	NAVFAC HI POTABLE WATER BRANCH STANDARD OPERATING PROCEDURE (SOP) NO. 16			
	<b>Routine Water Storage Tank Inspections and Checks</b>			
	Issued by: PRJ61	Effective Date: 8/9/2022	Revised Date: 8/9/2022	Pg. 1 of 11

## 1. PURPOSE & SCOPE

This SOP provides guidance for raw and treated water storage tank operational and maintenance checks.


## 2. REQUIREMENTS/BACKGROUND

EPA Office of Ground Water and Drinking Water, *Finished Water Storage Facilities*, August 2002

AWWA Manual M42: *Steel Water Storage Tanks* provides information regarding inspection of existing steel water storage tanks


AWWA Standard G200-04 provides best management practices for system operators including a section on Treated Water Storage Facilities

- 2.1. A comprehensive water storage tank preventative maintenance program can extend the operational life of the tank, save money on tank rehabilitation, help determine long and short term maintenance planning and budgeting, and achieve compliance with regulatory agency requirements.
- 2.2. A tank inspection should consist of careful examination of the tank's interior, exterior, foundation, and accessories. Tank inspections can be used to determine long and short term operation and maintenance requirements of a tank. Potable water storage tanks require routine inspections at the following frequencies:
  - 2.2.1. Routine inspections: monthly
  - 2.2.2. Periodic inspections: as needed
  - 2.2.3. Comprehensive inspections including tank cleaning: every 3-5 years
- 2.3. There are different types of storage tanks:
  - 2.3.1. Ground-level storage reservoirs/tanks typically have discharge pumps to the treatment process or system distribution.
  - 2.3.2. Elevated and hydro-pneumatic tanks typically float on the distribution system pressure.
- 2.4. Storage reservoirs/tanks are considered a "vulnerable" part of the distribution system, because in tanks (other than hydro-pneumatic) water surface is not pressurized (is at atmospheric pressure) and is exposed. Tanks are the one place in the distribution system where this is true, and so tank inspection is required to diligently assure maintenance of water quality. Tanks not properly sealed or with improper openings provide an entry-point for surface water runoff, birds, snakes, rats, etc. can enter the tank and contaminate the water.

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### 3. DEFINITIONS

<u>Cathodic Protection</u>	Cathodic protection is used to reduce corrosion on steel tanks, pipes, etc.
<u>Drain</u>	Valved opening on storage reservoirs/tanks that allows draining of the storage reservoir/tank. Drain commonly discharges to a stormwater discharge.
<u>Fall Protection</u>	Fall protection is required by OSHA to prevent falls when working at heights greater than four feet. Fall protection includes ladder cages, safety harness and line, safety nets, stair railings, and hand rails.
<u>Flap Valve</u>	A flap valve is often used at the discharge of the drain or overflow connections to the storage reservoir/tank to allow the free flow of water but prevent birds, rodents, etc. from entering. The flap valve typically uses a hinged elastomer or metallic flap that closes by gravity.
<u>Hatch</u>	Opening on storage reservoirs/tanks for personnel access.
<u>Inlet</u>	The point in the storage reservoir/tank that water enters.
<u>Level Indicator Transmitter</u>	Instrumentation that receives the level element signal, displays the signal, and transmits it to the control system.
<u>Outlet</u>	The point in the storage reservoir/tank that water exits.
<u>Overflow</u>	Opening on storage reservoirs/tanks that allows relief of the storage reservoir/tank in case of over-filling. The overflow drain commonly discharges to a stormwater discharge.
<u>Screen</u>	Corrosion-resistant wire mesh to keep birds, rodents, etc. out of the storage reservoir/tank.
<u>Splash Pad</u>	A concrete pad at the discharge of the drain or overflow connections to the storage reservoir/tank to prevent soil erosion.

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Vent

Opening on storage reservoirs/tanks that allows interior and exterior pressure to equalize.

**4. HEALTH/SAFETY REQUIREMENTS**

The following health and safety requirements should be followed by all personnel.


- 4.1. Be familiar with applicable safety data sheet (SDS).
- 4.2. Locate the proper safety equipment and verify it is operational (e.g., emergency eyewash, safety shower).
- 4.3. Identify and wear all appropriate personal protective equipment
- 4.4. Use proper handling procedures. For the procedures set forth in this SOP, the following additional health and safety requirements should be followed by all personnel.
- 4.5. Address work safety issues related to water storage tanks including confined space entry, fall protection, ladders, guardrails, removing lead paint from tanks, repainting, and applying coatings, among others. The latest requirements of relevant occupational health and safety guidelines or best practices must be adhered to when working in and around water storage tanks.
- 4.6. When working on or in a water storage tank, the operator must have proper personal safety equipment which may include a safety harness, wire rope grab or other fall arrest/restraint system, friction brakes, carabineers, lanyards, lifelines, anchor points and a hard helmet, among others.
- 4.7. Operators climbing or entering tanks should receive training for accessing heights and confined-space entry.

**5. ROLES & RESPONSIBILITIES**

- 5.1. Distribution System Operators operators should read and familiarize themselves with this SOP and the locations of all structures, equipment, instrumentation, controls, displays, and other items mentioned in this SOP.
- 5.2. Access to water storage structures must be restricted to authorized personnel only. Only trained and experienced workers are allowed to work in or on water storage facilities.

**6. EQUIPMENT/SUPPLIES/MATERIALS/TOOLS REQUIRED**


- 6.1. Confined space entry equipment
- 6.2. Fall protection equipment
- 6.3. Inspection mirror
- 6.4. Small bottle of 200 ppm spray bleach
- 6.5. Shoe covers for tank entry

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## 6.6. Pole sampler for grab samples from access hatch

## 7. PROCEDURE

- 7.1. Review the Level, Pressure, and Hydraulic Monitoring and Management SOP for more information about tank hydraulics.
- 7.2. Perform exterior inspections for obvious signs of intrusion or vandalism weekly.
- 7.3. Perform Monthly Checks
  - 7.3.1. Monthly operational sampling is recommended for the following monitoring parameters: free and total chlorine residual, temperature, heterotrophic plate count, total and fecal coliform bacteria, pH, turbidity, and total dissolved solids.
  - 7.3.2. Check for evidence of overflow, erosion under the splash pad, warning lights, wet ground, etc. If there is evidence of your reservoir overflowing, your pump controls may be malfunctioning. If the tank's level is below normal operating conditions, there may be a problem with the source of supply or water level controls.
  - 7.3.3. Visually inspect storage tanks for sanitary deficiencies to ensure they protect drinking water from contamination.
    - 7.3.3.1. Document the inspection, including photographs that will be useful for the next routine sanitary survey.
    - 7.3.3.2. Check vent screens for any openings to prevent small animals, bats, birds, insects, debris, dust, or organic matter from entering the tank.
    - 7.3.3.3. Check overflows for tight-closing flap valves or intact screens.
    - 7.3.3.4. Check the condition of the storage tank and look for cracks, structural damage, leaks, corrosion, and cathodic protection.
    - 7.3.3.5. Open access hatches and check the condition of the access hatch inner seal. The area around hatches should be cleaned/swept prior to opening hatch so as not to drop debris into the tank from around the hatch.
    - 7.3.3.6. Note water level, and observe if there any floating debris or sheen or any sediment buildup on the bottom. If sheen or floating debris, a single or series of short intentional overflows may be used to clear. Use a pole sampler dedicated for drinking water to obtain grab samples from the hatchway as needed.

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- 7.3.3.7. Inspection mirrors should be used to look at screens, inside tank, etc. The mirror can be used to beam the sunlight down to see if there is debris buildup on bottom of tank.
- 7.3.3.8. If entering the tanks, use a small bottle of 200 ppm spray bleach to disinfect the tank where accessed. Use shoe covers.
- 7.3.4. Inspect safety conditions – ladders, fall prevention, handrails, and access.
- 7.3.5. Inspect security conditions – fences, locks, lighting, ladder guards, vents, and telemetry systems (e.g., alarms, water quality sensors, water level sensors, control systems).
- 7.4. Perform as Needed
- 7.4.1. Perform storage tank maintenance activities including cleaning, painting, and repairing structures. Adhere to American Water Works Association (AWWA) Standards, National Sanitation Foundation (NSF), and American National Standards (ANSI) for disinfection procedures and approval of coatings.
- 7.4.2. Inspect storage tanks for defects. Both interior and exterior inspections are needed to ensure maintenance of physical integrity, security, and high water quality. The type and frequency of the inspection depends on the type of tank, its susceptibility to vandalism, age, condition, and time since last cleaning or maintenance, history of water quality, plus other local criteria.
- 7.4.3. You should conduct a comprehensive inspection of the interior whenever you drain the tank for cleaning. Industry standards recommend a comprehensive inspection of tanks—inside and out—every five years, except for newly constructed tanks. You should inspect a new tank within 10 years of service and every 5 years thereafter.
- 7.4.4. Clean storage tanks. Thoroughly clean tanks after any construction, maintenance, or repairs. Use a high-pressure water jet, sweep, scrub, or other methods to clean wall and floor surfaces thoroughly. You should flush all water and dirt from the tank. There are several AWWA-approved ways to disinfect a storage tank after you take it out of service for cleaning, inspection, or repairs. The simplest way is:
- 7.4.4.1. AWWA Standard C-652 Chlorination Method 3. Broom-clean the bottom of the tank then begin to add potable water until the tank is about 5 percent full. Next, add the appropriate quantity of chlorine directly into this water. The amount of chlorine added should result in a free chlorine residual between 2.5 and 3.0 parts per million when the tank is completely full. If you use regular household chlorine bleach (6 percent chlorine by weight), add 1 gallon for every 20,000 gallons of tank capacity. Contact the

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regional office if you are unsure how much chlorine and what type of chlorine to add to your tank.

- 7.4.4.2. After adding chlorine, fill the remaining 95 percent of the tank with potable water and wait 24 hours. At the end of 24 hours, measure the free chlorine residual of the water inside the tank. If the water in the tank has a free chlorine residual of at least 2 parts per million, then collect a coliform sample from the tank. If the coliform sample is satisfactory, then you may place the reservoir directly back into service. If the coliform sample shows the presence of coliform, contact the regional office for instruction on further disinfection and testing.
- 7.4.4.3. When you plan to take a tank out of service for cleaning and disinfection, be sure to make provisions to maintain an adequate water supply and adequate water pressure in the distribution system at all times. You may need to coordinate this with your local fire protection authority. If you are unsure how to provide service while the tank is off-line, contact our regional office for technical assistance.
- 7.4.4.4. If you cannot or do not want to take your tank out of service for inspection and cleaning, you should consider the cost and availability of using certified divers trained to inspect and clean a drinking water tank while the tank remains in service.

## 8. ATTACHMENTS/CHECKLISTS


- 8.1. Troubleshooting Guide for Storage Facilities
- 8.2. Recommended O&M Schedule for Storage Facilities

## 9. REVISION HISTORY


- 9.1. August 9, 2022 Original Issue

## 10. SOP MAINTENANCE

- 10.1. The NAVFAC-Hawaii UM PL shall annually review and update this SOP as necessary and shall assure that all other SOPs are managed in accordance with this SOP guidance.
- 10.2. This SOP is located in the PRJ61 Share Drive in the following directory:  
**S:\NAVFACHI\_A\PW6\PW65\\_Potable Water Files\SOPs for PRJ61**


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Troubleshooting Guide for Storage Facilities		
Problem	Possible cause	Possible solution
Loss of disinfectant residual	Long detention time. Increase in temperature. Depletion of disinfectant from exposure to sunlight. Entry of chlorine demanding contaminants.	Cover reservoir. Reduce detention time with baffles, recirculation, inlet diffuser, mechanical mixer, pumps. Relocate inlet/outlet in tank. Size facility for more frequent turnover. Check screens on vents. Install bird wires and fences if necessary. Clean and disinfect storage facility.
Increase in heterotrophic plate count	Loss of chlorine residual or contaminant entry.	Prevent loss of chlorine residual (see above) and rechlorinate storage tank. Check seals on hatches and screens on vents. Install bird wires and fences if necessary. Clean and disinfect storage facility.
Coliform bacteria occurrence	Loss of chlorine residual. Contaminant entry. Sediment or biofilm build-up.	Check seals on hatches and screens on vents. Install bird wires and fences if necessary. Clean and disinfect storage facility.
Disinfection byproducts formation	Long detention time. Increase in pH or chlorine residual. Boosting chlorine. Organic matter contamination or algae growth.	Reduce detention time with baffles, recirculation, inlet diffuser, mechanical mixer, pumps. Relocate inlet/outlet in tank. Size facility for more frequent turnover. Look at alternative disinfectants.
Nitrification	Long detention time.	Reduce detention time with baffles, recirculation, inlet diffuser, mechanical mixer, pumps. Relocate inlet/outlet in tank. Increase turnover rate or size facility for more frequent turnover.

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Troubleshooting Guide for Storage Facilities		
Problem	Possible cause	Possible solution
Sediment build-up	Excess suspended materials, lime, iron or manganese in source water. Minimal velocities allowing depositions. Contaminant entry.	Improve influent water quality. Reduce detention time with baffles, recirculation, inlet diffuser, mechanical mixer, pumps. Avoid scouring. Inspect and clean tank more frequently.
Floating material or surface film	Build-up of iron or manganese sediments. Growth of iron or manganese forming bacteria.	Improve influent water quality. Avoid scouring. Inspect and clean tank more frequently.
Taste and odor complaints	Long detention time. Growth of algae or other organisms. Contaminant entry. Leaching from internal coatings or new concrete tank. Source water potential for taste and odor such as high levels of hydrogen sulfides.	Cover open reservoirs. Check seals on hatches and screens on vents. Install bird wires and fences if necessary. Improve influent water quality. Chlorinate. Flush distribution system. Clean and disinfect storage tank.
Growth of algae or other biological organisms	Exposure to sunlight. Loss of chlorine residual. Long detention time. Sediment or biofilm build-up.	Cover open reservoirs. Check seals on hatches and screens on vents. Install bird wires and fences if necessary. Improve influent water quality. Flush distribution system. Clean and disinfect storage tank.
Contaminant entry	Uncovered reservoirs or improper design of floating cover. Damaged or missing screens on vents and entry of bats, birds, rodents, or insects. Cross connection at drain or overflow.	Cover open reservoirs. Check seals on hatches and screens on vents. Install bird wires and fences if necessary. Flush distribution system. Clean and disinfect storage tank.
Increase in pH.	Long detention time in concrete storage.	Provide coating on concrete walls. Increase turnover rate. Fluctuate water levels more frequently.
Biodegradation of internal coatings	Loss of chlorine residual allowing biological growth. Selection of wrong internal coating.	Prevent loss of chlorine residual. Chlorinate. Clean and disinfect storage tank.




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Troubleshooting Guide for Storage Facilities		
Problem	Possible cause	Possible solution
Biofilm growth	Loss of chlorine residual. Nutrients from coatings or contaminants. Corrosion of surface promoting biological and algae growth. Bacterial seeding.	Prevent loss of chlorine residual. Chlorinate. Clean and disinfect storage tank. Flush distribution system.
Color	Decaying vegetative material. Algae growth in uncovered reservoirs. Sediment scouring. Iron or manganese.	Improve source water quality. Install treatment for iron and manganese. Increase cleaning frequency.
Red water	Metals uptake from metal surfaces from lack of or improper cathodic protection. Iron or manganese.	Provide proper corrosion treatment. Install or calibrate cathodic protection. Use sequestering agent. Apply coatings properly.
Build-up of iron and manganese	Iron and manganese in source water and long detention times. Oxidation and settling of iron or manganese. Improper sequestering agent dose.	Improve source water quality. Install or optimize sequestering system. Increase cleaning frequency.

From: *Preventive Maintenance Program Guide for Small Public Water Systems Using Groundwater*, Washington State Department of Health, November 2011.

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Recommended O&M Schedule for Storage Facilities	
<b>Daily or Weekly</b>	
<input type="checkbox"/>	Check any warning lights or alarms – low water level, high water level, intrusion, power outage, etc.
<input type="checkbox"/>	Check storage tank for signs of security breaches – damaged fences, open gates, graffiti, vandalism, etc.
<input type="checkbox"/>	Check water level indicator – functioning, adequate amount of stored water, excessive water use.
<input type="checkbox"/>	Check the overflow line, vents, ladder access locks, roof access hatches, and controls that are readily visible from the ground for damage, vandalism, or other conditions.
<input type="checkbox"/>	Check storage tank and site after any adverse weather – high winds, rains, etc.
<b>Monthly</b>	
<input type="checkbox"/>	Check water level indicator.
<input type="checkbox"/>	Verify all openings are protected from surface runoff, windblown contaminants, insects, birds and animals.
<input type="checkbox"/>	Check tank overflow lines for signs of damage, such as, screens, flapper valves, check valves, splash plate, etc.
<input type="checkbox"/>	Check area for excessive vegetation or dangerous conditions – uncut grass, brush, dead trees, fire hazard, etc.
<input type="checkbox"/>	Check control valves for proper positions, open or closed.
<input type="checkbox"/>	Check control valves for damage or leaks.
<b>Quarterly</b>	
<input type="checkbox"/>	Check water level indicator.
<input type="checkbox"/>	Visually inspect tank exterior and roof for signs of damage, corrosion, degradation, leakage, or structural problems, with particular focus on all openings into the reservoir: reservoir roof and side wall vents, access hatch, and overflow outlet.
<input type="checkbox"/>	Check tank supporting structure for signs of damage, corrosion, degradation, structural or seismic inadequacy.
<input type="checkbox"/>	Check tank foundation for signs of damage, corrosion, degradation, structural inadequacy.
<input type="checkbox"/>	Tank catwalks/ladders free from signs of damage, corrosion, degradation, structural condition, vandalism, etc.
<input type="checkbox"/>	Tank area for water ponding, poor drainage areas, excessive vegetation, unhealthy trees, fire hazards, etc.

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<b>Recommended O&amp;M Schedule for Storage Facilities</b>	
<input type="checkbox"/>	Tank area free from combustible storage, trash, debris, brush, or other material that could present a fire hazard.
<input type="checkbox"/>	Tank area free of accumulation of material on or near parts possibly resulting in accelerated corrosion or rot.
<input type="checkbox"/>	Check earth embankments for erosion, burrowing animals, improper drainage and leakage.
<b>Annually or Seasonally</b>	
<input type="checkbox"/>	Check storage tank structural, seismic and sanitary integrity – leaks, corrosion, cracks, supports, warping, etc.
<input type="checkbox"/>	Inspect storage tank interior for pitting, concrete spalling, rot, corrosion, rust, water level sensors, biofilm build-up etc.
<input type="checkbox"/>	Exercise valves and make repairs as needed.
<input type="checkbox"/>	Document inspection and maintenance activity as part of an O&M program.
<input type="checkbox"/>	Inventory and evaluate storage facilities capacity, condition, replacement costs and plan for improvements.
<input type="checkbox"/>	Evaluate stored water for clarity, sediments, floating materials or films, unusual odors, insects, birds or animals.
<input type="checkbox"/>	Plan for storage facility improvements and budget for the associated cost.
<input type="checkbox"/>	Tank indicator inspected – every three years for steel storage tanks without corrosion protection.
<input type="checkbox"/>	Tank indicator inspected – every five years for storage tanks other than steel without corrosion protection.
<input type="checkbox"/>	Drain, inspect, clean and disinfect storage tank or use a diving maintenance service without draining tank.

From: *Preventive Maintenance Program Guide for Small Public Water Systems Using Groundwater*, Washington State Department of Health, November 2011.