- CSI PROJECT -

NORTHWEST LAKE WASHINGTON BASIN

PHASE 3 SUBREGIONAL PLANNING REPORT

October 2003

King County

Department of
Natural Resources and Parks
Wastewater Treatment Division

KING COUNTY CONVEYANCE SYSTEM IMPROVEMENT PROJECT

NORTHWEST LAKE WASHINGTON SUBREGIONAL PLANNING AREA

FINAL TASK 310 REPORT

OCTOBER 2003

HDR

In Association with

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KING COUNTY CONVEYANCE SYSTEM IMPROVEMENT PROJECT

TASK 310 REPORT

NORTHWEST LAKE WASHINGTON BASIN DETAILED PLANNING FOR SPECIFIC CSI PROJECTS

October 2003

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EXECUTIVE SUMMARY

King County's Conveyance System Improvement (CSI) project evaluates the regional wastewater conveyance system infrastructure, forecasting future demands and planning wastewater service improvements. The NW Lake Washington basin was identified as having suspected capacity problems in the basin prioritization phase of the CSI project, as summarized in the *Task 140 – Prioritization of Subregional Planning Areas* report. The straightforward planning needs and small number of conveyance facilities in the area allowed the project team to present one streamlined report for the NW Lake Washington basin, instead of separate background reports (Task 210, 220, 230) and alternatives development reports (Task 240, 250).

PLANNING BASIN BACKGROUND

The Northwest Lake Washington planning basin is located in northeast Seattle and eastern Shoreline, to the north and west of the Matthews Park Pump Station. This basin has been largely developed for several decades and has an aging wastewater infrastructure. King County's North Lake City Trunk, West Lake City Trunk and Thornton Creek Interceptor collect wastewater from the Ronald Sewer District and the City of Seattle, conveying flows to the Matthews Park Pump Station.

While the County's conveyance infrastructure in the NW Lake Washington basin is generally considered by King County staff to be in good operating condition, published observations of excessive infiltration and inflow (I/I) date back to the 1958 *Metropolitan Seattle Sewerage and Drainage Survey*. During the New Year 1996/97 storm, which was significantly larger than a once per 20-year flow event, documented overflows occurred in the North Lake City Trunk, the lower section of the West Lake City Trunk and in the Thornton Creek Interceptor.

The NW Lake Washington planning basin contains single-family development, with pockets of multi-family housing and commercial development, including the Northgate Mall area. The Puget Sound Regional Council (PSRC) forecasts slow residential population growth and moderate employment growth in the area in the coming decades, averaging 0.6 and 1.4 percent annually for residential population and commercial employment, respectively. Industrial sources contribute a negligible amount of wastewater to the conveyance system.

NW LAKE WASHINGTON WET WEATHER FLOW AND SYSTEM CAPACITY

Peak wet weather flow and the conveyance system's capacity largely determine the need and timing of future upgrades. In the NW Lake Washington planning basin, there are capacity shortfalls in Thornton Creek Interceptor. According to King County's flow projections, approximately two-thirds of the interceptor cannot convey the current peak 20-year flow without surcharging or overflowing. This analysis suggests the Thornton Creek Interceptor does not meet the King County design standard which limits sanitary sewer overflows

(SSOs) to an average of once per 20 years. In addition, many sections cannot convey the current peak 5-year flow. During the New Year 1996/97 storm, the documented overflows above the Thornton Creek Interceptor in the West Lake City Trunk may be attributable to limited downstream capacity.

The North and West Lake City Trunk sewers have sufficient capacity to convey the peak 20-year flow through 2050, given the growth and flow projections provided by King County.

ALTERNATIVES SUMMARY

The CSI project team considered three alternatives for addressing the capacity shortfalls in the Thornton Creek Interceptor:

- Alternative A: Parallel Sewer to Increase Capacity
- Alternative B: Peak Flow Attenuation Using Storage Facilities
- Alternative C: Demand Management via Infiltration and Inflow Control

For the parallel sewer and the storage alternatives, the CSI project team developed facility sizes to control the peak 20-year flow and developed estimates of operation and maintenance costs, capital construction costs and total project costs. For the I/I control alternative, the project team estimated the volume and overall percentage of I/I removal needed to meet the King County SSO standard.

The parallel sewer alternative is preferred, because it is dramatically less costly than reducing overflows through storage (Alternative B) and is more feasible than eliminating capacity shortfalls via I/I control (due to the magnitude of the capacity shortfalls and the local stormwater conveyance issues).

DESCRIPTION OF RECOMMENDED ALTERNATIVE

The parallel sewer alternative would improve the wet weather service level by adding new pipe to the capacity-limited sections of the interceptor. The parallel sewer would follow the existing alignment wherever the existing pipe is within the street. The alignment for the parallel sewer could follow a nearby on-street route wherever a capacity-limited section of existing sewer is located within a private property easement. Given the current service level and likelihood of future overflows, this alternative should be implemented without staged construction.

The parallel sewers would potentially add an additional 30.4 mgd of flow to the Matthews Park Pump Station and to the downstream conveyance system during the future peak 20-year flow event. More flow would be conveyed during a larger storm. The additional flow would require treatment at West Point and the flows could have an impact on CSOs in the Northern Service area. King County staff should assess the potential impacts of the additional flow to the County's CSO program's planned facilities.

The construction and project costs of implementing Alternative A were computed using the Tabula cost estimating tool, using 2003 as the planning year. The operation and maintenance costs were also estimated, assuming an annual pipe maintenance cost of $1 per lineal foot (Table ES-1). For a detailed breakdown of the cost estimates, see Appendix C.

Table ES-1. Thornton Creek Interceptor Parallel Sewer Construction Cost

Parallel Pipe Element	Length (ft)	Diameter (in)	Cost
Parallel Section 1	1,970	42	$1,550,000
Parallel Section 2	850	42	$816,000
Parallel Section 3	1,070	42	$2,520,000
Total Construction Cost[A]		**-**	**$4,886,000**
Total Project Cost[B]			**$10,492,000**
Est. Annual O&M Cost[C]			**$3,890 / year**

A. Construction costs were calculated using Tabula v1.0 with an assumed 2003 construction year. Tabula estimates 2003 costs by applying an inflation multiplier of 1.13 to the 1999 Seattle Engineering News Record Construction Cost Index (ENR CCI) value of 7137. Sections 1 and 2 were assumed cut and cover construction, and section 3 is assumed microtunnel construction.

B. Project cost include the following allied costs provided to the CSI project team by King County: sales tax = 8.8% of construction, design engineering = 20% of construction, construction management engineering = 12% of construction, labor = 16.8% of construction, closeout = 1% of labor, other costs = 1% of labor, land and ROW acquisition = 6.5% of construction, contingency = 30%.

C. Annual operation and maintenance costs assume $1 per lineal foot of pipe. This estimated cost is based on the 2000 budget report from the County's Sewer Inspection, Cleaning and Repair Program.

CONCLUSIONS AND RECOMMENDATIONS

The Thornton Creek Interceptor, unlike the other King County facilities in the basin, has extensive capacity shortfalls during the current once per 5-year and once per 20-year peak flow events. The current peak 20-year flow exceeds the full-pipe capacity in more than 3,700 feet of the interceptor's 6,269 lineal feet total. Most of the pipes projected as overcapacity in 2050 are currently overcapacity.

The CSI project team recommends constructing a parallel sewer to route flows around the capacity-limited sections, bringing the Thornton Creek Interceptor up to the peak 20-year flow service level. This alternative is fully described in the *Part 4, Alternative A: Parallel Sewer to Increase Capacity* section of the report. The parallel sewer alternative is preferred, because it is dramatically less costly than reducing overflows through storage (Alternative B) and is more feasible than eliminating capacity shortfalls via I/I control (due to the magnitude of the capacity shortfalls and the local stormwater conveyance issues).

The CSI project team recommends implementing the entire preferred alternative without staged construction (i.e. constructing the three parallel sewer segments in one project). Partial implementation of the preferred alternative will not incrementally reduce the likelihood of overflows from the Thornton Creek Interceptor.

Northwest Lake Washington Basin
Detailed Planning for Specific CSI Projects

The Conveyance System Improvement (CSI) project involves examining King County's wastewater conveyance infrastructure, forecasting future demands, and planning wastewater service improvements. The Northwest Lake Washington planning basin is located in northeast Seattle and eastern Shoreline, to the north and west of the Matthews Park Pump Station. This basin has been largely developed for several decades and has an aging wastewater infrastructure.

This report includes background information about the basin, flow projections and a capacity assessment, a discussion of alternatives to eliminate capacity shortfalls, and costs associated with implementing each alternative.

Part 1: Planning Basin Review

Service Area Description

The NW Lake Washington planning basin includes all of the area draining wastewater to the Matthews Park Pump Station, either through the Thornton Creek Interceptor system or via local City of Seattle sewers direct to the pump station, but does not include the Kenmore Interceptor lake line. The basin covers 7,755 acres, of which approximately 7,164 acres are sewered. The unsewered areas represent parks, open space and non-developable land – there are no homes served by septic systems. The basin extends from its western edge to the west of I-5, to its southwestern boundary at Sand Point on Lake Washington (Figure 1).

King County collects and conveys wastewater from two local agencies in the basin: the Ronald Sewer District (Ronald SD) and the City of Seattle. Each of the local agencies owns, operates and maintains a network of sewers that collect wastewater from private residential, commercial and industrial customers. King County functions as the wholesaler that provides wastewater conveyance, treatment and disposal to the local agencies. The Seattle and Ronald SD service boundary in the NW Lake Washington basin reflects the Seattle and Shoreline boundary along 145th Street. Because the drainage direction is mostly from north to south in the basin, wastewater from much of the Ronald SD travels through the Seattle sewer system before entering King County conveyance system. For some customers near the boundary between the agencies, Seattle customer's wastewater drains to Ronald SD sewers where local undulations in topography send flow northward before turning south.

The main surface water features in the basin are Thornton Creek and Lake Washington. The NW Lake Washington basin wastewater drainage follows the topography of the Thornton Creek watershed, sloping generally to the south and east, towards Lake Washington. Thornton Creek runs through a combination of piped section and surface water channels to Matthews Beach Park, where it discharges to Lake Washington. Stormwater conveyance and flooding has been a recurring problem in the Thornton Creek watershed. The stormwater

issues may account for the large number of direct stormwater connections to the otherwise separated sanitary sewers in the area. Any alternatives that include infiltration and inflow (I/I) removal must consider the destination and impacts of the stormwater taken out of the sewer system.

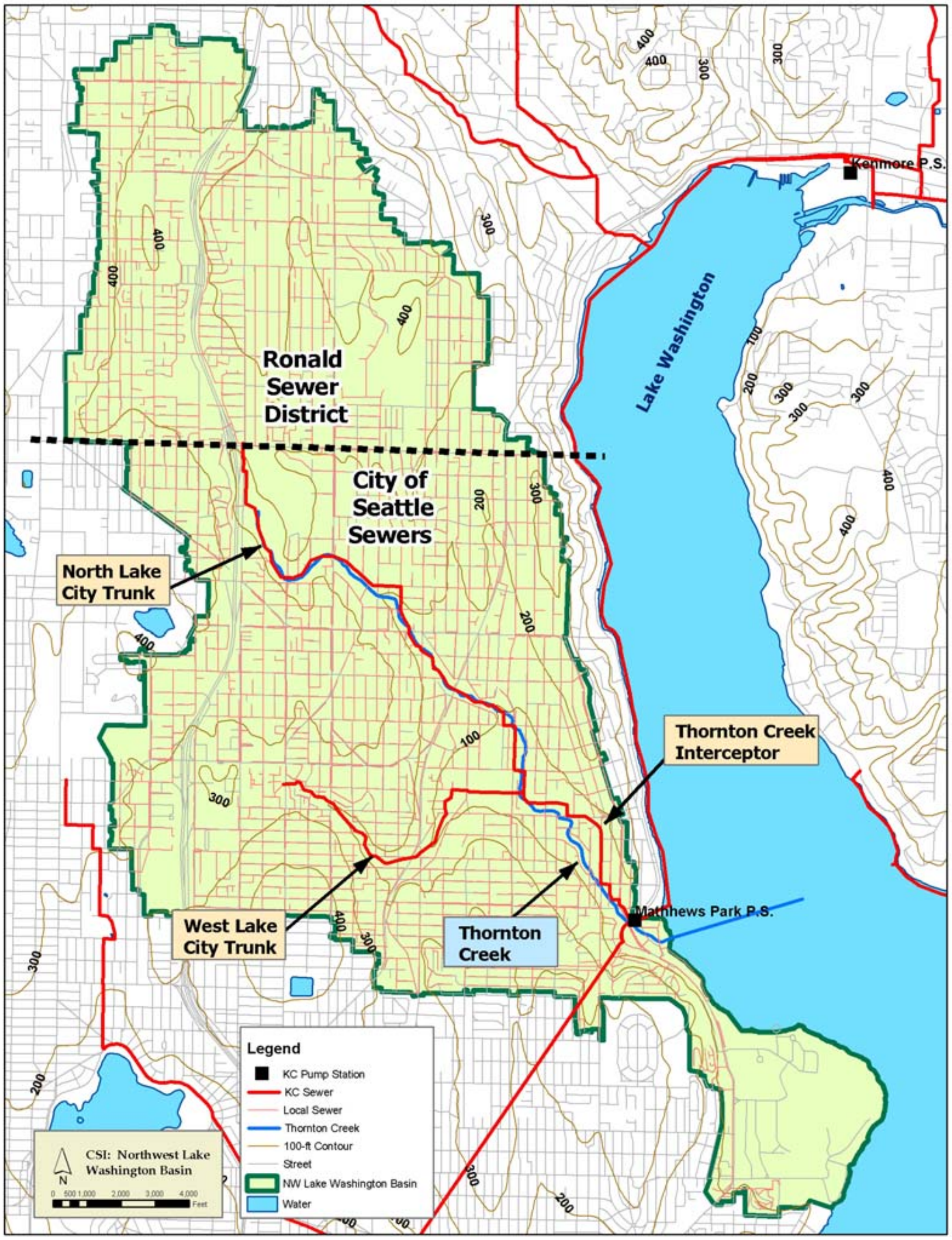

Figure 1. Northwest Lake Washington Basin Area

Planning Basin History and Drainage Problems

The 1958 *Metropolitan Seattle Sewerage and Drainage Survey* (1958 Plan) describes the early history of wastewater drainage in the NW Lake Washington area. Initially, sewers in northeast Seattle collected and discharged wastewater without treatment. In response to increased housing development in the area and concerns over degraded water quality in Lake Washington, the Lake City Sewer District was formed in 1946.

The Lake City system consisted of gravity drainage through the Thornton Creek watershed to a sewage treatment plan located at NE 107th Street and 36th Avenue NE[1]. The sewage treatment plant also received wastewater from the communities along the lakeshore to the north of Matthews Park via a pump station located near Lake Washington. Treated wastewater was discharged through a tunnel to the lake[2]. The City of Seattle annexed the Lake City Sewer District in 1954, and the treatment plant was decommissioned as the Metro regional wastewater conveyance system was developed in the late 1950s and 1960s.

While the County's conveyance system in the NW Lake Washington basin is generally considered by King County staff to be in good operating condition, excessive I/I contributions have been noted, including in 1958 Plan. In 1957, the plant was being expanded to a peak hydraulic capacity of 25 mgd, which is within 10 mgd of the present day capacity of many sections of the Thornton Creek Interceptor (see the *Hydraulic Capacity Assessment* section). During the New Year 1996/97 storm, which was significantly larger than a once per 20-year flow event, documented overflows occurred at the following locations (see Appendix A for pipe section capacities):

- North Lake City Trunk: NWW9-28
- North Lake City Trunk: NWW9-33
- West Lake City Trunk: NWW13-2, NWW13-1 (Siphon)
- Thornton Creek Interceptor: NW07-2A (Rock box/Sand catcher)

With the exception of manhole NWW9-28, the other manholes are located upstream of pipe sections with lower than average capacity for the system. Manhole NWW9-28 is located upstream of a short, steep section that has complex hydraulics.

[1] Today, this is where North and West Lake City Trunk sewers come together to form the Thornton Creek Interceptor.

[2] This tunnel is still in place. It serves as a high-flow stormwater bypass that directs water away from Thornton Creek during storms.

PART 2: REVIEW OF WASTEWATER CONVEYANCE FACILITIES

Local Conveyance Facilities

The City of Seattle and the Ronald SD own, operate and maintain gravity-draining, separated sewer systems in the NW Lake Washington basin. The Ronald SD pipes are located in the northern parts of the basin, within the City of Shoreline. The Ronald SD pipes discharge wastewater either directly to the North Lake City Trunk or to City of Seattle sewers that convey wastewater to the King County system. The City of Seattle sewers discharge to the North and West Lake City Trunk sewers and to the Thornton Creek Interceptor. Local topography allows most areas to be served by gravity sewers, but the City of Seattle operates one pump station, located at NE 107^{th} Street and 36^{th} Avenue NE. Figure 2 in the next section shows the areas covered by the Ronald SD and City of Seattle, as well as the drainage patterns in the basin. Table 1 lists the total pipe length in each system. The two local sewer pipes comprise 12-inch diameter and smaller mains, with some larger backbone collectors.

Table 1. Local Wastewater Conveyance Facilities

City of Seattle			Ronald Sewer District	
Pipe Diameter	*Total Length (ft)*		*Pipe Diameter*	*Total Length (ft)*
Up to 8-inch	646,845		Up to 8-inch	286,534
10 to 12-inch	35,848		10 to 12-inch	23,363
15 to 18-inch	27,349		15 to 18-inch	15,527
24 to 30-inch	4,159		24 to 30-inch	7,831
> 30-inch	1,830		> 30-inch	0

A. The table skips from 18-inch to 24-inch diameter pipe, because neither Seattle nor Ronald SD has 21-inch diameter sewers in the NW Lake Washington basin.

King County Conveyance Facilities

King County provides wastewater conveyance through a set of gravity sewers that follow the drainage pattern of the Thornton Creek watershed. The County pipes lead to the Matthews Park Pump Station, which is located near Lake Washington at the basin's outlet. The Matthews Park Pump Station conveys wastewater through the County's West Division conveyance facilities to West Point for treatment and discharge. Figure 2 shows the layout of conveyance facilities in the NW Lake Washington basin. Following the figure, the individual conveyance facilities are described.

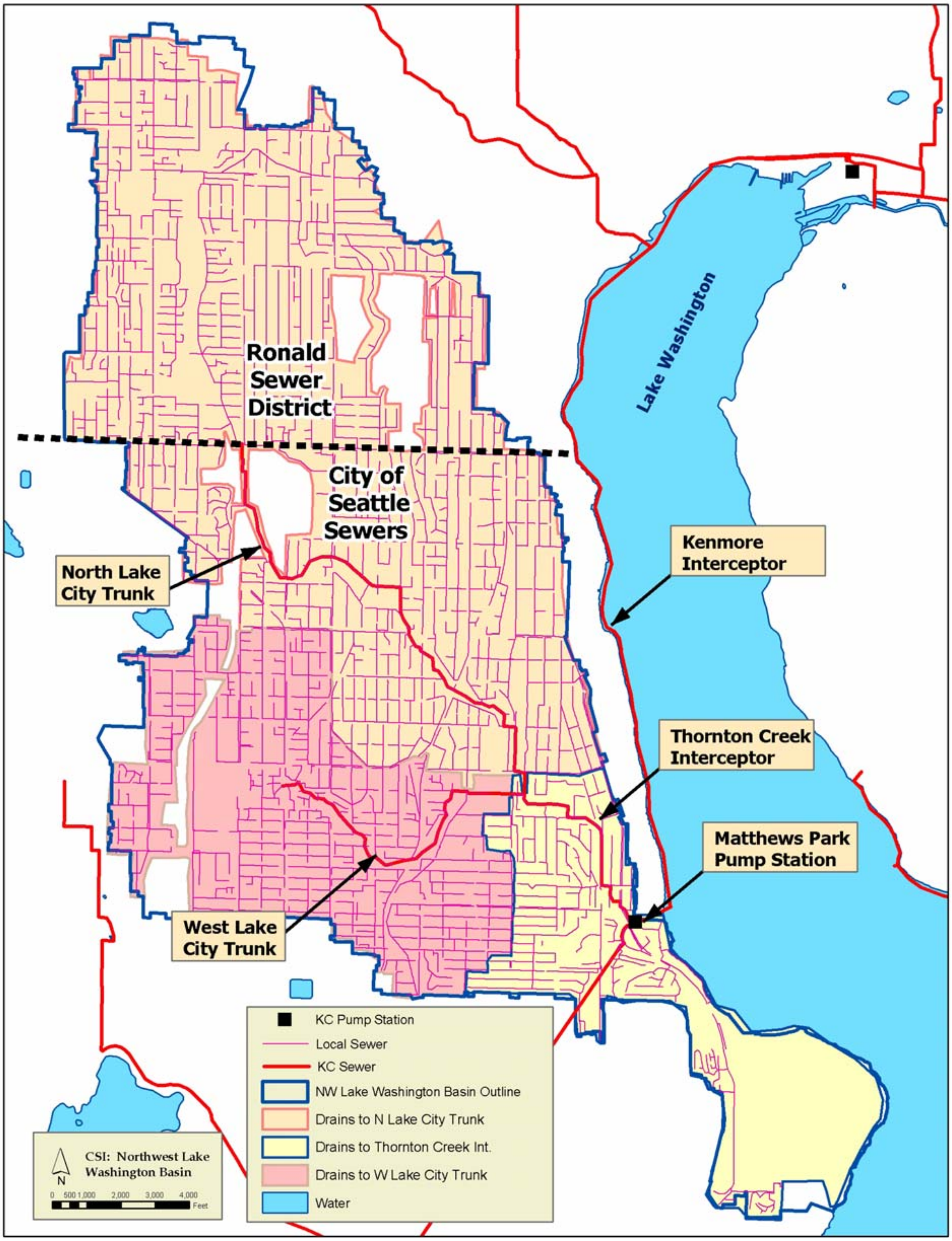

Figure 2. NW Lake Washington Basin Facilities and Drainage Pattern

North Lake City Trunk

The North Lake City Trunk drains an area of approximately 4,200 acres occupying the northern portion of the Northwest Lake Washington basin. The trunk was built between 1951 and 1958 to serve the expanding residential and commercial development in the area. The trunk extends for a distance just over 3 miles, much of which is routed through private property (see Figure 3), before it empties into the Thornton Creek Interceptor at manhole NWW10-01. The diameter of the North Lake City Trunk varies from 27-inch diameter to 42-inch diameter, constructed of reinforced concrete pipe (RCP). There are many side sewers from adjacent homes that connect directly to the trunk, instead of local City of Seattle sewers.

Distinctive features of the trunk include a Parshall flume (located at manhole NWW8-22) that was previously used for flow measurement. Also, a steep drop exists between manholes NWW9-27 and NWW9-26. Sewer backups have occurred at this location in the past, and it is suspected by King County staff that the energy loss associated with a hydraulic jump (super to sub-critical flow) immediately downstream of manhole NWW9-26 causes the occasional backups. The impact of the backups is compounded because this portion of the trunk runs through the backyards of local property owners.

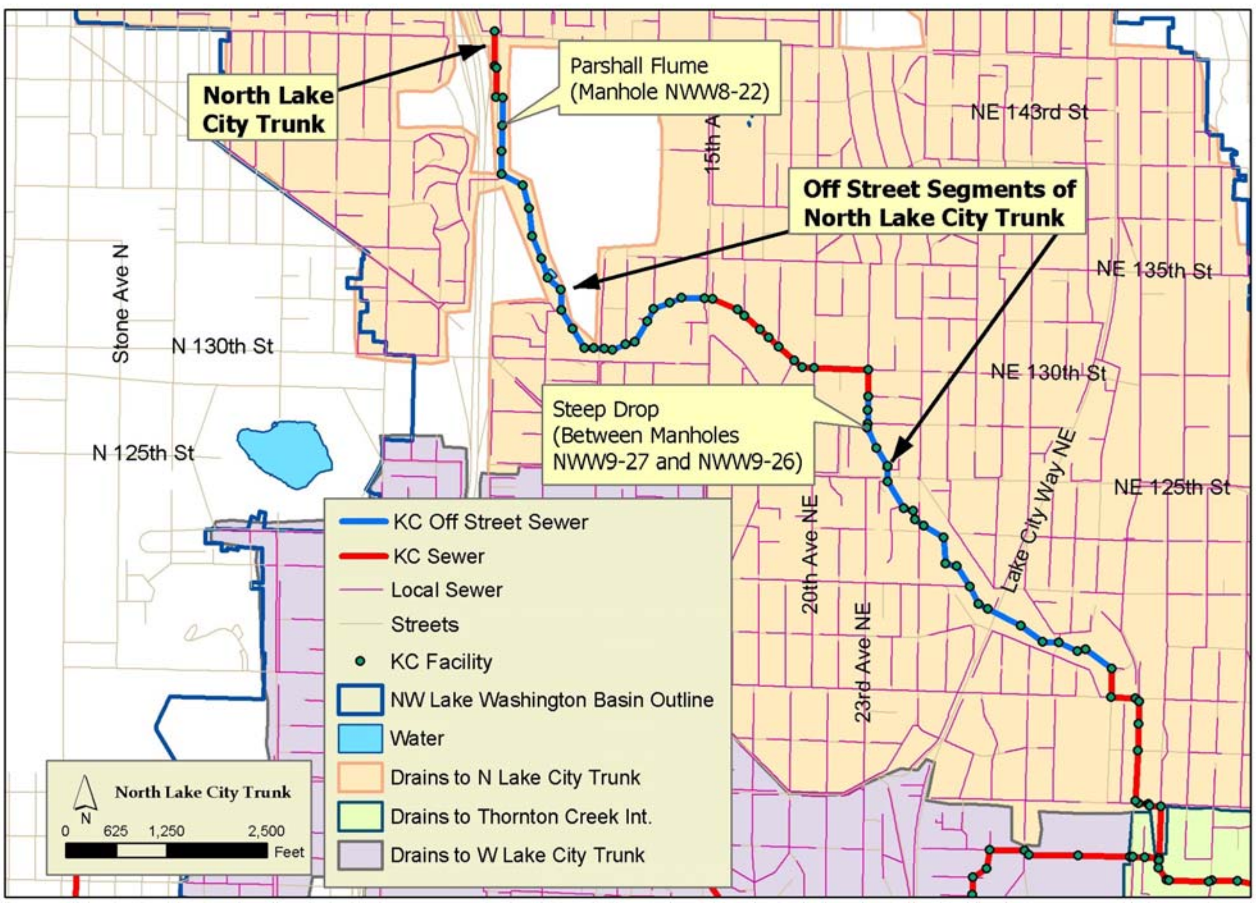

Figure 3. North Lake City Trunk Alignment

West Lake City Trunk

The West Lake City Trunk drains approximately 1,800 acres of the western Northwest Lake Washington basin. The trunk varies from 21-inch diameter to 36-inch diameter in size and is constructed of RCP material. Construction of the West Lake City Trunk took place between 1948 and 1959. At the end of the approximately 1-¾ mile trunk, wastewater flows into the Thornton Creek Interceptor at manhole NWW10-01. Sections of the West Lake City Trunk are on private property, instead of within the street right-of-way (see Figure 4). Many houses located along these sections West Lake City Trunk have their side sewers connected directly to the County trunk instead of connecting to the local Seattle sewer.

The Thornton Creek siphon is located between manholes NWW13-02 and NWW13-01 of the West Lake City Trunk. The siphon has three barrels: two 21-inch diameter barrels and a 15-inch diameter barrel. The siphon carries wastewater flows under Thornton Creek towards the Thornton Creek Interceptor. The siphon was originally built by the City of Seattle in 1958 and acquired by Metro in 1962.

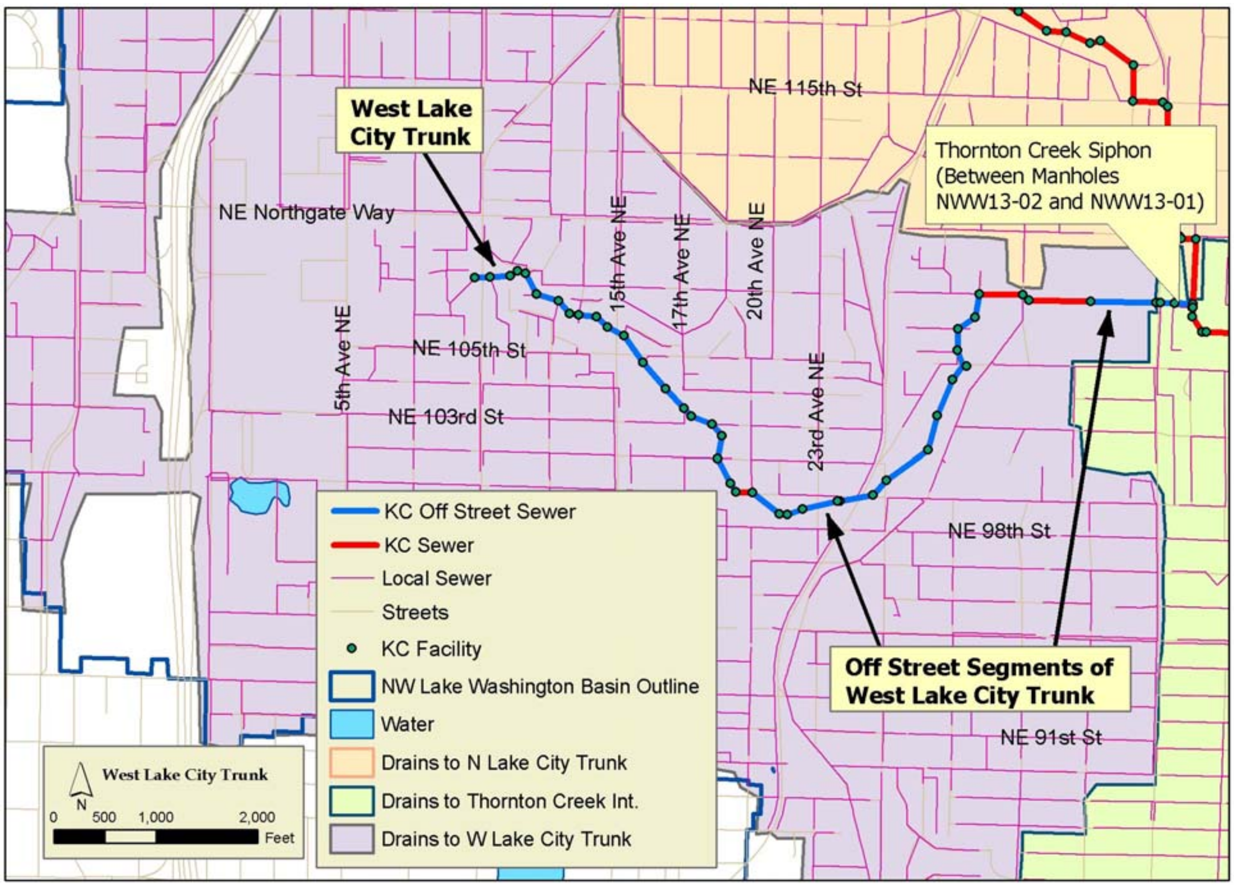

Figure 4. West Lake City Trunk Alignment

Thornton Creek Interceptor

The Thornton Creek Interceptor drains approximately 1,200 acres in the southern portion of the Northwest Lake Washington basin in addition to carrying wastewater flows from the North and West Lake City Trunks to the Matthews Park Pump Station. The North and West Lake City Trunks join at the Thornton Creek Junction Structure (originally built in 1958 and acquired by Metro in 1962), which is located at manhole NWW10-01. The junction structure is near the site of the former Lake City treatment plant (see the *Planning Basin History and Drainage Problems* section). The Thornton Creek Interceptor was built in 1965 as the Lake City treatment plant was decommissioned. The interceptor alignment initially passes through the Meadowbrook Pond stormwater facility and travels approximately 1-¼ miles to the Matthews Park Pump Station. The interceptor is located mostly within street rights-of-way, near Thornton Creek. The size of the pipeline ranges from 42 to 48-inches in diameter.

Structures of interest along the Thornton Creek Interceptor include a rock box (i.e. a grit and sediment catching structure) located at manhole W07-03A, and a low head structure (i.e. a constriction in the pipeline) at manhole W07-04 (Figure 5). The Thornton Creek Vortex Structure, located at manhole W07-23, drops wastewater from the 48-inch diameter interceptor into the 84-inch diameter Matthews Park Pump Station influent tunnel. The vortex regulates the rate of flow into the influent tunnel. The vortex structure was originally built by the City of Seattle in 1958 and acquired by Metro in 1962.

Other noteworthy infrastructure includes the old Lake City treatment plant outfall tunnel, which is located near manhole W07-08A. The tunnel is now used as a stormwater relief tunnel that routes potentially bed damaging and flood-inducing peak stormwater flow away from Thornton Creek and directly to Lake Washington.

The condition of the Thornton Creek Interceptor was assessed using CCTV cameras in June 2002. Some slight hydrogen sulfide damage and minimal sedimentation in the pipe just upstream of the Matthews Park Pump Station was observed. King County facilities inspection staff concluded that no rehabilitation would be required for the Thornton Creek Interceptor in the next 20 years, subject to the findings of future CCTV studies.

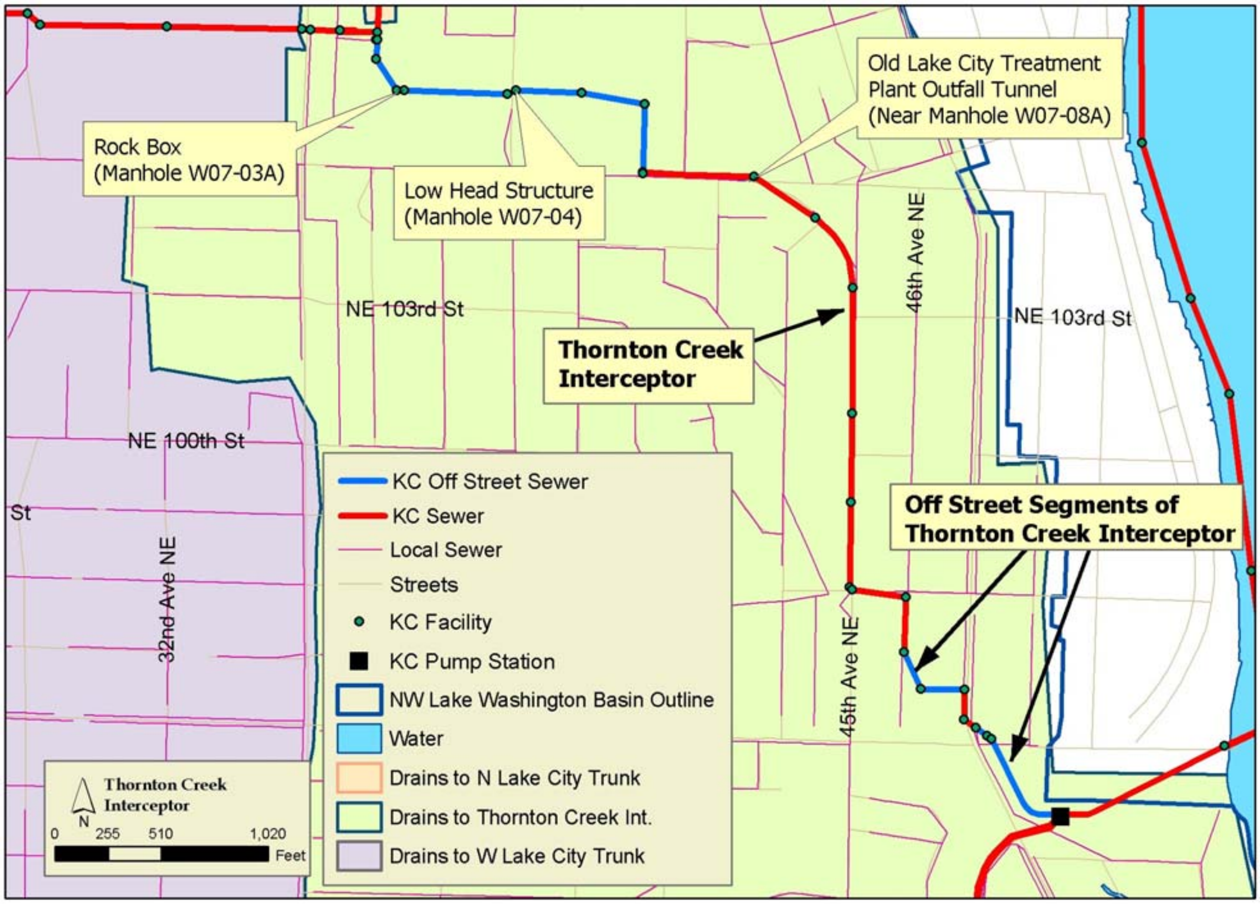

Figure 5. Thornton Creek Interceptor Alignment

Matthews Park Pump Station

At the downstream (southeast) end of the Thornton Creek Interceptor is the Matthews Park Pump Station. It is located at 9310 Sand Point Way NE in Seattle. The pump station receives wastewater flows from the north via the Kenmore Pump Station and Kenmore Interceptor and from the west via the North and West Lake City Trunks and the Thornton Creek Interceptor. The station pumps wastewater to the north portal of the Lake City Tunnel en route to treatment at the West Pont Treatment Plant. The pump station was initially built in 1967, the fourth pump was added in 1985, and odor control added in 1988.

Wastewater flow enters the station from the Thornton Creek Interceptor by an 84-inch diameter pipe. Flows from the Kenmore Interceptor enter the pump station by an 84-inch diameter pipe via the Matthews Park Junction Structure. The junction structure also houses a sluice gate, which allows lake water to flush the 84-inch diameter line that runs from the junction structure to the pump station.

From the pump station, parallel 42-inch and 54-inch diameter force mains carry wastewater flow 1,100 feet to the north portal of the Lake City Tunnel. Overflows are released to Lake Washington via seven 24-inch by 24-inch flap gates located in the underwater Kenmore Interceptor.

As of 2003, King County is in the process of upgrading the Matthews Park Pump Station. The firm pumping capacity of the upgraded station will be 85 mgd. For more information about the pump station and its equipment, consult the predesign and design reports.

Kenmore Interceptor

The Kenmore Interceptor, although not contained within the Northwest Lake Washington Basin, does contribute flow to the Matthews Park Pump Station and is mentioned for this reason. The Kenmore Interceptor, for reference in this document, begins at the junction where the McAleer Trunk joins the interceptor towards the northern edge of Lake Washington. The interceptor is 48 inches in diameter and extends for approximately 4 miles to the Matthews Park pump station, mostly located offshore within Lake Washington. The interceptor was built in 1964. All wastewater flows routed to the West Point Treatment Plant from East and North of Lake Washington are conveyed through the Kenmore Interceptor.

PART 3: POPULATION FORECASTS AND FLOW PROJECTIONS

This section reviews the population forecasts and wet weather flow projections provided by King County's Wastewater Treatment Division. The population forecasts determine the rate of growth in base wastewater flow expected in the area. The peak flow projections help identify areas of the collection system lacking sufficient capacity and needing upgrades.

Population and Employment Forecasts

The NW Lake Washington planning basin contains single-family development, with pockets of multi-family housing and commercial development, including the Northgate Mall area. The Puget Sound Regional Council (PSRC) forecasts slow residential population growth and moderate employment growth in the area in the coming decades, averaging 0.6 and 1.4 percent annually for residential population and commercial employment, respectively. (There is little industrial employment in the area and very little wastewater contribution from these sources.) The revised 2003 population and employment forecasts are listed here in and shown graphically in Figure 6.

Table 2. PSRC Revised 2003 Population and Employment Forecasts

Year	Residential Population	Commercial Employment	Industrial Employment
2000	64,655	21,933	316
2010	66,765	25,685	274
2020	69,809	30,366	313
2030	78,849	34,665	362
2040	81,414	38,880	357
2050	85,972	43,157	370
Avg. Annual Growth Rate:	0.6%	1.4%	0.3%

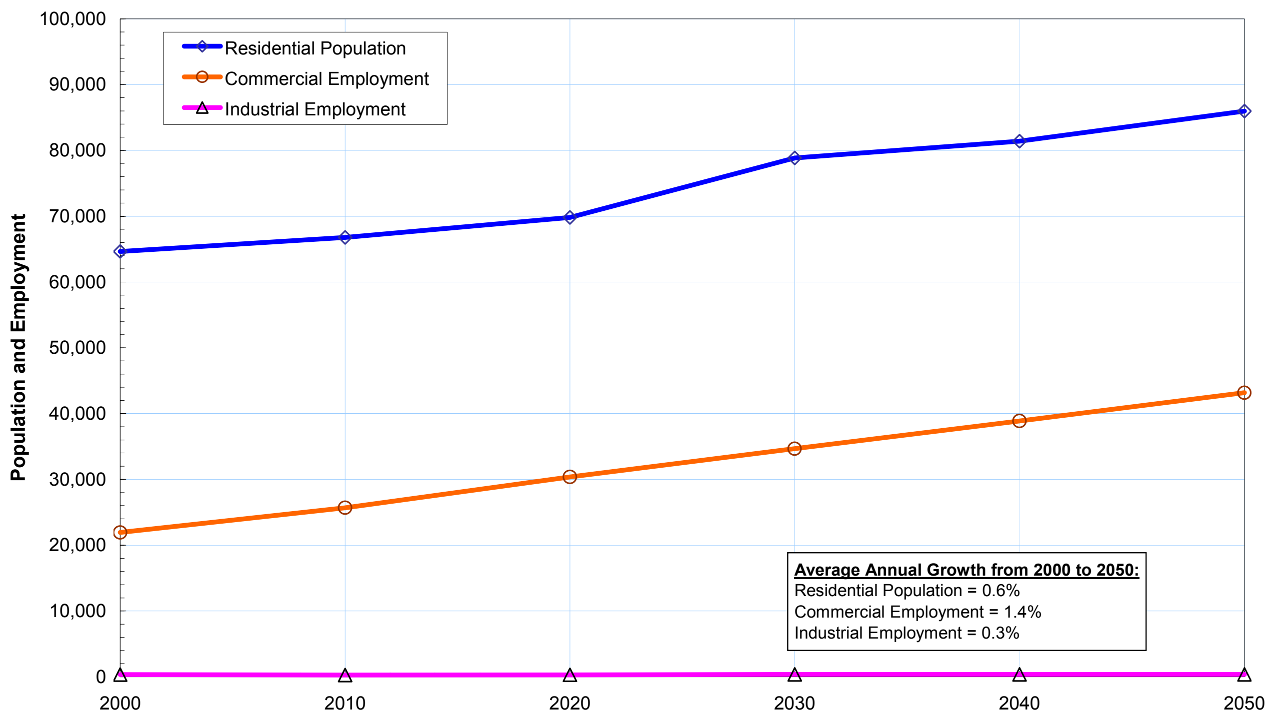

Figure 6. Residential Population, Commercial and Industrial Employment Forecasts

The PSRC forecasts are used in the CSI project to estimate the amount of base wastewater flow generated in the basin. King County has established unit base wastewater generation rates for each of the three population and employment categories. The unit rates are as follows:

- 60 gallons per capita day (gpcd) for residential customers
- 35 gpcd for commercial customers
- 75 gpcd for industrial customers

Table 3 lists the projected average daily base wastewater flow from 2000 to 2050. These base wastewater flows will be combined with infiltration and inflow (I/I) projections in the next section of this report to compute the peak design flow rate for each County conveyance facility in the basin.

Table 3. Base Wastewater Flow Projections from 2000 to 2050

Year	Residential (mgd)	Commercial (mgd)	Industrial (mgd)	Base Flow (mgd)
2000	3.88	0.77	0.02	4.67
2010	4.01	0.90	0.02	4.93
2020	4.19	1.06	0.02	5.27
2030	4.73	1.21	0.03	5.97
2050	5.16	1.51	0.03	6.70

Wet Weather Flow Projections

Peak wet weather flow and the conveyance system's capacity largely determine the need and timing of future upgrades. This section addresses wet weather flow in the NW Lake Washington basin by introducing: (1) peak 20-year flow projections, (2) the allocation of wastewater flow to specific pipe segments, and (3) the comparison of existing capacity with current and future projected peak 20-year flow.

The flow projections for the area, provided by King County, were derived from the 1999 Regional Wastewater Services Plan (RWSP) and updated by the Wastewater Treatment Division's modeling group in 2003 with data collected during the Regional I/I program. The data were reported in terms of unit wastewater generation by area, expressed in gallons per acre per day (gpad). One I/I rate is used for the entire planning area. The decade-to-decade increase in I/I from 2000 to 2030 reflects the assumed aging and degrading of the local and County sewers, with the increase estimated at seven percent per decade (non-compounded).

The sewered area for the NW Lake Washington basin was computed by summing the contributing areas from the flow monitoring *mini-basins* that were delineated by King County for the Regional I/I program. Table 4 lists the peak 5-year and 20-year flow, both rainfall-dependent I/I and total flow.

Table 4. Peak Flow in the NW Lake Washington Basin

Year	Sewered Area (Ac)	Base Flow (mgd)	Peak 5-yr I/I (gpad)[A]	Peak 20-yr I/I (gpad)[A]	Peak 5-yr Flow (mgd)	Peak 20-yr Flow (mgd)
2000	7,164	4.7	6,173	6,705	48.9	52.7
2010	7,164	4.9	6,577	7,144	52.0	56.1
2020	7,164	5.3	6,981	7,582	55.3	59.6
2030	7,164	6.0	7,385	8,021	58.9	63.4
2050	7,164	6.7	7,385	8,021	59.6	64.2

A. King County WTD assumes I/I increases at a rate of 7 percent per decade (non-compounded) from 2000 to 2030 to account for sewer aging and degrading.

Flow Allocation

As part of the Regional I/I program, King County WTD installed dozens of portable flow monitors in the NW Lake Washington basin and delineated 54 sub-basin areas, referred to as *mini-basins*. The mini-basin delineation was used to determine key information about the discharge of local system's wastewater into the King County system, specifically: (1) where does wastewater enter County pipes from the local systems, and (2) how much new flow is added at each input manhole. Using the winter 2001 portable flow monitor locations and the *mini-basins* delineated upstream of these flow monitors, the CSI project team determined the general drainage direction and contributing area to each input manhole. After computing the total area contributing to each manhole, the peak flow projections were allocated to each manhole proportionally.

Figure 7 shows the mini-basins in the NW Lake Washington basin. For more detailed information about where the local mini-basins add flow to the King County system, see Appendix B. Table B1 lists the sewered area and entry manhole to the King County system for each mini-basin. Accompanying figures, Figures B1, B2 and B3 show the locations of each of the input manholes in the system.

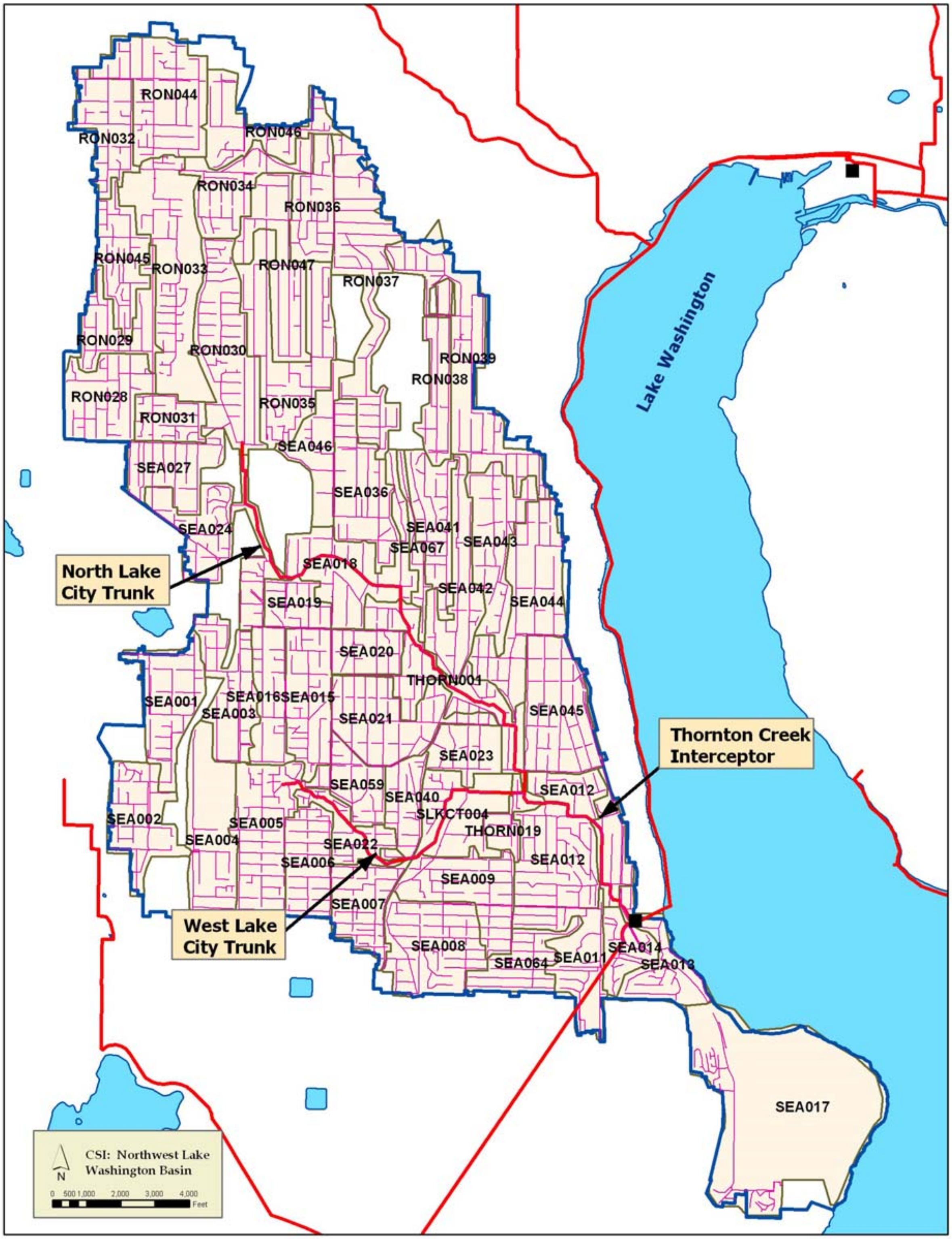

Figure 7. 2000 Mini-Basin Delineation in the NW Lake Washington Basin

Hydraulic Capacity Assessment

The project team computed the full pipe capacity of each section of pipe (manhole-to-manhole) for the North Lake City Trunk, West Lake City Trunk and Thornton Creek Interceptor, using the Manning's equation and a friction coefficient, n = 0.013. The full-pipe capacity of the County's sewers were compared to the peak 20-year flow projections to identify any pipes that do not meet King County's conveyance standard that limits overflows to an average of once per 20-years.

North Lake City Trunk Capacity Assessment

Figure 8 shows the capacity assessment for the North Lake City Trunk. The trunk has enough capacity to convey the once per 20-year flow through this project's planning horizon of 2050. The projected full-pipe capacity shortfall of 0.2 mgd in 2050 could result in minor surcharging. (Appendix A contains a corresponding table listing the remaining capacity/capacity shortfall for each pipe section for the North Lake City Trunk, as well as similar capacity tables for the West Lake City Trunk and Thornton Creek Interceptor.)

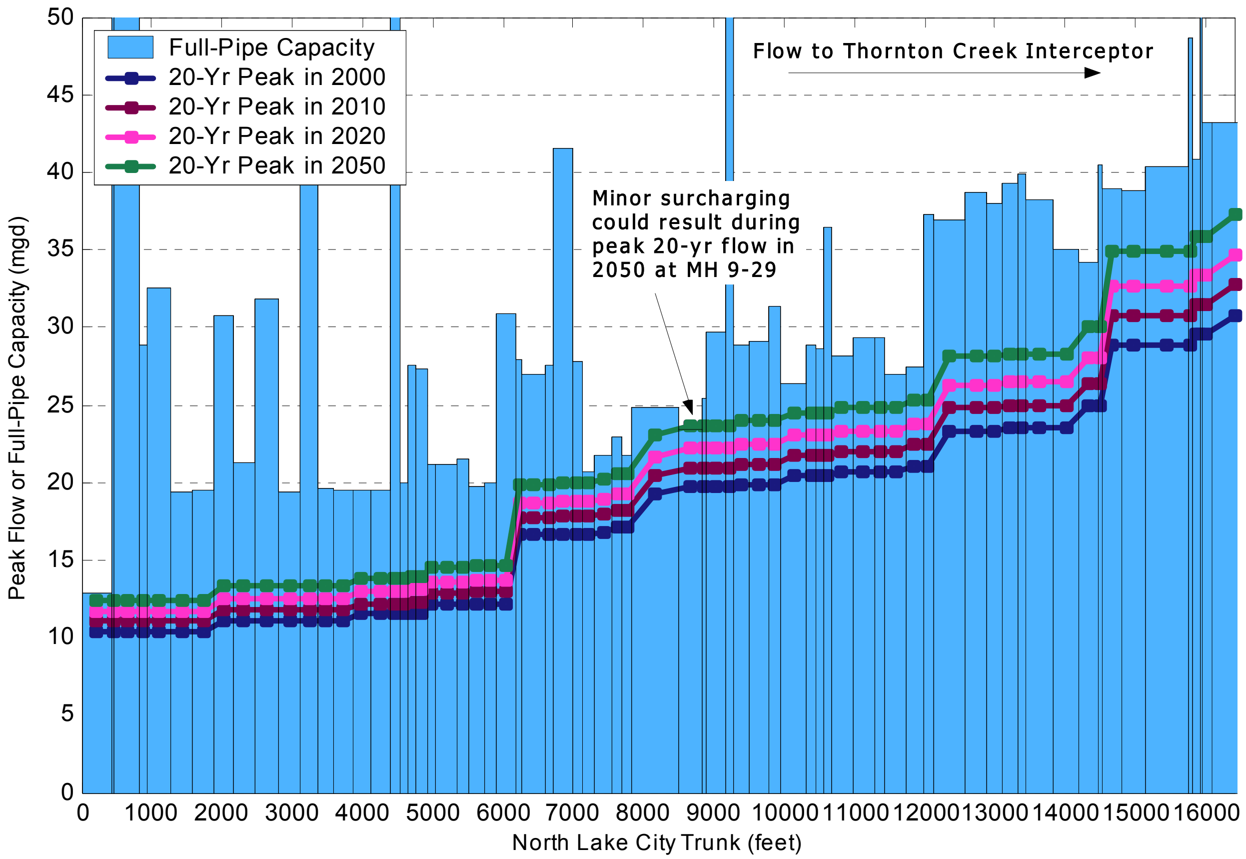

Figure 8. Capacity Assessment for the North Lake City Trunk

West Lake City Trunk Capacity Assessment

Figure 9 shows the capacity assessment for the West Lake City Trunk. The trunk has enough capacity to pass the peak 20-year flow through 2050, with an excess capacity of at least 5.5 mgd (minimum excess is from NWW11-01 to NWW12-12).

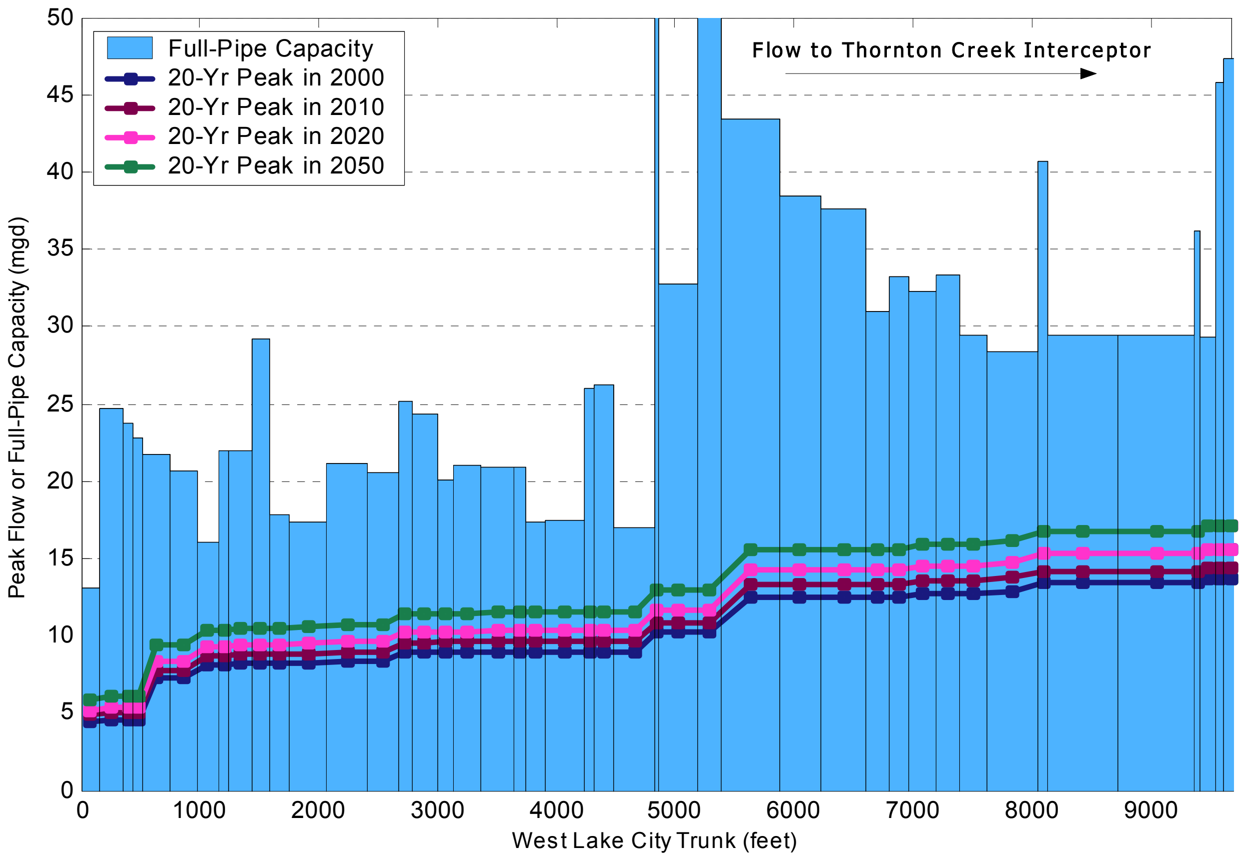

Figure 9. Capacity Assessment for the West Lake City Trunk

Thornton Creek Interceptor Capacity Assessment

Figure 10 shows the capacity assessment for the Thornton Creek Interceptor and the peak 20-year flow by decade from 2000 to 2050. The full-pipe capacity is exceeded by as much as 30 mgd for the peak 20-year flow in 2050. Overall, the pipeline has capacity shortfalls along 3,760 feet of its total of 6,269 lineal feet. The locations of the capacity shortfalls are consistent with the flooding observations from the New Year 1996/97 storm, which include overtopped manholes near the upstream end of the interceptor.

For comparison and to assess the sensitivity of the Thornton Creek Interceptor to peak flows, Figure 11 shows the peak 5-year flow against the full-pipe capacity. This figure demonstrates the Thornton Creek Interceptor cannot pass the peak 5-year flow without surcharging or overflows. Figure 12 shows in plan view the specific sections with limited capacity.

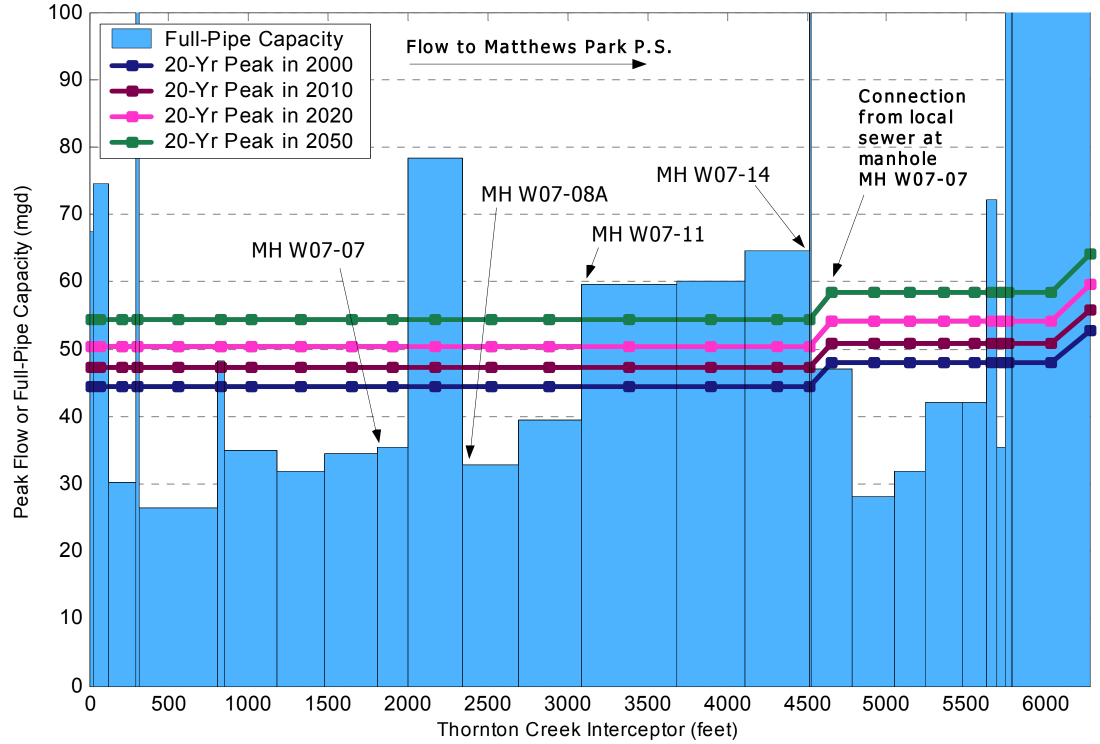

Figure 10. Thornton Creek Interceptor: Full-Pipe Capacity and Peak 20-Year Flow

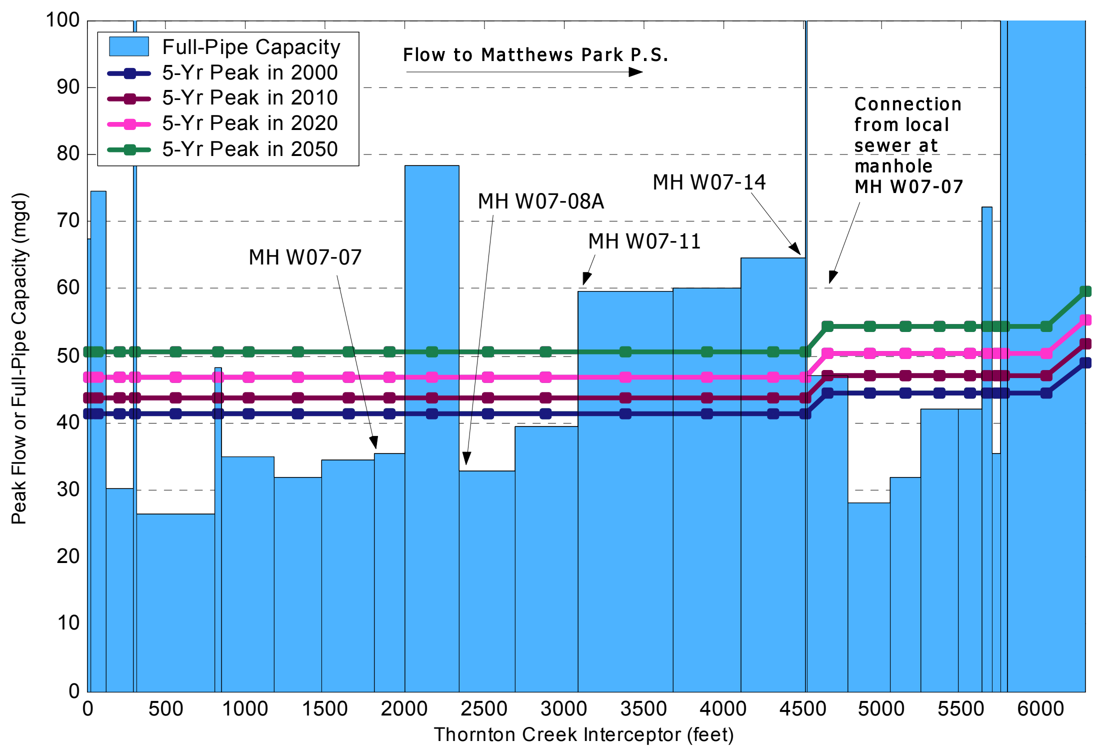

Figure 11. Thornton Creek Interceptor: Full-Pipe Capacity and Peak 5-Year Flow

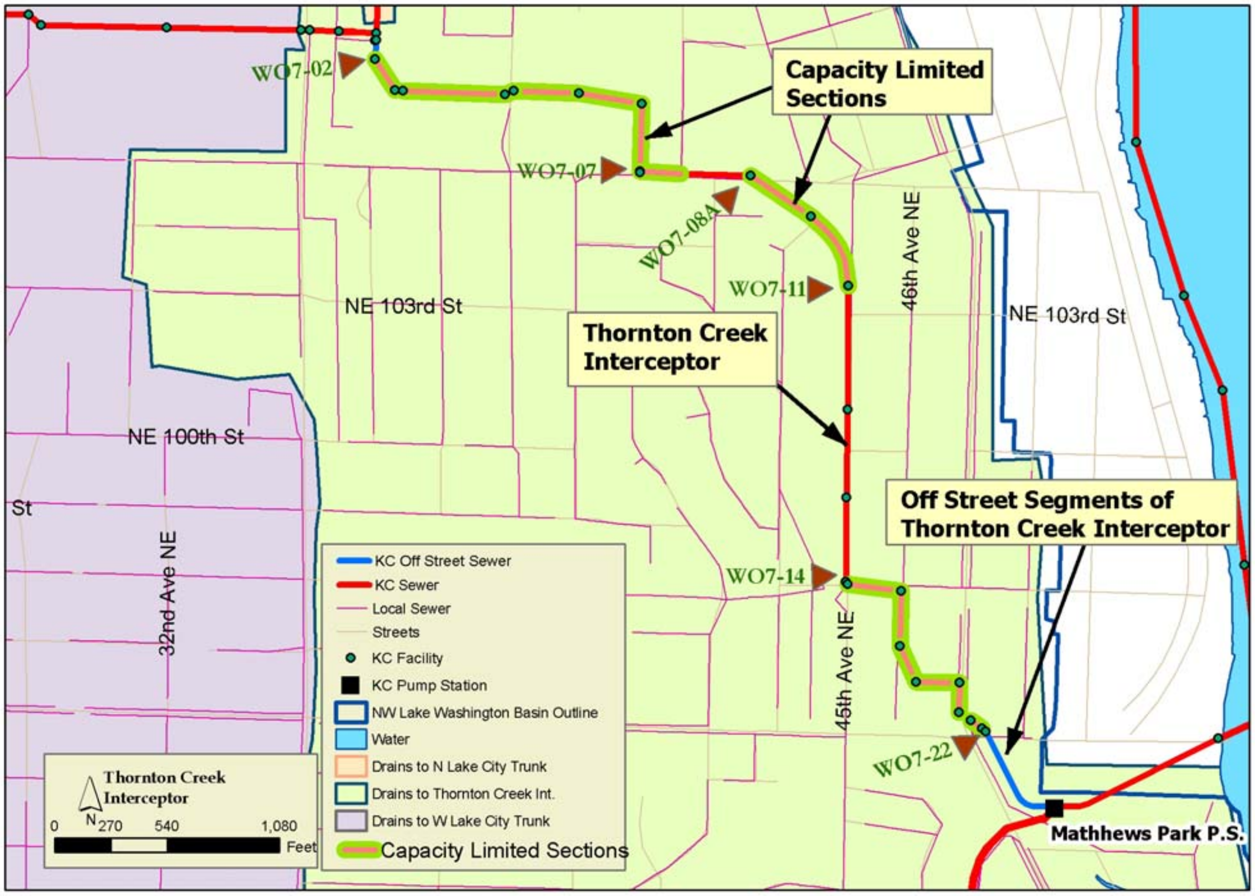

Figure 12. Location of Capacity Shortfalls in the Thornton Creek Interceptor

Summary of Capacity Shortfalls

In the NW Lake Washington planning basin, capacity shortfalls are limited to the Thornton Creek Interceptor. The North and West Lake City Trunk sewers have sufficient capacity to convey the peak 20-year flow through 2050, given the growth and flow projections provided by King County.

The alternatives discussed in the next section will address the capacity shortfalls in the Thornton Creek Interceptor. Specifically, the alternatives provide methods for increasing the capacity of this interceptor and/or reducing the wet weather demand in the system to meet the projected capacity shortfall of 30 mgd for the peak 20-year flow in 2050.

PART 4: ALTERNATIVES FOR RELIEVING CAPACITY SHORTFALLS

This section describes three alternatives for addressing the capacity shortfalls in the Thornton Creek Interceptor. The descriptions include information about facility sizing, operation and maintenance requirements (O&M), as well as capital construction and O&M costs. The outlines of each of the three alternatives were discussed with King County staff at a project meeting on May 15, 2003. In addition to the alternatives discussion, this section also contains a brief, planning-level overview of environmental, geotechnical and construction factors that could affect the implementation of the preferred alternative.

Alternative A: Parallel Sewer to Increase Capacity

This alternative would relieve the capacity shortfalls noted in the previous section by selectively constructing parallel piping wherever needed. Approximately two-thirds of the interceptor needs a capacity upgrade, particularly those that do not even meet the current peak 5-year flow (see Figure 11 in the *Hydraulic Capacity Assessment* section). Given the current service level, this alternative would be implemented without staged construction.

Figure 13 shows the capacity limited sections of the Thornton Creek Interceptor, along with proposed parallel sewer alignments[3]. The parallel sewer is divided into three separate sections (Table 5). The parallel sewer would follow the existing alignment, wherever the existing pipe is within the street. Where the existing pipe needs additional capacity, but is located off-street, the new parallel line would follow a different route, following local streets as much as possible.

The parallel sewers would potentially add up to additional 30.4 mgd of flow to the Matthews Park Pump Station and the downstream conveyance system during the future peak 20-year flow event or more during a larger storm (see Table 5). The additional flow would also require treatment at West Point. King County staff should assess the potential impacts of the additional flow to the County's CSO program's planned facilities.

If this alternative is implemented, the predesign and design project teams should confirm the feasibility of the alignments shown in Figure 13 and verify these are the best construction routes. Because this is a planning-level study to identify capacity problems and potential solutions, the project team did not conduct a survey of the local, underground utilities, traffic rates, or an extensive review of environmental constraints and permitting requirements. These issues should all be addressed during the predesign and design phases of the project.

[3] This alternative assumes parallel sewers would be built instead of replacing the existing pipes with one, larger diameter interceptor. King County's inspection of the Thornton Creek Interceptor suggests the pipe is not at the end of its useful life and can function in-place for decades to come. Constructing a parallel pipe is simpler than full pipe replacement, because the new pipe could avoid most, if not all, private property alignments and would not require connecting to local sewer lines. In addition, it is easier to maintain existing wastewater service during construction of a parallel pipe than full pipe replacement.

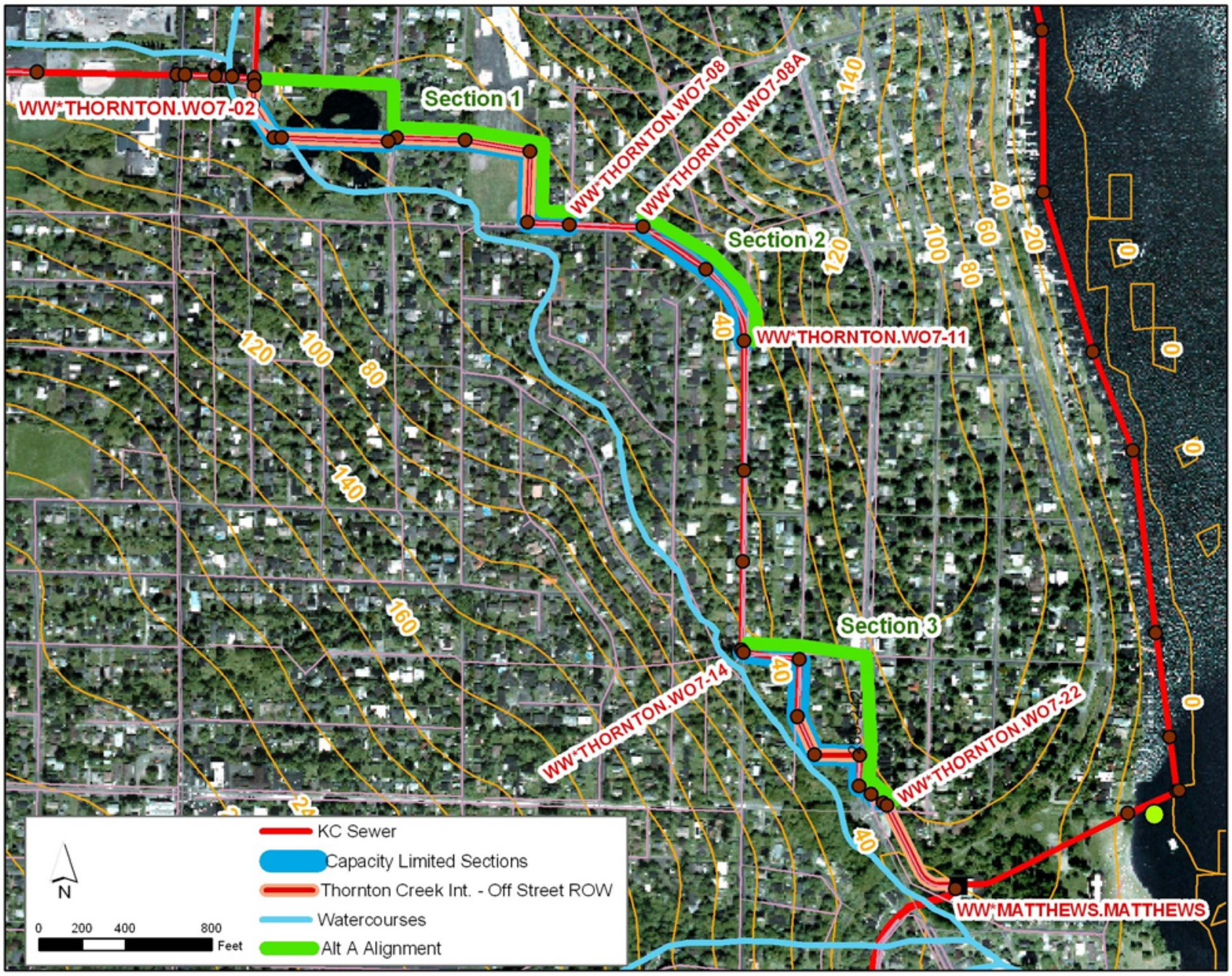

Figure 13. Thornton Creek Interceptor Capacity Limited Sections

Table 5. Alternative A Parallel Pipe Sections

Section	From MH	To MH	Length (ft)	Diameter (in)	Capacity (mgd)	Max Cover (ft)[A]
Section 1	NWW10-01	W07-08	1,970	42	40.0	10
Section 2	W07-08A	W07-11	850	42	30.8	19[B]
Section 3 [C]	W07-14	W07-22	1,270	42	35.7	49

A. The ground surface along the parallel pipe routes was estimated using the USGS 30-m DEM. Given the uncertainty in the DEM and pipe elevation values, the maximum cover estimate should be considered preliminary and subject to update during project predesign.

B. The maximum cover for section 2 is higher than expected. The parallel pipe follows the existing sewer in section 2, and thus will be equal to the cover on the existing pipe.

C. The project team assumed section 3 would be constructed by microtunnel. The alignment of section 3 results in a deeper pipe, but it would be located solely in the street right-of-way.

The construction and project costs of implementing Alternative A were computed using the Tabula cost estimating tool, using 2003 as the planning year (Table 6). The operation and maintenance costs were also estimated, assuming an annual pipe maintenance cost of $1 per lineal foot[4] (Table 7). For a detailed breakdown of the cost estimates, see Appendix C.

Table 6. Thornton Creek Interceptor Parallel Sewer Construction Cost

Parallel Pipe Element	Length (ft)	Diameter (in)	Cost[A]
Section 1	1,970	42	$1,550,000
Section 2	850	42	$816,000
Section 3	1,070	42	$2,520,000
Total Cost	3,890	-	$4,886,000

A. Construction costs were calculated using Tabula v1.0 with an assumed 2003 construction year. Tabula estimates 2003 costs by applying an inflation multiplier of 1.13 to the 1999 Seattle Engineering News Record Construction Cost Index (ENR CCI) value of 7137. Sections 1 and 2 were assumed cut and cover construction, and section 3 is assumed microtunnel construction.

Table 7. Thornton Creek Parallel Sewer Total Project and O&M Cost

Alternative	Construction Cost [A]	Project Cost [B]	Annual O&M Cost[C]
Alternative A: Thornton Creek Interceptor Parallel Sewer	$4,886,000	$10,492,000	$3,890 / year

A. Construction costs were calculated using Tabula v1.0 with an assumed 2003 construction year. Tabula estimates 2003 costs by applying an inflation multiplier of 1.13 to the 1999 Seattle Engineering News Record Construction Cost Index (ENR CCI) value of 7137.

B. Project cost include the following allied costs provided to the CSI project team by King County: sales tax = 8.8% of construction, design engineering = 20% of construction, construction management engineering = 12% of construction, labor = 16.8% of construction, closeout = 1% of labor, other costs = 1% of labor, land and ROW acquisition = 6.5% of construction, contingency = 30%.

C. Annual operation and maintenance costs assume $1 per lineal foot of pipe. This estimated cost is based on the 2000 budget report from the County's Sewer Inspection, Cleaning and Repair Program.

Alternative B: Peak Flow Attenuation Using Storage Facilities

Rather than increasing the conveyance capacity of the system, Alternative B would attenuate storm peaks using storage facilities (tanks or tunnels). To protect the Thornton Creek Interceptor, the storage facilities would be constructed upstream of the interceptor in available open space along the lower reaches of the North Lake City Trunk and the West Lake City Trunk. Aerial photographs of the area show undeveloped areas large enough to

[4] The annual maintenance cost for gravity sewers is based on the 2000 budget report for the County's Sewer Inspection, Cleaning and Repair program.

contain storage tanks. If a tunnel storage option were pursued, the project team would have to examine local utilities for potential conflicts along the alignments.

The project team calculated the reduction in flow expected for various size storage facilities, and then compared the flow reduction/storage volume relationships for facilities located on the North and West Lake City Trunk lines to determine the optimal sizing that would minimize capital expenditure and provide the 30.4 mgd reduction in flow needed to meet SSO standard. Figure 14 and Figure 15 show the relationship between storage volume and flow reduction. The calculations were based on the preceding and receding shape of the January 1990 design storm, as provided by KC WTD modeling group.

Both figures demonstrate that the greatest incremental flow reduction occurs for small storage volumes. In other words, as storage tanks grow larger, returns are diminished as the incremental rate flow reduction slows. By comparing the two *storage volume to flow reduction* relationships, the project team estimated the most efficient combination of storage between the two sites consists of 4.0 million gallons (MG) of storage on the North Lake City Trunk and 2.4 MG on the West Lake City Trunk. These storage volumes are shows as the *optimized storage volume* in both Figure 14 and Figure 15.

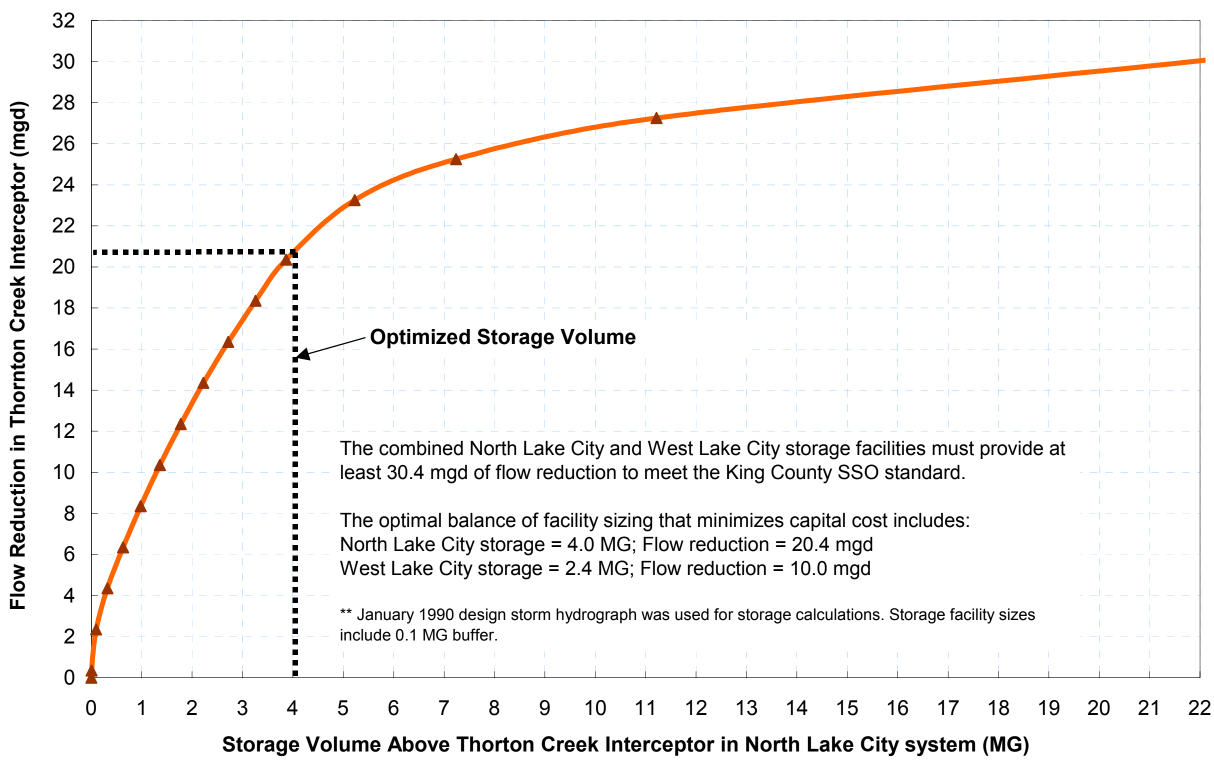

Figure 14. North Lake City Trunk: Estimated Storage and Flow Reduction

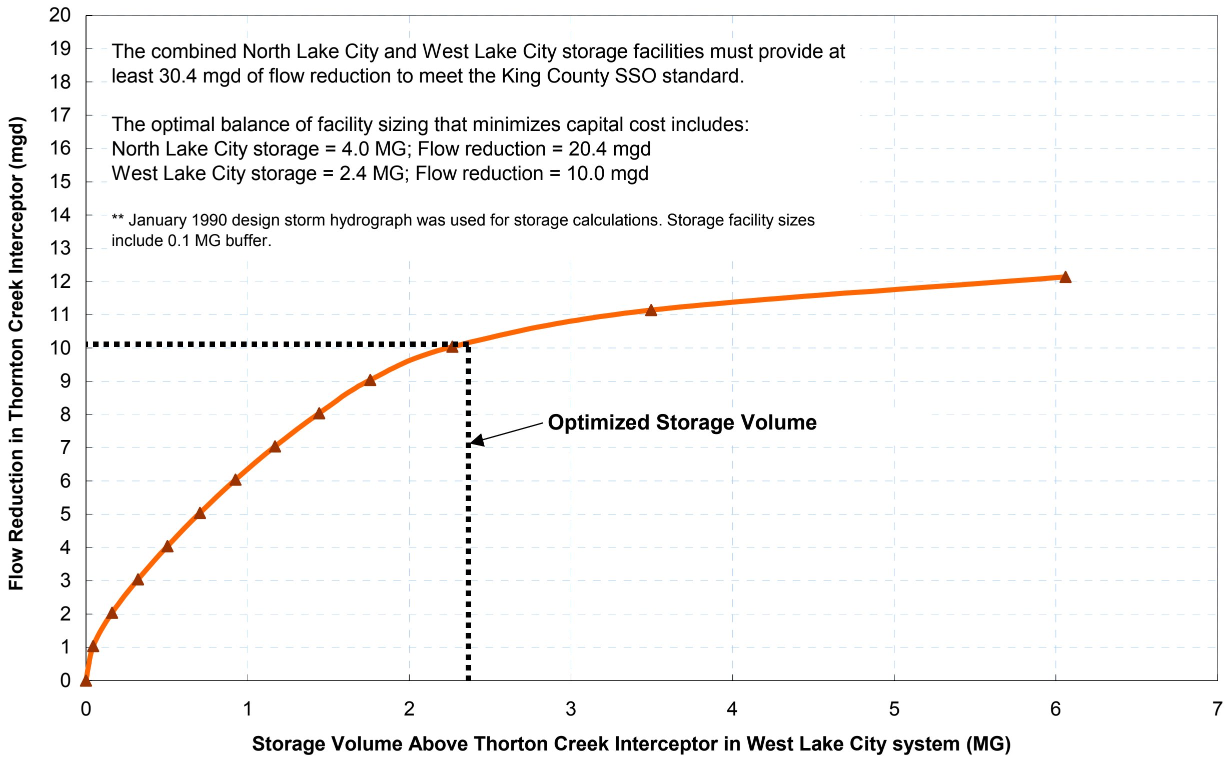

Figure 15. West Lake City Trunk: Estimated Storage and Flow Reduction

The construction cost of both Alternative B options, storage tanks and storage tunnels, were computed using the Tabula cost estimating tool, using 2003 as the planning year (Table 8). The costs for tunnel construction are considerably higher (on the order of two times) than a current King County project providing storage at North Creek. However, if the construction costs of Alternative B were reduced by half the resulting costs would still be considerably higher than other proposed alternatives. The total project cost of a tunnel option was computed using King County's allied costs (Table 9). The cost estimates assume the tanks would be 15 feet deep and the tunnels would be 14 feet in diameter. For detailed breakdown of these cost estimates, see Appendix C.

The method for estimating O&M costs at storage facilities was discussed with King County staff extensively during CSI South Sammamish basin planning, and the method is applied to the NW Lake Washington basin for this report. The *CSI Task 250 South Sammamish Basin Refining Wastewater Service Alternatives* report established an estimated annual O&M cost of $3,100 for a 1.5 MG tunnel (800 feet in length) that is used once per year.

Alternative B includes for two tunnels, 4.0 MG and 2.4 MG in volume (3,500 and 2,100 feet each in length, respectively) that would be used an average of once per two to three years. The Alternative B tunnels are larger but less frequently used than the reference tunnel considered in the South Sammamish basin O&M cost analysis. Using the *CSI Task 250 South Sammamish Basin Refining Wastewater Service Alternatives* report as a reference, the project team estimates the annual operation and maintenance for the 2.4 MG tunnel would be approximately $3,100, and the 4.0 MG tunnel would be $6,200.

Table 8. Storage Facility Construction Cost

Facility	Storage Volume	Storage Tunnel Construction Cost[A,B]	Storage Tank Construction Cost[A,C]
North Lake City Trunk Branch	4.0 MG	$16,300,000	$25,200,000
West Lake City Trunk Branch	2.4 MG	$11,800,000	$19,000,000
Total System	6.4 MG	$28,100,000	$44,200,000

A. Construction costs were calculated using Tabula v1.0 with an assumed 2003 construction year. Tabula estimates 2003 costs by applying an inflation multiplier of 1.13 to the 1999 Seattle Engineering News Record Construction Cost Index (ENR CCI) value of 7137.

B. The storage tunnel cost estimate assumes the tunnels are 14-feet in diameter. The 4.0 MG tunnel would be 3.500 feet in length. The 2.4 MG tunnel would be 2,100 feet in length. For more detail, see Appendix C.

C. The storage tank cost estimate assumes the tank would be 15 feet deep. For more detail, see Appendix C.

Table 9. Storage Tunnel Project and O&M Cost

Alternative	Construction Cost [A]	Total Project Cost [B]	Annual O&M Cost[C]
Alternative B: Two Storage Tunnels (2.4 MG and 4.0 MG)	$28,100,000	$60,400,000	$9,300 / year

A. Assumes tunnel construction. Construction costs were calculated using Tabula v1.0 with an assumed 2003 construction year. Tabula estimates 2003 costs by applying an inflation multiplier of 1.13 to the 1999 Seattle Engineering News Record Construction Cost Index (ENR CCI) value of 7137.

B. Total project cost include the following allied costs provided to the CSI project team by King County: sales tax = 8.8% of construction, design engineering = 20% of construction, construction management engineering = 12% of construction, labor = 16.8% of construction, closeout = 1% of labor, other costs = 1% of labor, land and ROW acquisition = 6.5% of construction, contingency = 30%.

C. Annual operation and maintenance costs assume $3,100 for the 2.4 MG tunnel and $6,200 for the 4.0 MG tunnel.

Alternative C: Demand Management via Infiltration and Inflow Control

The NW Lake Washington basin is classified as a separated system, but there are direct connections throughout the basin that add stormwater into the sanitary sewer. Given the age of the system and history of stormwater-related flooding problems in the Thornton Creek watershed, the direct connections are not surprising. Although there are currently no I/I pilot or demonstration projects planned for the area, the project team was instructed to estimate the volume and fraction of I/I that would have to be eliminated to bring the peak 20-year flow within the capacity of the existing sewer system. Table 10 lists the peak flow and available capacity for each pipe segment in the Thornton Creek Interceptor (capacity shortfalls are shown in red within parentheses).

Table 10. Capacity in the Thornton Creek Interceptor Peak 20-Year Flow

Thornton Creek Interceptor						Peak 20-Year Flow (mgd)		Available Capacity (mgd)	
U/S STA	From MH	To MH	Length (ft)	Diameter (in)	Capacity (mgd)	2000	2050	2000	2050
0	NWW10-01	WO7-01	28	42	67.5	44.5	54.4	23.0	13.1
28	WO7-01	WO7-02	92	42	74.5	44.5	54.4	29.9	20.1
120	WO7-02	WO7-02A	176	42	30.3	44.5	54.4	(14.2)	(24.1)
296	WO7-02A	WO7-03A	15	42	287.7	44.5	54.4	243.1	233.3
311	WO7-03A	WO7-03	497	42	26.5	44.5	54.4	(18.1)	(27.9)
808	WO7-03	WO7-04	42	42	48.2	44.5	54.4	3.7	(6.1)
850	WO7-04	WO7-05	332	48	35.0	44.5	54.4	(9.5)	(19.4)
1,182	WO7-05	WO7-06	298	48	31.9	44.5	54.4	(12.6)	(22.5)
1,480	WO7-06	WO7-07	328	48	34.5	44.5	54.4	(10.1)	(19.9)
1,808	WO7-07	WO7-08	193	48	35.5	44.5	54.4	(9.1)	(18.9)
2,001	WO7-08	WO7-08A	340	48	78.2	44.5	54.4	33.7	23.8
2,341	WO7-08A	WO7-10	352	48	32.9	44.5	54.4	(11.6)	(21.5)
2,693	WO7-10	WO7-11	392	42	39.4	44.5	54.4	(5.2)	(15.0)
3,085	WO7-11	WO7-12	600	42	59.6	44.5	54.4	15.1	5.2
3,685	WO7-12	WO7-13	421	42	60.0	44.5	54.4	15.5	5.6
4,106	WO7-13	WO7-14	404	42	64.6	44.5	54.4	20.1	10.2
4,510	WO7-14	WO7-15	16	42	190.8	44.5	54.4	146.3	136.4
4,526	WO7-15	WO7-16	259	48	47.0	47.9	58.5	(1.0)	(11.5)
4,785	**WO7-16**	**WO7-17**	**264**	**48**	**28.1**	**47.9**	**58.5**	**(19.9)**	**(30.4)**
5,049	WO7-17	WO7-18	188	48	31.8	47.9	58.5	(16.1)	(26.6)
5,237	WO7-18	WO7-19	241	48	42.0	47.9	58.5	(6.0)	(16.5)
5,478	WO7-19	WO7-20	142	48	42.1	47.9	58.5	(5.9)	(16.4)
5,620	WO7-20	WO7-21	70	48	72.1	47.9	58.5	24.2	13.6
5,690	WO7-21	WO7-22	55	48	35.5	47.9	58.5	(12.4)	(23.0)
5,745	WO7-22	WO7-23	35	48	734.7	47.9	58.5	686.7	676.2
5,780	WO7-23	MPPS	489	48	127.0	47.9	58.5	79.0	68.5
6,269[A]	MPPS[A]				85	52.7[A]	64.2[A]	32.3	20.8

A. The last row in the table includes flow from local sewers in the NW Lake Washington basin direct to the Matthews Park Pump Station. The flow originates in the area south of the pump station in the City of Seattle collection system. This flow values do not include any contribution from outside the NW Lake Washington basin, such as the flow through the Kenmore Interceptor.

Eliminating all capacity shortfalls would require 30.4 mgd of I/I removal. Expressed relative to the total 2050 peak 20-year I/I flow of 57.5 mgd (calculated from the peak 20-yr basin flow of 64.2 mgd minus the base flow of 6.7 mgd), eliminating capacity shortfalls in the Thornton Creek Interceptor would require 53 percent I/I removal. This level of I/I control could only be achieved through a comprehensive program that includes substantial sewer replacement and rehabilitation on private property.

When considering the costs and benefits of I/I removal, it is important to consider not only capital cost savings on NW Lake Washington facilities but also regional benefits, such as reduced stresses on facilities downstream of the NW Lake Washington, steadier operating conditions at pump stations, treating less 'clean' water at the County's treatment plants, and leaving more water in the basin for aquifer and local stream recharge.

Along with these benefits of I/I removal, adding stormwater to the local system would increase the frequency of wintertime flooding, unless additional stormwater facilities were constructed. Therefore, any I/I control efforts should consider the impacts to local stormwater management and flooding in the Thornton Creek watershed.

The project did not generate a cost estimate for Alternative C. There are other factors to consider before producing a cost estimate, such as the feasibility of removing 30.4 mgd of I/I, and the impacts of I/I removal to the local stormwater system. I/I removal costs are highly site specific and variable. Wherever feasible, relatively simple fixes such as roof drain and catch basin disconnection can cost less than $2 per gallon per day (gpd) of peak 20-year I/I removed. Typically, roof drains and catch basins only account for a small portion of total I/I. Other methods of I/I removal, such as sewer lateral repair, foundation drain disconnection and sewer main rehabilitation, are more costly. For planning-level studies, we can assume I/I reduction costs range from $2 to $12 per gpd of the 20-year peak I/I removed.

Summary of Alternatives Analysis

Constructing a parallel sewer along sections of the Thornton Creek Interceptor, as described in Alternative A, would limit overflows to an average of once per 20 years. The Matthews Park Pump Station has enough capacity to accept the additional flow a parallel sewer would bring during peak events.

The parallel sewer alternative is dramatically less costly than constructing a total of 6.4 MG of storage (Alternative B) volume in two separate tunnels. Based on this planning-level analysis, either the parallel sewer or storage alternative appears feasible, but the parallel sewer alternative should be preferred, because of its lower cost. Table 11 lists the construction, total project and O&M costs for these alternatives.

The project team also computed the level of I/I control to reduce the peak 20-year flow to within the capacity of the Thornton Creek Interceptor (Alternative C). Eliminating all the shortfalls would require 30.4 mgd of I/I removal, which corresponds to a 53 percent reduction of the peak 20-year I/I flow. This level of I/I control could only be achieved through a comprehensive program that includes substantial sewer replacement and rehabilitation on private property.

While the parallel sewer should be the preferred alternative for improving conveyance in the NW Lake Washington basin, its implementation will affect downstream facilities during large storms. When the additional parallel capacity is needed (estimated at approximately once per 2 to 3 years), the increased flow will require pumping and treatment. King County should perform an analysis of the treatment and CSO program impacts of adding additional flow to the downstream collection system.

Table 11. Thornton Creek Interceptor Alternatives Total Project and O&M Cost

Alternative	Construction Cost [A]	Total Project Cost [B]	Annual O&M Cost[C]
Alternative A: Thornton Creek Interceptor Parallel Sewer	$4,886,000	$10,492,000	$3,890 / year
Alternative B: Two Storage Tunnels (2.4 MG and 4.0 MG)	$28,100,000	$60,400,000	$9,300 / year

A. Construction costs were calculated using Tabula v1.0 with an assumed 2003 construction year. Tabula estimates 2003 costs by applying an inflation multiplier of 1.13 to the 1999 Seattle Engineering News Record Construction Cost Index (ENR CCI) value of 7137.

B. Total project cost include the following allied costs provided to the CSI project team by King County: sales tax = 8.8% of construction, design engineering = 20% of construction, construction management engineering = 12% of construction, labor = 16.8% of construction, closeout = 1% of labor, other costs = 1% of labor, land and ROW acquisition = 6.5% of construction, contingency = 30%.

C. Annual operation and maintenance costs assume $1 per lineal foot of pipe. This estimated cost is based on the 2000 budget report from the County's Sewer Inspection, Cleaning and Repair Program.

Environmental Characteristics

This section gives a brief review of specific environmental characteristics relevant to sewer construction. Specifically, King County's GIS group prepared maps of local wetlands (Figure 16) and high-potential erosion zones (Figure 17) within the NW Lake Washington area. These maps are prepared as a planning-level screening tool to alert King County staff to any environmental conditions that would impact construction. However, this review should not be considered exhaustive by any means. During project predesign, King County should further investigate the full set of environmental factors that could impact the project.

According to the wetlands coverage information provided by King County, wetlands are isolated to the north and western sections of the basin. Potential erosion zones are located in the north and northeast parts of the basin, well away from any of the identified capacity limited pipe sections in the Thornton Creek Interceptor. While not specifically identified in the datasets provided to the project team, the King County predesign team should also consider environmental constraints for construction in the vicinity of Thornton Creek.

Geotechnical Characteristics

This section gives a brief review of specific geotechnical characteristics relevant to sewer construction. Specifically, King County's GIS group prepared maps of local seismic hazard zones (Figure 18) and landslide prone areas (Figure 19). These maps are prepared as a planning-level screening tool to alert King County staff to any geotechnical conditions that may impact construction. King County should conduct a thorough geotechnical analysis of the final alignment during project predesign. The GIS coverages provided by King County do not indicate any seismic zones or landslide areas within the NW Lake Washington basin.

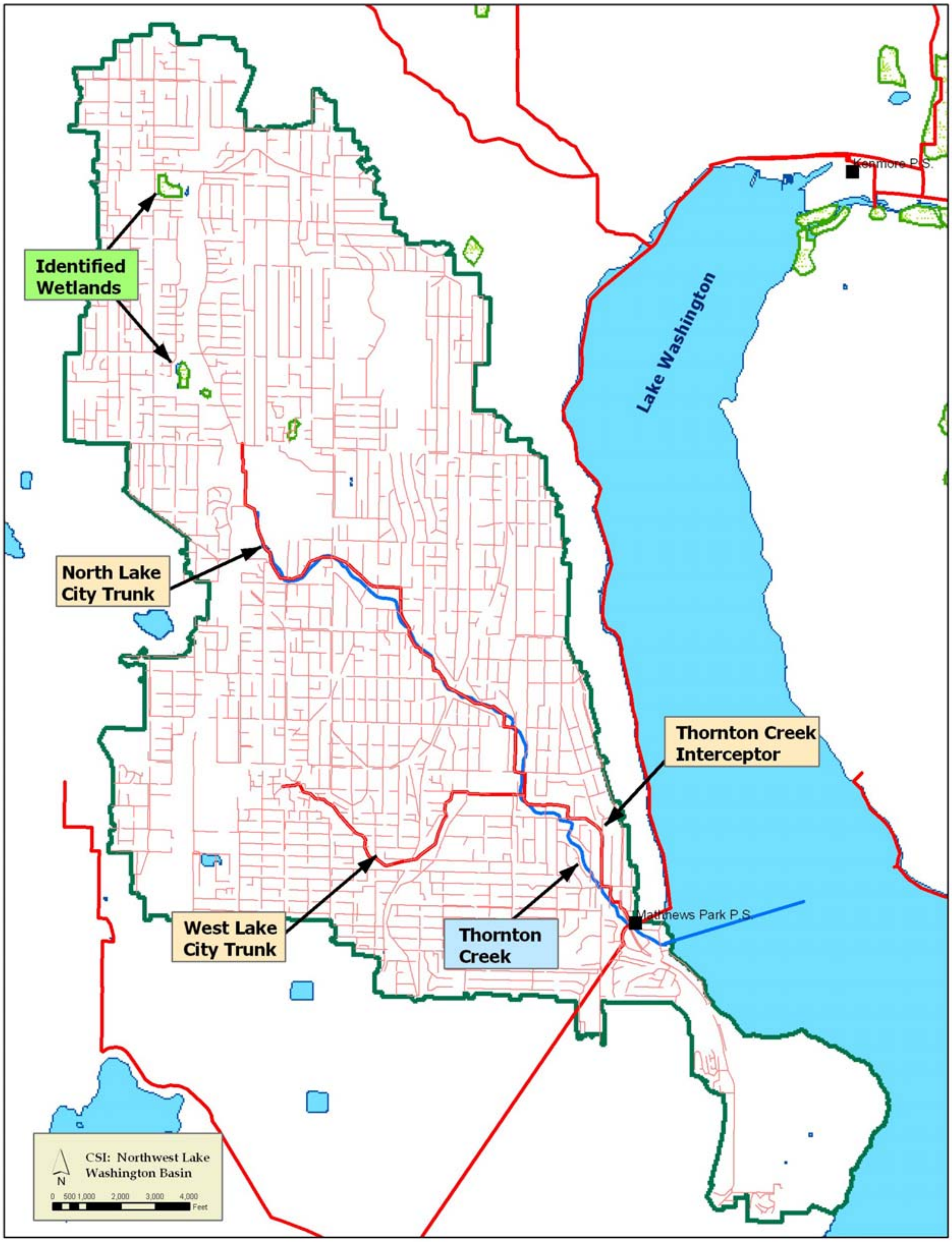

Figure 16. Wetlands in the NW Lake Washington Basin

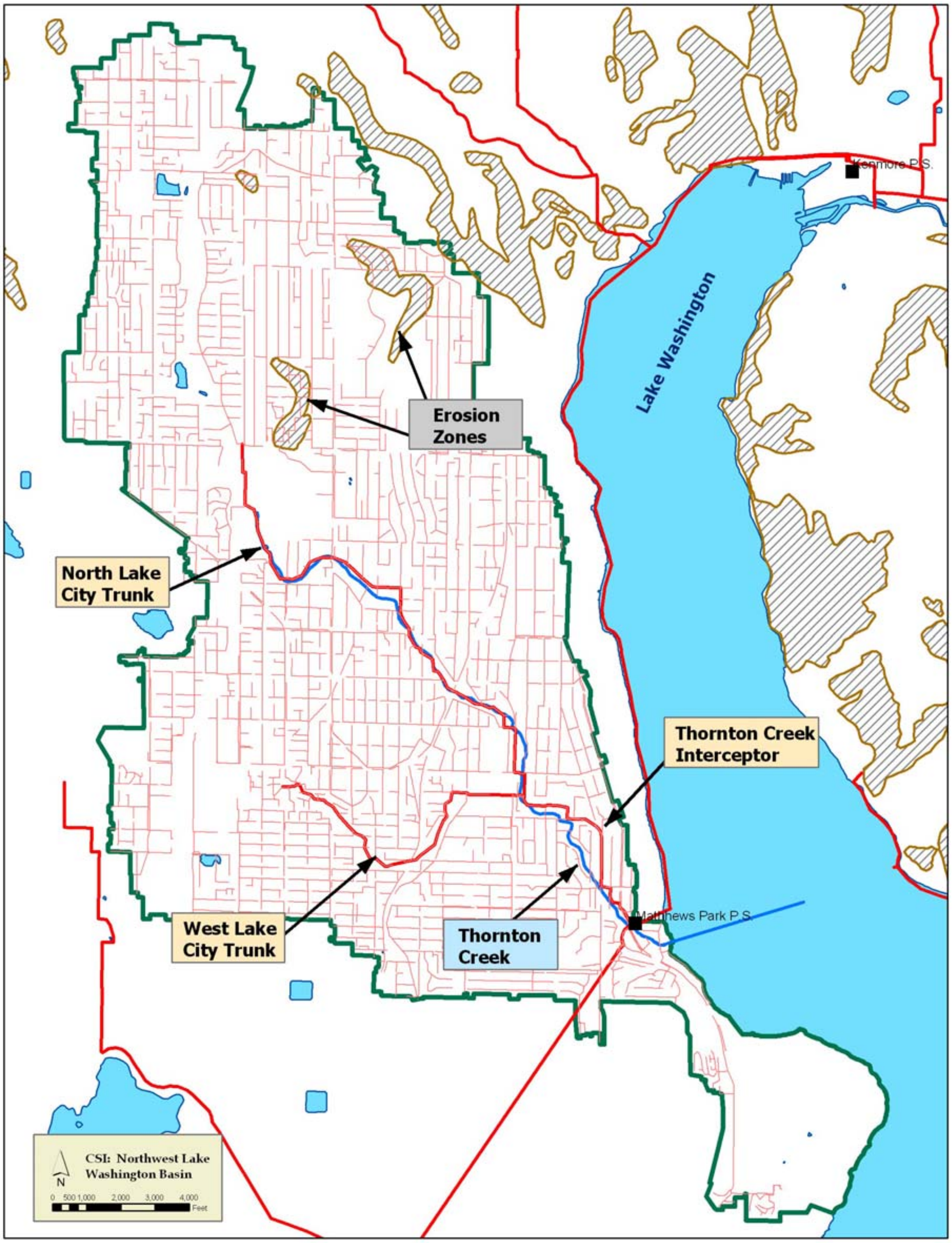

Figure 17. Erosion Zones in the NW Lake Washington Basin

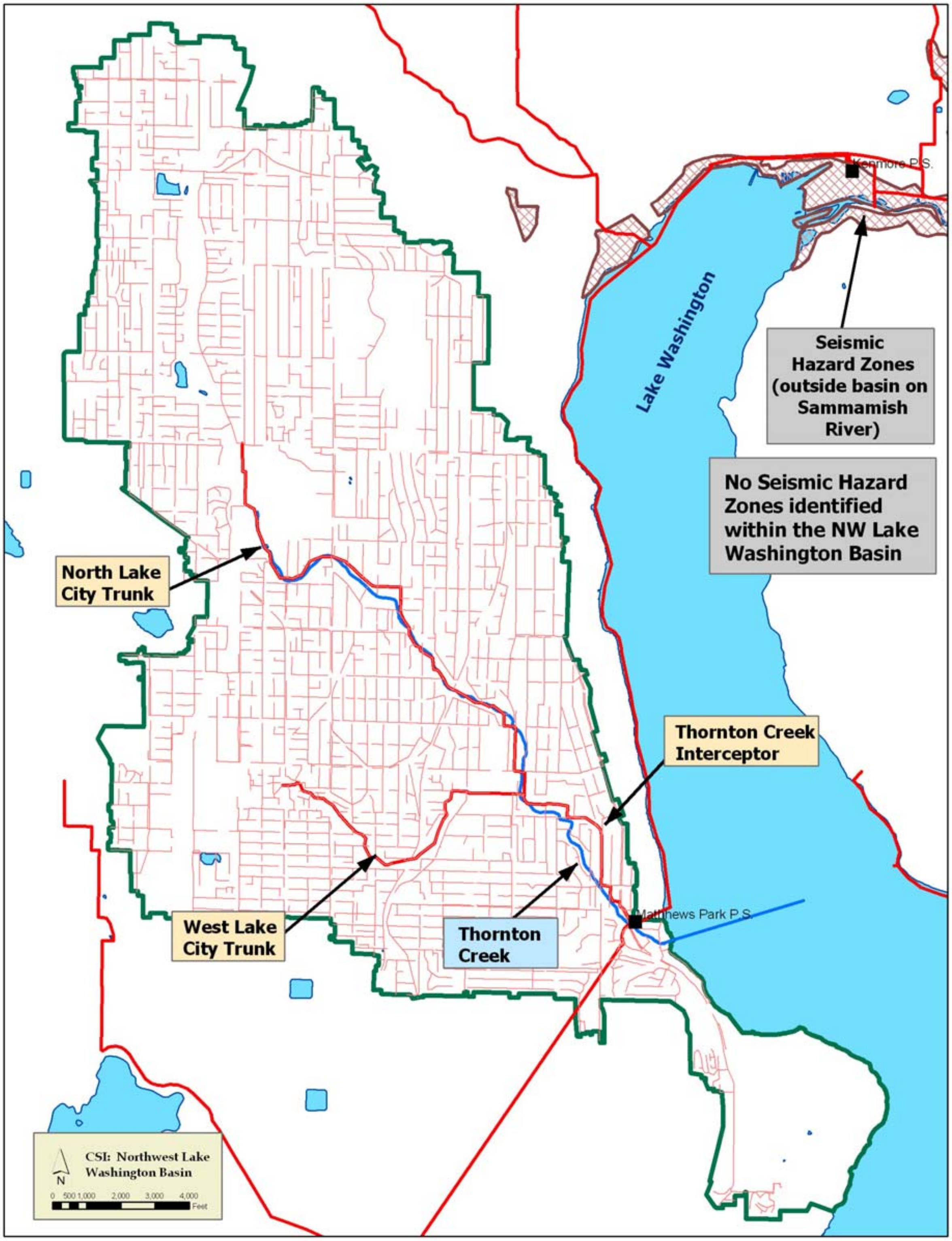

Figure 18. Seismic Hazard Zones Near the NW Lake Washington Basin

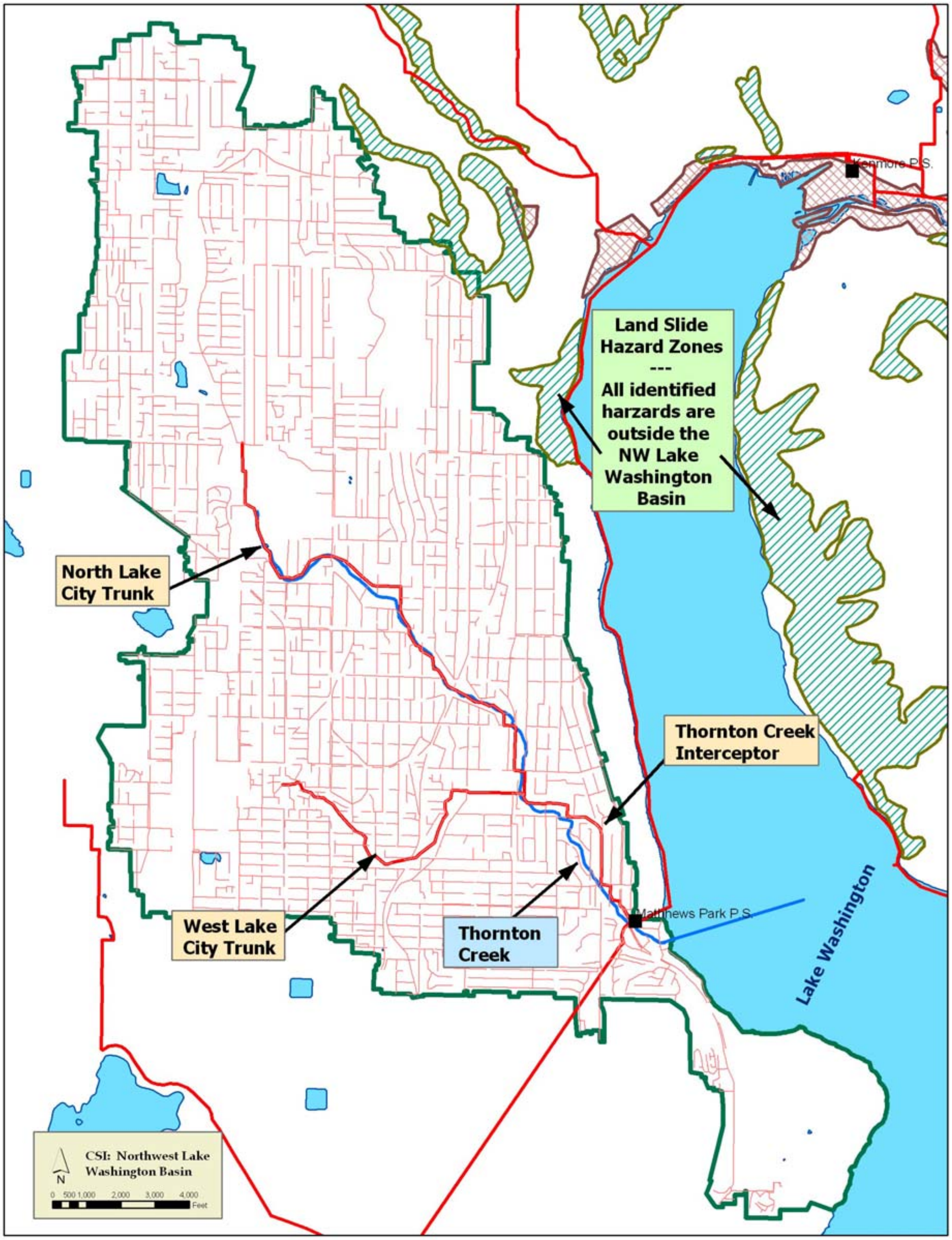

Figure 19. Landslide Hazard Zones Near the NW Lake Washington Basin

Construction Factors

The following construction factors should be considered by the follow-on predesign and design teams. The bullet items apply specifically to parallel sewer alternative (Alternative A), which is recommended as the preferred alternative.

- Several sections of the Thornton Creek Interceptor run through private property. The predesign and design team should compare the challenge of acquiring easements and building sewers on private property against the potentially longer route and deeper construction of building parallel pipes within the street right-of-way.

- This planning-level analysis did not include a survey of local utilities. The follow-on project predesign team should evaluate the selected routes for congested utilities.

- Traffic control is expected to be a minor impact during construction. Construction should be able to avoid major arterial routes.

PART 5: CONCLUSIONS AND RECOMMENDATIONS

This previous sections of this report evaluated the capacity of the existing wastewater conveyance infrastructure in the NW Lake Washington basin, identified capacity shortfalls, and described alternatives for alleviating any capacity problems, current and future. To summarize the capacity analysis, the North Lake City Trunk and West Lake City Trunk have enough capacity to convey the projected peak 20-year flow through 2050. The planned upgrades to the Matthews Park Pump Station will bring its capacity to 85 mgd, which is sufficient to convey the peak 20-year flow. The Thornton Creek Interceptor, unlike the other King County facilities in the basin, has extensive capacity shortfalls during the current once per 5-year and once per 20-year peak flow events. The current peak 20-year flow exceeds the full-pipe capacity in more than 3,700 feet of the interceptor's 6,269 lineal feet total. Most of the pipes projected as overcapacity in 2050 are currently overcapacity.

The CSI project team recommends constructing a parallel sewer to route flows around the capacity-limited sections, bringing the Thornton Creek Interceptor up to the peak 20-year flow service level. This alternative is fully described in the *Part 4, Alternative A: Parallel Sewer to Increase Capacity* section of the report. The parallel sewer alternative is preferred, because it is dramatically less costly than reducing overflows through storage (Alternative B) and is more feasible than eliminating capacity shortfalls via I/I control (due to the magnitude of the capacity shortfalls and the local stormwater conveyance issues).

The CSI project team recommends implementing the entire preferred alternative without staged construction (i.e. constructing the three parallel sewer segments described in the *Part 4, Alternative A: Parallel Sewer to Increase Capacity* section of the report), because partially implementing the preferred alternative will not incrementally reduce the likelihood of overflows from the Thornton Creek Interceptor.

The next stages of project development should include:

- Verifying the capacity analysis using hydraulic modeling software that computes the surcharged water surface profile during large storm events
- Compare the challenges of routing the parallel sewer along the current right-of-way across private property versus building a potentially longer route with deeper sewers entirely within the public street right-of-way
- Evaluating the preferred alternative routes for congested utilities