Ebeye 2010 Infrastructure Survey Report

565th EN DET (FEST-A)

United States Army Corps of Engineers

Honolulu Engineer District

15 June 2010

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, HONOLULU DISTRICT
FORT SHAFTER, HAWAII 96858-5440

REPLY TO
ATTENTION OF:

CEPOH-FE

15 June 2010

MEMORANDUM THRU Commander, US Army Corps of Engineers, Honolulu District, CEPOH-DE, Bldg 230, Forth Shafter, HI 96858-5440

FOR Commander, US Army Kwajalein Atoll / Reagan Test Site
CMR 701, Bldg 730, APO, AP 96555

SUBJECT: Ebeye Infrastructure Reconnaissance Report Closure Memorandum

1. In September 2009, the US Army Kwajalein Atoll (USAKA) Command requested support from the Honolulu District US Army Corps of Engineers to conduct a field engineering survey of the civil infrastructure on the Island of Ebeye.

2. The 565th Engineer Detachment, Forward Engineer Support Team-Advance (FEST-A) deployed to Kwajalein Atoll from April 1-14, 2010. The team surveyed four major utility systems on the island of Ebeye (Sewer, Water, Electrical, and Trash).

3. The objectives of this survey included: assessing existing conditions of utilities, researching operations and maintenance processes, identifying deficiencies, documenting findings, and recommending improvements.

4. The enclosed formal report was prepared and forwarded to the Honolulu District Executive Office, Engineering and Construction, Programs and Project Management, Office of Counsel, and the USACE Reachback Operations Center for comment and review. All comments and recommended changes were addressed or incorporated into the final report, dated June 15, 2010.

5. This report is intended to provide decision makers with critical infrastructure information to aid in capital planning and resource allocation.

6. This memorandum formally closes out the 565th Engineer Detachment's requirements for this mission. Please refer any questions to the undersigned at 540-686-2700.

FOR THE COMMANDER:

Encl

EVAN TING
MAJ, USA
Commanding

CEPOH-FE
SUBJECT: Ebeye Infrastructure Reconnaissance Report Closure Memorandum

565th Engineer Detachment (FEST-A):

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EXECUTIVE SUMMARY

Title: Infrastructure Survey of Ebeye, Republic of Marshall Islands (RMI)

Problem: Ebeye's critical utility infrastructure is deteriorated and is unable to sustain the current population.

Background: In September 2009, the U.S. Army Kwajalein Atoll (USAKA) Command requested support from the Honolulu District U.S. Army Corps of Engineers to conduct a field engineering survey of the civil infrastructure on the Island of Ebeye. In response to this request the 565th Engineer Detachment, Forward Engineer Support Team-Advance (FEST-A) was deployed to Kwajalein Atoll from 1 through 14 April 2010. The team surveyed four major utility systems on the island: Sewer, Water, Electrical, and Trash. The objectives of this survey was to assess the existing conditions of these utilities, research the processes used to operate and maintain them, identify deficiencies, document findings, and recommend improvements.

Findings: The overall condition of Ebeye's infrastructure is poor. Of the categories surveyed, only Electricity was determined to be in good condition. Other systems were unable to support the existing population, presented a health risk, or were non-functioning. Ebeye's infrastructure is compromised by a corrosive salt environment, lack of consistent maintenance, and deprivation of improvement investment. The following is a list of major findings by utility:

Sewer – The sanitary sewer treatment plant has not operated in five years. Raw sewage is released directly to the ocean approximately 500 feet offshore. Sanitary sewer equipment is inadequately sized and dilapidated from lack of maintenance and spare parts. Storm sewers are non-functioning due to being clogged. In addition, heavy rain events result in flooding of various areas throughout Ebeye.

Water – The water distribution and production system do not have enough capacity nor pressure to support the population. Water is rationed and is currently being distributed twice a week for durations of 45 minutes. There is a lack of spare parts, pumps, and one of three Reverse Osmosis filtration units is non-operational.

Electricity – The electrical generation and distribution system are in overall good condition. Ebeye has made recent improvements to the system and it is safe, reliable, and has the capacity to serve the population. However, there is a lack of redundancy for generator maintenance. In addition, the low voltage distribution requires upgrade and the switchgear equipment is antiquated.

Trash – The solid waste management system on Ebeye poses a health concern because they do not have a sustainable means of disposing trash. Trash is collected and deposited into an unsecure open dump, prior to being burned for volumetric reduction. The burning is often inadequate leaving a source for bacterial growth and promotion of vectors. There is a risk of toxic material contamination to adjacent and underground waters. Additionally, there are health risks to residents bordering the dumpsite.

Recommendations: The team recommends a total of 24 projects which are based on the assumption that Ebeye's current population is 15,000 persons. An accurate census report or other means should be used to verify this data. Below are the top three recommendations (projects) for each utility system:

Sewer
1. Bring the sewage treatment plant to an operational status and upgrade to meet U.S. EPA effluent standards.
2. Clear the existing drainage structures of sand and debris to bring to an operational status.
3. Replace pumps and controls in the sewage lift stations.

Water
1. Increase salt water production to supply adequate feed water for fresh water production and increase line pressure.
2. Increase fresh water production and line pressure to meet current population demand (15,000 PN).
3. Install salt and fresh water distribution system at north end of island.

Electrical
1. Install standby generator. Major scheduled maintenance on any generator cannot be performed until this standby generator is installed.
2. Upgrade low-voltage distribution system. Overhead lines are deteriorated and the wood poles were found to be of marginal integrity and structurally unsound.
3. Replace power plant switchgear. The switchgear ability to safely interrupt a fault is indeterminate because it is too old.

Trash
1. Construct engineered landfill. Environmental and health risks will be greatly reduced by controlling leachate and covering processed solid waste.
2. Install perimeter fence at landfill to secure and control access.
3. Install burn box for trash burning. The burn box burns trash more efficient in a controlled area which reduces the risk of spreading fire throughout the landfill.

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INTRODUCTION

The Island of Ebeye

The Island of Ebeye is located in the Kwajalein Atoll, Republic of the Marshall Islands (RMI). The coral and sand island is relatively flat with little topographical change in elevation; the maximum elevation is approximately 10 feet above mean sea level. The island is roughly 7,000 feet long by 800 feet wide (80 acres), and is located approximately 250 miles Northwest of the capital city of Majuro and 2,500 miles Southwest of Honolulu Hawaii (Figure 1.1). A series of causeways connect Ebeye to five smaller islands, which together form a small archipelago under the jurisdiction of the Kwajalein Atoll Local Government (KALGov). The main island has a population of approximately 15,000 residents and is likely to continue increasing for the foreseeable future. Ebeye is considered the most densely populated island in the pacific. In recent years the utility infrastructure has presented several serious challenges including frequent power outages, drinking water shortages, improper sanitation, and inadequate waste disposal.

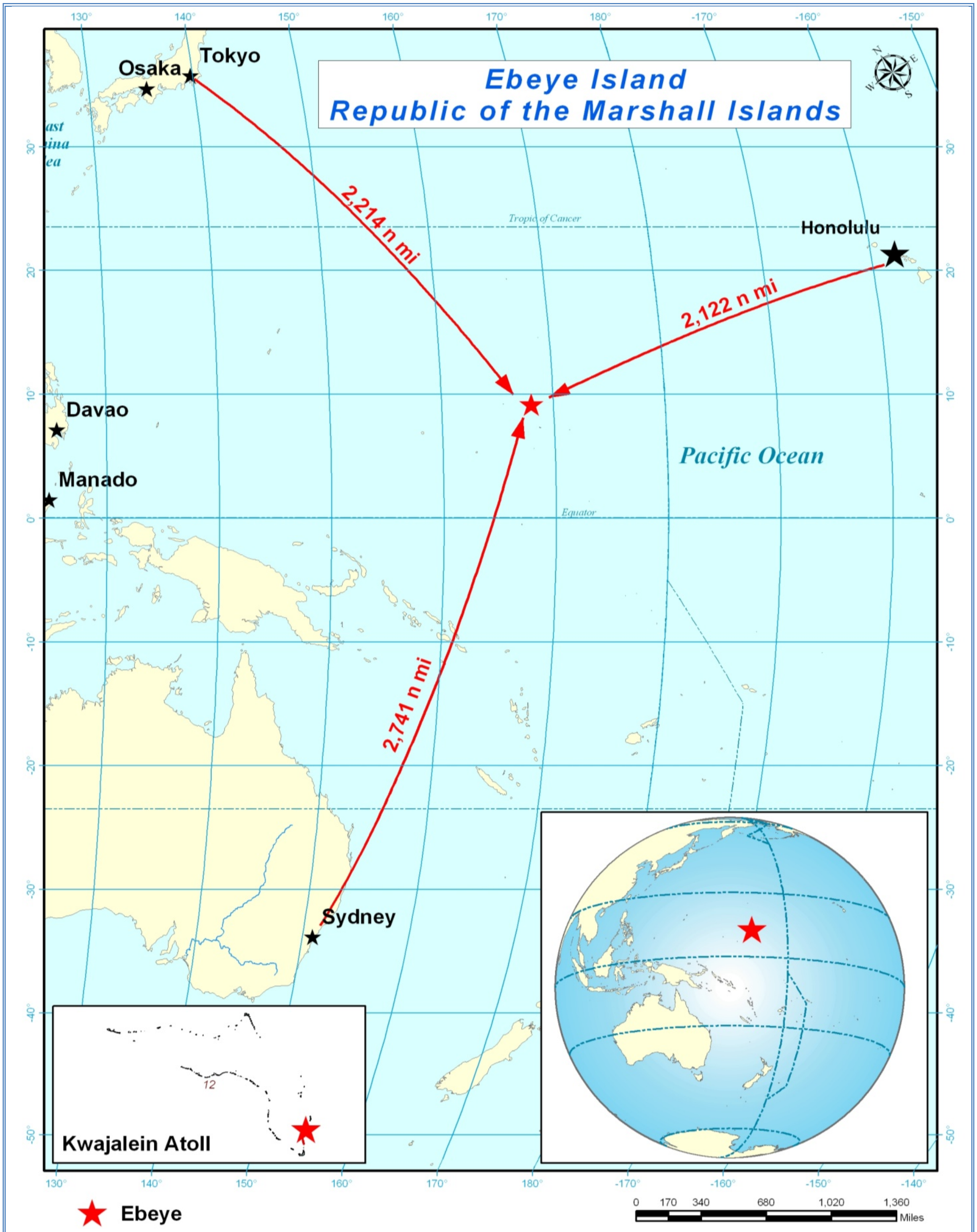

Figure 1.1 –Ebeye Location

Mission Background

In September of 2009 the U.S. Army Kwajalein Atoll (USAKA) Commander, COL Frederick Clark and the Honolulu District U.S. Army Corps of Engineers (USACE) Commander, LTC Jon Chytka discussed future Military Construction (MILCON) projects on the island of Kwajalein. In addition, the commanders discussed Ebeye's failing infrastructure, the need for a survey of Ebeye's utility systems, and training required for a specialized team of U.S. Army engineers. The USAKA staff proposed the idea to the Republic of the Marshal Islands (RMI). The RMI are aware of their infrastructure challenges, and have had previous surveys conducted, but welcomed the idea of getting an updated perspective. Shortly thereafter, LTC Chytka tasked the 565th Engineer Detachment, commonly known as a Forward Engineer Support Team-Advance (FEST-A) to conduct the survey. This mission was used to train the FEST-A for future contingency operations. Consequently, the FEST-A executed the mission at no cost to either the RMI Government or USAKA. On February 17, 2010, a definitive Scope of Work (SOW) was developed and agreed upon between USAKA (MAJ Christopher Mills, Director of Host Nation Activities), representatives from Space Missile Defense Command (SMDC), RMI, and MAJ Evan Ting, 565th Engineer Detachment Commander. Immediately following SOW development, the FEST-A initiated the mission planning process. Major Mills assisted with coordination of logistical support for the team's mission. The FEST-A team was deployed to Kwajalein Atoll to conduct field data collection April 1 - 14, 2010.

Scope of Work and Purpose

The FEST-A's scope of work for this mission entailed conducting an infrastructure survey focusing on the following utility systems:

- Sewer
  - Sanitary sewer
  - Storm sewer
- Water
  - Fresh water
  - Salt water
- Electrical
  - Generation
  - Distribution
- Trash
  - Collection
  - Disposal (Dumpsite)

The following are some of the key tasks associated with the scope of work above:

- Conduct mission in brief to USAKA Command and staff and representatives from RMI.
- Partner with the technical POC's of Kwajalein Atoll Joint Utilities Resources (KAJUR) and the Ebeye local government to conduct on-site field surveys for each system.
- Conduct field surveys to gather necessary system and condition data for each system. Evaluate findings and rough order of magnitude (ROM) estimates with respect to the previous Situation report by Office of the Chief Secretary of Majuro Island, dated 2008.
- In coordination with USAKA, KALGov and KAJUR, develop a prioritized project listing with ROM cost estimates to identify recommended system repairs and upgrades. These projects are intended to improve system safety, functionality, reliability, and maintainability. The highest priority will be assigned to projects that restore critical system capabilities to meet basic life needs, focusing on sustainability and maintainability.
- Create a single utility map that integrates Sewers, Water, Electricity, and Trash.
- Provide an out brief to USAKA Command and staff, KALGov, KAJUR, Chief Secretary to RMI, and representatives of the U.S. Embassy, to present preliminary survey findings and recommendations.
- Prepare a final report to include results of all significant observations, findings and recommendations. In addition, the report will include a recommended priority project list as described above. In cases where the current system design is not considered adequate, the projects to expand or modify the existing system will be identified.

Team Composition

The following is a list of team members from the 565th EN DET (FEST-A):

MAJ Evan Ting	Detachment Commander
Mr. Luong Tran, PE	Electrical Engineer
Mr. Ismael Delgado	Environmental Engineer
Mr. David Hinkle	Cartographer
Mr. Jon Hosaka	Mechanical Engineer
Mr. Edward McBride, PE	Civil Engineer

The following is a list of RMI representatives that assisted with field surveys:

Mr. Rodrigues Nakamura	KAJUR General Manager
Mr. James Kabua	KAJUR Water Superintendent
Mr. Majina Jacklick	KAJUR Water Plant Superintendent
Mr. Tony Loeak	KAJUR Electrical Distribution Superintendent
Mr. Samuel Dunahoe	KAJUR Power Plant Manager
Mr. Jojabot Kijabot	KAJUR Salt and Waste Water Supervisor
Mr. Roland Calvin	KALGov Engineer

The following is a list of USAKA staff members' who coordinated the mission and provided mission and logistical support to the team:

MAJ Christopher Mills	Director of Host Nation Activities, USAKA
Mr. Michael Sakaio	RMI Relations Specialist, USAKA

SWEAT-MSO Methodology

The survey was conducted in accordance with U.S. Army Infrastructure Reconnaissance (IR) doctrine Field Manual 3-34.170 Engineer Reconnaissance and ERDC/CERL SR-07-16, 17, 18 SWEAT Vol. 1, 2, and 3 (US Army Corps of Engineers Research and Development Center), (Headquarters Department of the Army & United States Marine Corps). The major areas of focus in this survey are defined by the acronym, SWEAT-MSO (an acronym that refers to the major categories of infrastructure reconnaissance; Sewer, Water, Electricity, Electrical, Academics, Trash - Medical, Safety and Other Considerations). The categories of Academics, Medical, and Safety are not covered in this survey. According to doctrine, "Infrastructure reconnaissance is focused on gathering technical information on the status of the large-scale public systems, services, and facilities of a country or region that are necessary for economic activity" (Headquarters Department of the Army & United States Marine Corps). Infrastructure reconnaissance is conducted in two phases: the assessment and the survey.

The assessment is normally conducted by operational forces as part of a tactical operation or in support of an operation. This phase provides a general synopsis of infrastructure conditions. The survey is a more in-depth investigation of the infrastructure to determine the condition of existing utilities and services. The FEST-A conducted the survey phase of infrastructure reconnaissance. During this survey phase, consultation with subject matter experts is often employed in order to augment team capabilities and provide additional engineering manpower.

For this mission U.S. Army Corps of Engineers Reachback Operations Center (UROC) engineers provided subject matter expert support ranging from sewage treatment plant design to reverse osmosis desalinization system construction cost estimates. Although this phase is both more technically focused and more detailed than the assessment phase, it does not replace purely technical engineering studies required for specific construction projects. This report is intended to provide decision makers with critical infrastructure information to aid in capital planning and resource allocation.

For this survey the team was able to review a variety of previous studies (shown in the bibliography), conduct wide ranging interviews with utility operators and managers and review construction plans and drawings.

Daily meetings with USAKA, and KAJUR during the survey helped the team resolve questions, focus resources on the highest survey priorities and maximize the effectiveness of KAJUR and KALGov assistance.

The FEST-A team employed the following methods to conduct their survey:

1. Formed four teams (Sewer, Water, Electricity, and Trash), partnering with representatives from KAJUR and KALGov to conduct field surveys.
2. Conducted interviews with utility operators, staff, and managers from KAJUR and KALGov in order to gain understanding of systems and processes, and to gather undocumented historical data.
3. Reviewed previous Ebeye infrastructure studies conducted others (shown in bibliography), in order to gain understanding of systems and challenges from differing perspectives.
4. Conducted field site visits for data collection, identification and validation of system processes, and to identify of systems components and deficiencies.
5. Reviewed construction and as-built documents to assist in identifying and confirming system components and processes.
6. Conducted surveys primarily by ocular inspections and documented findings with field notes and photographs.
7. Utilized FM 3-34.170 checklists as a survey guideline.
8. Consulted with subject matter experts (SMEs) from UROC, EPA, and Honolulu Engineer District.
9. Conducted daily meetings with USAKA and KAJUR during the survey to resolve questions, focus resources on the highest survey priorities and maximize the effectiveness of KAJUR and KALGov assistance.

As a tactical unit, the FEST-A is equipped with basic survey tools including flashlights, tape measures, multi-meters, laser range finders, Tele-Engineering Communications Equipment-Deployable (TCE-D) for video teleconferencing, Broadband Global Area Network (BGAN) satellite equipment, Automated Route Recon Kit (ARRK), digital cameras, and Coarse Acquisition (C/A) based GPS units. It should be noted that not all equipment was required nor used. In addition, some equipment that would have been useful in conducting the survey, were not available (i.e. survey grade GPS, toning equipment, etc.).

At the conclusion of the field survey the team provided an outbriefing to discuss preliminary survey findings to the Chief Secretary of the RMI, representatives of both KAJUR and KALGov, USAKA Commander and Staff, and members from the U.S. Embassy in Majuro.

In the survey process each utility is assigned a status code of Black, Red, Amber, or Green. Table 1.1 below provides a working description of each status category for each SWEAT-MSO survey area.

STATUS COLOR CODING OF INFRASTRUCTURE CATEGORIES (Table 6-3 FM 3-34.170)

Area	Green	Amber	Red	Black
Sewage	Sewage system works consistently No sewage observed and no odor Operational in 100% of public facilities	Sewage system works but treatment status undetermined No sewage observed but odor present and/or system damaged Operational in 50% or more of public facilities	No treatment observed but treatment plant exists Sewage observed and odor present Operational in less than 50% of public facilities	No sewage treatment system, destroyed Presence of raw sewage is a public health issue No operational sewage in public facilities
Water	Water distribution works at 100% capacity Tested as clean and/or local populace is consuming Running water in 100% of public facilities	Water distribution works at 50% or more of capacity/some leaks Appears clean, no smell and local populace states that it is clean Running water in 50% or more of public facilities	Water distribution does not work Does not appear clean and local populace states that it is not clean Running water in less than 50% of public facilities	No water distribution system, destroyed Tested non-potable and/or appears contaminated and has bad odor No running water in public facilities
Electricity	Power distribution system works; blackouts are planned Electric lines are 100%; no damage/no power loss Power grid station intact; secure	Power distribution system works; blackouts unplanned Electric lines are 50%; some minor damage/ undetermined power loss Power grid station operational; unsecure	Power distribution system is unreliable; frequent blackouts Electric lines are less than 50%; major damage/ noticeable power loss Power grid station nonoperational; unable to secure	No power distribution system, destroyed Electric lines are all down; hot wires exposed; significant power loss Power grid station stripped; destroyed
Trash	Formal trash collection system is operational Trash collection is in a central area that does not present a health hazard No trash buildup in public area	Formal trash collection system exists but is limited Unknown central trash collection area Limited trash in public facilities; relatively clean	No formal trash collection system Central trash collection area presents a possible health hazard Public facilities have no means to remove trash	No trash collection Trash is consolidated in an area that presents a health hazard Public facilities have excess trash

Table 1.1 - SWEAT –MSO Status Description

DRAFT

Utility Mapping Methods

In conjunction with the survey, the team prepared a utility map for each major system. Most map data was obtained through field surveys using handheld GPS units. System component locations were then compared with high resolution satellite imagery (QuickBird 0.6 meter resolution, captured in 2006) to correct GPS related inaccuracies. KAJUR and KALGov staff members were interviewed to determine the location of underground utility lines. A variety of construction and some as-built drawings were reviewed in order to identify features not observed during field surveys and to verify system component locations. All features were stored in a Spatial Data Standard for Facilities, Infrastructure and Environment (SDSFIE) compliant geodatabase. To the extent possible infrastructure component attributes such as size, and identification numbers were collected by FEST-A engineers. All collected information has been included in an interactive map based on the Adobe® Acrobat Reader. For maximum user utility a free plug-in is available for download at: http://www.terragotech.com/products/terrago-toolbar

Assumptions and Limitations

System information to include but not limited to: when systems were constructed, who constructed them, who designed them, and system capacities, were based on information gathered in interviews with utility operators and managers, validation by field site visits, and information in previous reports. This reliance on the above factors was necessary due to the lack of or limited access to record drawings, as-built plans, and O&M manuals and historical data.

Population and capacity estimates rely on limited census data. Ebeye officials informed the FEST-A that Ebeye will conduct a complete census next year. Current population estimates range from 12,000 and 15,000 residents. As a conservative planning factor, 15,000 residents is used throughout this report.

Accuracy for creation of comprehensive utilities map, especially underground utilities was limited due to the lack of toning and precision survey equipment. In addition, access to certain system components (i.e. manholes, screening and grit removal chambers, etc.) was limited due to lack of keys or non-functioning access equipment. Information was based on data gathered in interviews, visual validation during field site visits, and information from limited record drawings on hand.

Subsurface conditions could not be observed. Unless problems were identified by utility workers it was assumed that buried components are functional and in good condition.

Although infrastructure surveys are more technical in nature than infrastructure assessments, infrastructure surveys are based on U.S. Army tactical doctrine (Headquarters Department of the Army & United States Marine Corps).

The available time to conduct field surveys was limited to nine on-site days. The team did not have the ability to follow-up on items missed after leaving Ebeye.

SYSTEM CONDITIONS

This color chart is a snapshot of the condition of Ebeye's primary infrastructure systems as of April 2010. The following survey areas are a compilation of the general findings and recommendations of the individual system detailed reports.

With the exception of the electrical distribution system and the trash collection system, each of the backbone infrastructure systems showed increased levels of degradation. A detailed description is presented in the individual systems sections of this report.

SYSTEMS	SEWER		WATER	ELECTRICAL		TRASH	
	Sanitary	Storm	Fresh & Salt	Generation	Distribution	Collection	Disposal
RATINGS							

Table 1.2 - SWEAT –MSO Status Coding (A-M-S-O not assessed)

SANITARY SEWER

SANITARY SEWER

The sewer system was given an overall rating of "black" because it is non-operational and the presence of raw sewage is a public health issue.

System Description

The sewage collection system consists of: approximately 9,600 feet of 6 inch, 8 inch and 10 inch Polyvinyl Chloride (PVC), ductile iron and transite pipe; four lift stations; and 53 manholes distributed throughout the island. Because the sewer collection system uses reticulated saltwater for flushing, there is a saltwater supply system. The saltwater supply system is not covered in this section, but in the water portion of the report.

The island is broken down to four zones, and each zone has its own lift station (Figure 2.1). The four lift stations are used to transport the wastewater within the distribution mains to the sewage treatment plant. The lift stations also provide any preliminary treatment for the sewage treatment plant downstream; grit removal and screening. Every lift station, but number 3, has an adjacent grit chamber with screen. Lift station 3 does not have an associated grit chamber and empties directly to secondary treatment at the plant. Any debris or grit removed from the wastewater is manually collected and disposed of in the landfill. Flow from the main lift station can be directed to the sewage treatment plant or enter a bypass directly to the ocean.

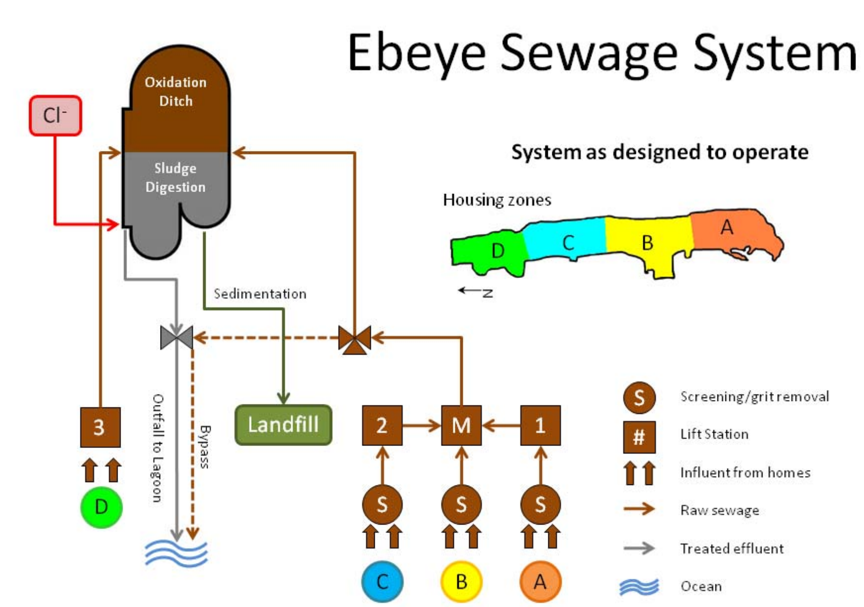

Figure 2.1 - Ebeye sewage system

The sewage treatment plant is a closed loop (Joint USA/USAF) or oxidation ditch design. An oxidation ditch is a "modified activated sludge system that utilizes long retention times (SRTs) to remove biodegradable organics." "Primary settling prior to the oxidation ditch is sometimes practiced, but is not typical in this design (US EPA)." Typical of most oxidation ditches, Ebeye does not use primary treatment. After preliminary treatment in the screening and grit chambers, the sludge goes directly to secondary treatment in the ditch. After secondary treatment, Ebeye chlorinates the supernate for tertiary or advanced treatment.

The sewage is run around in a loop, or racetrack, for bacteria to eat the sludge in the sewage (Figure 2.2). Ebeye uses two brush rotors to impart velocity to the sewage, oxygenate it, and break up any built-up slime layer. After the sewage is run around the "racetrack" three times, the solids are allowed to settle out and manually removed to the landfill. "The original design did not provide for waste sludge removal or disposal. The KAJUR operators state that the sludge must be removed by manually shoveling the wastewater solids from the oxidation ditch (American Samoa Power Authority (ASPA))."

Effluent is separated in an attached effluent box through a v-notch weir (Figure 2.3). The effluent is then chlorinated with liquid calcium hypochlorite ($Ca (ClO)_2$) or sodium hypochlorite ($NaClO$) solution prior to discharge in the lagoon. A diagram of the overall sewage system as it is designed to operate is given in Figure 2.1.

Sewage treatment plant characteristics:

- Oxidation ditch capacity (based on measurement) – 650,000 gallons
- Activated sludge system with tertiary treatment using chemical chlorine
- Age of plant – unknown
- Original designer - unknown
- Typical retention time – 18 to 24 hours (Joint USA/USAF)
- Population capacity, based on 50 gallons per capita per day (gpcd) and retention time of 20 hours (650,000 gal/50 gpcdx24hrs per day/20hrs) – 15,600 persons

Figure 2.2 - Oxidation ditch "racetrack"

Figure 2.3 - V-notch weir and effluent box

Findings

1. The sewage treatment plant was not in operation and has not been operated for a while. Interview of personnel, shows that the plant has not been operated in 5 years. Raw sewage

has been directly sent to the outfall in the lagoon. Republic of Marshall Islands EPA shows the presence of E-coli bacteria on the lagoon side of the island. The outfall is located approximately 500 feet offshore on the lagoon side of the island (Figure 2.4).

Figure 2.4 - Approximate locations of positive tests for E-coli bacteria

a. The plant is no longer operable and would take considerable investment to bring to an operable condition. Many components have deteriorated or are missing. The oxidation ditch still exists and is no good shape. However, it is currently filled with trash and rainwater (Figure2.5). The brush rotors are removed and corroding (Figure 2.6). The associated motors, mounts and seats are in need of repair or replacement (Figure 2.7). Overall the sewage treatment plant is in poor condition and could not operate if required. Figure 2.8 shows the current operation of the sewage treatment plant is in bypass.

Figure 2.5-Debris and rainwater in the oxidation ditch

Figure 2.6 - Brush rotor removed and corroding

Figure 2.7 - Rotor seat empty and in need of repair

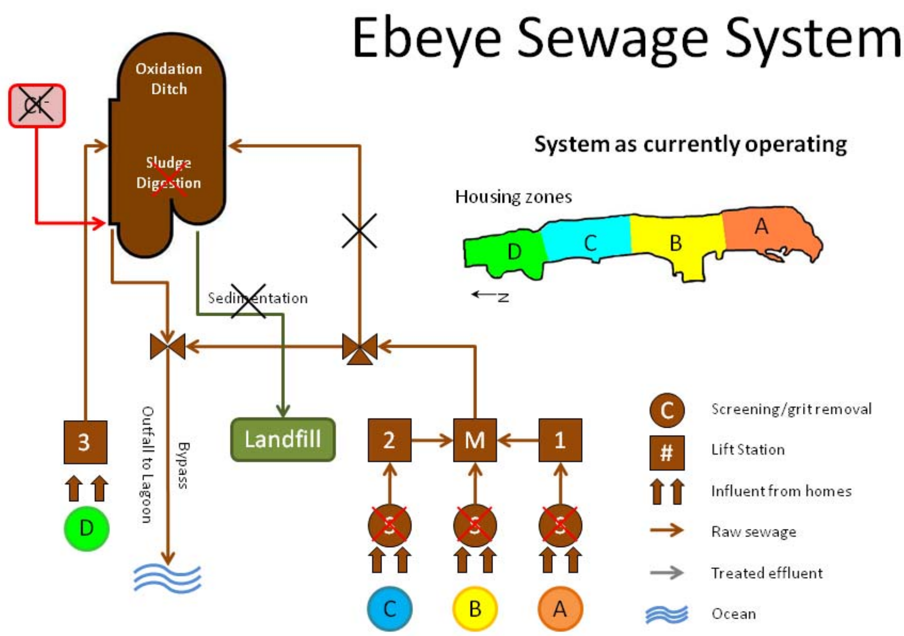

Figure 2.8 – Ebeye sewage system as currently operating

b. Investigation of the processes and discussion with the US Army Corps of Engineers Reachback Operations Center (UROC) has concluded that even if the plant was operational, it cannot meet modern United States sewage effluent quality standards as designed.

2. The lift stations are in need of repair and upgrade.
   a. Auxiliary and main pumps for the lift stations are mostly missing and have been replaced over the years with submersible pumps (Figure 2.9).
   b. Lift station #3 is the only one that still has an original pump, but does not have a backup (Figure 2.10).
   c. The equipment in the screening and grit removal chambers has been removed as they deteriorated, and were never replaced.
   d. Ductile iron piping associated with the lift stations is extremely corroded and needs replacement).

DATA NAMEPLATE

KJI Pump Co. Ltd.
Model 100KD07.52T
Q=211gpm/303,840 gpd
TDH=30 m/98.4 ft
10 HP

Figure 2.9- Spare submersible pump for lift stations

Figure 2.10 - Lift station #3 is the only one with an original pump, but the backup is gone

Figure 2.11 – Lift station #2 original pump and backup are no longer there

e. The underground piping associated with the sewage collection system piping, outside of the lift stations, seems to be in good condition. The transite and PVC seem to holding up well in the saltwater environment. However the line going from the main lift station to the sewage treatment plant could use some repair. While this survey was being conducted this line suffered a leak and was repaired with concrete. The repair was inadequate and the concrete of questionable quality. Unfortunately, KAJUR did not have the right equipment to properly repair the line and did the best with the material available.

3. A random sampling of the manholes was conducted to ascertain the condition of the feeder lines. Most manholes and lines were in good condition and flowed well. There was corrosion (rust) on many of the manhole covers as expected in a saltwater environment. Removal of the covers involved banging with a hammer to break free the rust, prior to prying it open with a pick axe. Seating rings and covers are both corroded.

Recommendations

1. Bring the sewage treatment plant to an operational status and meet modern US effluent quality standards.
   a. Install a pretreatment system to screen solids and remove grit. This can be rebuilding the grit chambers at the lift stations, or installing a centralized pretreatment at the sewage treatment plant. A system at the plant will reduce long term operations and maintenance costs.

b. Provide a new basin for equalization and pre-aeration. Equalization will reduce shock and stabilize the performance of the plant.
c. Install a secondary clarifier to improve the efficiency of the existing oxidation ditch. This will allow personnel the ability to return conditioned biomass to the oxidation ditch (return activated sludge) and equalization basin. Additionally, a clarifier would allow the sewage treatment plant to operate without having to use a settlement phase and manually shovel out solids from the oxidation ditch.
d. Install two new brush rotors and associated hardware. Hardware includes the motor controls, motor control centers, splash guards, mounting seats, and spray guard. The brush rotors are needed to oxygenate the sewage in the oxidation ditch for it to properly function. An oxidation ditch system cannot function without brush rotors.
e. Replace the 12” diameter three-way valve for the sewage outfall bypass. Interview of the operators indicate that this valve is “frozen” in place. Additionally, repair the concrete valve box.
f. Plumb lift station 3 back to the oxidation ditch instead of the effluent box.
g. Install a new system to disinfect effluent prior to discharge to the lagoon.
    i. Install a flash/mix chamber or contact tank.
    ii. Purchase and install a dispensing system for the chlorine.
    iii. Provide a storage facility for chemicals.

2. Replace the pumps and motor controls in the sewage lift stations. This includes the associated controls, new power feeds, bases and mounts as well as piping. All pumps should be solids handling self priming pumps.

    a. Upgrade the pump in main lift station to a minimum flow of 1,520 gpm and 106 feet of total dynamic head (TDH). This is based on extreme peak flow rate for 80% of the projected sewage, since lift station number 3 does not empty to the main lift station.

    The formula for extreme peak discharge (Joint USA/USAF):

$$R = \frac{C}{Q^{0.167}}$$

    At this flow for 10” line, using the Hazen-Williams formula, friction head loss per 100’ of concrete pipe is 2.3 feet. Minor friction loss for bends and valves are based on:

$$h_{minor} = k\frac{v^2}{2g}$$

    k ranges from 0.2 for a flanged elbow and 10 for a fully open globe valve

Velocity of the fluid is at and v (velocity) 6.2 fps for peak discharge

Based on 4,000 feet of pipe, 10 elbows and 2 valves, a TDH of 106 feet is needed

b. Upgrade the three other pumps in the other lift stations. Pumps should be rated for a minimum flow of 735 gpm and a minimum TDH of 20 feet.

   This is based on 1,000 foot of 10 inch concrete pipe; 30% of projected sewage flow; 5 elbows; and 2 globe valves with a similar analysis as above. However, in this case the required gpm was governed by maintaining a minimum velocity of 3 fps, "the design requires special care to secure velocities that will prevent clogging due to sedimentation of solids (Joint USA/USAF)." Pumps should be a common design for maintenance, parts and training.

3. There were other options pertaining to the sewage treatment plant presented by Mr. Remojo in his report (Ministry of Public Works). The presented options are based on a 2004 document from BECA Engineering that was not available for this report. The options present a screening plant with a raw sewage outfall to the ocean. These options were not explored by 565th Engineering Detachment (FEST-A) as they are not in compliance with the United States Environment Protection Agency (US EPA) regulations. However, they may be in compliance with the Republic of the Marshall Islands EPA regulations.

   Even though these options may not comply with US EPA regulations, they will substantially improve the situation. Two of the options presented are given in Table 2.1.

Screening Plant on the existing plant site with outfall to the ocean. Cost: $6,477,000	**Screening Plant on existing plant site with outfall to the lagoon. Cost $5,292,000**

Table 2.1 Options from RMI Ministry of Public Works Report, 2008

STORM SEWER SYSTEM

DRAINAGE

The storm sewer system (drainage or stormwater collection system) was given a rating of “red” because it is less than 50% operational.

System Description

The stormwater collection system on Ebeye is a gravity fed system that consists of trench drains, dry wells, storm drain manholes and ocean outfalls. Most of the drainage structures are provided in the roadway or close to the road, feeding drywells or going to ocean outfalls. Outside of the perimeter road the island slopes to the ocean, inside the road it is flat. Most surface runoff travels directly to the ocean. There are: 40 drywells, 40 manholes and 17 outfalls. Four of the outfalls are on the ocean side, the rest are on the lagoon side. Ebeye Island generally falls to the lagoon (west).

Pipe materials observed were primarily PVC and ABS, with some RCP. Because of the island’s low elevation above sea level, there are many short runs and dry wells. The drywells are 24” in diameter and vary up to 20 feet in depth (Figure 2.12).They are designed to hold water from a storm event and allow the held water to percolate back into the ground slowly over time. Additionally, most were fed from two 24”x18” side drains (Figure 2.13) that act as drains for gutters and trench drains. Each drywell holds 3.14 cubic feet of water per 1’ of depth, or 23.5 gallons per foot of depth. The percolation rate is unknown as no geotechnical studies were conducted as part of this report.

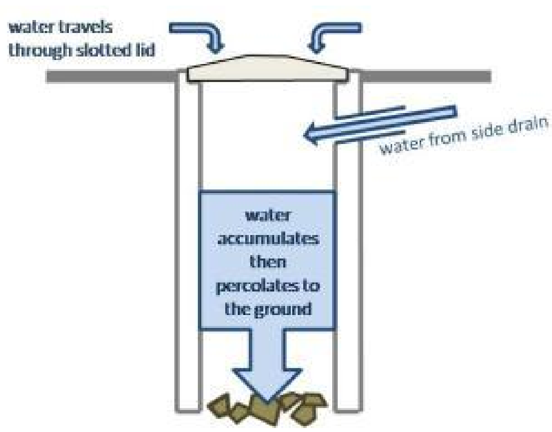

Figure 2.12 – Typical drywell detail

Figure 2.13 – Side drain feeding a drywell

Findings

1. The inspected drywells on the island were clogged with dirt and no longer functioning (Figures 2.14 and 2.15). Additionally, most of the trench drains on Ebeye are also filled with debris and sand (Figures 2.16 and 2.17). These drainage structures cannot function if filled with sand. The sand made it impossible to inspect these drainage structures for physical defects. It is assumed most of these drainage structures are in good shape.

Figure 2.14 - Dirt can be seen up to the cover of this drywell

Figure 2.15 - This side drain is filled with sand

Figure 2.16 - Dirt can be seen up to the top of the grill on these trench drains

Figure 2.17 - Most trench drains were filled with either dirt or debris

2. Storm manholes on the island either drained to an outfall or drywell. Structures draining to drywells were ineffective. The manholes draining to outfalls functioned better as some outfalls were still operational. Outfalls that were no longer functioning were: clogged,

missing, or need repair. Some have suffered from the effects of erosion; Figures 2.18, 2.19, 2.20 and 2.21 are examples of some of the conditions.

Figure 2.18 - Outfall exposed due to erosion and damaged

Figure 2.19 - Outfall clogged with sand

Figure 2.20 - Outlet headwall filled with debris

Figure 2.21 - Outfall exposed due to erosion

3. There were areas identified by KAJUR and KALGOV officials as flood problems areas. Identified flood problem areas are depicted in Figure 2.22. The results of the findings in these flood areas are identified in Table 2.2.

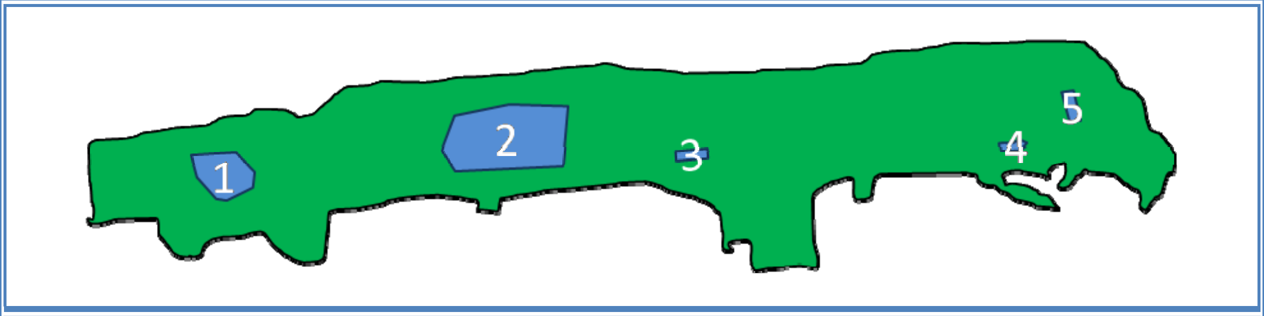

Figure 2.22 - Flood problem areas identified by KAJUR and KALGov officials

AREA	AREA, ACRES	FLOW, *Q(CFS)	FINDING
1	1.2	3.1	This unpaved area has no drainage structure.
2	2.9	7.6	Flooding of homes regularly occurs degrading the quality of life for this neighborhood. A drainage structure has been installed, but is inadequately sized for the area and is clogged.
3	0.038	.30	This paved area is just off the pier by Triple J store, the largest store on the island. There is an existing drainage structure in the area, but it easily clogs with sand. Recently the owner of Triple J had the outfall snaked which seemed to clear up the problem. However, this fix is only temporary as it quickly fills with debris and sand.
4	0.081	.64	This paved area is north of the RMI office and in front of a residence. It is in the bend where the perimeter road starts to head north from the south. There is an existing drainage structure in the area, but it easily clogs with sand.
5	0.044	.35	This is the paved road behind the RMI office. There is an existing drainage structure in the area, but it easily clogs with sand.

***Based on 24 hour, 10 year event using the Rational Method. Rainfall data provided by UROC.**

Table 2.2 – Findings of areas identified by KAJUR

Most of the piping used in the drainage structures was 12” in diameter. This diameter pipe is easily clogged with debris and sand, but may have been used because of the small differences in elevation on the island.

Recommendations

1. Clear the existing drainage structures of sand and debris to bring to an operational status.

2. Survey and repair dilapidated outfalls and associated piping.
   a. Outfalls that are exposed and damaged due to erosion.
   b. Outfalls that are clogged with sand and debris.

3. Recommend a topographic survey be conducted so a watershed analysis and storm water design can be conducted and managed. Without a topographical survey it is impossible to design a proper system for conveyance of water.

4. Design and build a storm drain infrastructure for areas 1 and 2 (Figure 2.2) identified by KAJUR. Area 2 should have a higher priority since there are more people living in that area.

5. Develop a maintenance plan to keep existing drainage structures clear of sand and debris. The maintenance plan needs to be developed by personnel that have historical observation of clogged areas. It is recommended that the plan be developed by "in-house" personnel familiar with the drainage issues.

Figure 2.23 – Sewer Utility Map

WATER SYSTEM

WATER

Ebeye's water system was given an overall rating of "red" because the system is performing at less than 50% of required capacity.

System Description

Ebeye's water system is comprised of salt water (SW) and fresh water (FW) components. Our team was unable to determine the age of the system since it was built and modified over the years. However, record drawings of planned improvements were found, dating back to 1987. Some of the original designed components are no longer in use, and other components have been added over the years. Below is a description of how the system currently operates.

SW system – SW is used for sanitary sewer and source water for the production of FW (potable water). Pumps draw source water from two 80 feet deep SW wells located on the south (Well field 1) and north (Well 2) ends of the island. Well Field 1 consists of three wells (Wells 1a, 1b north, and 1b south) and Well 2 is a single well. A portion of the SW is fed to a salt water distribution system for sanitary sewer and fire suppression. The distribution lines consist primarily of 6 inch PVC pipe (see Figure 3.1 for SW distribution). The other portion of the SW is delivered to the water treatment plant where it is processed into potable water for consumption or other uses.

FW system – Potable water is produced using the SW source described above. The SW is purified at Ebeye's water treatment plant (WTP), located in the center of the island. The SW is fed through a salt water reverse osmosis (RO) water filtration system manufactured by Hydropro, Inc. This system was installed on Ebeye between 2003 and 2004. The RO filtration system consists of three separate units: two 100,000 gallons per day (gpd) units (RO1 and 2) and one 150,000 gpd unit (RO3).

Product water filtered from the RO is produced at a ratio of approximately 30% potable water to 70% waste water. This means it takes approximately 10 gallons of salt water to make 3 gallons of potable water. The wastewater is released directly to the ocean through an outfall on the west side of the island. Product water (FW) is stored in three concrete 250,000 gallon (250K gallon) above ground tanks. The FW and SW distribution systems (Figure 3.1) consist of 4 and 6 inch diameter PVC mains, 2 inch laterals, and 1 inch service lines.

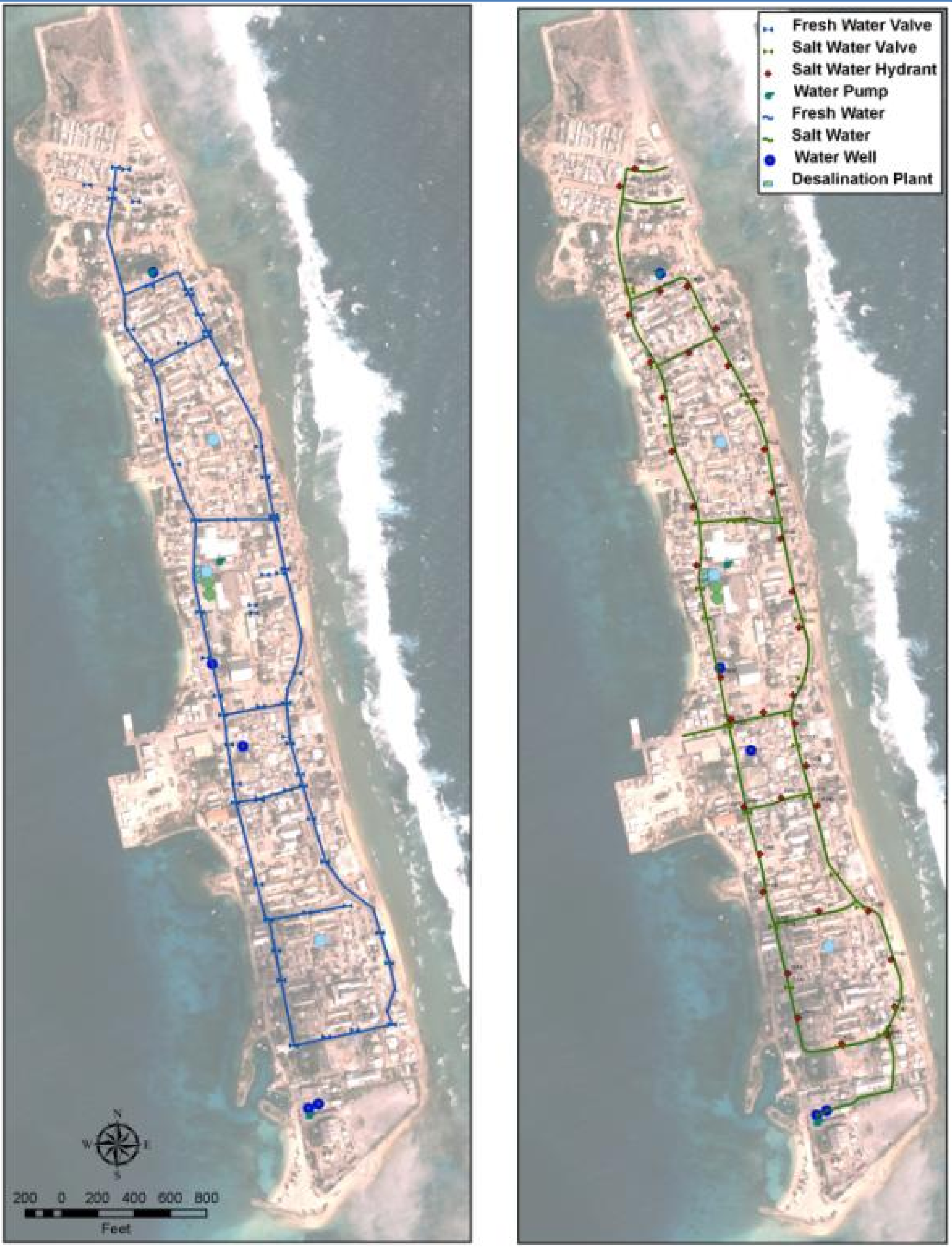

Figure 3.1 – Fresh and Salt Water Utility Map

Note: The water utility maps shown in Figure 3.1 do not show lateral or other minor lines. Pumps located at the water treatment plant provide pressure to a closed loop fresh water distribution system. Figure 3.2 is a map of major components of the water system. Figure 3.3

is a schematic of how the system is currently operating. Figure 3.4 and Figure 3.5 are photos of the RO units.

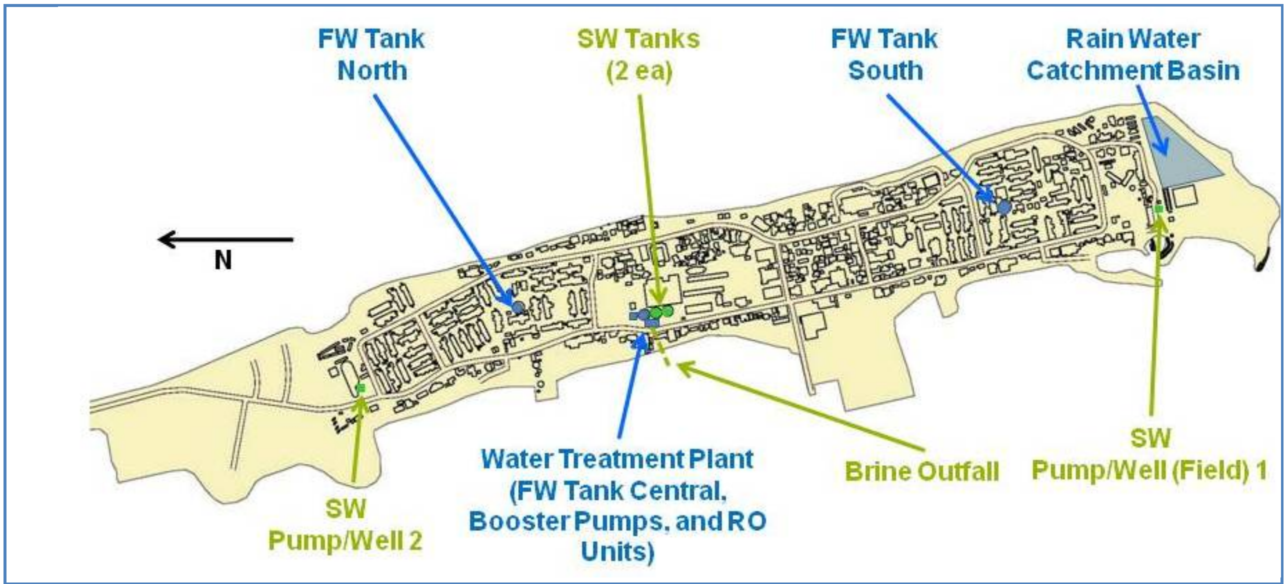

Figure 3.2 - Location of major equipment

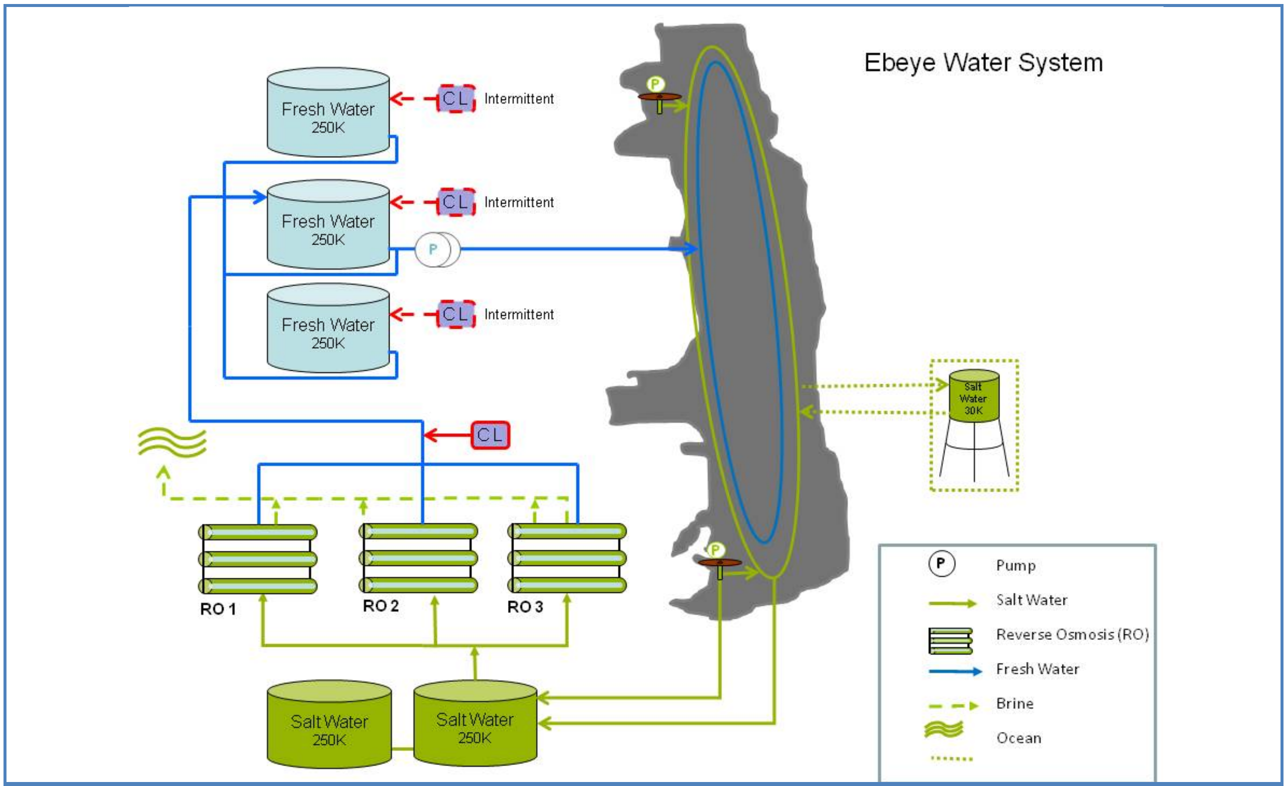

Figure 3.3 - Water System Illustration

	
Figure 3.4 – RO1 and RO2 (100,000 gpd each)	**Figure 3.5 – RO1 and RO2 (100,000 gpd each)**

Findings

1. SW supply is Insufficient. Based on the Ebeye's current population estimate of 15,000 residents, the current SW supply system cannot meet the calculated peak flow demand (US Army Corps of Engineers). The peak flow demand required is 3,020 gpm. This assumes an availability of water 24 hours a day to residents; and a planning factor of only 41 gallons per capita per day (gpcd) for potable water and a sanitary water demand of 21 gpcd (Linda Heaton). The current SW system can only supply 700 gpm of SW, 23% of the calculated peak demand.

    a. FW Peak demand calculations (US Army Corps of Engineers):

    Effective Design Population: 15,000

    Capacity Factor: 1.2

    Required daily demand: 41 gpcd FW and 21 gpcd SW

    $$Capacity\ Factor = \frac{1.25 - 1.15}{2} + 1.15 = 1.20$$

    Flow needed to fill one 250,000 gal tank over 48 hours

    $$\frac{250{,}000\ gal}{48\ hrs} \times \frac{hr}{60min} = 86.8gpm\ per\ tank$$

    Flow needed for a population of 15,000

$$15{,}000\ pn \times 41gpcd \times \frac{1\ day}{24\ hrs} \times \frac{hr}{60} \times 1.2 = 513gpm$$

Peak FW demand

$$3\ tanks \times \frac{86.8\ gpm}{tank} + 513\ gpm = 773\ gpm\ FW\ peak\ demand$$

b. SW Peak demand calculations:

SW water feeding the RO units

$$\frac{773\ gpm\ FW}{0.3(efficiency\ of\ RO\ unit)} = 2{,}580\ gpm\ SW\ for\ RO$$

SW Sanitation flow needed for a population of 15,000

$$15{,}000\ pn \times 21\ gpcd \times \frac{1\ day}{24\ hrs} \times \frac{1\ hr}{60\ min} \times 1.2 = 263gpm\ SW\ for\ sanitation$$

Peak SW demand

$$2\ tanks \times 86.8\frac{gpm}{tank} + 2{,}580\ gpm + 263\ gpm = 3{,}020\ gpm\ SW\ peak\ demand$$

c. There are two additional wells (collocated with the operational south well) that are not being used. No inspection equipment was available to ascertain the condition of these additional wells or supply capacity. In addition, the original purpose of these existing wells is unknown.

2. FW production is insufficient to meet the peak flow demand. Based on Ebeye's current population estimate of 15,000 residents, the current FW supply system cannot meet the calculated peak flow demand of 773 gpm. The capacity of the three RO units is 243 gpm, 31% of needed demand.

3. RO2 has been inoperable since 2005 due to lack of parts. The Government of RMI continues to work with the vendor to procure the needed parts.

4. Water pressure is insufficient to support the fire hydrant system and restrooms above the first floor of buildings. Reasons for low pressure in SW system include:
   a. No elevated tanks. At one time Ebeye had a 30K elevated SW storage tank. It is assumed this tank provided pressure to the SW loop and to support the fire hydrant system. According to KAJUR officials, the tank was removed more than 10 years ago.
   b. Pressure for SW system is provided solely by existing pumps located at the South and North Wells. These pumps do not adequately pressurize the SW loop (Figure 3.6 and Figure 3.7 are photos of Well Pumps 1 and 2).
   c. The fire hydrant system cannot be used for fire fighting. Fire fighting is now being accomplished using a tanker truck. Although most facilities on Ebeye are one story, there are some two and three story facilities. During interviews, KAJUR representatives informed our team that there is insufficient water pressure to service toilets above the first floor.

Figure 3.6 - Well Pump 1 (South)

Figure 3.7 - Well Pump 2 (North)

5. FW distribution system pressure is insufficient. Residents further away from the WTP lack sufficient pressure to support interior fixtures. Due to low pressure in their homes, residents are tapping into service lines and creating in-ground basins to gain access to water (Figures 3.8 and 3.9). KAJUR officials indicate this is a common practice. This practice further exacerbates the low pressure problem. Reasons for low pressure include:
   a. No elevated tanks.
   b. Existing pumps are inadequate to supply sufficient pressure for the FW loop.
   c. No pressure regulating valves (PRV) to control water pressure at the point of delivery.

Figure 3.8 - Example of in-ground basin

Figure 3.9 - Example of in-ground basin

6. The north end of island does not have SW or FW service. The existing water distribution system does not extend to the housing area located near the landfill (Figure 3.10). Some residents in the area have private water tanks that are typically filled by truck delivery.

Figure 3.10 - Area not covered by water distribution systems

7. The FW and SW storage tanks are in good condition, but do not have functional level gauges.
   a. All storage tanks were renovated in 2004 (Asian Development Bank (ADB)). Improvements included new 3/16 inch backing, rubber liners, and roof repairs. Tanks appear structurally sound with no cracks, spalling, or leaks.
   b. Water level gauges are installed on all tanks but do not function. KAJUR representatives monitor storage tank volumes by visual inspection. There are no meters measuring flow into the storage tanks to record usage data.

8. Facilities
   a. There are two SW and three FW pump houses. The pump houses are in good condition. The buildings are structurally sound, and roofs do not leak.
   b. The WTP building is in good condition. It is structurally sound, and roof does not leak.

Figure 3.11 – SW Pump House 1 (typical)

Figure 3.12 – FW Booster Pump House Central (typical)

9. Equipment
   a. Well 1 (South). The eight year old 20 HP, 250 gpm pump shown in Figure 3.6 above, is mounted on an exterior pad, is exposed to the elements, and showing signs of corrosion, but appears to be in fair condition (no adverse noises, leaks, vibration, etc). There are no back-up pumps, working pressure gauges, spare parts, or back-up power at the well site.
   b. Well 2 (North). The 450 gpm pump shown in Figure 3.7 above, is protected from the elements by a pump house. The age of the pump and motor are unknown, are showing signs of corrosion, but are working well (no adverse noises, leaks, vibration, etc). There are no back-up pumps, spare parts, or working pressure gauges on site. The emergency generator was taken out of service more than 5 years ago. The generator room is currently being used for storage.

c. FW Booster pumps. A 500 gpm main booster pump located in a pump house at the WTP pressurizes the water distribution system. The pump is in good condition (no corrosion, leakage, adverse noises, vibration, etc). A 130 gpm booster pump is used as a back-up for the main booster pump (Figure 3.13). During our visit the back-up pump was under repair. There is no back-up power and no spare parts were available for the booster pumps. It should be noted that booster pumps located at the north and south tanks have been out of service for several years.

Figure 3.13 – FW Booster Pumps

d. Residential water meters. Currently, the system does not have meters to measure the quantity of water supplied to consumers.

10. FW and SW distribution systems (pipes, valves, hydrants). During our visit there was no indication of leaks. Visual inspections of valves produced no significant adverse findings. Fire hydrants are in poor condition, heavily corroded, and are not being used (Figure 3.14).

Figure 3.13 - Fire Hydrant Condition (typical)

11. FW quality meets RMI EPA standards. Water exiting the RO system is chlorinated before it is stored in three 250,000 gallon above ground tanks. According to RMI EPA, water from the distribution system is tested twice each week for E-Coli and Coliform Bacterium. Officials could not recall the last incident in which a positive reading from Municipal water was obtained.

12. Corrosion is a major cause of premature equipment failure. The combination of high humidity and salt spray result in the rapid corrosion of metal valves, motors, pumps, and other equipment.

13. Condition of wells. A well study was not conducted during the survey. The condition and recharge rates of each well needs to be established.

14. Other sources of water are described below. These water sources are not part of the municipal water system. However, they provide limited alternatives to municipal water.
    a. Residential Rainwater Catchments - RMI EPPSO (Economic Policy, Planning, and Statistic Office) is currently conducting a house to house survey/study to determine number and condition of roof rainwater catchment systems on Ebeye. Preliminary indication is approximately 35% of households/commercial facilities have storage tanks, but many rooftop catchment systems are in disrepair (EPPSO). Data collection for the study is scheduled for completion at the end of summer 2010. It is EPPSO's policy to promote the use of rainwater catchment (with proper disinfection) for island consumption. RMI EPA indicated that most testing of private rainwater catchment tanks test positive for the E-Coli/Coliform.
    b. Municipal Rainwater Catchment - According to KAJUR and KALGov representatives, the rainwater catchment basin located near the power plant was taken out of service when the RO units were installed (~2003). Due to proximity to the power plant, there was concern that oil may leak into the catchment system. A project to rehabilitate the catchment area was scheduled in 2004 however only a portion of the work (fencing) was completed (Asian Development Bank (ADB)). The catchment facility continues to collect rainwater, but none of the water is currently used. Total capacity of the catchment is estimated at 8.5M gal per year, based on typical rainfall (100 inch per year).
    c. Many residents working on Kwajalein transport water back to Ebeye. The amount of water collected does not significantly offset the FW shortage.
    d. FW is also available for purchase at the water treatment plant. This supply station is referred to by residents as the "Oasis".

Recommendations

1. Increase SW production. This project will provide adequate SW to meet calculated peak demand of 3,020 gpm and also ensure adequate system pressure. This project includes design of the system in order to address of pressure problems.
    a. Conduct a well and hydrologic studies to determine the effective use of existing wells and requirements for additional wells.
    b. Install three new wells vicinity of WTP.
    c. Install three 800 gpm pumps rated at 110 feet TDH on new wells.
    d. Connect new wells to existing water system (3,000 feet of 10" schedule 80 PVC).
    e. Construct new facility to house new pumps, wells, and new RO system.

2. Increase FW production and pressure. This project will increase the FW production rate to meet the FW calculated peak demand of 773 gpm (or 1.1 Mgpd). The current capacity of the existing RO units is 350,000 gpd, leaving a deficit of 750,000 gpd. This project assumes adequate SW is available to meet feed water demands.
   a. Purchase replacement parts to repair RO2.
   b. Install new RO units with 750,000 gpd capacity, in new pump house (see above).
   c. Increase system pressure by closing water loop and installing 3ea, 300 gpm pumps (one each at North, Central, and South tanks) in existing pump houses.

3. Extend SW and FW distribution systems. This project will extend the distribution systems to service customers located on the north end of Ebeye.
   a. Install SW distribution lines with all appropriate components (i.e. PVC pipes, valves, and fire hydrants)
   b. Install FW distribution lines with all appropriate components (i.e. PVC pipes, and valves)

4. Replace fire hydrants. This project will replace all fire hydrants. This project requires the installation of 62 each hydrants.

5. Rehabilitate rain catchment basin. This project will repair the catchment basin allowing it to be put into service in order to improve the efficiency of the fresh water production system.
   a. Resurface catchment with 2 inch asphalt concrete surface
   b. Reconstruct catch basin
   c. Install 12" HPDE pipe and manholes

ELECTRICAL SYSTEM

The electrical system consists of the power generation plant and the high voltage distribution system.

System Description – Generation Plant

GENERATION PLANT

Overall, the condition of the generation plant is rated AMBER. The power plant has sufficient capacity for present and future growth. However, major scheduled maintenance of engine generators cannot be performed because the stand-by unit cannot be completely shutdown. Also, the switchgear and its associated equipment are 30 years old and replacement components are unavailable.

Electric power for Ebeye and the islands of North Loi, South Loi, Bijinkur, Ebwaj, and Gugeegue is generated from a single power plant located at the southern end of Ebeye Island (Figure 4.1). The plant was built and started operations in 1984. It contains three diesel generators of various sizes with a maximum total nameplate capacity of 4.3 megawatts (MW). However, the generators are safely set to produce only 3.6 megawatts. The average load demand is approximately 1.8 MW and peak demand during evening hours between 7:00 – 10:00 PM is 2.1 MW. Peak demand only requires two units running continuously with one unit in standby, should the main generator break down or be taken off line for emergency repair. The output rating of the generators is 480 volts (V). The output voltage is then stepped up to 13,800 V for distribution throughout the island. Residential usage makes up about 80% of total consumption. The power plant and the distribution system are managed by Kwajalein Atoll Joint Utility Resource (KAJUR) and are continuously manned. The Ebeye Power Plant is shown in Figure 4.2A and 4.2B.

Figure 4.1 - Satellite View of Power Plant

Diesel fuel is transported by ship from Majuro to Ebeye and stored in two identical 100,000 gallon tanks. Fuel is then pumped into the plant via a settling tank to reduce the moisture content. The plant consumes 2,900 gallons of fuel per day to generate a total of 43,000 kWh. The diesel tanks are shown in Figure 4.3.

Figure 4.2A – West View of Power Plant

Figure 4.2B – East View – Smokestack System

The three diesel generators are designed for load sharing operation and can be run in parallel. Normally, units #2 and #4 are operated continuously to power the loads while unit #3 is in stand-by. At the time of visit, unit #3 had a leaking radiator which prevents it from operating continuously for more than 48 hrs due to overheating. Replacement of the radiator is scheduled, pending receipt of additional materials which are on order. Key specifications for the diesel generators are listed below (Table 4.1). Figure 4.5 through Figure 4.8 show the engine room as well as each individual diesel engine generator.

Generators	Unit #2	Unit #3	Unit #4
Manufacturer	Cummins	Cummins	Cummins
Model	C1500D6	C5734	C1500D6
Type	Prime	Prime	Prime
Rated Power	1,286 KW	1,512 KW	1,500 KW
Rated Power	1,608 KVA	1,890 KVA	1875 KVA
Rated Current at 0.8 pf	1,394 Amps	2,273 Amps	2,257 Amps
Rated Voltage	277/480 V	277/480 V	277/480 V
Frequency	60 Hz	60 Hz	60 Hz
RPM	1,800	1,800	1,800
Alternator	Cummins	Newage	Stamford
Mfg Date	2008	2008	2008

Table 4.1 - Engine Generator Key Specifications

Figure 4.3 - Diesel Storage Tanks

Figure 4.4 – Engine Room

Figure 4.5 - Diesel Generator #2

Figure 4.6 - Engine Generator #3

Figure 4.7 - Engine Generator #4

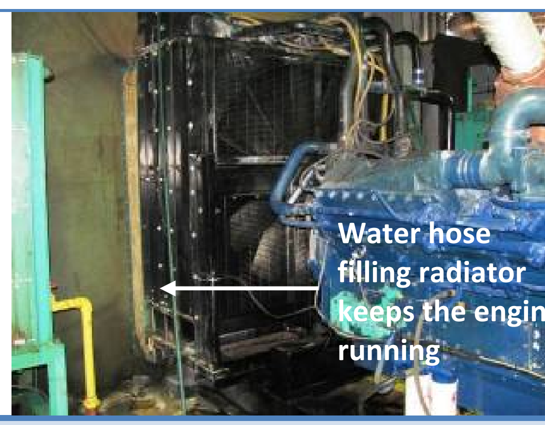

Figure 4.8 – Leaking Radiator - Unit #3

Plant Distribution Transformers

The output rating of the generators is 480 V. Transformers T1 and T2 step the voltage up to 13,800 V for distribution throughout the island. Figure 4.10 and Figure 4.11 show the two indoor transformers. The two transformers are rated as follows (Table 4.2):

Transformer	Size	Class	Configuration	Impedance	Mfg	Primary/Secondary
T1	3,000 kVA	ONAN 55/65°C	Delta-Wye	5.98%	Meiden	480 V/ 13,800 V
T2	3,000 kVA	ONAN 55/65°C	Delta-Wye	5.97%	Meiden	480 V/ 13,800 V

Table 4.2 - Step-Up Transformers

Figure 4.5 - Step-Up Transformer T1

Figure 4.6 - Step-Up Transformer T2

Power Plant Switchgear

Electricity produced by the generators is distributed throughout the island via the power plant switchgear. The switchgear is an indoor metal clad design which contains several distinct cabinets, and includes generator output breakers, generator synchronizing panels, generator control boards, transformer output breakers, and feeder distribution breakers. The feeder breakers are 13.8 kV, 1,200A vacuum circuit breakers (VCB). Key specifications for the circuit breakers are listed in Table 4.3 below. The generator switchgear is shown in Figure 4.12 and the control panel in Figure 4.13. Typical transformer breaker and the feeder breaker are shown in Figure 4.14 and Figure 4.15.

Circuit Breakers	DG Output	Transformer Output	Feeders #1 and #2
Manufacturer	Merlin Gerin	Meidensha Corp	Siemens
Type	VCB	VCB	VCB
Model		VJ-12B	FC-500B
Rated Max Voltage	480 V	15,000 V	15,000 V
Continuous Current	2,000 A	630	1,200
Short Circuit Current	85 kA	25 kA	18 kA
Interrupting Time	3 cycles	0.04s	3 cycles
Mfg Date	2002	2003	1984

Table 4.1 - Circuit Breaker Specifications

Figure 4.12 - Generator Switchgear

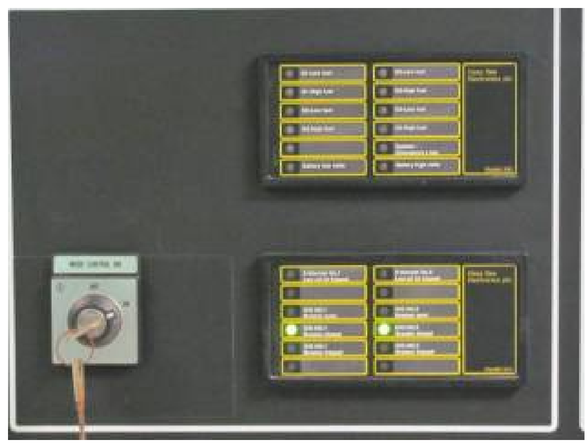

Figure 4.13 - Typical Generator Control Panel

Figure 4.14 - Transformer Output Breaker

Figure 4.15 - Feeder Breaker

Protective Relays

The primary switchgear is configured with protective relays. The purpose of these relays is to detect abnormal conditions (e.g., short circuit, overload, ground fault) and trip the affected circuit breaker to rapidly isolate a faulted circuit, while minimizing disruptions to unaffected portions of the system. Key specifications for the protective relays installed at the power plant are listed below (Table 4.4):

Generators Protection	Relays	Manufacture
Under and over voltage	27 & 59	Woodward
Generator differential	87G	Woodward
Directional ground	67G	Woodward
Loss of excitation	40	Woodward
Time overcurrent with voltage restraint	50/51	Woodward
Reverse power	67RP	Woodward
Generator bus overvoltage ground	64	Woodward
Synch check	25	Woodward
Under and over frequency	95	Woodward
Feeder Breakers Protection	**Relays**	**Manufacture**
Phase time and instantaneous overcurrent	50/51	Eaton FP5000
Directional ground	67	Eaton FP5000

Table 4.2 - Protective Relay Specifications

Power plant equipment is protected by a typical plant protection scheme, including over-current, over-voltage, under-voltage, differential, frequency, synch-check, and power relays. The protective relays are solid state units. There were no records of relay calibration. Typical relay control panels are shown in Figure 4.16 and Figure 4.17.

Figure 4.7 - Typical Generator Relay Panel

Figure 4.8 - Typical Feeder Relay Panel

Switchgear Stationary Battery

A set of 8 Exide 3CA-8 vented nickel cadmium stationary batteries rated for 200 ampere hours at 125 VDC supplies direct current power to the protective relays and control instruments. Figure 4.18 and Figure 4.19 show the battery and its inverter/charger, which is housed in an open area behind the switchgear.

Figure 4.18 - Battery Cells

Figure 4.19 - Charger/Rectifier

System Description – Primary Distribution

DISTRIBUTION

The underground distribution line, which was upgraded in 2002, is in good condition and operates within rated limits. The condition of the distribution system is rated GREEN.

Figure 4.20 - Underground Cable

The primary distribution system on Ebeye Island is mostly underground up to the location where the power line goes overhead to serve the island of Gugeegue, North of Ebeye. The total distance for the underground portion is 3.5 miles and the overhead distribution is 5 miles. The distribution system contains feeders #1 and #2 supplied from the power plant. A simplified map of the complete electrical distribution system is shown in Figure 4.25. In 2002, a large portion of the system was converted from overhead line to underground distribution. Both feeders exit the plant on the southern end of the island and extend to the northern end. Feeder #2 which runs along the ocean side carries approximately 800 kilowatts (kW) of load while feeder #1 on the lagoon side is loaded at 900 kW, due to greater industrial load. The underground conductors are copper shielded, 133% XLP-insulated Okonite cable, 3-single 4/0 AWG, rated approximately 235 amperes. As rated, each primary distribution feeder can provide up to 5,617 kVA of load at 13.8 kV before reaching its rated limit. Even though the two circuits are radial feeders (not in loop configuration which allows flexibility in operations), cross connect capability between two circuits exists via four sectionalizing switches at various locations on the island. The feeder cross-connect points result in a highly configurable system with good isolation and back-feed capability.

The last five miles of feeder #2 servicing the neighboring islands North of Ebeye remains overhead. Last year, KAJUR replaced the pole hardware and insulators of the overhead line. Due to time constraints, the scope of this survey did not include the evaluation of the secondary distribution of the system. Table 4.5 below shows the rated capacity, the peak currents which were recorded daily during the visit, and the calculated spare capacity for each feeder.

Feeder	Size	Capacity @ 13.8 kV	Peak Load @ 13.8 kV (recorded readings)	Spare Capacity
#1	4/0 AWG	235 amperes	48 amperes	187 amperes
#2	4/0 AWG	235 amperes	48 amperes	187 amperes
#1 and #2 Total		470 amperes	96 amperes	374 amperes

Table 4.3 - Feeder Capacities

Figure 4.21- Typical Sectionalizing Switch

Figure 4.22 – Typical Junction Box

Figure 4.23 – Typical pad-mounted transformer

Figure 4.24 - Overhead Line Ebeye/Guegeegue

The following table shows the distribution equipment associated with each feeder.

Equipment	Quantity	Feeder #1	Feeder #2
Primary poles, concrete	84	0	84
Transformers, pad-mound, 13.8kV to 120/208V	52	26	26
Transformers, pole-mount, 13.8kV to 120/208V	5	0	5
Switches, pad-mound, various size	7	2	5
Overhead, 2/0 AWG Bare Copper Conductor (miles)	5	0	5
Underground, 4/0 AWG XLP Shielded Insulated Conductor, 15KV (miles)	3.5	1.8	1.7

Table 4.6 - Distribution Equipment

Service Transformers

Along the distribution lines, 52 service transformers step down the distribution voltage of 13.8 kV to the customer's required voltage of 120/208 V. A majority of the service transformers are pad-mounted, although a very few pole-mounted transformers are installed in the system. The most common configuration is a Delta-Wye connection.A typical transformer installation is shown in Figure 4.23.

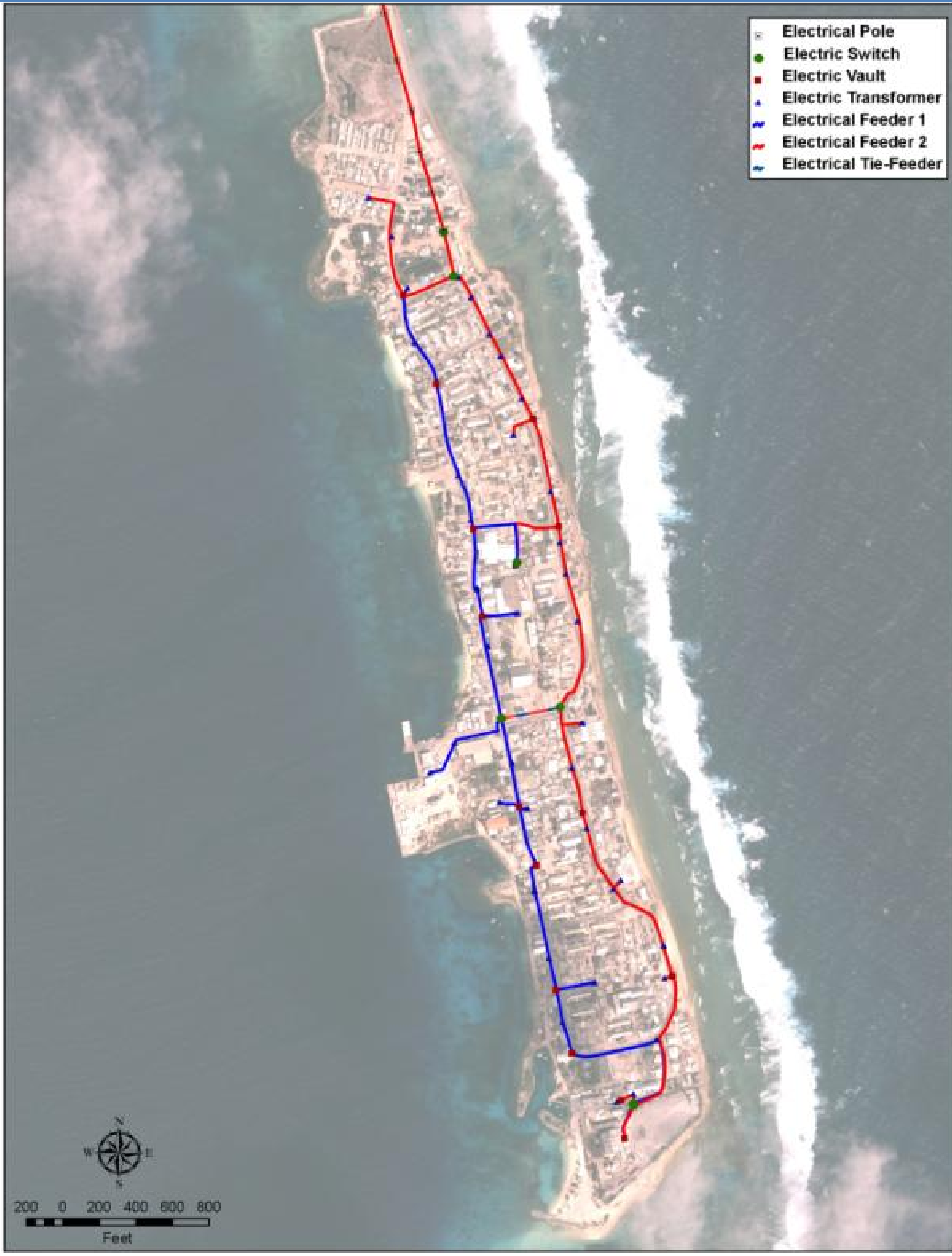

Figure 4.25 - Primary Underground Distribution Feeders #1 (Blue) and #2 (Red)

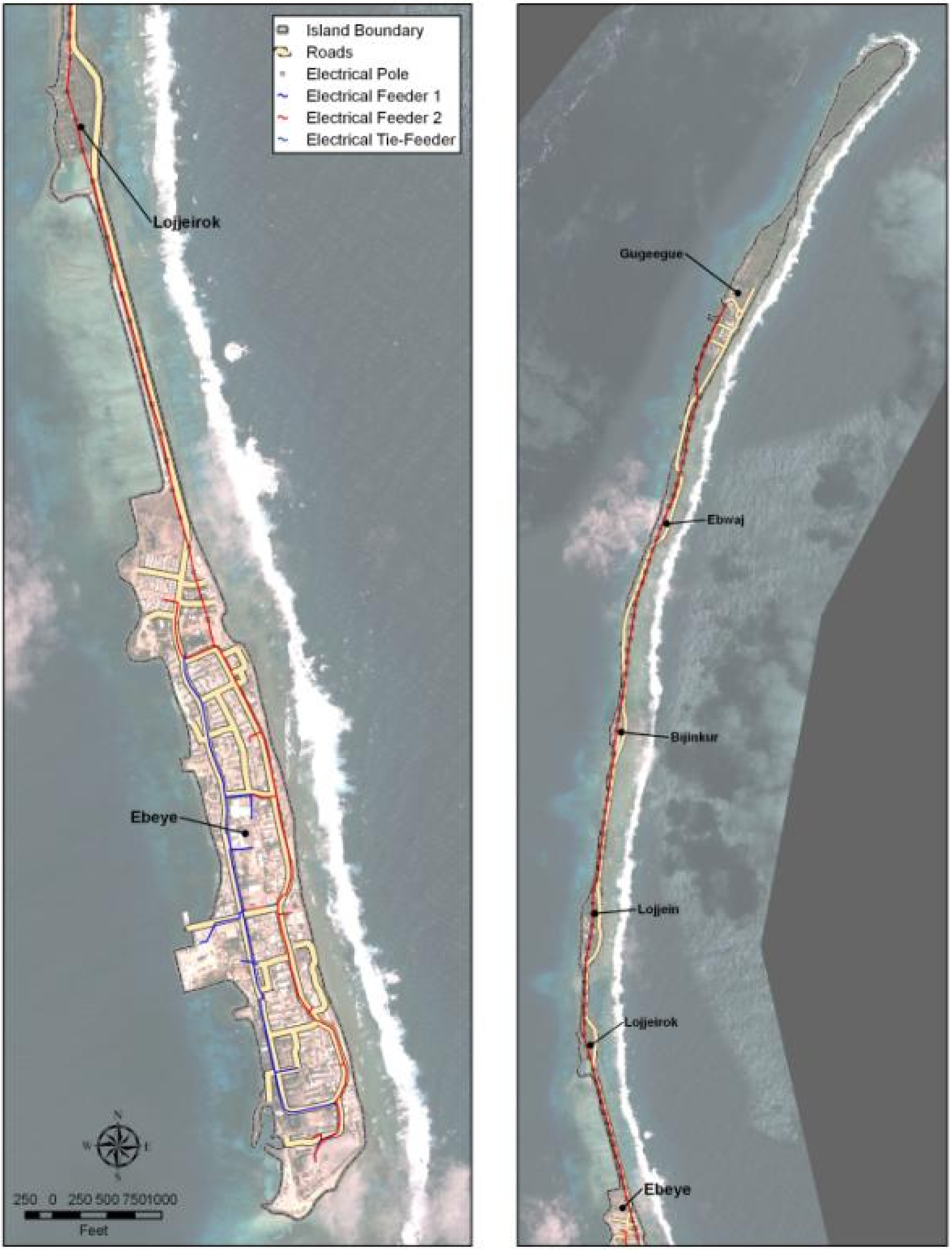

Figure 4.26 - Primary Underground Distribution Feeders #1 (Blue) and #2 (Red)

Findings

The following findings are primarily focused on system reliability, capacity, efficiency, safety, and maintainability. The following summarizes the survey results and observations.

1. High humidity and salt content caused rapid and excessive corrosion of equipment. Extra precaution should be taken in the specifications of materials and equipment, considering the high humidity, excessive salt content in the air and water, high temperatures, exposure to elements, etc. These conditions contribute to rapid and excessive corrosion of materials and equipment. Specifically, the intake louvers (4 each) of the power plant are seriously corroded and in need of replacement with stainless steel units. During operation, high humidity and the outside salt air is continuously pulled into the engine room. This has caused accelerated corrosion of the alternator copper winding. To prevent immature failure of the alternator unit, during 250-hour scheduled maintenance, the winding coil of the alternator is washed with high pressure and heat dried to remove the collected salt before being returned to service.

2. Lack of preventive maintenance causes premature failure of equipment and unnecessary unscheduled outages. Routine system maintenance is a fundamental requirement that has been neglected for years. The power plant medium voltage and low voltage switchgears do not appear to have been inspected or tested since the plant was built in 1984.

3. Generation plant has adequate capacity for present and future growth. Historical load data shows that the peak demand is about 2,100 kilowatts. The power plant has an output capacity of 3,600 kilowatts and should be able to meet the peak demand for a number of years. Peak load represents only 60% of generated capacity.

4. Obsolete switchgear in the generation plant. The power plant switchgear needs to be programmed for replacement. It has operated beyond a reasonable service life. Furthermore, the switchgear has not received any maintenance in over 10 years. The ability of this switchgear to operate safely cannot be established without this periodic maintenance. Even with maintenance, the switchgear ability to safely interrupt a fault is indeterminate because it is too old. The existing electrical distribution system might last another ten years or it might fail this year.

5. Underground distribution feeders operating within their rated capacity. Furthermore, line loading is acceptable even if one line carries both feeder loads. Voltage drop is negligible throughout the primary distribution system. Even though the two distribution lines are

radial, the system is flexible with many cross-connect and isolation points set up throughout the system.

6. Obsolete secondary distribution requires substantial upgrades. Even though the secondary distribution system is not included in the scope of the survey, the overhead lines (120/240V) and poles appear to be seriously deteriorated. Strong winds and heavy rains cause frequent flash-overs or short circuits along the overhead lines. In addition, many of the timber poles were found to be of marginal integrity, defective, loose, and structurally unsound.

7. Distribution transformers operated within rated capacity. Most transformers are loaded to less than 40 percent of their rated kVA, even during periods of peak demand. All the pad-mounted transformers were installed in 2002. At eight years old, the condition is still fairly good. The stainless steel cabinets do not exhibit any rust, leaking, or deterioration.

8. Continue the outstanding in-house improvement program. In recent years, KAJUR electricians have completed several in-house upgrades to the distribution system. Projects such as the installation of a new isolation switch and replacement of pole hardware on the Gugeegue overhead line have greatly improved the reliability and safety of the distribution systems (Figure 4.27). In the past, due to lack of system coordination, faults occurred on the 13.8 kV overhead line have caused nuisance tripping of the generators at the power plant. The new switch has effectively isolated the faults with minimum disruption of power to the rest of the system. Other upgrades such as replacement of old and inefficient high-pressure sodium street lights with LED fixtures have reduced system loss substantially (Figure 4.26).

Figure 4.9 – Upgrade Street Light to LED Fixture

Figure 4.10 – Replace Pole Hardware Project

Recommendations

1. Install a fourth generator. Presently, two of three generators are continuously operated to power peak load. The third generator is in standby for use in the event one of the main generators must be taken off line for emergency repair. Nevertheless, each generator must be removed from service on a regular basis for major preventive maintenance. Similarly, equipment failures can result in a generator being removed from service. In both cases a standby generator must be brought on line in order to meet demand. During these maintenance periods there is no standby capability. Should a single generator fail while one generator is undergoing maintenance or out of service for unscheduled maintenance electrical demand will not be satisfied. Examples of major maintenance include turbine overhauls and generator rewinds, for which complete shut-downs for weeks are required. Currently, major scheduled maintenance cannot be performed because the stand-by unit cannot be completely shutdown. The fourth generator will allow major scheduled maintenance of generators to be performed periodically. During the survey, KAJUR confirmed that the new generator had been ordered and delivery date is unknown at the time.

2. Upgrade the secondary low-voltage overhead distribution. Even though the secondary distribution (208/120 volts) was not included in the main scope, it was observed that many of the timber poles were found to be of marginal integrity, defective, loose, and structurally unsound.

3. Upgrade the switchgear and associated equipment in the power plant. The switchgear and its associated equipment in the power plant are 30-years old and replacement components are unavailable. All distribution feeders passed through this equipment. Should the system fail, half of the island will be without power for a prolonged period. The top concern is that the over-current protective relay of the main breaker of the feeder bus is no longer in operation and cannot be repaired. The role of a protective relay is to actuate the breaker to isolate a fault. Without a protective relay, the breaker will not trip should a short circuit occur on one of the downstream feeders.

4. Establish a standard preventive maintenance and testing program. Regular maintenance will measurably reduce the number of unscheduled outages. The reliability of the system can be improved substantially by implementing fairly simple and inexpensive monitoring and maintenance procedures. The maintenance and testing program should consist of two sections. The first section provides basic maintenance activities that should be performed monthly by qualified KAJUR electricians. The second section includes more complicated maintenance and testing that cannot be accomplished by in-house staff due to lack of the manpower, training, and experience. The reason for lack of maintenance is lack of funding and therefore, recommend that funds should be set aside annually and can only be spent for maintenance purpose only.

Figure 4.28 – Replace Leaking Radiator on Generator #3

As a minimum, the following electrical distribution system equipment needs to be specifically addressed by a periodic maintenance program. And most importantly, establish maintenance record baseline for comparison.

- Medium voltage switchgear and circuit breakers
- Generator control switchgear
- Low voltage switchgear and circuit breakers
- Protective relays
- Panel meters
- Battery and DC system
- Auxiliary equipment

5. Execute project to replace radiator and fan. During our survey, engine #3 had a leaking radiator and could not be run continuously for more than 48 hrs without overheating (Figure 4.28). KAJUR is aware of this problem and has taken measures to repair the radiator. Materials are currently on order. Normally, engine #3 is in standby for use in the event one of the main generators must be taken off line for emergency repair. However, with a leaking radiator, engine #3 will not be able to meet demand should one of operating generators experience a major failure.

6. Demolish abandoned Enterprise and Caterpillar diesel engines in the old power generation plant (Figure 4.29). Also, remove abandoned switchgear and control cabinets associated with the Enterprise engines. Empty space could be used for workshop or tools/spare parts storage.

Figure 4.29– Abandoned Enterprise Engines

7. Technical training. Establish a standard training program, including on-the-job training and off-island training for electricians and mechanics working in the power plant and distribution systems.

8. Perform a comprehensive study of the electrical generation and distribution system. This study should include power flow, short circuit, and electrical protection and coordination. The purpose of the short circuit study is to confirm that the equipment is operating within their nameplate short circuit rating. An underrated component might fail under this condition, potentially causing a fire, explosion, or unnecessary outage. The purpose of the system protection and coordination study is to (1) isolate permanent faults with minimum disruption of power to unaffected portions of the system, (2) limit damage to faulted equipment and minimize hazards to personnel and (3) minimize the possibility of fire or catastrophic damage to adjacent equipment.

TRASH COLLECTION

TRASH COLLECTION

The trash collection process was given an overall rating of "green" because it provides the community with a consistent reliable service.

System Description

The solid waste program on Ebeye is managed by the Kwajalein Atoll Local Government (KALGov), Department of Public Works (DPW). They are responsible for the collection and disposal of all the solid waste generated on the island, and also manage and operate the dumpsite. Currently, the program is fully subsidized by the government and no fees are charged to the residents for the service (American Samoa Power Authority (ASPA)).

Most of the trash generated on the island can be categorized as municipal solid waste, and comes from the residential areas which include several schools, grocery/clothing stores, and restaurants. In addition, there is also a hospital that generates medical waste, a power plant, fuel storage and dispensing facility, and several vehicle maintenance facilities that generate hazardous materials and waste.

Trash is collected by two municipal crews from 8:00 a.m. to 5:00 p.m., Monday through Sunday. The equipment utilized for this process consists of an 11 cubic yard trash compactor truck with a rear hydraulic loader and a five ton truck with a six cubic yard dumpster attachment (Figures 5.1 & 5.2)

Figure 5.1 - Trash collection crews

Figure 5.2 - Trash compactor truck, 11 CY capacity

Figure 5.3 - Typical trash bin setup

The DPW provides plastic trash bins for households, public facilities, and businesses to dispose of their trash (American Samoa Power Authority (ASPA)). There are approximately 300 plastic waste containers, of fifty gallon capacity, placed along the roads throughout the island. Approximately 22 cubic yards (13,333 lbs) of trash is collected daily from the bins along the roads (information provided by the Director of DPW) and up to 25 pounds of medical waste from the hospital (information provided by hospital director). The entire island is serviced in one shift, and the collection crews haul trash to the dump twice each day. Figure 5.3 shows a typical roadside trash bin setup.

Findings

1. The five ton truck with dumpster attachment is in poor condition and occasionally breaks down due to heavy usage. Budget constraints and lack of availability make obtaining replacement parts difficult

2. Field observations indicate that approximately 50% (160) of the trash collection bins need to be replaced. Most are missing lids, wheels or are broken. The open and broken containers attract rats, flies, dogs and cats.

Figure 5.1 - Medical waste accumulation point at the hospital

3. The medical waste generated at the hospital is stored next to regular trash in an uncovered non-secured area. The containers utilized are not appropriate for medical waste. The two drums that are used to accumulate the sharps and red bag waste are covered with a piece of plywood (Figure 5.4).

4. The current practice is to burn the medical waste in a 55 gallon metal drum at the dump which is ineffective, and poses a significant health and safety risk. However, the hospital recently received a Capital Improvement Program (CIP) grant through the U.S. Department of Health and Human Services in the amount of $111,000 for the purchase of a medical waste incinerator and medical waste sterilizer. This will allow the hospital to properly treat the medical waste prior to disposal and mitigate those risks. The hospital plans to locate and operate the incinerator at the dump and the sterilizer at the hospital. Figures 5.5 and 5.6 illustrate examples of the hospital preferred units; however the actual units to be installed will be selected after contract award.

Figure 5.5 - Proposed medical waste incinerator

Figure 5.6 - Proposed medical waste sterilizer

Recommendations

1. Purchase another trash compactor truck. This will provide backup in the event one truck breaks down and insure that the collection service is not interrupted. An additional collection truck will significantly reduce the amount of time and manpower needed to collect the trash.

2. Purchase 160 replacement trash bins. Include repair parts such as lids, hinges, and wheels. Repair and replace containers as needed. Another option is to purchase communal steel dumpsters which would reduce the amount of collection points and maintenance required.

3. Construct or install modular building to store medical waste. Include lighting, air conditioning, and ventilation. Provide reusable medical waste containers. Figure 5.7 shows an example of a prefabricated building that can be utilized for medical waste storage and the reusable containers.

4. Coordinate with DPW and RMI EPA for site selection of medical waste incinerator. The incinerator will require electrical power and a fuel source. Provide a facility to store the unit when not in use.

Figure 5.2 - Modular medical waste storage (typical)

DISPOSAL AND DUMPSITE OPERATIONS

DISPOSAL

The waste disposal and dumpsite operations were given an overall rating of “red” because conditions at the dump and the lack of waste processing pose a health, safety, and environmental risk.

System Description

The DPW relies mostly on burning of trash as a means of disposal. This includes all the trash from the residential areas, hospital, maintenance facilities, and power plant. The purpose of burning is to reduce the volume of solid waste to extend the life of the dump (Figure 5.8). Trash collected daily is dumped on the surface at random areas of the dump and left in place until it is burned (Figure 5.13). Trash is burned intermittently when the wind is blowing away from populated areas and when staff resources are available. Once burned, the trash piles are left in place and no further processing is conducted. The area at the dump used for oil dumping and burning is shown in Figure 5.9. Figures 5.10 and 5.11 are photos of the barrel used for burning of medical waste and the partially burned medical waste piles respectively

Figure 5.3 - Open trash burning

Figure 5.4 - Waste oil dump and burn area

Figure 5.5 - Medical waste burn barrel

Figure 5.6 - Partially burned medical waste

Current Landfill conditions:

The dump is located at the northern end of the island and occupies an area of approximately 5.3 acres (Figure 5.12). The facility is an open area where all the trash is dumped and eventually burned. There are no burial cells or trenches at the site and no compaction or fill is done. Currently, there are randomly spaced trash piles at the center of the site that occupy an area of approximately 3 acres (Figure 5.13), and along the west end, there is an area of approximately one acre used for discarded vehicles (Figure 5.14).

Figure 5.7 - Dumpsite map

Figure 5.8 - Dumping area at center of dump

Figure 5.9 – Discarded vehicles west end of dump

Figure 5.10 - Residential area adjacent to dump

The southern section borders a residential area (Figure 5.15). There are approximately 1.3 acres on the northern end which are clear of trash and currently used as a baseball field. Most of the dump is not fenced. The site is not secured and access is not controlled.

The RMI EPA Solid Waste Regulations (1989) defines an area used for disposal of solid waste as a landfill. However, it is important to note that this site does not have the typical characteristics of a landfill. There are no burial cells or trenches at the site. There is no liner or collection system to prevent leachate from migrating outside the unit. This would be classified as an open dump by U.S. standards.

Waste Composition:

The solid waste generated is a mixture of metals, paper, plastic bottles, glass, food, textile, garden, and other solid waste (Figures 5.16 & 5.17). There is also medical waste consisting of sharps, red bag waste, expired medicines and pharmaceuticals (Figure 5.18 & 5.19) and hazardous waste such as oil/fuel filters, paints, used oil, household chemicals and assorted batteries. A waste analysis survey with the quantities generated per each waste stream was not available at the time of the survey.

	
Figure 5.11 - Plastic bottles and containers in trash	**Figure 5.12 - Metals mixed in the trash**
	
Figure 5.13 - Sharps	**Figure 5.14 - Red bag medical waste**

Landfill equipment:

The equipment available for dumpsite operations had visible signs of deterioration and rust. However, the DPW stated that the equipment was functional. The equipment is a follows:

- Front end loader(Figure 5.20)
- Crane that was recently acquired from USAKA and will be utilized to harvest sand for dumpsite cover (Figure 5.21)

- Dump truck (Figure 5.22)
- Back hoe (Figure 5.23)

Figure 5.15 - Front end loader

Figure 5.16 - Crane

Figure 5.17 - Dump truck

Figure 5.18 - Back hoe

Findings

The findings are based on conditions observed during the site survey and from information gathered through interviews with KALGov representatives. There were no environmental samples taken, or testing done during the survey. Findings are as follows:

1. Environmental concerns regarding conditions at the dumpsite. The dump does not have a liner and there are no restrictions on the type of waste that is dumped and burned at the site. Several puddles of leachate were observed during the survey (Figure 5.24). (Leachate is the formation of highly contaminated water that forms after rainwater passes through the dump). Current dumpsite conditions pose a health and safety risk to the residents living

adjacent to the dump and the leachate pose a risk of contaminating the ground water and surrounding coastal environment.

2. The dumpsite is not secured and access is not controlled. Most of the perimeter is not fenced. There were several children observed playing at the dump during the survey (Figure 5.25), and some of them were close to the burning trash (Figure 5.26). Children playing at the dump risk exposure to hazardous material, medical waste, vectors, sharp objects, and toxic fumes from the burning trash (i.e. dioxins, toxic industrial chemicals/materials, etc).

Figure 5.19 - Leachate formation

Figure 5.20 - Unsecure dump site

Figure 5.21 - Burning trash piles

3. Processing of trash at the dump is insufficient. The trash collection process is efficient, however, once the trash is dumped at the site no further processing is done until it is burned. The trash piles are left open to the environment for extended periods of time and are a breeding place for vectors. The dump is infested with flies, rats, and other disease causing vectors which pose a health and safety risk to residents living next to the site. The homes are less than fifteen feet from the trash piles and in some of the homes the trash is literally in the backyards. Figure 5.27 and 5.28 depicts the conditions for residents living next to the dump.

Figure 5.22 - Trash piles in residential backyards

Figure 5.23 - Housing adjacent to dump

4. Inadequate trash burning process is inadequate. The current trash burning process results in large amounts of unburned trash, therefore the volume reduction is minimal (Figure 5.29). Observed burns were not of sufficient temperature and intensity to consume all the combustible materials. More importantly, low heat open burning of trash with large amounts of plastics emits numerous pollutants. These include dioxins (carcinogens), volatile organic compounds, carbon monoxide, particulates, and other pollutants which pose a health and safety hazard to the community. The risk is more significant to the residents within proximity to the dump.

Figure 5.24 - Partially burned trash pile

5. A solid waste management plan has not been developed. Currently, there are no written procedures or information available regarding:
    - Dumpsite operations plan (covering refuse, vector control, site access control, monitoring and recordkeeping, health and safety, and leachate control)
    - Trash burning procedures
    - Trash collection procedures
    - Waste minimization and recycling (removal of metals, junk cars and plastics)
    - Special waste collection and handling (hazardous materials and medical waste)

- Waste analysis survey (quantity and type of waste delivered to the landfill)
- Rate of dumpsite space being consumed and remaining life based on current practices.

6. The DPW lacks staff to operate the dump. - The DPW does not have a permanent staff or equipment staged at the dump to process the waste as it arrives daily. Current conditions at the site pose a health, safety and environmental risk and if not addressed the situation will get worse. In a meeting with Ebeye Mayor Johnny Lemari and Roland Calvin (KALGov Engineer), regarding the solid waste program, they stated that their plan is to contract out the dumpsite operations and that recycling would be part of the scope of work. However, no further information regarding the contract award timelines was provided.

7. Lack of recycling. There are no programs in place to remove recyclables from the waste prior to disposal.

8. There is no program in place to remove the hazardous waste from the rest of the solid waste prior to disposal. The DPW has made some attempts in the past to remove hazardous waste from the dump, especially lead acid batteries. However, they have had the batteries in storage for several years and are waiting on the RMI EPA for disposal guidance.

9. The dump is operating without a permit. In my meeting with the Mayor Johnny Lemari and Roland Calvin (DPW representative) they stated that the dumpsite was not permitted. The same information was provided by Mr. Harrington Dribo (RMI EPA Ebeye representative) in a subsequent meeting. The RMI EPA Solid Waste Regulations (Part V 19(c)) do not allow for any disposal sites to be grandfathered. Disposal sites that were operating prior to the effective date (August 25 1989) of the regulations were required to apply for a permit within sixty days of the effective dateInvalid source specified..

Recommendations

1. Construct an engineered landfill. The landfill can be constructed in several phases. There is an area of approximately 1.3 acres, currently used as a baseball field that is clear and can be developed in the first phase. Once that portion of the landfill is constructed, move the existing trash pile to that area and compact and fill. The second phase would consist of constructing the remaining 3.7 acres for future use. The landfill would require a permit from the RMI EPA.

2. Install a perimeter fence. This will ensure that access to the dump is controlled and the site is secured. The project consists of a 10 feet high chain link fence with gates located in the east and west perimeters for equipment and vehicle access.

3. Move the trash piles away from the homes. The conditions for residents on the southern border of the dump can be improved significantly by moving the trash piles away from their homes and by maintaining a minimum setback distance. The vector infestation can be reduced and controlled by compacting and filling all existing trash piles. Remove as much of the larger pieces of metal in the trash piles prior to compaction and fill. The DPW has a crane that can be utilized to harvest the sand needed for fill. However, a permit or approval from the RMI EPA should be obtained prior to harvesting of sand. Furthermore, the compaction and fill must be done in accordance to RMI EPA guidelines and standards.

4. Install a burn box. The burn box does not require electricity or fuel and is easy to operate and empty (Figure 5.30). However, plastics and hazardous materials must be removed prior to burning to reduce the volume of toxic pollutants. This system provides a confined and controlled area which reduces the risk of spreading fires throughout the landfill while burning. Open burning requires approval from the RMI EPA (Solid Waste Regulations Part VI, 28(i)).

Figure 5.25 – Typical metal burn box

5. Develop and implement a detailed solid waste management plan with specific goals, roles, responsibilities, and operational procedures. Partner with the RMI EPA for assistance, guidance, and training. The South Pacific Regional Environmental Program and the United Nations Environmental Program provide general guidelines regarding solid waste management and planning for small islands in the Pacific region which can be utilized for developing the plan. The manual is titled *Guidelines for Municipal Solid Waste Management Planning in Small Island Developing States in the Pacific Region, published in 1999 by the South Regional Environment Programme*. The plan can be developed internally by KALGov with the assistance from the RMI EPA.

6. Provide the staff needed to operate the dump. Contract out the dumpsite operations as planned or hire and train the staff needed to supervise operations and process trash at the site on a daily basis.

7. Conduct a study of the solid waste program to determine if a recycling is economically viable.

   Note: It is recognized that recycling may not be economically viable due the high cost of transportation, and the low value of the items recycled.

8. Conduct a survey to determine the amounts and types of hazardous waste generated, identify the sources, and develop a hazardous waste management plan. Coordinate with the RMI EPA for assistance in conducting the survey, developing the plan, training, and hazardous waste disposal guidance. It is considered that the survey and plan can be developed internally by KALGov.

9. Apply for a landfill permit and comply with the RMI EPA Solid Waste Regulations.

LIST OF REQUIREMENTS BY SYSTEM

Table 6.0 show the recommended projects identified with each system. These projects are intended to improve system safety, efficiency, reliability, and maintainability of the utility systems. These projects include initial training and key spare parts are assumed to be included in the project. Project managers should address such items in developing the specifications.

The following factors influenced the development of the recommended projects.

- The corrosive environment is very hard on equipment. Plant, equipment and materials used for infrastructure must be maintainable and sustainable.
- Lack of routine and preventive maintenance. Proposed infrastructure projects must be designed for reliability and maintained as much as possible.
- An extended loss of power could cause extensive health and safety hazards.
- Equipment that has operated beyond a reasonable service life should be identified and scheduled for eventual replacement.

Each proposed project is prioritized below as Low, Medium, or High as follows:

- High – the project is considered critical to the reliable continuation of the system.
- Medium – the project is considered important to correct deficient conditions, or to satisfy regulatory requirements.
- Low – the project improves the systems or to bring it up to U.S. standards, but is not considered an urgent necessity

PROJ	PRIORITY	PROJECT DESCRIPTION	SCOPE OF WORK
SEWER SYSTEM			
1	High	Bring the sewage treatment plant to an operational standard and upgrade it to new US EPA effluent standards	Install pretreatment system for screening and grit removal. Provide a new equalization basin. Install a secondary clarifier. Purchase two new brush rotors with associated controls. Replace the bypass valve and valve box. Re-pipe lift station no. 3. Install a new tertiary treatment system.
2	High	Clear existing drainage structures of sand and debris	Clean sand out of existing drainage structures to include drywells.
3	High	Survey and repair dilapidated ocean outfalls	Clear debris in front of outfalls, reconnect drains, clear outfall piping of debris, repair or replace headwalls. Backfill work included for erosion damage.
4	Med	Replace pumps and motor controllers in the sewage lift stations.	Upgrade pumps to meet extreme peak discharge flows. Purchase new controls for the lift stations. Purchase appropriate spares.
5	Med	Conduct a topographic survey	Develop base topographical map, benchmarks and establish elevations for future work.
6	Med	Design and build storm drain infrastructures Areas 1 and 2 identified by Ebeye officials.	Install new drainage structures in residential areas that suffer from extreme flooding during rain events. Work includes installation of catch basins, storm manholes and drain piping.

Table 6.0 – Recommended Projects

PROJ	PRIORITY	PROJECT DESCRIPTION	SCOPE OF WORK
WATER SYSTEM			
7	High	Increase salt water production and pressure	Conduct hydrological studies, construct three SW wells, install three 800gpm pumps, and construct pump/RO building
8	High	Increase fresh water production and pressure	Repair RO2, install new 750,000 gpd RO unit, and install three 300 gpm pumps in existing pump houses (north, central, and south tanks (equipment only)
9	High	Install salt and fresh water distribution system at north end of island	Install new fresh and salt water distribution system at north end of island.
10	Medium	Replace fire hydrants	Replace 62 fire hydrants
11	Low	Rehabilitate rain catchment basin	Overlay catchment basin with new base, modify drainage , and install new drain system

Table 6.0 – Recommended Projects

PROJ	PRIORITY	PROJECT DESCRIPTION	SCOPE OF WORK
ELECTRICAL DISTRIBUTION SYSTEM			
12	High	Electrical System Preventive Maintenance	The aging electrical system requires periodic maintenance to ensure that it can perform its design function safely and reliably.
13	High	Install Standby Generator	Install a 1.2 megawatts generator. Major scheduled maintenance on any generator cannot be performed because the stand-by unit cannot be completely shutdown
14	High	Upgrade Overhead Line, Low-Voltage Distribution	The overhead lines and poles appear to be seriously deteriorated
15	High	Replace Switchgear, Power Plant	The switchgear and its associated equipment in the power plant are 30-year old and replacement components are unavailable. All distribution feeders passed through this equipment. Should the system fail, half or the entire Ebeye will be without power for a prolonged period
16	Low	Demolish Generators	Demolish abandoned Enterprise and Caterpillar diesel engines in the old power generation plant and abandoned switchgear and control cabinets associated with the Enterprise engines.
17	Low	Perform Power Study	Conduct a comprehensive study of the generation and distribution system to include power flow, short circuit, and equipment protection and coordination

Table 6.0 – Recommended Projects

PROJ	PRIORITY	PROJECT DESCRIPTION	SCOPE OF WORK
TRASH SYSTEM			
18	High	Construct an engineered landfill	In two phases, moving trash piles each phase, grade, compact and line the current landfill. Phase one: 1.3 acres. Phase two: 3.7 acres. Install drain lines, vents, and catchments.
19	High	Install Landfill Perimeter Fence	Project consists of a 10 ft. high chain link fence with two 36 ft. wide sliding gates (2 ea. 18' x 10'). Total length is approximately 1800 ft.check if this is correct
20	High	Install Burn Box	Consist of a metal burn box, ½ inch steel plate construction, with a capacity of 40 cubic yard. The unit will not require electrical power or fuel source.
21	High	Purchase Trash Bins	Purchase 160 plastic trash bins, 50 gallon capacity, include repair parts such as lids, hinges, and wheels.
22	High	Purchase Modular Storage Building For Medical Waste Storage	8 ft. x 8 ft. prefabricated metal building prep for electrical hookup and includes lighting, air conditioning, ventilation and chemical coating for saltwater environments.

Table 6.0 – Recommended Projects

PROJ	PRIORITY	PROJECT DESCRIPTION	SCOPE OF WORK
TRASH SYSTEM			
23	Medium	Purchase A Trash Compactor Truck	Consists of 25,500 lbs Gross Vehicle Weight, 11 yard capacity, rear load body and hydraulic bin loader.
24	Medium	Conduct a recycling study	Conduct a study of the solid waste program to determine if recycling is economically viable.

Table 6.0 – Recommended Projects

SUMMARY

The sewer system was given a rating of “BLACK” because it is non-operational and the presence of raw sewage is a public health issue. For the last five years, raw sewage from the collection system has been directly pumped to the lagoon without treatment. The sewage treatment has not been used and is dilapidated to the point that it is no longer operational.

The storm drainage system was given a rating of “RED” because it is less than 50% operational. For the most part, the system is structurally sound. Sand and debris have clogged the system so it no longer functions properly. Maintenance is needed to bring the system back to an operational status and continued maintenance is needed to keep it operational.

The water system (salt and fresh) was given a rating of “RED” because it is less than 50% operational. The water distribution and production system do not have enough capacity nor pressure to adequately support the current population. One of three fresh water production units is out of service and the system is undersized. Potable water is rationed and distributed only twice a week for durations of 45 minutes. Salt water pump capacity is insufficient to support fire protection and service restrooms above the first floor.

Overall, the electrical system on Ebeye is rated “AMBER”. In the past, power would be off for weeks or months at a time due to a combination of problems including aging infrastructure in a corrosive environment, limited funding, skyrocket fuel costs, and lacking of preventive maintenance. However, since 2008, significant capital invested into the power plant has vastly improved the system reliability. System has become more stable with much less interruption. The power plant has been completely upgraded, with engines overhauled and additional standby units installed. However, the switchgear in the power plant is obsolete and in need of total replacement. All distribution feeders pass through this 40-year old equipment. The power plant switchgear needs to be programmed for replacement. The ability of this switchgear to operate safely is not known. The primary underground distribution line, which was upgraded in 2002, is in fair condition and operating within their rated limits. Finally, lack of routine and preventive maintenance continues to be the high item of concern. A proper maintenance program with adequate funding is essential for the sustainability of the system.

The trash collection process is rated "GREEN." The collection system works and provides the community with a reliable service. Overall rating for the dump and disposal operations is "RED". Trash disposal and dumpsite processes are in need of significant improvements. Current conditions and waste disposal practices at the dump pose a health, safety, and environmental risk, and if not addressed the situation will get progressively worse. Inadequate procedures include open dumping, open burning, uncontrolled access to the site, and lack of waste processing. Immediate initiatives that can be taken to reduce some of the health and safety risks are; installing a fence to secure the site, removing the trash piles away from the residential area, installing a burn box for more efficient trash burns, and initiating use of medical waste incinerator.

ACKNOWLEDGEMENTS

This infrastructure survey represents a large expenditure of the USAKA command's resources and required a substantial amount of coordination. We sincerely appreciate the support of the USAKA Commander, COL Frederick S. Clark, and his staff for providing the necessary support to make our field work productive. We would like to especially thank MAJ Christopher Mills and Mr. Michael Sakaio for taking time out of their busy schedule to work closely with us on all issues. They were both crucial to the success of this mission. We also extend our appreciation to KAJUR and KALGov Staff Mr. Rodrigues Nakamura, Mr. James Kabua, Mr. Majina Jacklick, Mr. Tony Loeak, Mr. Samuel Dunahoe, Mr. Jojabot Kijabot, and Mr. Roland Calvin. Last but not least, we would like to express our appreciation to all other staff members for their willingness to show our team their infrastructure systems and provide much of the background information in their respective functional areas. Without their support this survey would not have been possible.

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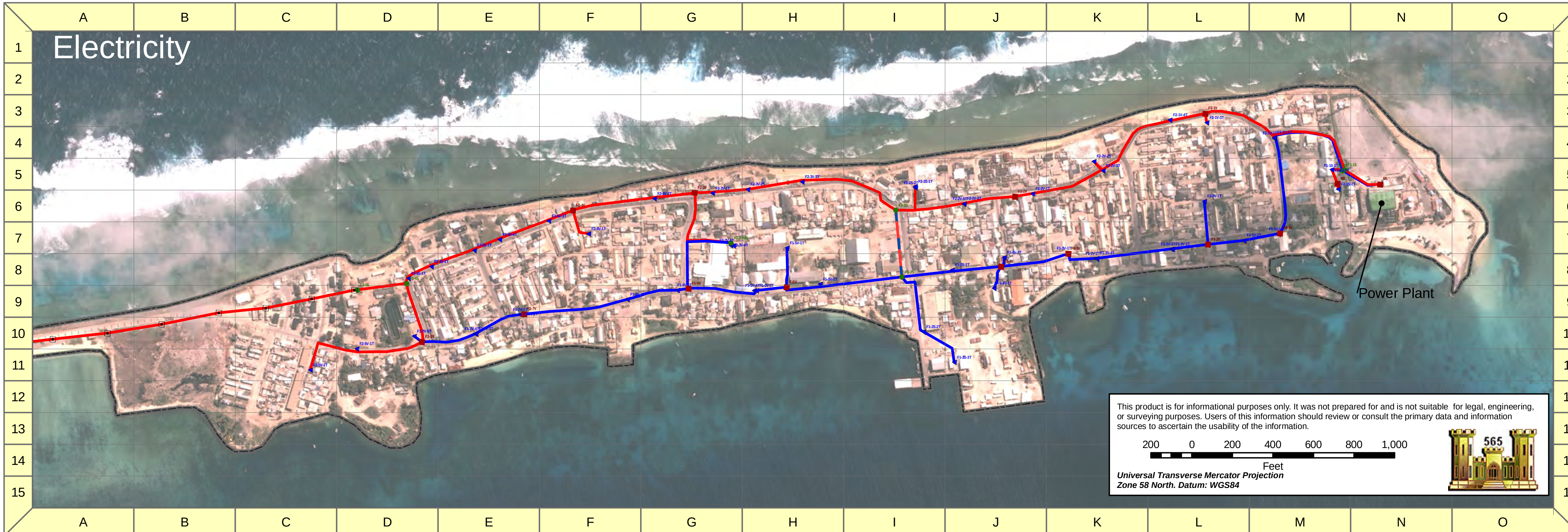
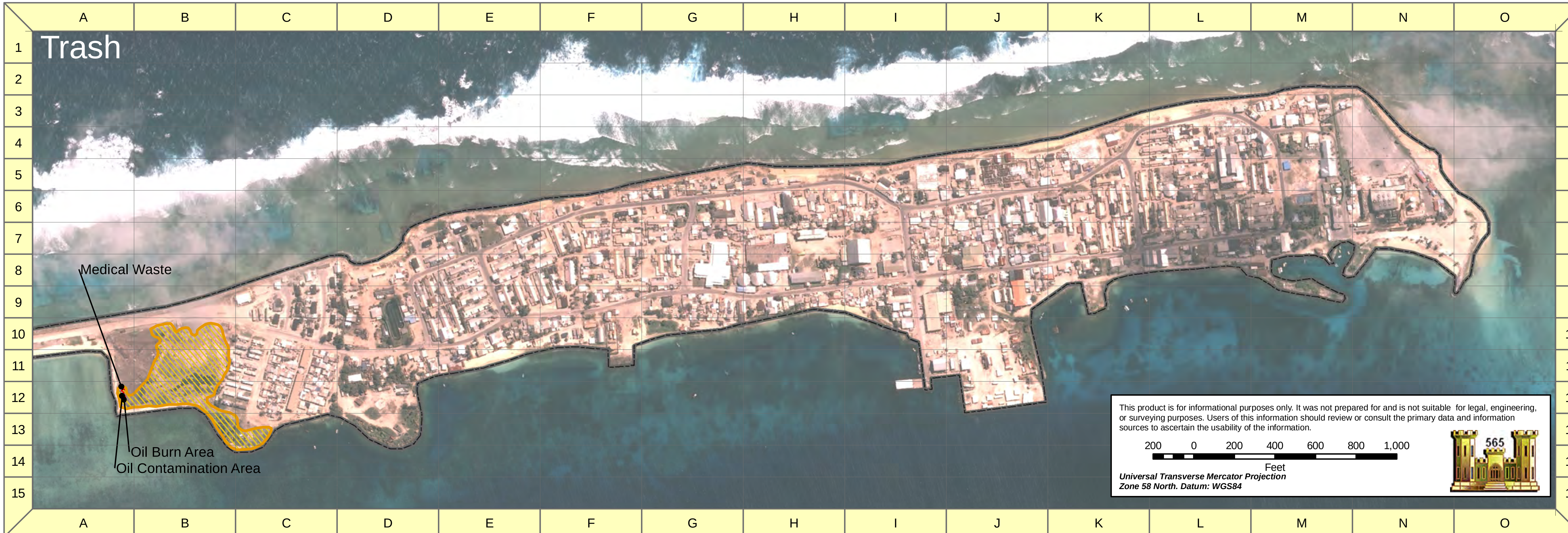
APPENDIX A, NOT USED

APPENDIX B, EBEYE UTILITIY MAPS


Electricity
Power Plant
This product is for informational purposes only. It was not prepared for and is not suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.
200 0 200 400 600 800 1,000
Feet
Universal Transverse Mercator Projection
Zone 58 North. Datum: WGS84
565


Water
Rainwater Catchment Area
RO Unit
Desalination Plant
Water Pump
Fresh Water
Salt Water
Known Alignment
Unknown Alignment
Water Tank
TankUseDOM
Fresh Water
Salt Water
Desalination
Water Well
Electrical Pole
Electric Switch
Electric Vault
Electric Transformer
Electrical Feeder 1
Electrical Feeder 2
Electrical Tie-Feeder
Lift Station
Communator/Screen
Storm Water Connected
Storm Water Drywell
Sanitary Sewer Manhole
Sanitary Sewer Outfall
Storm Water Outfall
Sewer Line
Storm Drain
Flood Area
Sewage Plant
Facility


Trash
Medical Waste
Oil Burn Area
Oil Contamination Area
This product is for informational purposes only. It was not prepared for and is not suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.
200 0 200 400 600 800 1,000
Feet
Universal Transverse Mercator Projection
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565


Sewer
Lift Station
Communator/Screen
Storm Water Connected
Storm Water Drywell
Sanitary Sewer Manhole
Sanitary Sewer Outfall
Storm Water Outfall
Sewer Line
Storm Drain
Flood Area
Sewage Plant
Solid Waste
Landfill
N
E
S
W