# Half-Century Assessment of the **West Point Treatment Plant**

## REPORT

Prepared in accordance with Motion 14882

**December 2017**


**King County**

Department of Natural Resources and Parks

Wastewater Treatment Division

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# List of Abbreviations

| | |
|---|---|
| **BOD** | biochemical oxygen demand |
| **CEPT** | chemically enhanced primary treatment |
| **CIG** | Climate Impacts Group |
| **CSO** | combined sewer overflow |
| **DCS** | distributed control system |
| **Ecology** | Washington State Department of Ecology |
| **EPA** | U.S. Environmental Protection Agency |
| **HRT** | hydraulic retention time |
| **IBC** | International Building Code |
| **L** | liter(s) |
| **Metro** | Municipality of Metropolitan Seattle |
| **mg** | milligram(s) |
| **mgd** | million gallons per day |
| **MBR** | membrane bioreactor |
| **NPDES** | National Pollutant Discharge Elimination System |
| **Orange Book** | *Sewage Treatment Plant Design Criteria* |
| **PCB** | polychlorinated biphenyl |
| **PPCPs** | pharmaceuticals and personal care products |
| **PSRC** | Puget Sound Regional Council |
| **PSTLS** | Puget Sound Toxics Loading Studies |
| **SCADA** | supervisory control and data acquisition |
| **TPAD** | temperature-phased anaerobic digestion |
| **treatment plant** | West Point Treatment Plant *(also West Point, WPTP)* |
| **TSS** | total suspended solids |
| **UBC** | Uniform Building Code |
| **UW** | University of Washington |
| **WA DNR** | Washington State Department of Natural Resources |
| **West Point** | West Point Treatment *Plant (also treatment plant, WPTP)* |
| **WPTP** | West Point Treatment Plant *(also West Point, treatment plant)* |
| **WTD** | Wastewater Treatment Division |

# Glossary

**Activated sludge:** A biological wastewater treatment process in which sludge is recycled from the end of the process to the beginning to maintain a healthy microbial population. The activated sludge process requires a reactor (see aeration basin), settling stage for removing solid material (sludge), and internal recycle stream that returns sludge to the reactor.

**Aeration basin:** A tank of pond air or oxygen used to contain and treat wastewater.

**Anaerobic digestion:** The biological degradation of organic matter in the absence of oxygen.

**Atmospheric river event:** Also known as a Pineapple Express, a long and narrow band of moisture in the atmosphere responsible for conveying large amounts of water from the Pacific islands to the western United States.

**Average daily dry weather flow:** The average flow received in a day by a sewer or wastewater treatment plant during dry months of the year, typically May through October.

**Average daily wet weather flow:** The average flow received in a day by a sewer or wastewater treatment plant during times of the year with heavier rainfall, typically November through April.

**Biochemical oxygen demand (BOD):** A measure of the quantity of oxygen used by microorganisms to break down pollutants in water or wastewater.

**Biosolids:** A primarily organic product produced from the wastewater treatment plant process, that can be beneficially recycled.

**Buildout:** A measure of the maximum development and growth within an urban area.

**Carbonaceous biochemical oxygen demand:** A measurement of the quantity of carbon-based pollutants in water or wastewater, determined by the amount of oxygen used by microorganisms to break down the pollutant.

**Class A biosolids:** The U.S. Environmental Protection Agency (EPA) designation for biosolids that have been treated to reduce pathogens to below detectable levels. Federal regulations require this level of quality for biosolids that are sold or given away in a bag or other container, or applied to lawns or home gardens.

**Class B biosolids:** The EPA designation for high-quality biosolids that have been treated to significantly reduce pathogens to levels that are safe for beneficial use in land application. Federal regulations require site management, crop harvest, and access restrictions when biosolids of this quality are land-applied.

**Clean Water Act:** The primary federal law in the United States responsible for regulating water quality. The Clean Water Act was enacted in 1972.

**Combined sewer overflow (CSO):** Discharge into water bodies by combined sewer systems designed to collect both stormwater and wastewater. CSOs are approximately 10 percent wastewater and 90 percent stormwater and occur during times of high flow caused by heavy rain or snowmelt.

**Design constraints:** Constraints that limit the treatment plant's hydraulic and load capacity and performance in meeting its design functions.

**Digester:** A tank used to contain and treat solid materials during the wastewater treatment process.

**Distributed control system (DCS):** A control system in which an overall operation (e.g., a wastewater treatment plant) is managed through non-centralized control of each individual stage of the process.

**Dry weather flow:** A reference to wastewater flow in a sewer system during periods of dry weather, typically May through October.

**Effluent:** The treated water discharged from a wastewater treatment plant.

**Engineering constraints:** Constraints that are inherent to the site and limit the design by known engineering methods.

**Firm capacity:** The capacity of a system to operate at peak demand with one component out of service for each unit in operation. For example, if a treatment plant has three 50-million gallon per hour pumps available, the firm capacity of the pumping system is 100 million gallons per hour.

**Flows and loads:** The amount of liquid (flows) and solid material (loads) received by a sewer system or wastewater treatment plant.

**Foaming:** The creation and buildup of foam within a wastewater treatment plant digester caused by chemical or biological activity (see digester).

**Functional constraints:** Constraints that limit a treatment plant's ability to treat wastewater to a higher level.

**Hydraulic capacity:** A measurement of the maximum quantity of liquid that can be contained by a vessel or process.

**Hydraulic loading:** A measure of the amount of liquid entering a treatment process at a wastewater treatment plant.

**Hydraulic retention time (HRT):** Also known as hydraulic residence time, the average length of time a fluid will remain within a confined space as determined by the rate of flow into the vessel. HRT is defined by the ratio of the volume of a vessel divided by the flow rate of fluid into the vessel.

**Impermeable cover:** Area of the ground surface that is covered by an impenetrable artificial material (e.g., paved), limiting stormwater infiltration into the soil (see infiltration below). Impermeable surfaces include roads, sidewalks, driveways, highways, roofs, etc.

**Infiltration:** Groundwater that enters a sewer system through cracks or leaks in pipes, often in old or damaged pipes.

**Inflow:** Stormwater that enters a sewer system through direct connections. Examples include sump pumps, roof drains, yard drains, and leaky manhole covers.

**Infiltration/inflow:** The combined measure of infiltration and inflow, groundwater, and stormwater that enters a sewer system through leaks and cracks in the sewer system.

**Influent:** The water that flows into a wastewater treatment plant.

**Instrumentation and controls:** Tools used to measure and control the wastewater treatment processes.

**International Building Code (IBC):** A building code developed by the International Code Council.

**Membrane bioreactor (MBR):** A wastewater treatment process that combines a membrane process, such as microfiltration or ultrafiltration, with a biological treatment process, such as activated sludge. MBRs are widely used for municipal and industrial wastewater treatment.

**National Pollutant Discharge Elimination System (NPDES):** Instituted as part of the Clean Water Act, a permit program that controls water pollution by regulating point sources that discharge pollutants into U.S. waters.

**Non-point source pollution:** Pollution caused by dispersed sources as opposed to a single source. An example of a non-point source pollution is rainwater washing oil from the road directly into Puget Sound.

**Nutrient removal:** The process of removing nitrogen and phosphorus from wastewater.

**Organic loading:** A measure of the amount of biochemical oxygen demand (BOD) or other organic pollutant applied to an individual wastewater treatment process (see biochemical oxygen demand).

**Peak wet weather flow:** The highest measure of flow that will be received by a sewer or wastewater treatment plant during times of the year with heavier rainfall, typically November through April.

**Pharmaceuticals and personal care products (PPCPs):** Commercially available products that contain pollutants found to enter the environment through water or wastewater. Examples of PPCPs include over-the-counter medicines and skin care products, such as sunscreen and lotion.

**Point source pollution:** A single identifiable source of pollution. Examples include a factory's smokestack or wastewater discharge pipe.

**Primary sedimentation tank:** A basin used during the initial stages of the wastewater treatment process that allows for the settling and removal of solid materials.

**Primary treatment:** The initial stage of the wastewater treatment process designed to remove solid material from wastewater.

**Seismic resilience:** The ability of a structure to withstand an earthquake, or other vibrations caused by the movement of the earth's crust, and not suffer damages.

**Secondary treatment:** The stage of wastewater treatment that removes a majority of pollutants, including dissolved solids, from the wastewater through biological processes and settling tanks. Secondary treatment occurs after primary treatment (see primary treatment).

**Stormwater runoff:** Rainfall or snowmelt that flows over the ground and into sewer collection systems or open water bodies.

**Supervisory control and data acquisition (SCADA):** A control system architecture that uses computers, networked data communications, and graphical user interfaces for high-level process supervisory management, but uses other peripheral devices such as programmable logic controllers to interface to the process plant or machinery.

**Thermophilic digestion:** A process used to treat solids produced during wastewater treatment. Thermophilic digestion breaks down solid materials at or above 122 degrees Fahrenheit and occurs in a thermophilic digester (see digester).

**Total suspended solids (TSS):** Solids in a water or wastewater sample that can be trapped by a filter of a specified size. TSS is a water quality parameter used in wastewater treatment to assess the quality of a wastewater sample after treatment in a wastewater treatment plant.

**Toxic contaminants:** Synthetic or naturally occurring chemical pollutants that are not regulated or typically monitored, but are suspected to be harmful to humans or the environment that include PPCPs.

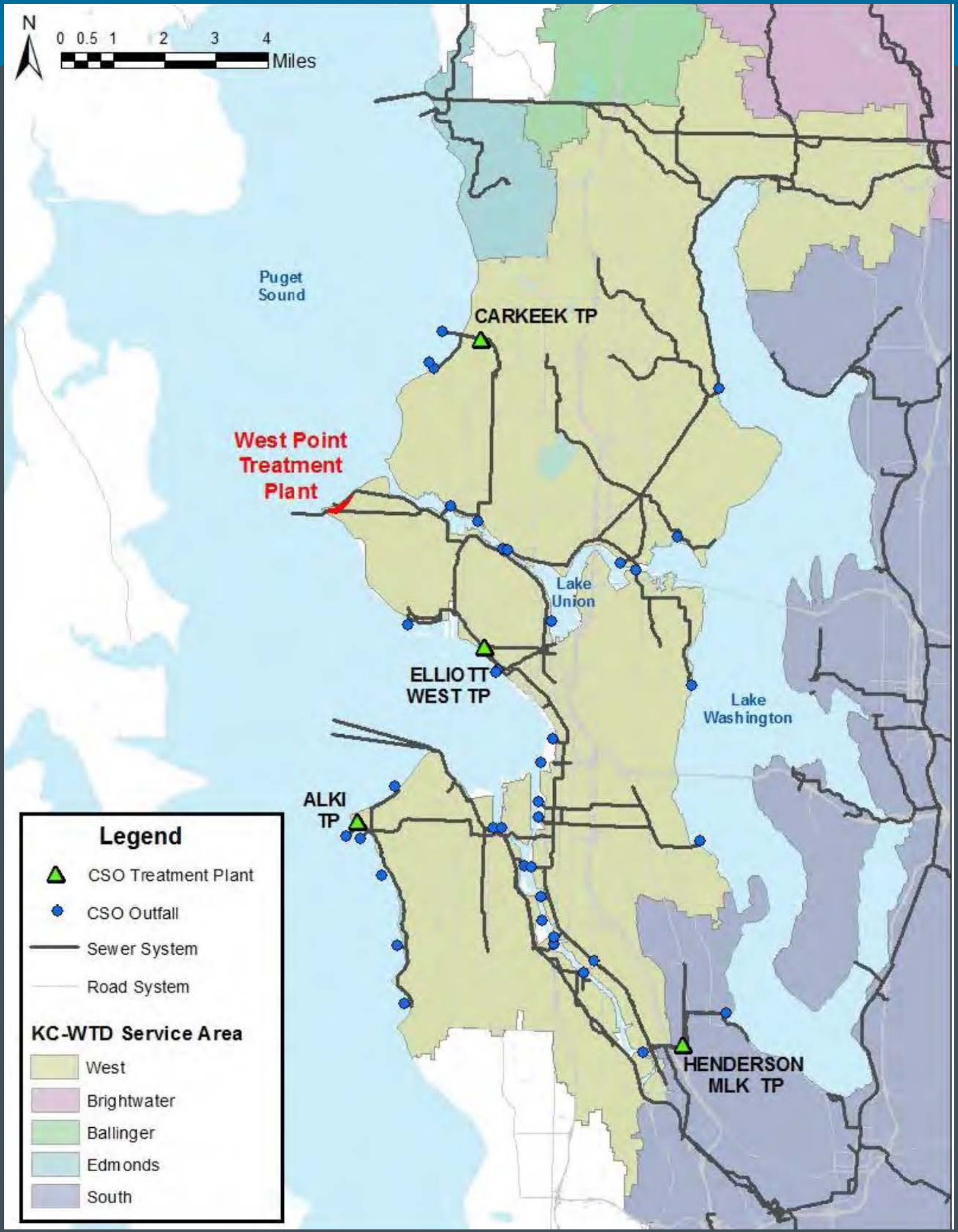
**Uniform Building Code (UBC):** A building code first published in 1927 by the International Conference of Building Officials to provide standardized requirements for safe construction. The UBC was replaced by the IBC in 2000.

**Urban growth area:** A region with defined boundaries designated for urban growth. Regions outside an urban growth area are generally preserved to be used for agriculture or to remain in a natural state.

**Wet weather flow:** A reference to wastewater flow and runoff that infiltrates a sewer system during periods of wet weather, typically November through April.

**FIGURE ES-1.**

**West Point treats wastewater from King County's West service area and flows from Seattle's combined stormwater/ wastewater sewer system. After 50 years of operation, this report assesses issues affecting the treatment plant's current and future performance.**



# Executive Summary

West Point Treatment Plant (West Point) serves as the key wastewater treatment facility for a significant portion of the King County Wastewater Treatment Division (WTD) service population. After 50 years of operation, it is appropriate to assess factors that may affect the treatment plant's current and future performance. This Half-Century Assessment summarizes West Point's ability to provide continued reliable service to the region in the future.

West Point faces a more complex and challenging operating environment today compared to when it was constructed. Factors impacting the treatment plant include population growth, new development, climate change, and increased regulatory requirements. In addition, peak storm flows regularly reach the treatment plant's hydraulic capacity. The West Point flooding event in early 2017 further highlights the need to assess the treatment plant's current condition and ability to meet projected needs in the coming decades.

The King County Council directed, as part of Motion 14882, that issues affecting the treatment plant's current and future performance be reviewed and assessed. This Half-Century Assessment evaluates West Point's conditions in key areas of potential impacts: changes in the operating environment over the treatment plant's 50-year history, current and future constraints that may limit treatment plant performance, and potential system vulnerabilities and operational concerns that have emerged over West Point's history of operation.

King County Motion 14882 requires the King County Executive to transmit a report to the County Council of a review and evaluation of West Point after a half century of operations (Half-Century Assessment). Specifically, the motion requires the report to address categories of potential impacts:

- Changes in operating context
- Current and projected constraints and limitations
- System vulnerabilities, treatment plant operations, and management context
- Increases in levels of toxics from outdoor urban surfaces

This assessment addresses each item in the categories outlined in Motion 14882 and serves as a continued review of West Point after the February 9, 2017, incident.

EXECUTIVE SUMMARY

# Changes in Operating Context

Since West Point's construction, the treatment plant's operating environment has changed considerably. The Seattle area has experienced dramatic population growth, new development, and changing industry. Storms have become more intense and water quality regulations have changed, with more changes expected in years to come.

Motion 14882 identified the following key changes to West Point's operating environment:

- Increases in service population
- Current and projected climate-driven changes in weather patterns and flow demand
- Changes in regulatory requirements
- Increased concerns about water quality
- Concentrated growth patterns associated with the County's Comprehensive Plan
- Increased industrial contributions to wastewater flow

For the purposes of this assessment, changes in regulatory requirements and increased concerns about water quality were combined into one review area (water quality and regulations), increases in service population and concentrated growth patterns associated with the County's Comprehensive Plan were combined (service population and growth patterns), and a discussion of levels of toxics is included here as it applies to the operating context of the treatment plant. Table ES-1 summarizes how well positioned the treatment plant is to meet changes in these operating contexts and recommended improvements to position West Point to meet related challenges in the future.

**TABLE ES-1. CHANGES IN OPERATING CONTEXT SUMMARY**

| CONTEXT | SUMMARY OVER TIME | IMPACT ON WEST POINT TREATMENT PLANT | RECOMMENDATION |
|---|---|---|---|
| **Service population and growth patterns** | West Point's service population is increasing at a higher-than-projected rate and is already at numbers previously anticipated for 2030. | Actual dry weather flows to West Point have decreased because of water conservation efforts. However, the amount of solids material in the wastewater has increased and will continue to increase because of population. | Further evaluate aeration and digestion process needs and alternatives as part of the recently initiated Treatment Plant Flows and Loadings Study. |
| **Climate changes** | Although the average rainfall over time is within historical norms, some climate models predict that increased frequency of peak wet weather events may occur and could continue to increase over time. | West Point may need to operate more often at sustained wet weather flow rates. | Ensure system reliability to treat sustained wet weather flows through continued asset management planning and practices. |
| **Impermeable cover** | Seattle's impermeable surface area is approaching buildout and has not significantly changed in recent history. | There has been no significant impact on the treatment plant. The conveyance system has seen increased stormwater flow over time, but not from increases in impermeable cover. | No recommendations. Any increase in impermeable cover in recent years has likely been insignificant in terms of stormwater runoff, and this is not expected to change in the future. |
| **Water quality and regulations** | Water quality concerns have increased over time and regulations have become more stringent. | The treatment plant is meeting current permit requirements. If future regulations include nitrogen removal and/or toxic contaminants, West Point is not capable of treating these parameters with its current technology and land limitations. | Continue to follow and track potential regulatory changes at the local and national level. If nutrient removal is regulated, perform a system-wide evaluation to determine the best alternative for West Point and the regional system. |
| **Industrial contributions to wastewater** | The makeup of industrial wastewater contributions to West Point have changed over time away from metal finishing to construction dewatering and beverages. | There has been no significant impact to West Point. WTD has implemented an industrial pretreatment program since 1969. Industrial flows are only 4% of the total flow to West Point and have minimal impact on the treatment process. | No recommendations. Continue pretreatment program. The percentage of wastewater flow entering West Point from industrial sources is expected to remain very low in the near future. |
| **Level of toxics** | Wastewater treatment plants are not considered the major pathway to Puget Sound for most urban runoff-based contaminants, such as automotive chemicals, herbicides, and pesticides. There are other toxic contaminants such as pharmaceuticals and personal care products (PPCPs) for which wastewater treatment plants are a pathway. However, none of these contaminants are currently regulated as part of the discharge permit. | West Point is meeting its permit conditions and there is no evidence that these contaminants may be impacting the efficiency of operations. If PPCPs are regulated in the future, West Point may not be capable of treating these parameters as currently configured. | Continue to follow and track potential regulatory changes at the local and national level. If PPCP removal is regulated, perform an evaluation to determine the best alternative for West Point. |

# Current and Projected Constraints and Limitations

West Point Treatment Plant began operating in 1966 as a primary-only treatment plant. The plant was upgraded to secondary treatment in the 1990s and several upgrades have been made over the last five decades, including new influent screens, new solids dewatering building, and on-site cogeneration of electricity. Over the years, the treatment plant has performed as designed and met National Pollutant Discharge Elimination System (NPDES) permit requirements with little exception.

**Biochemical oxygen demand**

Also referred to as BOD, a measure of the quantity of oxygen used by microorganisms to break down pollutants in water or wastewater.

As with any aging capital facility, factors that may limit West Point's continued service should be considered. Motion 14882 identified the following constraints and limitations that may currently or could potentially impact West Point's performance:

- Current and projected capacity
- Changes in wastewater processing technology
- Functional, design, and engineering constraints
- Land-based limitations

During review of these constraints and limitations, two issues were identified that could impact West Point's operations: in the near term, solids and biochemical oxygen demand (BOD) loadings (the amount of solid and soluble material sent to the treatment plant for removal) and in the long term, regulatory requirements. Both issues are constrained by the land-based limitations at West Point.

## Solids and BOD Loadings

West Point's service population is increasing at a higher-than-projected rate. In fact, the service area population has already hit a level that was previously projected for 2030. Actual dry weather flows to West Point have decreased because of water conservation efforts. However, solids and BOD loads have increased and will continue to increase because of population growth. WTD is currently undertaking a Treatment Plant Flows and Loadings Study for all three regional treatment plants, which will review in detail the flows, loadings, and limitations of each treatment process at the three regional treatment plants. The study is scheduled to be complete in December 2018.

WTD evaluates flow and loads within each treatment plant's service area every 10 years. The most recent projection was completed in 2013 and was based on 2010 census data. The 2013 results indicated that West Point would have adequate hydraulic capacity, but loads may be limited in the near term. A high-level review of solids and BOD loading data was conducted as a part of this Half-Century Assessment. This high-level review has suggested that the organic loading capacity of the digesters at West Point may be constrained earlier than estimated in the 2013 analysis. This constraint on the treatment plant is exacerbated by a digester foaming problem, which decreases digester capacity. Although treatment plant staff have managed the foaming issue and a substantial investigation of causes and potential remediation is ongoing, a permanent solution has not been identified and the problem persists. It is recommended that the digester foaming issue continue to be evaluated and that the solids loading capacity of the digesters be confirmed through the current Treatment Plant Flows and Loadings Study.

Although BOD loadings on the secondary treatment components of the treatment plant, specifically the aeration basins, have exceeded their design capacity on a couple of occasions, treatment plant effluent quality was not impacted. This indicates that there may be additional capacity in the treatment process. The potential additional capacity will be estimated through the Treatment Plant Flows and Loadings Study.

In addition to increases due to population, there will be increased solids and BOD loading to West Point following wet weather events because of additional combined sewer overflow (CSO) facilities. Wet weather treatment stations, such as Alki and the soon-to-be-constructed Georgetown facilities, treat only flows. Solids are stored during the storm and sent to West Point for processing following the event. Similarly, the storage tanks and tunnels that store the combined wastewater and stormwater during wet weather events introduce additional solids to

West Point. Prior to the CSO facilities (wet weather treatment, storage tanks, and storage tunnels), the excess flows and loads went out to Lake Washington, the Duwamish River, or Puget Sound as overflows.

Modeling based on 2010 population projections suggests that West Point can handle the additional solids from the CSO projects. However, with population increasing at a higher-than-predicted rate, it is not clear whether the treatment plant will be able to process the increased CSO solids loads with the current digester capacity. As stated, the Treatment Plant Flows and Loadings Study will review the flow and loading limitations in detail.

## Regulatory Requirements

Future regulations pose the second major constraint to West Point operations. Although the timing is unknown, the Washington State Department of Ecology (Ecology) may include a nitrogen removal limit in future NPDES permits for treatment plants discharging to Puget Sound, including West Point.

West Point has land-based limitations that put significant constraints on treatment plant expansion. These limitations include physical site restrictions and restrictions based on historical agreements with the City of Seattle. The current secondary treatment aeration basins would have to be approximately doubled in size to meet potential future nitrogen removal limits, which is not feasible given the current size of the treatment plant site. If nitrogen removal is required, it would mean designing and constructing a new treatment technology for the existing site. This approach presents significant engineering and constructability constraints, such as fitting the new technology on the existing site and keeping the treatment plant operational during construction, and previous conceptual studies indicate that it would be very expensive—in the multiple-billion-dollar range.

**Two issues were identified that could impact West Point's operations: solids and BOD loadings, and future regulatory requirements. Both of these issues are constrained by the limited space available on West Point's site.**

West Point during secondary treatment construction

EXECUTIVE SUMMARY

# System Vulnerabilities, Treatment Plant Operations, and Management Context

Motion 14882 also directed the review of system vulnerabilities and other treatment plant operations and management concerns. The West Point Treatment Plant (WPTP) Independent Assessment (AECOM, July 18, 2017) provided a hazards and operations review for West Point that covered treatment plant operations and management concerns focused on issues leading up to the incident on February 9, 2017. This Half-Century Assessment agrees with the operations and management findings of the WPTP Independent Assessment and provides additional review of system vulnerabilities.

Aging infrastructure, including the 1960s-era digesters, and wet weather flow reliability were identified as West Point's key areas of system vulnerability.

The following system vulnerabilities were considered for this assessment:

- Aging infrastructure
- Wet weather flow management reliability
- Redundancy
- Emergency bypass
- Power reliability
- Flooding
- Seismic resilience
- Tsunami

Both the July 2017 WPTP Independent Assessment and this Half-Century Assessment identified emergency bypass and power reliability as key system vulnerabilities for West Point. WTD has already started engineering studies around these two areas and will be reporting their status to the Council in early 2018. Aging infrastructure and wet weather flow management reliability were identified as key areas of vulnerability in this Half-Century Assessment and are described in more detail below. The other vulnerabilities are discussed in detail in the main report.

## Aging Infrastructure

Most of West Point's primary treatment system as well as three of its digesters and associated fuel system are a part of the original treatment plant. The secondary treatment system and additional three digesters, although newer, are more than 20 years old. During this assessment, several examples were noted that could pose risks to West Point operations, including the 1960s-era digesters, primary sedimentation tanks, and primary and secondary piping systems. A more thorough evaluation of facilities is recommended, including identification of repair/replacement for facilities posing significant risk of failure that would limit the treatment plant's treatment capability.

## Wet Weather Flow Management Reliability

While the average amount of rainfall each year has not changed, the frequency of high-intensity storms, such as the one on February 9, 2017, has increased. According to the Climate Change in Puget Sound State of Knowledge Report (Climate Impacts Group, 2015), the frequency of these intense storms, which are caused by long and narrow bands of moisture known as atmospheric rivers, is projected to increase from an average of two per year to a range of four to nine per year by the 2080s.

West Point is designed to manage peak wet weather flows and only 440 million gallons per day (mgd) can enter the treatment plant because of the conveyance system and treatment plant influent hydraulic capacity. Higher flows are stored in the conveyance system and at CSO control facilities. These flows are then drained to West Point when the treatment plant can accommodate the flows through secondary treatment. The main consequence of reaching peak wet weather flows is that the treatment plant's secondary system must run at higher flow rates more often and for longer periods to process the flows stored in the conveyance system through CSO facilities. Adequate redundancy—or backup units of critical equipment—will need to be in place, and maintenance and replacement/refurbishment projects will need to be performed to ensure that the treatment plant can reliably manage the increased flows and loads during the winter. WTD is currently evaluating its Asset Management Program and Strategic Asset Management Plan to determine how to improve this reliability.

WTD is already in the process of reviewing many future areas of concern. The following projects and studies are ongoing:

- System-wide Treatment Plant Flows and Loadings Study (Flows and Loadings Study)
- Resiliency and Recovery Study
- Evaluation of WTD's Strategic Asset Management Plan and Program

SECTION 1

# Introduction

King County Motion 14882 requires the King County Executive to transmit a report to the County Council of a review and evaluation of the West Point Treatment Plant (West Point) after a half century of operations. This Half-Century Assessment reviews the treatment plant's changing operating environment over the past 50 years and evaluates how well West Point is positioned for continued reliable operations in the future.

Specifically, the motion requires the report to address the following categories of potential impacts:

- **Changes in operating environment** (addressed in Section 2)
  - Increases in service population
  - Current and projected climate-driven changes in weather patterns and flow demand
  - Increased impermeable cover
  - Changes in regulatory requirements
  - Increased concerns about water quality
  - Concentrated growth patterns associated with the County's Comprehensive Plan
  - Increased industrial contributions to wastewater flow
- **Current and projected constraints and limitations** (addressed in Section 3)
- **System vulnerabilities, treatment plant operations, and management context** (addressed in Section 4)
- **Increases in levels of toxics from outdoor urban surfaces** (addressed in Section 2, Changes in Operating Context)

**This assessment reviews potential impacts to West Point operations in these key areas:**

**SECTION 2 //** Changes in Operating Context

**SECTION 3 //** Current and Projected Constraints and Limitations

**SECTION 4 //** System Vulnerabilities, Treatment Plant Operations, and Management Context

## SECTION 1
## Introduction

This assessment addresses each item in the categories as outlined in Motion 14882, and serves as a continued review of West Point after the February 9, 2017, incident. For the purposes of this study, changes in regulatory requirements and increased concerns about water quality were combined into one review area (water quality and regulations), increases in service population and concentrated growth patterns associated with the County's Comprehensive Plan were combined (service population and growth patterns), and a discussion of levels of toxics is included here as it applies to the operating context of the treatment plant.

Prior to this Half-Century Assessment, the King County Council adopted Motion 14826, requiring an independent assessment of the February 2017 West Point event. The WPTP Independent Assessment conducted by AECOM, dated July 18, 2017, identified 98 mitigation strategies to consider in addressing the 4 recommendations presented in the assessment. The assessment was focused primarily on identifying items that would prevent an incident, such as what occurred on February 9, 2017, from occurring again. King County Wastewater Treatment Division (WTD) is currently evaluating and responding to these recommendations. The WPTP Independent Assessment findings and recommendations were found to be relevant to ensuring that the February 2017 incident would not be repeated.


West Point, 1965

**SECTION 1**
**Introduction**

## Assessment Process

This Half-Century Assessment is due to Council 180 days after delivery of the WPTP Independent Assessment. To address the objectives of the review required by Motion 14882, while meeting the time constraints, the following steps were taken:

- **Data review:** Documents listed in Appendix A were reviewed and summarized.
- **Collaboration meetings and interviews:** Collaborative meetings were conducted with WTD to obtain historical input not readily available in documents.
- **Preparation of this Half-Century Assessment:** This assessment was developed through an iterative approach with WTD staff to ensure that future constraints were accurately presented.

## West Point Background

West Point has been in operation since 1966, with two major upgrades: a secondary treatment process was added in the 1990s and the influent screens were upgraded in 2015. The plant has also had several upgrades over the last five decades, including new influent screens, new solids dewatering building, and on-site cogeneration of electricity. The main purpose of West Point is to treat both dry and wet weather flows from WTD's West service area. Over the years, West Point has performed as designed and met National Pollutant Discharge Elimination System (NPDES) permit requirements with little exception.

The timeline in Figure 1 presents a general history of West Point.

**West Point faces a more complex and challenging operating environment compared to when it was constructed in the 1960s. This assessment evaluates how well West Point is positioned for continued reliable operations in the future.**

West Point, 1966

## West Point History

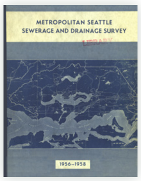
**FIGURE 1.**

General history of West Point Treatment Plant

1950 | 1960 | 1970 | 1980


### 1950s
**Wastewater and stormwater pollution of King County waterways becomes severe**

In 1956 King County voters approve a $6.25M bond to plan for a coordinated sewer system to combat pollution.

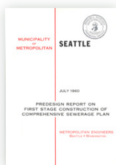



### 1958
**Metropolitan Seattle Sewerage and Drainage Survey**

This report becomes the foundation for Metro's unified sewage vision and is partly responsible for the creation of Metro.

### 1959
**Municipality of Metropolitan Seattle (Metro) forms**

Voters approve the formation of Metropolitan Engineers on September 9, 1958.



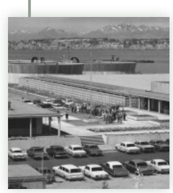

### 1960
**Predesign Report on First Stage Construction of Comprehensive Sewerage Plan**

### Early 1960s
**Alki, Carkeek, and Richmond wastewater treatment plants completed**

King County completes three new treatment plants.

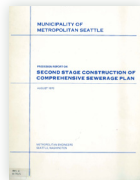
### 1964
**Kenmore Lake Line completed**

### 1964
**Matthews Beach Pump Station completed**



### 1966
**Dedication of West Point**

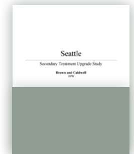
Construction of 125 mgd West Point is completed.



### 1970
**Predesign Report on Second Stage Construction of Comprehensive Sewerage Plan**

### 1973
**West Point sludge recycle starts up for fertilizer production**

### 1976
**West Point pilot plant study for secondary treatment options**



### 1978
**Secondary Treatment Upgrade Study**

The 1972 Clean Water Act mandates secondary treatment in all sewer works.

### 1978
**First comprehensive CSO plan for Seattle Metro system**

### 1984–85
**West Point Cogeneration system starts up to produce renewable energy from waste gas**

**1989**

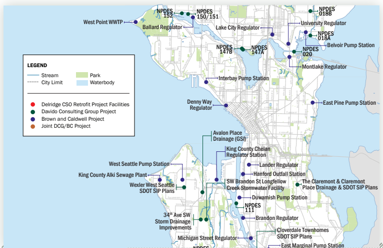
**Conversion of Carkeek Park Wastewater Treatment Plant to wet weather facility**

King County transfers baseflows from the Carkeek Park Wastewater Treatment Plant to West Point.

**1993**

**Richmond Beach Pump Station flow transfer**

Flows transferred to Edmonds with some flows diverted to West Point.



**1995/2000**

**CSO Control Facilities Plan and Update**

King County completes the CSO Control Facilities Plan, a comprehensive sediment management plan, and the preliminary design of the joint King County/Seattle Denny Way CSO Control project. CSO plan updated in 2000.

**1996**

**West Point secondary system upgrades completed**

**1999**

**The Regional Wastewater Service Plan**

Plan features a third treatment plant to provide more capacity and flexibility for the future: Brightwater.

**2015/2016**

**Puget Sound Beach Projects**

Construction completed on one green stormwater and three storage projects, reducing overflows to Puget Sound beaches during heavy rains.

**2017**

**Rainier Valley Wet Weather Storage**

Project is at substantial completion.

**1990 — 2000 — 2010 — 2020**

**1989**

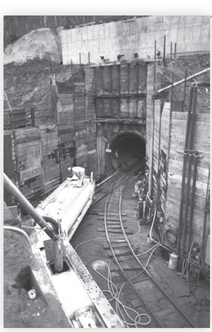
**West Point Facilities Plan**

Plan completed for secondary treatment upgrades and expansion.

**1991**

**Brick sewer rehabilitation**

King County rehabilitates 11 miles of brick sewer that flows to West Point.



**1991**

**Fort Lawton Parallel Tunnel**

New tunnel conveys more flow to West Point and creates redundancy for maintenance.

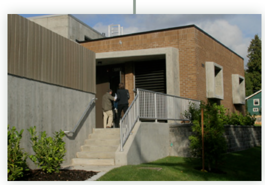
**1994**

**Metro merges with King County**

**1997**

**West Seattle Tunnel and Pump Station**

Transfers flows from Alki to West Point.



**2005**

**Henderson/MLK CSO Central Project**

King County's second largest storage facility stores and treats up to 4 million gallons during large storms.

**2005**

**Denny Way/Lake Union CSO Control Project**

This project directs excess flows to the Mercer Street tunnel for storage and Elliott West Wet Weather Treatment Station for treatment.

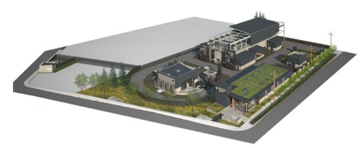
**2014**

**Ballard Siphon Upgrade**

Project is one example of increasing flows to West Point to prevent CSOs.

**2017**

**West Point recovery**



**2017**

**Georgetown Wet Weather Treatment Station**

Project is in construction.

**SECTION 2**

# Changes in Operating Context

Since West Point's construction, the treatment plant's operating environment has changed considerably. The Seattle area has experienced dramatic population growth, new development, and changing industry. The County's regional wastewater system infrastructure has been modified and expanded. In addition, new weather patterns have emerged and water quality regulations have changed, with more changes expected in years to come. West Point has adjusted to accommodate these shifting conditions over time.

Motion 14882 requires a review of the past 50 years of wastewater operations to determine the treatment plant's capabilities to continue to provide a high level of wastewater treatment to the current and projected future population.

Existing conditions that affect the treatment plant were examined to assess the treatment plant's performance as it was intended by its original design and most recent upgrade to secondary treatment. Potential future conditions, including population growth, changes in wastewater flow and influent quality, potential regulatory changes due to new environmental regulation, and climate change were reviewed. Land use and environmental changes, including changes in amount of impermeable surfaces, changes in industry output, and emerging toxic contaminants were also estimated and incorporated into projections of West Point's future treatment capability. For the purposes of this assessment, water quality concerns and changes in regulations were combined, and increases in service population and concentrated growth patterns associated with the County's Comprehensive Plan were combined. Levels of toxics were also included as an operating context.

The following subsections discuss how well positioned West Point is to meet these operating changes in the future.

**Operating Context Areas**

- **Service population and growth patterns**
- **Climate-driven changes**
- **Impermeable cover**
- **Water quality and regulations**
- **Industrial contributions to wastewater**
- **Level of toxics**

# Service Population and Growth Patterns

Wastewater comprising liquid and solid material is sent to West Point for treatment. The amount of wastewater sent to the treatment plant is measured as dry weather flow (flow received during dry months) and wet weather flow (flow received during periods of heavier rainfall). Because wet weather flow is influenced by rainfall, the impact of population changes on West Point is best understood by examining flow to the treatment plant during dry weather. Traditionally, population increases in a service area are reflected in increased total dry weather wastewater flows. However, at West Point, while the service area population has *increased*, actual dry weather flow to the treatment plant has *decreased* over time because of water conservation efforts. This decrease in flow accompanying the increase in population has resulted in more concentrated solids loading to West Point.

## How has the population changed over time?

The City of Seattle and West Point's service area population was approximately the same in 1960 as it was in 2000, as a considerable population decline occurred in the 1970s. From 1980 to 2000, the population increased steadily, and grew at a moderately high rate of approximately 7 percent from 2000 to 2010. From 2010 to 2017, the growth rate more than doubled to approximately 17 percent. While there are relatively minor differences between the boundaries of the City of Seattle and the boundaries of the West Point service area, as well as other differences in the estimates (e.g., areas on septic systems), the two estimates reflect the same relative population.

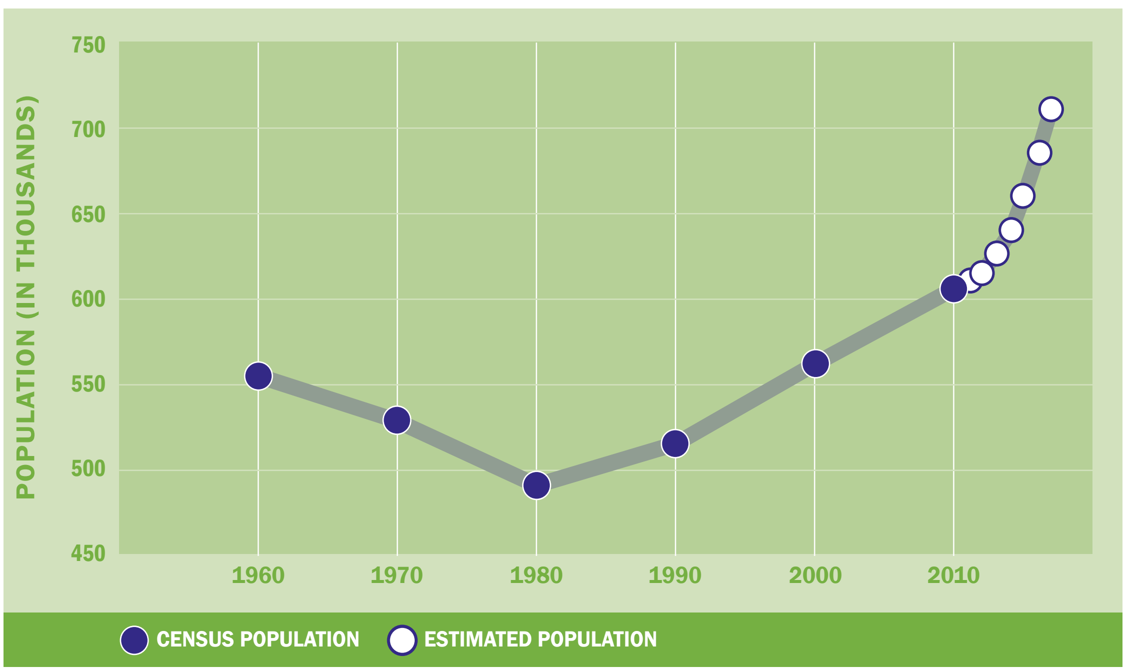
Population projections completed in 2013 estimated a 2017 population of approximately 650,000. However, actual population growth in the City of Seattle between 2000 and 2017 was significantly higher than predicted and, according to the Washington State Office of Financial Management, is already estimated at nearly 715,000—comparable to the projected population for 2030 of 713,700.

Seattle's population declined from 1960 to 1980 but for the most part has been steadily rising since 1980, growing at a moderately high rate from 2000 to 2010, and at double that rate from 2010 to 2017.

**FIGURE 2.**

City of Seattle residential population, 1960 to 2017

**SOURCE:** *Washington State Office of Financial Management*



From 2010 to 2017, West Point's service area population grew at a rate of 17 percent—putting Seattle at predicted 2030 population projections earlier than expected.

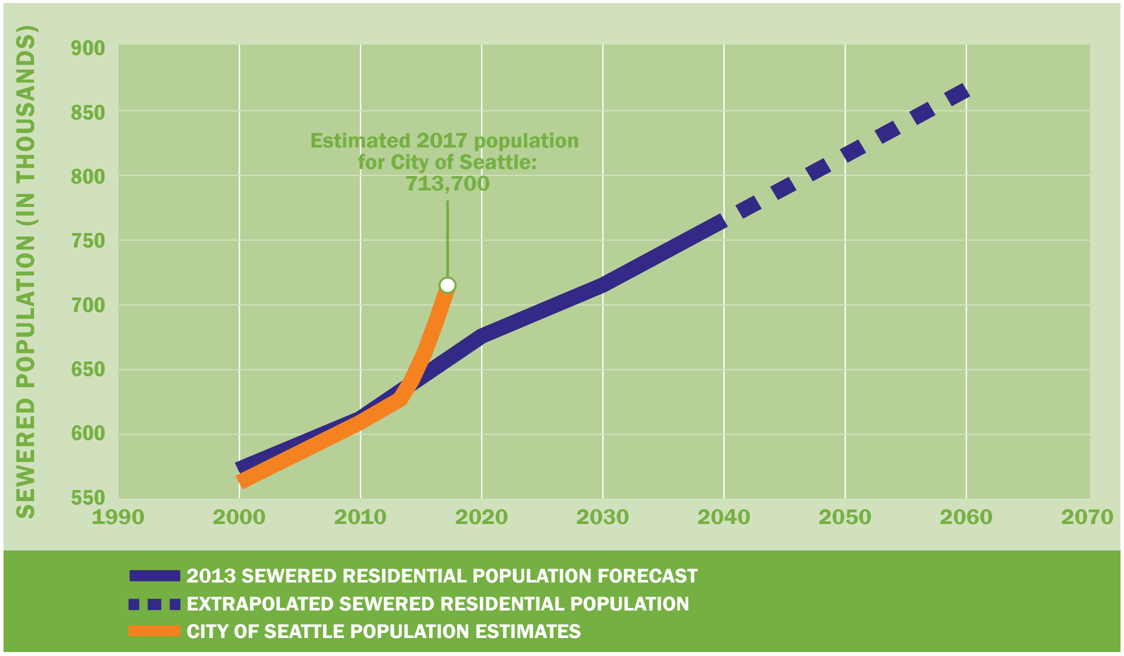



**FIGURE 3.**

City of Seattle historic and projected residential population, 2000 to 2060

**SOURCE:** *Washington State Office of Financial Management*

## How have dry weather flows changed?

As the population has increased, dry weather flows have decreased, which is a direct result of water conservation measures. Water use, which directly correlates to water flow to the treatment plant during dry weather, has reduced by an estimated 15 percent from 1975 to 2010, while the population has increased over the same period.

## How is the population projected to change in the future?

In 2014, the Puget Sound Regional Council (PSRC) estimated future population using *Washington State Office of Financial Management* data. Based on PSRC's estimates, the City of Seattle's total sewered residential population is projected to grow by a total of approximately 49 percent from 2010 to 2050.

## Has the increase in population impacted treatment plant operations?

Currently, West Point is meeting NPDES permit requirements and treatment plant operations are not impacted by the increase in population. Average dry weather flows are far below West Point's design flows and are expected to remain that way well into the future. However, because of increased population, West Point may be approaching capacity for total suspended solids (TSS) and biochemical oxygen demand (BOD). WTD identified this issue in 2014 and has been evaluating ways to address the treatment plant's capacity needs (King County WTD, 2013 Regional Wastewater Services Plan Comprehensive Review, June 2014).

The solids and BOD loading limitation is discussed further in the Current and Projected Constraints and Limitations section of this assessment (Section 3). Because of this solids limitation projection, WTD launched a Treatment Plant Flows and Loadings Study in 2017 to assess the capacity of each treatment process at all three major regional treatment plants. Results from this study are expected in December 2018 and will be used to help prioritize capital projects.

### Total suspended solids

Solids in a water or wastewater sample that can be trapped by a filter of a specified size. TSS is a water quality parameter used in wastewater treatment to assess the quality of a wastewater sample after treatment in a wastewater treatment plant.

### Biochemical oxygen demand

Also known as BOD, a measure of the quantity of oxygen used by microorganisms to break down pollutants in water or wastewater.

As the West Point service area population has grown, water consumption has decreased by 15 percent because of water conservation efforts.

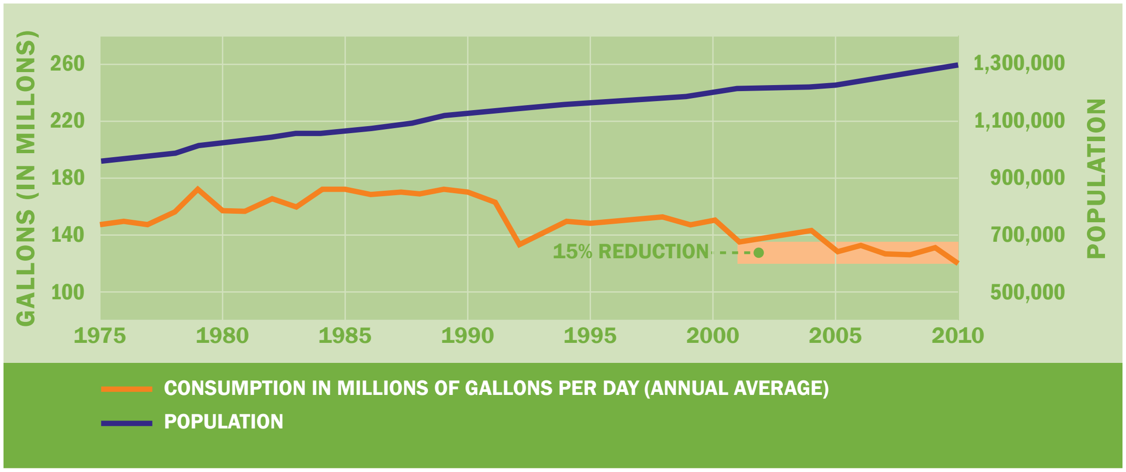



**FIGURE 4.**

City of Seattle water consumption, 1975 to 2010

**NOTE:** *Population is adjusted to reflect the proportion of the resident service area population actually using SPU water (i.e., excludes those that receive water from other sources).*

**SOURCE:** *Seattle Public Utilities 2013 Water System Plan*

## Will the King County Comprehensive Plan's growth patterns impact West Point?

The King County Comprehensive Plan is fundamental for directing and managing anticipated growth. It contains policies guiding development and land use in unincorporated areas of the county as well as service provision throughout the county and the region. King County's Comprehensive Plan dictates that growth, except under specific circumstances, should occur in the existing Urban Grown Area in accordance with the Growth Management Act. The patterns of growth are restricted largely to existing incorporated areas where decisions on density are made at the local (i.e., city) level. Therefore, the King County policies on concentrated growth patterns associated with the Comprehensive Plan are not anticipated to have a significant effect on flows and loads reaching West Point since the primary contributor to West Point is the Seattle service area and growth decisions are made by Seattle. However, as discussed in this subsection, changes in Seattle's population will impact West Point flows and loads.

## Looking Ahead //

The increase in population in West Point's service area has not resulted in a proportional increase in dry weather influent flows, mostly because of water conservation measures. Conversely, the population increase has resulted in an increase in solids and BOD loading to the treatment plant and it is now reaching its design capacity for TSS and BOD loads. West Point continues to meet discharge limitations for TSS and BOD concentrations; therefore, the extra load has not resulted in treatment performance issues to date. In addition, as Seattle is the primary contributor to West Point's flow and loads, the King County policies on concentrated growth patterns associated with the Comprehensive Plan are not anticipated to have a significant effect on West Point.

WTD is currently conducting a Treatment Plant Flows and Loadings Study to determine when solids and BOD loadings will be at capacity for each process within the three regional treatment plants.

# Climate-Driven Changes

**SECTION 2**
**Changes in Operating Context**

Gradual changes in air and sea temperature, and in average tidal levels, have been observed since the beginning of the 20th century—and it is believed that these changes will accelerate through the end of the 21st century. Long-term trends are difficult to predict because of significant year-to-year and decade-to-decade natural variability. However, the frequency of intense storms is expected to rise, which may lead to an increased frequency of peak wet weather flows at West Point.

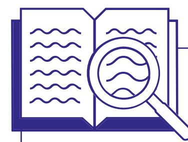
## What are the climate change expectations for the future?

In 2015, the Climate Impacts Group at the University of Washington (UW), an interdisciplinary research group that studies the impacts of natural climate variability and global climate change, published a *State of Knowledge* report (Maurer et al., 2015) that summarizes observed and likely future climate trends and key drivers of change. According to this report, "Puget Sound is experiencing long-term changes that are consistent with those observed globally as a result of human-caused climate change." More specifically, the report indicates that:

- Long-term warming has been observed and is projected to continue throughout the 21st century, leading to rising nighttime air temperatures and longer frost-free seasons.
- Occurrences of heavy rainfall caused by atmospheric river events are projected to be more frequent and more intense. The frequency of these events is projected to increase from an average of two per year to a range of four to nine per year by the 2080s.
- The region's large variations in annual rainfall recorded year to year and decade to decade are expected to continue and may become more pronounced. The average amount of rainfall each year is not expected to change. However, if storm intensity increases, West Point may experience peak wet weather flows more often.
- Despite the uncertainty surrounding precipitation trends, climate projections tend to agree that summer precipitation will decrease while winter precipitation will increase. An increase of 2 to 11 percent is projected by the 2050s. Other researchers project a somewhat higher increase (Warner et al., 2015).
- The Puget Sound region is projected to experience continued sea level rise throughout the 21st century. Absolute sea level is projected to rise an additional 14 to 54 inches in the Puget Sound region by 2100 (relative to 2000).

## What are the current and future impacts on West Point?

Given that long-term changes in precipitation are expected to be modest, the general trends of average daily dry weather flow and average daily wet weather flow are not expected to increase significantly because of climate-driven increases in stormwater flow to the sewer system. Year-to-year variations will continue to be large relative to general conditions. However, maximum daily flow and peak wet weather flow are more strongly related to heavy rainfall events, which are expected to increase. The frequency of flows reaching 440 million gallons per day (mgd) are expected to mirror any increase in frequency of atmospheric river events.



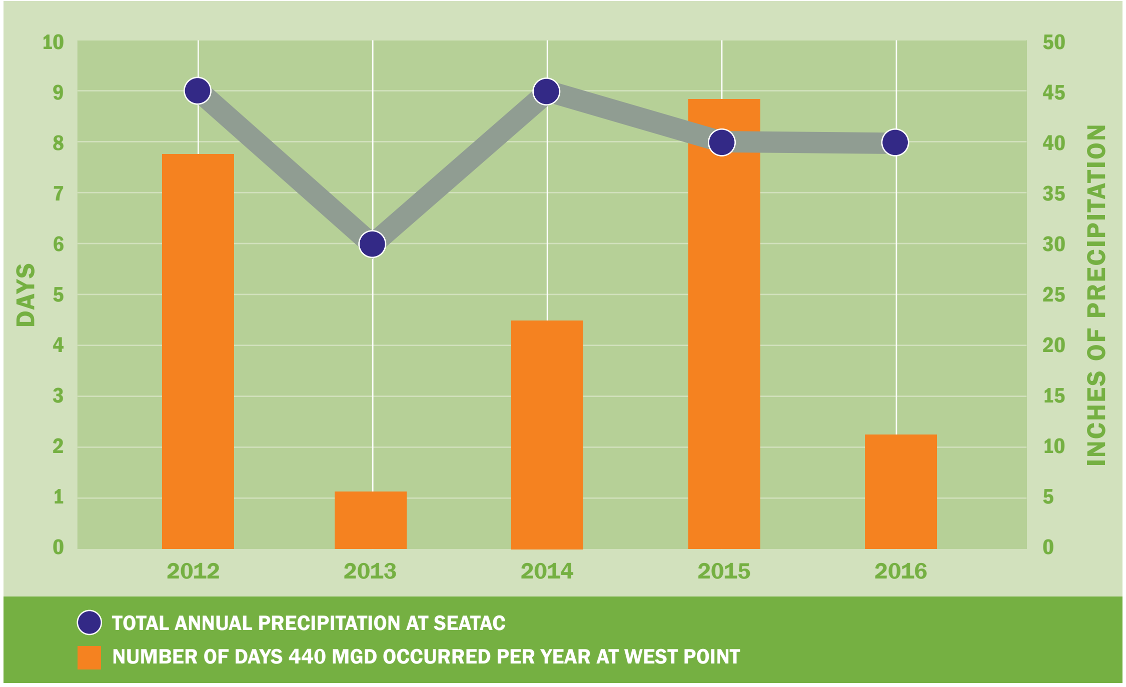
### Atmospheric river events

Also known as a Pineapple Express, an atmospheric river is a long and narrow band of moisture in the atmosphere responsible for conveying large amounts of water from the Pacific islands to the western United States.

**FIGURE 5.**

Frequency of West Point peak flows

**SOURCE:** *WTD data and CSO Annual Report*




Influent flow to West Point equaled the plant's hydraulic capacity of 440 mgd between one and eight times per year from 2012 to 2016. These are attributed to intense storms and not average annual rainfall.

Peak flows of 440 mgd into West Point through the collection system are generally associated with heavy rainfall periods of 1 or more inches over one to two days, and most notably with atmospheric rivers striking the Northwest. The frequency of flows reaching 440 mgd ranges from one to eight times per year, with an average of about four days per year over the period of 2012 to 2016.

The Northwest climate is highly variable, with large year-over-year and decade-over-decade variations. For example, the rainfall from 2000 to 2010 was relatively modest compared to the preceding and following decades. Looking from decade to decade and given the variability, the average annual amount of rainfall is not expected to significantly increase because of climate change.

However, heavy rainfall events, including those associated with atmospheric rivers, may increase from a long-term current average of two per year to a range of four to nine per year by the 2080s. Because atmospheric rivers strike the West Coast from California to British Columbia, the actual frequency of impact on Seattle may be less.

Thus, a gradual increase in the long-term average number of days peak flows of 440 mgd or more occur at West Point may be expected. Again, year-to-year variability will be high and will continue.

### SEA LEVEL RISE IMPACTS AT WEST POINT

Studies have shown that the apparent sea level rise in Seattle has been approximately 1 foot per century (Canning, 2001). Phillips and O'Neil (2013) concluded that West Point is not vulnerable to surface flooding under even the most extreme sea level rise prediction for the Puget Sound area, which at the time of the study was projected to be an approximate 50-inch sea level rise coupled with a 100-year storm surge event that adds an additional 3.19 feet of rise. Phillips and O'Neil (2013) note that structures protecting the treatment plant, such as the existing walls and beach berms, are important for protection against future sea level rise. Sea level rise, in combination with storm surge and high tide events, could affect effluent pump capacity at peak wet weather flow. However, more analysis is needed to determine the potential for such impacts to affect operations.

## How can West Point address climate-driven changes to flow?

The number of rainfall events that can cause peak flows to equal 440 mgd may gradually increase. West Point has been designed to, and has historically managed, 440 mgd. This was true even during the February 9, 2017 incident. On February 9, West Point was at peak flow and was able to treat the volume of flow. Flows could not be removed from the plant that night because of effluent pump failure.

Wastewater is delivered to West Point by two large-diameter tunnels: the Old Fort Lawton tunnel and the new Fort Lawton Parallel tunnel. Flows from these tunnels are combined at the influent control structure, which contains gates that can control flow to the raw sewage pumps and into the treatment plant. The control structure also includes an emergency bypass gate that can divert excess wastewater to the emergency bypass outfall.

The treatment plant's raw sewage pumps have a combined design capacity of 440 mgd. Flows to the treatment plant in excess of 440 mgd are managed throughout the conveyance system and CSO control facilities.

The County is required by combined sewer overflow (CSO) regulations to maximize flow to West Point consistent with the treatment plant's ability to accept those flows. The WTD Operations Plan describes a cascading approach to controlling flows into West Point that includes:

- Storing flow in the collection system and in defined CSO storage facilities
- Reducing flow to West Point from the Interbay Pump Station (serving the Elliott Bay Interceptor), which in turn may impact upstream CSOs, the Elliott West Wet Weather Treatment Station, the West Seattle Pump Station, and the Alki Wet Weather Treatment Station
- Limiting flow to the raw sewage pumps via pump speed, causing storage in the two Fort Lawton influent tunnels as available
- Operating the emergency bypass gate in the influent control structure to divert excess flow to the emergency bypass outfall

These cascading control options keep flow into the treatment plant to a maximum of 440 mgd. If flows exceed this amount, they will leave the system via a CSO or be contained for later release at existing CSO storage or treatment locations upstream.

### Looking Ahead //

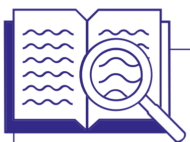
**West Point is expected to have more peak wet weather events in the future and the number will vary from year to year. WTD should:**

- **Continue monitoring climate change projections and any perceived impacts at West Point and develop adaptive management plans as appropriate**
- **Confirm capacity of effluent pumping in response to climate change impacts on tide levels**
- **Continue to follow existing emergency protocols to manage peak flows into West Point**
- **Ensure treatment plant reliability to treat increased wet weather flows through continued asset management planning and practices**

**SECTION 2**
Changes in Operating Context

# Impermeable Cover

As the Puget Sound region has developed and land uses have changed, the amount of impermeable cover—or hard surfaces—has increased. This change has resulted in an increase in stormwater runoff from the land surface. Increases in stormwater mainly impact the conveyance system and CSO control. Increases in stormwater have also required West Point to operate in wet weather mode more frequently and for longer periods.



**Impermeable cover**

Area of the ground surface that is covered by an impenetrable artificial material (e.g., paved), limiting stormwater infiltration into the soil. Impermeable surfaces include roads, sidewalks, driveways, highways, roofs, etc.

## How has impermeable cover changed over time?

The amount of impermeable cover in the Seattle area has increased since 1966. However, the impermeable area in the West Point service area does not appear to have changed recently—increasing by only 1.2 percent over the past 10 years. This minimal increase is due to the fact that the Seattle area is getting close to full buildout, and the amount of land available for development is decreasing.

Georeferenced data were used to calculate the percentage of impervious cover from 2001 to 2011, which increased from 47.8 to 49 percent. Prior to 2001, georeferenced data were not available, so an impermeable cover of 40 to 45 percent for 1960 was estimated by analyzing representative images from the UW map library from 1961 and comparing the images to the 2011 georeferenced data. Due to this method, these estimates should be considered approximations.

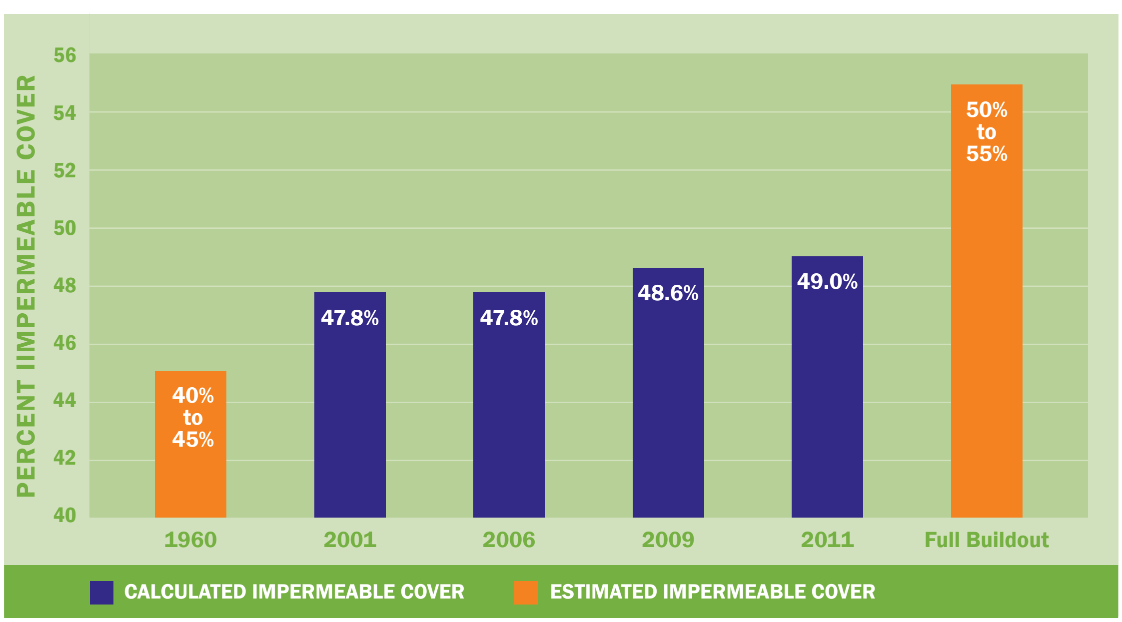
## How will impermeable cover change in the future?

The amount of future impermeable cover at full buildout was projected based on current zoning designations and an assessment of developable parcels. Based on this assessment, at full buildout, Seattle and West Point service area are predicted to be 50 to 55 percent impermeable cover. The exact year Seattle will reach full buildout is difficult to approximate because of how land available for development is zoned. Much of it is zoned as single-family residential, meaning that further buildout would be possible only through subdivision or rezoning. Some developable land is on large parcels, like golf courses and cemeteries. While these parcels theoretically could be converted to residential development, building on this land is unlikely in the near future.

**FIGURE 6.**

Percent impermeable cover in the West Point service area

**SOURCE:** *WTD georeferenced data and UW map library*



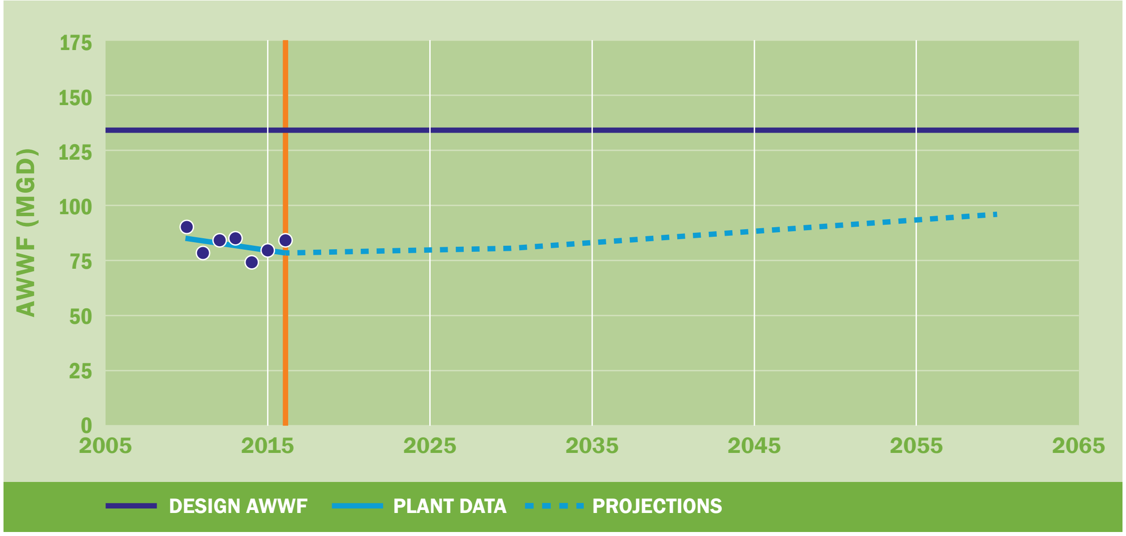



**FIGURE 7.**

**West Point average wet weather flow**

**SOURCE:** *WTD Treatment Plant Flow and Wasteload Projections Report and Plant data*

Even at nearly the maximum amount of impermeable cover in the service area, flow remains well below West Point's design flow.

The difference between the low and high ends of the future percent impermeable cover range reflects assumptions about development, including golf courses, cemeteries, and public schools. Because most of these areas are zoned as single-family residential, they could be developed in the future and the high end of the impermeable cover range assumes that this could happen. It may be counterintuitive to describe Seattle as fully built out with an impervious estimate of 50 to 55 percent, but city parks, greenbelts, and critical areas (e.g., steep slopes, shorelines, and wetlands) all contribute to undevelopable land.

An additional 1 percent increase in impermeable cover from the 2011 estimate—the most probable scenario—is not likely to significantly impact stormwater runoff. In addition, almost all future development will occur as redevelopment of already developed sites, as there is little opportunity for new development to occur in the service area. Redevelopment triggers rigorous requirements for stormwater runoff control, mostly on properties with little or no current flow control. Therefore, the amount of stormwater generated per acre of impervious area should gradually decrease in the future.

## Has the amount of impermeable cover impacted treatment plant operations?

Even at the nearly maximum amount of impermeable cover, average wet weather flow remains well below the treatment plant's design flow. Equally important, during large storms that produce peak wet weather events, the rate of flow entering West Point is hydraulically limited to 440 mgd (discussed in detail in the previous section on climate-driven changes). The increase in stormwater because of increases in impermeable cover has more impact on the conveyance system and CSO facilities. The primary impact to West Point is the need to reliably operate at wet weather conditions for longer periods as more stormwater is now stored in the conveyance system during wet weather events.

### Looking Ahead //

**The increase in impermeable cover that occurred during the first 30 to 40 years of operation can be assumed to have contributed to increases in wet weather inflows to West Point in the past, but the service area is at near full buildout. Any increase in impermeable area that has occurred in recent years has likely been insignificant in terms of stormwater runoff. This is not expected to change in the future. Therefore, there is no significant impact to West Point in the future based on impervious cover.**

**SECTION 2**
**Changes in Operating Context**

# Water Quality Concerns and Regulations

Neither the U.S. Environmental Protection Agency (EPA) nor the Clean Water Act existed when West Point was built in 1966. Before the mid-1990s, the removal of solids from wastewater, or “primary treatment,” was the only requirement at West Point. Over time, the public’s concerns about the environment and water quality have grown. Combined with changes in science, technology, regulations, and policy, this has resulted in greater efforts to remove *dissolved* waste from loads, a process that occurs during “secondary treatment.” West Point faces constraints despite having both primary and secondary treatment facilities in place as the number, type, and use of toxic and non-toxic chemicals have grown tremendously in recent decades. Concerns about water quality continue to increase and may lead to future changes in regulatory requirements for West Point’s operations.

**Point source pollution**

A single identifiable source of pollution. Examples of point source pollution include a factory’s smokestack or wastewater discharge pipe.

## How has public perception changed?

The end of World War II saw an expansion in manufacturing and technology, related increases in the use of chemicals and plastics, and a global population boom. Few environmental safeguards existed and, within a fairly short period, many water bodies were polluted. By the early 1960s, the public began to take notice. Books such as Rachel Carson’s *Silent Spring* (1962) and national events such as the Cuyahoga River fire (1969) highlighted environmental consequences and began to shift people’s perceptions. The environmental movement was recognized with the first “Earth Day” in April 1970 and the creation of the EPA that same year.

Locally, in the 1950s, untreated and partially treated wastewater flowed into Lake Washington, Puget Sound, and many rivers and smaller lakes without enough treatment, fouling water and making a sullied mess of local beaches. In 1958, voters created the Municipality of Metropolitan Seattle (Metro) and developed a regional wastewater treatment system to address these sources of pollution and clean up the local lakes and rivers.

Shortly after Metro was formed, construction began on two of the County’s regional treatment plants, West Point and South Treatment Plant, which were officially operating by 1966. By the late 1960s, regional water quality began improving dramatically. In 1994, King County assumed authority of Metro and its legal obligation to treat wastewater from 34 local jurisdictions that contract with WTD.

In the Northwest, as the region’s iconic salmon populations have declined and many people have started to personally experience the impacts of population growth and degradation of the environment, the importance of protecting and restoring the environment has become widely recognized. In recent years, Puget Sound has been listed for water quality impairments.

## How have regulations changed nationally?

One of the first significant pieces of legislation developed by the EPA to protect water quality was the Clean Water Act in 1972. The Clean Water Act established the NPDES, which made it unlawful to discharge any pollutant from a point source into navigable waters without a permit from the EPA.

The discharges that were the focus of early work by EPA were point source discharges, such as from wastewater treatment facilities, including West Point. The Clean Water Act required all sewage treatment plants to meet secondary treatment requirements by 1977. At the time, West Point provided only primary treatment. Eventually, West Point achieved secondary treatment in 1995.

The 1987 amendments to the Clean Water Act required states to establish water quality standards and identify water bodies that cannot meet those standards with point source control alone, and to develop best management practices and implementation plans for each impaired water body. Municipal and industrial stormwater permits were one part of the solution to non-point source pollution. Treatment and control of stormwater, including stormwater from commercial and industrial areas around Seattle, are also critical to controlling CSO events.

## How has the focus on Puget Sound's water quality changed?

Puget Sound is critically important to the economic, cultural, and social fabric of this region. Starting as early as 1983 with the establishment of the Puget Sound Water Quality Authority, Washington state has worked to develop a program to guide protection and restoration of Puget Sound. In 2005, Governor Christine Gregoire made restoration of Puget Sound a centerpiece of her administration's work with the stated goal of making it "fishable, swimmable, and diggable" in the time she held office. This resulted in the 2007 creation of the Puget Sound Partnership, an agency whose purpose is to oversee the restoration of Puget Sound by 2020. Puget Sound is also recognized as critical at the national level. As the nation's second-largest estuary, Puget Sound was one of the original areas established through the National Estuary Program.

The focus on Puget Sound health has increased significantly, with hundreds of identified water quality impairments under the Clean Water Act; listings of Puget Sound Chinook, Summer Chum, and Puget Sound Steelhead under the Endangered Species Act; and the impaired ecological health of many Puget Sound fish (e.g., tumors, altered spawning patterns, and physical abnormalities).

## How have permitting requirements changed at West Point?

The permitting of West Point has changed over the life of the treatment plant, reflecting its conversion from primary to secondary treatment in 1995. From startup in 1966 until the mid-1970s, the West Point permit limited the monthly average effluent to a BOD of 85 milligrams per liter (mg/L) and TSS of 65 mg/L. These permit requirements reflected the limitations of the primary treatment process that was in place at that time. In response to the Clean Water Act, provisional (or temporary) lower limits of 30 mg/L BOD and 30 mg/L TSS were identified in the late 1970s.

Initially, waivers from upgrading to secondary treatment were granted until the end of the 1980s. Planning of West Point's conversion to secondary treatment was initiated at that time. Washington State Department of Ecology (Ecology) fact sheets showed a gradual reduction in BOD

**National Pollutant Discharge Elimination System Permit**

Known as an NPDES permit and instituted as part of the Clean Water Act, a permit program that controls water pollution by regulating point sources that discharge pollutants into U.S. waters.

West Point's permitted limits of BOD have reduced over time, reflecting revised regulations after establishment of the Clean Water Act in the 1970s and the upgrade to secondary treatment in the 1990s.

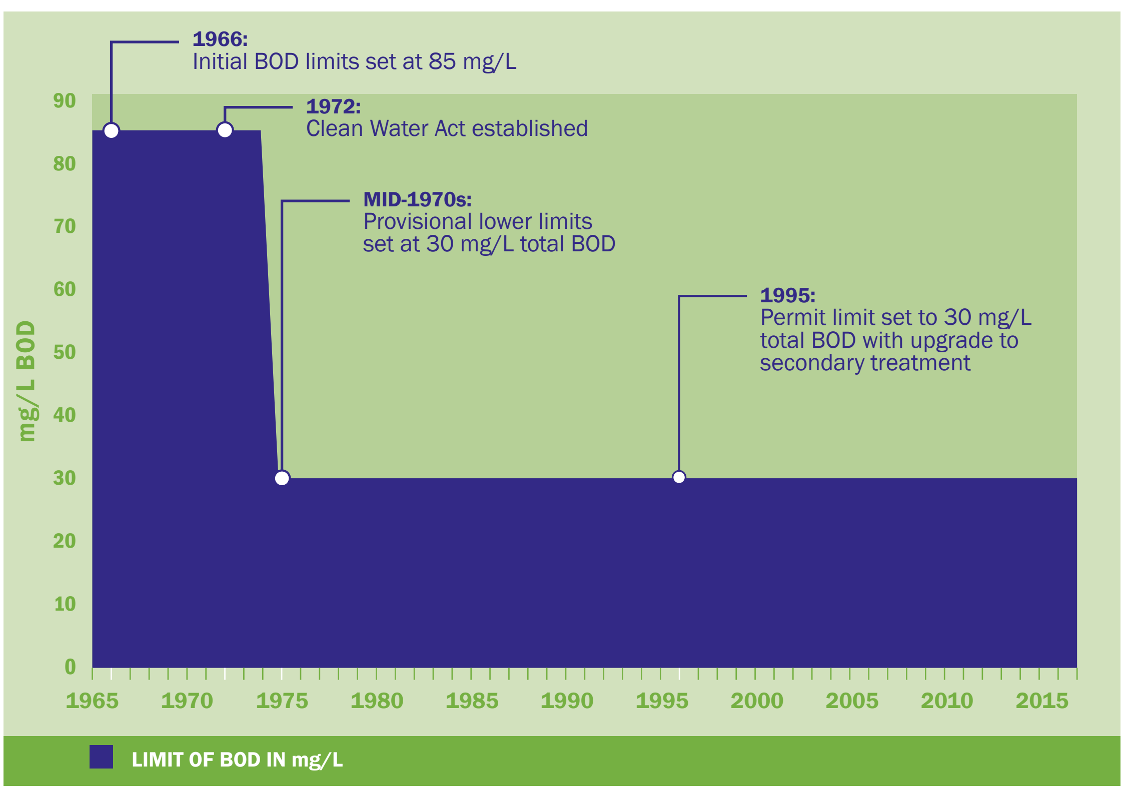



**FIGURE 8.**

**Changes in West Point's permitted BOD limits over time**

**SOURCE:** *WTD West Point NPDES permits* and TSS influent loading to West Point during the 1970s and 1980s. After upgrading to secondary treatment, the monthly average effluent BOD limit was set at a total BOD concentration of 30 mg/L and a TSS concentration limit of 30 mg/L. In addition, West Point's hydraulic (flow) capacity increased to a maximum monthly average of 215 mgd and a peak of 440 mgd. The treatment plant was designed and permitted to be a wet weather plant. West Point is required to meet all secondary treatment standards and effluent quality for flows up to 300 mgd and primary treatment standards for flows from 300 to 440 mgd. Above 300 mgd, the blended secondary treated and primary treated flow still needs to meet BOD and TSS removal requirements. With little exception, West Point has been compliant with these permit limits.

### How might permit requirements change in the future?

Increased concerns about water quality could lead to changes in regulatory requirements. Ecology has identified that nitrogen is the largest contributor to oxygen deficiency in Puget Sound waters, which negatively impacts the health of indigenous fish species. Nitrogen is present in low concentrations in surface runoff from agricultural land (non-point source), but at higher concentrations in the discharge from wastewater treatment plants (point sources). From a regulatory perspective, it is simpler to regulate point source discharges to reduce nitrogen loading to water bodies. Once Ecology has completed its modeling of oxygen depletion in Puget Sound, it is likely that it will begin to regulate nutrients, such as nitrogen, at treatment plants.

Although Ecology has not suggested a potential limit, the consequence of increased nutrient regulation is expected to be the need to approximately double the size of aeration basins in all affected treatment plants, which would be problematic because of the land-based limitations at West Point. Alternatively, West Point would need to consider use of new and expensive small-footprint treatment technologies, such as a membrane bioreactor (MBR) process, to comply with a requirement to remove nitrogen. WTD performed a conceptual Nitrogen Removal Study for West Point in March 2011, which reviewed alternatives for two potential permitting scenarios from Ecology. This conceptual study concluded that MBR technology could be implemented at West Point. However, this approach presents significant engineering and constructability constraints, such as fitting the new technology on the existing site and keeping the treatment plant operational during construction, and the 2011 study indicates that it would be very expensive—in the multiple-billion-dollar range. It may be more feasible for King County to achieve a systemwide level of nutrient reduction by adding additional nutrient removal at South Plant.

An increasing public awareness of toxic chemicals, such as pharmaceuticals found in water bodies, has led to concerns over what impact these compounds may have on water quality. Currently, EPA has not enacted legislative requirements for their control at wastewater treatment plants. Some toxic contaminants are biodegradable and others are not—those that are biodegradable will be removed at biological treatment facilities, but only if such facilities are operated in a manner that will allow this to occur. The secondary treatment facility at West Point was not designed to operate in that way and is not likely to remove the biodegradable toxic contaminants. The treatment plant would likely need additional aeration basin volume to accommodate such a change. In either case, non-biodegradable toxic contaminants would pass through the treatment plant.

#### Looking Ahead //

**West Point, with minor exceptions prior to February 2017, has met permit conditions since 1966. The treatment plant in its current configuration can continue to meet existing permit requirements. If Ecology sets new requirements for nitrogen removal in future permits, West Point will need to be significantly upgraded. WTD's West Point conceptual Nitrogen Removal Study in March 2011 concluded that new technologies could be implemented, but would present significant costs and constructability issues. If nutrient removal is regulated, a system-wide evaluation should be performed to determine the best alternative for West Point and the regional system. WTD should continue to monitor potential regulatory changes at the local and national level.**

# Industrial Contributions to Wastewater

**SECTION 2**
**Changes in Operating Context**

Some businesses produce wastes containing toxic contaminants that cannot be completely removed by treatment processes, which pass through to the environment or end up in the biosolids. Some contaminants can even interfere with treatment operations. Due to this, King County WTD has been implementing a industrial wastewater pretreatment program since the 1960s. Over the years, the number and type of industries that contribute wastewater to West Point have changed. However, these industries have historically contributed only 3–4 percent of West Point's total flow and do not significantly impact the operations or effectiveness of the treatment plant.

## How have the number and type of industrial dischargers changed?

The number and type of industries in the region have changed over the years, reflecting changes in the regional economy and technology. By the mid-1980s, 150 to 180 industrial users were discharging significant amounts of wastewater to West Point. By 2016, only 42 industrial dischargers were discharging significant amounts of wastewater in the West Point service area.

The types of industries have also changed significantly over the last 20 to 30 years. For instance, in the mid-1980s, many industries were associated with metal finishing plants that supported the aerospace industry. These industries have since largely moved out of the area. In addition, photo processing facilities closed because of changes in technology. Other technological changes occurred that impacted the quality of the industrial discharges, such as reduced use of mercury and silver for treatment in dental offices.

Currently, less industrial wastewater is delivered to West Point from traditional industrial wastewater discharges and more is generated as dewatering water from large construction projects. Also, when Brightwater came on line and began receiving industrial flows, there was a large reduction in the number of industrial facilities that discharge to West Point. Another recent change is the increase in food processors, such as breweries and wineries, where issues of BOD are more critical than metals or toxic contaminant content.

The number and type of industries contributing wastewater to West Point has changed significantly over the last 20 to 30 years. Currently, less industrial wastewater is delivered to West Point than in past decades.

Through King County's industrial pretreatment program, mercury levels in industrial wastewater discharges have been reduced by 40 percent since 2000.

## What changes have been implemented at West Point to address industrial dischargers?

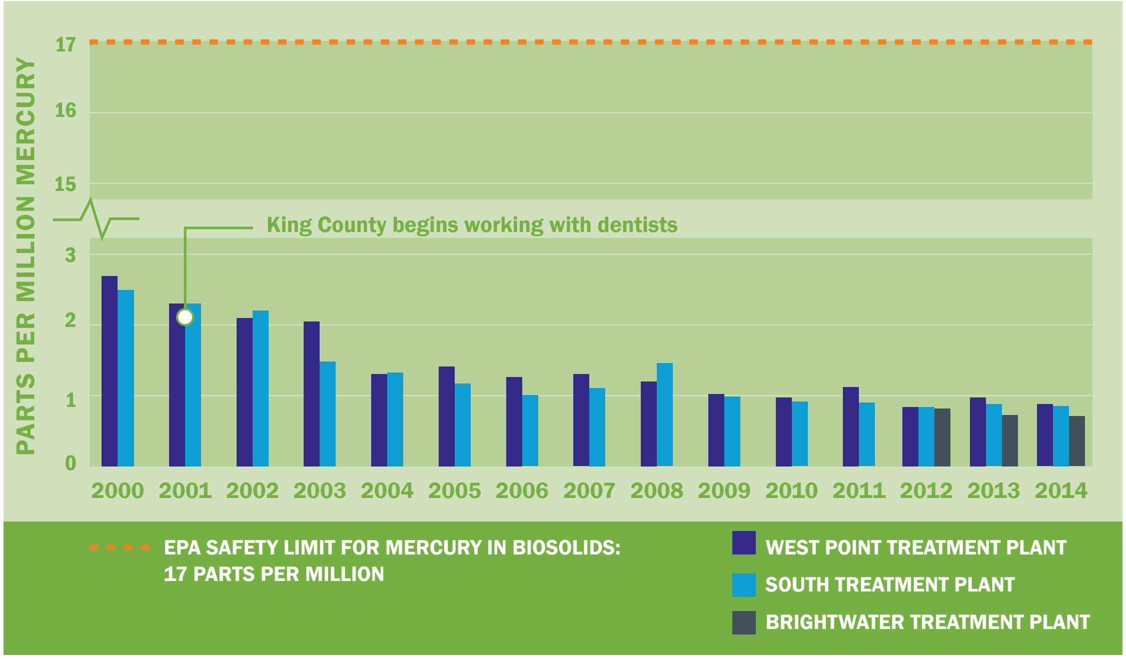
WTD has been proactive in its efforts to pretreat wastewater discharges from the region's industrial facilities to remove contaminants before they are sent to West Point. WTD has had a pretreatment program for industrial dischargers in place since 1969, nine years before the EPA established pretreatment standards. WTD's pretreatment program became one of the first in the United States to receive approval from the EPA, giving WTD full authority to issue and enforce permits. WTD was also the first utility in the nation to implement a dental pretreatment program, more than 15 years ahead of EPA regulations. Since implementation of this program, mercury in industrial discharges has been reduced by 40 percent.

WTD's award-winning industrial pretreatment program focuses on working in close cooperation with industries to address source control and pretreatment options. The proactive monitoring program includes inspections and sampling of significant industrial users. WTD provides technical assistance to facilities by helping them comply with regulations and acknowledges industry efforts through a compliance awards program.

**FIGURE 9.**

Mercury in industrial discharges since 2000

**SOURCE:** *King County WTD*




Less than 20 percent of metals entering West Point are estimated to be from industrial dischargers, likely due to WTD's rigorous pretreatment program. Significant changes in the volume or type of industrial dischargers are not expected in the future.

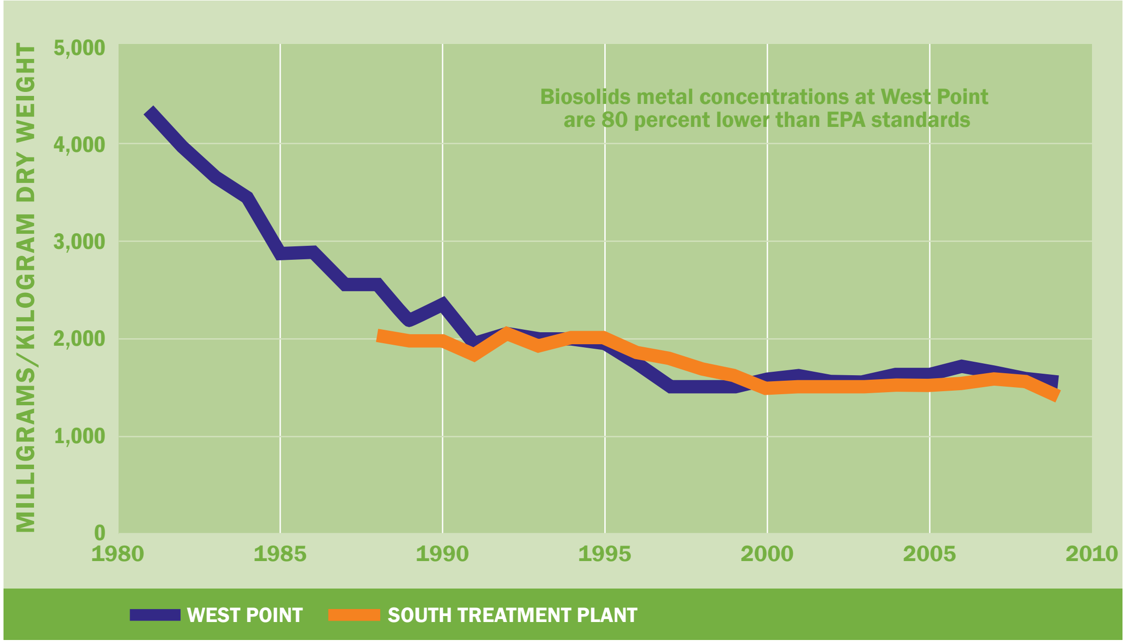



**FIGURE 10.**

Total metals content in West Point biosolids

*Total Metals= the sum of the concentrations of cadmium, chrome, copper, lead, mercury, nickel and zinc (milligrams/ kilogram dry weight)

**SOURCE:** *King County January 2015 Industrial Waste Program Fact Sheet: Discharging Industrial Wastewater to the King County Sewer System*

## Are industrial discharges influencing treatment plant operations?

Industrial wastewater accounts for only 3 to 4 percent of the inflow to West Point. Metals concentrations in industrial discharges are generally either very low or below detection, and consistently well within local or federal discharge limits. It is estimated that less than 20 percent of metals coming into West Point are from industrial dischargers, likely due to the rigorous pretreatment program.

The metals concentration of biosolids is one indicator of the influence of industrial contaminants on treatment plant operations. Since the 1980s and the adoption of local and federal limits, the total metals content of West Point's biosolids has dramatically decreased, in part because of the change in industrial contributions moving from metal plating to stormwater/construction dewatering. In general, biosolids metal concentrations at West Point are 80 percent lower than EPA standards.

Given these data, it is unlikely that industrial discharges are influencing treatment plant operations. This conclusion is supported by the fact that West Point continues to meet permit conditions such as BOD, TSS, and toxicity tests.

## Looking Ahead //

Significant changes in the volume or type of industrial dischargers to the West Point collection system are not expected in the near future. In addition, the percent of wastewater flow entering West Point from industrial sources is currently low and expected to remain very low. Pretreatment and source control efforts will continue to improve as new technologies are developed, but these efforts are not expected to significantly impact plant operations as contaminant levels are already very low.

**SECTION 2**
**Changes in Operating Context**

# Levels of Toxics

Many toxic contaminants entering the waste stream are generated by runoff from the watershed or accumulated through air deposition. The types and number of these contaminants have increased exponentially over the past half century, though their concentrations remain very low. West Point is not designed to treat most of these contaminants. However, the primary pathway for most of these contaminants to reach receiving waters is by stormwater runoff, and the toxic contaminants in their current concentrations do not significantly impact West Point operations or treatment effectiveness.

## How important are toxic contaminants in wastewater?

Although toxics, such as automotive chemicals, herbicides, and pesticides, exist in wastewater treatment plant effluent, treatment plants are not considered a critical pathway for these contaminants to enter water bodies. Starting in 2011, Ecology led a series of research efforts, the Puget Sound Toxics Loading Studies (PSTLS), that examined the various pathways through which toxic contaminants enter Puget Sound. Wastewater treatment plants were one of the many pathways examined. West Point was one of the 10 facilities monitored during the studies. Air deposition, groundwater, and surface runoff were other major pathways that were evaluated.

Ecology identified 16 key toxic contaminants based on their observed harm or threat of harm to the Puget Sound ecosystem. The 16 key toxic contaminants included a few heavy metals, petroleum, oil and grease, some pesticides and herbicides, polychlorinated biphenyls (PCBs), and other organic compounds.

Ecology prepared a final synthesis report from all of the PSTLS research (Ecology and King County, 2011) and compared the loading from the 16 key contaminants. Wastewater treatment plants generally accounted for less than 10 percent of the load of these trace contaminants entering Puget Sound for all but two of the contaminants, which were still not significant pathways to Puget Sound. In addition, although many of these contaminants are found in wastewater effluent, they are typically at concentrations below normal detection limits. For example, although multiple pathways contribute some zinc loading to Puget Sound, surface runoff is the primary pathway for zinc (as shown in Figure 11).

Surface water runoff is the primary pathway to Puget Sound for many toxic chemicals.

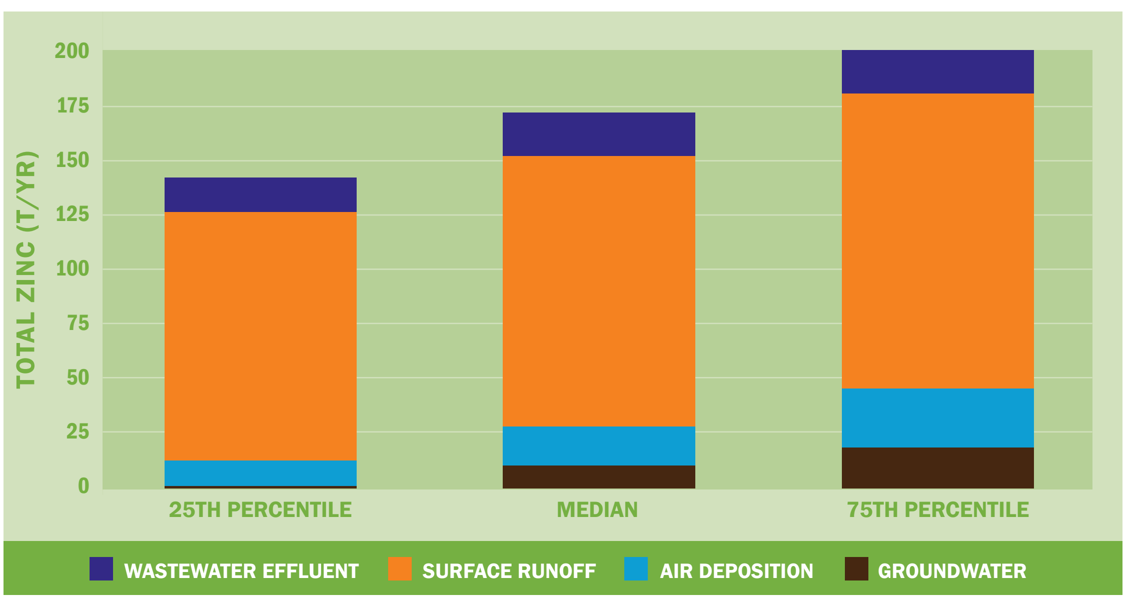



**FIGURE 11.**

Total zinc loads to Puget Sound

**SOURCE:** *WA Ecology and King County PSTLS Final Synthesis Report, 2011*

## What are the toxic contaminants of concern in wastewater?

Wastewater treatment plants are a critical pathway for a group of emerging toxic contaminants associated with pharmaceuticals and personal care products (PPCPs). There has been a significant upsurge in the use of PPCPs over the past 50 years. Pharmaceuticals alone account for thousands of chemicals. According to the Associated Press (as reported by Lubliner et al., 2010), 50 percent of Americans with health insurance are taking prescription drugs daily. Because these medications are not fully metabolized, and in the case of personal care products are just washed off, they end up in wastewater treatment plant influent. Although wastewater treatment plant processes, including those at West Point, may remove or destroy some of these chemicals, they are not currently designed to remove toxic contaminants and permit conditions do not require PPCP removal. Low concentrations of PPCPs have been detected in surface water, groundwater, marine waters, soils, sediments, and drinking water (Lubliner et al., 2010). Although these contaminants are being measured in the environment, they do not necessarily exist in problematic concentrations. The impact of low-level exposure on the environment and human health is unknown.

Ecology's study of PPCPs was not rigorous enough to draw conclusions about specific wastewater treatment technologies but, in that study and review of others, Ecology authors summarized that longer hydraulic retention time (HRT), longer solids retention time, and nitrate removal technologies were the operating conditions that appeared to improve removal efficiencies.

## Are these toxics affecting operations?

None of the 16 key toxic contaminants identified by Ecology (including PPCPs) are currently regulated as part of West Point's permit, so treatment plant operations are not modified or altered in any way to treat them. There is also no evidence that the presence of these toxic contaminants in the wastewater influent affects the efficiency of West Point operations, because the facility continues to meet its performance targets. WTD is currently conducting a Water Quality Assessment and Monitoring Study, analyzing the pathways of toxic contaminants. This Water Quality Assessment and Monitoring Study is meant to ensure that future projects to control pollution are well-planned and timed to improve water quality.

### Looking Ahead //

**Wastewater treatment plants are not considered the major pathway to Puget Sound for most urban runoff-based contaminants, such as automotive chemicals, herbicides, and pesticides. There are other toxic contaminants, such as PPCPs, for which wastewater treatment plants *are* a significant pathway. However, the impact of the low levels of these contaminants on the environment is unknown. In addition, wastewater treatment plant processes, including those at West Point, are not currently designed to remove toxic contaminants and permit conditions do not require PPCP removal. In addition, West Point is meeting its existing permit conditions, indicating there is no evidence that these contaminants are impacting the efficiency of operations. WTD should continue to monitor potential regulatory changes at the local and national level.**

SECTION 3

# Current and Projected Constraints and Limitations

Council Motion 14882 identified four areas for review: current and projected processing capacity; changes in wastewater processing technology; constraints acting upon the treatment plant including functional, design, and engineering constraints; and land-based limitations. The following section discusses how well positioned West Point is to meet these current and projected constraints and limitations in the future.

The previous section of this assessment discussed the external factors in which West Point has been operating and the potential impact of these factors on the treatment plant. This section discusses physical and process constraints and limitations within the fence line of the treatment plant, with the goal of focusing on the design treatment capabilities and not repeating operation and maintenance information provided in the WPTP Independent Assessment.

An overview of the treatment plant's current capacity is provided, followed by a discussion of West Point's potential functional, engineering, and design constraints. This section also describes new technologies that could potentially be employed at West Point and discusses one of the treatment plant's major constraints—land. Issues related to the collection system, training, and maintenance issues are not assessed in this section.

**Constraints and Limitations**

- **Current and projected treatment capacity demand compared to current capacity**
- **Functional, design, and engineering constraints including capacity limitations**
- **Wastewater processing technology**
- **Land-based limitations that constrain capital development**

# Treatment Capacity

How West Point's current and projected treatment capacity demand compares to current capacity

From its inception in 1966 until 1995, West Point was a primary treatment facility that met nominal solids removal requirements. With the 1995 upgrade, the treatment plant complied with the EPA's national requirements for secondary treatment: to remove dissolved organic matter in addition to solids. Specifically, provision was made to meet treated average monthly effluent concentration limits of 30 mg/L for total BOD and 30 mg/L for TSS. The 1995 upgrade provided West Point with the capacity to treat up to an average monthly flow of 215 mgd and a peak instantaneous flow of 440 mgd. In general, West Point has complied with these requirements since that time.

In its present operational state, it is likely that West Point will be able to accommodate the forecasted flows through 2030. However, West Point has limited hydraulic conveyance and liquid treatment train redundancy, as presented in the WPTP Independent Assessment and summarized in the following Constraints and Limitations subsection. In addition, the treatment plant's solids treatment capacity may be limited sooner than anticipated, which is also discussed in the next section.

Potential future needs, such as nutrient removal, or removal of PPCPs, will require a major capital investment at West Point. As discussed in the previous Water Quality Concerns and Regulations subsection, the County may be required to remove nitrogen from its discharge in the future. Providing such capabilities within the existing site would likely require installation of a different treatment technology from what currently exists at West Point. Installation of any new technology will be challenging because of the treatment plant's land-based limitations. A new technology would also have higher capital costs, electrical power requirements, and operating and maintenance costs than conventional treatment systems. These same technologies would also provide some PPCP removal, but only those that are biodegradable. Only advanced membrane processes, such as reverse osmosis and ultraviolet-assisted chemical oxidation, have been shown to be able to achieve a reasonable level of removal of non-biodegradable PPCPs.

## Looking Ahead //

**West Point currently has capacity to accommodate flows and loads in the near future. If additional nutrient or pollutant removal is required, new technologies would likely be required. Installation of any new technology would be challenging because of West Point's land-based limitations. In addition, a new treatment technology would pose higher capital costs, electrical power requirements, and operating and maintenance costs than conventional treatment systems.**

# Constraints and Limitations

Current and projected functional, engineering, and design constraints and limitations

West Point's performance may be limited by functional, engineering, and design constraints. Each of these types of constraints is discussed below in terms of current and projected future capabilities of the treatment plant.

External constraints acting upon the treatment plant include pounds of solids and BOD load, which are dictated by service area population and industrial input, and peak flows, which are dictated by combined sewer flow and infiltration and inflow in domestic and industrial base flows.

## Current Constraints

The functional, engineering, and design constraints that currently affect West Point are described below.

### FUNCTIONAL CONSTRAINTS

West Point is currently designed and permitted for three basic functions: hydraulic conveyance, liquid treatment, and solids treatment. With all systems and process units functioning properly, the treatment plant meets its intended functions. There are limitations and vulnerabilities if key treatment plant components are not functioning as intended, which are discussed below under Design Constraints and in the System Vulnerabilities section. West Point's principal functions include:

- **Hydraulic function:** The treatment plant conveys peak wastewater flows of up to 440 mgd to the outfall for discharge.
- **Liquid treatment function:** The treatment plant provides primary treatment for up to 440 mgd and conventional secondary treatment for up to 300 mgd, removing BOD and TSS to low levels and meeting permit requirements. Liquid treatment includes effluent disinfection before discharge. The treatment plant currently disinfects all effluent prior to discharge, meeting permit requirements.
- **Solids treatment function:** The treatment plant treats solids from primary and secondary liquid treatment and meets design intent, producing Class B dewatered biosolids.

### ENGINEERING CONSTRAINTS

No engineering constraints are relevant to the existing treatment plant in meeting its current assigned functions.

### DESIGN CONSTRAINTS

The current design constraints are the current-capacity constraints described below. These constraints were determined based on a high-level review of existing data and should be considered preliminary. WTD is currently undertaking a Treatment Plant Flows and Loadings Study, which will assess the capacity of each process within the treatment plant and confirm these findings.

- **Hydraulic constraints:** The treatment plant's hydraulic constraints are defined by the volume of water that each unit process can pass. The treatment plant is currently hydraulically limited to a design flow of 440 mgd through primary treatment with all units in service and 300 mgd through secondary treatment with one unit out of service. In assessing the capacity of West Point, it is important to understand what distinguishes West Point from most treatment facilities is the high proportion of stormwater combined with sewage received during storm-induced high influent flows. Large storms that have resulted in an entire day's flow volume exceeding 300 million gallons have occurred on 13 days over the past five years, whereas there were 181 days in five years when peak hourly flow was greater than 300 mgd and, on 146 of those days, flow had to be diverted around the secondary treatment process. As discussed previously in the Climate-Driven Changes subsection, the frequency of peak wet weather flows at West Point may increase in the future.

**Functional constraints**

Those constraints that limit the plant's ability to treat wastewater to a higher level.

**Engineering constraints**

Those constraints that are inherent to the site and limit the design by known engineering methods.

**Design constraints**

Those constraints that limit the plant's hydraulic and load capacity and performance in meeting its design functions.

West Point's primary near-term constraint is with the solids and BOD loading to the treatment plant. For the future, the major constraint is land-based, which limits any treatment plant expansion and significantly constrains the treatment plant's ability to meet potential future regulatory requirements.

In its present operational state, West Point can likely accommodate the forecasted flows through 2030. However, West Point has limited liquid treatment train redundancy, as discussed in the WPTP Independent Assessment with respect to hydraulic conveyance capacity.

Ecology's Sewage Treatment Plant Design Criteria (Orange Book) provides standards for wastewater treatment facility design based on federal standards; engineers are expected to follow these standards. Included in the Orange Book are requirements for redundancy in wastewater treatment facilities. "Total" capacity is when all wastewater treatment processes are in operation; "firm" capacity is the capacity when one of the designated processes requiring redundancy has one unit of that process off line. The treatment plant currently meets or exceeds recommendations of the Orange Book for treatment capacity. However, some pumping stations, wastewater treatment processes, and hydraulic conveyance components of the treatment plant do not have hydraulic firm capacity, which leaves the treatment plant vulnerable when units are off line for maintenance. West Point has redundancy for pumping secondary and effluent flow. However, there is no redundancy for influent pumping 440 mgd.

- **Liquid treatment organic loading constraints:** In contrast to hydraulic loading, the ability of the liquid stream portion of the treatment plant to process BOD and TSS is referred to in the wastewater treatment industry as organic loading rate. The treatment plant's principal liquids stream design loading criterion is pounds of BOD to the secondary portion of the treatment plant at a maximum month load. The design BOD loading to secondary treatment has been exceeded only twice in the past 17 years. However, the final effluent quality was not impaired by these periodic high loading events, which suggests that the treatment plant has excess secondary treatment capacity. The Treatment Plant Flows and Loadings Study is currently evaluating the capacity of each treatment process and will estimate the extent of this additional capacity.
- **Solids treatment constraints:** Based on a review of solids loading data for the past 5 years, both thickening and dewatering have firm capacity well above the treatment plant's current loads.

For anaerobic digestion, based on the hydraulic loading criterion, the existing digesters have approximately 40 percent extra capacity with all digesters on line. However, based on the digester organic loading criterion, the existing digesters are currently at 80 percent of their design loading with all digesters on line. Taking a digester off line for an extended period for repairs, upgrading, cleaning, or for any other maintenance reasons, is problematic.

West Point has experienced periodic digester foaming issues since 2013, compromising the loading capacity of the digesters. The foaming reduces the ability of the digesters to process solids. Because of current foaming issues with the digesters in combination with increased loads to the treatment plant that generate increasing solids, the treatment plant's solids treatment (digestion) capacity is approaching its limit with all digesters in service. Treatment plant staff have dealt with this situation during high-load periods in part by hauling some solids to the South Treatment Plant to reduce West Point digester loading and by use of a defoaming agent. However, there are restrictions on the number of truck trips allowed to the South Treatment Plant. These limits on hauling in combination with stressed digester capacity could potentially restrict removal of solids from the liquid stream, thereby limiting liquid stream treatment capability. Once the digester foaming issue is resolved, the treatment plant will be at 80 percent of design capacity limits with all digesters in service. This capacity limit is not considered an immediate concern. However, it supports the preliminary finding that West Point is reaching its solids and BOD loading limits earlier than anticipated.

## Projected Constraints for Expansion and Upgrades with Existing Treatment Technology

This section discusses the future constraints at West Point if upgrades are made using the existing facility and technology. Any construction, even for upgrades allotted for in the secondary treatment plant expansion, will be complex given the treatment plant's limited site footprint.

### FUNCTIONAL CONSTRAINTS

Within the current limits of the treatment plant site, there is insufficient space for treatment beyond current levels of basic BOD and TSS removal.

Because of current foaming issues with the digesters, the treatment plant's solids treatment (digestion) capacity is approaching its limit with all digesters in service. Once the digester foaming issue is resolved, the treatment plant will be at 80 percent of capacity limits with all digesters in service.

### ENGINEERING CONSTRAINTS

Land limitations are the primary engineering constraint at West Point. This limit is discussed separately in detail in the Land-Based Limitations that Constrain Capital Development subsection later in this section.

### DESIGN CONSTRAINTS

Design constraints are those that are limited by the engineering constraints mentioned above and are related principally to land availability. With the current footprint and technologies, West Point has minimal capability to relieve some current limitations on the treatment plant, as described below:

- **Hydraulic constraints:** To relieve the current hydraulic constraint of limited redundancy, West Point could add redundancy for some of the existing systems, including the influent pumps and primary clarifiers within the limits of land-based constraints. In addition, some West Point processes could potentially be further optimized to help relieve hydraulic limits, such as potentially implementing chemically enhanced primary treatment (CEPT) in the primary clarifiers to increase their capacity without building new ones.
- **Liquid treatment constraints:** The original West Point design concept (using the current secondary treatment technology) allowed for the expansion of this system to accommodate future flows and loads. Space has been reserved for two new aeration basins and two new secondary clarifiers for this purpose. A project currently under way at West Point will be installing new aerators/mixers, which is expected to increase aeration capacity by approximately 15 percent and remove additional BOD.
- **Solids treatment constraints:** The original design for secondary expansion identified a potential area for additional digestion capacity in the future. However, over the past 20 years, this area has been used for other treatment plant processes and ancillary support facilities. Further design analysis would have to be performed to determine actual area availability to add more digestion capacity and how it would fit within the current treatment plant processes. One additional digester would increase capacity to 25 percent above current loads.

For any of these options, future design analysis would need to be performed.

## Projected Constraints with Treatment Plant Reconfiguration for Advanced Treatment or Additional Capacity Expansion

This section discusses the potential future constraints at West Point if advanced treatment or additional capacity is required beyond the capability of the existing treatment plant technology and site.

As discussed above, West Point has limited expansion capability using current treatment plant technologies. Should future requirements dictate higher levels of treatment and/or should capacity increases be desired greater than possible with the treatment plant's existing technology and site, a reconfiguration would be required that could include conversion to new advanced treatment technologies. Undertaking such a conversion would pose severe constructability and cost issues. The following sections describe these constraints and limitations more specifically.

### FUNCTIONAL CONSTRAINTS

A variety of enhanced treatment levels of service could potentially be implemented with a complete treatment plant reconfiguration. Notably, new technologies for enhanced treatment have been proven in the 20 years since West Point was upgraded to secondary treatment. However, given the limits of land availability, there would continue to be a space tradeoff between flow and load treatment capacity and enhanced level of treatment in planning any changes at the treatment plant.

Ecology recently launched a Puget Sound Nutrient Reduction Control Project. A nitrogen removal requirement is likely to be added to the West Point permit in the future. If West Point were required to meet nitrogen discharge limits, the currently used secondary treatment technology would require significant modifications, including doubling the size of the aeration basins. The limited site space precludes this kind of expansion. Therefore, other potential ways to achieve effluent nitrogen limits within the existing land area would need to be explored.

WTD performed a Nitrogen Removal Study in 2011 that reviewed alternatives at a conceptual level for West Point. Other emerging processes beyond those identified in the 2011 study could be considered, including intensified treatment processes that would potentially require less site space. Potential new or different technologies are listed in the Wastewater Processing Technology subsection. Detailed engineering evaluations would need to be performed to confirm the feasibility, constructability, and cost of implementing advanced nutrient removal technologies at West Point.

The other future regulatory change could come with implementation of the new human health criteria in the state water quality standards that were recently updated. Over the next 50 years, new discharge limits for a variety of priority pollutant parameters likely could be added to the West Point permit. Advanced treatment technologies would need to be identified, explored, and implemented. As with nitrogen removal, because of space limitations at West Point, implementing standard technology would be difficult to nearly impossible. Alternative technologies would need to be explored.

### ENGINEERING CONSTRAINTS

One of the primary engineering constraints at West Point with implementing a new technology is the land limitations. For new technologies, constructability within the site constraints discussed below would be a significant issue, as would the limitations presented in the Land-Based Limitations that Constrain Capital Development section of this assessment.

A significant major constraint involved with reconfiguration to upgrade or replace existing facilities is keeping the treatment plant operational while new processes are under construction. With limited site space, an existing compact treatment plant design, and limited assigned space for additional units, maintaining treatment plant functions while removing and replacing any units would be difficult and risky. During any major construction of this sort there would likely be prolonged periods of limited treatment function and capacity. Construction would have to be staged so that some process units remain functional while others are removed and reconstructed, potentially one unit at a time. This process would significantly increase the construction schedule and costs.

In addition, any physical reorientation of the treatment plant to accommodate new treatment plant configurations would exacerbate constructability issues. Even in a treatment plant expansion that simply adds new process units allotted for in the secondary expansion design, some minor brief outages (hours) would be anticipated for tie-ins of new process connections. With major reconstruction, these outages or reduced capacity or function would be expected to last for extended periods, perhaps many months. Constructability would need to be a major consideration throughout the planning and design process.

For any of these options, future design analysis would need to be performed.

### DESIGN CONSTRAINTS

Bounded by the engineering constraints discussed above, design would be limited by currently known, proven, high-rate treatment technologies. Examples of new or different technologies that could potentially be applied at West Point are defined in the Wastewater Processing Technology subsection of this assessment.

Constructability due to land-based limitations is a primary constraint limiting potential upgrades and implementation of new technology at West Point.

## Looking Ahead //

**The primary near-term constraint is that the capacity of the treatment plant to treat solids and BOD loading may be limited earlier than anticipated. The primary long-term constraint is the land-based limitations of West Point's site footprint, especially if future regulatory requirements become more stringent. It is recommended that continued efforts be made to address digester foaming issues. The aeration and digestion system will be further evaluated through the Treatment Plant Flows and Loadings Study to determine when solids and BOD loadings will be at capacity.**

**SECTION 3**
**Current and Projected Constraints and Limitations**

# Wastewater Processing Technology

New technologies that could potentially address current and future constraints at West Point

WTD has been reviewing the application of new technologies at all of its treatment plants since the late 1990s. The new technologies discussed in this subsection may address the following factors:

- **Space/footprint:** Same or higher level of treatment may be performed in less space.
- **Treatment capacity (liquid and solids):** Capacity of a treatment process may be increased over present process capacity through new technology.
- **Treatment efficiency (liquid and solids):** Performance efficiency of a treatment process (better treatment) may be increased with new technology.
- **Regulatory change requirements (future):** Options to accommodate potential future regulatory requirements. For example, if regulatory nitrogen discharge limits are required in the future for West Point, the secondary treatment process may need to be modified to more efficiently and effectively remove nitrogen.
- **Operational risk:** Operational risks and other operational constraints may be reduced through new technologies, which are easier to manage and administer.
- **Instrumentation and controls:** Operational complexity may be reduced, clear and thorough control of treatment plant processes may be increased, and the efficiency of the connections and collaboration between collection system controls and treatment plant controls may be improved through new technology or more uniformly deployed existing treatment plant control software (Ovation).

## New Treatment Technologies that Could be Applied at West Point

Several current West Point processes and facilities may benefit from new technology. However, these new technologies require large capital investments and may also result in additional annual operating cost and energy use.

Many of these technologies have been assessed by WTD and are subject to the constraints and limitations presented in the previous section, including constructability on a land-limited site. Below is a list of example technologies that could potentially benefit West Point. Although these technologies have proved to be successful in other areas of the country, a detailed engineering analysis, potentially including pilot studies, would need to be conducted to determine whether the technologies are applicable to West Point-specific conditions and if they could be applied at West Point in a cost-effective manner.

### CHEMICALLY ENHANCED PRIMARY TREATMENT

CEPT relies on the addition of coagulation and flocculation chemicals (often ferric chloride and polymers) to capture, settle, and remove a greater percentage of influent total solids and BOD, and increase hydraulic capacity by a factor of two to three. CEPT requires chemical addition equipment and some modifications to primary tank operation. Some chemicals can be difficult to handle and store and would require modified safety and operational procedures and ancillary equipment. In addition, the increased solids settling with CEPT would increase the amount of solids requiring treatment and solids may be more difficult to digest.

### BIOMAG

BioMag is a ballasted clarification process that uses magnetite (fully inert iron ore particles) to increase the inventory of microorganisms carried in the system and enhance the secondary clarification process. BioMag has demonstrated the ability to increase capacity over two-fold while simultaneously achieving more efficient solids settling. BioMag could potentially add capacity to the treatment plant's secondary clarification without increasing the current secondary clarification footprint. The increased solids settling would increase the amount of solids requiring treatment.

### MEMBRANE BIOREACTOR SECONDARY

MBR treatment uses a nitrifying/denitrifying biological aeration process followed by membrane filtration rather than clarification. MBR treatment can remove all bacteria and most viruses from wastewater and produces a very high quality effluent. Implementation at West Point could incorporate nitrogen removal. Although it offers the best space-saving advantage over other technologies, an MBR treatment system would likely be difficult to construct, as the existing treatment plant would need to be kept operational during construction. In addition, MBR systems require more energy and maintenance than conventional clarification.

### NEW SOLIDS STABILIZATION PROCESSES

Several viable solids treatment (stabilization) technologies are in practice. Currently, West Point uses conventional anaerobic mesophilic (oxygen-absent, moderate temperature) digestion and produces a Class B biosolids product. Anaerobic thermophilic series digestion (oxygen-absent, thermophilic), or temperature-phased anaerobic digestion (TPAD) processes can improve solids destruction and improve tank volume efficiency. In addition, odors are controlled better with TPAD. Another stabilization process that could be reviewed would be the thermal hydrolysis (Cambi) process. Cambi has been used to enhance solids conversion to methane and reduce footprint. Cambi is complicated, equipment-intensive, and expensive to build.

Each of these different solids stabilization processes can produce a Class A biosolids product. Class A biosolids treatment provides greater disinfection of biosolids and greater solids destruction, at the cost of greater energy consumption.

### UPGRADE AND IMPLEMENTATION OF UNIFORM TREATMENT PLANT-WIDE INSTRUMENTATION AND CONTROLS

Currently, some Ovation distributed control system (DCS) technology for automated process control at West Point has already been implemented along with mobile supervisory control and data acquisition (SCADA). WTD is continuing to improve the controls system. Converting the treatment plant control system to a uniform Ovation DCS or other complete and comprehensive control system would improve safety with the latest technology and would offer the advantage of embedded applications for control efficiency and reliability.

New technology concepts for control systems include:

- **Smart equipment:** treatment equipment that contains controls embedded by the manufacturer, which connects to a controls system
- **Situational awareness graphics:** less distracting, more quickly understood
- **Small package intelligence:** smart relays, and similar, allowing less complex control
- **New technology starters and variable-frequency drives:** give more backup control

### Looking Ahead //

**Although these technologies have proved successful in other areas of the country, a detailed engineering analysis, and potentially pilot studies, would need to be conducted to determine whether the technologies are applicable to West Point-specific conditions and if they are cost-effective. It is recommended that WTD continue to actively investigate, research, and potentially test new technologies, including nitrogen removal. Other options may include diverting more flow to other treatment plants and adding or modifying treatment processes of those locations.**

**SECTION 3**
**Current and Projected Constraints and Limitations**

# Land-Based Limitations that Constrain Capital Development

West Point is located on a 32-acre site—very small for a treatment plant of its size. Land-based limitations at West Point are the most significant constraint on the treatment plant's ability to meet potential future regulatory requirements. Current treatment technology cannot be expanded to meet potential future nutrient removal requirements, and the adaptation to a new technology, such as MBR treatment, would have substantial constructability and cost challenges within the existing footprint of the treatment plant.

## Site Constraints

The current West Point location has been used for sewage removal since the early 1900s. Originally, a 144-inch-diameter City of Seattle-owned trunk sewer at West Point, constructed in 1910, emptied raw sewage on the beach during high flows or into Puget Sound during lower flows through a 48-inch-diameter outfall.

Construction of West Point began in 1962 on the approximately 32-acre treatment plant site, which was part of the former Fort Lawton military base. The treatment plant was initially constructed on the vacant land under the terms of a 99-year easement granted by the Department of the Army to Metro. The Washington State Department of Natural Resources (WA DNR) granted right-of-way in two tideland areas for wastewater treatment purposes. The treatment plant officially opened for operations in 1966.

The site footprint at West Point is physically restricted by the shoreline and Discovery Park.

In the 1960s and early 1970s the United States granted to Metro ownership of two parcels, 2.67 acres and more than 30 acres, respectively, that constitute the current West Point site. Other West Point property rights include various outfall, access, utilities, conveyance tunnels, drainage, and water reservoir easements within Discovery Park and WA DNR tidelands.

West Point's footprint is roughly defined by the top of the concrete retaining wall on the south and east boundaries, and the top of the landscaped soil berm on the north and west. The property is bordered by the City of Seattle's Discovery Park and historic West Point Lighthouse. Discovery Park, which includes a beach and surrounding trail systems that are extremely popular with recreational users year round, is accessible to the public through a Park Dedication and Easement Agreement granted by King County to the City of Seattle. The park's beach area is technically owned by King County and may be used for access, subsurface utilities, and temporary staging of construction within West Point's 32-acre treatment plant footprint. However, buying or leasing lands adjacent to the current West Point property is not feasible.

Since its inception in the 1960s, the treatment plant site has been a logical location for wastewater treatment serving the Seattle area because of stronger tidal and atmospheric currents in Puget Sound off of West Point. Most wastewater flows generated within the Seattle city limits now flow to West Point. In addition, most surface water runoff flowing to the CSO system flows to the treatment plant through gravity sewers. Re-plumbing the flow of wastewater and stormwater from the City to a different treatment location is not a practical consideration.

Thirty-two acres is a very small site for a treatment plant with the high flow levels of West Point (peak flow of 440 mgd). In comparison, WTD's South Treatment Plant is located on an 80-acre site (peak flows of 325 mgd). Brightwater Treatment Plant is on a 79-acre site and has a planned full buildout peak flow capacity of 170 mgd. Larger sites provide land for future expansion and for buffering mitigation of treatment plant functions (including noise and odor controls). Some space was set aside from the secondary design for two new aeration basins, two clarifiers, and a digester. However, over the past 20 years, some of this space has been used for other treatment plant process and ancillary support facilities. Further analysis would have to be performed to determine the specific area available to configure and/or remove existing facilities to add any new processes or technologies. Regardless, there is very limited space for any significant expansion of West Point.

The treatment plant site is further restricted by a high water table and the existence of well-documented historical artifacts. Therefore, construction below grade may be significantly restricted by these conditions.

## Conditions Allowing Expansion to Secondary Treatment

Upgrade and expansion of West Point to accommodate secondary treatment faced significant opposition from the surrounding community. As a result, the pre-construction siting, environmental review, and permitting process took several years to complete.

Required approvals included siting and construction permits through the City of Seattle with conditions that required maintaining public access to Discovery Park, minimizing traffic impacts to the surrounding neighborhood, and mitigating environmental losses. Approval of the City of Seattle's Master Shoreline permit was also required and challenged by opponents through the hearing examiner and at the State Hearings Board. Four environmental groups also collectively challenged the project plan—their concerns regarding site mitigation measures were ultimately resolved through the West Point Settlement Agreement.

The West Point Settlement Agreement and City of Seattle permits established additional limitations that affect future development at the treatment plant site. The area permitted for treatment plant construction now and into the future was defined by the following documents:

- West Point Secondary Expansion draft and final environmental impact statements (included mitigation requirements)
- West Point Settlement Agreement (a mitigation plan)
- Siting and construction permit conditions (Shoreline Master, Seattle Conditional Use, and U.S. Army Corps of Engineers 404 permits)

The approval processes above were complementary and reinforced one another. The conditions of each approval process were met during secondary expansion construction, and continue to be met today during operations. Specific conditions limiting future expansion include the City of Seattle's grant of the Plan-level Shoreline Substantial Development Permit and Council Conditional Use approvals in 1991, which required that the above-ground facilities occupy no

more than 32 acres, with no more than 6.1 acres of the facilities to be located in the Shoreline District. A second condition required that areas outside of the perimeter berm be permanently dedicated as a surface easement for public park and recreation purposes. Additional future expansion restrictions were included such as:

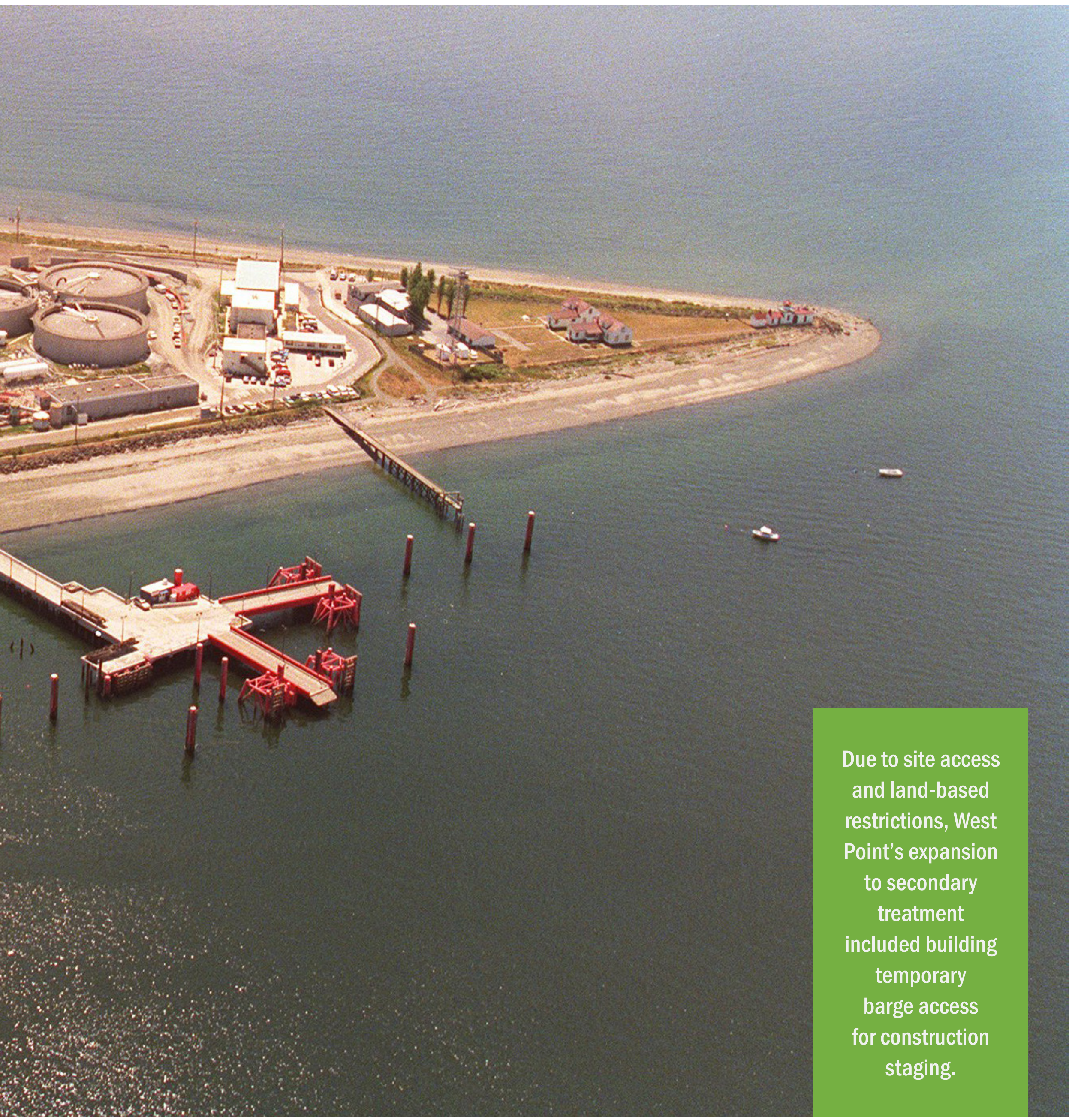
- Alternatives (to digesters) must reduce the existing total solids processing footprint
- Development height capped at 33 feet noting that exceptions may be made for noise or odor control equipment

In addition, there were many specific construction-related permit conditions (e.g., limitations to construction traffic and noise, and requiring offsite parking and bus transportation for construction workers).

Similar limitations may be put in place should the site undergo future major construction activity. Any major construction activities on the site will have permitting challenges and will require extensive stakeholder coordination.

**Looking Ahead //**

**Because of physical and administrative constraints, WTD can use only the existing site footprint for any future construction at West Point. The plant's current technology cannot be expanded within the current site to meet potential, future nutrient removal requirements and the installation of a new technology on the existing site footprint would present substantial constructability and cost challenges.**



Due to site access and land-based restrictions, West Point's expansion to secondary treatment included building temporary barge access for construction staging.

**SECTION 4**

# System Vulnerabilities, Treatment Plant Operations, and Management Context

Council Motion 14882 directed the review of system vulnerabilities and other treatment plant operations and management concerns, including training and maintenance practices over the period of the treatment plant's operations. The following section discusses how these vulnerabilities impact West Point operations.

The WPTP Independent Assessment, dated July 18, 2017, provided a hazard and operations review for West Point focusing on operations and management conditions. The primary findings and recommendations from the WPTP Independent Assessment are directly applicable to the operations and management area of this Council request. Part of the response to this Council Motion 14882 was to build on the Independent Assessment.

The WPTP Independent Assessment focused on what West Point needs to have in place to prevent a similar event to the February 2017 incident from occurring again. Major vulnerabilities included the need for power supply redundancy in pump control valves, optimized instrumentation and controls, incorporation of passive weir systems in the emergency bypass, and measures to reduce the risk of flooding.

Findings from this Half-Century Assessment agree with the operations and management findings of the WPTP Independent Assessment. This assessment builds on the WPTP Independent Assessment and provides additional review of the following system vulnerabilities:

- Aging infrastructure
- Wet weather flow management reliability
- Redundancy
- Emergency bypass
- Power reliability
- Flooding
- Seismic resilience
- Tsunami

## Aging Infrastructure

Aging facilities and support infrastructure pose some risk to operations, particularly where a lack of redundancy exists or difficult construction scenarios are involved with potential repair. For example, treatment plant staff have indicated that they have observed degradation and leaks in the primary effluent pipe and return activated sludge pipe leading into the aeration basins. Leaks have been repaired or contained to date. However, these pipes have no redundancy and a pipe failure would result in an outage of the secondary treatment system. Adding redundancy to these pipes would significantly reduce this risk, but would involve a difficult, invasive, and complex construction process. Not considered an immediate risk, an evaluation should be performed to evaluate the condition of the piping systems and determine near- and long-term requirements.

West Point's three north pod digesters and associated gas fuel system were built in the mid-1960s and have shown signs of structural concrete degradation. There is a risk that these old digesters could fail, limiting solids processing capability and ultimately liquids treatment capability. In addition, leaking gas has been reported in the digesters' gas fuel system—an issue that WTD is working to address. A similar risk exists with degradation of older digester floating covers. Repair (or replacement) of these old digesters and covers would reduce risks of failure. WTD is currently conducting a Resiliency and Recovery Study that includes a structural assessment, which will determine the nature and extent of any repairs needed throughout the treatment plant. The primary sedimentation tanks were also built in the mid-1960s. Treatment plant staff have identified some small leaks in the tanks, indicating vulnerability to more severe leaks requiring imminent repair. Fortunately, remedial repairs can be accomplished during dry summer months when all tanks are not required for effective treatment and leaks have been repaired or contained to date.

The above are examples of aging infrastructure that pose risks to West Point operations. There may be other facilities in need of repair. Although equipment repairs and replacements are continuously made as a normal part of West Point maintenance, a condition assessment of the treatment plant's facilities is recommended. WTD is currently conducting a review of its Strategic Asset Management Plan and Program to help ensure that issues of aging infrastructure are addressed.

### Looking Ahead //

**A thorough evaluation and condition assessment of facilities is recommended to identify repair/replacement projects for infrastructure posing a risk of failure that would limit the plant's processing capability. In addition, WTD is currently conducting a review of its Strategic Asset Management Plan and Program to help ensure that issues of aging infrastructure are addressed.**

## Wet Weather Flow Management Reliability

In addition to increased solids loadings due to population, there will be increased solids loading to West Point in wet weather events because of the addition of new storage and treatment facilities to control CSOs. Wet weather treatment stations, such as Alki and the soon-to-be-constructed Georgetown facilities, treat only flows. Solids are stored and sent to West Point for processing. Similarly, CSO tanks and tunnels store combined wastewater and stormwater during wet weather events and introduce additional solids to West Point when the stored flows are sent to West Point after a storm. Prior to the CSO facilities, excess flows and loads went out to the Lake Washington Ship Canal, Lake Union, Duwamish River, or Puget Sound as an overflow.

Modeling based on 2010 population projections suggests that West Point can handle the additional solids from the CSO projects. However, with population increasing at a higher-than-predicted rate, it is not clear whether the treatment plant will be able to process the increased CSO solids loads with the existing digester capacity. WTD is currently undertaking a Treatment Plant Flows and Loadings Study at all three regional treatment plants, which will review the flow and loading limitations in detail. The study is scheduled to be complete in December 2018.

In addition to the solids impacts from CSO facilities, West Point will need to operate the secondary treatment system at higher flow rates for longer periods to treat additional flows that are drained from future CSO storage facilities after wet weather events.

### Looking Ahead //

**Adequate redundancy will need to be in place and maintenance and repair/replacement projects will need to be performed to ensure that the treatment plant can reliably manage the increased flows and loads during wet weather. WTD is currently conducting a Treatment Plant Flows and Loadings Study to assess flow and loading limitations.**

## Redundancy

In the Constraints and Limitations section of this assessment, redundancy of process units and equipment was addressed in terms of limited capacity when unit processes are offline for maintenance. Redundancy is not generally a concern during average flows and loads because the equipment is sized for peak flows and loads and treatment plant staff can usually schedule planned maintenance during less vulnerable periods. Most of the time, including when the treatment plant is operating at dry weather flow or average wet weather flow, there is sufficient hydraulic redundancy, even with one process unit out of service. However, during peak flows and loads, lack of redundancy could pose a risk to the treatment plant if a process unit or piece of equipment fails unexpectedly. This type of event could lead to short-term bypasses around the treatment plant during peak periods.

The Constraints and Limitations section in this assessment identified the anaerobic digesters as a particular point of vulnerability, as these units are approaching their capacity limits to allow for planned maintenance activities.

### Looking Ahead //

**Redundant units should be considered along with emergency bypass options (which are discussed in the next section). Redundant units can reduce the probability of an emergency bypass. This recommendation was also identified in the WPTP Independent Assessment, and King County is in the process of assessing this option.**

## Emergency Bypass

West Point as currently designed has emergency flow bypass capability that can protect the treatment plant from flooding. However, existing emergency bypass systems rely on power, the appropriate action of gates, instruments and controls, and operator actions to function properly and flawlessly in situations of high flow and potential extreme hazard. The interactions of these mechanical and control functions are complex and subject to component failure, leaving the treatment plant vulnerable to flooding. In addition, if treatment plant tanks overflow to grade elevation, treatment plant grades and accesses to underground tunnels do not provide adequate protection to prevent underground facility flooding. The WPTP Independent Assessment recommended the evaluation of passive overflow systems, specifically for the influent control structure and the primary sedimentation tanks through the flow diversion structure. WTD has started an engineering evaluation to determine the feasibility of a passive overflow alternative for West Point. As part of this evaluation, it is recommended that passive overflow systems also be reviewed for the effluent pumping station.

The effluent pumping station currently has no overflow bypass to the emergency bypass channel. Addition of such a bypass with a passive overflow weir would allow continuation of secondary treatment in the event of effluent pumping station failure, diverting effluent to the emergency outfall with far less head restrictions and flow capability than the main outfall gravity bypass. The potential location and design of such a bypass requires further investigation.

**Looking Ahead //**

**The WPTP Independent Assessment recommended the evaluation of passive overflow systems for the influent control structure and the primary sedimentation tanks through the flow diversion structure. As part of this evaluation, it is recommended that a passive overflow system also be reviewed for the effluent pumping station.**

## Power Reliability

West Point depends on utility power for nearly all of its pumping and treatment functions (all but raw sewage treatment). Intermediate and effluent pumping are completely dependent on utility power. On average, approximately 7 megawatts are required to run the entire treatment plant and about half of the treatment plant's supplied power is used for the secondary treatment area.

Two independent power feeds enter the treatment plant: the Broad Street feeder and the Canal feeder. The Broad Street feeder serves and is routed through a residential area, ending at West Point. Power bumps on this line are not unusual. The Canal feeder is a dedicated line from Seattle City Light. Dual power feeds such as this are a common and accepted power redundancy measure for wastewater treatment plants, assuming overall power reliability from the feeders is acceptable. West Point has lost power at least three times in the last 20 years, with one incident on October 16, 1998, leading to an emergency bypass of the plant. A thorough analysis of these lines and supplying electrical infrastructure would be worthwhile. WTD is also in discussions with Seattle City Light to secure a second dedicated power line to serve West Point.

The treatment plant also has two 2.3-megawatt cogeneration engines that can use excess digester gas. These units do not have "black plant" restart capability, meaning they will go off line in a treatment-plant-wide power outage and cannot restart automatically. Should a power reliability study show that line power reliability is below standard, additional measures could be investigated, including adding black plant restart capability to the cogeneration units and/or adding some additional standby generator capability for critical loads.

### Looking Ahead //

**A power reliability study is recommended that includes assessment of power requirements to ensure continuation of some defined level of service, including reduction of overflow risks. WTD should continue to work with Seattle City Light to secure a second dedicated power line to serve West Point.**

# Flooding

Despite the best design and operational practices discussed in the Emergency Bypass section above, events could transpire to still cause process tankage overflow. In that event, severe life-safety flooding of the galleries is again possible. One potential option is to re-grade the site, directing any surface flooding to the shoreline, and further, to raise all gallery entrances above an elevation that can be compromised from surface grade-level flooding.

A low point in the treatment plant grade lies along the north side of the treatment plant at the ramp entrance to the grit loading area. This area is particularly vulnerable to surface flooding and may be able to be re-graded to divert any flooding towards the shoreline. In the event of surface flooding, short-term surface flow to the shoreline would potentially prevent underground gallery flooding, which can risk life safety and incapacitate the treatment plant for months, as in the 2017 event. Evaluating the feasibility and cost of re-grading is recommended.

**Looking Ahead //**

**The cost and feasibility of potential solutions to minimize surface-level flooding should be assessed, including re-grading the treatment plant site to direct surface flooding to the shoreline and raising gallery entrances.**

## Seismic Resilience

The treatment plant's seismic resilience is limited to its earthquake resistance capability at the time of its original design. West Point was originally constructed as a primary treatment-only plant. The building design code enforced at that time was the Seattle Building Code, which had adopted the 1961 Uniform Building Code (UBC). Digesters 4 and 5 were added in 1985 and designed in conformance with the 1982 edition of the UBC. Construction of the secondary treatment upgrades began in 1991 and was designed in conformance with the 1988 UBC. The current code used for design of water and wastewater facilities is the 2015 International Building Code (IBC). Seattle has adopted the IBC with local amendments.

Throughout this period of treatment plant expansion, seismic code provisions and requirements have evolved through research and lessons learned from observations following seismic events. Through these efforts, design requirements (e.g., codes) have changed with the sole purpose of reducing risks from earthquakes. While the main impetus for modern seismic codes is to protect the health, safety, and welfare of the public, some entities implement more stringent code provisions to protect building contents and, in the case of treatment facilities, enable post-earthquake operations.

WTD is currently developing a Resiliency and Recovery Study, which will identify seismic-related concerns and recommend near- and long-term projects to mitigate these concerns. WTD also has projects planned to improve seismic resiliency within the capital budget.

### Looking Ahead //

**WTD is currently conducting a Resiliency and Recovery Study, which will identify seismic-related concerns and recommend near- and long-term projects to mitigate these concerns. In addition, some seismic improvement projects are already included in WTD's capital budget.**

## Tsunami

The existing treatment plant can resist a tsunami up to the elevation of entrances to existing facilities (approximate elevation 118 feet expressed in treatment plant datum, lower at the entrance ramp to the grit removal area), to prevent flooding. However, the ability of treatment plant flows to discharge through the outfall may be compromised by high water elevations in Puget Sound. Tsunami flood elevations may reduce the effluent pumping capacity, which would result in reduced treatment plant throughput, requiring emergency bypass of excess flows entering the treatment plant.

Upgrading tsunami resistance of the treatment plant's existing facilities is possible, but would be limited by engineering design technology in conjunction with site physical characteristics. Tsunami-related concerns are being considered as part of the Resiliency and Recovery Study.

### Looking Ahead //

**Tsunami-related concerns are being considered as part of WTD's currently underway Resiliency and Recovery Study.**

SECTION 5

# Conclusions and Recommendations

Throughout this Half-Century Assessment, factors impacting West Point's current and future performance were identified and recommendations were made to sustain continued reliable operations at West Point in the future. The following provides an overview of assessment findings and, where applicable, includes recommendations and ongoing actions currently being undertaken at WTD.

## Changes in Operating Context

Since West Point's construction, the treatment plant's operating environment has changed considerably. Existing conditions that affect the treatment plant were examined to assess how well positioned West Point is to meet these operating changes in the future.

### Service Population and Growth Patterns

West Point's service area population has increased more than anticipated. However, actual flows to the treatment plant have decreased over time because of water conservation efforts. This decrease in flow accompanying the increase in population has resulted in more concentrated solids loading to West Point, which may be approaching its design capacity for TSS and BOD loads.

**ASSESSMENT FINDINGS**

West Point continues to meet discharge limitations for TSS and BOD concentrations. Therefore, the extra load has not resulted in a treatment performance issue to date. However, the solids and BOD loading may be a constraint for West Point sooner than anticipated. In addition, as Seattle is the primary contributor to West Point's flow and loads, the King County policies on concentrated growth patterns associated with the Comprehensive Plan are not anticipated to have a significant effect on West Point.

**ONGOING ACTIONS**

WTD is currently conducting a Treatment Plant Flows and Loadings Study to determine when solids and BOD loadings will be at capacity for each process within the three regional treatment plants.

### Climate-Driven Changes

Long-term rainfall trends are difficult to predict because of significant natural year-to-year and decade-to-decade variability. However, the frequency of intense storms is expected to increase.

**ASSESSMENT FINDINGS**

More frequent intense storms may lead to an increased frequency of peak wet weather flows at West Point.

**RECOMMENDATIONS**

WTD should continue monitoring climate change projections and any perceived impacts at West Point and to its collection system. Adaptive management plans should be developed as appropriate and capacity of effluent pumping in response to climate change impacts on tide levels should be confirmed. In addition, WTD should continue to follow existing emergency protocols to manage peak flows into West Point and ensure system reliability to treat increased wet weather flows through continued asset management planning and practices.

**ONGOING ACTIONS**

WTD is currently evaluating its Strategic Asset Management Plan and Program to ensure reliable operations.

### Impermeable Cover

As the Puget Sound region has developed and the amount of impermeable cover—or hard surfaces—has increased, stormwater runoff from the land surface has also increased. Increases in stormwater runoff have required West Point to operate reliably in wet weather mode more frequently and for longer periods, but otherwise there is no significant impact on the treatment plant.

**ASSESSMENT FINDINGS**

No significant impacts to West Point are expected in the future based on impermeable cover, as the service area is near full buildout and the amount of new impermeable cover will be minimal.

## Water Quality Concerns and Regulations

Concerns about water quality continue to increase and could lead to changes in regulatory requirements for West Point's operations. In its current configuration, the treatment plant can continue to meet existing permit requirements. If Ecology sets new requirements for nitrogen removal in future permits, West Point will need to be significantly upgraded. WTD's West Point conceptual Nitrogen Removal Study in March 2011 concluded that new technologies could be implemented, but would present significant cost, operability, and constructability issues.

**ASSESSMENT FINDINGS**
New regulations are likely to be implemented in the future.

**RECOMMENDATIONS**
If nutrient removal is regulated, a system-wide evaluation should be performed to determine the best alternative for West Point and the regional system. WTD should continue to actively investigate, research, and potentially test nitrogen removal technologies and monitor potential changes to regulations.

## Industrial Contributions to Wastewater

Over the years, the number and type of industries that contribute influent to West Point have changed, leading to different types and amounts of pollutants that contribute to the treatment plant's waste stream.

**ASSESSMENT FINDINGS**
Significant changes in the volume or type of industrial dischargers are not expected in the near future and the percent of wastewater flow entering West Point from industrial sources is expected to remain very low (3 to 4 percent of flow to West Point). Pretreatment and source control efforts will continue to improve as new technologies are developed, but these efforts are not expected to significantly impact treatment plant operations as contaminant levels are already very low.

## Levels of Toxics

Wastewater treatment plants are not considered the major pathway to Puget Sound for most urban runoff-based contaminants such as automotive chemicals, herbicides, and pesticides. There are other toxic contaminants, such as PPCPs, for which wastewater treatment plants *are* a significant pathway.

**ASSESSMENT FINDINGS**
West Point is meeting its permit conditions, which does not impart regulations on PPCPs, and there is no evidence that these contaminants are impacting the efficiency of operations.

**ONGOING ACTIONS**
WTD is currently conducting a Water Quality Assessment and Monitoring Study to ensure that future projects to control pollution are well-planned and timed to improve water quality. In addition, WTD should continue to monitor potential regulatory changes related to toxic contaminants at the local and national level.

## Current and Projected Constraints and Limitations

Several potential physical and process-related constraints within the fence line of the treatment plant were reviewed that may currently be or in the future could limit West Point's performance.

### Treatment Capacity

West Point has the capacity to provide primary treatment for peak flows of up to 440 mgd and secondary treatment for 300 mgd. In its present operational state, it is likely that West Point will be able to accommodate the forecasted flows through 2030. However, West Point has limited liquid treatment train redundancy and solids treatment capacity may also be limited.

Without major capital investment at West Point, potential future needs, such as nutrient or PPCP removal, cannot be achieved. Implementing such capabilities within the existing site would likely require a new treatment technology.

**ASSESSMENT FINDINGS**

West Point currently has capacity to accommodate flows and loads in the near future. If increased flow capacity is ever necessary, new technologies would likely be required. Installation of any new technology would be challenging because of West Point's land-based limitations. In addition, a new treatment technology would pose higher capital costs, electrical power requirements, and operating and maintenance costs than conventional treatment systems.

### Constraints and Limitations

West Point's performance may be limited by functional, engineering, and design constraints. External constraints acting upon the treatment plant include pounds of solids and BOD load, which are dictated by service area population and industrial input, and peak flows, which are dictated by combined sewer flow and infiltration and inflow in domestic and industrial base flows.

The primary near-term limitation is that the solids and BOD loading to the treatment plant may be constrained earlier than anticipated. The primary long-term constraint is the land-based limitations of West Point's site footprint.

**ASSESSMENT FINDINGS**

West Point has land-based limitations, which result in extreme constructability issues. This limitation hinders any potential treatment plant expansion and significantly constrains the treatment plant's potential to meet potential future regulatory requirements. In addition, West Point has experienced periodic digester foaming issues since 2013, compromising the loading capacity of the digesters. The foaming reduces the ability of the digesters to process solids.

**RECOMMENDATIONS**

It is recommended that current efforts be continued to address digester foaming issues.

**ONGOING ACTIONS**

The aeration and digestion systems will be further evaluated through the Treatment Plant Flows and Loadings Study to determine when solids and BOD loadings will be at capacity within each treatment process at the treatment plant.

## Wastewater Processing Technology

West Point is currently meeting its discharge permit requirements. Several current West Point processes and facilities may benefit from new technology if regulations change or if the Treatment Plant Flows and Loadings Study shows future treatment plant limitations. However, new technologies require large capital investments and may also result in additional annual operating costs. Many of the discussed technologies have been assessed by WTD and are subject to the constraints and limitations described above, including constructability on a land-limited site.

### ASSESSMENT FINDINGS

Although new treatment technologies have proved successful in other areas of the country, a detailed engineering analysis, and potentially pilot studies, would need to be conducted to determine whether the technologies are applicable to West Point-specific conditions and if they are cost-effective.

### RECOMMENDATIONS

It is recommended that WTD continue to actively investigate, research, and potentially test new technologies, including nitrogen removal. Other options may include diverting more flow to other treatment plants and adding or modifying treatment processes of those locations.

## Land-Based Limitations that Constrain Capital Development

The land-based limitations at West Point are the most significant constraint on the site's ability to meet potential future regulatory requirements.

### ASSESSMENT FINDINGS

Because of physical and administrative constraints, WTD can use only the existing site footprint for any future construction at West Point. The treatment plant's current technology cannot be expanded within the current site to meet stricter nutrient removal requirements and the installation of a new technology on the existing site footprint would present substantial constructability and cost challenges.

## System Vulnerabilities, Treatment Plant Operations, and Management Context

The WPTP Independent Assessment focused on what West Point needs to have in place to prevent a similar event to the February 2017 incident from occurring again. Findings from this Half-Century Assessment agree with the operations and management findings of the WPTP Independent Assessment. This Half-Century Assessment builds on the WPTP Independent Assessment and provides additional review of system vulnerabilities at West Point.

### Aging Infrastructure

The primary treatment facilities at West Point are still from the original 1960s construction and are more than 50 years old.

**ASSESSMENT FINDINGS**

Aging facilities and support infrastructure pose some risk to operations, particularly where a lack of redundancy exists or difficult construction or potential repair scenarios are involved.

**RECOMMENDATIONS**

A thorough evaluation of facilities is recommended to identify repair/replacement projects for infrastructure posing a risk of failure that would limit the treatment plant's processing capability.

**ONGOING ACTIONS**

WTD is currently conducting a review of its Strategic Asset Management Plan and Program to help ensure that issues of aging infrastructure are addressed.

### Wet Weather Flow Management Reliability

In addition to increased solids loadings due to the growing population, West Point will also receive increased solids loads following wet weather events because of the addition of CSO storage and treatment facilities to control CSOs.

**ASSESSMENT FINDINGS**

Adequate redundancy will need to be in place and maintenance and repair/replacement projects will need to be performed to ensure that the treatment plant can reliably manage the increased flows and loads during wet weather.

**ONGOING ACTIONS**

WTD is currently conducting a Treatment Plant Flows and Loadings Study and a review of its Strategic Asset Management Plan and Program to ensure reliable operations.

### Redundancy

Redundant backup units of critical equipment are essential to sustaining reliable treatment plant operations.

**ASSESSMENT FINDINGS**

During peak flows and loads, lack of redundancy could pose a risk to the treatment plant if a process unit or piece of equipment fails unexpectedly.

**RECOMMENDATIONS**

Redundant units should be considered, which can reduce the probability of an emergency bypass. This was also identified in the WPTP Independent Assessment.

**ONGOING ACTIONS**

WTD is currently in the process of addressing this concern in response to the WPTP Independent Assessment.

### Emergency Bypass

West Point is currently outfitted with an emergency flow bypass that can protect the treatment plant from flooding in situations of high flow and potential extreme hazard.

**ASSESSMENT FINDINGS**

The interactions of the mechanical and control functions needed for proper function of the emergency bypass systems are complex and subject to component failure, leaving the treatment plant vulnerable to flooding.

**RECOMMENDATIONS**

As part of the evaluation of passive overflow systems for the influent control structure and primary sedimentation tanks recommended in the WPTP Independent Assessment, review of a passive overflow system for the effluent pumping station is also recommended.

**ONGOING ACTIONS**

WTD is currently evaluating passive overflow systems for the influent control structure and primary sedimentation tanks in response to the WPTP Independent Assessment.

## Power Reliability

West Point depends on utility power for nearly all of its pumping and treatment functions. West Point has two independent power feeds, which is commonly accepted as redundant power in the wastewater industry.

**ASSESSMENT FINDINGS**

Power reliability may be improved by adding backup power to supply other critical pumping and treatment infrastructure.

**RECOMMENDATIONS**

A power reliability study is recommended that includes assessment of power requirements to ensure continuation of some defined level of service, including reduction of overflow risks.

**ONGOING ACTIONS**

WTD is currently in discussions with Seattle City Light to secure a second dedicated power line to serve West Point.

## Flooding

Despite the best design and operational practices, events could transpire to still cause process tankage overflow. In that event, severe flooding of the galleries is again possible.

**ASSESSMENT FINDINGS**

The current site grading could lead to flooding.

**RECOMMENDATIONS**

The cost and feasibility of potential solutions to minimize the risk of surface-level flooding should be assessed, including possibly re-grading the treatment plant site to direct surface flooding to the shoreline and raising gallery entrances.

## Seismic Resilience

Since the treatment plant's original construction and expansion in the 1990s, seismic code provisions and requirements have changed to further reduce risks from earthquakes. While the main goal of modern seismic codes is to protect the health, safety, and welfare of the public, some entities implement more stringent code provisions to protect building contents and, in the case of treatment facilities, enable post-earthquake operations.

**ASSESSMENT FINDINGS**

The treatment plant's seismic resilience is limited to its earthquake resistance capability at the time of its original design.

**ONGOING ACTIONS**

WTD is currently developing a Resiliency and Recovery Study, which will identify seismic-related concerns and recommend near- and long-term projects to mitigate these concerns. In addition, WTD has some seismic-related projects already included in the capital budget.

## Tsunami

The existing treatment plant can resist a tsunami up to the elevation of entrances of existing facilities.

**ASSESSMENT FINDINGS**

The ability of treatment plant flows to discharge through the outfall may be compromised by high water elevations in Puget Sound. Tsunami flood elevations may reduce the amount of wastewater the treatment plant can process, requiring emergency bypass of excess flows entering the treatment plant.

**ONGOING ACTIONS**

Tsunami-related concerns are being considered as part of the Resiliency and Recovery Study.

**SECTION 6**

# Assessment Limitations

This assessment was performed in a short period with a goal of steering King County Wastewater Treatment Division (WTD) to next steps to address the primary issues identified in the report.

This document was prepared solely for King County WTD in accordance with professional standards at the time the services were performed and in accordance with the contract between King County and Brown and Caldwell dated August 1, 2017. This document is governed by the specific scope of work authorized by King County. We have relied on existing King County WTD and third-party reports and data (some more than 50 years old), information collected during King County WTD staff interviews, limited visual facility walkthroughs, and other information or instructions provided by King County WTD. Unless otherwise expressly indicated, Brown and Caldwell has made no independent investigation or verification as to the validity, completeness, or accuracy of such information, and does not assume responsibility for errors or misrepresentations of this information.

This document sets forth the summation of services performed and general recommendations to be further considered with respect to the property or facilities described therein. King County WTD recognizes and acknowledges that these services were performed within various limitations, including budget and time constraints, and the services do not include any detailed analyses or modeling to vet the recommendations.

Reuse of this document by anyone other than King County WTD is at the sole risk of the user. Brown and Caldwell makes no warranties, express or implied, with respect to this document, except for those, if any, contained in the agreement pursuant to which the document was prepared.

**APPENDIX**

# Reference Documents

The following table lists the reference documents used to develop this assessment, presented in the order in which each document is cited.

| FILE NAME | DOCUMENT NAME | AUTHOR, DATE | INFORMATION FROM WTD OR BROWN AND CALDWELL STAFF |
|---|---|---|---|
| CIG_JOCLIM_ duliereetalchanges713 | Changes in Twentieth-Century Extreme Temperature and Precipitation over the Western United States Based on Observations and Regional Climate Model Simulations | (Duliere et al. 2017) | Changes in 20th century extreme temperature and precipitation over the western United States from regional climate model simulations and observations. |
| CIG_JOHYDROMET_Warner et al. 2015_Changes in Winter ARs | Changes in Winter ARs | (Warner et al. 2015) | Article that states that atmospheric rivers are projected to increase by an average of 22% by the end of the century because of climate change. |
| CIG_SCL_Trends_ Report_20161215.compressed | Historical Climate Trends for Seattle City Light | (Mauger et al. 2016) | Historical climate trends for Seattle City Light. |
| 2015_King_County_SCAP-Full_Plan | King County's 2015 Strategic Climate Action Plan | (King County 2015) | An overview of WTD's adaptation efforts are on pages 104/105. The commitment to assess impacts on wastewater conveyance and treatment is made on page 122. |
| Climate Change MOU_WTD_ WLR_UW 4-23-15 | MOU Between the Water and Land Resources Division and WTD King County Department of Natural Resources and Parks (DNRP) | (King County April 2015) | The agreement with UW to model climate change impacts on storm patterns is attached. The first page describes how King County's Wastewater Treatment Division and Water and Land Resources Division are cost-sharing the project. The rest of the agreement describes what UW is doing. |
| Website link, not in folder | University of Washington Climate Impacts Group's "Time of Emergence" project: http://toe.cig.uw.edu/. | | This project tried to look at rate of change relative to natural variability to assess data would show statistically significant changes for many different climate and hydrology variables. |
| PugetSound-SoK_2015 | Climate Change In Puget Sound State of Knowledge | (Climate Impacts Group 2015) | Climate Change in Puget Sound State of Knowledge. |

| FILE NAME | DOCUMENT NAME | AUTHOR, DATE | INFORMATION FROM WTD OR BROWN AND CALDWELL STAFF |
|---|---|---|---|
| KC_DeGasperi_2010_RiverFlooding_ClimateChange_kcr2142 | Climate Change Impacts on River Flooding | (DeGasperi 2010) | Trends in precipitation patterns in our region. |
| West Point SLR Memo_02192013 | Sea Level Rise Vulnerability Assessment Memo | (Phillips and O'Neil 2013) | This supplementary analysis concluded that the treatment plant is not vulnerable to surface flooding under even the most extreme sea-level rise prediction for the Puget Sound area. |
| 2016_CSO-CD_Annual | Combined Sewer Overflow Control Program 2016 Annual CSO and Consent Decree Report | (King County 2016) | Latest annual CSO report. |
| WestPoint_Secondary_Facilities_Plan_w11x17 | West Point Secondary Treatment Facilities Project Facilities Plan | (CH2M Hill 1989) | March 1989 Facilities Plan. |
| WestPoint_Secondary_Facilities_add1_w11x17 | West Point Secondary Treatment Facilities Project Addendum to the March 1989 West Point Facilities Plan | (CH2M Hill 1990) | Major revisions or refinements made since the Facilities Plan was submitted in March 1989. |
| OpPlan | King County Wastewater Treatment Division (WTD) West Section Sewer System Operational Plan | | This Plan has been developed as interactive electronic plan to provide rapid and thorough access to all information of use in operating the West Division system. |
| 1411_TPFlowAndWasteload Projections_2010-2060 | Treatment Plant Flow and Wasteload Projections 2010-2060 | (King County 2014) | This report documents the methodology and results of the 2014 flow and wasteload projections for King County's three regional treatment plants: West Point, South, and Brightwater plants. |
| Attachment_A-KingCountyComprehensivePlan-120516 | County's Comprehensive Plan 2016 Update | (King County December 2016) | The 2016 update is a major (every four year) review of the Comprehensive Plan. It builds on King County's 25 years of success in implementing the Growth Management Act. |
| March–June 2017 Summary of KCWTD-monitoring results-onepager | Summary: Marine and Environmental Monitoring Results, as of June 23, 2017 | (King County 2017) | WQ two-months after West Point failure. |
| March 2017 WQ Assessment Monitoring Update | Water Quality Assessment and Monitoring Study Update | (King County 2017) | The KC WQA is a comprehensive, scientific look at water quality in water bodies where King County has uncontrolled CSOs. This extra review ensures that King County and others can rely on the results to make decisions to improve water quality. |
| PSN Dialogue Speaker Bios and Key Points Handout | Puget Sound Nutrient Dialogue Notes, July 19, 2017 | 2017 | Notes from PSN meeting July 19th, 2017. |
| WA0029181_WestPoint_FinalPermit_2014-12-19 | NPDES Waste Discharge Permit No. WA0029181 West Point 2014–2021 | (Ecology 2014) | NPDES Permit 2014–2021. |
| WestPointWWTP_Factsheet '09 | WestPointWWTP_Factsheet '09 | (Ecology 2009) | This fact sheet explains and documents the decisions the Department of Ecology (Ecology) made in drafting the proposed NPDES permit. |
| WestPointWWTP_Permit '09 | NPDES Waste Discharge Permit No. WA0029181 West Point 2009–2014 | (Ecology 2009) | NPDES Permit 2009–2014. |

| FILE NAME | DOCUMENT NAME | AUTHOR, DATE | INFORMATION FROM WTD OR BROWN AND CALDWELL STAFF |
|---|---|---|---|
| CH2M1989_Final Waste Loads for Design of West Point | Final Memorandum for Activity 200010202 Flow and Waste Load Development Final Waste Loads for Design of the West Point Secondary Treatment Plant | (CH2M Hill 1989) | |
| CH2M1997_West Point One Year Performance Certification | One Year Project Performance Certification Final Report West Point Secondary Treatment Facilities | (CH2M Hill 1997) | |
| West_Point_Nitrogen_ Removal_Study | ASSESSMENT OF POTENTIAL NITROGEN REMOVAL TECHNOLOGIES AT THE WEST POINT PLANT AND THEIR IMPACT ON FUTURE WATER REUSE PROGRAM DEVELOPMENT | (Carollo 2011) | This report extends the work done by Carollo and King County to an evaluation at West Point for potential strategies and consequences of implementing nitrogen removal. |
| WP_Permit_Conditions | West Point Permit Conditions | (Ecology 1991) | |
| WP_Settlement_ Agreement_1991 | West Point Settlement between Metro Seattle (King County) and the City of Seattle | (Ecology 1991) | |
| _Technology Assessment Projects 2000--2010 | King County Department of Natural Resources and Parks Wastewater Treatment Division Technology Evaluations (2000-2009) | (King County 2010) *John Smyth | |
| FINALS~1.ppt | South Plant & West Point Nitrogen Removal Studies Summary of Findings | (Ecology September 1, 2011) | |
| Sims_PCL-SMI Ltr_050797 | Correspondence on Executive Report and Recommendation for Alternative Solids Processing at West Point | (King County 1997) | Memo to Council member Jane Hauge with actions taken in response to PCL/SMI's contract termination. |
| Tech Assess Tracking Report 2010_FINAL | Report on active studies about technology updates for KC facilities. | (Smyth 2010) | |
| Tech Assess Tracking Report 2011_FINAL | Report on active studies about technology updates for KC facilities. | (Smyth 2011) | |
| Tech Assess Tracking Report 2012_FINAL | Report on active studies about technology updates for KC facilities. | (Smyth 2012) | |
| Tech Assess Tracking Report 2013_FINAL | Report on active studies about technology updates for KC facilities. | (Smyth 2013) | |
| WP Design Data_Capacities | Appendix B—Plant Design Data | (King County 2006) | West Point Manual Plant Overview Appendix B. |
| WP Digesters_CFD Modeling_paper | | (Edward Wicklein and Alan Straub) | |
| West Point Biogas Utilization Study_2016—FINAL RPT | Final Report for West Point Treatment Plant Biogas Utilization Study | (Brown and Caldwell 2016) | The West Point Treatment Plant Biogas Utilization Study evaluated the existing biogas utilization systems at King County's West Point, defined and evaluated potential capital modifications to equipment and systems, and identified a preferred capital project. |

| FILE NAME | DOCUMENT NAME | AUTHOR, DATE | INFORMATION FROM WTD OR BROWN AND CALDWELL STAFF |
|---|---|---|---|
| West Point Digester Odor TM 8Sep04rev1 | Engineering Evaluation of Alternative Technologies for West Point Digestion System Odor and Capacity Improvements | (CDM 2004) | The objective of this Technical Memorandum (TM) is to evaluate two technologies proposed by the ThermoEnergy Corporation (Vendor): 1) conversion of raw wastewater solids to fuel (“ThermoFuel”) and 2) removal of ammonia from centrate (“Ammonia Removal Process” or “ARP”). |
| West Point Self-Assessment Report 7-20-2017 | After Action Self-Assessment Report February 9, 2017 Emergency Bypass Event at West Point | (King County July 2017) | This report is an in depth look at what events contributed to the flooding at the West Point Treatment Plant on February 9, 2017. |
| 170718-WPt-Ind-Assmt-Report-AECOM | West Point Treatment Plant Independent Assessment | (AECOM 2017) | This report summarizes the results of the independent assessment completed by AECOM of the Feb. 9th incident at the West Point. |
| WPTP Indep Assess - AECOM - Recommendations_only | West Point Treatment Plant Independent Assessment - Recommendations Only | King County | This table includes a summary compiled by King County of recommendations from the WPTP Independent Assessment completed by AECOM of the Feb. 9th incident at the WPTP. |
| WPTP-Flood-2017-Report-and-Appendix_ch2m | WPTP-Flood-2017-Report-and-Appendix_ch2m | (CH2M 2017) | |
| GWWTS-FINAL-SolidsReturnTM-2014-12-16-T210-11 | Georgetown Wet Weather Treatment Station GWWTS Solids Return TM | (CH2M 2014) | |
| Edited response frm B Crawford-limit CSO storage until WPTP at 250 | Response from Bruce C on limited CSO storage return to when WPTP is below 250 mgd | Bruce Crawford email correspondence September 12, 2017 | Response from Bruce C on limited CSO storage return to when WPTP is below 250 mgd. |
| SCWQP TEPS Control Set Points 9-8-17_Intro ONLY _DRAFT-NOT FOR DISTRIBUTION | SCWQP Set Points Memo | Bob Swarner, King County, September 8, 2017 | This memo is still very much in draft form and still under discussion with SPU since it’s about the Ship Canal Tunnel design. I excerpted the first two pages that reference the 250 mgd. |
| Feasible AA for CSO-Related Secondary Proc Div at WPTP 2009 | Feasible Alternatives Analysis for CSO-Related Secondary Process DiversionatWestPointTreatmentPlant (2009) and the associated appendices. | (King County 2009) | This document may have a little information addressing your question, but also seems to have a lot of potentially useful information on constraints, history and decisions related to WP capacity, and more. I’ve only briefly read some sections, but could definitely see applicability to other tasks. |
| Thickened Sludge Hauls to South Plant.xlsx | Sludge hauls to South Plant from October 2016 – May 2017 | King County last updated 6/15/17 | Sludge hauls to South Plant from October 2016 – May 2017. |
| Additional Flood Data Request 1999-2011.xlsx | Daily plant data from 1/1/1999 – to 12/31/2011 | King County | This should have flow, TSS and BOD for different stages of the treatment plant, as well as number of digesters online. |
| WPTP Process Performance Data.xlsx | Process performance data for West Point from 2012 – 2017. | King County | These data were provided for the Flows and Loadings Study already, but may help with filling in any gaps from the daily treatment plant data above. |
| 1989_WPTP Geotech Data Report | | King County | Summary of the geotechnical data collected as part of the secondary expansion project. |

| FILE NAME | DOCUMENT NAME | AUTHOR, DATE | INFORMATION FROM WTD OR BROWN AND CALDWELL STAFF |
|---|---|---|---|
| 1991_WPTP Geotech Summary | | King County | Summary of all the geotechnical reports compiled for the secondary expansion. |
| Program History for WP_50 Report.docx | King County Industrial Waste Program | King County | Industrial Waste Program history and overview (including changes to permits over time). |
| IW total flow.msg | | King County | An email outlining the total flow contributions from Industrial contributors. |
| 2013 Annual Pretreatment Report.pdf | | King County | Annual reports (2013 & 2016) showing Water quality and Biosolids impacts due to Industrial Waste, as well as a chart of mercury in Biosolids. |
| 2016 Annual Pretreatment Report.pdf | | King County | Annual reports (2013 & 2016) showing Water quality and Biosolids impacts due to Industrial Waste, as well as a chart of mercury in Biosolids. |
| Talking Points for Mark.docx | Talking Points for Mark | King County | Risk analysis and incident information, prepared for Mark Isaacson in the aftermath of the February 9th incident. |
| Options for Industrial Permitted Facilities During a System Emergency.docx | Options for Industrial Permitted Facilities During a System Emergency | (Strong 2017) Despina Strong, March 2, 2017 | |
| Graph mercuryBiosoldis15.pdf | EPA safety limit for mercury in biosolids: 17 parts per million | King County | |
| West Point NPDES Permit 1974 | | (Ecology 1974) | |
| West Point NPDES Permit 1986 | | (Ecology 1986) | |
| West Point NPDES Permit 1992 | | (Ecology 1992) | |
| West Point NPDES Permit 1995 with Modification | | (Ecology 1995) | |
| 9512_ StewardsofTheWaters_1995 | Stewards of the Waters Report | (King County 1995) | Report from 1995 discussing the future of West Point and wastewater treatment for King County. |
| WP inf-eff prior poll Jan'07_6-22-17.xlsx | Priority Pollutant data from 2007 - 2017 | (King County 2017) | |