

BOARD OF COMMISSIONERS - AGENDA MEMORANDUM

Subject: Interim Improvements
Refined Scope Report

Date: June 1, 2021

Staff Contact: Jay Regenstreif

Project: c21005

Approved by:

Department Manager

Finance Manager

General Manager

JA

INTRODUCTION:

On March 29, 2021, the Board approve the Scope of Work for engineering services to address the sewer capacity issues in the North Sewer Service Area sewer system. A Workshop to discuss portions of the Refined Scope Report was held with the Board on April 19, 2021. Today's meeting is providing the Board with the completed Refined Scope Report.

POLICY:

8/10/2015	Res No. 4518: Sammamish Plateau Wastewater 2013 Comprehensive Plan
9/2016	North Diversion Interim Improvement Evaluation by Gray & Osborne
1/2021	North Diversion Phase 1 Analysis
2/22/2021	Res. 5018: Declaring a 90-day Moratorium on the issuance of Certificates of Sewer Availability and approval of new sewer service connections in the North Sewer Service Area.
3/1/2021	Res. 5019: Declaring an emergency and waiving solicitation requirements relating to retention of Engineering Services to design improvements to address sewer capacity issues.
3/29/2021	Board approved Scope of Work for Interim Improvements Engineering Design Contract
4/19/2021	Board Refined Scope Workshop – Board approved limiting the permanent solutions identified in the North Diversion Phase 1 Analysis to Alternatives A-3 and A-6.

BACKGROUND:

The scope of work for the Interim Improvements Engineering Design Contract includes:

1. Refined Scope Report.
2. Identification of potential immediate temporary improvements to provide support for the system until improvements of a more permanent nature can be implemented.
3. Design of project elements of the 2021 Analysis options referred to as "Alternative I-4":
 - Central Lake Force Main (Alternative I-4 Phase 1)
 - North Lake Lift Station (Alternative I-4 Phase 1, including Storage elements of Alternative I-2)
 - North Lake Force Main (Alternative I-4 Phase 2)

The Refined Scope Report includes information to support design of the Interim Improvements and management of the moratorium status:

- 1) **Flow per Connection:** Defining a flow rate per customer. This flow rate, defined as a Residential Customer Equivalent (RCE) can be translated to number of ERUs that are available for adding new customers. Capacity metrics for the Interim Improvements, to provide a roadmap for moving through adding capacity to the system, and monitoring when added capacity will be depleted.

- 2) **Alignment of Interim Improvements with Permanent Alternatives.** Determine and illustrate how proposed Interim improvements, specifically Project I-4, align and complement the permanent improvements identified in the Analysis.
This alignment section was presented to the Board as part of the Workshop on April 19, 2021.
- 3) **System Limitations:** Providing a roadmap for moving through adding capacity to the system, and monitoring when added capacity will be depleted, and additional improvements will be required.
- 4) **King County Standards:** Impact of using King County standards instead of District standards.

District staff will be providing a presentation at the Board meeting.

BUDGET STATUS:

Interim Improvements Design Contract Budget Total
\$630,000 Estimate: Time & Materials, not to exceed

Align Interim/Long Term Sewer Report (c21005.30000.0875.3020)

Gray & Osborn Estimate:	\$ 42,520.00
Through 4/24/2021	\$ 2,805.32
Remaining	\$ 39,714.68

FISCAL IMPACT:

The cost of the project will be funded by Sewer General Facility Charges and/or rates.

OPTIONS:

No options. This meeting is to present the Refined Scope Report, which supports the design of the Interim Improvements and use of metrics to determine available capacity provided by the interim improvements, once installed.

STAFF RECOMMENDATIONS: NA

ATTACHMENTS:

- Refined Scope Report

SAMMAMISH PLATEAU WATER & SEWER DISTRICT

KING COUNTY

WASHINGTON



NORTH SEWER SERVICE AREA REFINED SCOPE REPORT

**G&O #21495
JUNE 2021**



Gray & Osborne, Inc.
CONSULTING ENGINEERS

SAMMAMISH PLATEAU WATER & SEWER DISTRICT

KING COUNTY

WASHINGTON



NORTH SEWER SERVICE AREA REFINED SCOPE REPORT



G&O #19582.00

JUNE 2021



Gray & Osborne, Inc.
CONSULTING ENGINEERS

TABLE OF CONTENTS

INTRODUCTION AND PURPOSE	1
BACKGROUND	2
FLOW PER CONNECTION	4
Domestic Flow.....	4
Infiltration and Inflow	5
Total Flow.....	6
ALIGNMENT OF INTERIM PROJECT I-4 WITH PERMANENT SOLUTIONS	7
SYSTEM LIMITATIONS.....	9
Interim Project I-4	10
Project I-4 Phase 1A – North Lake Lift Station.....	10
Project I-4 Phase 1B – Central Lake Lift Station Force Main.....	10
Project I-4 Phase 2 – Central Lake Sammamish Gravity Basin.....	10
Project I-4 Phase 3 – North Lake Sammamish Gravity Basin.....	11
Additional Capacity Improvements	12
Permanent Solution A-3 – Additional Lakefront Improvements.....	12
Permanent Solution A-6 or King County SPD Phase 1	12
Permanent Solution A-3 – Bypass Central Lake Gravity Main.....	12
A-3A – North Lake Sammamish Lift Station Force Main.....	12
A-3B – Central Lake Sammamish Force Main	13
A-3C – North Lake Sammamish Gravity Improvements	13
Permanent Solution A-6 – Inglewood Lift Station Bypass to Control Structure	13
Permanent Solution SPD Phase 1	14
System Limitations Summary.....	14
KING COUNTY STANDARDS.....	17
King County Standards Facility Sizing Impacts.....	19
CONCLUSIONS	21

LIST OF TABLES

<u>No.</u>	<u>Table</u>	<u>Page</u>
1	Domestic Flow per Single Family ERU (SF ERU)	5
2	Existing I/I Flow per SF ERU	6
3	Flow per SF ERU Summary	7
4	Interim Improvement Project I-4 Summary	12
5	Permanent Solution A-3 Bottlenecks and Improvements	15
6	Permanent Solution A-6 Bottlenecks and Improvements	16
7	SPD Phase 1 Bottlenecks and Improvements	16
8	Capacity Improvements Cost per ERU Summary	17
9	King County and District Sewer Design Flow Standards Comparison	18
10	Lift Station Basin Maximum Flows	19
11	Lift Station Required Capacity Comparison	20
12	Lift Station Required Capacity Comparison	21

LIST OF FIGURES

<u>No.</u>	<u>Figure</u>	<u>On or After Page</u>
1	North Sewer Service Area	2
2	2021 Analysis Permanent and Interim Alternatives	4
3	2021 Analysis Decision Matrix and Project I-4	8
4	2021 Analysis Decision Matrix and Project I-4 – Permanent Solutions A-3 and A-6	9
5	NSSA Comparison of Flows – King County versus District Standard Assumptions	18

INTRODUCTION AND PURPOSE

The North Basin Refined Scope Report (Report) continues the work begun with the Sammamish Plateau Water (the District) 2013 Wastewater Comprehensive Plan and continued with the North Diversion Interim Improvements Evaluation and the North Diversion Phase One Analysis. The North Diversion Phase One Analysis (Analysis) was completed in early 2021. The Analysis determined that the existing system downstream of the Inglewood Lift Station, which includes the North Lake Sammamish Lift Station and the Central Lake Sammamish Lift Station, is at capacity. The Analysis also identified a number of projects that would allow the District to continue to provide service for the North Sewer Service Area (NSSA) in the event that the King County Sammamish Plateau Diversion (SPD) project (previously referred to as the North Diversion) cannot be constructed prior to the completion of Phase 1 of the SPD project. The NSSA includes the Northeast Plateau, Beaver Dam, Inglewood East, Tiburon, North Lake Sammamish, and Central Lake Sammamish sewer basins. The NSSA is shown in Figure 1.

In February 2021, the District declared a moratorium for new service connections in the NSSA until such time that improvements can be in place to meet increased growth. The moratorium was predicated by a heavy rain event in January 13, 2021 that reinforced the findings in the Analysis that the existing systems was at capacity. On March 1, 2021, the District declared an emergency and authorized staff to contract with Gray & Osborne to design interim improvements Project I-4 as identified in the Analysis, and to prepare the Refined Scope Report.

The Refined Scope Report (Report) will perform several functions, all providing support to the interim improvement projects and basis of decisions on the current moratorium:

1. **FLOW PER CONNECTION.** Define a flow rate per single family equivalent residential unit (SF ERU). This flow rate can be translated to a number of connections that can be considered for release from the moratorium after completion of capacity improvements like Project I-4. This flow rate per SF ERU can also be used to inform decisions on reinstatement of the moratorium if growth has increased beyond the capacity of constructed improvements.
2. **ALIGNMENT OF INTERIM PROJECT I-4 WITH PERMANENT SOLUTIONS.** Determine and illustrate how proposed improvements, such as Phases One and Two of Project I-4 align and complement the permanent improvements identified in the Analysis. The District has identified Alternatives A-3 and A-6 as preferred alternatives for the permanent solution.

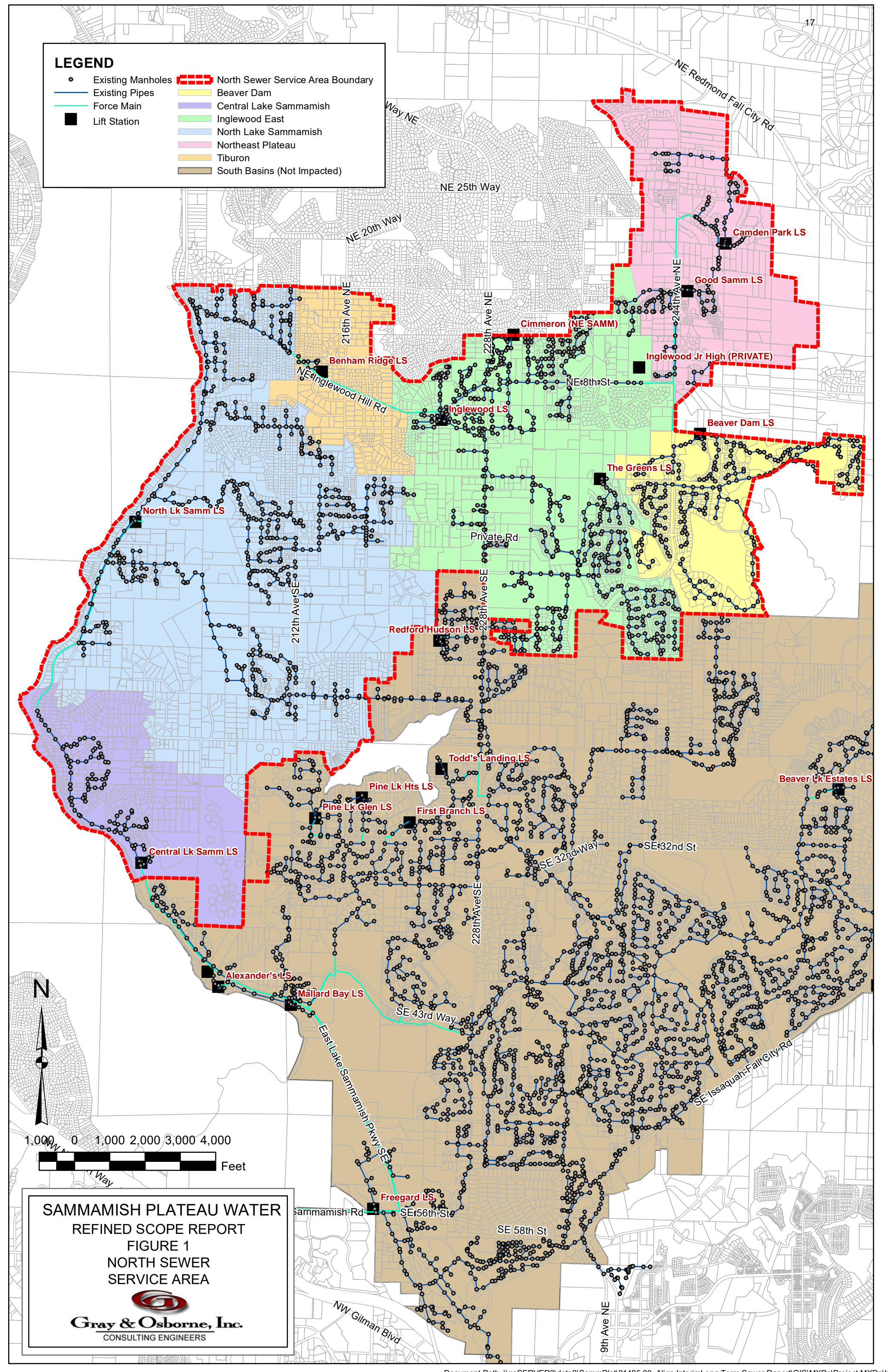
3. **SYSTEM LIMITATIONS.** Identify system limitations, future “bottlenecks” and capacity improvements needed to stay ahead of growth in the service area.
4. **KING COUNTY STANDARDS.** Determine the sizing and cost impacts associated with designing improvements to King County standards.

BACKGROUND

In 2011, Gray & Osborne contracted with the District for the update of its Wastewater Comprehensive Plan/General Sewer Plan (“2013 Plan”), which was completed and approved in 2014. This work defined existing and projected future sewer flows for the District, including domestic flows and infiltration and inflow (I/I) flows. The 2013 Plan also put a significant amount of effort into identifying improvements required for basins in the northern portion of the District, specifically the basins flowing to the Inglewood, North Lake Sammamish, and Central Lake Sammamish Lift Stations. These basins currently flow to the South East Lake Sammamish Interceptor on an interim basis until the King County Wastewater Treatment Division (KCWTD) constructs the North Diversion (also known as the Sammamish Plateau Diversion Phase 1 (“SPD 1”), which is how the system along the East Lake Sammamish Parkway was ultimately designed to be served. The 2013 Plan included identification of triggers that would indicate the system was nearing capacity. According to the assumptions presented in the 2013 Plan, the North Diversion would have been required to be in service by 2018 or else the District risked capacity problems downstream of the Inglewood Lift Station. After the 2013 Plan was published, KCWTD notified the District that the earliest the North Diversion could be in service is approximately 2025.

In 2015, the District again contracted with Gray & Osborne to update the planning growth projections, verify domestic flow values, update I/I flow rates, and identify interim improvements the District could construct at its Inglewood, North Lake Sammamish, and Central Lake Sammamish Lift Stations that would maintain service until the North Diversion could be constructed. The goal was to provide small, incremental improvements rather than larger, more expensive projects that would be stranded investments once the King County project was completed. This project produced a report titled the “North Diversion Interim Improvements Evaluation” (2016 Evaluation).

In 2017, King County adopted the Conveyance System Improvement (CSI) program for the next 10 years. The update indicated that a project identified as the SPD would be delayed indefinitely and that the District should proceed with whatever improvements are needed to continue sending flows south for the foreseeable future. King County also indicated that it would consider contributing financially to District projects that



would otherwise have been stranded investments, since the County benefits financially by delaying construction of the North Diversion. This new phased approach proposed by King County defers the costs of the SPD, but it is a completely new approach and a departure from planning that the District has relied upon for decades.

This change of course by King County dramatically impacted the conclusions of the previous planning efforts. In order to account for these changes in assumptions, the District and King County commissioned the North Diversion Phase One Analysis (2021 Analysis) to identify options for both long-term service to the south, as well as interim projects intended ensure the system continues to function until the long-term improvements can be constructed. The 2021 Analysis identified six permanent solution options as well as a number of interim improvements. Figure 2 illustrates the scope and extents of these alternatives. The 2021 Analysis, finalized in January 2021, recommended initiating design and construction of Interim Projects I-2 and I-4 as soon as possible. Project I-2 consist of the construction of additional wastewater storage at the North Lake Lift Station and the Central Lake Lift Station to provide peak hour flow and emergency overflow storage in the event that flows exceed the lift station capacity. Project I-4 consists of three phases of construction: replacement of 1,000 LF of 8-inch Central Lake Lift Station force main with 16-inch force main (I-4 Phase 1), increasing the capacity of the North Lake Lift Station to 1,750 gpm (I-4 Phase 1), extension of the North Lake Lift Station force main with approximately 5,600 LF of 16-inch force main to increase the capacity of the lift station to 2,000 gpm (I-4, Phase 2), and increasing the capacity of the gravity system downstream of the Inglewood Lift Station force main discharge to prevent surcharging (I-4 Phase 3).

On February 22, 2021, the District declared a temporary moratorium on issuance of new Certificates of Sewer Availability and for new service connections in the NSSA until such time that improvements can be in place to meet increased growth. The moratorium was predicated by a heavy rain event in January 2021 that reinforced the findings in the 2021 Analysis that the existing system was at capacity, and at least one trigger identified in the 2013 Plan had been exceeded. On March 1, 2021, the District declared an emergency and authorized staff to contract with Gray & Osborne to design interim improvements Project I-4 Phases 1 and 2 as identified in the 2021 Analysis, to prepare the Refined Scope Report, and to identify immediate temporary improvements to reduce the chance of overflows until Project I-4 can be constructed and in service. The temporary moratorium was extended on May 24, 2021 until August 23, 2021, by which time consideration of the proposed immediate temporary improvements to the existing system can be considered for their potential to provide additional capacity in the system.

FLOW PER CONNECTION

Establishing a standard gallon per minute per SF ERU flow rate will provide a method to determine how many additional connections can be allowed upon completion of elements of Project I-4 and other improvements, until such time that a District identified Permanent Solution is completed or King County completes the SPD Phase 1. SF ERU flows are split into two components: domestic flow, or flows produced by the customer and discharged to the sewer system, and infiltration and inflow (I/I), which consists of stormwater and groundwater that enters into the sewer system.

DOMESTIC FLOW

The 2013 Plan identified an average daily flow of 155 gpd per residential customer equivalent (SF ERU), which represents the flow from an average single-family residence, and is the sewer version of an ERU. This flow was established based on meter readings for winter months. The meter infrastructure in the District for the 2013 Plan was limited to bimonthly reading covering a 2-month period. In 2019 the District implemented an Advanced Metering Infrastructure (AMI) system that allows for instantaneous reading of customer meters. This allows the District to review domestic flows on a daily and monthly basis, and specific domestic flows during peak storm events. Review of information for the District's Draft Wastewater Comprehensive Plan Update (Draft Plan), currently being developed, shows that the SF ERU flow rate has been steadily decreasing over time. AMI data for November 2019 through January 2020 indicates an SF ERU value of 129 gpd, or 0.09 gpm/SF ERU.

AMI information has also been used to develop a diurnal curve for each sewer basin. The diurnal curve establishes a domestic peaking factor that is applied in the District's hydraulic model and to establish the peak hourly domestic flow. The average peaking factor in the NSSA is 1.47.

Domestic flow has been trending down consistently over the past decades, due to a number of factors including low flow plumbing fixtures and appliances required as part of new construction and general conservation efforts. This decline was seen during development of both the 2013 Plan and the current update. For this reason, the peak domestic flow of 0.13 gpm/SF ERU, based on 2020 data has been selected for use.

Table 1 provides a summary of the domestic flow criteria developed for the updated Draft Plan.

LEGEND

- Existing Manholes

—

 Existing Pipes

Gravity Main Improvements

Force Main Improvements

Force Main

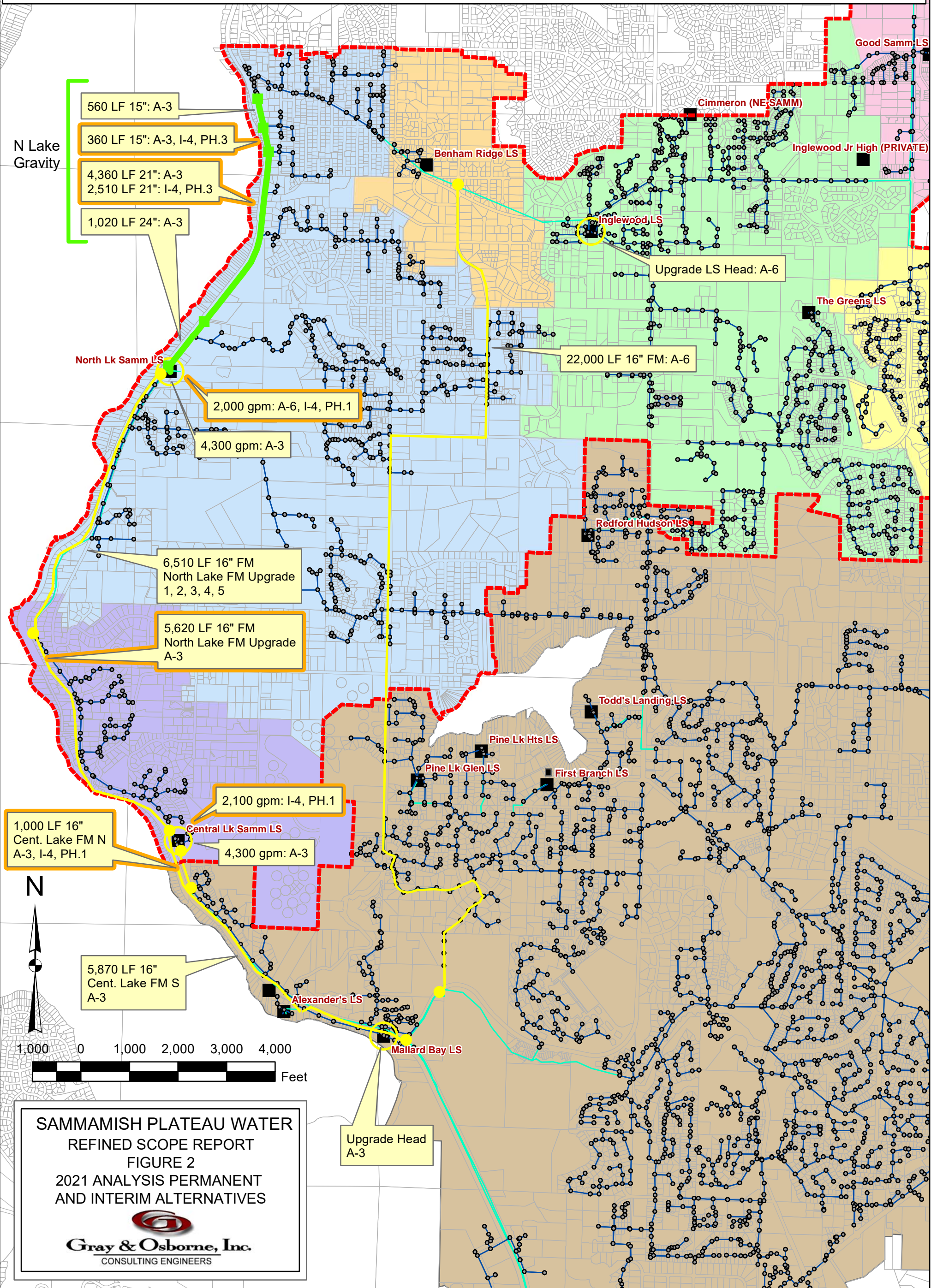
Lift Station

Lift Station Improvements
- North Sewer Service Area Boundary
- Beaver Dam
- Central Lake Sammamish
- Inglewood East
- North Lake Sammamish
- Northeast Plateau
- Tiburon
- South Basins (Not Impacted)

Permanent Solution

Project I-4 Improvement

SUMMARY OF IMPROVEMENTS
REQUIRED FOR ALTERNATIVES



SAMMAMISH PLATEAU WATER
REFINED SCOPE REPORT
FIGURE 2
2021 ANALYSIS PERMANENT
AND INTERIM ALTERNATIVES



TABLE 1**Domestic Flow per Single Family ERU (SF ERU)**

Basin	2020 SF ERU	Average Daily Flow		Domestic Peaking Factor	Peak Domestic Flow	
		ADF (gpd)	ADF (gpm)		PDF (gpd)	PDF (gpm)
Beaver Dam	780	100,620	70	1.45	145,899	101
Central Lake Sammamish	279	35,991	25	1.51	54,346	38
Inglewood East	2,154	277,866	193	1.47	408,463	284
North Lake Sammamish	1,295.5	167,120	116	1.47	245,666	171
Northeast Plateau	500	64,500	45	1.53	98,685	69
Tiburon	52	6,708	5	1.46	9,794	7
Total	5,061	652,869	453	1.47	959,717	666
Flow/SF ERU		129 gpd/ERU	0.09 gpm/ERU		190 gpd/ERU	0.13 gpm/ERU

INFILTRATION AND INFLOW

For evaluation of I/I for these basins, storm events from December 18 to 20, 2019 and January 11 to 13, 2021 have been analyzed to establish existing peak I/I rates. Both storms resulted in flows that exceeded the flow trigger identified for the North Lake Lift Station and required the manual operation of three pumps at the North Lake Lift Station. The highest flows generated for each sewer basin were not all from the same storm. For this reason, peak I/I has been established using the larger of the two events for each basin.

To establish the peak gpm/SF ERU for the I/I component, comparisons to the existing I/I flows for the NSSA has been compared with the established peak I/I rates for the maximum zoning capacity, as established for the Draft Plan. The ultimate peak I/I rates are 1,100 gallons per acre per day (gpad) or the measured peak rate, whichever is greater. Table 2 presents the existing I/I gpm/SF ERU calculation.

TABLE 2**Existing I/I Flow per SF ERU**

Dry Weather I/I ⁽¹⁾					
Basin	2020 SF ERU	Existing Basin Area (acre)	Existing I/I Flow (gpd)	Existing I/I Flow (gpm)	Existing I/I Rate (gpad)
Beaver Dam	780	393	4,078	3	10
Central Lake Sammamish	279	143	0	0	0
Inglewood East	2,154	772	55,051	38	71
North Lake Sammamish	1,295.5	779	36,519	25	47
Northeast Plateau ⁽²⁾	500	120	5,884	4	49
Tiburon	52	15	0	0	0
Total	5,061	2,222 acres	101,533 gpd	71 gpm	46 gpad
Flow per SF ERU (gpm)		0.01 gpm/SF ERU			
Wet Weather I/I – Peak I/I Flows					
Basin	2020 SF ERU	Existing Basin Area (acre)	Existing I/I Flow (gpd)	Existing I/I Flow (gpm)	Existing I/I Rate (gpad)
Beaver Dam	780	393	175,305	104	381
Central Lake Sammamish	279	143	65,300	133	1,343
Inglewood East	2,154	772	490,789	561	1,047
North Lake Sammamish	1,295.5	779	295,180	244	450
Northeast Plateau	500	120	118,575	92	1,102
Tiburon	52	15	11,768	12	1,106
Total	5,061	2,222 acres	1,156,916 gpd	1,146 gpm	521 gpad
Flow per SF ERU (gpm)		0.23 gpm/SF ERU			

(1) Dry weather I/I rates calculated as negative are shown as 0 gpm and 0 gpad.

(2) Values provided are for Camden Park Lift Station.

TOTAL FLOW

Since the purpose of developing a flow per SF ERU is to establish triggers for consideration of when to lift and when to reinstitute the moratorium, it is appropriate to use existing SF ERU values and existing I/I rates to determine those triggers. The proposed interim capacity improvements should be completed in the next two years. Also, the District has indicated that it will be attempting to reduce or at least maintain current I/I levels through additional I/I reduction efforts. For these reasons we are recommending establishment of a flow rate of 0.36 gpm/SF ERU peak wet weather flow for the purposes of this Report. This compares to a dry weather flow rate of 0.14 gpm/SF ERU. The District may elect to refine and redefine this value over time as more information becomes available. Table 3 provides a summary of domestic and I/I flow per SF ERU from Tables 1 and 2.

TABLE 3**Flow per SF ERU Summary**

Criteria	Peak Domestic Flow	Existing I/I Flow	Total
Dry Weather Flow per SF ERU	0.13 gpm	0.01 gpm	0.14 gpm/SF ERU
Wet Weather Flow per SF ERU	0.13 gpm	0.23 gpm	0.36 gpm/SF ERU

ALIGNMENT OF INTERIM PROJECT I-4 WITH PERMANENT SOLUTIONS

The 2021 Analysis identified six potential projects that could be constructed to address build out flows in the NSSA. These alternatives were identified as permanent solutions. The 2021 Analysis also identified a number of interim improvements, smaller projects to allow additional sewer connections within the NSSA. The District has elected to begin design and construction of Interim Project I-4 as identified in the 2021 Analysis. Figure 3 provides a matrix that illustrates the compatibility of each of the permanent solutions (A-1 through A-6) with Interim Project I-4.

A Workshop held with the Board on May 7, 2021, included a discussion of how the six permanent solutions aligned with Interim Project I-4. This information was presented in a matrix, and based on the associated discussion, the District has elected to focus on the evaluation of Permanent Solutions A-3 and A-6 as permanent solutions. Alternative A-6 is the District's preferred permanent solution. Figure 4 provides the matrix with a focus on Permanent Solutions A-3 and A-6.

	A-1	A-2	A-3	A-4	A-5	A-6
Permanent Alternative Segment						
Interim I-4 Segment Used						
Interim I-4 Segment Not Used						
Inglewood Lift Station Pump imp for increased head						
Plateau Force Main 22,000 LF 16-inch						
Inglewood Force Main 10,000 LF 16-inch						
North Lake Gravity Mains 560 LF 15-inch 360 LF 18-inch 2,510 LF 21-inch 1,850 LF 21-inch 1,020 LF 24-inch						
	I-4 Phase 3	I-4 Phase 3	I-4 Phase 3	I-4 Phase 3	I-4 Phase 3	I-4 Phase 3
	I-4 Phase 3	I-4 Phase 3	I-4 Phase 3	I-4 Phase 3	I-4 Phase 3	I-4 Phase 3
North Lake Lift Station Upgrade to 2,800 gpm Upgrade to 4,300 gpm	I-4 Ph 1 2,000 gpm	I-4 Ph 1 2,000 gpm	I-4 Ph 1 2,000 gpm	I-4 Ph 1 2,000 gpm	I-4 Ph 1 2,000 gpm	I-4 Ph 1 2,000 gpm
North Lake Force Main 6,510 LF 16-inch 5,620 LF 16-inch						
	I-4 Phase 2	I-4 Phase 2	I-4 Phase 2	I-4 Phase 2	I-4 Phase 2	I-4 Phase 2
Central Lake Gravity 1,900 LF 18-inch 3,820 LF 21-inch						Not if use Force Main
Central Lake Lift Station Upgrade to 2,800 gpm Upgrade to 4,300 gpm						
Central Lake Force Main 1,000 LF 16-inch 5,870 LF 16-inch	I-4 Phase 1	I-4 Phase 1	I-4 Phase 1	I-4 Phase 1	I-4 Phase 1	I-4 Phase 1

FIGURE 3

2021 Analysis Decision Matrix and Project I-4

	A-3	A-6
Permanent Alternative Segment		
Interim I-4 Segment Used	Bypass Central Lake Gravity Main	Bypass East Lake Sammamish System
Interim I-4 Segment Not Used		
Inglewood Lift Station Pump imp for increased head		
Plateau Force Main 22,000 LF 16-inch		
Inglewood Force Main 10,000 LF 16-inch		
North Lake Gravity Mains 560 LF 15-inch 360 LF 18-inch 2,510 LF 21-inch 1,850 LF 21-inch 1,020 LF 24-inch		
	I-4 Phase 3	I-4 Phase 3
	I-4 Phase 3	I-4 Phase 3
North Lake Lift Station Upgrade to 2,800 gpm Upgrade to 4,300 gpm	I-4 Ph 1 2,000 gpm	I-4 Ph 1 2,000 gpm
North Lake Force Main 6,510 LF 16-inch 5,620 LF 16-inch		
	I-4 Phase 2	I-4 Phase 2
Central Lake Gravity 1,900 LF 18-inch 3,820 LF 21-inch		Not if use Force Main
Central Lake Lift Station Upgrade to 2,800 gpm Upgrade to 4,300 gpm		
Central Lake Force Main 1,000 LF 16-inch 5,870 LF 16-inch	I-4 Phase 1	I-4 Phase 1

FIGURE 4

2021 Analysis Decision Matrix and Project I-4 – Permanent Solutions A-3 and A-6

SYSTEM LIMITATIONS

The District has a number of limitations in its existing collection system along East Lake Sammamish Parkway, downstream of the Inglewood Lift Station force main discharge. The following sections list the existing system limitations along East Lake Sammamish Parkway in the priority of their capacity limitation. The initial sections align with the projects identified in the 2021 Analysis, and additional areas are added based on hydraulic model results developed with the current update to the Draft Plan.

Construction of Permanent Solutions A-3, A-6 or the King County SPD Phase 1 eliminates a number of these future limitations by diverting flows from Inglewood Lift Station away from the East Lake Sammamish Parkway sewer system.

INTERIM PROJECT I-4

Project I-4 Phase 1A – North Lake Lift Station

North Lake Lift Station has a rated capacity of 1,150 gpm and currently pumps flows from pumped from the Inglewood Lift Station, the Tiburon Basin and added by the North Lake Sammamish Basin, south to the Central Lake Lift Station. The lift station is a three-pump station and can pump 1,250 gpm if all three pumps are forced on in manual mode. During heavy rain events, the station cannot keep up with the increased flows from Inglewood Lift Station and I/I levels in the North Lake Sammamish basin. Phase 1 of Project I-4 will increase the rated capacity of this lift station to 1,750 gpm.

This increased capacity of North Lake Lift Station will be required for zoning capacity flows from the North Lake Sammamish Basin, although the timing of construction could be significantly delayed. This is the case regardless of the construction of Permanent Solution A-6 or the King County SPD.

Project I-4 Phase 1B – Central Lake Lift Station Force Main

Central Lake Lift Station currently has a rated capacity of 1,500 gpm. Pumping capacity is currently limited by approximately 1,000 LF of 8-inch force main downstream of the lift station. Phase 1 of Project I-4 will replace the 1,000 LF with 1,000 LF of 16-inch force main. This will increase the capacity of the existing pump to 2,100 gpm; sufficient to handle increased pumping from the North Lake Lift Station.

The Central Lake force main improvements and the North Lake Lift Station capacity improvements are both essential parts of Phase 1 of Project I-4. Although the timing of construction could be delayed, increased capacity of Central Lake Lift Station will be required regardless of the construction of Permanent Solution A-6 or the King County SPD.

Completion of Project I-4 Phases 1A and 1B will result in improved system capacity.

Project I-4 Phase 1: Capacity improvement = 500 gpm
Currently overcapacity by 200 gpm
Net capacity gain = 300 gpm, Additional SF ERU = 833

Project I-4 Phase 2 – Central Lake Sammamish Gravity Basin

Hydraulic modeling of the Central Lake Sammamish collection system indicates that the collection can only convey 1,750 gpm without significant surcharging. Once Phase 1 of Project I-4 is complete, the Central Lake Sammamish gravity collection system is the

next system limitation. Phase 2 of Project I-4 consists of approximately 5,600 LF of 16-inch force main that will serve to pump flows from North Lake Lift Station around this limited gravity system. This force main will allow the District to increase the capacity of the North Lake Lift Station by 250 gpm to 2,000 gpm.

Although the timing of construction could be delayed, increased capacity of North Lake Lift Station will be required regardless of the construction of Permanent Solution A-6 or the King County SPD.

Completion of Project I-4 Phase 2 will result in improved system capacity.

Project I-4 Phase 2: Capacity improvement = 250 gpm
Additional SF ERU = 694

Project I-4 Phase 3 – North Lake Sammamish Gravity Basin

Hydraulic modeling of the North Lake Sammamish collection system indicates that surcharging occurs in the collection system downstream of the Inglewood Lift Station. To date, the District does not have any evidence, either anecdotal or physical, that surcharging does occur in the field to corroborate the hydraulic model. In April 2021, the District installed a level sensor and flow monitor in the system to determine if surcharging does occur, and if it does, the extent of the surcharging.

Phase 3 of Project I-4 identifies replacement of approximately 2,900 LF of gravity main with 18- to 24-inch gravity sewers. Although this project does improve the available capacity of the gravity system a minimum of 700 gpm, it is not clear at this time whether or not this improvement would allow for additional SF ERU. The requirement for, timing of and potential added system capacity will be considered further when data regarding the surcharging has been gathered and further evaluated.

Project I-4 Phase 3 may be avoided if the District constructs Permanent Solution A-6, which pumps Inglewood Lift Station flows directly to the Control Structure and bypasses the East Lake Sammamish Parkway collection system altogether. Construction of the King County SPD would also allow elimination of this project.

Completion of Project I-4 Phase 3 will result in improved gravity system capacity, but may not provide for additional overall system capacity.

Project I-4 Phase 3: Capacity improvement = 700 gpm
Additional SF ERU = Unknown

TABLE 4**Interim Improvement Project I-4 Summary**

Project	Project Cost ⁽¹⁾	ERUs	\$/ERU
Interim Improvements I-4			
Phase 1: Upgrade North Lake Lift Station and Central Lake Force Main	\$3,017,000	833	\$3,622
Phase 2: Central Lake Gravity - Bypass	\$5,142,000	694	\$7,409
Funded Interim Improvements I-4 Total	\$8,159,000	1,527	\$5,343
Phase 3: North Lake Gravity	\$3,717,000	TBD	TBD
Interim Improvements I-4 Total	\$11,854,000	TBD	TBD

(1) Project Cost from North Diversion Phase 1 Analysis, January 2021.

ADDITIONAL CAPACITY IMPROVEMENTS

The following improvements would be used to continue to relieve bottlenecks and system limitations beyond Project I-4, as necessary due to bridge the gap between Interim Improvements and a permanent solution. The permanent solutions considered in the discussion include Alternative A-3, A-6 and SPD Phase 1.

Permanent Solution A-3 – Additional Lakefront Improvements

Projects A-3A, A-3B and A-3C would encompass the remaining components of Permanent Solution A-3. Permanent Solution A-3 would convey all of the flows from the Inglewood Lift Station through the lakefront system, at an estimated required flow rate of 4,300 gpm.

Permanent Solution A-6 or King County SPD Phase 1

If the permanent solution chosen is A-6 or King County SPD, the flows from the Inglewood Lift Station do not go through the lakefront system, and these additional lakefront improvements would be stranded investments.

PERMANENT SOLUTION A-3 – BYPASS CENTRAL LAKE GRAVITY MAIN**A-3A – North Lake Sammamish Lift Station Force Main**

The existing North Lake Lift Station force main has a diameter of 10 inches and a capacity of 2,000 gpm. Replacing approximately 6,500 LF with 16-inch force main will allow for increased capacity in the North Lake Lift Station, but will result in the next limitation in the downstream Central Lake Lift Station and Central Lake force main.

A-3B – Central Lake Sammamish Force Main

Accommodating flows greater than 2,000 gpm from the North Lake Lift Station will require replacement of approximately 5,900 LF of 12-inch force main downstream of Central Lake Lift Station with a 16-inch force main. This section is downstream of the 8-inch force main previously identified for replacement as part of Project I-4 Phase 1B.

A-3C – North Lake Sammamish Gravity Improvements

The final limitation is additional improvements to the gravity system between Inglewood Lift Station and the North Lake Sammamish Lift Station.

This is a continuation of improvements identified as part of Project I-4 Phase 3. This includes the installation of approximately 3,130 additional LF of gravity 15-inch, 21- and 24-inch gravity improvements between the Inglewood Lift Station force main discharge and the North Lake Lift Station.

The gravity system improvements would meet the maximum zoning capacity land use requirements and peak I/I rates as currently identified in the Draft Plan.

Permanent Solution A-3, Sections A, B, and C:

Capacity improvement = 2,300 gpm

Additional SF ERU = 6,389

Project Cost = \$31,623,000

Cost per ERU = \$4,950

PERMANENT SOLUTION A-6 – INGLEWOOD LIFT STATION BYPASS TO CONTROL STRUCTURE

This project redirects Inglewood Lift Station flows from the lakefront system. This includes installation of 22,000 feet of force main to carry the flows from the Inglewood Lift Station over the plateau to the Control Structure.

The project will also include improvements to the Inglewood Lift Station to increase horsepower, so the pumps can meet higher heads required to go over the higher elevations.

Permanent Solution A-6: Capacity improvement = 2,600 gpm

Additional SF ERU = 7,222

Project Cost = \$24,201,000

Cost per SF ERU = \$3,351

PERMANENT SOLUTION SPD PHASE 1

This is a King County proposed project, to carry flows from the Inglewood Force Main, north to the King County system in Redmond. The current schedule for SPD Phase 1 has installation by 2030. Completion of this project requires approval of full funding by King County Council, with this decision occurring at the end of 2022 or beginning of 2023.

Alternative SPD1: Capacity improvement = 2,600 gpm

Additional SF ERU = 7,222

Project Cost = \$107,527,000

Cost per SF ERU = \$14,889

SYSTEM LIMITATIONS SUMMARY

Tables 5, 6 and 7 provide a summary of the system limitations and potential SF ERUs associated with interim improvements and permanent improvements leading to each individual permanent solution. Table 8 provides a summary of the costs per SF ERU for all projects.

Table 5 provides a summary of the capacity limitations, their improvements and the potential SF ERU that could be allowed to develop upon completion of the project if Alternative A-3 is selected as the District's preferred solution.

TABLE 5**Permanent Solution A-3 Bottlenecks and Improvements**

Priority	Capacity Limitation	Improvement	Capacity Increase	SF ERU Added
1	North Lake Lift Station	Project I-4, Ph 1A: Upgrade North Lake Lift Station – 1,750 gpm	300 gpm (Net)	833
	Central Lake Lift Station	Project I-4, Ph. 1B: 1,000 LF of 16-inch Force Main		
2	Central Lake Gravity Basin	Project I-4, Ph. 2: 5,600 LF of 16-inch Force Main	250 gpm	694
3	North Lake Gravity Basin	Project I-4 Ph. 3: 2,900 LF of 18-inch to 24-inch Gravity Main	N/A	N/A
4	North Lake Lift Station Force Main	Project A-3A: 6,500 LF of 16-inch Force Main	2,300 gpm	6,389
	Central Lake Force Main	Project A-3B: 5,900 LF of 16-inch Force Main		
	North Lake Gravity Basin	Project A-3C: 6,000 LF of 18-inch, 21-inch and 24- inch Gravity		

Table 6 provides a summary of the capacity limitations, their improvements and the potential SF ERU that could be allowed to develop upon completion of the project if Alternative A-6 is selected as the District's preferred solution.

TABLE 6**Permanent Solution A-6 Bottlenecks and Improvements**

Priority	Capacity Limitation	Improvement	Capacity Increase	SF ERU Added
1	North Lake Lift Station	Project I-4, Ph 1A: Upgrade North Lake Lift Station – 1,750 gpm	300 gpm (Net)	833
	Central Lake Lift Station	Project I-4, Ph. 1B: 1,000 LF of 16-inch Force Main		
2	Central Lake Gravity Basin	Project I-4, Ph. 2: 5,600 LF of 16-inch Force Main	250 gpm	694
3	North Lake Gravity Basin	Project I-4 Ph. 3: 2,900 LF of 18-inch to 24-inch Gravity Main	N/A	N/A
4	North Lake Gravity Basin	Permanent Solution A-6: 22,000 LF of 18-inch Force Main	2,600 gpm	7,222
		Permanent Solution A-6: Increase Horsepower of Inglewood Lift Station		

Table 7 provides the same analysis assuming that King County constructs the SPD Phase 1.

TABLE 7**SPD Phase 1 Bottlenecks and Improvements**

Priority	Capacity Limitation	Improvement	Capacity Increase	SF ERU Added
1	North Lake Lift Station	Project I-4, Ph 1A: Upgrade North Lake Lift Station – 1,750 gpm	300 gpm (Net)	833
	Central Lake Lift Station	Project I-4, Ph. 1B: 1,000 LF of 16-inch Force Main		
2	Central Lake Gravity Basin	Project I-4, Ph. 2: 5,600 LF of 16-inch Force Main	250 gpm	694
3	North Lake Gravity Basin	Project I-4 Ph. 3: 2,900 LF of 18-inch to 24-inch Gravity Main	N/A	N/A
4	North Lake Gravity Basin	SPD Phase 1 (King County)	2,600 gpm	7,222

TABLE 8**Capacity Improvements Cost per ERU Summary**

Project	Project Cost ⁽¹⁾	ERUs	\$/ERU
Interim Improvements I-4			
Phase 1: Upgrade North Lake Lift Station and Central Lake Force Main	\$3,017,000	833	\$3,622
Phase 2: Central Lake Gravity - Bypass	\$5,142,000	694	\$7,409
Funded Interim Improvements I-4 Total	\$8,159,000	1,527	\$5,343
Phase 3: North Lake Gravity	\$3,717,000	TBD	TBD
Interim Improvements I-4 Total	\$11,854,000	TBD	TBD
Permanent Solutions			
Project A-3: Bypass Central Lake Gravity Main	\$31,623,000	6,389	\$4,950
Project A-6: Inglewood Lift Station Bypass to Control Structure	\$24,201,000	7,222	\$3,351
Sammamish Plateau Diversion Phase 1	\$107,527,000	7,222	\$14,889

(1) Project Cost from North Diversion Phase 1 Analysis, January 2021.

KING COUNTY STANDARDS

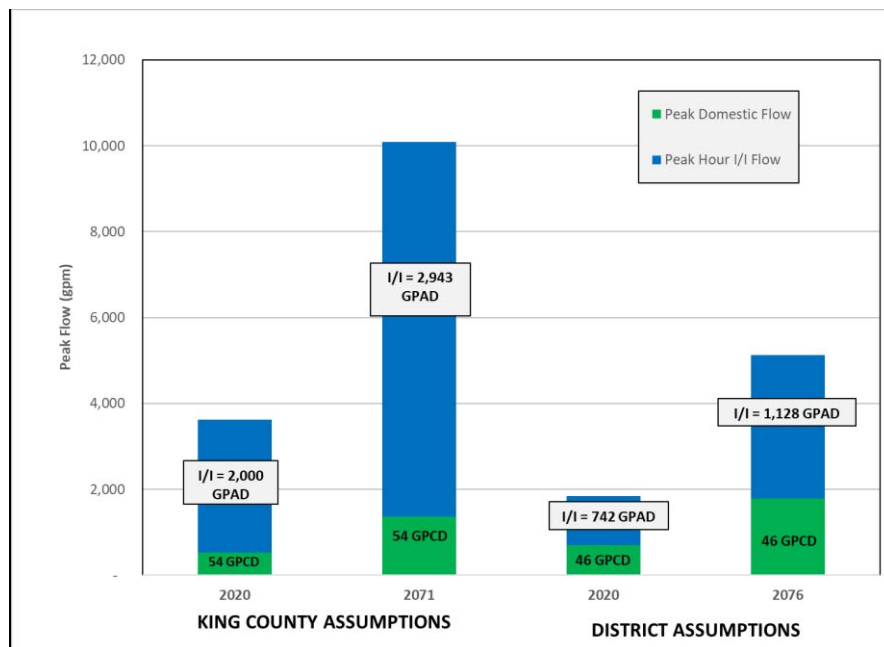
The District has been in discussions with King County for a number of years regarding the capacity limitations of the East Lake Sammamish Parkway sewer system and developing a plan that is compatible with King County's long-term vision for service to the NSSA, including the SPD. Discussions have included the concept that the District construct improvements that would ultimately be transferred to King County Wastewater Treatment Division for operation and maintenance. King County has indicated that this would only be possible if facilities were constructed to meet King County Standards.

The 2021 Analysis provided a comparison of the applicable design and planning standards for sewer flows used by King County and the District. Table 9 provides a summary of the key difference in standards that would impact sizing of facilities.

TABLE 9**King County and District Sewer Design Flow Standards Comparison**

King County	District
Planning Horizon	
50-years; 2071 for the purpose of this Report	Maximum Zoning Capacity, estimated to occur in 2076
SF ERU Definition	
54 gallons per capita per day * 2.8 persons per household = 151 gpd (0.11 gpm)	129 gpd (0.09 gpm)
Infiltration and Inflow	
Initial I/I – The 20-year peak flow based a 20-year storm and modeled antecedent conditions is used for existing sewers, and 2,000 gpad is applied to new construction.	Initial I/I – Based on measured I/I from storms on 12/18/19 through 12/20/19, 2019, and 1/11/21 through 1/13/21, whichever was greater for each basin.
I/I Degradation – 7% per decade degradation rate from existing levels	I/I Degradation – 1,100 gpad at the Maximum Zoning Capacity (build out), or Existing I/I levels with a 7% per decade degradation rate, whichever is greater.

The standard with the most impact on flows is the I/I assumptions. Figure 5 provides an illustration of the impacts of the different standards on District peak flows in the NSSA.

**FIGURE 5****NSSA Comparison of Flows – King County versus District Standard Assumptions**

As illustrated in Figure 5, peak flows in the NSSA would nearly double if King County standards are applied, and the majority of the difference in flow is attributed to the different standards for I/I flows. Table 10 summarizes the differences in peak flows to each of the critical lift station basins for King County and District standards. Basin flows identified are only flows from those basins directly contributing to the lift station and do not include contributing flows from other lift stations. The combined basin's total flow is provided in the last column.

TABLE 10

Lift Station Basin Maximum Flows

Standard	Required Peak Flows for Inglewood Lift Station Basins (gpm)⁽¹⁾	Required Peak Flows for North Lake Lift Station Basins (gpm)⁽²⁾	Required Peak Flows for Central Lake Lift Station Basin (gpm)	Total (gpm)
King County	5,004	4,357	1,073	10,434
District	3,010	2,100	759	5,869

(1) Inglewood Lift Station Basins include the Beaver Dam, Inglewood East, and the Northeast Plateau Basins.

(2) North Lake Lift Station Basins include the North Lake Sammamish Basin the Tiburon Basin.

As noted previously, applying King County standards to the proposed facilities effectively doubles the required design flows for the NSSA.

KING COUNTY STANDARDS FACILITY SIZING IMPACTS

The sizing impacts of King County Standards for the affected lift stations in the NSSA are shown in Table 11. For Alternative A-6 it is assumed that only the Inglewood Lift Station would be designed to King County standards, since the North and Central Lift Stations would remain as District facilities. Similarly, with regard to Alternative A-3, the Central Lake Lift Station is assumed to remain a District local facility and will not be subjected to King County standards for flows.

TABLE 11**Lift Station Required Capacity Comparison**

Lift Station	Inglewood	North Lake	Central Lake
Permanent Solution A-3			
District Standard Required Capacity	2,600 gpm	4,400 gpm	600 gpm
King County Standard Required Capacity	5,000 gpm	9,400 gpm	600 gpm
Permanent Solution A-6			
District Standard Required Capacity	2,600 gpm	2,100 gpm	2,200 gpm
King County Standard Required Capacity	6,000 gpm	2,100 gpm	2,200 gpm

Designing to King County standards also impacts the pipe sizing required. Typical standards for force main design is to provide a velocity somewhere between 2.5 and 8 feet per second (fps). Velocity below 2.5 fps is not high enough to scour the pipeline during normal pump runs and the force main will not self-clean, which can lead to solids depositing in the pipeline and reducing the effective diameter of the pipeline. If the velocity is higher than 8 fps, the head losses created due to friction limit the pumping capacity of the station and significantly more horsepower is required to provide the design flows.

Another element associated with designing to King County's standards is King County's desire to provide operational flexibility to pump either to Brightwater or to the South Treatment Plant in the future. This has been a stated desire for the County and is exemplified by the proposed SPD Phase 2 project included in the 2017 King County Conveyance System Improvements (CSI) report. SPD Phase 2 provided for a dual 30- and 12-inch pipelines that would allow flows from the District's Control Structure and the NSSA be directed either to the King County south conveyance system (as it flows now) or north through the SPD to King County's north system. With this in mind, pipelines constructed for either Alternative A-3 or A-6 would need to consider the flows from the Control Structure, in addition to flows from NSSA, with the understanding that flows from the Control Structure would need to be pumped to use the pipeline constructed as part of Alternative A-6.

Table 12 compares King County standards to District standards for the design parameters for the various force main alternatives.

TABLE 12**Lift Station Required Capacity Comparison**

Permanent Solution A-3				
	District Standards for Pipe Size	King County Standards for Pipe Size		
Design Parameter	District Flows to South	District Flows to South⁽¹⁾	King County Flows to South	King County Flows to North⁽²⁾
Required Capacity (gpm)	4,300	4,300	9,360	11,187
Diameter (inch)	16	30	30	30
Velocity (ft/s)	6.9	2.0	4.3	5.1
Permanent Solution A-6				
	District Standards for Pipe Size	King County Standards for Pipe Size		
Design Parameter	District Flows to South	District Flows to South⁽¹⁾	King County Flows to South	King County Flows to North⁽²⁾
Required Capacity (gpm)	2,600	2,600	5,000	11,187
Diameter (inch)	18	30	24	30
Velocity (ft/s)	3.3	1.2	3.3	5.1

(1) Pipeline designed to meet King County standards, but expected flows meet District standards.

(2) King County Flows to North are based on modeled peak flows to the Control Structure per the District's Draft Wastewater Comprehensive Plan.

A significant issue with designing facilities to meet King County flow standards is that while pipelines have significant anticipated life cycles (75 to 100 years), pumping facilities do not. Mechanical and electrical equipment typically only last 20 to 25 years before it is in need of replacement. Designing the force main to meet King County standards requires that the pump station be designed to meet minimum velocity requirements in the pipeline, which requires pumping equipment that is twice as large and will likely not see flows half its capacity for the life of the equipment. This is why King County facilities are often designed with parallel pipelines; one for existing flows and one for future growth, which again adds to the capital cost of facilities.

CONCLUSIONS

The following summarizes the conclusions of this report:

1. For the purposes of translating sewer system capacity to addition of single-family sewer connections, the peak wet-weather flow value of 0.36 gpm/SF ERU is recommended. The District should review and revise this value as more information becomes available.

2. The District should focus on the solutions A-3 and A-6 from the 2021 Analysis moving forward. The two alternatives are the most compatible with Interim Project I-4.
3. Completion of all three phases of Project I-4 allows for the construction of 1,527 SF ERU in the NSSA. If additional capacity beyond that provided by Project I-4 is needed before completion of a permanent solution, the added improvements would be stranded investments, unless the permanent solution chosen is Permanent Solution A-3.
4. Designing facilities to King County standards will significantly increase the required sizes of the constructed facilities. Larger facilities will result in higher capital costs, and due to issues with oversized pumps and force mains, may also result in operational issues until higher flows are reached. District standards for flows will be utilized for Interim Improvement I-4 projects.