# AFTER-ACTION ASSESSMENT REPORT

FEBRUARY 2025

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PREPARED FOR

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# EXECUTIVE SUMMARY

HNTB was contracted by the City of Richmond to perform an after-action assessment of the events at the Richmond Department of Public Utilities (DPU) Water Treatment Plant (WTP) that led to a loss of water service for residents across the region. HNTB made a site visit, conducted staff interviews, requested, and received numerous documents from DPU, reviewed available records and data, and reviewed additional, publicly available information.

**Event Description:** The following is a high-level description of the event that led to the loss of water service. Additional details surrounding the event are included in the after-action assessment report.

- Main Feeder 1 from Dominion Energy went out. Main Feeder 2 still had power.
- Power did not automatically transfer from Main Feeder 1 to Main Feeder 2 due to an equipment failure and the WTP completely lost power.
- Without power, operators were not able to close filter effluent valves or turn on filter effluent pumps. The backup battery powered system did not close the filter effluent valves.
- With flow of water continuing through the filters, the water level increased in both clearwells until it reached the plant basements and submerged equipment and critical electrical equipment.
- Diesel-fueled pumps were used to pump water out of the basements, but they were not able to pump at the rate required to overcome or even keep up with flow rate of water coming through the filters.
- The water in the basements damaged equipment which resulted in a complete WTP outage for nearly 36 hours.

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The after-action assessment report includes additional detailed findings from the investigation process in the following areas: WTP basement flooding and dewatering, storm preparation, power systems, staffing, training, operating procedures, asset management and maintenance, and communications. Refer to the full report for detailed information and conclusions. The following preliminary and long-term recommendations were developed based on the investigation findings. All of the recommendations from the preliminary findings are listed in addition to several additional recommendations.

Short-Term **Recommendations:** The following actions are recommended for immediate implementation.

- Operate the WTP in Summer Mode all the time or at least during storm events that have risks of power outages (DPU has indicated that this has been implemented as the normal operating mode moving forward).
- Develop a Bus Tie/ATS failure plan, train all electrical staff on the plan, and post the plan on each Bus Tie cabinet (SG 6 and SG 7).
- Review staffing plans and consider staffing the WTP with mechanical and electrical staff during storm events that have risks of power outages. If staffing at this level is not feasible, at minimum implement all other recommendations and develop severe storm event response protocol with requirement that maintenance staff on call during storm events can respond in 30 minutes or less.
- Provide a filter effluent valve UPS with a parallel duplicate backup UPS in each plant, all with minimum runtime of one (1) hour, and ensure that both function as intended to close all filter effluent valves on loss of power. Size the UPS to close all filter valves simultaneously. In lieu of a backup UPS, a small backup generator could be considered to provide backup power in the event of the first UPS failing. The UPS sizing and operation should meet the requirements of Chapter 7 of the Virginia Electrical Code (2020) for Legally Required Systems.
- Install a SCADA UPS with a longer runtime, a minimum of one (1) hour. The UPS sizing and operation should meet the requirements of Chapter 7 of the Virginia Electrical Code (2020) for Legally

Required Systems.

- Provided all other recommendations are implemented, one (1) hour of runtime for all UPS units would be sufficient under normal operating conditions. However, consideration should be given to providing UPS units with longer runtimes based on the outage that occurred during this event, which was an hour and twenty minutes, or 1.3 hours. An additional buffer of 50-percent additional runtime should also be considered for the SCADA UPS as well, which would provide two (2) hours of runtime.

- Change the programming in Plant 1 SCADA to match Plant 2 so that the filter effluent valves are set to manual, and the manual set point is set to zero when SCADA is on UPS power.
- Verify filter effluent valve fail safe positions are set to close or reprogram to close.
- Add clearwell high level floats that signal SCADA to override filter effluent valve commands to close the valves.
- Ensure all filter valve actuators are rated as watertight and provide seal-tight fitting and conduit drain fitting prior to the seal-tight fitting within 10-inches of the actuator body. Install a breather fitting near the basement ceiling. Inspect the seal-tight fittings initially after one (1) month and then annually to check if water intrusion has occurred.
- Install visual indicators of filter effluent valve positions with remote open/close switch for each at locations in each basement that are safely accessible by operators in the event of minor flooding.
- Develop written SOPs for plant operation with the input of plant staff. Then, establish a system for training staff on standard procedures and regularly updating SOPs.
- Develop standardized agenda for start of shift or shift change meetings with the input of plant staff. Include safety and emergency operating plan reminders in the agenda and log notes and record of all shift meetings.
- Implement safety program that complies with 12VAC5-590-560 including a safety training program for all staff.
- Expand DPU Emergency Operations Manual to include scenario and process-specific actions plant staff across the entire WTP should take during emergency events. Ensure plan is kept current and readily accessible per 12VAC5-590-505.
- Establish communication protocol to notify wholesale customers (Henrico, Chesterfield, Hanover) and other large users immediately in event of WTP outage to reduce consumption. Review contact information monthly so that contacts are up to date.
- Install dewatering pumps, such as hydraulic-driven pumps, which avoid high suction head issues affecting the priming of the existing dewatering pumps. Dewatering pumps should also have higher flow rates than the existing dewatering pumps, 3,000 to 6,000 gpm is recommended, and permanent piping that routes water away from the plant basements.

Long-Term Recommendations: The following actions are recommended for implementation over several years given the time or financial implications of the recommendations.

- Review staffing plans and consider the addition of a float operator to each shift, so that typical staffing is four (4) operators per shift. If there is an issue getting coverage for an operator that needs a day off, there are always a minimum of three (3) operators.
- Raise as many critical electrical systems above the plant basements as practical.
- Provide an automatic transfer system for the existing backup generator system (DPU has indicated that this is included as part of a current capital project).
- Seal clearwell as much as possible by repairing any cracks or spalling in the concrete and sealing any pipe penetrations and hatches to reduce the flow rate at which water from the clearwell can flood the basement.
- Develop and implement an asset management plan that includes maintenance and replacement of water system assets, both in the WTP and out in the distribution system.

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# AFTER-ACTION ASSESSMENT REPORT

## 1. Introduction

HNTB was contracted by the City of Richmond to perform an after-action assessment of the events at the Richmond Department of Public Utilities (DPU) Water Treatment Plant (WTP) on January 5 and January 6, 2025, that led to a loss of water service for residents across the region. The purpose of this report is to summarize the after-action assessment.

HNTB previously submitted an After-Action Review Preliminary Findings report to the City of Richmond, which was released to the public on February 14, 2025. It should be noted that there are updates to those findings within this report as additional information was received between the release of the Preliminary Findings and the compilation of this assessment.

## 2. Investigation Process

For the after-action assessment HNTB made a site visit, conducted staff interviews, requested, and received numerous documents from DPU, reviewed available records and data, and reviewed additional, publicly available information.

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HNTB was on site at the DPU's WTP Monday, January 27, 2025, through Wednesday, January 29, 2025. HNTB was joined on site by three (3) representatives from the Virginia Department of Health (VDH) Office of Drinking Water (ODW): Bailey Davis, Chief of Field Operations, Jane Nunn, Compliance and Enforcement, and James Reynolds, Richmond Field Office.

After arriving on site Monday, January 27, HNTB was given a tour of the facility by Doug Towne, Plant Operations Superintendent, and Leroy Rice, Plant Operations Supervisor, Senior. While on site HNTB interviewed the following DPU staff and VDH staff were also present for all interviews:

1. Kenny Weeks, Program and Operations Manager
2. Arnie Eberly, Program and Operations Supervisor
3. Matt (Evans) Brizendine, Utility Plant Specialist Supervisor — Electrical
4. Victor Fischer, Plant Operator
5. Leroy Rice, Plant Operations Supervisor, Senior
6. Doug Towne, Plant Operations Superintendent
7. Eric Whitehurst, Deputy Department Director, Senior
8. Demario Roache, Utility Plant Specialist — I&C
9. Oral Gardner, Utility Plant Specialist — Mechanical
10. Logan Roach, Plant Operator
11. Charles Watts, Plant Operations Supervisor
12. Wyatt Cotner, Plant Operator
13. Tom Marsh, Plant Operator
14. Donald Murray, Plant Operator

After the site visit, HNTB requested to interview former DPU Director April Bingham, but she declined to be interviewed.

Through a series of data requests and responses, DPU provided the following list of documents for

HNTB's review:

1. WTP Operations Organization Chart
2. WTP Maintenance Organization Chart
3. Job Specifications for various DPU positions
4. Clearwell Inspection Reports
5. 2001 Water Master Plan
6. 2020 Condition Assessment Technical Memorandum
7. Water Capital Improvement Plant
8. Department of Public Utilities Emergency Operations Manual (2021 Update)
9. Various WTP Drawings
10. Various WTP Reports
11. SCADA Records
12. Uninterruptable Power Supply Sizing Calculations, Specifications, and Operation Information
13. 2023 and 2024 Maintenance Records

Note this list is not a comprehensive listing but provides a general idea of the documents reviewed as part of the investigation.

# 3. Water Treatment Plant Overview

A brief overview of the WTP is included for reference in other sections of the assessment. The WTP has a rated capacity of 132 million gallons per day (MGD) and consists of two interconnected treatment trains, Plant 1 built in 1924, and Plant 2 built in 1950, which are shown in **Figure 1.** The WTP typically treats 50 to 75 MGD.

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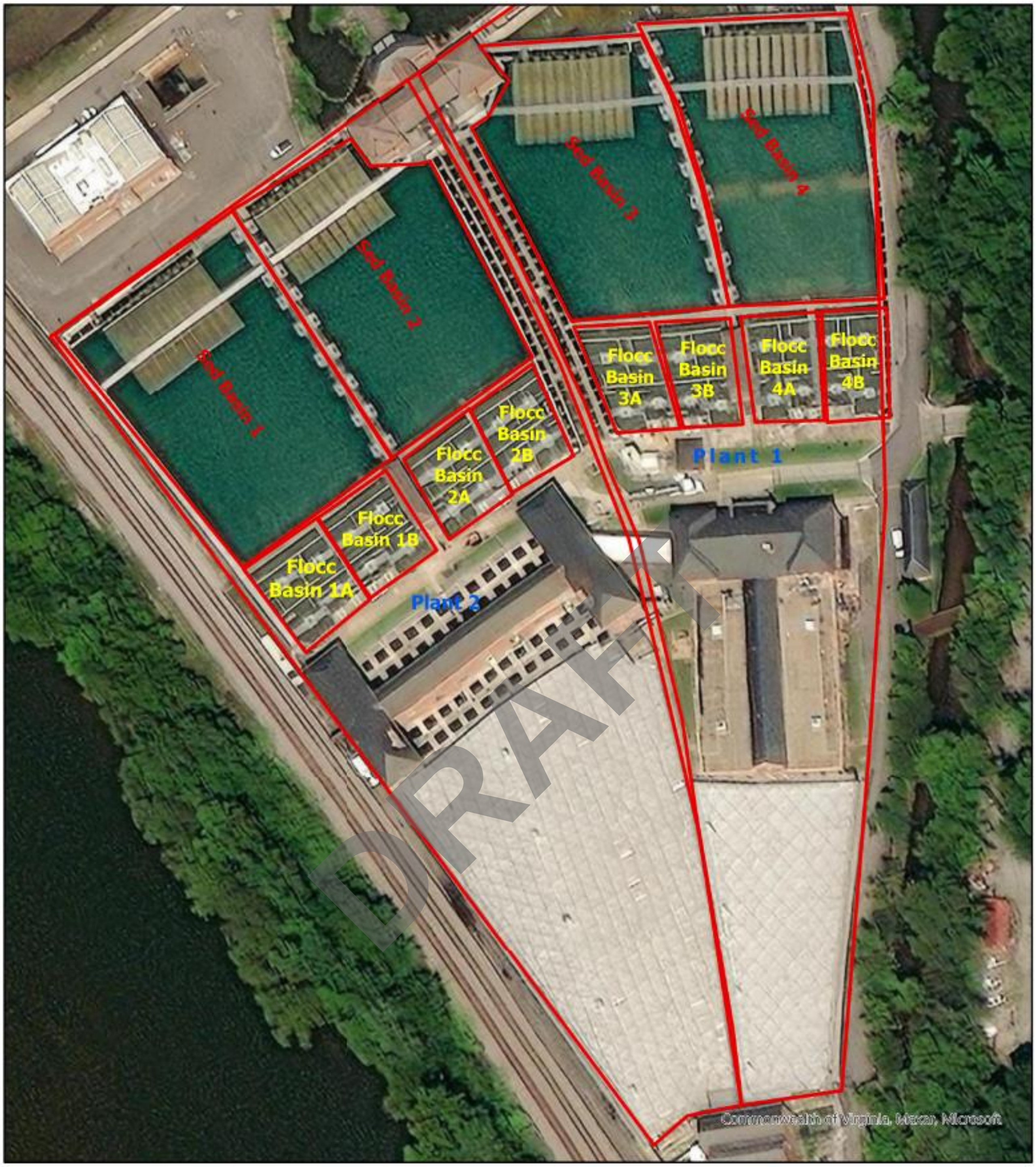


**Figure 1.** WTP Overview[1]

## 3.1. Water Treatment Plant Process

This report focuses on the main flow path through the WTP from low service pumps to the finished water basins. The following terms are used throughout the description of the WTP and upset events and are defined here for reference. Note: There are many other systems, subsystems, equipment, and controls not specifically mentioned here because they are not in the direct path of flow from

[1] U.S. Environmental Protection Agency. (2022). *Safe Drinking Water Act Compliance Inspection Report*

raw to finished water or related to the events being reviewed.

- Low service pumps: pump water from the raw water basin to raw water channels that flow to the flocculation basins.
- Raw water channels: channels in which polymer and alum are mixed with the raw water to start the coagulation and flocculation processes needed to settle out as many solids as possible.
- Flocculation basins: tanks that provide gentle mixing of the raw water to continue the flocculation process and settle out as many solids as possible.
- Sedimentation basins: large tanks that provide large cross-sectional volume, which allows the water to slow down and become less turbulent. As the water becomes less turbulent, solids start to settle out, leaving only smaller, lighter non-settleable solids suspended in the water.
- Filter influent gates: open and close to allow or stop the flow of water into the filters (these gates are manually operated).
- Filters: tanks with filter media that removes the non-settled, non-soluble solids from the water.
- Filter effluent valves: open and close to control the flow of water from the filters to the clearwells (these valves are typically automatically operated).
- Clearwells: water storage structures below the filters that hold water to be used in the backwash cycle to clean the filters or pumped to the finished water basins.
- Filter effluent pumps: pump water from the clearwells to the finished water basins. May also be referred to as finished water pumps, aerator pumps, or aerators.
- Finished water basins: water is stored until pumped into the distribution system for customer use.

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Under normal operation WTP flow is lifted by four (4) low service pumps to then flow by gravity through two (2) raw water channels, eight (8) flocculation basins, four (4) sedimentation basins, and twenty-two (22) filters, ten (10) in Plant 1 and twelve (12) in Plant 2. Lower flow rates can pass through those treatment steps entirely by gravity if the James River level is high enough. Filtered water enters clearwells under the filters in each plant. The filtered water is pumped from the clearwells to finished water basins and is then pumped to distribution. A flow diagram for the WTP is shown in **Figure 2.**

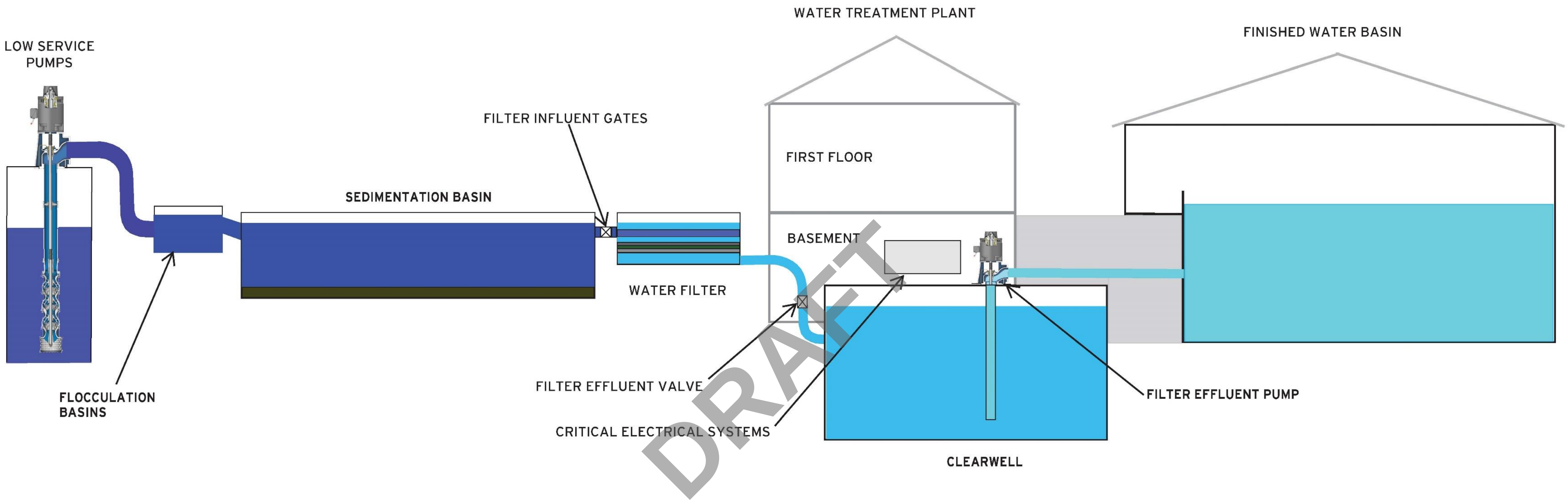


**Figure 2.** WTP Flow Diagram

## 3.2. Water Treatment Plant Electrical and Control Systems

The following electrical and control terms are used throughout the description of the upset event and are defined here for reference.

- Main Feeder: the plant may be powered from two (2) main power supplies labelled as Main Feeder 1 and Main Feeder 2. Power flows from Dominion Energy through either Main Feeder 1 or Main Feeder 2 to Switchgear SG 6.
- Backup Generator: diesel-fueled engines that generate backup power for the WTP.
- Switchgear SG 6: a series of control cabinets designed to act like large light switches to turn on and off power to electrically protect the plant and to switch over to auxiliary/backup power during a loss of power from the electric utility. SG 6 contains a Bus Tie (or Automatic Transfer Switch (ATS)) designed to switch power from Main Feeder 1 to Main Feeder 2 or from Main Feeder 2 to Main Feeder 1 if either power source loses power. There is also manual transfer switch to transfer to power from the generator system to the WTP. Power flows from SG 6 to SG 7.
- Switchgear SG 7: a duplicate circuit of SG 6, which connects power from SG 6 to the WTP via switchboards, electrical panels, Motor Control Centers (MCC), and other power distribution panels and devices.
- SCADA: Supervisory Control and Data Acquisition (SCADA), which is a type of automation and control system that the plant operators use to collect data on how the WTP is operating and to control how the WTP processes are adjusted and operated.
- Electric Valve Actuator: electrical motor used to remotely operate a valve.
- UPS: Uninterruptable Power Supply (UPS) which utilizes batteries to store energy and provide backup power for connected systems.
- Agastat Relay: electromechanical time delay relay inside the Bus Tie Cabinet (part of the switchgear). Closes the bus tie after the power has been off for the set amount of time.
- Relay: a type of electromechanical switch used to turn power off and on.
- ATS: Automatic Transfer Switch (ATS) and is another way of describing the Bus Tie Cabinet function. When there is a power supply failure, the ATS automatically switches over to backup power supply.
- Switch: for the purposes of this document, switch refers to a type of electrical device that is used to open or close an electrical circuit, which turns on and off the power to attached electrical components.
- Summer Mode: refers to the WTP being fed from both incoming power feeders. Allows power from both feeders to flow through each side of the switchgear to different portions of the plant.
- Winter Mode: refers to the WTP being fed from incoming power Main Feeder 1. This allows the entire WTP to be supplied power by Feeder 1 which is less expensive power than Feeder 2. Winter Mode operation was established by DPU over 20 years ago as a cost savings measure during times of the year that power outages from thunderstorms are significantly less frequent.

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The change to Winter Mode happens after September 30 and the change back to Summer Mode happens by May 30.

## 3.3. Switchgear SG 6 and SG 7 Operation

Switchgear SG 6 and SG 7 are operated in one of two modes of operation: Summer Mode or Winter Mode. An illustration of Summer Mode in Switchgear SG 6 and SG 7 is shown in **Figure 3** and an illustration of Winter Mode in Switchgear SG 6 and SG 7 is shown in **Figure 4**. Summer Mode mitigates the risk of a complete WTP power outage when one (1) of the Main Feeders loses power. The Agastat Relay closes the bus tie switch between sides of the switchgear. Summer Mode also allows the Bus Tie/ATS in SG 7 to function as a spare for the Bus Tie/ATS in SG 6. If the Bus Tie/ATS in SG 6 fails to close on loss of a feed, then the Bus Tie/ATS in SG 7 would close and maintain power to the entire WTP. Winter Mode is utilized to take advantage of less expensive power from Main Feeder 1 but requires the Bus Tie/ATS in SG 6 to operate to restore power to the WTP when Main Feeder 1 loses power. When operating in Winter Mode, the Bus Tie/ATS in SG 6 becomes a singular critical component with no redundancy.

## 3.4. Backup Generator Operation

A tertiary backup generator system was installed to provide backup power to Switchgear SG 6 if a hurricane or other natural disaster causes widespread power line failures that would result in the plant not having access to either of the two (2) electric utility power feeds for a long duration of time. The system was installed in response to a hurricane that left the plant without power for several days. The generator system is currently manually operated, but there is a capital project in process that will automate start-up of and transfer to the generator system. Staff interviewed reported a wide variety of times required to start-up the backup generator and transfer power manually, ranging from 5 minutes to 45 minutes.

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## 3.5. UPS Operation

The are two (2) primary UPS units that provide backup power to the SCADA system and filter effluent valves. UPS units are typically only provided for critical systems due to cost and sizes are kept to a minimum to mitigate any adverse effects of power outages or fluctuations. The programming differs between Plant 1 and Plant 2 when the SCADA system in each plant is on UPS power. In Plant 1, the valves are switched to manual mode and set to the current manual set point. If this set point is not zero, the valve does not close, and the operator must set the value to zero to close the valve. In Plant 2, the valves are switched to manual, and the manual set point is set to zero, starting with Filter 11 and then each subsequent filter in 15-second intervals until all are closed.

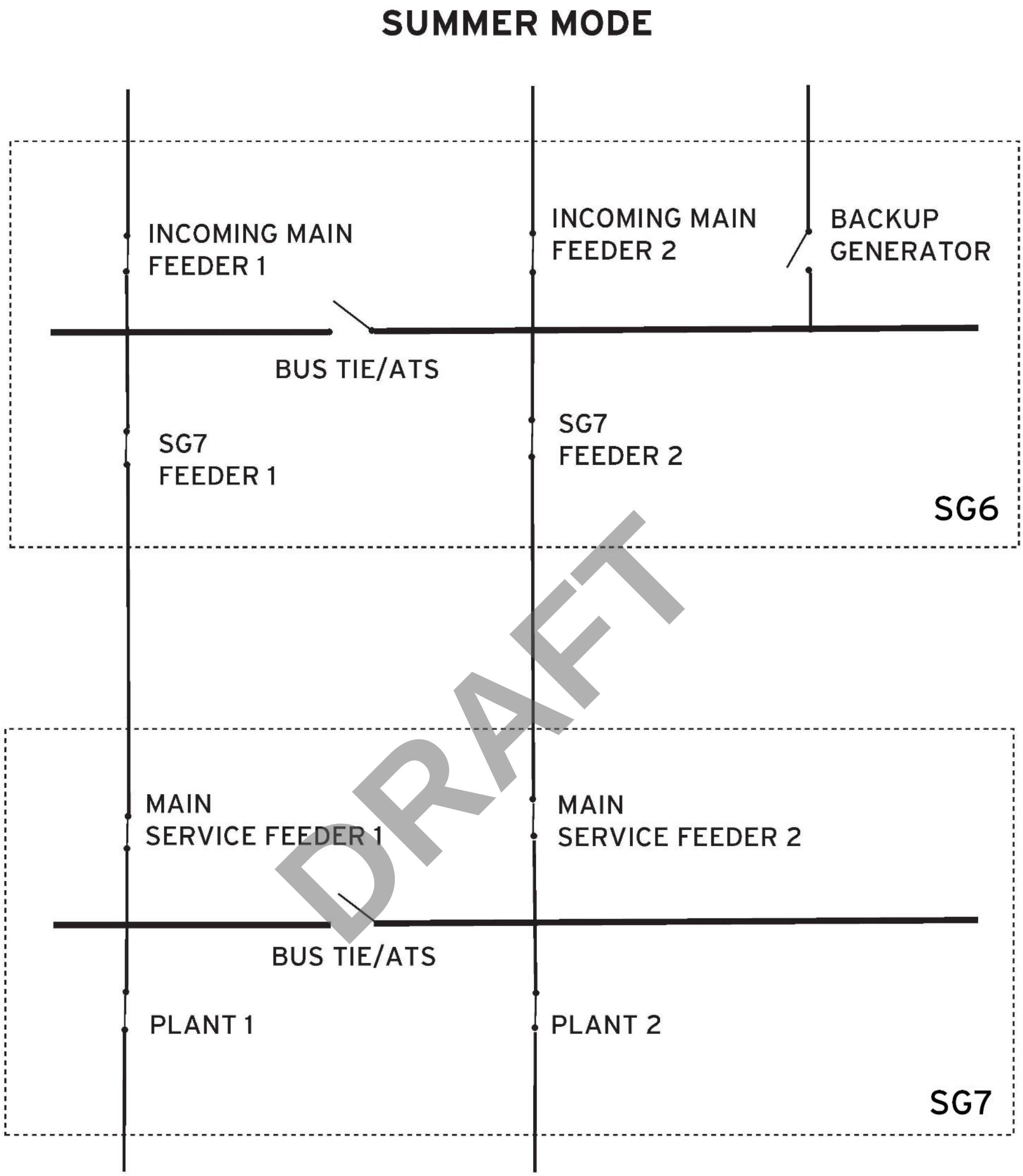


**Figure 3.** Switchgear SG 6 and SG 7 Summer Mode

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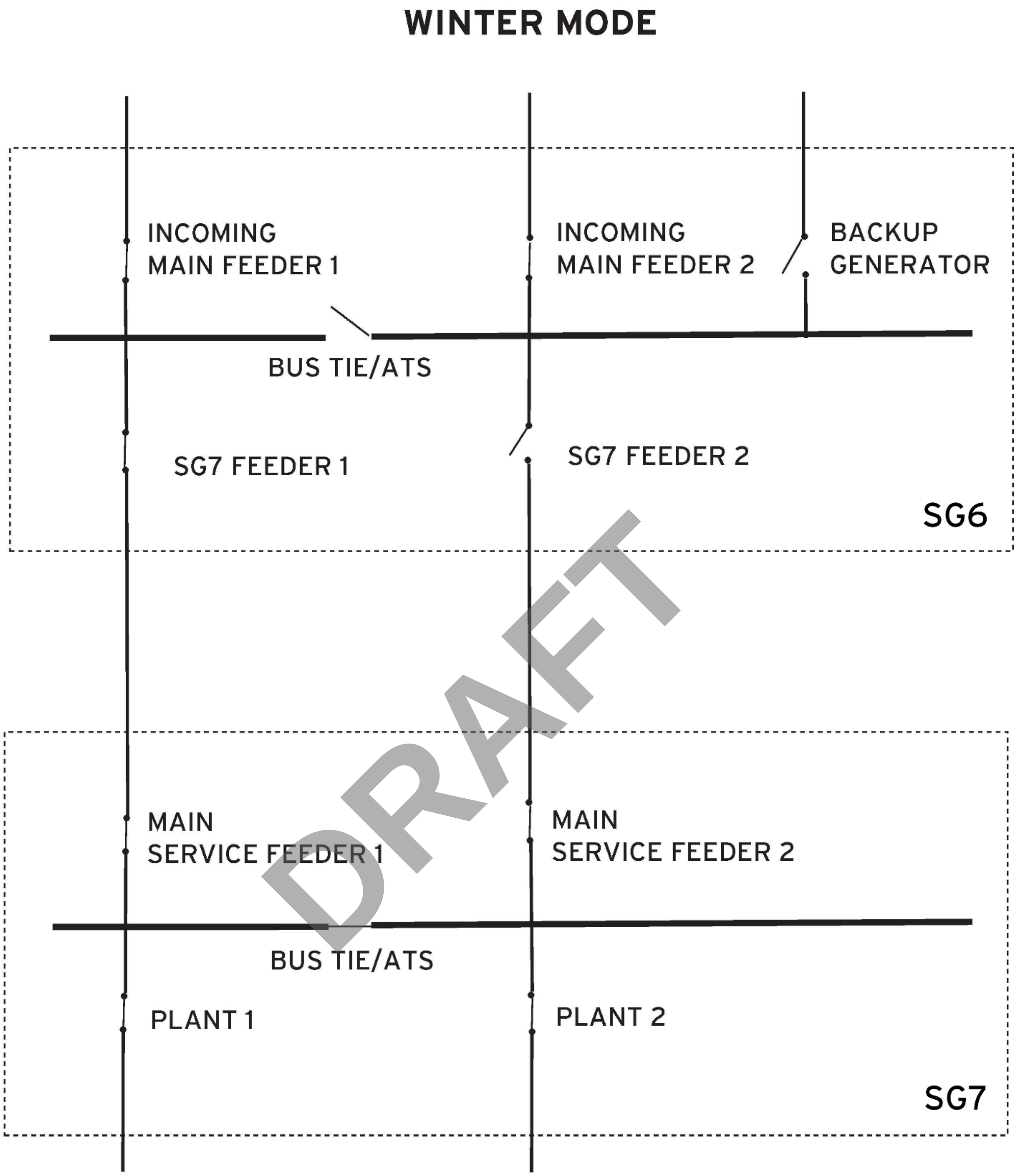


**Figure 4.** Switchgear SG 6 and SG 7 Winter Mode

# 4. Event Description

The WTP experienced a complete loss of power in the early morning hours of January 6, 2025. Staff on site at the time the WTP lost power were one (1) Plant Operations Supervisor, three (3) Plant Operators (two (2) regularly schedule night shift operators plus one (1) day shift operator that arrived early for their shift), and one (1) Utility Plant Specialist — Mechanical. The Utility Plant Specialist was on-site for snow removal. The WTP was operating in Winter Mode, so only Main Feeder 1 was powering the entire facility. Main Feeder 1 from Dominion Energy went out, likely due to icing from the winter storm occurring at the time. Main Feeder 2 still had power. The Bus Tie/ATS in SG 6 failed to automatically transfer from Main Feeder 1 to Main Feeder 2 and the WTP completely lost power. The WTP SCADA system lost communication with the server and stopped functioning at the same time as power was lost. Without power, operators were not able to close filter effluent valves or turn on filter effluent pumps. The filter effluent valve UPS failed to close the filter effluent valves, either due to insufficient battery power or the SCADA system not functioning.

With forward flow of water continuing through the filters by gravity, the water level increased in both clearwells until it reached the plant basements with pumps, valve actuators, electrical panels, and other equipment; ultimately reaching over six (6) feet high in both basements.

One (1) Electrical Utility Plant Specialist (electrician) arrived early for their shift at 6:00 AM. The electrician focused on checking the status of Main Feeder 1 and Main Feeder 2 in SG 6 and SG 7 and manually transferring power from Main Feeder 1 to Main Feeder 2. They did not attempt to start the backup generators and switch to generator power at any point during the event. The Utility Plant Specialist Electrical Supervisor completed the manual transfer from Main Feeder 1 to Main Feeder 2 and restored power to the WTP approximately one (1) hour and 20 minutes after it was lost. The water level was several feet high in both basements, and equipment was damaged by the time power was restored.

Diesel-fueled pumps were used to pump water out of the basements, but they were not able to pump at the rate required to overcome or even keep up with flow rate of water coming through the filters. Additional pumps were brought to the WTP by wastewater treatment plant (WWTP) maintenance staff to help with dewatering. It was not until the flow of water through the filters was stopped at 8:10 AM, approximately two (2) hours and 25 minutes after power was lost, that the pumps were able to start lowering the water level in the basements. The water in the basements damaged equipment which resulted in a complete WTP outage for nearly 36 hours.

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## 4.1. Event Timeline

Through information provided by DPU, information provided by VDH, staff interviews, and review of SCADA, HNTB compiled the following timeline of events. Additional events may have occurred that are not listed. This timeline is intended to capture the critical items related to the event.

| | |
|---|---|
| FRIDAY, JANUARY 3, 2025 | |
| | Virginia Governor Glenn Youngkin declares state of emergency in advance of winter storm that will pass through Virginia January 5 and 6. |
| SUNDAY, JANUARY 5, 2025 | |
| | Richmond Mayor Danny Avula declares state of emergency due to anticipated impact of severe weather. |
| MONDAY, JANUARY 6, 2025 | |
| 4:25 AM | WTP experiences a short power outage (power bump) that only lasts a few seconds. In response to power bump, WTP operators reduce filter effluent flow rate to 1.5 MGD. Finished water pump N3 goes out of service as a result of the power bump. |

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|---|---|
| 4:35 AM | WTP operators attempt to restart N3, but it fails to start effectively. Operators then prime finished water pump N1 as a replacement and start it up successfully. Operators then begin a check of critical equipment throughout the WTP. Operators increase filter effluent flow rate to 3.15 MGD once 60 MGD finish flow is reestablished. |
| 5:45 AM | WTP loses power. SCADA system goes down and loses communication with the plant without power. Operators and Utility Plant Specialist - Mechanical staff that were on hand to help with snow clearing begin priming Godwin dewatering pumps for both Plant 1 and Plant 2. The suction side hose for the Godwin pump for Plant 1 was disconnected from the pump and had to be reconnected, causing a delay in dewatering. |
| 5:50 AM | Operators observe water beginning to rise and flood the basements of both Plant 1 and Plant 2. Operators call WTP Electrical and I&C staff and ask them to come to the WTP to help restore power. |
| 5:55 AM | Operators observe at least 6 feet of water in the pipe gallery (lowest level) in the basements of both Plant 1 and Plant 2. |
| 6:05 AM | Godwin pump for Plant 2 catches prime and begins discharging water from the Plant 2 filter gallery. |
| 6:20 AM | Water was observed spouting from finished water pump N2 check valve. The pump was in the process of being rebuilt after repairs, and a cover on N2's discharge check valve casing was not secured. Water levels had reached the bottom stair of the staircase leading down to both basements. |
| 6:30 AM | Utility Plant Specialist Electrical Supervisor arrives at the WTP, goes to SG 7, and observes no voltage on the meter reader. He then immediately goes to check on SG 6. |
| 6:35 AM | Godwin pump for Plant 1 catches prime after issues with priming and begins discharging water from the Plant 1 filter gallery. |
| 6:40 AM | Utility Plant Specialist Electrical Supervisor opens SG 6 and observes the main feed is lost and that the bus tie that ties feed 1 to feed 2 together had not closed. An attempt is made to close the breaker using the control handle, but the breaker does not close. |
| 6:45 AM | Utility Plant Specialist Electrical Supervisor observes the main feeds. Main Feeder 1 is open without power and Main Feeder 2 is closed and has power. Dominion Energy is called and notified that Main Feeder 1 is down. |
| 7:00 AM | Utility Plant Specialist Electrical Supervisor goes to Main Feeder 1 switch to observe voltage. Phase 1-2 has full voltage (4160V), but Phase 2-3 has 1800V and Phase 3-1 has 2100V. Plant Superintendent notifies DPU Director as well as Chesterfield County and Henrico County plant staff and requests a demand reduction from both systems. |
| 7:05 AM | Utility Plant Specialist Electrical Supervisor closes the bus tie breaker manually by closing the plunger on the breaker manually. Power is restored to the WTP via Main 2. SCADA regains power but has communication errors. There are 2 sump pumps in the basement of each Plant and an unknown number of sump pumps begin to run once power is restored. Water elevation in the Plant 2 basement has reached the bottom of the MCC panel. |
| 7:30 AM | Dominion Energy arrives on site to evaluate and repair Main Feeder 1. |
| 7:40 AM | Operators manually close the settling basin influent and effluent valves. Operators then work to manually close all of the filter influent valves. |
| 7:45 AM | Program and Operations Manager calls the WWTP maintenance staff to support and bring pumps to help dewater. |
| 8:00 AM | Dewatering pumps and additional maintenance staff from WWTP arrive at WTP to support. Maintenance staff work to hook up four 2-inch submersible pumps |
| 8:10 AM | Floodwater continues to rise. Operators and maintenance staff work to confirm that all filter influent valves are completely closed. Once this is completed, water begins to recede in the basement. Dewatering continues throughout the morning and afternoon. |
| 8:30 AM | Dominion Energy restores power to Main 1. The bus tie at SG 1 opens automatically once power is restored. DPU Director notifies Chesterfield County contact that power is restored. Chesterfield returns to normal operation. |

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|---|---|
| 10:00 AM | Plant Superintendent notifies DPU Director and Deputy Department Director that there may be a service interruption and to start considering issuing a Boil Water Advisory. |
| 2:30 PM | Plant 2 is mostly dewatered, and WTP staff begin to dry motors, actuators, and other equipment. |
| 2:50 PM | Representative from VDH calls Plant Superintendent after hearing about issues at the WTP from a third party. Plant Superintendent indicates to VDH that WTP has not produced water since the early morning due to flooding as a result of a power outage. |
| 3:00 PM | Plant Superintendent notifies DPU Director and Deputy Department Director that Byrd Park Reservoir levels are low and have dropped to about 10 feet. |
| 4:26 PM | City of Richmond issues a Boil Water Advisory. |
| 4:30 PM | Plant 1 is mostly dewatered. WTP and WWTP staff begin to dry motors, actuators, and other equipment. |
| 5:30 PM | Representative from VDH arrives at the WTP but cannot get in the gate and could not contact staff at the WTP. Representative leaves the site. |
| 6:50 PM | Representative from VDH arrives at the WTP and is able to get inside the gate. |
| TUESDAY, JANUARY 7, 2025 | |
| 11:30 AM | Field Director from VDH Richmond Field Office arrives at WTP. VDH staff remain on site until the boil water advisory is lifted. |

### 4.2. Treatment Plant Disruption

The water in the WTP basements damaged pieces of equipment and electrical components including valve actuators and pumps. Once dewatering operations were complete, DPU staff worked to dry out equipment and electrical panels to assess what was and was not functional. Several of the filter effluent pumps had to be sent out for refurbishment before they could be placed back in operation and most of the electric valve actuators were damaged and non-functional. At the time of HNTB's site visit, very few filter valve actuators in Plant 1 were working, most of the valves were being operated manually, and DPU was in the process of replacing the non-working actuators. Several of the filter valves in Plant 2 had hydraulic actuators that were not as affected by the flooding. WTP production did not resume until the evening of Tuesday, January 7. Full water service was restored to the distribution system on Thursday, January 9, and the boil water advisory was lifted for the City of Richmond on Saturday, January 11.

Richmond's main reservoir, the Byrd Park Reservoir, has a storage capacity of approximately 55 million gallons (MG). Due to an ongoing construction project at the reservoir, half of the reservoir was out of service and the half in service could only be filled less than three-quarters full, significantly reducing its storage capacity. With this constraint, Richmond's distribution system was at an increased risk be able to meet demands in the event of loss of WTP production.

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## 5. Investigation Findings

### 5.1. WTP Basement Flooding and Dewatering

Flooding of the Plant 1 and Plant 2 basements was the cause of the equipment failures and extended WTP outage. If the filter effluent pumps stop pumping, due to power outage or equipment failure, and flow continues through the filter, the water level in the clearwells can rise quickly, overflow the clearwells, and start flooding the Plant 1 and Plant 2 basements. Operations staff indicated that they prevent flooding from happening or worsening by closing the filter effluent valves, but they have very little time to react. Reaction times reported ranged from five (5) to fifteen (15) minutes. HNTB calculated times for water to reach various depths in the basements based on plant drawings, typical clearwell levels, and WTP flow rates to validate these reaction times. At a WTP flow rate of 60 MGD, water could reach two (2) to three (3) feet of depth in the lowest part of the basement in less than twelve (12) minutes. The time would be even less if the clearwell was at a high level to start. Operators noted that the clearwell level is typically maintained near full to ensure there is adequate finished water for backwashes and to provide better suction conditions for the filter effluent pumps.

All filter valves are in the lowest level of the plants and are accessed via stairs and a number of ladders from platforms in the center of the basement. Manual operation of the valves quickly is impractical because of how they are accessed, the number of valves (22), the amount of time it takes to operate a valve by hand, and the potential safety risks for an operator to be in the lowest levels once flooding starts.

WTP staff interviewed indicated that the basement flooding was a common occurrence at the WTP but that typically meant a small amount of water in the lowest level of the basement that does not damage equipment. Multiple staff interviewed cited a past flooding event, which resulted in an at least 6 (six) hour timeframe where plant production was paused as a result of flooding in the basement. The primary difference noted by staff between the flooding event on January 6 and previous flooding events was that the WTP had power.

Once there is water in the basements, staff use a combination of sump pumps in the plant basements and standby pumps located at grade to pump water out of the basements. The standby pumps are Godwin dewatering pumps with self-priming devices. The pumps have a maximum capacity of approximately 1,770 gallons per minute under ideal conditions. The conditions these pumps are operating in are less than ideal, with nearly 20-feet of suction lift required by pumps and over 60-feet of six (6) inch pipe and hose from the basement to the pump, so the actual pumping capacity is likely less than half of the maximum capacity. The pumps also discharge at grade which can allow the water to flow back into the basements, which did happen in Plant 1 in the dewatering efforts during this event.

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## 5.2. Storm Preparation

Governor Youngkin declared a state of emergency for the State of Virginia on January 3. Mayor Avula followed this up by declaring a state of emergency for the City Richmond due to the anticipated impact of the storm. The Deputy Department Director also participated in calls hosted by the Virginia Department of Emergency Management (VDEM) discussing the winter storm and storm preparation. Despite these indicators of the severity of the incoming winter storm, multiple staff members indicated that there was no discussion of storm preparation from leadership at the at the WTP. Two (2) mechanical staff members were assigned to the overnight shift for the evening of January 5 to help with snow and ice clearing.

There was little proactive action taken at the WTP to prepare the plant for the event of a power outage. Outside of staffing the overnight shift with mechanics for snow removal, there was no formal discussion or written notice or reminders to the staff on specific actions needed to prepare the plant for a potential power outage caused by the storm. There were only informal discussions among the operators at the shift change on actions to take in the event of a power outage. Staff also noted that electrical and I&C staff had been on hand for the overnight shift for previous storm events, but that was not the case for this event. The only preparations taken by staff were to fuel vehicles and backup generators and fill chemical tanks. The backup generators were also verified to be operational by staff during a pre-storm check on January 4. Otherwise, standby equipment was not prepared for the event of a power outage. For example, the suction hose for the Godwin dewatering pump for Plant 1 was disconnected from the pump at the time of the event and had frozen. Staff noted that because the hose was frozen, it took five (5) to ten (10) minutes and three

(3) staff members to reconnect the hose. It also took Plant 1's dewatering pump approximately 30 minutes longer than Plant 2's dewatering pump to catch prime and begin dewatering the basement, which may have been caused by ice around the hose's seal created a poor seal.

WTP staff were not adequately prepared for the incoming storm. Management should have alerted all staff working during the storm about the potentially disruptive nature of the incoming storm and reminded staff of emergency operating procedures. At the beginning of shifts where there are storm events, safety measures and emergency procedures should be discussed with all staff on shift so that they are aware of what actions to take in the event of an emergency, such as a power outage. If there are severe weather conditions where a power outage is possible, actions should also be taken to prepare any standby equipment at the WTP for a potential outage so that time is not spent on procedures that could have been done ahead of time, especially when time is of the essence and all hands on staff are needed to respond.

## 5.3. Power Systems

The WTP was in Winter Mode operation of the switchgear system, and this put the WTP at risk because the SG 6 Bus Tie/ATS becomes a singular critical component. Given the risk, an SG 6 Bus Tie/ATS failure plan should have been attached to the SG 6 Bus Tie/ATS Cabinet and electrical staff trained on its content. If an electrical staff member had been on site during the power failure, then completing a manual transfer as detailed in a failure plan may have prevented the basement water from reaching the critical electrical systems. Once the electrician did arrive on site, they spent time assessing the situation and restoring power via a manual transfer, but it is unclear if they were trained to complete the transfer because the manual transfer was not completed until the electrical supervisor arrived on site.

As noted in the event description, no attempts were made to start the backup generators. DPU staff's focus was on restoring WTP power from Main Feeder 2 once they established that it still had power. This would seem to be the prudent course of action because had the transfer been made in a timely fashion, by having trained staff on site to react accordingly, then the length of time without power would have been minimized and shorter than the time required to manually transfer to backup generator power.

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DPU had a third-party, Electric Power Systems (EPS), review the bus tie failure in SG 6. An email summarizing their findings is included in **Appendix A**. The bus tie failure was attributed to a failed "close" coil. Maintenance staff noted that they use a third-party to inspect and test the switchgear on a three (3) year interval, based on InterNational Electrical Testing Association (NETA) guidance, and the switchgear was due for its next inspection and test in 2025. The failure of the coil would be difficult, if not impossible, to predict, even with more frequent testing.

Based on staff interviews, it is unclear if the filter effluent valve UPS does what it is intended to do and closes filter effluent valves on loss of power. The difference in programming between the plants may explain the confusion about the function of the filter effluent valve UPS. Consistent programming and having the Plant 1 program match the Plant 2 program would minimize confusion and ensure that the filter effluent valves close in both plants automatically. This would also ensure the valves stay closed until an operator has confirmed that the filter effluent pumps are running, and forward flow can resume through the filters without flooding the plant basements. Given that time is of the essence to prevent flooding, the UPS should be sized adequately, and programming changed to close all valves simultaneously.

## 5.4. Staffing

Staffing for operations at the WTP typically consists of three (3) operators: a chief operator, Plant 1 operator, and Plant 2 operator. Prior to the event operators were on 12-hour shifts, two (2) shifts per day. After the event operators were on 8-hour shifts, three (3) shifts per day. Operations management, including Operations Supervisor, Senior and Superintendent are typically at the WTP for a typical day shift and on call at all other hours.

Maintenance staff are typically at the WTP for a typical day shift and then rotate call for after-hours maintenance needs. Staff interviewed indicated that maintenance staff may be scheduled at the WTP for additional shifts during storm events. The discipline (i.e., mechanical, electrical, or I&C) and number of maintenance staff scheduled varied based on staff interviews. At the time of the power outage on January 6, only one (1) mechanical staff member were on site for the overnight shift to help with snow and ice clearing; two (2) were schedule and initially on site but one (1) went home early. There were no electrical or I&C on site at the time of power outage. Only the electrical staff are trained and able to perform the transfer to generator power, so there was not a qualified individual on site to switch to generator power in the event of a power outage.

Based on staff interviews, there are occasional problems finding coverage when an operator calls in sick or otherwise cannot come in, which can result in the plant being staffed by only two (2) operators. As of January 6, there were two (2) operator vacancies at the WTP, which can exacerbate issues in finding staff to cover shifts.

Supervision at the WTP is split such that the Plant Operations Superintendent oversees the operations staff while the Program and Operations Manager oversees the maintenance staff, which includes mechanics, electricians, and I&C technicians. From interviews with WTP staff and leadership, it was evident that this organizational structure created communication issues, where critical information and job needs were not shared across groups, which was amplified during the response to the power outage. Some operations staff noted during the interviews that they did not know what to do or how to help during the event and felt that the initial response efforts were the responsibility of the maintenance staff.

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## 5.5. Training

Based on staff interviews, there are no established training procedures or written training manuals at WTP. While on-the-job training is irreplaceable, written training manuals and job descriptions that are updated regularly are critical to ensure every staff member has access to the same information and critical plant knowledge is not lost as staff retire or move on. Written training documents can help new staff learn procedures quickly. In addition to continual training, annual training and exercises should also be conducted on critical standard operating and emergency procedures to ensure staff are well-equipped to carry them out. AWWA's (American Water Works Association) Utility Management G-Series standards recommend an education or training program to transfer appropriate knowledge, skills, and experience necessary to maintain the competencies of plant personnel to fulfill their tasks and maintain operation at the WTP. AWWA recommends continual assessment of staff skills and knowledge to support the mission of the facility.

Multiple staff members also noted that there was no formal safety training established and that most safety measures were communicated through on-the-job training and reminders. VDH Waterworks Regulations as established in 12VAC5-590-560 require that waterworks owners institute a safety program to inform personnel of known hazards, preventive measures, and emergency procedures pertaining to the operation of the plant.

Appropriate training for both standard operation and emergency operation is critical in allowing staff to effectively respond to emergency situations, such as an extended power outage. It is also critical that there is established safety protocol and staff are aware of job hazards and adhere to safety measures, especially during an emergency situation, as staff safety should be the highest priority. Lack of adequate training and written training documents can lead to a lack of awareness of critical actions that need to occur in an emergency event, such as the event that occurred on January 6.

## 5.6. Operating Procedures

Based on staff interviews of WTP operators, electricians, mechanics, and instrumentation specialists, there is a lack of established written Standard Operating Procedures (SOPs) for typical plant operations and for emergency operations. Some operators noted that there are some written SOPs for basic processes, but some are over a decade old and potentially out of date and multiple operators noted that they would not know where to find these SOPs. It is standard practice at waterworks facilities that SOPs are established to ensure staff are consistent in carrying out processes to operate and maintain the WTP while meeting facility and regulatory requirements. AWWA's Utility Management G-Series standards note that developing and regularly updating SOPs for equipment and plant production processes as a best practice for WTP operation.

It is also a standard practice at waterworks facilities to establish an emergency response plan so that staff can understand how to quickly respond to an emergency situation, such as a power outage. AWWA's Utility Management G-Series standards recommend developing, documenting, and maintaining SOPs specific to emergency preparedness, noting that scenario-specific response actions should be a part of these SOPs. DPU does have an Emergency Operations Manual that was last updated in 2021, but a physical copy of this manual was not available at the WTP prior to or during the events on January 6. This plan also lacks facility and process-specific actions that operators of the WTP would need to take in the event of a power outage, which is common for waterworks of DPU's size. At a minimum, SOP's outlining closing the filter effluent or influent valves in the event of a power outage, initiating standby power, and starting the generator should be included in the Emergency Operations Manual to address critical procedures during a power outage. Staff also noted that they had never been involved in any tabletop exercises to simulate a response to emergency situations.

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VDH Waterworks Regulations as established in 12VAC5-590-505 require that community water works shall develop and maintain an emergency management plan for extended power outages and that the plan be kept current and readily accessible in the event of a power outage. Without awareness of the location or contents of the emergency management plan, staff will not be equipped to take the necessary actions to respond in the event of an emergency.

## 5.7. Asset Management and Maintenance

DPU did not have a separate asset management plan that detailed how assets are maintained and replaced, but did provide the Water Master Plan (2001), Condition Assessment Technical Memorandum (2020), Water Capital Plan, and maintenance work orders for HNTB's review. The Water Master Plan included projects at the WTP that were slated for implementation from 2001 to 2007 however many of these projects were only recently implemented or are just now being implemented per the Water Capital Plan. There could be many reasons for the 20-year delay of capital projects, but it indicates that there may be substantial amounts of deferred replacement that leads to running equipment to failure. The Condition Assessment and work orders indicate that the WTP assets have been cataloged and tagged with unique asset identifiers, so the groundwork has been laid for an asset management plan.

Completed and closed maintenance work orders (WOs) from 2023 and 2024 were reviewed and analyzed. In addition, Operations staff interviewed noted that there is limited access for them to submit work orders for maintenance staff to address items of concern. Only Operations supervisors have access to submit work orders. Multiple operations staff members had indicated that they either were not able or did not know how to access the system to check on the status of a work order. Providing greater access for operators to the computerized maintenance management system (CMMS) could reduce the administrative load on Operations supervisors to submit all corrective maintenance (CM) WOs and allow for greater clarity of maintenance activities and status for operators.

Based on the analysis of the WOs, there are opportunities to improve the detail of the maintenance records and streamline the record keeping ensuring regular and proper maintenance occurs. A majority of the work orders entered into the DPU's CMMS lacked key identifying information and detail, such as asset IDs, asset names, asset locations, and the specific actions taken to complete the WO. This is particularly present in CM WOs, which have a minimal amount of detail and identifiers. Preventive maintenance (PM) WOs contain more asset identifiers but still have a lack of qualitative descriptions of the corrective actions taken to complete the work. From review of the WOs, it was not apparent if maintenance is performed to the degree required. For regular and frequent preventive maintenance, the staff notes for corrective actions taken rarely indicate any further corrective actions are required, such as repair, refurbishment, or replacement.

There were many instances of similar PM WOs open at the same time for the same asset or group of assets, which indicates that some PM is not regularly completed within the recommended time interval. This most commonly occurred with equipment that has PM with multiple intervals within a year and with equipment that requires PM for both individual assets as well as a larger group of assets. There are several individual and group PM WOs which are structured similarly for pumps, motors, and raw water channel mixers. Restructuring of the PM schedule to reduce PM overlap for the same set of assets would decrease the administrative load required to individually review, complete, and close out PMs which overlap.

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PM orders frequently extend past the required interval time or indicated due date to complete and close in the CMMS, with monthly PMs taking longer than a month and quarterly PMs taking longer than a quarter to complete, for instance. Overdue preventative maintenance can cause equipment to leak, malfunction, or not operating properly. Irregular preventative maintenance may lead to increased operations and maintenance (O&M) costs and potentially unnecessary capital investments over the course of an asset's life cycle if equipment is improperly maintained. Maintenance staffing shortages may also be a factor in PMs extending past their required intervals. As of January 6, there were two (2) mechanical vacancies and three (3) electrical vacancies at the WTP.

## 5.8. Communication

There were several communication deficiencies, both internally and externally to major stakeholders, discovered throughout the review process.

Prior to the event, staff members interviewed indicated that there was not any discussion of storm preparation from leadership at the WTP even though the Governor Youngkin had declared a state of emergency on January 3. It was noted by multiple staff members present during the event and in response to the event that there was a lack of leadership and little direction on a course of action.

Staff worked within fragmented groups and communicated with each other to respond to the outage. A clear chain of command should be established and understood by all staff in an emergency situation. Staff also noted multiple instances of moving throughout the WTP during the event without handheld radios. Not only is this a safety hazard with staff's whereabouts potentially being unknown to others, but it is also an efficiency concern as streamlined communication between all responding parties in the event of a time-sensitive emergency is crucial to ensure mission-specific actions are being carried out. Of particular concern was that no warning or communication preceded power being restored to the WTP.

The City of Richmond has three (3) wholesale customers: Henrico County, Chesterfield County, and Hanover County. According to DPU's 2018 Water Supply Plan Update, average daily metered sales to these wholesale customers in 2017 was 26.6 MGD, which accounted for about 45% of the WTP's average daily production. Chesterfield County and Henrico County plant staff were not notified about the event at the WTP until 7:00 AM, over an hour after the plant had lost power. Hanover County was not initially notified because the Plant Superintendent did not have up-to-date contact information. They were not notified about the event until 2:00 PM, over eight hours after the power outage.

In the event of a power outage where water conservation is needed, DPU's Emergency Operations Manual notes that DPU should notify wholesale customers. Only two of the three wholesale customers were notified of the issues at the WTP the morning of January 6, and the discussions at that time did not adequately convey the severity of the situation at the WTP. All three (3) wholesale customers should have been notified about the severity of the situation much sooner so that they could adequately respond, potentially increase production at their own facilities, and implement their own emergency response procedures. Several regional coordination calls did occur between DPU, its wholesale customers, and VDH the afternoon of January 6, but a thorough understanding of the issues at the WTP and the recovery efforts remained unclear to the parties external to DPU. It is critical that DPU's wholesale customers are notified of any plant production issues as soon as they are known and that demand reductions from the wholesale customers are requested if water conservation is needed. Earlier notification about a WTP outage would allow the utilities to reduce their demands on the DPU's system and notify their large users to also reduce their demands. Doing so will limit widespread water supply issues and reduce stress on the water supply systems in the region in the event of a WTP outage.

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DPU failed to reach out to VDH to notify them of the event at the WTP the morning of January 6, and the ODW's Chief of Field Operations first heard of potential issues from the local health department. It was not until a staff member from the ODW's Richmond Field Office called the Plant Superintendent that afternoon that VDH was made aware of the issues at the WTP. While Virginia Department of Health Waterworks Regulations as established in 12VAC5-590-570 requires that VDH be notified within 24 hours of this incident, it is best practice to notify them as soon it was evident that the event was going to impact plant production and impacts to the distribution system were possible. In an emergency event such as this one, VDH can help communicate with other utilities in the region, aid in emergency response, and assist with communication to the public.

## 5.9. Conclusions

The loss of power at the WTP resulted in basement flooding, critical electrical systems becoming submerged in water, and, ultimately, an inability for the WTP to produce drinking water and pressure levels dropping across the distribution system. It could be argued that the root cause of this incident was the power failure of Main Feeder 1; however, that is beyond DPU's control and a power outage is a scenario that the WTP should be equipped to handle, so this cannot be considered as the root cause. The WTP was operating in Winter Mode, so the Bus Tie/ATS in SG 6 was a singular critical component. The failure of the Bus Tie/ATS in SG 6 to automatically transfer from Main Feeder 1 to Main Feeder 2 because a coil in the Bus Tie/ATS failed was determined to be the root cause of the event. If this Bus Tie/ATS worked as intended, the WTP power supply would have been switched over to Main Feeder 2, which still had power at the time of the failure. While this failure was determined to be the root cause, operating in Winter Mode put the WTP at greater risk. Had the WTP been operating in Summer Mode, at minimum Plant 2 still would have had power or the Bus Tie/ATS in SG 7 would have worked as intended and the WTP power supply would have switch over to Main Feeder 2. In addition, the above concerns regarding the basement flooding and dewatering, power systems, control systems, staffing, training, operating procedures, asset management, maintenance, and communication all contributed to the escalation of the event at the WTP on January 6. These factors revealed several concerns and opportunities for improvement regarding operation of the WTP to mitigate the risk of a similar event occurring again.

# 6. Recommendations

The step in the WTP process where water is pumped from the clearwells to the finished water basins is a limiting factor in the operation of the WTP. If the flow is not continually pumped out of the clearwells or the flow into the clearwells is not stopped quickly, there is a high risk of the water level rising in the basement. Maintaining power to the filter effluent valves and ensuring the valves close when power is lost and the WTP is on battery power are critical to ensuring that the water level does not rise from the clearwells into the basements and damage equipment.

## 6.1. Immediate Recommendations

The following actions are recommended for immediate implementation.

- Operate the WTP in Summer Mode all the time or at least during storm events that have risks of power outages (DPU has indicated that this has been implemented as the normal operating mode moving forward).
- Develop a Bus Tie/ATS failure plan, train all electrical staff on the plan, and post the plan on each Bus Tie cabinet (SG 6 and SG 7).
- Review staffing plans and consider staffing the WTP with mechanical and electrical staff during storm events that have risks of power outages. If staffing at this level is not feasible, at minimum implement all other recommendations and develop severe storm event response protocol with requirement that maintenance staff on call during storm events can respond in 30 minutes or less.
- Provide a filter effluent valve UPS with a parallel duplicate backup UPS in each plant, all with minimum runtime of one (1) hour, and ensure that both function as intended to close all filter effluent valves on loss of power. Size the UPS to close all filter valves simultaneously. In lieu of a backup UPS, a small backup generator could be considered to provide backup power in the event of the first UPS failing. The UPS sizing and operation should meet the requirements of Chapter 7 of the Virginia Electrical Code (2020) for Legally Required Systems.
- Install a SCADA UPS with a longer runtime, a minimum of one (1) hour. The UPS sizing and operation should meet the requirements of Chapter 7 of the Virginia Electrical Code (2020) for Legally Required Systems.
    - Provided all other recommendations are implemented, one (1) hour of runtime for all UPS units would be sufficient under normal operating conditions. However, consideration should be given to providing UPS units with longer runtimes based on the outage that occurred during this event, which was an hour and twenty minutes, or 1.3 hours. An additional buffer of 50-percent additional runtime should also be considered for the

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SCADA UPS as well, which would provide two (2) hours of runtime.

- Change the programming in Plant 1 SCADA to match Plant 2 so that the filter effluent valves are set to manual, and the manual set point is set to zero when SCADA is on UPS power.
- Verify filter effluent valve fail safe positions are set to close or reprogram to close.
- Add clearwell high level floats that signal SCADA to override filter effluent valve commands to close the valves.
- Ensure all filter valve actuators are rated as watertight and provide seal-tight fitting and conduit drain fitting prior to the seal-tight fitting within 10-inches of the actuator body. Install a breather fitting near the basement ceiling. Inspect the seal-tight fittings initially after one (1) month and then annually to check if water intrusion has occurred.
- Install visual indicators of filter effluent valve positions with remote open/close switch for each at locations in each basement that are safely accessible by operators in the event of minor flooding.
- Develop written SOPs for plant operation with the input of plant staff. Then, establish a system for training staff on standard procedures and regularly updating SOPs.
- Develop standardized agenda for start of shift or shift change meetings with the input of plant staff. Include safety and emergency operating plan reminders in the agenda and log notes and record of all shift meetings.
- Implement safety program that complies with 12VAC5-590-560 including a safety training program for all staff.
- Expand DPU Emergency Operations Manual to include scenario and process-specific actions plant staff across the entire WTP should take during emergency events. Ensure plan is kept current and readily accessible per 12VAC5-590-505.
- Establish communication protocol to notify wholesale customers (Henrico, Chesterfield, Hanover) and other large users immediately in event of WTP outage to communicate that the WTP is offline and to request a reduction in consumption. Review contact information monthly so that contacts are up to date.
- Install dewatering pumps, such as hydraulic-driven pumps, which avoid high suction head issues affecting the priming of the existing dewatering pumps. Dewatering pumps should also have higher flow rates than the existing dewatering pumps, 3,000 to 6,000 gpm is recommended, and permanent piping that routes water away from the plant basements.

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## 6.2. Long-Term Recommendations

The following actions are recommended for implementation over several years given the time or financial implications of the recommendations.

- Review staffing plans and consider the addition of a float operator to each shift, so that typical staffing is four (4) operators per shift. If there is an issue getting coverage for an operator that needs a day off, there are always a minimum of three (3) operators.
- Raise as many critical electrical systems above the plant basements as practical.
- Provide an automatic transfer system for the existing backup generator system (DPU has indicated that this is included as part of a current capital project).
- Seal clearwell as much as possible by repairing any cracks or spalling in the concrete and sealing any pipe penetrations and hatches to reduce the flow rate at which water from the clearwell can flood the basement.
- Develop and implement an asset management plan that includes maintenance and replacement of water system assets, both in the WTP and out in the distribution system.

## 6.3. Post Recommendation Situational Mitigation

The following details how the recommendations above will reduce the likelihood of an incident or reduce the impact of an incident in the future. This event was started by a loss of utility power however there is a risk that power failure inside of the WTP could lead to a similar event with flooding in the basement.

The WTP can have primary power provided by either Main Feeder 1, Main Feeder 2, or both. Each of these power feed schemes require switchgears SG 6 and SG 7 to properly set up to do so.

Setting up the WTP so that both Main Feeders are powering it (Summer Mode), should be the standard mode of operation. This is a type of quasi-dual power feed where Plant 1 is fed from Main Feeder 1 and Plant 2 is fed from Main Feeder 2; where if one feeder loses power a Bus Tie/ATS engages and allows both Plant 1 and 2 to continue to operate on one (1) power feeder.

Furthermore, this mode of operation allows the Bus Tie/ATS of SG 7 to be operated as a redundant system for the Bus Tie/ATS in SG 6. (Note: Some modification may need to be made to the switchgear(s) to allow for redundant operation. Operation manuals for SG 6 and SG 7 were not available to verify if any modification would be required.) Having a redundant switchgear Bus Tie/ATS substantially mitigates the risk of a primary power failure.

The following steps would take place automatically on loss of Main Feeder 1 (same concept applies for loss of Main Feeder 2):

Step 1. After SG 6 detects the failure of Main Feeder 1, it opens Incoming Main Feeder 1. (This prevents power back feeding to the utility.)

Step 2. SG 6's Bus Tie/ATS closes to continue to supply power to Plant 1. Power is restored and no further steps are implemented. If SG 6's ATS fails to close, then Step 3 is initiated.

Step 3. After a preset amount of time, SG 7 detects the loss of power from SG 7 Main Feeder 1 and opens SG 7's Main Service Feeder 1. (This prevents power from back feeding to SG 6.)

Step 4. SG 7's Bus Tie/ATS closes to continue to supply power to Plant 1.

If both bus ties fail to close, electrical staff would implement the bus tie failure plan to manually close the bus tie and continue to supply power to both plants.

The following steps would take place automatically on loss of both main feeders:

Step 1. After SG 6 detects the failure of Main Feeder 1, it opens Incoming Main Feeder 1 and 2. (This prevents power back feeding to the utility.)

Step 2. SG 6's Generator ATS detects loss of power and starts the backup generators.

Step 3. SG 6's Generator ATS closes to continue to supply power to Plant 1. Power is restored.

In the event of an internal WTP electrical failure, the UPS system will maintain power to the SCADA system and filter effluent valves. The SCADA system will close all filter effluent valves and keep them closed until an operator intervenes and opens the valves.

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If power is maintained to the WTP and the filter effluent pumps in either plant stop due to a different electrical issue, equipment failure or other issue, the high-level float in the clearwell will signal the SCADA system to close the filter effluent valves to prevent flooding.

Should a small amount of flooding occur, more effective dewatering pumps with permanent discharge piping will pump the water down more quickly than the current dewatering pumps.

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# APPENDIX A

# EPS FINDINGS AND RESPONSE TO SG 6 BUS TIE FAILURE

DRAFT

# Brizendine, Matthew E. - DPU

**From:** Ben Condon <b.condon@epsii.com>
**Sent:** Tuesday, January 14, 2025 8:54 AM
**To:** Brizendine, Matthew E. - DPU
**Cc:** RVA-ADMIN
**Subject:** Richmond Freshwater MV Gear Transfer Scheme Troubleshooting

**CAUTION:** This message is from an external sender - Do not open attachments or click links unless you recognize the sender's address and know the content is safe.

Evans,

Arrived on site yesterday to troubleshoot the transfer scheme in the MV Gear.
On arrival I met with Skip to review the events that lead to the plant losing utility power.
Skip informed me when one of the Dominion feeds dropped, the corresponding main break opened, but the tie breaker failed to close automatically. He stated there was a power blip earlier in the morning and it appeared everything transferred successfully earlier that morning. He also informed me a blown fuse had been found and replaced. Talking with the person who responded to the original outage, the TIE breaker was charged on arrival and did not need to be manually charged.

At this time, I reviewed the switchgear wiring diagram. I located a fuse on the drawings that would have been in the "close" circuit for the tie breaker. Audibly asked Skip if the blown fuse was 20 amp FU1 in the tie cabinet. He said yes.

Then we went to visually inspect the switchgear. It was noticed that the White Indicating Light (WIL) was illuminated above the TIE breaker, the WIL should not be illuminated in the state the switchgear was in (both mains closed, tie open, system in auto). The TIE breaker also showed DISCHARGED.
We confirmed both AC and DC control power was present. Therefore, the charging motor should have operated. It was also noticed that the CLOSE push button on the front of the breaker seemed slightly depressed and had not returned to its "ready" state.

We removed the TIE breaker from the cubicle and plugged it into the remote testing station that is inside the switchgear building. The TIE breaker immediately charged (removing the breaker from the cell had let the CLOSE button return to its proper "ready" position). We tried electrically operating the close function on the test station. The TIE did not close. We pressed the CLOSE button on the front of the breaker. Breaker closed but did not start charging again as it should. It was noticed again that the CLOSE button on the front of the breaker was depressed and had not returned to its proper "ready" point. We lifted the breaker and inspected underneath. The close button can be electrically or mechanically operated. The mechanical portion of the button was binding slightly. I manually returned the button to its proper state and the breaker immediately started charging. We again tried to close the breaker electrically, but we were unsuccessful. The CLOSE coil is bad.

At this point we removed a SPARE breaker from the switchgear and performed the same checks.
Plugged in: Breaker charged.
Hit close on test station: breaker closed and recharged to be ready for another operation.
Hit open on test station: breaker opened.
Hit close on front of breaker: breaker closed and recharged.
Hit open on front of breaker: breaker opened.
Hit close on test station: breaker closed and recharged.
Hit open on test station: breaker opened.

This breaker operated successfully and was installed in the TIE cubicle. White Indicating Light above the tie was NOT illuminated. As it should not be.

My assessment is the original TIE breaker had operated successfully and charged from a prior operation because the breaker was charged and did not need to be manually charged to close and restore power to the plant. Then during the outage that dropped the plant, the MAIN opened properly on loss of utility power. The TIE did not close due to a failed CLOSE coil. The coil failing resulted in a blown fuse for the 240v controls in the tie cubicle. Once the fuse was replaced the coil had completely failed to the point of open circuiting, so there was no longer a fault.

The TIE was manually closed, leaving the close button mid "travel". This state of mid travel prevented the breaker from charging again.

I am happy to discuss anything and everything. Feel free to pull me into a call. Please let me know if you have any questions.

Thank You,

**Ben Condon**
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**epsii.com**

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