



King County, Department of Natural Resources
Wastewater Treatment Division

West Point Treatment Plant Capital Program

West Point Treatment Plant Electrical System

Strategic Master Plan – FINAL

Date: November 3, 2021



King County

Department of
Natural Resources and Parks
Wastewater Treatment Division

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Revision History

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Contents

West Point Treatment Plant Electrical System	1
West Point Treatment Plant Electrical System	i
Chapter 1 Executive Summary	1-1
Chapter 2 Introduction	2-1
2.1 Background	2-1
2.1.1 Administrative Order Number 19477	2-2
Chapter 3 Goals, Objectives and Strategies	3-1
Chapter 4 Goal 1: Improve Power Quality and Reliability of Seattle City Light Services to West Point Treatment Plant	4-1
4.1 Objective 1.1: SCL Coordination (Power Quality and Reliability Improvements)	4-1
4.2 Recommendations to Achieve Goal 1	4-2
Chapter 5 Goal 2: Improve Power Quality Within the West Point Treatment Plant Power Distribution System	5-1
5.1 Objective 2.1: Power Quality Improvements Project	5-1
5.2 Recommendations to Achieve Goal 2	5-2
Chapter 6 Goal 3: Improve Electrical Equipment Reliability	6-1
6.1 Objective 3.1: Electrical Improvements Program	6-1
6.2 Objective 3.2: Electrical Equipment Asset Maintenance	6-2
6.2.1 Uninterruptible Power Supplies and Variable Frequency Drives	6-2
6.2.2 Low-Voltage Panelboards	6-2
6.2.3 DC Battery Systems	6-2
6.3 Recommendations to Achieve Goal 3	6-3
Chapter 7 Goal 4: Plan for Future Electrical System Modifications	7-1
7.1 Objective 4.1: Coordination and Implementation of WPTP Planning Projects	7-1
7.1.1 Clean Water Plan	7-1

7.1.2	Digester Capacity Study	7-1
7.1.3	Puget Sound Nutrient General Permit	7-2
7.1.4	Plant Energy Balance	7-2
7.1.5	Plant-wide NFPA 820 Analysis	7-2
7.2	Objective 4.2: Coordination and Implementation of Raw Sewage Pump Replacement Project 7-3	
7.3	Recommendations to Achieve Goal 4	7-3
7.3.1	West Point Master Plan	7-3
7.3.2	Raw Sewage Pump Replacement	7-4
Chapter 8	Implementation of Electrical Strategic Master Plan Recommendations	8-1
8.1	Near-term Recommendations.....	8-1
8.2	Long-term Recommendations	8-1
8.3	Summary of Recommendations	8-2

Tables

Table 1-1.	Recommendations for Electrical Strategic Master Plan	1-1
Table 8-1	Near-term Electrical Activities	8-1
Table 8-2	Recommended Actions for Electrical Strategic Master Plan	8-1

Figures

Figure 8-1	Implementation of Electrical Strategic Master Plan Recommendations.....	8-3
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Appendices

Appendix A	Seattle City Light (SCL) Actions Status Log (September 2021)	
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Acronyms and Abbreviations

ATS	Automatic Transfer Switch
County	King County
DC	Direct Current
Ecology	Washington Department of Ecology
EOL	End of Life
EPS	Effluent Pump Station
ESMP	Electrical Strategic Master Plan
IPS	Intermediate Pump Station
kV	Kilovolts
NFPA	National Fire Protection Association
PSNGP	Puget Sound Nutrient General Permit
RSP	Raw Sewage Pump
SCADA	Supervisory Control and Data Acquisition
SCL	Seattle City Light (electric utility)
TIN	Total Inorganic Nitrogen
TM	Technical Memorandum
UPS	Uninterruptible Power Supply
V	Volts
VFD	Variable Frequency Drive
WTD	King County Wastewater Treatment Division
WPCP	West Point Capital Program
WPMP	West Point Master Plan
WPTP	West Point Treatment Plant

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Chapter 1

Executive Summary

West Point Treatment Plant (WPTP) is the largest of King County's three regional wastewater treatment facilities, providing service to Seattle, Shoreline, north Lake Washington, north King County, and parts of Snohomish County. The facility has experienced loss of power and voltage sags resulting in the shutdown of equipment, and in some cases, secondary bypass and discharge of partially treated wastewater to Puget Sound. One event in July 2019 resulted in both secondary diversion and a full plant bypass.

In response to the secondary bypasses associated with power disruptions at WPTP, the King County Wastewater Treatment Division (WTD) completed a power quality assessment identifying recommended measures to reduce voltage sags and the resulting secondary bypass events. The recommendations included developing a strategic master plan for the electrical system at WPTP to improve overall power reliability and resiliency. Creation of the strategic electrical master plan was also required as a corrective action in Administrative Order 19477 issued by the Washington Department of Ecology (Ecology).

The purpose of this Electrical Strategic Master Plan (ESMP) is to document the goals, objectives and recommendations for maintaining a reliable and resilient electrical power distribution system at WPTP. The findings and recommendations in the ESMP were developed by evaluating:

- Capital improvement projects for electrical infrastructure and electrically-powered equipment that have been approved through WTD's portfolio management process and had funding resources allocated.
- Capital improvement projects for electrical infrastructure and electrically-powered equipment that have been requested but are not currently funded.
- Comprehensive Planning studies and regulatory requirements that will impact future electrical system needs at WPTP.
- Asset management practices associated with replacing aging assets and maintaining reliable equipment.

Recommendations to achieve the goals identified in the ESMP include near-term (0-5 year) efforts that are ongoing (funded) or should occur as soon as funding can be allocated, and long-term (6-20 year) activities that should be initiated when ongoing comprehensive planning studies are complete, and new effluent discharge permit requirements are established. The majority of the near-term activities have funding resources allocated and are underway. ESMP recommendations are summarized in Table 1-1.

Executive Summary

Table 1-1. Recommendations for Electrical Strategic Master Plan

No.	Recommendation	Funding Status	Description
Near-term (0-5 year)			
1	Power Reliability Project	Funded for Study only	Negotiate and execute an electrical service agreement with Seattle City Light to complete actions that improve the reliability and quality of power delivered to WPTP.
2	Power Quality Improvements	Funded	Continue the Power Quality Improvements Project as planned to mitigate electrical voltage sags that can affect critical plant equipment.
3	Electrical Improvements Program	Funded	Complete the Electrical Improvements Program (13kV Distribution System Improvements, Main Substation Improvements and 480V Distribution System Improvements)
4	Low Voltage Distribution	Funded	Evaluate low voltage (less than 480V) panelboards and consider for upgrades depending on outcome of the evaluations.
5	DC Battery Systems	Funded	Evaluate direct current (DC) battery systems and consider for replacements depending on outcome of the evaluations. Evaluation will be completed during the alternatives analysis for the Electrical Improvements Program. If replacement is recommended it will be included as part of the Main Substation Improvements Project.
6	Raw Sewage Pump Replacement	Funded	Continue with the Raw Sewage Pump Replacement Project to increase firm capacity of the RSP system and provide new electrical motors.
Long-term (6-20 year)			
7	West Point Master Plan (WPMP)	Funding for Plan to be requested in future budget allocations	Create a Master Plan for WPTP that determines recommended improvements to meet long-term needs at the facility, including an updated Electrical Master Plan that documents electrical system improvements required to implement recommended improvements. The WPMP will identify recommended capital improvement projects that address condition-related equipment replacement at the time of the plan, and address needs defined by the Clean Water Plan, Digester Capacity Study, plant energy balance, and process improvements required to comply with the Puget Sound Nutrient General Permit during the planning horizon.
8	Implementation of WPMP Electrical Improvements	Funding to be requested in future budget allocations	Electrical improvements identified in the West Point Master Plan will be reviewed through WTD's Portfolio Management process for funding approval in future capital budgets.

Chapter 2

Introduction

The WPTP ESMP was developed to provide a unified outline and a high-level review of electrical power distribution improvements projects, and to document how these projects achieve WTD's goals and objectives for electric power at WPTP. The ESMP also identifies new recommendations that should be funded and completed to achieve the stated goals for electrical system reliability and resiliency. WPTP is a critical element of King County's regional wastewater treatment system that will continue to benefit from a reliable, resilient electrical power distribution system to provide dependable wastewater treatment plant operation now, and in the future.

2.1 Background

On July 19, 2019, WPTP electrical service experienced a brief reduction in voltage (known as a voltage sag) that resulted in a shutdown of pumps critical to operation of the plant, and a temporary discharge of untreated wastewater into Puget Sound. Similar voltage sags leading to critical pump shutdowns have previously occurred, however, discharge of wastewater was avoided in these instances due to lower wastewater flow through the plant, and rapid response by WPTP operations staff. These events led to a mutual interest from King County (which owns and operates WPTP) and Seattle City Light (SCL, which operates the electric utility serving WPTP) to identify and address the root causes of full plant bypasses and secondary bypasses related to power system disruptions. As a result, a power quality assessment was performed, and the results and recommendations summarized in the *West Point Treatment Plant Power Quality Assessment Report* (Brown and Caldwell 2020).

The *Power Quality Assessment Report* recommendations included the following:

“Create a strategic master plan for West Point electrical systems that establishes the objectives and vision for future work at West Point, identifies a prioritized list of projects to meet those objectives, and describes the sequence for implementing planned projects.”

Subsequently, the State of Washington Department of Ecology (Ecology) issued Administrative Order number 19477 requiring King County Wastewater Treatment Division (WTD) to implement corrective actions to address secondary bypasses caused by the voltage sag issues and complete the strategic master plan recommended in the *Power Quality Assessment Report*.

Several near-term electrical capital improvement projects have been funded by WTD to address requirements associated with aging electrical infrastructure at WPTP. The scope of the ESMP includes the electrical power distribution system primarily within the fence line at WPTP. It does not include instrumentation and control systems, lighting systems, and other special systems (fire alarms, communications, security, etc.). In addition, the SCL electrical services located outside the WPTP property, which are being addressed by a separate effort, are also not

Introduction

included as part of the detailed ESMP but are briefly discussed herein as part of the long-term objectives for improved power reliability at WPTP.

2.1.1 Administrative Order Number 19477

On February 2, 2021, Ecology issued Administrative Order 19477 to WTD regarding multiple secondary diversion events related to issues with the power quality delivered to the plant by SCL and WPTP's protective pump controls and main electrical power system. These bypass events varied in duration from five to 45 minutes, and bypass volumes ranging from 0.05 to 2.5 million gallons; the events were primarily related to voltage sags experienced on the utility supply to WPTP.

WTD contracted with Brown and Caldwell to perform an independent power quality assessment of WPTP, which was completed on May 28, 2020. This assessment was provided to Ecology and was the basis for the directives in the Administrative Order. The directives included in the Administrative Order are as follows:

1. Produce a report describing proposed changes to the Ovation (SCADA) system control logic for the IPS and effluent pumps that WTD evaluated and implemented to allow the pumps to operate longer during a voltage sag (see Near-term Action 2 in Attachment 1). The report must describe all implemented changes and all proposed changes considered but not implemented. For any change not implemented, discuss the reason for not implementing the change. Submit this report to Ecology by June 30, 2021.
2. Produce a report describing other process, mechanical, or operational strategies WTD can use to mitigate against unauthorized secondary diversions at the WPTP. The evaluation must identify potential strategies that prevent unauthorized secondary diversions and determine whether each strategy is feasible to implement. If prevention options are not feasible, identify strategies considered to minimize duration and volume of unauthorized diversions and to mitigate against possible water quality impacts of those diversions. Include in the report a schedule for implementing each feasible measure in the shortest time possible. Submit this report to Ecology by September 30, 2021.
3. Develop a strategic master plan for West Point's electrical system (see Near-term Action 1 in Attachment 1). As part of the master plan, identify near-term electrical system modifications WTD will complete in the next 3-5 years to improve overall power reliability and resiliency. The plan must evaluate as a potential modification the feasibility of installing voltage regulating equipment that can reduce the number of voltage sags observed at the West Point Treatment Plan (see Near-term Action 5 in Attachment 1). Include in the plan a detailed implementation schedule for the corrective actions. Submit the plan and schedule to Ecology by December 31, 2021.
4. Implement corrective actions according to the schedule in the strategic master plan (see corrective action 3) no later than December 31, 2025. If the master plan schedule proposes completion dates after December 31, 2025, WTD must

Introduction

demonstrate to Ecology that earlier completion is not feasible. Ecology will evaluate reasonable extension of this schedule date on a case-by-case basis.

This ESMP is intended to partially address Item 3 in the directives noted above and provide a plan to maintain a reliable and resilient electrical distribution system at WPTP. In WTD's efforts to comply with the Administrative Order, the work directly associated with evaluation of voltage regulation equipment (Directive 3) and the related implementation (Directive 4) are being performed under a separate Power Quality Improvements Project outside of this ESMP, which has been fully funded by WTD. In addition, WTD is coordinating with SCL regarding potential improvements to their electrical services to WPTP, identified as Power Reliability Improvements. The Power Reliability Improvements work has been funded by WTD for the evaluation/study phase only.

Directives 1 and 2 have been addressed separately by WTD.

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Chapter 3

Goals, Objectives and Strategies

The purpose of the ESMP is to identify the goals, objectives and strategies needed to plan for a reliable and resilient electrical power distribution system at WPTP.

The ESMP goals and corresponding objectives are outlined below.

- Goal 1: Improve power quality and reliability of SCL services to WPTP
 - Objective 1.1: SCL coordination (Power Quality and Reliability Improvements)
- Goal 2: Improve power quality within the WPTP power distribution system
 - Objective 2.1: Power Quality Improvements Project
- Goal 3: Improve electrical equipment reliability
 - Objective 3.1: Electrical Improvements Program
 - Objective 3.2: Electrical equipment asset maintenance
- Goal 4: Plan for electrical system modifications because of WPTP modifications that will be required to address regulatory requirements
 - Objective 4.1: Coordination and implementation of WPTP planning projects
 - Objective 4.2: Coordination and implementation of Raw Sewage Pump Replacement project

These goals are intended to:

- Address short-and long-term electrical power distribution needs at WPTP to improve overall reliability and resiliency.
- Ensure that aging electrical equipment is replaced in a timely fashion to maintain reliable operations.
- Plan for significant WPTP process modifications that are occurring and/or likely to occur based on current planning studies and expected regulatory modifications. These process modifications are expected to have significant impacts on the existing WPTP power distribution system and other related systems at WPTP.

Strategies to achieve the defined goals above are presented in the following chapters.

Recommendations include:

- Complete ongoing and planned capital improvements that have been approved through WTD's portfolio management process and had funding resources allocated.

Goals, Objectives and Strategies

- Continue to replace equipment based on established replacement cycles through WTD's existing asset management program.
- Provide funding for evaluation to confirm that all electrical assets are included in the asset management program and determine formal replacement schedules where expected useful life is not identified.
- Allocate funding for and complete new comprehensive planning studies.

Chapter 4

Goal 1: Improve Power Quality and Reliability of Seattle City Light Services to West Point Treatment Plant

4.1 Objective 1.1: SCL Coordination (Power Quality and Reliability Improvements)

WTD has been evaluating alternatives to improve power quality and reliability for the sources of electric supply to the plant. SCL supplies power to the WPTP via two 26 kilovolt (kV) services from SCL distribution-level substations, the Canal Substation and the Broad Street Substation. The Canal Substation serves as the primary feed for the treatment plant, while the Broad Street Substation serves as a back-up feed that is activated if the Canal Substation feed goes down. Alternating between feeds is controlled by an automatic transfer switch (ATS) in SCL's yard at the treatment plant. Once an outage has been confirmed at the Canal Substation, the ATS takes approximately 10 seconds to switch from the faulty feed to the live feed. No power is being delivered to the WPTP during that 10-second period, and the systems that do not have battery backup power shut down. Once power is supplied back to the plant, plant systems must be restarted and brought back into an operational state. For some equipment at the WPTP, this startup process can require up to 20 minutes. The lack of power to essential plant systems during this period of switching and startup can lead to full plant bypasses or bypass of the secondary treatment system.

Other WTD treatment facilities receive their electrical utility power at 115kV (transmission level service), which has a higher degree of reliability and is not as prone to propagating voltage sags. WTD has been working with SCL to determine the feasibility and cost to implement either replacement of the 26 kV distribution level services with 115 kV transmission level services to WPTP, or installation of a truly redundant and dedicated second 26kV distribution level feed service that includes advanced switching.

In collaboration with WTD, SCL has identified eleven corrective actions that the utility can implement to improve power quality and reliability at WPTP. These actions are documented, tracked and monitored by SCL and WTD. Appendix A includes a summary of the action log as of September 2021. Although WTD is not responsible for completing these corrective actions, staff are coordinating closely with SCL to review proposed actions and ensure those actions do not negatively affect either plant operation or ongoing construction activities.

Preliminary cost estimates for various dedicated second utility feed alternatives range from \$50 million to more than \$200 million. King County has approved funding support for WTD's study of power quality and reliability improvements for the WPTP. Work on this study is ongoing, and

Goal 1: Improve Power Quality and Reliability of Seattle City Light Services to West Point Treatment Plant

final implementation plans have not been established nor funded. Cost responsibilities will need to be negotiated with SCL.

4.2 Recommendations to Achieve Goal 1

It is recommended that WTD and SCL continue the ongoing coordination effort and develop an implementation plan to continue to improve SCL's overall power quality and reliability to WPTP. As part of this effort, it is recommended that WTD establish a formal agreement with SCL to establish mutually-agreeable terms, conditions, goals, plans, schedules, and accountability for providing long-term power quality and reliability to the WPTP from SCL. Such an agreement should define expectations for each party and bring focus to completing improvements to the WPTP power services in a timely fashion.

Chapter 5

Goal 2: Improve Power Quality Within the West Point Treatment Plant Power Distribution System

5.1 Objective 2.1: Power Quality Improvements Project

Corrective Action 3 of Administrative Order 19477 required WTD to “evaluate as a potential modification the feasibility of installing voltage regulating equipment that can reduce the number of voltage sags observed at the West Point Treatment Plant.” WTD has funded and begun design of the Power Quality Improvements Project. This project will provide:

- Upgrade/optimization of the existing pump variable speed controls to allow pumps to ride through most voltage sag events.
- New, large scale, uninterruptible power supply (UPS) systems to mitigate electrical voltage sags that have been affecting critical process/pumping systems.

Upgrade and optimization of the existing pump controls includes hydraulic analysis to confirm capacity as well as to confirm that ride-through will not damage the plant outfall. The hydraulic analysis will be complete by the end of 2021.

Revisions to drives will be made on one pump in the Intermediate Pump Station (IPS) and one pump in the Effluent Pump Station (EPS) to confirm functionality. This confirmation exercise requires that the plant experience a voltage sag to prove the functionality of the drive modifications. Once the functionality is proven, revisions will be implemented on the remaining drives if supported by the hydraulic analysis. The estimated completion date for the first two drives is November 30, 2021. Once the drives are tested over the wet season, and if supported by the hydraulic analysis, revision of the remaining drives is planned for completion by June 1, 2022.

The large-scale UPSs will supply power to the IPS and EPS and provide resiliency to voltage sags and short outages that are not mitigated by the previously described measures. Installation of the UPS system requires the demolition of an existing building and the construction of a new building with robust foundations to carry the 1,300,000 pounds of electrical and ancillary equipment associated with the new UPS system. Once startup and commissioning of the new UPS is complete, the UPS system will mitigate voltage sags that would impact IPS and EPS operations. As of issuance of the ESMP, the approximate timeframes for completion of the Power Quality improvements are as follows:

Goal 2: Improve Power Quality Within the West Point Treatment Plant Power Distribution System

- Start of construction: Third Quarter 2022
- Substantial completion: Second Quarter 2024

5.2 Recommendations to Achieve Goal 2

Successful implementation of the Power Quality Improvements Project is expected to achieve this goal. No additional recommendations are warranted at this time.

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Chapter 6

Goal 3: Improve Electrical Equipment Reliability

6.1 Objective 3.1: Electrical Improvements Program

A great number of the electrical assets at WPTP are reaching the end of their useful lives. While WTD has replaced many assets in conjunction with capital improvements at the plant, WTD recently conducted a formulation effort that identified three (3) major components of electrical improvements needed at the WPTP in the near-term. These components or projects are:

- 13kV Distribution System Improvements
- Main Substation Improvements
- 480V Distribution System Improvements

The projects mentioned above are now combined into the WPTP Electrical Improvements Program and are intended to replace equipment that has been identified as at, or reaching, the end of its useful life. The Electrical Improvements Program implements recommendations of the *Electrical Improvements Project Scope Definition Technical Memorandum* (Jacobs Engineering Group 2020). The program has been funded by WTD and is expected to start planning for preliminary design in late 2021.

A significant process-related project in the near-term that will affect the electrical power distribution system is the Raw Sewage Pump (RSP) Replacement project currently in predesign. This project will replace the existing RSP engines with new electric motors and variable frequency drives (see Chapter 7). Due to the expected additional electrical load associated with the RSP motors, this project includes improvements to the existing 13 kV Main Substation to provide power to the new equipment. The RSP Replacement Project also includes necessary improvements to the 480V distribution equipment associated with the RSP facility. WTD has been actively coordinating to assure that interfaces between the RSP Replacement Project and Electrical Improvements Program are managed efficiently.

Discussions with the Comprehensive Planning staff identified several upcoming planning studies and expected new discharge permit limits that may have substantial, long-term impacts to the treatment processes at WPTP (see Chapter 7). Based on the estimated timing for these changes, it is recommended that the Electrical Improvements Program proceed as planned. Delaying the projects comprising this Program could increase the likelihood of electrical equipment failures, potentially increasing the possibility of future secondary bypasses.

Goal 3: Improve Electrical Equipment Reliability

6.2 Objective 3.2: Electrical Equipment Asset Maintenance

The *Electrical Improvements Project Scope Definition Technical Memorandum* and WTD asset management data were reviewed to assess the asset classes included and the asset replacement frequency used as a basis of WTD's electrical equipment replacement. This review showed that existing capital projects and planned equipment replacement will result in timely replacement of the majority of electrical assets at WPTP. Of the assets for which the installation date and end-of-life date are included, the replacement intervals are appropriate and consistent with industry standards and asset replacement is being completed based on scheduled replacement dates. WTD should continue to maintain and update information in the asset management database.

The review identified two asset classes for which replacement cycles are not fully documented in WTD's asset management database: 1) low voltage (under 480 volts) panelboards, and 2) DC battery systems. These asset classes and recommended actions are described in Sections 6.2.2 and 6.2.3 below.

6.2.1 Uninterruptible Power Supplies and Variable Frequency Drives

Uninterruptible power supplies (UPSs) provide continuous power to equipment and control devices in the event of a power outage, and therefore are critical to continuous operations at WPTP. WTD manages UPS replacements through the existing asset management program and is replacing UPS equipment at a frequency that is standard in the industry for this type of equipment.

Variable frequency drives (VFDs) are used to vary the speed of three phase electric motors and are typically applied to pumps and similar equipment at wastewater treatment plants. WTD manages the replacement of all VFDs on motors supplied with 480V powers through the existing asset management program. The VFD replacement occurs at a frequency that is standard in the industry for this type of equipment.

6.2.2 Low-Voltage Panelboards

WTD has not evaluated low voltage (under 480 volts) panelboards for a replacement frequency. Currently, these systems are repaired by WTD staff when failures occur. It is recommended that this type of equipment be evaluated, and a replacement cycle and replacement plan be put in place based on equipment condition and industry standard replacement frequency.

6.2.3 DC Battery Systems

WPTP has three DC battery systems (batteries/chargers) that provide critical power for switchgear and other controls. These battery systems have not been replaced since their original installation (circa_2011) and there is no current schedule to replace these systems in their entirety. Battery replacements are noted in the asset database to be performed every five

Goal 3: Improve Electrical Equipment Reliability

(5) years by O&M staff, which is a reasonable schedule. It is recommended that these systems be evaluated, and replacement scheduled accordingly. Based on the findings of this ESMP, evaluation of the DC battery system has been added to the scope of the alternatives analysis included in the Electrical Improvements Program. If replacement or upgrade is recommended, it will be included in the Main Substation improvements being completed as part of the Electrical Improvements Program.

6.3 Recommendations to Achieve Goal 3

The following recommendations are included to achieve Goal 3:

- Complete the Electrical Improvements Program.
- Continue to replace UPS and VFD equipment based on existing established replacement cycle.
- Add DC Battery System assessment to the Electrical Improvements Program and develop a long-term replacement cycle for battery and charger systems.
- Provide funding for evaluation of low voltage panelboards. Confirm that complete asset information is included in the asset management database and develop a long-term replacement cycle.

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Chapter 7

Goal 4: Plan for Future Electrical System Modifications

7.1 Objective 4.1: Coordination and Implementation of WPTP Planning Projects

Additional, future electrical system requirements at WPTP will be driven by the findings of comprehensive planning efforts currently underway. WTD's approach to implementing the capital improvements is to address new regulatory requirements for discharge to Puget Sound. Final recommendations could significantly change the long-term electrical system requirements at WPTP. Current comprehensive planning studies, regulatory drivers, and information needs were identified through workshops with WTD staff and are described below.

7.1.1 Clean Water Plan

WTD is currently developing a system-wide comprehensive plan called the *Clean Water Plan* to provide guidance for the significant investment that will be required to protect regional water quality and manage wastewater services for WTD's service area. The plan will assess demands on the regional wastewater system and develop strategies that allow WTD to weigh the water quality benefits and wastewater rate impacts of various strategies. The *Clean Water Plan* recommendations will guide capital project requests in future budget cycles. The electrical system requirements associated with these projects will be determined by the recommended alternatives selected for implementation of each capital improvement project.

7.1.2 Digester Capacity Study

WTD completed the *King County Treatment Plant Flow and Loads Study* (Brown and Caldwell 2019) to determine the timeframe in which existing unit processes will reach their treatment capacity. The *Treatment Plant Flow and Loads Study* identified digester capacity as one of the critical treatment capacity limitations at WPTP. The next step in WTD's comprehensive planning process is to develop conceptual alternatives and define potential solutions to address the capacity need. These potential solutions will form the basis of capital project planning, design, and implementation.

The solids handling needs at WPTP are complex and a long-term strategy to provide required capacity has not been developed. Because of space constraints at the WPTP site, the alternatives for expanding digester capacity may include high-rate processes that use a smaller footprint than the current digestion process but have a higher energy demand. The higher energy demand could require revisions and/or upgrades to the electrical system. In 2021, WTD initiated a digester capacity study to assess the solids capacity need, evaluate secondary

Goal 4: Plan for Future Electrical System Modifications

objectives for digestion, and recommend next steps to provide sufficient digestion capacity. This study will be completed in 2023 and will also inform long-term electrical requirements at WPTP.

7.1.3 Puget Sound Nutrient General Permit

Ecology has developed a Draft Puget Sound Nutrient General Permit (PSNGP) to regulate the discharge of total inorganic nitrogen (TIN) into Puget Sound. The Draft PSNGP requires that WTD's TIN effluent load remain below a specified action level. Ecology is continuing to develop water quality standards for TIN, and future permits may include numerical TIN effluent limits for facilities discharging to Puget Sound. WTD's strategy for addressing current and potential future general permit requirements could change the type of treatment used at WPTP, and therefore impact the electrical distribution equipment required at the plant.

7.1.4 Plant Energy Balance

In addition to electrical power, WPTP utilizes a variety of energy sources for operations. Examples include:

- Biogas created from the digestion process, which supplies fuel for boilers, provides power to RSP engine drives, and supplies cogeneration equipment generating heat and electric power.
- Propane gas, which is used to supply boilers, a small standby generator, and waste gas burner pilots, and is also a supplemental source of power for RSP engines.
- Heat generated from the RSP drive engines, which is extracted for heat loop used for the digestion process as well as for building heating.

WTD is designing improvements to replace the RSP drive engines with new, variable speed electric motor drives. When this occurs, biogas will be redirected from the RSPs to the boilers to offset the loss of heat recovered from the gas-fired drive engines. WTD staff identified the need for an overall plant energy balance to make long-term decisions regarding the capacity of all the available energy sources and the load associated with the utilization of these energy sources in a coordinated, efficient manner. This plant energy balance will inform long-term electrical power needs at WPTP.

7.1.5 Plant-wide NFPA 820 Analysis

The National Fire Protection Association (NFPA) establishes standards to protect against hazards associated with fire and explosions in wastewater treatment plants. NFPA 820 identifies hazard classifications that determine the safety features that should be included in electrical equipment based on the environmental conditions in close proximity to the equipment. WTD last completed a plant-wide analysis to identify hazardous/classified locations in the 1990s. A comprehensive update based on current NFPA 820 guidelines and considering current and recommended future treatment process changes would help WTD staff determine the appropriate requirements and safety protection features for new electrical equipment.

Goal 4: Plan for Future Electrical System Modifications

7.2 Objective 4.2: Coordination and Implementation of Raw Sewage Pump Replacement Project

WTD is completing predesign of a project to increase the firm capacity of the RSPs and replace the existing engine-driven RSPs with new electrical motor prime movers and variable frequency speed controllers.

As noted in Section 6.1, the expected additional electrical load associated with the RSP motors will require improvements to the existing 13 kV Main Substation to provide power to the new equipment. The RSP Replacement Project also includes necessary improvements to the 480V distribution equipment associated with the RSP facility. WTD has been actively coordinating to assure that interfaces between the RSP Replacement Project and Electrical Improvements Program are managed efficiently.

In addition, WTD has been actively coordinating to address other impacts to the WPTP that are a result of the change from engines to motor drives for the RSPs. Several of these items are discussed in Section 7.1.4, Plant Energy Balance.

7.3 Recommendations to Achieve Goal 4

The following recommended actions are needed to ensure reliable power distribution at WPTP.

7.3.1 West Point Master Plan

The electrical systems (and other plant and process systems at WPTP) are expected to undergo significant changes as WTD institutes projects recommended in the current comprehensive planning efforts and required to meet new effluent discharge limits. These efforts are not yet defined enough to determine the associated electrical system improvement requirements. To achieve Goal 4, it is recommended that WTD complete a West Point Master Plan (WPMP) that holistically considers the long-term treatment needs and effluent discharge requirements at WPTP and establishes recommended Capital Improvement Projects that WTD can consider for funding and implementation.

Often, treatment plant facility plans are primarily focused on process improvements and/or modifications, and the other on-site utilities are addressed as part of the detailed design efforts later. In the case of WPTP, the complex inter-relationships of all the systems and the limited available site space necessitate that the plant be evaluated on a holistic basis. It is critical that the WPTP electrical systems be evaluated and included as part of the WPMP to ensure long-term electrical reliability, resiliency, capacity and redundancy as they are considered to minimize the possibilities of plant upsets or secondary bypasses. The WPMP should also include an update of the plant-wide NFPA analysis to document area classifications following recommended plant improvements, and an updated plant electrical single-line diagram clearly indicating changes required as part of each recommended capital improvement project. Electrical improvements recommended in the WPMP will be evaluated through WTD's Portfolio Management process for funding and approval in future capital budgets.

Goal 4: Plan for Future Electrical System Modifications

7.3.2 Raw Sewage Pump Replacement

Successful implementation of the Raw Sewage Pump Replacement Project is expected to achieve this goal. No additional recommendations are warranted at this time.

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Chapter 8

Implementation of Electrical Strategic Master Plan Recommendations

The existing projects, ongoing studies, and recommended activities form a comprehensive set of actions to maintain reliable power for the existing electrical system. This section summarizes the ESMP recommendations, documents the timeframe during which the recommendations occur, and illustrates the relationships between them.

Recommendations are defined as near-term (0-5 years) or long-term (6-20 years) based on their funding status, urgency, and dependency on other ongoing activities.

8.1 Near-term Recommendations

In the near-term (0-5 years), several capital improvements projects are scheduled for design and construction at WPTP. It will be critical for WTD to coordinate the implementation of these projects to allow for continuous treatment of flows, and to minimize re-work where multiple projects interface with the same portion of the power distribution system. Key planning studies and ongoing asset replacement activities will also continue in the near-term. **Error! Reference source not found.** summarizes near-term activities.

Table 8-1 Near-term Electrical Activities

Activities Underway	New Activities
Electrical Improvements Program	Low Voltage Distribution Replacement
Power Quality Improvements	DC Battery System Assessment
Power Reliability Improvements	
VFD, UPS Replacement	
Clean Water Plan	
Digester Capacity Study	
RSP Replacement Project	

8.2 Long-term Recommendations

Long-term recommendations are those that will be initiated in the next 6-20 years. The WPMP and capital improvement recommendations generated in that Plan are the primary long-term recommendations in this ESMP. Asset management activities including those currently in place and those identified through the assessment of the low voltage distribution system and DC battery systems (Goal 3), will continue during the long term. The completion of power reliability improvements described in Goal 1 and the Electrical Improvements Program described in Goal 3, will also extend into the long-term period.

Implementation of Electrical Strategic Master Plan Recommendations

8.3 Summary of Recommendations

Figure 8-1 shows the timeframes of, and relationships between, recommendations to meet the ESMP Goals, and Table 8-2 provides a summary of these recommendations. Implementing these actions in concert with ongoing activities provides a comprehensive and strategic approach to electrical improvements at WPTP.

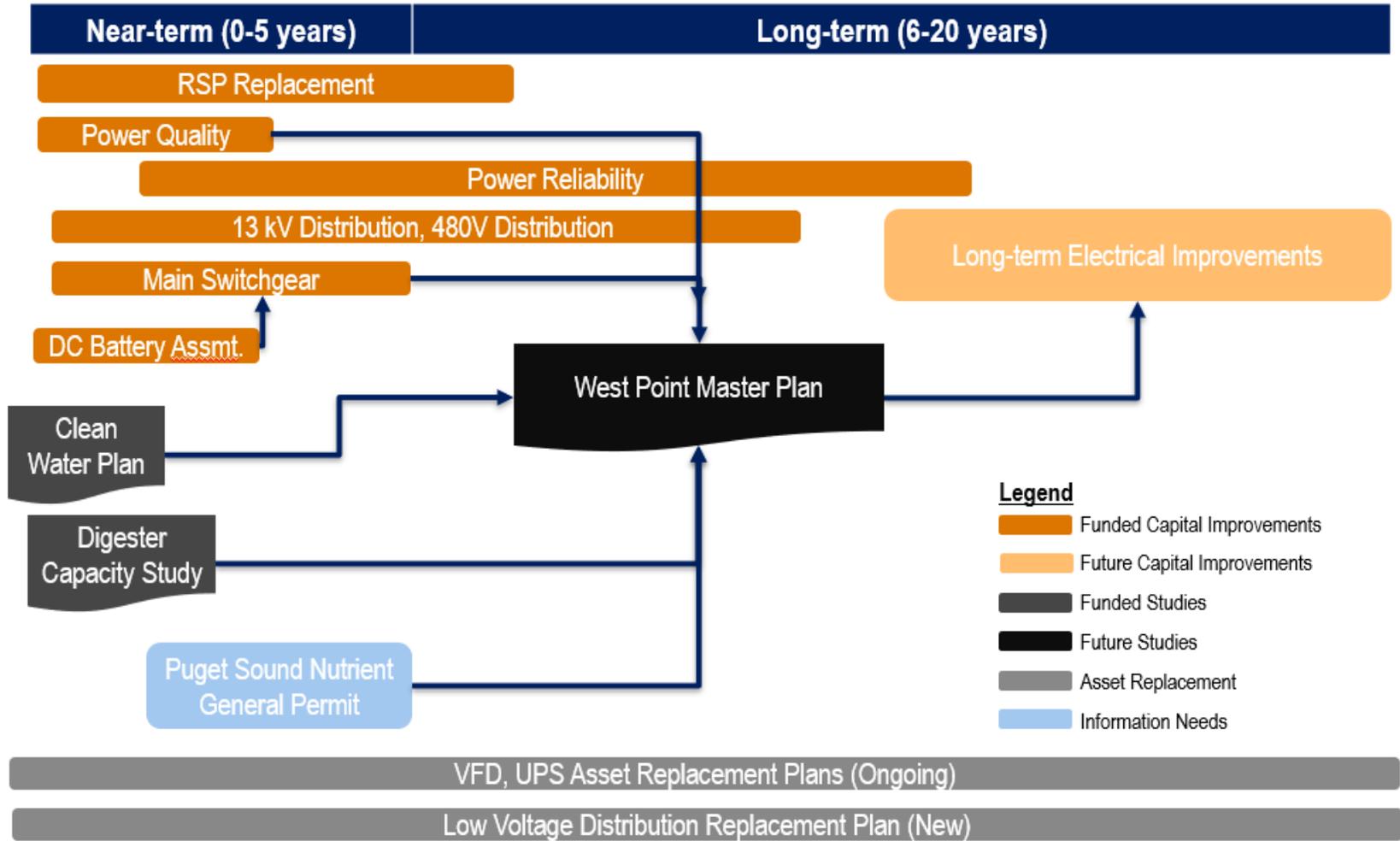


Figure 8-1 Implementation of Electrical Strategic Master Plan Recommendations

Table 8-2 Recommended Actions for Electrical Strategic Master Plan

No.	Recommendation	Funding Status	Description
Near-term (0-5 year)			
1	Power Reliability Project	Funded for Study only	Negotiate and execute an electrical service agreement with Seattle City Light to complete actions that improve the reliability and quality of power services delivered to WPTP.
2	Power Quality Improvements	Funded	Continue the Power Quality Improvements Project as planned to mitigate electrical voltage sags that can affect critical plant equipment.
3	Electrical Improvements Program	Funded	Complete the Electrical Improvements Program (13kV Distribution System Improvements, Main Substation Improvements and 480V Distribution System Improvements)
4	Low Voltage Distribution	Funded	Evaluate low voltage (less than 480V) panelboards and consider for upgrades depending on outcome of the evaluations.
5	DC Battery Systems	Funded	Evaluate DC battery systems and consider for replacements depending on outcome of the evaluations. Evaluation will be completed during the alternatives analysis for the Electrical Improvements Program. If replacement or upgrade is recommended it will be included as part of the Main Substation Improvements Project.
6	Raw Sewage Pump Replacement	Funded	Continue with the Raw Sewage Pump Replacement Project to increase firm capacity of the RSP system and provide new electrical motors.
Long-term (6-20 year)			
7	West Point Master Plan (WPMP)	Funding for Plan to be requested in future budget allocations	Create a Master Plan for WPTP that determines recommended improvements to meet long-term needs at the facility, including an updated Electrical Master Plan that documents electrical system improvements required to implement recommended improvements. The WPMP will identify recommended capital improvement projects that address condition-related equipment replacement at the time of the plan, and address needs defined by the Clean Water Plan, Digester Capacity Study, plant energy balance, and process improvements required to comply with the Puget Sound Nutrient General Permit during the planning horizon.
8	Implementation of WPMP Electrical Improvements	Funding to be requested in future budget allocations	Electrical improvements identified in the West Point Master Plan will be reviewed through WTD's Portfolio Management process for funding approval in future capital budgets.

WPTP Electrical System Strategic Master Plan

APPENDIX A – SEATTLE CITY LIGHT (SCL) ACTIONS STATUS LOG (SEPTEMBER 2021)

Corrective Action #	Reliability/ Quality	Action Name	Target Completion Date	Requires Coordination with WPTP Operations
1	Quality	Power Pole Replacement	11/1/2022	
2	Quality	Split the Distribution Bus	Completed	X
3	Quality	Vegetation Management	7/1/2022	
4	Quality and Reliability	Substation Maintenance Upgrades	Q4, 2022	
5	Quality and Reliability	Accelerated Cable Testing Broad (2600) and Canal dedicated (2728)	Testing Complete, Target for repairs is 4/30/2022	X
6	Quality and Reliability	Replace Transformers Protective Switches at SCL's West Point Substation	Completed	X
7	Quality	Support Customer-Side Solutions	Ongoing	
8	Quality and Reliability	Electric Power Research Institute (EPRI) Grid Vulnerability	TBD	
9	Quality, possibly reliability	Battery Energy Storage System (BESS) ¹	TBD	
10	Quality and Reliability	Metal-Clad Switchgear at WP	TBD	X
11	Reliability, with impact on Quality	Improve Power Reliability at WP	TBD	X

1. Equivalent to Power Quality Improvements Project