FAUNTLEROY CREEK CULVERTS REPLACEMENT

30% BASIS OF DESIGN TECHNICAL MEMORANDUM

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Prepared by:

DAVIDO CONSULTING GROUP, INC
OSBORN CONSULTING, INC
DAVID EVANS & ASSOCIATES, INC
WATERFALL ENGINEERING, LLC

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1. Introduction

1.1. Project Summary

Fauntleroy Creek is located in West Seattle, with its headwaters in Fauntleroy Park, draining east to west and discharging to the Puget Sound south of the Fauntleroy Ferry Dock (Figure 1-1). Of the three existing culverts along Fauntleroy Creek, two culverts (45th Ave SW and California Ave SW) have been identified as priorities for replacement by the Seattle Public Utilities (SPU) Culvert Program. Repair of the culverts was initially considered; however, SPU's pipe assessment group evaluated the culverts, noted their extensive structurally deteriorated condition, assigned a high risk of failure rating to each one and recommended replacements by 2019. In addition, the Washington Department of Fish and Wildlife (WDFW) will not permit repair of a small diameter culvert that is classified as a fish barrier. Therefore, the culverts must be replaced with structures that meet federal fish passage requirements. The 45th Ave SW culvert is entirely owned by SPU, whereas the California Ave SW culvert is partially owned by SPU and partially owned by (and located on) the Fauntleroy Church, United Church of Christ (Fauntleroy Church) property. The downstream Fauntleroy Way culvert was replaced in 1998 and is not included in this project. Refer to the Fauntleroy Creek Culverts Replacement Project Preliminary Engineering Report (DCG, Inc. 2019) for additional background information.

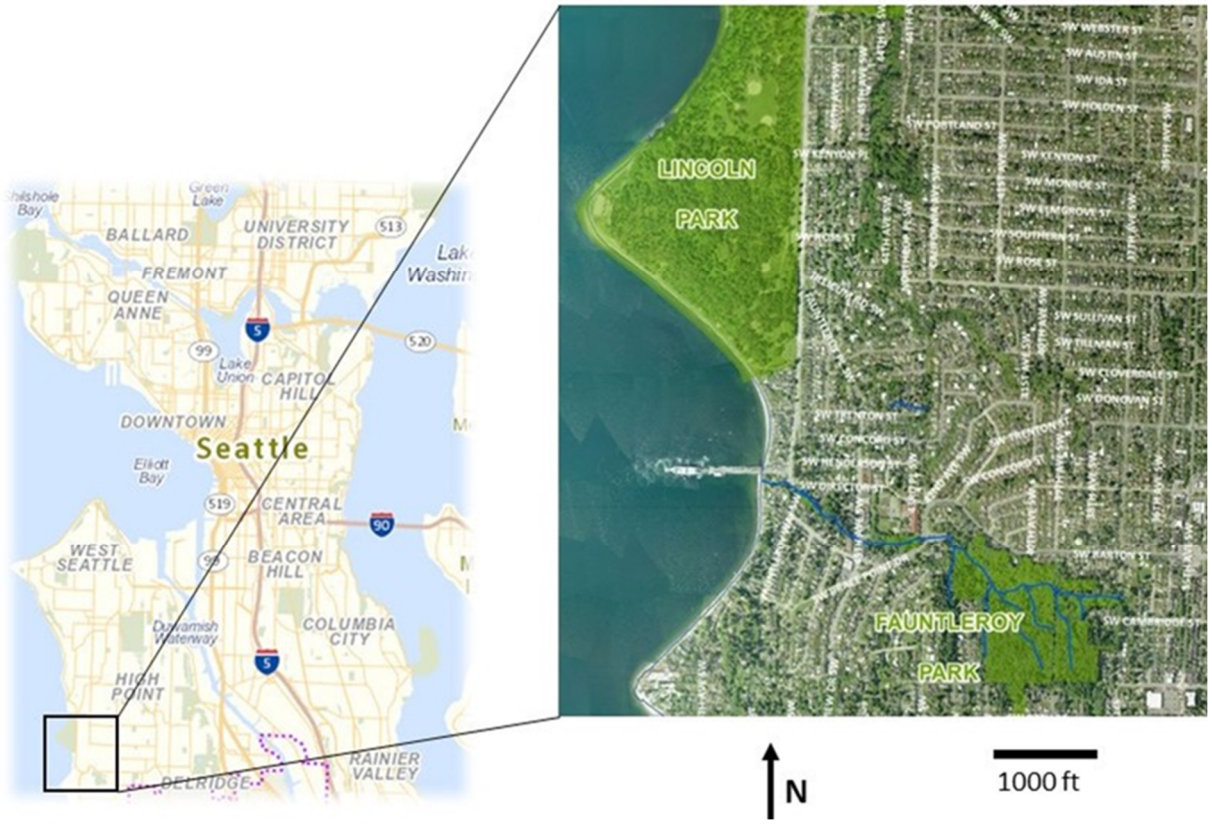

Figure 1-1. Project Vicinity and Site Map

1.2. Purpose of Basis of Design

This report documents the design methodology and assumptions employed by the design team for completing the design of the Fauntleroy Creek Culverts Replacement Project. This Basis of Design will be updated as needed as design progresses.

The Basis of Design is a collaborative effort between SPU and the Davido Consulting Group (DCG), Inc. team (Consultant Team). The Consultant Team consists of Osborn Consulting, Inc. (OCI), and David Evans and Associates, Inc. (DEA).

1.3. Stakeholders

The design will be developed with the intention of representing the objectives of the following stakeholders:

- SPU
- SDOT
- Seattle Parks Department (SPR)
- Homeowners adjacent and near the project
- The Fauntleroy Church and Fauntleroy Hall
- Neighborhood Groups
- Environmental Groups
- Tribes
- Design Professionals

2. Applicable Codes and Standards

The Fauntleroy Creek Culverts Replacement Project will be designed based on standards and codes set by the City of Seattle (SPU, Seattle Department of Transportation [SDOT], Seattle Parks Department [SPR], Seattle City Light [SCL], Seattle Department of Construction and Inspections [SDCI]), State agencies (WDFW, Washington Department of Ecology [Ecology]), and federal agencies (Army Corp of Engineers [USACE] with input from the Tribes, U.S. Fish and Wildlife Services [USFWS], National Marine Fisheries Services [NMFS], and the United States Access Board) (see Table 2-1).

Table 2-1. Codes and Standards

Standard or Code	Applicable Components
SPU Design Standards and Guidelines	Water, Drainage and Wastewater
SPU Cost Estimating Guidelines with 2017 Unit Costs	Cost Estimate
City of Seattle Standard Plans for Municipal Construction, 2020 Edition	Site and Roadway Restoration, Culvert Design
City of Seattle Standard Specifications for Road, Bridge, and Municipal Construction, 2020 Edition	Site and Roadway Restoration, Culvert Design

Table 2-1. Codes and Standards	
Standard or Code	**Applicable Components**
Seattle Department of Transportation, Streets Illustrated, the Right-of-Way Improvements Manual	Right-of-way Design and Restoration
Seattle Department of Transportation, Right-of-Way Opening and Restoration Rules, 2017	
DRAFT 2021 City of Seattle Stormwater Manual (January 2021)	Site Restoration, Storm System Design, Culvert Design
SPU/SDOT Inter-Departmental CAD Standard (Design and Construction Phase)	Site and Roadway Restoration, Culvert Design
2018 International Fire Code (IFC) with Seattle Amendments	Private Driveway Access
2014 United States Access Board, Outdoor Developed Areas	Site Restoration, Passive Park Design
Hydraulic Code of Washington (RCW 77.55 and WAC 220-660)	In-Stream Construction
Fish Passage (RCW 77.57.030, WAC 220-660-190, WAC 220-660-200)	In-Stream Construction, Fish Passage Design
WDFW 2012 Stream Habitat Restoration Guidelines	Stream Habitat Restoration Design
DPD Shoreline Master Program (SMC 23.60A)	Shoreline Construction
2017 Edition Seattle Parks and Recreation Standards	Restoration Area Park Amenities
Streets Illustrated: Seattle's Right-of-Way Improvements Manual	Right-of-Way Restoration
WSDOT Bridge Standard Drawings	Right-of-Way Restoration, Culvert Design
WSDOT Bridge Design Manual (BDM) – 2020	Culvert Design
WSDOT Geotechnical Design Manual – 2020	Culvert and Wall Design
WSDOT Hydraulics Manual - 2019	Fish Passage Design
2020 AASHTO LRFD Bridge Design Specifications, 9th edition	Culvert Design
2018 International Building Code (case by case basis)	Roadway Restoration (if applicable)
Shoreline Management Permit and Enforcement Procedures (WAC 173-27)	Shoreline Construction
Shoreline Management Act of 1971 (RCW 90.58)	Shoreline Construction
Army Corps of Engineers Standards – Biological Evaluation (BE)/ Biological Assessment (BA), Wetland Delineation (if applicable), Mitigation Plan	In-Stream Construction, Fish Passage Design, Site Restoration, Dredging
WDFW 2013 Water Crossing Design Guidelines (WCDG)	In-Stream Construction, Fish Passage Design, Culvert Design, Site Restoration
Seattle Municipal Code (SMC) 23.60.220 Environments established.	Public Access
SMC 23.44.006 and 23.47A.004	Parks and Open Spaces
SMC 23.47A.016, SMC 23.54.030	Parking space, access standards, landscaping
SMC 25.11 and Seattle Directors Rule 16-2008	Tree Protection and Designation of Exceptional Trees

3. Stream and Culvert Design Concepts

3.1. Fish Passage Design Methodology

WDFW has identified two total barriers to fish passage at the 45th Avenue SW and California Ave SW crossings of Fauntleroy Creek. These crossings will be addressed as part of the Fauntleroy Creek Culverts Replacement Project, which will replace the existing culverts with fish passable structures that incorporate a step-pool channel morphology to accommodate the steep channel gradient. To design the proposed structures, a fish passage methodology that is suitable to the existing site conditions must be selected from guidance provided in the WCDG and Section 220-660-190 of the WAC.

As the 45th Avenue SW and California Avenue SW crossings both have channel slopes exceeding 3%, bankfull widths less than 15 feet, and floodplain utilization ratios below 3.0, the stream simulation methodology has been selected. The intent of stream simulation is to simulate a channel with natural stream characteristics and habitat that will provide fish passage. This methodology will be used for both the California Avenue SW and 45th Avenue SW culvert designs.

3.2. Design Flows and Climate Change Impacts

Preliminary design flows were developed by Aqualyze, Inc. based on the SWMM5 model for the Fauntleroy Creek first developed in 2010 and extensively revised and calibrated in 2018. The modeling approach including development of design flows using the SWMM5 model is detailed in the 30% Modeling Approach Memorandum (DCG, Inc. 2020). The previous calibration was validated against stream flow data during the 30% design effort. The validation results and proposed design flows are summarized in the SWMM5 Model Validation Memo (MSA 2021). Table 3-1 shows the preliminary design flow values. To incorporate increased peak flows resulting from climate change, the 100-year peak flow will be increased by 20-percent to approximate year 2100 climate adjusted flow rates.

Table 3-1. Preliminary Design Flows[1]

Design Flows	Existing 24-hour Peak Discharge (CFS)[2]	Anticipated Future 24-hour Peak Discharge (non-attenuated) (CFS)[3]
1-Year	3.1	3.1
2-Year	8.5	8.4
10-Year	N/A	17.2
25-Year	21.1	23.0
50-Year	25.0	28.2
100-Year	29.2	34.0
Year 2100 100-Year	-	40.8

[1] Peak Flows were calculated using Log-Pearson type III method to estimate peak flows for a range of intervals from long-term simulation with 40-years of historic rainfall adjusted for 2035 climate.

[2]Downstream of 45th Ave SW culvert; existing 24-hour peak discharge rates attenuated by undersized culvert.

[3]Downstream of 45th Ave SW culvert; anticipated 24-hour peak discharge rates assume attenuation from existing culvert is removed.

3.3. Reach Assessment

A reach assessment is necessary to inform fish passage crossing design using the stream simulation design methodology. The WCDG recommends using a reach upstream of the existing culvert, where impacts of an undersized culvert are not accounted for in the assessment. The WCDG recommends determining the following stream characteristics to inform the fish passage crossing design:

- Channel type
- Bankfull width
- Flood plain utilization ratio
- Prevailing stream gradient
- Long profile
- Bed material gradation

The existing stream geometry is characterized by the parameters and estimates provided in Table 3-2. These stream elements have been documented in the Bankfull Width Memo (OCI 2018), OHWM Memo (OCI 2018), and Geomorphology Report (OCI 2019).

Table 3-2. Stream Geometry Design Parameters

Parameter	Value	Comments
Manning's n	0.075*	Represents the hydraulic roughness of the channel for a gravel substrate and rough irregular boundaries (used for hydraulic sizing of channel). In the proposed condition, this will be modified to vary according to stream reach and roughness of the varying channel segments (Yochum and Bledsoe 2010). Yochum and Bledsoe completed a study that provides physical interpretations of Manning's n and discusses why higher values should be used rather than values listed in previous research (Chow 1959). *Manning's n value is based on field observations during geomorphology assessment (OCI 2019).
Slope	0.054-0.056 ft/ft	Average slope over representative reach.
Channel top width	7 ft	Average channel top width (bankfull width). Determination of bankfull width documented in technical memo (OCI 2019).
Channel depth	0.50 ft	Average channel depth at bankfull flow based on the existing model which will be varied in the proposed design to represent the channel depths of steps and pools. Channel depth based on the average bankfull depth at 19 surveyed cross-sections.

Table 3-2. Stream Geometry Design Parameters		
Parameter	**Value**	**Comments**
Sinuosity	1.1	Represents the ratio of stream length to valley length. Measurements were taken throughout the valley and do not include the existing culvert area.
Width/depth	8	Ratio of the channel top width divided by average channel depth is used as a delineator of channel type, influences sediment transport capacity, and indicates the connectivity of the floodplain.
Channel type	A4	Rosgen stream Type A4, tending towards type E channel (Rosgen 1994).
Meander Length	120 ft / 78 ft	Measured from survey data/approximate "typical" channel meander length for one full meander in an unconstrained setting (WDFW 2012).
Radius of Curvature	175 ft	Approximate average radius of curvature measured from survey data.
Belt Width	16 – 26 ft, 21 ft (average)	Minimum and maximum "typical" floodplain widths over a range of most constrained to least constrained. Average value for "typical" floodplain width for this channel size and type (WDFW 2013).
Floodplain Utilization Ratio	18.8/7 = 2.7	Represents the ratio of the floodplain width to the bankfull width (WDFW 2012).

3.4. Culvert Width Sizing

The culvert bed width at both crossings has been determined per the stream simulation methodology using field measurements of bankfull width and Equation 3.2 of the WCDG. The average bankfull widths measured in the field were found to be approximately 6.4 feet and 6.6 feet for the California Avenue SW and 45th Avenue SW culverts, respectively. A bankfull width of 7 feet has been selected for sizing the proposed culvert structures.

The minimum width of the culvert using the stream simulation methodology is calculated as follows:

- For culverts with length-to-width ratio less than 10:

Equation 3.2

$$W_{culvert\ bed} = 1.2 * W_{ch} + 2 \text{ (in feet)}$$

- For culverts with a length-to-width ratio greater than 10:

$$W_{culvert\ bed} = 1.3 * \text{(Equation 3.2)} = 1.3 * (1.2 * W_{ch} + 2) \text{ (in feet)}$$

Where: W_{ch} = the width of the bankfull channel.

$W_{culvert\ bed}$ = minimum width of bed in culvert, rounded up to the next whole foot.

Therefore, the culvert widths calculated using the stream simulation methodology are:

- For standard culverts with a length-to-width ratio less than 10:

Wculvert bed = 1.2 * 7 + 2 = 10.4 feet

Wculvert bed = 11 feet.

For long stream simulation culverts with a length-to-width ratio greater than 10, the WCDG recommend increasing the culvert width by 30 percent to accommodate a meandering channel within the culvert for increased roughness. In addition to the added roughness resulting from the increased structure width, a step-pool channel morphology within the structure will provide additional channel complexity. The long culverts are calculated as 14 feet wide per the following:

Wculvert bed = 1.3 (1.2 * 7 + 2) = 13.5 feet

Wculvert bed = 14 feet

Per Equation 3.2 of the WCDG, the minimum clear span for both the California Avenue SW and 45th Avenue SW culverts is 11 feet. The minimum opening will be increased to 14 feet based on guidance provided for long culverts, which will conservatively provide high capacity for flows and meet stream simulation criteria.

3.5. Culvert Height and Freeboard

The WCDG provide general recommendations for freeboard within culverts. According to the guidelines, culverts with a bankfull width less than 8 feet are recommended to have a clearance of 1 foot above the 100-year water surface elevation. It is noted that the recommended clearances are not based on empirical studies or hydraulic modeling.

Hydraulic modeling will be used to analyze the 100-year event through the proposed culvert crossings. Clearance through the culvert will depend on various factors, including steam channel design, channel slope, structural limitations of precast concrete culverts, and maintenance access. A minimum of 1-ft of freeboard above the 100-yr water surface elevation will be provided. The proposed design will have a minimum of 6-ft of clearance from the creek thalweg to the top of culvert for maintenance access.

3.6. Stream Alignment and Profile

The proposed design includes approximately 1,230 linear feet of stream channel enhancements which will incorporate a step-pool channel morphology, large woody material, and channel regrading through the Kilbourne Ravine. The existing culvert alignment at the California Avenue SW crossing will be shifted north, and through the existing church parking lot. Upstream of the proposed culvert structure the stream will be conveyed within a segment of vertical-walled channel to increase ecological connectivity. Where the open-channel alignment transitions to the vertical walled segment the radius of curvature of the channel bend will exceed five times the bankfull width, such that sediment and debris transport are essentially the same as on a straight reach (Forest Service Stream-Simulation Working Group Ed. 2008). The proposed

channel alignment through the Kilbourne Ravine is generally consistent with the existing alignment and incorporates a similar degree of sinuosity. The stream channel alignment at the 45th Ave SW crossing will approximate the existing condition and the proposed 45th Ave SW culvert will have a slight curve to minimize impacts to adjacent properties. Where the open channel transitions to the culvert inlet, the radius of curvature of the channel bend entering the 45th Ave SW culvert will exceed five times the bankfull width.

To meet stream simulation criteria, proposed fish passage crossings must have a slope ratio no greater than 1.25. The slope ratio is defined as the ratio between the proposed culvert bed gradient and natural channel gradient (typically measured upstream of the existing culvert). To determine the natural channel gradient, a long profile was created which incorporated topographic survey data and supplemental LiDAR data, extending approximately 1,200 feet upstream of the existing California Ave SW culvert crossing and 680 feet downstream of the existing 45th Ave SW culvert crossing. The natural channel gradient was calculated as 5.2 percent, measured between approximately 350 feet and 1,200 feet upstream of the California Ave SW crossing. The gradient was measured outside the limits of the backwater created by the existing culvert and upstream of an exposed segment of Lawton Clay. In general, the average channel slope through the project limits is approximately 5.5 percent. Based on the natural channel gradient measured upstream of the crossing, the slope of the proposed culvert crossings must be below 6.5 percent to satisfy the slope ratio stream simulation criterion. Beginning at the upstream grading limits, the proposed design incorporates a channel slope of 5.7 percent which transitions to a slope of 5.4 percent just upstream of the 45th Ave SW crossing. The resulting slope ratio for both proposed channel slopes is 1.0, beneath the 1.25 limit.

3.7. Stream Channel Design

To accommodate the steep channel slope within the project limits, a step-pool morphology will be incorporated into the proposed design consistent with guidance provided in the WCDG and channel morphologies typically found at similar gradients. Steps are formed by larger cobbles, boulders, and large woody material that interlock, and pools are low points in the channel profile (below the average grade line). Large woody material will be anchored as needed using natural methods and will create spawning and rearing habitat by reducing flow velocities in portions of the creek. While the bed will be engineered, it will be created using natural channel design properties.

The D_{84} of Streambed material within the Kilbourne Ravine will be calculated using the Unit-Discharge Bed Design methodology and 100-year design flow as recommended in the WCDG for channels with gradients exceeding 4.0% (WDFW 2013). Additional particle sizes including the D_{100}, D_{50}, and D_{16}, will be determined using Equations 3.6, 3.7, and 3.8 of the WCDG, respectively. The existing D_{84} is about 1-inch and the proposed D_{84} in the channel is approximately 5-inches. The WCDG recommend that for gradients exceeding 4 percent the streambed substrate should be composed of materials that are not generally mobile at any but the highest expected flows. As the existing bed material mobilizes at the 2-year flow event, the proposed material is larger to maintain channel stability.

3.8. Culvert Bed Design

To accommodate the steep channel slope through the proposed culverts, a step-pool morphology will be incorporated into the proposed design consistent with guidance provided in the WCDG and channel morphologies typically found at similar gradients. Steps are formed by the larger cobbles and boulders, and the pools are low points in the channel profile (below the average grade line). While the bed will be engineered, it will be created using natural channel design properties.

The D_{84} of Streambed material within the culverts will be calculated using the Unit-Discharge Bed Design methodology and 100-year design flow as recommended in the WCDG for channels with gradients exceeding 4.0% (WDFW 2013). The calculations will also consider maximum shear stress values during the 100-year flow event in the steep areas downstream of each step. Additional particle sizes including the D_{100}, D_{50}, and D_{16}, will be determined using Equations 3.6, 3.7, and 3.8 of the WCDG, respectively. The existing D_{84} is about 1-inch and the proposed D_{84} in the culverts ranges from approximately 7.5-inches in the channel bars and pools to 15-inches in the steps. The existing average stream profile within the project limits of 5.4 percent is controlled by smaller sediment and large woody material, as such the streambed material in the culvert will be larger than the existing gradation to account for the loss in roughness provided by large woody material outside the structures. The WCDG also recommend that for culvert gradients exceeding 4 percent the streambed substrate should be composed of materials that are not generally mobile at any but the highest expected flows. As the existing bed material mobilizes at the 2-year flow event, the proposed material is larger to maintain channel stability.

Multiple scour mechanisms will be analyzed as components of total scour at the 45th Ave SW and California Ave SW crossings. These mechanisms are summarized below, and will include contraction scour, abutment scour, and wall scour. The 100-year flow event was selected as the design storm used for the scour analysis, and the 500-year flow event was used as a check.

- Contraction scour - equations provided in the United States (US) Federal Highway Administration (FHWA) Hydraulic Engineering Circular (HEC) 18: Evaluating Scour at Bridges (FHWA 2012).
- Abutment scour - NCHRP methodology provided in HEC 18 (FHWA 2012).
- Wall Scour - using Equations 4.3 and 4.4 for scour at longitudinal structures in HEC 23: Bridge Scour and Stream Instability Countermeasures (FHWA 2009)
- Bend scour - using the Thorne equation (FHWA 2012).
- Long-term aggradation and degradation calculations will be completed for the 60% design based on equations provided in HEC 20: Stream Stability at Highway Structures (FHWA 2012).

3.9. Stream Bypass and Dewatering

A temporary stream bypass will be used to isolate the in-water work area. The bypass will include gravel bag berms or other materials to block flow and either a gravity pipe or a force main to convey flows around the work area. The contractor will be responsible for pump sizing and bypass pipes, based on typical flow rates during the in-water construction window. Flow

rates will be available from the previous hydrologic modeling results. Items such as sediment mats, riprap, or other erosion control measures will be used to prevent erosion at the bypass pipe outlet.

Block nets will be used on the upstream and downstream ends of the bypass to capture and move fish out of the work area prior to the work and to prevent fish from entering the bypass equipment areas during the work. Fish capture and removal will be performed by a qualified biologist.

Construction dewatering will be designed based on expected groundwater flows provided by the geotechnical engineer. Dewatering will include filter bags and other appropriate materials as needed to remove sediment material and pollutants before discharging to the steam. The contractor will be responsible for sizing of dewatering pumps and pipes.

3.10. Sediment Management

OCI documented the results of a preliminary geomorphology analysis to inform the evaluation of effects on channel morphology and sediment transport dynamics. Based on the documented morphology of the channel, stream simulation design methodology for a fish passable culvert design is appropriate for Fauntleroy Creek. The WCDG (Barnard 2013) provides guidance for the acceptable design approaches for fish passable culverts and bridges. The geomorphology of Fauntleroy Creek met the technical criteria for applying the stream simulation design methodology. The channel is moderately confined and exhibits lateral and vertical channel stability. The existing stream gradient, outside of culverts, averaged 4 to 5 percent, and the sediment load was not excessive.

The sediment transport analysis focused on evaluating bedload sediment transport. Suspended sediment transport typically moves more sediment mass quicker than bedload transport, but the sediment load is composed of fine sand and silt. Suspended sediment can have a large effect on the streambed, but that effect is limited to low gradient or low energy locations that force deposition from sediment upstream. The Fauntleroy Creek channel (outside of culverts) within most of the study area is relatively steep and changes in channel morphology, in response to sediment dynamics, are driven by bedload transport processes. Locations that have predominantly sandy bed material (e.g. the larger pools and fish ladder pools upstream of 45th Avenue SW culvert,) can be filled up with suspended load material. Neither of the future stream simulation-designed culverts should have any issues related to fine sediment accumulation as long as the channel gradient through each culvert is equal to or slightly steeper than their respective upstream open channel segments. The aggregate will be designed so that sediment accumulation equilibrium will be reached, and therefore prevent aggradation or scour.

Replacement of the two culverts may affect the timing of future sediment delivery to the lower segment of Fauntleroy Creek downstream of 45th Ave SW. Under the present condition flow and sediment transport are both constrained by culvert capacity and temporary blockages cause backwater and sediment deposition upstream of the culverts. Replacement culverts will have increased hydraulic capacity and a much lower chance of becoming blocked by debris. Future sediment will be routed through the culverts rather than be forced to deposit and stored upstream of the culverts. This effect may be somewhat mitigated by introducing more wood structures in the streambed to trap and store sediment. Existing in-stream woody structures are effectively storing sediment and metering the rate of sediment transport. With or without the

culverts the channel will adjust itself through erosion and deposition to approach an equilibrium condition in which sediment delivery is determined by sediment supply. It is recommended that any stabilization measures and instream wood structures installed to mitigate downstream sediment delivery rates be monitored to determine if they remain in place and document the effectiveness in storing sediment. Further refinement during the design phase should consider adequate maintenance access to instream sediment control structures.

Estimated total sediment load for the 24-hour duration 100-year flow event was approximately 3.3 tons. Estimated cumulative total sediment load for the 2017–2018 wet season was 3.1 tons. This estimate is based on sediment transport capacity. Actual sediment delivery may be less if the available sediment supplied to the channel, by slope processes and channel erosion, is less than the hydraulic transport capacity. Total sediment delivery may be more in situations where a large volume of sand and silt is delivered quickly to the stream and where short-term high suspended sediment loads are deposited in the streambed as high flows subside. The estimated sediment loads for the flow scenarios evaluated are a small fraction of the available sediment stored in the channel. This is an indication that the channel is not in a "sediment starved" condition and provides additional evidence that the channel profile is vertically stable.

3.11. Post-Construction Monitoring Plan

A post-construction monitoring plan may be implemented to periodically assess the functionality of the proposed fish passage structures and perform routine maintenance. Maintenance may include activities such as removing large woody material and debris that has entered the culvert or otherwise impacted channel function. Some crossing types which do not strictly adhere to fish passage guidelines provided in the WAC require periodic inspection at an interval determined by the engineer and relevant agencies, or prescribed in the WAC.

4. Civil Design Concepts

The Civil Design Concepts section of this report will address civil site work associated with the proposed culvert, creek realignment, roadway improvements and modifications to the Fauntleroy Church parking lot.

The existing properties in the area are a combination of residential, commercial, the Fauntleroy Church, Fauntleroy Hall, and City ROW. The topography generally slopes towards the Puget Sound from east to west. Conflicting utilities will be demolished and/or relocated. Proposed civil site improvements include stormwater collection, grading, sidewalk/roadway paving, parking improvements/refinements and utility conflict resolution. Creek alignment and restoration design are addressed above in Stream and Culvert Design Concepts.

4.1. Site Control Elevations

The site control for the project is based on the project survey prepared by SPU, dated 06/25/2020 The survey references Washi. ngton State Plane Coordinate System, North Zone, NAVD88 vertical datum, and NAD83-2011 horizontal datum. The survey contains a network of City-recorded monuments encompassing the project that will be used for horizontal control as well as three vertical control points.

4.2. Zoning and Land Use

Per DPD Zoning Maps 177 and 178, the proposed Fauntleroy Creek alignment primarily passes through residential zoning (SF5000 and LR2). Chapters 23.44.006 and 23.47A.004 of City of Seattle Municipal Code (SMC) state that Parks and Open Spaces are principal uses permitted outright for the single family residential and neighborhood commercial zones that apply to the project. Subsequent sections of the SMC relate to typical residential and commercial construction, which does not apply directly to the project.

4.3. Geologic and Geotechnical Considerations

Geologic and geotechnical considerations are addressed in the Geotechnical Report (SPU 2020).

4.4. Existing ROW Utilities

The replacement, relocation, temporary protection and temporary bypass of existing utilities has been addressed in design and there will be continued coordination with utility owners as the design progresses. Known utilities in the Right-of-way (ROW) at each site are summarized below.

45th Ave SW

- Overhead power and communications lines. To be temporarily removed/relocated during construction by Seattle City Light, coordination will continue throughout the design process.
- 8-inch water main and associated services. To be temporarily capped and removed within the project limits during construction, then replaced by Contractor with SPU leading cut/cap and final tie-in of new water main.
- 8-inch public combined sewer main is located on the east side of 45th Ave SW on the north end of the project near limits of work. Relocation and bypass is not anticipated to be required.
- Stormwater detention facility (Endolyne) and maintenance holes in the street-end of SW Barton St on the east side of 45th Ave SW, and associated pipe that discharges to creek upstream of culvert inlet. To be temporarily removed during construction by the Contractor. A temporary storm bypass will be required, and replacement per the contract plans after construction of the culvert.
- Storm inlets and laterals in the street end on the east side of 45th Ave SW. To be temporarily removed during construction by the Contractor. A temporary storm bypass will be required, and replacement per the contract plans after construction of the culvert.
- All additional utilities within the proposed pavement restoration area but beyond the limits of proposed culvert excavation will be protected in place during construction. Such utilities include, but are not limited to, storm drain structures and pipes, water main and associated services and meters, gas, and communication lines.

California Ave SW

- Overhead power and communications lines, and utility poles. To be temporarily removed/relocated during construction by Seattle City Light, coordination will continue throughout the design process.
- 42-inch pipe storm drain (PSD) and associated drainage structures and laterals. To be temporarily removed during construction by SPU. A temporary storm bypass will be required.
- 8-inch water main and associated services. To be temporarily capped and removed during construction by SPU. No bypass is needed. It is anticipated that potholing will be conducted to determine the elevation of the water main.
- 1-1/4- to 2-inch diameter gas line (size varies with location). To be relocated/supported during construction pending further coordination with Puget Sound Energy.
- 12-inch by 24-inch communication bank (Century Link). To be relocated/supported during construction pending further coordination with Century Link.
- 24-inch clay culvert. To be removed and replaced with a fish passable culvert. It is anticipated that the existing culvert will not be used for temporary stream bypass due to the location.
- There is no sewer main located within the California Ave SW right-of-way in the vicinity of the project.
- All additional utilities within the proposed pavement restoration area but beyond the limits of proposed culvert excavation will be protected in place during construction. Such utilities include, but are not limited to, storm drain structures and pipes, water main and associated services and meters, gas, and communication lines.

4.5. Stormwater Management

Stormwater management regulations ensure safe and efficient conveyance of stormwater runoff caused by impervious land surfaces in urban environments, alleviating the risk of flood damage. This project will adhere to the requirements as defined in the DRAFT January 2021 Seattle Municipal Code, Stormwater Division (SMC 22.800 – 22.808), which references the DRAFT 2021 Stormwater Manual. Stormwater analysis will be performed per the guidelines defined in the Seattle Municipal Code.

Project classification and stormwater requirements are detailed in the Fauntleroy Creek Culverts Replacement Drainage Report (DCG, Inc. 2021). Based on conversations with SPU, the project is classified as a Retrofit Project per the DRAFT 2021 Stormwater Code and is exempt from stormwater code requirements for all portions of the project located in the ROW and on private property. Therefore, no new flow control or water quality requirements apply to the project, although existing flow control treatment that appears to have been built by the Endolyne project, will be replaced in kind per discussions with SPU.

45th Ave SW

No public storm or public sewer system extensions will be required for the 45th Ave project site within 45th Ave SW or the street ends to the east and west of 45th Ave SW. However, structures and lateral / collection pipes will be required to provide discharge to Fauntleroy Creek.

Grading and paving will direct stormwater to maintain the existing drainage paths and stormwater basins which result in discharge to Fauntleroy Creek, existing public combined sewer system in 45th Ave SW, and the existing storm system in SW Wildwood Pl via existing private storm conveyance systems.

An existing detention structure located in the east street end which outfalls to Fauntleroy Creek will be removed and replaced. in-kind replacement for the size and extents of the existing structure. The detention structure will collect similar runoff as well as from unconfirmed areas within the Endolyne Apartments property at 9212 & 9214 45th Ave SW parcel 234670-0000.

A series of storm structures will be used to collect surface runoff and any accumulation of runoff in the stairs and areas upstream and downstream of the culvert. These storm structures will also be connections for footing drains for walls and stairs upstream and downstream of the culvert. Footing drains will collect groundwater and route it via 4" and 6" pipes. The storm system of surface runoff and groundwater should be routed to discharge via energy dissipation above the ordinary highwater mark of the new stream alignment. A sump will be included prior to discharge of these systems for settlement of fines prior to entering Fauntleroy Creek.

Due to depth of the footing drains for the retaining walls at culvert inlet and outlet, non-standard extra depth catch basins, Type 241, are proposed.

California Ave SW

Grading and paving will direct stormwater to the proposed and/or existing storm system.

However, to provide additional environmental benefits to the project, water quality facilities are being installed as a part of the Fauntleroy Church parking lot improvements. The proposed drainage system will discharge to both the PSD along California Ave SW as well as directly to Fauntleroy Creek. The proposed system discharging to the public storm drain system will receive basic water quality treatment while flows discharging to the creek will undergo enhanced water quality treatment.

The stormwater conveyance for California Ave SW ROW will match existing conditions. The proposed work in the ROW will not require any changes to the storm conveyance system except for replacing 44-feet of the 42-inch PSD.

The Fauntleroy Church parking lot improvements will include significantly re-grading the parking lot. Proposed stormwater conveyance for the parking lot will include four water quality treatment facilities, three new catch basins, and one new storm maintenance hole. The majority of stormwater from the upper lot will drain to Water Quality Facility 1, prior to discharging to the PSD. Approximately 980 square feet of driveway drainage will bypass the water quality facility and discharge to the PSD un-treated. The middle parking lot is split into two subdrainage basins. The western portion of the lot drains to Water Quality Facility 2, prior to discharging to the PSD. Approximately 340 square feet of the driveway will bypass the water quality facility

and discharge to the PSD un-treated. The eastern portion of the middle parking lot drains to a catch basin and is conveyed to Water Quality Facility 4, prior to discharging to the Fauntleroy Creek. The lower parking lot is also split into two subdrainage basins. The western portion of the lot drains to Water Quality Facility 3, prior to discharging to the PSD. The eastern portion of the middle parking lot drains to Water Quality Facility 4, prior to discharging to the Fauntleroy Creek. The roof runoff from the Fauntleroy Church will bypass the water quality treatment facility and discharge directly to Fauntleroy Creek, matching existing flow patterns.

4.6. Construction Stormwater Pollution Prevention Plan (CSWPPP) and Construction Stormwater and Erosion Control (CSEC) Plan

Construction site stormwater pollution prevention control is required for all construction projects within the City of Seattle. Best management practices, as outlined in the DRAFT 2021 City of Seattle Stormwater Manual, will be utilized for erosion and sediment control. A draft CSWPP outline is provided with the 30% design deliverable under separate cover. The CSEC measures are shown on the Site Preparation & CSEC Plans, numbered CD10X in the project plans.

All proposed CSEC measures will adhere to City of Seattle and Ecology guidelines and requirements. Stormwater control on the construction site will consist of implementing best management practices (BMPs) on the site to prevent water quality problems and impacts to downstream resources. BMPs are summarized in the DRAFT Seattle Stormwater Manual, Volume 2: Construction Stormwater Control. The following BMPs, at a minimum, are expected to be used:

- Preserving natural vegetation
- Buffer zones
- Slope Protection
- High visibility silt fence
- Stabilized construction entrance
- Mulching, matting and compost blankets
- Straw wattles
- Coir Logs
- Storm drain inlet protection

The contractor will be required to prepare a CSWPPP for approval by SPU. The plan will include a narrative describing the existing site conditions, work to be completed, and erosion and pollution control BMPs that will be implemented as well as Construction plan sheets depicting the BMPs will also be prepared as part of the plan. Per Section 8-01.3(2) of the COS Standard Specifications, the Construction Stormwater Pollution Prevention submittal must include:

- Construction Stormwater and Erosion Control Plan (CSECP)
- Tree, Vegetation, and Soil Protection Plan (TVSPP)

- Spill Plan (SP)
- Temporary Discharge Plan (TDP)
- Dewatering Plan

4.7. Traffic Control During Construction

The contractor will be responsible for providing traffic control as approved by SDOT. The project should attempt to minimize impacts to neighborhood and regional traffic, including residential access, business access, emergency vehicle access, and access to the Fauntleroy Ferry Terminal. In addition, construction-related impacts to parking, drop-offs, and pedestrian safety at the California Ave SW site for access to Fauntleroy Hall and the Fauntleroy Church will be carefully considered and coordinated throughout the ongoing design process. Consideration for the West Seattle Bridge construction will need to be further coordinated and evaluated with SDOT.

Partial or complete road closures for 45th Ave SW and single lane closures for California Ave SW site are anticipated during construction. The design team will identify construction sequencing requirements to help minimize impacts to the neighborhood and the wider community during subsequent phases of design.

Access to private parcels during construction at 45th Ave SW will also be mitigated and carefully addressed. If the road is closed to traffic during all or portions of the construction, temporary parking for the affected buildings may be provided in the ROW or nearby offsite Parking for the Endolyne Building will be impacted and a temporary access driveway is proposed. Areas that are disturbed for temporary access will be restored to similar existing conditions. Business access for customers, employees and deliveries, including the possibility of SPU securing temporary parking, will also be discussed further in subsequent phases of design.

4.8. Construction Staging Area

Construction access and staging areas will be identified, evaluated, and determined throughout the ongoing design phase.

The Fauntleroy Church upper and middle parking lots are currently identified as potential staging areas for the California Culvert work. The lower parking lot of the Church is intended to remain accessible for Church access to the maximum extent feasible.

Potential staging areas for the 45th Ave project site work includes the large parking area and vacant land area at 4401 SW Director St parcels 248820-0530, 248820-0525, 248820-0520, 248820-0515, 248820-0510, and 248820-0505. Small portions of the 45th Ave ROW are also identified to the north and south of the culvert as potential staging areas.

4.9. City Right-of-Way Restoration

Restoration of the ROW will be per the SDOT Right-of-way Opening and Restoration Rules (ROWORR, SDOT DR 01-2017), the Seattle Right-of Way Improvements Manual, and the Standard Plans and Specifications for Municipal Construction (2020 Edition). Full pavement restoration will occur where open-cut excavation is used. Pavement restoration type and

thickness depends on road classification and street type and has been incorporated into the design in compliance with SDOT requirements.

45th Ave SW

The existing ROW of 45th Ave SW is 60-feet total consisting of a roadway that is 36-feet wide with two travel lanes and two parking lanes. Sidewalks and planting strips align both sides of the road in the vicinity of the project.

45th Ave SW has the following classifications:

- Street Classification – Non-Arterial
- Street Type – Neighborhood Yield Street
- Transit Classification – Not Designated
- Truck Classification – Not listed
- Bicycle Classification – Not listed
- Posted Speed – Not Posted

The 45th Ave SW design will include the following improvements:

- Two replaced driveways to the east and west street ends
- One replaced driveway to 9144 45th Ave SW
- One replaced driveway to 9212 & 9214 45th Ave SW
- Pavement, sidewalk, and curb restoration to match existing
- Replacement of landscape strips along the eastern and western sides of 45th Ave SW
- New public amenity space and park at west street end with benches, concrete pavement, and overlook
- Two replaced ADA parking stalls at the west street end and an additional stall and signage along west side of 45th Ave SW near Seattle Housing Authority building north entrance

Per the SDOT ROW Opening and Restoration Rule, the replaced roadway pavement will be:

- 10” Roadway Cement Concrete, over;
- 6” Mineral Aggregate Type 2
- Where necessary, 2” HMA Cl ½” for overlay

California Ave SW

The existing roadway in California Ave SW is 40-feet wide with two travel lanes and two transit/parking lanes. Sidewalks align both sides of the road and there are no planting strips in the vicinity of the project. Two RapidRide bus stops are located in the project area, one adjacent to the Fauntleroy Hall on the west side of the street and one adjacent to the upper

Church parking lot. These bus stops will be impacted by construction and coordination with King County Metro will be required as the design progresses.

California Ave SW has the following classifications:

- Street Classification – Minor Arterial
- Street Type – Urban Center Connector
- Transit Classification – Minor Transit Route
- Truck Classification – Not listed
- Bicycle Classification – Not listed
- Posted Speed – 25 MPH

The California Ave SW design will include the following improvements:

- Two relocated driveways at the Church property
- One replaced driveway at Fauntleroy Hall property
- Pavement, sidewalk, and curb restoration to match existing
- Installation of a landscape strip along the eastern sidewalk adjacent to the Church property

Per the SDOT ROW Opening and Restoration Rule, the replaced roadway pavement will be:

- 2" HMA Cl ½" over;
- 12" Roadway Cement Concrete, over;
- 6" Mineral Aggregate Type 2

4.10. Parcel Restoration

Portions of the private properties adjacent to the culverts will require restoration of areas impacted by construction.

45th Ave SW

The private parcel no. 248820-0480 at 9144 45th Ave SW will require restoration of asphalt parking areas, concrete driveway, and a brick wall to be rebuilt in-kind.

The private parcel no. 234670-0000 at 9212 & 9214 45th Ave SW will require restoration of landscaping, replacement of three trees, and concrete driveway paving.

The private parcel no. 248720-1221 at 4500 & 4502 SW Wildwood Pl will require restoration of waste storage area with concrete paving and fencing. This parcel will also require restoration to current ADA design standards. The existing walkway is replaced with an ADA accessible walkway from the building access on the southwest corner of SW Barton St and 45th Ave SW, and provides trash and ADA access to the sidewalk of 45th Ave. The redesign of this access is incorporated with the design of the 45th West Overlook described in Section 4.12.

California Ave SW

With the exception of the Fauntleroy Church property, it is anticipated that the improvements would be replaced in-kind. This would likely include repaving and restriping asphalt parking areas, lawn and landscape restoration (including amended soil, as applicable), and replaced fencing.

4.11. Parking Restoration for the Fauntleroy Church

Significant impacts to the Fauntleroy Church parking lot will occur due to the realignment of the creek and project goal to daylight the creek to the maximum extent feasible. The reconfigured parking lot will provide 74 stalls, matching and slightly exceeding the quantity required for maximum capacity of the Church facility (1 stall for each 80 square feet of all auditoria and public assembly rooms required for religious facilities = 72 stalls required). Parking layout, Summarized in Table 4-1, is based on SMC 23.54.030 - Parking stall and access standards and RCW 19.27.550.

Table 4-1. Parking Lot Layout Design Standards

Parking Lot	Design Element	Design Criteria	Design Approach
Upper Lot	Parking Angle	Angled	60 degree
	Stall Width	7.5 to 8.5 ft	7.5-ft (compact stall) 8.0-ft (medium stall)
	Stall Length	15 to 19 ft	15-ft (compact stall) 16-ft (medium stall)
	Aisle Width	13 to 17.5 ft for one-way traffic	15 ft, one-way traffic
	Number of ADA Stalls	See below	0
	Number of Compact Stalls	See below	9
	Total Number of Stalls	Portion of 72	22
Lower Lot	Parking Angle	Angled	60 degree
	Stall Width	7.5 to 8.5 ft	7.5-ft (compact stall) 8.5-ft (large stall) 8.0-ft (ADA)
	Stall Length	15 to 19 ft	15-ft (compact stall) 19-ft (large and ADA stalls)
	Aisle Width	20-ft for fire apparatus access, one-way traffic	20-ft (1-way traffic)
	Number of ADA Stalls	3 (two vehicle, one van)	3 (two vehicle, one van)
	Number of Compact Stalls	See below	23
	Total Number of Stalls	Portion of 72	52
	Total Number of Stalls	**72**	**74**
	Total Number of ADA Stalls	3 (two vehicle, one van)	3 (two vehicle one van)

Table 4-1. Parking Lot Layout Design Standards			
Parking Lot	**Design Element**	**Design Criteria**	**Design Approach**
	Total Number of Compact Stalls (35% minimum, 65% maximum)	26 min., 47 max.	26 min. and 49 max. required; 31 provided

Existing stalls were counted and measured. The existing parking lot striping does not meet the current parking standards for stall length and aisle width. The proposed parking design reconfigures the lower and middle lots into one larger lower lot flanking the open walled stream channel and an upper lot accessible from the alley. The number of accessible stalls and minimum regular stalls (combination of large and medium stalls) were included to meet SMC 23.54.030. Aisle widths, stall width, and stall length were laid out per Exhibit C in SMC 23.54.030.E.1. Bicycle parking is included to meet SMC 23.54.015.B8 for religious facilities.

4.12. Streetscape and Public Amenity Areas

Overall Design Theme

Through a public involvement process, the design styles and themes to inform the elements of the public facilities will be developed as part of the next phase of design. An overall image or theme for the Fauntleroy Creek Culverts Replacement Project will make the different crossing locations visible and understandable as part of a larger project. The pavement patterning, design of guardrails and other site features will be consistent at all public viewpoints to assist with wayfinding. These features will be unique and visible from the street side to give the public an understanding of the underground creek alignment from the surface. A retaining wall with ornamental guardrail will define the edge of the overlooks. Site furnishings such as benches, trash receptacles, bollards, light fixtures and educational signage will be developed further and the next phase of design and have a unique West Seattle flair.

45th West Overlook

The existing street end currently provides 3 parking spaces and an informal public gathering area overlooking the wooded ravine. Restoration of the area will include replacing the parking with two accessible parking stalls with aisle to meet code requirements, with the third ADA stall on 45th Ave SW. Restoration will also include providing a formalized gathering area with seating, protective barriers to prevent vehicles from being able to drive over the edge; ornamental guardrails, educational signage, planting beds, site furnishings such as trash receptacle, lighting, railings will be further developed in the next phase of design. A projecting perforated metal deck with guardrail will provide a viewpoint down to the creek channel and give visitors the sense of being in the tree canopy while getting a better view of the ravine. The design will consider safety and provide low plantings for open sightlines and guardrails to prevent accidental falls from the overlook.

Maintenance access to the culvert mouth will be provided by a set of stairs traversing a terraced slope above the culvert. The stairway will be screened from view by a solid fence and evergreen plantings. A gate with lock will allow maintenance staff access.

Impacted to adjacent properties will be repaired to meet current codes. The parcel to the south will have a new ramp with handrails, low curb walls and new walkway to provide ADA compliant access to their doorway. The parcel to the north will require an easement for the maintenance access walkway and stairs. Concrete paving will be selected to also allow periodic maintenance vehicle parking if needed for maintenance of the culvert outlet or slope.

45th East Street End

The existing street end is fully fenced at the top of slope and the level area is used by adjacent properties to access parking, stairs, dumpsters and an existing maintenance stairway into the ravine. Restoration of the area will maintain access to the parking and provide a solid fence with gate to limit public access to this side. The West overlook is intended to be the amenity area for this stretch of the creek. The East side is dominated by vehicular uses and pedestrian movement through the area is discouraged.

Maintenance access to the culvert mouth will be provided by a set of stairs traversing a terraced slope above the culvert. The stairway will be screened from view by a solid fence and evergreen plantings. A gate with lock will allow maintenance staff access.

California West

The area above the culvert mouth on the west side of California Ave SW has an existing bus stop and sidewalk. A new public viewing plaza will be provided as an expansion to the bus stop area and widening of the pedestrian walk. A retaining wall with ornamental guardrail will define the edge of the overlook. Site furnishings such as benches, trash receptacles, bollards, light fixtures and educational signage will be developed further and the next phase of design. The placement of seat walls, bollards and other elements will provide a barrier to vehicles accidentally heading towards the retaining wall. All elements will be located with clear sightlines and safety in mind.

California East and Church Overlooks

The California parking lot will have an open walled channel where the creek traverses between the underground culvert and the natural ravine to the east. This is the location where the public will have a clear view of the underground culvert and understand the depth of the new creek alignment below the street level. The Church parking lot will be rebuilt as a one-way loop with the walled culvert in the center. A bridge will provide vehicular and pedestrian crossing for the north to south portions of the parking lot. Walkways along the walled channel edges give pedestrians views into the channel and provide access to an overlook plaza at the point where the walled channel and wing walls meet the natural creek segment. This is also a starting point for the existing trail system into the Park property to the south.

The edges of the walled channel will have a concrete barrier with ornamental guardrail on top to provide both vehicular and pedestrian safety at the top of the channel walls. The west end of the channel adjacent to the California Ave SW sidewalk will expand to create a wider plaza area to encourage people to look into the channel and travel in to explore the site. Similar to the other public overlooks, the site furnishings, pavement finish, guardrails, lighting, benches, signage will be consistent with the other public overlooks.

At the eastern side of the parking lot where the creek transitions to the natural creek channel, another overlook will provide views of the bend in the creek and up the ravine to the south. The vehicles will transition on a raised table to cross the bridge and the pavement will change from asphalt to concrete to let the drivers know it is a pedestrian dominant area and they need to travel more slowly. Bollards will separate the vehicle zone from the pedestrian zone for safety. This gathering area will be sized to allow for groups to gather and use the space as an outdoor classroom, trailhead meeting spot, photography area for special church events or meeting friends for birdwatching.

Church Parking Lot

The lower parking lot will be flattened and expanded to the north to provide more parking at the level of the Church for easier access to the sidewalk and the Church. A retaining will separate the lower lot with the northern upper lot. The upper lot will be paved and formalized to provide stalls, aisles and planting buffers meeting city requirements. A stair will connect the upper lot with the sidewalk on the west and a second trail style path and set of stairs will provide a connection along the east side of the parking lot. Lighting, handrails and guardrails will provide safety for pedestrians and vehicles at the top of the wall and along the stairs. Vehicular access to this lot will be from the alley only.

4.13. Restoration Planting

General planting design considerations

Avoid planting trees within 10 feet of walls, stairs, fence lines, trail edges to avoid conflicts and prevent unnecessary pruning. Avoid planting trees over waterlines, stormwater or sewer pipes. Avoid planting shrubs within 3 feet of fences or trail edges. Plant palette has yet to be determined.

Tree Protection

Protect all trees that are not in the grading area or that are not significantly impacted by grading. An arborist report, when available, will be used to inform which trees can be retained and will be protected.

Ravine slopes

Slopes greater than 2:1 where new grading meets the existing steeper slopes will be reinforced with jute mat for erosion control. Plants will be installed through the mat. Arborist chip mulch will be placed on top for weed and erosion control. Slopes steeper than 2.5:1 will receive slope protection in the form of hydromulch or bonded fiber matrix.

Slopes between 3:1 and 2:1 will receive coir logs at a maximum of 10’ on center running parallel to the slope for erosion control. Soil or compost will be installed where the existing topsoil has been removed. Arborist chip mulch will be placed on top for weed and erosion control.

Plantings will be primarily one gallon size mix of conifer, deciduous trees and shrubs, ferns spaced at 4’ on center on average. Species will be chosen for their dense root structure and ability to grow quickly to hold the soil slope in place.

Terraced planters above Culvert

Walled terraced planters set on top of the culvert will have drainage aggregate and drain lines installed and a minimum of 18" depth of planting soil and 3" compost top mulch. Planters will receive a mix of coniferous and deciduous large to medium shrubs, ferns and small trees located to allow views into the ravine and screen walls or stairs where desirable for adjacent properties.

Wingwall terraces

Wingwalls extending from the culvert openings will create a transition from the existing steep slopes of the ravine to the new stream bed. Wing walls located in the narrow straight segment 'V' channel will be tapered from the culvert headwall down to meet grade. Retaining walls serving to terrace the slope and create the bend at the California walled channel entry are a series of terraced walls following parallel with the slope. These are designed to allow for wall heights to be lower and create more level planting areas between them for trees and larger shrubs to establish, provide more natural look, and improve habitat. Footing drains will be provided behind the walls. These terraces set into the natural hillside will include tilling compost into the subgrade and the soil depth will be amended in those areas where the native soil had to be removed. These planting areas above the terrace walls will infiltrate and not have subsurface drainage that is proposed for the terraces above the culvert.

Parking lot plant beds

Parking lot islands will include plant materials to comply with City of Seattle code for institutional parking lots. Parking lot islands will receive a minimum of 2.5" compost tilled into the subgrade to encourage infiltration, with a minimum of 9" planting soil and 3" top mulch. Plant materials will be a maximum of 30" high to allow for sightlines across the parking lot. Trees will be limbed up to 6-7' height for sightlines.

Street frontage plantings

Street frontage planting strips will be restored to match the previous condition. New planting strips will have evergreen groundcover to meet City standards. Street trees will meet the City of Seattle's planting and species requirements based on location relative to utilities, driveways, bus stops, and other structures.

Irrigation

An irrigation system design has not yet been determined. It is assumed that areas within the rights of way will be hand watered. The Church parking lot will likely have a permanent irrigation system connected to the Church's existing point of connection and be maintained by the Church.

5. Structural Design Concepts

5.1. Temporary Shoring and Permanent Walls

The project will utilize both temporary and permanent walls.

Temporary soldier pile walls will be used to construct precast box culverts. The temporary walls will use internal bracing to avoid conflicts with tiebacks extending beyond the ROW. As the culvert is constructed and backfilled, braces will be removed in reverse order of original installation. Some of the temporary walls near wingwalls will be repurposed and used for permanent walls to facilitate installation of maintenance access paths.

Permanent soldier pile walls will use both cantilevered piles and tieback supported piles. Tiebacks will only be used where easements are not required at the California site. Walls are designed for a scour depth of 6ft. A reinforced shotcrete fascia is applied over the temporary timber lagging.

Headwalls will be used over the culvert to bridge the gap between either temporary or permanent walls. Headwalls will be constructed using MSE geosynthetic walls. Headwalls will bear either atop the precast culvert or atop one another. A shotcrete or precast concrete fascia will be used to protect the exposed face of the headwall.

Gravity walls will be used where wall heights are 4ft or less. These walls are used to avoid the more expensive soldier pile or MSE wall construction while enabling the contractor to install the gravity wall while in compliance with OSHA for maximum temporary cut heights of 4ft.

5.2. Structural Control Elevations

The site control for the project is based on the project survey prepared by SPU, dated 09/13/2018. The survey references Washington State Plane Coordinate System, North Zone, NAVD88 vertical datum, and NAD83-2011 horizontal datum.

5.3. Lateral Earth Pressure

- Lateral Earth Pressures for Preliminary Design of Permanent Soldier Pile Walls, dated September 2020, by SPU Geotechnical Engineering
- Lateral Earth Pressures for Preliminary Design of Temporary Soldier Pile Walls, dated September 2020, by SPU Geotechnical Engineering
- Loads For Preliminary Buried Culvert Design, dated September 2020, by SPU Geotechnical Engineering

5.4. Structural Design Criteria

- AASHTO LRFD Bridge Design Specifications, Customary U.S. Units, 9th Edition
- AASHTO Guide Specifications for LRFD Seismic Bridge Design, 2nd Edition, 2011, with Interim Revisions
- AASHTO LRFD Bridge Construction Specifications, 3rd Edition, 2010, with Interim Revisions
- City of Seattle Standard Specification for Road, Bridge, and Municipal Construction – 2020
- City of Seattle Right-of-Way Improvement Manual (COS ROWIM)

- City of Seattle Standard Plans for Municipal Construction – 2020 (COS Std Spec)
- WSDOT Standard Specification for Road, Bridge, and Municipal Construction – 2020
- WSDOT Bridge Design Manual (BDM) - June 2020
- WSDOT Design Manual (DM) - 2019
- WSDOT Geotechnical Design Manual (GDM) - 2019

5.5. Material of Construction

- Steel: ASTM A36, ASTM A572, ASTM A972
- Concrete: Shotcrete, Class 4000; Precast Concrete, Class 4000 min., Class 5000 for culverts
- Concrete Reinforcement: ASTM A615
- Ground Anchors: Pressure grouted 270 ksi wire strands
- Gravel Backfill for Walls

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