# Taylor Creek Restoration: Sediment Management Options Evaluation

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## Purpose of Memo

**The purpose of this memo is to support shared decision-making by SPU and SPR related to SPU's Taylor Creek Restoration Project in advance of the 2/8/2022 ProView meeting.** The project was presented to ProView and ProView Tech, as well as to SPU's Asset Management Committee. Overlapping concerns were voiced from SPU and SPR, as well as from Friends of Dead Horse Canyon a local community stewardship group. While there appears to be general support of the intent of the project to restore creek health and salmon habitat, there are concerns about the project's short-term impacts to the environment particularly in relation to the proposed sediment management approach and installation of large woody material (LWM). SPR concerns were centered on impacts to trees and the natural environment as well as Parks user experience (i.e., disruption in use of park and perceived public impacts), and future O&M expectations for SPR staff. Friends of Dead Horse Canyon have also expressed concerns to SPU and SPR about potential impacts of the construction on the site and forest canopy where they have been actively involved in stewardship and reforestation.

To address these concerns, SPU's project team was asked to return to ProView with information on other alternatives and impacts. While ProView was identified by SPR as their decision-making forum, the intent for the 2/8/2022 ProView meeting is to have a collaborative exchange of ideas with decisions about design elements on SPR property being made at a subsequent ProView meeting. As part of the decision making, the cost-sharing and maintenance responsibilities between the departments need to be clarified and documented. The memo and associated attachments provide:

1. Project overview and history (including sediment problems)
2. Sediment management objectives
3. Overview of sediment management options including:
    a. Costs
    b. Benefits and risks
    c. Temporary and long-term environmental impacts
    d. Alternative large woody material (LWM access options and delivery methods
4. O&M assumptions (Appendix A)
5. Tree Survey (Appendix B)
6. Proposed permanent fill slope in place of existing boardwalk (Appendix C)

# Project Overview and History

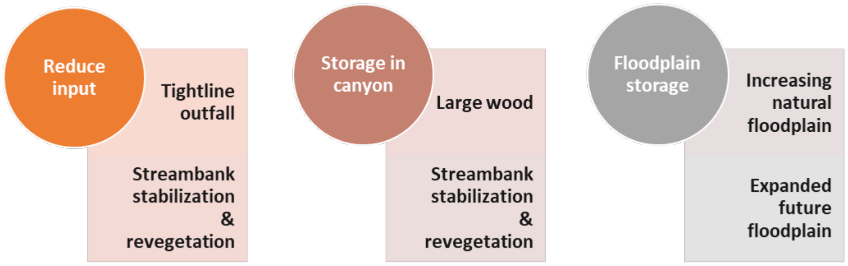
The Taylor Creek Restoration project is a watershed scale effort being led by SPU to improve fish passage, restore fish habitat, replace, and upgrade aging drainage infrastructure and restore more natural ecological processes in Taylor Creek. The project proposes to:

- Replace the Rainier Ave culvert (current fish passage barrier) with a bridge
- Correct two additional fish passage barriers to enable fish passage into Dead Horse canyon
- Restore creek, floodplain, and shoreline habitat downstream of the Rainier Ave. culvert, and to restore upstream floodplain and creek habitat adjacent to Lakeridge Park
- Provide new shoreline access and extend public natural area protection along Taylor Creek
- Provide pedestrian improvements across Rainier Ave and between SPU's lake-side property and Lakeridge Playfield and make drainage improvements that will benefit the playfield.
- Tightline two stormwater outfalls in Dead Horse canyon
- Stabilize a section of the trail and buried sewer line within Dead Horse canyon
- Restore the creek channel and banks within Dead Horse canyon through installation of large woody material

The physical habitat, natural hydrology and the sediment regime in this watershed have been altered significantly with urban development over the past 100 years, resulting in excessive erosion and transport of material to the shoreline. The heavy sediment load has caused flooding to several private properties and impact the ability of landowners to use their docks which resulted in claims to the City and SPU. Replacement of the Rainier Ave. culvert is among SPU's highest priority culverts for replacement. It is in poor condition, undersized for current and future flows and is fish passage barrier. The Taylor Creek delta and channel are restoration priorities in the region's salmon recovery plans to improve habitat for federally listed Chinook salmon and other salmonids. To support all of these needs, SPU purchased seven properties to support this project.

SPU's initial design was focused on the culvert replacement and restoration of the lower creek channel and delta and confined to the public ROW and SPU-owned properties. This initial design (taken to approximately 60% design) relied on a proposed in-stream sediment pond to collect excess sediment where it would be dredged and disposed of routinely. This approach was not supported by permitting agencies and had negative environmental impacts. In2019, SPU began developing an alternative approach for a more natural and sustainable approach to sediment management that focused on solving problems at the source. SPU expanded the project design scope to include other actions on SPR property within Dead Horse canyon to reduce sources of erosion, increase sediment storage and restore Taylor Creek to a more natural and resilient state. A preliminary design was developed for this new body of work in the upper canyon and presented to SPR via ProView Tech (9/22/21 and 9/28/21) and to SPU's Asset Management Committee. Following comments from both Departments the project team evaluated additional options (described below) for trying to address our sediment management objectives.

## Sediment Management Objectives



SPU's design process has been ongoing for several years and was informed by information from past reports and previous monitoring efforts. Beginning in 2018, SPU started collecting stream flow and sediment data from Taylor Creek. This monitoring revealed higher estimates (600 cy/yr.) of sediment input than previously documented.  This new data became one of a few key drivers and led the project team to shift its approach to sediment management away from a simple focus on traditional sediment storage to a more holistic sediment management strategy that would address the problem at the source, be more sustainable without excess maintenance, could manage the currently estimated sediment load, is cost-effective over an estimated 50-year life cycle, and puts the natural system on a trajectory of improved function to support future conditions.

The team developed a design around three objectives which are thought to be necessary to meet the project goals: 1) reduce or eliminate the causes of erosion and sediment input in the canyon, 2) add sediment storage in-stream, and 3) add sediment storage through floodplain restoration near Lakeridge Playfield (and potentially through expansion in a future phase).

## Current Design

SPU's current design is Machine Placed LWM (Option 1) and was developed to address the sediment management objectives described above. This option is centered on a robust placement of LWM including 23 large, machine-placed wood structures through the mainstem and East and West Forks as well as 102 timber frame structures along the banks of Taylor Creek. Collectively, the structures are designed to capture 3,200 cubic yards of material and as they fill and provide erosion protection in concert with other erosion control measures. As the structures fill and provide slope stabilization and erosion control of the channel banks, we expect a new equilibrium to be achieved and the sediment volume and grain size reaching the lower channel and delta to be reduced to 100-200 cubic yards per year. In concert with other erosion control measures, including tightlining two outfalls, installing timber frame structures around each large wood structure, and managing the ravine wall vegetation, we expect a 90% reduction in annual sediment delivery over time.

As designed, a temporary access roadway would be needed to transport material to the canyon and bring in equipment needed to install the LWD. The temporary access road would require removal of 104 trees. This option provides the greatest long-term benefits to the watershed and least need for repetitive construction cycles in the long-term.  This option would create conditions that will, over time, raise the elevation of the creek channel to match the elevation of the floodplain and stop the continued downcutting and erosion of the channel.  Without appropriately-sized and placed material, we run the risk that the structures 1) don't remain stable over time, 2) fill too quickly and/or 3) aren't effective in building up the channel enough to reconnect to the floodplain and reduce downcutting.  Resulting consequences could include damage to the downstream salmon habitat improvements, excess deposition at the creek mouth, sediment build-up in the culvert and continued downcutting and erosion upstream of the structures.

## Sediment Management Alternatives

While the current design is thought to best meet creek habitat objectives, it requires a temporary access road to bring in the LWM and associated construction materials. Given concerns about the impacts and costs of the current design, the team evaluated additional LWM options and access routes. These options are Hand-Placed LWM (Option 2), and a Hybrid LWM option (Option 3) which would construct a partial access road for machine-placed wood in the lower half of the canyon, and only hand-placed wood in the upper portion of the canyon. Neither of these options will be as effective in capturing and storing sediment or reducing erosional processes in the canyon and require on-going continued maintenance and construction of additional LWM structures in the future to keep the habitat function of the project as a whole. The alternative options also may not be effective in raising the channel elevation over time to reconnect with the floodplain and stop continued upstream downcutting of the creek channel.

For each option the project team considered how the LWM could be transported to the site (i.e., delivery method) and how the material would be installed (i.e., installation method), how well each of these options would meet the sediment management objectives, the benefits and impacts, and O&M activities that would be required (Table 3). A supplemental write-up on O&M activities and estimated costs is included as Appendix A.

The sections below provide a discussion of all three options including benefits and risks, costs, sustainability, and maintenance requirements. **A matrix summarizing each of the options is provided in Table 3.**

### Benefits and Risk

#### Current Design (Option 1)

When fully mature, the LWM structures in our current design should raise the canyon floor by 5 feet, with the goal of restoring the canyon to its presumed historical condition and reducing future erosion. The structures will also support streambank stabilization as they fill, elevating and widening the streambed and thus adding support to the overly steepened toe of the canyon walls. These streambed structures alone will result in a more stable system that releases less sediment over time. In concert with other erosion control measures, including tightlining two outfalls, installing timber frame structures around each large wood structure, and managing the ravine wall vegetation, we expect a 90% reduction in annual sediment delivery downstream compared to existing conditions. Long-term, the larger, machine-placed structures will provide the most benefit to the canyon from an erosion, sediment control, floodplain, and habitat perspective.

The current design option, while solving the sediment management problem most effectively, is not without its drawbacks. A temporary access road would need to be constructed to provide access for materials delivery and equipment to access and install the structures. Design recommendations for the temporary access road would be in place for at least 2 years and would result in 104 trees greater than 6-inch diameter being removed (87 deciduous, 17 coniferous as summarized in Table 1). This is an immediate impact to the habitat along the slopes and would change the tree canopy on the west canyon slope for several years while new plantings establish. Appendix B includes a more detailed list of the trees (tag #, location, diameter, deciduous or coniferous classification) that would need to be removed to make way for the temporary access road as well as those trees that are within the 15-foot buffer of the edges of the access road. This is in addition to impacts to many smaller diameter trees planted and maintained by volunteers. Trees within the buffer would not be removed but limbs or roots could potentially be impacted by construction work. Additional tree health studies as well as tree species identification would be performed, as requested by Parks, based on the sediment management strategy decision.

*Table 1. Tree Impacts in Dead Horse Canyon from Temporary Access Road and Tightlines (red = trees within SPR property)*

| **Tree Type** | **Number to be removed by DSH Range (inches)** | | | | ***Subtotal*** |
|---|---|---|---|---|---|
| | 6-12 | >12-24 | >24-36 | >36-48 | |
| Dead Horse Canyon | | | | | |
| Conifer | 15 | 1 | 0 | 1 | *17* |
| Deciduous | 31 | 47 | 7 | 2 | *87* |
| | | | | ***Total*** | ***104*** |
| Tightlines | | | | | |
| Conifer | 5 (1) | 0 | 0 | 0 | *5* |
| Deciduous | 1 | 1 | 0 | 0 | *2* |
| | | | | ***Total*** | ***7*** |
| | | | | ***Grand Total*** | ***111*** |

Additional benefits of this option include the ability to install additional sewer access (maintenance holes or clean outs) during road construction which will help SPU improve sewer maintenance, and the potential elimination of one of the deteriorated boardwalks and replacement with a trail and permanent retaining wall (see Appendix C for proposed layout). The potential elimination of the boardwalk has been preliminarily discussed with SPR engineering and will be presented at the Feb 8th ProView.

### Hand-Placed LWM (Option 2)

While the hand-placed structures would not require an access road, there is inherently more risk to installing smaller structures due to uncertainty on expected performance and shortcomings in addressing the sediment management problem. Hand-placed structures would be much smaller, since they don't require machines for placement, and they won't be able to capture as much sediment (about 1000 cubic yards in total) or increase the canyon floor by as many feet (about 1.5 ft maximum). Hand-placed structures wouldn’t be as effectively embedded in the banks of the creek, therefore increasing the potential for wood shifting, and potentially increasing the maintenance of the wood structures in the first few years to ensure fish passability (O&M requirements and costs are described in more detail in later section of this document). The channel erosion control benefits of hand-placed structures would also be significantly reduced. Without the ability to get heavy equipment into the canyon to install and anchor the timber frame structures they would be much smaller and not as effective in bank stabilization; at this time, we are unsure if they would be part of the design. Since they wouldn’t be anchored to the bank, there is also risk in wood movement downstream as well as the creek routing around the LWM.

### Hybrid LWM (Option 3)

A hybrid option of partial machine- and partial hand-placed structures would be a compromise in benefits from the current design, and certainly more beneficial than the hand placed option in terms of sediment management. Impacts due to machine required access would be realized in the lower half of the canyon and risks present with the hand-placed structures would apply in the upper half of the canyon. For the purposes of evaluation, the hybrid option access road would terminate just north (downslope) of the pedestrian boardwalk on the west canyon slope. This would allow placement of larger structures in the lower channel where they are most needed.

An additional benefit of this option includes the ability to provide some additional sewer access points (e.g., maintenance hole or clean outs) during road construction which will help SPU improve sewer maintenance. Elimination of the boardwalk and replacement with a trail is not possible under this option as the proposed temporary road would end before the boardwalk.

## Costs

The added cost to install LWM is summarized in Table 2 below. The current design requires a temporary access road and machines to place the largest wood, therefore, it is the most cost up front. However, this option is not expected to require routine maintenance as the structures fill and achieve equilibrium, and this option provides the least risk to the performance of the structures in achieving both maximum sediment capture and erosion control (and reduction).

Options 2 and 3 have not been fully estimated, and if pursued, would also require significant re-design effort so these costs are estimated as within a range. Both of those options would require future maintenance and possibly new capital projects initiated to supplement the LWM to ensure sufficient sediment capture and erosion control (see next section).

**All the options represent a significant investment in Park property and the long-term sustainability of the natural ecosystem.** Although not described below, a “do-nothing” option is the least costly and would perpetuate the current condition of the canyon, which is in active erosion. A “do-nothing” approach would result in destruction of the downstream restoration measures around the Rainier Ave S culvert and stretch to the Lake Washington shoreline and require regular dredging and maintenance of the lower channel.

*Table 2. Sediment Management Options CIP Costs*

| **Option** | Current Design LWM Option 1 | Hand-Placed LWM Option 2 | Hybrid LWM Option 3 |
|---|---|---|---|
| **Remaining Hard Cost** | $9,200,000 | $3,600,000 *estimated* | $5,700,000 *estimated* |
| **LWM** | $4,900,000 | $3,000,000 *est* | $3,500,000 *est* |
| **Access Rd** | $3,700,000 | -- | $1,600,000 *est* |
| **Floodplain** | $400,000 | $400,000 *est* | $400,000 *est* |
| **Misc** | $200,000 | $200,000 *est* | $200,000 *est* |
| **Soft Cost** | | | |
| **Remaining costs** | $1,000,000 | $2,000,000 *est* | $2,200,000 *est* |
| **Total Remaining CIP Cost** | $13M | $8-10M *estimated* | $10-12M *estimated* |

## Sustainability and Required Maintenance

Sustainability and required maintenance is described in future detail for each of the options below. Note: both the Corps and WDFW are strongly motivated to not permit structures that can become barriers to fish movement Therefore, the regulators would likely want assurances through the project design, and/or routine maintenance that the structures remain fish passable in perpetuity for all the options.

### Current Design (Option 1)

The current design is the most sustainable and the project team does not anticipate having to plan for routine long-term maintenance. These structures would become part of the natural environment and not capital assets. There may be some focused efforts in specific locations, but no new access road or channel disturbance. These structures would help build up the stream channel and reconnect more of the channel with the adjacent floodplain to allow for reduced velocities and greater sediment storage. There is a limit to the height of ravine filling along the channel and sediment accumulation in the current design approaches that height. By stabilizing the bed and bank, we should address the major factors in the currently observed, accelerated sediment generation in the ravine. Having less sediment, and smaller sized sediment delivered to the delta should mean that the delta will grow more slowly than in the past. The finer materials in the delta will both translate further out into the lake and will have more room to spread out, allowing the delta to form generally within the City's property. However, at some point and with any natural process, the delta may expand beyond City property lines.

Unplanned adaptive management for this option, and the other options, could include adding more wood and small tweaks on the system to maintain sediment capture and ensure fish passability. Because machine-placed wood is anchored into the banks, it is least susceptible to movement, and while continued monitoring would be needed to ensure the structures remain fish passable, the likelihood of actually having to adjust the structures beyond the 5-year mark is extremely low. With the sediment capture capacity and the erosion reduction measures, the lower rate of sediment generation is intended to be similar to the pre-development condition for Taylor Creek. There would still be an urban runoff influence on the creek, so it is desirable to have some mobile sediment to maintain a dynamic channel bed and sediment transport to the delta to maintain the delta and shoreline habitat. Overall, we're expecting very little to no management of these structures.

## Hand-Placed LWM (Option 2)

Option 2 is the least sustainable in terms of longevity, both structurally and for the ability to reduce erosion and capture sediment. The hand-placed structures would not be able to capture the desired amount of sediment that is currently being delivered to the stream. They are also more likely to fail during large storm events as they will not be anchored into the bank similarly to Option 1.

Planned O&M for this option would require annual inspections, adjustment of structures and the periodic addition of new structures potentially at intervals as frequent as every 2-5 years depending on how the structures perform and when the site reaches equilibrium. Rebuilding these new structures are beyond resource capacity and abilities of SPU maintenance crews. During the first few years following construction and before significant erosion reduction has occurred, the LWM structures may fill quickly and be at capacity within 1-2 yrs. based of installation. This could warrant supplemental wood placement in the required 2–5-year interval. Because hand-placed wood is more susceptible to movement, indefinite monitoring accompanied with likely adjustments to the existing structures would be needed to ensure the structures remain fish passable. Observations of hand-placed LWM placed just upstream of Holyoke St. reveal that while the structures have remained physically intact after 20 years, they filled quickly and are no longer doing the job of capturing sediment.

While routine maintenance or adaptive management wouldn't necessarily be needed as soon as the structures are full – the performance of the structures may need to be evaluated for a period after equilibrium to see what the new sediment regime is and consider if other adaptive management actions would be needed and feasible. The timing of LWM storage rates is also influenced by landslides which are unpredictable but appear to occur on ~ 10-year cycles. Adaptive management activities could include the addition of LWM following landslides, or dredging the creek channel on SPU property downstream, and expanding the floodplain if and as additional properties can be acquired from willing sellers.

## Hybrid LWM (Option3)

A hybrid option may provide a moderate level of sustainability between Options 1 and 2. For the lower half of the canyon where the portion of LWM would be larger and installed by machine, required maintenance may be relatively low to none (similar to Option 1). In other words, we wouldn't expect to need to re-enter the lower machine-built portion again. For the upper half, where structures would be smaller and hand-placed, maintenance would be commensurate with Option 2, requiring stabilization, adjustment and supplemental structures added in 3–7-year intervals.

Adaptive management for Option 3 is expected to be like Option 2 Hand-Placed in that we'd need continued adaptive management efforts in regular intervals to supplement the hand placed structures and add storage in the upper canyon. The project team estimates that because the larger more stable LWM in the lower half of the canyon would initially compensate for less sediment retention upstream, the asset management strategy could be more on the order of every 3-7 years. Indefinite monitoring accompanied with likely adjustments to the existing structures would be needed in the upper half of the canyon to ensure the structures remain fish passable.

The following tables are available to support decision making:

- *Table 3 Sediment Management Options + Lower Taylor Creek Restoration – Benefits & Risks Comparison* is a detailed compilation of the information provided in the above sections for easier comparison of the options and to support decision-making.
- *Table 4 Options Comparison: Ability to Meet Sediment Management Objective* shows how the individual project elements relate to the sediment management strategies, and the extent to which the elements are able to address the overall sediment management objectives.

*Table 3. Sediment Management Options + Lower Taylor Creek Restoration – Benefits & Risks Comparison*

| | **Option 1 Machine-placed LWM (Current design)** | **Option 2 – Hand-Placed LWM** | **Option 3 – Hybrid Hand/Machine LWM** |
|---|---|---|---|
| **Description** | **Max. Wood Storage now; full temp access road**<br>(23 structures, 3200CY retention potential, plus erosion control measures) | **Only hand-placed now; no access road**<br>(17 structures, 1000CY retention potential, limited/no erosion control measures) | **Combo hand/machine placed now; partial access road**<br>(Something in between Op 1 & Op 2) |
| **Access, Installation & Material Delivery Method** | **Machine materials delivery (requires temporary access road from Holyoke St. up into canyon)**<br>**Machine LWM placement** | **Hand carried and placed materials; Assumed access from Holyoke St.** | **Lower 1/3 – ½ of creek gets temporary access road and machine placed large wood structures**<br>**Upper half of creek gets hand placed large wood structures**<br>**Access from Holyoke St. *** |
| **Duration or Phasing** | <u>2 yr. construction</u><br>Yr. 1 - Temporary access road construction + machine placed LWM, apartment demo, Rainier Ave Culvert construction<br>Yr. 2 - Remaining machine placed LWM + temporary access road removal, lower project area restoration | <u>2 yr. construction (potential for additional year due to slower pace) + additional construction on an on-going basis.</u><br>Yr. 1 - Hand placed only LWM, apartment demo, Rainier Ave Culvert construction<br>Yr. 2 – Remaining hand placed LWM, lower project area restoration | <u>2 yr. construction + additional construction on an on-going basis.</u><br>Yr. 1 - Partial temporary access road + machine placed LWM<br>Yr. 2 - Hand placed LWM, lower project area restoration |
| **Total Project Cost** | $43.7M | $32-37M *estimated* | $35-40M *estimated* |
| **Cost Burden** | 2022-2026 CIP Budget Cycle | 2022-2026 CIP Budget Cycle $32-37M<br>Wait and see on add'l sed mgmt. work and consider adding<br>2026-2030 CIP Budget Cycle $10-20M | 2022-2026 CIP Budget Cycle $30M<br>Wait and see on add'l sed mgmt. work and consider adding 2026-2030 CIP Budget Cycle $10-15M |
| **Environmental/Ecological Impacts** | 1. Removal of 104 trees (87 deciduous, 17 conifer)<br>2. Soil disturbance of bank sediments for LWM embedment throughout mainstem and into east fork<br>3. Soil disturbance within temporary access road footprint extending to east fork | 1. No tree removal, or minimal removal if SPR identifies trees in canyon that could be used for inclusion in creek habitat)<br>2. Soil disturbance impacts limited to footpaths around creek banks<br>3. Limited plant restoration along creek banks | 1. Removal of approx. 55 trees<br>2. Soil disturbance of bank sediments for LWM embedment throughout half of the mainstem<br>3. Soil disturbance within temporary access road footprint approx. halfway up canyon<br>4. Increased carbon emissions due to equipment and machine use |

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|---|---|---|---|
|  | 4. Increased carbon emissions due to equipment and machine use<br>5. Invasive plant removal throughout entire disturbed area<br>6. Restoration throughout entire disturbed area with thousands of plants and trees<br>7. Funding for Parks invasives management on east canyon wall | 4. Funding for Parks invasives management on east canyon wall | 5. Invasive plant removal throughout entire disturbed area<br>6. Restoration throughout entire disturbed area with hundreds of plants and trees<br>7. Funding for Parks invasives management on east canyon wall |
| **Benefit** | 1. Addresses problem at source to extent feasible<br>a. Maximizes sediment retention<br>b. Maximizes erosion control<br>2. No expected O&M costs for long term sediment management<br>3. Allows installation of additional access points for sewer line maintenance<br>4. Allows lower Taylor Creek floodplain design to be self-maintaining (no future dredge of floodplain)<br>5. Potential for replacement of wooden boardwalk with fill embankment (reducing Parks risk and maintenance with respect to pedestrian use, reducing SPU risk and maintenance with respect to sewer line)<br>6. Least cost burden long term<br>7. Long-term health of canyon increased with decreased erosion, increased floodplain, increased sediment storage, increased plant diversity | 1. Least ecological impact now<br>2. Less cost burden now | 1. Achieves slightly more sediment retention than Option 2 (but less than Option 1)<br>2. Less ecological impact than Option 1<br>3. Allows installation of *some* additional access points for sewer line maintenance |
| **Risk** | 1. Estimated 5 - 14 yr. fill period<br>2. Greater temporary ecological impacts<br>3. Increased cost burden now<br>4. Landslides could decrease fill rate | 1. Estimated 1 - 5 yr. fill period<br>2. **Highest risk to LWM efficiency,** less sediment reduction long-term<br>3. No erosion control measures other than limited planting in disturbed areas along creek banks – continued erosional processes | 1. Estimated 3 - 7 yr. fill period<br>2. **Moderate risk to LWM efficiency,** less sediment reduction long-term<br>3. Limited erosion control measures commensurate with extent of temporary access road and machine placed LWM |

| | | | |
|---|---|---|---|
| | | 4. Higher burden on O&M in years 2-?<br>5. Increased cost burden long-term – Likely initiate new CIP project in 1-5 years (adding large wood)<br>6. Landslides could decrease fill rate<br>7. Potential for additional construction year to accommodate slower pace of work | 4. Higher burden on O&M in years 3-?<br>5. Increased cost burden long-term – Likely initiate new CIP project in 5-10 years (adding large wood)<br>6. Landslides could decrease fill rate |
| **Planned Operations & Maintenance** | **Least O&M Burden**<br>Structures will not be SPU assets; no routine maintenance expected. Structures will be treated as habitat features and left in place to integrate into creek channel. | **Most O&M Burden**<br>Routine maintenance may be needed **every** 2-5 years:<br>- adding new wood structures<br>- maintaining fish passability beyond 5 years | **Moderate O&M Burden**<br>Routine maintenance may be needed **every** 3-7 years:<br>- adding new wood structures<br>- maintaining fish passability beyond 5 years for upper canyon only |
| **Possible Adaptive Management Needs** | Adaptive management/monitoring options within first 2-3 (up to 5) years:<br>- add more wood or make small tweaks on system | Ongoing adaptive management/monitoring:<br>dredge creek if sediment causes blockage issues<br>- expand floodplain in future | Ongoing adaptive management/ monitoring:<br>- dredge creek if sediment causes blockage issues<br>- expand floodplain in future |
| **50 yr Lifecycle Cost:** | $43.7M (includes $1.1M O&M)<br>Long term costs could be reduced if road stays permanent | $46M (includes $15M O&M over 50 years) | $48M (includes $8M O&M over 50 years)<br>Long term costs could be reduced if half road stays permanent |
| **Alternative Access LWM Delivery Options** | **The current design assumes access from Holyoke St.**<br>**LWM delivered by Helicopter**:<br>- Some road access likely still needed for equipment to install the LWM<br>- Risk of tree canopy damage (blow down)<br>- Possibly infeasible due to height of tree canopy<br>- Difficulty of obtaining special Congested Air permit<br>- Safety hazard for staff and contractor during delivery<br>- No staging area or flight path identified<br>- Potential need for staging areas to be developed in canyon (tree height/elevation)<br>- Likely decreased material delivery cost | N/A – all materials sized to be carried in next to the creek by hand. | Same as Option 1, applied to the lower half of the canyon. Upper canyon, same as Option 2. |

| | | | |
|---|---|---|---|
| | **LWM delivered by Pack Animals**:<br>- Risk of additional construction year to accommodate slower pace of work<br>- As designed, the structures require machine placement – so machines would be required within the creek channel anyways<br>- Some road access likely still needed for equipment to install the LWM | | |
| **Meets Reduced Sediment Input Objective** | **Strongly Meets Objective**<br>- Reduced ravine wall erosion with tightlines<br>- Reduced channel erosion – stabilize banks with embedded structures, timber frames and bank revegetation<br>- Decreases channel slope over time, resulting in reduced flow velocity | **Does not meet Objective as well as Options 1 & 3**<br>- Reduced ravine wall erosion with tightlines<br>- Least erosion control – structures are not embedded and no timber frames<br>- Decreases channel slope the least, resulting in little velocity change | **Does not meet Objective as well as Option 1, better than Option 2**<br>- Reduced ravine wall erosion with tightlines<br>- Moderate erosion control – structures in lower half of canyon provide the most benefit<br>- Decreased channel slope significantly in lower half of canyon, but only small change in upper half |
| **Meets Increased Sediment Storage (floodplain) in Dead Horse Canyon Objective** | **Strongly Meets Objective**<br>- Maximum sediment storage with largest LWM structures<br>- Approaches height of allowable filling in channel – reducing channel slope the most and allows maximum floodplain connection | **Does not meet Objective as well as Options 1 & 3**<br>- Least sediment storage with smallest LWM structures<br>- Decreases channel slope the least, smallest floodplain reconnection | **Does not meet Objective as well as Option 1, better than Option 2**<br>- Moderate sediment storage with combination of large and small LWM structures<br>- Connecting to maximum floodplain in lower half of channel, but smallest connection in upper half |

*Potential additional access concept identified at 69th Ave. but has not been scoped or design—to be discussed at ProView.

*Table 4. Options Comparison: Ability to Meet Sediment Management Objectives*

🟩 Expected to meet goals
🟨 May partially meet goals
🟥 Unlikely to meet goals

| **SEDIMENT MANAGEMENT OBJECTIVES** | **Project Elements** | **Option 1 Machine-Placed LWM** | **Option 2 Hand-placed LWM** | **Option 3 Hybrid Machine & Hand LWM** | **Previous-Sediment Pond Option** |
|---|---|---|---|---|---|
| **Reduce Sediment Input** | **Tightline outfalls** | 🟩 | 🟩 | 🟩 | 🟩 |
| | **Timber frames** – stabilize and re-vegetate banks – reduce erosion | 🟩 | 🟥 | 🟨 | 🟥 |
| | **Instream LWM** – Reduce peak flows – decrease channel slope/build-up stream bed | 🟩 | 🟨 | 🟨 | 🟥 |
| | **Invasive removal and revegetation** in canyon | 🟩 | 🟩 | 🟩 | 🟥 |
| **Increase Sediment Storage – Canyon** | **Instream LWM** – captures in-stream sediment | 🟩 | 🟨 | 🟨 | 🟥 |
| | **Timber frames** – stabilize and revegetate bank - captures more sediment | 🟩 | 🟥 | 🟨 | 🟥 |
| **Increase Sediment Storage – Floodplain** | **Floodplain reconnection in Dead Horse Canyon** – increased channel bed elevation reconnects channel to floodplain areas, increasing storage potential | 🟩 | 🟥 | 🟨 | 🟥 |
| | **Floodplain restoration** adjacent to Lakeridge Playfield | 🟩 | 🟨 | 🟩 | 🟥 |
| **Ensure Sustainability and Resiliency** | **Most self-sustaining** without planned routine maintenance | 🟩 | 🟥 | 🟨 | 🟥 |

**CONSIDERATIONS for SPR PROPERTY (DRAFT based on SPU understanding; SPR edits welcome)**

| | | | | | |
|---|---|---|---|---|---|
| **Environmental Impacts and Benefits** | **Limit short-term impacts** – Tree/vegetation removal or slope disturbance limited or none | 🟥 | 🟩 | 🟨 | 🟨 |
| | **Increase long-term benefits** – Creek and habitat health improved | 🟩 | 🟨 | 🟨 | 🟥 |
| **Community Impacts and Benefits** | **Limit short-term impacts** – Community use not impacted | 🟥 | 🟩 | 🟨 | 🟩 |
| | **Increase long-term benefits** – trail and boardwalk improvements | 🟩 | 🟥 | 🟨 | 🟥 |

# Appendix A

## Taylor Creek Restoration Project: O&M Assumptions for Sediment Management Options

01.31.22 – prepared by Cody Nelson and Betsy Lyons

## Overview of Proposed Sediment Management Strategy

The Taylor Creek Restoration project was originally designed to include a sediment pond to capture sediment below Dead Horse Canyon. Concerns about the difficulty and cost of maintaining a sediment pond led the DWW Line of Business (LOB) to suggest a change in approach. The intent was to move away from a fixed sediment management facility, towards a more holistic, natural sediment management strategy which would be more sustainable and cost effective over the full lifecycle of the project. Effectively managing sediment is important for: 1) limiting impacts to SPU assets, 2) preventing impacts to adjacent private property, and 3) protecting the City's investment in salmon habitat restoration.

**The sediment management objectives are to reduce sediment input and increase sediment storage.** Large woody materials (LWM, also called bed control structures) and associated timber frame structures were added to the design to: 1) stabilize the channel and banks within the ravine and 2) capture sediment and 3) build up the channel so it can reconnect to its floodplain. The structures will support streambank stabilization and reduce channel erosion as they fill and reduce the slope at the bottom of the canyon walls; the slope reduction itself will lend to a more stable system that releases less sediment over time. **The overall goal of the instream and bank wood structures in the current design is to establish a new sediment equilibrium within Dead Horse Canyon that results in greater overall stability and reduced sediment export levels that are more like pre-disturbance conditions. The purpose of this strategy is to solve the problem at the source, without putting long term burden on SPU Operations & Maintenance and Asset Management staff.**

## Proposed Large Wood Structures

Based on recently collected flow and sediment data collected since 2018, the estimated sediment loads coming from the canyon and stream channel are thought to be approximately 600-CY/yr. The large wood structures need to be designed to trap and hold this observed sediment load. The recommended design includes 23 bed control structures with 18 structures in the mainstem, 4 structures in the East Fork, and 1 structure in the West Fork. The mainstem and the East Fork are target areas as these locations are the main contributors of sediment to Taylor Creek based on observations of ongoing erosion. The size and type of structures were determined based on sediment modeling and the team's decision to pursue the most robust structure scenario with the ability to capture the most sediment and reduce sediment input. The size and height of the structures was developed to build the channel bed to heights that will allow floodwaters to engage a much broader portion of the ravine bottom to reduce the potential for future erosion. The bed control structures also include a long, low-slope downstream portion to provide fish passage both immediately after construction and as the structures fill with sediment. The design with sloped sill logs to provide fish passage during different flow levels was employed at previous SPU projects in Thornton Creek (Thornton Confluence and Kingfisher/Knickerbocker sites).

The bed control structures will be constructed with 20- to 30-foot long, 12- to 18-inch diameter logs, plus additional slash, bolted connections, and manila rope lashings. The strength of the structure results from excavation to embed the larger logs to reduce the potential for lateral erosion after installation. These materials are large and will require machine installation. Revegetation will occur on slopes that are disturbed by material delivery and LWM installation and around the bed control structures to provide additional stabilization.

## Function of Large Wood Structures Over Time

The project team anticipates two distinct future sediment regimes would occur with the proposed instream structures (Current design)):

- **Phase 1 – deposition within Dead Horse Canyon**. After construction, sediment will accumulate behind wood structures. The rate of sediment deposition will be significantly influenced by the degree of landsliding and amount of rainfall. Not all sediment will be trapped in Phase 1; we expect that the finer size fractions will continue to be transported downstream. Total sediment yield, however, is anticipated to be well below volumes observed previously. We anticipate Phase 1 to last more than 10 years, but that time could be longer or shorter depending on frequency and size of landslides. The volume of overall sediment yield will be reduced from existing conditions, dependent on landslide frequency and magnitude. Yields during Phase 1 are expected to be much less than 50% of the existing conditions yield during the filling phase, with very little coarse sediment exported from the ravine.

**Phase 2 – new equilibrium**. After structures fill to near their trap potential, we expect the ravine to start exporting sediment at a new, reduced rate compared to existing conditions as the system develops a new equilibrium that is less erosive. After structures have filled, the sediment regime will find new equilibrium, the channel bed/banks will be stabilized, and the risk of landsliding will be reduced. The goal is that 50+years from now, the structures are no longer obviously visible, the channel bed has been aggraded/sediment is stored in situ, and native plants have fully established. Phase 2 success is also dependent on successful native vegetation establishment and weed control. The volume of overall sediment yield during this phase will again be dependent on landslide frequency and magnitude; however, we expect Phase 2 to have ~90% reduction in annual yield when compared to typical existing conditions. This means in the future we expect to have 100-200 cy/year coming down the creek, which is desirable, more manageable long-term and will support a dynamic channel bed and is more manageable long term.

Sediment will continue to be produced from the ravine, and periodic landslides will continue to contribute sediment to the channel over time. However, there is a limit to the height of ravine filling along the channel, and the recommended LWM structures approach that height. By stabilizing the bed and bank, we are addressing the major factors in the currently observed, accelerated sediment generation in the ravine. When the structures fill, they will have accomplished their goal of stabilizing channel incision and bank erosion, and raised the channel bed by 5-ft. There will be sediment transport throughout the reach – less so immediately after construction prior to filling, then at a reduced output into the future, at which point more maintenance can be focused on lower Taylor Creek if sediment accumulates in areas that create issues. Ongoing weed control and native revegetation, particularly on the east side of the ravine should be part of the landscape management plan to help reduce erosion on the steepest slopes.

At the confluence with Lake Washington, less sediment and smaller sized sediment delivered to the delta should mean that the delta will grow more slowly than in the past. The finer materials in the delta will both translate further out into the lake and will have more room to spread out, allowing the delta to form generally within the City's property. However, at some point, the delta could expand beyond the property lines. Currently, the project team does not consider a future dredge necessary.

## Assumptions: Planned Operations & Maintenance (O&M)

**The recommended design eliminates planned O&M efforts (over other options) and is likely to have the lowest adaptive management needs compared with other options.** The combined actions in the recommended design will effectively reduce the overall net sediment input in two ways: active storage by the large wood structures and reduction of erosional inputs from the stream bed and banks. Once installed, sediment will start being captured at the same time erosional processes are starting to be controlled through tightlining, bank stabilization and revegetation. By capturing the existing sediment load and reducing the sediment load over time, the structures essentially eliminate ongoing maintenance for SPU in the lower channel. The bed control structures are designed to restore a channel profile that avoids the focused stream power of today's entrenched channel, thereby reducing long term erosional processes. As the log structures are buried, they will also be saturated which will slow the degradation of the logs, preserving their function s new trees grow and stabilize the bed and banks.

Although we don't anticipate any annual maintenance of log structures, the channel will be vulnerable in the first years after installation as vegetation establishes. By year 5, we anticipate the structures will weather some larger storms, and we hope to see a continued positive response in the active storage of the structures.

## Assumptions: Potential Adaptive Management

While regular, planned maintenance of the structures is not anticipated, unplanned adaptive management needs may arise like most projects. Unexpected needs are likely to arise on an irregular basis and identified through observations particularly during the first 5 years after installation:

1) <u>Minor adjustments at individual structures</u> may be necessary as the sediment pools fill, and local hydraulic conditions change. Adjustments should *only be necessary* if the log configuration and sediment accumulation is resulting in local channel bed or bank instability or is causing a complete fish passage barrier that regulatory agencies would expect to be fixed. Thresholds for erosion would be developed as part of the ***Sediment Monitoring and Adaptive Management Plan*** to identify persistent erosion that has the potential to undermine the structure (e.g., focused flow below the lowest logs, or between the instream structure and the timber frames higher on the bank). For fish passage, repeated years with water surface drops of more than 0.8 ft would probably signal the need for appropriate for modification. If needed adjustments to the structure could be completed with hand crews to remove or reposition individual logs or cut notches in the logs to allow for improved passage. These adjustments should only be completed

with review and approval from SPU personnel or consultants familiar with the structure design and design intent.

2) Landscape establishment and invasives management should occur over the first 5 years after the project is built. Native forest community plant establishment has a multitude of benefits including slope stabilization, capturing water and runoff, increasing amount and type of habitat and it provides a future source of large woody material. The current significant levels of ivy and other invasive vegetation will hinder revegetation efforts, so annual monitoring and maintenance to support successful revegetation will support achieving the sediment reduction goals of the project. *Landscape establishment and pre-construction invasive species management will be part of the project regardless of LWM installation method. However, the aerial extent of vegetation management will vary somewhat depending on impacts from installation of the LWM.* The 'added' costs of vegetation maintenance that would be associated with the different LWM delivery and installation options is included in the 50 yr. lifecycle estimates below for the options involving road construction and added impacts.

## Lifecycle Costs and Assumptions

The 50-year lifecycle O&M costs associated with the LWM were calculated using the assumptions shown below in Table 1, and then inflated based on SPU's Cost Estimating Guide and cost work-book.

*Table 1 Lifecycle cost estimates and assumptions for sediment management options*

| | **Machine-placed LWM (Current Design) Option 1** | **Hand-placed LWM Option 2** | **Hybrid LWM Option 3** | **Sediment Pond** |
|---|---|---|---|---|
| Expected Future Sediment Delivery | 100-200 cy/yr. range (acceptable range) | >200 cy/yr. | > 200 cy/yr. | >600 cy/yr. |
| **O&M Actions and Frequency** | LWM inspections (twice in yrs. 1-5)<br>Plant establishment (annually in Yrs. 1-5 (for area impacted by road.) | LWM inspections annually yrs. 1-5; and every 5 yrs. for next 25 yrs.)<br>LWM structure addition every 2-5 yrs. | LWM inspections annually in upper canyon, twice in first 5 yrs. in lower canyon; and every five yrs. in upper watershed for next 25 yrs.<br>LWM structure addition every 3-7 yrs.<br>Plant establishment (annually in Yrs. 1-5 for area impacted by road.) | $500,000 dredging costs/yr. (half the cost for Meadowbrook) |
| **O&M Assumptions for** | LWM inspections (twice during yrs. 1- | LWM inspections (twice during yrs. 1-5); | LWM inspections – annually in upper | $500,000 annual dredging costs/yr. |

|  |  |  |  |  |
|---|---|---|---|---|
| **Cost Estimates** | 5);<br>$10,000/inspection based on crew of 2 @ 40 hrs. @$125/hr.<br>Plant establishment Yrs. 1-5 (60K)<br>- 3:1 Mitigation for tree loss<br>- 4 acres x $15,000/ac/yr.x 5 yrs. | $10,000/inspection based on crew of 2 @ 40 hrs. @$125/hr.<br>LWM addition in year 3; and then every 5 yrs. starting in yr. 6 and continuing for 5 times. Cost estimate based on initial cost estimate of $1.5M for hand-placement and inflated for future yrs. | area; twice during first 5 years in lower canyon; based on crew of 2 @ 20 hrs. @$125/hr.<br>Plant establishment Yrs. 1-5 (60K)<br>- 3:1 Mitigation for tree loss<br>- 2 acres x $15,000/ac/yr. 5 yrs.<br>In upper canyon LWM addition in yr. 3 and every 5 yrs. starting in yr. 6 and continuing for 5 times Assume $750K per LWM addition (half the cost of Option 2 Hand Placement); and inflated for future yrs. | (half the cost for Meadowbrook)<br>*Or alternatively, the facility could be redesigned based on recent estimates of sediment input (600 cy/yr) and size of sediment pond design (200 cy)* |
| **Possible Adaptive Management *(not included in cost estimates)*** | Response to landslide or storm events.<br>Fish passage modifications (notch or reposition logs)<br>Dredging<br>Expanded floodplain restoration | Response to landslide or storm events.<br>Fish passage modifications (notch or reposition logs)<br>Dredging<br>Expanded floodplain restoration | Response to landslide or storm events.<br>Fish passage modifications (notch or reposition logs)<br>Dredging<br>Expanded floodplain restoration | Expanded floodplain restoration<br>More or less dredging |
| **Total Project Cost thru Construction** | $ 43,700,000 | $ 37,000,000 est | $ 39,800,000 est | $ 30,000,000 |
| **50 Yr LWM LifeCycle O&M Costs- *inflated**** | $ 400,000 | $ 9,300,000 | $ 4,030,000 | $25,900,000 |

While 50 years is not necessarily the life of the structures, for comparison the team used the standard facilities/asset 50-year lifecycle as a time period that staff are used to evaluating costs for expected

O&M.  Costs for planned O&M and limited adaptive management are included in the costs presented in Table 1 along with the assumptions that were made in calculating the estimates.  These are <u>not</u> comprehensive O&M estimates for the entire project, nor do they include all potential adaptive management needs.

As discussed in the memo, there is significant variability in the expected life cycle costs of the sediment management options, so understanding the cost and maintenance implications of each option is important.  Figure 1 shows the total lifecycle cost for each option and the proportion distribution of capital investment vs anticipated O&M over a 50. Yr. lifecycle.

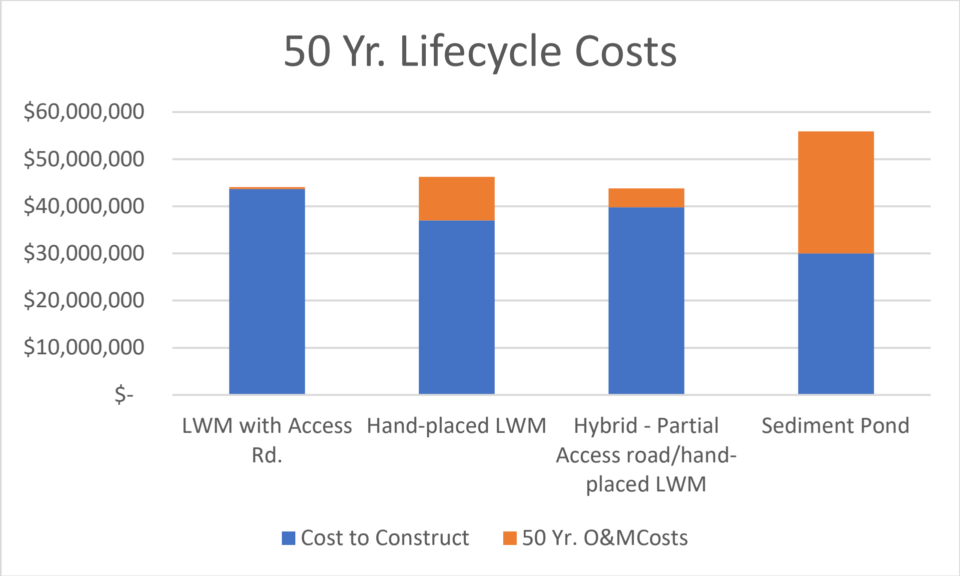

*Figure 1 Estimated 50 yr. Lifecycle Costs for Sediment Management Options*

## Complementary Actions Beyond the Project Scope

In addition to the efforts proposed as part of the Taylor Creek Restoration Project, there are additional activities underway or that could be planned by various City Departments, King County or other partners to improve the overall condition of the watershed and enhance SPU's sediment management strategy.

### City of Seattle Stormwater Code

City of Seattle's Stormwater Code is one of the City's most comprehensive tool for managing stormwater to prevent impacts to lakes, streams and wetlands in Seattle, and over time to reduce the footprint of impervious surfaces in the City. Long-term stormwater management within the Taylor Creek Watershed will improve the outcome of any sediment management strategy implemented within the creek bed/banks.

### Partnerships with King County and/or Skyway

Untreated stormwater from Unincorporated King County within the Bryn Mawr-Skyway area (Skyway Water and Sewer District), and within City of Seattle limits drains directly to the watershed via a number of uncontrolled outfalls along the edge of the canyon. These outfalls contribute to the erosion of the canyon walls and increases the sediment input into the creek. SPU and King County should implement focused stormwater management around the canyon to further reduce sediment input from surrounding areas. This could include the following actions:

- Develop partnering plan with King County
- Identify smaller contributing basins and model runoff
- Identify and implement green, blue or grey solutions to capture/treat/store runoff from public and private sources
- Continue to protect and restore headwater wetlands

## Green Stormwater Infrastructure Incentives

Parcels eligible for GSI flow control incentives such as rebates on cisterns and raingardens – does not apply to the eastern side of the basin outside City Limits, or to upper watershed and headwater wetlands which are also outside of City limits. Within the public Right of Way, GIS incentives for flow control apply in a small portion of the upper watershed, and incentives for water quality and flow control apply on the east side of the ravine.

## Future Joint Acquisition and Floodplain Restoration

Both SPU and SPR have an interest in the future joint acquisition of any of the four parcels adjacent to Lakeridge Park (along 68th Ave S) where there are willing sellers. Such a partnership would provide expanded natural park lands, allow for trail connectivity from Lake WA through Lakeridge Park and into Dead Horse Canyon, provide an opportunity to expand the floodplain restoration and improve salmon habitat. At this time, this work is beyond the scope, capacity and budget of both Departments but a conceptual plan for future restoration was developed by SPU to demonstrate future compatibility with the existing design.

## Green Seattle Partnership (GSP) and Friends of Dead Horse Canyon

Both GSP and Friends of Dead Horse Canyon are actively involved in plant stewardship (removal of invasive plants and reforestation) within the canyon. This work is critical for increasing canopy cover which will reduce erosion, provide habitat, sequester carbon and provide slope stability. Continued support for these efforts should be demonstrated.

BUFFER TABLE

| # | TAG | SIZE | N | E | EL |
|---|---|---|---|---|---|
| 1 | 1003 | 12″ (DEC) | 188724.02 | 1290809.92 | 75.01 |
| 2 | 1033 | 24″ (DEC) | 188695.46 | 1290795.62 | 75.40 |
| 3 | 1036 | 6″ (CON) | 188666.97 | 1290801.77 | 75.13 |
| 4 | 1034 | 10″ (CON) | 188664.11 | 1290795.20 | 75.50 |
| 5 | 1035 | 18″ (DEC) | 188649.67 | 1290789.63 | 76.84 |
| 6 | 1037 | 18″ (DEC) | 188648.03 | 1290814.02 | 73.85 |
| 7 | 3044 | 6″ (DEC) | 188611.12 | 1290750.63 | 91.80 |
| 8 | 3045 | 15″ (DEC) | 188610.58 | 1290753.06 | 93.12 |
| 9 | 3043 | 15″ (DEC) | 188609.61 | 1290751.35 | 93.13 |
| 10 | 3042 | 18″ (DEC) | 188609.14 | 1290749.03 | 93.08 |
| 12 | 3041 | 15″ (DEC) | 188607.13 | 1290749.38 | 91.64 |
| 14 | 3040 | 18″ (DEC) | 188606.12 | 1290747.48 | 91.48 |
| 18 | 3049 | 30″ (DEC) | 188564.02 | 1290733.52 | 94.09 |
| 21 | 3053 | 20″ (DEC) | 188511.67 | 1290749.01 | 99.63 |
| 22 | 3052 | 18″ (DEC) | 188510.64 | 1290745.57 | 100.92 |
| 25 | 3064 | 6″ (CON) | 188488.56 | 1290802.14 | 97.39 |

BUFFER TABLE

| # | TAG | SIZE | N | E | EL |
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| 26 | 3067 | 24″ (DEC) | 188475.15 | 1290836.18 | 94.01 |
| 27 | 3065 | 48″ (CON) | 188458.05 | 1290815.11 | 104.97 |
| 28 | 3059 | 15″ (CON) | 188454.24 | 1290787.17 | 125.05 |
| 29 | 3066 | 20″ (DEC) | 188446.33 | 1290828.06 | 98.40 |
| 30 | 3081 | 30″ (DEC) | 188428.61 | 1290824.93 | 108.50 |
| 31 | 3080 | 20″ (DEC) | 188425.62 | 1290819.75 | 111.56 |
| 32 | 3079 | 20″ (DEC) | 188425.09 | 1290816.25 | 111.46 |
| 33 | 3084 | 12″ (DEC) | 188393.28 | 1290866.33 | 107.09 |
| 34 | 3085 | 15″ (DEC) | 188392.43 | 1290865.68 | 107.11 |
| 35 | 3083 | 12″ (DEC) | 188392.26 | 1290867.74 | 107.71 |
| 36 | 3082 | 24″ (DEC) | 188390.21 | 1290867.48 | 107.72 |
| 37 | 3088 | 18″ (DEC) | 188373.93 | 1290901.45 | 109.28 |
| 38 | 3087 | 24″ (DEC) | 188364.87 | 1290905.88 | 110.95 |
| 40 | 3076 | 15″ (DEC) | 188343.38 | 1290868.81 | 136.63 |
| 41 | 3091 | 24″ (DEC) | 188324.65 | 1290926.97 | 110.86 |
| 42 | 3094 | 10″ (DEC) | 188289.15 | 1290940.06 | 115.19 |

BUFFER TABLE

| # | TAG | SIZE | N | E | EL |
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| 43 | 3093 | 12″ (DEC) | 188287.83 | 1290939.68 | 115.54 |
| 44 | 1138 | 15″ (DEC) | 188287.62 | 1290954.11 | 106.10 |
| 45 | 3092 | 18″ (DEC) | 188287.12 | 1290940.92 | 115.82 |
| 46 | 1137 | 15″ (DEC) | 188284.90 | 1290954.54 | 106.81 |
| 48 | 3121 | 40″ (CON) | 188253.58 | 1290957.30 | 111.35 |
| 49 | 3115 | 12″ (CON) | 188235.59 | 1290930.81 | 131.05 |
| 50 | 3116 | 12″ (DEC) | 188228.17 | 1290930.21 | 130.76 |
| 53 | 3120 | 20″ (DEC) | 188184.43 | 1290951.17 | 131.03 |
| 54 | 3122 | 15″ (DEC) | 188177.78 | 1290987.35 | 122.51 |
| 55 | 3123 | 20″ (DEC) | 188173.74 | 1290985.69 | 122.50 |
| 56 | 3114 | 8″ (CON) | 188154.80 | 1290987.51 | 124.56 |
| 57 | 3113 | 30″ (DEC) | 188148.98 | 1290989.60 | 126.80 |
| 59 | 3109 | 12″ (DEC) | 188103.13 | 1290973.42 | 134.76 |
| 60 | 3110 | 18″ (DEC) | 188102.87 | 1290975.43 | 134.76 |
| 61 | 3107 | 12″ (CON) | 188098.79 | 1290934.22 | 156.82 |
| 65 | 3137 | 18″ (DEC) | 188009.15 | 1290943.92 | 159.95 |

BUFFER TABLE

| # | TAG | SIZE | N | E | EL |
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| 66 | 3136 | 36″ (CON) | 188001.94 | 1290943.02 | 160.97 |
| 67 | 3146 | 20″ (DEC) | 187970.77 | 1290987.19 | 150.40 |
| 69 | 3168 | 24″ (DEC) | 187918.29 | 1291007.66 | 138.34 |
| 70 | 3148 | 24″ (DEC) | 187916.04 | 1290956.85 | 158.93 |
| 71 | 3169 | 24″ (DEC) | 187913.79 | 1291001.87 | 140.84 |
| 72 | 3167 | 24″ (CON) | 187901.22 | 1291000.22 | 144.12 |
| 73 | 1290 | 24″ (CON) | 187896.77 | 1291017.05 | 132.28 |
| 74 | 3166 | 10″ (DEC) | 187893.88 | 1290994.05 | 143.82 |
| 75 | 1291 | 12″ (CON) | 187890.04 | 1291011.38 | 133.31 |
| 76 | 3144 | 24″ (DEC) | 187886.33 | 1290952.78 | 163.63 |
| 77 | 3165 | 36″ (CON) | 187874.08 | 1290992.17 | 147.82 |
| 80 | 3154 | 18″ (DEC) | 187866.04 | 1290943.07 | 166.17 |
| 83 | 3159 | 24″ (CON) | 187846.70 | 1290939.60 | 167.65 |
| 84 | 3163 | 48″ (DEC) | 187845.67 | 1290986.10 | 156.07 |
| 85 | 3162 | 24″ (CON) | 187844.81 | 1290978.92 | 157.27 |
| 88 | 3173 | 18″ (DEC) | 187814.38 | 1290933.09 | 169.20 |

BUFFER TABLE

| # | TAG | SIZE | N | E | EL |
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| 90 | 3172 | 10″ (DEC) | 187807.40 | 1290932.28 | 167.28 |
| 91 | 3161 | 48″ (DEC) | 187806.77 | 1290967.47 | 161.98 |
| 93 | 1335 | 10″ (DEC) | 187768.56 | 1290981.66 | 152.12 |
| 95 | 3183 | 40″ (DEC) | 187764.36 | 1290971.93 | 158.99 |
| 96 | 1336 | 15″ (DEC) | 187764.29 | 1290981.50 | 151.39 |
| 97 | 1337 | 15″ (DEC) | 187761.96 | 1290981.39 | 151.89 |
| 102 | 3230 | 6″ (CON) | 187735.10 | 1290966.94 | 158.31 |
| 103 | 1340 | 20″ (DEC) | 187733.75 | 1290985.96 | 153.39 |
| 105 | 3228 | 51″ (CON) | 187717.75 | 1290974.10 | 157.39 |
| 106 | 3195 | 21″ (DEC) | 187716.80 | 1290913.72 | 178.69 |
| 108 | 3192 | 16″ (DEC) | 187715.51 | 1290931.09 | 171.28 |
| 109 | 3198 | 52″ (CON) | 187710.39 | 1290920.36 | 176.86 |
| 110 | 3199 | 12″ (DEC) | 187708.51 | 1290917.02 | 178.20 |
| 111 | 3200 | 7″ (DEC) | 187707.92 | 1290915.42 | 177.97 |
| 112 | 3201 | 11″ (DEC) | 187707.08 | 1290916.43 | 177.97 |
| 113 | 3204 | 12″ (DEC) | 187706.40 | 1290924.42 | 175.95 |

BUFFER TABLE

| # | TAG | SIZE | N | E | EL |
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| 115 | 3205 | 8″ (DEC) | 187703.82 | 1290924.34 | 175.38 |
| 116 | 3202 | 12″ (DEC) | 187703.38 | 1290915.64 | 175.41 |
| 117 | 3225 | 8″ (CON) | 187700.18 | 1290957.51 | 164.71 |
| 120 | 3206 | 12″ (DEC) | 187679.66 | 1290908.42 | 172.71 |
| 121 | 3207 | 15″ (DEC) | 187678.03 | 1290905.98 | 173.04 |
| 122 | 3220 | 10″ (DEC) | 187677.44 | 1290949.55 | 162.30 |
| 124 | 3215 | 10″ (DEC) | 187660.55 | 1290931.26 | 169.61 |
| 127 | 3211 | 36″ (DEC) | 187630.12 | 1290931.97 | 169.81 |
| 128 | 3240 | 17″ (DEC) | 187628.50 | 1290884.63 | 181.48 |
| 130 | 3239 | 20″ (DEC) | 187623.23 | 1290884.18 | 181.48 |
| 132 | 3273 | 20″ (DEC) | 187602.97 | 1290923.15 | 164.90 |
| 133 | 3263 | 16″ (DEC) | 187602.75 | 1290874.51 | 185.13 |
| 134 | 3265 | 7″ (DEC) | 187596.99 | 1290890.60 | 178.99 |
| 135 | 3267 | 19″ (DEC) | 187593.05 | 1290887.15 | 179.17 |
| 136 | 3266 | 8″ (DEC) | 187592.86 | 1290889.43 | 179.08 |
| 138 | 3268 | 31″ (DEC) | 187589.18 | 1290886.12 | 180.71 |

BUFFER TABLE

| # | TAG | SIZE | N | E | EL |
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| 139 | 3269 | 17″ (DEC) | 187589.03 | 1290891.75 | 178.40 |
| 140 | 3274 | 15″ (DEC) | 187587.89 | 1290937.67 | 155.84 |
| 141 | 3275 | 10″ (DEC) | 187573.62 | 1290936.92 | 154.98 |
| 144 | 1418 | 12″ (DEC) | 187551.96 | 1290928.92 | 164.66 |
| 145 | 3257 | 13″ (DEC) | 187546.51 | 1290901.77 | 170.57 |
| 146 | 1435 | 12″ (DEC) | 187536.76 | 1290930.09 | 166.02 |
| 150 | 3244 | 6″ (DEC) | 187492.24 | 1290907.09 | 166.80 |
| 151 | 3291 | 22″ (DEC) | 187489.72 | 1290940.94 | 155.70 |
| 152 | 3292 | 8″ (DEC) | 187487.13 | 1290942.41 | 154.67 |
| 153 | 3242 | 42″ (CON) | 187482.12 | 1290905.08 | 164.72 |
| 155 | 3241 | 6″ (CON) | 187474.32 | 1290908.84 | 164.03 |
| 158 | 3284 | 53″ (CON) | 187437.88 | 1290912.59 | 164.36 |
| 159 | 3282 | 31″ (CON) | 187422.72 | 1290904.60 | 163.61 |
| 160 | 3283 | 6″ (DEC) | 187418.28 | 1290913.54 | 162.92 |
| 161 | 1478 | 8″ (DEC) | 187416.34 | 1290949.70 | 155.63 |
| 162 | 1479 | 20″ (DEC) | 187415.59 | 1290952.26 | 152.59 |

BUFFER TABLE

| # | TAG | SIZE | N | E | EL |
|---|---|---|---|---|---|
| 166 | 3314 | 11″ (DEC) | 187376.44 | 1290913.14 | 176.29 |
| 167 | 3313 | 17″ (DEC) | 187373.23 | 1290911.59 | 178.11 |
| 168 | 3326 | 41″ (DEC) | 187339.40 | 1290931.99 | 176.80 |
| 169 | 3312 | 21″ (DEC) | 187334.31 | 1290974.39 | 171.11 |
| 172 | 3308 | 34″ (DEC) | 187293.20 | 1291013.23 | 178.87 |
| 175 | 3331 | 41″ (CON) | 187273.90 | 1291035.33 | 179.91 |
| 178 | 3338 | 15″ (DEC) | 187254.11 | 1291065.71 | 173.48 |
| 181 | 3337 | 7″ (CON) | 187251.04 | 1291058.35 | 175.81 |
| 184 | 3336 | 15″ (DEC) | 187242.65 | 1291053.68 | 177.12 |
| 185 | 3335 | 6″ (DEC) | 187241.76 | 1291053.06 | 177.98 |
| 188 | 3348 | 12″ (DEC) | 187225.03 | 1291034.68 | 184.28 |
| 189 | 3347 | 20″ (DEC) | 187212.30 | 1291037.58 | 183.57 |
| 190 | 3341 | 12″ (CON) | 187210.21 | 1291075.52 | 175.57 |
| 191 | 3346 | 12″ (DEC) | 187201.44 | 1291038.89 | 184.67 |
| 194 | 3342 | 27″ (DEC) | 187188.63 | 1291079.69 | 178.30 |
| 196 | 3344 | 8″ (DEC) | 187170.13 | 1291051.23 | 186.34 |

BUFFER TABLE

| # | TAG | SIZE | N | E | EL |
|---|---|---|---|---|---|
| 197 | 3352 | 6″ (CON) | 187165.22 | 1291091.54 | 174.17 |
| 198 | 3351 | 12″ (DEC) | 187165.07 | 1291085.60 | 176.17 |
| 199 | 3345 | 8″ (DEC) | 187164.12 | 1291051.82 | 187.00 |
| 200 | 3354 | 10″ (DEC) | 187162.58 | 1291092.26 | 174.81 |
| 201 | 3355 | 45″ (DEC) | 187140.25 | 1291059.33 | 185.35 |
| 202 | 3365 | 13″ (DEC) | 187135.59 | 1291061.77 | 188.14 |
| 203 | 3356 | 55″ (CON) | 187128.36 | 1291030.24 | 193.81 |
| 204 | 3364 | 15″ (DEC) | 187116.13 | 1291078.39 | 183.62 |
| 205 | 3366 | 10″ (DEC) | 187106.74 | 1291060.09 | 186.35 |
| 208 | 3371 | 9″ (DEC) | 187069.50 | 1290992.03 | 203.42 |
| 210 | 3378 | 10″ (DEC) | 187056.61 | 1291031.33 | 195.55 |
| 213 | 3383 | 38″ (DEC) | 187025.85 | 1290980.48 | 206.11 |
| 214 | 3384 | 6″ (DEC) | 187021.56 | 1290981.26 | 205.67 |
| 216 | 3413 | 6″ (DEC) | 186967.63 | 1290974.18 | 207.05 |
| 218 | 3396 | 24″ (DEC) | 186944.08 | 1291038.23 | 202.12 |
| 222 | 3485 | 12″ (DEC) | 186938.75 | 1291209.45 | 191.23 |

BUFFER TABLE

| # | TAG | SIZE | N | E | EL |
|---|---|---|---|---|---|
| 223 | 3407 | 25″ (CON) | 186921.61 | 1291033.12 | 206.79 |
| 224 | 3486 | 19″ (DEC) | 186914.56 | 1291210.94 | 195.24 |
| 225 | 3417 | 19″ (DEC) | 186911.96 | 1290983.88 | 209.53 |
| 226 | 3408 | 35″ (DEC) | 186911.81 | 1291036.50 | 205.45 |
| 227 | 3423 | 40″ (CON) | 186909.03 | 1291017.04 | 210.54 |
| 228 | 3487 | 25″ (DEC) | 186901.22 | 1291202.61 | 195.61 |
| 229 | 3422 | 20″ (DEC) | 186896.59 | 1291024.92 | 209.85 |
| 230 | 3416 | 42″ (DEC) | 186896.31 | 1290993.83 | 207.63 |
| 231 | 3426 | 19″ (DEC) | 186888.92 | 1291047.20 | 200.05 |
| 232 | 3418 | 7″ (DEC) | 186883.19 | 1291000.43 | 207.44 |
| 234 | 3519 | 20″ (DEC) | 186879.32 | 1291211.28 | 203.48 |
| 235 | 3427 | 16″ (CON) | 186878.34 | 1291050.61 | 199.36 |
| 236 | 3419 | 11″ (DEC) | 186874.10 | 1291007.97 | 206.85 |
| 238 | 3520 | 17″ (DEC) | 186871.27 | 1291211.97 | 201.49 |
| 239 | 3521 | 14″ (CON) | 186863.31 | 1291211.49 | 200.17 |
| 240 | 1699 | 15″ (DEC) | 186858.52 | 1291181.97 | 185.32 |

| VAULT SERIAL # | DATE | MARK | NATURE | MADE | CHK'D | REV'D |
|---|---|---|---|---|---|---|
| 38358 | | | | | | |

REVISIONS

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wagners1 Nov-16-21 8:19am

**90% SUBMITTAL (NOT FOR CONSTRUCTION)**

Appendix B, Tree Survey

BUFFER TREE TABLE (1 OF 2)

APPROVED FOR ADVERTISING
LIZ ALZEER
DEPARTMENT OF FINANCE & ADMINISTRATIVE SERVICES
SEATTLE, WASHINGTON . . . . . . . . . . . . . . 20 . . .

BY: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
PURCHASING AND CONTRACTING DIRECTOR

INITIALS AND DATE
DESIGNED
CHECKED
DRAWN
CHECKED

INITIALS AND DATE
REVIEWED:
DES. CONST.
SDOT PROJ. MGR.
RECEIVED
REVISED AS BUILT

ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 0-02.3 OF THE PROJECT MANUAL.

Seattle Public Utilities
ORDINANCE NO. PW NO.
SCALE: H. 1"=20', V. 1"=10'

# DEAD HORSE CANYON RAVINE STABILIZATION AND SEDIMENT STORAGE DESIGN

JOB PC C399315
CO
VPI # 792-262
PK001
SHEET 1 OF 5

## BUFFER TABLE

| # | TAG | SIZE | N | E | EL |
|---|---|---|---|---|---|
| 242 | 3433 | 23″ (DEC) | 186855.61 | 1291006.29 | 219.05 |
| 243 | 1682 | 15″ (DEC) | 186855.37 | 1291094.38 | 189.27 |
| 244 | 3430 | 7″ (DEC) | 186854.12 | 1291034.54 | 202.38 |
| 245 | 3508 | 17″ (DEC) | 186854.06 | 1291220.21 | 206.12 |
| 246 | 1681 | 24″ (DEC) | 186853.72 | 1291093.24 | 189.27 |
| 248 | 3429 | 14″ (DEC) | 186853.25 | 1291035.41 | 202.39 |
| 250 | 3432 | 46″ (CON) | 186848.50 | 1291029.73 | 205.90 |
| 251 | 3431 | 31″ (DEC) | 186848.02 | 1291033.97 | 203.90 |
| 252 | 1700 | 18″ (DEC) | 186836.36 | 1291193.38 | 186.73 |
| 253 | 3504 | 11″ (DEC) | 186827.29 | 1291224.40 | 200.39 |
| 255 | 3503 | 20″ (DEC) | 186818.64 | 1291226.71 | 199.80 |
| 256 | 3446 | 6″ (CON) | 186816.86 | 1291066.35 | 211.92 |
| 258 | 1677 | 30″ (DEC) | 186815.17 | 1291108.59 | 198.45 |
| 263 | 1710 | 24″ (DEC) | 186797.68 | 1291188.98 | 183.83 |
| 265 | 1679 | 6″ (CON) | 186794.95 | 1291111.75 | 191.64 |
| 266 | 3501 | 13″ (DEC) | 186794.60 | 1291230.33 | 201.82 |

## BUFFER TABLE

| # | TAG | SIZE | N | E | EL |
|---|---|---|---|---|---|
| 267 | 1709 | 18″ (DEC) | 186791.53 | 1291188.95 | 183.73 |
| 269 | 1727 | 24″ (DEC) | 186779.91 | 1291079.48 | 204.14 |
| 270 | 1708 | 8″ (DEC) | 186766.61 | 1291163.37 | 183.98 |
| 271 | 1725 | 20″ (DEC) | 186761.85 | 1291092.69 | 190.63 |
| 272 | 1706 | 18″ (DEC) | 186760.36 | 1291168.84 | 191.13 |
| 273 | 1726 | 8″ (DEC) | 186760.12 | 1291098.99 | 188.42 |
| 274 | 1724 | 20″ (DEC) | 186759.67 | 1291094.87 | 190.63 |
| 276 | 1707 | 8″ (DEC) | 186754.39 | 1291159.70 | 189.69 |
| 277 | 3492 | 9″ (DEC) | 186752.32 | 1291198.18 | 203.52 |
| 278 | 3491 | 14″ (DEC) | 186751.96 | 1291200.34 | 203.59 |
| 280 | 1720 | 12″ (DEC) | 186751.26 | 1291133.60 | 186.21 |
| 281 | 1719 | 12″ (DEC) | 186749.39 | 1291133.39 | 187.32 |
| 282 | 1717 | 12″ (DEC) | 186748.12 | 1291144.43 | 188.31 |
| 283 | 1718 | 18″ (DEC) | 186747.56 | 1291133.05 | 187.35 |
| 284 | 1721 | 12″ (DEC) | 186746.69 | 1291126.13 | 186.53 |
| 285 | 1732 | 18″ (DEC) | 186735.64 | 1291045.56 | 195.78 |

## BUFFER TABLE

| # | TAG | SIZE | N | E | EL |
|---|---|---|---|---|---|
| 286 | 1731 | 24″ (DEC) | 186727.48 | 1291051.75 | 194.10 |
| 287 | 1729 | 12″ (DEC) | 186726.46 | 1291087.97 | 186.68 |
| 288 | 3527 | 12″ (DEC) | 186726.16 | 1291202.85 | 208.22 |
| 289 | 3528 | 10″ (DEC) | 186724.03 | 1291202.75 | 205.31 |
| 292 | 3539 | 8″ (DEC) | 186709.12 | 1291219.75 | 206.74 |
| 293 | 3537 | 13″ (DEC) | 186708.46 | 1291220.82 | 204.65 |
| 294 | 3538 | 11″ (DEC) | 186707.51 | 1291218.28 | 203.89 |
| 295 | 2140 | 6″ (DEC) | 186704.93 | 1291046.94 | 185.47 |
| 296 | 1757 | 18″ (CON) | 186702.78 | 1291134.80 | 193.16 |
| 297 | 1756 | 24″ (CON) | 186698.04 | 1291132.35 | 194.46 |
| 299 | 3020 | 26″ (DEC) | 186645.61 | 1291251.85 | 200.71 |
| 300 | 3009 | 22″ (DEC) | 186617.64 | 1291215.49 | 199.79 |

### BUFFER TREES NOTES:

1. TOTAL NUMBER OF BUFFER TREES: 204.
    - 166 DECIDUOUS
    - 38 CONIFER
2. ANY TREES TO BE REMOVED THAT ARE NOT INCLUDED ON TABLE MUST BE APPROVED BY OWNER OR ENGINEER.

| DATE | MARK | NATURE<br>REVISIONS | MADE | CHK'D | REV'D |
|---|---|---|---|---|---|

VAULT SERIAL #
38358

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**90% SUBMITTAL (NOT FOR CONSTRUCTION)**

BUFFER TREE TABLE (2 OF 2)

APPROVED FOR ADVERTISING
LIZ ALZEER
DEPARTMENT OF FINANCE & ADMINISTRATIVE SERVICES
SEATTLE, WASHINGTON . . . . . . . . . . . . . 20 . . .
BY: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
PURCHASING AND CONTRACTING DIRECTOR

INITIALS AND DATE
DESIGNED
CHECKED
DRAWN
CHECKED

INITIALS AND DATE
REVIEWED:
DES. CONST.
SDOT PROJ. MGR.
RECEIVED
REVISED AS BUILT

ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 0-02.3 OF THE PROJECT MANUAL.

ENGINEER'S NAME
STATE OF WASHINGTON
#### REGISTERED
PROFESSIONAL ENGINEER

Seattle Public Utilities
ORDINANCE NO. PW NO.
SCALE: H. 1"=20', V. 1"=10'

# DEAD HORSE CANYON RAVINE STABILIZATION AND SEDIMENT STORAGE DESIGN

JOB PC C399315
CO
VPI # 792-262
PK002
SHEET 2 OF 5

## CUT TREE TABLE

| # | TAG | SIZE | N | E | EL |
|---|---|---|---|---|---|
| 11 | 3046 | 20″ (DEC) | 188607.59 | 1290754.39 | 91.32 |
| 13 | 3047 | 24″ (DEC) | 188606.26 | 1290752.35 | 89.75 |
| 15 | 3048 | 18″ (DEC) | 188605.29 | 1290752.08 | 91.83 |
| 16 | 1046 | 8″ (DEC) | 188587.10 | 1290765.71 | 83.65 |
| 17 | 1047 | 22″ (DEC) | 188581.72 | 1290763.21 | 86.49 |
| 19 | 3054 | 20″ (DEC) | 188545.19 | 1290753.65 | 92.45 |
| 20 | 3060 | 15″ (DEC) | 188519.95 | 1290779.05 | 95.65 |
| 23 | 3062 | 8″ (DEC) | 188502.18 | 1290806.73 | 94.72 |
| 24 | 3063 | 15″ (DEC) | 188494.23 | 1290796.79 | 97.90 |
| 27 | 3065 | 48″ (CON) | 188458.05 | 1290815.11 | 104.97 |
| 30 | 3081 | 30″ (DEC) | 188428.61 | 1290824.93 | 108.50 |
| 31 | 3080 | 20″ (DEC) | 188425.62 | 1290819.75 | 111.56 |
| 32 | 3079 | 20″ (DEC) | 188425.09 | 1290816.25 | 111.46 |
| 39 | 3086 | 12″ (DEC) | 188358.64 | 1290895.73 | 112.87 |
| 47 | 3095 | 18″ (DEC) | 188268.63 | 1290940.05 | 122.15 |

## CUT TREE TABLE

| # | TAG | SIZE | N | E | EL |
|---|---|---|---|---|---|
| 51 | 3124 | 12″ (DEC) | 188205.01 | 1290964.55 | 125.21 |
| 52 | 3125 | 10″ (DEC) | 188203.80 | 1290965.89 | 125.00 |
| 58 | 3108 | 15″ (DEC) | 188108.20 | 1290964.21 | 136.54 |
| 62 | 3111 | 15″ (DEC) | 188084.41 | 1290971.15 | 140.21 |
| 63 | 3112 | 6″ (DEC) | 188082.70 | 1290970.69 | 140.15 |
| 64 | 3126 | 48″ (DEC) | 188048.29 | 1290965.22 | 153.12 |
| 68 | 3145 | 24″ (DEC) | 187968.74 | 1290984.90 | 150.40 |
| 78 | 3164 | 12″ (DEC) | 187873.73 | 1290980.76 | 154.67 |
| 79 | 3155 | 15″ (DEC) | 187867.11 | 1290958.71 | 160.44 |
| 81 | 3156 | 12″ (DEC) | 187860.52 | 1290956.09 | 159.82 |
| 82 | 3157 | 12″ (DEC) | 187847.31 | 1290954.12 | 160.95 |
| 86 | 3158 | 12″ (DEC) | 187838.66 | 1290948.69 | 162.22 |
| 87 | 3160 | 20″ (DEC) | 187831.01 | 1290962.70 | 162.35 |
| 89 | 3174 | 15″ (DEC) | 187813.73 | 1290940.48 | 164.62 |
| 92 | 3185 | 10″ (DEC) | 187775.09 | 1290953.19 | 164.94 |

## CUT TREE TABLE

| # | TAG | SIZE | N | E | EL |
|---|---|---|---|---|---|
| 94 | 3184 | 18″ (DEC) | 187768.27 | 1290956.47 | 165.35 |
| 98 | 3186 | 15″ (DEC) | 187754.83 | 1290947.13 | 168.93 |
| 99 | 3188 | 17″ (DEC) | 187750.35 | 1290935.69 | 169.85 |
| 100 | 3189 | 13″ (DEC) | 187741.78 | 1290937.47 | 170.23 |
| 101 | 3190 | 12″ (DEC) | 187736.17 | 1290935.80 | 170.46 |
| 104 | 3229 | 13″ (DEC) | 187731.31 | 1290952.66 | 168.58 |
| 107 | 3224 | 7″ (DEC) | 187715.85 | 1290944.19 | 169.70 |
| 108 | 3192 | 16″ (DEC) | 187715.51 | 1290931.09 | 171.28 |
| 114 | 3223 | 9″ (DEC) | 187706.06 | 1290941.07 | 171.33 |
| 115 | 3205 | 8″ (DEC) | 187703.82 | 1290924.34 | 175.38 |
| 118 | 3222 | 9″ (DEC) | 187699.99 | 1290942.45 | 167.69 |
| 119 | 3221 | 7″ (DEC) | 187684.75 | 1290931.59 | 171.06 |
| 123 | 3214 | 7″ (CON) | 187669.06 | 1290924.54 | 171.49 |
| 125 | 3212 | 7″ (CON) | 187646.69 | 1290920.16 | 173.73 |
| 126 | 3213 | 8″ (CON) | 187633.42 | 1290920.11 | 173.76 |

## CUT TREE TABLE

| # | TAG | SIZE | N | E | EL |
|---|---|---|---|---|---|
| 129 | 3231 | 9″ (CON) | 187625.19 | 1290917.49 | 174.47 |
| 131 | 3271 | 6″ (CON) | 187607.58 | 1290911.58 | 173.41 |
| 137 | 3272 | 6″ (CON) | 187589.83 | 1290917.25 | 167.32 |
| 142 | 3270 | 15″ (DEC) | 187573.18 | 1290921.22 | 166.61 |
| 143 | 3258 | 8″ (DEC) | 187558.51 | 1290902.32 | 171.33 |
| 147 | 1434 | 9″ (DEC) | 187531.02 | 1290925.39 | 166.62 |
| 148 | 1433 | 14″ (DEC) | 187510.66 | 1290925.88 | 166.80 |
| 149 | 1432 | 14″ (DEC) | 187508.59 | 1290926.37 | 166.51 |
| 154 | 3290 | 10″ (DEC) | 187481.72 | 1290920.86 | 163.73 |
| 156 | 3293 | 7″ (CON) | 187471.72 | 1290922.74 | 162.53 |
| 157 | 3294 | 25″ (DEC) | 187444.46 | 1290929.11 | 163.35 |
| 163 | 3295 | 13″ (DEC) | 187403.60 | 1290940.98 | 166.05 |
| 164 | 3296 | 8″ (DEC) | 187399.63 | 1290940.52 | 164.72 |
| 165 | 3297 | 12″ (DEC) | 187394.02 | 1290942.20 | 167.33 |
| 170 | 3311 | 15″ (DEC) | 187333.62 | 1290965.15 | 173.14 |

## CUT TREE TABLE

| # | TAG | SIZE | N | E | EL |
|---|---|---|---|---|---|
| 171 | 3325 | 23″ (DEC) | 187298.52 | 1290967.60 | 181.16 |
| 173 | 3310 | 6″ (DEC) | 187286.14 | 1290990.96 | 183.44 |
| 174 | 3324 | 25″ (DEC) | 187283.43 | 1290972.14 | 183.44 |
| 176 | 3323 | 20″ (DEC) | 187266.48 | 1290995.71 | 184.68 |
| 177 | 3328 | 11″ (DEC) | 187257.18 | 1291031.67 | 181.46 |
| 179 | 3327 | 9″ (DEC) | 187252.64 | 1291025.87 | 183.25 |
| 180 | 3329 | 7″ (DEC) | 187251.82 | 1291034.28 | 182.19 |
| 182 | 3330 | 14″ (DEC) | 187250.06 | 1291036.95 | 181.84 |
| 183 | 3332 | 23″ (DEC) | 187246.70 | 1291016.47 | 183.81 |
| 186 | 3333 | 13″ (DEC) | 187237.07 | 1291046.31 | 178.22 |
| 187 | 3334 | 19″ (DEC) | 187234.72 | 1291048.42 | 177.88 |
| 192 | 3339 | 32″ (DEC) | 187200.33 | 1291062.55 | 180.30 |
| 193 | 3340 | 20″ (DEC) | 187197.05 | 1291063.10 | 179.94 |
| 195 | 3343 | 6″ (CON) | 187175.78 | 1291058.05 | 179.58 |
| 206 | 3368 | 32″ (DEC) | 187092.01 | 1291028.15 | 193.49 |

## CUT TREE TABLE

| # | TAG | SIZE | N | E | EL |
|---|---|---|---|---|---|
| 207 | 3369 | 32″ (DEC) | 187088.83 | 1291027.25 | 195.24 |
| 209 | 3370 | 24″ (DEC) | 187062.90 | 1291009.39 | 201.81 |
| 211 | 3379 | 10″ (CON) | 187041.67 | 1291002.99 | 200.48 |
| 212 | 3380 | 6″ (CON) | 187040.05 | 1291006.17 | 200.00 |
| 215 | 3381 | 43″ (DEC) | 187001.49 | 1291003.91 | 202.50 |
| 217 | 3402 | 24″ (DEC) | 186944.89 | 1291002.79 | 206.90 |
| 219 | 3484 | 19″ (DEC) | 186941.26 | 1291195.70 | 190.94 |
| 220 | 3403 | 9″ (DEC) | 186940.60 | 1291008.59 | 207.38 |
| 221 | 3405 | 8″ (DEC) | 186940.25 | 1291003.47 | 206.04 |
| 233 | 3421 | 18″ (DEC) | 186879.44 | 1291022.61 | 207.44 |
| 237 | 3420 | 9″ (CON) | 186872.62 | 1291020.51 | 206.65 |
| 241 | 3490 | 6″ (CON) | 186855.81 | 1291190.87 | 193.85 |
| 247 | 3489 | 17″ (DEC) | 186853.53 | 1291191.24 | 193.45 |
| 249 | 3428 | 9″ (CON) | 186852.45 | 1291042.65 | 200.57 |
| 254 | 3447 | 32″ (DEC) | 186822.10 | 1291077.90 | 212.92 |

## CUT TREE TABLE

| # | TAG | SIZE | N | E | EL |
|---|---|---|---|---|---|
| 257 | 1675 | 24″ (CON) | 186815.37 | 1291094.50 | 206.79 |
| 259 | 1702 | 15″ (DEC) | 186814.03 | 1291201.01 | 188.45 |
| 260 | 1676 | 12″ (CON) | 186813.36 | 1291097.41 | 204.90 |
| 261 | 3502 | 13″ (DEC) | 186810.57 | 1291221.17 | 195.44 |
| 262 | 1703 | 15″ (DEC) | 186807.28 | 1291202.99 | 190.78 |
| 264 | 1678 | 12″ (DEC) | 186797.29 | 1291104.60 | 197.49 |
| 268 | 1728 | 24″ (DEC) | 186787.07 | 1291101.51 | 192.07 |
| 271 | 1725 | 20″ (DEC) | 186761.85 | 1291092.69 | 190.63 |
| 274 | 1724 | 20″ (DEC) | 186759.67 | 1291094.87 | 190.63 |
| 275 | 1704 | 15″ (DEC) | 186759.20 | 1291174.06 | 192.09 |
| 279 | 1705 | 8″ (DEC) | 186751.91 | 1291173.35 | 192.76 |
| 290 | 1715 | 20″ (DEC) | 186714.52 | 1291162.56 | 194.69 |
| 291 | 1716 | 12″ (DEC) | 186712.51 | 1291167.73 | 194.67 |
| 298 | 3019 | 8″ (CON) | 186675.42 | 1291209.15 | 196.15 |

## REMOVED TREES NOTES:

1. TOTAL NUMBER OF TREES TO BE REMOVED: 104.
   - 87 DECIDUOUS
   - 17 CONIFER
2. ANY TREES TO BE REMOVED THAT ARE NOT INCLUDED ON TABLE MUST BE APPROVED BY OWNER OR ENGINEER.

| DATE | MARK | NATURE | MADE | CHK'D | REV'D |
|---|---|---|---|---|---|
|  |  |  |  |  |  |

REVISIONS

VAULT SERIAL #
38358

\\wdcnas01\spucad data\cadd\Project\261-1315\05-designdrawings\B-Sheets\3 PK0033.dwg
wagners1 Nov-16-21 8:23am

**90% SUBMITTAL (NOT FOR CONSTRUCTION)**

CUT TREE TABLE

APPROVED FOR ADVERTISING
LIZ ALZEER
DEPARTMENT OF FINANCE & ADMINISTRATIVE SERVICES
SEATTLE, WASHINGTON . . . . . . . . . . . . . 20 . . .
BY: . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
PURCHASING AND CONTRACTING DIRECTOR

INITIALS AND DATE
DESIGNED
CHECKED
DRAWN
CHECKED

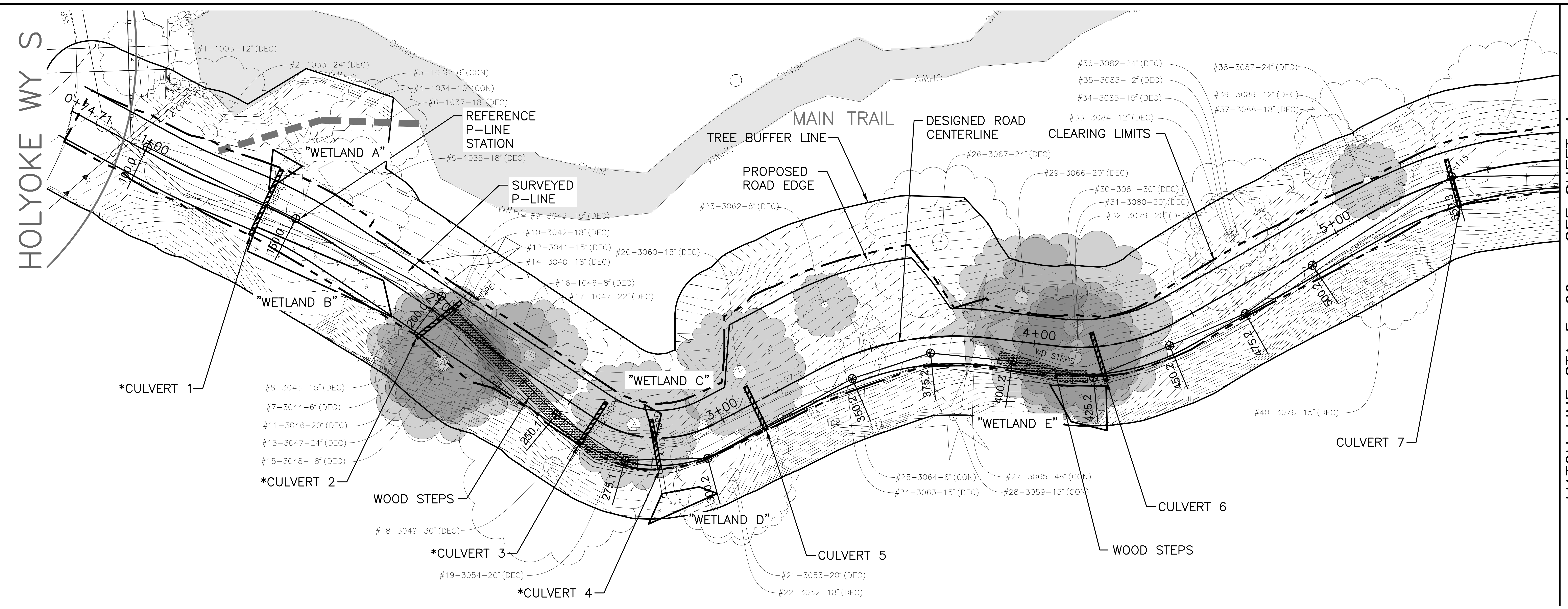
INITIALS AND DATE
REVIEWED:
DES. CONST.
SDOT PROJ. MGR.
RECEIVED
REVISED AS BUILT

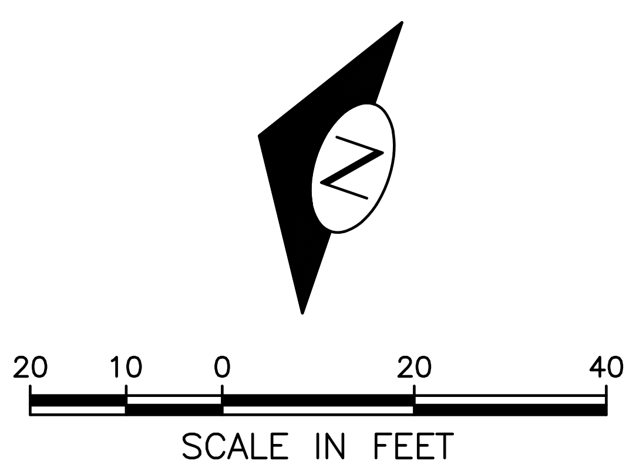
ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 0-02.3 OF THE PROJECT MANUAL.

Seattle Public Utilities
ORDINANCE NO. PW NO.
SCALE: H. 1"=20', V. 1"=10'

DEAD HORSE CANYON
RAVINE STABILIZATION AND
SEDIMENT STORAGE DESIGN

JOB PC C399315
CO
VPI # 792-262
PK003
SHEET 3 OF 5



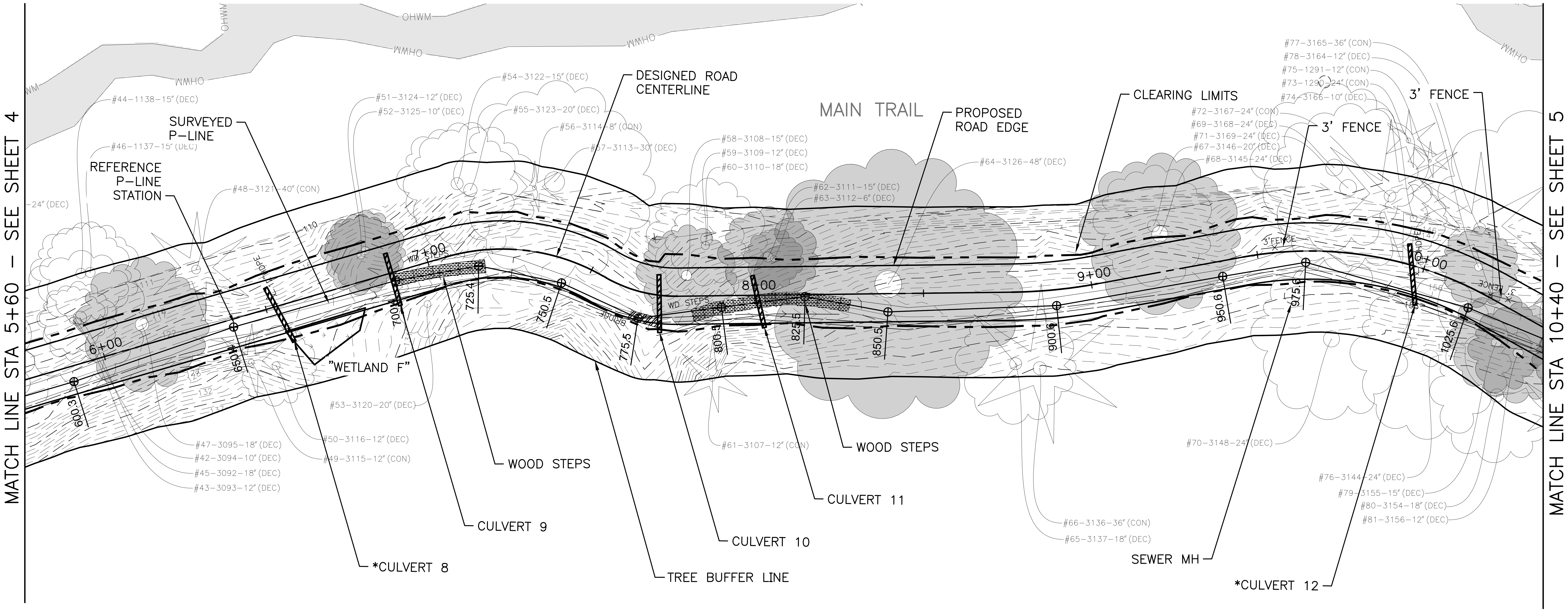


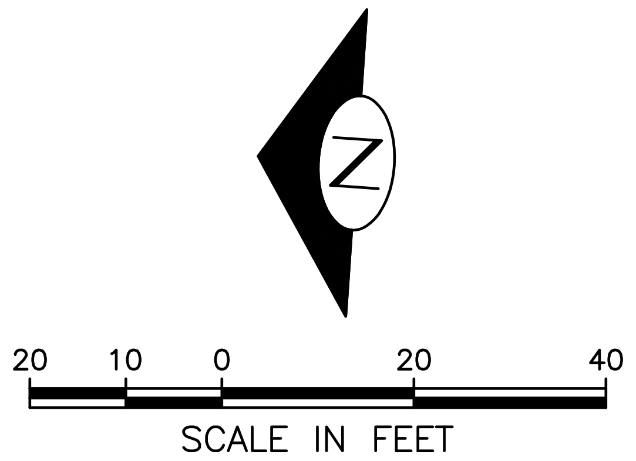
## CSEC & DEMO LEGEND:

CLEARING LIMITS

POTENTIAL MACHINE ACCESS PT

CONIFER TREE  DECIDUOUS TREE  TREES REMOVED





## NOTES:

1. ALL TREES IN DESIGNATED CLEARING LIMITS ON CSEC & DEMOLITION PLAN SHEETS SHALL BE REMOVED. ANY TREES THAT REQUIRE REMOVAL OUTSIDE THE CLEARED LIMIT REQUIRED FOR CONSTRUCTION OF ACCESS ROAD MUST RECEIVE APPROVAL FROM OWNER OR ENGINEER.
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3. ALL STRUCTURES WITHIN CLEARING LIMITS SHALL BE REMOVED PRIOR TO ANY EXCAVATION OR EMBANKMENT.

**90% SUBMITTAL (NOT FOR CONSTRUCTION)**

CSEC & DEMO PLAN – MAIN TRAIL (1 OF 3)

| VAULT SERIAL # | DATE | MARK | NATURE | MADE | CHK'D | REV'D |
|---|---|---|---|---|---|---|
| 38358 | | | REVISIONS | | | |

\\wdcnas01\spucad data\cadd\Project\261-1315\05-designdrawings\B-Sheets\7 PK104.dwg
wagners1 Nov-16-21 8:29am

APPROVED FOR ADVERTISING
LIZ ALZEER
DEPARTMENT OF FINANCE & ADMINISTRATIVE SERVICES
SEATTLE, WASHINGTON . . . . . . . . . . . . . 20 . . .
BY: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
PURCHASING AND CONTRACTING DIRECTOR

INITIALS AND DATE
DESIGNED
CHECKED
DRAWN
CHECKED

INITIALS AND DATE
REVIEWED:
DES. CONST.
SDOT PROJ. MGR.
RECEIVED
REVISED AS BUILT

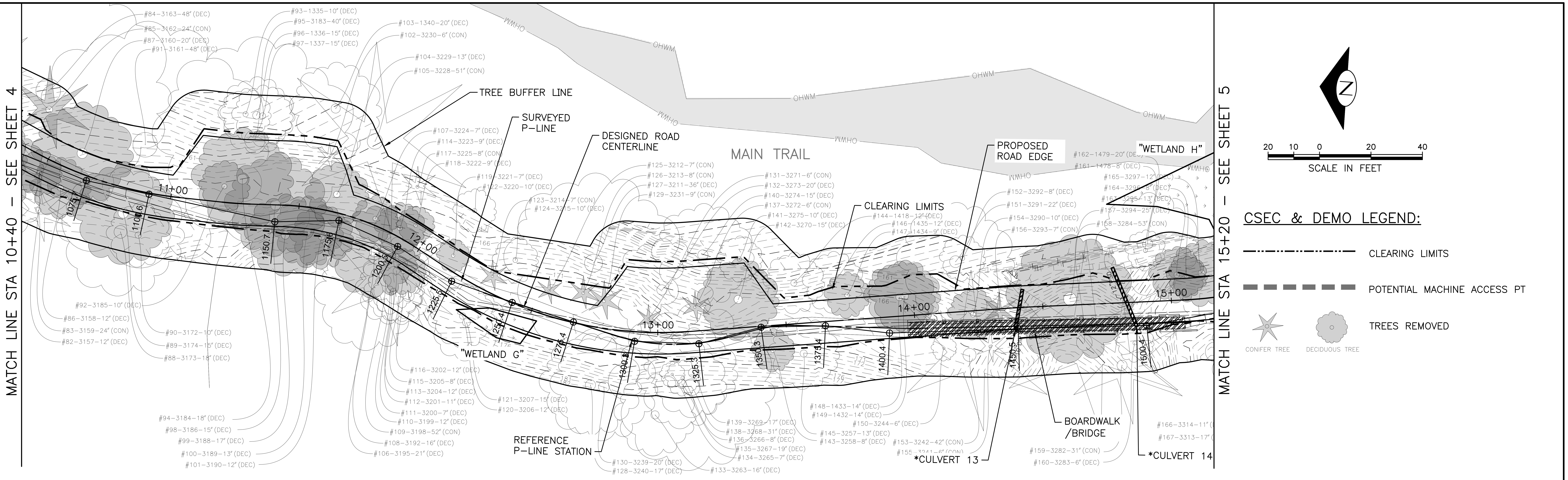
ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 0-02.3 OF THE PROJECT MANUAL.

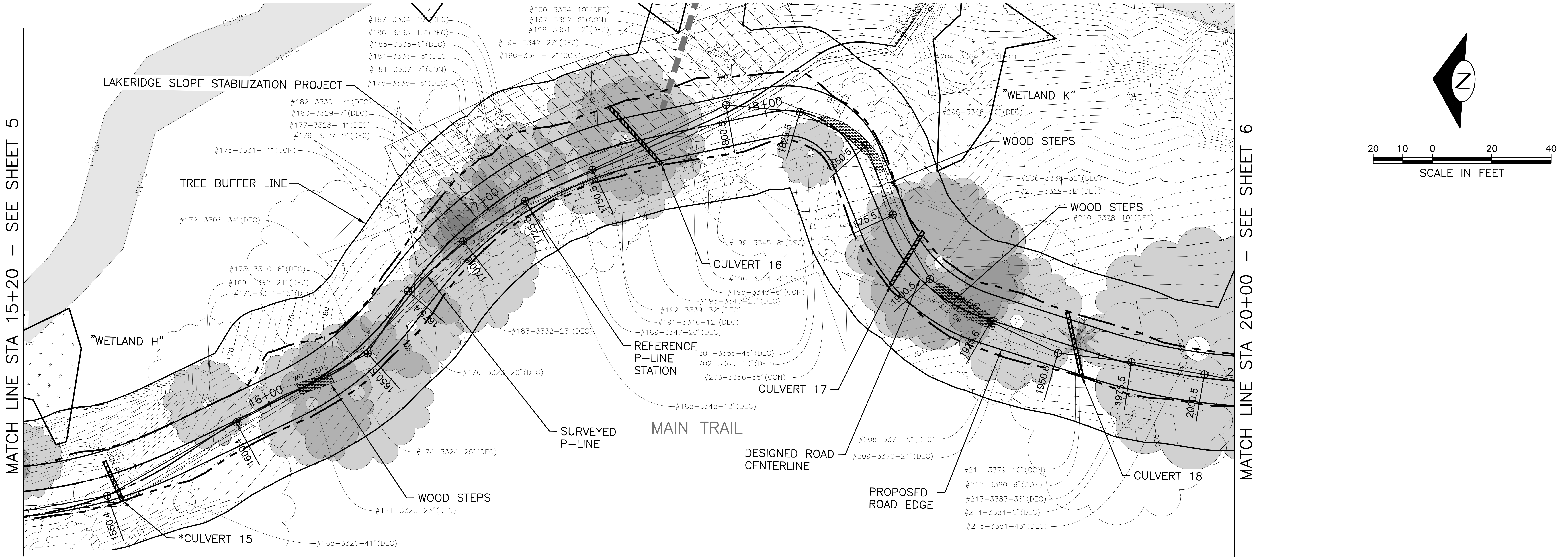
ENGINEER'S NAME
####

Seattle Public Utilities
ORDINANCE NO. PW NO.
SCALE: 1"=20'

# DEAD HORSE CANYON RAVINE STABILIZATION AND SEDIMENT STORAGE DESIGN

JOB PC C399315
CO
VPI # 792-262
PK101
SHEET 4 OF 5





| VAULT SERIAL # | DATE | MARK | NATURE REVISIONS | MADE | CHK'D | REV'D |
|---|---|---|---|---|---|---|
| 38358 | | | | | | |

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CSEC & DEMO PLAN – MAIN TRAIL (2 OF 3)

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PURCHASING AND CONTRACTING DIRECTOR

| INITIALS AND DATE | INITIALS AND DATE |
|---|---|
| DESIGNED<br>CHECKED | REVIEWED:<br>DES. CONST.<br>SDOT PROJ. MGR. |
| DRAWN<br>CHECKED | RECEIVED<br>REVISED AS BUILT |

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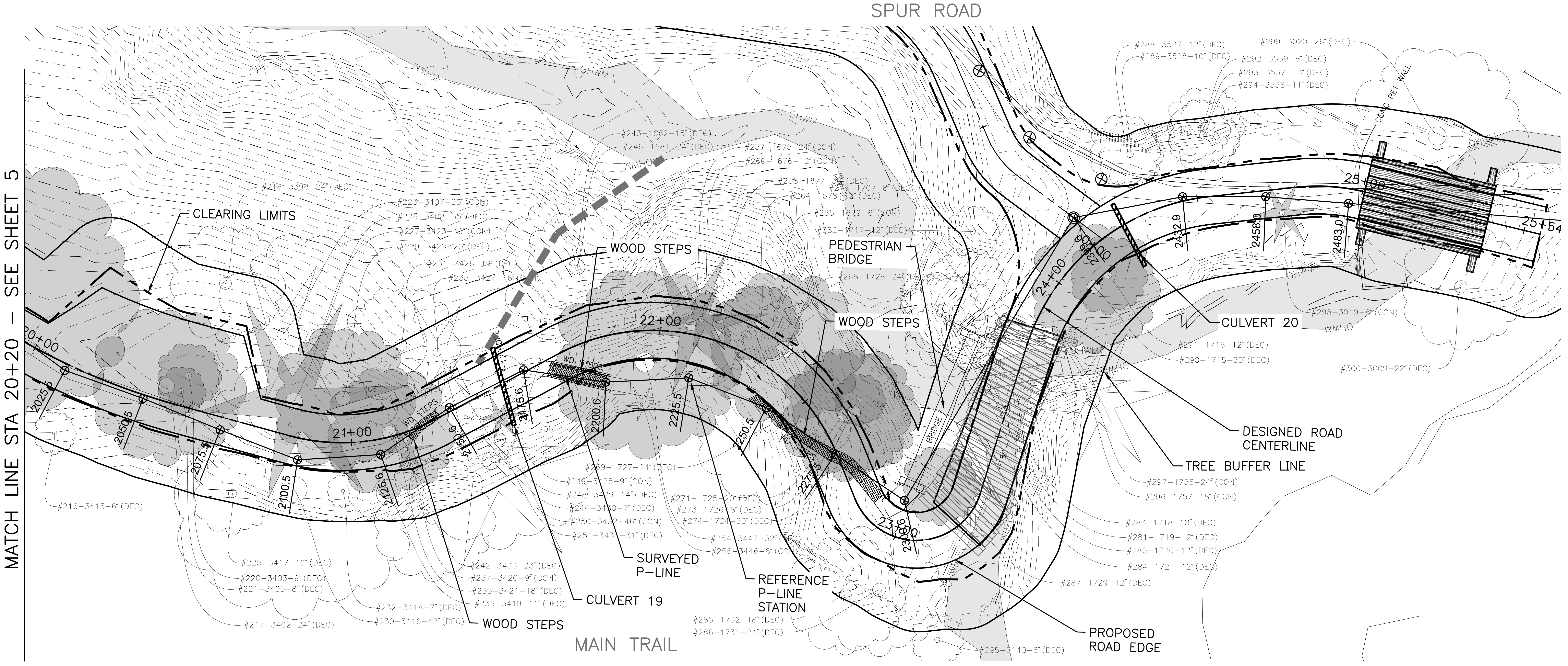
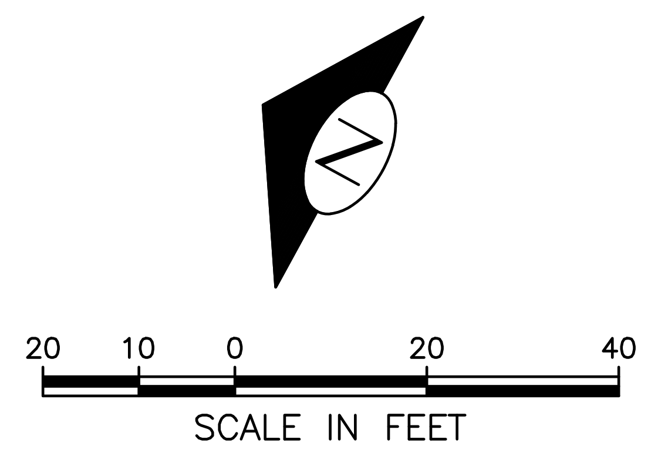
ENGINEER'S NAME
####

Seattle Public Utilities
ORDINANCE NO. PW NO.
SCALE: 1"=20'

# DEAD HORSE CANYON RAVINE STABILIZATION AND SEDIMENT STORAGE DESIGN

JOB PC C399315
CO
VPI # 792–262
PK102
SHEET 5 OF 5





## CSEC & DEMO LEGEND:

| | |
|---|---|
| —··—··—··— | CLEARING LIMITS |
| ▬ ▬ ▬ ▬ ▬ | POTENTIAL MACHINE ACCESS PT |
| ✶ CONIFER TREE<br>● DECIDUOUS TREE | TREES REMOVED |

VAULT SERIAL # 38358

| DATE | MARK | NATURE | MADE | CHK'D | REV'D |
|---|---|---|---|---|---|
| | | | | | |
| | | REVISIONS | | | |

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CSEC & DEMO PLAN – MAIN TRAIL (3 OF 3)

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PURCHASING AND CONTRACTING DIRECTOR

INITIALS AND DATE
DESIGNED
CHECKED
DRAWN
CHECKED

INITIALS AND DATE
REVIEWED:
DES. CONST.
SDOT PROJ. MGR.
RECEIVED
REVISED AS BUILT

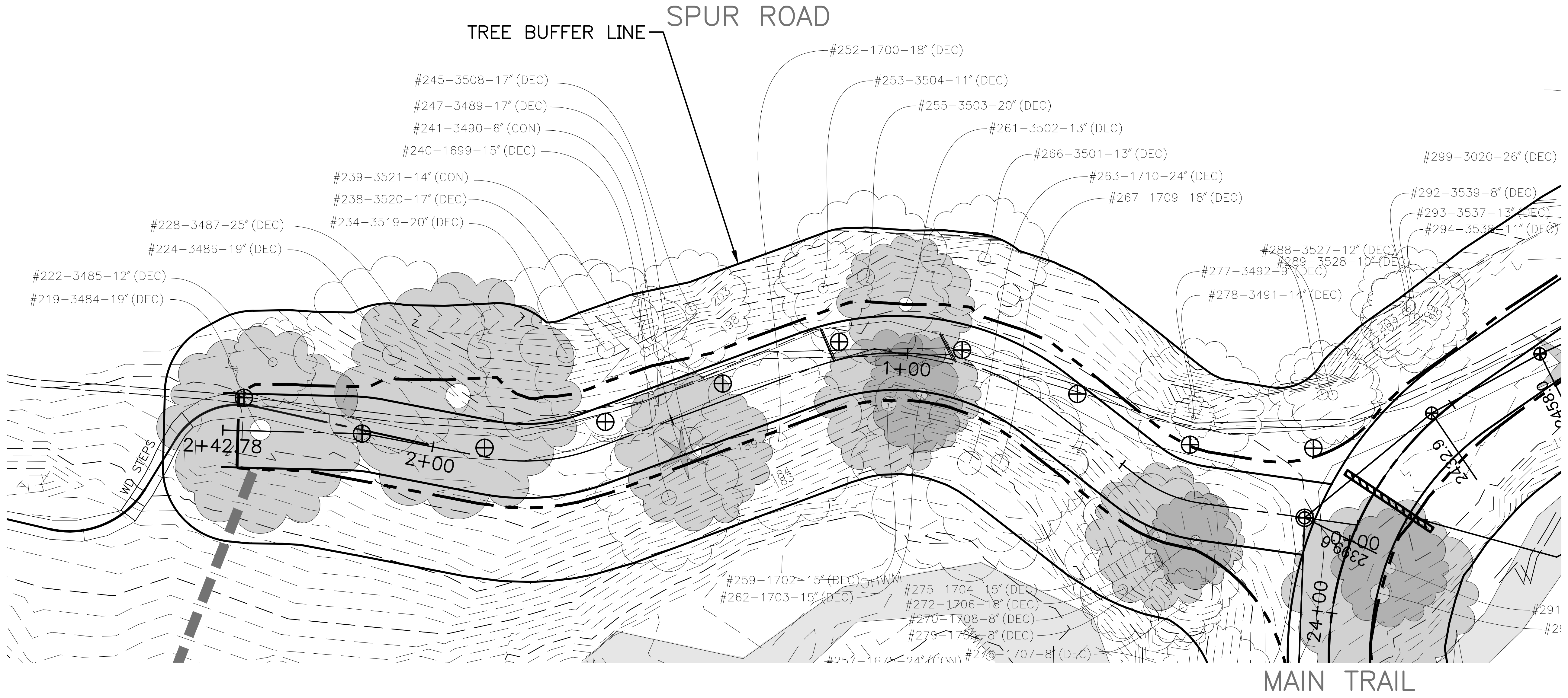
ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 0–02.3 OF THE PROJECT MANUAL.

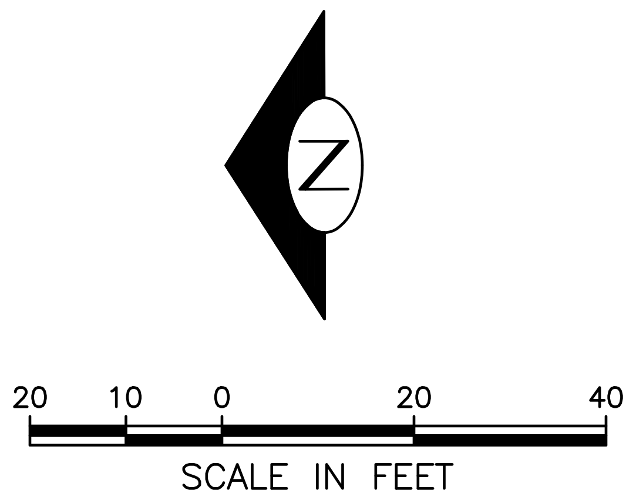
ENGINEER'S NAME
####

Seattle Public Utilities
ORDINANCE NO. PW NO.
SCALE: 1"=20'

DEAD HORSE CANYON
RAVINE STABILIZATION AND
SEDIMENT STORAGE DESIGN

JOB PC C399315
CO
VPI # 792–262
PK103
SHEET 6 OF 5





## CSEC & DEMO LEGEND:

| | |
|---|---|
| –··–··–··– | CLEARING LIMITS |
| ▬ ▬ ▬ ▬ ▬ | POTENTIAL MACHINE ACCESS PT |
| ✶ CONIFER TREE ● DECIDUOUS TREE | TREES REMOVED |

## NOTES:

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**90% SUBMITTAL (NOT FOR CONSTRUCTION)**

CSEC & DEMO PLAN – SPUR ROAD

| VAULT SERIAL # | DATE | MARK | NATURE REVISIONS | MADE | CHK'D | REV'D |
|---|---|---|---|---|---|---|
| 38358 | | | | | | |

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wagners1 Nov-16-21 8:38am

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BY: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
PURCHASING AND CONTRACTING DIRECTOR

| INITIALS AND DATE | INITIALS AND DATE |
|---|---|
| DESIGNED<br>CHECKED | REVIEWED:<br>DES. CONST.<br>SDOT PROJ. MGR. |
| DRAWN<br>CHECKED | RECEIVED<br>REVISED AS BUILT |

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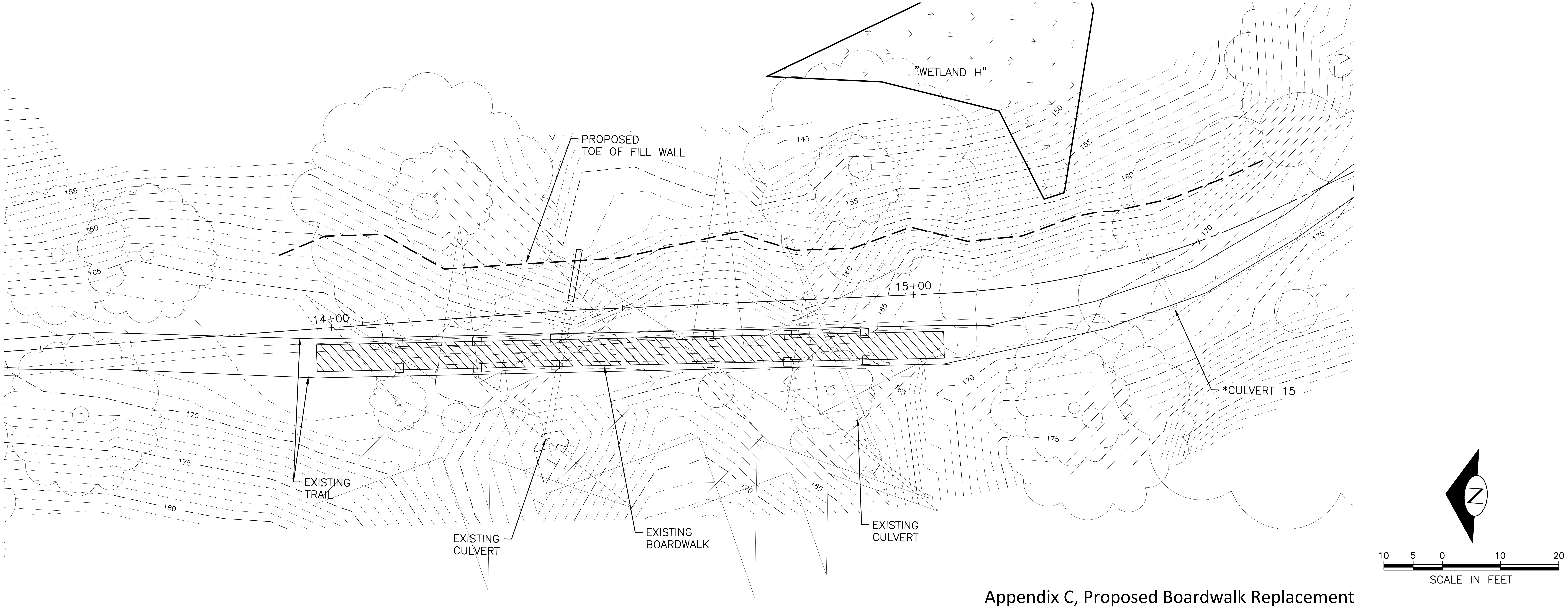
Seattle Public Utilities
ORDINANCE NO. PW NO.
SCALE: 1"=20'

DEAD HORSE CANYON
RAVINE STABILIZATION AND
SEDIMENT STORAGE DESIGN

JOB PC C399315
CO
VPI # 792–262
PK104
SHEET 7 OF 5



Appendix C, Proposed Boardwalk Replacement

PLAN & PROFILE – PERMANENT EMBANKMENT WITH FILL WALL