Schuster Slope
Activities and Monitoring Report
2016/2017

Prepared by City of Tacoma

Passive Open Space Program

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Contents

1. 0 Introduction

The Schuster Slope Landscape Management Plan (2015) (hereafter referred to as “LMP”) was permitted in 2015, and provides goals, objectives, and performance standards for slope stability, forest health, public safety, and other elements (Table 1). The Schuster Slope Management Area – Unit 1 Work Plan (GeoEngineers, 2015; Appendix A) (hereafter referred to as “Work Plan”) was created to provide a detailed planting and restoration plan for the first of ten management units (MUs) based on recommendations from the LMP.

The purpose of this report is to provide an overview of the activities performed on Schuster Slope during 2016/2017, including activities from the Work Plan. Relevant performance standards outlined in the Schuster Slope Landscape Management Plan will be addressed, and monitoring results from 2017 will be summarized and used to make recommendations concerning future activities.

1. 1 Schuster Slope Background Information

Schuster Slope is a steeply sloped, urban forest adjacent to the west shore of Commencement Bay in Tacoma, WA. Approximately 55% of the area is comprised of slopes greater than 60% that frequently experience soil creep, surficial sloughing and debris flows. The dominant trees on Schuster Slope are early successional species, such as red alder and big leaf maple. Under naturally occurring forest succession processes, shade tolerant conifers and other longer lived woody species would have established, however, both the presence of invasive species and the lack of local parent material have precluded this opportunity. Restoration efforts are focused on moving Schuster Slope toward a healthy North Pacific Maritime Mesic Wet Douglas-Fir-Western Hemlock Forest ecosystem for improved stormwater benefit and slope stability.

Schuster Slope is made up of 10 management units (Figure 1), totaling 31.2 acres. Restoration began in 2015 and survival rings were cut around trees across the entire site. Slope stabilization efforts, including the installation of erosion control best management practices (BMPs) and planting native vegetation, occurred on Management Unit 1 (MU1) in 2016. Management Unit 1 is located at the southern end of the slope and is 2.8 acres in size. Habitat restoration area monitoring was performed for MU1 in 2017, and will take place for a total of five consecutive growing seasons to determine vegetation survivability and coverage as they pertain to the LMP permit requirements for the City of Tacoma. Monitoring outcomes will ultimately be used to assess if standards related to slope stability, forest health, public safety, and other objectives are being met, as described in Section 4 of the LMP (See Table 1). Qualitative observations concerning human induced actions will also be considered.

1. 2 Management Unit 1 Description

The LMP indicates Schuster Slope is divided into nine MUs, however these were re-distributed to create more homogeneous units to better accommodate future work. Management Unit 1 (MU1) remains unchanged from the LMP.

In the Baseline Conditions Assessment Report for Schuster Slope (GeoEngineers, 2014), the majority of MU1 was considered to have a high landslide susceptibility as evidenced by active soil creep, limited groundcover vegetation and loose surficial soils. Slopes within the project area typically range from 60% to over 100%.

Vegetation within MU1 includes a mature deciduous canopy throughout most of the unit, and prior to restoration, heavy Himalayan blackberry (*Rubus armeniacus*) infestations were found in the understory in some locations, and sparse understory vegetation in others. Heavy infestations of English ivy (*Hedera helix*) and old-man's beard (*Clematis vitalba*) were also noted in some locations before restoration efforts took place. The top section of the slope, where there is a less steeply sloped bench adjacent to Stadium Way, can be characterized by young tree stands without overstory forest canopy; prior to restoration invasive monocultures also were present. Some of the invasive monocultures extended down the slope over steep terrain, and still exists in some areas with greater than 80% slope.

1. 3 Management Unit 1 Treatment Plot Descriptions and Pre-Restoration Conditions

Management Unit 1 is divided into six treatment plots (Figure 2) based upon differences in soil composition, sunlight, slope and vegetation.

Treatment Plot 1 (TP1) is a 10 ft x 16 ft experimental plot of land with slopes greater than 80% (Table 2). No trees were present in TP1, however it was shaded by trees from adjacent areas. All of TP1 was covered with invasive Himalayan blackberry (*R. armeniacus*) prior to restoration. Treatment Plot 2 (TP2), is located below TP1 (Figure 2), and generally has steep slopes (60%-100%). Treatment Plot 2 received full sun, and had 100% invasive species cover made up of Himalayan blackberry (*R. armeniacus*) and Scotch broom (*Cytisus scoparius*). Treatment Plot 3 (TP3) and Treatment Plot 4 (TP4) are located at the top of the slope. These areas were in full sun, and had approximately 80% invasive species cover dominated by Himalayan blackberry (*R. armeniacus*). Treatment Plots 1-4 all have similarly sandy soils.

Treatment plots located at the top of the slope (TPs 3 and 4) are separated from those at the bottom of the slope (TPs 2, 5 and 6) by a "no touch" area, where slopes are 80% or greater (red hatched area in Figure 2). Treatment Plot 1 is located in this region.

Treatment Plot 5 (TP5) is located below TP3, and above the retaining wall adjacent to Schuster Parkway. Despite having a full canopy of big leaf maple (*Acer macrophyllum*) trees, there was approximately 60% invasive cover dominated by Himalayan blackberry (*R. armeniacus*) that existed in patches throughout the site. Soils in this area are sandy with some gravel and cobble. Treatment Plot 6 (TP6) is the largest treatment plot in MU1, and consists of very steep slopes, gravelly soils with significant amounts of cobble, a full canopy of big leaf maples (*A. macrophyllum*), and little to no native understory vegetation prior to restoration. Approximately 30% of the area was covered with invasive vines. A small wetland is present at the toe of the slope in TP6.

2. 0 Management Unit 1 Activities

2. 1 Management Considerations

The following management considerations were taken into account when developing the LMP (Table 1).

- **Slope Stability and Geologic Hazard Mitigation:** This element is the main priority within the project area and will be considered critical in areas where slopes exceed 40%.
- **Forest Health:** This element should be applied throughout the project area in order to ensure the long-term success and habitat improvement of the project area.
- **Public Safety and Infrastructure Protection:** This element should be applied within public areas and adjacent to infrastructure where there is public interaction.
- **Views from Adjacent Areas:** This element may be considered in areas where view management has been identified in this management plan or by a private project proponent.
- **Voluntary Stewardship:** This element should be considered in areas that have the appropriate site conditions to provide for community volunteerism and restoration.

2. 2 Restoration Overview

Restoration began on Schuster Slope in 2015, and survival rings (ivy and clematis) were cut around trees in areas that were safely accessible to crews. Intensive restoration activities began in 2016, on the first of ten management units (Figure 1). Management Unit 1 is approximately 124,303 ft^2, however only 89,470 ft^2, or slightly over 2 acres, were involved in the Work Plan due to the band of severely steep slopes (80%->100%) cross-cutting the area (Figure 2). Management Unit 1 was divided into six treatment plots (TPs). Treatment Plot 6 makes up approximately 51% of MU1, however only 40% of TP6 was planted in 2016. Restoration work was performed by Washington Conservation Corps (WCC) crews, and supervised by Passive Open Space Program staff.

2. 3 Invasive Vegetation Removal

Monocultures of invasive species and other noxious weeds were sprayed with 0.75% Triclopyr with a 1.0% surfactant. Those weeds found in the wetland or wetland buffer areas were sprayed with an aquatic formulation of 2.0% glyphosphate with a 1.0% surfactant. Once the weeds died, they were brush-cut to the ground, and covered with erosion control blanket in areas where slopes were >60%. This methodology provided a BMP by leaving the roots *insitu* to lessen soil disturbance and help maintain slope integrity until newly planted vegetation becomes established. Weeds that were not sprayed with herbicide were also brush-cut to the ground and/or covered with erosion control blanket (Table 1 – Sections 4.2.1.1 and 4.2.2.2).

2. 4 Erosion Control BMP Installation

Erosion control blankets made of 100% coir or 70% straw/30% coir were installed in all TPs, and 9" diameter straw wattles, wrapped in photo-degradable netting, were installed with wooden stakes in TPs 2 and 6 (Table 3)(Table 1 – Section 4.2.1.2). Ecology blocks were installed at the bottom of TP2, directly below TP1, for erosion control and safety in case of erosion from TP1, the 10 ft x 16 ft experimental treatment plot. Silt fencing was installed below the entire length of TPs 2, 5, and 6 to help with erosion and debris containment.

2. 5 Vegetation Installation

Vegetation was planted in each treatment plot in accordance with the LMP (Table 4)(Table 1 – Sections 4.2.1.1 and 4.2.2.1). Planting for MU1 occurred during the time periods outlined in Table 5, after the installation of erosion control materials. Groundcover was not planted in TP2 per the Work Plan, but will be planted within the next several years once the Himalayan blackberry (*R. armeniacus*) is better controlled. Also in accordance with the Work Plan, TP2 was planted as a 20 ft lateral band beginning from the bottom of the MU. As this vegetation matures, the next 20 ft lateral band will be planted upslope, with this process continuing until all areas safe for work crews have been planted. Shrubs and groundcover were not planted in TP4 per the Work Plan, but will be added later, once the trees have had an opportunity to establish.

One deviation occurred with planting TP1, in which evergreen huckleberry (*Vaccinium ovatum*) was not installed, but all other species from the palette were planted. All plants listed in the palette for TP6 were installed (Table 4), with the substitution of Douglas fir (*Pseudotsuga menziesii*) for grand fir (*Abies grandis)* when grand fir were unavailable. These trees were planted on the slope face and near the toe of the slope.

DRiWATER™ containers were installed next to all planted trees, including vine maples, in TPs 3, 4, and 5, and replaced once during the summer of 2016. DRiWATER™ is a portable water source held in a solid cellulose form that naturally biodegrades and releases water over time. SoilMoist™ was not used in TP3 as was part of the original Work Plan as it was not recommended for large restoration planting activities. Rigid seedling protection tubes were placed around all trees planted in MU1. The purpose of these tubes was to help reduce herbivory, provide structure for the growing trees, and help prevent the trees from being trampled.

2. 6 Treatment Plot 6-Experimental Sub-Treatment Plots

Initially, three experimental case studies were planned for TP6: 1. straw wattles with integrated plantings and added soil amendments, 2. straw wattles with integrated plantings, added soil amendments, and fabric lining the planting holes, and 3. straw wattles with no plantings, however option 3 was eliminated and all areas of TP6 were planted, or will be planted. Soils in this treatment plot are rocky and nutrient poor. Due to the low expected survivorship of newly planted vegetation in TP6, it was determined that the entire area should be planted.

Fabric lining the planting holes included straw, burlap blanket, or coir blanket, and some holes were left unlined to serve as a control group. The lining in the holes remained the same across individual sub-treatment plots (sub-TPs). For each of the different fabric types, there were at least two sub-TPs where groundcover was planted, and at least one sub-TP where groundcover was not planted, for a randomized complete block design (RCBD) (Table 6). For a correctly executed RCBD, two of the sub-TPs should have been planted with groundcover, and without fabric lined holes; instead there were three sub-TPs with no groundcover and no fabric lined holes when there should have been only one. The only sub-TPs planted in 2016 include: 1A, 2A, 2B, 3B, 3C, and 1C (Figure 3). Sub-treatment plots planted in 2017 include: 1D, 2E, and 3F. The remainder of the sub-TPs, 1E and 2F, will be planted during 2018.

3. 0 Methods

3. 1 Monitoring Requirements from the Landscape Management Plan

According to the Schuster Slope Landscape Management Plan Specifications (2015), "a monitoring plan will be implemented by the project proponent or project proponent's representative to document the progress and challenges of the plants and project area according to the objectives and performance standards for the management element(s) as defined in Section 4.2 of the Management Plan. Monitoring must be prepared by a Certified Horticulturalist, Restoration Ecologist, Professional Wetland Scientist, Certified Arborist, Landscape Architect or other qualified professional as approved by the City. Monitoring will also assist in identifying adaptive management needs. The planting area will be monitored for a minimum period of 5 growing seasons from the date of installation. The project will be specifically monitored for the survival of the planted material within the planting area, the aerial coverage of noxious or invasive weed species, soil erosion, vandalism, disease, survivability, human activity, and slope failure."

"Monitoring of the restoration site will include the following:

- Establishment of at least one 50 foot monitoring transect per quarter acre of planting area to monitor survival of plantings, percent cover of plantings, composition of the plant community, and noxious/invasive weed species coverage.
- Percent survivability will be monitored using randomly selected but permanent sample plots located along the established permanent transect (2 sample plots per 50 foot transect). Sample plots will consist of a 9 foot radius circle from a stationary point along transect.
- Photographs will be collected from each transect end and each sample plot point to compare vegetation density and compositions from year to year.
- Observations of the project area for excessive erosion, slope instability, vandalism, disease, plant stress, human activity and debris, as well as general observations of the entire planting area and/or areas directly adjacent."

See Table 1 – Sections 4.2.1.1 and 4.2.2.1.

3. 2 Monitoring Personnel

The development of monitoring methodologies, data collection, and data analyses were performed by City of Tacoma Passive Open Space staff.

3. 3 Monitoring Locations

3. 3. 1 Transect and Quadrat Selection

According to the LMP, transects were required to be 50 ft in length and have two quadrats, each with a 9 ft radius. It was initially determined that transects should run vertically, or downslope, in order to capture variability between contours on these steep slopes, however most vertical transects could be only ~ 25 ft in length due to the short vertical length of most treatment plots. The maximum possible length for any vertical transect was 50 ft. To capture this variability, quadrats were established along vertical transects (1 quadrat per 25 ft transect, as opposed to 2 quadrats per 50 ft transect in most instances), and data was collected from the quadrat only. Additional horizontal transects (following along a single contour) were established in each treatment plot, where data was collected. It was also thought that less damage would occur on the slope in monitoring along a single contour. In subsequent years, all quadrats will be located along the horizontal contour, as there didn't appear to be significant variability due to verticality within a TP.

The total number of transects was selected based upon the acreage of the treatment plot to equal one 50 ft transect per quarter acre. The maximum length of the TP was determined and divided by 9 ft (quadrat diameter) to identify the total number of potential transects (X) (note that the quadrat diameter was supposed to be 18 ft, as opposed to 9 ft). A random number generator was used to identify the location of the first transect between 5 and 9 ft, and all subsequent transects were spaced 9 ft apart. These transects were numbered 1 through X. A random number generator was used to select a transect (1 through X) for quadrat sampling. This step was repeated until the appropriate number of transects (N) was identified. If a transect was randomly selected more than once, the previous step was repeated until a new number appeared. If the last numbered transect (X) could not accommodate a 9 ft circular quadrat, the transect line was moved back the appropriate number of feet from the edge of the TP. This entire selection process typically excluded a 1.0 ft perimeter around one-half to three-fourths of the entire treatment plot. Quadrat locations were selected along the transect using the same procedure. Monitoring was performed on 9 ft diameter quadrats, as opposed to 18 ft diameter quadrats. Year 2 (Y2) monitoring at previously monitored sites will be expanded to 18 ft, and all future baseline monitoring will include 18 ft diameter quadrats.

3. 3. 2 Locating Transects and Quadrats in the Field

Prior to monitoring, all transects and quadrats were identified on a map in ArcGIS, and their distances from key landmarks were measured using the distance tool. These distances were used in the field to identify starting points for transects. Measurements were made from permanent landmarks with either a wheel measure or a tape measure. A tape measure was used to identify the center point for each quadrat along the transect where a 4 ft piece of metal rebar was pounded into the ground. The top ~1 ft of the rebar had been previously spray-painted white or red in order to find the same locations in subsequent years. Most rebar was pounded into the ground ~ 1.5 ft. White, spray-painted marks were also made on the wall and/or sidewalk above TPs 3 and 4, and below TPs 2, 5, and 6 that were in line with each transect for ease in future location. Black sharpie was used to write labels on each of the marks. The beginning and end points of transects along the single contours were also marked in the field using rebar. GPS coordinates were taken at the beginning and end of each transect using a Trimble R1 GNSS receiver with an antennae to boost the signal.

3. 3. 3 Total Number of Transects and Quadrats in each Treatment Plot

The number of transects within each TP was based upon the LMP requirements of one 50 ft transect per quarter acre. Two 25 ft vertical transects were established in TPs 2, 3, 4, and 6-1C (Figure 3). There was one quadrat associated with each of these transects. For TP5, two quadrats were placed along one 50 ft transect. One 50 ft horizontal transect that followed the contour was monitored for all TPs. All of TP1 was sampled due to its small size (10 ft x 16 ft).

3. 4 Data Collection

Data collected in the quadrats and transects was used to monitor survival of plantings, composition of the plant community, invasive species coverage, and visual changes in the plant community over time. Also, data was collected that would identify excessive erosion, slope instability, vandalism, and other human activity.

All data was recorded with an iPad model A1657, using a Survey 123 program that was linked to the City of Tacoma Environmental Services ESRI cloud. All data was downloaded into an excel spreadsheet before being deleted from the iPad.

3. 4. 1(a) Data Collection within Quadrats

To collect data within a quadrat, a rope was marked at 4.5 ft from the top of a loop. The loop was placed around the rebar, and a temporary 9 ft circle (quadrat) was marked using stake flags. Data observations were made regarding native plant numbers, percent aerial coverage, and other physical factors associated with the quadrat (Table 7).

Degree slope was measured on an iPhone 6S using the Clinometer Application with a slope finder created by Peter Breitling (2016), then converted to percent slope. The phone was laid directly on the ground near the center of the quadrat and slope was read. In the future, staff will use a professional grade clinometer to verify slope in the same locations. Flags were removed after data collection.

3. 4. 1(b) Estimating Vegetation Planting Numbers in Quadrats

Installed vegetation was not monitored in the quadrats immediately after planting, therefore the amount of vegetation planted in each quadrat had to be estimated. The area of the quadrat was calculated using the formula Area = πr^2. Therefore, the area of each quadrat was $\pi(4.5^2)$ ft , making every quadrat 63.6 ft^2. The quadrat area was divided by the total area of the TP, or sub-TP, to estimate the percent area each quadrat occupied within the TP. The total number of plants installed per TP, or sub-TP, was multiplied by the percent area of each quadrat to obtain the expected number of each plant installed per quadrat. Since the expected plant numbers were most often fractions, numbers were rounded up or down to the nearest whole number. Survival rates in TP1 are accurate as the precise number of installed plants was known, and the entire TP was monitored due to its small size.

For future survivability calculations, transects and quadrats will be established at the time of planting and baseline data will be collected in order to make direct comparisons between vegetation at Y0 (year zero) the planting year, and subsequent years. 2017 will be the only year in which survivability is estimated using planting numbers versus baseline gathered data.

3. 4. 2 Estimation of Coverages in Transects

In order to collect data within a transect, a mark was made at 3 ft on a piece of rebar. The end of the rebar was held from the center line of the transect outward. The center line was identified by a tape measure that was laid on the ground between transect end points. One sampler walked the line, noting the beginning and end point (in feet and inches) along the tape measure for each native plant that touched the 3 ft rebar on either side of the center line (Table 8). Percent native plant coverage was estimated by dividing the total length a plant covered within the transect by the total length of the transect. The percent bare ground and percent invasive species coverages were estimated visually using a Daubenmire scale.

4. 0 Results/Discussion

4. 1 General Observations

Average slope ranged from 37%-80% in the quadrats, with all areas having dry, sandy soils. Treatment Plot 6 also had significant amounts of gravel and cobble (Table 9). Some amount of leaf litter existed in all TPs, but was greatest in TP2, which occurs at the toe of the slope where leaf litter could have accumulated. Percent canopy cover did not appear to correlate with litter depth. No course woody debris (CWD) was found in any of the quadrats. There was no significant soil compaction in any of the quadrats.

The percent bare ground ranged from 5%-50%, and was lowest in TPs 2, 3 and 4. Bare ground may have been correlated with % overstory canopy cover, but did not appear to be correlated invasive species removal (Table 12), slope, or anthropogenic activities. Bare ground was highest in TPs 1, 5 and 6, which also had the greatest % overstory canopy cover. The resulting shade could have prevented plants from establishing in these areas. Treatment Plot 5 had a foot trail running through one of the quadrats, which also may have contributed to increased bare ground. Treatment Plot 6 received little to no foot traffic, but had little understory vegetation that existed prior to restoration, and very little of the newly planted vegetation that survived, which is the likely reason for more bare soil relative to other TPs. Treatment Plot 1 is very steep, and had been covered by 100% invasive species that were removed, therefore 25%-50% bare ground was not surprising. There was no remaining evidence of erosion control blanket in TP1, however in all other TPs significant amounts of blanket remained.

Slopes within the treatment plots were generally stable with no evidence of slumps or slides. Sites demonstrating little to no erosion tended to have erosion control fabric evident on 50% or greater of the ground surface area examined. Erosion control blanket was installed on all steep slopes, however it degraded more quickly in some areas, primarily due to increased exposure to sun and precipitation. Some erosion was present in the quadrats monitored in TPs 1, 3, 4, and 6 (Table 8). Gravel and larger cobble became dislodged while monitoring TP6. Any foot traffic on TP6 results in erosion; fortunately this area is very steep and does not tend to receive much transient activity. TPs 3 and 4 had significant transient activity.

4. 2 Plant Survival

Quadrats were used to determine survival rates of planted vegetation. Across all treatment plots monitored in MU1, there was an average plant survival rate of 80.7% based on data collected from all of TP1 and all planted quadrats in TPs 2-6 (Table 10).

Survivability in TP1 was lowest at 16.7%. This is most likely due to a combination of steep slopes (80% - 100%) and high numbers of invasive species surrounding three sides of this small 10 ft x 16 ft treatment plot.

Data and visual observations supported the highest plant survivability in TP3 at 140.0% (Table 10). The survival rate was likely overestimated because baseline data was unavailable in the sampled quadrats, and the number of plants installed in Y0 was estimated based on planting numbers (see section 3. 4. 1(b)). Plants were also installed in clumped formation, but estimates were made based upon plants being evenly distributed across treatment plots, which likely skewed survivability estimates. Treatment Plot 3 was partially shaded (5%-25% overstory canopy cover (Table 9)), which seemed to improve vegetation establishment during the 2017 growing season. Although foot traffic, encampments, and debris were high in this area, most of the activity was isolated to the trail, thus resulting in less damage to the plants.

Plants in TP4 showed high survival at 100.0%, especially those found in areas that received some shade throughout the day. Treatment Plot 4 had a 25% overstory canopy cover. The plant survival rate in TP2 was 142.9%. Again, these survival rates are likely to be overestimated, and did not align with visual observations of the entire plot.

Treatment Plot 5, which was mostly shaded (75%- 95% overstory canopy cover), had a plant survivability rate of 66.7%. Sandy soils containing more gravel and cobble than the areas previously discussed may have prevented higher plant survival rates in TP5.

Survival was the low in TP6 Subplot-1C (TP6-1C) at 17.6%, which has steep, rocky slopes, and poor soil nutrients. Plants were not expected to perform well in this area, therefore several experimental treatments were applied to TP6 to try and identify the best installation methods that may improve plant establishment and long-term success. The treatment in Subplot-1C included lining the planting holes with straw.

Plants installed at the top and toe of the slope appeared to have better survival rates compared to those found on the slope face, where it was generally steeper. Plants in sunny areas had lower survival, most likely due to the drought experienced in the region during the summer of 2016. Tree survival was lower in general compared to shrubs and groundcover. Trees that performed best include grand fir (*Abies grandis*), shore pine (*Pinus contorta*) and cascara (*Rhamnus purshiana*), whereas Western red cedar (*Thuja plicata*), Douglas fir (*Pseudotsuga menziesii*) and Western hemlock (*Tsuga hererophylla*) showed poor survival. Plants demonstrating the highest survivorship included shrubs and groundcover, such as snowberry (*Sympharicarpos albus*), swordfern (*Polystichum munitum*), vine maple (*Acer circinatum*), tall Oregon grape (*Mahonia aquifolium*), Nootka rose (*Rosa nutkana*), and oceanspray (*Holodiscus discolor*). The Pacific wax myrtle (*Myrica californica*) that was planted arrived poorly rooted, and thus performed poorly with minimal survival. In the future, poor stock will be refused. Grazing of plants occurred in all TPs, including those plants with seedling tubes, however this did not appear to have a significant effect on survival.

Overall, survival within the monitoring areas appeared to be higher than survival within the TPs. Data from quadrats monitored in Y2-Y5 will be compared to data from Y1 to provide information on plant survival statistics. In future restorations on Schuster Slope, monitoring of the quadrats will take place after being planted to collect baseline data in Y0. This will provide more accurate estimates of plant survival and coverage in subsequent years (Y1-Y5).

4. 3 Percent Cover and Plant Community Composition

Plant coverage was estimated using data collected in transects. Coverage in TP1 was estimated using the Daubenmire scale across the entire TP. In addition to having the highest plant survivorship, TP3 also had the highest native plant coverage across all transects at 69.5% (Table 11). Deciduous vegetation made up the majority of the coverage at 41.0%. These species were mostly shrubs that included oceanspray (*H. discolor*) and Nootka rose (*R. nutkana*). Dominant evergreen vegetation included Kinnikinnick (*Arctostaphylos uva-ursi*), tall Oregon grape (*M. aquifolium*) and shore pine (*P. contorta*). Bare ground made up 25%-50% of the transect, while invasive species covered 25%-50% and was dominated by horsetail (*Equisetum* sp.) and sow thistle (*Sonchus* sp.). Similar to TP3, TP4 is located at the top of the slope and had the second highest native plant coverage at 55.0%. Like TP3, the majority of species were deciduous (37.8%), but unlike TP3, most of the coverage in the TP4 transect was due to existing native vegetation versus vegetation planted in Y0. Invasive species made up 25%-50% of the coverage consisting of willowherb (*Epilobium* sp.), old man's beard (*Clematis vitalba*) and nipplewort (*Lapsana communis*), and the percent bare ground was low (0%-5%).

Treatment Plot 2, located at the toe of the slope had 43.8% native plant coverage (26.2% evergreen/17.7% deciduous). Evergreen species that dominated this transect included tall Oregon grape (*M. aquifolium*) and grand fir (*A. grandis*), while oceanspray (*H. discolor*) made up the majority of the deciduous vegetation. Bare ground and invasive species coverage ranged from 25%-50% and 5%-25% respectively. Himalayan blackberry (*R. armeniacus*) and old man's beard (*C. vitalba*) made up most of the invasive species (Table 11).

Transects located on the slope face, in TP5 and TP6-1C had lower plant coverages at 36.7% and 24.7%, respectively. Both treatment plots were dominated by deciduous vegetation, consisting primarily of vine maple (*A. circinatum*), with some oceanspray (*H. discolor*). Vegetation in TP6-1C showed more signs of stress compared to that in TP5. Once again, TP6 has high amounts of cobble and poor soil nutrients. Western red cedar (*T. plicata*) and grand fir (*A. grandis*) found in TP5 were healthy, however 67% of the evergreen trees planted in TP6-1C did not survive. Evergreen huckleberry (*V. ovatum*) in TP6-1C ranged from stressed to healthy. Both treatment plots had 25%-50% bare ground, however TP6-1C had less invasive species coverage (0%-5%) compared with TP5 (25%-50%). Nipplewort (*L. communis*) and old man's beard (*C. vitalba*) were the primary invasive species in TP5, and Himalayan blackberry (*R. armeniacus*) and nipplewort (*L. communis*) were the most common invasive species in TP6-1C.

Native plant coverage was lowest in TP1 at 7.5%. Invasive species, such as Himalayan blackberry (*R. armeniacus*) and old man's beard (*C. vitalba*) dominated this plot with 50-75% coverage.

There was a significant decrease in invasive species coverage pre and post-restoration activities (Table 12). The average invasive species coverage prior to restoration was 75%, with TP1 and TP2 showing 100% invasive coverage and all other treatment plots in MU1, except 6-1C, having at least 50% invasive species coverage. The average invasive species coverage post restoration was 22.5%, which was skewed by TP1, with 50%-75% invasive species coverage. Three of the four sides of TP1 were still dominated by invasive species, making it extremely difficult for plant establishment. In areas where Washington Conservation Corps (WCC) crews were able to eradicate a significant area of Himalayan blackberry (*R. armeniacus*) prior to planting, other opportunistic species moved in, such as nipplewort (*L. communis*), willowherb (*Epilobium* sp.), and sow thistle (*Sonchus* sp.), albeit their coverages were much lower. None of these weeds were considered noxious, and did not require mandatory removal.

4. 4 Human Activities and Safety

Homeless encampments were found in all treatment plots in MU1 except TPs 1 and 6 prior to restoration. The encampment clean-up costs for MU1 was $49,886 and took approximately 6 days. A fence was installed around TP2 and TP3 to prevent transient activity from the top of the slope to the bottom of the slope, which serves as a pathway from Stadium Way to the underside of the bridge for the I-705 off-ramp. The fence was installed by the City of Tacoma Neighborhood and Community Services Office. A section of fence that was installed at the top, southern end of TP3 has since been illegally removed, and thrown onto one of the steepest portions of TP2. Locks have been cut off the gated portion of the fence (on the north side) several times, and it is fairly easy to slip around the outside of the fenced area. Since entering into restoration, fewer encampments have been found on MU1, but the number of encampments in MU2 have increased. None of our monitored transects or quadrats had an encampment over the past year, however one quadrat in TP5 did have a trail through it that could have attributed to lower plant survivability.

Unfortunately, a significant amount of trash and debris was found in all TPs, which was likely to have had a detrimental effect on vegetation. Graffiti is a constant issue at the top of TP3 along the wall dividing Schuster Slope from Stadium Way. Fortunately, this wall is adjacent to the existing trail, and doesn't result in too much trampling of vegetation, however a lot of garbage is left in this area as well as used hypodermic needles.

4. 5 Performance Measures/Goals

(See Table 1)

4. 5. 1 Slope Stability and Geologic Hazard Mitigation/Forest Health

There are no slope stability or vegetation performance measures for monitoring year 1 (Y1) based on the LMP permit requirements. According to the LMP, goals are to have 80% planted species survival in monitoring year 3 (Y3) and 60% survival in monitoring year 5 (Y5), and a long-term goal of 2/3^{rds} of the tree cover consisting of evergreen conifer trees, with less than 10% aerial coverage of invasive species. Having 100% soil binding root mass is a long term goal that will not be achieved until installed vegetation begins to mature. In the meantime, erosion control measures were applied across MU1 per the LMP and remain largely intact, aside from TP1.

Plant survival rates are currently under 60% in TPs 1 and 6-1C. A long-term goal is to have 2/3^{rds} of the tree canopy cover consist of evergreen conifer trees, however those planted in Y0 did not perform well. Overstory canopy coverage was made up primarily of deciduous trees. Additionally, evergreen trees made up only 13.8% of the foliar coverage in TP4, which had the most found in any monitored area. Replacement planting is not scheduled until monitoring Y3.

Invasive species were managed throughout the year, with invasive species treatment and/or removal having occurred three times in MU1 during 2016/2017. Invasive species coverage averaged 22.5% at the time of sampling.

4. 5. 2 Public Safety

Public safety performance measures were met during 2016/2017. Passive Open Space Program staff surveyed the areas adjacent to public areas along Schuster Parkway and Stadium Way. Areas were surveyed in November of 2017 and March of 2017 for hazard trees and to ensure areas were clear for public surveillance. No actions were required.

4. 5. 3 Views from Adjacent Properties

An Administrative Guidance plan has been developed for public view management from adjacent properties (Chapter 9.20 TMC (Trees and Shrubs – View Blockage). A draft document has been created for private view management on Schuster Slope, however the final developed plan cannot be utilized until all other performance measures are met for a given area.

4. 5. 4 Volunteer Stewardship

Small areas that are safe for volunteers are located next to steep drop-offs, therefore no areas of MU1 are considered safe for volunteers. As work progresses to other areas of Schuster Slope, volunteer stewardship will be considered.

4. 6 Adaptive Management/Recommendations

Plant survival rates will be used to adapt the number and species planted in the future, in an attempt to ensure greater survival. Locations of high invasive species will continue to be identified routinely and assigned to the WCC crews for treatment and continued maintenance.

Based on the monitoring data, the following adaptive management strategies are recommended:

- Invasive species will continue to be monitored and prioritized for removal by WCC crews.
- Quadrat diameter will be expanded from 9 ft to 18 ft, whenever possible in MU1, and for quadrats established in the future.
- Replacement plantings in Y3 will be overplanted based on survival numbers to achieve a target plant survival rate of 60% by monitoring Y5.
- As time allows, infill planting will take place in monitoring Y2, to achieve an 80% plant survival rate by monitoring Y3.
- The original planting palette will continue to be used for trees, with the possible addition of more species of native evergreen trees, such as Western white pine (*Pinus monticola*) and incense cedar (*Calocedrus decurrens*).
- DRiWATER™ will not be used as it is no longer manufactured and a similar product does not exist.
- Seedling tubes will no longer be used as they did not appear to aid in plant establishment, and it requires unnecessary disturbance of the slope to remove them when plants begin to mature.

5.0 References

1. Baseline Conditions Assessment Report for Schuster Slope. 2014. GeoEngineers, Tacoma, WA.
2. Schuster Slope Landscape Management Plan. 2015. City of Tacoma Environmental Services and Metro Parks Tacoma, Tacoma, WA.
3. Schuster Slope Management Area – Unit 1 Tacoma, Washington. 2016. GeoEngineers, Tacoma, WA.

Table 1. Summary of Schuster Slope Goals, Objectives, Standards and Progress from the Landscape Management Plan

Management Consideration	Goal	Objective	Standard(s)	Timeline	Progress 2016-2017
4. 2. 1 Slope stability and geologic hazard mitigation					
4. 2. 1. 1 Surface water and erosion control	A self-sustaining native plant community to provide rainwater interception, erosion control, and overall stormwater benefit.	To create an evergreen dominated, multi-layer canopy structure of large trees, small trees, shrubs and groundcover.	• 100% soil-binding tree root zone shall be maintained for healthy mature trees (calculated as 1 ft-radius of lateral root extent per 1" dbh). • 2/3rds tree cover will consist of evergreen conifers. • A minimum tree density of 436 trees per acre will be maintained. • Monitoring for a minimum of 5 years will be required to ensure establishment and survivability of plantings.	Site preparation and installation of select planting areas are anticipated to be completed within one year. Monitoring and maintenance will be conducted over a 5 year period to allow for plant establishment and adaptive management.	Site preparation, planting (Y0), and monitoring (Y1) in MU1-TPs 1, 2, 3, 4, 5, 6-1C. Site preparation, planting, and baseline monitoring MU1-TPs 6-1D, 6-2E, and 6-3F.
4.2.1.2 Steep slope stabilization	Improve slope stability throughout project area.	Implement soil stabilization and erosion control measures where applicable to allow the establishment of vegetation	• Erosion control measures will be implemented in accordance with the most current version of the City erosion control best management practices (BMP's) as provided by the City's Stormwater Management Manual on slopes 40% and greater	Erosion control BMP's should be implemented prior to land disturbing activities including planting. Implementing soil stabilization and erosion control measures on slopes	Erosion control blanket installed in all areas with slopes from 60%-80% in MU1-TPs 2-6. Erosion control blanket was installed in all of TP1, where slopes are >80%, under the advisement of

		and provide public safety and infrastructure protection.	where applicable. • Slopes 67% or greater over a distance of 10 ft in vertical height or greater shall be evaluated by a geotechnical consultant or an engineering geologist experienced in slope stability to evaluate for the appropriateness of working on that slope and implementing a landscape management program.	67% or greater requiring engineering solutions, specifically areas where public safety and infrastructure protection are a concern. May require considerable time to allow for slope assessment, design, permitting, and installation activities.	GeoEngineers. Silt fence installed along the entire toe of MU1. Ecology blocks installed in MU1-TP2.
4.2.2 Forest health					
4.2.2.1 Native vegetation	Create a multi-layered canopy of vegetation and improve habitat.	In addition to the tree requirements contained in the Surface Water and Erosion Control Goal, planting areas will contain mature shrub and groundcover layers.	• Mature shrub and groundcover shall be maintained at 100% aerial coverage once established. • Shrub layer shall consist of at least 3 native species, and a minimum of one species shall be evergreen; groundcover layer will consist of at least 2 native species, and a minimum of one species shall be evergreen. • Each planted shrub and groundcover layer will meet 80% survival by Monitoring Year 3 (Y3) and 60% survival by Monitoring Year 5 (Y5).	Site preparation and installation of select planting areas are anticipated to be completed within one year. Monitoring and maintenance will be conducted over a five year period to allow for plant establishment and adaptive management.	Site preparation, planting (Y0), and monitoring (Y1) in MU1-TPs 1, 2, 3, 4, 5, 61C. Site preparation, planting, and baseline monitoring MU1-TPs 6-1D, 6-2E, and 6-3F.
4.2.2.2 Invasive vegetation	Provide for a native	Less than 10% of the aerial	• Remove invasive vegetation from the	The initial removal of invasive species per	Invasive removal for all of MU1, and re-

	dominated, healthy target ecosystem.	coverage of vegetation will consist of invasive species.	project area and monitor and maintain to prevent resurgence for a minimum period of 5 years. • Replant area where invasive vegetation was removed with new native vegetation which conforms to the target ecosystem forest type.	planting area is anticipated to be completed within one year. Monitoring and maintenance will be conducted over a 5-year period to control invasive species and allow for native plant establishment.	treatment three times throughout year.
4.2.3 Public safety					
	Enhance public safety using vegetation management.	Vegetation will be maintained for natural surveillance within public areas.	• In an area measuring 10 horizontal ft adjacent to all public areas, vegetation should be actively maintained to provide open views in a zone between 3 to 8 ft above the ground surface. This includes planting low shrubs and groundcovers and limbing up trees to 8 ft. • In area where homeless encampments or transient activity use is high, all trails should be thoroughly closed and selected species of plants should be planted that are vigorous and have thorns or other such protections that will deter public access.	The initial vegetation management is anticipated to be completed within one year for active management areas. Vegetation maintenance and tree assessments should be conducted annually as long as the public safety and infrastructure applies.	Vegetation and tree assessments were performed in November and March along Stadium Way and Schuster Parkway. No actions were required.
		Maintain public safety through	• Conduct tree assessments annually along all public		

		tree management.	areas. • Remove hazardous trees and branches where they can impact public areas and infrastructure.		
4.2.4 Views from adjacent areas					
4.2.4.1 Public view management	Provide public views while maintaining mature mixed conifer forested conditions.	Establish native vegetation prior to vegetation pruning or removal for public views.	• Trees shall be pruned to current industry standards according to the most current versions of ANSI Z133.1 for safety of pruning operations, the ANSI A300 Standard Practices, and the Tree Pruning Guidelines of the International Society of Arboriculture. • Tree removal and/or pruning to maintain views shall not be conducted until the management unit has met all other applicable goals, objectives, and standards. • No more than 25% of any one tree's crown may be removed in any pruning event and for a minimum of one year following. No tree topping will be allowed under any circumstance. • If mitigation planting is required in order to satisfy goals, objectives, and	Site preparation and installation of select planting areas are anticipated to be completed within one year. Monitoring and maintenance will be conducted over a 5 year period to allow for plant establishment. Pruning actions are only permitted during the allowable time frame.	Chapter 9.20 TMC (Trees and Shrubs – View Blockage) Administrative Guidance put in place.

			standards of the management plan, pruning for view enhancement may not be conducted until the planting has become established (3 years following planting).		
4.2.4.2 Private view management	Provide a process for a private vegetation modification request on City property to enhance a private view.	Provide a transparent process where project proponents may apply for and receive approval to conduct landscape management activities on the Schuster Slope that are in conformance with the techniques and goals in this management plan.	• All management actions approved for private view management shall be conducted in accordance and compliance with this management plan. • Tree removal and/or pruning to maintain views shall not be conducted until the management unit has met all other applicable goals, objectives, and standards. • No more than 25% of any one tree's crown may be removed in any pruning event and for a minimum of one year following. No tree topping will be allowed under any circumstance. • If mitigation planting is required in order to satisfy goals, objectives, and standards of the management plan, pruning for view enhancement may not be conducted until the	Site preparation and installation of select planting areas are anticipated to be completed within one year. Monitoring and maintenance will be conducted over a 5 year period to allow for plant establishment. Pruning actions are only permitted during the allowable time frame.	A draft guideline has been created.

			planting has become established (3 years following planting).		
4.2.5 Voluntary stewardship					
	Offer public “hands-on” opportunities to gain access to and restore the Schuster Slope project area.	Provide volunteer opportunities for the diverse Tacoma demographic while implementing strategies and tactics outlined in this plan.	Recruit, train, deploy, and support volunteers in the specific areas where volunteers can safely and effectively work towards the goals and objectives of this management plan.	Ongoing.	Small areas that are safe for volunteers are located next to steep drop-offs, therefore no areas of MU1 are considered safe for volunteers.

Table 2. Treatment Plot Pre-Restoration Conditions

Treatment Plot (TP)	Area (square feet)	*Slope (%)	Primary Soil Texture	Sun Exposure	~Invasive Species Cover (%)
1	168	80 - 100	Sand	Shade – Part-shade	100
2	4,537	60 - 100	Sand	Sun- Part-shade	100
3	16,307	40 - 60	Sand	Sun-part-shade	80
4	8,116	40 - 60	Sand	Sun-Part-shade	80
5	14,442	60 - 100	Sand	Shade – Part-shade	60
6	45,900	60 - 100	Gravel	Shade – Part-shade	30

* Small areas of all TPs have slopes from 1%-40%. Ranges in the table above represent the majority of the TP.

Table 3. Erosion Control Best Management Practices (BMPs) used in Management Unit 1

Treatment Plot	~ Coverage of Erosion Control Blanket (%)	~ Linear Feet of Straw Wattles Installed	Other BMPs
1	100	0	
2	100	200	Silt fence & Ecology blocks
3	60	0	
4	90	0	
5	90	0	Silt fence
6	100	10,700	Silt fence

Table 4. Planting Palettes for Management Unit 1

Treatment Plots 1, 5, and 6 **Slope Face and Toe** **Dry to Moist Soils, Shade to Part Shade**							
Scientific Name	**Common Name**	**Form**		**Mature Height**	**Stock Type and Spacing O.C.**		**Percent of Plantings**
Tree Layer							
Abies grandis	Grand fir	Evergreen	Tree	100 ft	C, S	15 ft	50
Rhamnus purshiana	Cascara	Deciduous	Tree	30 ft	C, S	15 ft	10
Thuja plicata	Western redcedar	Evergreen	Tree	100 ft	C, S	15 ft	20
Tsuga heterophylla	Western hemlock	Evergreen	Tree	100 ft	C, S	15 ft	20
Shrub Layer							
Acer circinatum	Vine maple	Deciduous	Shrub	20 ft	C, S	6 ft	20
Corylus cornuta	Beaked hazelnut	Deciduous	Shrub	12 ft	C, S	6 ft	15
Holodiscus discolor	Oceanspray	Deciduous	Shrub	12 ft	C, S	6 ft	20
Myrica californica	Pacific Wax-Myrtle	Evergreen	Shrub	15 ft	C, S	6 ft	20
Oemleria cerasiformis	Indian plum	Deciduous	Shrub	15 ft	C, S	6 ft	15
Vaccinium ovatum	Evergreen huckleberry	Evergreen	Shrub	12 ft	C, S	6 ft	10
Ground Cover Layer							
Gaultheria shallon	Salal	Evergreen	Shrub	3 ft	C, S	4 ft	25
Mahonia nervosa	Low Oregon grape	Evergreen	Shrub	2 ft	C, S	4 ft	25
Polystichum munitum	Sword fern	Evergreen	Fern	3 ft	C, S	4 ft	25
Symphoricarpos albus	Snowberry	Deciduous	Shrub	4 ft	C, S	4 ft	25
Treatment Plot 2 (No Groundcover 2016/2017) **Slope Face and Toe** **Dry to Moist Soils, Sun**							
Scientific Name	**Common Name**	**Form**		**Mature Height**	**Stock Type and Spacing O.C.**		**Percent of Plantings**
Tree Layer							
Abies grandis	Grand fir	Evergreen	Tree	100 ft	C, S	15 ft	50
Rhamnus purshiana	Cascara	Deciduous	Tree	30 ft	C, S	15 ft	10
Pinus contorta	Shore pine	Evergreen	Tree	40 ft	C, S	15 ft	20
Pseudotsuga menziesii	Douglas-fir	Evergreen	Tree	100 ft	C, S	15 ft	20
Shrub Layer							
Acer circinatum	Vine maple	Deciduous	Shrub	20 ft	C, S	6 ft	15
Corylus cornuta	Beaked hazelnut	Deciduous	Shrub	12 ft	C, S	6 ft	15
Holodiscus discolor	Oceanspray	Deciduous	Shrub	12 ft	C, S	6 ft	15
Myrica californica	Pacific Wax-Myrtle	Evergreen	Shrub	15 ft	C, S	6 ft	20
Mahonia aquifolium	Tall Oregon grape	Evergreen	Shrub	8 ft	C, S	6 ft	20
Rosa nutkana	Nootka rose	Deciduous	Shrub	10 ft	C, S	6 ft	15
Ground Cover Layer							

Arctostaphylos uva-ursi	Kinnikinnick	Evergreen Shrub	< 1 ft	C, S 4 ft	25
Symphoricarpos albus	Snowberry	Deciduous Shrub	4 ft	C, S 4 ft	25

Treatment Plot 3 and Treatment Plot 4 (Trees Only 2016/2017) Top of Slope; Dry to Moist Soils, Sun					
Scientific Name	**Common Name**	**Form**	**Mature Height**	**Stock Type and Spacing O.C.**	**Percent of Plantings**
Tree Layer					
Rhamnus purshiana	Cascara	Deciduous Tree	30 ft	C, S 15 ft	25
Pinus contorta	Shore pine	Evergreen Tree	40 ft	C, S 15 ft	75
Shrub Layer					
Acer circinatum	Vine maple	Deciduous Shrub	20 ft	C, S 6 ft	15
Corylus cornuta	Beaked hazelnut	Deciduous Shrub	12 ft	C, S 6 ft	15
Holodiscus discolor	Oceanspray	Deciduous Shrub	12 ft	C, S 6 ft	15
Myrica californica	Pacific Wax-Myrtle	Evergreen Shrub	15 ft	C, S 6 ft	20
Mahonia aquifolium	Tall Oregon grape	Evergreen Shrub	8 ft	C, S 6 ft	20
Rosa nutkana	Nootka rose	Deciduous Shrub	10 ft	C, S 6 ft	15
Ground Cover Layer					
Arctostaphylos uva-ursi	Kinnikinnick	Evergreen Shrub	< 1 ft	C, S 4 ft	25
Symphoricarpos albus	Snowberry	Deciduous Shrub	4 ft	C, S 4 ft	25

C = Containerized 1 gallon or larger
ft = Feet
O.C. = On center spacing in feet (ft)
S = Seedling
[1] Madrone can be installed, however, due to its high transplant mortality it is not recommended as a primary planting.

Table 5. Planting and Monitoring Schedule for Management Unit 1

Treatment Plot	Planting Month and Year (Y0)	Baseline Monitoring Month and Year	Monitoring Year 1 (Y1) Month and Year
1	01/2016	none	07/2017
2	12/2015	none	07/2017
3	01/2016	none	07/2017
4	01/2016	none	07/2017
5	02/2016	none	07/2017
6-1C	03/2016	none	07/2017
6-1D	03/2017	08/2017	to be completed in 2018
6-2E	03/2017	08/2017	to be completed in 2018
6-3F	03/2017	08/2017	to be completed in 2018

Table 6. Treatment Plot 6 Sub-Plot Treatments

Groundcover	absent				present			
Planting Fabric	none	straw	burlap	coir	none	straw	burlap	coir
Sub-TP								
1A	X							
2A							X	
2B						X		
3B				X				
3C	X							
1C						X		
1D							X	
3D			X					
2E	X							
1E								X
3F								X
2F		X						

Table 7. Data Collection in Quadrats

Variable	Measurement
Native plant name	Identified to species whenever possible
Number of each native plant	Individually counted
Estimated coverage for each native plant species using a Daubenmire scale	0%-5%, 5%-25%, 25%-50%, 50%-75%, 75%-95%, 95%-100%
Primary, secondary, and tertiary invasive species present	Identified to species whenever possible
Estimated coverage for each invasive species using a Daubenmire scale	0%-5%, 5%-25%, 25%-50%, 50%-75%, 75%-95%, 95%-100%
Slope	Percent
Aspect	Cardinal direction
Dominant soil texture	Clay, silt, sand, gravel
Soil Moisture (typical of summer months)	Dry, damp, saturated, standing water
Soil compaction	None, moderate, light, heavy
Estimated bare ground using a Daubenmire scale	0%-5%, 5%-25%, 25%-50%, 50%-75%, 75%-95%, 95%-100%
Course woody debris > 5" in diameter using a Daubenmire scale	0%-5%, 5%-25%, 25%-50%, 50%-75%, 75%-95%, 95%-100%
General Observations	Dumping, timber trespass, tree of concern, etc.
Evidence of erosion	Stable, erosion, slump, slide
Evidence of erosion control material	None, coir, jute, straw coir, straw lined, straw wattles
Coverage of erosion control material	None, 1-50%, 50-100%
Overstory canopy coverage using a Daubenmire scale	0%-5%, 5%-25%, 25%-50%, 50%-75%, 75%-95%, 95%-100%
Origin of overstory canopy (trees great than 2" dbh)	Inside quadrat, outside quadrat, both within and outside quadrat
Phototags	Photos taken from N, S, E, and W when possible

Table 8. Data Collection in Transects

Variable	Measurement
Native plant name	Identified to species whenever possible
Number of each native plant	Individually counted
Native plant species location and total length along transect	Feet and Inches
Year native species planted	Y0, Y1, Y2, Y3, Y4, Y5, volunteer, unknown
Condition of native plant	Healthy, stressed, dead
Estimated coverage of invasive species using a Daubenmire scale	0%-5%, 5%-25%, 25%-50%, 50%-75%, 75%-95%, 95%-100%
Dominant invasive species present (up to 5)	Identified to species whenever possible
Estimated bare ground using a Daubenmire scale	0%-5%, 5%-25%, 25%-50%, 50%-75%, 75%-95%, 95%-100%
General observations	Encampment, trail, debris, etc.
Phototags	Photos taken from beginning and end point of each transect with GPS coordinates

Table 9. General Observations for Management Unit 1: Quadrat Averages

Treatment Plot	1*	2	3	4	5	6-1C
% Slope**	>80	80	37	69	63	80
Soil Texture	Sand	Sand	Sand	Sand	Sand	Gravel
Soil Moisture	Dry	Dry	Dry	Dry	Dry	Dry
Soil Compaction	None	None	Light-Moderate	Light-Moderate	None	None
Litter Depth (inches)	<0.5	1	0.5	<0.5	0.5	<0.5
% Bare Ground	25-50	5-25	5-25	5-25	25-50	25-50
% Course Woody Debris	0-5	0-5	0-5	0-5	0-5	0-5
% Overstory Canopy Cover	75-95	50	5-25	25	75-95	75-95
Overstory Canopy Origin	Outside Quadrat	Outside Quadrat	Outside Quadrat	Inside and Outside Quadrat	Outside Quadrat	Outside Quadrat
Restoration Status	Partially Cleared and Planted	Partially Cleared and Planted	Partially Cleared and Planted	Partially Cleared and Planted	Planted Only/Not Cleared	Planted Only/Not Cleared
Slope Stability	Erosion	Stable	Some Erosion	Some Erosion	Stable	Erosion
Erosion Control Present	No	Yes	Yes	Yes	Yes	Yes
Erosion Control Type		Biodegradable Coir	Biodegradable Coir or Straw	Straw Coir	Biodegradable Coir	Biodegradable Coir
% Erosion Control Coverage	0	>50	1-50	>50	50	1-50
Observations	All erosion control blanket disintegrated		Some debris		Partial trail	

* Data for TP1 includes the entire plot and is not averaged.

** Percent slope was estimated using an iPhone application and will be re-measured in the same locations in future years using professional equipment.

Table 10. Plant Survival Rates by Treatment Plot

Treatment Plot	Average Survival Rate (%)	Well-Performing Species	Conditions
1	16.7	Grand Fir (*Abies grandis*) Vine Maple (*Acer circinatum*)	Dry to Moist Soil, Sand, Sun to Part-Shade
2	142.9	Tall Oregon Grape (*Mahonia aquifolium*), Nootka Rose (*Rosa nutkana*)	Dry to Moist Soil, Sand, Sun to Part-Shade
3	140.0	Snowberry (*Sympharicarpos albus*), Vine Maple (*Acer circinatum*) Shore Pine (*Pinus contorta*)	Dry to Moist Soil, Sand, Sun to Part-Shade
4	100.0	Cascara (*Rhamnus purshiana*)	Dry to Moist Soil, Sand, Sun to Part-Shade
5	66.7	Swordfern (*Polystichum munitum*), Snowberry (*Sympharicarpos albus)*	Dry to Moist Soil, Sand-Gravel, Shade to Part-Shade
6-1C	17.6	Snowberry (*Sympharicarpos albus)*	Dry to Moist Soil, Gravel, Shade to Part-Shade
Average	80.7		

*The number of plants installed per monitoring location was estimated based upon the total number of plants installed per treatment plot (see section 3.4.1(b)).

Table 11. Estimated Ground Coverage by Plant Type in Transects

TP	% Dec GC	% EG GC	% Dec Shrub	% EG Shrub	% Dec Tree	% EG Tree	% Dec Total	% EG Total	% Dec + EG	% Bare Ground	% Inv Sp
1	2.5	0.0	2.5	0.0	0.0	2.5	5.0	2.5	7.5	37.5	62.5
2	0.0	0.0	17.7	13.7	0.0	12.5	17.7	26.2	43.8	37.5	15.0
3	0.0	6.7	38.3	8.5	2.7	13.3	41.0	28.5	69.5	37.5	37.5
4	24.0	0.0	0.0	0.0	13.8	17.2	37.8	17.2	55.0	2.5	15.0
5	0.0	0.0	25.2	0.0	0.0	11.5	25.2	11.5	36.7	37.5	15.0
6-1C	0.0	0.0	16.5	6.8	0.0	1.3	16.5	8.2	24.7	37.5	2.5

*TP = treatment plot; Dec = deciduous; EG = evergreen; Inv Sp = invasive species, GC = groundcover; No GC planted

** All data for TP1, bare ground, and invasive species coverage are recorded as the mid-point of the Daubenmire scale range.

Table 12. Invasive Species in Management Unit 1 Pre and Post Restoration

	Pre-Restoration			Post Restoration (Year 1)			
Treatment Plot	% Coverage	Dominant Invasive Species	Secondary Invasive Species	% Coverage	Dominant Invasive Species	Secondary Invasive Species	Tertiary Invasive Species
1	100	Himalayan Blackberry *(Rubus armeniacus)*	Old man's beard (*Clematis vitalba*)	50-75	Old man's beard (*Clematis vitalba*)	Himalayan Blackberry *(Rubus armeniacus)*	Sow Thistle (*Sonchus* sp.)
2	100	Himalayan Blackberry *(Rubus armeniacus)*		5-25	Himalayan Blackberry *(Rubus armeniacus)*	* Old man's beard (*Clematis vitalba*)	Nipplewort (*Lapsana communis*)
3	80	Himalayan Blackberry *(Rubus armeniacus)*	Old man's beard (*Clematis vitalba*)	25-50	Horsetail (*Equisetum* sp.)	Sow Thistle (*Sonchus* sp.)	*Cleaver (*Galium* sp.)
4	80	Himalayan Blackberry *(Rubus armeniacus)*		5-25	Willowherb (*Epilobium* sp.)	Old man's beard (*Clematis vitalba*)	Nipplewort (*Lapsana communis*)
5	60	Himalayan Blackberry *(Rubus armeniacus)*	English Ivy (*Hedera helix*)	5-25	*Nipple-wort (*Lapsana communis*)	* Old man's beard (*Clematis vitalba*)	*Cleaver (*Galium* sp.)
6-1C	30	English Ivy (*Hedera helix*)	Old man's beard (*Clematis vitalba*)	0-5	*Nipple-wort (*Lapsana communis*)	<u>Himalayan Blackberry</u> *(Rubus armeniacus)*	

* Species found in both the transect and quadrat. Data for TP1 includes the entire area. Percent coverage in Y1 is based on data collected in transects.

Figure 1. Schuster Slope Management Units

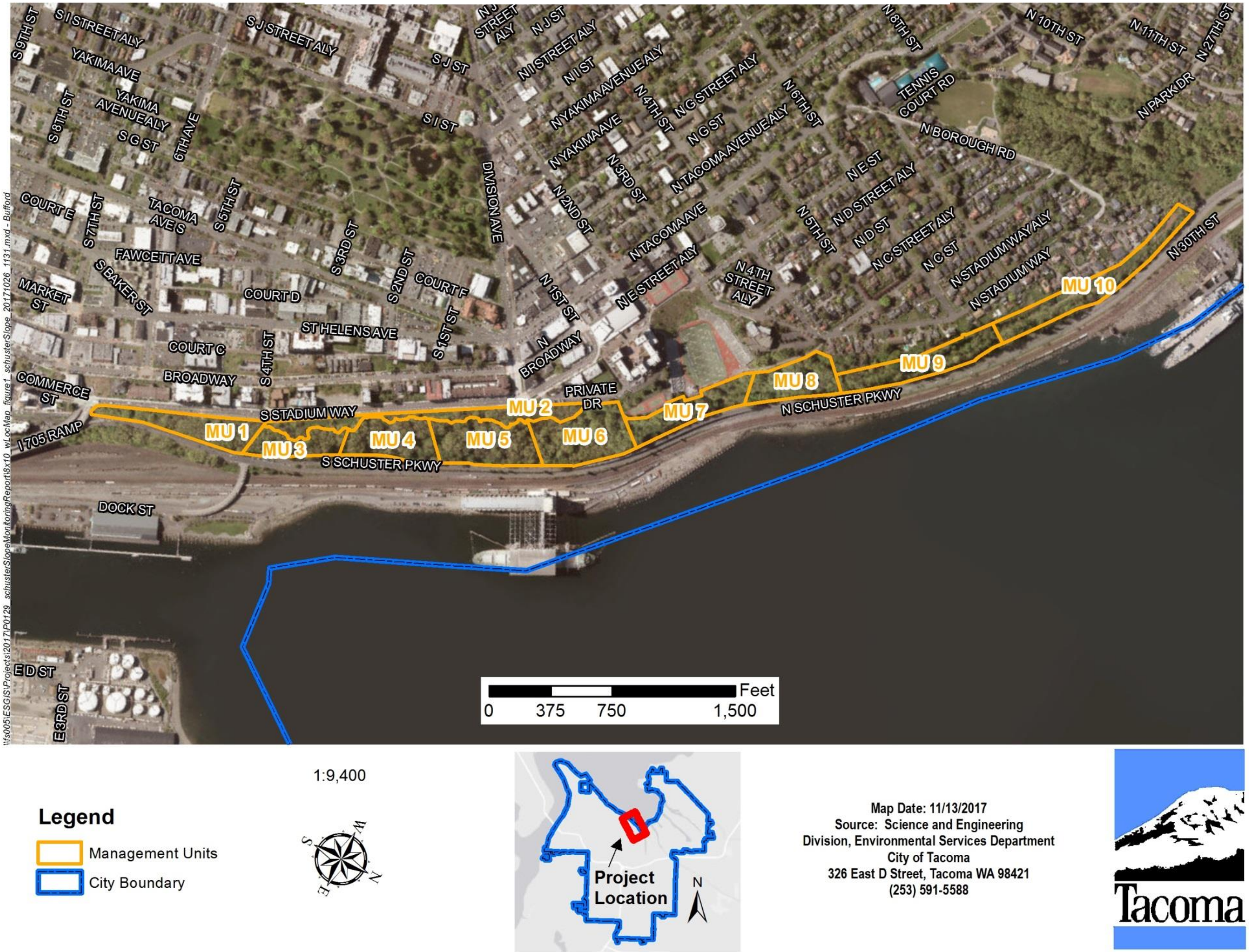

Figure 2. Schuster Slope Management Unit 1

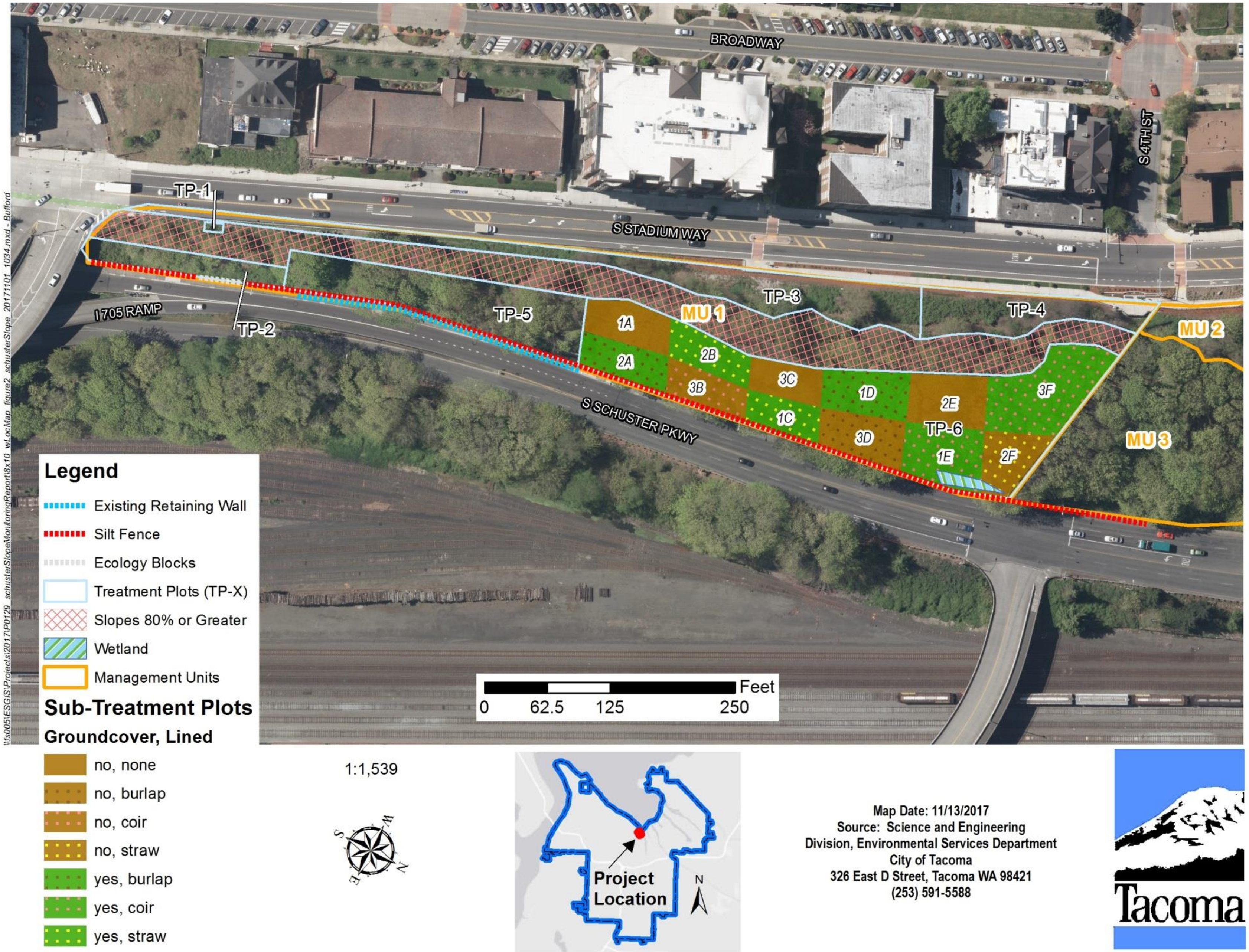

Figure 3. Schuster Slope Monitoring 2017