

CHAPTER 7 – WATER SYSTEM FACILITIES CONDITION ASSESSMENT

7.1 Introduction

A condition assessment of equipment associated with wells, booster stations and the Ugum WTP was conducted in February and March 2005. The assessment was performed by visiting each of the sites and visually inspecting the equipment. When possible, the equipment was assessed during operation. This chapter summarizes the results of the condition assessment. Selected reservoirs were assessed separately as part of the corrosion assessment and are discussed in Volume 1, Chapter 11 - Corrosion Assessment. Electrical power assets were assessed separately and are discussed in Volume 1, Chapter 12 – Electrical Assessment.

7.2 Assessment Approach

A team consisting of a Brown and Caldwell senior operations specialist and an engineer, together with GWA staff, visited each of the well sites and booster stations, and the Ugum WTP, and conducted a qualitative assessment of equipment physical condition and functionality. The qualitative assessment consisted primarily of visual observation, but in case where equipment was operating, a visual and sound assessment was also conducted. GWA staff who accompanied the assessment team was questioned about the equipment and their input was used to assess “mean time between failures” because maintenance records were not available readily.

Table 7-1 lists the elements that were assessed. It includes the component, the information assessed for the component and the details of the assessment. A full assessment is provided in a CD in Appendix 2B.

Table 7-1 – Assessment Elements

Component	Assessment Information	Detail
Motors	<ul style="list-style-type: none"> • Physical Condition • Functionality • Runtime • Motor Base • Meantime Between Failure • Vibration • Temperature • High Efficiency Motor 	<ul style="list-style-type: none"> • 0 to 4 Rating (see Table 7-2) • 0 to 4 Rating (See Table 7-3) • Hours if available • 0 to 4 Rating • Excessive, high but acceptable, normal • Normal, excessive (if equipment was operating) • Normal, excessive (if equipment was operating) • Yes, no
Driven Equipment	<ul style="list-style-type: none"> • Physical Condition • Functionality • Runtime • Motor Base • Meantime Between Failure • Vibration • Temperature • Cavitation • Seals Functional • Seal Water Functional 	<ul style="list-style-type: none"> • 0 to 4 Rating (see Table 7-2) • 0 to 4 Rating (See Table 7-3) • Hours if available • 0 to 4 Rating • Excessive, high but acceptable, normal • Normal, excessive (if equipment was operating) • Normal, excessive (if equipment was operating) • Yes, no (if applicable) • Yes, no (if applicable) • Yes, no (if applicable)

Table 7-1 – Assessment Elements (continued)

Component	Component	Component
Buildings	<ul style="list-style-type: none"> • Exterior Wall Condition • Interior Wall Condition • Exterior Finish Condition • Interior Finish Condition • Equipment Finish Condition • Roof Condition • Window Condition • Pipe Support Condition • Equipment Layout Access OK 	<ul style="list-style-type: none"> • 0 to 4 Rating (see Table 7-2) • 0 to 4 Rating (see Table 7-2) • 0 to 4 Rating (see Table 7-2) • 0 to 4 Rating (see Table 7-2) • 0 to 4 Rating (see Table 7-2) • 0 to 4 Rating (see Table 7-2) • 0 to 4 Rating (see Table 7-2) • 0 to 4 Rating (see Table 7-2) • Yes, no
Wellhead	<ul style="list-style-type: none"> • Top Block Condition • Flange Condition • Pipe/Valve Condition • Pipe/Valve Bases 	<ul style="list-style-type: none"> • 0 to 4 Rating (see Table 7-2) • 0 to 4 Rating (see Table 7-2) • 0 to 4 Rating (see Table 7-2) • 0 to 4 Rating (see Table 7-2)
Chlorination System	<ul style="list-style-type: none"> • Chlorine Pump • Chlorine Pump Base • Chlorinator • Chlorine Scale 	<ul style="list-style-type: none"> • 0 to 4 Rating (see Table 7-2) • 0 to 4 Rating (see Table 7-2) • 0 to 4 Rating (see Table 7-2) • 0 to 4 Rating (see Table 7-2)
Generators	<ul style="list-style-type: none"> • Back-up Power • Emergency Generator • Physical Condition • Functionality • Size Adequate • Fuel Tank • Spill Containment • Transfer Switch • Outdoor Panel 	<ul style="list-style-type: none"> • Yes, no • On-site, potable, auto start, manual start • 0 to 4 Rating (see Table 7-2) • 0 to 4 Rating (see Table 7-3) • Yes, no • Yes, no • Yes, no • Yes, no • Yes, no
Miscellaneous	<ul style="list-style-type: none"> • Hoist 	<ul style="list-style-type: none"> • Yes, no

Both physical condition and functionality were given numeric ratings from 0 to 4. Descriptions of these ratings are provided in Table 7-2 and 7-3. Physical condition relates to the appearance, including apparent wear and corrosion, as well as operating characteristics such as noise, vibration and temperature. Functionality relates to the ability of the piece of equipment to accomplish its purpose.

Table 7-2 – Equipment Physical Condition Rating

Rating Scale	Description
0	Not Applicable
1	Equipment integrity severely compromised by corrosion and/wear.
2	Moderate to high risk of failure
3	Visible degradation of equipment, but acceptable
4	Well-maintained, like new condition of equipment

Table 7-3 – Equipment Functionality Rating

Rating Scale	Description
0	Not Applicable (Not operational or abandoned)
1	Equipment is not currently functioning for its intended use.
2	Equipment is in service but function is highly impaired.
3	Equipment functions as intended; maintenance frequencies and tasks as expected for this asset class.
4	Equipment functions as intended; maintenance frequencies and tasks exceed (i.e. are less than) those expected for this asset class.

7.3 Factors Affecting Condition

There are several factors that affect the condition of equipment of the GWA water system. Some of these factors are controllable and some are not. Several of these factors are described below.

- **Use** – All equipment has a useful or expected life. As the run-time hours increase, the condition of the equipment naturally degrades.
- **Maintenance** – Predictive and preventive maintenance activities are necessary for any equipment to achieve its useful life. These activities can also prolong and even extend the useful life of equipment. Equipment has been historically poorly maintained.
- **Power Quality** – The quality of electrical power supplied by GPA affects the life of electrical motors. The effect of power quality on motors is being addressed in a separate report.
- **Corrosive Environment** – GWA equipment and facilities are affected by rust and corrosion due to the island’s marine air.
- **Vandalism /Theft** – Most of GWA’s water facilities are not secure and show indications of vandalism. Though most stationary equipment are not targets of theft, some appurtenant equipment such as emergency generator batteries are. Many of the batteries associated with GWA generators have been removed to prevent their theft. This reduces their functionality because they cannot start automatically.
- **Weather and Natural Disasters** – Guam experiences typhoons and earthquakes. Within the last 10 years, two super typhoons with winds exceeding 200 miles per hour hit the island.

There is a lot of synergy among these factors that affect condition. For example, when a piece of equipment fails or is taken out of service, the use of back-up equipment increases. Poor maintenance practices and the corrosive environment place added wear on the back-up equipment, further reducing its useful life.

7.4 Condition Assessment

The discussion of the condition assessment for GWA’s water system is organized by wells, booster stations, and the Ugum WTP. An assessment of the emergency generators associated with the wells and boosters stations is also provided. This chapter is intended to summarize the results of the

condition assessment. Appendix 2B contains all the information collected. It is important to note that GWA has been working to improve the condition of all facilities since this condition assessment was performed. For example, the chlorination systems at the wells have been improved by adding new chlorinators, pumps and scales as necessary. Similarly, the centrifuge at the Ugum WTP has been replaced and is now operational. As a result of these efforts, the poor condition of many of the facilities has been mitigated.

7.5 Wells

110 wells were assessed. Almost two-thirds of the 35 emergency generators operated by GWA are not functioning as intended.

Even though GWA uses some part of the buildings associated with the wells, most of the buildings are owned and maintained by GPA. The buildings have significant damage to vandalism and typhoons. The buildings owned by GPA are in overall better condition than the buildings owned by GWA.

The chlorination pumps associated with the wells are in fair to good condition, but for many, their installation is poor. Some are located indoors and some are located outdoors. GWA has aggressively improved the chlorination systems since this assessment and is nearing completion of this effort.

7.6 Booster Stations

Overall, the booster stations have good functional ratings though the physical condition of many is poor. Failure of a booster station has an immediate result on water delivery to certain service areas.

Only seven of the booster station generators are owned and operated by GWA, and most of them are in poor condition.

Most of the buildings are in fair to good condition. Vandalism, poor maintenance and typhoons have taken their toll on finishes, windows, doors and other appurtenances.

7.7 Ugum WTP

Much of the equipment at the Ugum WTP is in poor physical condition, but is functioning to provide potable water.

Though each of the liquid stream processes is important, chemical feed is critical for continuous operation of the plant. There is little redundancy in the chemical feed equipment to ensure reliable operation.

Significant improvements in the reliable operation of the Ugum WTP have been made in the last two years, but the poor equipment condition makes it vulnerable to failure.

7.8 Conclusions

The following conclusions can be made from the condition assessment that was conducted for GWA's water system:

- The overall condition of equipment in the water system was poor (but has been under continual improvement since the condition assessment was performed).
- Much of GWA's infrastructure suffers from the effects of natural disasters, poor maintenance and vandalism.

- Significant corrosion is evident for all infrastructures, and the reservoirs are the most vulnerable to this corrosion.
- The sole finished water reservoir at the Ugum WTP is in service but has typhoon damage.
- One of the filters at the Ugum WTP has structural damage.
- There is no redundancy of chemical feed equipment.

7.9 Recommendations

The following recommendations are made for existing water production, treatment and distribution facilities.

- The sole finished water reservoir at the Ugum WTP needs to be rehabilitated.
- The Ugum WTP processes need to be upgraded to its full rated capacity of 4.0 mgd average daily flow.
- A detailed corrosion assessment and plan needs to be implemented for all reservoirs and mechanical equipment (see Volume 1, Chapter 11 – Corrosion Assessment).
- Continue with the planned turnover of emergency generator maintenance to GPA.
- General maintenance of buildings and equipment (e.g., painting) needs to be performed based on availability for funds from the operating budget.
- GWA's SCADA system needs repair to ensure greater operational control over the water system.

7.10 CIP Impacts

The condition of GWA's water system infrastructure has the following impacts on the 20-year CIP:

- The Ugum WTP finished water reservoir needs to be repaired and a redundant reservoir needs to be constructed.
- GWA is modifying the Ugum WTP to membrane filtration to achieve full capacity of 4.0 mgd average daily flow.
- A corrosion assessment and rehabilitation program is needed for GWA facilities, particularly the reservoirs.
- Repairs/improvements to the SCADA system need to be made to improve operability of the system.
- A maintenance set-aside has been included in the CIP ensure funds are available for normal repair and replacement.