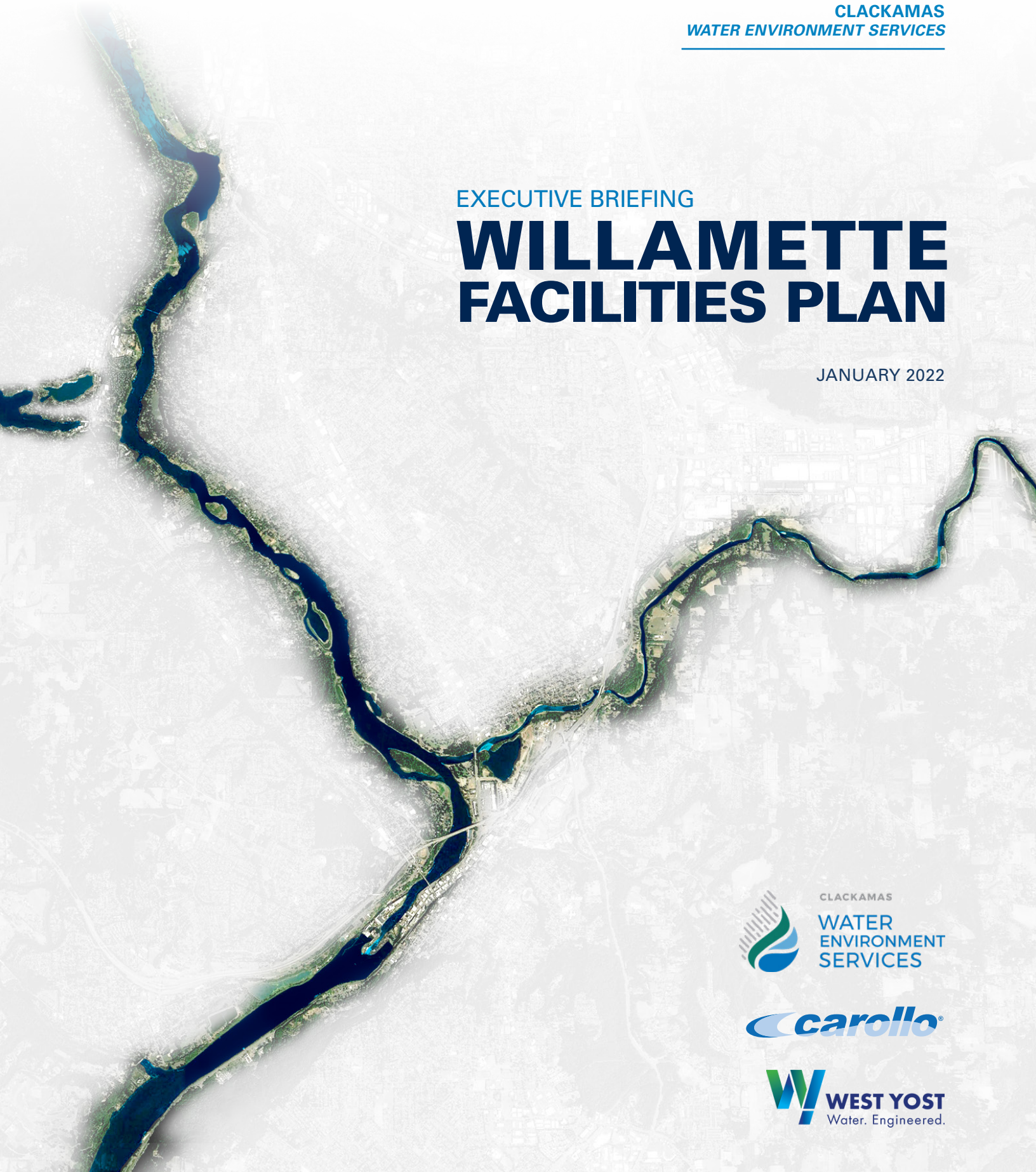
CLACKAMAS
WATER ENVIRONMENT SERVICES

EXECUTIVE BRIEFING

WILLAMETTE FACILITIES PLAN

JANUARY 2022



CLACKAMAS WATER ENVIRONMENT SERVICES

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Water. Engineered.

Introduction

Scope and Purpose

Clackamas Water Environment Services (WES, District) has completed a 20-year planning process for its wastewater treatment facilities that discharge to the Willamette River. This Willamette Facilities Plan (WFP, Plan) identifies improvements needed to provide capacity for growth, address aging infrastructure, and protect human health and the environment by meeting regulatory requirements through the year 2040. The Plan complies with the Oregon Administrative Rule (OAR) and guidance issued by the State of Oregon Department of Environmental Quality (DEQ). Such compliance facilitates agency approval of the Plan and allows the District to fund necessary projects with low-interest construction loans and/or grants administered through the Clean Water State Revolving Fund (SRF) program.

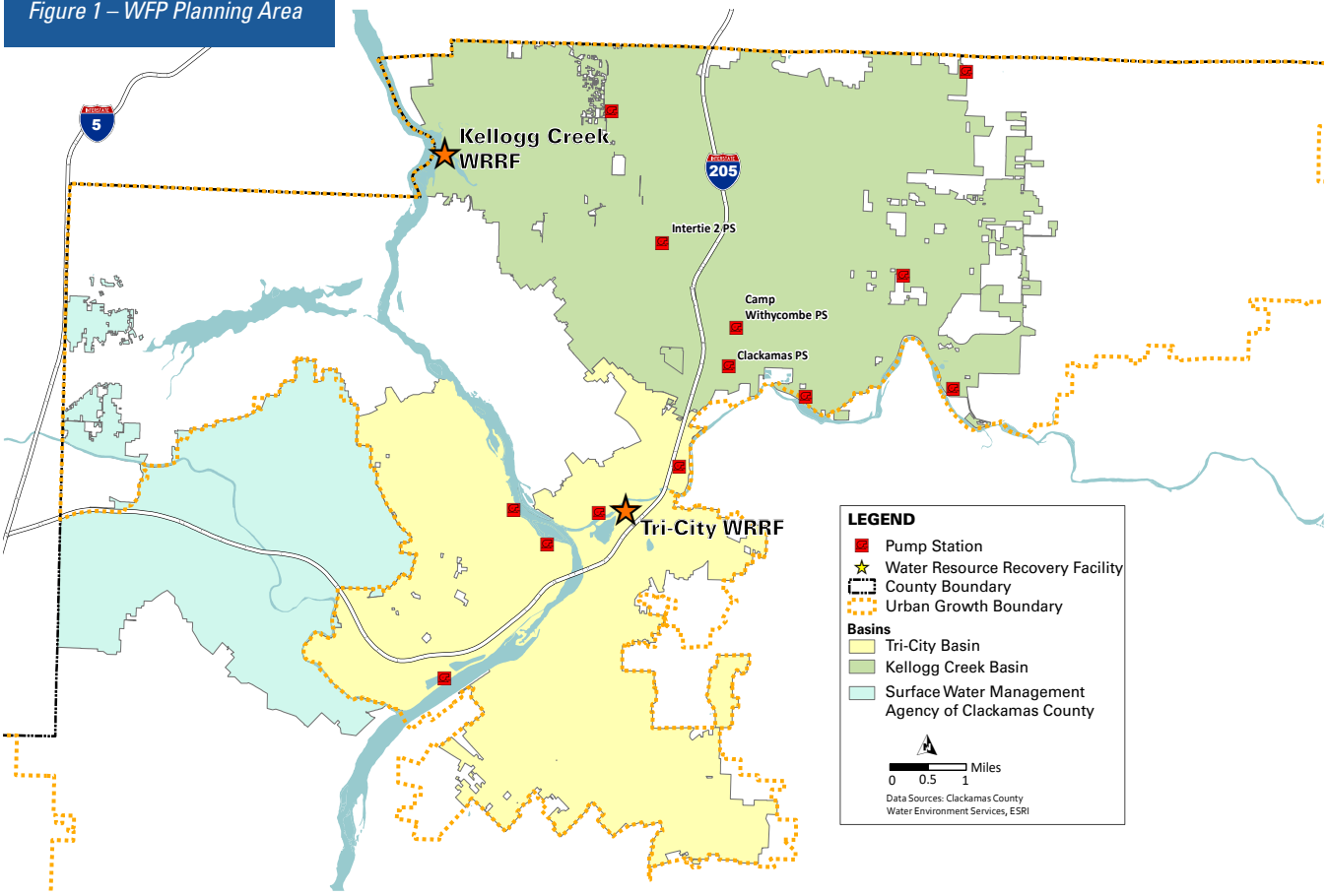
Recommended improvements presented in the Plan are based on an evaluation of regional alternatives that consider the District's Kellogg Creek and Tri-City Water Resource Recovery Facilities (WRRF), as well as wastewater collection and conveyance facilities located throughout the District's service area. This comprehensive, regional approach allows the District to:

- Identify the best use of its wastewater collection, conveyance, and treatment infrastructure;
- Develop a prioritized Capital Improvement Program (CIP) to addresses current needs while preparing for potential future requirements;
- Implement sustainable, affordable solutions that support economic development; and
- Continue to protect Willamette River water quality now and into the future.

Planning Area Definition

The planning area for the WFP is shown in Figure 1. Wastewater from two different basins within the planning area is conveyed to District-owned facilities for treatment. The planning approach taken by WES collectively considers both the Kellogg Creek basin, which conveys wastewater to the Kellogg Creek WRRF, and the Tri-City basin, which conveys wastewater to the Tri-City WRRF. This approach is supported by the fact that the two basins are interconnected at key locations, allowing the District to route wastewater from the Kellogg Creek basin to the Tri-City basin to optimize the capacity and performance of the entire system.

Figure 1 – WFP Planning Area



Wastewater Flows And Loads

Planning Area Population

Determining current and future population numbers within the District is a key initial step in the planning process. Consistent with OAR and DEQ guidance, the WFP is based on 2016 population estimates (Population Forecasts for Clackamas County Service Districts, August 2016), in conjunction with Portland State University's Population Research Center certified population estimates and the 2018 Oregon Metro Regional Transportation Plan.

Table 1 summarizes the planning area population projections through the year 2040. Overall, the population served by WES expected to increase by approximately 33 percent, with 64 percent of the growth occurring in the Kellogg Creek WRRF basin, and 36 percent of the growth in the Tri-City WRRF basin. Figures 2 and 3 illustrate more specifically where growth is expected to occur.

Table 1 – Planning Area Population Projection

Jurisdiction	2015	2020	2025	2030	2035	2040
Tri-City Basin[1]	69.406	76,565	80,621	84,185	86,308	88,766
Kellogg Creek Basin[2]	93,364	103,791	109,754	117,730	124,227	129,670
Planning Area Total[3]	**164,770**	**180,356**	**190,015**	**201,915**	**210,535**	**218,436**

Notes:
(1) EcoNorthwest growth estimate refers to the Tri-City Basin as TCSD.
(2) EcoNorthwest growth estimate refers to the Kellogg Creek Basin as CCSD No. 1.
(3) Sum of Tri-City Basin Total and Kellogg Creek Basin Total.

Figure 2 – Kellogg Creek Basin Population Projection

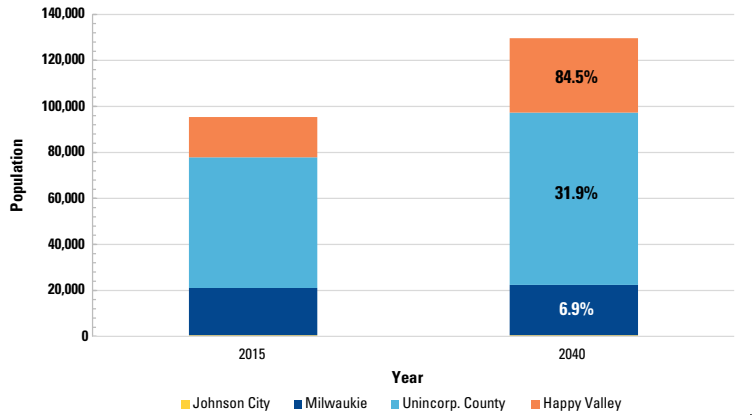
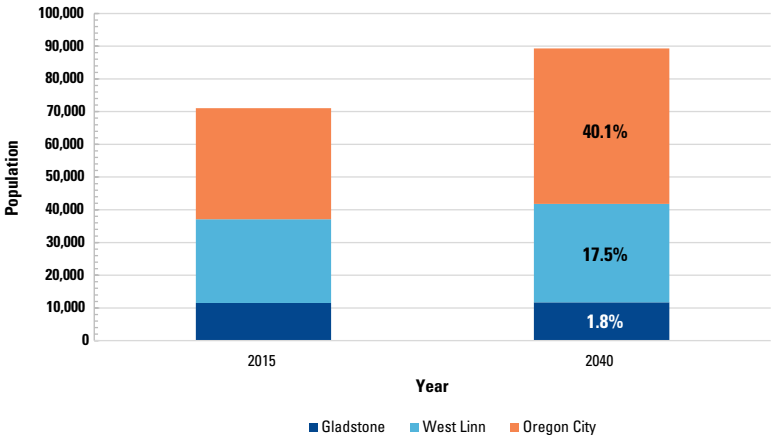


Figure 3 – Tri-City Basin Population Projection



Flow and Load Projections

Estimating the quantity of wastewater that will be generated as population grows is also an essential planning step. Daily wastewater flow (the volume of wastewater generated per day, represented in millions of gallons per day, or mgd) and load (the pounds of organic and solid matter contained within that wastewater volume, represented in pounds per day, or ppd) are each important. With respect to loads, biochemical oxygen demand (BOD) and carbonaceous BOD (cBOD) – which measure organic matter – and total suspended solids (TSS) – which measures solid matter – are two key parameters.

Seasonal Flow Considerations

In rainy climates such as the Pacific Northwest, a strong relationship exists between precipitation and wastewater flow. This is due to rainwater entering the sewer system, either through direct connections (known as "inflow") or as groundwater flowing through leaky pipes (known as "infiltration"). As a result, the amount of flow from a given service area can vary substantially throughout the year. To capture this variation, the Plan includes flow and load estimates for both "dry weather" (May through October) and "wet weather" (November through April) seasons. Through a separate but related planning effort (Collection System Master Plan, Jacobs, 2019) WES has evaluated ways to reduce infiltration and inflow (I/I). The Collection System Master Plan recommendation to reduce I/I by 65 percent in 19 key basins is the basis for the maximum and peak flow values presented in this Plan.

Key Design Criteria

The ability to provide reliable, effective conveyance and treatment of wastewater is determined by flow and/or load criteria, depending on the type of process being evaluated. Facility capacities documented in this Plan are based on industry-standard design criteria and are briefly summarized in Table 2 below.

Current and Projected Values

Flow and load projections for the areas serving the Kellogg Creek and Tri-City WRRFs are combined and shown in Figures 4 and 5, respectively.

Table 2 – Key WFP Flow and Load Criteria

Type of Wastewater Process	Applicable Criteria
Wastewater Conveyance (e.g., pipelines, pumping stations)	Peak Hour Flow (mgd)
Liquid Stream Wastewater Treatment (e.g., screening, settling, biological process)	Avg, Max Month, and Peak Hour Flow (mgd) Avg, Max Month, and Max Week Load (ppd)
Solid Stream Wastewater Treatment (e.g., thickening, digestion, dewatering)	Avg, Max Month, and Max Week Load (ppd)

Figure 4 – Current and Future Flow Projections

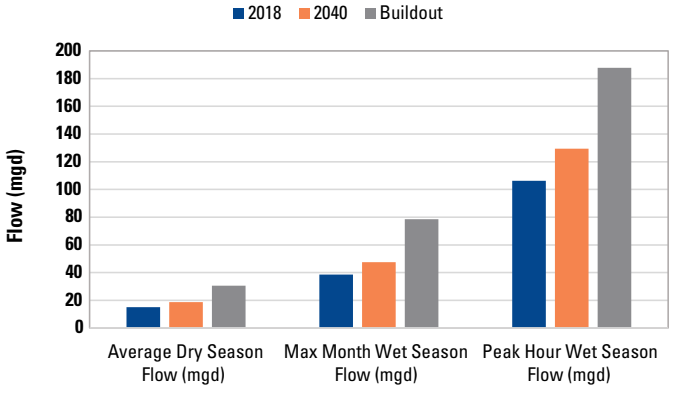
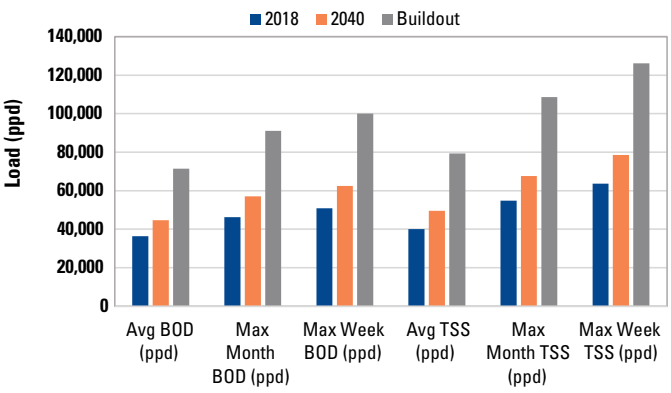


Figure 5 – Current and Future Load Projections



Regulatory Considerations

Existing Permit Limits

The WFP evaluates WES's ability to meet current and potential future water quality permit requirements. Current requirements are included in the Kellogg Creek and Tri-City WRRF National Pollution Discharge Elimination System (NPDES) Permits, summarized in Tables 3, 4, and 5. Both permits include two distinct seasons to determine regulatory compliance:

- **Dry Weather Season:** During the regulatory dry weather season effluent limits are established at more stringent levels, protecting water quality when low streamflow and high temperature conditions exist in the Willamette River.
- **Wet Weather Season:** Conversely, during the regulatory wet weather season, Willamette River streamflow increases and temperatures cool. Less stringent effluent limits are needed to protect water quality during these times.

Such a seasonal approach protects water quality in an affordable, sustainable manner. This Plan assumes the seasonal approach to permitting will continue in the future.

Table 3 – Kellogg Creek WRRF Effluent Permit Limits

Parameter	Average Effluent Concentrations		Monthly Average, lbs/day	Weekly Average, lbs/day	Daily Maximum, lbs
	Monthly	Weekly			
May 1 – October 31					
$CBOD_5$	15 mg/L	25 mg/L	1300	2000	2600
TSS	20 mg/L	30 mg/L	1700	2600	3400
November 1 – April 30					
BOD_5	25 mg/L	40 mg/L	2100	3200	4200
TSS	30 mg/L	45 mg/L	2500	3800	5000
Other Parameters Limitations					
Total Chlorine Residual	Shall not exceed a monthly average concentration of 0.03 mg/L and a daily maximum concentration of 0.07 mg/L.				
Ammonia - May 1 to October 31	Shall not exceed a maximum daily limit of 60.1 mg/L or an average monthly limit of 33.9 mg/L.				
Ammonia - November 1 to April 30	Shall not exceed a maximum daily limit of 41.9 mg/L or an average monthly limit of 25.4 mg/L.				

Table 4 – Tri-City WRRF Effluent Permit Limits

Parameter	Average Effluent Concentrations		Monthly Average, lbs/day	Weekly Average, lbs/day	Daily Maximum, lbs[1]
	Monthly	Weekly			
May 1 – October 31					
$CBOD_5$	10 mg/L	15 mg/L	1050	1750	2100
TSS	10 mg/L	15 mg/L	1400	2100	2800
November 1 – April 30					
BOD_5	25 mg/L	40 mg/L	2800	4500	5600
TSS	30 mg/L	45 mg/L	3400	5100	6800
Other Parameters Limitations					
Total Chlorine Residual	Shall not exceed a monthly average concentration of 0.02 mg/L and a daily maximum concentration of 0.04 mg/L.				
Ammonia - May 1 to October 31	The interim limit no longer applies as WES fulfilled the MAO requirements.				

Notes:
(1) The daily mass load limit is suspended on any day that the flow exceeds 23.8 mgd (twice th design average dry weather flow).

Table 5 – Effluent Permit Limits Common to Both WRRFs

Parameter	Limitation
E.coli Bacteria	Shall not exceed 126 organisms per 100 ml monthly geometric mean. No single sample shall exceed 406 organisms per 100 ml.
pH	Shall be within the range of 6.0-9.0.
BOD_5 Removal Efficiency	Shall not be less than 85 percent monthly average.
TSS Removal Efficiency	Shall not be less than 85 percent monthly average.

Future Permit Considerations

Throughout the planning process, WES maintained a high degree of communication and close coordination with Oregon DEQ. This allowed the planning team to make reasonable assumptions with respect to potential regulatory limits that may be included in future NPDES Permits for the Kellogg Creek and Tri-City WRRFs. A summary of the regulatory assumptions that were used to guide the analysis of alternatives in the WFP is presented in Table 6:

Table 6 – Regulatory Assumptions

Kellogg Creek NPDES Permit Assumptions	Tri-City Permit Assumptions
BOD/TSS Concentration Limits	
The current permit is not based on the basin standard for technology-based limits for BOD and TSS; however, since the recommended improvements will not change the liquid-stream capacity, no change should be made.	The current permit is based on the basin standard for technology-based limits for BOD and TSS, and no change to this standard should be made.
BOD/TSS Mass Load Limits	
The requirement to meet daily BOD and TSS mass load limits is not currently suspended during peak flow conditions. In the future, WES believes these mass load limits should be suspended on any day that flow exceeds the hydraulic capacity of the secondary treatment process, or 18 mgd. An alternative approach to suspending the mass load limits would be to establish new daily load limits according to OAR 240-041-0061 (9)(b), which requires the highest and best practical treatment to minimize the discharge of pollutants.	The requirement to meet daily BOD and TSS mass load limits is currently suspended during peak flow conditions. In the future, WES believes these mass load limits should continue to be suspended on any day that flow exceeds two times the average daily flow. An alternative approach to suspending the mass load limits would be to establish new daily load limits according to OAR 240-041-0061 (9)(b), which requires the highest and best practical treatment to minimize the discharge of pollutants. As growth occurs over time, additional flow must be transferred from Kellogg Creek to Tri-City. Accordingly, wet weather BOD and TSS mass loads will also increase. WES completed extensive modeling during the planning process to demonstrate that this transfer of load will not impact water quality.
Ammonia Limits	
An interim ammonia limit was included in the existing NPDES permit. However, with improved mixing at the Kellogg Creek outfall, the ammonia limit is no longer warranted; therefore it is assumed to be removed from future permits.	There is no ammonia limit in the existing permit, and no ammonia limit is required/warranted in future permits. Additionally, a new outfall and diffuser are planned that will improve mixing.
Effluent Toxicity	
Modeling was completed to demonstrate no reasonable potential to violate water quality standards at the edge of the outfall mixing zones.	Modeling was completed to demonstrate no reasonable potential to violate water quality standards at the edge of the outfall mixing zones.
Temperature	
A mass balance shows there is room for approximately 50 percent growth within the existing thermal load allocation.	A mass balance shows there is room for approximately 30 percent growth within the existing thermal load allocation.

Existing WRRF Condition and Capacity

Kellogg Creek and Tri-City WRRF Condition

The condition of existing treatment facilities must be well understood in order to develop a 20-year CIP. This allows for the inclusion and scheduling of projects to rehabilitate or replace components of the existing WRRF that naturally wear-out over time. Such projects are known as "R&R Projects." As part of the WFP, an extensive condition assessment was conducted by a team of mechanical, structural, and electrical/instrumentation engineers. This team identified the need for R&R Projects based on comprehensive assessment of virtually every structural, mechanical, electrical, and instrumentation component (or "asset") comprising WES's wastewater pumping and treatment and infrastructure. Table 7 summarizes the scoring system developed by WES's team.

Overall, the condition of the Kellogg Creek and Tri-City WRRFs is sound, with the majority of assets scoring 3 or better. However, several assets at both facilities will require substantial refurbishment or replacement over the next decade.

Table 7 – Condition Assessment Scoring System

Condition Score	Description
1 (Best)	**Excellent:** Very little wear. Fully operable, well maintained, and consistent with current standards. No further action required.
2	**Good:** Sound and well maintained but showing slight signs of wear. Able to deliver full efficiency with little or no performance deterioration. Minor rehabilitation may be needed.
3	**Moderate:** Functionally sound but showing normal wear. Minor failures or diminished efficiency/ performance causing increased maintenance. Moderate rehabilitation needed.
4	**Poor:** Functional but requiring a high level of maintenance to remain operational. Likely to cause reduce performance in the near term. Major rehabilitation or replacement needed.
5 (Worst)	**Very Poor:** Useful life has been exceeded and/or excessive maintenance cost are needed to remain in operation and reduce risk of breakdown. Immediate replacement required.

Kellogg Creek and Tri-City WRRF Capacity

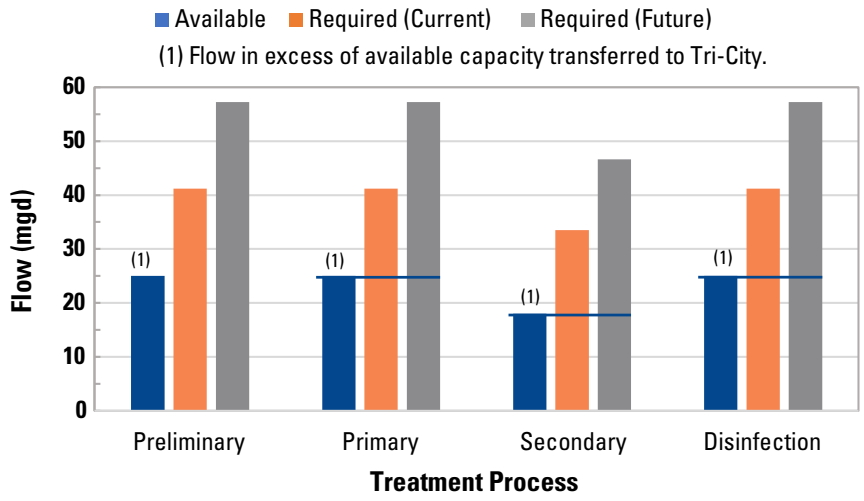
The capacity of existing wastewater conveyance and treatment infrastructure must also be defined to identify projects needed to accommodate future growth. Expansion projects for WES's conveyance infrastructure were identified previously (Collection System Master Plan, Jacobs, 2019). This Plan focuses on identifying expansion projects needed to address capacity deficiencies at the Kellogg Creek and Tri-City WRRFs. Projects to address both liquid stream capacity (i.e., the ability of facilities to treat wastewater flow), and solid stream capacity (i.e., the ability of the facilities to process the solids contained in the wastewater) are identified.

Kellogg Creek WRRF Capacity

Liquid Stream Capacity

Under existing NPDES permit limits, the existing Kellogg Creek WRRF has sufficient capacity to treat current and projected flows during most of the year. However, WRRF treatment capacity is capped at 25 mgd. Because peak flows in the Kellogg Creek basin currently exceed 25 mgd during large storm events, excess flow is transferred to the Tri-City WRRF. This practice will continue and will become more frequent due to growth in the Kellogg Creek basin. Figure 6 summarizes the liquid stream capacity analysis at the Kellogg Creek WRRF, with the capacity of major unit processes represented in units of flow.

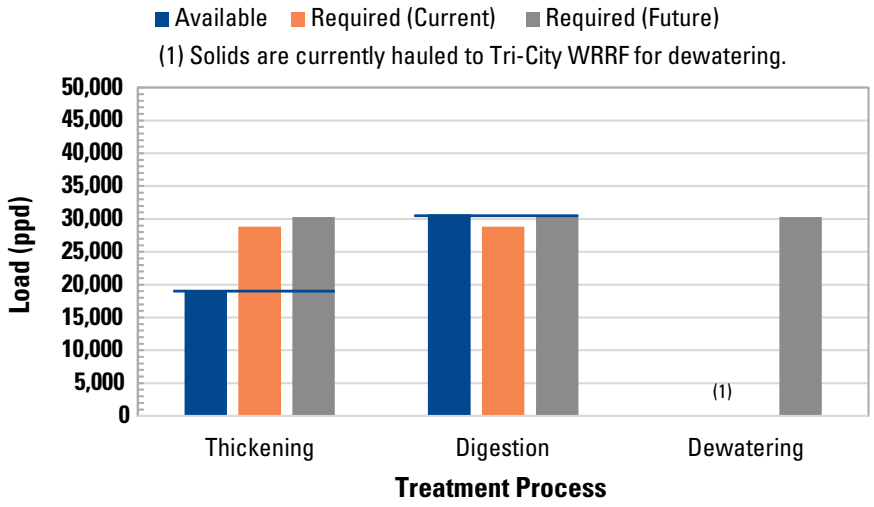
Figure 6 – Kellogg Creek WRRF Liquid Stream Capacity



Solid Stream Capacity

The capacity of the major Kellogg Creek solids stream treatment processes is shown in Figure 7, with the capacity of major unit processes represented in units of pounds. As shown, improvements to increase the capacity of solids thickening and digestion are required within the planning period. Dewatering, improvements are also needed to eliminate the current practice of hauling solids from Kellogg Creek to Tri-City for dewatering.

Figure 7– Kellogg Creek WRRF Solid Stream Capacity

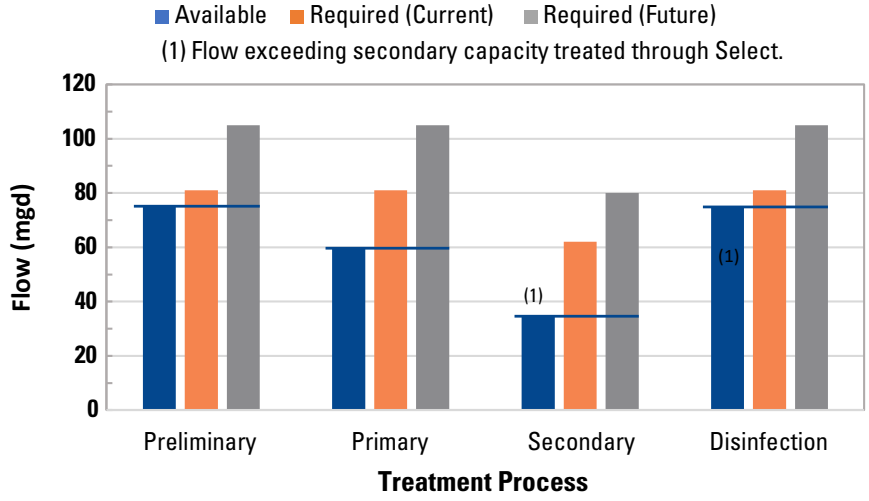


Tri-City WRRF Capacity

Liquid Stream Capacity

Figure 8 summarizes the liquid stream capacity analysis at the Tri-City WRRF under existing NPDES permit limits. As shown in the figure, multiple liquid stream processes have reached their capacity to treat peak flow. To address this limitation, the WFP focuses on alternatives that would increase the peak flow hydraulic capacity of the Tri-City WRRF from 72 mgd to 105 mgd within the next several years.

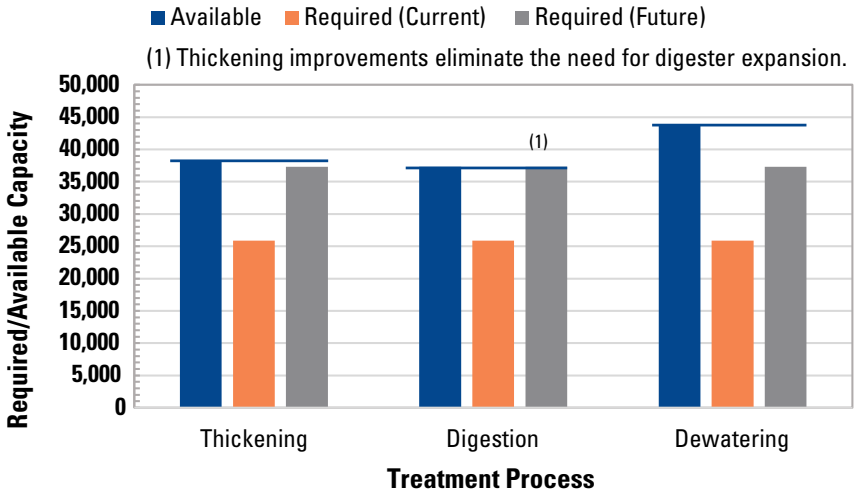
Figure 8 – Tri-City WRRF Liquid Stream Capacity



Solid Stream Capacity

The capacity of the major Tri-City solids stream treatment processes is shown in Figure 9. As shown in the figure, the existing solids handling processes at Tri-City each have adequate capacity; therefore, solids capacity expansion is not required in the near-term. Depending on several factors, the available capacity of the existing solids thickening process may be exceeded near the end of the 20-year planning period. To be conservative, a project to increase thickening capacity around the year 2040 is therefore included in the WFP.

Figure 9 – Tri-City WRRF Solid Stream Capacity



Basin-Wide Scenario Analysis

With the foundational elements of the Plan established, the planning team evaluated a number of basin-wide scenarios to answer several questions, including:

1. **During the wet weather season:** Should peak flows be treated and discharged at a remote facility located at the Blue Heron property on the West side of the Willamette River, or conveyed to the Tri-City WRRF for treatment and discharge?
2. **During the dry weather season:** If regulatory requirements become more stringent in the future, what combination of Kellogg Creek and Tri-City WRRF capacity provides the most cost-effective means of protecting Willamette River water quality?

Basin-Wide Scenario Recommendations

An extensive analysis was completed to compare different basin-wide scenarios based on their capital and life cycle costs as well as non-cost factors that are consistent with WES's mission and objectives, including:

- Operational Complexity
- Water Quality
- NPDES Permitting Challenges
- Environmental/Land Use Challenges
- Community Benefit/Impact

Providing Peak Flow Treatment During the Wet Weather Season

Conveying peak wet weather flows to the Tri-City WRRF for treatment and discharge is the recommended approach. The estimated capital and life cycle costs of this approach are very close to the costs of other approaches and expanding the Tri-City WRRF offers several non-cost advantages, including reduced operational complexity and fewer permitting challenges.

Meeting Potential Future Permit Requirements During the Dry Weather Season

If future NPDES permits include nutrient limits, modifying the existing Tri-City WRRF to achieve permit compliance is the recommended approach. This means that liquid stream biological treatment improvements will not likely be needed at the Kellogg Creek WRRF. However, space to modify the treatment process at the Kellogg Creek site should be retained in case this ever changes.

Taking a basin-wide approach makes the best use of available land for process expansion at Tri-City while preserving the BOD and TSS treatment capacity at Kellogg Creek. Regulatory compliance may require a basin-wide NPDES permit that is based on water quality modeling. Similar permits have been developed used before to measure compliance at other treatment facilities in Oregon, and WES has initiated water quality modeling to support this approach as part of the WFP.

WES's basin-wide planning approach makes the best use of wastewater infrastructure in both WRRF basins.

Recommended Plan – Kellogg Creek WRRF

The planning team completed a detailed facilities plan for the Kellogg Creek WRRF, based on the evaluation of basin-wide scenarios as well as prior analyses of flows, loads, capacity, condition, and water quality regulations. Table 8 summarizes projects that are recommended to be completed within the planning period.

Table 8 – Kellogg Creek WRRF Recommended Projects

Project	Description	Estimated Capital Cost
Disinfection	▪ Replace existing disinfection equipment that has reached the end of its useful life with new, reliable disinfection equipment.	$2.8M
Solids Handling	▪ Replace existing thickening equipment that has reached the end of its useful life and is undersized with properly sized, reliable thickening equipment. ▪ Improve the existing digestion process to increase total and reliable capacity to treat current and future loads. ▪ Add new equipment to eliminate the need to haul digested sludge to the Tri-City WRRF for dewatering.	$24.3M
Digester Gas Utilization	▪ Install new gas storage, treatment, and cogeneration systems to increase the beneficial use of fuel produced as a by-product of anaerobic digestion.	$5.9M
R&R Projects	▪ Complete near-term, mid-term, and long-term R&R projects as recommended by the condition assessment.	$7.9M
Total 20-year Investment in the Kellogg Creek WRRF		**$40.9M**

The proposed site plan for the Kellogg Creek WRRF is shown in Figure 10. This site plan addresses the priority improvements through the planning period and retains space for future process improvements to meet more restrictive NPDES permit limits, if needed.

Figure 10 – Kellogg Creek WRRF Site Plan

Recommended Plan – Tri-City WRRF

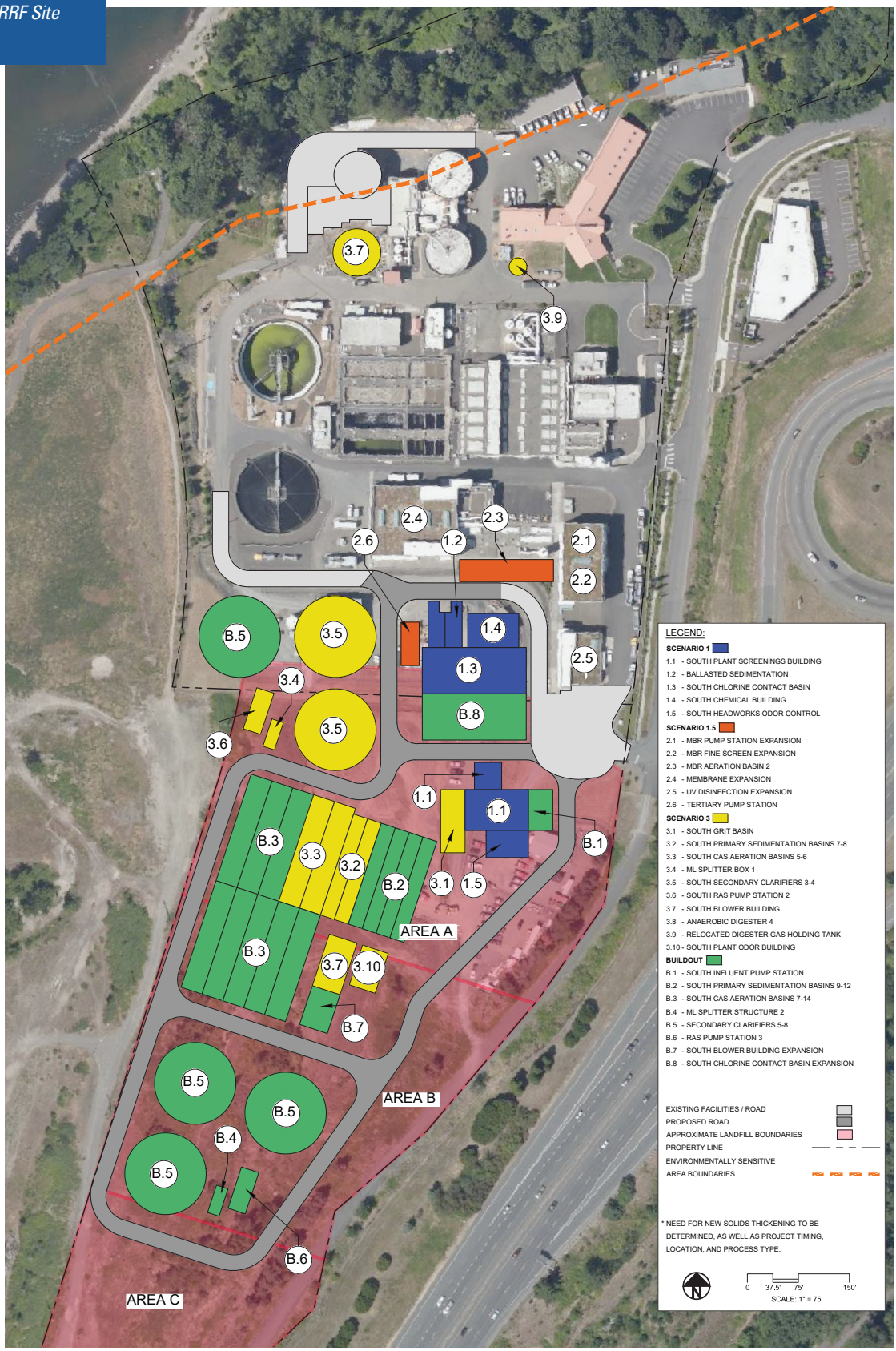
The planning team also completed a detailed facilities plan for the Tri-City WRRF. Table 9 summarizes projects that are recommended to be completed within the planning period.

Table 9 – Tri-City WRRF Recommended Projects

Project	Description	Estimated Capital Cost
Peak Flow Hydraulic Improvements	▪ Install a new peak flow treatment process (ballasted sedimentation) south of the existing WRRF to increase peak flow hydraulic capacity to 105 mgd. » NOTE: The ballasted sedimentation process has been used to effectively treat peak wet weather flows at numerous wastewater facilities in Oregon and throughout the US. In the event that this approach does not meet regulatory approval at the Tri-City WRRF, a similar process involving biological treatment may be required. This is expected to cost an additional $30 million; however, the planning team does not believe this additional investment is needed to meet NPDES permit limits and protect Willamette River water quality.	$53.7M
Thickening Improvements	▪ Install new facilities to thicken primary sludge from existing and new primary sedimentation basins.	$7.6M
R&R Projects	▪ Complete near-term, mid-term, and long-term R&R projects as recommended by the condition assessment.	$16.9M
Total 20-year Investment in the Tri-City WRRF		**$78.2M**

The proposed site plan for the Tri-City WRRF is shown in Figure 11. For space planning purposes, this site plan includes buildout facilities for wet weather treatment and is consistent with the basin-wide recommendation to meet potential future NPDES limits by expanding the secondary treatment process at Tri-City.

Figure 11 – Tri-City WRRF Site Plan

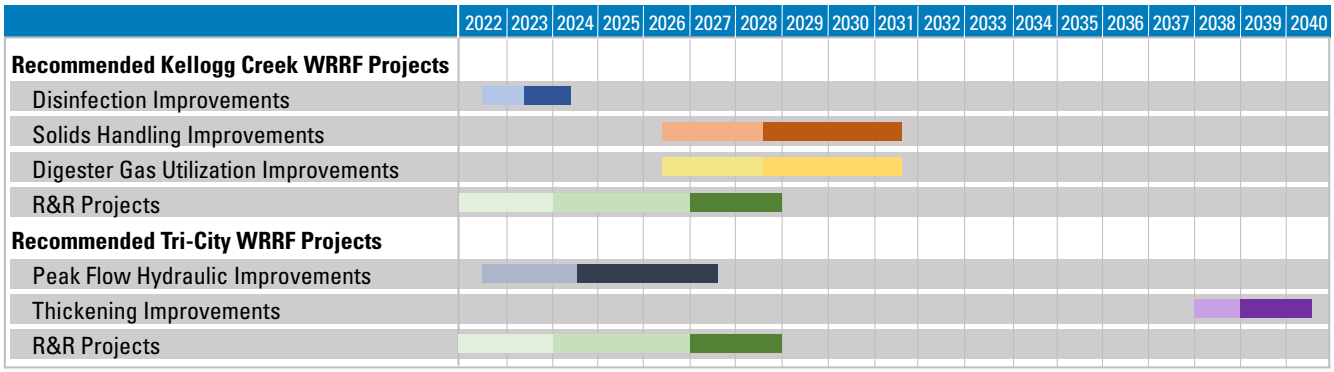


Schedule and 20-Year CIP

Developing a schedule and 20-year CIP for the recommended projects is the final step in the planning process. The schedule must consider numerous factors including the criticality, magnitude, and duration of each project. The availability of funding and overall affordability is also a substantial factor in determining the CIP. For the WFP, the District attempted to uniformly distribute the total cash expenditure over the planning period to mitigate sewer rate impacts.

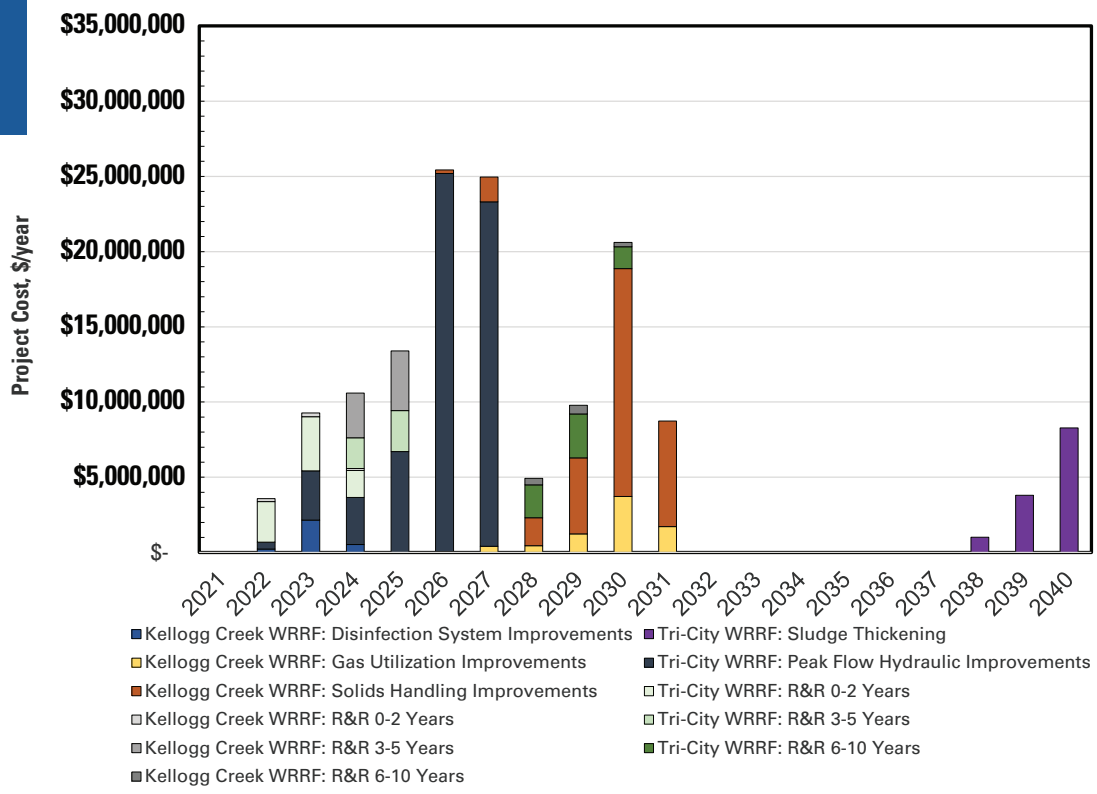
The proposed schedule for the recommended projects at the Kellogg Creek and Tri-City WRRFs is shown in Figure 12. Major projects at each facility include both design and construction phases. R&R projects are distributed uniformly across the time period associated with their priority (i.e., 0 to 2 years, 3 to 5 years, 6 to 10 years). In actuality, these projects may be performed separately through maintenance contracts, grouped together, or included in one of the larger capital projects occurring within the same time period.

Figure 12 – Kellogg Creek and Tri-City WRRF Recommended Projects Schedule



The proposed cash expenditure schedule associated with the recommended plan is shown in Figure 13. The estimated cost of completing each expansion and R&R project is shown for each year of the planning period. The District's other investments for projects in the wastewater collection and conveyance system, the Tri-City WRRF Outfall, and/or projects associated with non-process facilities (e.g., lab and administrative buildings that are needed to support treatment process functions) are not shown in Figure 13.

Figure 13 – Kellogg Creek and Tri-City WRRF Proposed Cash Expenditure Schedule



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January 19, 2022

Willamette Facilities Plan

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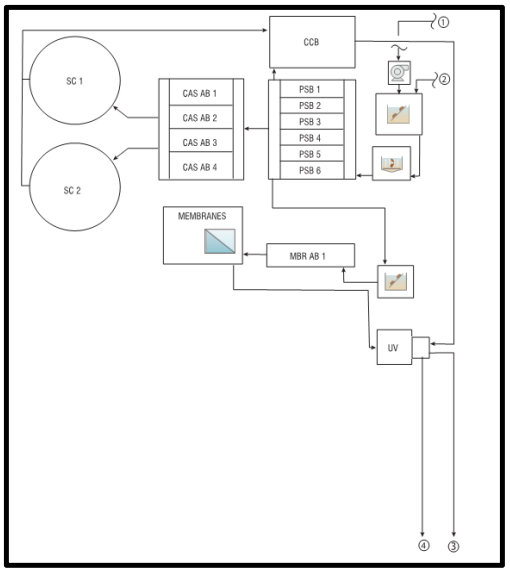
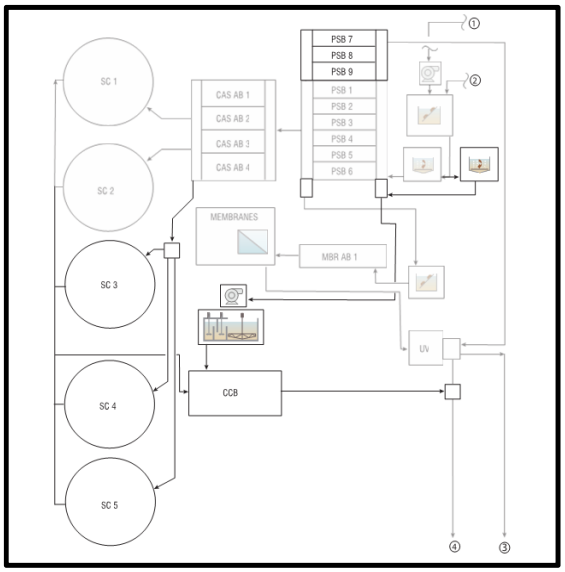
What is a Facilities Planning Process



Existing Facilities - 2020

- Regulatory
- Capacity
- Condition



Required Facilities - 2040

CLACKAMAS WATER ENVIRONMENT SERVICES

WRF Condition Assessment

Score	Description
1 (Best)	Excellent: No action required
2	Good: Minor rehab may be needed
3	Moderate: Moderate Rehab needed
4	Poor: Needs Major Rehab or Replacement
5 (Worst)	Very Poor: Needs Immediate Replacement

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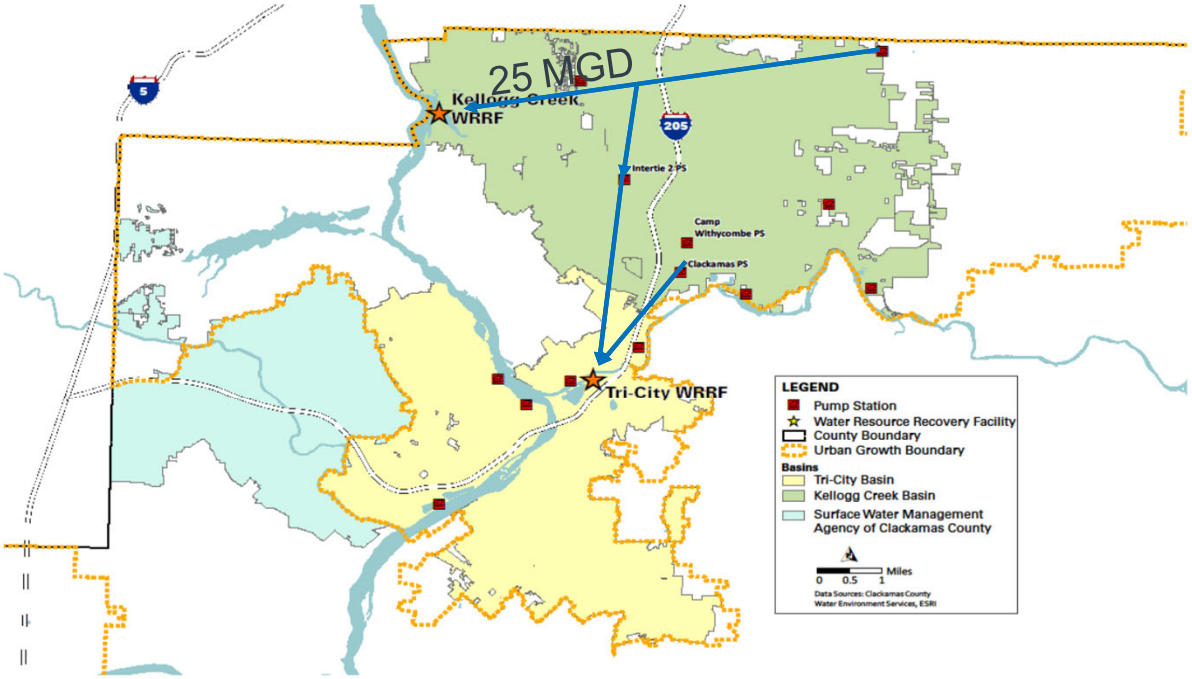
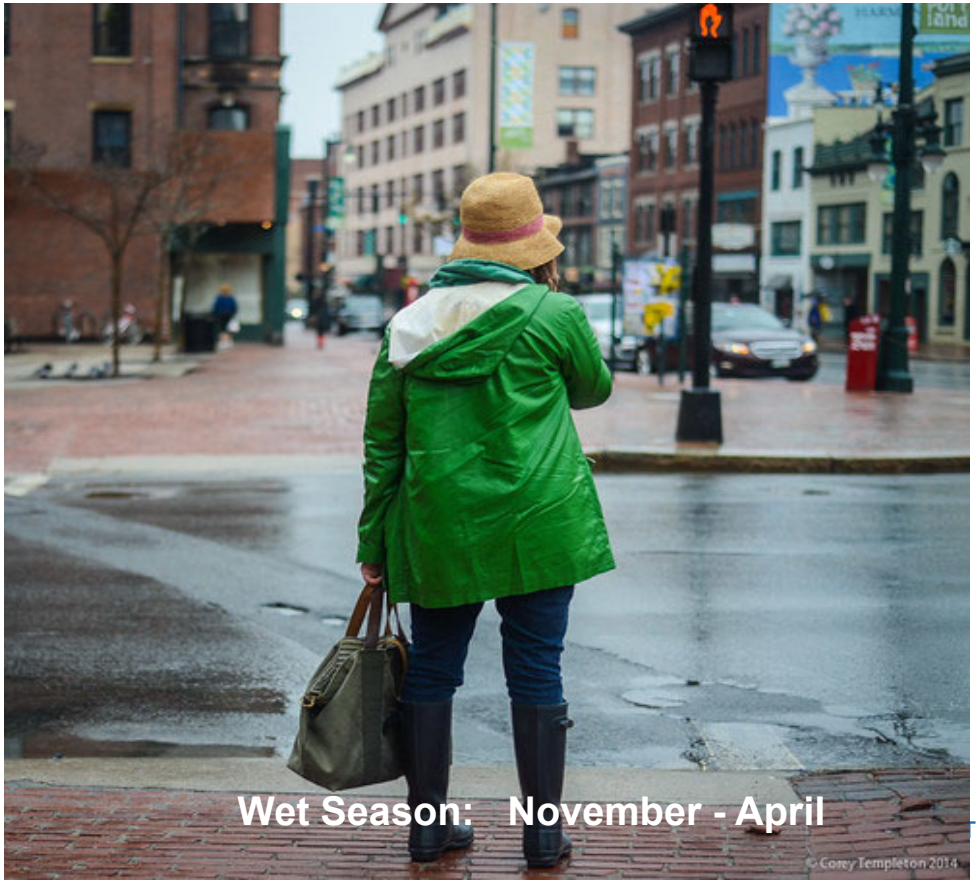
Capacity

WFP Looked at Best Way to Integrate Treatment Across Service Areas



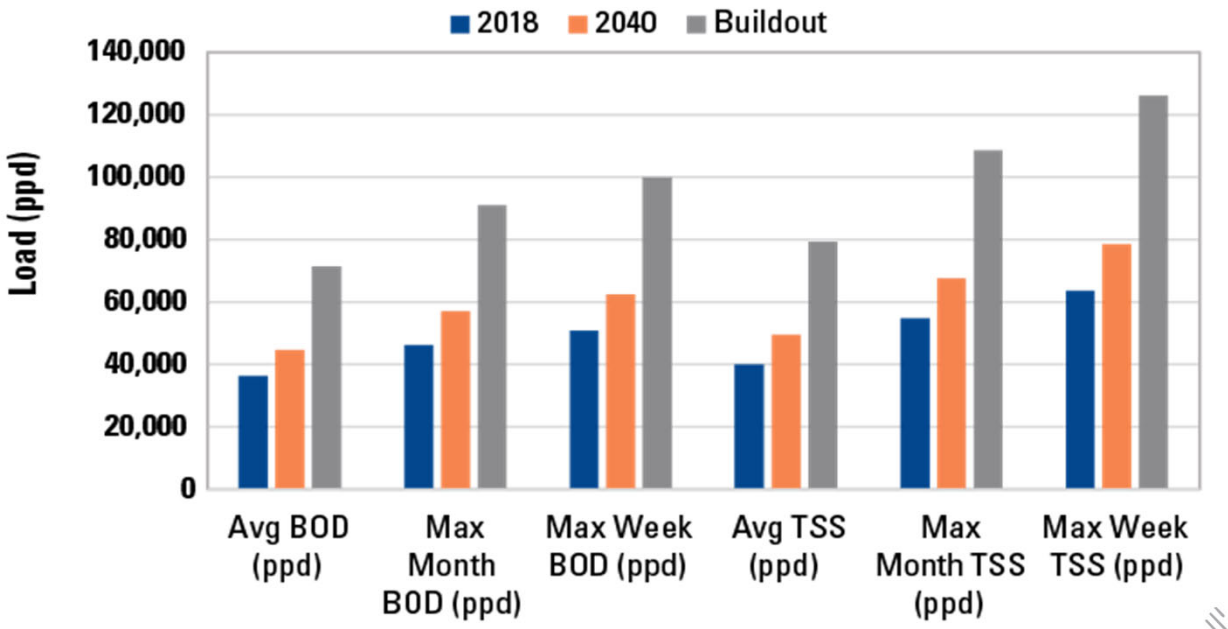
CLACKAMAS WATER ENVIRONMENT SERVICES

Wastewater Treatment Has Two Regulatory Seasons



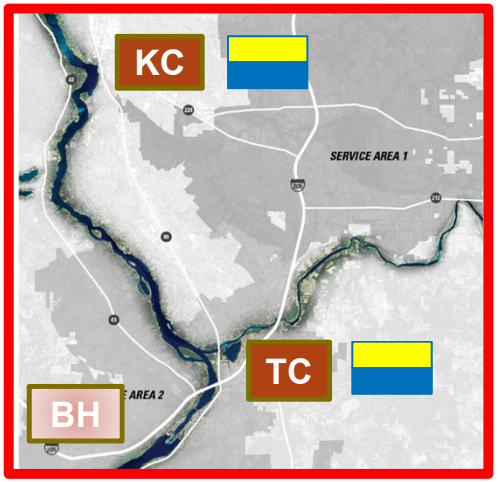
Dry Season

Dry Weather: Population (=Load) Projection

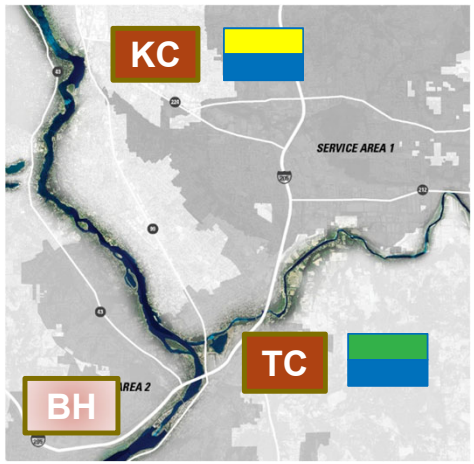


CLACKAMAS WATER ENVIRONMENT SERVICES

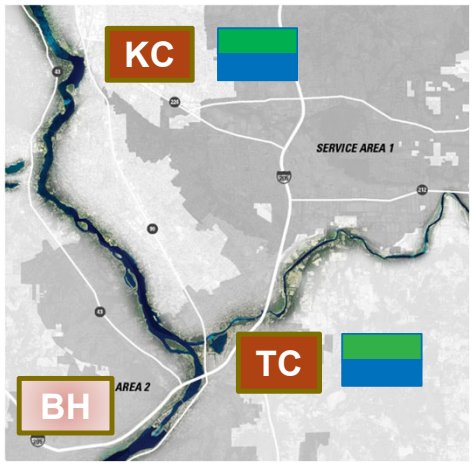
Dry Weather Scenarios



Scenario 1
Current Permit Limits



Scenario 1.5
Nutrient Removal
Combined Permit



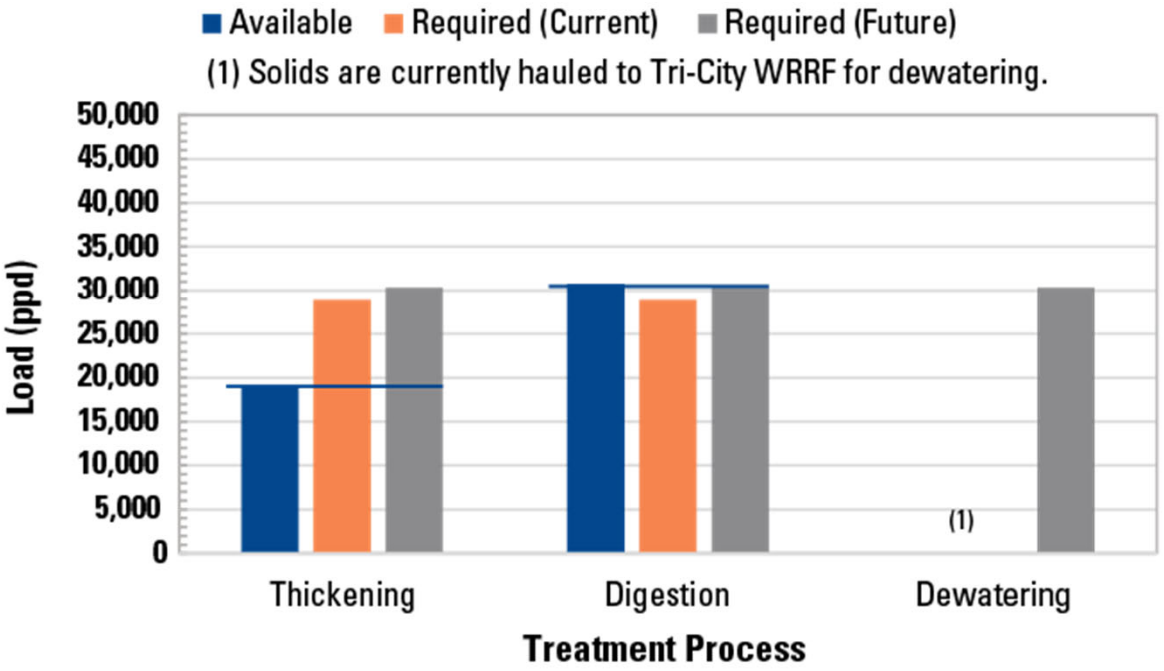
Scenario 3
Nutrient Removal
Individual Permits

Water Quality →

Cost →

CLACKAMAS WATER ENVIRONMENT SERVICES

Kellogg Creek WRRF Dry Weather Capacity Needs



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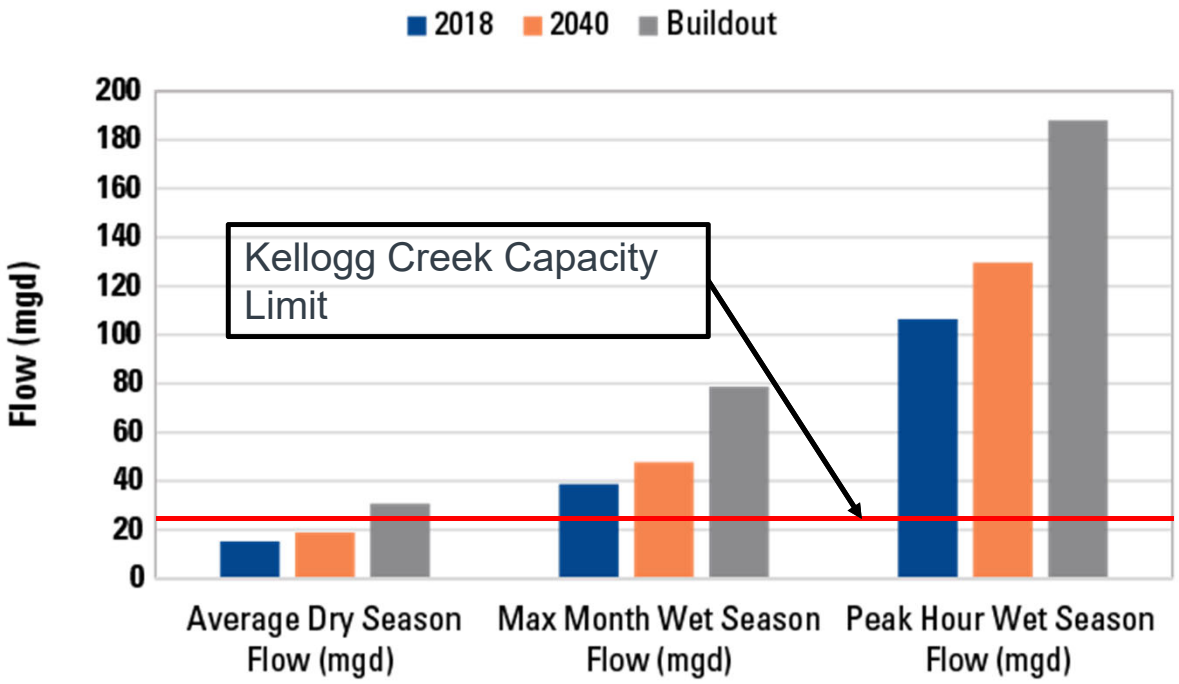
Wet Season

Wet Weather: Flow Projection (with I/I Reduction)



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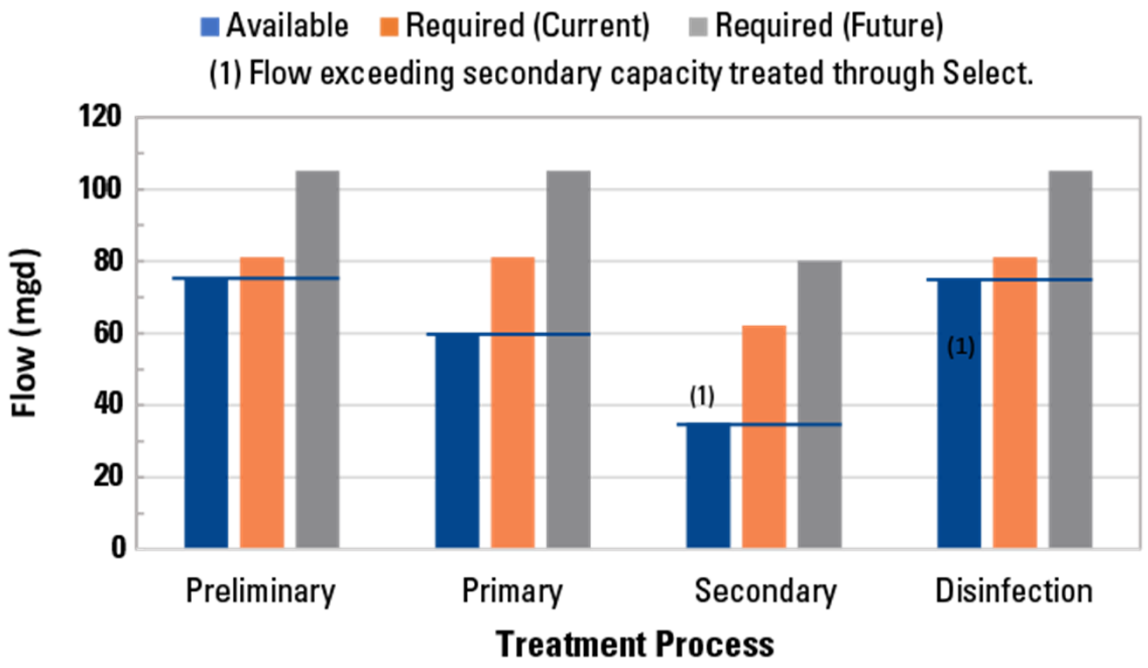
Tri-City WRRF Wet Weather Capacity Needs



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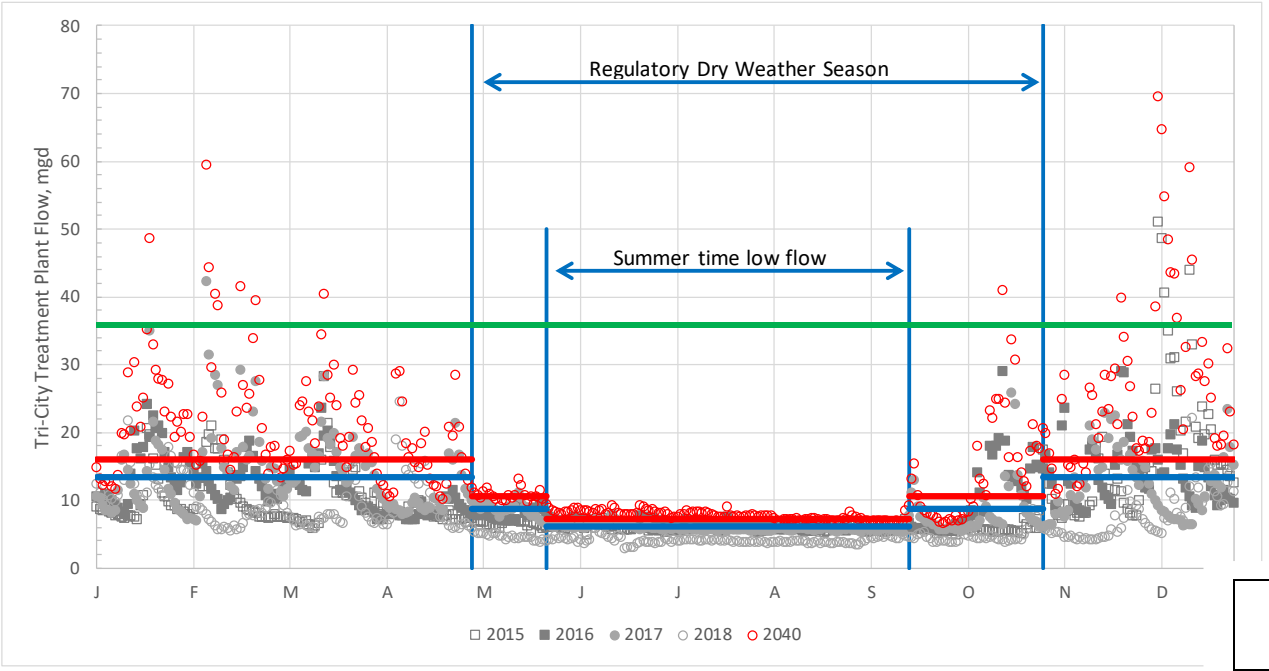
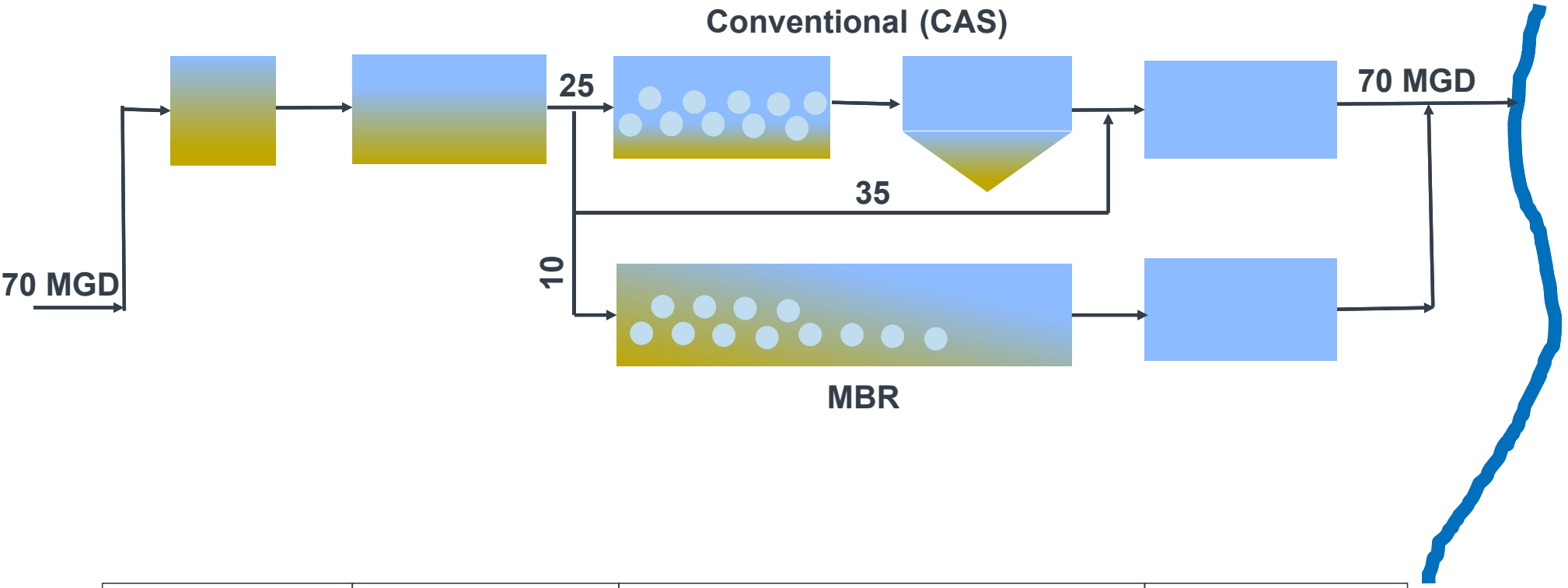
Infrequent Peak Flow at Tri-City Presents Challenges



Estimated Value	Current [1]	Projected (2040)
% of Time Q ≤ 35 mgd	99%	98%
No. of ST Events per Year	3	9
Average Annual ST Duration (hrs)	50	180
% of Annual Flow Discharged as ST	1%	3%
(1) Average of 2015 - 2018 data		

Wet Weather Treatment – Existing Tri-City



Prelim. Treatment	Primary Treatment	Secondary Treatment	Disinfection

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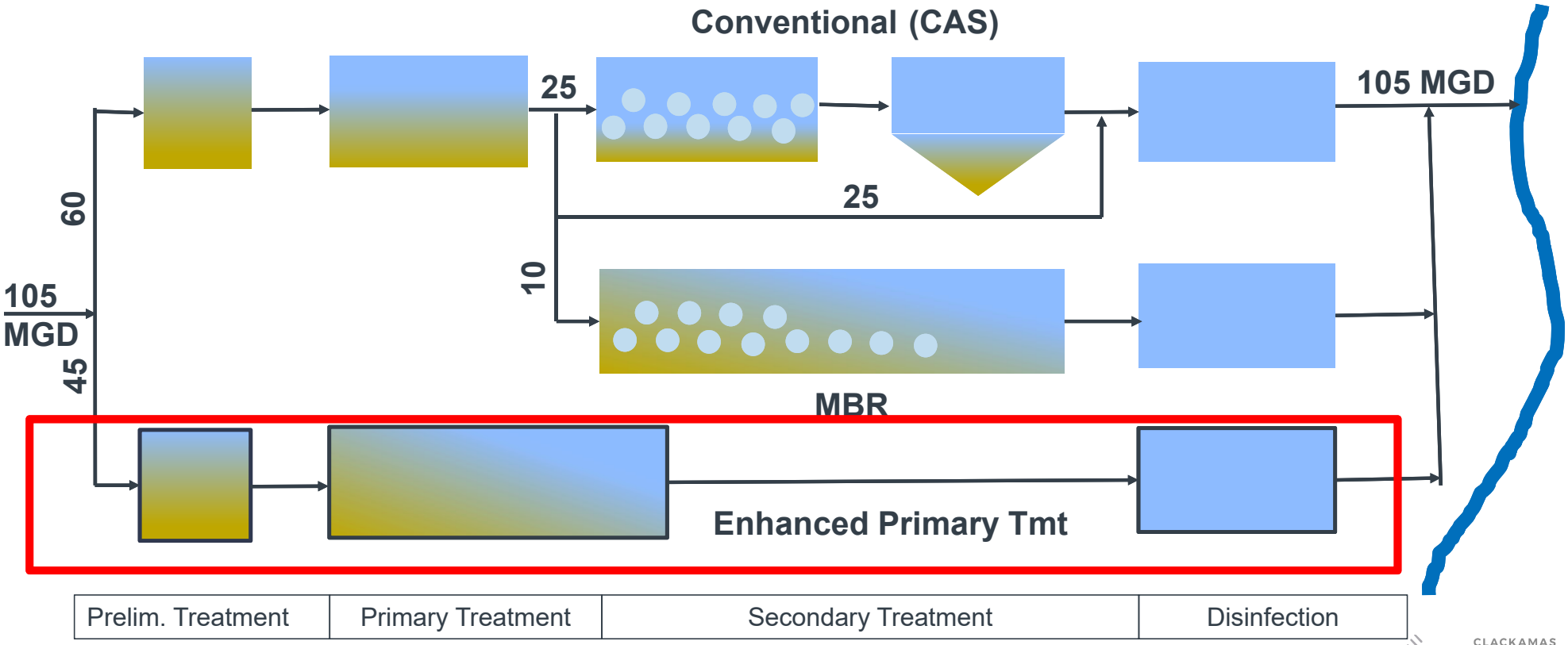
Wet Weather Scenario – Expanded Tri-City



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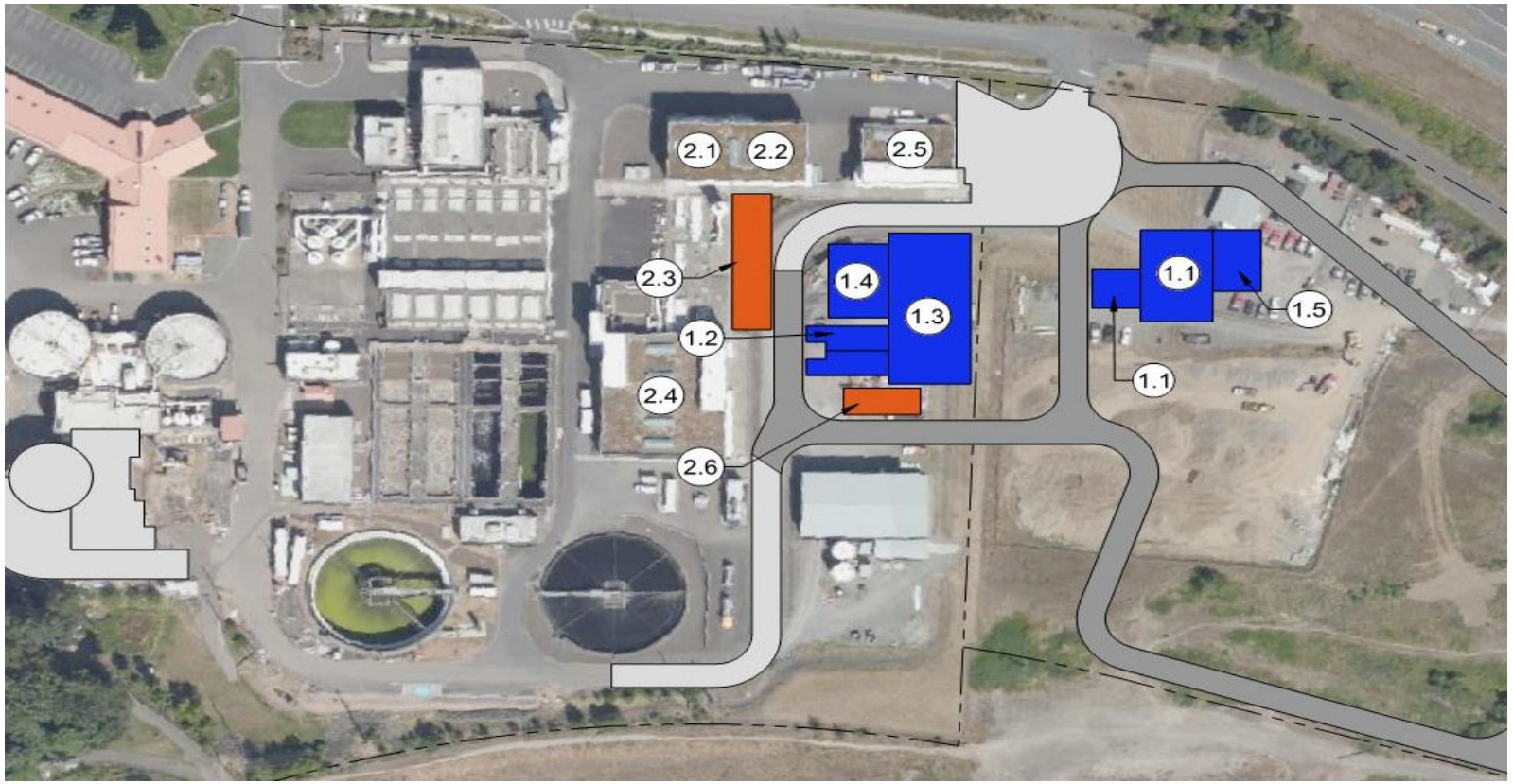
Recommended 2040 Tri-City Site Layout



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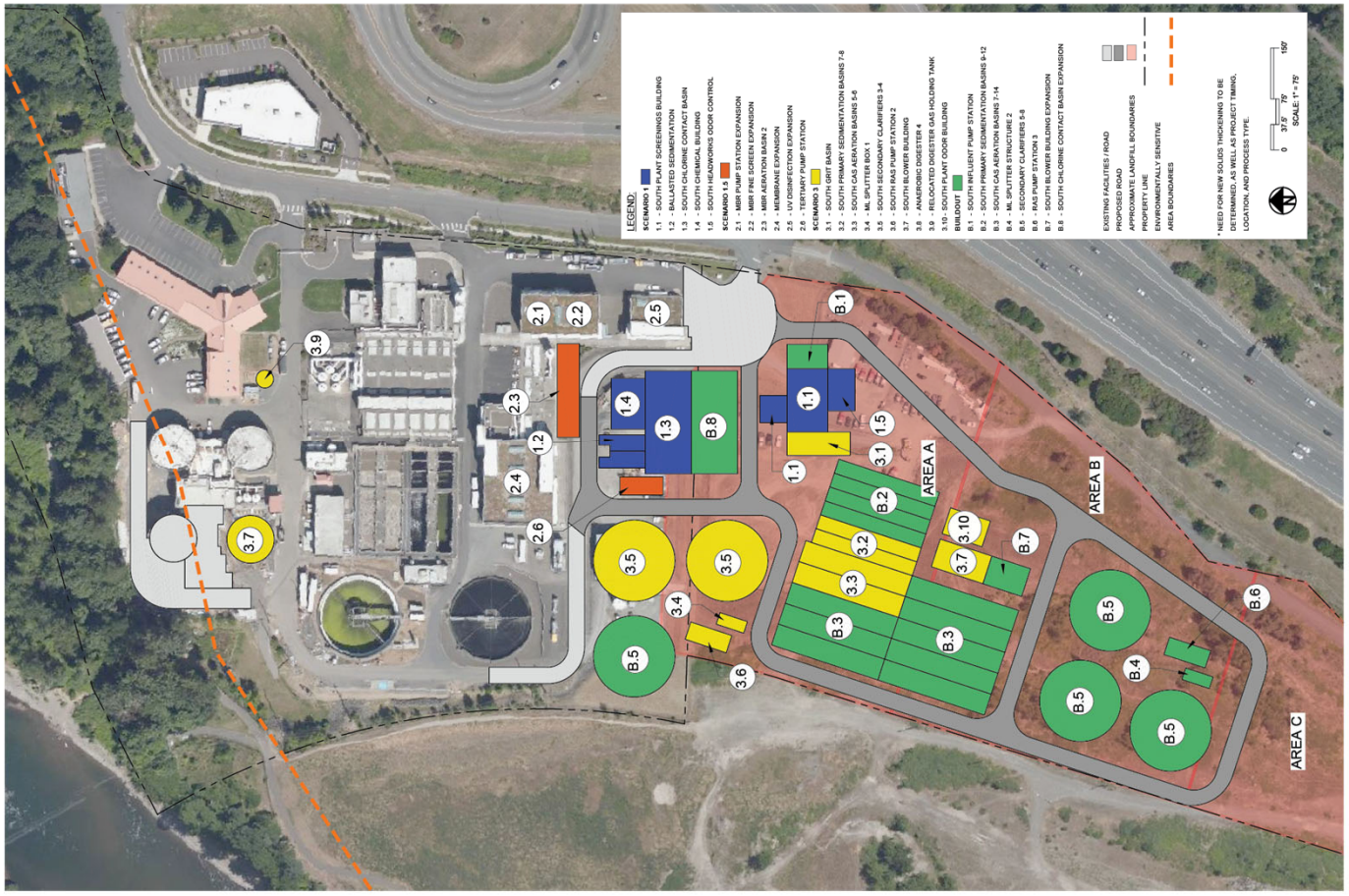
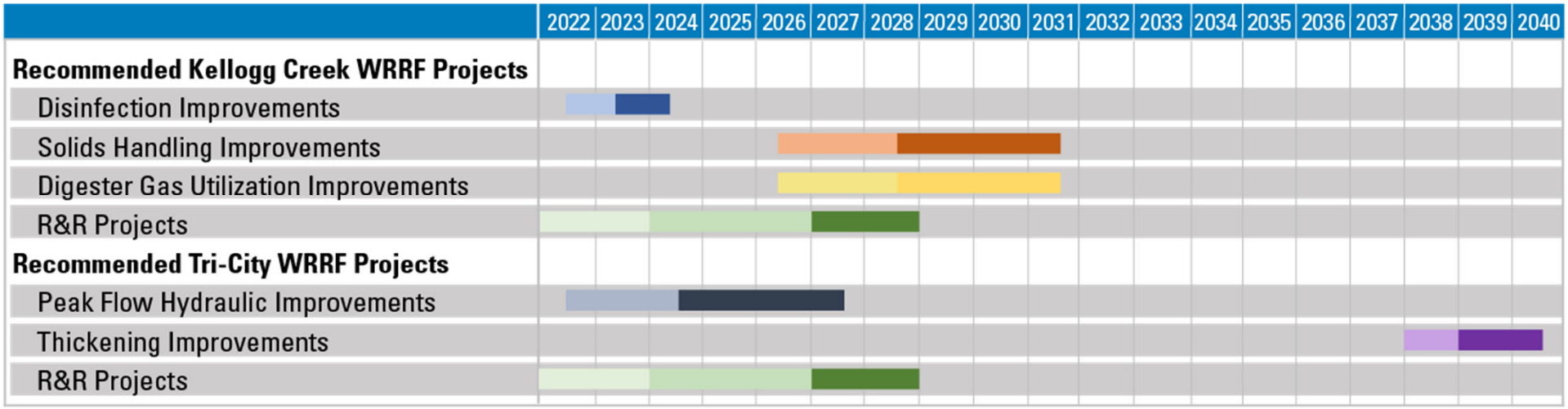
Recommended Conceptual Tri-City Site Plan at Buildout



CLACKAMAS WATER ENVIRONMENT

WRF Capital Plan Recommended Implementation Schedule



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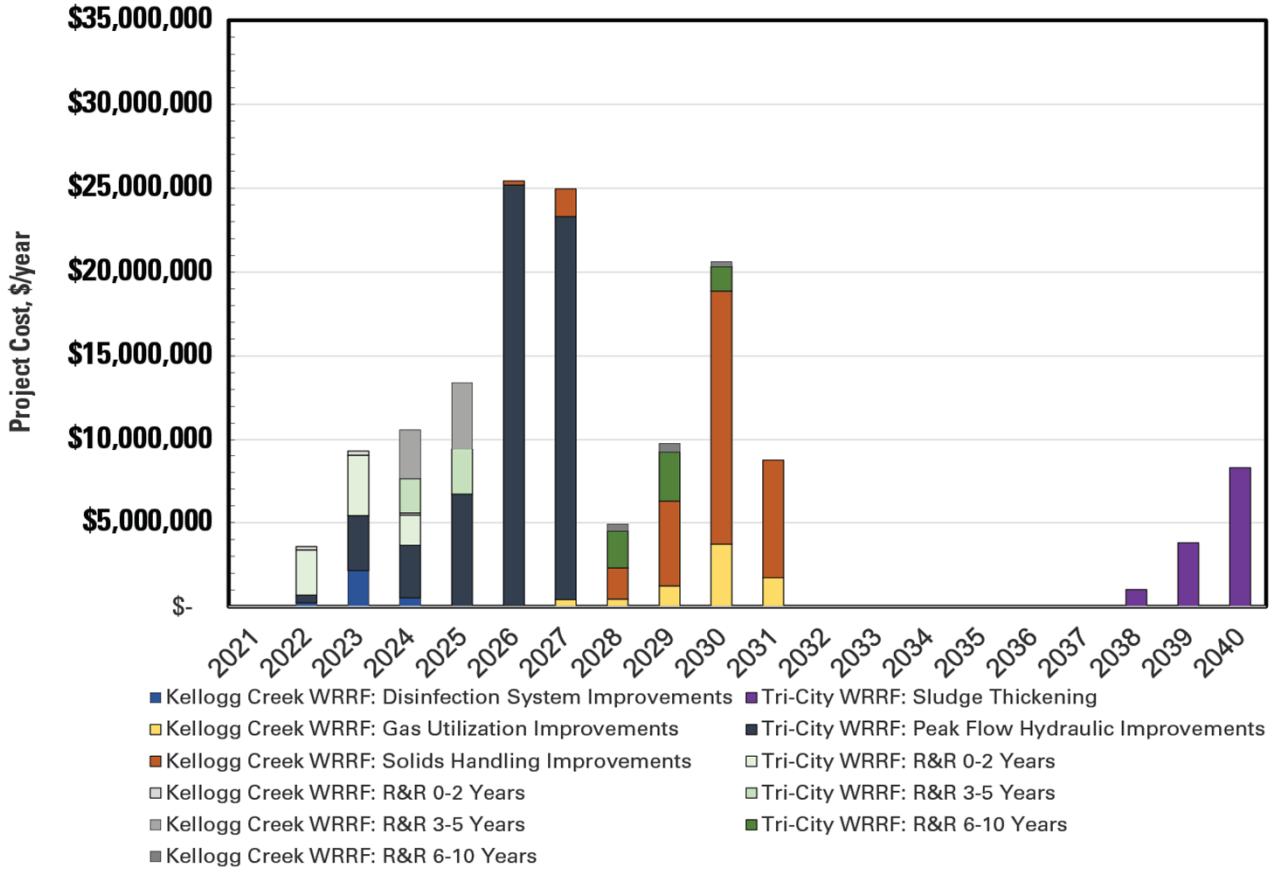
WRF Capital Plan Proposed Cash Expenditure Schedule



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