Fact Sheet 4.2: Wastewater Treatment Systems

The mitigation objective of this Fact Sheet is to identify ways to maintain or quickly restore the operation of wastewater treatment plants impacted by floods and hurricanes to provide services to users and prevent contamination from sewage overflow into the environment.

During hurricanes or flooding, the elements needed to ensure the ongoing operation of wastewater treatment systems are at high risk for damage. After the storm, wastewater treatment system components may need repair or replacement to bring the system back to full operation. It is important to identify these at-risk elements before a severe storm happens so that mitigation strategies can be developed and put into action to avoid or minimize storm damage and quickly restore service.

Table 4.2.1 summarizes some common mitigation strategies that can strengthen wastewater treatment systems and prevent contamination of surrounding areas. These strategies are then discussed in the sections that follow.

Table 4.2.1. Common Wastewater Treatment System Mitigation Solutions

Solutions and Options	***Wind***	***Wind-Driven Rain***	***Flooding***
Mitigation Solution: For Lift Stations			
Option 1: Elevate or Relocate			✓
Option 2: Protect or Divert			✓
Option 3: Floodproof			✓
Option 4: Provide Redundant Systems	✓	✓	✓
Mitigation Solution: For Headworks			
Option 1: Elevate or Relocate			✓
Option 2: Protect or Divert			✓
Option 3: Floodproof		✓	✓
Option 4: Provide Redundant Systems	✓	✓	✓

Solutions and Options	***Wind***	***Wind-Driven Rain***	***Flooding***
Mitigation Solution: For Wastewater Treatment Plants			
Option 1: Elevate or Relocate			✓
Option 2: Protect or Divert			✓
Option 3: Floodproof		✓	✓
Option 4: Provide Redundant Systems	✓	✓	✓
Mitigation Solution: For Chemical and Fuel Supplies			
Option 1: Elevate or Relocate			✓
Option 2: Floodproof			✓
Option 3: Secure or Attach	✓		✓
Option 4: Provide Redundant Systems	✓		✓
Mitigation Solution: For Instrumentation and Electrical Controls			
Option 1: Elevate or Relocate			✓
Option 2: Floodproof			✓
Option 3: Provide Redundant Systems	✓	✓	✓
Mitigation Solution: For Power Supplies			
Option 1: Elevate or Relocate			✓
Option 2: Floodproof		✓	✓
Option 3: Provide Redundant Systems	✓	✓	✓

Mitigation Solution: For Lift Stations

Lift stations move wastewater from a lower level to a higher level. They are usually located at the lowest areas in gravity-fed sewer systems. Because of their locations, they are prone to flooding and power outages. If lift stations lose power, untreated sewage can back up into homes, businesses, and critical facilities and flow into waterways, causing a threat to public health and the environment.

Option 1: Elevate or Relocate

When evaluating this option, consider the following:

- Elevate or relocate electrical components such as motors, switchgears and motor control centers at risk for flood damage to locations above the design flood elevation.
- Extend vent lines above the potential design flood elevation (Figure 4.2.1).

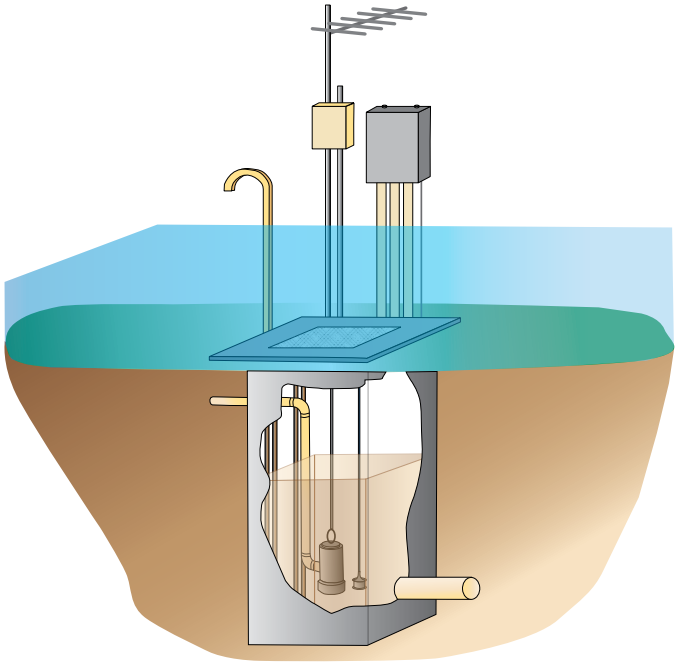


Figure 4.2.1. Extend vent pipes and electrical controls above the flood elevation at lift stations.

- Raise below-ground lift stations either by elevating them in-place or by replacing the lift station to the level of the potential highest flood elevation or higher based on local standards.
- Elevate backup generators above the highest potential flood elevation.

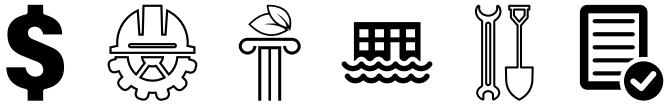
CONSIDERATIONS:

Option 2: Protect or Divert

When evaluating this option, consider the following:

- Install gates on influent and emergency overflow lines at the inflow and overflow locations.
- Divert floodwater and surge away from the lift station using green infrastructure.

CONSIDERATIONS:



Option 3: Floodproof

When evaluating this option, consider the following:

- Use temporary flood barriers for lift stations that are at risk for only minor flooding.
- Install permanent barriers, such as flood walls, berms, levees, or sealed doors, for the most at-risk lift stations.
- Install fully submersible pumps in lift stations.
- Install electrical components, controls and circuitry in water-resistant cabinets in lift stations.
- Install backflow prevention devices such as valves on lines that flow into the lift station and emergency overflow lines.
- Install water-tight manhole covers and vault access hatches in flood-prone areas to limit inflow into the gravity sewer system.

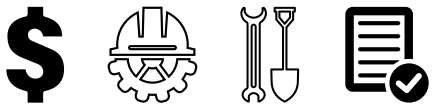
CONSIDERATIONS:

Option 4: Provide Backup Systems

When evaluating this option, consider the following:

- Install standby generators to power critical equipment in a lift station.
- Install quick-connects on equipment to attach to portable generators.
- Use generators that run on more than one type of fuel. This will allow the generators to still be used if it becomes difficult to obtain one fuel type.
- Install a renewable energy supply with a battery system.

CONSIDERATIONS:



Mitigation Solution: For Headworks

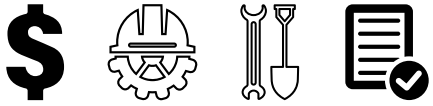
The headworks of a wastewater treatment plant is where wastewater enters a wastewater treatment plant. The headworks screen and remove solids, grit and other debris from the incoming wastewater to avoid clogging other parts of the treatment system. The headworks system is made up of the structures and equipment at the beginning of the wastewater treatment process, including gates and flow controls, metering equipment, pumps, mechanical screens, and grit removal systems. Because of its low elevation, the headworks is at risk for damage from flooding. If the headworks fails without a relief or bypass system in place, it can create a backwater effect on the collections system, which can flood streets, basements and low-lying buildings with untreated sewage.

Option 1: Elevate or Relocate

When evaluating this option, consider the following:

- Before the storm hits, remove and store at-risk, expensive equipment and controls to prevent damage and lessen the time required to bring the system back online.
- Elevate pump and screen motors above the 0.2%-annual-chance (500-year) flood elevation to decrease the risk of flood damage.
- Also, raise electrical system components, instrumentation and other critical systems above the 0.2%-annual-chance (500-year) flood elevation to decrease the risk of flood damage.

CONSIDERATIONS:

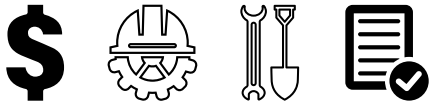


Option 2: Protect or Divert

When evaluating this option, consider the following:

- Upgrade mechanical screens to prevent them from being blocked by debris and to handle sand, grit, trash, and debris potentially entering pumps during and immediately after a flood.

CONSIDERATIONS:

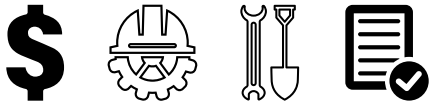


Option 3: Floodproof

When evaluating this option, consider the following:

- Place electrical equipment that is at risk for flood damage in water-resistant cabinets.
- Replace dry well pumps with submersible pumps.

CONSIDERATIONS:

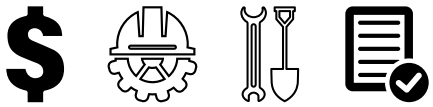


Option 4: Provide Redundant Systems

When evaluating this option, consider the following:

- Install secondary controls, such as float switches for pumps, that are not dependent on Supervisory Control and Data Acquisition (SCADA) systems to allow headworks to resume their function during power outages and interruption to telemetry switches.
- Provide an additional power supply source—either a portable generator with quick-connects on at-risk equipment or a permanent generator with appropriate fuel supply tanks to support continued headworks operation.
- Replace motorized equipment with diesel-driven or dual-option mechanisms. Diesel-driven motors use less fuel than gasoline-powered motors so run longer on the same amount of fuel. They also are relatively easy to maintain and less flammable. Dual fuel motors can run on gasoline or propane, which allows the motor to continue running if one fuel is not available but the other is.
- Increase pump capacity to meet the needs during floods and hurricanes.

CONSIDERATIONS:



Mitigation Solution: For Wastewater Treatment Plants

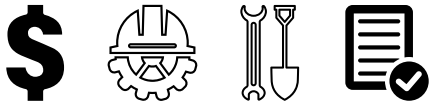
Wastewater treatment plants include buildings, system components and equipment needed to treat wastewater. Wastewater treatment system buildings that are key to system operation must be protected from water entry before, during and after a hurricane or flood. Flooding or surge can damage the buildings and destroy process equipment, communications controls, field equipment, and important data records while blocking access to the plant.

Option 1: Elevate or Relocate

When evaluating this option, consider the following:

- Elevate process tank pads to be above the 0.2%-annual-chance (500-year) flood elevation.
- Elevate or relocate individual equipment, instrumentation or controls that are at risk from flooding to be above the 0.2%-annual-chance (500-year) flood elevation.
- Elevate control centers, equipment and furnishings vital to operations or relocate them to a higher floor of the building.
- See Fact Sheet 3.1, *Foundations,* and Fact Sheet 3.4.2, *Building Utility Systems—Electrical,* for additional information.

CONSIDERATIONS:



Option 2: Protect or Divert

When evaluating this option, consider the following:

- Anchor any air tanks to prevent them from floating.
- Use green infrastructure to reroute or collect floodwater.
- Install pumping systems or channels and culverts that can collect and drain floodwater effectively.
- Build a combined sewage overflow tunnel or a large collection pond to collect sewage overflow for future treatment. These equalization basins typically hold a volume determined by the highest expected flow. Increasing the volume can help mitigate larger recurrence flood events.
- Install corrosion-resistant equipment in coastal areas.

CONSIDERATIONS:

Option 3: Floodproof

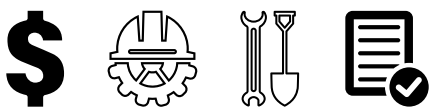
When evaluating this option, consider the following:

- Install barriers such as door shields on building entry points, including windows, doors and garages.
- Seal wall and floor openings using water-resistant sealants.
- Install backflow prevention devices on sewers and drains in at-risk buildings.
- Isolate electrical equipment in water-resistant closets.
- Construct levees, floodwalls or berms to be higher than the 0.2%-annual-chance (500-year) flood elevation around extremely flood-prone facilities (Figure 4.2.2).

Figure 4.2.2. Constructing a flood wall that extends above the 500-year flood elevation can help protect a wastewater treatment plant from flood damage. The blue lines indicate the approximate location of the planned floodwall for this treatment facility. (U.S. Environmental Protection Agency [EPA], 2021)

- See Fact Sheet 3.2, *Walls and Openings,* for additional information about protecting buildings from flood damage.

CONSIDERATIONS:

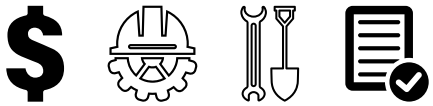


Option 4: Provide Backup Systems

When evaluating this option, consider the following:

- Install a generator at a height that would be above the 0.2%-annual-chance (500-year) flood elevation or install wiring (called a quick-connect) to make it possible to use a temporary backup generator.
- Ensure that generators that use fuel have fuel tanks installed above the 0.2%-annual-chance (500-year) flood elevation and that the fuel tanks are anchored firmly in place.
- Install motorized equipment and generators capable of using more than one fuel type. This will allow them to continue to work when disasters limit the availability of one fuel type.
- Construct a large storage tank to store sewage overflows for future treatment.

CONSIDERATIONS:



Mitigation Solution: For Chemical and Fuel Supplies

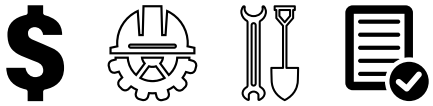
A constant supply of treatment chemicals and fuel is needed to operate a wastewater treatment system, particularly after a flood. Flooding can slow down or completely stop delivery of chemicals or fuel to the facility if access to the treatment plant is blocked or if the availability of these items is impacted.

Option 1: Elevate or Relocate

When evaluating this option, consider the following:

- Elevate tank platforms and tanks above the 0.2%-annual-chance (500-year) flood elevation.
- Raise individual instruments and motor control centers above the 0.2%-annual-chance (500-year) flood elevation or relocate them to facilities away from the flood zone.
- Elevate fill and vent lines above 0.2%-annual-chance (500-year) flood elevation.

CONSIDERATIONS:



Option 2: Floodproof

When evaluating this option, consider the following:

- Install protective barriers around a tank to a height above the 0.2%-annual-chance (500-year) flood elevation.
- Replace instrumentation enclosures and control boxes with water-resistant models.
- Install submersible pumps to pump out water that accumulates within the protective barrier.
- Install corrosion-resistant equipment, storage tanks and fasteners in coastal areas. Additional information about corrosion-resistant materials in coastal environments can be found in NFIP Technical Bulletin 8, *Corrosion Protection for Metal Connectors and Fasteners in Coastal Areas.*

CONSIDERATIONS:

Option 3: Secure

When evaluating this option, consider the following:

- Fill storage tanks to their maximum volume prior to a storm to prevent floating or backflow.
- Anchor tanks to platforms using non-corrosive strapping (Figure 4.2.3).

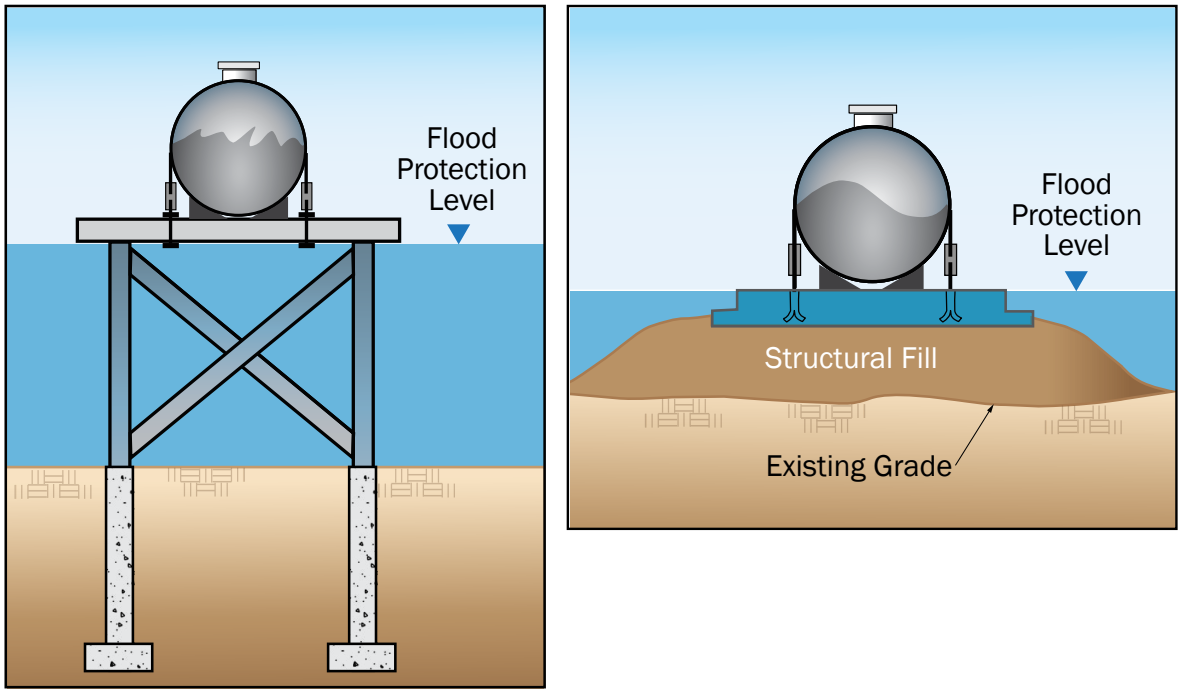
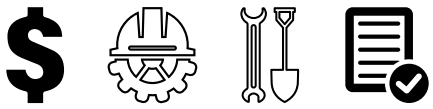


Figure 4.2.3. Raise tanks above the 500-year flood elevation and secure them with non-corrosive hardware to keep them from floating.

CONSIDERATIONS:



Option 4: Provide Redundant Systems

When evaluating this option, consider the following:

- Install larger volume or secondary chemical and fuel tanks to ensure treatment operations remain ongoing until more supplies are available or access is restored.

CONSIDERATIONS:

Mitigation Solution: For Instrumentation and Electrical Controls

Instrumentation and controls for wastewater treatment systems are critical equipment for operating these systems. Ensuring that they do not fail during hurricane and flood events or that they can be quickly or easily repaired after a storm will help improve resilience and decrease possible threats to public health and the environment.

Option 1: Elevate or Relocate

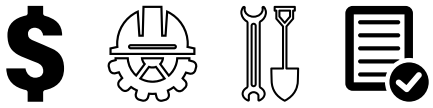
When evaluating this option, consider the following:

Raise service panels above the 0.2%-annual-chance flood elevation and relocate electrical vaults outside of the floodplain.

Elevate individual instruments, motor control centers and critical components to heights above 0.2%-annual-chance (500-year) flood elevation (Figure 4.2.4).

Figure 4.2.4. Elevating instrumentation can protect it from damage during flooding. (Source: U.S. EPA, 2014)

CONSIDERATIONS:

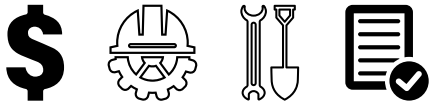


Option 2: Floodproof

When evaluating this option, consider the following:

- Replace or upgrade connections, motor controls and junction boxes with water-resistant versions.
- Use water-resistant electrical components, controls and circuitry.
- Isolate critical components in water-resistant cabinets.
- Replace pumps, flow meters and gate valve operators with submersible models.
- Isolate the equipment that is most likely to be exposed to floodwaters so it can be removed quickly, repaired or replaced. Make sure that staff can operate all systems manually.

CONSIDERATIONS:

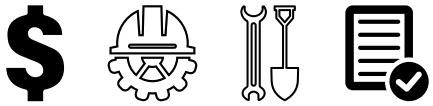


Option 3: Provide Redundant Systems

When evaluating this option, consider the following:

- Provide hardwired backup controls that are separate from the SCADA systems.
- Have secondary controls at another location or remote access capabilities.

CONSIDERATIONS:



Mitigation Solution: For Power Supplies

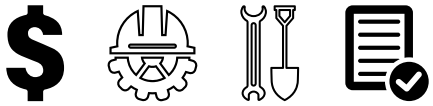
Wastewater treatment plants use a large amount of power to complete the treatment processes. If the treatment plant does not have redundant systems for critical parts of the process that depend on power, service may be disrupted during hurricanes or floods. This disruption could result in raw sewage backup or even discharge of raw sewage following hurricanes or floods. Some strategies to mitigate the impacts of a loss of power wastewater treatment facilities are identified below. See Fact Sheet 3.4.2, *Building Utility Systems—Electric,* and Fact Sheet 4.3, *Electric Power,* for additional information about mitigating power supply disruptions.

Option 1: Elevate or Relocate

When evaluating this option, consider the following:

- Elevate all at-risk critical electrical equipment above the 0.2%-annual-chance flood elevation.
- Raise service panels above the 0.2%-annual-chance flood elevation or relocate electrical vaults and service panels away from the floodplain.
- Elevate power substations.

CONSIDERATIONS:

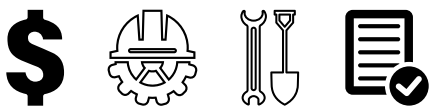


Option 2: Floodproof

When evaluating this option, consider the following:

- Install a floodwall or protective berm around the substations to the 0.2%-annual-chance flood elevation.
- Replace or upgrade connections and junction boxes with water-resistant panels.
- Use submersible pumps in areas at risk for flooding.

CONSIDERATIONS:



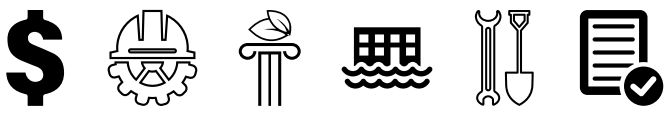
Option 3: Provide Redundant Systems

When evaluating this option, consider the following:

- Install an additional power feed to the treatment plant.
- Establish more reliable connections to the power source or use a dedicated feeder between the power station and the treatment plant.
- Install permanent standby generators at priority locations.
- Wire pump stations with quick-connect capability to use portable backup generators.
- Consider multi-fuel options, allowing equipment to continue to work even if one fuel type is unavailable due to the disaster.
- Consider the addition of a flood- and wind-resistant microgrid system to power the wastewater treatment plant.
- Install solar panels or wind turbines with backup storage batteries to reduce electrical grid dependency (Figure 4.2.5).

Figure 4.2.5. Installing renewable energy resources like solar panels can provide a standby source of power for wastewater treatment facilities. (National Renewable Energy Laboratory [NREL], 2017)

CONSIDERATIONS:



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