barrigada	0.00	0.01	0.02	0.03	0.03	0.15	0.17	0.17	0.17	0.17	0.21
Non-Project	Andersen AFB	1.31	1.41	1.45	1.51	1.55	1.57	1.57	1.57	1.57	1.57	1.89
Non-Project	Remaining Navy	1.95	1.95	1.99	2.03	2.07	2.07	2.21	2.21	2.21	2.21	2.36

Notes:

1. New systems with extensive metering and new technology are expected to reduce system leakage losses from standard 15% to 5% at USMC Relocation Areas
2. Improvements to the current systems are expected to reduce system leakage losses on new sources to the standard 15%.
3. Existing UFW from Barrigada are included in the Remaining Navy estimates.

Maximum Daily Demand (mgd)

Population Type		Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Project Alt 1	Finegayan	0.16	0.59	1.63	2.02	2.42	8.17	8.75	8.75	8.75	8.75	10.6
Project Alt 3/8	Finegayan	0.16	0.40	1.17	1.55	1.92	5.28	5.58	5.58	5.58	5.58	6.7
Project Alt 3/8	Barrigada	0.00	0.21	0.51	0.53	0.55	3.24	3.54	3.54	3.54	3.54	4.4
Non-Project	Andersen AFB	3.14	3.44	3.55	3.75	3.86	3.94	3.94	3.94	3.94	3.94	4.88
Non-Project	Remaining Navy	9.82	9.82	10.13	10.43	10.77	10.77	11.84	11.84	11.84	11.84	12.98

UFC Based Maximum Daily Demand (mgd)

Non-Project	Andersen AFB	3.93	4.22	4.34	4.53	4.65	4.72	4.72	4.72	4.72	4.72	5.7
Non-Project	Remaining Navy	9.35	9.35	9.65	9.96	10.29	10.29	11.37	11.37	11.37	11.37	12.5

UFC Based Maximum Daily Demand (mgd) Addition over Baseline

Non-Project	Andersen AFB	0.00	0.30	0.41	0.61	0.72	0.80	0.80	0.80	0.80	0.80	1.74
Non-Project	Remaining Navy	0.00	0.00	0.31	0.61	0.95	0.95	2.02	2.02	2.02	2.02	3.17

Population Type		Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
AF Average Daily Demand (mgd) - Based on Billing 10/09-4/10							1,426,859	gpd				
Average Daily Domestic Demand		666,859										
UFW	50%	713,429										
AF Average Daily Demand (mgd)		2.14										
Navy Average Daily Demand (mgd) - Based on Avg. Production							11.7	mgd				
Average Daily Domestic Demand		1.38				GWA	3.60					
						UFW 25%	2.93					
AF Average Daily Demand (mgd)		8.10				Industrial	3.80					
AF Maximum Daily Demand (mgd) - Based on Billing 10/09-4/10												
Maximum Daily Domestic Demand		1,333,717										
UFW	50%	1,046,859										
AF Maximum Daily Demand (mgd)		3.14										
Navy Average Daily Demand (mgd) - Based on Avg. Production												
Maximum Daily Domestic Demand		2.75										
UFW	25%	3.27										
AF Maximum Daily Demand (mgd)		9.82										

	Alt 1	Alt 3	Alt 3			Alt 3
Storage Requirements 2019	Finegayan	Finegayan	N Barr	AAFB	Navy	AF Barr
Maximum Fire Demand (gpm) from JGMMP	7,500	7,500	1,125	7,500	3,000	1,125
Duration (min)	150	150	90	150	150	90
Fire Demand Storage (gal)	1,125,000	1,125,000	101,250	1,125,000	450,000	101,250
Avg Daily Demand (mgd)	6.0	3.9	2.3	3.2	10.1	1.1
50% Avg Daily Use (gpd)	2,975,940	1,973,903	1,156,570	1,593,667	5,070,344	571,378
1 hour of Average Daily Use (gal)	247,995	164,492	96,381	132,806	422,529	47,615
Minimum Storage Required (gal)	4,348,935	3,263,395	1,354,200	2,851,472	5,942,873	720,242
Minimum Storage Required (mg)	**4.3**	**3.3**	**1.4**	**2.9**	**5.9**	**0.7**

Ind N Barr	1167765	gpd
Ind AF Barr	53113.3	gpd
UFW	5%	

Storage Requirements 2010	Finegayan	AAFB	Navy
Maximum Fire Demand (gpm) from JGMMP	7,500	7,500	3,000
Duration (min)	150	150	150
Fire Demand Storage (gal)	1,125,000	1,125,000	450,000
Avg Daily Demand (mgd)	0.1	2.1	8.1
50% Avg Daily Use (gpd)	66,433	1,070,144	4,050,000
1 hour of Average Daily Use (gal)	5,536	89,179	337,500
Minimum Storage Required (gal)	1,196,969	2,284,323	4,837,500
Minimum Storage Required (mg)	**1.2**	**2.3**	**4.8**

Appendix C.3
Meeting Minutes

DRAFT
MEETING NOTES
GUAM WATERWORKS AUTHORITY (GWA)
PROJECT COMMENCEMENT

Date: June 10th, 2009

Location: Guam Water Authority Office - Engineering Department Building

Time: 0900 Local Time

I. Staff Attendance

- ♦ The following staff attended:
  - AECOM/Earth Tech: Claire Hunt, Yang Ma
  - GWA: Julie Shane, Brett Railey
  - NAFAC Pacific: Kevin Oshiro
  - NAFAC Mariana: Jack Brown, Paul Owen

II. Purpose

- The purpose of the meeting is to obtain information on the GWA water and wastewater facilities that could support the planned DoD expansion. The focus of the Barrigada water and wastewater utilities study is to develop utility options for the Marine Corps Relocation alternatives to the Barrigada area. The selected alternatives would then be included in the EIS document.

Wastewater

III. Possible Impacts on GWA Sewer System

- Barrigada Cantonment Alternatives will trigger future Guam civilian as well as the project induced civilian population to locate within central sewer basin instead of prior assumed northern basin, especially along Rt15 between Barrigada and Dededo.
- GWA is not in position to give anticipated population distribution due to upcoming military buildup. JGPO should supply the respective info.

IV. Information on Existing Sewer System for Barrigada Area

- GWA does not have reliable records on sewer along Rt8, Rt10 and Rt15. The 24” VCP along Rt8 may be 40 to 50 years old. Sewer has not been surveyed, and flow meters are installed to measure the flow. The current sewer condition info and as built plans are not available. GWA doesn't have pump station capacity info for Barrigada and Manglao Pump stations. There are no records to determine how much flow they are currently pumping.

- Guam Water Resources Master Plan (WRMP) prepared in 2007 is not a reliable source for sewers along Rt8, Rt10 and Rt15. GWA recommend us to use as built plans, however as-built plans are not available.
  a. GWA recommends to do survey of sewer lines along Rt8, Rt10 and Rt15 for current capacity and condition, and modeling to determine the available remained sewer capacity. Suggest using local subcontractor to do sewer modeling (MWH H2O MAP sewer)

V. GWA - Upcoming Sewer Improvement Project

a. CCU approved a $37.45M contract to improve sewer lines under Marine Corps Drive in central Guam. Project is planned to start in September and will finish in 24 months. Project includes 1) Building a new PS replace Mamajanao PS in Tumon and a relief sewer directly from Tumon to Hagatna WWTP; 2) Rehabilitation of Agana Main Pump station; 3) Building a new Pump station at top of hill next to Rt4 and a new sewer relief line conveying prior Rt sewer directly into Hagatna WWTP.
b. After Marine Corps Drive sewer improvement project, only flow from Tamuning, flow from Rt8 and flow from commercial port to WWTP flow into Hagatna Main Pump station. The current flow (4-6 mgd) to Hagatna Main PS will be reduced by half after the improvement project.
c. Barrigada Cantonment Alternatives may require upgrading of the upcoming Hagatna Main Pump station.
d. Sewer lines under Marine Corp Drive and Rt4 have good records and hydraulic modeling information.

VI. Hagatna WWTP

a. Hagatna WWTP was rehabilitated in February 2007 and the plant has full design capacity of 12 mgd. Effluent discharge over 6 mgd will backflow during high tide.
b. Plant is in compliance with all discharge requirements except when there's a dumping from septic tanks.
c. To accommodate DoD planned Barrigada flow, GWA suggests plant need to be upgraded with: 1) Septic receiving station; 2) Grit removal; 3) Advance Primary Treatment if flow reaches design capacity; 4) Disinfection with UV preferred due to high shipping cost of chlorine.
d. GWA believes NPDES permit will remain as Primary Treatment unless plant incoming flow goes over 12 mgd which triggers expansion of the plant.

<u>Water</u>

VII. Water Systems

- GWA plans 16 wells to address construction worker and induced population for the proposed buildup. The locations have not been identified. GWA plans to have the locations identified for the next JGPO meeting in late June 2009. GWA may have a different configuration for the Cantonment 3 and 8 alternatives.
- GWA wants the DoD and GWA proposed wells to be planned cooperatively in order to maximize yield from the NGLS. GWA accepts that DoD will have a separate water system. GWA is willing to consider suggestions on GWA well placement from DoD. Brett Railey is responsible for identifying the 16 locations, but is occupied with both this and numerous other tasks.
- GWA stated that three new wells have been installed at the airport: two 200 gpm and one 100 gpm. The system includes central treatment with GAC for TCE and PCE clean up. Wells are not online, tentatively scheduled to be online in July 2009. GWA and the airport are developing an agreement for GWA to operate the system for the airport.
- GWA is concerned that existing DoD well capacity is not being considered to meet demand from the build up and that the AF and Navy do not seem to be coordinating water system efforts. Jack Brown described that the Guam DoD utilities will eventually be operated through the Navy and headed by Jack Brown.
- Paul Owens stated that the Barrigada Well #3 is expected to be online in a few months and Well #8 will be replaced by the SeaBees next year.
- GWA stated that water trading alternatives are being considered to reduce the cost of pumping south to north. GWA suggests using water from Fena Reservoir to meet build up demand at Barrigada, but understands that the cost to transport water is a consideration. Jack Brown estimates that it costs $0.30 per KGAL for power to pump water north.
- GWA will not provide GIS coverages.
- The Navy will provide GIS coverages from the water utility report if this information is of use to GWA in siting the 16 new wells.

DRAFT
MEETING NOTES
GUAM EPA
PROJECT COMMENCEMENT

Date: June 10, 2009

Location: GEPA facility

Time : 900 Local Time

I. Staff Attendance

- ♦ The following staff attended:
  - GEPA: Angel Marquez, Susan Marquez
  - NAVFAC Pacific: Kevin Oshiro
  - NAVFAC Mariana: Jack Brown, Paul Owen, Omar Damion
  - AECOM/Earth Tech: Claire Hunt

I. Permitting

- Omar Damian currently holds the GEPA-NAVFAC Marianas liaison position through mid-2009. Questions on the permits should be handled through the liaison. A permit committee was active between 2007 and 2008. Omar Damian is working to restart the committee. NAVFAC is preparing a website with all permit requirements described for use by contractors.
- Legislation was passed within the last year requiring GWA approval of all well locations (including exploratory borings) before GEPA will review permits. Omar Damion will send a copy of the legislation to Kevin Oshiro.
- GEPA has a 30 day review period for permits.
- GEPA recommends that the agency be involved in the initial stages of activities requiring permits and throughout the process (e.g., 30%, 60% and 90% complete design reviews).
- Permits required are the well drilling and well operating permits. There are also design submittals with the building permit. Exploratory wells require the well drilling permit. The test boring permit is for stratigraphy only. The dewatering permit is unlikely to be required.

II. GWUDI

- The GWUDI determination from EPA is likely but the extent of the designation is not certain. The NGLS is assumed to be GWUDI. Tests are required to prove otherwise to avoid more stringent treatment requirements.
- The Barrigada area should be considered GWUDI.
- The GWUDI study is not on schedule.

III. Well Placement Constraints

- GEPA assumes a 1000' zone of influence (2000' separation between wells). GEPA will consider closer well spacing if supported by site data.
- GEPA requires a 1000' separation between wells and potential contaminant sources such as septic lines. GEPA will consider reducing this separation for supply wells where the water is treated at a WTP. Another potential contaminant source on AAFB are the injection wells which collect stormwater that is disposed back to the aquifer
- GEPA suggests reducing energy usage by limiting water transport through the NIW mains.

IV. GWA Water Quality and GIS Data

- Angel Marquez will provide GWA water quality data for comparison to federal MCLs and will include unregulated compounds.
- GEPA may provide some of their GIS coverages.
- No groundwater data is available in the Barrigada Area. The Navy wells in the area are currently down. GEPA will want analytical data from Barrigada if wells are installed.

V. DoD Water System

- Jack Brown explained that the joint region will manage the DoD water system.
- GEPA noted that the AF is installing wells on AAFB but will still be using the Marbo wells. GEPA suggested rehabilitating existing DoD wells such as the Tumon Maui well and Marbo #2 well. The Tumon Maui has an active permit although it is not in use.
- GEPA notes that the AF wells on the NW Field are experiencing fast drawdown and are currently not pumping continuously.
- DoD states that the location of the planned wells is independent of the location of the housing location.
- GEPA suggests expanding the Fena Reservoir to met increasing demand. DoD states that expansion of the Fena Reservoir is still possible if the water resources in the north are not sufficient to meet projected demand.

VI. Limits on Well Capacity

- GEPA determines the permit well capacity based on well specific data (e.g., pump tests and chloride levels). The pump for a well can be selected following the permitting.

VII. DoD Exploratory Borings Study (anticipated start July 09 for seismic study)

- GEPA is not aware of the DoD exploratory borings and associated study (geophysical testing) planned on AAFB and Barrigada. GEPA requests the siting plan.
- DoD explains that the exploratory borings study supports the EIS but has not been discussed at JGPO meetings.
- GEPA does not have a set list of required tests for new wells.

VIII. Non-DoD Water Systems

- GEPA states that the three airport wells are still undergoing pump tests.

- The largest GWA wells are near Agana Springs (A30 and A31) with capacities of 1000 gpm and 750 gpm. These wells are not operated simultaneously.

DRAFT
MEETING NOTES
WERI –UNIVERSITY OF GUAM
PROJECT COMMENCEMENT

Date: June 11th, 2009

Location: WERI Marine Building

Time1600 Local Time

I. Staff Attendance

- ♦ The following staff attended:
  - WERI: Dr. Jensen
  - NAVFAC Pacific: Kevin Oshiro
  - AECOM/Earth Tech: Claire Hunt

II. Anticipated performance of proposed wells in Navy Barrigada

- Dr. Jensen said the nearby wells are an indicator of the performance of the proposed wells. Navy Wells #3 and #8 are currently down. There are relatively high chlorides in the replacement Well #3. From McDonald et al. performance of nearby GWA wells varies. Wells in the area of dirty limestone are less productive. Some wells in the Agana sub-basin may draw from channels with a connection to the ocean, resulting in higher chloride levels. Adjacent GWA wells in the parabasal zone vary in chloride levels. Some wells closer to the ocean are higher in chlorides. Some wells have increasing chloride levels over time, but the levels are still within acceptable limits for the parabasal zone. Careful placement of the wells on Barrigada is likely to determine performance.

III. Anticipated performance of proposed wells on AAFB

- Dr. Jensen believes it is possible to withdraw the quantities of water proposed for the DoD wells, but the installation should be conducted in steps to identify good locations and expand the well field from these locations.

IV. Review of 1992 Mink Study

- Dr. Jensen hasn't begun the review and has several demands on his time during the upcoming weeks. He can complete a review by Aug. 31, 2009.
- Dr. Jensen commented that the methodology used in the Mink study is not obsolete. An updated study would include a larger data set from the late 1990s through the present. A revision is likely to increase the estimate of sustainable yield by approximately 20%.

V. Zone of Influence

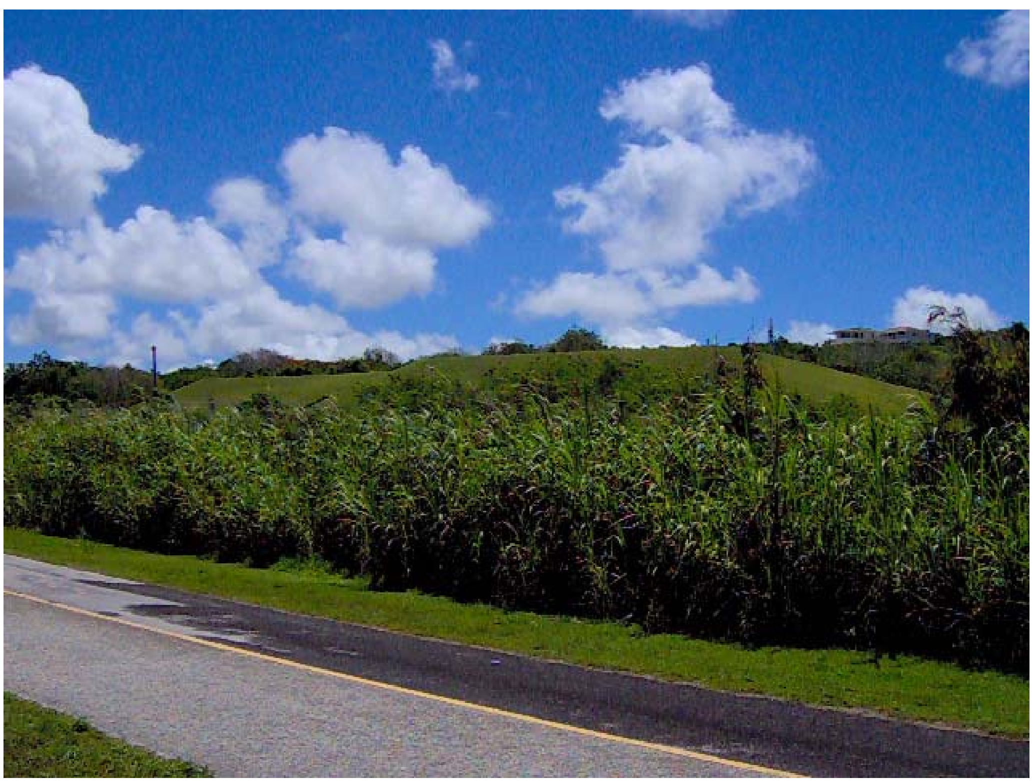
- The 1000’ zone of influence estimate is based on the hydraulic conductivity in major fractures and overestimates the value for most wells which are screened in the limestone matrix and do not cross a major fracture.

Appendix C.4
Photographs

Rehabilitation at NCS 3 – June 09

Rehabilitation at NCS 3 – June 09

Rehabilitation at NCS 8 – June 09



Barrigada Reservoir – June 09

Booster Pump Station – Photo From UTS 2005

Appendix D
Wastewater

Appendix D.1
Cost Estimates

AECOM

PROJECT COMPUTATION SHEET

Client: NAVFEC
Project: Utility Study on MC Relocation to Guam w/ Barrigada Alt.
Design Calculations
File Name: 113128 preliminary cost
Latest Revision: 09-Apr-10

Subject: Cost Estimation

Project No.:113128
Prepared By: YM
Date: 13-July-2009
Reviewed By:

OPTION 1A: EXPAND AND UPGRADE THE GOV GUAM NDWWTP TO SECONDARY TREATMENT

Construction Categories	Quantity	Applicable Specifications for Cost Estimating	Cost Opinion
A. NDWWTP SHORT-TERM NECESSARY IMPROVEMENTS			
Septage Receiving Station (new)	1 ea	Septage storage tank, screen, two blowers, diffusers,	1,317,425
FOG Receiving Station (new)	1 ea	Headed grease holding tank, heat trace system, two	565,513
Headworks (refurbish)	1 ea	Two (2) 6mm fine screens, grit chamber retrofit, new	2,629,062
Primary Clarifier (refurbish)	2 ea	New Sludge Collectors, electrical, pumps, coatings,	4,093,805
Anaerobic Digester (refurbish)	2 ea	New sludge mixing, heat exhangers, electrical,	11,883,186
Solids Dewatering Building (replace)	1 ea	Structure replacement, one centrifuge, one feed	3,428,310
Influent and Effluent Samplers (new)	2 ea	Automatic samplers	159,292
Sludge Drying Bed (refurbish)	1 ea	Concrete repair, valves	79,646
Standby Diesel Generator	1 ea	300 KW	398,230
Site Work and Utilities	1 ls		1,567,312
B. NDWWTP LONG-TERM IMPROVEMENTS			
Chlorine Contact Tank (refurbish)	2 ea	New mixers, chemical feed pumps, effluent flow	1,246,726
Anaerobic Digester (new)	1 ea	New sludge mixing, heat exhangers, electrical,	10,265,735
Digester Gas Utilization (new)	1 ea	Engine generator, gas purification, compressor	2,188,274
Sludge Dewatering Centrifuge (new)	1 ea	2,000 lb/hr centrifuge	2,713,381
Plant Odor Control System (new)	1 ea	Odor control system	477,876

AECOM

PROJECT COMPUTATION SHEET

Client: NAVFEC
Project: Utility Study on MC Relocation to Guam w/ Barrigada Alt.
Design Calculations
File Name: 113128 preliminary cost
Latest Revision: 09-Apr-10

Subject: Cost Estimation

Project No.:113128
Prepared By: YM
Date: 13-July-2009
Reviewed By:

Adm/Lab, Workshop, Storage (refurbish)	1 ea	Adm/Lab, workshop, storage	663,717
Site Work and Utilities	1 ls		1,120,581
C: UPGRADE TO SECONDARY NDWWTP			
Primary Clarifier	new 1 ea	concrete form construction 130' dia x 7'swd	7,182,903
Pumping Station	new 1 ea	concrete form construction 40' L x 25' W x 16' H	3,236,814
Trickling Filters	new 3 ea	concrete form construction 120' dia x 24'swd	26,066,549
Secondary Clarifiers	new 4 ea	concrete form construction 125' dia x 14'swd	31,649,628
Chlorine Contact Tank	new 1 ea	concrete form construction 60' L x 40' W x 8' swd	4,316,814
Anaerobic Digesters	new 2 ea	concrete form construction 80' dia x 18'swd	22,719,743
Influent and Effluent Samplers	new 2 ea		159,292
Solids Dewatering Building Expansion	1 ea	One 2,000 lb/hr centrifuge	2,119,009
Site Work and Utilities	1 ls		6,821,553
Relief Sewer	1 ea	GS: 3,650'd15", 4,700'd24"; FM:17,500'd18"; 2 PS	14,752,434
Outfall Upgrade	1 ea	40 diffusers w/ 400' long	3,450,000

AECOM

PROJECT COMPUTATION SHEET

Client: NAVFEC
Project: Utility Study on MC Relocation to Guam w/ Barrigada Alt.
Design Calculations
File Name: 113128 preliminary cost
Latest Revision: 09-Apr-10

Subject: Cost Estimation

Project No.:113128
Prepared By: YM
Date: 13-July-2009
Reviewed By:

TREATMENT SUBTOTAL COST	104,272,305
SEWER & OUTFALL SUBTOTAL COST	18,202,434
TOTAL COST	$122,474,738
PROJECT SERVICES	$42,866,158
TOTAL ESTIMATED COST - GUAM	$165,340,897
TOTAL REQUEST (ROUNDED)	**$165,341,000**

OPTION 2: EXPAND & UPGRADE HAGATNA WWTP TO SECONDARY TREATMENT (12 MGD)

Construction Categories	Quantity	Applicable Specifications for Cost Estimating	Cost Opinion
Chemical Enhanced Precipitation for Primary Settlement (new)	1 ea	Chemical storage tanks, dosing pumps and contral	323,336
Pumping Station (new)	1 ea	Concrete form construction 40' L x 25' W x 16' H	2,025,080
Trickling Filter (new)	3 ea	Concrete form construction 85' dia x 24'swd	14,793,451
Secondary Clarifier (new)	3 ea	Concrete form construction 220' L x 60' W x 12'swd	22,078,906
UV Disinfection Channel (new)	3 ea	3 UV channels of 30' L x 12' W, 1 outlet weir structure 56' L x 14' W. Each channel with three banks of UV lamps	2,856,000

AECOM

PROJECT COMPUTATION SHEET

Client: NAVFEC
Project: Utility Study on MC Relocation to Guam w/ Barrigada Alt.
Design Calculations
File Name: 113128 preliminary cost
Latest Revision: 09-Apr-10

Subject: Cost Estimation

Project No.:113128
Prepared By: YM
Date: 13-July-2009
Reviewed By:

Effluent Pump Station (refurbish)	1 ea	New effluent pumps, electrical, controls, coatings, piping and valves, concrete repair	488,496
Aerobic Digester (new)	5 ea	Concrete form construction 44' L x 18' W x 21' swd	10,002,053
Site Work and Utilities	1 ls		3,679,713
Relief Sewer	1 ea	15,300' 18" dia	6,092,920
	1 ea	1,500' 21" dia	716,814
	1 ea	6,900' 24" dia	3,846,903
TREATMENT SUBTOTAL COST			56,247,035
SEWER & OUTFALL SUBTOTAL COST			10,656,637
TOTAL COST			$66,903,672
PROJECT SERVICES			$23,416,285
TOTAL ESTIMATED COST - GUAM			**$90,319,957**
TOTAL REQUEST (ROUNDED)			**$90,300,000**

AECOM

PROJECT COMPUTATION SHEET

Client: NAVFEC
Project: Utility Study on MC Relocation to Guam w/ Barrigada Alt.
Design Calculations
File Name: 113128 preliminary cost
Latest Revision: 09-Apr-10

Subject: Cost Estimation

Project No.:113128
Prepared By: YM
Date: 13-July-2009
Reviewed By:

OPTION 3: DoD SECONDARY TREATMENT on DoD LAND (3.7 MGD)

Construction Categories	Quantity	Applicable Specifications for Cost Estimating	Cost Opinion
Headworks (new)	1 ea	Two (2) 6mm fine screens Two (2) Aerated grit chambers, ea 40' L x 12' W x 7' SWD	3,457,593
Primary Clarifier (new)	3 ea	Concrete form construction 55' dia x 10'swd	6,098,230
Pumping Station (new)	1 ea	Concrete form construction 40' L x 25' W x 16' H	1,686,903
Trickling Filters (new)	3 ea	Concrete form construction 60' dia x 24'swd	8,380,354
Secondary Clarifiers (new)	3 ea	Concrete form construction 75' dia x 13'swd	10,458,159
Chlorine Contact Tank (new)	2 ea	Concrete form construction 50' L x 20' W x 14' swd	2,729,204
Anaerobic Digesters (new)	3 ea	Concrete form construction 65' dia x 18'swd	23,246,681
Influent and Effluent Samplers (new)	2 ea		159,292
Solids Dewatering Building (new)	1 ea	Two 125 gpm centrifuges	10,518,159
Site Work and Utilities	1 ls		4,671,420
	1 ea	3,650' 15" dia	1,162,832

PROJECT COMPUTATION SHEET

Client: NAVFEC
Project: Utility Study on MC Relocation to Guam w/ Barrigada Alt.
Design Calculations
File Name: 113128 preliminary cost
Latest Revision: 09-Apr-10

Subject: Cost Estimation

Project No.:113128
Prepared By: YM
Date: 13-July-2009
Reviewed By:

Sewer Interceptors	1 ea	33,300' 21" dia	15,913,274
	1 ea	13,400' 24" dia	7,470,796
	1 ea	18,700' 18" dia force main	7,450,885
Sewage Pumping Station	2 ea	One with 3 x 125 HP pumps One with 3 x75 HP pumps	4,000,221
Effluent Transmission Line	1 ea	5,000' 24" dia	2,787,611
Ocean Out Fall & Piping	1 ea	2,400' 24" dia	7,008,850
TREATMENT SUBTOTAL COST			71,405,995
SEWER & OUTFALL SUBTOTAL COST			45,794,469
TOTAL COST			$117,200,465
PROJECT SERVICES			$41,020,163
TOTAL ESTIMATED COST - GUAM			**$158,220,627**
TOTAL REQUEST (ROUNDED)			**$158,200,000**

PROJECT COMPUTATION SHEET

Client: NAVFEC
Project: Utility Study on MC Relocation to Guam w/ Barrigada Alt.
Design Calculations
File Name: 113128 preliminary cost
Latest Revision: 09-Apr-10

Subject: Cost Estimation

Project No.:113128
Prepared By: YM
Date: 13-July-2009
Reviewed By:

OPTION 4: DoD SECONDARY TREATMENT at HAGATNA WWTP to Treat DoD load Only (1.6 MGD)

Construction Categories	Quantity	Applicable Specifications for Cost Estimating	Cost Opinion
Headworks (new)	1 ea	Two (2) 6mm fine screens Two (2) Two (2) Vortex grit chambers, ea 14' L x 2' W channel and 7' dia chamber	2,811,929
Primary Clarifier (new)	3 ea	Concrete form construction 60' L x 20' W x 12'swd	4,465,487
Chemical Enhanced Precipitation for Primary Settlement (new)	1 ea	Chemical storage tanks, dosing pumps and contral	118,327
Pumping Station (new)	1 ea	Concrete form construction 25' L x 25' W x 16' H	1,403,894
Trickling Filters (new)	3 ea	Concrete form construction 35' dia x 24'swd	4,013,920
Secondary Clarifiers (new)	3 ea	Concrete form construction 100' L x 20W x 12'swd	5,458,938
UV Disinfection System (new)	2 ea	2 UV channels total 20' L x 8' W, 1 outlet weir structure 14' L x 12' W. Each channel with two banks of UV lamps	925,088

AECOM

PROJECT COMPUTATION SHEET

Client: NAVFEC
Project: Utility Study on MC Relocation to Guam w/ Barrigada Alt.
Design Calculations
File Name: 113128 preliminary cost
Latest Revision: 09-Apr-10

Subject: Cost Estimation

Project No.:113128
Prepared By: YM
Date: 13-July-2009
Reviewed By:

Effluent Pump Station (refurbish)	1 ea	New effluent pumps, electrical, controls, coatings, piping and valves, concrete repair	584,602
Anaerobic Digesters (new)	3 ea	Concrete form construction 30' dia x 30'swd	4,286,564
Influent and Effluent Samplers	2 ea		0
Solids Dewatering Building	1 ea	Two 60 gpm centrifuges	10,093,381
Site Work and Utilities	1 ls		2,391,907
Sewer Interceptors	1 ea	15,300' 18" dia	6,092,920
	1 ea	6,900' 24" dia	3,297,345
	1 ea	3,500' 18" dia force main	1,393,805
Sewage Pumping Station	1 ea	3 x 25 HP pumps	985,646
TREATMENT SUBTOTAL COST			36,554,037
SEWER & OUTFALL SUBTOTAL COST			11,769,717
TOTAL COST			$48,323,754
PROJECT SERVICES			$16,913,314
TOTAL ESTIMATED COST - GUAM			**$65,237,068**
TOTAL REQUEST (ROUNDED)			**$65,200,000**

Appendix D.2
Calculations

AECOM

PROJECT COMPUTATION SHEET

Project No.:113128
Prepared By: YM
Date: 7-July-2009
Reviewed By:

Client: NAVFAC
Project: Utility Study on MC Relocation to Guam for Barrigada Alternative
Design Calculations
File Name: 113128 unit_process
Latest Revision: 31-Jul-09

Subject: Influent Loading

TOTAL INFLUENT LOAD

	Original Design Conditions at Hagatna WWTP	Military Flows FY2019
Population	115,000	10,380
Per Capita Contributions		
BOD, lbs/capit/day	0.160	0.2
SS, lbs/capit/day	0.180	0.23
Sewage Flows		
Avg. Flow, MGD	12.0	1.3
Peak Flow, MGD	21.0	3.9
Plant Recycle Flow, MGD		
BOD, lbs/day	18,400	2,076
TSS, lbs/day	20,700	2,387
FSS, %	40.0%	40.0%
VSS, %	60.0%	60.0%
FSS, lbs/day	8,280	955
VSS, lbs/day	12,420	1,432
BOD, mg/L	184	199
TSS, mg/L	207	229

AECOM

PROJECT COMPUTATION SHEET

Client: NAVFAC
Project: Utility Study on MC Relocation to Guam for Barrigada Alternative
Design Calculations
File Name: 113128 unit_process
Latest Revision: 31-Jul-09

Subject: Unit Process Design

Project No.:113128
Prepared By: YM
Date: 7-July-2009
Reviewed By:

	Design Conditions FY2019
TOTAL INFLUENT LOAD	
Avg. Flow, MGD	1.6
Peak Flow, MGD	5.0
Plant Recycle Flow, MGD	
BOD, lbs/day	2,652
TSS, lbs/day	3,050
FSS, %	40%
VSS, %	60%
FSS, lbs/day	1,220
VSS, lbs/day	1,830
BOD, mg/L	200
TSS, mg/L	230
EFFLUENT CONCENTRATION REQ.	
BOD, mg/L	30
TSS, mg/L	30

PRELIMINARY TREATMENT	Design Conditions FY2019

Vortex Grit Removal Sys.

AECOM

PROJECT COMPUTATION SHEET

Client: NAVFAC
Project: Utility Study on MC Relocation to Guam for Barrigada Alternative
Design Calculations
File Name: 113128 unit_process
Latest Revision: 31-Jul-09

Subject: Unit Process Design

Project No.:113128
Prepared By: YM
Date: 7-July-2009
Reviewed By:

	Design Conditions FY2019
Capacity for One Channel of Two System	
Peak Q, mgd	2.5
Channel Geometry	
Length, ft	14
Width, ft	2
Depth, ft	1
Cross Area, sf	2
Velocity @ 60% Peak Q, f/s	1.15
Vortex Chamber Diameter, ft	7.0

PRIMARY CLARIFIERS

	Design Conditions FY2019
Design	
Average SOR, gpd/sf	900
Peak SOR, gpd/sf	2000
Detention Time, hrs	2
Polymer Dose, mg/L	0.75
Ferric Chloride Dose, mg/L	20

AECOM

PROJECT COMPUTATION SHEET

Client: NAVFAC
Project: Utility Study on MC Relocation to Guam for Barrigada Alternative
Design Calculations
File Name: 113128 unit_process
Latest Revision: 31-Jul-09

Subject: Unit Process Design

Project No.:113128
Prepared By: YM
Date: 7-July-2009
Reviewed By:

	Design Conditions FY2019
Tank Geometry	
Length, ft	60
Width, ft	20
SWD, ft	12
Unit Surface Area, sf	1200
Unit Volume, cf	14400
NUMBER OF TANKS REQ'D	
Based on AVG. SOR	1.47
Based on Peak SOR	2.07
Based on Detention Time	1.23
Number Of Tanks Installed	3
Number Of Tanks In Service	2
Number Of Tanks In Maintenance	1
Total Service Surface Area, sf	2400
CALCULATED SOR's, gpd/sf	
Ave. Day	663
Peak Hour	2071
Calculated Det. Times	

AECOM

PROJECT COMPUTATION SHEET

Client: NAVFAC
Project: Utility Study on MC Relocation to Guam for Barrigada Alternative
Design Calculations
File Name: 113128 unit_process
Latest Revision: 31-Jul-09

Subject: Unit Process Design

Project No.:113128
Prepared By: YM
Date: 7-July-2009
Reviewed By:

	Design Conditions FY2019
Ave. Day, Hrs.	6.5
Peak Hour, Hrs.	2.1

Calculated Peak Weir Load, gal/d-ft.

Peak Weir Load	13183

SECONDARY TREATMENT

Trickling Filters

(BOD LOADING ONLY)

	Design Conditions FY2019
DESIGN ASSUMPTIONS:	
Primary BOD Removal, %	45
Primary TSS Removal, %	80
BOD Loading, lb/1000 cf-day	50
Filter Depth, ft	24
Primary Effluent	
PRI. EFF. BOD LOAD, lbs/d	1459
PRI. EFF. TSS LOAD, lbs/d	610
PROCESS EFFLUENT REQ.	
BOD, mg/L	30
TSS, mg/L	30

AECOM

PROJECT COMPUTATION SHEET

Project No.:113128
Prepared By: YM
Date: 7-July-2009
Reviewed By:

Client: NAVFAC
Project: Utility Study on MC Relocation to Guam for Barrigada Alternative
Design Calculations
File Name: 113128 unit_process
Latest Revision: 31-Jul-09

Subject: Unit Process Design

	Design Conditions FY2019
EFF. BOD LOAD, lbs/d	398
EFF. TSS LOAD, lbs/d	398
Process Characteristics	
PROCESS FLOW, MGD	4.970
PROCESS LOAD, BOD lbs/d	2304
Total Volume Required	
Cu. Ft.	46087
FINAL DESIGN DATA	
Tank Liquid Depth, ft.	24.0
Diameter, ft.	35
Unit Surface Area, sf.	962
Unit Volume, cf.	23,091
Unit Volume, gals.	172,718
Unit Volume, MG.	0.173
Number of Tanks Needed	2.0
Number of Tanks Installed	3
Number of Tanks In Service	2
Surface Area In Service, sf.	1,924.23

AECOM

PROJECT COMPUTATION SHEET

Project No.:113128
Prepared By: YM
Date: 7-July-2009
Reviewed By:

Subject: Unit Process Design

Client: NAVFAC
Project: Utility Study on MC Relocation to Guam for Barrigada Alternative
Design Calculations
File Name: 113128 unit_process
Latest Revision: 31-Jul-09

	Design Conditions FY2019
Volume In Service, cf.	46,181
Volume In Service, gals.	345,437
Volume In Service, Mil. Gals.	0.35
CALCULATED HYDRAULIC LOADING	
Process Daily Flow	113
CALCULATED LOADING	
lbs. BOD/1000 Cu. Ft.	50

AECOM

PROJECT COMPUTATION SHEET

Client: NAVFAC
Project: Utility Study on MC Relocation to Guam for Barrigada Alternative
Design Calculations
File Name: 113128 unit_process
Latest Revision: 31-Jul-09

Subject: Unit Process Design

Project No.:113128
Prepared By: YM
Date: 7-July-2009
Reviewed By:

	Design Conditions FY2019

SECONDARY CLARIFIERS

	Design Conditions FY2019
Design	
Average SOR, gpd/sf	500
Peak SOR, gpd/sf	1,200
Detention Time, hrs	2
Tank Geometry	
Length, ft	100
Width, ft	20
SWD, ft	12
Floor Slope	0.25:12
Unit Surface Area, sf	2000
NUMBER OF TANKS REQ'D	
Based on AVG. SOR	1.59
Based on Peak SOR	2.07
Based on Detention Time	0.74
Number Of Tanks Installed	3
Number Of Tanks In Service	2
Total Surface Area, sf	4000

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PROJECT COMPUTATION SHEET

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Subject: Unit Process Design

	Design Conditions FY2019
CALCULATED SOR's, gpd/sf	
Ave. Day	398
Peak Hour	1243
Calculated Det. Times	
Ave. Day, Hrs.	5.42
Peak Hour, Hrs.	1.73

UV DISINFECTION CHANNEL

	Design Conditions FY2019
Channel Geometry	
Length, ft	20
Width, ft	2.5
Depth, ft	3
Surface Area, sf	50
Volume, cf	150
Number Channels Installed	2
Number Channels In Service	1

	Design Conditions FY2019
Outlet Weir Structure Geometry	
Length, ft	14
Width, ft	10
Depth, ft	3
Surface Area, sf	140
Volume, cf	420

ANAEROBIC SLUDGE DIGESTER

(RETENTION TIME ONLY)

	Design Conditions FY2019
DESIGN ASSUMPTIONS:	
Primary Solid Concentration, %	4
Primary Sludge Specific Gravity	1.02
Primary BOD Removal, %	45
Primary TSS Removal, %	80
Secondary Solid Concentration, %	4
Secondary Sludge Specific Gravity	1.025
Solid Retention Time, day	15
Process Characteristics	
PRIMARY SLUDGE, lbs/d	2440
SECONDARY SLUDGE, lbs/d	530

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PROJECT COMPUTATION SHEET

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Subject: Unit Process Design

	Design Conditions FY2019
PRIMARY SLUDGE FLOW, gpd	7171
SECONDARY SLUDGE FLOW, gpd	1551
PRI + 2NDRY SLUDGE FLOW, gpd	8722
Total Volume Required	
gals.	130827
Cu. Ft.	17488
Tank Geometry	
Tank Liquid Depth, ft.	30.0
Diameter, ft.	30
Unit Surface Area, sf.	707
Unit Volume, cf.	21,206
Unit Volume, gals.	158,619
Unit Volume, MG.	0.159
Number of Tanks Needed	0.8
Number of Tanks Installed	1
Number of Tanks In Service	1
Surface Area In Service, sf.	707
Volume In Service, cf.	21,206
Volume In Service, gals.	158,619

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PROJECT COMPUTATION SHEET

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Subject: Unit Process Design

Project No.:113128
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	Design Conditions FY2019
Volume In Service, Mil. Gals.	0.16
Calculated Hydraulic Retention Time days	18

SLUDGE DEWATERING CENTRIFUGES	Design Conditions FY2019
DESIGN ASSUMPTIONS:	
Volatile Solid in Primary Sludge, %	60
Volatile Solid in Humus, %	50
Volatile Solid Destruction in Digestion, %	55
Digested Sludge Concentration, %	4
Digested Sludge Specifc Gravity	1.04
Cake Solid Content, %	18
Solid Capture Rate, %	85
DIGESTER EFFLUENT	
Fixed Solids, lbs/d	1241
Volatile Solids, lbs/d	778
Digested Sludge, lbs/d	2019
Digested Sludge Flow, gpd	5820

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Latest Revision: 31-Jul-09

Subject: Unit Process Design

	Design Conditions FY2019
CENTRIFUGE INFLUENT	
DIGESTED SLUDGE, lbs/d	2019
DIGESTED SLUDGE FLOW, gpd	5820
Designed Unit Centrifuge Solid Loading	
gph	3600
NUMBER OF CENTRIFUGES REQ'D	
7 d/wk, 24 hr/d	0.07
5 d/wk, 8 hr/d	0.28
Number Of Centrifuges Installed	
7 d/wk, 24 hr/d	2
5 d/wk, 8 hr/d	2
Number Of Centrifuges In Service	
7 d/wk, 24 hr/d	1
5 d/wk, 8 hr/d	1

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PROJECT COMPUTATION SHEET

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Subject: Unit Process Design

Project No.:113128
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	Design Conditions FY2019
TOTAL INFLUENT LOAD	
Avg. Flow, MGD	3.1
Peak Flow, MGD	8.0
Plant Recycle Flow, MGD	
BOD, lbs/day	5,286
TKN, lbs/day	971
NH3, lbs/day	583
TSS, lbs/day	5,186
Total P, lbs/day	139
FSS, %	40%
VSS, %	60%
FSS, lbs/day	2,074
VSS, lbs/day	3,112
BOD, mg/L	206
TKN, mg/L	38
NH3, mg/L	23
TSS, mg/L	202
Total P, mg/L	5.4
EFFLUENT CONCENTRATION REQ.	
BOD, mg/L	30
TSS, mg/L	30

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Design Calculations
File Name: 113128 unit_process
Latest Revision: 31-Jul-09

Subject: Unit Process Design

	Design Conditions FY2019
PRELIMINARY TREATMENT	Design Conditions FY2019
Aerated Grit Chamber	
Criteria at Peak Hour	
Detention Time, Mins.	3
Available Tank Geometry	
Length, ft	40
Width, ft	12
Depth, ft	7
Surface Area, sf	480
Volume, cf	3360
Detention Time @ Peak Q, Minutes	4.5
Number of Tanks Req'd	
By Detention Time	0.7
Number Tanks Installed	2
Number Tanks In Service	1

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File Name: 113128 unit_process
Latest Revision: 31-Jul-09

Subject: Unit Process Design

Design Conditions FY2019

PRIMARY CLARIFIERS

	Design Conditions FY2019
Design	
Average SOR, gpd/sf	900
Peak SOR, gpd/sf	2000
Detention Time, hrs	2
Tank Geometry	
Diameter, ft	55
SWD, ft	10
Unit Surface Area, sf	2376
Unit Volume, cf	23758
NUMBER OF TANKS REQ'D	
Based on AVG. SOR	1.44
Based on Peak SOR	1.69
Based on Detention Time	1.44
Number Of Tanks Installed	3
Number Of Tanks In Service	2
Number Of Tanks In Maintenance	1

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PROJECT COMPUTATION SHEET

Client: NAVFAC
Project: Utility Study on MC Relocation to Guam for Barrigada Alternative Design Calculations

Subject: Unit Process Design

Project No.:113128
Prepared By: YM
Date: 7-July-2009
Reviewed By:

File Name: 113128 unit_process
Latest Revision: 31-Jul-09

	Design Conditions FY2019
Total Service Surface Area, sf	4752
CALCULATED SOR's, gpd/sf	
Ave. Day	648
Peak Hour	1692
Calculated Det. Times	
Ave. Day, Hrs.	5.5
Peak Hour, Hrs.	2.1
Calculated Peak Weir Load, gal/d-ft.	
Peak Weir Load	23262

SECONDARY TREATMENT **Trickling Filters** (BOD LOADING ONLY)	Design Conditions FY2019
DESIGN ASSUMPTIONS:	
Primary BOD Removal, %	30
Primary TSS Removal, %	60
BOD Loading, lb/1000 cf-day	50

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PROJECT COMPUTATION SHEET

Client: NAVFAC
Project: Utility Study on MC Relocation to Guam for Barrigada Alternative
Design Calculations
File Name: 113128 unit_process
Latest Revision: 31-Jul-09

Subject: Unit Process Design

Project No.:113128
Prepared By: YM
Date: 7-July-2009
Reviewed By:

	Design Conditions FY2019
Filter Depth, ft	24
Primary Effluent	
PRI. EFF. BOD LOAD, lbs/d	3700
PRI. EFF. TSS LOAD, lbs/d	2074
PROCESS EFFLUENT REQ.	
BOD, mg/L	30
TSS, mg/L	30
EFF. BOD LOAD, lbs/d	771
EFF. TSS LOAD, lbs/d	771
Process Characteristics	
PROCESS FLOW, MGD	8.039
PROCESS LOAD, BOD lbs/d	4941
PROCESS LOAD, TKN lbs/d	2212
Total Volume Required	
Cu. Ft.	98824
FINAL DESIGN DATA	
Tank Liquid Depth, ft.	24.0
Diameter, ft.	60

	Design Conditions FY2019
Unit Surface Area, sf.	2,827
Unit Volume, cf.	67,858
Unit Volume, gals.	507,581
Unit Volume, MG.	0.508
Number of Tanks Needed	1.5
Number of Tanks Installed	3
Number of Tanks In Service	2
Surface Area In Service, sf.	5,654.87
Volume In Service, cf.	135,717
Volume In Service, gals.	1,015,162
Volume In Service, Mil. Gals.	1.02
CALCULATED HYDRAULIC LOADING	
Process Daily Flow	62
CALCULATED LOADING	
lbs. BOD/1000 Cu. Ft.	36

SECONDARY CLARIFIERS

	Design Conditions FY2019

Design

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	Design Conditions FY2019
Average SOR, gpd/sf	500
Peak SOR, gpd/sf	1,200
Detention Time, hrs	2
Tank Geometry	
Diameter, ft	75
SWD, ft	13
Floor Slope	0.25:12
Unit Surface Area, sf	4418
NUMBER OF TANKS REQ'D	
Based on AVG. SOR	1.39
Based on Peak SOR	1.52
Based on Detention Time	0.60
Number Of Tanks Installed	3
Number Of Tanks In Service	2
Total Surface Area, sf	8836
CALCULATED SOR's, gpd/sf	
Ave. Day	349
Peak Hour	910

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File Name: 113128 unit_process
Latest Revision: 31-Jul-09

Subject: Unit Process Design

	Design Conditions FY2019
Calculated Det. Times	
Ave. Day, Hrs.	6.69
Peak Hour, Hrs.	2.57

CHLORINE CONTACT

	Design Conditions FY2019
Chlorine Contact Tanks	
Criteria at Peak Hour	
Detention Time, Mins.	15
Available Tank Geometry	
Length, ft	50
Width, ft	20
Depth, ft	14
Surface Area, sf	1000
Volume, cf	14000
Detention Time @ Peak Q, Minutes	18.8
Number of Tanks Req'd	
By Detention Time	0.8

Latest Revision: 31-Jul-09

	Design Conditions FY2019
Number Tanks Installed	2
Number Tanks In Service	1

Calculated Hydraulic Retention Time

minutes	19

ANAEROBIC SLUDGE DIGESTER

(RETENTION TIME ONLY)

	Design Conditions FY2019
DESIGN ASSUMPTIONS:	
Primary Solid Concentration, %	4
Primary Sludge Specific Gravity	1.02
Primary BOD Removal, %	30
Primary TSS Removal, %	60
Secondary Solid Concentration, %	1.5
Secondary Sludge Specific Gravity	1.025
Solid Retention Time, day	15
Process Characteristics	
PRIMARY SLUDGE, lbs/d	3112
SECONDARY SLUDGE, lbs/d	1465

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Subject: Unit Process Design

	Design Conditions FY2019
PRIMARY SLUDGE FLOW, gpd	9145
SECONDARY SLUDGE FLOW, gpd	11425
PRI + 2NDRY SLUDGE FLOW, gpd	20569
Total Volume Required	
gals.	308541
Cu. Ft.	41243
Tank Geometry	
Tank Liquid Depth, ft.	18.0
Diameter, ft.	65
Unit Surface Area, sf.	3,318
Unit Volume, cf.	59,730
Unit Volume, gals.	446,777
Unit Volume, MG.	0.447
Number of Tanks Needed	0.7
Number of Tanks Installed	3
Number of Tanks In Service	1
Surface Area In Service, sf.	3,318
Volume In Service, cf.	59,730
Volume In Service, gals.	446,777

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PROJECT COMPUTATION SHEET

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Project No.:113128
Prepared By: YM
Date: 7-July-2009
Reviewed By:

	Design Conditions FY2019
Volume In Service, Mil. Gals.	0.45
Calculated Hydraulic Retention Time days	22

SLUDGE DEWATERING CENTRIFUGES	Design Conditions FY2019
DESIGN ASSUMPTIONS:	
Volatile Solid in Primary Sludge, %	60
Volatile Solid in Humus, %	50
Volatile Solid Destruction in Digestion, %	55
Digested Sludge Concentration, %	4
Digested Sludge Specifc Gravity	1.04
Cake Solid Content, %	18
Solid Capture Rate, %	85
DIGESTER EFFLUENT	
Fixed Solids, lbs/d	1977
Volatile Solids, lbs/d	1170
Digested Sludge, lbs/d	3147
Digested Sludge Flow, gpd	9070

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	Design Conditions FY2019
CENTRIFUGE INFLUENT	
DIGESTED SLUDGE, lbs/d	3147
DIGESTED SLUDGE FLOW, gpd	9070
Designed Unit Centrifuge Solid Loading lbs/hour	1000
NUMBER OF CENTRIFUGES REQ'D	
7 d/wk, 24 hr/d	0.13
5 d/wk, 8 hr/d	0.55
Number Of Centrifuges Installed	
7 d/wk, 24 hr/d	2
5 d/wk, 8 hr/d	2
Number Of Centrifuges In Service	
7 d/wk, 24 hr/d	1
5 d/wk, 8 hr/d	1

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	Design Conditions FY2019
HAGATNA WWTP FLOW, MGD	
TOTAL ADF	12.00
Peaking Factor from Ratio of Peak and Average Flow in GWA Master Plan	1.75
Peak Daily Wet Weather	21.00
TOTAL INFLUENT LOAD	
Avg. Flow, MGD	12.0
Peak Flow, MGD	21.0
Plant Recycle Flow, MGD	
BOD, lbs/day	18,415
TSS, lbs/day	20,717
FSS, %	40%
VSS, %	60%
FSS, lbs/day	8,287
VSS, lbs/day	12,430
BOD, mg/L	184
TSS, mg/L	207
EFFLUENT CONCENTRATION REQ.	
BOD, mg/L	30
TSS, mg/L	30

	Design Conditions FY2019

PRIMARY CLARIFIERS

	Design Conditions FY2019
Design	
Average SOR, gpd/sf	900
Peak SOR, gpd/sf	2000
Detention Time, hrs	2
Polymer Dose, mg/L	0.75
Ferric Chloride Dose, mg/L	20

SECONDARY TREATMENT

Trickling Filters

(BOD LOADING ONLY)

	Design Conditions FY2019
DESIGN ASSUMPTIONS:	
Primary BOD Removal, %	45
Primary TSS Removal, %	80
BOD Loading, lb/1000 cf-day	50
Filter Depth, ft	24

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	Design Conditions FY2019
Primary Effluent	
PRI. EFF. BOD LOAD, lbs/d	10128
PRI. EFF. TSS LOAD, lbs/d	4143
PROCESS EFFLUENT REQ.	
EFF. BOD LOAD, lbs/d	3002
EFF. TSS LOAD, lbs/d	3002
Process Characteristics	
PROCESS FLOW, MGD	21.000
PROCESS LOAD, BOD lbs/d	12380
Total Volume Required	
Cu. Ft.	247598
FINAL DESIGN DATA	
Tank Liquid Depth, ft.	24.0
Diameter, ft.	85
Unit Surface Area, sf.	5,675
Unit Volume, cf.	136,188
Unit Volume, gals.	1,018,687
Unit Volume, MG.	1.019

Latest Revision: 31-Jul-09

	Design Conditions FY2019
Number of Tanks Needed	1.82
Number of Tanks Installed	3
Number of Tanks In Service	2
Surface Area In Service, sf.	11,349.00
Volume In Service, cf.	272,376
Volume In Service, gals.	2,037,373
Volume In Service, Mil. Gals.	2.04
CALCULATED HYDRAULIC LOADING	
Process Daily Flow	81
CALCULATED LOADING	
lbs. BOD/1000 Cu. Ft.	45

SECONDARY CLARIFIERS

	Design Conditions FY2019
Design	
Average SOR, gpd/sf	500
Peak SOR, gpd/sf	1,200
Detention Time, hrs	2

Tank Geometry

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PROJECT COMPUTATION SHEET

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	Design Conditions FY2019
Length, ft	220
Width, ft	60
SWD, ft	12
Floor Slope	0.25:12
Unit Surface Area, sf	13200
NUMBER OF TANKS REQ'D	
Based on AVG. SOR	1.82
Based on Peak SOR	1.33
Based on Detention Time	0.84
Number Of Tanks Installed	3
Number Of Tanks In Service	2
Total Surface Area, sf	26400
CALCULATED SOR's, gpd/sf	
Ave. Day	455
Peak Hour	795
Calculated Det. Times	
Ave. Day, Hrs.	4.74
Peak Hour, Hrs.	2.71

	Design Conditions FY2019
	Design Conditions FY2019

UV DISINFECTION CHANNEL

Channel Geometry	
Length, ft	30
Width, ft	2.5
Depth, ft	6
Surface Area, sf	75
Volume, cf	450
Number Channels Installed	3
Number Channels In Service	2
Outlet Weir Structure Geometry	
Length, ft	14
Width, ft	56
Depth, ft	6
Surface Area, sf	784
Volume, cf	4704
Number Channels Installed	1

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PROJECT COMPUTATION SHEET

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	Design Conditions FY2019
Number Channels In Service	1

AEROBIC SLUDGE DIGESTER

(RETENTION TIME ONLY)

	Design Conditions FY2019
DESIGN ASSUMPTIONS:	
Primary Solid Concentration, %	5
Primary Sludge Specific Gravity	1.02
Primary BOD Removal, %	45
Primary TSS Removal, %	80
Secondary Solid Concentration, %	5
Secondary Sludge Specific Gravity	1.02
Solid Retention Time, day	20
Process Characteristics	
PRIMARY SLUDGE, lbs/d	16573
SECONDARY SLUDGE, lbs/d	3563
PRIMARY SLUDGE FLOW, gpd	38965
SECONDARY SLUDGE FLOW, gpd	8376
PRI + 2NDRY SLUDGE FLOW, gpd	47341

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PROJECT COMPUTATION SHEET

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File Name: 113128 unit_process
Latest Revision: 31-Jul-09

Subject: Unit Process Design

	Design Conditions FY2019
Total Volume Required	
gals.	946824
Cu. Ft.	126564
Existing Aerobic Tank Volume, Cu. Ft.	58061
Required Aerobic Tank Volume, Cu. Ft.	68503
Tank Geometry	
Tank Liquid Depth, ft.	21.0
Length, ft.	220
Width, ft.	18
Unit Surface Area, sf.	3,960
Unit Volume, cf.	83,160
Unit Volume, gals.	622,037
Unit Volume, MG.	0.622
Number of Tanks Needed	0.8

SLUDGE DEWATERING CENTRIFUGES	Design Conditions FY2019

PROJECT COMPUTATION SHEET

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	Design Conditions FY2019
DESIGN ASSUMPTIONS:	
Volatile Solid in Primary Sludge, %	60
Volatile Solid in Humus, %	50
Volatile Solid Destruction in Digestion, %	55
Digested Sludge Concentration, %	4
Digested Sludge Specifc Gravity	1.04
Cake Solid Content, %	18
Solid Capture Rate, %	85
DIGESTER INFLUENT	
Fixed Solids, lbs/d	8411
Volatile Solids, lbs/d	5276
Total Sludge, lbs/d	13687
Total Sludge Flow, gpd	39451
CENTRIFUGE INFLUENT	
DIGESTED SLUDGE, lbs/d	13687
DIGESTED SLUDGE FLOW, gpd	39451
Existing Centrifue Capacity, gpm	150
NUMBER OF CENTRIFUGES REQ'D	
7 d/wk, 24 hr/d	0.18

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File Name: 113128 unit_process
Latest Revision: 31-Jul-09

Subject: Unit Process Design

Project No.:113128
Prepared By: YM
Date: 7-July-2009
Reviewed By:

	Design Conditions FY2019
5 d/wk, 8 hr/d	0.27
Number Of Centrifuges Installed	
7 d/wk, 24 hr/d	2
5 d/wk, 8 hr/d	2
Number Of Centrifuges In Service	
7 d/wk, 24 hr/d	1
5 d/wk, 8 hr/d	1

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File Name: 113128 unit_process
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Subject: Unit Process Design

	Design Conditions FY2019
HAGATNA WWTP FLOW, MGD	
TOTAL ADF	12.00
Peaking Factor from Ratio of Peak and Average Flow in GWA Master Plan	1.75
Peak Daily Wet Weather	21.00
TOTAL INFLUENT LOAD	
Avg. Flow, MGD	12.0
Peak Flow, MGD	21.0
Plant Recycle Flow, MGD	
BOD, lbs/day	18,415
TSS, lbs/day	20,717
FSS, %	40%
VSS, %	60%
FSS, lbs/day	8,287
VSS, lbs/day	12,430
BOD, mg/L	184
TSS, mg/L	207
EFFLUENT CONCENTRATION REQ.	
BOD, mg/L	85
TSS, mg/L	50

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	Design Conditions FY2019
	Design Conditions FY2019

UV DISINFECTION CHANNEL

Channel Geometry	
Length, ft	30
Width, ft	2.5
Depth, ft	6
Surface Area, sf	75
Volume, cf	450
Number Channels Installed	3
Number Channels In Service	2
Outlet Weir Structure Geometry	
Length, ft	14
Width, ft	56
Depth, ft	6
Surface Area, sf	784
Volume, cf	4704
Number Channels Installed	1
Number Channels In Service	1

Appendix D.3
Meeting Minutes

DRAFT
MEETING NOTES
GUAM WATERWORKS AUTHORITY (GWA)
PROJECT COMMENCEMENT

Date: June 10th, 2009

Location: Guam Water Authority Office - Engineering Department Building

Time: 0900 Local Time

I. Staff Attendance

- ♦ The following staff attended:
  - AECOM/Earth Tech: Claire Hunt, Yang Ma
  - GWA: Julie Shane, Brett Railey
  - NAVFAC Pacific: Kevin Oshiro
  - NAVFAC Mariana: Jack Brown, Paul Owen

II. Purpose

- The purpose of the meeting is to obtain information on the GWA water and wastewater facilities that could support the planned DoD expansion. The focus of the water and wastewater utilities study is to develop alternatives for the Marine Corps Relocation to
- Barrigada area. The selected alternatives would then be included in the EIS document.

<u>Wastewater</u>

III. Possible Impacts on GWA Sewer System

- Barrigada Cantonment Alternatives will trigger future Guam civilian as well as the project induced civilian population to locate within central sewer basin instead of prior assumed northern basin, especially along Rt15 between Barrigada and Dededo.
- GWA is not in position to give anticipated population distribution due to upcoming military buildup. JGPO should supply the respective info.

IV. Information on Existing Sewer System for Barrigada Area

- GWA does not have reliable records on sewer along Rt8, Rt10 and Rt15. The 24" VCP along Rt8 may be 40 to 50 years old. Sewer has not been surveyed, and flow meters are installed to measure the flow. The current sewer condition info and as built plans is not available. GWA doesn't have pump station capacity info for Barrigada and Manglao Pump stations. There are no records to determine ow currently how much flow they are pumping.

- Guam Water Resources Master Plan (WRMP) prepared in 2007 is not a reliable source for sewers along Rt8, Rt10 and Rt15. GWA recommend us to use as built plans, however as-built plans are not available.
  a. GWA recommends to do survey of sewer lines along Rt8, Rt10 and Rt15 for current capacity and condition, and modeling to determine the available remained sewer capacity. Suggest using local subcontractor to do sewer modeling (MWH H2O MAP sewer)

V. GWA - Upcoming Sewer Improvement Project

a. CCU approved a $37.45M contract to improve sewer lines under Marine Corps Drive in central Guam. Project is planned to start in September and will finish in 24 months. Project includes 1) Building a new PS replace Mamajanao PS in Tumon and a relief sewer directly from Tumon to Hagatna WWTP; 2) Rehabilitation of Agana Main Pump station; 3) Building a new Pump station at top of hill next to Rt4 and a new sewer relief line conveying prior Rt sewer directly into Hagatna WWTP.
b. After Marine Corps Drive sewer improvement project, only flow from Tamuning, flow from Rt8 and flow from commercial port to WWTP flow into Hagatna Main Pump station. The current flow (4-6 mgd) to Hagatna Main PS will b reduced by half after the improvement project.
c. Barrigada Cantonment Alternatives may require upgrading of the upcoming Hagatna Main Pump station.
d. Sewer lines under Marine Corp Drive and Rt4 have good records and hydraulic modeling information.

VI. Hagatna WWTP

a. Hagatna WWTP was rehabilitated in February 2007 and the plant has full design capacity of 12 mgd. Effluent discharge over 6 mgd will backflow during high tide.
b. Plant is in compliance with all discharge requirements except when there’s a dumping from septic tanks.
c. To accommodate DoD planned Barrigada flow, GWA suggests plant need to be upgraded with: 1) Septic receiving station; 2) Grit removal; 3) Advance Primary Treatment if flow reaches design capacity; 4) Disinfection with UV preferred due to high shipping cost of chlorine
d. GWA believes NPDES permit will remain as Primary Treatment unless plant incoming flow goes over 12 mgd which triggers expansion of the plant.

Appendix D.4
Photographs

Hagatna WWTP Pictures

Agana Main Pump Station

Effluent Channel for Primary Clarifier

Sludge Dewatering Building

Primary Clarifier

Effluent Pump Station

Flow Diversion Structure

Aerobic Digester

I. PARTIES

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III. REPRESENTATION

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IV. INFORMATION SHARING AND DECISION MAKING

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V. OBJECTIVES

The Parties understand that the following objectives for the MOU and subsequent agreements, as applicable are to be achieved with the urgency to ensure critical timelines are met:

1. Develop a strategy to provide adequate capability within the Island Wide Power System (IWPS) to reliably meet the projected power generation demand increase of the military build currently defined as a facilities level demand of approximately 30MW at Finegayan and Andersen and a ship support [transient] load of up to 25MW at Apra Harbor.

2. Evaluate the reliability of the IWPS consistent with requirements identified in the current Navy-GPA Customer Service Agreement (CSA) and any future contract negotiated upon expiration of the CSA.

3. Develop the transmission capability and reliability to support the increased DoD loads at Finegayan, Andersen, Apra Harbor and other affected areas.

4. There may be future power requirements, undefined at this time, that may require collaboration and resolution between DoD and GPA.

5. Identify costs attributable to increased military requirements. Details concerning allocation of these costs will be incorporated into the contractual agreements between DoD and GPA as appropriate.

6. Cooperate with federal and local agencies to resolve the challenges, including funding, to provide power generation and transmission requirements for DoD and civilian population growth associated with the military build-up.

7. Utilize available low or no cost financing from the Government of Japan (GOJ) to the extent available.

8. Work collaboratively to help GPA pursue long term development of renewable and reusable energy sources to reduce the need for new base load in the future.

9. Evaluate as a long-term objective opportunities for the privatization and/or integration of on-base distribution system with GPA.

10. Work to develop and utilize common standards related to security, reliability, interoperability, construction and performance.

11. Work collaboratively to achieve a timely transition to an IWPS fuel mix that meets EPA requirements.

VI. PROPOSED SOLUTIONS

The Parties understand that the following proposals represent the most promising solutions based upon available information, financial, technical, and legal constraints to the objectives identified above.

1. Combustion Turbines:

a. DoD has funded a study to evaluate the feasibility of reconditioning five existing combustion turbines (CT's) owned by GPA (Dededo #1 22 MW, Dededo #2 – 22 MW, Macheche – 22 MW, Marbo – 16 MW, and Yigo – 22 MW). Depending upon the results of this study, the Parties will identify up to three CT's that can be reconditioned to meet the DoD's requirement of 55 MW of system reliability.

b. In the event that additional generating capacity is required, the Parties will evaluate the possibility of reconditioning additional CT's as outlined above or the steps necessary for GPA to pursue long term development of new base load generation capacity. DoD anticipates that it would be able to identify whether the additional capacity requirement exists by December 2015 and would endeavor jointly with GPA to determine and pursue the best option to provide such additional capacity by that date.

c. The reconditioning and operation of the reconditioned CT's may be done through a private entity created for the purpose of receiving low-cost financing from GOJ.

d. GPA may be able to contract with the private entity for the reconditioning and subsequent maintenance and operation of the CT's in a manner similar to existing GPA Independent Power Producer (IPP) and Performance Management Contracts.

e. DoD would endeavor to negotiate favorable terms with GOJ for the financing of the private entity. The private entity may also be required to obtain alternate financing.

f. Secure the services via a contract agreement between the private entity and GPA.

g. The contract between DoD and GPA would reflect a rate structure that would allow GPA to recover agreed upon costs to improve the system, including costs associated with a low or no cost loan/bond with in the current rate structure adjusted for inflation..

2. Transmission and Distribution.

a. DoD and GPA will plan and develop transmission and distribution systems that support DoD requirements that are located within the installation and/or on Federal property. Ownership of the transmission system will be transferred to GPA upon terms acceptable to GPA and DoD.

b. GPA will develop and/or upgrade the transmission system not located on the installation, but required to support increased DoD loads. Agreed upon costs associated with transmission facilities exclusively serving DoD loads shall be assigned to DoD. Costs for such transmission facilities serving both DoD and civilian loads shall be allocated between DoD and civilian customers in a manner consistent with Section V.5 above. Such development and/or upgrades will be made consistent with the terms of the contracts or agreements and GPA's approved service rules and rate schedules.

3. Renewable Energy

a. The Parties agree to cooperate and share information in discussing and planning possible projects to create electricity from geothermal, wind, solar, ocean/tidal, or other alternate sources of energy.

b. The Parties will cooperatively research and pursue alternate funding sources to implement renewable energy options within the IWPS.

4. Demand Side Management (DSM)

a. DoD and GPA will explore opportunities and solutions for improved demand side management.

VII. NEXT STEPS

In order to facilitate the possible implementation of the foregoing solutions the Parties agree to engage in further discussions:

1. Evaluate appropriate contractual and rate structures between GPA and DoD that will provide reasonable security to a private entity and GPA for the repairs and reconditioning of the existing CTs to increase reliability.

2. Evaluate applicable contractual and service rules covering DoD contributions to transmission system development and determine if such provisions are adequate and fair to both parties.

3. Evaluate the feasibility of GPA contracting with a private entity for the refurbishment of CT's and the operation and maintenance of such units. Identify any legal or financial barriers and proposed solutions. Identify any required technical assistance from DoD.

4. Develop agreements to formalize the concepts provided herein.

VIII. OTHER PROVISIONS

1. This MOU may be amended subject to the mutual written agreement of the Parties.

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I. PARTIES

Parties to this Memorandum of Understanding (MOU) are the United States Navy and the Guam Waterworks Authority (GWA).

II. PURPOSE

It is the desire of the Parties that through joint planning and cooperation the requirements to meet the water and waste water needs expected from the proposed military buildup on Guam can be met in a manner that is mutually beneficial and maximizes the effectiveness of the overall Department of Defense (DoD) and GWA utility systems. The purpose of this MOU is to establish objectives and a framework for further discussions relating to the implementation of utility service solutions devised to address the projected additional water and waste water requirements of the proposed military build up in Guam due to the planned relocation of Marines from Okinawa to Guam and other matters identified in the Draft EIS/OEIS Guam and CNMI Military Relocation. The Parties further recognize that this MOU, and the objectives, goals, and processes agreed upon are subject to applicable laws of the United States and the Government of Guam, and that such legal requirements applicable to either Party take precedence over any understanding reflected in this MOU.

III. REPRESENTATION

The Parties may appoint and designate representatives to meet, at such times and places as are mutually convenient. As necessary, the Parties may invite representatives from relevant Federal and GovGuam agencies that may have a stake in these matters to participate in the discussions. The parties agree to work in good faith to accomplish the objectives set forth in this MOU.

IV. INFORMATION SHARING AND DECISION MAKING

The Parties agree to make every reasonable effort to share with one another existing information relevant to their water-related requirements and proposed solutions in a timely manner. Such information may consist of technical descriptions of each supplier's facilities, planning studies, estimates, requirements, designs, rates, schedules, and forecasts. Each Party will designate a representative to respond promptly to requests for information or explain why such information cannot be provided.

V. OBJECTIVES

The Parties recognize that all the water resources on Guam are critical assets essential to the future of Guam and must be protected for present and future uses. This fundamental principle will guide the objectives set forth below, the efforts to provide water for the people of Guam and cooperation between the Parties.

The Parties understand that the following general objectives are to be achieved:

1. Identify costs attributable to increased military requirements. Details concerning allocation of those costs will be incorporated into the agreements as appropriate.

2. Cooperate with federal and local agencies to resolve the challenges, including funding, to provide potable water and waste water treatment services for DoD and civilian population growth associated with the military build-up.

3. Work to develop and utilize common standards related to security, reliability, interoperability, construction and performance.

4. Utilize available low or no cost financing from the Government of Japan (GOJ) to the extent available.

DRINKING WATER OBJECTIVES:

1. Develop processes for sharing information and making resource and infrastructure decisions, with the ultimate goal of joint management of the Northern Guam Lens Aquifer (NGLA) and protection of water resources on Guam.

2. Develop permanent drinking water supplies sufficient to meet:

a. the requirements of the military buildup on Guam and associated requirements identified in the EIS, and

b. the requirements of Guam's projected civilian growth and development.

c. future requirements of the people of Guam extending beyond the military buildup and its related impacts.

3. Improve the overall quality, reliability and availability of the water supply for all of Guam.

4. Provide the framework for subsequent agreements for the transfer, exchange and cost recovery of water resources between the Parties.

5. Coordinate efforts to resolve the challenges of providing water treatment for DoD and civilian populations.

WASTE WATER OBJECTIVES

1. Cooperate with regulatory agencies to resolve the challenges of providing waste water treatment for Guam civilian and DoD population growth.

2. Improve waste water collection and treatment for all of Guam.

3. Cooperate in making facility and infrastructure planning decisions.

4. Support GWA efforts to improve capability of its existing waste water treatment plants to continue to support DoD needs.

5. Provide the framework for subsequent agreements for the treatment of DoD wastewater at GWA facilities.

FUTURE OBJECTIVES

1. The Parties agree to evaluate opportunities to integrate military and civilian water and wastewater systems on Guam. Such integration may involve the future transfer of production, distribution, collection, and treatment systems from Navy to GWA. The Parties understand that such transfer would require a long term demonstration by GWA of their capability to maintain a world class level of service, agreement on terms and conditions acceptable to both GWA and DoD, and possible legislative authorization.

2. The Parties agree to establish an interagency agreement for laboratory services.

VI. PROPOSED SOLUTIONS

The following proposals represent the most promising solutions based upon current information, financial, technical, and legal constraints to the objectives identified above.

1. GWA will develop and/or upgrade water and waste water distribution, collection, and treatment systems not located on DoD property, but required to support the increased DoD loads.
2. The Parties will cooperate in determining the most cost effective and timely source(s) of funding to facilitate the proposed solutions.
3. The Parties will identify potential sources of funding for infrastructure impacts associated with the military buildup to include low or no cost funding from GOJ.
4. Agreed upon costs associated with meeting DoD requirements will be allocated to and paid for by DoD through a utility agreement, including costs associated with low or no cost loan/bond within the current rate structure adjusted for inflation.

DRINKING WATER

1. The Parties will cooperate in completing studies related to meeting the water needs of Guam including NGLA sustainability studies. DoD studies related to water resources will seek prior coordination with GWA and, as needed, GEPA, United States Geological Survey (USGS) and University Of Guam Water & Environmental Research Institute (UOG/WERI). Future studies will be

coordinated between GWA, DoD and other Federal and GovGuam agencies that may have a stake or required expertise in these matters. GWA will assist DoD in the development of the objectives and methodology to accomplish such studies.

2. The Parties will cooperate in the selection of future water well sites.

3. The Parties will cooperate in developing appropriate plans for the integration of new water production and distribution infrastructure with existing water systems.

4. The Parties will share water resources as needed to address urgent needs.

WASTEWATER

1. The preferred option for addressing all wastewater needs in northern Guam is to upgrade and/or expand Guam's Northern District Waste Water Treatment Plant (NDWWTP).

2. The Parties will develop a process that addresses the planning loads for the NDWWTP as a basis for calculating cost sharing and sources of funds to facilitate agreement on responsibility for each element.

3. The Parties agree to cooperate in efforts to increase the capacity of the NDWWTP to address applicable regulatory requirements and recognize that such projects must be planned and phased consistent with available funding and regulatory requirements.

4. The parties agree to cooperate to assess potential impacts to other wastewater infrastructure and identify options for mitigating the impacts.

LONG TERM AQUIFER MANAGEMENT

The Parties will cooperate in all aspects of water resource development on Guam to ensure the long term, sustainable management of the NGLA. In order to accomplish this objective, the Parties will designate representatives to convene a management advisory team to make recommendations on priorities and issues. The following provides an initial outline for this team:

1. Senior Advisory Group (SAG) – This group will meet to review recommendations of the Working Group (WG), technical experts and regulatory agencies. SAG will cooperate in developing a prioritization of major water resource infrastructure projects and sharing of water resources based on current assessments of the NGLA. SAG will consist at a minimum of:

a. GWA General Manager or designated representative.

b. CO, NAVFAC MARIANAS or designated representative.

c. CCU, Chairman or designated representative

d. GEPA, Administrator or designated representative

e. UoG-WERI Director or designated representative

2. Working Group (WG) – This group will meet regularly but no less than quarterly to assess the health of the NGLA, make minor adjustments as needed to water resource sharing, and develop a prioritized list of recommendations for SAG on proposed, major water resource infrastructure projects. WG will consist at a minimum of:

a. GWA Chief Engineer

b. NAVFAC MARIANAS UEM Product Line Coordinator

c. GEPA Representative

3. Technical Experts (TE) – This group will maintain regular communication as needed to share water resource data real time and raise concerns and issues to the WG. TE will develop and maintain all databases and technical tools in cooperation with WERI and USGS needed to monitor and assess the health of the NGLA. TE will consist, at a minimum, of:

a. GWA Engineering Staff

b. NAVFAC MARIANAS UEM

c. GEPA

d. WERI

e. USGS

VII. NEXT STEPS

In order to facilitate the possible implementation of the foregoing solutions the parties agree to have further discussions to:

1. Evaluate appropriate rate structures that will provide reasonable security to any private entity and to GWA for the development of additional water and waste water infrastructure.

2. Evaluate applicable laws, service rules and contracts for DoD contributions to system development and determine if such provisions are adequate and fair to both parties.

3. Evaluate the feasibility of a private entity performing the upgrade and/or expansion of the NDWWTP and other infrastructure related to the operation and

maintenance of the facility. Identify any legal or financial barriers and proposed solutions. Identify any required technical assistance from DoD.

4. Evaluate and monitor the timelines required to implement the proposed solutions relative to the timelines required to meet the demand increase resulting from military and civilian population growth.

5. Develop agreements to formalize the concepts provided herein.

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7. Utilize available financing from the Government of Japan (GOJ) to the extent available.

8. Work collaboratively to help GPA pursue long term development of renewable and reusable energy sources to delay timing and/or reduce generation capacity for future new base load.

9. Evaluate as a long-term objective opportunities for the privatization and/or integration of on-base distribution system with GPA.

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2. Cooperate with federal and local agencies to resolve the challenges, including funding, to provide potable water and waste water treatment services for DoD and civilian population growth associated with the military build-up.

3. Work to develop and utilize common standards related to security, reliability, interoperability, construction and performance.

4. Utilize available financing from the Government of Japan (GOJ) to the extent available.

DRINKING WATER OBJECTIVES:

1. Develop processes for sharing information and making resource and infrastructure decisions, with the ultimate goal of joint management of the Northern Guam Lens Aquifer (NGLA) and protection of water resources on Guam.

2. Develop permanent drinking water supplies sufficient to meet:

a. the requirements of the military buildup on Guam and associated requirements identified in the EIS, and

b. the requirements of Guam's projected civilian growth and development.

c. future requirements of the people of Guam extending beyond the military buildup and its related impacts.

3. Improve the overall quality, reliability and availability of the water supply for all of Guam.

4. Provide the framework for subsequent agreements for the transfer, exchange and cost recovery of water resources between the Parties.

5. Coordinate efforts to resolve the challenges of providing water treatment for DoD and civilian populations.

WASTE WATER OBJECTIVES

1. Cooperate with regulatory agencies to resolve the challenges of providing waste water treatment for Guam civilian and DoD population growth.

2. Improve waste water collection and treatment for all of Guam.

3. Cooperate in making facility and infrastructure planning decisions.

4. Support GWA efforts to improve capability of its existing waste water treatment plants to continue to support DoD needs.

5. Provide the framework for subsequent agreements for the treatment of DoD wastewater at GWA facilities.

FUTURE OBJECTIVES

1. The Parties agree to evaluate opportunities to integrate military and civilian water and wastewater systems on Guam. Such integration may involve the future transfer of production, distribution, collection, and treatment systems from Navy to GWA. The Parties understand that such transfer would require agreement on terms and conditions acceptable to both GWA and DoD, subject to GWA meeting reasonable minimum reliability and quality standards, and possible legislative authorization.

2. The Parties agree to establish an interagency agreement for laboratory services.

VI. PROPOSED SOLUTIONS

The following proposals represent the most promising solutions based upon current information, financial, technical, and legal constraints to the objectives identified above.

1. GWA will develop and/or upgrade water and waste water distribution, collection, and treatment systems not located on DoD property, but required to support the increased DoD loads.
2. The Parties will cooperate in determining the most cost effective and timely source(s) of funding to facilitate the proposed solutions.
3. The Parties will identify potential sources of funding for infrastructure impacts associated with the military buildup to include funding from GOJ.
4. Agreed upon costs associated with meeting DoD requirements will be allocated to and paid for by DoD through a utility agreement.

DRINKING WATER

1. The Parties will cooperate in completing studies related to meeting the water needs of Guam including NGLA sustainability studies. DoD studies related to water resources will seek prior coordination with GWA and, as needed, GEPA, United States Geological Survey (USGS) and University Of Guam Water & Environmental Research Institute (UOG/WERI). Future studies will be coordinated between GWA, DoD and other Federal and Gov. Guam agencies that may have a stake or required expertise in these matters. GWA will assist

DoD in the development of the objectives and methodology to accomplish such studies.

2. The Parties will cooperate in the selection of future water well sites.

3. The Parties will cooperate in developing appropriate plans for the integration of new water production and distribution infrastructure with existing water systems.

4. The Parties will share water resources as needed to address urgent needs.

WASTEWATER

1. The preferred option for addressing all wastewater needs in northern Guam is to upgrade and/or expand Guam's Northern District Waste Water Treatment Plant (NDWWTP).

2. The Parties will develop a process that addresses the planning loads for the NDWWTP as a basis for calculating cost sharing and sources of funds to facilitate agreement on responsibility for each element.

3. The Parties agree to cooperate in efforts to increase the capacity of the NDWWTP to address applicable regulatory requirements and recognize that such projects must be planned and phased consistent with available funding and regulatory requirements.

4. The parties agree to cooperate to assess potential impacts to other wastewater infrastructure and identify options for mitigating the impacts.

LONG TERM AQUIFER MANAGEMENT

The Parties will cooperate in all aspects of water resource development on Guam to ensure the long term, sustainable management of the NGLA. In order to accomplish this objective, the Parties will designate representatives to convene a management advisory team to make recommendations on priorities and issues. The following provides an initial outline for this team:

1. Senior Advisory Group (SAG) – This group will meet to review recommendations of the Working Group (WG), technical experts and regulatory agencies. SAG will cooperate in developing a prioritization of major water resource infrastructure projects and sharing of water resources based on current assessments of the NGLA. SAG will likely consist at a minimum of:

   a. GWA General Manager or designated representative.

   b. CO, NAVFAC MARIANAS or designated representative.

   c. CCU, Chairman or designated representative

   d. GEPA, Administrator or designated representative

   e. UoG-WERI Director or designated representative

2. Working Group (WG) – This group will meet regularly but no less than quarterly to assess the health of the NGLA, make minor adjustments as needed to water resource sharing, and develop a prioritized list of recommendations for SAG on proposed, major water resource infrastructure projects. WG will consist at a minimum of:

   a. GWA Chief Engineer

   b. NAVFAC MARIANAS UEM Product Line Coordinator

   c. GEPA Representative

3. Technical Experts (TE) – This group will maintain regular communication as needed to share water resource data real time and raise concerns and issues to the WG. TE will develop and maintain all databases and technical tools in cooperation with WERI and USGS needed to monitor and assess the health of the NGLA. TE will consist, at a minimum, of:

a. GWA Engineering Staff

b. NAVFAC MARIANAS UEM

c. GEPA

d. WERI

e. USGS

VII. NEXT STEPS

In order to facilitate the possible implementation of the foregoing solutions the parties agree to have further discussions to:

1. Evaluate appropriate rate structures that will provide reasonable security to any private entity and to GWA for the development of additional water and waste water infrastructure.

2. Evaluate applicable laws, service rules and contracts for DoD contributions to system development and determine if such provisions are adequate and fair to both parties.

3. Evaluate the feasibility of a private entity performing the upgrade and/or expansion of the NDWWTP and other infrastructure related to the operation and

maintenance of the facility. Identify any legal or financial barriers and proposed solutions. Identify any required technical assistance from DoD.

4. Evaluate and monitor the timelines required to implement the proposed solutions relative to the timelines required to meet the demand increase resulting from military and civilian population growth.

5. Develop agreements to formalize the concepts provided herein.

VIII. OTHER PROVISIONS

1. This MOU may be amended subject to the mutual written agreement of the Parties.

2. This MOU does not obligate the funds of either Party and makes no financial commitments.

3. This MOU may be terminated by either Party upon providing 30 days written notice to the other.

4. This MOU is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity, by any party against the United States or GWA, or agencies, instrumentalities, officers, employees, or agents, of either.

______________________________	______________________________
JOINT REG MARIANAS	**CHAIR, CCU**
Date:__________________________	Date:__________________________
______________________________	______________________________
NAVFAC MARIANAS	**GM, GWA**
Date:__________________________	Date:__________________________

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