

Republic of Palau Water Treatment Plants – Preliminary Assessment



**U.S. Department of the Interior
Bureau of Reclamation
Office of Insular Affairs**

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The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Republic of Palau Water Treatment Plants – Preliminary Assessment

prepared for

**Republic of Palau
Palau Public Utilities Corporation**

prepared by

**Bureau of Reclamation
Technical Service Center**

funded by

**U.S. Department of the Interior
Office of Insular Affairs**

Cover Photograph: The Ngatpang Mechebechubel Water Treatment Plant. (Reclamation/Mike Kramer)



**U.S. Department of the Interior
Bureau of Reclamation
Office of Insular Affairs**

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Acknowledgments photograph of Reclamation team and PPUC staff (from left to right): Anthony Rudimch (PPUC), Jeff Morris (Reclamation), Mike Kramer (Reclamation), Gregorio Decherong (PPUC), Scott Irvine (Reclamation), David Bai (PPUC), and Marson Aderiano (PPUC).

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Abbreviations and Acronyms

%	percent
alum	aluminum sulfate
AVGF	automatic valveless gravity filters
DOI	U.S. Department of the Interior
E. coli	Escherichia coli
EQPB	Environmental Quality Protection Board
gpm	gallons per minute
Interior Secretary	Head of the U.S. Department of the Interior
mg/L	milligrams per liter
MGD	million gallons per day
NTU	Nephelometric Turbidity Unit
PAC	powdered activated carbon
plants	water treatment plants
PPUC	Palau Public Utilities Corporation
psi	pounds per square inch
Reclamation	Bureau of Reclamation
RO	reverse osmosis
rpm	revolutions per minute
TDS	total dissolved solids
team	Reclamation team (consisting of two engineers from the Technical Service Center's Water Treatment Group and one engineer from the Native American and International Affairs Office)
TSC	Technical Service Center

Purpose

The Bureau of Reclamation (Reclamation) is providing technical assistance to the Palau Public Utilities Corporation (PPUC) to assess existing conditions of 17 water treatment plants (plants) across the Republic of Palau, most of which are not currently complying with regulatory drinking water standards. This report documents the conditions observed during onsite visits conducted February 10 through 14, 2020; and provides preliminary recommendations for next steps. The information obtained during this trip, along with other data collected, will be used to prepare a work plan and budget to develop alternatives for process and equipment modifications needed to comply with these standards, and to address other issues such as capacity and aging infrastructure.

Background

PPUC was created in 2013 by the Palau Government through the Utilities Consolidation Act to merge water, wastewater, and electric utilities under a single umbrella utility. PPUC has responsibility to undertake, operate, and maintain water treatment facilities for public potable water supplies throughout Palau. Under the act, PPUC is required to set water rates for customers to recover all the costs for operations and capital expenses, contingent upon compliance with water quality standards for drinking water. According to PPUC staff and a review of the available data, the existing water treatment facilities have been unable to meet the regulatory water quality standards and, therefore, PPUC has been unable to raise the water rates to obtain the revenue needed to upgrade their plants.

At the request of the U.S. Department of the Interior's (DOI) Office of Insular Affairs, Reclamation is providing technical assistance to PPUC to assess their plants and provide recommendations for modifications to achieve compliance with regulatory standards. As a first step, a Reclamation team of engineers (two engineers from the Technical Service Center's [TSC] Water Treatment Group and one engineer from the Native American and International Affairs Office) traveled to Palau to visit the plants to observe their condition and operation, collect relevant data, and meet with facility managers and plant operators to better understand the treatment challenges. During the week of February 10, 2020, the team met with PPUC staff and visited a total of 17 plants serving most of the residents of Palau. The site visit at each plant included meeting with plant operators, viewing surface water intake facilities where accessible, viewing operator logsheets when available, photographing infrastructure and equipment, and observing equipment operations and procedures.

This report documents the observations and information collected during the site visits and provides recommendations for next steps to address the water treatment challenges. TSC's Water Treatment Group will subsequently develop a proposed scope of work to assist PPUC with implementing the recommendations, but future assistance will depend upon funding availability from DOI's Office of Insular Affairs.

Plant Assessment

The team visited 17 plants during a 5-day period in February 2020. All the plants visited by the team are located on Babeldaob Island, except for the Peleliu plant, which is located on Peleliu Island. The map in figure 1 was provided by PPUC and shows the locations of most of the plant facilities on Babeldaob Island. There are several other plants managed by PPUC located in the outlying Angaur, Kayangel, and Southwest Islands, which the team did not visit and are not included in this assessment and report. The team's activities and site visits are summarized below.

Site Visit Summary

February 10, 2020

- Meeting at PPUC office in Koror with Anthony Rudimch, Project Planning and Implementation Department Manager; Marson Aderiano, Outlying States Water Operations Supervisor; and David Bai, Environmental Safeguards Officer. Reviewed and discussed PPUC records, including Palau drinking water standards applicable to water treatment facilities.
- Meeting with U.S. Embassy in Airai with Ambassador Amy Hyatt. Discussed team mission and contact information for U.S. Government personnel in other agencies who are assisting the Palau Government.
- Site visit to the Ngchesar plant and meeting with the plant operator.
- Site visit to the Melekeok Ngerkoranges plant and adjacent river intake, and meeting with the plant operator.
- Site visit to the Melekeok Tohobei plant and meeting with the plant operator.
- Site visit to the Ngiwal plant and meeting with the plant operator.
- Site visit to the Ngardmau plant and nearby river intake, dam, and reservoir of the water source.

February 11, 2020

- Site visit to the Ngarchelong Ollei plant and nearby river intake, dam, and reservoir of the water source; and meeting with the plant operator.
- Site visit to the Ngarchelong Mengellang plant and nearby river intake, dam, and reservoir of the water source; and meeting with the plant operator.
- Site visit to the Ngaraard Ulimang plant and offsite distribution tanks; nearby river intake, dam, and reservoir of the water source; and meeting with the plant operator.



Figure 1.—Ariel image of Babeldaob and Koror Islands showing state boundaries and some of the plants and source water intake locations (courtesy of PPUC).

February 11, 2020 (Continued)

- Site visit to the Ngaraard Ngkeklau plant and meeting with the plant operator.
- Site visit to the Ngardmau plant and meeting with the plant operator.

February 12, 2020

- Site visit to the Ngaremlengui Ngermetengel plant and nearby river intake, dam, and reservoir of the water source; and meeting with the plant operator.
- Site visit to the Ngaremlengui Imeong plant and offsite distribution tank, and meeting with the plant operator.
- Site visit to the Ngatpang Ibobang plant and nearby river intake, dam, and reservoir of the water source; and meeting with the plant operator.
- Site visit to the Ngatpang Mechebechubel plant and offsite distribution tank, and meeting with the plant operator.

February 13, 2020

- Meeting at PPUC office with senior managers David Dengokl, Water Operations Manager; and Gregorio Decherong, Chairman of the Board of Directors; along with PPUC staff noted in previous meeting on February 10, 2020. Discussed PPUC concerns with water and wastewater treatment facilities and the preliminary observations of the team.
- Site visit to the Airai plant and source water intakes at the Ngerikill river and the Ngerimel dam; and meeting with the plant operator.
- Site visit to the Aimeliik Mongami plant and offsite distribution tank; nearby river intake, dam, and reservoir of the water source; and meeting with the plant operator.
- Site visit to the Aimeliik Ngchemiangel plant and nearby river intake, dam, and reservoir of the water source; and meeting with the plant operator.

February 14, 2020

- Site visit to the Peleliu plant and offsite distribution tank, and meeting with the plant operator.

Direct Filtration Plants

Most of the plants have similar water sources, treatment processes, operations and maintenance procedures, treatment performance, and regulatory compliance issues. This section presents the conditions observed during the site visits to the direct filtration plants, which are all located in the outlying states on Babeldaob Island. These facilities provide water for rural communities, with each plant generally serving between 50 and 200 customers, most of which are private residential homes

with multiple residents. In a direct filtration system, the source water flows directly to the filter without a prior sedimentation step.

Water Sources and Intake Systems

Fifteen of the seventeen plants treat surface water diverted from nearby rivers (the two exceptions are at Ngiwal and Peleliu, which treat shallow groundwater from wells). The rivers are supplied by abundant rainfall in a tropical climate, about 150 inches per year on average. Some of the plant operators reported that during droughts or periods of below average rainfall, there is insufficient river water supply to meet the needs of the PPUC customers. Under these conditions, water is transported to the impacted residential areas from other plant locations that are less impacted by reduced rainfall.

The watersheds that contribute surface runoff to the rivers consist of lush tropical vegetation but also include rural residential and farming areas. The plant operators and PPUC staff reported that residential wastewater systems and farming operations are suspected of discharging pollutants into the watershed, which may contaminate the source water for the plants. The team visited the river intake facilities for most of the plants, but did not examine the watershed conditions that might affect the water quality in the rivers.

The source water intake system for most of the plants consists of a concrete basin with screen located adjacent to, or connected to, a concrete dam, which is constructed to create a shallow impoundment to reduce the river water velocity and allow for some settling of suspended river sediments prior to entering the intake basin. The observed water depths at many impoundments commonly ranged from 2 to 5 feet, which limits the effectiveness of particle settling. The appearance of the impounded water exhibited a wide variation in clarity depending on water depth and precipitation events. The impounded water was typically turbid and murky during and after precipitation events, which occur frequently.

The river water is conveyed from the intake sump to the plant through a pipeline (typically cast iron, 4 to 6 inches in diameter) either by gravity flow or pressurized flow from a pumping plant located at the intake basin. In both cases, the source water is usually delivered to the plant yard with an elevation head of 15 to 20 feet to permit gravity flow through the water treatment system.

The general maintenance procedures for the intake systems are weekly inspections and manual cleaning of intake screens, and dredging of sediments from the impoundment every 2 to 3 years. Dredging is usually accomplished as a community effort using shovels and buckets. Intake systems with pumping facilities also require frequent maintenance of pumps and valves. Source water flow quantity and water quality parameters are not measured at the intake systems. Examples of river dams and intake systems are shown in figures 2 and 3.

Water Treatment Process

Fifteen of the seventeen plants have the same water treatment process, direct filtration (i.e., no sedimentation step) followed by chlorine disinfection, which is described in this section. A typical plant is shown in figure 4. The Peleliu plant has a reverse osmosis treatment process and the Airai plant has a conventional surface water treatment train; both systems will be described in other sections of this report.



Figure 2.—The Aimeliik Ngchemiangel dam and intake system.



Figure 3.—The Ngaraard Ulimang dam and intake system.



Figure 4.—The Ngchesar plant yard with (left to right) automatic valveless gravity filters, concrete chlorination storage tank (clearwell), and pump house for treated water distribution.

Direct Filtration.—All the direct filtration systems in Palau are automatic valveless gravity filters (AVGF) that are designed to normally operate continuously without instrumentation, sensors, operator intervention, or other external controls. The continuous operation includes periodic backwashing events that are automatically triggered when the head loss through the filter media reaches a maximum level. The performance of the AVGF is monitored and periodic inspections are performed by plant operators. The components of the AVGF are shown in figure 5.

During filtration, the source water discharges into the constant head tank, which is open to atmospheric pressure. The source water flows downward through the constant head outlet pipe to the upper chamber of the filter tank, and then through the filter media into the collection chamber.

The filtrate flows upward from the collection chamber through the effluent duct to fill the backwash chamber. When the backwash chamber becomes full, the filtrate exits through the effluent pipe and flows to the nearby concrete clearwell/disinfection tank. The filter effluent pipe is at a higher elevation than the top of the chlorination tank, which provides gravity flow.

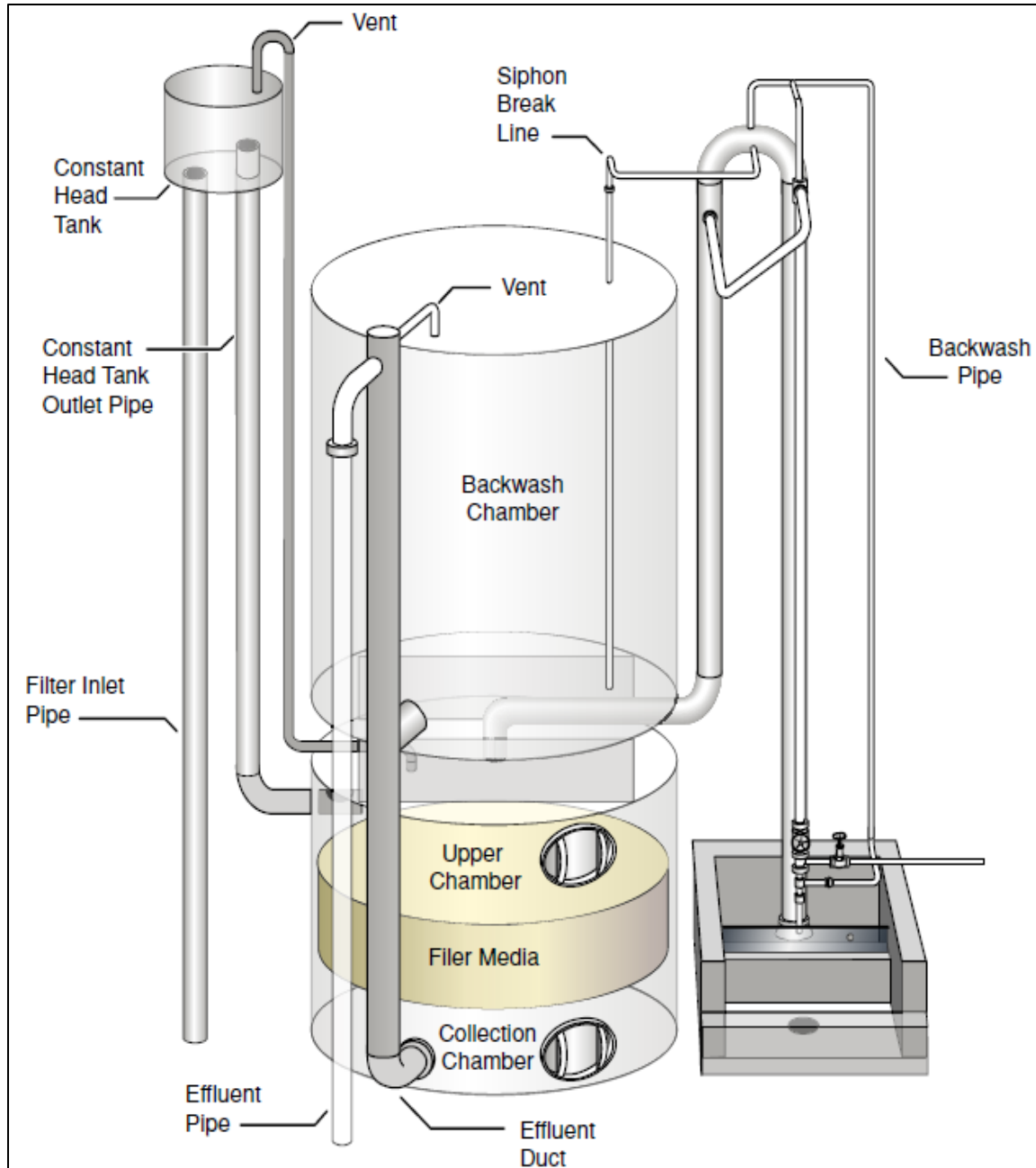


Figure 5.—Component diagram for the AVGF used at most Palau plants.

As filtration proceeds, the head loss through the filter media gradually increases as sediment becomes trapped in the media pores causing the water level to rise in the backwash pipe on the opposite side of the tank. The filtration cycle proceeds until the water level reaches the high point in the backwash pipe, which triggers a backwash cycle. During filter backwash, the water in the backwash chamber reverses the flow direction back into the collection chamber and then upward through the media, which washes the accumulated sediment out through the backwash pipe. Figure 6 shows flow schematics during filtration and backwashing. Backwashing continues until the water level in the backwash chamber drops sufficiently to expose the end of the siphon break line.

At that point, air is drawn into the backwash pipe, the backwash is stopped, and a new filtration cycle commences. Backwash flows are discharged outside the yard into a nearby drainage channel, which flows back to the river.

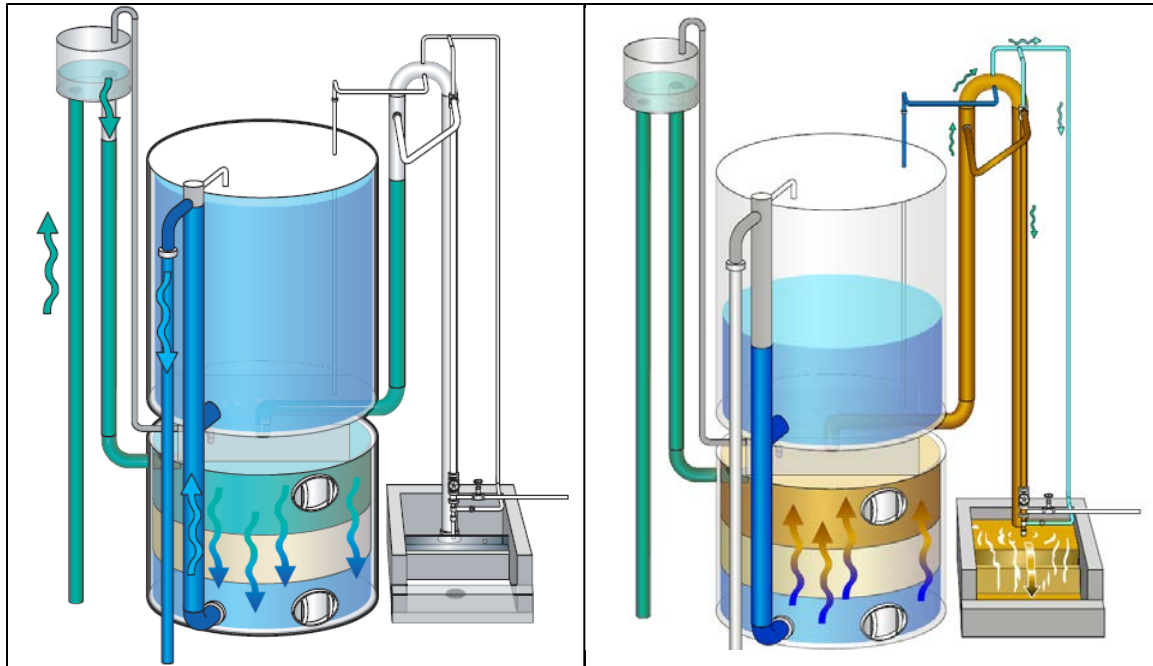


Figure 6.—AVGF flow schematics for filtration (left) and backwashing (right).

A fine-grained sand is used for the single media filtration. A few 50-pound sacks of blasting sand were observed in storage at a couple of the plant sites, and plant operators indicated they were left over from past media replacement. The sand is placed to a depth of 2 feet on a steel plate, which separates the collection chamber from the upper chamber. The steel plate is fitted with 2-inch-diameter screen strainers through which the filtrate flows into the collection chamber.

The filtration tanks range in size from about 5 to 10 feet in diameter, which equates to a flow capacity between about 40 and 160 gallons per minute (gpm), respectively, based on a nominal filtration rate of 2 gpm per square foot of filter area (per PPUC documentation).

Chlorine Disinfection.—Many of the direct filtration plants originally installed chlorine injection systems for disinfection of the filtered water. Over the years, plant operators were not able to perform maintenance and obtain needed replacement parts thus the chlorine injection systems became inoperable. Only the Aimeliik Mongami plant currently uses a metered chlorine injection system, which is injected through a static mixer into the inlet pipe of the clearwell tank. All other direct filtration plants use 3-inch calcium hypochlorite tablets, which are manually placed through a hatch into a mixing trough where the filtered water enters at the top of the clearwell tank. The contact chamber for most of the tablet systems do not provide complete flow contact with the chlorine tablets, and the clearwell basins do not contain baffles or other flow devices to control chlorine contact time as the water flows from the inlet to the outlet of the clearwell. A typical clearwell is shown in figure 7 and a typical tablet chlorination system is shown in figure 8.



Figure 7.—The concrete disinfection clearwell at Ngardmau plant.



Ngchesar distribution
tanks - chlorinator tablet
system

Figure 8.—Three-inch chlorination tablets stacked within plastic tubes at the Ngchesar plant clearwell.

The concrete clearwell tanks range in size from approximately 20,000 to 50,000 gallons. A typical 20,000-gallon tank measures 16 feet x 16 feet x 14 feet high. There are commonly one or two clearwell tanks within each treatment yard. The disinfected water exits the clearwell near the bottom of the tank and either flows by gravity to PPUC customers or is pumped to one or more distribution tanks located at a higher elevation. Additional tablet chlorination is applied at each distribution tank, which discharges into a gravity flow distribution pipeline to customers.

Operations and Maintenance.—The direct filtration plants are typically operated between 8 and 16 hours per day and are staffed by two or more operators with morning and afternoon shifts, 7 days per week. The treatment systems are not equipped with flow measurement devices although PPUC staff indicated that procurement and installation of flowmeters are among the project proposals under consideration for funding. Due to lacking flow measurement, plant operators rely on water level measurements within the clearwell tank to adjust plant operating hours and pumping operations. The water level is monitored using a float connected with a string to an external weight, such as a plastic jug hanging against the wall (see figure 7).

Plant operators stated that automatic backwashing of the filter tanks occurs two or more times per day. Additionally, all operators perform one or more manual backwashing cycles during both the morning and afternoon shifts, depending on the clarity of the filter effluent. There is no equipment or instrumentation to measure turbidity, therefore, manual backwashing is performed when operators visually observe particle breakthrough in samples, which are collected multiple times each day from filter effluent sample ports. Visual turbidity spikes occur in response to precipitation events resulting in more frequent backwashing of the filters. The operators report that the filter sand media is replaced about every 3 years.

The plant operators monitor disinfection performance using two Hach testing kits—Pathogen Screen Field Test Kit (catalog number 2859100) and the Free and Total Chlorine Test Kit (catalog number 1454200). The pathogen test kits are not effective as the reagents are used to identify only sulfur producing bacteria and require the use of an autoclave, which the operators do not possess. The chlorine test kits, however, should yield accurate results if the testing procedures are followed. The operators stated that they try to maintain residual chlorine levels between 0.2 and 1.0 milligrams per liter (mg/L) in the treated effluent; however, they also report that it is difficult to maintain chlorine residual within this range using the manual tablet chlorination system within the clearwell. Sometimes the effluent chlorine concentrations are too high and sometimes too low.

The plant operators live within the district served by their plants and do their best to optimize treatment performance, but the limitations of the equipment, instrumentation, and supplies do not provide adequate controls to ensure safe drinking water supplies. Consequently, most PPUC customers do not drink the treated water without boiling it first. Many residents use catchment basins to harvest rainwater or purchase bottled water for drinking supplies.

Most of the direct filtration plants were constructed between the late 1980s and late 1990s, and are in an outdoor tropical environment subject to frequent precipitation and saline humidity from the surrounding ocean air. These conditions promote corrosion of the metal and concrete materials of construction. Although many of the tanks and pipes were sandblasted and recoated about 2 years ago, some of the equipment and infrastructure at the sites showed significant signs of corrosion and leaking, including above-ground pipes, tanks (both steel and concrete), valves, and pumps.

Breakdowns of mechanical and electrical equipment are common occurrences. Inoperable pumps and valves were awaiting repair or replacement at most sites. Examples of corrosion and leaking are shown in figures 9 and 10.



Figure 9.—Concrete efflorescence and spalling on the Ngatpang Mechebechubel clearwell tank.



Figure 10.—Corrosion of the backwash pipe on the Ngatpang Mechebechubel filter tank.

Airai Plant

The Airai plant is a 4-million gallons per day (MGD) surface water treatment plant located at the southern end of Babeldaob Island in the State of Airai. The plant was upgraded to its current configuration in 1989, and provides drinking water to the State of Airai and Koror where about 75 percent (%) of the population of Palau resides (about 15,000 residents). Koror is an island connected by a causeway to Airai and is also the primary destination for the tourist industry.

Airai Water Sources

The Airai plant is supplied freshwater from two sources in the State of Airai—the Ngerikill River and Ngerimel Dam. About 3 MGD is pumped from the Ngerikill River and about 1 MGD flows by gravity from the reservoir at Ngerimel Dam. These two water sources generally meet the water demands of the Koror-Airai urban area, but are impacted by drought about every 5 to 10 years. During the drought of 2016, the reservoir was emptied, and water rationing was implemented for Koror-Airai. The Ngerimel Dam and Reservoir are shown in figure 11.

Airai Water Treatment Process

The Airai plant is a conventional water treatment process consisting of chemical feed, coagulation, flocculation, sedimentation, filtration, followed by disinfection. The water supply enters the treatment process at the subsurface concrete wet well. The feedwater is pumped from the wet well to the flocculation basins. Three chemical injection ports provide dosing of aluminum sulfate (alum; for coagulation), soda ash (to raise the pH), and powdered activated carbon (PAC; to adsorb natural organic compounds for taste and odor control). The chemicals are supplied in 50-pound sacks and mixed with water through hoppers inside a chemical mixing room prior to injection into the feedwater (no rapid mix system) between the wet well and the flocculation basin.

The outdoor flocculation and sedimentation basins were constructed using common wall concrete construction. Flocculation proceeds from a high energy mixing chamber with mixers rotating at 45 revolutions per minute (rpm) to a low energy mixing chamber with mixers rotating at 20 rpm. There are six parallel flocculation bays, which flow into three parallel sedimentation bays. A flocculation chamber is shown in figure 12.

Sludge collected in the sedimentation bays is removed using a mechanical scraper and then pumped to sludge drying beds in the plant yard. Sludge inputs are rotated among seven parallel sludge drying beds, each of which allow for up to 2 months of drying time. After that, the dried sludge is removed and applied to local roads with compaction. The sludge drying beds are shown in figure 13.

The clarified water from the sedimentation bays flows by gravity to single media sand filtration. The filtration is accomplished using five parallel AVGF tanks, which are identical in design and operation to the AVGF systems described in detail in the “Direct Filtration Plants” section of this report. The Airai AVGF tanks are shown in figure 14. Filtrate from the AVGF tanks flows by gravity to the clearwell, which is a baffled subsurface concrete basin enclosed in a building.



Figure 11.—The Ngerimel Dam and Reservoir.



Figure 12.—Flocculation chamber at the Airai plant.



Figure 13.—The sludge drying beds at the Airai plant.



Figure 14.—The filter tanks at the Airai plant.

Soda ash is again added via a metering pump to raise the pH of the filtered water via a metering pump, which is injected into the pipe between the filter tanks and clearwell. Disinfection is accomplished using granular calcium hypochlorite, which is supplied by 50-pound buckets and mixed with water in the chemical mixing room. A chemical metering pump is used to provide the required chlorine dose directly to the inlet basin of the clearwell, shown in figure 15. High service vertical turbine pumps are used to distribute the finished water from the clearwell to the Koror-Airai service area. A schematic of the Airai water treatment process is shown in figure 16.



Figure 15.—The inlet basin of the Airai plant clearwell.

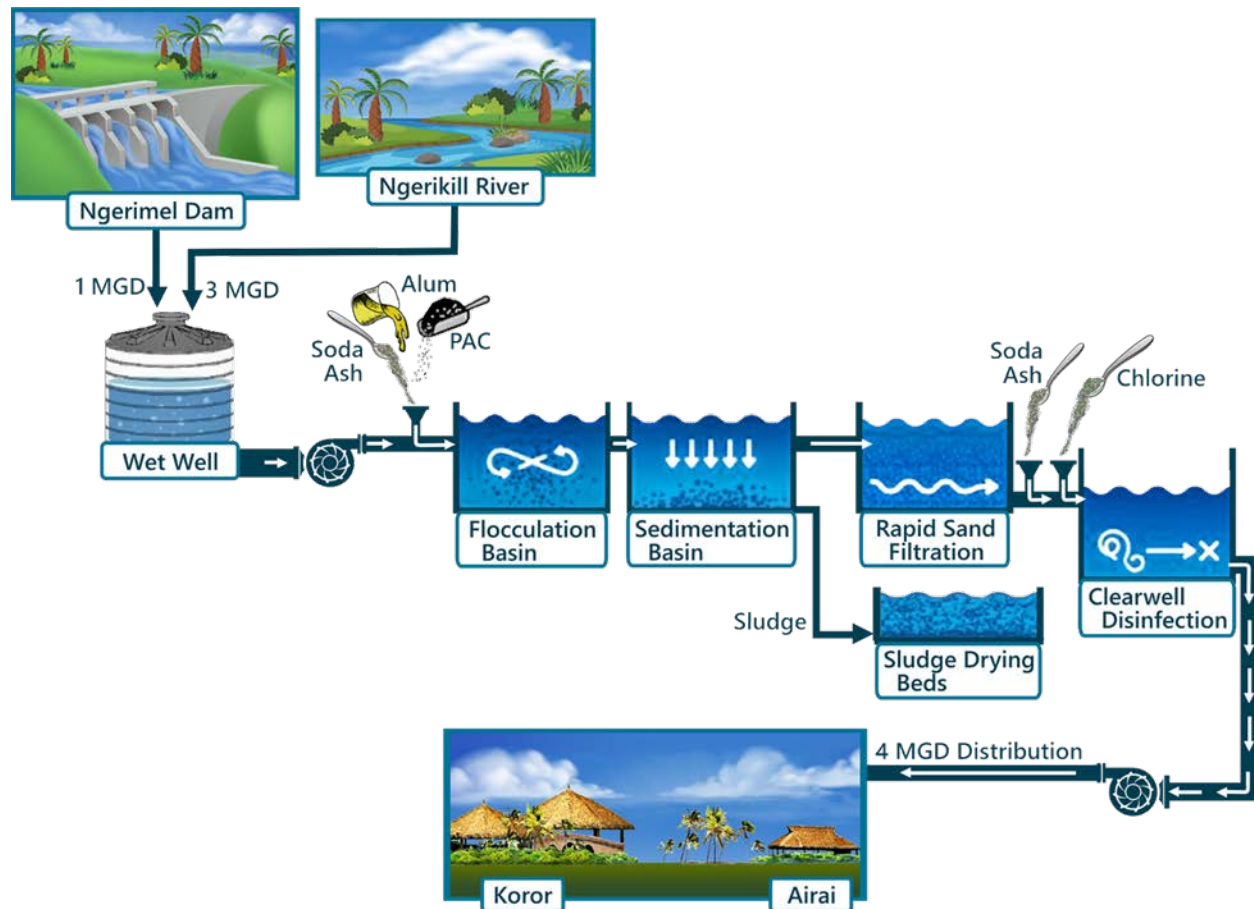


Figure 16.—Flow schematic of the water treatment process at the Airai plant.

Operations and Maintenance

The Airai plant is staffed by multiple operators for each of three shifts to provide 24-hour operation, 7 days per week. The surface water source levels and intake screens are checked twice daily at the dam and river intake locations. There is very limited process instrumentation and automation. An in-line turbidimeter does not work so plant operators rely on manual turbidity measurements performed and recorded hourly on the raw feedwater, clarified water, and filtered water. The manual measurements are made using a Hach 2100Q turbidimeter, but the operators do not calibrate this instrument. The operators also perform and record residual chlorine measurements from the clearwell effluent using a Hach reagent test kit.

The plant operators stated they perform daily calibration of chemical dosing and conduct daily coagulation jar tests to adjust the alum dose rate. Soda ash is added to raise the pH in the raw feedwater (possibly to provide the optimal pH for coagulation) and the filtered water (presumably to create a non-corrosive finished water). However, operators lack the instrumentation to measure the pH. The flowmeter at the beginning of the treatment process does not work, but there is a functioning Yokogawa flowmeter connected to the high service pump distribution pipe that provides instantaneous flow rate and flow totalizer measurements for treated flows leaving the plant.

Automatic backwashing is functional on only two of the five AVGF tanks. Plant operators perform manual backwashing on all five tanks, as needed, based on the hourly turbidity measurements. Corrosion of metal materials is evident in piping, pumps, and tanks throughout the yard, and mechanical breakdowns are common due to the age and condition of system components. Although operators can meet the treatment performance requirements, substantial labor is required to operate and maintain the plant due to general deterioration of the equipment and lack of replacement parts, supplies, instrumentation, and controls.

Peleliu Plant

The Peleliu plant provides water for about 200 households, a school, and a diesel powerplant for the residents of Peleliu Island, which is located about 25 miles southwest of Koror.

Peleliu Water Treatment Process

The Peleliu plant is unique compared to all other PPUC plants in that it uses reverse osmosis (RO) to desalinate brackish ground water provided by six artesian wells within the plant yard. Ground water from the artesian wells flows by gravity into a single wet well. Vertical turbine pumps convey the well water to a tee where one branch flows to the RO system. The second branch bypasses the RO system and, instead, is chlorinated using a metered chlorine injection system as shown in figure 17, and then flows to a distribution tank at a higher elevation outside the plant yard. The chlorinated ground water in the distribution tank is blended with the RO product water from a separate distribution tank at a wye in the pipeline, which conveys the treated water from the distribution tanks by gravity flow several miles to the town center. The RO concentrate and filter backwash are discharged to the surface of nearby mangrove swamps outside the plant yard.

The RO system was designed and built by Hitachi Aqua-Tech Engineering in Singapore; it was installed and commenced operation in 2013. Onsite documentation indicates that the system was designed for a feedwater salinity of 1,200 mg/L of total dissolved solids (TDS) and a nominal 80 gpm product water capacity. The RO system is housed within an air-conditioned trailer and consists of a two-stage, 3x2 array of 4-inch membrane elements, shown in figure 18. The supplied membrane elements are Hydranautics CPA5-LD, polyamide spiral-wound membranes; six membrane elements are housed within each of five Codeline pressure vessels fastened to a skid rack. Pretreatment components include pressure sand filtration, 1-micron cartridge filtration, and antiscalant chemical injection. The RO product water is disinfected using a chlorine injection system.

Operations and Maintenance

The RO system appears to be well maintained and operated. The plant operators record measurement data from the RO instrumentation and some calculated quantities on a daily operator logsheet. However, instrument calibration is not performed so the accuracy of these measurements and calculations is uncertain. Except for residual chlorine measurements in the effluent, water quality parameters for the raw and treated water are not sampled and measured. The RO system is operated at 80% recovery using Hypersperse MDC150 as a scaling inhibitor at a dosage rate of 2.3 mg/L.



Figure 17.—The chlorine injection system for the well water that is blended with RO product water.



Figure 18.—The 3x2 array of 4-inch pressure vessels on the RO skid rack of the Peleliu plant.

According to the plant operators, the RO system operation varies between 4 and 24 hours per day, although the chlorinated bypass flow is operated up to 18 hours per day. RO system flowmeters indicate that it generates about 90 gpm of product flow to the RO distribution tank. There are no blending controls or flowmeters to manage or monitor the rate of blending between the RO product water and the chlorinated bypass flow.

The plant operators report that some local residents fill personal water jugs from the RO product distribution tank for drinking water supplies, but the remainder of the tank is blended with the chlorinated bypass flow to PPUC customers whom do not use the blended water for drinking without first boiling it.

A brief glance through the daily operator logsheets finds that the RO feedwater salinity varies between 300 and 1,000 mg/L of TDS over several months as measured by system conductivity probes. The feedwater salinity is highest when the RO system is turned on each day and quickly drops about 30 to 40 percent within the first hour of operation for the remainder of the day. Due to lacking instrument calibration or confirmation tests, the accuracy of these salinity measurements is uncertain.

The plant operators are knowledgeable about the pressure drop thresholds that trigger maintenance procedures for backwashing the pressure filters, replacing the cartridge filter, and cleaning and replacing the membrane elements. The pressure filters are backwashed when head loss reaches 15 pounds per square inch (psi), which generally occurs at intervals between 2 and 3 weeks.

Maintenance records indicate that particle fouling and scaling of membranes have not been an issue since 2014. On average, the cartridge filter is replaced yearly. The RO system is equipped with a clean-in-place chemical cleaning system for the membranes. According to the lead plant operator, the last clean-in-place was performed about 3 years ago, and only six RO membrane elements (within a single 2nd stage pressure vessel) have been replaced since 2014.

Conclusions and Recommendations

The site visits allowed the team to document existing conditions, interview plant operators, and gather relevant regulatory and performance data. The primary conclusions are:

1. There is insufficient monitoring of water quality parameters to fully evaluate regulatory compliance and evaluate treatment technology alternatives.
2. Alternative treatment technologies should be evaluated with onsite testing to develop appropriate retrofits and/or new treatment systems that are required to comply with regulatory standards.

General recommendations regarding water quality monitoring, water supply during drought conditions, and the development of an appraisal level report for treatment alternatives apply to all the treatment facilities. The site-specific conclusions and recommendations are organized according to the type of treatment plant.

Water Quality Monitoring

There is insufficient monitoring of water quality parameters across all plants. Current PPUC efforts appear limited to residual chlorine and turbidity measurements in treated water at the Airai and Peleliu plants, and residual chlorine measurements only in treated effluent at the direct filtration plants. The turbidity measurements lack quality control calibration procedures, and the Peleliu measurements are made prior to blending of two separate treatment streams.

Additionally, the Environmental Quality Protection Board (EQPB) performs monthly sampling and laboratory analysis of treated effluents at all plants and some locations in the distribution systems (appendix A) thus to monitor regulatory compliance for residual chlorine, turbidity, total coliform, and *Escherichia coli* (*E. coli*). The laboratory results show that all the direct filtration plants occasionally do not meet the drinking water quality standards for the treated effluent (appendix B).

EQPB testing results also show that the Airai plant does meet the drinking water quality standards in the treated effluent for the four measured parameters (chlorine, turbidity, coliform, and *E. coli*) in the finished water entering the distribution system. Plant operators and other PPUC staff are generally confident that this plant meets drinking water standards based on EQPB testing; their primary concerns are deterioration and maintenance of the treatment facilities and a public perception that the water is not safe to drink. However, the EQPB data also show occasional turbidity spikes above 1.0 and nondetectable residual chlorine concentrations at some locations in the distribution system. It is also noted that the available EQPB 2019 testing results do not include measurements of other regulated contaminants, which might be present in the treated water.

In addition, the Airai plant operators are unable to measure and monitor pH stability of the treated water entering the distribution system, which is important for monitoring potential corrosivity within the distribution system. Distribution piping exposed to fluctuations in pH are more

susceptible to release of scales and metals as compared to more stable conditions. Rapid or extensive changes in pH may also trigger microbial changes and releases into the water. The extent of current monitoring does not appear to be sufficient to ensure regulatory compliance throughout the various reaches of the distribution system.

General Recommendation No. 1

It is recommended that PPUC develop a water quality monitoring program that covers all PPUC plants. At a minimum, the program should:

- Provide regular information about source water quality including turbidity, suspended solids, pH, pathogens, color, inorganics, organic carbon, hardness, alkalinity, and TDS (for ground water sources);
- Provide increased sampling and testing of water quality throughout the reaches of the Koror-Airai distribution system for all regulated constituents to ensure regulatory compliance;
- Ensure that finished water entering the distribution systems meets all applicable standards for disinfection and turbidity, and is treated to minimize corrosion at the consumer's tap;
- Monitor distribution system water quality to evaluate changes due to contact with system materials and water age;
- Provide data to assist plant operators to manage treatment operations and optimize performance of treatment systems;
- Characterize the concentration and variability of salinity in the ground water wells that supply the Ngiwal and Peleliu plants; and
- Keep the public informed when the water is safe to drink, and when it is not safe to drink.

Increased sampling, testing, and publishing of the water quality in the Koror-Airai distribution system will be a key factor in addressing the public's concern that the water is not safe to drink. The collection of water quality data from the monitoring program will also be essential to address the findings and recommendations for the evaluation of treatment technologies at the individual treatment plants described in the following sections. Once treatment modifications are implemented to ensure regulatory compliance, the water quality monitoring program will be an important factor in assuring PPUC customers that the water is safe to drink.

The water quality monitoring program will identify whether there are constituents beyond the four that are currently monitored that might require other treatment technologies. Additionally, water quality monitoring of the salinity of the source water derived from wells at the Ngiwal and Peleliu plants will assist in evaluating desalination alternatives and blending options at both locations. Water quality monitoring will also identify source waters with potential pathogen contamination in the contributing watershed. It is recommended that PPUC investigate and address any identified source water contamination.

General Recommendation No. 2

Develop a Source Water Assessment to identify point and non-point sources or potential sources of contamination in the watershed that may impact source water quality and downstream treatment operations.

Water Supply During Drought Conditions

The surface waters that supply most of the plants are dependent upon rainfall precipitation and runoff that feed into riverflows within each watershed. During drought conditions, these riverflows are significantly reduced and adversely impact the water supply for the direct filtration plants since the dams that supply these plants are shallow (about 2 to 5 feet deep) with negligible water storage capacity. Although the Ngerimel Dam and Reservoir is much larger and deeper (about 23 feet), it supplies the much larger Airai plant and is also severely impacted during drought conditions.

General Recommendation No. 3.

Conduct a drought resilience value planning study to evaluate options to improve efficiency and storage capacity of existing water supplies, and to identify options for new water supply sources. A value planning study would generate preliminary designs and cost estimates for a range of alternatives to improve drought resilience for the direct filtration plants and, particularly, for the Airai plant since it is the primary water supply for about 15,000 people.

Appraisal Evaluation and Report

All of the plants visited by the team face significant challenges ranging from non-compliance with drinking water quality standards, to inadequate treatment technology, and deteriorating equipment. These challenges are best addressed through the collection of data and the development of an appraisal level study of alternatives and costs.

General Recommendation No. 4.

Prepare an appraisal level report with cost estimates and recommendation for alternatives to retrofit existing systems and/or install new treatment systems to comply with drinking water quality standards. The appraisal analysis should include the development of water quality and treatment testing data to cover the range of issues encountered at the different types of plants. Specific recommendations for the types of testing and data needed are described in the following sections.

Airai Plant

The Airai plant is arguably the most important plant due to its size and the fact that it supplies water to about 75% of the country's population. The available water quality data for the treated effluent indicate that the plant meets drinking water quality standards; however, there may be options to optimize and improve performance of the treatment process and possibly reduce operating costs.

Treatment Process.—The plant operators monitor treatment performance using hourly turbidity measurements of the raw, clarified, and filtered process streams. On the day of the site visit (February 13, 2020), the 12 hourly measurements noted on the operator logsheet (table 1) show:

- Raw water turbidity ranges between 7 and 9 NTU.
- Clarified water turbidity ranges between 0.4 and 1.9 NTU, with 10 of 12 measurements below 1 NTU, which indicates good performance of the flocculation/sedimentation basin.
- Filtered water turbidity ranges between 0.5 and 0.9 NTU, with 9 of 12 measurements exceeding the clarified water turbidity, which indicates impaired performance of the filters.

The coagulation process normally includes the addition of PAC, but the dosing system for this chemical was broken and awaiting repair during the site visit. It was noted that the alum dose rate on this date was 38 mg/L, and that this dosage rate is typical for other days. This alum dosage rate is on the high end for conventional surface water treatment plants, and it represents a corresponding high chemical cost for the plant. Additionally, the high alum dosage reduces alkalinity and pH, which may be the reason that soda ash is added to the process stream. Factors that affect the effectiveness of coagulation and flocculation include pH, mixing speed of the flocculator, and time.

Table 1.—Turbidity Measurement Data Transcribed From Airai Plant Operator Logsheets (February 13, 2020)

Time	Turbidity (NTU) Raw	Turbidity (NTU) Clarified	Turbidity (NTU) Finished
00:00	7.20	0.50	0.45
01:00	7.26	0.47	0.63
02:00	7.61	0.46	0.68
03:00	8.00	0.45	0.72
04:00	7.92	0.54	0.83
05:00	8.67	1.70	0.94
06:00	8.17	1.94	0.78
07:00	8.12	0.90	0.94
08:00	7.69	0.40	0.70
09:00	7.71	0.44	0.66
10:00	7.54	0.42	0.55
11:00	7.49	0.66	0.54

Airai Recommendation No. 1

A jar testing program should be implemented to evaluate alternative coagulants and/or determine whether the alum dosage rate can be reduced through pH adjustment, mixing speed adjustment, or the addition of a polymer chemical. The jar testing program should test over the range of raw water turbidity and alkalinity to enable a clear understanding of the correlation of these water quality variables and the required coagulant dosage rate.

Airai Recommendation No. 2

A pilot filter evaluation test program should be implemented to evaluate how to achieve lower turbidity in the filtered water, ideally below 0.5 NTU in 95% of the sample measurements. Filter test options would include the evaluation of alternative grades of sand, dual media filtration using other media such as anthracite and granular activated carbon, and media depth.

Direct Filtration Plants

The EQPB water quality testing data for the direct filtration plants show that the direct filtration plants often do not meet the drinking water standards among the four parameters that are monitored through monthly sampling and testing. The plant operators report difficulty in controlling turbidity (especially after precipitation events) and residual chlorine concentrations in the treated water. These challenges should be addressed through an evaluation of the water source intake systems, the treatment process, and operational controls.

Surface Water Intake Systems.—Observations at some of the source water locations found instances of high turbidity and color of the water entering the intake system (see figures 2 and 3). At all of these sites, the intake structure is located within a shallow impoundment (between 2 and 5 feet deep) that does not provide much opportunity for hydraulic settling of suspended solids. Deeper impoundments would provide more time for settlement of suspended solids and reduce the turbidity of the source water entering the intake structures.

Direct Filtration Recommendation No. 1

Perform a study of raw water suspended solids loading and the river intake system for each surface water source location to evaluate alternatives for reducing turbidity and suspended solids entering the plants. The study should include measurements of turbidity and suspended solids under different streamflow and weather conditions. Depending on the level of solids loading and options to modify the intake system and dam impoundment, onsite particle settling tests can be performed to assess particle settling time as a function of water depth. These data can be used to evaluate costs and benefits for modifications to the intake systems, such as deeper dredging or raising the dam elevation.

Water Treatment Process.—Most direct filtration plants around the world include the addition of a chemical coagulant and flocculation basin to improve the effectiveness of the filter. The direct filtration plants lack both a flocculation basin and a sedimentation basin, which is more accurately described as an in-line direct filtration process.

Direct filtration treatment for drinking water is usually not adequate for source waters having turbidity greater than 5 NTU. Based on visual observations at the river intake locations, the Palau source waters do not meet this criterion. Although the addition of a chemical coagulant prior to filtration might improve the turbidity removal, it would likely not be enough to meet regulatory requirements, especially during rainfall events that produce large turbidity spikes. Based on these factors, along with the performance data of the Airai plant, a conventional surface water treatment process appears to be the most likely solution to meet the drinking water quality standards.

Direct Filtration Recommendation No. 2

Perform jar, bench, and pilot studies to develop a conventional water treatment process for each of the direct filtration plants. Jar tests can evaluate chemical coagulants, flocculation speeds, and settling time. Bench and pilot tests should include coagulation, flocculation, sedimentation, and filtration. An efficient testing approach would be to develop and demonstrate a successful pilot-scale treatment process at the plant site with the most challenging source water, and then rotate it through each of the other plant locations to optimize the design for each source water. Ideally, the treatment process would be identical for all locations (with variations in size and chemical dosing) to enable uniform operator training and procedures for PPUC operators.

Disinfection.—The EQPB water quality testing data show multiple instances where the residual chlorine concentrations fall below the minimum required level of 0.2 mg/L in the treated water and non-detect level in distribution system at most direct filtration plants, and the occasional presence of pathogens at a few locations. During the site visits, most plant operators indicated that it is difficult to control the chlorine dosage using the calcium hypochlorite tablets. The tablets are placed manually into troughs that do not allow full contact and mixing with the influent water as it is introduced into the clearwell tank. The clearwell tanks do not have mechanical mixers or baffled flow devices to assist with chlorine contact. Without adequate flow turbulence or other mixing, it is possible that zones of varying chlorine concentration develop within the tank, resulting in large variations in residual concentrations in the finished water effluent. Additionally, the lack of adequate turbidity removal in the direct filtration process potentially produces a variable chlorine demand in the clearwell.

Direct Filtration Recommendation No. 3

Perform a study to evaluate alternative disinfection strategies to provide greater control and consistency of residual chlorine concentrations in the treated effluent. The study should include a comparison of the tablet method with a metered chlorine injection system, and an examination of the flows and chlorine contact time within the clearwell. Some of the direct filtration plants do not have grid power available at the site. The power required for a chlorine injection system could be supplied through a solar power system, although grid power will likely be required at all sites to implement the recommended conventional treatment process.

Instrumentation.—The plant operators of the direct filtration plants lack basic instrumentation needed to control operations and comply with water quality standards.

Direct Filtration Recommendation No. 4

At a minimum, each plant should install flowmeters for influent feedwater and effluent treated water, and plant operators should be provided with portable turbidimeters to monitor and control treatment performance.

Peleliu Plant

The RO system at the Peleliu plant is in good condition and appears to be adequately operated and maintained. The primary concern expressed by the plant operators and other PPUC staff is that the RO system lacks enough capacity to meet the municipal water demand and, therefore, it is blended with unfiltered, chlorinated well water to provide the required supply for residents. The EQPB water quality data show that the blended water stream to the residents frequently has low residual chlorine concentrations, high turbidity levels, and the presence of pathogens.

During the site visit, it was noted that the RO operator logsheets show mildly brackish feedwater salinities from the ground water wells range between 300 and 1,000 mg/L of TDS over a period of several months (see table 2). This RO feedwater originates from the same ground water wells as the unfiltered chlorinated water that bypasses the RO system.

Although not a health hazard, salinity above 500 mg/L is the standard threshold when desalination is considered for aesthetic purpose. Based on the limited salinity data, it appears that blending of desalinated flow with a non-desalinated flow is an appropriate and economical strategy to meet the aesthetic standard of 500 mg/L of TDS for drinking water. A controlled blending ratio of RO product and non-desalinated ground water should be able to achieve an acceptable level of salinity and taste for PPUC customers.

The issue of non-compliance with drinking water standards (assuming the wells are classified as ground water under the influence of surface water) for turbidity, residual chlorine, and pathogens in the blended water can be addressed through 1) adding a direct filtration treatment process with coagulation and possibly a flocculation basin, and 2) improved chlorination system monitoring and control. Adding treatment and controls for the blended stream will be less costly and easier to operate than conversion to desalination of the entire municipal supply.

Table 2.—TDS Data Transcribed From Peleliu Operator Logsheets for RO System.

Date	Time	Raw Water TDS (mg/L)	RO Product TDS (mg/L)
11/27/2019	08:17	381	50.4
11/27/2019	09:00	364	59.9
11/27/2019	10:00	329	60.5
11/27/2019	11:00	288	70.5
01/30/2020	13:35	805	94.2
01/30/2020	14:19	531	102
01/30/2020	16:23	481	97.8

Peleliu Recommendation No. 1

Perform a study to evaluate:

- Alternative coagulants and filter media for the ground water bypass flows that are blended with the RO product flows;
- Improvements in the disinfection monitoring and control to achieve consistent and adequate residual chlorine concentrations in the blended water supply;
- Blending ratios of RO product and filtered bypass flows to determine an acceptable range of salinity in the blended flows and the potential need for post treatment stabilization; and
- Whether additional desalination capacity is required to achieve the aesthetic salinity standard of 500 mg/L of TDS and, if required, electro dialysis desalination should be considered as an alternative to RO because the capital and operations and maintenance costs are usually lower for electro dialysis as compared to RO for mildly brackish water like the ground water at the Peleliu plant.

Peleliu Recommendation No. 2

Flowmeters should be installed on at least two of the flow streams to monitor and control the blending ratio of water from the RO product distribution tank and the bypass flow from the ground water distribution tank.

Appendix A

Environmental Quality Protection Board (EQPB) Monthly Water Quality Results

EQPB Monthly Water Quality Results

Absence meanse Negative and Presence means Positive for coliform bacteria or E. coli

ROP SAFE DRINKING WATER QUALITY STANDARD

The Safe Drinking Water Quality Standard is Zero Total and Fecal Coliform/E. Coli bacteria per 100 ml water sample

Turbidity is not more than 1 NTU as a monthly average, or not more that 5 NTU as an average of two consecutive days

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
12/6/2018	Mongami	1.98	2.81	Absence	Absence
12/6/2018	Ngchemiangel	1.29	6.66	Absence	Absence
12/6/2018	Ngatpang	1.74	2.14	Absence	Absence
12/6/2018	Ibobang	0.69	7.57	Absence	Absence
12/6/2018	Ngermetengel	0.10	3.25	Absence	Absence
12/6/2018	Imeong	0.51	1.21	Absence	Absence
12/5/2018	Ngardmau	0.64	0.62	Presence	Absence
12/5/2018	Ollei	0.37	4.71	Absence	Absence
12/5/2018	Ngerchelong	0.93	3.75	Absence	Absence
12/5/2018	Choll	1.37	1.86	Absence	Absence
12/5/2018	Ngaraard	0.77	1.74	Presence	Absence
12/4/2018	Ngkeklau	0.55	1.47	Absence	Absence
12/4/2018	Ngiwal	0.15	0.96	Absence	Absence
12/4/2018	Ngiwal Housing	1.72	4.55	Absence	Absence
12/4/2018	Melkeok	0.27	2.33	Absence	Absence
12/4/2018	Ngchesar	0.34	1.99	Absence	Absence

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
12/3/2018	KAWTP	0.78	0.74	Absence	Absence
12/3/2018	Airai Ordemel	0.64	0.46	Absence	Absence
12/3/2018	Airai Ngerusar	0.61	0.76	Absence	Absence
12/3/2018	Airai Ikoranges	0.28	0.26	Absence	Absence
12/3/2018	Ngermid	0.68	0.44	Absence	Absence
12/3/2018	Harris	0.68	0.54	Absence	Absence
12/3/2018	Mindszenty	0.69	0.55	Absence	Absence
12/3/2018	T-dock	0.64	0.41	Absence	Absence
12/3/2018	IDID	0.63	0.45	Absence	Absence
12/3/2018	Ngerbeched	0.61	0.94	Absence	Absence
12/3/2018	EQPB Lab	0.66	0.54	Absence	Absence
12/3/2018	Meyuns	0.58	0.68	Absence	Absence
12/3/2018	Happy Landing	0.63	0.41	Absence	Absence
12/3/2018	Malakal	0.55	0.43	Absence	Absence
12/3/2018	Airai Oikull Center	0.04	3.44	Absence	Absence

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
1/9/2019	Mongami	1.11	3.06	Absence	Absence
1/9/2019	Ngchemiangel	1.91	5.32	Absence	Absence
1/9/2019	Ngatpang	1.71	3.55	Absence	Absence
1/9/2019	Ibobang	1.20	5.41	Absence	Absence
1/9/2019	Ngermetengel	1.07	2.80	Absence	Absence
1/9/2019	Imeong	0.97	1.70	Absence	Absence
1/8/2019	Ngardmau	0.01	2.86	Presence	Absence
1/8/2019	Ollei	0.18	4.22	Absence	Absence
1/8/2019	Ngerchelong	0.92	2.31	Absence	Absence
1/8/2019	Choll	0.02	5.48	Absence	Absence
1/8/2019	Ngaraard	0.73	2.70	Presence	Absence
1/8/2019	Ngkekklau	0.52	3.77	Absence	Absence
1/7/2019	Ngiwal	0.05	0.60	Absence	Absence
1/7/2019	Ngiwal Housing	0.00	1.21	Absence	Absence
1/7/2019	Melkeok	0.47	1.65	Absence	Absence
1/7/2019	Ngchesar	1.21	2.28	Absence	Absence

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
1/2/2019	KAWTP	0.94	0.39	Absence	Absence
1/2/2019	Airai Ordomei	0.68	14.9	Absence	Absence
1/2/2019	Airai Ngerusar	0.62	1.93	Absence	Absence
1/2/2019	Airai Ikoranges	0.63	1.88	Absence	Absence
1/2/2019	Ngermid	0.48	0.93	Absence	Absence
1/2/2019	Harris	0.67	0.93	Absence	Absence
1/2/2019	Mindszenty	0.73	0.51	Absence	Absence
1/2/2019	T-dock	0.73	0.57	Absence	Absence
1/2/2019	IDID	0.68	0.57	Absence	Absence
1/2/2019	Ngerbeched	0.67	0.61	Absence	Absence
1/2/2019	EQPB Lab	0.66	0.62	Absence	Absence
1/2/2019	Meyuns	0.42	0.34	Absence	Absence
1/2/2019	Happy Landing	0.73	0.41	Absence	Absence
1/2/2019	Malakal	0.63	0.57	Absence	Absence
1/2/2019	Airai Oikull Center	no water	no water	Absence	Absence

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
3/7/2019	Mongami	0.06	2.57	Absence	Absence
3/7/2019	Ngchemiangel	0.73	5.52	Absence	Absence
3/7/2019	Ngatpang	1.30	1.80	Absence	Absence
3/7/2019	Ibobang	1.08	4.22	Absence	Absence
3/7/2019	Ngermetengel	0.44	2.11	Absence	Absence
3/7/2019	Imeong	0.71	1.57	Absence	Absence
3/7/2019	Ngardmau	0.44	0.87	Absence	Absence
3/5/2019	Ollei	1.10	3.47	Absence	Absence
3/6/2019	Ngerchelong	0.42	2.48	Absence	Absence
3/7/2019	Choll	0.33	1.04	Absence	Absence
3/8/2019	Ngaraard	0.37	0.97	Absence	Absence
3/4/2019	Ngkekklau	0.97	0.98	Absence	Absence
3/4/2019	Ngiwal	0.12	1.90	Absence	Absence
3/4/2019	Ngiwal Housing	0.12	1.55	Absence	Absence
3/4/2019	Melkeok	0.52	1.36	Absence	Absence
3/4/2019	Ngchesar	1.43	3.26	Absence	Absence

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
3/12/2019	KAWTP	0.82	0.57	Absence	Absence
3/12/2019	Airai Ordomei	0.40	0.92	Absence	Absence
3/12/2019	Airai Ngerusar	0.42	0.75	Absence	Absence
3/12/2019	Airai Ikoranges	0.28	0.74	Absence	Absence
3/12/2019	Ngermid	0.42	0.63	Absence	Absence
3/12/2019	Harris	0.45	0.44	Absence	Absence
3/12/2019	Mindszenty	0.51	0.64	Absence	Absence
3/12/2019	T-dock	0.46	0.49	Absence	Absence
3/12/2019	IDID	0.42	0.84	Absence	Absence
3/12/2019	Ngerbeched	0.51	0.46	Absence	Absence
3/12/2019	EQPB Lab	0.52	0.38	Absence	Absence
3/12/2019	Meyuns	0.39	0.35	Absence	Absence
3/12/2019	Happy Landing	0.44	0.69	Absence	Absence
3/12/2019	Malakal	0.33	0.48	Absence	Absence
3/12/2019	Airai Oikull Center	0.02	11.4	370	12

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
4/10/2019	Mongami	1.49	3.46	Absence	Absence
4/10/2019	Ngchemiangel	0.07	9.25	Absence	Absence
4/10/2019	Ngatpang	1.65	1.99	Absence	Absence
4/10/2019	Ibobang	0.72	9.52	Absence	Absence
4/10/2019	Ngermetengel	0.02	5.01	Absence	Absence
4/10/2019	Imeong	0.04	2.51	Absence	Absence
4/9/2019	Ngardmau	0.42	0.56	Absence	Absence
4/9/2019	Ollei	0.32	2.92	Absence	Absence
4/9/2019	Ngerchelong	0.48	1.74	Absence	Absence
4/9/2019	Choll	0.01	1.37	Absence	Absence
4/9/2019	Ngaraard	0.01	3.74	Absence	Absence
4/3/2019	Ngkeklaou	0.59	2.80	Absence	Absence
4/3/2019	Ngiwal	0.40	4.99	Absence	Absence
4/3/2019	Ngiwal Housing	0.12	1.78	Absence	Absence
4/3/2019	Melkeok	1.24	1.37	Absence	Absence

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
4/4/2019	KAWTP	0.78	0.24	Absence	Absence
4/4/2019	Airai Ordomei	0.40	0.50	Absence	Absence
4/4/2019	Airai Ngerusar	0.38	0.48	Absence	Absence
4/4/2019	Airai Ikoranges	0.30	0.50	Absence	Absence
4/4/2019	Ngermid	0.38	0.21	Absence	Absence
4/4/2019	Harris	0.42	0.26	Absence	Absence
4/4/2019	Mindszenty	0.44	0.23	Absence	Absence
4/4/2019	T-dock	0.47	0.25	Absence	Absence
4/4/2019	IDID	0.45	0.25	Absence	Absence
4/4/2019	Ngerbeched	0.44	0.70	Absence	Absence
4/4/2019	EQPB Lab	0.52	0.23	Absence	Absence
4/4/2019	Meyuns	0.39	0.69	Absence	Absence
4/4/2019	Happy Landing	0.44	0.83	Absence	Absence
4/4/2019	Malakal	0.39	0.22	Absence	Absence
4/4/2019	Airai Oikull Center	0.02	2.60	>2400	26

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
5/14/2019	Mongami	0.04	3.46	160	4
5/14/2019	Ngchemiangel	0.06	9.25	1	0
5/14/2019	Ngatpang	1.39	1.99	Absence	Absence
5/14/2019	Ibobang	0.49	9.52	Absence	Absence
5/14/2019	Ngermetengel	0.37	5.01	Absence	Absence
5/14/2019	Imeong	0.05	2.51	Absence	Absence
5/8/2019	Ngardmau	0.34	0.56	Absence	Absence
5/8/2019	Ollei	0.35	2.92	Absence	Absence
5/8/2019	Ngerchelong	0.40	1.74	Absence	Absence
5/8/2019	Choll	0.06	1.37	Absence	Absence
5/8/2019	Ngaraard	0.07	3.74	Absence	Absence
5/7/2019	Ngkeklaou	1.15	2.80	Absence	Absence
5/7/2019	Ngiwal	0.04	4.99	Absence	Absence
5/7/2019	Ngiwal Housing	0.14	1.78	Absence	Absence
5/7/2019	Melkeok	0.16	1.37	Absence	Absence
5/7/2019	Ngchesar	0.52	5.18	Absence	Absence

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
5/2/2019	KAWTP	1.06	0.75	Absence	Absence
5/2/2019	Airai Ordomei	0.49	0.24	Absence	Absence
5/2/2019	Airai Ngerusar	0.52	0.22	Absence	Absence
5/2/2019	Airai Ikoranges	0.17	0.94	Absence	Absence
5/2/2019	Ngermid	0.28	0.84	Absence	Absence
5/2/2019	Harris	0.29	0.58	Absence	Absence
5/2/2019	Mindszenty	0.32	0.52	Absence	Absence
5/2/2019	T-dock	0.34	0.84	Absence	Absence
5/2/2019	IDID	0.32	0.60	Absence	Absence
5/2/2019	Ngerbeched	0.24	0.52	Absence	Absence
5/2/2019	EQPB Lab	0.38	0.71	Absence	Absence
5/2/2019	Meyuns	0.22	0.40	Absence	Absence
5/2/2019	Happy Landing	0.33	0.59	Absence	Absence
5/2/2019	Malakal	0.29	0.73	Absence	Absence
5/2/2019	Airai Oikull Center	0.03	2.89	>2400	140

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
6/6/2019	Mongami	0.00	10.60	11	0
6/6/2019	Ngchemiangel	0.20	13.00	Absence	Absence
6/6/2019	Ngatpang	0.03	7.29	0	Absence
6/6/2019	Ibobang	0.46	11.90	Absence	Absence
6/6/2019	Ngermetengel	0.46	10.80	Absence	Absence
6/6/2019	Imeong	0.25	3.05	Absence	Absence
6/5/2019	Ngardmau	0.08	2.17	0	0
6/5/2019	Ollei	0.35	3.49	Absence	Absence
6/5/2019	Ngerchelong	0.03	1.51	0	0
6/5/2019	Choll	0.41	1.18	Absence	Absence
6/5/2019	Ngaraard	0.04	8.14	1	0
6/4/2019	Ngkeklaou	0.63	1.26	Absence	Absence
6/4/2019	Ngiwal	0.16	1.22	0	0
6/4/2019	Ngiwal Housing	0.33	1.00	Absence	Absence
6/4/2019	Melkeok	0.05	0.65	>2400	12
6/4/2019	Ngchesar	0.18	4.24	0	0

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
6/3/2019	KAWTP	0.85	0.77	Absence	Absence
6/3/2019	Airai Ordomei	0.42	0.67	Absence	Absence
6/3/2019	Airai Ngerusar	0.44	0.62	Absence	Absence
6/3/2019	Airai Ikoranges	0.04	2.05	Absence	Absence
6/3/2019	Ngermid	0.36	1.15	Absence	Absence
6/3/2019	Harris	0.38	0.84	Absence	Absence
6/3/2019	Mindszenty	0.51	0.86	Absence	Absence
6/3/2019	T-dock	0.51	0.89	Absence	Absence
6/3/2019	IDID	0.47	0.63	Absence	Absence
6/3/2019	Ngerbeched	0.24	0.37	Absence	Absence
6/3/2019	EQPB Lab	0.47	0.94	Absence	Absence
6/3/2019	Meyuns	0.10	0.53	Absence	Absence
6/3/2019	Happy Landing	0.45	0.98	Absence	Absence
6/3/2019	Malakal	0.13	0.43	Absence	Absence
6/3/2019	Airai Oikull Center	0.04	6.39	>2400	340

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
7/3/2019	Mongami	0.04	11.04	1	0
7/3/2019	Ngchemiangel	0.05	13.40	1	0
7/3/2019	Ngatpang	0.11	6.08	2	0
7/3/2019	Ibobang	0.72	7.38	Absence	Absence
7/3/2019	Ngermetengel	0.27	8.51	Absence	Absence
7/3/2019	Imeong	0.39	2.11	Absence	Absence
7/4/2019	Ngardmau	0.27	0.90	Absence	Absence
7/4/2019	Ollei	0.03	7.75	1	0
7/4/2019	Ngerchelong	0.00	7.71	11	0
7/4/2019	Choll	0.29	3.06	Absence	Absence
7/4/2019	Ngaraard	0.01	4.05	0	0
7/2/2019	Ngkeklaou	0.07	1.03	0	0
7/2/2019	Ngiwal	0.10	1.54	0	0
7/2/2019	Ngiwal Housing	0.07	1.03	0	0
7/2/2019	Melkeok	0.02	0.70	2400	210
7/2/2019	Ngchesar	0.56	2.56	Absence	Absence

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
6/3/2019	KAWTP	0.51	0.64	Absence	Absence
6/3/2019	Airai Ordomei	0.42	0.72	Absence	Absence
6/3/2019	Airai Ngerusar	0.51	0.96	Absence	Absence
6/3/2019	Airai Ikoranges	0.42	0.83	Absence	Absence
6/3/2019	Ngermid	0.31	0.61	Absence	Absence
6/3/2019	Harris	0.66	0.66	Absence	Absence
6/3/2019	Mindszenty	0.64	0.79	Absence	Absence
6/3/2019	T-dock	0.59	0.80	Absence	Absence
6/3/2019	IDID	0.57	0.76	Absence	Absence
6/3/2019	Ngerbeched	0.62	0.96	Absence	Absence
6/3/2019	EQPB Lab	0.58	1.04	Absence	Absence
6/3/2019	Meyuns	0.43	0.51	Absence	Absence
6/3/2019	Happy Landing	0.51	0.87	Absence	Absence
6/3/2019	Malakal	0.46	0.68	Absence	Absence
6/3/2019	Airai Oikull Center		2.29	>2400	96

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
8/8/2019	Mongami	0.91	3.05	Absence	Absence
8/8/2019	Ngchemiangel	0.77	5.19	Absence	Absence
8/8/2019	Ngatpang	0.56	2.64	Absence	Absence
8/8/2019	Ibobang	1.04	5.66	Absence	Absence
8/8/2019	Ngermetengel	0.23	2.93	Absence	Absence
8/8/2019	Imeong	0.33	1.15	Absence	Absence
8/8/2019	Ngardmau	0.68	0.65	Absence	Absence
8/8/2019	Ollei	0.25	5.56	Absence	Absence
8/8/2019	Ngerchelong	1.05	3.49	Absence	Absence
8/8/2019	Choll	0.00	4.16	Absence	Absence
8/8/2019	Ngaraard	1.20	1.46	Absence	Absence
8/6/2019	Ngkeklaou	0.38	2.85	Absence	Absence
8/6/2019	Ngiwal	0.00	0.69	Absence	Absence
8/6/2019	Ngiwal Housing	0.05	0.98	2	0
8/6/2019	Melkeok	0.00	0.95	2000	330
8/6/2019	Ngchesar	0.84	2.26	Absence	Absence

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
8/12/2019	KAWTP	1.01	0.46	Absence	Absence
8/12/2019	Airai Ordomei	0.68	0.58	Absence	Absence
8/12/2019	Airai Ngerusar	0.72	0.54	Absence	Absence
8/12/2019	Airai Ikoranges	0.70	0.62	Absence	Absence
8/12/2019	Ngermid	0.67	0.65	Absence	Absence
8/12/2019	Harris	0.76	0.71	Absence	Absence
8/12/2019	Mindszenty	0.77	0.61	Absence	Absence
8/12/2019	T-dock	0.71	0.67	Absence	Absence
8/12/2019	IDID	0.69	0.60	Absence	Absence
8/12/2019	Ngerbeched	0.66	0.63	Absence	Absence
8/12/2019	EQPB Lab	0.64	0.70	Absence	Absence
8/12/2019	Meyuns	0.42	0.56	Absence	Absence
8/12/2019	Happy Landing	0.41	0.41	Absence	Absence
8/12/2019	Malakal	0.36	0.52	Absence	Absence
8/12/2019	Airai Oikull Center	0	7.60	>2400	96

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
9/12/2019	Mongami	1.31	5.14	Absence	Absence
9/12/2019	Ngchemiangel	0.68	8.52	Absence	Absence
9/12/2019	Ngatpang	0.27	6.15	Absence	Absence
9/12/2019	Ibobang	0.18	5.64	Absence	Absence
9/12/2019	Ngermetengel	0.18	3.98	Absence	Absence
9/12/2019	Imeong	0.28	3.56	Absence	Absence
9/11/2019	Ngardmau	0.60	0.70	Absence	Absence
9/12/2019	Ollei	0.03	5.59	Absence	Absence
9/12/2019	Ngerchelong	0.69	3.27	Absence	Absence
9/12/2019	Choll	0.14	3.62	Absence	Absence
9/12/2019	Ngaraard	0.70	2.25	Absence	Absence
9/11/2019	Ngkeklaou	0.99	2.90	Absence	Absence
9/11/2019	Ngiwal	0.38	0.69	Absence	Absence
9/11/2019	Ngiwal Housing	0.59	3.36	Absence	Absence
9/11/2019	Melkeok	0.69	1.02	Absence	Absence
9/11/2019	Ngchesar	0.41	3.70	Absence	Absence

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
9/4/2019	KAWTP	0.89	3.63	Absence	Absence
9/4/2019	Airai Ordomei	0.62	1.09	Absence	Absence
9/4/2019	Airai Ngerusar	0.6	1.08	Absence	Absence
9/4/2019	Airai Ikoranges	0.59	0.29	Absence	Absence
9/4/2019	Ngermid	0.49	1.27	Absence	Absence
9/4/2019	Harris	0.49	0.96	Absence	Absence
9/4/2019	Mindszenty	0.60	1.39	Absence	Absence
9/4/2019	T-dock	0.61	0.54	Absence	Absence
9/4/2019	IDID	0.61	1.09	Absence	Absence
9/4/2019	Ngerbeched	0.64	0.50	Absence	Absence
9/4/2019	EQPB Lab	0.64	2.02	Absence	Absence
9/4/2019	Meyuns	0.46	0.64	Absence	Absence
9/4/2019	Happy Landing	0.63	0.94	Absence	Absence
9/4/2019	Malakal	0.59	0.77	Absence	Absence
9/4/2019	Airai Oikull Center	0.01	27.30	>2400	390

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
10/10/2019	Mongami	0.42	2.88	Absence	Absence
10/10/2019	Ngchemiangel	0.17	6.60	47	0
10/10/2019	Ngatpang	1.08	2.42	Absence	Absence
10/10/2019	Ibobang	1.17	6.87	Absence	Absence
10/10/2019	Ngermetengel	0.41	2.90	Absence	Absence
10/10/2019	Imeong	0.58	1.45	Absence	Absence
10/9/2019	Ngardmau	0.54	0.50	Absence	Absence
10/9/2019	Ollei	1.08	6.87	Absence	Absence
10/9/2019	Ngerchelong	0.76	6.44	Absence	Absence
10/9/2019	Choll	0.10	1.81	0	0
10/9/2019	Ngaraard	0.84	1.33	Absence	Absence
10/8/2019	Ngkeklaou	0.00	2.32	1	0
10/8/2019	Ngiwal	0.16	2.26	0	0
10/8/2019	Ngiwal Housing	0.21	2.85	Absence	Absence
10/8/2019	Melkeok	0.49	1.36	Absence	Absence
10/8/2019	Ngchesar	0.94	4.86	Absence	Absence

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
10/7/2019	KAWTP	0.25	0.54	Absence	Absence
10/7/2019	Airai Ordomei	0.40	0.80	Absence	Absence
10/7/2019	Airai Ngerusar	0.37	0.73	Absence	Absence
10/7/2019	Airai Ikoranges	0.39	0.63	Absence	Absence
10/7/2019	Ngermid	0.40	0.50	Absence	Absence
10/7/2019	Harris	0.38	0.38	Absence	Absence
10/7/2019	Mindszenty	0.42	0.51	Absence	Absence
10/7/2019	T-dock	0.47	0.49	Absence	Absence
10/7/2019	IDID	0.47	0.49	Absence	Absence
10/7/2019	Ngerbeched	0.47	0.38	Absence	Absence
10/7/2019	EQPB Lab	0.46	0.52	Absence	Absence
10/7/2019	Meyuns	0.30	0.44	Absence	Absence
10/7/2019	Happy Landing	0.48	0.62	Absence	Absence
10/7/2019	Malakal	0.47	0.36	Absence	Absence
10/7/2019	Airai Oikull Center	0	8.57	>2400	260

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
11/6/2019	Mongami	0.01	27.30	1	0
11/6/2019	Ngchemiangel	0.12	23.80	0	0
11/6/2019	Ngatpang	0.01	17.10	2	0
11/6/2019	Ibobang	0.75	7.50	Absence	Absence
11/6/2019	Ngermetengel	0.50	9.85	Absence	Absence
11/6/2019	Imeong	0.01	3.37	0	0
11/6/2019	Ngardmau	0.35	2.27	Absence	Absence
11/6/2019	Ollei	0.28	8.28	Absence	Absence
11/6/2019	Ngerchelong	0.76	4.76	Absence	Absence
11/6/2019	Choll	0.00	7.12	1	0
11/6/2019	Ngaraard	0.01	11.60	0	0
11/5/2019	Ngkeklaou	0.44	1.66	Absence	Absence
11/5/2019	Ngiwal	0.03	0.62	0	0
11/5/2019	Ngiwal Housing	0.44	1.58	Absence	Absence
11/5/2019	Melkeok	0.65	1.00	Absence	Absence
11/5/2019	Ngchesar	0.21	4.36	Absence	Absence

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
11/4/2019	KAWTP	0.78	0.47	Absence	Absence
11/4/2019	Airai Ordomei	0.55	0.50	Absence	Absence
11/4/2019	Airai Ngerusar	0.51	0.51	Absence	Absence
11/4/2019	Airai Ikoranges	0.52	0.60	Absence	Absence
11/4/2019	Ngermid	0.28	0.45	Absence	Absence
11/4/2019	Harris	0.61	0.46	Absence	Absence
11/4/2019	Mindszenty	0.53	0.42	Absence	Absence
11/4/2019	T-dock	0.41	0.36	Absence	Absence
11/4/2019	IDID	0.47	0.26	Absence	Absence
11/4/2019	Ngerbeched	0.45	0.18	Absence	Absence
11/4/2019	EQPB Lab	0.60	0.39	Absence	Absence
11/4/2019	Meyuns	0.42	0.46	Absence	Absence
11/4/2019	Happy Landing	0.47	0.33	Absence	Absence
11/4/2019	Malakal	0.28	0.29	Absence	Absence
11/4/2019	Airai Oikull Center	0	6.03	>2400	610

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
12/5/2019	Mongami	0.01	9.38	31	2
12/5/2019	Ngchemiangel	0.96	10.10	Absence	Absence
12/5/2019	Ngatpang	0.04	8.03	0	0
12/5/2019	Ibobang	0.26	9.01	Absence	Absence
12/5/2019	Ngermetengel	8.30	5.14	Absence	Absence
12/5/2019	Imeong	0.34	1.94	Absence	Absence
12/5/2019	Ngardmau	0.03	0.48	0	0
12/5/2019	Ollei	0.00	8.39	0	0
12/5/2019	Ngerchelong	1.43	7.82	Absence	Absence
12/5/2019	Choll	0.07	1.75	0	0
12/5/2019	Ngaraard	0.09	5.18	0	0
12/3/2019	Ngkeklaau	0.76	2.16	Absence	Absence
12/3/2019	Ngiwal	0.04	0.38	0	0
12/3/2019	Ngiwal Housing	1.32	3.32	Absence	Absence
12/3/2019	Melkeok	0.87	1.61	Presence	Absence
12/3/2019	Ngchesar	1.66	2.60	Absence	Absence

Date DD/MM/YEAR	Location	Chlorine Residual mg/L	Turbidity NTU	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
12/2/2019	KAWTP	0.79	0.26	Absence	Absence
12/2/2019	Airai Ordemel	0.56	0.37	Absence	Absence
12/2/2019	Airai Ngerusar	0.58	0.38	Absence	Absence
12/2/2019	Airai Ikoranges	0.56	0.55	Absence	Absence
12/2/2019	Ngermid	0.45	0.39	Absence	Absence
12/2/2019	Harris	0.48	0.33	Absence	Absence
12/2/2019	Mindszenty	0.58	0.38	Absence	Absence
12/2/2019	T-dock	0.53	0.32	Absence	Absence
12/2/2019	IDID	0.57	0.40	Absence	Absence
12/2/2019	Ngerbeched	0.56	0.23	Absence	Absence
12/2/2019	EQPB Lab	0.62	0.42	Absence	Absence
12/2/2019	Meyuns	0.43	0.38	Absence	Absence
12/2/2019	Happy Landing	0.59	0.40	Absence	Absence
12/2/2019	Malakal	0.51	0.42	Absence	Absence
12/2/2019	Airai Oikull Center	0	1.71	>2400	55

Location	Date DD/MM/YEAR	Chlorine Residual mg/L	Turbidity (NTU)	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
Elochel	3/1/2019	0.01	0.41	1	0
School	3/1/2019	0.04	0.37	0	0
CHC	3/1/2019	0.44	8.07	0	0
Old WTP	3/1/2019	0.58	0.44	Absence	Absence
New WTP	3/1/2019	0.22	0.22	0	0

Location	Date DD/MM/YEAR	Chlorine Residual mg/L	Turbidity (NTU)	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
Peleliu PWSS					
Elochel	4/4/2019	0.09	0.56	5	0
School	4/4/2019	0.04	0.81	20	0
CHC	4/4/2019	0.01	6.11	3	0
WTP (old)	4/4/2019	0.09	1.59	1	0
Angaur PWSS					
Dock	4/24/2019	1.18	0.82	Absence	Absence
Gulibert	4/24/2019	1.35	1.11	Absence	Absence
Ramon	4/24/2019	1.01	62.1	Absence	Absence
Kayangel PWSS					
WTP	4/22/2019	0.04	4.49	1	0
Cita	4/22/2019	0.03	0.68	6	0
School	4/22/2019	>2.20	1.12	21	0
CHC	4/22/2019		0.62	4	0

Location	Date DD/MM/YEAR	Chlorine Residual (mg/L)	Turbidity	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
Angaur Dock	05/20/2019	0.02	0.74	0.35	0
Angaur Gulibert	05/20/2019	0.03	0.87	0.19	0
Angaur Ramon	05/20/2019	0.08	1.6	46	1
Angaur Priest Ho	05/20/2019	0.04	0.9	65	0

Location	Date DD/MM/YEAR	Chlorine Residual mg/L	Turbidity (NTU)	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
Peleliu PWSS					
School	9/18/2019	0.19	0.53	0	0
CHC	9/18/2019	0.48	5.55	0	0
Old WTP	9/18/2019	0.78	0.73	0	0
Elochel	9/10/2019	0.09	0.78	0	0
School	9/11/2019	0.29	0.77	Absence	Absence
CHC	9/12/2019	1.18	0.82	Absence	Absence
Old WTP	9/13/2019	1.35	1.11	Absence	Absence
Angaus PWSS					
Dock	9/18/2019	0.08	0.47	210	1
Gulibert	9/18/2019	0.02	0.51	2	0
Ramon	9/18/2019	0.01	0.39	2	0

Location	Date DD/MM/YEAR	Chlorine Residual mg/L	Turbidity (NTU)	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
Peleliu PWSS					
Elochel	7/10/2019	0.06	0.21	0	0
School	7/10/2019	0.19	1.48	0	0
CHC	7/10/2019	0.62	1.65	Absence	Absence
WTP	7/10/2019	0.54	0.52	Absence	Absence
Angaur PWSS					
Dock	7/11/2019	0.03	0.46	10	0
Gulibert	7/11/2019	0.01	0.54	7	0
Ramon	7/11/2019	0.01	0.66	81	0
Priest House	7/11/2019	0.01	0.27	67	0
School	7/11/2019	0.03	2.33	57	0

Location	Date DD/MM/YEAR	Chlorine Residual mg/L	Turbidity (NTU)	Total Coliform MPN per 100 ml water sample	E.coli MPN per 100 ml water sample
Angaur PWSS					
Dock	11/19/2019	0.32	0.4	0	0
L. Gulibert Resid	11/19/2019	0.04	0.33	0	0
R. Carlos Reside	11/19/2019	0	0.35	4	0
Priest House	11/19/2019	0.04	0.37	3	0
Kayangel PWSS					
School	11/20/2019	0.01	0.42	0	0
Sita	11/20/2019	0.03	0.82	0	0

Appendix B

Environmental Quality Protection Board (EQPB) Regulations, Current as of February 25, 2013

CHAPTER 2401-51 PUBLIC WATER SUPPLY SYSTEM REGULATIONS

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GENERAL PROVISIONS

2401-51-01 Authority

These regulations are promulgated by the Republic of Palau Environmental Quality Protection Board pursuant to the authority granted it by Republic of Palau Public Law 1-58. These regulations shall have the force and effect of law.

(Effective May 26, 1996)

2401-51-02 Purpose

The purpose of these regulations, technical provisions and specifications is to establish certain minimum standards and requirements as determined by the Republic of Palau Environmental Quality Protection Board to be necessary for the public health and safety to insure that public water supply systems are protected against contamination and do not constitute a health hazard.

(Effective May 26, 1996)

2401-51-03 Definitions

As used herein, unless the content otherwise requires, the term:

(A) "Best available technology" or "BAT" means the best technology, treatment techniques, or other means which the Board finds, after examination for effectiveness under field conditions and not solely under laboratory conditions, are available (taking cost into consideration). For the purposes of setting MCLs for synthetic organic chemicals, any BAT must be at least as effective as granular activated carbon.

(B) "Board" means the Republic of Palau Environmental Quality Protection Board or its authorized representative.

(C) "Certified Laboratory" means a laboratory approved by the Board in the case of a laboratory located in the Republic of Palau, or by the EPA if

located outside Palau, except that measurements for turbidity, free chlorine residual, temperature and pH may be performed by any person acceptable to the Board.

(D) "Chairman of the Palau Environmental Quality Protection Board", or "Chairman" means the Chairman personally or his duly authorized representative.

(E) "Coagulation" means a process using coagulant chemicals and mixing by which colloidal and suspended materials are destabilized and agglomerated into flocs.

(F) "Confluent growth" means a continuous bacterial growth covering the entire filtration area of a membrane filter, or a portion thereof, in which bacterial colonies are not discrete.

(G) "Contaminant" means any physical, chemical, biological or radiological substance or matter in water.

(H) "Conventional filtration treatment" means a series of processes including coagulation, flocculation, sedimentation, and filtration resulting in substantial particulate removal.

(I) "CT" or "CT_{calc}" is the product of "residual disinfectant concentration" (C) in mg/l determined before or at the first customer, and the corresponding "disinfectant contact time" (T) in minutes, i.e., "C" x "T". If a public water system applies disinfectants at more than one point prior to the first customer, it must determine the CT of each disinfectant sequence before or at the first customer to determine the total percent inactivation or "total inactivation ratio." In determining the total inactivation ratio, the public water system must determine the residual disinfectant concentration of each disinfection sequence and corresponding contact time before any subsequent disinfection application point(s). "CT_{99.9}" is the CT value required for 99.9 percent (3-log) inactivation of *Giardia lamblia* cysts. The inactivation ratio is:

$$\frac{CT_{calc}}{CT_{99.9}}$$

and the sum of the inactivation ratios, or total inactivation ratio shown as:

$$\frac{(CT_{calc})}{(CT_{99.9})}$$

is calculated by adding together the inactivation ratio for each disinfection sequence. A total inactivation ratio equal to or greater than 1.0 is assumed to provide a 3-log inactivation of *Giardia lamblia* cysts.

(J) "Diatomaceous earth filtration" means a process resulting in substantial particulate removal in which:

- (1) A precoat cake of diatomaceous earth filter media is deposited on a support membrane (septum), and
- (2) While the water is filtered by passing through the cake on the septum, additional filter media known as body feed is continuously added to the feed water to maintain the permeability of the filter cake.

(K) "Direct filtration" means a series of processes including coagulation and filtration but excluding sedimentation resulting in substantial particulate removal.

(L) "Disinfectant" means any oxidant, including but not limited to chlorine, chlorine dioxide, chloramines, and ozone added to water in any part of the treatment or distribution process, that is intended to kill or inactivate pathogenic microorganisms.

(M) "Disinfectant contact time" ("T" in CT calculations) means the time in minutes that it takes for water to move from the point of disinfectant application or the previous point of disinfectant residual measurement to a point before or at the point where residual disinfectant concentration ("C") is measured. Where only one "C" is measured, "T" is the time in minutes that it takes for water to move from the point of disinfectant application to a point before or at where residual disinfectant concentration ("C") is measured. Where more than "C" is measured, "T" is:

(1) For the first measurement of "C", the time in minutes that it takes for water to move from the first or only point of disinfectant application to a point before or at the point where the first "C" is measured; and,

(2) For subsequent measurements of "C", the time in minutes that it takes for water to move from the previous "C" measurement point to the "C" measurement point for which the particular "T" is being calculated.

Disinfectant contact time in pipelines must be calculated based on "plug flow" by dividing the internal volume of the pipe by the maximum hourly flow rate through that pipe. Disinfectant contact time within mixing basins and storage reservoirs must be determined by tracer studies or an equivalent demonstration.

(N) "Disinfection" means a process which inactivates pathogenic organisms in water by chemical oxidants or equivalent agents.

(O) "Domestic or other non-distribution system plumbing problem" means a coliform contamination problem in a public water system with more than one service connection that is limited to the specific service connection from which the coliform-positive sample was taken.

(P) "Dose Equivalent" means the product of the absorbed dose from ionizing radiation and such factors as account for differences in biological effectiveness due to the type of radiation and its distribution in the body as specified by the International Commission on Radiological Units and Measurements (ICRU).

(Q) "EPA" means the United States Environmental Protection Agency.

(R) "Federal Act" means 42 USC Section 300f et seq., commonly referred to as the Safe Drinking Water Act (Public Law 93- 523) and its implementing regulations.

(S) "Filtration" means a process for removing particulate matter from water by passage through porous media.

(T) "Flocculation" means a process to enhance agglomeration or collection of smaller floc particles into larger, more easily settleable particles through gentle stirring by hydraulic or mechanical means.

(U) "Gross alpha particle activity" means the total radioactivity due to alpha particle emission as inferred from measurements on a dry sample.

(V) "Gross beta particle activity" means the total radioactivity due to beta particle emission as inferred from measurements on a dry sample.

(W) "Groundwater" means any source of water that is exposed only to an enclosed atmosphere before entry into a treatment, storage or distribution system.

(X) "Groundwater under the direct influence of surface water" means any water beneath the surface of the ground with:

(1) Significant occurrence of insects or other macroorganisms, algae, or large-diameter pathogens such as *Giardia lamblia*, or

(2) Significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlate to climatological or surface water conditions.

Direct influence must be determined for individual sources in accordance with criteria established by the Board. The Board determination of direct influence may be based on site-specific measurements of water quality and/or documentation of well construction characteristics and geology with field evaluation.

(Y) "Halogen" means one of the chemical elements chlorine, bromine or iodine.

(Z) "Lead free" means solders and flux containing not more than 0.2 percent lead, and pipes and pipe fittings containing not more than 8.0 percent lead.

(AA) "Legionella" means a genus of bacteria, some species of which have caused a type of pneumonia called Legionnaires Disease.

(BB) "Man-made beta particle and photon emitters" means all radionuclides emitting beta particle and/or photons listed in Maximum Permissible Body Burdens and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure, U.S. National Bureau of Standards Handbook 69, except the daughter products of thorium-232, uranium-235, and uranium-238.

(CC) "Maximum Contaminant Level" or "MCL" means the maximum permissible level of a contaminant in water which is delivered to the free flowing outlet of the ultimate user of a public water system, except in the case of turbidity where the maximum permissible level is measured at the point of entry to the distribution system. Contaminants added to the water under circumstances controlled by the user and, except those resulting from corrosion of piping and plumbing caused by water quality, are excluded from this definition.

(DD) "Near the first service connection" means at one of the 20 percent of all service connections in the entire system that are nearest the water supply treatment facility, as measured by water transport time within the distribution system.

(EE) "Maximum Total Trihalomethane Potential" or "MTP" means the maximum concentration of total trihalomethanes produced in a given water containing a disinfectant residual after 7 days at a temperature of 25 degrees Centigrade or above.

(FF) "Performance Evaluation Sample" means a water reference sample sent to a laboratory for the purpose of demonstrating that the laboratory can successfully analyze the sample within the acceptable limits of performance.

(GG) "Person" means the national government of the Republic of Palau, a Palau state government, a political subdivision, a public or private institution, corporation, partnership, joint venture, association, firm, or company organized or existing under the laws of the Republic or one or more of its state governments; a lessee or other occupant of property; or an individual, acting singly or as a group.

(HH) "Picocurie" or "pCi" means that quantity of radioactive material producing 2.22 nuclear transformations per minute.

(II) "Point of disinfectant application" is the point where the disinfectant is applied and water downstream of that point is not subject to recontamination by surface water runoff.

(JJ) "Point-of-entry treatment device" is a treatment device applied to the drinking water entering a house or building for the purpose of reducing contaminants in the drinking water distributed throughout the house or building.

(KK) "Point-of-use treatment device" is a treatment device applied to a single tap used for the purpose of reducing contaminants in drinking water at that one tap.

(LL) "Potable water" means water which is of a quality that meets the requirements of these regulations and is intended for human consumption.

(MM) "Public Water Supply System" means a system for the provision to the public of piped water for human consumption, if such system has at least fifteen (15) service connections or regularly serves an average of at least twenty-five (25) individuals daily at least sixty (60) days out of the year. Such term includes (1) any collection, treatment, storage, and distribution facilities under control of the operator of such system and used primarily in connection with such system, and (2) any collection or pretreatment storage facilities not under such control which are used primarily in connection with such system. A public water system is either a community water system" or a non-community water system."

(1) "Community Water System" means a public water system which serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents.

(2) "Non-Community Water System" means a public water system that is not a community water system.

(3) "Non-Transient Non-Community Water System" means a public water system that is not a community water system and that regularly serves at least 25 of the same persons over 6 months per year.

(NN) "Rem" means the unit dose equivalent from ionizing radiation to the total body or any internal organ or organ system. A "millirem (mrem)" is 1/1000 of a rem.

(OO) "Residual disinfectant concentration" ("C" in CT calculations) means the concentration of disinfectant measured in mg/l in a representative sample of water.

(PP) "Sanitary Survey" means an on-site review of the water source, facilities, equipment, operation and maintenance of a public water supply system for the purpose of evaluating the adequacy of such source, facilities, equipment, operation, and maintenance for producing and distributing safe drinking water.

(QQ) "Sedimentation" means a process for removal of solids before filtration by gravity or separation.

(RR) "Slow sand filtration" means a process involving passage of raw water through a bed of sand at low velocity (generally less than 0.4 m/h) resulting in substantial particulate removal by physical and biological mechanisms.

(SS) "Standard sample" means the aliquot of finished drinking water that is examined for the presence of coliform bacteria.

(TT) "Supplier of water" means any person who owns or operates a public water supply system.

(UU) "Surface water" means any source of water that is open to the atmosphere and subject to runoff. This includes springs, except where the Board determines that there is adequate protection from infiltration of surface contaminants.

(VV) "System with a single service connection" means a system which supplies drinking water to consumers via a single service line.

(WW) "Tamper" means to introduce a contaminant into a public water system with the intention of harming persons, or to otherwise interfere with the operation of a public water system with the intention of harming persons.

(XX) "Too numerous to count" means that the total number of bacterial colonies exceeds 200 on a 47-mm diameter membrane filter used for coliform detection.

(YY) "Total Trihalomethanes" or "TTHM" means the sum of the concentration in milligrams per liter of the trihalomethane compounds (trichloromethane [chloroform], dibromochloromethane, bromodichloromethane and tribromomethane [bromoform]), rounded to two significant figures.

(ZZ) "Trihalomethane" or "THM" means one of the family of organic compounds, named as derivatives of methane, wherein three of the four hydrogen atoms in methane are each substituted by a halogen atom in the molecular structure.

(AAA) "Virus" means a virus of fecal origin which is infectious to humans by water-borne transmission.

(BBB) "Waterborne disease outbreak" means the significant occurrence of acute infectious illness, epidemiologically associated with the ingestion of water from a public water system which is deficient in treatment, as determined by the appropriate Republic of Palau National or appropriate state agency.

(CCC) The following words and terms defined in the July 1, 1993 edition of 40 CFR Section 141.2 have the meanings ascribed to them in that Section:

- (1) Action level
- (2) Compliance cycle
- (3) Compliance period
- (4) Corrosion inhibitor
- (5) Effective corrosion inhibitor residual
- (6) First draw sample
- (7) Initial compliance period: 1993-1995
- (8) Initial compliance period 150: 1993-1995
- (9) Initial compliance period <150: 1996-1998
- (10) Large water system
- (11) Lead service line
- (12) Maximum contaminant level
- (13) Medium-size water system
- (14) Optimal corrosion control treatment
- (15) Repeat compliance period
- (16) Service line sample
- (17) Single family structure
- (18) Small water system

(Effective May 26, 1996)

SITING AND DESIGN REVIEW

2401-51-04 Siting Requirements

(A) No person may enter into a financial commitment for or initiate construction of a new water supply system or significantly increase the capacity of or modification to an existing public water supply system, until he has submitted to the Board a notification of intent which shall include a conceptual, descriptive plan with appropriate sketches detailing proposed location, water source/capacity, budget estimates and other data as described in Section 2401-51-06 and the Board has given its approval.

(B) To the extent practicable, the location for part or all of a new or expanded public water supply system should be avoided at a site which:

- (1) Is subject to a significant risk from earthquakes, floods, fires or other disasters which could cause a breakdown of the public water supply system or a portion thereof;
- (2) Except for intake structures, is within the floodplain of a 100-year flood or is lower than any recorded high tide where appropriate records exist;
- (3) In case of a roof catchment, has not been given reasonable consideration as to effective typhoon-protection measures of buildings, roofs, guttering and other catchment appurtenances.

(Effective May 26, 1996)

2401-51-05 Design and Construction Review Requirements

(A) No person shall cause or allow the construction of, or change to, any public water supply without approval of final drawings and specifications by the Board or its Executive Officer.

- (B) Final drawings and specifications shall be reviewed on the basis of the judged ability of the completed facility to produce water of a quality which meets the standards prescribed by these regulations.
- (C) Public water supply installation, change, or addition shall not include routine maintenance, review of pipe connection hydrants and valves or replacement of equipment pipes, and appurtenances with equivalent equipment, piping and appurtenances.
- (D) All work performed on a public water supply shall be in accordance with accepted engineering practices, such as the American Water Works Association and the Committee of the Great Lakes-Upper Mississippi River Board of State Public Health and Environmental Managers.

(Effective May 26, 1996)

2401-51-06 Notification of Intent

No person may enter into a financial commitment for or initiate construction of a new water supply system or significantly increase the capacity of or modification to an existing public water supply system, until he has submitted to the Board the following information, and the Board has given its approval:

- (A) Name and address of person who intends to construct or modify a public water supply system;
- (B) Name and address of person who will be the supplier of water to the public;
- (C) Location of proposed water source(s), on an 8 1/2" 11" portion of topographic map;
- (D) Type of source (spring, stream, well, roof catchment, ground catchment, other);
- (1) If catchment, horizontal area in square feet;
- (a) if roof catchment, type of roof materials;
- (b) if ground catchment, description of vegetative cover;
- (2) If well(s);
- (a) estimated depth(s);
- (b) measures to be taken to exclude surface water from well(s);
- (c) kind of pump(s) to be used (hand, electric, windmill, etc.);
- (3) If surface water;
- (a) type of surface water;
- (b) measures intended to be taken to preserve the water source (e.g. watershed protection plan).
- (E) Estimated capacity of sources in gallons per day during normal rainfall conditions;
- (F) Existing methods of sewage disposal and methods expected in the future, for the system and service area;
- (G) Planned raw water storage capacity, or increase thereof;
- (H) Description of proposed water treatment process;
- (I) Number of persons to be supplied at initiation of operation;
- (J) Anticipated population of service area ten (10) years from now;
- (K) Budget estimate for construction, operation and maintenance;

- (L) Expected source(s) of funds; and
- (M) Other data as may be required by the Board.

(Effective May 26, 1996)

2401-51-07 Approval

The Board or its Executive Officer shall review a notice of intent to construct or modify a public water supply system for completeness within 30 calendar days from receipt and either:

- (A) Fully or conditionally approve the notice for preparation of final plans and specifications for the proposed facility; or;
- (B) Notify the proposed constructor that additional information is needed; or,
- (C) Deny the proposal stating, in writing, appropriate environmental reasons for the denial.

(Effective May 26, 1996)

2401-51-08 Final Drawings and Specifications

(A) No person shall cause or allow the construction of or change in any public water supply system without approval of final drawings and specifications by the Board.

(B) The final drawings and specifications shall follow the intent expressed in the approved Notification of Intent.

(C) Preparation of final drawings and specifications shall be supervised by a person experienced in the construction and operation and maintenance of water supply systems, based on accepted engineering practices, such as the American Water Works Association and the Committee of the Great Lakes-Upper Mississippi River Board of State Public Health and Environment Managers, and directed toward construction of a facility which will produce potable water.

(D) Upon review of final drawings and specifications, the Board may:

- (1) Approve the drawings and specifications;
- (2) Request changes in the drawing and specifications of the construction; or
- (3) Deny approval.

(Effective May 26, 1996)

PERMITS

2401-51-09 Permit Required

Any person who engages in construction of or change to any public water supply system within the Republic of Palau shall first obtain from the Board or its Executive Officer a permit for the proposed activity. *The construction of or change to any public water supply system subject to the provisions of this Chapter shall comply with the terms, conditions, provisions and management plans for any National,*

State or traditional conservation area, preserve or other protected area as established by law.*

(Effective May 26, 1996)

*(Amendment Effective March 12, 1999)

2401-51-10 Application for Permit

(A) Application for a permit shall be on a form approved by the Board and shall be submitted by the person undertaking the construction of or change to any public water supply system.

(B) Applications shall be accompanied by the plan, specifications, and other information as described in Sections 2401-51-04 through 2401-51-08.

(C) Applications shall be accompanied by a processing fee of \$100.00, which is not refundable, except that no fee is required for the Government of the Republic of Palau or its State Governments.

(Effective May 26, 1996)

DRINKING WATER QUALITY STANDARDS

2401-51-11 General Provisions

(A) It is the responsibility of the supplier of water to assure a quality of water supply that equals or exceeds the standards of the these Public Water Supply Systems Regulations. This includes assurance by the supplier that users do not contaminate the public water supply system by the use of improper cross-connections or backflow of wastewater or non-potable water sources.

(B) Maximum contaminant level testing shall be done in accordance with approved method(s) in the latest edition of Standard Methods for the Examination of Water and Wastewater, by the American Public Health Association. Said analyses of drinking water contaminants shall be performed by a certified laboratory. The Board Laboratory shall perform any and all maximum contaminant level testing for which it is certified unless and until Board delegates such testing responsibilities to another certified laboratory facility.

(C) All public water supply systems in the Republic of Palau must be disinfected, meeting the disinfection specifications of the Board.

(D) Water Supply Systems Regulations, including MCL's and monitoring frequencies may be amended at any time.

(E) The Board has the authority to determine compliance or initiate enforcement action based upon analytical results or other information compiled by the agency and its representatives.

(Effective May 26, 1996)

2401-51-12 Maximum Contaminant Levels for Microbiological Contaminants

(A) The maximum contaminant levels (MCL) for total coliform bacteria, applicable to community and non-community water systems is based on the presence or absence of total coliforms in a sample, rather than on coliform density.

(1) For a system which collects fewer than 40 samples per month, if no more than one sample collected during a month is total coliform-positive, the system is in compliance with the MCL for total coliforms.

(2) For a system which collects at least 40 samples per month, if no more than 5.0 percent of the samples collected during a month are total coliform-positive, the system is in compliance with the MCL for total coliforms.

(B) Any fecal coliform-positive repeat sample or E. Coli-positive repeat sample, or any total coliform-positive repeat sample following a fecal coliform-positive or E. Coli-positive routine sample constitutes a violation of the MCL for total coliforms. For purposes of the public notification requirements in Sections 2401-51-42 through 2401-51-51, this is a violation that may pose an acute risk to health.

(C) A public water system must determine compliance with the MCL for total coliforms in Divisions (A) and (B) of this Section for each month in which it is required to monitor for total coliforms.

(D) The best technology, treatment techniques, or other means available for achieving compliance with the maximum contaminant level for total coliforms in Divisions (A) and (B) of this Section are as follows:

(1) Protection of wells from contamination by coliforms by appropriate placement and construction;

(2) Maintenance of a disinfectant residual throughout the distribution system;

(3) Proper maintenance of the distribution system including appropriate pipe replacement and repair procedures, main flushing programs, proper operation and maintenance of storage tanks and reservoirs, and continual maintenance of positive water pressure in all parts of the distribution system;

(4) Filtration and/or disinfection of surface water, as described in Sections 2401-51-75 through 2401-51-84, or disinfection of ground water using strong oxidants such as chlorine, chlorine dioxide, or ozone; and

(5) For systems using ground water, compliance with the requirements of a Board-approved Wellhead Protection Program.

(Effective May 26, 1996)

2401-51-13 Routine Microbiological Sampling

(A) Suppliers of water for community and non-community water systems shall collect and analyze water for coliform bacteria in accordance with provisions of this Section to determine compliance with Section 2401-51-12.

(B) Total coliform samples shall be collected at points which are representative of the conditions within the distribution system in accordance with a written sample siting plan reviewed and approved by the Board.

(C) The monitoring frequency for total coliforms for community water systems shall be as follows:

(1) The supplier of water for a community water system shall take total coliform samples at regular time intervals, and in number proportionate to the population served by the system. In no event shall the frequency be less than:

Population Served Per Month	Minimum Number of Analyses
25 to 1,000	1
1,001 to 2,500	2
2,501 to 3,300	3
3,301 to 4,100	4
4,101 to 4,900	5
4,901 to 5,800	6
5,801 to 6,700	7
6,701 to 7,600	8
7,601 to 8,500	9
8,501 to 12,900	10
12,901 to 17,200	15
17,201 to 21,500	20
21,500 to 25,000	25

(2) Based upon a history of no total coliform bacterial contamination and on a sanitary survey conducted by the Board in the past five years showing the water system to be supplied solely by a protected ground water source and free of sanitary defects, a community water system serving 25 to 1,000 persons, with written permission from the Board, may reduce this sampling frequency except that in no case shall it be reduced to less than one per quarter.

(D) The monitoring frequency for total coliforms for non-community water systems shall be as follows:

(1) A non-community water system using only ground water (except ground water under the direct influence of surface water as defined in Section 2401-51-03) and serving 1,000 persons or fewer must monitor each calendar quarter that the system provides water to the public, except that the frequency may be reduced with written permission from the Board, if a sanitary survey shows that the system is free of sanitary defects. The reduced frequency shall not be less than once per year.

(2) A non-community water system using only ground water (except ground water under the direct influence of surface water as defined in Section 2401-51-03) and serving more than 1,000 persons during any month must monitor at the same frequency as a like-sized community water system, as specified in Division (C) of this Section, except that the frequency may be reduced with written permission from the Board, for any month the system serves 1,000 persons or fewer. The reduced frequency shall not be less than once per year. For systems using ground

water under the direct influence of surface water, Paragraph (D)(4) of this Section applies.

(3) A non-community water system using surface water, in total or in part, must monitor at the same frequency as a like-sized community water system, as specified in Division (D) of this Section, regardless of the number of persons it serves.

(4) A non-community water system using ground water under the direct influence of surface water, as defined in Section 2401-51-03, must monitor at the same frequency as a like-sized community water system, as specified in Division (C) of this Section. The system must begin monitoring at this frequency beginning six months after the Board determines that the ground water is under the direct influence of surface water.

(E) The public water system must collect samples at regular time intervals throughout the month, except that a system which uses ground water (except ground water under the direct influence of surface water, as defined in Section 2401-51-03), and serves 4,900 persons or fewer, may collect all required samples on a single day if they are taken from different sites.

(F) A public water system that uses surface water or ground water under the direct influence of surface water, as defined in Section 2401-51-03, and does not practice filtration in compliance with Sections 2401-51-75 through 2401-51-84 must collect at least one sample near the first service connection each day the turbidity level of the source water, measured as specified in Section 2401-51-82, exceeds 1 NTU. This sample must be analyzed for the presence of total coliforms. When one or more turbidity measurements in any day exceed 1 NTU, the system must collect this coliform sample within 24 hours of the first exceedance, unless the Board determines that the system, for logistical reasons outside the system's control, cannot have the sample analyzed within 30 hours of collection. Sample results from this coliform monitoring must be included in determining compliance with the MCL for total coliforms in Section 2401-51-12.

(G) Special purpose samples, such as those taken to determine whether disinfection practices are sufficient following pipe placement, replacement, or repair, shall not be used to determine compliance with the MCL for total coliforms in Section 2401-51-12.

(Effective May 26, 1996)

2401-51-14 Repeat Monitoring

(A) If a routine sample is total coliform-positive, the public water system must collect a set of repeat samples within 24 hours of being notified of the positive result. A system which collects more than one routine sample/month must collect no fewer than three repeat samples for each total coliform-positive sample found. A system which collects one routine sample/month or fewer must collect no fewer than four repeat samples for each total coliform-positive sample found. The Board may extend the 24-hour

limit on a case-by-case basis if the system has a logistical problem in collecting the repeat samples within 24 hours that is beyond its control. In the case of an extension, the Board must specify how much time the system has to collect the repeat samples.

(B) The system must collect at least one repeat sample from the sampling tap where the original total coliform-positive sample was taken, and at least one repeat sample at a tap within five service connections upstream and at least one repeat sample at a tap within five service connections downstream of the original sampling site. If a total coliform-positive sample is at the end of the distribution system, or one away from the end of the distribution system, the Board may waive the requirement to collect at least one repeat sample upstream or downstream of the original sampling site.

(C) The system must collect all repeat samples on the same day, except that the Board may allow a system with a single service connection to collect the required set of repeat samples over a four-day period or to collect a larger volume repeat sample(s) in one or more sample containers of any size, as long as the total volume collected is at least 400 ml (300 ml for systems which collect more than one routine sample/month).

(D) If one or more repeat samples in the set is total coliform-positive, the public water system must collect an additional set of repeat samples in the manner specified in Divisions (A) through (C) of this Section. The additional samples must be collected within 24 hours of being notified of the positive result, unless the Board extends the limit as provided in Division (A) of this Section. The system must repeat this process until either total coliforms are not detected in one complete set of repeat samples or the system determines that the MCL for total coliforms in Section 2401-51-12 has been exceeded and notifies the Board.

(E) If a system collecting fewer than five routine samples/month has one or more total coliform-positive samples and the Board does not invalidate the sample(s) under Section 2401-51-15, it must collect at least five routine samples during the next month the system provides water to the public, except that the Board may waive this requirement if the conditions of Paragraphs (E)(1) or (E)(2) of this Section are met. The Board cannot waive the requirement for a system to collect repeat samples in Divisions (A) through (D) of this Section.

(1) The Board may waive the requirement to collect five routine samples the next month the system provides water to the public if the Board, or an agent approved by the Board, performs a site visit before the end of the next month the system provides water to the public. Although a sanitary survey need not be performed, the site visit must be sufficiently detailed to allow the Board to determine whether additional monitoring and/or any corrective action is needed. The Board cannot approve an employee of the system to perform this site visit, even if the employee

is an agent approved by the Board to perform sanitary surveys.

(2) The Board may waive the requirement to collect five routine samples the next month the system provides water to the public if the Board has determined why the sample was total coliform-positive and establishes that the system has corrected the problem or will correct the problem before the end of the next month the system serves water to the public. In this case, the Board must document this decision to waive the following month's additional monitoring requirement in writing, have it approved and signed by the supervisor of the Board official who recommends such a decision, and make this document available to the public. The written documentation must describe the specific cause of the total coliform-positive sample and what action the system has taken and/or will take to correct the problem. The Board cannot waive the requirement to collect five routine samples the next month the system provides water to the public solely on the grounds that all repeat samples are total coliform-negative. Under this Paragraph, a system must still take at least one routine sample before the end of the next month it serves water to the public and use it to determine compliance with the MCL for total coliforms in Section 2401-51-12. Unless the Board has determined that the system has corrected the contamination problem before the system took the set of repeat samples required in Divisions (A) through (D) of this Section, and all repeat samples were total coliform-negative.

(F) After a system collects a routine sample and before it learns the results of the analysis of that sample, if it collects another routine sample(s) from within five adjacent service connections of the initial sample, and the initial sample, after analysis, is found to contain total coliforms, then the system may count the subsequent sample(s) as a repeat sample instead of as a routine sample.

(G) Results of all routine and repeat samples not invalidated by the Board must be included in determining compliance with the MCL for total coliforms in Section 2401-51-12.

(Effective May 26, 1996)

2401-51-15 Invalidation of Total Coliform Samples

(A) A total coliform-positive sample invalidated under this Section does not count towards meeting the minimum monitoring requirements of this Section.

(B) The Board may invalidate a total coliform-positive sample only if the conditions of Paragraphs (B)(1), (B)(2), or (B)(3) of this Section are met.

(1) The laboratory establishes that improper sample analysis caused the total coliform-positive result.

(2) The Board, on the basis of the results of repeat samples collected as required by Divisions (A) through (D) of Section 2401-51-14, determines that the total coliform-positive sample resulted from a domestic or other non-distribution system plumbing

problem. The Board cannot invalidate a sample on the basis of repeat sample results unless all repeat sample(s) collected at the same tap as the original total coliform-positive sample are also total coliform-positive, and all repeat samples collected within five service connections of the original tap are total coliform-negative (e.g., Board cannot invalidate a total coliform-positive sample on the basis of repeat samples if all the repeat samples are total coliform-negative, or if the public water system has only one service connection).

(3) The Board has substantial grounds to believe that a total coliform-positive result is due to a circumstance or condition which does not reflect water quality in the distribution system. In this case, the system must still collect all repeat samples required under Divisions (A) through (D) of Section 2401-51-14, and use them to determine compliance with the MCL for total coliforms in Section 2401-51-12. To invalidate a total coliform-positive sample under this Paragraph, the decision with the rationale for the decision must be documented in writing, and approved and signed by the supervisor of the Board official who recommended the decision. The Board must make this document available to the public. The written documentation must state the specific cause of the total coliform-positive sample, and what action the system has taken, or will take, to correct this problem. The Board may not invalidate a total coliform-positive sample solely on the grounds that all repeat samples are total coliform-negative.

(C) A laboratory must invalidate a total coliform sample (unless total coliforms are detected) if the sample produces a turbid culture in the absence of gas production using an analytical method where gas formation is examined (e.g., the Multiple-Tube Fermentation Technique), produces a turbid culture in the absence of an acid reaction in the Presence-Absence (P-A) Coliform Test, or exhibits confluent growth or produces colonies too numerous to count with an analytical method using a membrane filter (e.g., Membrane Filter Technique). If a laboratory invalidates a sample because of such interference, the system must collect another sample from the same location as the original sample within 24 hours of being notified of the interference problem, and have it analyzed for the presence of total coliforms. The system must continue to re-sample within 24 hours and have the samples analyzed until it obtains a valid result. The Board may waive the 24-hour time limit on a case-by-case basis.

(Effective May 26, 1996)

2401-51-16 Sanitary Surveys

(A) Public water systems which do not collect five or more routine samples/month must undergo an initial sanitary survey by June 29, 1994 for community public water systems and June 29, 1999 for non-community water systems. Thereafter, systems must undergo another sanitary survey every five years,

except that non-community water systems using only protected and disinfected ground water, as defined by the Board, must undergo subsequent sanitary surveys at least every ten years after the initial sanitary survey. The Board must review the results of each sanitary survey to determine whether the existing monitoring frequency is adequate and what additional measures, if any, the system needs to undertake to improve drinking water quality.

(B) In conducting a sanitary survey of a system using ground water in any area which is the subject of an Environmental Quality Protection Board wellhead protection program, information on sources of contamination within the delineated wellhead protection area that was collected in the course of developing and implementing the program should be considered instead of collecting new information, if the information was collected since the last time the system was subject to a sanitary survey.

(C) Sanitary surveys must be performed by the Board or an agent approved by the Board. The system is responsible for ensuring the survey takes place.

(Effective May 26, 1996)

2401-51-17 Fecal Coliforms /Escherichia coli (E.coli) Testing

(A) If any routine or repeat sample is total coliform-positive, the system must analyze that total coliform-positive culture medium to determine if fecal coliforms are present, except that the system may test for E. coli in lieu of fecal coliforms. If fecal coliforms or E. coli are present, the system must notify the Board by the end of the day when the system is notified of the test result unless the system is notified after the Board office is closed, in which case the system must notify the Board before the end of the next business day.

(B) The Board has the discretion to allow a public water system, on a case-by-case basis, to forgo fecal coliform or E. coli testing on a total coliform-positive sample if that system assumes that the total coliform-positive sample is fecal coliform-positive or E. coli-positive. Accordingly, the system must notify the Board as specified in Division (A) of this Section and the provisions of Division (B) of Section 2401-51-12 apply.

(Effective May 26, 1996)

2401-51-18 Analytical Methodology

(A) The standard sample volume required for total coliform analysis, regardless of analytical method used, is 100 ml.

(B) Public water systems need only determine the presence or absence of total coliforms; a determination of total coliform density is not required.

(C) Public water systems must conduct total coliform analyses in accordance with one of the following analytical methods:

(1) Multiple-Tube Fermentation (MTF) Technique, as set forth in "Standard Methods for the Examination of Water and Wastewater," 1985, American Public Health Association et al., 16th edition. Method 908, 908A, and 908B-pp. 870-878, except that 10 fermentation tubes must be used; or "Microbiological Methods for Monitoring the Environment, Water and Wastes", U.S. EPA, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio 45268 (EPA-600/8-78-017, December 1978, available from ORD Publications, CERL, U.S. EPA, Cincinnati, Ohio 45268), Part III, Section B.4.1-4.6.4, pp. 114-118 (Most Probably Number Method), except that 10 fermentation tubes must be used; or

(2) Membrane Filter (MF) Technique, as set forth in "Standard Methods for Examination of Water and Wastewater," 1985, American Public Health Association et al., 16th edition, Method 909, 909A and 909B-pp. 886-896; or "Microbiological Methods of Monitoring the Environment, Water and Wastes," U.S. EPA, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio 45268 (EPA-600/8-78-017, December 1978, available from ORD Publications, CERL, U.S. EPA, Cincinnati, Ohio 45268), Part III, Section B.2.1-2.6, pp. 108-112; or

(3) Presence-Absence (P-A) Coliform Test, as set forth in "Standard Methods for the Examination of Water and Wastewater," 1985, American Public Health Association et al., 16th edition, Method 908E-pp. 882-886; or

(4) Minimal Medium ONPG-MUG (MMO-MUG) Test, as set forth in the article "National Field Evaluation of a Defined Substrate Method for the Simultaneous Detection of Total Coliforms and Escherichia coli from Drinking Water: Comparison with Presence-Absence Techniques" (Edberg et al.), Applied and Environmental Microbiology, Volume 55, pp. 1003-1008, April 1989. (Note: The MMO-MUG Test is sometimes referred to as the Autoanalysis Colilert System.)

(D) In lieu of the 10-tube MTF Technique specified in Paragraph (C)(1) of this Section, a public water system may use the MTF Technique using either five tubes (20-ml sample portions) or a single culture bottle containing the culture medium for the MTF Technique, i.e., lauryl tryptose broth (formulated as described in "Standard Methods for the Examination of Water and Wastewater," 1985, American Public Health Association et al., 16th Edition, Method 908A-pp. 872), as long as a 100-ml water sample is used in the analysis.

(E) Public water systems must conduct fecal coliform analysis in accordance with the following procedure. When the MTF Technique or Presence-Absence (P-A) Coliform Test is used to test for total coliforms, shake the lactose-positive presumptive tube or P-A bottle vigorously and transfer the growth with a sterile 3-mm loop or sterile applicator stick into brilliant green lactose bile broth and EC medium to determine the presence of total and fecal coliforms, respectively. For EPA-approved analytical methods which use a membrane filter, remove the membrane containing

the total coliform colonies from the substrate with a sterile forceps and carefully curl and insert the membrane into a tube of EC medium. (The laboratory may first remove a small portion of selected colonies for verification.) Gently shake the inoculated EC tubes to insure adequate mixing and incubate in a water-bath at 44.5 +/- 0.2 degrees Centigrade for 24 +/- 2 hours. Gas production of any amount in the inner fermentation tube of the EC medium indicates a positive fecal coliform test. The preparation of EC medium is described in "Standard Methods for the Examination of Water and Wastewater," American Public Health Association, 16th Edition, Method 908C-pp. 879, paragraph 1a. Public water systems need only determine the presence or absence of fecal coliforms; a determination of fecal coliform density is not required.

(F) Copies of the analytical methods cited in "Standard Methods for the Examination of Water and Wastewater" may be obtained from the American Public Health Association et al.; 1015 Fifteenth Street, NW; Washington, DC 20005. Copies of the methods set forth in "Microbiological Methods for Monitoring the Environment, Water and Wastes" may be obtained from ORD Publications, U.S. EPA, 26 W. Martin Luther King Drive, Cincinnati, Ohio 45268. Copies of the MMO-MUG Test as set forth in the article "National Field Evaluation of a Defined Substrate Method for the Simultaneous Enumeration of Total Coliforms and Escherichia coli from Drinking Water: Comparison with the Standard Multiple Tube Fermentation Method" (Edberg et al.) may be obtained from the American Water Works Association Research Foundation, 6666 West Quincy Avenue, Denver, CO 80235. Copies may be inspected at the Board's office.

(Effective May 26, 1996)

2401-51-19 Response to Violation

(A) A public water system which has exceeded the MCL for total coliforms in Section 2401-51-12 must report the violation to the Board no later than the end of the next business day after it learns of the violation, and notify the public in accordance with Sections 2401-51-42 through 2401-51-51.

(B) A public water system which has failed to comply with a coliform monitoring requirement, including the sanitary survey requirement, must report the monitoring violation to the Board within ten days after the system discovers the violation, and notify the public in accordance with Sections 2401-51-42 through 2401-51-51.

(Effective May 26, 1996)

2401-51-20 Maximum Contaminant Levels for Turbidity

(A) The maximum contaminant levels for turbidity are applicable to both community and non-community water systems using surface water sources in whole

or in part. The requirements in this Section apply to unfiltered systems that the Board has determined in writing pursuant Sections 2401-51-75 through 2401-51-84 must install filtration, until June 29, 1993, or until filtration is installed, whichever is later.

(B) The maximum contaminant levels for turbidity in drinking water, measured at a representative entry point(s) to the distribution system, are:

(1) Not more than one (1) Turbidity Units (TU) as determined by a monthly average pursuant to sampling and analytical requirements prescribed in Section 2401-51-21, except that five (5) or fewer turbidity units may be allowed if the supplier of water can demonstrate to the Board that the higher turbidity does not do any of the following:

- (a) interfere with disinfection;
 - (b) prevent maintenance of an effective disinfectant agent throughout the distribution system; or
 - (c) interfere with microbiological determinations;
- (2) Five (5) TU based on an average of two consecutive days pursuant to Section 2401-51-21.

(Effective May 26, 1996)

2401-51-21 Turbidity Sampling and Analytical Requirements

(A) Turbidity testing is required of all community and non-community water systems using surface water sources in whole or in part. The requirements in this Section apply to unfiltered systems that the Board has determined in writing pursuant to Sections 2401-51-75 through 2401-51-84, must install filtration, until June 29, 1993, or until filtration is installed, whichever is later.

(B) Samples shall be at least once a day at representative entry point(s) to the distribution system for determining compliance with Section 2401-51-20. If the Board determines that a reduced sampling frequency in a non-community system will not pose a risk to public health, it can reduce the required sampling frequency. Reduced turbidity frequency shall be permitted only in those public water systems that practice disinfection and which maintain an active residual disinfectant in the distribution system, and in those cases where the Board has indicated in writing that no unreasonable risk to health existed under the circumstances.

(C) The turbidity measurement shall be made by the Nephelometric Method in accordance with the recommendations set forth in the "Standard Methods for the Examination of Water and Wastewater," published by the American Public Health Association, or the EPA approved edition, or "Methods of Chemical Analysis of Water and Wastes," EPA Environmental Monitoring and Support Laboratory, March, 1979, Method 180.1- Nephelometric Method. Calibration of the turbidimeter shall be made either by the use of a formazin standard as specified in the cited references or a styrene divinyl-benzene polymer standard

(Amco-AEPA-1 Polymer) commercially available from Amco Standards international.

(D) If the result of a turbidity analysis indicates that the maximum allowable limit has been exceeded, the sampling and measurement shall be confirmed by resampling as soon as practicable and preferably within one (1) hour. If the repeat sample confirms that the maximum allowable limit has been exceeded, the supplier of water shall report to the Board within forty-eight (48) hours. The repeat sample shall be the sample used for the purpose of calculating the monthly average. If the monthly average of the daily samples exceeds the maximum allowable limit, or if the average of two samples taken on consecutive days exceeds five (5) TU, the supplier of water shall report to the Board and notify the public as directed in Sections 2401-51-41 through 2401-51-51.

(E) Sampling for non-community water systems shall begin immediately upon December 18, 1992.

(Effective May 26, 1996)

2401-51-22 Maximum Contaminant Levels for Inorganic Chemicals

(A) The maximum contaminant level for nitrate is applicable to both community and non-community water systems. The levels for the other inorganic chemicals apply only to community water systems.

(B) The following are the maximum contaminant levels for inorganic chemicals other than fluoride:

Contaminant	MCL (mg/l)
Arsenic	0.050
Barium	1.000
Cadmium	0.010
Chromium	0.050
Fluoride	4.000
*Lead	*0.050
Mercury	0.002
Nitrate (as N)	10.000
Selenium	0.010
Silver	0.050

*Additional Regulations apply. See Sections 2401-51-35, 2401-51-36, and 2401-51-48.

(Effective May 26, 1996)

2401-51-23 Inorganic Chemical Sampling and Analytical Requirements

(A) Sampling and analyses for inorganic chemicals shall be done in compliance with Sections 2401-51-22 and 2401-51-23.

(B) Initial sampling and analyses shall be completed by December 18, 1992. The sampling frequency shall be as follows:

(1) Community water supplies shall perform sampling and analyses for inorganic chemicals once every year

for surface water systems and once every three years for ground water systems.

(2) For non-community water systems, whether supplied by surface or ground water sources, analyses for nitrate shall be completed upon the December 18, 1992 effective date of these regulations. These analyses shall be repeated once every three years or as otherwise determined by the Board.

(C) If the result of an analysis made pursuant to this Section indicates that the level of any contaminant listed in Section 2401-51-22 exceeds the maximum contaminant level, the supplier of water shall report to the Board within seven (7) days and initiate three additional analyses at the same sampling point within one (1) month.

(D) When the average of four (4) analyses made pursuant to this Section, rounded to the same significant figures as the maximum contaminant level for the substance in question, exceeds the maximum contaminant level, the supplier of water shall report to the Board pursuant to Section 2401-51-41 and perform public notification pursuant to Sections 2401-51-42 through 2401-51-51. Monitoring following public notification shall be at a frequency designated by the Board and shall continue until the maximum contaminant level has not been exceeded in two successive samples or until a monitoring schedule as a condition of a variance, exemption or enforcement action shall become effective.

(E) The provisions of Divisions (C) and (D) of this Section notwithstanding, compliance with the maximum contaminant level for nitrate shall be determined on the basis of the mean of two analyses. When a level exceeding the maximum contaminant level for nitrate is found, a second analysis shall be initiated within twenty-four (24) hours, and, if the mean of the two analyses exceeds the maximum contaminant level, the supplier of water shall report his findings to the Board pursuant to Section 2401-51-41 and notify the public as directed by Sections 2401-51-42 through 2401-51-51.

(F) For the initial analyses required by Divisions (A) and (B) of this Section, data for surface waters acquired within one year prior to December 18, 1992 and data for ground waters acquired within three (3) years prior to December 18, 1992 may be substituted at the discretion of the Board.

(G) Analyses conducted to determine compliance with the maximum contaminant levels prescribed in Section 2401-51-22 shall be made in accordance with the methods prescribed by 40 CFR 141.23(f).

(H) In addition to complying with Divisions (A) through (G) of this Section, systems monitoring for fluoride must comply with the requirements of the following Paragraphs:

(1) Where the system draws water from one source, the system shall take one sample at the entry point to the distribution system.

(2) Where the system draws water from more than one source, the system must sample each source at the entry points to the distribution system.

(3) If the system draws water from more than one source and sources are combined before distribution, the system must sample at the entry point to the distribution system during periods representative of the maximum fluoride levels occurring under normal operating conditions.

(4) The Board may alter the frequencies for fluoride monitoring as set out in this Section to increase or decrease such frequency considering the following factors: reported concentrations from previously required monitoring; the degree of variation in reported concentrations; and other factors which may affect fluoride concentrations such as changes in pumping rates in ground water supplies or significant changes in the system's configuration, operating procedures, source of water, and changes in stream flows.

(5) Monitoring may be decreased from the frequencies specified in this Section upon application in writing by the water system if the Board determines that the system is unlikely to exceed the MCL, considering the factors listed in Paragraph (H)(4) of this Section. Such determination shall be made in writing and set forth the basis for the determination. In no case shall monitoring be reduced to less than one (1) sample every 10 years. For systems monitoring once every 10 years, the Board shall review the monitoring results every 10 years to determine whether more frequent monitoring is necessary.

(6) Analysis for fluoride under this Section shall only be used for determining compliance if conducted by laboratories that have analyzed Performance Evaluation samples to within 10% (plus or minus) of the reference value at fluoride concentrations from 1.0 mg/l to 10.0 mg/l, within the last 12 months.

(7) Compliance with the MCL shall be determined based on each sampling point. If any sampling point is determined to be out of compliance, the system is deemed to be out of compliance.

(Effective May 26, 1996)

2401-51-24 Maximum Contaminant Levels for Organic Chemicals Other Than TTHMs and VOCs

The following are the maximum contaminant levels for organic chemicals other than TTHM and VOC. The maximum contaminant levels for these organic chemicals apply to all community water systems. Compliance with these maximum contaminant levels is calculated as directed in Section 2401-51-25.

Contaminant MCL	(mg/l)
(A) Chlorinated hydrocarbons:	
Endrin (1,2,3,4,10, 10-hexachloro-6, 7-epoxy-1,4, 4a,5,6,7,8,81-octahydro-1,4-endo,endo-5,8-dimethanonaphthalene)	0.0002
Lindane (1,2,3,4,5,6-hexachlorocyclohexane, gamma isomer)	0.004
Methoxychlor (1,1,1-Trichloro-2, 2-bis [p-	0.1

methoxyphenyl] ethane)	
Toxaphene (C10H10Cl8-Technical chlorinated camphene, 67-69 percent chlorine)	0.005
(B) Chlorophenoxy:	
2,4-D (2,4-Dichlorophenoxyacetic acid)	0.1
2,4,5-TP Silvex (2,4,5-Trichlorophenoxy-propionic acid)	0.01

(Effective May 26, 1996)

2401-51-25 Sampling and Analytical Requirements for Organic Chemical Other Than TTHMs and VOCs

An analysis of substances for the purpose of determining compliance with Section 2401-51-24 shall be made as follows:

(A) For all community water systems utilizing surface water sources, analyses shall be completed by December 18, 1992. Samples analyzed shall be collected during the period of the year designated by the Board as the period when contamination by pesticides is most likely to occur. These analyses shall be repeated at intervals specified by the Board but in no event less frequent than at three-year intervals.

(B) For community water systems utilizing only ground water sources, analyses shall be completed by those systems specified by the Board.

(C) If the result of an analysis made pursuant to Divisions (A) and (B) of this Section indicates that the level of any contaminant listed in Section 2401-51-24 exceeds the maximum contaminant level, the supplier of water shall report to the Board within seven (7) days and initiate three (3) additional analyses within one month.

(D) When the average of four (4) analyses made pursuant to Division (C) of this Section, rounded to the same significant figures as the maximum contaminant level for the substance in question, exceeds the maximum contaminant level, the supplier of water shall report to the Board as directed in Section 2401-51-41 and give notice to the public as directed in Sections 2401-51-42 through 2401-51-51. Monitoring after public notification shall be at a frequency designated by the Board and shall continue until the maximum contaminant level has not been exceeded in two successive samples or until a monitoring schedule as a condition to a variance, exemption or enforcement action shall become effective.

(E) For the initial analysis required by Divisions (A) and (B) of this Section, data for surface water systems acquired within one year prior December 18, 1992 and data for ground water systems acquired within three years prior to December 18, 1992 may be substituted at the discretion of the Board.

(F) Analysis made to determine compliance with Section 2401-51-24 shall be made in accordance with methods prescribed in 40 CFR 141.24(e) and (f).

(Effective May 26, 1996)

2401-51-26 Maximum Contaminant Level for Total Trihalomethanes

The maximum contaminant level for total trihalomethanes listed in this Section applies only to community water systems which serve a population of 10,000 or more individuals and which add a disinfectant (oxidant) to the water in any part of the drinking water treatment process. For the purposes of these regulations, the concentration of total trihalomethanes is defined as the sum of the concentrations of bromodichloromethane, dibromochloromethane, tribromomethane (bromoform) and trichloromethane (chloroform). Compliance with the maximum contaminant level is calculated as directed in Section 2401-51-27(G).

<u>Contaminant</u>	<u>MCL (mg/l)</u>
Total	Trihalomethanes 0.10

(Effective May 26, 1996)

2401-51-27 Total Trihalomethane Sampling and Analytical Requirements

(A) Initial sampling to determine compliance with Section 2401-51-26 shall begin immediately upon December 18, 1992. The minimum number of samples required to be collected by the system shall be based upon the number of treatment plants used by the system, except that multiple wells drawing from a single aquifer may, with the approval of the Board, be considered one treatment plant for determining the minimum number of samples. All samples taken within an established frequency shall be collected within a 24-hour period.

(B) For all community water systems using surface water sources in whole or in part, and for all community water systems using only ground water sources that have not been determined by the Board to qualify for the monitoring requirements of Division (A) of this Section, analyses for total trihalomethanes shall be performed at quarterly intervals on at least four water samples for each treatment plant used by the system. At least 25% of the samples shall be taken at locations within the distribution system reflecting the maximum residence time of the water in the system. The remaining 75% shall be taken at representative locations in the distribution system taking into account number of persons served, different sources of water and different treatment methods employed. The results of all analyses per quarter shall be arithmetically averaged and reported to the Board within 30 days of the system's receipt of such results. All samples collected shall be used in the computation of the average, unless the analytical results are invalidated for technical reasons. Sampling

and analyses shall be conducted in accordance with the methods listed in Division (H) of this Section.

(C) Upon the written request of a community water system, the monitoring frequency required by Division (B) of this Section may be reduced by the Board to a minimum of one sample analyzed for TTHMs per quarter taken at a point in the distribution system reflecting the maximum residence time of the water in the system. The determination of reduced monitoring frequency must be made in writing by the Board and be based upon data from at least one (1) year of monitoring in accordance with Division (B) of this Section, which indicates compliance with the TTHM maximum contaminant level of 0.10 mg/l pursuant to Section 2401-51-26; and be based upon an assessment of local conditions specific to the system which demonstrate that total trihalomethane concentrations will be consistently below the maximum contaminant level.

(D) If at any time during which the reduced monitoring frequency prescribed by Divisions (C) and (D) of this Section applies, the results from any analysis exceed 0.10 mg/l of TTHMs and such results are confirmed by at least one check sample taken promptly after such results are received, the system shall immediately begin monitoring in accordance with Division (B) of this Section and such monitoring shall continue for at least one (1) year before the frequency may be reduced again. In the event that the system makes any significant change to its source of water or treatment program, the system shall immediately begin monitoring in accordance with Division (B) of this Section and such monitoring shall continue for at least one (1) year before the frequency may be reduced again. At the discretion of the Board, a system's monitoring frequency may and should be increased above the minimum in those cases where it is necessary to detect variations in the TTHM levels within the distribution system.

(E) Upon the written request to the Board, a community water system using only ground water sources may seek to have the monitoring frequency required by Division (B) of this Section reduced to a minimum of one sample for maximum TTHM potential per year for each treatment plant used by the system and taken at a point in the distribution system reflecting the maximum residence time of the water in the system. The system shall submit to the Board the results of at least one sample analyzed for maximum TTHM potential for each treatment plant used by the system and taken at a point in the distribution system reflecting the maximum residence time of the water in the system. The system's monitoring frequency may only be reduced upon a written determination by the Board that, based upon the data submitted by the system, the system has a maximum TTHM potential of less than 0.10 mg/l and that, based upon an assessment of local conditions specific to the system, the system is not likely to approach or exceed the maximum contaminant level for TTHMs. The results of all analyses shall be reported to the Board within 30 days of the system's receipt of such results. All

samples collected shall be used for determining whether the system must comply with the monitoring requirements of Divisions (B), (C), and (D) of this Section, unless the analytical results are invalidated for technical reasons. Sampling and analyses shall be conducted in accordance with the methods listed in Division (H) of this Section.

(F) If at any time during which the reduced monitoring frequency prescribed by Division (E) of this Section applies, the results from any analysis taken by the system for maximum TTHM potential are equal to or greater than 0.10 mg/l, and such results are confirmed by at least one check sample taken promptly after such results are received, the system shall immediately begin monitoring in accordance with Division (B) of this Section and such monitoring shall continue for at least one (1) year before the frequency may be reduced again. In the event that the system makes any significant change to its raw water source or treatment program, the system shall immediately analyze an additional sample for maximum TTHM potential taken at a point in the distribution system reflecting maximum residence time of the water in the system for the purpose of determining whether the system must comply with the monitoring requirements of Division (B) of this Section. At the discretion of the Board, the monitoring frequency may and should be increased above the minimum in those cases where it is necessary to detect variations in the TTHM levels within the distribution system.

(G) Compliance with Section 2401-51-26 shall be determined based upon a running annual average of quarterly samples collected by the system as prescribed in Divisions (B) or (C) of this Section. If the average of samples covering any 12 month period exceeds the maximum contaminant level, the supplier of water shall report to the Board as directed by Section 2401-51-41 and notify the public as directed by Sections 2401-51-42 through 2401-51-51.

(H) Sampling and analyses made pursuant to Sections 2401-51-26 and 2401-51-27 shall be conducted by one of the following EPA-approved methods:

(1) "The Analysis of Trihalomethanes in Drinking Water by the Purge and Trap Method," Method 501.1, EMSL, EPA Cincinnati, Ohio.

(2) "The Analysis of Trihalomethanes in Drinking Water by Liquid/Liquid Extraction," Method 501.2, EMSL, EPA Cincinnati, Ohio. Samples for TTHMs shall be dechlorinated upon collection to prevent further production of trihalomethanes, according to the procedures described in the above two methods. Samples for maximum TTHM potential should not be dechlorinated and should be held for seven days at 25 degrees Centigrade (or above) prior to analysis, according to the procedures described in the above two methods.

(I) Before a community water system makes any significant modifications to its existing treatment process for the purposes of achieving compliance with Section 2401-51-26, such system must submit and obtain Board approval of a detailed plan setting

forth its proposed modification and those safeguards that it will implement to ensure that the bacteriological quality of the drinking water served by such system will not be adversely affected by such modification. Each system must comply with the provisions set forth in the plan approved by the Board. At a minimum, an approved plan shall require the system modifying its disinfection practice to:

- (1) Evaluate the water system for sanitary defects and evaluate the source water for biological quality;
- (2) Evaluate its existing treatment practices and consider improvements that will minimize disinfectant demand and optimize finish water quality throughout the distribution system;
- (3) Provide baseline water quality survey data of the distribution system. Such data should include the results from monitoring for coliform and fecal coliform bacteria, fecal streptococci, standard plate count at 35 degrees Centigrade and 20 degrees Centigrade, phosphate, ammonia nitrogen and total organic carbon. Virus studies should be required where source waters are heavily contaminated with sewage effluent.
- (4) Conduct additional monitoring to assure continued maintenance of optimal biological quality in finished water, for example, when chloramines are introduced as disinfectants or when pre-chlorination is being discontinued. Additional monitoring should also be required by the Board for chlorate, chlorite and chlorine dioxide when chlorine dioxide is used. Standard plate count analyses should be also be required by the Board as appropriate before and after any modifications.
- (5) Consider inclusion in the plan of provisions to maintain an active disinfectant residual throughout the distribution system at all times during and after the modification.

(Effective May 26, 1996)

**2401-51-28 Maximum Contaminant
Levels for Volatile
Organic Chemicals**

(A) The following maximum contaminant levels for volatile organic chemicals apply to community water systems and non-transient non-community water systems. Compliance with the maximum contaminant levels for volatile organic chemicals is calculated pursuant to Section 2401-51-29.

Contaminant	MCL (mg/l)
Benzene	0.005
Carbon Tetrachloride	0.005
1,2-Dichloroethane	0.005
Trichloroethylene	0.005
Para-Dichlorobenzene	0.075
1,1-Dichloroethylene	0.007
1,1,1-Trichloroethane	0.20
Vinyl Chloride	0.002

(B) The Board identifies the following as the best technology, treatment techniques, or other means available for achieving compliance with the maximum contaminant levels for volatile organic chemicals listed in Division (A) above: central treatment using packed tower aeration; central treatment using granular activated carbon for all these chemicals except vinyl chloride.

(Effective May 26, 1996)

**2401-51-29 Volatile Organic
Chemicals Sampling
and Analytical
Requirements**

Initial sampling to determine compliance with Section 2401-51-28 shall begin immediately upon December 18, 1992 and analyses shall be completed by December 18, 1993 for both community and non-transient non-community water systems. Analyses for the purposes of determining compliance with Section 2401-51-28 shall be conducted as follows:

- (A) Ground water systems shall sample at points of entry to the distribution system representative of each ell but after any application of treatment. Sampling must be conducted at the same location(s) every three months for one (1) year except as provided for in Paragraph (H)(1) of this Section.
- (B) Surface water systems shall sample at points in the distribution system representative of each source or at entry points to the distribution system after any application of treatment. Surface water systems must sample each source every three months except as provided for in Paragraph (H)(2) of this Section. Sampling must be conducted at the same location or a more representative location each quarter.
- (C) If the system draws water from more than one source and sources are combined before distribution, the system must sample at an entry point to the distribution system during periods of normal operating conditions.
- (D) All community water systems and non-transient water systems serving more than 10,000 people shall analyze all distribution and/or entry-point samples, as appropriate, representing all source waters beginning no later than January 1, 1988. All community water systems and non-transient water systems serving from 3,300 to 10,000 people shall analyze all distribution and/or entry-point samples, as required in this Section, representing all source waters beginning no later than January 1, 1989. All other community water systems and non-transient water systems shall analyze all distribution and/or entry-point samples, as required in this Section, representing all source waters beginning no later than January 1, 1991.
- (E) The Board may require confirmation samples for positive or negative results. If a confirmation sample(s) is required by the Board or EPA, then the sample result(s) should be averaged with the first sample result and used for compliance determination in accordance with Division (I) of this Section. The

Board has the discretion to delete results of obvious sampling errors from this calculation.

(F) The analysis for vinyl chloride is required only for ground water systems that have detected one or more of the following two-carbon organic compounds: Trichloro- ethylene, tetrachloroethylene, 1,2-dichloroethane, 1,1,1- trichloroethane, cis-1,2-dichloroethylene, trans-1,2- dichloroethylene, or 1,1-dichloroethylene. The analysis for vinyl chloride is required at each distribution or entry point at which one or more of the two-carbon organic compounds were found. If the first analysis does not detect vinyl chloride, the Board may reduce the frequency of the vinyl chloride monitoring to once every three (3) years for that sample location or other sample locations which are more representative of the same source. Surface water systems may be required to analyze for vinyl chloride at the discretion of the Board.

(G) A State or individual public water system may choose to composite up to five samples from one or more public water systems. Compositing of samples is to be done in the laboratory by the procedures listed below. Samples must be analyzed within fourteen (14) days of collection. If any organic contaminant listed in Section 2401-51-28 is detected in the original composite sample, a sample from each source that made up the composite sample must be reanalyzed individually within fourteen (14) days of sampling. The sample for reanalysis cannot be the original sample but can be a duplicate sample. If duplicates of the original samples are not available, new samples must be taken from each source used in the original composite and analyzed for VOCs. Reanalysis must be accomplished within fourteen (14) days of the second sample. To composite samples, the following procedure must be followed:

(1) Compositing samples prior to GC analysis.

(a) add 5 ml or equal larger amounts of each sample (up to 5 samples are allowed) to a 25 ml glass syringe. Special precautions must be made to maintain zero headspace in the syringe.

(b) the samples must be cooled at 4 degrees Centigrade during this step to minimize volatilization losses.

(c) mix well and draw out a 5-ml aliquot for analysis.

(d) follow sample introduction, purging, and desorption steps described in the method.

(e) if less than five samples are used for compositing, a proportionately smaller syringe may be used.

(2) Compositing samples prior to GC/MS.

(a) inject 5-ml or equal larger amounts of each aqueous sample (up to 5 samples are allowed) into a 25-ml purging device using the sample introduction technique described in the method.

(b) the total volume of the sample in the purging device must be 25 ml.

(c) purge and desorb as described in the method.

(H) The Board may reduce the monitoring frequency specified in Divisions (A) and (B) of this Section, as explained herein:

(1) The monitoring frequency for ground- water systems is as follows:

(a) when VOCs are not detected in the first sample (or any subsequent samples that may be taken) and the system is not vulnerable as defined in Paragraph (H)(4) of this Section, monitoring may be reduced to one (1) sample and must be repeated every five (5) years.

(b) when VOCs are not detected in the first sample (or any subsequent sample that may be taken) and the system is vulnerable as defined in Paragraph (H)(4) of this Section: monitoring (i.e., one sample) must be repeated every three (3) years for systems >500 connections or every five (5) years for systems less than or equal to 500 connections.

(c) if VOCs are detected in the first sample (or any subsequent sample that may be taken), regardless of vulnerability, monitoring must be repeated every three (3) months, as required under Division (A) of this Section.

(2) The repeat monitoring frequency for surface water systems is as follows:

(a) when VOCs are not detected in the first year of quarterly sampling (or any other subsequent sample that may be taken) and the system is not vulnerable as defined in Paragraph (H)(4), monitoring is only required at the discretion of the Board.

(b) when VOCs are not detected in the first year of quarterly sampling (or any other subsequent sample that may be taken) and the system is vulnerable as defined in Paragraph (H)(4): monitoring must be repeated every three (3) years for systems >500 connections or every five (5) years for systems less than or equal to 500 connections.

(c) when VOCs are detected in the first year of quarterly sampling (or any other subsequent sample that may be taken), regardless of vulnerability, monitoring must be repeated every three (3) months, as required under Division (B) of this Section.

(3) The Board may reduce the frequency of monitoring to once per year for a ground water system or surface water system detecting VOCs at levels consistently less than the MCL for three consecutive years.

(4) Vulnerability of each public water system shall be determined by the Board based upon an assessment of the following factors:

(a) previous monitoring results;

(b) number of persons served by the public water system;

(c) proximity of a smaller system to a larger system;

(d) proximity to commercial or industrial use, disposal, or storage of Volatile Synthetic Organic Chemicals;

(e) protection of the water source.

(5) A system is deemed to be vulnerable for a period of three years after any positive measurement of one or more contaminants listed in Section 2401-51-30, Unregulated Contaminants, or Section 2401-51-28, except for trihalomethanes or other demonstrated disinfection by-products.

(I) Compliance with Section 2401-51-28 shall be determined based on the results of running annual average of quarterly sampling for each sample location. If one location's average is greater than the

MCL, then the system shall be deemed to be out of compliance immediately. If a public water system has a distribution system separable from other parts of the distribution system with no interconnections, only that part of the system that exceeds any MCL as specified in Section 2401-51-28 will be deemed out of compliance. The Board may reduce the public notice requirement to that portion of the system which is out of compliance. If any one sample result would cause the annual average to be exceeded, then the system shall be deemed to be out of compliance immediately. For systems that only take one sample per location because no VOCs were detected, compliance shall be based on that one sample.

(J) Analysis under this Section shall be conducted using the EPA methods prescribed in 40 CFR 141.24(g)(10) or their equivalent as approved by EPA. These methods are contained in "Methods for the Determination of Organic Compounds in Finished Water," September 1986, available from Environmental and Support Laboratory (EMSL), EPA, Cincinnati, OH 45268.

(K) Analysis under Division (J) of this Section shall only be conducted by laboratories that have received conditional approval by the Board or EPA according to the following conditions:

(1) To receive conditional approval to conduct analyses for benzene, vinyl chloride, carbon tetrachloride, 1,2-dichloroethane, trichloroethylene, 1,1-dichloroethylene, 1,1,1-trichloroethane, and paradichlorobenzene the laboratory must:

(a) analyze Performance Evaluation samples which include these substances provided by the EPA Environmental Monitoring and Support Laboratory or equivalent samples provided by the Board.

(b) achieve quantitative acceptance limits under Paragraphs (K)(1)(c) and (K)(1)(d) of this Section for at least six of the seven subject organic chemicals.

(c) achieve quantitative results on the analyses performed under (K)(1)(a) of this Section that are within ± 20 percent of the actual amount of the substances in the Performance Evaluation sample when the actual amount is greater than or equal to 0.010 mg/l.

(d) achieve quantitative results on the analyses performed under (K)(1)(a) of this Section that are within ± 40 percent of the actual amount of the substances in the Performance Evaluation sample when the actual amount is less than 0.010 mg/l.

(e) achieve a method detection limit of 0.0005 mg/l, according to the procedures in 40 CFR Part 136, Appendix B.

(f) be currently approved by EPA or Board for the analyses of trihalomethanes under Sections 2401-51-26 and 2401-51-27.

(2) To receive conditional approval for vinyl chloride the laboratory must:

(a) analyze Performance Evaluation samples provided by the EPA Environmental Monitoring and Support Laboratory or equivalent samples provided by the Board.

(b) achieve quantitative results on the analyses performed under (K)(1)(a) of this Section that are within ± 40 percent of the actual amount of vinyl chloride in the Performance Evaluation sample.

(c) achieve a method detection limit of 0.0005 mg/l, according to the procedures in 40 CFR Part 136, Appendix B.

(d) receive approval or be currently approved by the Board or EPA under Paragraph (K)(1) of this Section.

(L) The Board has the authority to allow the use of monitoring data collected after January 1, 1983, for purposes of monitoring compliance. If the data is consistent with the other requirements in this Paragraph, the Board may use that data to represent the initial monitoring if the system is determined by the Board not to be vulnerable under the requirements of this Section.

(M) The Board may increase required monitoring where necessary to detect variations within the system.

(N) Each approved laboratory must determine the method detection limit (MDL), as defined in Appendix B of 40 CFR Part 136, at which it is capable of detecting VOCs. The acceptable MDL is 0.0005 mg/l. This concentration is the detection level for purposes of Divisions (E), (F), (G), and (H) of this Section.

(Effective May 26, 1996)

2401-51-30

Special Sampling Requirements for Unregulated Organic Chemicals

(A) List of Unregulated Organic Contaminants. All community and non-transient non-community water systems shall monitor for the 36 unregulated organic chemicals listed below except as provided for in 2401-51-31(E).

- (1) Chloroform;
- (2) Bromodichloromethane;
- (3) Chlorodibromomethane;
- (4) Bromoform;
- (5) trans-1,2-Dichloroethylene;
- (6) Chlorobenzene;
- (7) m-Dichlorobenzene;
- (8) Dichloromethane;
- (9) cis-1,2-Dichloroethylene;
- (10) o-Dichlorobenzene;
- (11) Dibromomethane;
- (12) 1,2-Dichloropropene;
- (13) Tetrachloroethylene;
- (14) Toluene;
- (15) p-Xylene;
- (16) o-Xylene;
- (17) m-Xylene;
- (18) 1,1-Dichloroethane;
- (19) 1,2-Dichloropropane;
- (20) 1,1,2,2-Tetrachloroethane;
- (21) Ethylbenzene;
- (22) 1,3-Dichloropropane;
- (23) Styrene;

- (24) Chloromethane;
- (25) Bromomethane;
- (26) 1,2,3-Trichloropropane;
- (27) 1,1,1,2-Tetrachloroethane;
- (28) Chloroethane;
- (29) 1,1,2-Trichloroethane;
- (30) 2,2-Dichloropropane;
- (31) o-Chlorotoluene;
- (32) p-Chlorotoluene;
- (33) Bromobenzene;
- (34) 1,2-Dichloropropene;
- (35) Ethylene dibromide (EDB);
- (36) 1,2-Dibromo-3-chloropropane (DBCP)

(B) Additional Unregulated Organic Contaminants. Monitoring for the 15 unregulated organic contaminants listed below may be required at the discretion of the Board.

- (1) 1,2,4-Trimethylbenzene;
- (2) 1,2,4-Trichlorobenzene;
- (3) 1,2,3-Trichlorobenzene;
- (4) n-Propylbenzene;
- (5) n-Butylbenzene;
- (6) Napthalene;
- (7) Hexachlorobutadiene;
- (8) 1,3,5-Trimethylbenzene;
- (9) p-Isopropyltoluene;
- (10) Isopropylbenzene;
- (11) Tert-Butylbenzene;
- (12) Sec-butylbenzene;
- (13) Fluorotrichloromethane;
- (14) Dichlorodifluoromethane;
- (15) Bromochloromethane.

(Effective May 26, 1996)

2401-51-31 Unregulated Organic Chemical Sampling and Analytical Requirements

(A) All community and non-transient non-community water systems shall monitor for the contaminants prescribed in Section 2401-51-30 by the dates specified below:

- (1) Systems serving over 10,000 persons shall begin monitoring no later than January 1, 1988.
- (2) Systems serving from 3,300 to 10,000 persons shall begin monitoring no later than January 1, 1989.
- (3) Systems serving less than 3,300 persons shall begin monitoring no later than January 1, 1991.

(B) Surface water systems shall sample at points in the distribution system representative of each water source or at entry points to the distribution system after any application of treatment. The minimum number of samples is one year of quarterly samples.

(C) Ground water systems shall sample at points of entry to the distribution system representative of each well after any application of treatment. The minimum number of samples is one sample per entry point to the distribution system.

(D) The Board may require confirmatory samples for positive or negative results.

(E) Community water systems and non-transient non-community water systems must monitor for EDB and DBCP only if the Board determines that they are vulnerable to contamination by either or both of these substances. For the purpose of this Paragraph, a vulnerable system is defined as a system which is potentially contaminated by EDB and DBCP, including surface water systems where these two compounds are applied, manufactured, stored, disposed of, or shipped upstream, and for ground water systems in areas where the compounds are applied, manufactured, stored, disposed of, or shipped in the ground water recharge basin, or for ground water systems that are in proximity to underground storage tanks that contain leaded gasoline.

(F) Public water systems may use monitoring data collected any time after January 1, 1983, to meet the

TABLE A		
AVERAGE ANNUAL CONCENTRATIONS ASSUMED TO PRODUCE A TOTAL BODY OR ORGAN DOSE OF 4 MILLIREM/YEAR		
Radionuclide	Critical Organ	pCi Per Liter
Tritium	Total Body	20,000
Strontium-90	Bone Marrow	8

requirements for unregulated monitoring, provided that the monitoring program was consistent with the requirements of Sections 2401-51-28 through 2401-51-31.

(G) All community and non-transient non-community water systems shall repeat the monitoring required in this Section no less frequently than every five (5) years from the dates specified in Division (A) of this Section.

(H) States or public water systems may composite up to five samples when for substances in Section 2401-51-30.

(I) Analyses under Sections 2401-51-28 through 2401-51-31 shall be conducted using the recommended methods as prescribed in 40 CFR 141.40(g).

(J) Analyses under Sections 2401-51-28 through 2401-51-31 shall only be conducted by laboratories approved under 2401-51-29(K). In addition to the requirements of 2401-51-29(K), each laboratory analyzing for EDB and DBCP must achieve a method detection limit for EDB and DBCP of 0.00002 mg/l, according to the procedures in Appendix B of 40 CFR Part 136.

(Effective May 26, 1996)

2401-51-32 Maximum Contaminant Levels for Radionuclides

The following are the maximum contaminant levels for radionuclides which apply to community water systems:

- (A) Combined Radium-226 and Radium-228: 5 pCi/l.
- (B) Gross Alpha Particle Activity (including radium-226 but excluding radon and uranium): 15 pCi/l.

(C) Beta Particle and Photon Activity from Man-Made Radionuclides:

(1) The average annual concentration of beta particle and photon radioactivity from man-made radionuclides in drinking water shall not produce an annual dose equivalent to the total body or any internal organ greater than four (4) millirem/year.

(2) Except for the radionuclides listed in Table A, the concentration of man-made radionuclides causing 4 millirems total body or organ dose equivalent shall be calculated on the basis of a 2 liter per day drinking water intake using the 168 hour data listed in "Maximum Permissible Body Burdens and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure," National Bureau of Standards Handbook 69. If two or more radionuclides are present, the sum of their annual dose equivalent to the total body or to any organ shall not exceed 4 millirem/year.

(Effective May 26, 1996)

**2401-51-33 Radionuclides Sampling
and Analytical
Requirements**

(A) Monitoring requirements for gross alpha particle activity, radium 226 and radium-228.

(1) Initial sampling to determine compliance with Section 2401-51-32 shall begin immediately upon the December 18, 1992 effective date of these regulations and the analysis shall be completed within one year of that date. Compliance shall be based on the analysis of an annual composite of four consecutive quarterly samples or the average of the analyses of four samples obtained at quarterly intervals.

(b) when the gross alpha particle activity exceeds 5 pCi/l, the same or an equivalent sample shall be analyzed for radium-228.

(2) For the initial analysis required by Paragraph (A)(1) of this Section, data acquired within one year prior to December 18, 1992 may be substituted at the discretion of the Board.

(a) more frequent monitoring shall be conducted when ordered by the Board in the vicinity of mining or other operations which may contribute alpha particle radioactivity to either surface or ground water sources of drinking water.

(b) a supplier of water shall monitor in conformance with Paragraph (A)(1) of this Section within one year of the introduction of a new water source for a community water system. More frequent monitoring shall be conducted when ordered by the Board in the event of possible contamination or when changes in the distribution system or treatment processing occur which may increase the concentration of radioactivity in finished water.

(c) a community water system using two or more sources having different concentrations of radioactivity shall monitor source water, in addition to

water from a free-flowing tap, when ordered by the Board.

(d) monitoring for compliance with Section 2401-51-32 after the initial period need not include radium-228, except when required by the Board, provided that the average annual concentration of radium-228 has been assayed at least once using the quarterly sampling procedure required by Paragraph (A)(1) of this Section.

(e) suppliers of water shall conduct annual monitoring of any community water system in which the radium-226 concentration exceeds 3 pCi/l, when ordered by the Board.

(4) If the average annual maximum contaminant level for gross alpha particle activity or total radium as set forth in Section 2401-51-32 is exceeded, the supplier of a community water system shall give notice to the Board pursuant to Section 2401-51-41 and notify the public as required by Sections 2401-51-42 through 2401-51-51. Monitoring at quarterly intervals shall be continued until the annual average concentration no longer exceeds the maximum contaminant level or until a monitoring schedule as a condition to a variance, exemption or enforcement action shall become effective.

(B) Monitoring Requirements for Manmade Radioactivity in Community Water Systems.

(1) By December 18, 1992, systems using surface water sources and serving more than 100,000 persons and such other community water systems as are designated by the Board shall be monitored for compliance with Section 2401-51-32 by analysis of a composite of four consecutive quarterly samples or analysis of four quarterly samples. Compliance with Section 2401-51-32 may be assumed if the average annual concentration of gross beta particle activity is less than 50 pCi/l and if the average annual concentrations of tritium and strontium-90 are less than those listed in Table A, provided that if both radionuclides are present the sum of their annual dose equivalents to bone marrow shall not exceed 4 millirem/year.

(a) if the gross beta particle activity exceeds 50 pCi/l, an analysis of the sample must be performed to identify the major radioactive constituents present and the appropriate organ and total body doses shall be calculated to determine compliance with Section 2401-51-32.

(b) suppliers of water shall conduct additional monitoring, as ordered by the Board, to determine the concentration of man-made radioactivity in principal watersheds designated by the Board.

(c) at the discretion of the Board, suppliers of water utilizing only ground waters may be required to monitor for man-made radioactivity.

(2) For the initial analysis required by Paragraph (B)(2) of this Section, data acquired within one year prior to December 18, 1992, may be substituted at the discretion of the Board.

(3) After the initial analysis required by Paragraph (B)(2) of this Section suppliers of water shall monitor

at least every four years following the procedure given in Paragraph (B)(2) of this Section.

(4) The supplier of any community water system designated by the Board as utilizing waters contaminated by effluent from nuclear facilities shall immediately initiate quarterly monitoring for gross beta particle and iodine-131 radioactivity and annual monitoring for strontium-90 and tritium.

(a) quarterly monitoring for gross beta particle activity shall be based on the analysis of monthly samples or the analysis of a composite of three monthly samples. The former is recommended. If the gross beta particle activity in a sample exceeds 15 pCi/l, the same or an equivalent sample shall be analyzed for strontium-89 and cesium-134. If the gross beta particle activity exceeds 50 pCi/l, an analysis of the sample must be performed to identify the major radioactive constituents present and the appropriate organ and total body doses shall be calculated to determine compliance with Section 2401-51-32.

(b) for iodine-131, a composite of five consecutive daily samples shall be analyzed once each quarter. As ordered by the Board, more frequent monitoring shall be conducted when iodine-131 is identified in the finished water.

(c) annual monitoring for strontium-90 and tritium shall be conducted by means of the analysis of a composite of four consecutive quarterly samples or analysis of four quarterly samples. The latter procedure is recommended.

(d) the Board may allow the substitution of environmental surveillance data taken in conjunction with a nuclear facility for direct monitoring of man-made radioactivity by the supplier of water where the Board determines such data is applicable to a particular community water system.

(5) If the average annual maximum contaminant level for man-made radioactivity set forth in Section 2401-51-32 is exceeded, the operator of a community water system shall give notice to the Board pursuant to Section 2401-51-41 and to the public as required by Sections 2401-51-42 through 2401-51-51. Monitoring at monthly intervals shall be continued until the concentration no longer exceeds the maximum contaminant level or until a monitoring schedule as a condition to a variance, exemption or enforcement action shall become effective.

(6) Analyses made to determine compliance with Section 2401-51-32 shall be made in accordance with procedures prescribed by 40 CFR 141.25.

2401-51-34 Special Monitoring for Sodium

(A) Suppliers of water for community water systems shall collect and analyze one (1) sample per treatment plant at the entry point of the distribution system for the determination of sodium concentration levels. Samples must be collected and analyzed annually for systems using surface water sources in whole or in part, and at least every three years for systems using solely ground water sources. The

minimum number of samples required to be taken by the system shall be based on the number of treatment plants used by the system, except that multiple wells drawing raw water from a single aquifer may, with the approval of the Board, be considered one treatment plant for determining the minimum number of samples. The supplier of water may be required by the Board to collect and analyze water samples for sodium more frequently in locations where the sodium content is variable.

(B) The supplier of water shall report to the Board the results of the analyses for sodium within the first 10 days of the month following the month in which the sample results were received or within the first 10 days following the end of the required monitoring period as stipulated by the Board, whichever of these is first. If more than annual sampling is required the supplier shall report the average sodium concentration within 10 days of the month following the month in which the analytical results of the last sample used for the annual average were received.

(C) The Board shall notify appropriate local public health officials of the sodium levels by written notice by direct mail within three months.

(D) Analyses for sodium shall be performed by the flame photometric method in accordance with the procedures described in "Standard Methods for the Examination of Water and Wastewater," 14th Edition, pp. 250-253; or by Method 273.1, Atomic Absorption-Direct Aspiration, or Method 273.2, Atomic Absorption-Graphite Furnace, in "Methods for Chemical Analysis of Water and Waste," EMSL, Cincinnati, EPA, 1979; or by Method D1428-64(a) in Annual Book of ASTM Standards, Part 31, Water.

(Effective May 26, 1996)

2401-51-35 Special Monitoring for Corrosivity Characteristics

(A) Suppliers of water for community water systems shall collect samples from a representative entry point to the water distribution system for the purposes of analysis to determine the corrosivity characteristics of the water.

(1) The supplier shall collect two (2) samples per treatment plant for analysis for each plant using surface water sources wholly or in part or more if required by the Department: one during mid-winter and one during mid-summer. The supplier of the water shall collect one (1) sample per plant for analysis for each plant using ground water sources or more if required by the Board. The minimum number of samples required to be taken by the system shall be based on the number of treatment plants used by the system, except that multiple wells drawing raw water from a single aquifer may, with the approval of the Board, be considered one treatment plant for determining the minimum number of samples.

(2) Determination of the corrosivity characteristics of the water shall include measurement of pH, calcium

hardness, alkalinity, temperature, total dissolved solids (total filterable residue), and calculation of the Langlier Index in accordance with Division (C) of this Section. The determination of corrosivity characteristics shall only include one (1) round of sampling (two samples per plant for surface water and one sample per plant for ground water sources). The Board may require more frequent monitoring as appropriate. The Board may also require monitoring for additional parameters which indicate corrosivity characteristics, such as chlorides and sulfates. In certain cases, the Aggressive Index, as described in Division (C) of this Section, may be approved by the Board for use instead of the Langlier Index; the supplier shall request in writing to the Board.

(B) The supplier of water shall report to the Board the results of the analyses for the corrosivity characteristics within the first 10 days of the month following the month in which the sample results were received. If more frequent sampling is required by the Board, the supplier can accumulate the data and can report each value within 10 days of the month following the month in which the analytical results of the last sample were received.

(C) Analyses conducted to determine the corrosivity of the water shall be made in accordance with the methods and procedures described in 40 CFR 141.42(c).

(D) Community water supply systems shall identify whether the following construction materials are present in their distribution system and report to the Board:

- (1) Lead from piping, solder, caulking, interior lining of distribution mains, alloys and home plumbing.
- (2) Copper from piping and alloys, service lines, and home plumbing.
- (3) Galvanized piping, service lines, and home plumbing.
- (4) Ferrous piping materials such as cast iron and steel.
- (5) Asbestos cement pipe.

(Effective May 26, 1996)

**2401-51-36 Prohibition on Use of
Lead Pipes,
Solder and Flux**

(A) It is prohibited to use, after June 19, 1986, any pipe, solder, or flux that is not lead-free, as that term is defined in Section 2401-51-03, in the installation or repair of:

- (1) Any public water system, or
- (2) Any plumbing in a residential or nonresidential facility providing water for human consumption which is connected to a public water system. This prohibition shall not apply to leaded joints necessary for the repair of cast iron pipes.

(B) Each public water system shall identify and provide notice to persons that may be affected by lead contamination of their drinking water where such

contamination results from either or both of the following:

- (1) The lead content in the construction materials of the public water distribution system,
 - (2) Corrosivity of the water supply sufficient to cause leaching of lead. Notice shall be provided notwithstanding the absence of a violation of any national drinking water standard. The manner and form of notice are specified in Section 2401-51-48.
- (C) The requirements of this Section shall become effective June 19, 1988, and shall be enforced through plumbing codes, or such other means of enforcement as the Board may determine to be appropriate.

(Effective May 26, 1996)

**2401-51-37 Use of Point of Entry
Treatment Devices**

(A) Public water systems may use point-of-entry devices to comply with maximum contaminant levels only if they meet the requirements of this Section.

(B) It is the responsibility of the public water system to operate and maintain the point-of-entry treatment system.

(C) The public water system must develop and obtain the approval of the Board for a monitoring plan before point-of-entry devices are installed for compliance. Under the approved plan, point-of-entry devices must provide health protection equivalent to central water treatment. "Equivalent" means that the water would meet all national primary drinking water regulations and would be of acceptable quality similar to water distributed by a well-operated central treatment plant. In addition to the VOCs, monitoring must include physical measurements and observations such as total flow treated and mechanical condition of the treatment equipment.

(D) Effective technology must be properly applied under a plan approved by the Board and the microbiological safety of the water must be maintained.

(E) The Board must require adequate certification of performance, field testing, and, if not included in the certification process, a rigorous engineering design review of the point-of-entry devices.

(F) The design and application of the point-of-entry devices must consider the tendency for increases in heterotrophic bacteria concentrations in water treated with activated carbon. It may be necessary to use frequent backwashing, post-contact disinfection, and Heterotrophic Plate Count monitoring to ensure that the microbiological safety of the water is not compromised.

(G) All consumers shall be protected. Every building connected to the system must have a point-of-entry device installed, maintained and adequately monitored. The Board must be assured that every building is subject to treatment and monitoring, and that the rights and responsibilities of the public water

system customer convey with title upon sale of property.

(Effective May 26, 1996)

2401-51-38 Use of Other Non-Centralized Treatment Devices

Public water systems shall not use bottled water or point-of-use devices to achieve compliance with an MCL. Bottled water or point-of-use devices may be used on a temporary basis to avoid an unreasonable risk to health.

(Effective May 26, 1996)

OPERATORS CERTIFICATION AND REPORTING

2401-51-40 Operators Certification

Two years after the establishment of a training and certification program, each public water supply system shall be under the technical supervision of a certified operator, certification to be granted by the Board or by another agency recognized by the Board.

(Effective May 26, 1996)

2401-51-41 Reporting Requirements

(A) Except where a shorter period is specified in this part, the supplier of water must report to the Board the results of any test, measurement or analysis required by this part within:

- (1) The first ten (10) days following the month in which the result is received, or
- (2) The first ten (10) days following the end of the required monitoring period as stipulated by the Board, whichever of these is the shortest.

(B) Except where a different reporting period is specified in this part, the supplier of water must report to the Board within forty-eight (48) hours the failure to comply with any MCL drinking water standard (including failure to comply with monitoring requirements) set forth in this part.

(C) The water supply system, within ten (10) days of completion of each public notification required pursuant to Sections 2401-51-42 through 2401-51-51, shall submit to the Board a representative copy of each type of notice distributed, published, posted, and/or made available to the persons served by the system and/or to the media.

(D) The water supply system shall submit to the Board within the time stated in the request copies of any records required to be maintained under Section 2401-51-52 hereof or copies of any documents then in existence which the Board is entitled to inspect pursuant to its statutory and regulatory authorities.

(E) The water supply system required to comply with the disinfection and filtration requirements of Sections 2401-51-75 through 2401-51-82, must also comply

with reporting requirements as specified in Sections 2401-51-83 and 2401-51-84.

(F) The National Primary Drinking Water Regulations, as set forth in the July 1, 1993 edition of 40 CFR Section 141.90 are hereby adopted by reference.

(G) In the event of any conflict between the National Primary Drinking Water Regulations adopted by reference in the preceding Division and existing Republic of Palau Environmental Quality Protection Board Water Supply System Regulations, the more stringent standard or requirement shall be applied.

(Effective May 26, 1996)

PUBLIC NOTIFICATION AND RECORD KEEPING

2401-51-42 Public Notice For Maximum Contaminant Level, Treatment Technique, and Variance and Exemption Schedule Violations

(A) For any maximum contaminant level or treatment violation technique that does not pose an acute risk to human health, except as provided for in Division (D) of this Section, notice shall be:

(1) By publication in a daily newspaper of general circulation in the areas served by the system as soon as possible, but in no case later than fourteen (14) days after the violation or failure. If the area served by a public water system is not served by a daily newspaper of general circulation, notice shall instead be given by publication in a weekly newspaper of general circulation serving the area. If the area served by a public water system is not served by a weekly newspaper of general circulation, notice shall instead be given by a public service announcement on the principal radio station serving the area to be broadcast a minimum of four times a day for five (5) consecutive days; and

(2) By mail delivery (by direct mail, or with the water bill), or by hand delivery not later than forty-five (45) days after the violation or failure. The Board may waive mail or hand delivery if it determines that the owner or operator of the public water system in violation has corrected the violation within the forty-five (45) day period. The Board must make the waiver in writing and within the forty-five (45) day period.

(B) For any maximum contaminant level or treatment technique violation that may pose an acute risk to human health, except as provided for in Division (D) of this Section, notice shall be made by furnishing a copy of the notice to the principal radio and television stations serving the area served by the public water system as soon as possible but in no case later than seventy-two (72) hours after the violation. The following violations are acute violations:

- (1) Any violations specified by the Board as posing an acute risk to human health.
- (2) Violation of the MCL for nitrate as defined in Section 2401-51-22.

(3) Violation of the MCL for total coliforms, when fecal coliforms or E. Coli are present in the water distribution system as specified in Section 2401-51-12(B).

(4) Occurrence of a waterborne disease outbreak, as defined in Section 2401-51-03, in an unfiltered system subject to the requirements of Sections 2401-51-75 through 2401-51-84.

(C) Except as provided in Divisions (D) and (E) of this Section, following the initial notice given under Division (A) of this Section, the owner or operator of the public water system shall furnish notice, at least once every three (3) months by mail delivery (by direct mail or with the water bill) or by hand delivery for as long as the violation or failure exists.

(D) In lieu of the requirements of Divisions (A) and (B) of this Section, the owner or operator of a community water system in the area that is not served by a daily or weekly newspaper of general circulation or a television or radio station, must give notice by hand delivery or by continuous posting in conspicuous places within the area served by the system. Notice by hand delivery or posting must begin as soon as possible, but no later than seventy-two (72) hours after the violation or failure for acute violations, or fourteen (14) days after the violation or failure for any other violation. Posting must continue for as long as the violation or failure exists. Notice by hand delivery must be repeated at least every three (3) months for as long as the violation or failure exists.

(E) In lieu of the requirements of Divisions (A) and (B) of this Section, the owner or operator of a non-community water system may give notice by hand delivery or by continuous posting in conspicuous places within the area served by the system. Notice by hand delivery or posting must begin as soon as possible, but no later than seventy-two (72) hours after the violation or failure for acute violations, or fourteen (14) days after the violation or failure for any other violation. Posting must continue for as long as the violation or failure exists. Notice by hand delivery must be repeated at least every three (3) months for as long as the violation or failure exists.

(F) The owner or operator may give notice to only a portion of the population served if it can clearly demonstrate that only a segment of the water system is affected by the problem which results in the need for public notice.

(Effective May 26, 1996)

**2401-51-43 Public Notice for Other
Violations, Variances,
Exemption**

The owner or operator of a public water system shall notify persons served by the system whenever the system fails to comply with any of the monitoring and analytical requirements pursuant to Sections 2401-51-11 through 2401-51-39 of these Regulations; or is granted a variance, exemption or exclusion; or is subject to a compliance agreement, or enforcement

action, relating to an applicable maximum contaminant level; or fails to comply with the requirements of any schedule prescribed in any such document. Such notice shall be given as follows:

(A) Except as provided in Divisions (C) and (D) of this Section, the owner or operator of a public water system must give notice within three (3) months after the sampling violation or the granting of a variance, exemption, exclusion; or the imposition of a compliance agreement or enforcement action; or violating the requirements thereof, by publication in a daily newspaper of general circulation in the area served by the system. If the area served by the public water system is not served by a daily newspaper of general circulation, notice shall instead be given by publication in a weekly newspaper of general circulation serving the area. If the area served by the public water system is not served by a newspaper of weekly publication, notice shall instead be given by a public service announcement on the principal radio station serving the area a minimum of four times a day for five consecutive days.

(B) Except as provided by Divisions (C) and (D) of this Section, following the initial notice given under Division (A) of this Section, the owner or operator of a public water system shall furnish notice at least once every three (3) months by direct mail, or by hand delivery, for as long as the condition for which the initial notice was given exists. Repeat notice of the existence of a variance or exemption must be given every three (3) months for as long as the variance or exemption remains in effect.

(D) In lieu of the requirements of Divisions (A) and (B) of this Section the owner or operator of a non-community water system may give notice, within three (3) months of the violation or the granting of the variance or exemption, by hand delivery or by continuous posting in conspicuous places within the area served by the system. Posting must continue for as long as the violation exists, or a variance or exemption remains in effect. Notice by hand delivery must be repeated every three (3) months for as long as the violation exists or a variance or exemption remains in effect. Repeat notice of the existence of a variance or exemption must be given every three (3) months for as long as the variance or exemption remains in effect.

(Effective May 26, 1996)

**2401-51-44 Public Notice To New
Billing Units**

The owner or operator of a community water system must give a copy of the most recent public notice for any outstanding violation of any maximum contaminant level, or treatment technique requirement, or any variance or exemption schedule to all new billing units or hookups prior to or at the time service begins.

(Effective May 26, 1996)

**2401-51-45 Content of the
Public Notice**

- (A) Each notice shall be bi-lingual, written and/or spoken in both Palauan and English.
- (B) Each notice shall provide a clear and readily understandable explanation of the violation, any potential adverse health effects, the population at risk, the steps that the public water supply system is taking to correct such violation, the necessity for using alternative water supplies, if any, and any preventative measures the consumer should take to minimize exposure until the violation is corrected.
- (C) Each notice shall be conspicuous and shall not contain any unduly technical language, unduly small print, or other problems that frustrate the purpose of such notice.
- (D) Each notice shall include the telephone number of the owner or operator, or designee of the public water system as a source of additional information concerning the notice.

(Effective May 26, 1996)

**2401-51-46 Mandatory Health
Effects Information**

When providing the information on potential adverse health effects required by Section 2401-51-45 in notices of violations of maximum contaminant levels or treatment technique requirements, or notices of the granting of the continued existence of exemptions or variances, or notices of failure to comply with a variance or exemption schedule, the owner or operator of a public water supply system shall include the language specified by the EPA for each of the contaminants listed in Sections 2401-51-11 through 2401-51-39. The Board hereby adopts and incorporates by reference EPA's mandatory health effects language, 40 CFR 141.32(e)(1-14).

(Effective May 26, 1996)

**2401-51-47 Specific Public Notice
Requirements for
Fluoride**

- (A) The supplier of water for community and non-transient, non-community water systems that exceed 2.0.mg/l for fluoride as determined by the last single sample taken in accordance with the requirements of Sections 2401-51-22 and 2401-51-23 of these Regulations but do not exceed the MCL for fluoride as specified by Sections 2401-51-22 and 2401-51-23 of these Regulations, shall give public notice to all billing units annually and all new billing units at the time service begins.
- (B) The public notice for fluoride shall contain language adopted by the Board. The language specified by EPA in 40 CFR Section 143.5(b), is hereby adopted by the Board.

(Effective May 26, 1996)

**2401-51-48 Specific Public Notice
Requirements for Lead**

- (A) The owner or operator each community water system and each non-transient, non-community water system shall issue notice to persons served by the system that may be affected by lead contamination of their drinking water. The Board may require subsequent notices. The owner or operator shall provide notice under this Section even if there is no maximum contaminant level violation for lead.
- (B) Notice is not required to be given under Division (A) of this Section if the system demonstrates to the Board that the water system, including the residential and non-residential portions connected to the water system, are lead free. For the purposes of this Paragraph, the term "lead free" when used with respect to solders and flux refers to solders and flux containing not more than 0.2 percent lead, and when used with respect to pipes and pipe fittings refers to pipes and pipe fittings containing not more than 8.0 percent lead.
- (C) Notice shall be given to persons served by the system either by:
 - (1) Three (3) newspaper notices, one in each of three (3) consecutive months, or
 - (2) A public service announcement on the principal radio station serving the area four times a day once a month for three consecutive months, or
 - (3) Once by mail notice with the water bill or in a separate mailing, or
 - (4) Once by hand delivery.
- (D) For non-transient, non-community water systems, notice may be given by continuous posting. If posting is used, the notice shall be posted in a conspicuous place in the area served by the system and continue for three (3) months.
- (E) Content of Notice
 - (1) Each notice shall be bi-lingual, written in both Palauan and English. Each notice shall provide a clear and readily understandable explanation of the potential sources of lead in drinking water, potential adverse health effects, reasonably available methods the user may employ to minimize exposure to lead in the drinking water, any steps the water system is taking to mitigate lead content in drinking water, and the necessity for using alternative water supplies, if any.
 - (2) Each notice shall also include specific advice on how to determine if materials containing lead have been used in homes and how to minimize exposure to water likely to contain high levels of lead. Each notice shall be conspicuous and shall not contain unduly technical language, small print, or similar problems that frustrate the purpose of the notice. Each notice shall contain the telephone number of the owner, operator, or designee of the public water system as a source of additional information regarding the notice.
 - (3) Each notice shall contain language adopted by the Board. The language of 40 CFR Section 141.34(d) is adopted by the Board.

(F) Mandatory Health Effects Information. When providing the information in public notices required under this Section on the potential adverse health effects of lead in drinking water, the owner or operator of the water system shall include language adopted by the Board. The language specified in 40 CFR Section 141.34(d) is hereby adopted by the Board.

(Effective May 26, 1996)

2401-51-49 Submission of Notices

A copy of all notices must be submitted within ten (10) days to the Board as verification of notification.

(Effective May 26, 1996)

2401-51-50 Failure to Notify

The Board may give any notice to the public required under Sections 2401-51-41 through 2401-51-51, on behalf of the owner or operator of the public water system if the Board complies with the requirements of this Section. However, the owner or operator of the public water system remains legally responsible for ensuring that the requirements of this Section are met.

(Effective May 26, 1996)

2401-51-51 Additional Public Notice Requirements

(A) The National Primary Drinking Water Regulations, as set forth in the July 1, 1993 edition of 40 CFR Sections 141.32 and 141.85 are hereby adopted by reference.

(B) In the event of any conflict between the National Primary Drinking Water Regulations adopted by reference in Division (A) of this Section and existing Republic of Palau Environmental Quality Protection Board Water Supply System Regulations, the more stringent standard or requirement shall be applied.

(Effective May 26, 1996)

2401-51-52 Records Maintenance

The owner or operator of a public water supply system shall retain on its premises or at a convenient location near its premises the following records:

(A) Records of bacteriological analyses shall be kept for at least five (5) years. Records of chemical and radionuclide analyses shall be kept for at least ten (10) years. Record information shall include the following:

- (1) The date, place, and time of sampling, and the name of the person who collected the sample;
- (2) Identification of the sample as to whether it was a routine distribution system sample, check sample, raw or process water sample or other special purpose sample;
- (3) Date of analysis;

(4) Laboratory and person responsible for performing analysis;

(5) The analytical technique/method used; and

(6) The results of the analysis.

(B) Records of action taken by the system to correct violations of these regulations shall be kept for at least five (5) years after the last action taken with respect to the particular violation involved.

(C) Copies of any written reports, summaries or communications relating to sanitary surveys of the system conducted by the system itself, by a private consultant, or by any National Government or United States Federal agency, shall be kept for a period not less than ten (10) years after completion of the sanitary survey involved.

(D) Records concerning a variance or exemption granted to the system shall be kept for a period ending not less than five (5) years following the expiration of such a variance or exemption.

(F) In the event of any conflict between the National Primary Drinking Water Regulations adopted by reference in the preceding Paragraph and existing Republic of Palau Environmental Quality Protection Board Water Supply System Regulations, the more stringent standard or requirement shall be applied.

(Effective May 26, 1996)

2401-51-53 Right of Entry

In addition to any other right of entry authority provided by law, the Board and its authorized representatives may, at any time, inspect public water supply systems, take water samples, and perform tests in water quality, whether or not the Board has evidence that the system is in violation of any applicable legal requirement.

(Effective May 26, 1996)

WATER SUPPLY DURING EMERGENCIES

2401-51-54 Emergency Permits

Whenever emergencies affecting the safety or adequacy of a public water supply system requires modifications or additions thereto, the Board shall be notified. The Board may issue emergency construction permits with/or containing special conditions as deemed necessary for the proper safeguarding of the health of the water consumers. Plans and specifications covering the work as constructed under the emergency permit shall be submitted to the Board as soon as reasonably possible, but in no case later than two (2) weeks after the construction work has been done. Modifications required by the Board after review of the submission shall be made promptly.

(Effective May 26, 1996)

2401-51-55 Emergency Situations

(A) Toxics Contamination. Non-potability by reason of the presence of toxic or other contaminating substances in the supply which cannot be removed by existing treatment methods and which, if ingested, might be injurious to the health of consumer. Presence of such substances might be identified by such parameters as odor, taste, color, chemical tests, the presence of extensive fish kills in the water source, or by other evidence. In case of such an emergency the supplier of water shall:

(1) Deliver disinfected water from other suitable sources to such public consumers as hospitals and similar institutions. The water so delivered shall be disinfected to the satisfaction of the Board.

(2) Take appropriate steps under the supervision of the Board to properly identify the nature and source of the contaminant.

(3) Advise individual consumers to find other emergency sources of water until notified by the Board that the public water supply system is potable.

(4) Advise individual consumers to disinfect their emergency water supply by either boiling at a rolling boil for one (1) minute or more, or adding one (1) teaspoon of 5% (five percent) sodium hypochlorite solution (bleach, such as Clorox) to five (5) gallons of clear odorless water, stir and letting it stand thirty (30) minutes before using, or as may be prescribed by the Board. In this event, the Board shall supervise the supplier's operations, and document circumstances surrounding the contamination, including its cause and identification of any person(s) implicated in such contamination.

(B) Mechanical Failure and/or Natural Disaster. Non-potability by reason of the inactivation of the system due to major mechanical failure, typhoon, earthquake or similar disaster: In this case, the supplier will notify the Board and the water consumers by the quickest available means of communication. The supplier will also:

(1) Deliver disinfected water from suitable sources to such public consumers as hospitals and similar institutions. The water so delivered shall be disinfected to the satisfaction of the Board.

(2) Advise consumers as to where potable water from the plant or system may be obtained if such is obtainable.

(C) Rationing of Water. If potable water is not available from the system, the supplier will advise the consumers by the fastest available means where other water sources may be found in the immediate vicinity. The supplier shall advise individual consumers to disinfect their emergency water supply by either boiling at a rolling boil for one (1) minute or more, or adding one (1) teaspoon of 5% (five percent) sodium hypochlorite solution (bleach, such as Clorox) or 5% (five percent) calcium hypochlorite to five (5) gallons of clear odorless water, stir and let it stand thirty (30) minutes before using, or as may be prescribed by the Board. The supplier shall keep on hand sufficient disinfectant (sodium or calcium hypochlorite) for use by consumers who may not have access to such disinfectants during the emergency.

(D) The Board shall supervise the operations of the supplier.

(Effective May 26, 1996)

VARIANCES

2401-51-56 Variances Authorized

The Board may grant variances from the requirements of the water supply systems regulations under the conditions and in a manner which are not less stringent than those which may be granted under Sections 1415 and 1416 of the federal Act, except that variances from the MCL for total coliforms and variances from any of the treatment technique requirements may not be granted.

(Effective May 26, 1996)

2401-51-57 Requirements for a Variance

(A) The Board may grant one or more variance to any public water system within the Republic of Palau from any requirement respecting a maximum contaminant level prescribed in these regulations upon a finding that:

(1) Because of characteristics of the raw water sources which are reasonably available to the system, the system cannot meet the requirements respecting the maximum contaminant levels of such drinking water regulations despite application of the best technology, treatment techniques, or other methods which the Board finds are generally available (taking cost into consideration); and,

(2) The granting of a variance will not result in an unreasonable risk to the health of persons served by the system.

(B) The Board may grant one or more variances to any public water supply system within the Republic of Palau from any requirement of a specified treatment technique of an applicable drinking water regulation upon a finding that the public water system applying for the variance has demonstrated that such treatment technique is not necessary to protect the health of persons because of the nature of the raw water source of such system.

(Effective May 26, 1996)

2401-51-58 Variance Request

A supplier of water may request the granting of a variance by submitting such a request in writing to the Board. Suppliers of water may submit a joint request for variances when they seek similar variances under similar circumstances. A variance request shall include:

(B) Relevant analytical results of water quality sampling of the system, including results of relevant tests conducted pursuant to the requirements of these regulations; and

(C) For any request made under Division (A) of Section 2401-51-57:

(1) Explanation in full and evidence of the best available treatment technology and techniques.

(2) Economic and legal factors relevant to ability to comply.

(3) Analytical results of raw water quality relevant to the variance request.

(4) A proposed compliance schedule, including the date each step toward compliance will be achieved. Such schedule shall include as a minimum the following dates:

(a) Date by which arrangement for alternative raw water source or improvement of existing raw water source will be completed;

(b) Date of initiation of the connection of the alternative raw water source or improvement of existing raw water source; and

(c) Date by which final compliance is to be achieved.

(5) A plan for the provision of safe drinking water in the case of an excessive rise in the contaminant level for which the variance is requested.

(6) A plan for interim control measures during the effective period of variance.

(E) Other information, if any, believed to be pertinent by the applicant.

(F) Such other information as the Board may require.

(Effective May 26, 1996)

2401-51-59 Consideration of Variance Request

(A) The Board shall act on any variance request submitted pursuant to Section 2401-51-58 within ninety (90) days of receipt of the request.

(B) In its consideration of whether the public water system is unable to comply with a contaminant level required by these regulations because of the nature of the raw water source, the Board shall consider such factors as the following:

(1) The availability and effectiveness of treatment methods for the contaminant which the variance is requested.

(2) Cost and other economic considerations such as implementing treatment to improve the quality of the source water or using an alternate source.

(C) In its consideration of whether a public water system should be granted a variance to a required treatment technique because such treatment is unnecessary to protect the public health, the Board shall consider such factors as the following:

(1) Quality of the water source including water quality data and pertinent sources of pollution.

(2) Source protection measures employed by the public water system.

(Effective May 26, 1996)

2401-51-60 Disposition of a Variance Request

(A) If the Board decides to deny the application for a variance, it shall notify the applicant of its intention to issue a denial. Such notice shall include a statement of reasons for the proposed denial, and shall offer the applicant an opportunity to present, within thirty (30) days of receipt of the notice, additional information or argument to the Board. The Board shall make a final determination on the request within thirty (30) days after receiving any additional information or argument. If no additional information or argument is submitted by the applicant, the application shall be denied.

(B) If the Board proposes to grant a variance request submitted pursuant to Section 2401-51-58, it shall notify the applicant of its decision in writing. Such notice shall identify the variance, the facility covered, and shall specify the period of time for which the variance will be effective.

(1) For the type of variance specified in 2401-51-57(A), such notice shall provide that the variance will be terminated when the system comes into compliance with the applicable regulation, and may be terminated upon finding by the Board that the system has failed to comply with any requirements of a final schedule pursuant to the terms and conditions of the variance.

(2) For the type of variance specified in 2401-51-57(B), such notice shall provide that the variance may be terminated at any time upon finding that the nature of the raw water is such that the specified treatment technique for which the variance was granted is necessary to protect the health of persons or upon a finding that the public water system has failed to comply with monitoring and other requirements prescribed by the Board as a condition of the granting of the variance.

(C) For a variance specified in 2401-51-57(A)(1), the Board shall propose a schedule for:

(1) Compliance (including increments of progress) by the public water system with each contaminant level requirement covered by the variance; and,

(2) Implementation by the public water system of such control measures as the Board may require for each contaminant covered by the variance.

(D) The proposed schedule for compliance shall specify dates by which steps towards compliance are to be taken, including at the minimum, where applicable:

(1) Date by which arrangement for an alternative raw water source or improvements of existing raw water source will be completed;

(2) Date of initiation of the connection for the alternative raw water source or improvement of the existing raw water source; and,

(3) Date by which final compliance is to be achieved.

(E) The proposed schedule may, if the public water system has no access to an alternative raw water source and can effect or anticipate no adequate improvement of the existing raw water source, specify an indefinite time period for compliance until a new and effective treatment technology is developed at which time a new compliance schedule shall be prescribed by the Board.

(F) The proposed schedule for implementation control measures during the period of variance shall specify interim treatment techniques, methods and equipment, and dates by which steps towards meeting the interim control measures are to be met.

(G) The schedule shall be prescribed by the Board at the time the variance is granted, subsequent to provision of opportunity for hearing pursuant to Section 2401-51-61.

2401-51-61 Public Hearing on Variance

(A) Before a variance or a schedule pursuant to Section 2401-51-60 may take effect, the Board shall provide notice and opportunity for public hearing on the variance or schedule. A notice given pursuant to the preceding sentence may cover more than one (1) such variance or schedule and a hearing held pursuant to such notice shall include each of the variances covered by the notice.

(B) Public notice of a proposed variance or schedule and opportunity for public hearing on such shall be circulated in a manner designed to inform interested and potentially interested persons of the proposed variance. The public notice shall be posted at the principal post office which serves the area of the public water supply system and shall be announced over the radio or television station serving the area of the public water supply system. All public notices shall be bi-lingual in both Palauan and English. Requests for hearing may be submitted by any interested person. Frivolous and/or insubstantial requests for hearing may be denied by the Executive Officer of the Board. Requests must be submitted to the Board within twenty (20) days after issuance of the public notice mentioned above. Hearing requests shall include the following information:

(1) The name, address and telephone number of the individual, organization or other entity requesting hearing;

(2) A brief statement of the interest of the person making the request in the proposed variance or schedule and information that the requesting person intends to submit at such hearing; and,

(3) The signature of the individual making the request, or, if the request is made on behalf of an organization or other entity, the signature of a responsible official of the organization or other entity.

(C) The Executive Officer of the Board shall give notice in the manner set forth in Division (B) of this Section of any hearing to be held pursuant to a request by an interested person or on the Board's motion. Notice of the hearing shall also be sent to the person requesting the hearing, if any. Notice of the hearing shall include a statement of the purpose, information regarding the time and location for the hearing, and the address and telephone number of an office at which interested persons may obtain further information concerning the hearing. The hearing location specified in the public notice shall be within an involved state or hamlet. Notice of the hearing

shall be given not less than fifteen (15) days prior to the time scheduled for the hearing.

(D) A hearing conducted pursuant to Division (C) of this Section shall be conducted before the Board. The Board shall have the authority to call witnesses, receive written and oral testimony, compel necessary attendance through subpoena, and take such action as may be necessary to assure the fair and efficient conduct of the hearing.

(Effective May 26, 1996)

2401-51-62 Final Action on Variance

Within thirty (30) days after termination of the public hearing process described above, the Board shall, taking into consideration information obtained during the hearing and other relevant information, grant, deny, or grant as modified a proposed variance or schedule.

(Effective May 26, 1996)

2401-51-63 Alternative Treatment Techniques

The Board may grant a variance from any treatment technique requirement of these regulations to a supplier of water, upon a showing from any person that an alternative treatment technique not included in said requirement is at least as efficient in lowering the level of the contaminant with respect to said requirement which was prescribed. A variance under this Section shall be conditioned on the effective use of the alternative treatment technique which is the basis of the variance.

(Effective May 26, 1996)

2401-51-64 Variances from the Maximum Contaminant Level for Fluoride and the Maximum Contaminant Levels for Organic Chemicals

The Board hereby adopts and incorporates by reference the identified best technology, treatment techniques, or other means available for achieving compliance with maximum contaminant levels for fluoride (40 CFR 142.61) and synthetic organic chemicals (40 CFR 142.62).

(Effective May 26, 1996)

EXEMPTIONS

2401-51-65 Exemptions Authorized

The Board may grant exemptions from the requirements of the water supply systems regulations under the conditions and in a manner which is not less stringent than those which may be granted under

Sections 1415 and 1416 of the federal Act, except that exemptions from the MCL for total coliforms and exemptions from any of the treatment technique requirements may not be granted.

(Effective May 26, 1996)

2401-51-66 Requirements for an Exemption

The Board may exempt any public water system from any requirement respecting a maximum contaminant level or any treatment technique requirement, or from both, of an applicable water supply systems regulation upon a finding that:

- (A) Due to compelling factors (which may include economic factors) the public water system is unable to comply with such contaminant level or treatment technique requirement;
- (B) The public water system was in operation on the effective date of such contamination level or treatment technique requirement; and,
- (C) The granting of the exemption will not result in an unreasonable risk to health.

(Effective May 26, 1996)

2401-51-67 Exemption Request

A supplier of water may request the granting of an exemption pursuant to this Section for a public water system by submitting a request for exemption in writing to the Board. Suppliers of water may submit a joint request for exemptions when they seek similar exemptions under similar circumstances. Any written request for an exemption shall include the following information:

- (A) The nature and duration of the exemption requested;
- (B) Relevant analytical results of water quality sampling of the system, including results of relevant tests conducted pursuant to the requirements of these regulations;
- (C) Explanation of the compelling factors such as time or economic factors which prevent such system from achieving compliance;
- (D) Other information, if any, believed by the applicant to be pertinent to the application;
- (E) A proposed compliance schedule, including the date when each step toward compliance will be achieved; or,
- (F) Such other information that the Board may require.

(Effective May 26, 1996)

2401-51-68 Consideration of an Exemption Request

(A) The Board shall act on any exemption request submitted pursuant to Section 2401-51-67 within ninety (90) days of receipt of the request.

- (B) In its consideration of whether the public water system is unable to comply due to compelling factors, the Board shall consider such factors as the following:
 - (1) Construction, installation, or modification of treatment equipment or systems;
 - (2) The time needed to put into operation a new treatment facility to replace an existing system which is not in compliance; and
 - (3) Economic feasibility of compliance.

(Effective May 26, 1996)

2401-51-69 Deposition of an Exemption Request

(A) If the Board decides to deny the application for an exemption, it shall notify the applicant of its intention to issue a denial. Such notice shall offer the applicant an opportunity to present, within thirty (30) days after receiving such notice, additional information or argument. If no additional information or argument is submitted by the applicant, the application shall be denied.

(B) If the Board grants an exemption request, it shall notify the applicant of its decision in writing. Such notice shall identify the facility covered, and shall specify the termination date of the exemption. Such notice shall provide that the exemption will be terminated when the system comes into compliance with the applicable regulation, and may be terminated upon finding by the Board that the system has failed to comply with any requirements of a final schedule issued pursuant to Section 2401-51-72.

(C) The Board shall propose a schedule for:

- (1) Compliance (including increments of progress) by the public water system with each contaminant level requirement and treatment requirement covered by the exemption.
 - (2) Implementation by the public water system of such control measures as the Board may require for each contaminant covered by the exemption.
- (D) The schedule shall be prescribed by the Board within one (1) year after the granting of the exemption, subsequent to provision of opportunity for hearing pursuant to Section 2401-51-70.

(Effective May 26, 1996)

2401-51-70 Public Hearing on Exemption

(A) Before a schedule proposed by the Board pursuant to 2401-51-69(D) may take effect, the Board shall provide notice and opportunity for public hearing on the schedule. A notice given pursuant to the preceding sentence may cover the proposal of more than one such schedule and a hearing held pursuant to such notice shall include each of the schedules covered by the notice.

(B) Public notice of a proposed exemption or schedule and opportunity for public hearing on such shall be circulated in a manner designed to inform

interested and potentially interested persons of the proposed variance. The public notice shall be posted at the principal post office which serves the area of the public water supply system and shall be announced over the radio or television station serving the area of the public water supply system. All public notices shall be bi-lingual in both Palauan and English. Requests for hearing may be submitted by any interested person. Frivolous and/or insubstantial requests for hearing may be denied by the Executive Officer of the Board. Requests must be submitted to the Board within twenty (20) days after issuance of the public notice mentioned above. Hearing requests shall include the following information:

(1) The name, address and telephone number of the individual, organization or other entity requesting hearing;

(2) A brief statement of the interest of the person making the request in the proposed exemption or schedule and information that the requesting person intends to submit at such hearing; and,

(3) The signature of the individual making the request, or, if the request is made on behalf of an organization or other entity, the signature of a responsible official of the organization or other entity.

(C) The Executive Officer of the Board shall give notice in the manner set forth in Division (B) of this Section of any hearing to be held pursuant to a request by an interested person or on the Board's motion. Notice of the hearing shall also be sent to the person requesting the hearing, if any. Notice of the hearing shall include a statement of the purpose, information regarding the time and location for the hearing, and the address and telephone number of an office at which interested persons may obtain further information concerning the hearing. The hearing location specified in the public notice shall be within an involved state or hamlet. Notice of the hearing shall be given not less than five (5) days prior to the time scheduled for the hearing.

(D) A hearing conducted pursuant to Division (C) of this Section shall be conducted before the Board. The Board shall have the authority to call witnesses, receive written and oral testimony, compel necessary attendance through subpoena, and take such action as may be necessary to assure the fair and efficient conduct of the hearing.

(Effective May 26, 1996)

2401-51-71 Final Action

Within thirty (30) days after termination of the public hearing process described above, the Board shall, taking into consideration information obtained during the hearing and other relevant information, grant, deny, or grant as modified a proposed exemption or schedule.

(Effective May 26, 1996)

2401-51-72 Exemptions from the Maximum Contaminant Level for Fluoride and the Maximum Contaminant Levels for Organic Chemicals

The Board hereby adopts and incorporates by reference the identified best technology, treatment techniques, or other means available for achieving compliance with maximum contaminant levels for fluoride (40 CFR 142.61) and synthetic organic chemicals (40 CFR 142.62).

(Effective May 26, 1996)

PROVISION OF ADEQUATE WATER SUPPLY BY PRIVATE DEVELOPERS

2401-51-73 Provision of Adequate Water Supply Required

The provision of an adequate water supply to the public shall be ensured by private developers. All private developments which must serve an average of twenty-five (25) individuals daily with water shall be required to assist the supplier of water to the public in the development of additional water supplies or with other improvements as may be necessary due to the increased demand on the public system from the development project. This assistance may be through direct financing of water improvement projects, provision of a private water supply system for the project, or by other means acceptable to the governing agency and the Board.

(Effective May 26, 1996)

2401-51-74 Failure to Provide for Adequate Water Supply

The Board shall not issue any permits for projects which will serve an average of twenty- five (25) individuals daily with water or otherwise reduce the supply or quality of water to the region in which the project is located until the adequate provision of water is ensured.

(Effective May 26, 1996)

FILTRATION AND DISINFECTION

2401-51-75 General Requirements

(A) These regulations establish criteria under which filtration is required as a treatment technique for public water systems supplied by a surface water source and public water systems supplied by a ground water source under the direct influence of surface water. In addition these regulations establish treatment techniques requirements in lieu of maximum contaminant levels for the following contaminants: Giardia lamblia, viruses, heterotrophic plate count bacteria, Legionella, and turbidity. Each

public water system with a surface water source or a ground water source under the direct influence of surface water must provide treatment of that source water that complies with these treatment techniques requirements. The treatment technique requirements consist of installing and properly operating water treatment processes which reliably achieve:

(1) At least 99.9 percent (3-log) removal and/or inactivation of *Giardia lamblia* cysts between a point where the raw water is not subject to recontamination by surface water runoff and a point downstream before or at the first customer; and

(2) At least 99.99 percent (4-log) removal and/or inactivation of viruses between a point where the raw water is not subject to recontamination by surface water runoff and a point downstream before or at the first customer.

(B) A public water system using a surface water source or a ground water under the direct influence of surface water is considered to be in compliance with the requirements of Division (A) of this Section if it meets the filtration requirements in Sections 2401-51-77 through 2401-51-81 and the disinfection requirements in Section 2401-51-76.

(C) Each public water system using a surface water source or a ground water source under the direct influence of surface water must be operated by qualified personnel who meet the requirements specified by Section 2401-51-40 and other such requirements as specified by the Board.

(D) The Board hereby adopts and incorporates by reference the "Guidance Manual for Compliance with the Surface Water Treatment Rule," March 1991 or more recent edition, which provides guidance and information to assist public water supplies in complying with applicable requirements under this Section.

(Effective May 26, 1996)

2401-51-76 Disinfection

(A) A public water system that uses a surface water source or a ground water source under the direct influence of surface water, and that provides filtration, must provide disinfection treatment as specified in this Section beginning June 29, 1993, or beginning when filtration is installed, whichever is later. Failure to meet any requirement of this Section after the applicable date(s) specified in this Division is a treatment technique violation.

(B) If filtration treatment is required by Sections 2401-51-77 through 2401-51-81 of these regulations or the Board has determined in writing that filtration treatment is required, the public water system must comply with any interim disinfection requirements the Board deems necessary before filtration is installed.

(C) Each public water system which provides filtration treatment must provide the following disinfection treatment:

(1) The disinfection treatment must be sufficient to ensure that the total treatment processes of that

system achieve at least 99.9 percent (3-log) inactivation and/or removal of *Giardia lamblia* cysts and at least 99.99 percent (4-log) inactivation and/or removal of viruses, as determined by the Board.

(2) The residual disinfectant concentration in water entering the distribution system, measured as specified in 2401-51-82(A)(5) and (B)(2), cannot be less than 0.2 mg/l for more than 4 hours.

(3) The residual disinfection concentration in the distribution system, measured as total chlorine, free chlorine, combined chlorine, or chlorine dioxide, as specified in 2401-51-82(A)(5) and (B)(3) cannot be undetectable in more than 5 percent of the samples each month, for any two consecutive months that the system serves water to the public. Water in the distribution system with a heterotrophic bacteria concentration less than or equal to 500/ml, measured as heterotrophic plate count (HPC) as specified in 2401-51-82(A)(3), is deemed to have a detectable disinfectant residual for purposes of determining compliance with this requirement. Thus, the value "V" in the following formula cannot exceed 5 percent in one month, for any two consecutive months.

$$V = \frac{c+d+e}{a+b} \times 100$$

where:

- a = number of instances where the residual disinfectant concentration is measured;
b = number of instances where the residual disinfectant concentration is not measured but heterotrophic bacteria plate count (HPC) is measured;
c = number of instances where the residual disinfectant concentration is measured but not detected and no HPC is measured;
d = number of instances where the residual disinfectant concentration is measured but not detected and where the HPC is >500/ml; and

(4) If the Board determines, based on site-specific considerations, that a system has no means for having a sample transported and analyzed for HPC by a certified laboratory under the requisite time and temperature conditions specified by Section 2401-51-82(A)(3) and that the system is providing adequate disinfection in the distribution system, the requirements of Paragraph (A)(3) of this Section do not apply to that system.

(Effective May 26, 1996)

2401-51-77 Filtration

A public water system using a surface water source or a ground water source under the direct influence of surface water must provide treatment consisting of both disinfection, as specified in Section 2401-51-76, and filtration treatment which complies with the requirements of Sections 2701-51-78 through 2401-51-81 by June 29, 1993, unless as otherwise specified in this Paragraph. A public water system that uses a ground water source under the direct influence of surface water must meet the

requirements of this Section beginning 18 months after the Board has determined that it is under the direct influence of surface water or has determined in writing that filtration is required. Failure to meet any requirement of this Section after the date specified in this introductory Paragraph is a treatment technique violation.

(Effective May 26, 1996)

2401-51-78 Conventional Filtration Treatment or Direct Filtration

(A) For systems using conventional filtration, the turbidity level of representative samples of a system's filtered water must be less than or equal to 0.5 NTU in at least 95 percent of the measurements taken each month, measured as specified in Section 2401-51-82, except that if the Board determines that the system is capable of achieving at least 99.9 percent removal and/or inactivation of *Giardia lamblia* cysts at some turbidity level higher than 0.5 NTU in at least 95 percent of the measurements taken each month, the Board may substitute this higher turbidity limit for that system. However, in no case may the Board approve a turbidity limit that allows more than 1 NTU in more than 5 percent of the samples taken each month, measured as specified in Section 2401-51-82.

(B) The turbidity level of representative samples of a system's filtered water must at no time exceed 5 NTU, measured as specified in Section 2401-51-82.

(Effective May 26, 1996)

2401-51-79 Slow Sand Filtration

(A) For systems using slow sand filtration, the turbidity level of representative samples of a system's filtered water must be less than or equal to 1 NTU in at least 95 percent of the measurements taken each month, measured as specified in Section 2401-51-82, except that if the Board determines there is no significant interference with disinfection at a higher turbidity level, the Board may substitute this higher turbidity limit for that system.

(B) The turbidity level of representative samples of a system's filtered water must at no time exceed 5 NTU, measured as specified in Section 2401-51-82.

(Effective May 26, 1996)

2401-51-80 Diatomaceous Earth Filtration

(A) For systems using diatomaceous earth filtration, the turbidity level of representative samples of a system's filtered water must be less than or equal to 1 NTU in at least 95 percent of the measurements taken each month, measured as specified in Section 2401-51-81.

(B) The turbidity level of representative samples of a system's filtered water must at no time exceed 5 NTU, measured as specified in Section 2401-51-81.

(Effective May 26, 1996)

2401-51-81 Other Filtration Technologies

A public water system may use a filtration technology not listed in Sections 2401-51-78 through 2401-51-80 if it demonstrates to the Board, using pilot plant studies or other means, that the alternative filtration technology, in combination with disinfection treatment that meets the requirements of Section 2401-51-76(C), consistently achieves 99.9 percent removal and/or inactivation of *Giardia lamblia* cysts and 99.99 percent removal and/or inactivation of viruses. For a system that makes this demonstration, the requirements of Section 2401-51-79 apply.

(Effective May 26, 1996)

2401-51-82 Analytical and Monitoring Requirements for Disinfection and Filtration

(A) Only the analytical methods(s) specified herein, or otherwise approved by Board, may be used to demonstrate compliance with the requirements of Sections 2401-51-76 through 2401-51-81. Measurements for pH, temperature, turbidity, and residual disinfectant concentrations must be conducted by a party approved by the Board. Measurements for total coliforms, fecal coliforms, and HPC must be conducted by a laboratory certified by the Board or EPA to do such analysis. Until laboratory certification criteria are developed for the analysis of HPC and fecal coliforms, any laboratory certified for total coliform analysis is deemed certified for HPC and fecal coliform analysis. The following procedures shall be performed in accordance with the publications listed.

(1) Fecal coliform concentration. Method 908C (Fecal Coliform MPN Procedures), pp. 878-880. Method 908D (Estimation of Bacterial Density), pp. 880-882, or Method 909C (Fecal Coliform Membrane Filter Procedure), pp. 896-898, as set forth in Standard Methods for the Examination of Water and Wastewater, 1985, American Public Health Association et al., 16th edition.

(2) Total coliform concentration. Method 908A (Standard Total Coliform Multiple-Tube (MPN) Tests), pp. 872-876, Method 908B (Application of Tests to Routine Examinations), pp. 876-878, Method 908D (Estimation of Bacterial Density), pp. 880-882, Method 909A (Standard Total Coliform Membrane Filter Procedure), pp. 887-894, or Method 909B (Delayed-Incubation Total Coliform Procedure), pp. 894-896, as set forth in Standard Methods for the Examination of Water and Wastewater, 1985, American Public Health Association et al., 16th edition; Minimal Medium ONPG-MUG Test, as set forth in the article "National Field Evaluation of a

Defined Substrate Method for the Simultaneous Enumeration of Total Coliforms and Escherichia coli from Drinking Water: Comparison with the Standard Multiple Tube Fermentation Method" (Edberg et al.), Applied and Environmental Microbiology, Volume 54, pp. 1595-1601, June 1988 (as amended under Erratum, Volume 54, p. 3197, December, 1988).

NOTE: The Minimal Medium ONPG-MUG Test is sometimes referred to as the Autoanalysis Colilert System. Systems may use a five-tube test or a ten-tube test.

(3) Heterotrophic Plate Count. Method 907A (Pour Plate Method), pp. 864-866, as set forth in Standard Methods for the Examination of Water and Wastewater, 1985, American Public Health Association et al., 16th edition.

(4) Turbidity. Method 214A (Nephelometric Method-Nephelometric Turbidity Units), pp. 134-136, as set forth in Standard Methods for the Examination of Water and Wastewater, 1985, American Public Health Association et al., 16th edition.

(5) Residual disinfectant concentration. Residual disinfectant concentrations for free chlorine and combined chlorine (chloramines) must be measured by Method 498C (Amperometric Titration Method), pp. 303-306, Method 408D (DPD Ferrous Titrimetric Method), pp. 306-309, Method 408E (DPD Colorimetric Method), pp. 309-310, or Method 408F (Leuco Crystal Violet Method), pp. 310-313, as set forth in Standard Methods for the Examination of Water and Wastewater, 1985, American Public Health Association et al., 16th edition. Residual disinfectant concentrations for free chlorine and combined chlorine may also be measured by using DPD colorimetric test kits if approved by the State. Residual disinfectant concentrations for ozone must be measured by the Indigo Method as set forth Bader, H., Holgne, J. "Determination of Ozone in Water by the Indigo Method; A Submitted Standard Method"; Ozone Science and Engineering, Vol. 4, pp. 169-176, Pergamon Press Ltd., 1982, or automated methods which are calibrated in reference to the results obtained by the Indigo Method on a regular basis, if approved by the State.

NOTE: This method will be published in the 17th edition of Standard Methods for the Examination of Water and Wastewater, American Public Health Association et al.; the Iodometric Method in the 16th edition may not be used. Residual disinfectant concentration for chlorine dioxide must be measured by Method 410B (Amperometric Method) or Method 410C (DPD Method), pp. 322-324, as set forth in Standard Methods for the Examination of Water and Wastewater, 1985, American Public Health Association et al., 16th edition.

(6) Temperature. Method 212 (Temperature), pp. 126-127, as set forth in Standard Methods for the Examination of Water and Wastewater, 1985, American Public Health Association et al., 16th edition.

(7) pH. Method 423 (pH Value), pp. 429-437, as set forth in Standard Methods for the Examination of

Water and Wastewater, 1985, American Public Health Association, 16th edition. Copies of the methods published in "Standard Methods for the Examination of Water and Wastewater" may be obtained from the American Public Health Association et al., 1015 Fifteenth Street, NW., Washington, DC 20005; copies of the Minimal Medium ONPG-MUG Method as set forth in the article "National Field Evaluation of a Defined Substrate Method for the Simultaneous Enumeration of Total Coliforms and Escherichia coli from Drinking Water: Comparison with the Standard Multiple Tube Fermentation Method" (Edberg et al.), Applied and Environmental Microbiology, Volume 54, pp. 1595-1601, June 1988 (as amended under Erratum, Applied and Environmental Microbiology, Volume 54, p. 3197, December, 1988), may be obtained from the American Water Works Association Research Foundation, 6666 West Quincy Avenue, Denver, Colorado, 80235; and copies of the Indigo Method as set forth in the article "Determination of Ozone in Water by the Indigo Method" (Bader and Holgne), may be obtained from Ozone Science & Engineering, Pergamon Press Ltd., Fairview Park, Elmsford, New York 10523. Copies may be inspected at the U.S. Environmental Protection Agency, Room EB15, 401 M Street, SW., Washington, DC 20460 or at the Office of the Federal Register, 1100 L Street, NW., Room 8401, Washington, DC.

(B) Monitoring requirements for systems using filtration treatment. A public water system that uses a surface water source or a ground water source under the influence of surface water and provides filtration treatment must monitor in accordance with this Paragraph beginning June 29, 1993, or when filtration is installed, whichever is later.

(1) Turbidity measurements as required by Sections 2401-51-77 through 2401-51-81 must be performed on representative samples of the system's filtered water every four hours (or more frequently) that the system serves water to the public. A public water system may substitute continuous turbidity monitoring for grab sample monitoring if it validates the continuous measurement for accuracy on a regular basis using a protocol approved by the Board. For any systems using slow sand filtration or filtration treatment other than conventional treatment, direct filtration, or diatomaceous earth filtration, the Board may reduce the sampling frequency to once per day if it determines that less frequent monitoring is sufficient to indicate effective filtration performance. For systems serving 500 or fewer persons, the Board may reduce the turbidity sampling frequency to once per day, regardless of the type of filtration treatment used, if the Board determines that less frequent monitoring is sufficient to indicate effective filtration performance.

(2) The residual disinfectant concentration of the water entering the distribution system must be monitored continuously, and the lowest value must be recorded each day, except that if there is a failure in the continuous monitoring equipment, grab sampling every 4 hours may be conducted in lieu of continuous monitoring, but for no more than 5 working days

following the failure of the equipment, and systems serving 3,300 or fewer persons may take grab samples in lieu of providing continuous monitoring on an ongoing basis at the frequencies each day prescribed in Table B. If at any time the residual disinfectant concentration falls below 0.2 mg/l in a system using grab sampling in lieu of continuous monitoring, the system must take a grab sample every 4 hours until the residual disinfectant concentration is equal to or greater than 0.2 mg/l.

(3) The residual disinfectant concentration must be measured at least at the same points in the distribution system and at the same time as total coliforms are sampled, as specified in Sections 2401-51-11 through 2401-51-15, except that the Board may allow a public water system which uses both a surface water source or a ground water source under direct influence of surface water, and a ground water source to take disinfectant residual samples at points other than the total coliform sampling points if the State determines that such points are more representative of treated (disinfected) water quality within the distribution system. Heterotrophic bacteria, measured as heterotrophic plate count (HPC) as specified in Paragraph (A)(3) of this Section, may be measured in lieu of residual disinfectant concentration.

SYSTEM SIZE BY POPULATION	SAMPLES PER DAY†
<500	1
501 to 1,000	2
1,001 to 2,500	3
2,501 to 3,300	4

†The day's samples cannot be taken at the same time. The sampling intervals are subject to Board review and approval.

(4) If the Board determines, based on site-specific considerations, that a system has no means for having a sample transported and analyzed for HPC by a certified laboratory under the requisite time and temperature conditions specified by Paragraph (A)(3) of this Section and that the system is providing adequate disinfection in the distribution system, the requirements of Paragraph (B)(3) of this Section do not apply to that system.

(Effective May 26, 1996)

2401-51-83 Reporting and Record Keeping Requirements for Filtration and Disinfection: General Requirements

(A) A public water system that uses a surface water source or a ground water source under the direct influence of surface water, for which filtration treatment is required by Sections 2401-51-77 through 2401-51-81 or the Board has determined in writing

that filtration is required, must comply with any reporting requirements specified by the Board until filtration is in place.

(B) A public water system that uses a surface water source or a ground water source under the direct influence of surface water and provides filtration treatment must report monthly to Board the information specified herein, beginning June 29, 1993, or when filtration is installed, whichever is later.

(1) Turbidity measurements as required by 2401-51-82(B) must be reported within 10 days after the end of each calendar month in which the system has, at any time, served water to the public. Information that must be reported includes:

(a) the total number of filtered water turbidity measurements taken during the month.

(b) the number and percentage of filtered water turbidity measurements taken during the month which are less than or equal to the turbidity limits specified in Sections 2401-51-77 through 2401-51-81 for the filtration technology being used.

(c) the date and value of any turbidity measurements taken during the month which exceed 5 NTU.

(2) Disinfection information specified in 2401-51-82(B) must be reported to the Board within 10 days after the end of each month the system serves water to the public. Information that must be reported includes:

(a) for each day, the lowest measurement of residual disinfectant concentration in mg/l in water entering the distribution system.

(b) the date and duration of each period when the residual disinfectant concentration in water entering the distribution system fell below 0.2 mg/l and the date and time when the Board was notified of the occurrence.

(c) the following information on the samples taken in the distribution system in conjunction with the total coliform monitoring pursuant to Section 2401-51-76:

(i) number of instances where the residual disinfectant concentration is measured;

(ii) number of instances where the residual disinfectant concentration is not measured, but the heterotrophic plate count (HPC) is measured;

(iii) number of instances where the residual disinfectant concentration is measured but not detected and no HPC is measured;

(iv) number of instances where no residual disinfectant concentration is detected and where HPC is >500/ml;

(v) number of instances where residual disinfectant concentration is not measured and where HPC is >500/ml;

(vi) for the current and previous month in which the system served any water to the public, the value of "V" in the following formula:

$$V = \frac{c+d+e}{a+b} \times 100$$

where:

a = number of instances where the residual disinfectant concentration is measured;

- b = number of instances where the residual disinfectant concentration is not measured but heterotrophic bacteria plate count (HPC) is measured;
- c = number of instances where the residual disinfectant concentration is measured but not detected and no HPC is measured;
- d = number of instances where the residual disinfectant concentration is measured but not detected and where the HPC is >500/ml; and
- e = number of instances where the residual disinfectant concentration is not measured and HPC is >500/ml.

(d) if the Board determines, based on site-specific considerations, that a system has no means for having a sample transported and analyzed for HPC by a certified laboratory under the requisite time and temperature conditions specified by 2401-51-82(A)(3) and that the system is providing adequate disinfection in the distribution system, the requirements of Paragraph (B)(2)(c) of this Section do not apply.

(e) a system need not report the data listed in Paragraph (B)(2) of this Section if all the data listed in Paragraphs (B)(2) of this Section remain on file at the system and the Board determines that the system has submitted all the information required by Paragraph (B)(2) of this Section for at least 12 months.

(Effective May 26, 1996)

2401-51-84 Reporting and Record Keeping Requirements for Filtration and Disinfection: Immediate Notification Required

(A) Each system, upon discovering that a waterborne disease breakout potentially attributable to that water system has occurred, must report that occurrence to the Board as soon as possible, but no later than by the end of the next business day.

(B) If at any time the turbidity exceeds 5 NTU, the system must inform the Board as soon as possible, but no later than by the end of the next business day.

(C) If at any time the residual disinfectant falls below 0.2 mg/l in the water entering the distribution system, the system must notify the Board as soon as possible, but not later than by the end of the next business day. The system must also notify the Board by the end of the next business day whether or not the residual disinfectant was restored to at least 0.2 mg/l within 4 hours.

(Effective May 26, 1996)

ENFORCEMENT

2401-51-85 Applicability

The procedures and regulations described in Title 24 of the Palau National Code for implementation and enforcement shall apply to the regulations contained in this Chapter. Penalties assessed under these regulations shall be for the number of days the public water supply remains in violation.

(Effective May 26, 1996)

2401-51-86 Penalties

(A) Any person who violates any provision of these regulations or any certificates, standard or order issued by the Board or any agency charged with responsibilities pursuant to these regulations shall be subject to a civil penalty not to exceed one thousand dollars (\$1,000) for each day of each such violation.

(B) Any person who willfully or negligently violates any provision of these regulations, or of any certification, certification condition, standard or order of the Board or any agency charged with responsibilities pursuant to these regulations, shall be subject to criminal prosecution and upon conviction shall be punished by a fine of not less than one hundred dollars (\$100) nor more than twenty-five thousand dollars (\$25,000) for each violation or by imprisonment not exceeding three (3) months, or both. Upon subsequent convictions for violations of these regulations, any such person shall be punished by a fine of not less than five hundred dollars (\$500) nor more than fifty thousand dollars (\$50,000) for each day of violation or by imprisonment not exceeding six (6) months, or both.

(C) Persons who, willfully or negligently, tamper with a public water system, shall be imprisoned for not more than 5 (five) years, fined, or both.

(D) Any person who attempts to tamper with a public water supply or threatens to do so shall be subject to imprisonment for not more than 3 (three) years, a fine, or both.

(E) The Board may bring a civil action against any person who tampers, attempts to tamper, or makes a threat to tamper with a public water system. The court may impose on such person a civil penalty of not more than fifty thousand dollars (\$50,000.00) for such tampering or not more than twenty thousand dollars (\$20,000.00) for such attempt or threat.

(Effective May 26, 1996)

MISCELLANEOUS PROVISIONS

2401-51-87 Severability

If any provision of these regulations or the application of any provision of these regulations to any person or circumstance is held invalid, the application of such provision to other persons or circumstances and the remainder of these regulations shall not be affected thereby.

(Effective May 26, 1996)

2401-51-88 Repealer

The regulations contained herein shall replace the Republic of Palau Environmental Quality Protection Board Public Water Supply System Regulations currently in effect in the Republic of Palau.

(Effective May 26, 1996)