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INSPECTION AND SANITARY SURVEY REPORT FOR THE GUAM WATERWORKS AUTHORITY PUBLIC WATER SYSTEM

Guam, United States Territory
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PURPOSE OF INSPECTION AND SANITARY SURVEY OF THE GUAM WATERWORKS AUTHORITY PUBLIC WATER SYSTEM

As authorized under Section 1445(b) of the federal Safe Drinking Water Act (SDWA), 42 United States Code (U.S.C.) § 300j-4(b), David Parker (D. Parker) and Kacy Sable (K. Sable), enforcement officers of the U.S. Environmental Protection Agency (EPA), performed a sanitary survey inspection of the three Guam Waterworks Authority (GWA) public water systems (PWS), consisting of the following PWS (with corresponding PWS identification numbers):

- Guam Waterworks Authority Southern Water System (GU0000001)
- Guam Waterworks Authority Central Water System (GU0000003)
- Guam Waterworks Authority Northern Water System (GU00000006)
- Airport System (GU0000018) (owned by the Guam International Airport Authority and operated under contract by the Guam Waterworks Authority).

The primary purpose of this sanitary survey inspection is to ensure that the GWA public water system is capable of producing water that is potable and to ensure that the water supplier is meeting the requirements of the SDWA and its implementing regulations. See generally 42 U.S.C. § 300f et seq., 40 Code of Federal Regulations (CFR) Parts 141-143.

A public water system is generally defined under the SDWA as a system for the provision to the public of water through pipes or other constructed conveyances, if such system has at least 15 service connections or regularly serves at least 25 individuals. See SDWA § 1401 (4), 42 U.S.C. § 300f(4). A supplier of water is defined under the SDWA to include any person who owns or operates a public water system. See SDWA § 1401(5), 42 U.S.C. § 300f(5).

Section 1445(b)(1) of the SDWA provides, among other things, that the Administrator of EPA, or his/her designated representatives, upon presenting appropriate credentials and a written notice to any supplier of water or other person subject to a national primary drinking water regulation prescribed under section 1412 of the SDWA or any requirement to monitor an unregulated contaminant, or person in charge of the property of such supplier or other person, is authorized to enter any establishment, facility, or other property of such supplier or other person in order to determine whether such supplier or other person has acted or is acting in compliance with the SDWA, including for this purpose, inspection, at reasonable times, of records, files, papers, processes, controls, and facilities, or in order to test any feature of a public water system, including its raw water source. See 42 U.S.C. § 300j-4(b)(1).

The EPA is authorized to conduct an inspection under Section 1445(b) of the SDWA, 42 U.S.C. § 300j-4(b). The primary purpose of this inspection is to ensure that the public water system is capable of producing water that is potable and to ensure that the water supplier is

meeting the requirements of the SDWA and implementing its regulations. See generally 42 U.S.C. § 300f et seq., 40 CFR Parts 141-143.

The EPA defines a sanitary survey as: an on-site review of the water source (identifying sources of contamination using results of source water assessments where available), facilities, equipment, operation, maintenance and monitoring compliance of a public water system to evaluate the adequacy of the system, its sources and operations and the distribution of safe drinking water (40 CFR § 141.2).

The goal of a sanitary survey is to evaluate and document the capabilities of the water system sources, treatment, storage, distribution network, operation and maintenance, and overall management to continually provide safe drinking water and to identify deficiencies that may adversely impact a public water system's ability to provide a safe, reliable water supply.

NEIC conducted these sanitary surveys and PWSS compliance inspections at the request of EPA Region 9, and Region 9 will make timely and appropriate compliance and enforcement decisions under the SDWA including addressing significant deficiencies based on the Ground Water Rule and Surface Water Treatment Rule. Additional formal enforcement actions may be warranted to address systemic public health threats identified in the report.

The following eight components of a public water system are reviewed during a sanitary survey:

- Sources
- Finished water storage
- Pumps, pump facilities, and controls
- Monitoring, reporting, and data verification
- Operator compliance with licensing requirements
- Treatment
- Distribution system
- Water system management and operations

A sanitary survey is a critical element in ensuring that water systems are capable of providing water that is protective of the public health. Sanitary surveys are carried out to evaluate the capability of a drinking water system to consistently and reliably deliver an adequate quality and quantity of safe drinking water to the consumer, and to evaluate the system's compliance with drinking water regulations.

Information generated by a sanitary survey helps to identify existing and potential sanitary risks, including significant deficiencies. Significant deficiencies are defined by the EPA as "a defect in design, operation, or maintenance, or a failure or malfunction of the sources,

treatment, storage, or distribution system, that EPA determines to be causing, or has the potential for causing, the introduction of contamination into the water delivered to consumers." 40 CFR § 141.723.

The sanitary survey and inspection of the GWA public water systems was performed by D. Parker and K. Sable, inspectors with the EPA National Enforcement Investigations Center (NEIC), accompanied by staff from the Guam Environmental Protection Agency (GEPA) and GWA. The sanitary survey consisted of field inspections and interviews of staff and management of GWA. This on-site work took place from April 23 – May 3, 2012.

Due to time constraints, not all facilities of the GWA water systems were inspected. Table 1 summarizes the number and types of facilities inspected while the EPA inspectors were on-site.

A brief summary of findings was presented to GWA and GEPA management on May 4, 2012.

This report provides more detailed findings and deficiencies identified for the GWA PWS. Table 1 summarizes the GWA facilities inspected. Refer to **Appendix – Sanitary Survey Summary Table**, for a complete list of each asset visited, the date it was visited, a list of sanitary survey forms completed for each asset, and the photographs associated with asset observations.

Table 1. GWA FACILITIES INSPECTED (*NEIC-Created)
Project Name
Location

Facility Type	Total (from GWA Master Plan)	Total Visited During Inspection
Surface water treatment plant	1	1
Spring source	1	1
Wells	120	22
Tanks	36	11
Booster pump stations	35	9
Stormwater basins	?	3
Wastewater pump stations	?	6

PREPARATION FOR THE GWA SANITARY SURVEY

The following information was reviewed by the inspectors and evaluated prior to performing the sanitary survey:

- *Preliminary Draft Water System and Operations Assessment of GWA.* Prepared for EPA Region 9 by PG Environmental LLC (November 2010).
- *GWA Master Planning Technical Assessment.* Prepared for EPA Region 9 by PG Environmental LLC (January 2010).
- *Ugum Surface Water Treatment Facility Rehabilitation/Modification Retrofit Basis of Design Report.* Prepared for GWA by TG Engineers, PC (March 2008).
- EPA Region 9 findings from April 2009 GWA public water system inspections.
- Consulting Engineer's Report. Prepared by R.W. Beck, Inc. for GWA (October 2010).
- Historical SDWA (NPDWR) compliance data for GWA from EPA's files

KICKOFF MEETINGS

A preliminary meeting with GEPA was conducted on April 23, 2012, at the GEPA headquarters facility. In attendance were GEPA Director Eric Palacios, GEPA Acting Chief Engineer Angel Marquez, and the following GEPA personnel: Maricar Quezon, Johnny Abedania, Benny Cruz, and Jerry Aquino. Also attending were Michael Mann from EPA Region 9 and Trent Rainey, Kacy Sable, Daren Vanlerberghe, and David Parker from EPA NEIC. The purpose of this meeting was to introduce the EPA NEIC water and wastewater inspection team members, review the goals of this inspection, and to discuss matters of relevance to this inspection with the GEPA regulators.

A site opening conference took place on April 24, 2012, at the GWA administrative office. In attendance for GWA was Martin Roush (general manager). EPA NEIC inspectors attending were Trent Rainey, Kacy Sable, Daren Vanlerberghe, and David Parker. For a complete list of participants in the opening conference, refer to **Appendix – Opening Conference Sign-in Sheet**. The purpose of the inspection/sanitary survey was explained, and the schedule was discussed. EPA inspectors presented a copy of the inspection notification letter (dated April 17, 2012) and credentials. Arrangements were made for GWA personnel to accompany EPA and GEPA during the field portion of the inspection over the next two weeks.

Additional meetings and discussion took place during the course of the sanitary survey, primarily with GWA managers and operating personnel.

GWA WATER SYSTEM- OVERVIEW AND GENERAL DESCRIPTION

ORGANIZATIONAL STRUCTURE

The Congress of Guam passed Public Law 1-12 on June 30, 1950, which gave the Department of Public Works the authority to administer all utility services. As a result of the need to expand utility services, the 1st Guam Legislature passed Public Law 1-88 on June 6, 1952, thereby creating the Public Utility Agency of Guam (PUAG) to administer the drinking water and wastewater utilities. The Guam Waterworks Authority was formed as a semi-autonomous, self-supporting agency on July 21, 1996, with the passage of Public Law 23-119.

The Guam Waterworks Authority is responsible for all aspects of the engineering, operation, and maintenance of the Northern, Central, and Southern public water systems (as well as contract operations for the airport water system) including the sources, treatment, distribution, and storage.

The Guam Waterworks Authority is managed by an elected, non-partisan, five-member Consolidated Commission on Utilities, which oversees the operations of both the Guam Waterworks Authority and the Guam Power Authority (GPA). The day-to-day management of the Guam Waterworks Authority is under the oversight of Martin Roush, who serves as the general manager. Paul Kemp serves as the assistant general manager of GWA. At the time of the inspection, the production division was led by Ed Taimangalo, acting division manager. The distribution division was led by Anthony Chargualaf, acting division manager. The GWA organizational structure is illustrated in Figure 1.

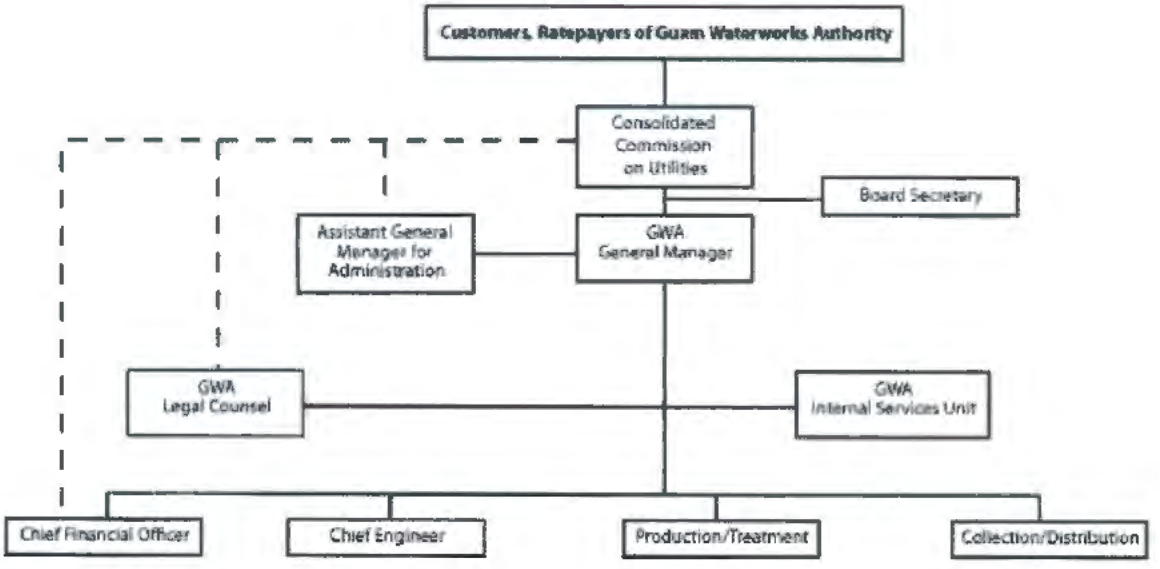

Figure 1. Guam Waterworks Authority Organization Chart

WATER SYSTEM- POPULATION AND COVERAGE

Guam is the southernmost island in the Mariana chain and is also the largest island in Micronesia. It is 30 miles long and varies between 4 and 12 miles in width. The island has a total area of approximately 212 square miles. The island does experience tropical cyclones and earthquakes on occasion.

The Guam Waterworks Authority PWS is charged with providing water to the population of the island. The total population served and number of service connections for each GWA PWS is presented in Table 2.

Table 2. GWA PWS INFORMATION
Project Name
Location

PWS Name	PWS ID Number	Population Served	Active Service Connections	Inactive Service Connections
GWA Southern	GU0000001	5,504	11,908	2,715
GWA Central	GU0000003	22,000	9,683	3,112
GWA Northern	GU0000006	146,050	19,522	5,197
Totals		**173,554**	**41,113**	**11,024**

GENERAL DESCRIPTION OF WATER SYSTEM

At the time of the inspection, records indicated that GWA operated and maintained more than 200 separate facilities across the island. Table 2 breaks the distribution of these facilities down amongst the three PWS owned by GWA. Note that not all of the listed facilities are currently in use.

Table 3. GWA FACILITY INFORMATION
Project Name
Location

PWS Name	Wells	Springs	Reservoirs	Booster Stations	Treatment Plants
GWA Southern	2	4	14	16	1
GWA Central	0	1	8	9	0
GWA Northern	119	0	14	10	0
Totals	**121**	**5**	**36**	**35**	**1**

The transmission and distribution systems for each of the three GWA PWS are combined into a common network consisting of approximately 380 miles of piping. Water sources feed the supply lines from which customer connections are made (some in very close proximity to the sources and disinfection points).

Water demand for the three GWA PWS was estimated to be 43 million gallons per day (mgd) in March 2010. During that same period of time (March 2010), GWA reports that they produced 38.5 mgd and purchased the difference from the United States Navy (USN) (water produced at the USN Fena water treatment plant [WTP]). Discussions with GWA and USN

indicated that recent work completed by GWA to rehabilitate the Santa Rita spring source in the GWA Central PWS have resulted in reductions of approximately 50 percent in the amount of USN water purchased by GWA.

In general, many of the aforementioned facilities are in poor operating condition as a result of minimal preventative and corrective maintenance.

Figure 2 illustrates the boundaries among the GWA Northern, Central and Southern PWS. Note that the boundaries illustrated in Figure 2 are inexact insofar as the three GWA PWS have potential overlaps of service areas that result from the utilization of different sources over time. More information concerning service overlaps can be found in the GWA Master Plan.

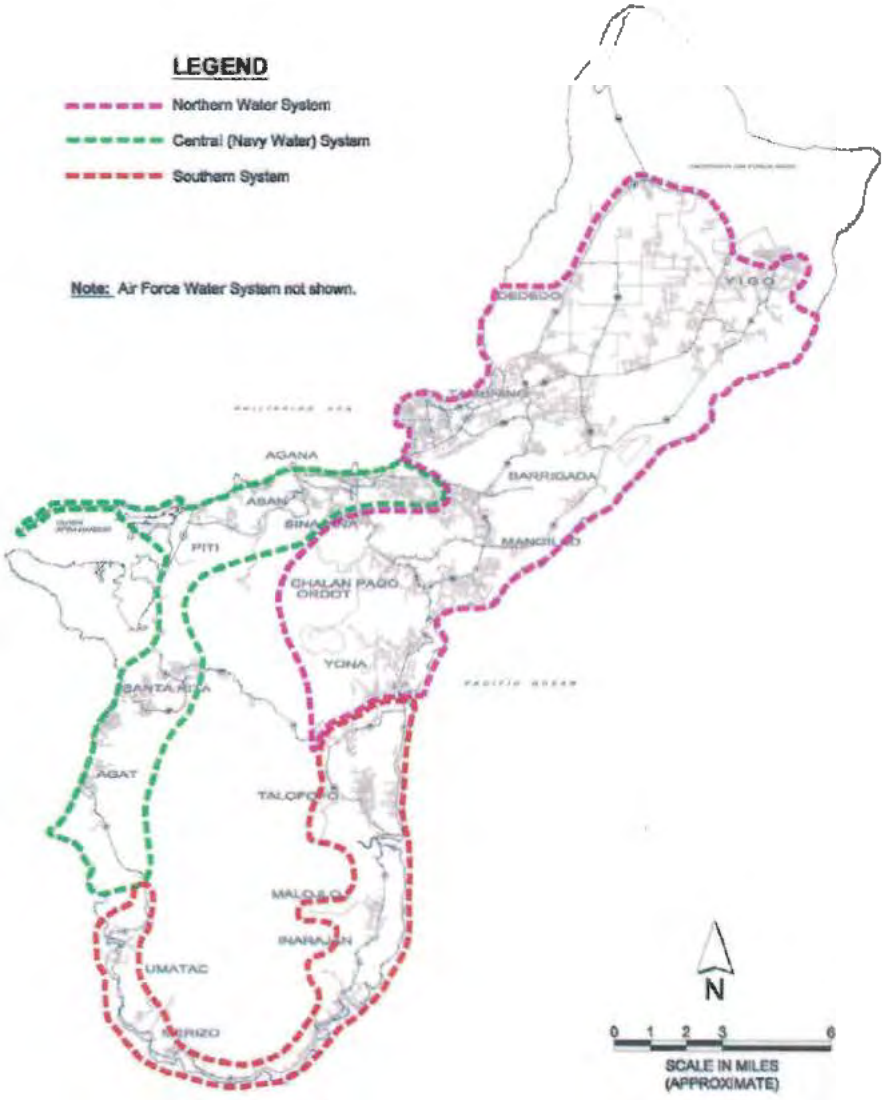

Figure 2. GWA PWS Boundaries
Project Name
Location
Source: GWA Master Plan

Sources

Sources consist of surface water, springs, and groundwater wells.

Surface Water

GWA uses surface water to serve customers in the Southern and Central PWS. GWA purchases water from the USN, which is produced at the Fena WTP for delivery to customers in the GWA Central PWS. Although the inspectors did visit the USN Fena WTP as part of the discussion concerning Disinfection By-Product (DBP) Rule compliance, that visit was for informational purposes only and was not part of the GWA sanitary survey. Information concerning the USN Fena WTP can be found in the GWA Master Plan.

GWA utilizes the Ugum River as the water source for the Ugum WTP, which serves the GWA Southern PWS. The water intake is located on the Ugum River near its confluence with the Talofofo River. The Ugum watershed covers an area of approximately 7.3 square miles and receives water from runoff and spring discharges. Stream flow in the Ugum River varies between 1.3 mgd in the dry season and 4.5 mgd in the wet season. Although the Ugum WTP was designed to treat up to 4 mgd, the stream flow in the dry season limits the amount of water available. A dam was created by GWA on the Ugum River in 1992 to create a pool in which the Ugum WTP intake structure is located. This dam allows for the withdrawal of up to 2 mgd from the river.

Anecdotal information obtained from GWA personnel indicate that other surface water sources were utilized by GWA in the past, including an unfiltered surface water source in the area of the Geus booster pump station that was taken off-line in the early 1990s.

Springs

GWA has used five springs as sources for its Central and Southern PWS. Information concerning all of the GWA spring sources is presented in Table 3. At the time of the inspection, only the Santa Rita spring was being utilized as a water source. Water from the Santa Rita spring was routed into a collection box where it mixed with water purchased from the USN FENA WTP before entering the distribution system.

Table 4. GWA SPRING SOURCES
Project Name
Location

Spring Name	Location	Production (gallons per minute [gpm])	System Served	Status
Asan	Asan	298	Central	Inactive
Santa Rita	Santa Rita	165	Central	Active
Laelae	Umatac	37	Southern	Inactive
Siligin	Merizo	10	Southern	Inactive
Geus	Merizo	53	Southern	Inactive

Groundwater Wells

GWA operates 121 wells, all but 2 of which are located in the GWA Northern PWS. The GWA wells are classified geographically, using a lettering and numbering system. The letters in the name refer to the well's general geographic location and the numbers denote the order in which the wells were drilled. A key to the well locations is found in Table 5.

Table 5. GWA WELL LOCATION KEY
Project Name
Location

Well Series Name	Number of Wells	GWA System	Location
A	26	Northern	Agana region
AG	2	Northern	Machananao (Agafa Gumas) region
D	27	Northern	Dededo region
EX	2	Northern	Dededo Golf Course Compound
F	19	Northern	Finegayan region
H	1	Northern	Harmon Village region
HGC	1	Northern	Santa Ana Subdivision in Dededo region
M	18	Northern	Barrigada region
MJ	2	Southern	Malojloj region
NAS	1	Northern	Tiyan region
Y	20	Northern	Yigo region

A list of all GWA wells can be found in **Appendix – Well List and Location**.

The U.S. Geological Survey (USGS) has done much work to characterize Guam's groundwater resources and the associated geology of the island **Appendix – Hydrologic Resources of Guam (USGS)**. Volcanic rock makes up the island's foundation. The northern area of the island that is used for groundwater withdrawal is made up of limestone that overlays the volcanic rock. This limestone geology allows for high porosity and high permeability. Geologic faults crossing the island add to the complexity of the limestone rock's permeability. Rainfall on the island infiltrates the thin layer of soil and permeates through the underlying rock formations before entering the aquifer. The aquifer on Guam is composed of a freshwater-lens system. The freshwater lens floats on top of salt water, and the two layers are separated by a zone of brackish water. Salinity in a freshwater-lens system is graduated, with low levels of chlorides in the upper layers of the freshwater zone. Chloride levels increase down through the freshwater zone through the transitional brackish zone and into the salt water layer.

Well configuration is essentially identical throughout the GWA system, but specific details vary from site to site. Multi-stage submersible pumps bring the water up from the wells. Standard well site configuration consists of a well pad, a well head, an air relief valve, a sounding tube, a check valve, a bypass line equipped with a manual gate valve, and an automatic bypass valve. Most of the wells were found to be equipped with gaseous chlorine disinfection systems. The chlorination systems are typically housed in closed structures located in close proximity to the wellheads.

The wells are manually operated. Some wells pump water to a ground-level storage tank before the water enters the distribution system, but many other wells pump water directly into the distribution system with no additional storage.

All of the wells are located outside and are enclosed by a chain link fence with a gate. Emergency power supply is accomplished by means of diesel generators located on-site. These generators are owned and operated by the Guam Power Authority (GPA). Fuel for the generators is stored on-site in above-ground tanks.

Three wells (A-8, F-8, and NAS-01) are equipped with granular activated carbon (GAC), which was designed to remove organic chemical contaminants. GAC treatment was installed at well A-8 as a precautionary measure due to the well's proximity to an underground storage tank. The contaminant of concern at well F-8 is ethylene dibromide (EDB) and Trichlorethylene (TCE) at well NAS-01. At the time of the inspection, all three of these wells were being utilized for production yet none of the three GAC units were in operation. The inspectors were unable to ascertain when the GAC treatment units were taken off-line at each of these three wells, but review of GWA's monitoring data indicates that TCE concentrations at well NAS-01 are greater than 50% of the MCL, while EDB monitoring at well F-8 has resulted in no detections of this chemical from 2009 until the present.

Water Quantity Issues

Groundwater utilization – Based on observations made while on-site and on careful review of historical records, the inspectors determined that many of the GWA wells are withdrawing water at rates higher than permitted by GEPA in order to meet demand. The fresh water aquifer that is used on Guam is relatively small and is vulnerable to salt water intrusion if withdrawal rates outpace resupply. This practice of overuse, if continued, may result in increased levels of total dissolved solids (TDS) and chlorides (as has been observed at well D-13, which has resulted in its current disuse).

Service outages – GWA officials report that water outages occur on a regular basis. Data provided by GWA indicates that 113 emergency (unplanned) outages occurred during fiscal year (FY) 2011. These reported emergency outages had a cumulative duration of 634 hours. GWA also reported that 33 planned outages occurred during FY 2011. These planned outages had a cumulative duration of 283 hours.

The number and duration of outages is of concern due to the potential introduction of contaminants into the distribution system during outages. During these outages, low-and negative-pressure events can occur. These events allow contaminants, such as potentially harmful microorganisms, to be transferred from surrounding areas into the distribution lines through pipe joints or other openings in the pipes.

Water Quality Issues

Surface water source vulnerabilities – The inspectors noted that the Ugum River intake is located downstream of Talofofo Falls Park and the Layon landfill. Operators were unable to ascertain whether these nearby land uses pose any potential impacts to the raw water supply.

Spring source – The inspectors were unable to ascertain raw water quality of the spring source. The turbidimeter located on-site was nonfunctional at the time of the inspection. Information supplied by the GWA laboratory indicates that disinfection by-product (DBP) levels in the GWA Central PWS have risen since the Santa Rita spring was brought back on-line, which indicates that the spring source is contributing DBP precursors into the system. The Surface Water Treatment Rule required that all spring sources be evaluated to determine if they are under the influence of surface water. No decision has been made concerning the characterization of the Santa Rita spring in regard to groundwater under the direct influence of surface water (GWUDI), although there is a study underway by GWA, Guam EPA and EPA Region 9.

Groundwater contamination (microbial) – Review of GWA and GEPA records indicates that microbial contamination is an issue at numerous GWA well locations. Monitoring information collected in 2011 from untreated well water indicates that total coliform bacteria contamination occurred in 60 out of 120 wells that were samples (50 percent occurrence rate) and that fecal coliform bacteria contamination occurred in 10 out of 120 wells (8 percent occurrence rate). These levels of occurrence are significantly higher than what is typically found in groundwater wells that have not been impacted by outside sources of contamination.

Of particular concern is the fact that three wells (A-23, A-25, and A-31) were found to have fecal coliform bacteria in the raw water during multiple quarters of sampling in 2011. These three wells are located in the Chaot area in close proximity to several locations (Chaot wastewater pump station and the manholes near the A-23 well) where many significant wastewater spills have occurred and are still occurring on a regular basis. These three wells are also located in close proximity to a storm water detention basin/underground injection control (UIC) well site that has been observed (by Guam EPA and US EPA personnel) to receive wastewater overflows from a nearby manhole.

This microbial contamination could be caused by unsanitary conditions of the wellheads (that have resulted from a lack of maintenance). Guam's limestone geology in the northern area of the island (where groundwater is used) can also allow microbial contaminants to descend through the permeable rock and into the aquifer. Potential sources of contamination include septic systems, leaking wastewater pipes, sewage spills, animal waste, and UIC well injectate.

Discussions with GWA and GEPA representatives revealed that although several GWA wells have been provisionally declared groundwater under the direct influence of surface water, final decisions in regard to the GWUDI status of GWA's wells have been suspended pending the outcome of a ongoing study by EPA Region 9, GEPA, and GWA. The inspectors were informed by the GWA general manager that the GWA ceased collecting data for the GWUDI study at some point in the recent past. The inspectors noted that the ongoing microbial contamination of GWA's groundwater sources makes completion of this study and resulting regulatory decisions regarding the GWUDI status of these wells highly important.

Groundwater contamination (chemical) – GWA monitoring data indicates that groundwater contamination has occurred and is ongoing. A paper prepared in 2009 for an American Water Resources Association conference details Guam's groundwater contamination from 1996-2007 and is found in **Appendix – AWRA 2009**. GWA provided the inspectors with chemical and microbiological monitoring data from 2009 through 2012, which is found in **Appendix – GWA PWS Monitoring Information from 2009-2012**. The following list highlights the most important results of GWA's chemical monitoring:

- Ethylene dibromide (EDB) was found in well F-8 in 1996 at a concentration of 0.12 micrograms per liter (µg/L) (which was an exceedance of the EPA maximum contaminant level [MCL]). Granular activated carbon (GAC) treatment was installed at well F-8 in 1999, but EDB has not been detected in monitoring at that well since it was brought back on-line after treatment was installed.
- Tetrachloroethylene (PCE) has been found in at least 11 GWA wells since 1996. Raw water concentrations of PCE were found to exceed the MCL at wells A-6, A-5, and A-28 (note that the inspectors were unable to determine if any regulatory violations of the running annual average occurred).
- Chlordane has been found in at least 59 GWA wells since 1996. Raw water concentrations of chlordane in well M-14 have been found to exceed the MCL at least 5 times (note that the inspectors were unable to determine if any regulatory violations of the running annual average occurred).
- Trichlorethylene (TCE) has been detected in at least 12 GWA wells since 1996. Levels exceeding 50 percent of the MCL have been observed in wells NAS-1 and D-16.
- Nitrate has been found in all GWA wells since 1996. Concentrations exceeding 50 percent of the MCL have been found in wells A-26 and M-4.
- Dieldrin (an unregulated pesticide) has been found in at least 88 GWA wells since 1996. The highest concentration of Dieldrin observed to date is 1.6 µg/L. Monitoring data from 2011 indicated Dieldrin concentrations of 1.2 µg/L at well Y-15. Although there is no EPA MCL for Dieldrin, the World Health Organization (WHO) has issued a combined guideline value

for Aldrin and Dieldrin of 0.03 µg/L. In the absence of federal regulations, several states have adopted their own guidelines and/or MCLs for Dieldrin, which are as follows:

- Illinois – primary drinking water standard (MCL) of 1 µg/L combined Aldrin and Dieldrin
- California – drinking water guideline of 0.05 µg/L combined Aldrin and Dieldrin
- FL – drinking water guideline of 0.002 µg/L for Dieldrin
- Arizona – drinking water guideline of 0.002 µg/L for Dieldrin
- Maine – drinking water guideline of 0.02 µg/L for Dieldrin
- New Hampshire – drinking water guideline of 0.002 µg/L combined Aldrin and Dieldrin

- Chlorides have been found in the vast majority of GWA's wells. Monitoring in 2011 found that 13 of GWA's wells exceed the EPA secondary standard for chloride and that well D-13 has been taken off-line due to high levels of chloride.

Well siting – Many of the wells that the inspectors visited were located near potential sources of contamination (trash dumping, storm water ponding basins, UIC wells, wastewater pump stations, sewer manholes, diesel fuel storage tank containment areas designed to discharge to the ground near wellheads). Considering the microbial and chemical contamination of the groundwater that was documented during this inspection, and the evidence of ongoing, frequent and significant wastewater spills from sewer lift stations and manholes, it would be prudent to consider implementation of a wellhead protection program for all of the GWA wells.

Treatment

Surface Water – The Ugum WTP was originally designed, constructed, and operated as a conventional WTP (rapid mix, flocculation, sedimentation, and filtration). This facility was converted to a microfiltration membrane treatment facility (0.2 micrometer (µm) nominal pore size) over the past several years. The conversion of the Ugum WTP resulted in a configuration of rapid mix/chemical addition, contact basins, membrane filtration, backwash settling, backwash supernatant clarification, and sludge treatment. The finished water is disinfected by means of gaseous chlorination. **Appendix – Ugum WTP Process Diagram** outlines the overall treatment process.

Springs – Water from Santa Rita spring mixes with water that is purchased from the USN Fena WTP. This water is then disinfected by gaseous chlorination before it enters the distribution system. Disinfection was configured with 150-pound gaseous chlorine cylinders on scales, an automatic switchover regulator/manifold, booster pump, and injector.

Groundwater – Most of the wells were found to be equipped with gaseous chlorine disinfection systems. The chlorination systems are typically housed in closed structures located in close proximity to the wellheads. Typical sites consist of 150-pound gaseous chlorine cylinders, a regulator/manifold, booster pump, and injector. Many of the chlorinators were

found to have automatic switchover manifolds. Some of the sites were found to have functioning scales.

Finished Water Storage

GWA provided information concerning 36 storage tanks/reservoirs that have served its three PWS. At the time of this inspection, only 20 of the tanks were being used, with a capacity of 25.21 million gallons. All of the currently used tanks were constructed of welded steel located at ground level. All of the tanks inspected were found to be in a serious state of disrepair, including many with direct openings into the tanks.

Distribution System

The GWA distribution system consists of approximately 386 miles of pipe. Pipe materials include asbestos/cement, cast iron, ductile iron, polyvinyl chloride (PVC), and some are reported to be unknown. The GWA distribution system is a blending of many legacy systems that date to the first half of the 20th century, changes made during the Japanese occupation of 1941-1944, and development that has occurred on the island since that time. A lack of historical records related to the distribution system makes operations and repair work challenging. Much of the distribution system is old, and many areas are undersized, being served by 2-inch mains, which are inadequate to meet customer demand.

Transmission and distribution lines are combined in the GWA distribution system. This results in water supply sources feeding the distribution lines to which customers are connected (some of which are immediately adjacent to wells or disinfection points). This situation makes it challenging for GWA to achieve regulatory compliance with the disinfection requirements set forth under the National Primary Drinking Water Regulations (NPDWR).

The GWA distribution system is completely integrated among the three PWS. Water from the Northern and Central PWS can be routed to the Southern PWS by means of isolation and pressure-reducing valves. GWA is currently working to identify existing pressure zones by means of a "bubble map," which is shown in Figure 4. However, it should be pointed out that the pressure zones are poorly understood by operators and that much of the work involved in isolating and routing finished water is accomplished by trial and error. The GWA distribution system pressure zone bubble map can be found in **Appendix – GWA Distribution System Pressure Zone Bubble Map**.

Pumps, Pumping Facilities and Controls

GWA use several types of pumps and pumping facilities (booster stations):

- The GWA distribution system is served by 35 booster pump stations (all inspected booster pumps were of the in-line variety).

- Each well has a pump/motor assembly (all inspected wells had submersible pump/motors).
- Gas chlorination systems have a booster pump for the high pressure/high chlorine solution feed injection line.

GWA Water Quality Monitoring, Reporting, and Data Verification

In public drinking water supplies, microorganisms including bacteria, viruses, and protozoans are the contaminants of greatest concern, as they have the greatest chance of reaching levels high enough to cause acute health effects. Acute health effects occur immediately, or after very short exposure, and are therefore of serious concern. Acute health effects include diseases such as cholera, typhoid, hepatitis, salmonellosis, giardiasis, cryptosporidiosis, and other diseases caused by microorganisms. Microorganisms in water can make people ill, and can be particularly dangerous or deadly for high-risk populations, including the elderly, infants, persons whose immune system are weakened due to HIV/AIDS, chemotherapy, or other reasons.

Only one non-microbial contaminant is regulated by EPA as an acute contaminant. Nitrate is an inorganic chemical, which, if present at sufficiently high levels in a drinking water supply, can cause acute health effects; specifically, it can cause serious impacts on infants less than 6 months of age. High levels of nitrate can result in "blue-baby" syndrome, (Methemoglobinemia). In this condition, the nitrate interferes with oxygen uptake by the infant, and can result in brain damage and even death.

Other contaminants regulated by NPDWR may cause chronic, or long-term, health effects. Chronic effects occur after people consume a contaminant at levels over EPA's safety standards for many years. The drinking water contaminants that can have chronic effects are chemicals, including metals (such as lead and arsenic) disinfection by-products (such as total trihalomethanes or haloacetic acids, which can be formed when water with high natural organic material content [such as surface water] is chlorinated]; solvents and other volatile organic chemicals; pesticides; radionuclides (such as radium); and other minerals (such as fluoride, which may be naturally occurring or may be added to help prevent tooth decay). Examples of the chronic effects of drinking water contaminants are cancer, liver or kidney problems, or reproductive difficulties.

Information provided by GWA and GEPA to the inspectors indicate that approximately 240 coliform bacteria samples are being taken in the distribution system each month. Although a complete data verification was not performed due to insufficient time, based on discussions with GWA and GEPA personnel, and a high level review of data summaries, monitoring for volatile and synthetic organic chemicals, pesticides, disinfection by-products, radionuclides, and unregulated contaminants appears to be occurring in compliance with regulatory monitoring schedules. Monitoring for all inorganics except lead and copper appears to be occurring in compliance with regulatory monitoring schedules. However, lead and copper monitoring has not

occurred in any of the three GWA PWS since 2003, resulting in monitoring and reporting noncompliance with the Lead and Copper Rule.

Water System Management, Operations And Administration

Figure 1 illustrates the organizational structure for GWA. Financial information is found on the GWA website (www.guamwaterworks.org/annual_rpts.html), which includes the 2010 - 2014 financial plan (see **Appendix – GWA 5 Year Financial Plan 2010-2014**), which lists income and expenses for FY 2008 and FY 2009 while projecting budgets for FYs 2010 through FY 2014.

Operator Compliance with Licensing Requirements

EPA's national guidelines for operator certification programs, and GEPA's regulations regarding water system operators' certification, require the following:

- The operator(s) in responsible charge (or equivalent) of the public water system must hold a valid certification equal to or greater than the classification of their water system, including each treatment facility and distribution system, as determined by the state;
- That all operating personnel making process control/system integrity decisions about water quality or quantity that affect public health must be certified; and
- That a designated certified operator be available for each operating shift.

GEPA has adopted operator certification regulations that are applicable to all GWA-operated PWS. These regulations are found in **Appendix – GEPA Operator Certification Regs.** Inspectors noted a shortage of qualified operators throughout the GWA drinking water systems. A list of certified operators with GWA and a listing of operators in direct responsible charge is found in **Appendix – Water Certified Operators & DRC.**

SUMMARY OF MAJOR FINDINGS – SIGNIFICANT DEFICIENCIES AND RECOMMENDED ACTIONS

The following describes the major findings and significant deficiencies identified during the sanitary survey. Detailed observations of the inspection of the system can be found in **Appendix – On-site Inspection Notes.** In addition, sanitary survey forms documenting observations made at pump stations, tanks, and wells are included in **Appendix –SS Forms PS Tanks Wells**. A sanitary survey form documenting observations made at Santa Rita spring is included in **Appendix –SS Form Santa Rita Spring.** Sanitary survey forms documenting observations made at the Ugum WTP are located in **Appendix – SS Forms Ugum**. Sanitary survey forms documenting observations made at the airport facility operated by GWA can be found in **Appendix – SS Forms Airport.**

SOURCES

The water supply source is the beginning of the drinking water system. Preventing contamination from entering the source is a critical means of preventing contaminants from reaching consumers. The condition, reliability, quality, quantity, operation, and vulnerability of sources are evaluated as part of a sanitary survey.

Surface Water Source (Ugum River)

A. The lack of routine maintenance (both corrective and preventative) and standard operational procedures (SOPs) is a significant concern at all three GWA PWS. This lack of routine maintenance is exemplified in the following significant deficiencies that were found at the Ugum River intake facility:
   1. There is a lack of adequate backup pumps (only two pumps were found to be operational during the inspection and both were in use). The third pump was not present and was awaiting maintenance.
   2. The newly installed Amiod pre filters (100 microns) were out of service (for the past 2 months) due to problems with their actuator valves and the controlling supervisory control and data acquisition (SCADA) system.
   3. Pump #1 has a noticeable vibration in the drive shaft and a leaking packing gland. Operations staff informed the inspectors that the packing gland has to be replaced once per month.
   4. The intake structure (screened box) is not secured and has been known to wash away in high flow events.
   5. The diesel fuel storage tank containment area at the intake was visibly undersized and was designed to discharge to the ground where it could flow downhill to the Ugum River.
   6. Holes in the concrete at the intake dam need to be repaired to maintain structural integrity.
   7. The flow meter at the intake has been in operation for approximately 2 years but has never been calibrated. This calibration needs to be conducted on a regular basis.
   8. The turbidimeter located at the raw water pump site is not calibrated. This calibration needs to be conducted on a regular basis.
   9. GWA should implement routine and corrective maintenance at all intake appurtenances, which include meters, valves, pumps, piping, and pressure gauges.

B. Potential sources of contamination exist within the watershed and are should be evaluated.

1. A potential source of sewage exists upstream at Talofofo Falls Park. GWA should make sure that park management notifies the Ugum WTP if there is a spill or discharge.
2. Recreational activities on the Ugum River at the intake site and upstream allow people in close proximity to the intake structure.
3. There is a locked gate on the entry road to the intake facility, but there is a residence within the secured zone, which allows people access to the intake facility.

Spring Source (Santa Rita)

A. The lack of routine maintenance (both corrective and preventative) and standard operational procedures (SOPs) is a significant concern at all three GWA PWS. This lack of routine maintenance is exemplified in the following significant deficiencies that were found at the Santa Rita spring facility:
   1. No operating flow meter was found at the spring.
   2. No operating turbidimeter was found at the spring.
   3. The piping pit vault that leads from the clear well to the chlorination treatment facility was found to be flooded to a depth of 3 feet. This left valving and flow meters inaccessible.
   4. Pumps #1 and #2 were found to be leaking.
   5. GWA should implement routine and corrective maintenance at all spring appurtenances, which include meters, valves, pumps, piping, and pressure gauges.

B. The spring box (clear well) structure was found to have the following deficiencies:
   1. Gaps between corrugated metal roof and clear well walls allow entry by animals, birds, and reptiles.
   2. Heavy vegetative growth around the clear well structure should be removed.

Groundwater Sources

A. The aforementioned ongoing microbial and chemical contamination of the GWA wells, if not addressed adequately, poses a significant potential risk to public health.

B. Wells are located in close proximity to potential sources of contamination (trash dumps, storm water ponding basins, underground injection control wells, sinkholes, wastewater pump stations, sewer manholes, and diesel fuel storage tank containment areas designed to discharge to the ground near wellheads). The inspectors were informed that no wellhead protection plans exist for the GWA wells. In light of the ongoing chemical and microbial contamination of the GWA wells, these issues should be addressed immediately.

C. GWA appears to be withdrawing more groundwater than GEPA permits authorize. This may be a major factor in the fact that 13 of GWA's wells exceed the EPA secondary (non-health based) standard for chlorides. Although chloride is a secondary standard, exceedance of chlorides may result in wells becoming unusable. This in turn, could lead to a decrease in water supply, with consequent potential impacts on both water quantity and water quality.

D. Direct openings (holes) through the wellhead sanitary seals ("well caps") and/or well casings provide a potential route for contamination to directly enter into the well casings.
   1. Cracks in well pads and well casings and improperly sealed sanitary seals.
   2. Open end (missing caps) of sounding tubes (which go directly through the well casing).
   3. Missing screens on vents (which go directly through the well casing).

E. Many of the wells were found to have bypass lines that were routed into the ground and off-site without an air gap. Furthermore, most of the automatic bypass valves were found to be

non-functional. Operators use gate valves to manually operate bypass lines. This operation can allow the possible contamination of the well source by backsiphonage.

F. Site security was found to be inadequate at many of the well sites.
   1. While most of the well sites were fenced, many of them had missing or damaged sections of fencing or did not have barbed wire around the top of the fence.
   2. Some of the sites did not have locked gates.
   3. Signs of vandalism (graffiti) were found at the well sites.

G. The lack of routine maintenance (both corrective and preventative) and standard operational procedures (SOPs) is a significant concern at all three GWA PWS. This lack of routine maintenance is exemplified in the following significant deficiencies that were found at the well sites:
   1. Many of the wells were found to have leaking pipes and valves.
   2. Many of the sites had old, abandoned equipment (piping, gauges, meters, etc.) cluttering the well sites.
   3. Many of the pipes were rusted, and a significant number of bolts that were used to join pipe flanges and various fittings were found to be completely rusted away due to a lack of routine maintenance (painting).
   4. Many of the flow meters, valves, air relief valves (ARVs), and pressure gauges did not function because they had not been maintained.

TREATMENT

Water treatment facilities are critical for preventing unacceptable drinking water quality for public consumption. A water system's treatment facilities and processes should be capable of removing or inactivating physical, chemical, and biological impurities in the source water. Sanitary surveys evaluate the water treatment processes in use at the water system. The evaluation typically considers the design, operation, maintenance, and management of the water treatment facilities, to identify existing or potential sanitary risks.

Surface Water Source (Ugum WTP)

A. Any excess untreated raw water that enters the head works of the plant (after being pumped approximately 1.5 miles from the Ugum River intake) is diverted to a storm water discharge that also contains overflow from the ground-level storage tank (finished water that has been chlorinated) into a concrete structure that allows for discharge of this chlorinated water into a receiving stream. At the time of this inspection, the concrete structure into which this flow was collected was composed of three concrete walls and the discharge flowed out of the open side of the structure. Although the inspectors were unable to ascertain the volume of flow, it was noted that the discharge occurred continuously during the course of the inspection. It should be noted that the Ugum WTP does hold an National Pollutant Discharge Elimination System (NPDES) Permit (GU0020371) that only authorizes the discharge of treated "Clean-in-Place and Chemical Enhanced Backwash Wastewater" from the membrane filters. Therefore, the observed discharge of chlorinated water does not appear to be authorized by the aforementioned (NPDES) permit.

B. Data recording devices for continuous turbidity meters on individual filters have been installed, but the data is irretrievable due to the lack of computer software to interface with the MEMLOG device (Memcor filter data capture device). Thus, this information cannot be reported as required by the Surface Water Treatment Rules.

C. The facility has no emergency plan for chlorine storage and release, as required by the Clean Air Act (CAA).

D. The ground-level storage tank appeared to provide inadequate contact time for chlorine to achieve adequate protozoan disinfection (log removal requirements are set forth under the Surface Water Treatment Rules) due to the inlet/outlet flow configuration.

E. Concerns over the chemical feed are as follows:
   1. The chemical addition mixing motor at the rapid mix has been inoperative for the past 3 months. Chemical feed is accomplished via gravity feed through the rapid mix bypass line and mixed hydraulically. Operations staff was unable to tell the inspectors when this motor would be repaired.
   2. Plant operators do not regularly conduct jar tests and leave the coagulant (aluminum chlorohydrate) dosing set at 6.8 milligrams per liter (mg/L) regardless of changes to the raw water quality.

F. Stage 2 Disinfection By-Products Rule noncompliance in the GWA Southern PWS brings into question operational practices at the Ugum WTP related to the removal of organics (DBP precursors) through the treatment train:
   1. Plant operators and engineering staff do not appear to understand the correlation between ineffective coagulant dosing, inadequate sedimentation and DBP precursor removal.
   2. Only one flocculation/sedimentation basin (now called contact basin #2) was in operation during the inspection. The second basin (contact basin #1) was down for service (and had been for more than a year due to the treatment plant upgrade process). As a result, all plant flow is routed through contact basin #2, leaving very little time for settling to occur.
   3. The contact basin design does not incorporate the use of v-notch weirs. Instead, the flow is routed through three submerged holes at the end of the basin. This flow regime allows large quantities of flocculation to carry over from the sedimentation basin onto the filters.
   4. The high flow rate through contact basin #2 and the high carryover rate of flocculation particles to the filters make this treatment process minimally effective in regard to organics (DBP precursors) removal. This resulted in the recent Stage 2 DBP noncompliance in the GWA Southern PWS.

G. Membrane filter concerns:
   1. Membrane filters are exposed to direct sunlight, which can lead to premature degradation from exposure to ultraviolet light.
   2. Membrane filters are subjected to a chemical "clean in place" (CIP) cleaning cycle at a rate twice as frequent as that recommended by the manufacturer due to excessive fouling.

H. Chemical storage concerns:
   1. The aluminum chlorohydrate (ACH) liquid storage tank located in the downstairs chemical room does not have adequate containment.
   2. Sulfuric acid now in the upstairs chemical storage room and in the downstairs chemical feed room needs to be stored in an area with containment.
   3. The upstairs chemical storage room lacks a floor drain system.

I. The lack of routine maintenance (both corrective and preventative) and standard operational procedures (SOPs) is a significant concern at all three GWA PWS. This lack of routine maintenance is exemplified in the following significant deficiencies that were found at the well sites:
   1. The radiator on the emergency power diesel generator is not functioning (and has been non-functional for over a year). The operators have tried to remedy this situation by placing a running hose in the radiator whenever the generator is operated.
   2. The plant operator reported that plant SCADA system turbidity readings are unreliable.

3. There are two broken pieces of conduit on the floor of the generator room that allow water to flow down into the conduit past exposed wiring.
4. The ACH pump designated for the backwash clarifier is not working due to a broken part and has been out of service for over 2 months.
5. The electrical wiring box located under the entrance stairs to the filter gallery needs a cover to shield the exposed wiring.
6. Various meters, valves, pumps and pressure gauges were non-functional.
7. The spare parts inventory was low.

J. The Ugum operators are using the monthly operations report (MOR) form from the previous conventional plant instead of the new MOR form designed by GEPA and EPA Region 9 specifically for the membrane facility.

K. No turbidity calibration standards were located on-site. Plant operators indicated that the bench-top turbidimeter (Hach 2100AN) is calibrated twice per week by the GWA information technology staff.

Spring Source (Santa Rita)

A. The chlorine scales are broken in the chlorine feed room.

B. The chlorine residual meter has not worked since January 2012. Free chlorine residuals are determined by grab samples collected at a sample tap in the pump room.

C. Although the ongoing Stage 2 DBP Rule violations (both total trihalomethanes [TTHM] and haloacetic acids [HAA5]) at the Guam Central Water System are partly the result of the DBP precursors found in the finished water purchased from the USN Fena WTP, data collected since the Santa Rita spring was recently brought back online indicate that DBP concentrations have increased in the GWA Central PWS since that time. This means that any work to return the GWA Central PWS to compliance with the Stage 2 DBP Rule must involve both the purchased Navy water and the water obtained from Santa Rita spring.

D. The lack of routine maintenance (both corrective and preventative) and standard operational procedures (SOPs) is a significant concern at all three GWA PWS. This lack of routine maintenance is exemplified in the following significant deficiency that was found at the Santa Rita spring site:
   1. The turbidimeter was not functioning.

Groundwater Sources

A. Disinfection concerns:
   1. One of the active well sites (D-5) visited by the inspectors did not have any type of disinfection installed even though total coliform contamination has occurred in the past.
   2. One of the well sites (F-5) was found to have run out of chlorine gas (according to the operator log) on April 29, 2012. This site has experienced total coliform contamination in the past.
   3. Some of the well sites do not have automatic switchover capability between multiple tanks of chlorine gas.
   4. Some of the well sites only have manifolds (i.e. no auto-switchover) for both of the chlorine tanks.
   5. Chlorine tank scales were found to be nonfunctional at several of the well sites.
   6. Chlorine residual samples taken by GEPA personnel did not match the GWA operator log entries for the same day.

B. Site security was found to be inadequate at many of the chlorination facilities.

1. While most of the well sites (where the chlorination facilities are located) were fenced, many of them had missing or damaged sections of fencing or did not have barbed wire around the top of the fence.
2. Some of the chlorination facilities did not have locked doors.
3. Signs of vandalism (graffiti) were found at the chlorination facilities.

FINISHED WATER STORAGE SYSTEMS

Properly designed, maintained, and operated finished water storage facilities serve several functions:

- Allow source and treatment facilities to operate at or near uniform rates, even though the demands of the system may fluctuate (buffer supply/demand fluctuations);
- Supply peak and emergency needs of the system;
- Maintain adequate pressure in the system;
- Provide extended contact or detention time for disinfection;
- Serve as reservoirs for the blending and mixing of water from different sources that may have varying water qualities.

In general, the GWA finished water storage tanks do not provide many of the normal functions of a well-designed and operated water system. Most of the storage tanks are old and in deteriorated condition, have openings and/or leaks, and are susceptible to contamination. Some of the tanks are empty or near empty much of the time; while others are full and may overflow. There has been a documented instance of catastrophic structural failure of a GWA tank in 2005 (Barrigada #1) which resulted in structural damage to the adjacent Barrigada #2 tank (which had to be taken out of service as a result).

Note that the purpose of this sanitary survey inspection was not to assess structural integrity of the water tanks, but to identify sanitary deficiencies. However, obvious structural deficiencies, when observed, were noted.

A. Most of the reservoirs had deficiencies that leave them open to contamination:
   1. Open/corroded tank roof vents directly allow contamination to enter.
   2. All tanks were found to have unlocked hatches.
   3. Most of the tanks were found to have no screens or flappers on their overflows.
   4. Some tanks were found to have had leaks in the past.

B. Most of the tanks were found to have no working control systems (non-functioning altitude valves; no controls on well pumps or booster pumps, overflowing storage tanks, etc.).

C. One elevated storage tank (Yigo Elevated) that was said to be out of service had a noticeable leak (which indicated that water was coming into the tank).

D. Site security was found to be inadequate at many of the finished water storage facilities.
   1. While most of the tank sites were fenced, many of them had missing or damaged sections of fencing or did not have barbed wire around the top of the fence.
   2. Many of the facilities had unlocked gates.

3. Many of the access ladders were severely corroded and some had no safety cages for rooftop access. None of the tanks with caged ladders had lockable gates to prevent unauthorized access.
4. Rooftop hatches were reported to be unlocked at all sites visited by the inspectors.
5. Most of the tanks had been vandalized with graffiti.

E. The lack of routine maintenance (both corrective and preventative) and standard operational procedures (SOPs) is a significant concern at all GWA PWS. This is exemplified in the following significant deficiencies that were found at the finished water storage sites:
   1. No regular cleaning or maintenance is conducted.
   2. Severe external rust and corrosion was found on all of the tanks inspected on the walls, base welds seams, and anchor bolts. Some of the anchor bolts were found to have completely rusted away due to neglect.
   3. Trash (including spoiled meat) was found to have been dumped beside the GWA reservoirs. This can present a health hazard since all of the tanks have unscreened vents which can allow disease-carrying organisms to enter the tanks via flys and other insects.
   4. Overflows at some of the tanks were routed to ground level without an air gap. Vegetative overgrowth prevented the inspectors from finding all of the overflow discharge sites.
   5. Many of the valve vaults were either flooded, uncovered, and/or unsecured.

DISTRIBUTION SYSTEM

The water distribution system is the link between the water source, storage, and the consumer. The water distribution system consists of piping, valves (isolation and pressure control), fire and flush hydrants, meters, and other appurtenances. The sanitary survey looks for areas where water quality might deteriorate in the distribution system for any reason, including: problems with the physical infrastructure (pipes, valves, pressure control stations, hydrants, etc.); inadequate pressure, cross-connections, and backflow; and inadequate operation or maintenance of facilities.

One area of particular concern with the three GWA PWS is cross-connections, and the potential for backflow of contaminated water into the distribution system. A cross-connection is a physical connection between any part of a water system and another contaminant source of unknown or questionable quality. Cross-connections can allow contaminated water and other contaminants to backflow into the water system as a result of backpressure or backsiphonage. Most water systems and localities in the United States have adopted plumbing codes that require the builders of a new or remodeled facility or building to eliminate or protect all cross-connections. Codes usually allow local building officials to inspect the facility or building to look for cross-connections during construction, and annually thereafter. In addition, many water utilities have a cross-connection control program that requires high-risk customers (such as factories, hospitals, schools, certain businesses, or homes with a high risk for backflow into the system) to install, test, and maintain a backflow prevention device on their service lines, to prevent contaminated water from back flowing into the system.

The inspectors were informed that GWA now requires acceptable backflow prevention devices in portions of the Southern PWS where homes and businesses that are connected to the PWS are also connected to small spring sources (non-regulated water supplies). The inspectors verified this practice while visiting AWR radio station, where backflow prevention devices had been installed.

Evaluation of the GWA distribution system was based on a review of water system maps, sampling plans, sampling results (including historical distribution system chlorine residual and bacteriological test results), field observations of distribution system components, and discussions with water operator personnel.

A. Design and operational concerns:
   1. Operators (and engineering) lack full understanding of how many and which pressure zones are present and how sources, boosters, valves, water lines, storage, and other distribution system appurtenances are related to pressure zones; this lack of understanding results in difficulties in managing water pressure and water quantity.
   2. Undersized water lines (specifically, a very large amount of 2" water line) impact water pressure and water quality (potential cross- connections, lack of adequate fire flow).
   3. Operators manually open and close valves for pressure and quantity control.
   4. Incomplete pressure relief valve (PRV) and Altitude valve routine operation and maintenance program (checking settings, inspecting for leaks, other problems)
   5. Geographic information system (GIS) maps are not complete, especially in some areas (legacy water lines).
   6. Some valves are closed, causing dead-ends in distribution.
   7. Bottle necks are prevalent in certain areas and have caused problems, including line breaks, low and/or high pressure, etc.

B. Water outages occur in numerous villages (see earlier discussion in "Finished Water Storage Systems").

C. Water loss rate is approximated at 50 percent.

D. Distribution lines are repeatedly patched (some single lengths of pipe have up to 7 patches) instead of replaced.

E. The lack of routine maintenance (both corrective and preventative) and standard operational procedures (SOPs) is a significant concern at all three GWA PWS. This lack of routine maintenance is exemplified in the following significant deficiencies that were found in the distribution system:
   1. An inadequate cross connection control program exists within GWA.
   2. There is no flushing program.
   3. No valve preventative maintenance or valve exercise programs exist.

PUMPS, PUMPING FACILITIES, AND CONTROLS

A sanitary survey includes an assessment of pumps and pumping facilities including design, use, operation and maintenance issues, including reliability and sanitary risks.

Several chlorine treatment system solution feed pumps were inspected at the well sites, as well as distribution system pump booster stations. Overall system design was reviewed through

review of GWA water system maps and existing planning documents such as the GWA Master Plan.

A. Design and operational concerns:
   1. None of the booster pump stations visited by the inspectors had pump controls installed.
   2. Some of the booster pump stations were installed in low-lying areas where they are at risk of flooding.
   3. Several of the booster pump stations were located outside with no protective coverings.
   4. Electrical hazards were noted at several pump facilities (from flooding due to leaks and unsafe electrical connections).
   5. Many of the wells pump directly into the distribution system to areas where there is no storage tank prior to, or floating on that portion of the distribution system.

B. The lack of routine maintenance (both corrective and preventative) and standard operational procedures (SOPs) is a significant concern at all three GWA PWS. This lack of routine maintenance and SOPs is exemplified in the following significant deficiencies that were found pumps, pumping facilities and controls:
   1. Lack of maintenance on pumps has resulted in severely damaged, corroded, non-functional pumps, motors, wiring, electrical controls, and other appurtenances.
   2. Leaking seals were found on many pumps.
   3. Leaking valves, leaking lines, nonfunctional pressure gauges, and highly rusted piping resulting in leaks were observed at pump facilities.
   4. Many of the pump facilities had no backup pumps (they were either not present or non-functional).

WATER QUALITY MONITORING, REPORTING, AND DATA VERIFICATION

The three GWA PWS's are required to meet all applicable Drinking Water Regulations, including the National Primary Drinking Water Regulations promulgated by the EPA and the drinking water regulations promulgated by GEPA, including all maximum contaminant level standards, treatment techniques (TT) and performance standards (PS); monitoring and reporting (M/R) requirements; public notification (PN); and other requirements. The objectives of surveying the water quality monitoring/reporting/data verification are to:

- Review the water quality monitoring plan of the public water system for conformance with regulatory requirements;
- Verify that the water quality monitoring plan is being followed by checking test results;
- Verify that all in-house testing as well as equipment and reagents being used conform to accepted test procedures;
- Verify the data submitted to the regulatory agency; and
- Evaluate the procedures an operator follows to identify any problems with the process, determine the changes needed to correct the problem, and how adjustments to the process are approved and performed as needed.

Due to time constraints, a full review of the compliance of the three GWA PWS with all applicable regulations was not done as part of this inspection/sanitary survey.

Compliance monitoring data from 2009 through the first quarter of 2012 was reviewed during the inspection. Even though many microbial samples from the untreated groundwater were positive for total coliform and fecal coliform bacteria, there was only one total coliform rule (TCR) violation during that time period, an acute TCR violation at the Central Water System in July 2011, that was identified and addressed (including public notification) by GWA.

Aside from the aforementioned historical chemical contamination issues related to the groundwater sources, analysis of the chemical monitoring data found the following instances of ongoing noncompliance:

1. Lead and Copper Rule compliance monitoring has not been conducted since 2003 in any of the three GWA PWS (monitoring and reporting violation that has not been reported to the Safe Drinking Water Information System [SDWIS])
2. Stage 2 DBP Rule violations at the Guam Central Water System (reported to SDWIS in April 2012)
   - TTHM MCL violations ongoing continuously since 1st Quarter 2010
   - HAA5 MCL violations:
     - 1st Quarter 2010
     - 2nd Quarter 2010
     - 3rd Quarter 2011
     - 4th Quarter 2011
     - 1st Quarter 2012
3. Stage 2 DBP Rule violations at the Guam Southern Water System (not reported to SDWIS)
   - HAA5 violation:
     - 1st Quarter 2012

The inspections of the Ugum WTP and Santa Rita spring resulted in the discovery of ongoing inadequate monitoring and reporting at both of these facilities. The Ugum WTP does not currently conduct continuous turbidity monitoring and reporting as required by the Surface Water Treatment Rules. The Santa Rita spring does not currently conduct continuous chlorine residual monitoring or continuous turbidity monitoring and reporting as required by the Surface Water Treatment Rules.

GWA WATER SYSTEM MANAGEMENT, OPERATIONS, AND ADMINISTRATION

Water system management, operations, and administration are major factors that affect the performance of a water system, and deficiencies in these areas can impact the quality of water provided to the consumers. Management provides the direction, funding, and support that are needed for a public water system to continually supply safe drinking water. Management and staff need to work together to create an environment that facilitates meeting the goal of providing the best possible quality of drinking water to the consumer. Areas routinely reviewed in sanitary

surveys include basic information on the system's management, staffing, operations, and maintenance, as well as system revenue, budgeting, and procurement.

GWA water system operations and management were evaluated through observations of operations staff in the field; by conducting interviews with Water Division and Laboratory Division operational staff and managers; and by reviewing previous water system management/administrative evaluations. A detailed management and administration assessment (including detailed reviews of budgets) was not performed due to lack of time.

The deficiencies highlighted below are directly linked to weaknesses and problems inherent in the system's management, operation and administration. EPA's inspection and survey indicates that the deficiencies related to infrastructure can be attributed to, at the most basic level, deficiencies related to management of the system. For example, upper level management has not established clear water quality goals for the water system. EPA inspectors identified the following deficiencies that need to be addressed:

1. No formal, comprehensive training program (skills-based) currently exists for operators and other personnel.
2. GWA's hydraulic model is neither complete nor accurate enough to make operational or design decisions.
3. Lack of metering of all customers, and lack of a master metering program, results in lack of knowledge of demand of unmetered customers, lack of information on water demand and flows in and between water service areas and pressure zones; and results in water quantity and water pressure issues.
4. No preventive maintenance programs exist for most operational areas of the drinking water systems. As a result, virtually all of the facilities inspected (wellheads, pumps, treatment facilities, storage tanks, hydrants, other distribution system components) are in varying levels of disrepair or failure.
5. Lack of an effective asset management program has resulted in rapid deterioration of assets and potentially significant financial losses. Equipment and facilities are used until they break and are discarded, rather than maintained to last as long as possible.
6. Ineffective procurement processes result in many critical items not being purchased or not being purchased in a timely manner.
7. Data are collected, but are not always sufficiently analyzed to assist with operational decisions.
8. Standard operating procedures are virtually non-existent, and need to be developed and implemented that cover every aspect of the drinking water system.

OPERATOR COMPLIANCE WITH LICENSING REQUIREMENTS

One of the eight core components of a sanitary survey is to assess the water system's compliance with state operator certification requirements. EPA's national guidelines on water system operators certification require, at a minimum, that the operator(s) in responsible charge or equivalent must hold a valid certification equal to or greater than the classification of their water system, including each treatment facility and distribution system, as determined by the state; that all operating personnel making process control/system integrity decisions about water quality or

quantity that affect public health be certified; and that designated certified operator be available for each operating shift. GEPA has adopted regulations that reflect EPA's national guidelines.

A list of certified operators with GWA and a listing of operators in direct responsible charge is found in **Appendix – Water Certified Operators & DRC**. Information gleaned during the inspection has resulted in the following observations:

1. GWA operates facilities with insufficient operators in direct responsible charge (DRC). DRCs are not always present as required under GEPA operator certification requirements. It was discovered that no Level 4 Operator is actually located on site at the Ugum WTP (the current DRC is located off-site).
2. No formal operator training program exists.

MAJOR FINDINGS- SIGNIFICANT DEFICIENCIES AND RECOMMENDED ACTIONS

PRIORITIZING DEFICIENCIES

A1 Actual effect, major impact, continuous
A2 Actual effect, minor impact, continuous or actual effect, major impact, intermittent
A3 Actual effect, minor impact, intermittent
P1 Potential effect, major impact, continuous
P2 Potential effect, minor impact, continuous or potential effect, major impact, intermittent
P3 Potential effect, minor impact, intermittent

SOURCES

Wells

Significant Deficiencies

- A1 – Wells located near potential sources of contamination (trash dumping, storm water detention basins, UIC wells, wastewater pump stations, sewer manholes, and diesel fuel storage tank containment areas designed to discharge to the ground near wellheads)
- A1 – Microbial contamination of GWA wells
- A1 – Chemical contamination of GWA wells
- A1 – GWA appears to be withdrawing more groundwater than GEPA permits authorize
- A2 – Open sounding tubes
- A2 – Cracks in well pads and well casings and improperly sealed sanitary seals
- A2 – Lack of well pads at some of the locations
- A2 – Missing screens on well casing vents
- P2 – Many of the wells were found to have leaking pipes and valves.
- P2 – Many of the wells were found to have bypass lines that were routed into the ground and off-site without an air gap.

Recommendations

- Lack of adequate site security – missing or damaged fencing and signs of vandalism (graffiti) on structures should be repaired or replaced..
- Begin routine and corrective maintenance of all wellhead appurtenances and well facilities – meters, valves, pumps, Air Relief Valves (ARV), piping, pressure gauges, etc.
- Remove unnecessary items (old lines, gauges, meters, etc.).

Surface Water Source (Ugum River)

Significant Deficiencies

- A2 – Lack of adequate backup pumps (only two pumps operational day of survey, both in use)
- A2 – The newly installed Amiod pre filters (100 microns) were out of service for the past 2 months due to problems with their actuator valves and the controlling SCADA system.
- P1 – Pump #1 has a noticeable vibration in the drive shaft and a leaking packing gland that has to be replaced once per month.
- P2 – Intake structure (screened box) is not secured and has been known to wash away in high flow events.
- P2 – Diesel fuel storage tank containment area at the intake was visibly undersized and was designed to discharge to the ground where it could flow downhill to the Ugum River.

Recommendations

- Possible sewage source upstream (Talofofo Falls Park) – Should notify owner/operators of need to notify Ugum WTP if there is a spill or discharge.
- Recreational activities on the Ugum River at the intake site which currently allow people in close proximity to the intake structure should be evaluated.
- Flow meter at intake should be calibrated.
- Turbidimeter located at the raw water pump site should be calibrated.
- Repair holes in concrete at the intake dam to maintain structural integrity
- Implement routine and corrective maintenance at all intake appurtenances – meters, valves, pumps, pre filters, piping, pressure gauges, etc.

Spring Source (Santa Rita)

Significant Deficiencies

- A1 – Lack of operating flowmeter at spring source.
- A1 – Lack of operating turbidimeter at spring source.
- A1 – Gaps between corrugated metal roof and clear well walls allow entry by animals, birds, and reptiles.
- A2 – The piping pit vault that leads from the clear well to the chlorination treatment facility was found to be flooded to a depth of 3 feet, leaving valving and flow meters inaccessible.
- P1 – Pumps #1 and #2 were leaking.

Recommendations

- Remove heavy vegetative growth around the clear well structure.

- Implement routine and corrective maintenance at all spring appurtenances – meters, valves, pumps, piping, pressure gauges, etc.

TREATMENT

Ugum WTP

Significant Deficiencies

- A1 – Any excess water that enters the head works of the plant is diverted to a storm water discharge that also contains overflow from the ground-level storage tank into a concrete structure that allows for discharge of this chlorinated water into a receiving stream. This discharge of chlorinated water does not have an NPDES permit.
- A1 – The ground-level storage tank appeared to provide inadequate contact time for chlorine to achieve adequate protozoan disinfection (log removal) due to the inlet/outlet flow configuration.
- A1 – Data recording devices for continuous turbidity meters on individual filters are installed, but the data is irretrievable due to the lack of computer software to interface with the MEMLOG device.
- A1 – The facility has no emergency plan for chlorine storage and release.
- A1 – Ground storage tank vent is completely open.
- A1 – No turbidity calibration standards were located on site. Plant operators indicated that the bench-top unit (Hach 2100AN) is calibrated twice per week by the GWA information technology staff.
- A1 – Plant operators do not regularly conduct jar tests and leave the coagulant (aluminum chlorohydrate) dosing set at 6.8 mg/L regardless of changes to the raw water quality.
- A1 – Plant operators and engineering staff did not understand the correlation between ineffective coagulant dosing, inadequate sedimentation and disinfection by product precursor removal (which has lead to regulatory compliance issues with the DBP Stage 2 Rule).
- A2 – Only one flocculation/sedimentation basin (now called contact basin #2) was in operation during the inspection. The second basin (contact basin #1) was down for service (and had been for more than a year due to the treatment plant upgrade process). As a result, all plant flow is routed through contact basin #2.
- A2 – Sedimentation basin (contact basin) design does not incorporate the use of v-notch weirs. Instead, the flow is routed through three holes at the upper end of the basin. This flow regime allows floc to carry over from the sedimentation basin onto the filters.
- A2 –The plant operator reported that plant SCADA system turbidity readings are unreliable.
- A2 – The Ugum WTP operators are using the MOR form from the previous conventional plant instead of the new MOR form designed by GEPA and EPA Region 9 for the membrane facility.
- A2 – Spare parts inventory is low
- A2 – The radiator on the diesel generator is not functioning (and has been non-functional for more than a year).

- P1 – Membrane filters are exposed to direct sunlight which can lead to premature degradation from exposure to ultraviolet light.
- P1 –Membrane filters are subjected to a chemical "clean in place" (CIP) cleaning cycle at a rate twice as frequent as that recommended by the manufacturer due to excessive fouling.
- P2 –Sulfuric acid in the upstairs chemical storage room and in the downstairs chemical feed room needs to be stored in an area with containment.
- P2 – There are two broken pieces of conduit on the floor of the generator room that allow water to flow down into the conduit past exposed wiring.
- P2 – The ACH liquid storage tank located in the downstairs chemical room does not have adequate containment.
- P3 – The chemical addition mixing motor at the rapid mix has been inoperative for the past 3 months. Chemical feed is accomplished via gravity feed through the rapid mix bypass line and mixed hydraulically.
- P3 – Ground storage tank hatches (2) not locked.

Recommendations

- Implement routine and corrective maintenance at all treatment appurtenances – meters, valves, pumps, pressure gauges, etc.
- A floor drain system needs to be installed in the upstairs chemical storage room.
- The ACH liquid storage tank located in the downstairs chemical room does not have adequate containment in the event of a spill. This situation needs to be remedied.
- The ACH pump designated for the backwash clarifier is not working due to a broken part and has been out of service for over 2 months). This situation needs to be remedied.
- The electrical wiring box located under the entrance stairs to the filter gallery needs a cover to shield the exposed wiring.
- Inspectors noted an unmarked drain from the bottom of the diesel generator. The drain hose was plugged with a greasy rag. The line should be properly valved and identified.

Santa Rita Spring

Significant Deficiencies

- A1 – No functioning turbidimeter.
- A2 – The chlorine residual meter has not worked since January 2012. Chlorine (Cl2) residuals are determined by grab samples collected at a sample tap in the pump room.
- A2 – The chlorine scales are broken in the chlorine feed

Wells (Chlorination/Disinfection)

Significant Deficiencies

- A1 – One of the well sites (D5) did not have any type of disinfection installed even though total coliform contamination has occurred there in the past.
- A1 – One of the well sites (F5) was found to have run out of chlorine gas (according to the operator log) on April 29, 2012. This site has experienced total coliform contamination in the past.
- A2 – Some of the well sites do not have automatic switchover capability between multiple tanks of chlorine gas.
- A2 – Some of the well sites only have manifolds (i.e. no auto-switchover) for both of the chlorine tanks.
- A2 – Chlorine tank scales were found to be nonfunctional at several of the well sites.
- A2 – Chlorine residual samples taken by GEPA personnel did not match the GWA operator log entries for the same day.
- P2 – Inadequate site security – No, or inadequate, fencing; open gates; unlocked doors; lack of barbed wire; evidence of vandalism (graffiti).

DISTRIBUTION SYSTEM

Significant Deficiencies

- A1 – Operators (and engineering) lack full knowledge and understanding of how many and which pressure zones are present, and how sources, boosters, valves, water lines, storage and other distribution system appurtenances are related to pressure zones; this lack of understanding results in difficulties in managing water pressure and water quantity
- A1 – Undersized water lines impact water pressure and water quality (potential cross-connections which could allow backlow and/or backsiphonage; inadequate fire flow)
- A1 – Operators open and close valves for pressure and quantity control, without written standard operating procedures (SOPs).
- A1 – Incomplete PRV/Altitude valve routine operation and maintenance program (checking settings, inspecting for leaks, other problems)
- A1 – Maps (GIS) are not complete, especially in some areas (legacy water lines).
- A1 – Water loss is approximately 50 percent.
- A1 – General lack of written SOPs for most routine distribution operation and maintenance activities.
- A2 – Water outages occur in numerous villages.
- A2 – Inadequate / no regular valve preventive maintenance program – including isolation valves, pressure reducing and sustaining valves, air relief valves, all other valves.
- A2 – Some valves are closed, causing dead ends in distribution, not always deliberately.
- A2 – No regular flushing program.

- A2 – Bottle necks are prevalent in certain areas, and have caused problems including line breaks, low and/or high pressure, etc.
- P1- Inadequate/no cross-connection control program.

FINISHED WATER STORAGE SYSTEMS

Significant Deficiencies

Reservoirs

- A1 – Open/corroded tank roof vents directly allow contamination to enter
- A1 – Other openings in roof – through hatches or other openings
- A1 – Severe internal external rust and corrosion – walls, base and other welds, anchors
- A1 – One elevated storage tank (Yigo Elevated) that was said to be out of service had a noticeable leak (which indicated that water is coming into the tank)
- A2 – Lack of functioning control systems (non-functioning altitude valves; no controls on well pumps or booster pumps, overflowing storage tanks, etc).
- A2 – No regular cleaning or maintenance of storage tanks. This was evidenced by severe corrosion of anchor bolts (many completely rusted through), overflow pipes, and valves.
- P1 – Inadequate site security – No, or inadequate, fencing, open gates, lack of barbed wire, evidence of vandalism.
- - P1 – Trash and other debris dumped around reservoirs.
- - P2 – Flooded, uncovered, and unsecured valve vaults.
- - P2 – Leaking tanks.
- - P2 – The overflow is not accessible at some locations (difficult to gain access to area).
- - P2 – No screen or flapper on overflows.
- - P2 – Ladders not locked.
- - P2 – Ladders severely corroded or no cage (unusable, no routine access to roof).

Recommendation

- GWA should properly maintain facilities and grounds (remove overgrown vegetation, take away garbage, repair security breaches, etc.)

PUMPS/ PUMP FACILITIES AND CONTROLS

Significant Deficiencies

Booster Pumps

- A2 – Lack of maintenance on pumps leads to intermittent service and supply

- P2 – Leaking seals in pumps
- P2 – Leaking valves, leaking lines, highly rusted piping resulting in leaks
- P2 – Flooding of booster pump stations
- P2 – Electrical hazards – flooding, inadequate electrical connections
- P2 – Booster pumps in open – no protective structure (no building/roof)
- P2 – Lack of adequate back-up pumps – either not present or not functioning
- P2 – Lack of pump controls (no control systems)

Recommendation

- Implement routine and corrective maintenance at all pumping appurtenances – meters, valves, pumps, piping, pressure gauges, etc.

MONITORING, REPORTING AND DATA VERIFICATION

Findings

- Pb/Cu monitoring has not been conducted since 2003.
- An acute total coliform rule (TCR) violation occurred in July 2011 in the Central Water System that was identified and addressed (including public notification) by GWA.
- Stage 2 DBP Rule violations (reported to SDWIS in April 2012).
  - Central Water System
    - TTHM MCL violations ongoing continuously since 1st Quarter 2010
    - HAA5 MCL violations:
      - 1st Quarter 2010
      - 2nd Quarter 2010
      - 3rd Quarter 2011
      - 4th Quarter 2011
      - 1st Quarter 2012
  - Southern Water System
    - HAA5 MCL violation in 1st Quarter 2012
- Public Notification has not been conducted by GWA for the Stage 2 DBP Rule violations

Ugum Water Treatment Plant

- Inadequate monitoring and reporting (lack of continuous turbidity monitoring and reporting).

Santa Rita Spring

- Inadequate monitoring and reporting (lack of chlorine residual continuous monitoring and the continuous turbidity meter was nonfunctional).

WATER SYSTEM MANAGEMENT AND OPERATIONS

Significant Deficiencies

- A1 – No formal, comprehensive training program (skills based) for operators and other personnel
- A1 – Inadequate or no preventive maintenance and lack of adequate SOPs for most operational areas.
- A1 – Hydraulic model is neither complete nor accurate enough to make operational or design decisions.
- A2 – Lack of metering of all customers also results in lack of knowledge of demand of unmetered customers (example, farmers)) and results in water quantity and water pressure issues.
- P1 – Data are collected, but are not always sufficiently analyzed to assist with operational decisions
- P2 – Need SOPs for most areas

Recommendation

- Continue to improve utility-wide communications to address previous lack of complete communication between departments

OPERATOR COMPLIANCE WITH LICENSING REQUIREMENTS

Significant Deficiencies

- A2 – Insufficient DRCs – DRC's are not always present as required under GEPA operator certification requirements. No level 4 operator is actually located on site at the Ugum WTP.
- A2 – Lack of operator training program.

Field Branch Data Package Review Record

Project Name: **Guam Waterworks Authority - PWS Sanitary Survey**	Project No.: VP0989
Project Leader: Trent Rainey	
Project Location: Island of Guam	Region: NA
Measurement Activity: GPS Data Collection	
Measurer(s): D. Vanlerberghe	
Procedures/Methods Used: Global Positioning System (GPS) Data Collection, NEICPROC/10-007	
Instrument(s): Ricoh 700SE GPS camera	
Purpose: Document site with geotagged photographs	
Regulatory Considerations: CWA	
Reviewer's Name: Carrie Middleton	

Summary of Review:

From April 23-May4, 2012, a Ricoh 700SE GPS camera was used to photograph field activities and site conditions on the Island of Guam, by Daren Vanlerberghe (NEIC). Geospatial Experts GPS-Photolink software was used to process the photographs and create an output Appendix CS A- NEIC Photographs for the civil report VP0989E02. The attributes were entered for the photographs.

Reviewed:

1. Photographs, geotagging information (latitude, longitude, DOP values, altitude, and compass direction)
2. Internal draft report workproduct VP0989E02, Appendix CS A.

Documentation was complete and data was corrected according to the EPA Metadata Standard for Geospatial Data. Data was reviewed and compared to the photograph descriptions. The output PDF clearly shows a map of the features with red arrows depicting photograph locations. Some photographs that were taken indoors do not have GPS data due to lack of GPS satellite coverage.

Action Requested: Suggested adding App CS A, VP0989E02, and Page 1 of XX to footers of appendix output in workproduct (using Adobe Acrobat). The data meets the quality objectives for the project.

Reviewer Signature:	Date:
Project Leader Signature:	Date:
Final Statement of Reviewer*:	
Reviewer Signature*:	Date:

* *Only if action is requested*

Distribution: ☐ Project File, ☐ Branch QA Representative, ☐ Branch Chief, ☐ Measurer(s)