

DRAINAGE SYSTEMS ANALYSIS

FLOODPLAIN RECONNECTION

Technical Memorandum

December 18, 2018

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Salmon in Longfellow Creek, Seattle. Holli Margell, 2009. http://nativelightphoto.com/

Thornton Creek Confluence Restoration, Seattle. Natural Systems Design, 2014. http://naturaldes.com

Flooding in South Park, Seattle. Sheila Harrsion, Seattle Public Utilities, 2009.

Lake Union, Seattle. Seattle Public Utilities Photo Archive, date unknown.

Floodplain Reconnection

Technical Memorandum

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Abbreviations

CIP	capital improvements projects
City	City of Seattle
DSA	Drainage System Analysis
DWW	Drainage and Wastewater
ECA	environmental critical areas
ESA	Endangered Species Act
GIS	geographic information system
ISP	Integrated System Plan
LIDAR	Light Detection and Ranging
SME	subject matter expert
SPU	Seattle Public Utilities
TM	technical memorandum

1. Introduction

The objective of this Floodplain Reconnection Topic Area Summary technical memorandum (TM) is to summarize opportunities to reconnect creeks to their historic floodplains. The work associated with this TM includes updating an analysis (Williamson 2009) that relied on a geographical information system (GIS) model to identify and prioritize floodplain reconnection opportunities on Seattle's five main salmon-bearing creeks. The prioritization was based primarily on site suitability (90 percent) and ecological value (10 percent).

The GIS model was originally developed for Seattle Public Utilities (SPU) by a graduate student (Scott Williamson) who provided an electronic copy of the analysis and associated map products, but not the GIS model. For this effort, SPU re-created the GIS model and updated SPU's GIS data to reflect two recently completed floodplain reconnection projects.

This TM presents background information on the Floodplain Reconnection Topic Area, the analysis method, results of the analysis, a discussion of results, and recommendations on how the results could be used for SPU's upcoming Integrated System Plan (ISP). Additional information is also provided on data gaps, potential future work associated with floodplain reconnection mapping, and other possible uses for this information outside of the ISP.

2. Background

Floodplains provide several important natural drainage functions. They store water, slow storm flows, allow for sediment deposition, cool surface waters by mixing them with colder groundwater, provide habitat and filter water using biological and physical mechanisms. Over the last century of urban development in Seattle, most of the floodplains have been filled in, covered by impervious surfaces, or disconnected from the creek channel by physical structures, roads, culverts, bank armoring or because of channel incising or recontouring of creek channels. These changes have led to reductions in flood storage, groundwater discharge, and natural water filtration, and have contributed to increased creek flooding and flashiness, bank erosion, increased sediment input into creeks, and declines in habitat quantity and quality.

One of SPU's mandates is to safely manage drainage in the public right of way. This has become an increasingly difficult task due to the loss of historic wetland and floodplain areas, limited availability and high cost of land space, coupled with on-going land use development and increasing impervious surfaces. Over the last two decades, floodplain reconnection has become increasingly recognized as an effective option for improving drainage (Rohde et al. 2005, Seavy et al. 2009). Reconnecting creeks to their historic floodplains could help SPU better manage drainage and, in some cases, help address flooding by increasing flood storage capacity. Compared with more traditional grey storage solutions, floodplain reconnection projects often provide added value such as improved habitat and community benefits. Also, unlike more traditional capital improvement projects (CIPs), which start to depreciate once constructed, habitat improvements tend to increase in value over time, as sites mature and provide more functions (e.g., increased canopy cover and shade, higher quality public green space, less erosive peak flows, more balanced sediment, wood, and gravel transport, and greater habitat diversity).

In 2009, SPU sponsored development of a GIS model by a University of Washington graduate student, Scott Williamson as part of his gradate thesis (Williamson 2009). The GIS model evaluated the suitability of sites, on the five main salmon-bearing creeks (Piper's, Thornton, Taylor, Fauntleroy, and Longfellow) for floodplain reconnection. In general, GIS model was used to identify the best opportunities for floodplain reconnection as "flood prone terraces of minimal slope at an accessible height above an armored stream bank" (Williamson 2009). These are broad, low-lying areas adjacent to creeks where adjacent uplands are separated from direct connection to the creek channel due to bank armoring. This assessment was based on the GIS model which identified and prioritized floodplain reconnection opportunities using a "suitability" calculation shown in Figure 1. The calculation assessed the selected sites for the following elements:

- *Physical suitability* (90 percent of the total score) is based on the average of five variables: percent slope, height above stream, bank armoring, flood prone area, and infiltration potential.
- *Habitat restoration potential* (10 percent of the total score) is based on the average of four variables: juvenile salmonids, salmonid redds, understory vegetation, and substrate material.

Overall Suitability

$$S = .90\ P + .10\ H$$

where:

S= Overall Suitability Score (1-10)
P= Physical Suitability Score (1-10)
H= Habitat Restoration Potential (1-10)

Figure 1. Floodplain reconnection suitability calculation

3. Methods

SPU completed the following tasks to re-create the GIS model developed by Williamson and identify priority floodplain reconnection opportunities:

1. Updated SPU's GIS data to reflect the two floodplain reconnection projects on Thornton Creek that were completed since the original analysis (Thornton Confluence and Knickerbocker projects). SPU's Urban Watercourse layer was updated with the current (post-restoration) creek channel configuration. The GIS update did not include changes in elevation of the creek channels.
2. Re-calculated suitability scores using methodology described in Williamson 2009, and using more current data including recently generated light detection and ranging (LIDAR) data, updated information on environmental critical areas (ECA), and newer juvenile salmon sampling data.
3. Performed quality assurance and quality control checks consisting of spot comparisons against the original thesis results.
4. Identified, using SME input, broad stream reaches with the highest suitability for floodplain reconnection. This was done visually by identifying the stream reaches that had the greatest

concentration of sites with high floodplain reconnection suitability scores. These areas are shown in the floodplain suitability maps in Appendix A.

4. Results

The floodplain reconnection suitability maps developed for this TM are presented in Appendix A. These maps indicate the floodplain reconnection suitability scores for the five major creeks. The results are similar to those produced in the original analysis. The maps also indicate the best opportunities for floodplain reconnection in each watershed. Of the five watersheds included in the analysis, Thornton Creek, Longfellow Creek, and Piper's Creek watersheds have the greatest floodplain reconnection opportunities. These are highlighted on the maps linked on the Drainage Systems Analysis SharePoint site below.

The current version of the Floodplain Reconnection DWW GIS layer is at: (https://seattlegov.sharepoint.com/sites/spu-D1/Planning/DWW%20GIS%20Library/Forms/AllItems.aspx)

A PDF copy of the 2009 Williamson thesis is available at: (https://seattlegov.sharepoint.com/sites/spu-D1/DSA/PPL/Forms/Floodplain%20Reconnection.aspx)

5. Discussion

Data and analysis limitations associated with this TM include:

- SPU's GIS data is not entirely accurate or complete with respect to elevations, channel armoring, or stream configuration so the attributes of any individual site are not precise which could affect the site score. The location of the creek, floodplain or individual site may vary from mapped locations.
- Suitability calculations were based on physical characteristics and did not consider land ownership and/or feasibility of obtaining permission or property rights for floodplain reconnection. Depending on how property is acquired there could also be negative impacts to individuals or communities.
- In the original analysis, the exact methods used to combine the floodplain raster units into floodplain management areas were not clear. A more precise ranking of individual sites could be done if the original model was better understood, although this is probably not necessary to support the ISP. The priority reaches identified by SMEs and the GIS layer should be enough for broad planning needs.
- Not all headwater wetlands were included in the analysis. Headwater wetlands provide the source waters for individual creeks. They are located high in the upper watershed where they function like a large sponge absorbing and collecting water which begins to flow as water accumulates and the grade becomes steeper. The exact boundary between the end of the wetland and start of the stream channel is not always known or mapped correctly. Some of the headwater wetlands are outside of the mapped extent of the creek layer (upstream of end of creek layer), and some are not immediately adjacent to the mapped creek channel and therefore, not included in the analysis. Headwater wetlands adjacent to creeks are often places where floodplain reconnection can be the most effective. These sites are located higher in the watershed so stormwater is treated as it flows through the wetlands and before it enters the stream. Additionally, some stormwater filters into the ground before entering the stream system. This recharges the supply of groundwater recharge and moderates stream temperature.

- Equity was not evaluated as part of the DSA floodplain reconnections analysis, as the methodology used to identify floodplain reconnection sites and areas of high suitability was entirely science-based. However, benefits and impacts from floodplain reconnection opportunities should be examined through an equity lens when sites are further prioritized, as mentioned in Sections 6.1 and 6.2.

6. Recommendations for Future Use

6.1 How Information Could be Used for ISP

This information could be used for the ISP to:

- Identify locations where floodplain reconnection projects may help reduce flooding and address drainage problems. This could be done by looking for overlap between flooding problems and sites with moderate to high suitability for floodplain reconnection. Adjacent headwater wetlands could also be included as potential sites for floodplain reconnection or protection (see Section 7.2 for additional details). Protecting headwater wetland areas upstream of floodplain reconnection sites could maximize the value of such restoration efforts (such as the West Fork headwater wetland of Taylor Creek).
- The City is a partner in regional salmon recovery efforts, and this information could help identify floodplain reconnection opportunities that could be developed by SPU (or others) to support federal Endangered Species Act recovery efforts for Chinook salmon. The Mapes Creek daylighting project is an example of successful stream channel improvements for Chinook salmon (Tabor et al. 2018) and could have been greatly enhanced with additional floodplain reconnection.
- Evaluate the potential for floodplain reconnection projects to reduce volume of flows into the combined system (i.e., may help to reduce sanitary sewer overflows or combined sewer overflows).
- Identify where floodplain reconnection opportunities could be combined with individual creek culvert CIPs to help slow flows and collect sediment to prevent potential downstream impacts often associated with culvert upsizing.
- Identify floodplain reconnection opportunities that would support broader City-wide goals around equity and open space/green space, climate change, and canopy cover. This information could be used to direct other agencies to sites that support the goals of multiple City Departments.
- Advance discussions with the Department of Parks and Recreation about its acquisition needs and to identify sites of mutual interest, which could include natural areas that provide multiple benefits, such as flood storage as well as meeting equity goals (e.g., access to parks and open space).

When considering project sites, feasibility should be considered. The most feasible sites for floodplain reconnection are likely to be those that are on, or adjacent to, public property, and/or parcels that are not heavily developed and/or where acquisition may be more likely. Seattle Parks and Recreation Real Property has been willing to partner with SPU to take ownership of floodplain parcels provided SPU completes floodplain reconnection and stream restoration. Examples include Thornton South Branch Kingfisher Natural Area, Thornton North Branch 125th Ave NE, and lower Taylor floodplain parcels.

In the future, an equity criterion should be included in the prioritization of floodplain reconnection opportunities. Floodplain reconnection projects provide open space/green space and siting of these projects

could help meet equity-based goals. However, depending on how property is acquired, there could also be negative impacts to individuals or communities.

6.2 How information could be used outside of ISP

This information might also be useful outside of ISP to:

- Identify sites that could be used by other City Departments or external entities as potential sites for alternative stormwater code compliance. Floodplain reconnection may be an alternative to traditional detention tanks or ponds and provides a broader range of benefits including open space/green space, habitat improvements, canopy coverage etc. SPU is proposing to evaluate this idea in a proof of concept effort that will compare the cost and benefits of grey versus green solutions in meeting alternative detention requirements for the Delridge Street Improvement project. Should this pilot be successful, there may be more interest and need in mapping the suitability of additional floodplain reconnection sites throughout the City.
- Support local, state, and federal grant requests. Many agencies are looking for projects that can provide multiple benefits including flood reduction and environmental or habitat improvements.

7. Additional Information

The following is provided as additional information.

7.1 Related DSA Topic Areas

Related DSA Topic Areas are 2.0 Flooding, 4.0 Fish Passage Barriers, and 6.0 Aquatic Habitat Opportunities. Floodplain reconnection projects may address known flooding problems, be associated with fish passage barriers and/or be combined with or complement aquatic habitat restoration or protection efforts.

7.2 Additional Work/Data Gaps

The model could be expanded and used to identify floodplain reconnection opportunities on all the creeks in Seattle. The scope of the original 2009 analysis and this TM, only included the five main salmon-bearing creeks in Seattle. In the absence of this analysis, the DWW line of business and individual project teams should keep floodplain reconnection opportunities in mind as DWW CIP projects are initiated and developed to consider whether floodplain reconnection could be part of a solution.

As part of a more comprehensive strategy to maximize the value of floodplain reconnection efforts, the floodplain reconnection suitability model and analysis could be modified to identify opportunities to enhance floodplain reconnection projects by including headwater wetland restoration or protection. Headwater wetland areas could be identified using the ECA maps (wetlands, riparian, and peat settlement areas), along with LIDAR, to identify flat plateau areas adjacent to the floodplain at the upper end of mapped watercourses. These headwater wetlands, if protected and/or restored, could provide additional water retention and treatment, stream temperature modulation, infiltration, and groundwater recharge.

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Appendix A: Floodplain Reconnection Suitability Maps by Watershed

Seattle Public Utilities

Drainage System Analysis Task 5

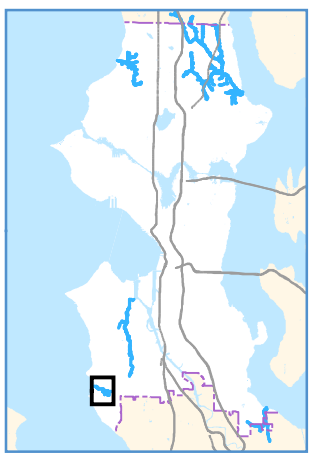
Floodplain Reconnection - Fauntleroy Creek

LINCOLN PARK

Puget Sound

FAUNTLEROY WAY SW

SW BARTON ST



LEGEND

Overall Suitability

High : 9.875

Low : 1

Best Opportunity Sites*

Focus Urban Watercourse

Parks

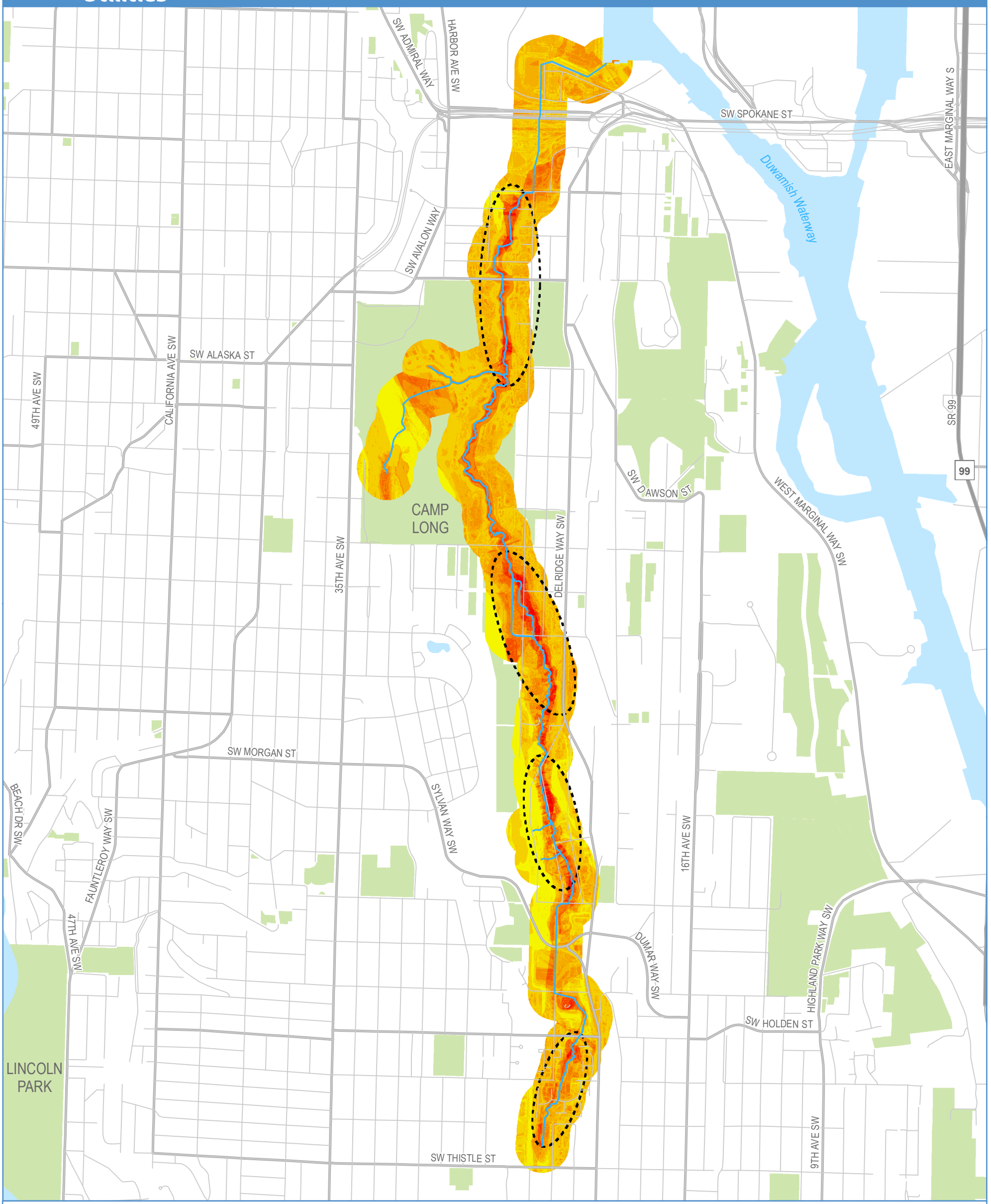
*The best opportunity sites were based on subject matter expertise considering the concentration of sites with high floodplain reconnection suitability and knowledge of sites.

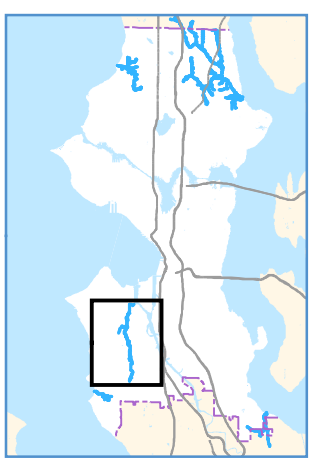
Author: SPU Shin Date: 12/11/2018 File Path: X:\Separated Systems\Business_Areas\DSA\GISLibrary\MXD\Task 5\Task5_FloodplainReconnection_DShin.mxd

Seattle Public Utilities

Drainage System Analysis Task 5

Floodplain Reconnection - Longfellow Creek





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Seattle Public Utilities

Drainage System Analysis Task 5

Floodplain Reconnection - Piper's Creek

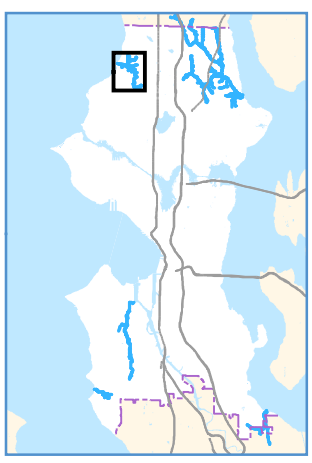
Puget Sound

CARKEEK PARK

3RD AVE NW

HOLMAN RD N

HOLMAN RD NW



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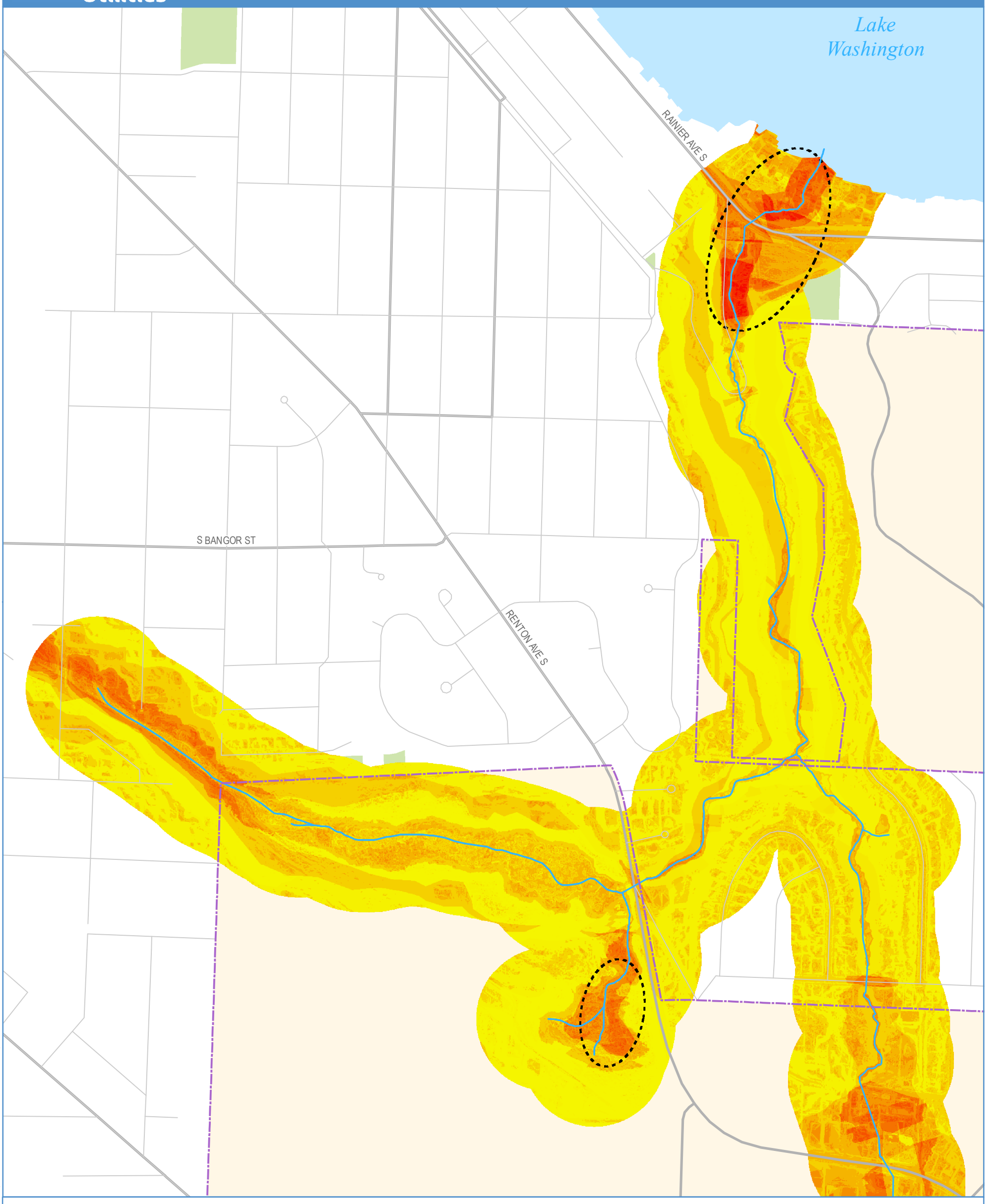
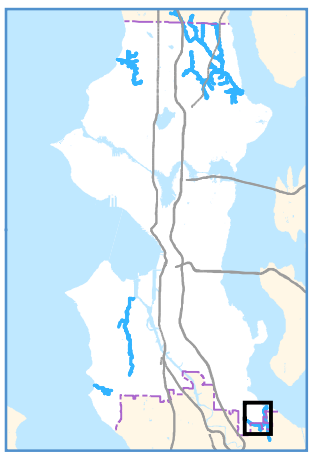
Seattle Public Utilities

Drainage System Analysis Task 5

Floodplain Reconnection - Taylor Creek





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Best Opportunity Sites*

Focus Urban Watercourse

City Limits

Parks

*The best opportunity sites were based on subject matter expertise considering the concentration of sites with high floodplain reconnection suitability and knowledge of sites.

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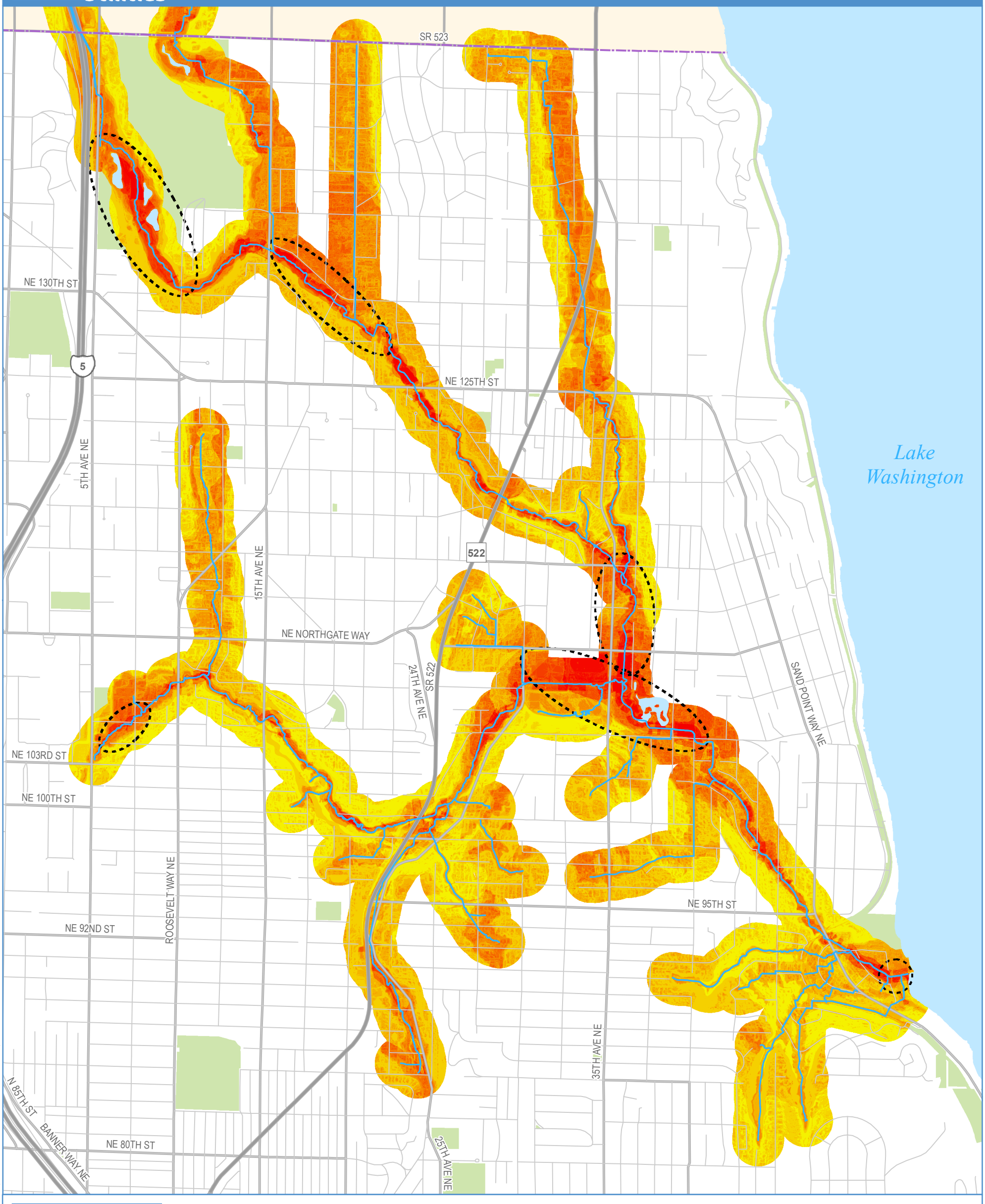
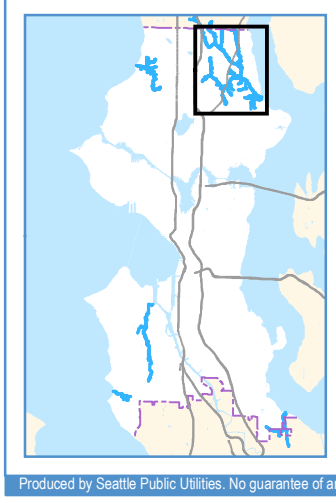
Seattle Public Utilities

Drainage System Analysis Task 5

Floodplain Reconnection - Thornton Creek





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