2-01 Clearing, Grubbing, and Roadside Cleanup

SS 2-01.3 Construction Requirements

SS 2-01.3(1) Clearing

Before starting grading operations, it is necessary to prepare the work area by removing all trees, brush, buildings, and other objectionable material and obstructions that may interfere with the construction of the roadway. From the standpoint of roadside appearance and control of erosion on the right of way, it is advantageous to preserve natural growth where possible. When shown in the Plans, the first order of work shall be the installation of high visibility fencing (HVF) to delineate all areas for protection or restoration. The Project Engineer should double check the placement of the HVF and ensure it matches the locations indicated on the Joint Aquatic Resource Permit Application. In addition, the Project Engineer should discuss with the Landscape Architect the preservation of natural growth which will not interfere with roadway and drainage construction before starting clearing operations. If vegetation outside the clearing limits is damaged during the clearing or grubbing operations, or if pruning is required, the Landscape Architect or State Horticulturist may be contacted for assistance. Areas to be omitted from clearing or extra areas to be cleared should be determined before starting work and an accurate record made during staking operations.

Staking

Clearing stakes at least 4 ft long and marked “Clearing” should be set at the proper offset marking the limits of the area to be cleared. These stakes normally should be set at 100-ft intervals on tangents and at shorter intervals on curves, depending on the sharpness of the curve. Where slope treatment is provided, clearing normally should be staked to a distance of 10 ft beyond the limits of the slope treatment with a distance of 5 ft being considered the absolute minimum distance required. Normally, grading stakes should not be set until clearing and grubbing work in a given area is completed. The method of measurement used at interchange areas should be such as to preclude the possibility of duplication or overlapping of measured areas.

SS 2-01.3(2) Grubbing

Grubbing provides for additional preparation of the work area by removal of remaining stumps, roots, and other obstructions which exist on or in the ground in all areas designated for grubbing. It should be noted that complete grubbing is not required under embankments where the fill height above natural ground, as measured to subgrade or embankment slope elevation, exceeds 5 ft. This exception does not apply to any area where a structure must be built, subdrainage trenches are to be excavated, unsuitable material is to be removed, or where hillsides or existing embankments are to be terraced. Grubbing is important to the structural quality of the roadway and every effort should be made to obtain a thorough job. Grubbing should be completed at least 1,000 ft in advance of grading operations.

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Standard Specifications

for Road, Bridge, and Municipal Construction

2016

M 41-10

Washington State Department of Transportation

AMERICAN PUBLIC WORKS ASSOCIATION
APWA
Washington State Chapter

KC EXH 3 - 059

INTRO.GR1

SPECIAL PROVISIONS

The following Special Provisions are made a part of this contract and supersede any conflicting provisions of the 2016 Standard Specifications for Road, Bridge and Municipal Construction, and the foregoing Amendments to the Standard Specifications.

Several types of Special Provisions are included in this contract; General, Region, Bridges and Structures, and Project Specific. Special Provisions types are differentiated as follows:

(date)	General Special Provision
(******)	Notes a revision to a General Special Provision and also notes a Project Specific Special Provision.
(Regions[1] date)	Region Special Provision
(BSP date)	Bridges and Structures Special Provision

General Special Provisions are similar to Standard Specifications in that they typically apply to many projects, usually in more than one Region. Usually, the only difference from one project to another is the inclusion of variable project data, inserted as a “fill-in”.

Region Special Provisions are commonly applicable within the designated Region. Region designations are as follows:

Regions[1]	
ER	Eastern Region
NCR	North Central Region
NWR	Northwest Region
OR	Olympic Region
SCR	South Central Region
SWR	Southwest Region
WSF	Washington State Ferries Division

Bridges and Structures Special Provisions are similar to Standard Specifications in that they typically apply to many projects, usually in more than one Region. Usually, the only difference from one project to another is the inclusion of variable project data, inserted as a “fill-in”.

Project Specific Special Provisions normally appear only in the contract for which they were developed.

DIVISION1.GR1

Division 1
General Requirements

DESWORK.GR1

DESCRIPTION OF WORK

DESWORK1.FR1
(March 13, 1995)

Payment

Payment will be made for the following bid item when included in the proposal:

"Structure Surveying", lump sum.

The lump sum contract price for "Structure Surveying" shall be full pay for all labor, equipment, materials, and supervision utilized to perform the Work specified, including any resurveying, checking, correction of errors, replacement of missing or damaged stakes, and coordination efforts.

1-05.4.OPT2.GR1

(August 7, 2017)

Contractor Surveying - Roadway

Copies of the Contracting Agency provided primary survey control data are available for the bidder's inspection at the office of the Engineer.

The Contractor shall be responsible for setting, maintaining, and resetting all alignment stakes, slope stakes, and grades necessary for the construction of the roadbed, drainage, surfacing, paving, channelization and pavement marking, illumination and signals, guardrails and barriers, and signing. Except for the survey control data to be furnished by the Contracting Agency, calculations, surveying, and measuring required for setting and maintaining the necessary lines and grades shall be the Contractor's responsibility.

The Contractor shall inform the Engineer when monuments are discovered that were not identified in the Plans and construction activity may disturb or damage the monuments. All monuments noted on the plans “DO NOT DISTURB” shall be protected throughout the length of the project or be replaced at the Contractors expense.

Detailed survey records shall be maintained, including a description of the work performed on each shift, the methods utilized, and the control points used. The record shall be adequate to allow the survey to be reproduced. A copy of each day's record shall be provided to the Engineer within three working days after the end of the shift.

The meaning of words and terms used in this provision shall be as listed in "Definitions of Surveying and Associated Terms" current edition, published by the American Congress on Surveying and Mapping and the American Society of Civil Engineers.

The survey work shall include but not be limited to the following:

1. Verify the primary horizontal and vertical control furnished by the Contracting Agency, and expand into secondary control by adding stakes and hubs as well as additional survey control needed for the project. Provide descriptions of secondary control to the Contracting Agency. The description shall include coordinates and elevations of all secondary control points.

2. Establish, the centerlines of all alignments, by placing hubs, stakes, or marks on centerline or on offsets to centerline at all curve points (PCs, PTs, and PIs) and at points on the alignments spaced no further than 50 feet.

3. Establish clearing limits, placing stakes at all angle points and at intermediate points not more than 50 feet apart. The clearing and grubbing limits shall be 5 feet beyond the toe of a fill and 10 feet beyond the top of a cut unless otherwise shown in the Plans.

4. Establish grading limits, placing slope stakes at centerline increments not more than 50 feet apart. Establish offset reference to all slope stakes. If Global Positioning Satellite (GPS) Machine Controls are used to provide grade control, then slope stakes may be omitted at the discretion of the Contractor

5. Establish the horizontal and vertical location of all drainage features, placing offset stakes to all drainage structures and to pipes at a horizontal interval not greater than 25 feet.

6. Establish roadbed and surfacing elevations by placing stakes at the top of subgrade and at the top of each course of surfacing. Subgrade and surfacing stakes shall be set at horizontal intervals not greater than 50 feet in tangent sections, 25 feet in curve sections with a radius less than 300 feet, and at 10-foot intervals in intersection radii with a radius less than 10 feet. Transversely, stakes shall be placed at all locations where the roadway slope changes and at additional points such that the transverse spacing of stakes is not more than 12 feet. If GPS Machine Controls are used to provide grade control, then roadbed and surfacing stakes may be omitted at the discretion of the Contractor.

7. Establish intermediate elevation benchmarks as needed to check work throughout the project.

8. Provide references for paving pins at 25-foot intervals or provide simultaneous surveying to establish location and elevation of paving pins as they are being placed.

9. For all other types of construction included in this provision, (including but not limited to channelization and pavement marking, illumination and signals, guardrails and barriers, and signing) provide staking and layout as necessary to adequately locate, construct, and check the specific construction activity.

10. Contractor shall determine if changes are needed to the profiles or roadway sections shown in the Contract Plans in order to achieve proper smoothness and drainage where matching into existing features, such as a smooth transition from new pavement to existing pavement. The Contractor shall submit these changes to the Engineer for review and approval 10 days prior to the beginning of work.

The Contractor shall provide the Contracting Agency copies of any calculations and staking data when requested by the Engineer.

To facilitate the establishment of these lines and elevations, the Contracting Agency will provide the Contractor with primary survey control information consisting of descriptions of two primary control points used for the horizontal and vertical control,

Memorandum

To: Barbara Flemming, Senior Deputy Prosecuting Attorney

From: Bill Schultheiss, P.E. (WA. P.E. #46108)

Rebecca Sanders, PhD, Lisa Enns

Date: May 19, 2016

Re: East Lake Sammamish Trail Demand Analyses

King County has asked Toole Design Group (TDG) to estimate bicycle volumes on the East Lake Sammamish Trail, a significant link in the King County Trail network. The King County trail network is an important component of the overall transportation network, connecting major population and employment centers via safe, comfortable off-street facilities. In addition to transportation, the benefits of trail facilities include increasing public health and wellness and boosting the economy.

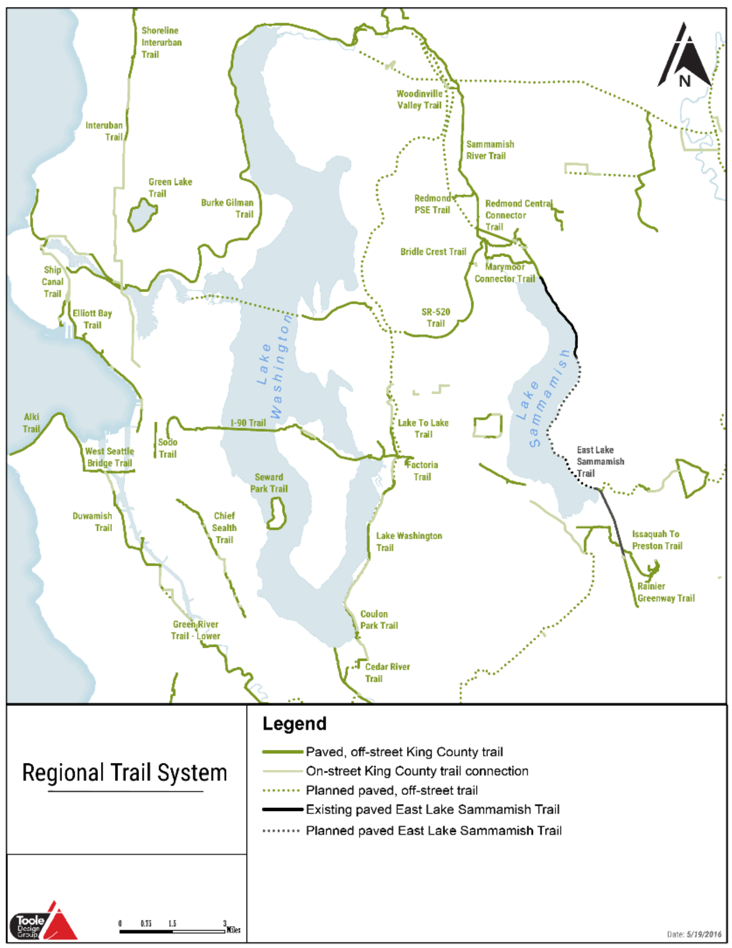

Figure 1 - King County Regional Trail System

The East Lake Sammamish Trail (ELST) will be a key part of King County's regional trail network, shown in Figure 1. The ELST runs along the east side of Lake Sammamish for approximately 11 miles, connecting Issaquah and Redmond through Sammamish. Both Issaquah and Redmond's comprehensive plans call for concentrating growth and development in mixed use centers and offering multiple options for transportation. The ELST will directly connect these cities via a flat, paved, high quality trail that provides a safe and comfortable alternative to riding on roadways. The ELST will provide transportation and recreational opportunities for residents in Sammamish, Issaquah, Redmond, and the surrounding region. In addition to connecting the adjacent communities, the trail will be a vital link in the 44-mile regional trail corridor, linking Puget Sound to east King County and the Cascade Foothills.

The demand analysis presented in this document aims to provide the project team with a means to inform the overall design of the trail, including width as well as traffic control measures that will ensure a safe user experience.

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Direct Demand Model

In the past few years, the quality of data available for bicycling on trails in King County has increased. Several permanent trail counters were installed by the Seattle Department of Transportation (SDOT) in 2014, and the Washington Department of Transportation (WSDOT) installed permanent counters in several locations approximately a year ago. The additional data allows for the use of a more sophisticated trail estimate methodology than was previously available. The National Cooperative Highway Research Program's (NCHRP) Report 770[1], Estimating Bicycling and Walking for Planning and Project Development: A Guidebook, was consulted to select the best method for this analysis. NCHRP Report 770 is the result of a multi-year research effort that developed improved methods for estimating bicycling and walking for planning and project development purposes. Some of the methods only account for commute trips, so a direct demand model, which accounts for all trip purposes (including recreational use), was chosen for this analysis. This model is one of the most widely used tools to predict bicycle and pedestrian volumes. This process uses characteristics of the built environment and existing trail counts to provide an estimate of volumes on a new facility. The direct demand model only takes into account bicycle volumes. Pedestrian volumes are factored into the estimate via a mode split analysis based on similar trails.

The direct demand model recommended in NCHRP Report 770 follows this six-step process to estimate trail volumes:

1. Gather data from seven existing, permanent trail counters.
2. Create a "catchment area" around the permanent trail counters.
3. Summarize land use characteristics within the catchment area.
4. Analyze trail characteristics, such as elevation gain and connectivity.
5. Explore models including factors gathered in steps 3 and 4 to determine which factors influence trail usage.
6. Apply factors discovered in step 5 to surrounding land use and trail characteristics of the proposed East Lake Sammamish Trail.
7. Estimate pedestrian/bicycle mode split and apply pedestrian adjustment to calculate total trail volumes.

The following sections explain how estimated trail volumes were developed following this process.

1. Bicycle Counts

The first step in a direct demand model is to gather existing bicycle volumes. The Seattle Department of Transportation has 12 permanent bicycle counters that gather bicycle volumes continuously. This data is available from the City's website summarized by hour. We selected only off-street, paved trail count locations, similar to the proposed East Lake Sammamish trail. An entire year of data from 2014 was selected to include in the analysis from these counters:

- Elliott Bay Trail at Myrtle Edwards Park
- Burke-Gilman Trail at NE 70th
- Mountains to Sound Trail west of the I-90 Bridge
- Chief Sealth trail at S Thistle St

[1] Transportation Research Board, NCHRP Report 770, "Estimating Bicycling and Walking for Planning and Project Development: A Guidebook," Research sponsored by the American Association of State Highway and Transportation Officials (AASHTO) in cooperation with the Federal highway Administration, Final Report, 2014

The Washington Department of Transportation (WSDOT) has also begun installing permanent counters along trails. WSDOT counters used in this analysis were:

- I-90 trail at SE 34th St
- SR 520 trail at NE 24th St
- Sammamish River trail at Redmond City Hall

Two of the WSDOT counters have been running for at least a year, allowing us to select a year's worth of data from May 1, 2015, to April 30, 2016, with the exception of the Sammamish River Trail, which did not have data points for May or June. Using the Federal Highway Administration's Traffic Monitoring Guide methodology outlined in Chapter 4, "Traffic Monitoring for Non-Motorized Traffic," the missing May and June volumes were extrapolated to complete the Sammamish River Trail data set.

King County also provided data from two recently installed counters along the East Lake Sammamish Trail. Location #1 is on the East Lake Sammamish Trail just south of the intersection with the Marymoor Connector Trail in Redmond, and location #2 is on the East Lake Sammamish Trail just north of the intersection with the Issaquah-Preston Trail in Issaquah. These counters provide continuous data in the same manner as the SDOT and WSDOT counters. They were installed in the spring of 2016, thus data is only available from April 8- April 20, 2016. Annual counts were extrapolated from this two week period following the procedures from the Federal Highway Administration's Traffic Monitoring Guide methodology.

The goal of this analysis is to identify the volumes of trail traffic on the ELST at different times of the year, week, and day. To represent the spectrum of volumes expected, six volume metrics were pulled from each counter: annual, peak weekday, peak weekend, average weekday, average weekend, and peak hour. **Since the counts provided by King County were only from the month of April, the peak weekday, peak weekend, and peak hour volumes pulled from the April data are likely slightly lower than actual peak volumes the trail will experience in summer months.** The trail counts provided and national research show that bicycle usage rises in the summer months, resulting in actual peak volumes occurring between May and August which can correspond up to 12% of the annual trail traffic volumes. April data for these two count locations was also used to calculate average weekday and average weekend day volumes. The average data should be very similar to actual averages, as April is a typical month for bicycle ridership.

2. Catchment Area

In order to gather land use characteristics in areas near the trail, a catchment buffer was created. A GIS software analysis tool was used to find all areas of a trail within a 2 mile distance from each trail with a bicycle counter. A 2-mile proximity buffer around the trail was selected based on research which shows bicyclists will go up to a total of 3 miles out of their way to access high quality/low stress bicycle facilities (including bike lanes, bicycle boulevards, low traffic streets, and multi-use paths).[2] The actual built road and trail network was used to determine the catchment areas which results in the buffer's irregular shapes. Once on the trail, we assumed that a bicyclist would stay on the trail for 2-4 miles.

A future potential counter location was created on the ELST, near 190th Pl SE, that is used for trail volume estimates. The catchment area process was then applied to that location. All nine resulting catchment areas are shown in Figure 2.

[2] Jennifer Dill and John Gliebe, "Understanding and measuring bicycling behavior: a focus on travel time and route choice," Final report OTREC-RR-08-03 prepared for Oregon Transportation Research and Education Consortium (OTREC), December 2008.

The result of this process is a catchment area around each counter location for people who have easy access to the trail, either by bicycle or a short car drive. Some trail users will likely drive or bicycle more than two miles to a trail access point, thus the catchment areas shown are likely conservative estimates that will have the effect of reducing potential trail volume. These users will be more influenced by the quality of the trail, such as connectivity, elevation gain, and other factors described in Section 4.

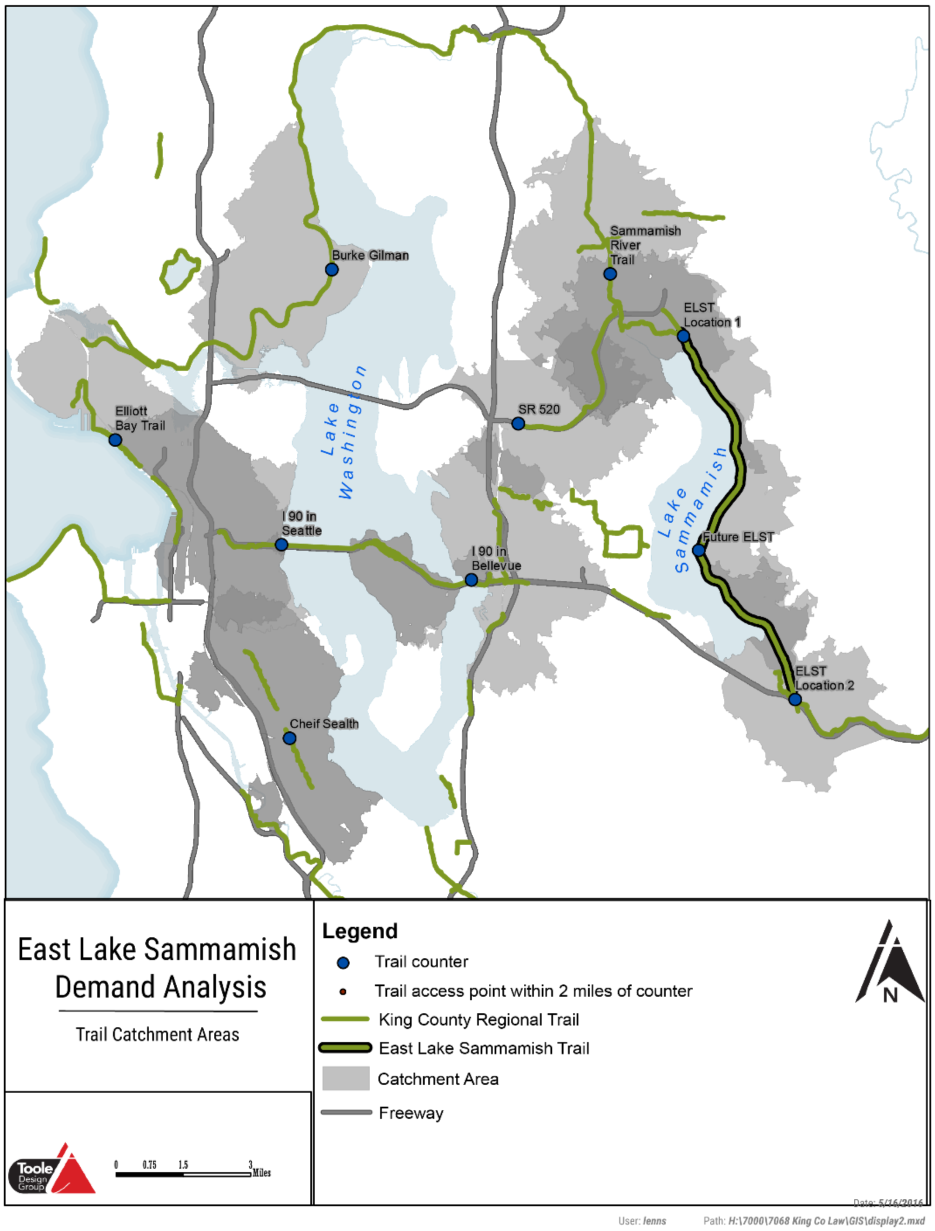

Figure 2: Catchment Areas

3. Land Use Information

The NCHRP Report 770 lists several factors that may influence bicycle use, including population and employment densities, land use mix, facility characteristics, transit availability, and major generators. These factors, along with other readily available factors, were gathered and represent existing conditions and data as provided from the King County data sets. All factors represent current conditions. The following describes each factor considered in this process:

Transit Access

Transit access was calculated by the sum of number of bus trips available per week at each stop in the catchment area, using King County data from the General Transit Feed Specification.

Population

Block groups that intersect the catchment area were selected, and the population calculated. Data is the 2015 estimate from the Office of Financial Management, tabulated by block group. Population density was calculated by dividing the 2015 population by the total land area of the selected block groups.

Employment

Employment values are from the Puget Sound Regional Council, tabulated by census tract. Census tracts that intersect the catchment area were selected, and employment values summed. Employment density was calculated by dividing the total employment by the total land area of the selected census tracts.

Street Network

A connected street network can be a factor in influencing bicycle rates. The number of intersections was summed in each catchment area.

Access Area

The total square mileage of each catchment area was calculated. A larger catchment area means that the trail is easier to access.

College Enrollment

Colleges are major activity generators for a region. The King County "schsite_point" layer was used to find colleges and universities within each catchment area, and each school's website was used to estimate enrollment.

4. Trail Characteristics

In addition to surrounding land use, characteristics of the trail or facility itself influence bicycle ridership. The trails selected for analysis all have similar characteristics to the future East Lake Sammamish Trail, but there are a few differences that were explored.

Connectivity

Trail connectivity may drive trail use, as bicyclists on longer rides may prefer a connected trail network. Multiple factors were explored as a way to measure connectivity.

Total mileage of King County Regional Trails in the catchment area

King County has a robust regional trail network. Most of the network is off-road, paved trails. However, on-street connections were included in this factor as a measure of connectivity.

Connected miles of paved, off-street trails

Some bicyclists may prefer to ride their entire route along paved, off-street trails. The total connected miles of paved, off-street trail was summed for each trail location.

Paved, off-street trail extension past the catchment area

An additional measure of trail connectivity was also explored in the model; the trail was considered not extended if it did not connect to any other paved trails on either end of the catchment area (such as the Chief Sealth), semi-connected if the trail connected on one end of the catchment area (SR 520 Trail) and very connected if it connected on both ends (Burke Gilman, Sammamish River).

Elevation

Most trails in the King County Trail network have little to no elevation gain. A few, however, have a significant amount of elevation change, which may impact trail usage. Elevation gain was calculated using bicycle directions on Google Maps, divided by the distance of the trail within the catchment area to calculate average elevation gain/mile. The Chief Sealth, 520, and I-90 trails had the most elevation change; the Burke-Gilman, Elliott Bay, and Sammamish River trails had little to no elevation change. The East Lake Sammamish trail will also have little to no elevation change.

Freeway

The 520 and I-90 trails run directly adjacent to a freeway. Noise and stress level of freeway trails may deter some riders. Trails near a freeway were coded as a value of one, and non-freeway trails were given a value of zero.

5. Exploratory Models

The direct demand model attempts to explain observed levels of bicycle activity on facilities as related to surrounding land uses or facility characteristics. Because the explanatory variables act simultaneously to influence demand, we need a way to control for their influence in order to understand how important one variable is in comparison to another. We do this through regression analysis, which allows us to mathematically estimate the influence of each variable compared to all of the other variables. Additionally, we can use the regression outputs to determine how significant each relationship is—that is, how likely it is that the observed relationship is due to a real relationship as opposed to chance. The regression analysis compared estimated demand on the East Lake Sammamish Trail to segments of the larger King County trail system. The first step of a regression analysis is exploratory regression, which entails producing many different models to find out which variables best predict volumes.

During the exploratory phase, we discovered that the Chief Sealth trail had many characteristics that were not typical of the rest of the network. The trail is unconnected and hilly, which was accounted for by the elevation and network connectivity factors. However, the Chief Sealth trail also has a parallel roadway option, which could divert significant traffic from the trail. Due to this factor, the Chief Sealth trail was determined an outlier and removed from the analysis.

After running various models to determine the best fit, the following variables were found to have the highest influence on trail ridership.

- Population density
- College enrollment
- Miles of trail in the catchment area
- Connections to shared-use paths once the trail leaves the catchment area
- Intersection density
- Network length

However, many of these variables are highly correlated[3], and therefore cannot coexist in a model without causing problems. For example, population density is highly correlated with both college enrollment and intersection density,

[3] We used a correlation value cut-off of 0.6.

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meaning that there is enough similarity between population density and the other two variables that the model is unable to attribute accurate values to either intersection density or college enrollment when population density is also included. Additionally, we can assume that when a model includes intersection density or college enrollment, some portion of the explanatory value of those variables is due to population density. However, in both cases, there is something else that made those variables a better fit for the model than just population density. Modeling is as much an art as a science in this way.

Another important aspect of modeling is having enough data points to be able to say something with confidence. Although King County is on the forefront of collecting bicycle volume data, there were only 8 robust data points to work with. While the models we present here are significantly better than not knowing any information at all (i.e., the "null model"), additional count locations would have allowed us to produce a more robust model.

6. Application of Predictive Model

After testing several models in the exploratory phase, final models were selected based on a combination of the highest R squared value (a measure of how much of the variation in bicycle volumes can be explained by the model), the statistical significance of the variables (a measure of how likely it is that the observed relationship is real and not just by chance), and minimal multicollinearity (as explained in Section 5, a correlation value of 0.6 was the cut-off for inclusion in the model). A separate model was built for each volume estimate: annual, peak hour, average weekday, average weekend day, peak weekday, and peak weekend day. Because the models are different, the annual volumes do not automatically match up with the average weekday and average weekend day volumes.

The following regression equations use 2015 and 2016 conditions, meaning that the resulting volumes are an estimate of what trail usage would be if the trail were built today.

Each variable in the model is a land use or trail characteristic described in steps 3 and 4.

Annual

This model estimates the annual trail volume. The model indicates that intersection density, ability to easily access the trail, college enrollment, and network mileage influences the annual volume. Note that this and all other models presented here were based on eight data points. The resulting annual volumes are much lower than expected from the calculation of average weekend and weekday volumes separately, but this is not unexpected, given that each model has some percentage of error, as noted by the R-squared values.

The annual model had an R-squared value of 0.7538, suggesting that the significant variables predict approximately 75% of the variation in annual trail counts from the eight data locations. The model produced the following equation, which can be applied to the ELST fictional point to predict its annual volume:

= exp(9.710414 + 0.0005635*intersection density + 0.1153764*access area + 0.000024*college enrollment + 0.0062116*network mileage)

Poisson (count) models are easier to interpret if we turn the coefficients above into incidence rate ratios (IRRs), which explain the expected change in annual counts due to the effect of each variable, holding all other variables constant in the model. This model produces the following IRRs:

- Intersection density – for a one-unit increase in intersection density, annual counts would be expected to change by a factor of 1.0006 (increase by 0.06%)
- Access Area – for a one-unit increase in square mileage of access area, annual counts would be expected to change by 1.12 (increase by 12%)

- College enrollment – for a one-student increase in college enrollment, annual counts would be expected to just barely change (increase by 0.002%)
- Network mileage – for a one-mile increase in network mileage, annual counts would be expected to change by 1.0062 (increase by 0.62%)
- Constant – This represents the value when all other variables in the model are evaluated at zero. In this case, the expected annual volume when all other variables are zero would be 16,488.

When the equation was applied to the data, the model predicted an annual volume of 57,945.

Peak Weekday

This model estimates the peak weekday volume of the trail. This model indicates that ability to easily access the trail, college enrollment, and connections to other paved trails influence the peak weekday volume. The peak weekday model had an R-squared value of 0.9103, suggesting that the significant variables predict approximately 91% of the variation in peak weekday trail counts from the eight data locations. The model produced the following equation, which can be applied to the ELST fictional point to predict its peak weekday volume:

= exp(3.559199 + 0.0009682*intersection density + 0.1436083*access area + 0.4158266*paved, off-street trail connections+ 0.0000247*college enrollment)

The peak weekday model produced the following IRRs:

- Intersection density – for a one-unit increase in intersection density, peak weekday counts would be expected to change by a factor of 1.0010 (increase by 0.1%)
- Access Area – for a one-unit increase in square mileage of access area, peak weekday volumes would be expected to change by 1.15 (increase by 15%)
- College enrollment – for a one-student increase in college enrollment, peak weekday volumes would be expected to just barely change (increase by 0.002%)
- Network connections – for each additional connection beyond the catchment area to a paved, off-street trail, peak weekday volumes could be expected to change by 1.52 (increase by 52%)
- Constant – This represents the value when all other variables in the model are evaluated at zero. In this case, the expected peak weekday volumes when all other variables are zero would be 35.

When the equation was applied to the data, the model predicted a peak weekday volume of 269.

Peak Weekend

This model estimates the peak weekend volume of the trail. The model indicates that population density, miles of trail, and connections to other paved trails significantly influence the peak weekend volume. The peak weekend model had an R-squared value of 0.6767, suggesting that the significant variables predict approximately 68% of the variation in peak weekend trail counts from the eight data locations. The model produced the following equation, which can be applied to the ELST fictional point to predict its peak weekend volume:

= exp(5.397286 + 0.0000332*population density + 0.0250577* total mileage of King County Regional Trails in the catchment area + 1.014041* paved, off-street trail connections)

The peak weekend model produced the following IRRs:

- Population density – for a one-unit increase in population density, peak weekend counts would be expected to change by a factor of 1.0010 (increase by 0.1%)
- Miles of regional trail—for each additional mile of trail in the catchment area, peak weekend volumes could be expected to change by 1.025 (2.5%)
- Network connections – for each additional connection beyond the catchment area to a paved, off-street trail, peak weekend volumes could be expected to change by 2.75 (increase by 175%)
- Constant – This represents the value when all other variables in the model are evaluated at zero. In this case, the expected peak weekend volumes when all other variables are zero would be 221.

When the equation was applied to the data, the model predicted a peak weekend volume of 2,236.

Peak Hour

This model estimates the peak hour volume of the trail. This model indicates that total mileage of King County Regional Trails in the catchment area, college enrollment and trail connections influence the peak hour volume. The peak hour model had an R-squared value of 0.7505, suggesting that the significant variables predict approximately 75% of the variation in peak hour trail counts from the eight data locations. The model produced the following equation, which can be applied to the ELST fictional point to predict its peak hour volume:

= exp(3.801138 + 0.037278* total mileage of King County Regional Trails in the catchment area + 0.0000225*college enrollment +0.6865772* paved, off-street trail connections)

The peak hour model produces the following IRRs:

- Miles of regional trail—for each additional mile of trail in the catchment area, peak hour volumes could be expected to change by 1.038 (3.8%)
- Network connections – for each additional connection beyond the catchment area to a paved, off-street trail, peak hour volumes could be expected to change by 1.99 (increase by 99%)
- College enrollment – for a one-student increase in college enrollment, peak hour volumes would be expected to just barely change (increase by 0.002%)
- Constant – This represents the value when all other variables in the model are evaluated at zero. In this case, the expected peak hour volumes when all other variables are zero would be 45.

When the equation was applied to the data, the model predicted a peak hour volume of 233.

Average Weekday

This model estimates the average weekday volume of the trail. This model indicates that college enrollment, intersection density, and access area influence the average weekday volume. The average weekday model had an R-squared value of 0.7946, suggesting that the significant variables predict approximately 79% of the variation in average weekday trail counts from the eight data locations. The model produced the following equation, which can be applied to the ELST fictional point to predict its average weekday volume:

= exp(3.745707 + 0.0000255*college enrollment + 0.000946*intersection density + 0.1115804*access area)

The average weekday model produces the following IRRs:

- College enrollment – for a one-student increase in college enrollment, average weekday volumes would be expected to just barely change (increase by 0.002%)
- Intersection density – for a one-unit increase in intersection density, average weekday counts would be expected to change by a factor of 1.00095 (increase by 0.1%)
- Access Area – for a one-unit increase in square mileage of access area, average weekday volumes would be expected to change by 1.12 (increase by 12%)
- Constant – This represents the value when all other variables in the model are evaluated at zero. In this case, the expected average weekday volumes when all other variables are zero would be 42.

When the equation was applied to the data, the model predicted an average weekday volume of 113.

Average Weekend Day

This model estimates the average weekend day volume of the trail. The only variable that was found to be statistically significant for the average weekend day volume model was college enrollment. Relatedly, this model had an R-squared value of 0.3705, suggesting that the significant variable only predicts approximately 37% of the variation in average weekend day trail counts from the eight data locations. This model suggests that there is a similar base average weekend day volume for the entire trail system, and high college enrollment increases the base. This model produced the following equation, which can be applied to the ELST fictional point to predict its peak weekday volume:

= exp(6.293539 + 0.000022*college enrollment)

The average weekend day model produces the following IRRs:

- College enrollment – for a one-student increase in college enrollment, average weekend day volumes would be expected to just barely change (increase by 0.002%).
- Constant – This represents the value when all other variables in the model are evaluated at zero. In this case, the expected average weekend day volumes when all other variables are zero would be 541.

When the equation was applied to the data, the model predicted an average weekend day volume of 541.

East Lake Sammamish Volumes

Applying these equations to the factors to the East Lake Sammamish Trail, the resulting volumes are:

Table 1: Estimated trail volumes on the East Lake Sammamish Trail

Annual	Peak Hour	Average Weekday	Average Weekend Day	Peak Weekday	Peak Weekend Day
57945	233	113	541	269	2236

Figure 3 and Figure 4 on pages 13 and 14 show the estimated average weekday and weekend day volumes in comparison to other regional trails.

Future Bicycle Use Estimate

Using the estimates calculated in the direct demand model, we can assume that trail ridership will increase along with population increase in the area. Population forecasts for the area are readily available from the Puget Sound Regional Council. Using data from the Regional Macroeconomic forecast and using 2015 as a base year for comparison, we can calculate the percentage of growth for 5, 10, and 20 years in the future.

Table 2: Expected population change in 5, 10, and 20 years

Year	Expected Percent Population Change (from 2015)
2020	6%
2025	10%
2035	19%

Assuming a linear relationship between expected population growth and trail ridership, the estimated future trail bicyclist volumes are shown in Table 3.

Table 3: Estimated future trail bicycle volumes with static bicycling rates

Year	Annual	Peak Hour	Average Weekday	Average Weekend Day	Peak Weekday	Peak Weekend Day
2015	57945	233	113	541	269	2,236
2020	61422	247	120	573	285	2,370
2025	63740	256	124	595	296	2,460
2035	68955	277	134	644	320	2,661

These volumes assume that the rate of bicycling in the region will remain the same. It is very likely that actual numbers will be much higher, due to the network effect of a completed trail network, as well as increased bicycling rates as Issaquah and Redmond grow denser and encourage land use mixes in their urban growth centers. According to the online Census Explorer, King County's bicycling commute rate has grown from 0.9% in 2000 to 1.5% in 2013, a growth of approximately 0.04% per year. If this growth continues at a linear rate, in addition to the population growth, the future volumes of bicyclists estimated on the East Lake Sammamish Trail are:

Table 4: Estimated future trail bicycle volumes with increasing bicycling rates

Year	Annual	Peak Hour	Average Weekday	Average Weekend Day	Peak Weekday	Peak Weekend Day
2015*	57945	233	113	541	269	2,236
2020	70871	285	138	662	329	2,735
2025	93158	375	182	870	432	3,595
2035	143213	576	279	1337	665	5,526

*A bicycling rate of 1.5% was assumed for 2015.

Again, these numbers may be underestimated because the Census and American Community Survey only ask about commuting habits, and do not take into account any growth in recreational or non-commute bicycling.

Future Bicycle and Pedestrian Use Estimate

The model above only considers bicycle volumes. To estimate trail use including pedestrians, a mode split factor was applied. The mode-split factor was determined by calculating how many users of the trail system, on average, are bicyclists. All trail counts from step 1 which included both pedestrian and bicyclists counts were assessed to identify an average mode split for trails in this region. The average trail mix consisted of 64% bicyclists with 36% pedestrians, thus the mode split factor of 0.64. Applying this factor to Table 3 calculates expected total trail usage with static bicycling rates.

Table 5: Estimated future trail volumes (bicycle and pedestrian) with static bicycling rates

Year	Annual	Peak Hour	Average Weekday	Average Weekend Day	Peak Weekday	Peak Weekend Day
2015	90539	364	177	845	420	3,494
2020	95972	386	188	895	445	3,703
2025	99594	400	194	930	463	3,844
2035	107742	433	209	1,006	500	4,158

If we assume that the level of pedestrian activity will grow in conjunction with increased bicycling activity, we can apply the mode split factor to Table 4 and calculate expected total trail usage with increasing bicycle and pedestrian activity.

Table 6: Estimated future trail volumes (bicycle and pedestrian) with increasing bicycling rates

Year	Annual	Peak Hour	Average Weekday	Average Weekend Day	Peak Weekday	Peak Weekend Day
2015*	90539	364	177	845	420	3,494
2020	110736	445	216	1,034	514	4,273
2025	145559	586	284	1,359	675	5,617
2035	223770	900	436	2,089	1,039	8,634

*A bicycling rate of 1.5% was assumed for 2015.

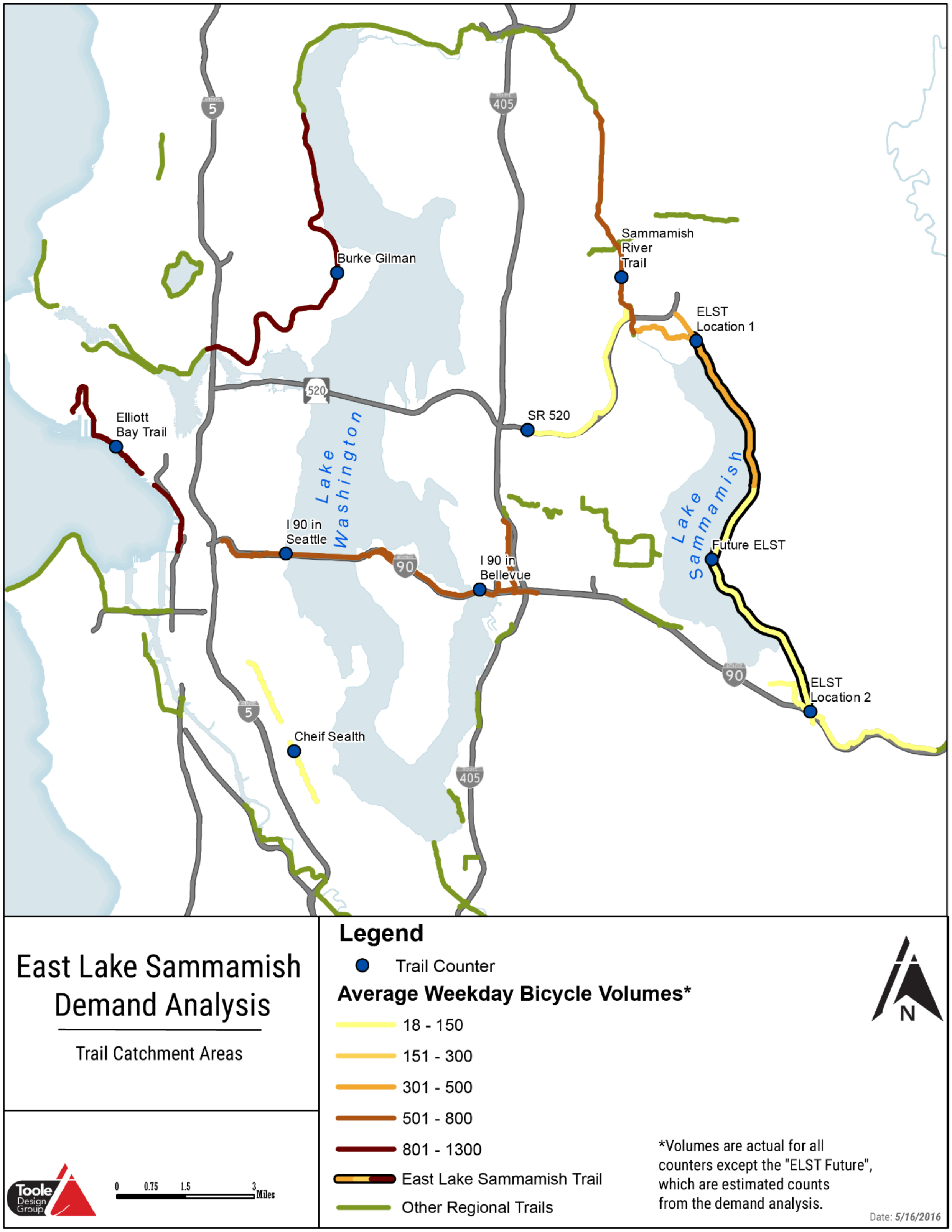


Figure 3: Estimated Average Weekday Bicycle Volumes

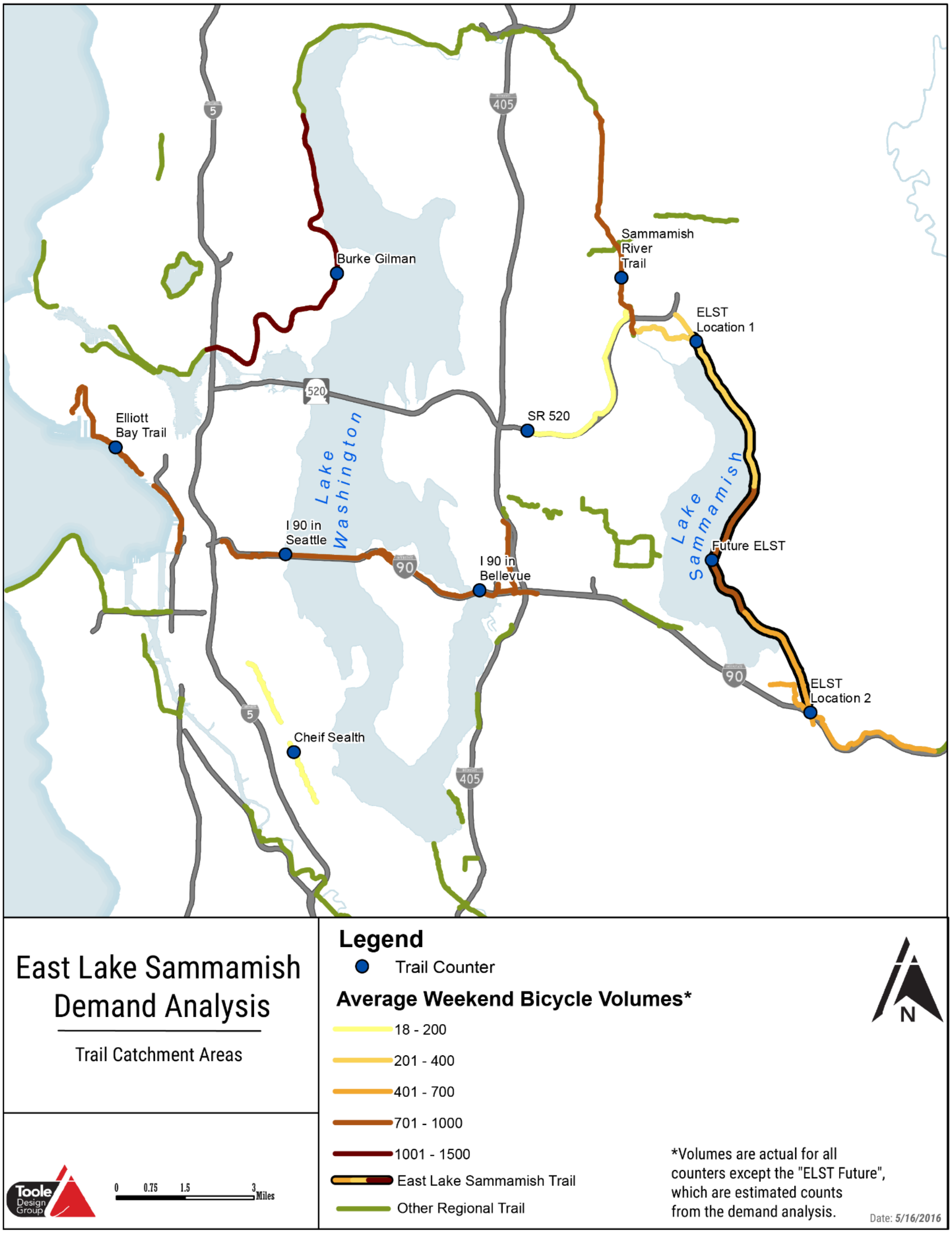


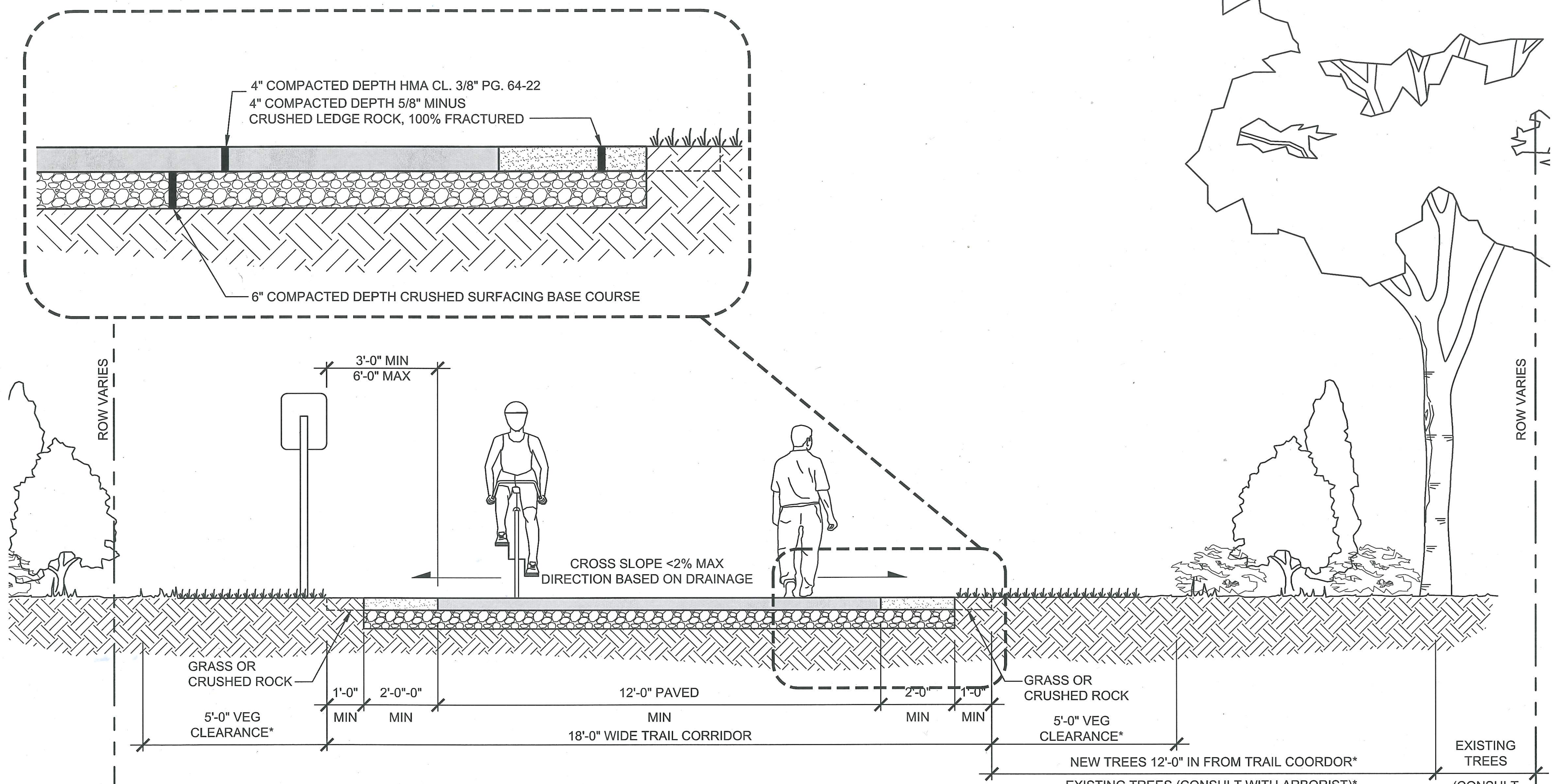
Figure 4: Estimated Average Weekend Bicycle Volumes

Conclusion

The East Lake Sammamish trail will become a critical transportation facility for residents and employees in East King County. As part of the King County Regional trail system, the trail will provide a safe, pleasant non-motorized transportation and recreation option for the entire region. The estimates of volumes of bicyclists that will use this trail are similar to other regional trails, with peak volumes near those of the I-90 trail and the Elliott Bay trail. **Peak hourly volumes should be anticipated to be above 300 users per hour when the trail is complete and grow towards 900 users per hour in the future. As part of the regional trail network, the trail should be designed to anticipate growing use and be able to handle projected future demands while providing a safe operating environment for all users.**

Similar to other transportation projects, it is recommended the 20 year demand projections be considered when planning for the design of a trail facility. Given the anticipated opening day and 20 year volumes, a minimum trail width of at least 12 feet is needed to meet both AASHTO and WSDOT guidelines, as well as King County guidelines for regional trails.[4] Anything less than 12 feet will compromise safety and the ability to meet projected demand and will likely lead to conflicts between pedestrians and bicyclists during peak periods of travel.

[4] King County trail guidelines recommend a trail width of at least 12 feet where volumes are anticipated to be greater than 2,000 users a day on peak days (as in the context of estimated user volumes on the ELST).



NOTE:
*CLEARANCE VARIES AT CROSSINGS BASED ON REQUIRED ENTERING SIGHT DISTANCE (CONSULT WITH PARKS ENGINEER).

1 **REGIONAL TRAIL**
TYPICAL CROSS SECTION

NOT TO SCALE

REGIONAL TRAIL STANDARD

DWG # RTS-1

King County
Department of Natural Resources & Parks
Parks & Recreation Division

APPROVED FOR PUBLICATION
3/20/17
KEVIN BROWN, DIRECTOR DATE

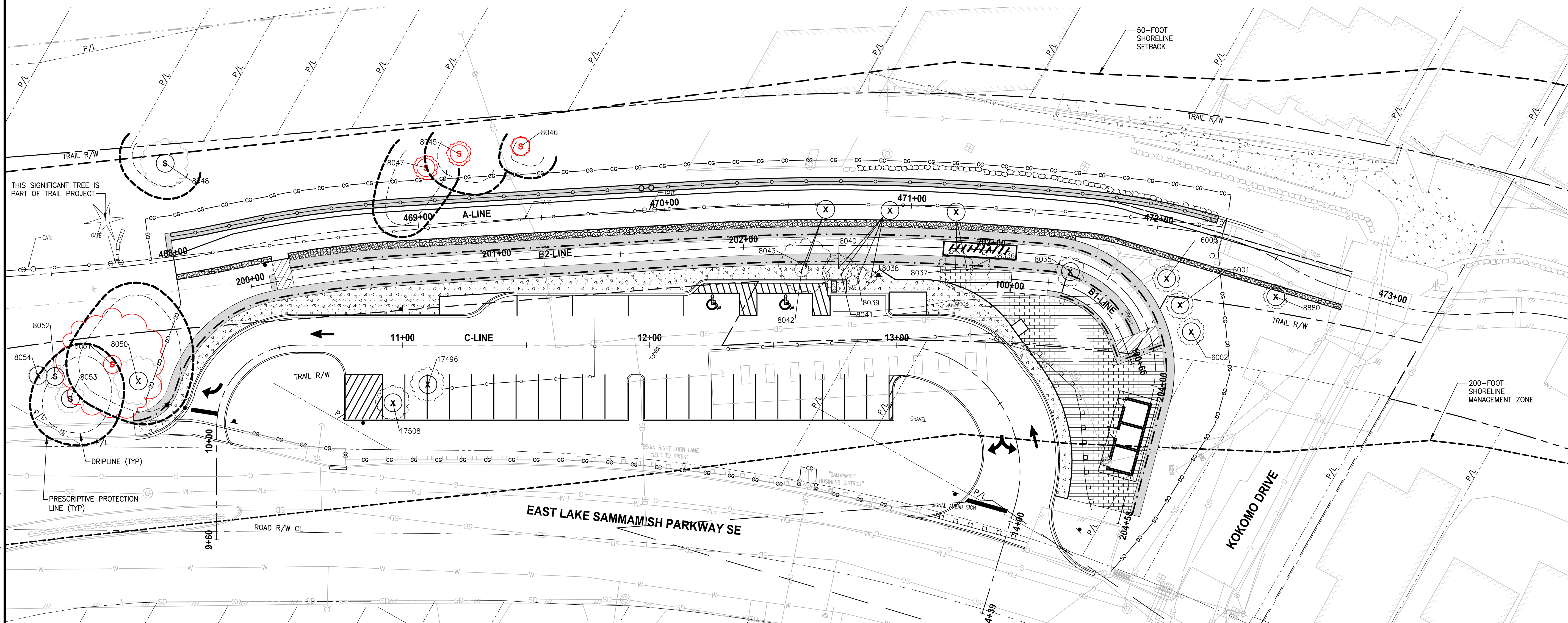
ENG/ARCH APPROVAL:	DATE	3/20/17	DATE ISSUED	2017-03-14	SHEET #
OPERATIONS APPROVAL:	DATE		DATE REVISED	2017-03-14	1 OF 1
NOTE: THIS PLAN IS NOT A LEGAL ENGINEERING DOCUMENT			VERSION	2017-1	

FILE: 2017-03-20 RTS1 LAYOUT: RTS1 PATH: X:\CIP Projects\Regional Trail Standards\CAD Standards\2017-03-01 Received PLOTTED BY: bradfordb DATE: Monday, March 20, 2017 9:32:14 AM

REVISIONS OR ADDITIONS MAY OCCUR TO STANDARD DETAILS AT ANY POINT IN TIME. VERIFICATION OF COMPLIANCE WITH CURRENT REGULATIONS AND CODES IS SOLELY THE RESPONSIBILITY OF THE DESIGNER OR ENGINEER.

KC EXH 5 - 078

SEC'S 8, 17 TWP. 24 N., RGE. 06 E, W.M.



PLAN

SCALE IN FEET

0 20 40

TREE REMOVAL AND PRESERVATION NOTES:

S RETAIN

X REMOVE (PER ARBORIST)

S ADDITIONAL REMOVED TREES PER PRESCRIPTIVE REQUIREMENT

LEGEND:

—CG—CG— CLEARING AND GRUBBING

— — — PRESCRIPTIVE TREE PROTECTION LINE (PER SMC 21A.37.270)

8000 8000 8"ø AND LARGER TREE EVALUATED BY ARBORIST

GENERAL NOTE:

1. ONLY 8"ø AND LARGER TREES ARE SHOWN ON THESE PLANS. TREES ARE DEPICTED AS A SYMBOL NOT THE ACTUAL TREE SIZE.

TREE TABLE

TREE #	SPECIES	DBH (INCHES)	DEFECTS	COMMENTS	PRUNE	RECOMMENDATION
6000	bitter cherry	8, 9 (12)		topped in recent past	N	REMOVE
6001	bitter cherry	10, 8 (13)		topped in recent past	N	REMOVE
6002	bitter cherry	11, 9 (14)		topped in recent past	N	REMOVE
8035	bitter cherry	16	ivy covering trunk	topped in recent past	N	REMOVE
8036	pacific madrone	26	leans w, decay, 40% dieback	topped in recent past	N	REMOVE
8037	pacific madrone	11, 16 (19)	leans w, decay, 20% dieback	topped in recent past	N	REMOVE
8038	pacific madrone	13	cankers, 80% dieback	leans n, topped in recent past	N	REMOVE
8039	pacific madrone	19	decay, 30% dieback	leans w, topped in recent past	N	REMOVE
8040	pacific madrone	18	leans w, decay	leans w, topped in recent past	N	REMOVE
8041	pacific madrone	24	20% dieback	topped in recent past	N	REMOVE
8042	pacific madrone	13	10% dieback	topped in recent past	N	REMOVE
8043	pacific madrone	18	20% dieback	topped in recent past	N	REMOVE
8045	big leaf maple	15, 7, 14, 14 (26)		forks at 1', trunk decay	N	SAVE
8046	big leaf maple	10, 8, 8 (15)		poor trunk taper	N	SAVE
8047	big leaf maple	11, 15, 21 (28)	decay, some dieback	decay, some top dieback/decline	N	SAVE
8048	black cottonwood	29		forks at 5'	N	SAVE
8050	pacific madrone	33, 22	one dead trunk, 30lcr, cankers	major decline-diseased, 80% dead	N	REMOVE
8051	big leaf maple	30, 42, 35		significant deadwood in crown	Y	SAVE
8052	pacific madrone	20, 11 (23)	dead codominant stem, 30lcr	dead codom stem, decline	Y	SAVE
8053	big leaf maple	21		typical form, moderate deadwood	Y	SAVE
8054	pacific madrone	17	20% crown, leans w over trail	high-risk tree in bad condition, leans west over trail	N	REMOVE
8880	oregon ash	17		no conerning defects	N	REMOVE
17496	pacific madrone	20		diseased, heavy lean north	N	REMOVE
17508	pacific madrone	38	rotten at bottom of stump	99% dead	N	REMOVE

NOTE: IMPLEMENTATION OF PRESCRIPTIVE TREE PROTECTION (RECOMMENDED CONDITION OF APPROVAL #6) RESULTS IN LOSS OF 4 ADDITIONAL TREES

TOTAL TREE	SAVE	REMOVE*	MONITOR
24	8	17	0

* TOTAL TREES PROPOSED TO BE REMOVED USING ARBORIST PROTECTION RECOMMENDATIONS.

NOTE:

1. ASSESSMENT OF TREE RETENTION ON THIS PLAN IS BASED ON EXISTING CONDITIONS IN JULY, 2017.

CITY OF SAMMAMISH APPROVAL	
City Engineer	Date
Community Development	Date

REVISED 60 % REVIEW SUBMITTAL

NOT FOR CONSTRUCTION

	REVISIONS	DATE	BY
1	PRESCRIPTIVE TREE PROTECTION	10/12/17	DAP

DESIGNED J. JUN
DRAWN B. PURGANAN
CHECKED P. JOHANNESSEN
APPROVED Y. HO

ONE INCH AT FULL SCALE. IF NOT, SCALE ACCORDINGLY
FILE NAME BL1521075P21T03TP-01
JOB No. 554-1521-075 P21T03
DATE JULY 2017

PHOEBE L. JOHANNESSEN STATE OF WASHINGTON 37382 REGISTERED PROFESSIONAL ENGINEER

PRELIMINARY

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ENGINEERING . PLANNING . ENVIRONMENTAL SCIENCES
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P 206.394.3700
WWW.PARAMETRIX.COM

PROJECT NAME
EAST LAKE SAMMAMISH MASTER PLAN TRAIL
INGLEWOOD HILL ROAD PARKING LOT
SAMMAMISH, WA

TREE PRESERVATION PLAN EXHIBIT
FILE NUMBER SSDP2016-00414

SHEET NO. 1 OF 1

TP1

PATH: U:\PSO\Projects\Clients\1521-KingCo\554-1521-075-ELST\99Svcs\CADD\Phase 21\T03\Dwg\ PLOTTED BY: mccabryo DATE: Monday, October 16, 2017 8:47:46 AM

LAYOUT: TP1