ENVIRONMENTAL CHECKLIST

for the proposed

Electrical Engineering and Computer Science Project – Displaced Parking

prepared for

Western Washington University Facilities Development & Capital Budget Department

December 2021

EA Engineering, Science, and Technology, Inc., PBC
Perkins&Will
Associated Earth Sciences
Tree Solutions
PREFACE

The purpose of this Environmental Checklist is to identify and evaluate probable environmental impacts that could result from the Electrical Engineering and Computer Science (EECS) Project – Displaced Parking and to identify measures to mitigate those impacts. The EECS Project – Displaced Parking would include the development of a 43-space surface parking lot on the site.

The State Environmental Policy Act (SEPA)\(^1\) requires that all governmental agencies consider the environmental impacts of a proposal before the proposal is decided upon. This Environmental Checklist has been prepared in compliance with the State Environmental Policy Act; the SEPA Rules, effective April 4, 1984, as amended (Chapter 197-11, Washington Administrative Code), which implements SEPA.

This document is intended to serve as SEPA review for site preparation work, construction, and operation of the EECS Project – Displaced Parking. Analysis associated with the proposed project contained in this Environmental Checklist is based on conceptual plans for the project. While not construction-level detail, the conceptual plans accurately represent the eventual size, location and configuration of the proposed project and is considered adequate for analysis and disclosure of environmental impacts.

This Environmental Checklist is organized into three major sections. Section A of the Checklist (beginning on page 1) provides background information concerning the Proposed Action (e.g., purpose, proponent/contact person, project description, project location, etc.). Section B (beginning on page 2) contains the analysis of environmental impacts that could result from implementation of the proposed project, based on review of major environmental parameters. This section also identifies proposed mitigation measures. Section C (page 15) contains the signature of the proponent, confirming the completeness of this Environmental Checklist.

Project-relevant analyses that served as a basis for this Environmental Checklist include: Geotechnical Report (AESI, 2021); Greenhouse Gas Emissions Worksheet (EA, 2021); and, Arborist Report (Tree Solutions, 2021).

\(^{1}\) Chapter 43.21C. RCW
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ENVIRONMENTAL CHECKLIST

A. BACKGROUND

1. Name of proposed project, if applicable: Electrical Engineering and Computer Science (EECS) Project – Displaced Parking

2. Name, address, and phone number of Owner / Decision maker:
   Rick Benner, Director
   Facilities Development & Capital Budget, MS 9122
   Western Washington University
   Bellingham, WA 98225
   (360) 650-3550

3. Name, address, and phone number of contact person:
   Mark Nicasio, Project Manager/Architect
   Facilities Development & Capital Budget, MS 9122
   Western Washington University
   Bellingham, WA 98225
   (360) 650-6296

4. Date checklist prepared: December 21, 2021

5. Department requesting checklist: WWU Facilities Development

6. Proposed timing or schedule (including phasing, if applicable): Construction is anticipated to start in June 2023 and be completed in Sept. 2023.

7. Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain: Yes. The proposed Displaced Parking, the subject of this Environmental Checklist, would replace permit parking in WWU Lot 17 G that would be displaced by the proposed EECS building.

8. List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal: The follow environmental analyses were prepared in support of this Environmental Checklist:
   - Geotechnical Report (AESI, 2021), see Appendix A;
   - Greenhouse Gas Emissions Worksheet (EA, 2021), see Appendix B; and,
   - Arborists Report (Tree Solutions, 2021), see Appendix C.

9. Do you know whether applications are pending for governmental approvals of other proposals directly affecting the property covered by your proposal? If yes, explain: There are no known applications that are pending for governmental approvals that will affect the subject property.

10. List any government approvals or permits that will be needed for your proposal, if known: The following permits will be required for the proposed parking:
City of Bellingham

- Clearing Permit;
- Grading Permit;
- Electrical Permit; and
- Temporary and Permanent Stormwater Management Plan Approvals.

11. Give a brief and complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page: The approximately 19,000-sq. ft. EECS Displaced Parking site is located in the WWU neighborhood in Bellingham, Washington (see Figure 1, Vicinity Map). The site is situated in the core of the WWU campus. Wade King Service Road is located to the east and south, the Wade King Recreation Center track is further to the east (beyond the service road); the Wade King Student Recreation Center is to the south (beyond the service road); and wooded open space areas are to the west and north (see Figure 2, Aerial Map). The site is currently occupied by lawn.

The proposed EECS Displaced Parking project is a paved surface parking lot that would provide 43 angled parking stalls, accessed by a one-way, southwest-bound driveway (see Figure 3, Site Plan). The parking spaces would replace 43 parking spaces in Lot 17 G that would be displaced by the proposed EECS building.

B. ENVIRONMENTAL ELEMENTS

C. EARTH

The following responses are based on the Geotechnical Report prepared by AESI in June 2021 (see Appendix A).

1. General description of the site (Choose one):
   a. ☒ Flat
   b. ☐ Rolling
   c. ☐ Hilly
   d. ☐ Steep Slopes
   e. ☐ Mountainous
   f. ☐ Other: ____________________________

2. What is the steepest slope on the site (approximate percent slope): The steepest slope onsite is approximately 7%.

3. What general types of soils are found on the site (for example – clay, sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any prime farmland: Three excavation borings were conducted on the EECS Displaced Parking site. Based on the borings, soils on the site are typically fill; moist to very moist grayish brown, sandy, silt; and weathered Chuckanut Formation bedrock. The depth to bedrock varies from 11-25 feet below grade. None of the soils are considered agricultural soils and no prime farmland is present.
Note: This figure is not to scale

Source: Bing Maps and EA Engineering, 2021

Figure 1
Vicinity Map
4. Are there surface indications or a history of unstable soils in the immediate vicinity? If so describe: There are no visible surface indications or history of unstable soils onsite or in the site vicinity. The City of Bellingham Environmental Critical Areas (ECA) maps show no existing ECAs (e.g., geotechnical hazards) on the project site. However, all western Washington is at risk of a strong seismic event.

5. Describe the purpose, type, and approximate quantities of any filling or grading proposed. Indicate source of fill: Excavation would be required for the proposed asphalt pavement and associated stormwater detention system for the parking lot. Approximately 1,130 cubic yards of excavation is estimated.

6. Could erosion occur as a result of clearing, construction, or use? If so, generally describe: Construction of the EECS Displaced Parking would result in the temporary exposure of soils on the site, and erosion is possible in conjunction with any construction activity. Minimal erosion is anticipated to occur for this project because the site is generally flat and appropriate Temporary Erosion and Sedimentation Control (TESC) measures and Best Management Practices (BMPs) would be implemented, in accordance with City of Bellingham standards.

7. About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)? Following construction, approximately 95% of the site would be covered in impervious surfaces (asphalt pavement).

8. Proposed measures to reduce or control erosion, or other impacts to the earth, if any: The following measures are proposed to reduce or control erosion, or other earth-related impacts:

   - Erosion and sedimentation control would be implemented, in accordance with City of Bellingham standards, including:
     - Limit earthwork to seasonally drier periods, if possible;
     - Use perimeter silt fences, stabilized entrances, and straw bales in exposed areas;
     - Limit vegetation removal to those areas required to construct the project;
     - Establish new landscaping as soon a practical after grading is complete;
     - Collect surface water as close to the source as possible; and
     - Implement permanent drainage control as soon as possible.

   - Areas of proposed paving should be assessed and some level of remedial preparation of existing fill could be warranted.

   - The geotechnical consultant could perform geotechnical review of plans prior to final design.

   - The geotechnical consultant could be retained to provide geotechnical special inspections during construction.
D. AIR

1. What types of emission to the air would result from the proposal (i.e. dust, automobile, odors, and industrial wood smoke) during construction and when the project is completed? If any, generally describe and give approximate quantities if known: During dry months of construction: dust could be generated by excavation and sitework activities. Other construction emissions would be created by heavy equipment exhaust during grading activities, as well as from any potential lifts and forklifts used onsite. Following construction, automobile traffic would not increase as this parking lot would provide replacement parking for parking displaced from Lot 17G for proposed construction of the EECS building. Therefore, traffic emissions would remain unchanged.

The scale of global climate change is so large that a project’s Greenhouse Gas (GHG) impacts can only be evaluated on a cumulative scale, and it is not anticipated that a single development project would cause an individually discernible impact on global climate change. To evaluate the climate change impacts of the EECS Displaced Parking project, a GHG Emissions Worksheet has been prepared to estimate the emissions footprint for the lifecycle of the proposed project on a gross-level basis (see Appendix B). For this project, the emissions estimate is based on:

- **Embodied Emissions** – extraction, processing, transportation, construction, and disposal of materials, and landscape disturbance.

The Worksheet estimate is based on the size of the proposed paved area (approximately 18,050 sq. ft.). It is estimated that lifespan emissions from the proposed project would be approximately 903 MTCO₂e¹. Note that this calculation is usually used for pavement associated with roadways. Because the EECS Displaced Parking pavement would not have as heavy of use as a roadway, it would likely use less material, and have a longer lifespan, and the actual embodied emissions would likely be lower.

2. Are there any off-site sources of emissions or odor that may affect your proposal? If so, generally describe: Vehicle traffic in the vicinity of the site is the primary existing source of emissions and odors, including traffic on the Wade King Service Road. Off-site emissions and odors are not anticipated to affect the proposed project.

3. Proposed measures to reduce or control emissions or other impacts to air, if any: Although no significant construction or operational air quality impacts are anticipated with the proposed project, the following measures are proposed to help reduce or control emissions:

- **Construction contractors would be required to comply with all applicable federal, state, and local air quality regulations, and would be required to prepare a plan to minimize dust and odors during construction. Examples of measures that would be implemented include:** Construction work areas would be covered in crushed rock and the site would be watered from a hydrant or water truck to minimize or eliminate dust.

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¹ MTCO₂e is defined as Metric Ton Carbon Dioxide Equivalent; it equates to 2,204.62 pounds of CO₂. This is a standard measure of the amount of CO₂ emission reduced or sequestered. Carbon is not the same as CO₂. Sequestering 3.67 tons of CO₂ is equivalent to sequestering of one ton of carbon.
• Depending on the sensitivity of the adjacent buildings, and any nearby fresh air intakes, the exhaust odors (e.g., from heavy equipment, lifts, and forklifts) could be addressed with scrubbers on the equipment.

E. **WATER – SURFACE**

1. Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into: No surface water body exists onsite or in the vicinity of the site.

2. Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? If yes, please describe and attached available plans: No, as no surface water body exists onsite or in the vicinity of the site.

3. Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material: No fill/dredge material would be placed in/removed from surface waters, as no surface water body or wetlands exist onsite or in the vicinity of the site.

4. Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known: No surface water withdrawals or diversions would occur, as no surface water body exists onsite or in the vicinity of the site.

5. Does the proposal lie within a 100-year floodplain? If so, note the location on the site plan: No, the site is not located in a 100-year floodplain.

6. Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge: No discharge of waste materials to surface waters would occur, as no surface water body exists onsite or in the vicinity of the site.

F. **WATER – GROUND**

1. Will ground water be withdrawn, or will water be discharged to ground water? Give general description, purpose, and approximate quantities if known: No ground water would be withdrawn or water discharged to ground water. Per the Geotechnical Report, the static groundwater elevation is anticipated to be below the bottom of the excavation for the parking lot and associated stormwater detention (see Appendix A).

2. Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example: domestic sewage; industrial - containing chemicals; agricultural; etc.). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve: No waste materials would be discharged into the ground from septic tanks or other sources.
G. **WATER – RUNOFF** *(Including storm water)*

1. Describe the source of runoff (including storm water) and method of collection and flow disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other water? If so, describe: Under the proposal, a permanent stormwater management system would be installed that would comply with City of Bellingham requirements. Stormwater from the parking lot would be collected in a series of catch basins and routed via gravity flow to a below grade stormwater detention vault and stormwater quality treatment facilities, prior to discharging to the existing 12-inch dedicated stormwater drainage line in the Wade King Service Road. Stormwater from this portion of the WWU campus eventually discharges to Bellingham Bay.

2. Could waste materials enter ground or surface waters? If so, generally describe: Waste materials are not expected to enter ground or surface waters because stormwater quality treatment measures would be installed as part of the stormwater management system per City of Bellingham standards.

3. Proposed measures to reduce or control surface, ground, and runoff water impacts, if any: The proposed project would comply with applicable City requirements relating to surface water runoff control and water quality. TESC and BMPs would be implemented during construction and the site would be stabilized following construction to minimize erosion and sedimentation. A permanent stormwater management system would also be installed. Therefore, no significant impacts on surface or groundwater are expected.

H. **PLANTS**

The following responses are based, in part, on the Arborist Report prepared by Tree Solutions in July 2021 *(see Appendix C).*

1. Check types of vegetation found on the site:
   a. ☒ Grass
   b. ☒ Shrubs
   c. ☐ Pasture
   d. ☐ Crop or Grain
   e. ☒ Deciduous Tree: red alder, bigleaf maple, Oregon ash, bitter cherry
   f. ☒ Evergreen Tree: Douglas Fir, western redcedar, giant sequoia
   g. ☐ Wet Soil Plants: Cattail, Buttercup, Bullrush, Skunk Cabbage, or Other
   h. ☐ Water Plants: Water Lily, Eelgrass, Milfoil, or Other
   i. ☒ Other Types of Vegetation: Himalayan Blackberry

2. What kind and amount of vegetation will be removed or altered? All the grasses and shrubs (including Himalayan blackberry) onsite would be removed for construction of the **EECS Displaced Parking**.

   An arborist assessed all the trees greater than 6 inches in diameter at standard height (DSH) that could be impacted by development of the proposed parking lot. A total of 40 trees were identified that meet this criterion. Of these, it is expected that 5 trees would be removed: 1 red alder, 1 Douglas fir, and 3 western redcedar *(see Appendix C for details).*

3. List threatened or endangered species known to be on or near the site: No known threatened or endangered plant species are located on or near the site.
4. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any: Proposed landscaping would include:

- Trees planted to replace the trees that would be removed with construction of the parking lot are intended to be native evergreen trees at a 1:1 replacement ratio. These 5 replacements trees would be sited as close as feasible to the locations of the removed trees, on the slope along in the western portion of the site. Additional trees could be provided if space is available. Enhancement plantings of shrubs or groundcover would be provided for areas disturbed by construction and along the stormwater discharge swale in the western portion of the site.

I. ANIMALS

1. Check any birds and animals which have been observed on or near the site or are known to be on or near the site:

   a. Birds: ☐ Hawk ☐ Heron ☐ Eagle ☒ Songbirds

   b. Mammals: ☒ Deer ☐ Bear ☐ Elk ☐ Beaver

   c. Fish: ☐ Bass ☐ Trout ☐ Salmon ☐ Herring ☐ Shellfish

   d. Other:

   Birds: A variety of native birds are present or migrate across campus. Mammals: squirrels, rats, and racoons inhabit the campus; deer wander through campus; other animals come down to the WWU campus from the nearby Sehome Hill Arboretum and neighborhoods on occasion. Fish: No surface waters and associated fish are present onsite or near the site.

2. List any threatened or endangered species known to be on or near the site: No threatened or endangered animal species are known to be on or near the site.

3. Is the site part of a migration route? If so, explain: Yes. The entire Puget Sound area is within the Pacific Flyway, a major north-south flyway for migratory birds in America, extending from Alaska to Patagonia. Every year, migratory birds travel some or all this distance -- in spring and in fall -- following food sources, heading to breeding grounds, or travelling to overwintering sites.

4. Proposed measure to preserve or enhance wildlife, if any: Proposed measures to preserve or enhance wildlife include:

   - The replacement trees planted in the western portion of the site are intended to be native species that are anticipated to provide wildlife habitat, particularly since the trees that would be removed are in poor health.

   - The proposal would comply with applicable City requirements related to surface water management, which would protect aquatic species downstream of the site in Bellingham Bay.

J. ENERGY AND NATURAL RESOURCES

1. What kinds of energy (electric, natural gas, oil, wood-stove, solar) will be used to meet the completed project’s energy needs? Describe whether it will be used for heating, manufacturing, etc.: No new use of energy would be required for the EECS Displaced Parking project. Lighting for the project would be provided by roadway lighting along the Wade King Service Road.
2. Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe: **No, the project would not affect the potential use of solar energy by adjacent properties.**

3. What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any: **None required.**

K. **ENVIRONMENTAL HEALTH**

1. Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill or hazardous waste, which could occur as a result of this proposal? If so, describe:
   a. Describe special emergency services that might be required: **No hazardous/toxic chemicals would be used, transported to, or stored in the proposed parking lot. No special emergency services are expected to be required for the proposal. It is possible that normal fire, medical, and/or other emergency services may, on occasion, be needed from the City of Bellingham during construction and operation of the project.**
   b. Proposed measures to reduce or control environmental health hazards, if any: **None required.**

2. Noise
   a. What types of noise exist in the area which may affect your project (for example, traffic, equipment, operation, other): **The predominant source of existing noise in the vicinity of the project site is from vehicular traffic on adjacent streets (e.g., the Wade King Service Road). Existing traffic noise is not anticipated to affect the proposed project.**
   b. What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site: **Construction noise would be created from the following activities: back-up alarms on trucks, forklifts, aerial lifts, and earthwork equipment; and general heavy equipment engine noise during earthwork and underground utility work. Automobile traffic would increase to the project site, but an overall increase of traffic to the campus is not anticipated because the proposed project represents displacement parking for a lot that would be eliminated by the proposed EECS building.**
   c. Proposed measures to reduce or control noise impacts, if any: **The project would comply with the City of Bellingham’s noise regulations, including hours of construction.**
L. LAND AND SHORELINE USE

1. What is the current use of the site and adjacent properties: The site is currently occupied by lawn (the site was recently converted back to lawn after being used as a temporary gravel parking lot during construction of the Interdisciplinary Science Building). All adjacent uses and buildings are part of WWU campus. To the east and south of the site is the Wade King Service Road, further east (beyond the service road) is the Wade King Recreation Center track; to the southwest (beyond the service road) is the Wade King Student Recreation Center Track; and to the west and north is wooded open space (see Figure 2, Vicinity Map).

2. Has the site been used for agriculture? If so, describe: No, the project site is located in an urban area and has not been used as a working farmland for over 100 years.

3. Describe any structures on the site: There are no existing structures onsite.

4. Will any structures be demolished? If so, describe: No structures would be demolished.

5. What is the current comprehensive plan designation of the site: The Comprehensive Plan designation of the EECS Displaced Parking site is WWU Neighborhood, Area 1, and its zoning classification is Institutional. The site is located in District 10 of the WWU Institutional Master Plan (IMP).

6. If applicable, what is the current shoreline master program designation of the site? The site is not located within a designated shoreline area.

7. Has any part of the site been classified as an “Environmentally Sensitive” area? If so, specify: According to the City of Bellingham Environmental Critical Areas (ECA) maps, there are no existing ECA’s on the project site.

8. Approximately how many people would reside / work in the completed project? No people would reside/work in the project.

9. Approximately how many people would the completed project displace? No people would be displaced by the project.

10. Proposed measures to avoid or reduce displacement impacts, if any: None required.

11. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any: The use of the site would be compatible with the Comprehensive Plan, zoning, and IMP.

M. HOUSING

1. Approximately how many units would be provided, if any? Indicate whether high, middle or low income housing: No housing units would be provided.

2. Approximately how many units, if any would be eliminated? Indicate whether high, middle or low income housing: No housing units would be eliminated.

3. Proposed measures to reduce or control housing impacts, if any: None required.
N. AESTHETICS

1. What is the tallest height of any proposed structure(s), not including antennas? What is the principle exterior building material(s) proposed: No buildings are proposed.

2. What views in the immediate vicinity would be altered or obstructed: No views would be altered or obstructed with the project.

3. Proposed measures to reduce or control aesthetics impacts, if any: Landscaping, including evergreen trees planted to replace trees that would be removed for the project, would be planted around the proposed parking lot.

O. LIGHT AND GLARE

1. What type of light or glare will the proposal produce? What time of day would it mainly occur: The parking lot surface and glass and painted exteriors of the cars parking in the lot would produce light and glare during daylight hours. Vehicles parking within the parking lot would produce light from dusk through dawn; the vehicles and paved parking surface itself would generate glare during daylight hours. The parking lot would use the existing roadway lighting along the Wade King Service Road for night time lighting, swapping out some of the metal halide heads with LED heads.

2. Could light or glare from the finished project be a safety hazard or interfere with views: No views would be affected by the light or glare generated by the project.

3. What existing off-site sources of light or glare may affect your proposal: No off-site sources of light or glare are anticipated to affect the proposed project.

4. Proposed measures to reduce or control light or glare impacts, if any: None required.

P. RECREATION

1. What designated and informal recreational opportunities are in the immediate vicinity: WWU Campus has many open green spaces and fields; a wooded area with a number of paths is located to the north, south, and west of the site and the Wade King Recreation Center Track to the east and the Wade King Recreation Center to the southeast of the site.

2. Would the proposed project displace any existing recreational uses? If so, describe: No, the proposed project would not displace any recreational uses.

3. Proposed measures to reduce or control impacts on recreation, including recreation opportunities to be provided by the project or applicant, if any: None required.

Q. HISTORIC AND CULTURAL PRESERVATION

1. Are there any places (or objects) listed on / proposed for, national, state or local preservation registers known to be on or next to the site? If so, generally describe: There are no places or objects proposed or listed on an historic register on or next to the site.

2. Generally describe any landmarks or evidence of historic, archeological, scientific, or cultural importance known to be on or next to the site: No historic or cultural landmarks or evidence are known on or next to the site.
3. Proposed measures to reduce or control impacts, if any: Significant impacts to historic or cultural resources are not expected. However, in the unlikely event that cultural resources are inadvertently discovered during construction, all work would be halted and WWU, Washington State Department of Archaeology and Historic Preservation (DAHP), the City of Bellingham, and potentially affected tribes would be notified.

R. TRANSPORTATION

1. Identify public streets and highways serving the site, and describe proposed access to the existing street system. Show on the site plans, if any: Access to the proposed project would be from the Wade King Service Road, between W College Way and 21st Street.

2. Is the site currently served by public transit? If not, what is the approximate distance to the nearest transit stop: No, the site is not served by public transit as it is located off of a service road. The closest transit stop is located within a 5-minute walk, on Bill McDonald Parkway.

3. How many parking spaces would the completed project have? How many would the project eliminate: The project would create 43 parking stalls, replacing the same number of stalls in Lot 17G that would be displaced by the proposed EECS Building. The project would not eliminate any parking.

4. Will the proposal require any new roads or streets, or any improvements to existing roads or streets not including driveways? If so, generally describe (indicate whether public or private): The project would not require any new roads, street, or improvements to existing roads.

5. Will the project use (or occur in the immediate vicinity of) water, rail or air transportation? If so, generally describe: No, the project would not use or occur near water, rail, or air transportation.

6. How many vehicular trips per day would be generated by the completed project? If known, indicate when peak volumes would occur: The proposed project would not generate any new trips to WWU campus as a whole.

7. Proposed measures to reduce or control transportation impacts, if any: None required.

S. PUBLIC SERVICES

1. Would the project result in an increased need for public services (for example – fire or police protection, healthcare, schools, other)? If so, generally describe: The proposed project could generate the need for public services to the site due to the addition of parking in the proposed lot; however, this would not represent an overall increase in the need for public services on the campus because the proposed lot would replace an existing lot in another part of campus. To the extent that emergency service providers have planned for service demands from WWU, no significant impacts are expected.

2. Proposed measures to reduce or control direct impacts on public services, if any: While those who park in the proposed lot could generate demand for emergency services to the site, it is anticipated that adequate service capacity is available to preclude the need for additional public facilities/services.
T. UTILITIES

1. Choose which utilities are currently available at the site:
   
   a. ☐ Electricity
   b. ☐ Natural Gas
   c. ☐ Water
   d. ☐ Refuse Service
   e. ☐ Telephone
   f. ☐ Sanitary Service
   g. ☐ Septic System
   h. ☒ Other No utilities are currently available on the site

1. Describe the utilities that are proposed for the project, the utility providing the service and the construction activates on the site or in the immediate vicinity which might be needed: None required. The project would replace metal halide lights on the poles along the Wade King Service Road with LED heads.

U. SIGNATURE

1. The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

Signature: [Signature]

Gretchen Brunner, Senior Planner,
EA Engineering, Science, and Technology, Inc., PBC

Date Submitted: December 21, 2021
APPENDIX A

Geotechnical Report
Subsurface Exploration, Geologic Hazard, and Geotechnical Engineering Report

WWU ELECTRICAL ENGINEERING AND COMPUTER SCIENCE BUILDING
Bellingham, Washington

Prepared For:
PERKINS & WILL

Project No. 20200298E001
June 2, 2021
June 2, 2021  
Project No. 20200298E001

Perkins & Will  
1301 Fifth Avenue  
Seattle, Washington 98101

Attention: Mr. Anthony Gianopoulos

Subject: Subsurface Exploration, Geologic Hazard, and Geotechnical Engineering Report  
WWU Electrical Engineering and Computer Science Building  
Bellingham, Washington

Dear Mr. Gianopoulos:

We are pleased to present the enclosed copy of the referenced report. This report summarizes the results of tasks including subsurface exploration, geologic hazard analysis, laboratory testing, and geotechnical engineering, and offers recommendations for design of the project. This report is based on a schematic design plan set dated March 5, 2021. We should be allowed to review our report and update it as needed as project plans reach completion.

We have enjoyed working with you on this study and are confident that the recommendations presented in this report will aid in the successful completion of your project. Please contact me if you have any questions or if we can be of additional help to you.

Sincerely,

ASSOCIATED EARTH SCIENCES, INC.  
Kirkland, Washington

Kurt D. Merriman, P.E.  
Senior Principal Engineer
I. PROJECT AND SITE CONDITIONS

1.0 INTRODUCTION

This report presents the results of Associated Earth Sciences, Inc.’s (AESI’s) subsurface exploration, geologic hazard analysis, and geotechnical engineering study for the proposed WWU Electrical Engineering and Computer Science (EECS) building in Bellingham, Washington. The site location is shown on the “Vicinity Map,” Figure 1. The approximate locations of explorations completed for this study are shown on the “Site and Exploration Plan,” Figures 2 and 3. Logs of our subsurface explorations are included in Appendix A. Laboratory testing is included in Appendix B.

1.1 Purpose and Scope

The purpose of this study is to provide subsurface soil and groundwater data to be utilized in the design of the WWU EECS building project. Our study included advancing eleven exploration borings (EB-1 through EB-11) and performing a geologic study of subsurface sediment and groundwater conditions. Geotechnical engineering studies were completed to formulate recommendations for the type of suitable foundations, allowable foundation soil bearing pressures, anticipated foundation settlements, erosion considerations, excavation shoring considerations, and general site drainage. This report summarizes our current fieldwork and offers design recommendations based on our present understanding of the project.

1.2 Authorization

Authorization to proceed with this study was given to AESI by means of a consultant agreement dated November 18, 2020. Our study was accomplished in general accordance with our proposal dated November 18, 2020. This report has been prepared for the exclusive use of Perkins & Will and its agents, for specific application to this project. Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering and engineering geology practices in effect in this area at the time our report was prepared. No other warranty, express or implied, is made.

2.0 PROJECT AND SITE DESCRIPTION

The new EECS building will consist of a partial basement level topped by four levels at ground level and above. Gross floor area will be 58,275 square feet. The basement will be constructed in an excavation supported by a top-down shoring system that will be bidder-designed and is expected to consist of a cantilevered soldier pile wall. The building will be constructed with a
ground level close to existing grade, at an elevation that matches the adjacent Communications Facility building. A new parking area is planned as part of the project at a separate location nearby to the west near the Student Recreation Center. The parking area will be constructed close to existing grades, and will be underlain by a stormwater detention system.

2.1 Historical Geotechnical Work

AESI previously completed geotechnical engineering for design and construction of the Academic Instruction Center (AIC) building nearby to the southwest of the future EECS building. The AIC building was underlain by existing fill and soft, compressible sediments, which were in turn underlain by sandstone bedrock. The depth to bedrock was highly variable. The AIC building was constructed with a conventional shallow foundation design underlain by an aggregate pier ground improvement system. A similar foundation support approach is planned for the EECS building.

3.0 SITE EXPLORATION

Our field investigation for the current study was conducted in January 2021 and included advancing eleven exploration borings. The existing site conditions, and the approximate locations of subsurface explorations referenced in this study, are presented on the “Site and Exploration Plan” (Figures 2 and 3). The various types of sediments, as well as the depths where the characteristics of the sediments changed, are indicated on the exploration logs, which are included in Appendix A. The depths indicated on the logs where conditions changed may represent gradational variations between sediment types. If changes occurred between sample intervals in our exploration borings, they were interpreted. Our explorations were approximately located in the field by measuring from known site features depicted on existing plans used to create Figures 2 and 3.

The conclusions and recommendations presented in this report are based, in part, on the explorations completed for this study. The number, locations, and depths of the explorations were completed within site and budgetary constraints. Because of the nature of exploratory work below ground, extrapolation of subsurface conditions between field explorations is necessary. It should be noted that differing subsurface conditions may be present due to the random nature of deposition and the alteration of topography by past grading and/or filling. The nature and extent of variations between the field explorations may not become fully evident until construction. If variations are observed at that time, it may be necessary to re-evaluate specific recommendations in this report and make appropriate changes.
3.1 Exploration Borings

Explorations completed for this study were advanced using a track-mounted drill. During the drilling process, samples were generally obtained at 2½- to 5-foot-depth intervals. The borings were continuously observed and logged by a geologist from our firm. The exploration logs presented in Appendix A are based on the field logs, drilling action, visual observation of the samples collected, and laboratory grain-size testing data included in this report.

Disturbed, but representative samples were obtained by using the Standard Penetration Test (SPT) procedure in accordance with ASTM International (ASTM) D-1586. This test and sampling method consists of driving a standard 2-inch, outside-diameter, split-barrel sampler a distance of 18 inches into the soil with a 140-pound hammer free-falling a distance of 30 inches. The number of blows for each 6-inch interval is recorded, and the number of blows required to drive the sampler the final 12 inches is known as the Standard Penetration Resistance (“N”) or blow count. If a total of 50 is recorded within one 6-inch interval, the blow count is recorded as the number of blows for the corresponding number of inches of penetration. The resistance, or N-value, provides a measure of the relative density of granular soils or the relative consistency of cohesive soils; these values are plotted on the attached exploration boring logs.

The samples obtained from the split-barrel sampler were classified in the field and representative portions placed in watertight containers. The samples were then transported to our laboratory for further visual classification and laboratory testing.

4.0 SUBSURFACE CONDITIONS

4.1 Regional Geologic Map

Published geologic mapping for the site and immediate vicinity were reviewed on the United States Geological Survey National Geologic Map Database. We retrieved a copy of the geologic map of the Bellingham 1:100,000 quadrangle, Washington, Thomas J. Lapen, Washington Division of Geology and Earth Resources, Open File Report 2000-5, 2000. This map indicates that the site is expected to be underlain at shallow depth by Chuckanut Formation bedrock.

4.2 Site Stratigraphy

As shown on the exploration logs, subsurface conditions encountered at the site consisted of Chuckanut Formation bedrock, typically covered by 5 to 15 feet of existing fill. Between existing fill and bedrock, three borings encountered recent alluvium and six encountered Quaternary glacial drift. The following sections present more detailed subsurface information on the sediment types encountered at the site.
Surfacing

Most of the exploration borings were completed in locations with existing asphalt paving or existing crushed rock parking area surfacing. Notes on surface conditions are included on the exploration logs in Appendix A.

Fill

Fill soils (those not naturally placed), were encountered in all of our exploration borings to depths ranging from 5 to 15 feet below the existing ground surface. Existing fill was typically medium dense, and consisted of silty sand with variable content of organic material, gravel, and sandstone clasts likely derived from previous on-site grading. Existing fill is not recommended for support of building foundations or floor slabs, and warrants remedial preparation below ancillary structures and paving. Existing fill is not suitable to be used as a stormwater infiltration receptor. Excavated existing fill is expected to be wetter than optimum for compaction purposes and is expected to contain areas of bedrock clasts, organic content, and minor construction debris that would need to be removed prior to reuse in structural fill applications. Reuse of excavated existing fill in structural fill applications is only allowed if explicitly permitted by project specifications.

Alluvium

Stratigraphically underlying the fill, three borings in the planned building area encountered natural sediments interpreted as alluvium. Alluvium was observed to consist of very loose to medium dense silt and sand with varying organic content. The alluvium at boring EB-3 was notably organic and was described to contain woody debris. Alluvial sediments are unlikely to provide direct structural support due to the depth below grade where they were observed. Alluvial sediments are not suitable as a stormwater infiltration receptor due to their fine texture and limited lateral and vertical stratigraphic distribution. Alluvial sediments are not expected to be excavated in substantial quantities and therefore are unlikely to be used in structural fill applications.

Quaternary Glacial Drift

Stratigraphically underlying the fill six borings encountered Quaternary glacial drift. Glacial drift was observed to consist of typically medium dense silt and silty sand, with variable but generally low organic content. Quaternary glacial drift is unlikely to provide direct structural support, or to be handled in substantial quantity during site grading due to the depth below existing grade where it was encountered. Quaternary glacial drift is not suitable as a stormwater infiltration receptor due its fine texture.
Bedrock

Each boring with the exceptions of EB-7 and EB-11 encountered sandstone bedrock of the Chuckanut Formation. The bedrock varied in consistency, in some cases leading to drilling refusal nearly as soon as it was encountered in a boring, an in other locations allowing drill penetration of up to 9 feet even with the lightweight limited-access exploration drill rig. Highly variable strength and excavation resistance of the Chuckanut Formation bedrock is common, and was experienced during construction of the WWU AIC building a short distance from the current project. Chuckanut Formation bedrock is suitable for structural support as recommended in this report. Chuckanut Formation bedrock is not suitable as an infiltration receptor and is not expected to be handled in substantial quantity during site grading.

4.3 Hydrology

Groundwater was not encountered in any of the exploration borings for this study at the time they were completed (January 2021). Perched groundwater was not observed, but is possible during the wetter winter months.

4.4 Laboratory Testing

Grain-Size Analysis

AESI performed three grain-size analyses (sieves) on representative samples retrieved from the exploration borings. The laboratory test results are included in Appendix B.
II. GEOLOGIC HAZARDS AND MITIGATIONS

The following sections present data, conclusions, and recommendations related to geologic hazards. We reviewed the City of Bellingham Geologic Hazards Map (April 2018). No geologic hazards are mapped at the project.

5.0 LANDSLIDE HAZARDS AND MITIGATIONS

The project area is relatively flat. Quantitative slope stability analysis was not completed and is not warranted, in our opinion.

6.0 SEISMIC HAZARDS AND MITIGATIONS

The site does not include areas designated as Seismic Hazard Areas on the previously-referenced City of Bellingham Geologic Hazards Map. The following discussion is a more general assessment of seismic hazards that is intended to be useful to the project design team in terms of understanding seismic issues, and to the structural engineer for structural design.

All of Western Washington is at risk of strong seismic events resulting from movement of the tectonic plates associated with the Cascadia Subduction Zone (CSZ), where the offshore Juan de Fuca plate subducts beneath the continental North American plate. The site lies within a zone of strong potential shaking from subduction zone earthquakes associated with the CSZ. The CSZ can produce earthquakes up to magnitude 9.0, and the recurrence interval is estimated to be on the order of 500 years. Geologists infer the most recent subduction zone earthquake occurred in 1700 (Goldfinger et al., 2012). Three main types of earthquakes are typically associated with subduction zone environments: crustal, intraplate, and interplate earthquakes. Seismic records in the Puget Sound region document a distinct zone of shallow crustal seismicity (e.g., the Seattle Fault Zone). These shallow fault zones may include surficial expressions of previous seismic events, such as fault scarps, displaced shorelines, and shallow bedrock exposures. The shallow fault zones typically extend from the surface to depths ranging from 16 to 19 miles. A deeper zone of seismicity is associated with the subducting Juan de Fuca plate. Subduction zone seismic events produce intraplate earthquakes at depths ranging from 25 to 45 miles beneath the Puget Lowland including the 1949, 7.2-magnitude event; the 1965, 6.5-magnitude event; and the 2001,

6.8-magnitude event) and interplate earthquakes at shallow depths near the Washington coast including the 1700 earthquake, which had a magnitude of approximately 9.0. The 1949 earthquake appears to have been the largest in this region during recorded history and was centered in the Olympia area. Evaluation of earthquake return rates indicates that an earthquake of the magnitude between 5.5 and 6.0 is likely within a given 20-year period.

Generally, there are four types of potential geologic hazards associated with large seismic events: 1) surficial ground rupture, 2) seismically induced landslides or lateral spreading, 3) liquefaction, and 4) ground motion. The potential for each of these hazards to adversely impact the proposed project is discussed below.

6.1 Surficial Ground Rupture

We reviewed published geologic maps of inferred faults on the United States Geological Survey Quaternary Fault and Fold Database of the United States. The site is not underlain or in close proximity to mapped faults, and therefore the potential for surface rupture at the project site is anticipated to be low.

6.2 Liquefaction

Liquefaction is a temporary loss in soil shear strength that can occur when loose granular soils below the groundwater table are exposed to cyclic accelerations, such as those that occur during earthquakes. The observed site sediments were observed to be unsaturated and are not expected to be prone to liquefaction due to their generally high density and absence of shallow groundwater. A detailed liquefaction hazard analysis was not performed as part of this study, and none is warranted, in our opinion.

6.3 Ground Motion/Seismic Site Class (2018 International Building Code)

Structural design of the new building should follow 2018 International Building Code (IBC) standards. We recommend that the project be designed in accordance with Site Class “C” in accordance with the 2018 IBC, and the publication American Society of Civil Engineers (ASCE) referenced therein, the most recent version of which is ASCE 7-16.

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7.0 EROSION CONTROL

Project plans should include implementation of temporary erosion controls in accordance with local standards of practice. Control methods should include limiting earthwork to seasonally drier periods if possible, use of perimeter silt fences, stabilized construction entrances, and straw mulch in exposed areas. Removal of existing vegetation should be limited to those areas that are required to construct the project, and new landscaping and vegetation with equivalent erosion mitigation potential should be established as soon as practical after grading is complete. During construction, surface water should be collected as close as possible to the source to minimize silt entrainment that could require treatment or detention prior to discharge. Timely implementation of permanent drainage control measures should also be a part of the project plans, and will help reduce erosion and generation of silty surface water onsite.
III. DESIGN RECOMMENDATIONS

8.0 INTRODUCTION

Our explorations indicate that, from a geotechnical engineering standpoint, the proposed project is feasible provided the recommendations in this report are incorporated into design and construction of the project. Surficial fill soils and native sediments below the new building are soft, and an aggregate pier ground improvement system is recommended below foundations and floor slabs.

- We recommend that the new building foundations and floor slabs and any other substantial structures be constructed using a conventional shallow foundation system underlain by ground improvement consisting of the installation of aggregate piers. Other foundation support alternatives are possible, including removing and replacing existing fill or installing foundation piles. We are available to discuss other foundation support approaches on request.

- The project will include a shoring wall around the perimeter of the basement. The subsurface conditions in that portion of the site vary substantially and additional subsurface data will be needed to design the shoring system. A bidder-designed soldier pile shoring wall is expected, and should be designed based on supplementary subsurface explorations that have not been completed at the time this report was written.

- Areas of new paving and other similar ancillary structures should be assessed, and some level of remedial preparation of existing fill may be warranted as outlined in the “Site Preparation” section of this report.

- Stormwater infiltration for the project is not recommended.

9.0 SITE PREPARATION

Erosion and surface water control should be established around the perimeter of the excavation to satisfy City of Bellingham requirements.
9.1 Building Pad Area

Site preparation should include removal of all existing pavement, structures, buried utilities, and any other deleterious material from below the new building. The subgrade for the building pad, or for structural fill placement below the building pad, is expected to consist of existing fill. The subgrade should be proof-rolled and compacted. Any areas that are soft, yielding, organic, or otherwise unsuitable should be repaired as needed based on site observations during construction. Structural fill should then be placed to reach planned grades. The building pad should be capped with a working surface of at least 8 inches of crushed rock to facilitate construction of aggregate piers.

9.2 Paving Areas

Areas of planned paving should be prepared by stripping existing vegetation and topsoil, removing structures and utilities to be demolished, and excavating to planned paving subgrade elevation. The resulting subgrade should then be evaluated visually, compacted, and proof-rolled. Exposed soils are expected to consist of existing fill. Areas with organic or deleterious material, or areas that yield during proof-rolling should receive additional preparation tailored to proof-rolling results and field conditions at the time of construction.

9.3 Allowance Recommendations

Because building and paving subgrades will consist of existing fill, some amount of remedial subgrade preparation will likely be needed. We recommend establishing a unit cost in bid documents for removal and export of unsuitable soils, and import of suitable granular fill. The unit prices should be based on in situ bank cubic yards as the unit of measurement. An allowance should be included to encourage competitive unit pricing during bidding. The allowance language should establish that earthwork allowances are to be used only at the owner's direction, and in accordance with unit prices. For planning purposes we recommend including 500 cubic yards of export/import in bid documents. This is an arbitrary number intended to encourage competitive pricing, and to allow the owner to budget for anticipated remedial preparation. The actual amount used may be more or less based on field conditions during construction.

9.4 Temporary Cut Slopes

In our opinion, stable construction slopes should be the responsibility of the contractor and should be determined during construction based on the conditions encountered at that time. For estimating purposes, however, we anticipate that temporary, unsupported cut slopes in existing fill be planned at a maximum slope of 1.5H:1V (Horizontal:Vertical). Temporary cut slopes may need to be adjusted in the field at the time of construction based on the presence of surface water or perched seepage zones. As is typical with earthwork operations, some sloughing and
raveling may occur, and cut slopes may have to be adjusted in the field. In addition, WISHA/OSHA regulations should be followed at all times.

9.5 Site Disturbance

Some of the on-site soils contain a high percentage of fine-grained material, which makes them moisture-sensitive and subject to disturbance when wet. The contractor must use care during site preparation and excavation operations so that the underlying soils are not softened, particularly during wet weather conditions. If disturbance occurs in areas of conventional footings, the softened soils should be removed and the area brought to grade with clean crushed rock fill. Because of the moisture-sensitive nature of the soils, we anticipate that wet weather construction would significantly increase the earthwork costs over dry weather construction.

9.6 Winter Construction

The existing fill material contains substantial silt and is considered highly moisture-sensitive. Soils excavated onsite will likely require drying during favorable dry weather conditions to allow their reuse in structural fill applications. During winter conditions use of excavated on-site soils in compacted fill applications may not be possible, and the use of imported fill or cement treatment of on-site soils may be needed if sitework will be completed during the winter. Care should be taken to seal all earthwork areas during mass grading at the end of each workday by grading all surfaces to drain and sealing them with a smooth-drum roller. Stockpiled soils that will be reused in structural fill applications should be covered whenever rain is possible.

If winter construction is expected, crushed rock fill should be used to provide construction staging areas where exposed soil is present. The stripped subgrade should be observed by the geotechnical engineer, and should then be covered with a geotextile fabric, such as Mirafi 500X or equivalent. Once the fabric is placed, we recommend using a crushed rock fill layer at least 10 inches thick in areas where construction equipment will be used. Soil-cement treatment is another approach to providing a workable site during the winter. We are available to provide more detailed cement-treatment recommendations on request and if allowed by the governing jurisdiction.

9.7 Frozen Subgrades

If earthwork takes place during freezing conditions, all exposed subgrades should be allowed to thaw, and then be recompacted prior to placing subsequent lifts of structural fill. Alternatively, the frozen material could be stripped from the subgrade to reveal unfrozen soil prior to placing subsequent lifts of fill. The frozen soil should not be reused as structural fill until allowed to thaw and adjusted to the proper moisture content, which may not be possible during winter months.
10.0 STRUCTURAL FILL

Structural fill should be placed and compacted according to the recommendations presented in this section and requirements included in project specifications. All references to structural fill in this report refer to subgrade preparation, fill type, placement, and compaction of materials, as discussed in this section. If a percentage of compaction is specified under another section of this report, the value given in that section should be used.

Structural fill is defined as non-organic soil, acceptable to the geotechnical engineer, placed in maximum 8-inch loose lifts, with each lift being compacted to at least 95 percent of the modified Proctor maximum dry density using ASTM D-1557 as the standard. In the case of roadway and utility trench filling, the backfill should be placed and compacted in accordance with City of Bellingham standards. At this time we are not aware of any planned right-of-way work associated with the project. For planning purposes, we recommend the use of a well-graded sand and gravel for on-site road and utility trench backfill.

The contractor should note that AESI should evaluate any proposed fill soils prior to their use in fills. This would require that we have a sample of the material at least 3 business days in advance of filling activities to perform a Proctor test and determine its field compaction standard. Soils in which the amount of fine-grained material (smaller than the No. 200 sieve) is greater than approximately 5 percent (measured on the minus No. 4 sieve size) should be considered moisture-sensitive. Use of moisture-sensitive soil in structural fills is not recommended during the winter months or under wet site and weather conditions. Most of the on-site soils are moisture-sensitive and have natural moisture contents over optimum for compaction and will likely require moisture-conditioning before use as structural fill. In addition, construction equipment traversing the site when the soils are wet can cause considerable disturbance. If import soil is required, a select import material consisting of a clean, free-draining gravel and/or sand should be used. Free-draining fill consists of non-organic soil with the amount of fine-grained material limited to 5 percent by weight when measured on the minus No. 4 sieve fraction and at least 30 percent retained on the No. 4 sieve.

A representative from our firm should observe the subgrades and be present during placement of structural fill to observe the work and perform a representative number of in-place density tests. In this way, the adequacy of the earthwork may be evaluated as filling progresses and any problem areas may be corrected at that time. It is important to understand that taking random compaction tests on a part-time basis will not assure uniformity or acceptable performance of a fill. As such, we are available to aid the owner in developing a suitable monitoring and testing frequency.
11.0 FOUNDATIONS

Conventional shallow footings may be used for building support when founded on existing fill soils improved by placement of aggregate piers, as previously discussed. Building foundations should be designed for an allowable foundation soil bearing pressure of 5,000 pounds per square foot (psf). This allowable foundation soil bearing pressure may be increased by one-third to accommodate transient wind and seismic loads.

Perimeter footings should be buried at least 18 inches into the surrounding soil for frost protection. However, all footings must penetrate to the prescribed bearing stratum, and no footing should be founded in or above organic or loose soils. All footings should have a minimum width of 18 inches.

It should be noted that the area bound by lines extending downward at 1H:1V from any footing must not intersect another footing or intersect a filled area that has not been compacted to at least 95 percent of ASTM D-1557. In addition, a 1.5H:1V line extending down from any footing must not daylight because sloughing or raveling may eventually undermine the footing. Thus, footings should not be placed near the edge of steps or cuts in the bearing soils.

Foundation settlement parameters are established as part of the aggregate pier design process and are summarized in the following report section. Disturbed soil not removed from footing excavations prior to footing placement could result in increased settlements. All footing areas should be inspected by AESI prior to placing concrete to verify that the design bearing capacity of the soils has been attained and that construction conforms to the recommendations contained in this report. Such inspections may be required by the governing municipality. Perimeter footing drains should be provided, as discussed under the “Drainage Considerations” section of this report.

11.1 Aggregate Piers

Aggregate piers are recommended below the new building and any other substantial structures. Aggregate piers are vertical columns of compacted stone that are constructed on the building pad before new foundations are constructed. The purpose of aggregate piers is to both improve existing fill soils and to transmit loads to more competent native bearing soils at depth. Aggregate piers are formed by drilling or displacing the existing soil column to a pre-determined depth with an auger or vibratory mandrel. Crushed rock is fed from the surface and compacted in thin lifts resulting in a column of compacted aggregate and compaction of soils surrounding the pier.
Aggregate piers are proprietary systems and are designed by the contractor who installs them. The contractor will determine the depth and diameter of the pier holes and the appropriate spacing. Aggregate pier designs are specifically tailored to a foundation plan, and the locations and depths of foundations should be determined prior to aggregate pier design. Conventional shallow foundations are then constructed above the subgrade after piers have been installed. The aggregate pier contractor should review exploration logs contained in this report carefully. Existing fill soils, such as those observed in our explorations, may contain drilling obstacles. Where drilling obstacles are encountered, the contractor should be prepared to relocate planned piers or remove obstacles, as needed, as part of the base bid work.

The aggregate pier design should be based on the following parameters:

**Footings:**

- Maximum Allowable Bearing Pressure for Footings Supported by Aggregate Piers: 5,000 psf
- Maximum Total Long-Term Settlement for Footings: ≤ 1 inch
- Maximum Long-Term Differential Settlement of Adjacent Footings: ≤ ½ inch over 30 feet ≤1 inch over 200 feet
- Maximum Aggregate Pier Spacing Under Foundations: 8 feet

**Floor Slabs:**

- Subgrade Modulus (Minimum): 50 lb/in³
- Maximum Long-Term Total Settlement for Slabs: ≤ 1 inch
- Maximum Long-Term Differential Settlement for Slabs: ≤ ½ inch over 30 feet

We recommend full-time construction observation by AESI during pier installation to verify that the piers extend to native bearing soils. Air or water jetting are not acceptable practices during the installation of aggregate piers.
12.0 DRAINAGE CONSIDERATIONS

Traffic across the on-site soils when they are damp or wet will result in disturbance of the otherwise firm stratum. Therefore, during sitework and construction, the contractor should provide surface drainage and subgrade protection, as necessary.

Any retaining walls, basement walls, and all perimeter foundation walls should be provided with a drain at the footing elevation. Drains should consist of rigid, perforated, PVC pipe surrounded by washed gravel. The level of the perforations in the pipe should be set at the bottom of the footing, and the drains should be constructed with sufficient gradient to allow gravity discharge away from the building. The perforations should be located on the lower portion of the pipe. In addition, any retaining or subgrade walls should be lined with a minimum, 12-inch-thick, washed gravel blanket, backfilled completely with free-draining material over the full height of the wall (excluding the first 1 foot below the surface). Composite drainage mats such as Mira Drain 6000 installed in accordance with the manufacturer’s recommendations may be used in lieu of the free-draining aggregate blanket for walls such as stormwater detention vaults that will not be completed as finished habitable space on the interior. The drainage aggregate or composite drain mats should tie into and freely communicate with the footing drains. Roof and surface runoff should not discharge into the footing drain system, but should be handled by a separate, rigid, tightline drain.

To minimize erosion, stormwater discharge or concentrated runoff should not be allowed to flow down any steep slopes. In planning, exterior grades adjacent to walls should be sloped downward away from the structures at an inclination of at least 3 percent to achieve surface drainage. Runoff water from impervious surfaces should be collected by a storm drain system that discharges into the site stormwater system.

13.0 FLOOR SLABS

Floor slabs are expected to be underlain by aggregate piers. The slabs should be cast atop a minimum of 4 inches of washed pea gravel or washed crushed rock to act as a capillary break where moisture migration through the slabs is to be controlled. The capillary break material should be overlain by a 10-mil-thick vapor barrier material prior to concrete placement. American Concrete Institute (ACI) recommendations should be followed for all concrete placement.
14.0 FOUNDATION WALLS

The following recommendations may be applied to conventional walls up to 8 feet tall. We should be allowed to offer situation-specific input if any taller walls are planned. All backfill behind foundation walls or around foundation units should be placed in accordance with our recommendations for structural fill and as described in this report. Horizontally backfilled walls, which are free to yield laterally at least 0.1 percent of their height, may be designed to resist lateral earth pressure represented by an equivalent fluid equal to 35 pounds per cubic foot (pcf). Fully restrained, horizontally backfilled, rigid walls that cannot yield should be designed for an equivalent fluid of 50 pcf. Walls with sloping backfill up to a maximum gradient of 2H:1V should be designed using an equivalent fluid of 55 pcf for yielding conditions or 75 pcf for fully restrained conditions. If parking areas are adjacent to walls, a surcharge equivalent to 2 feet of soil should be added to the wall height in determining lateral design forces.

As required by the 2018 IBC, retaining wall design should include a seismic surcharge pressure in addition to the equivalent fluid pressures presented above. Considering the site soils and the recommended wall backfill materials, we recommend a seismic surcharge pressure of 5H and 10H psf, where H is the wall height in feet for the “active” and “at-rest” loading conditions, respectively. The seismic surcharge should be modeled as a rectangular distribution with the resultant applied at the midpoint of the walls.

The lateral pressures presented above are based on the conditions of a uniform backfill consisting of excavated on-site soils or imported structural fill compacted to 90 percent of ASTM D-1557 within about 3 feet of the wall. A higher degree of compaction is not recommended, as this will increase the pressure acting on the walls. A lower compaction may result in settlement of the slab-on-grade or other structures supported above the walls. Thus, the compaction level is critical and must be tested by our firm during placement. Surcharges from adjacent footings or heavy construction equipment must be added to the above values. Perimeter footing drains should be provided for all retaining walls, as discussed under the “Drainage Considerations” section of this report.

It is imperative that proper drainage be provided so that hydrostatic pressures do not develop against the walls. Wall drainage recommendations are presented in Section 14.0 of this report.

14.1 Passive Resistance and Friction Factors

Lateral loads can be resisted by friction between the foundation and the natural soils or supporting structural fill soils, and by passive earth pressure acting on the buried portions of the foundations. The foundations must be backfilled with structural fill and compacted to at least 95 percent of the maximum dry density to achieve the passive resistance provided below. We recommend the following allowable design parameters which include a factor of safety of 1.5:
• Passive equivalent fluid = 250 pcf
• Coefficient of friction = 0.35

15.0 EXCAVATION SHORING

The project will include excavation shoring in an area that is rectangular in plan view and located around the perimeter of the partial basement of the new building. The shoring is expected to extend one building level below grade, and a maximum exposed shoring wall height of up to 10 feet is anticipated. The shoring wall has not yet been designed, and is expected to be bidder-designed. The shoring wall is expected to consist of cantilevered soldier piles and wood lagging. No tiebacks are anticipated.

The shoring wall may be temporary and structurally superseded by the building basement wall when it is constructed or may be incorporated into the permanent structural design of the building. If the wall is temporary, the design would not typically include seismic loading conditions and no corrosion protection is typically provided. Permanent shoring walls are required to satisfy seismic loading conditions and metal parts of the system are usually encapsulated, epoxy-coated, or painted to provide long-term corrosion protection.

The area of the proposed shoring is characterized by several different subsurface materials with different engineering properties. In general, the surficial fill soils consist of fill, alluvium, and glacial drift soils which are weak and provide less support for shoring systems. These surficial weak soils are underlain by bedrock which provides good support for shoring systems but can be difficult to excavate to install shoring components. The depth/elevation at which the change from weak to strong materials occurs varies widely, ranging from about 5 to 20 feet below existing grade at the locations of borings included in this report. We recommend that the shoring be designed based on supplementary exploration borings specifically completed to provide shoring design information.

AESI contacted two local shoring contractors with design-build experience on projects similar to this one. Based on those conversations, cantilevered soldier pile shoring is expected to be feasible. It should be noted that shoring systems are not perfectly rigid, and correctly-designed cantilevered soldier pile walls allow some lateral deflection at the wall face and some lateral and vertical displacements in the retained soil zone. If settlement-sensitive structures are located within a horizontal distance of the shoring system equal to twice the shoring height, consideration should be given as to the sensitivity of the adjacent structure(s) to settlement. If small amounts of settlement are unacceptable additional settlement mitigations methods (such as underpinning) or alternate shoring designs (such as tieback walls with pre-tensioned anchors) could be considered.
16.0 STORMWATER INFILTRATION

Our subsurface explorations encountered existing fill, alluvial sediments, glacial drift, and sandstone. Infiltration into existing fill is not permissible by code and is not recommended. None of the native sediments we observed were texturally well suited and laterally extensive enough to serve as a stormwater infiltration receptor. Stormwater infiltration at this site is not feasible in our opinion and is not recommended.

17.0 PAVEMENT AND SIDEWALK RECOMMENDATIONS

The pavement sections included in this report section are for driveway and parking areas onsite, and are not applicable to right-of-way improvements. At this time, we are not aware of any planned right-of-way improvements; however, if any new paving of public streets is required, we should be allowed to offer situation-specific recommendations.

Pavement and sidewalk areas should be prepared in accordance with the “Site Preparation” section of this report. Soft or yielding areas should be overexcavated to provide a suitable subgrade and backfilled with structural fill.

New paving may include areas subject only to light traffic loads from passenger vehicles driving and parking, and may also include areas subject to heavier loading from vehicles that may include buses, fire trucks, food service trucks, and garbage trucks. In light traffic areas, we recommend a pavement section consisting of 3 inches of hot-mix asphalt (HMA) underlain by 4 inches of crushed surfacing base course. In heavy traffic areas, we recommend a minimum pavement section consisting of 4 inches of HMA underlain by 2 inches of crushed surfacing top course and 4 inches of crushed surfacing base course. The crushed rock courses must be compacted to 95 percent of the maximum density, as determined by ASTM D-1557. All paving materials should meet gradation criteria contained in the current Washington State Department of Transportation (WSDOT) Standard Specifications.

Depending on construction staging and desired performance, the crushed base course material may be substituted with ATB beneath the final asphalt surfacing if desired. The substitution of ATB should be as follows: 4 inches of crushed rock can be substituted with 3 inches of ATB, and 6 inches of crushed rock may be substituted with 4 inches of ATB. ATB should be placed over a native or structural fill subgrade compacted to a minimum of 95 percent relative density, and a 1½- to 2-inch thickness of crushed rock to act as a working surface. If ATB is used for construction access and staging areas, some rutting and disturbance of the ATB surface should be expected to result from construction traffic. The general contractor should remove affected areas and replace them with properly compacted ATB prior to final surfacing.
18.0 RECOMMENDATIONS FOR FUTURE WORK

- Additional exploration borings are recommended to delineate subsurface conditions at the location of the planned shoring walls. Shoring walls should be bidder-designed based on the supplementary subsurface explorations.

- We recommend that we be allowed to work with the design team to prepare project specifications for aggregate piers. It may be valuable to complete additional subsurface explorations in the building footprint to determine the depth of existing fill and depth to bedrock at additional locations. The additional subsurface data would allow for better owner cost estimating, better aggregate pier design by the contractor, and would make construction change orders due to varying subsurface conditions less likely. We are available to discuss additional subsurface explorations on request.

The two items listed above are recommended but are not included in our currently-approved scope of services for the project. We are available to provide scope of work and cost recommendations for these items on request.

19.0 PROJECT DESIGN AND CONSTRUCTION MONITORING

We recommend that AESI perform a geotechnical review of the plans prior to final design completion. In this way, we can confirm that our recommendations have been correctly interpreted and implemented in the design. The City of Bellingham may require a plan review by the geotechnical engineer as a condition of permitting.

We recommend that AESI be retained to provide geotechnical special inspections during construction, and preparation of a letter summarizing our construction phase work when construction is complete. The City of Bellingham may require such geotechnical special inspections. The integrity of the earthwork and foundations depends on proper site preparation and construction procedures. In addition, engineering decisions may have to be made in the field in the event that variations in subsurface conditions become apparent.
We have enjoyed working with you on this study and are confident these recommendations will aid in the successful completion of your project. If you should have any questions or require further assistance, please do not hesitate to call.

Sincerely,

ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

Bruce Guenzler
Bruce W. Guenzler, L.E.G. Kurt D. Merriman, P.E.
Senior Associate Geologist Senior Principal Engineer

Attachments:  Figure 1. Vicinity Map
                Figure 2. Site and Exploration Plan
                Figure 3. Site and Exploration Plan
                Appendix A. Exploration Logs
                Appendix B. Laboratory Testing Results
LEGEND

SITE

EXPLORATION BORING, DEPTH OF FILL

NOTE: BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

SITE AND EXPLORATION PLAN

WWU EE AND CS BLDG - PARKING IMPROVEMENTS
BELLINGHAM, WASHINGTON

DATA SOURCES / REFERENCES:
BASEMAPE RECEIVED FROM PERKINS & WILL VIA EMAIL
LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

PROJ NO.
20200298E001
DATE: 2/21
FIGURE: 3

38 new parking stalls, used for PW758 Contractor Parking/St; during construction
APPENDIX A

Exploration Logs
### Terms Describing Relative Density and Consistency

<table>
<thead>
<tr>
<th>Component</th>
<th>Density</th>
<th>SPT © blows/foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse-Grained Soils</td>
<td>Very Loose</td>
<td>0 to 4</td>
</tr>
<tr>
<td></td>
<td>Loose</td>
<td>4 to 10</td>
</tr>
<tr>
<td></td>
<td>Medium Dense</td>
<td>10 to 30</td>
</tr>
<tr>
<td></td>
<td>Dense</td>
<td>30 to 50</td>
</tr>
<tr>
<td></td>
<td>Very Dense</td>
<td>&gt;50</td>
</tr>
<tr>
<td>Fine-Grained Soils</td>
<td>Very Soft</td>
<td>0 to 2</td>
</tr>
<tr>
<td></td>
<td>Soft</td>
<td>2 to 4</td>
</tr>
<tr>
<td></td>
<td>Medium Stiff</td>
<td>4 to 8</td>
</tr>
<tr>
<td></td>
<td>Stiff</td>
<td>8 to 15</td>
</tr>
<tr>
<td></td>
<td>Very Stiff</td>
<td>15 to 30</td>
</tr>
<tr>
<td></td>
<td>Hard</td>
<td>&gt;50</td>
</tr>
</tbody>
</table>

### Component Definitions

<table>
<thead>
<tr>
<th>Component</th>
<th>Size Range and Sieve Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulders</td>
<td>Larger than 12&quot;</td>
</tr>
<tr>
<td>Cobblestone</td>
<td>3&quot; to 12&quot;</td>
</tr>
<tr>
<td>Gravel</td>
<td>3&quot; to No. 4 (4.75 mm)</td>
</tr>
<tr>
<td>Fine Gravel</td>
<td>3/4&quot; to No. 4 (4.75 mm)</td>
</tr>
<tr>
<td>Sand</td>
<td>No. 4 (4.75 mm) to No. 200 (0.075 mm)</td>
</tr>
<tr>
<td>Coarse Sand</td>
<td>No. 4 (4.75 mm) to No. 10 (2.00 mm)</td>
</tr>
<tr>
<td>Medium Sand</td>
<td>No. 10 (2.00 mm) to No. 40 (0.425 mm)</td>
</tr>
<tr>
<td>Fine Sand</td>
<td>No. 40 (0.425 mm) to No. 200 (0.075 mm)</td>
</tr>
<tr>
<td>Silt and Clay</td>
<td>Smaller than No. 200 (0.075 mm)</td>
</tr>
</tbody>
</table>

### Estimated Percentage

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace</td>
<td>&lt;5</td>
</tr>
<tr>
<td>Some</td>
<td>5 to &lt;12</td>
</tr>
<tr>
<td>Modifier (silty, sandy, gravelly)</td>
<td>12 to &lt;30</td>
</tr>
<tr>
<td>Very modifier (silty, sandy, gravelly)</td>
<td>30 to &lt;50</td>
</tr>
</tbody>
</table>

### Moisture Content

- Dry: Absence of moisture, dusty, dry to the touch
- Slightly Moist: Perceptible moisture
- Moist: Damp but no visible water
- Very Moist: Water visible but not free draining
- Wet: Visible free water, usually from below water table

### Symbols

- Cement grout surface seal
- Bentonite seal
- Filter pack with blank casing section
- Screened casing or Hydrotub with filter pack End cap

---

**Notes:**
- Percentage by dry weight
- SPT Standard Penetration Test (ASTM D-1586)
- In General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)
- Depth of ground water
- ATD = At time of drilling
- Static water level (date)
- Combined USCS symbols used for fines between 5% and 12%
**Asphalt - 3 inches**

Moist, tannish brown, silty, fine SAND, trace gravel; contains pieces of weathered sandstone (SM).

**Weathered Chuckanut Formation**

Moist, gayish brown, silty, SAND, trace organics (SM).

As above; becomes tannish brown SANDSTONE; poor recovery.

Bottom of exploration boring at 8 feet

No groundwater encountered.
Asphalt - 3 inches Fill

Moist, brown to gray, silty, GRAVEL (GM).

Moist, mottled grayish brown, sandy, SILT, trace gravel; unsorted (ML).

As above; blowcounts likely overstated due to gravel.

---

### Water Level at time of drilling (ATD)

Project Name: WWU Electrical Engineering & Computer Science Building
Location: Bellingham, WA
Driller/Equipment: Geologic Drill / Mini Track Rig
Hammer Weight/Drop: 140# / 30

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Samples</th>
<th>Graphic Symbol</th>
<th>Well Completion</th>
<th>Water Level</th>
<th>Blows/Foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>S-1</td>
<td>Moist, brown to gray, silty, GRAVEL (GM).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>S-2</td>
<td>Moist, mottled grayish brown, sandy, SILT, trace gravel; unsorted (ML).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>S-3</td>
<td>As above; blowcounts likely overstated due to gravel.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Other Tests**

- **Sampler Type (ST):**
  - 2" OD Split Spoon Sampler (SPT)
  - 3" OD Split Spoon Sampler (D & M)
  - Grab Sample

- **Ground Surface Elevation (ft):** 311 +/-
- **Datum:** NAVD 88
- **Date Start/Finish:** 1/20/21, 1/20/21

**Logged by:** JDH
**Approved by:** JHS
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Samples</th>
<th>Graphic Symbol</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>S-4</td>
<td></td>
<td>Weathered Chuckanut Formation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gray, SANDSTONE; poor recovery.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bottom of exploration boring at 15.4 feet</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No groundwater encountered.</td>
</tr>
</tbody>
</table>

**Blows/Foot**

<table>
<thead>
<tr>
<th>Blows/Foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>40</td>
</tr>
</tbody>
</table>

**Well Completion**

<table>
<thead>
<tr>
<th>Blows/Foot</th>
<th>50/5</th>
</tr>
</thead>
</table>

**Other Tests**

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

**Logged by:** JHS

**Approved by:** JHS
Moist, grayish brown, silty, SAND, trace gravel, trace organics (SM).

As above; contains chunks of weathered sandstone (SM).

Moist, bluish gray, sandy, SILT; few organics (woody debris) (ML).
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Samples</th>
<th>Graphic Symbol</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>S-4</td>
<td></td>
<td>Bottom of exploration boring at 15.4 feet</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No groundwater encountered.</td>
</tr>
</tbody>
</table>

**Chuckanut Formation**  
Brown, SANDSTONE; poor recovery.

**Groundwater**  
No groundwater encountered.

**Exploration Number**  
EB-3

**Datum**  
NAVD 88

**Hole Diameter (in)**  
4

**Blows/Foot**  
10 20 30 40

**Other Tests**  

**Sampler Type (ST):**  
1 2" OD Split Spoon Sampler (SPT)  
2 3" OD Split Spoon Sampler (D & M)  
3 Grab Sample  
M - Moisture  
Water Level ()

**Logged by:**  
JDH

**Approved by:**  
JHS
**Asphalt - 4 inches**

**Fill**

- Moist, brownish gray, silty, SAND; few gravels; contains chunks of weathered sandstone (SM).
- As above; becomes bluish gray.

**Alluvium**

- Moist to very moist, greenish gray, silty, SAND, trace organics (SM).
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Samples</th>
<th>Graphic Symbol</th>
<th>DESCRIPTION</th>
<th>Well Completion</th>
<th>Blows/Foot</th>
<th>Other Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>S-4</td>
<td></td>
<td>Weathered Chuckanut Formation</td>
<td>No recovery. Driller notes rocky drill action and refusal at 13 feet. Bottom of exploration boring at 13.3 feet No groundwater encountered.</td>
<td>50/3&quot;</td>
<td>50/3&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Water Level at time of drilling (ATD)</td>
<td>10</td>
<td>20</td>
</tr>
</tbody>
</table>

**Project Name:** WWU Electrical Engineering & Computer Science Building

**Location:** Bellingham, WA

**Driller/Equipment:** Geologic Drill / Mini Track Rig

**Hammer Weight/Drop:** 140#/ 30
**Asphalt - 6 inches Fill**

- Moist, bluish gray, silty, SAND; few gravels and woody debris (SM).
- As above; becomes grayish brown; trace brick debris (SM).

---

**Alluvium**

- Moist, dark grayish brown, sandy, SILT, trace organics; few fine gravels (ML).

---

**Exploration Boring**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Samples</th>
<th>Graphic Symbol</th>
<th>Well Completion Water Level</th>
<th>Blows/Foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>S-1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>S-2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>S-3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Sampler Type (ST):**

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample

**Ground Surface Elevation (ft):** 314 ±/-

**Datum:** NAVD 88

**Date Start/Finish:** 1/20/21, 1/20/21

**Hole Diameter (in):** 4

**Approved by:** JHS
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Samples</th>
<th>Graphic Symbol</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>S-4</td>
<td></td>
<td><strong>Quaternary Glacial Drift</strong>&lt;br&gt;Moist, mottled grayish brown, fine sandy, SILT, trace organics (ML/CL).</td>
</tr>
<tr>
<td>20</td>
<td>S-5</td>
<td></td>
<td><strong>Weathered Chuckanut Formation</strong>&lt;br&gt;Moist, gray to dark gray, silty, SAND (SM/SC).</td>
</tr>
</tbody>
</table>

**Exploration Boring**

- **Project Number**: 20200298E001
- **Exploration Number**: EB-5
- **Sheet**: 2 of 3

- **Project Name**: WWU Electrical Engineering & Computer Science Building
- **Location**: Bellingham, WA
- **Driller/Equipment**: Geologic Drill / Mini Track Rig
- **Hammer Weight/Drop**: 140# / 30

- **Ground Surface Elevation (ft)**: 314 +/-
- **Datum**: NAVD 88
- **Date Start/Finish**: 1/20/21, 1/20/21
- **Hole Diameter (in)**: 4

<table>
<thead>
<tr>
<th>Blows/Foot</th>
<th>Completion Water Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>30</td>
<td>6</td>
</tr>
<tr>
<td>40</td>
<td>6</td>
</tr>
</tbody>
</table>

**Sampler Type (ST):**
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample

**Logged by:** JDH
**Approved by:** JHS
Bottom of exploration boring at 29 feet
No groundwater encountered.

Moist, brownish gray, fine sandy, SILT (ML/CL).

As above; few coal seams.

Sample Symbol: 4

Grab Sample

Other Tests:

Sample Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample

No Recovery

Ring Sample

Shelby Tube Sample

Other Tests:

Blows/Foot

25

30

35

Ground Surface Elevation (ft) 314 +/- Datum NAVD 88

Date Start/Finish 1/20/21 1/20/21

Well Completion

58 83

Hole Diameter (in) 4

Water Level at time of drilling (ATD)
**Asphalt - 4 inches**

Moist, gray, to dark gray, silty, SAND; few gravels (SM).

**Quaternary Glacial Drift**

Moist, grayish brown, silty, SAND, some gravel, trace organics (SM).
**Project Name:** WWU Electrical Engineering & Computer Science Building  
**Location:** Bellingham, WA  
**Driller/Equipment:** Geologic Drill / Mini Track Rig  
**Hammer Weight/Drop:** 140#/30

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Samples</th>
<th>Graphic Symbol</th>
<th>DESCRIPTION</th>
<th>Well Completion Water Level Blows/Ft</th>
<th>Blows/Foot</th>
</tr>
</thead>
</table>
| 15        | S-4     |                | Weathered Chuckanut Formation  
Gray, SILT/MUDSTONE.  
Bottom of exploration boring at 16.5 feet  
No groundwater encountered. |  |  |

**Exploration Number:** EB-6  
**Ground Surface Elevation (ft):** 313 +/-  
**Datum:** NAVD 88  
**Date Start/Finish:** 1/20/21, 1/20/21  
**Hole Diameter (in):** 4  
**Blows/Foot:**

- 10
- 20
- 30
- 40

**Sampler Type (ST):**

- 2" OD Split Spoon Sampler (SPT)  
- 3" OD Split Spoon Sampler (D & M)  
- Grab Sample  
- No Recovery  
- Ring Sample  
- Shelby Tube Sample  

**Other Tests:**

- Water Level at time of drilling (ATD)

**Logged by:** JHS  
**Approved by:** JHS  
**Datum:** NAVD 88
Bottom of exploration boring at 11.5 feet
No groundwater encountered.

Asphalt - 4 inches

Moist, grayish brown, silty, SAND, trace organics; few gravels (SM).

As above; dark brown (SM).

Quaternary Glacial Drift

Moist, bluish gray, silty, SAND, some gravel (SM).

Bottom of exploration boring at 11.5 feet
No groundwater encountered.
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Samples</th>
<th>Graphic Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>S-1</td>
<td></td>
<td>Asphalt - 4 inches</td>
</tr>
<tr>
<td>5</td>
<td>S-1</td>
<td></td>
<td>Fill</td>
</tr>
<tr>
<td>10</td>
<td>S-2</td>
<td></td>
<td>Weathered Chuckanut Formation</td>
</tr>
</tbody>
</table>

Moist, brown to grayish brown, silty, SAND; few gravels (SM).

Bottom of exploration boring at 10.4 feet
No groundwater encountered.
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>400</th>
<th>S-1</th>
<th>Fill</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Moist to very moist, mottled grayish brown, sandy, SILT; few gravels (ML).</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>5</th>
<th>S-2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Quaternary Glacial Drift</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very moist, gray, sandy, SILT; few to trace fine gravel; poor recovery (ML).</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>10</th>
<th>S-3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>28</td>
</tr>
</tbody>
</table>

Sample Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample

No Recovery
Ring Sample
Shelby Tube Sample

M - Moisture
Water Level ()
Water Level at time of drilling (ATD)

Logged by: JDH
Approved by: JHS
### Exploration Boring

**Project Name:** WWU Electrical Engineering & Computer Science Building  
**Location:** Bellingham, WA  
**Driller/Equipment:** Geologic Drill / Mini Track Rig  
**Hammer Weight/Drop:** 140# / 30

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Samples</th>
<th>Graphic Symbol</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>S-4</td>
<td></td>
<td>As above; poor recovery.</td>
</tr>
<tr>
<td>20</td>
<td>S-5</td>
<td></td>
<td>As above; moist to very moist; interbed of sand; stratified (ML).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Blows/Foot</th>
<th>Water Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>20</td>
<td>7</td>
</tr>
<tr>
<td>30</td>
<td>6</td>
</tr>
<tr>
<td>40</td>
<td>1</td>
</tr>
</tbody>
</table>

**Well Completion Data**

- **Water Level (ft):**
  - 15: 7
  - 20: 6

**Other Tests**

- **Hammer Weight/Drop:** 140# / 30
- **Driller/Equipment:** Geologic Drill / Mini Track Rig
### Weathered Chuckanut Formation

No recovery. Driller notes rocky drill action.

- Bottom of exploration boring at 25.3 feet
- No groundwater encountered.
**Project Name:** WWU Electrical Engineering & Computer Science Building  
**Location:** Bellingham, WA  
**Driller/Equipment:** Geologic Drill / Mini Track Rig  
**Hammer Weight/Drop:** 140# / 30

### Exploratory Boring

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Samples</th>
<th>Graphic Symbol</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td>Fill</td>
</tr>
</tbody>
</table>

Moist to very moist, grayish brown, silty, SAND; few gravels and organics (SM).

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Samples</th>
<th>Graphic Symbol</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>S-2</td>
<td></td>
<td>Quaternary Glacial Drift</td>
</tr>
</tbody>
</table>

Moist, mottled brown to grayish brown, silty, SAND; few gravels and organics (SM).

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Samples</th>
<th>Graphic Symbol</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>S-3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Moist, grayish brown, sandy, SILT; few gravels and weathered bedrock fragments; unsorted (ML).

**Sample Type:**
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample

**Other Tests:**
- Water Level at time of drilling (ATD)

**Approved by:** JHS

AESRDR 20200298E001.GPJ  February 9, 2021

<table>
<thead>
<tr>
<th>Blows/Foot</th>
<th>Water Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>30</td>
<td>40</td>
</tr>
</tbody>
</table>

**Logged by:** JDH
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Samples</th>
<th>Graphic Symbol</th>
<th>Well Completion</th>
<th>Blows/Foot</th>
<th>Other Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>S-4</td>
<td></td>
<td>40</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DESCRIPTION**

Weathered Chuckanut Formation

- Moist, grayish brown, silty, SAND; few pieces of bedrock; poor recovery (SM).
- Bottom of exploration boring at 12.5 feet
- No groundwater encountered.
### Exploration Boring

**Project Number**: EB-11  
**Location**: WWU Electrical Engineering & Computer Science Building  
**Driller/Equipment**: Geologic Drill / Mini Track Rig  
**Hammer Weight/Drop**: 140# / 30

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Samples</th>
<th>Graphic Symbol</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>S-1</td>
<td></td>
<td>Poor recovery. Cuttings appear moist, brown, silty, SAND, with some bedrock pieces and trace organic debris.</td>
</tr>
<tr>
<td>5</td>
<td>S-2</td>
<td></td>
<td>Moist to very moist, silty, SAND, trace gravel, trace organics (SM). Driller notes potential cobbles at 8 feet.</td>
</tr>
</tbody>
</table>
| 10         | S-3     |                | Quaternary Glacial Drift  
Moist, mottled grayish brown, silty, SAND, trace cobbles; few gravels; unsorted (SM). Driller notes initial refusal likely on cobble at 9 feet.  
Moist, bluish gray, silty, gravelly, SAND (SM/SP). |

Bottom of exploration boring at 11.3 feet  
No groundwater encountered.

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Blows/Foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

**Logged by**: JDH  
**Approved by**: JHS
APPENDIX B

Laboratory Testing Results
Particle Size Distribution Report

<table>
<thead>
<tr>
<th>% +3”</th>
<th>Coarse</th>
<th>Fine</th>
<th>Coarse</th>
<th>Medium</th>
<th>Fine</th>
<th>Silt</th>
<th>Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>5.5</td>
<td>5.1</td>
<td>21.5</td>
<td>41.5</td>
<td>26.4</td>
<td></td>
</tr>
</tbody>
</table>

TEST RESULTS

<table>
<thead>
<tr>
<th>Opening Size</th>
<th>Percent Finer</th>
<th>Spec.* (Percent)</th>
<th>Pass? (X=Fail)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/8”</td>
<td>100.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/2”</td>
<td>98.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/8”</td>
<td>97.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#4</td>
<td>94.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#8</td>
<td>91.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#10</td>
<td>89.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#20</td>
<td>81.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#40</td>
<td>67.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#60</td>
<td>51.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#100</td>
<td>37.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#200</td>
<td>26.4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Material Description
silty SAND, some gravel

Atterberg Limits (ASTM D 4318)

\[
\text{PL} = \text{NP} \quad \text{LL} = \text{NV} \quad \text{PI} = \text{NP}
\]

USCS (D 2487) = SM
AASHTO (M 145) = A-2-4(0)

Coefficients
\[
\begin{align*}
D_{90} &= 2.1190 \\
D_{85} &= 1.2142 \\
D_{60} &= 0.3276 \\
D_{50} &= 0.2398 \\
D_{10} &= 0.0972 \\
C_u &= \frac{D_{60}}{D_{10}} = 3.3746 \\
C_c &= \frac{D_{85}}{D_{90}} = 0.5714
\end{align*}
\]

Remarks

Date Received: 01/26/2021  Date Tested: 02/05/2021
Tested By: NAS
Checked By: JH/BG
Title: 

Location: Onsite
Sample Number: EB-6  Depth: 5'

Client: Western Washington University
Project: WWU Electrical Engineering and Computer Science BLDG
Project No: 20200298 E001

Date Sampled: 01/21/2021
Particle Size Distribution Report

<table>
<thead>
<tr>
<th>Opening Size</th>
<th>Percent Finer</th>
<th>Spec. Finer (Percent)</th>
<th>Pass? (X=Fail)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5&quot;</td>
<td>100.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1&quot;</td>
<td>89.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>75.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5/8&quot;</td>
<td>74.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>70.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>68.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#4</td>
<td>65.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#8</td>
<td>63.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#10</td>
<td>62.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#20</td>
<td>59.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#40</td>
<td>55.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#60</td>
<td>50.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#100</td>
<td>41.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#200</td>
<td>27.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Material Description
gravelly, silty SAND

Atterberg Limits (ASTM D 4318)

\[
\begin{align*}
\text{PL} &= \text{NP} \\
\text{LL} &= \text{NV} \\
\text{PI} &= \text{NP}
\end{align*}
\]

Classification
USCS (D 2487) = SM
AASHTO (M 145) = A-2-4(0)

Coefficients
\[
\begin{align*}
D_{90} &= \frac{25.8728}{25.8728} \\
D_{85} &= \frac{23.4424}{23.4424} \\
D_{60} &= \frac{0.8705}{0.8705} \\
D_{50} &= \frac{0.2507}{0.2507} \\
D_{10} &= \frac{0.0841}{0.0841} \\
D_{10} &= \frac{C_U}{C_c}
\end{align*}
\]

Remarks

Date Received: 01/26/2021  Date Tested: 02/05/2021

Tested By: NAS  Checked By: JH/BG

Title:  

Location: Onsite  Depth: 10'

Sample Number: EB-10  Sample Number: EB-10

Client: Western Washington University
Project: WWU Electrical Engineering and Computer Science BLDG

Project No: 20200298 E001  Figure
Particle Size Distribution Report

<table>
<thead>
<tr>
<th>GRAIN SIZE - mm.</th>
<th>0.001</th>
<th>0.010</th>
<th>0.100</th>
<th>1.00</th>
<th>10.0</th>
<th>100.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>% +3&quot; coarse</td>
<td>0.0</td>
<td>2.5</td>
<td>11.1</td>
<td>5.7</td>
<td>10.0</td>
<td>34.6</td>
</tr>
<tr>
<td>% +3&quot; fine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>36.1</td>
</tr>
<tr>
<td>% gravel fine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>36.1</td>
</tr>
<tr>
<td>% sand coarse</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>36.1</td>
</tr>
<tr>
<td>% sand fine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>36.1</td>
</tr>
<tr>
<td>% fines silt</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>36.1</td>
</tr>
<tr>
<td>% clay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>36.1</td>
</tr>
</tbody>
</table>

**TEST RESULTS**

<table>
<thead>
<tr>
<th>Opening Size</th>
<th>Percent Finer</th>
<th>Spec. x (Percent)</th>
<th>Pass? X=Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;</td>
<td>100.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>97.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5/8&quot;</td>
<td>94.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>93.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>91.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#4</td>
<td>86.4</td>
<td></td>
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</tr>
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<td>81.8</td>
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</tr>
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<td></td>
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</tr>
<tr>
<td>#20</td>
<td>76.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#40</td>
<td>70.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#60</td>
<td>62.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#100</td>
<td>51.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#200</td>
<td>36.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Material Description**
silty SAND, some gravel

**Atterberg Limits (ASTM D 4318)**
- PL = NP
- LL = NV
- PI = NP

**USCS (D 2487)**
- SM
- AASHTO (M 145) = A-4(0)

**Coefficients**
- D90 = 8.4715
- D85 = 3.7836
- D60 = 0.2227
- D50 = 0.1372
- D30 = 0.1372
- D15 = 0.1372
- Cc = 0.1372

**Remarks**

**Date Received:** 01/26/2021  **Date Tested:** 02/05/2021

**Tested By:** NAS
**Checked By:** JH/BG

**Title:**

**Location:** Onsite
**Sample Number:** EB-11
**Depth:** 9'

**Client:** Western Washington University
**Project:** WWU Electrical Engineering and Computer Science BLDG
**Project No:** 20200298 E001

**Date Sampled:** 01/21/2021
APPENDIX B

GHG Emissions Worksheet
Introduction
The Washington State Environmental Policy Act (SEPA) requires environmental review of development proposals that may have a significant adverse impact on the environment. If a proposed development is subject to SEPA, the project proponent is required to complete the SEPA Checklist. The Checklist includes questions relating to the development's air emissions. The emissions that have traditionally been considered cover smoke, dust, and industrial and automobile emissions. With our understanding of the climate change impacts of GHG emissions, the City of Seattle requires the applicant to also estimate these emissions.

Emissions created by Development
GHG emissions associated with development come from multiple sources:
- The extraction, processing, transportation, construction and disposal of materials and landscape disturbance (Embodied Emissions)
- Energy demands created by the development after it is completed (Energy Emissions)
- Transportation demands created by the development after it is completed (Transportation Emissions)

GHG Emissions Worksheet
This GHG Emissions Worksheet has been developed to assist applicants in answering the SEPA Checklist question relating to GHG emissions. The worksheet was originally developed by King County, but the City of Seattle and King County are working together on future updates to maintain consistency of methodologies across jurisdictions.

The SEPA GHG Emissions worksheet estimates all GHG emissions that will be created over the life span of a project. This includes emissions associated with obtaining construction materials, fuel used during construction, energy consumed during a buildings operation, and transportation by building occupants.

Using the Worksheet
1. Descriptions of the different residential and commercial building types can be found on the second tabbed worksheet ("Definition of Building Types"). If a development proposal consists of multiple projects, e.g. both single family and multi-family residential structures or a commercial development that consists of more than one type of commercial activity, the appropriate information should be estimated for each type of building or activity.
2. For paving, estimate the total amount of paving (in thousands of square feet) of the project.

3. The Worksheet will calculate the amount of GHG emissions associated with the project and display the amount in the "Total Emissions" column on the worksheet. The applicant should use this information when completing the SEPA checklist.

4. The last three worksheets in the Excel file provide the background information that is used to calculate the total GHG emissions.

5. The methodology of creating the estimates is transparent; if there is reason to believe that a better estimate can be obtained by changing specific values, this can and should be done. Changes to the values should be documented with an explanation of why and the sources relied upon.

6. Print out the “Total Emissions” worksheet and attach it to the SEPA checklist. If the applicant has made changes to the calculations or the values, the documentation supporting those changes should also be attached to the SEPA checklist.
## Section I: Buildings

<table>
<thead>
<tr>
<th>Type (Residential) or Principal Activity (Commercial)</th>
<th># Units</th>
<th>Square Feet (in thousands of square feet)</th>
<th>Embodied</th>
<th>Energy</th>
<th>Transportation</th>
<th>Lifespan Emissions (MTCO2e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-Family Home......................................</td>
<td>0</td>
<td>98</td>
<td>672</td>
<td>792</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Multi-Family Unit in Large Building .................</td>
<td>0</td>
<td>33</td>
<td>357</td>
<td>766</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Multi-Family Unit in Small Building ...............</td>
<td>0</td>
<td>54</td>
<td>681</td>
<td>766</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mobile Home.............................................</td>
<td>0</td>
<td>41</td>
<td>475</td>
<td>709</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Education ..............................................</td>
<td>0.0</td>
<td>39</td>
<td>646</td>
<td>361</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Food Sales ............................................</td>
<td>0.0</td>
<td>39</td>
<td>1,541</td>
<td>282</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Food Service .........................................</td>
<td>0.0</td>
<td>39</td>
<td>1,994</td>
<td>561</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Health Care Inpatient ................................</td>
<td>0.0</td>
<td>39</td>
<td>1,938</td>
<td>582</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Health Care Outpatient .............................</td>
<td>0.0</td>
<td>39</td>
<td>737</td>
<td>571</td>
<td>0</td>
<td>0</td>
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<tr>
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<td>723</td>
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<td>0</td>
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<td>339</td>
<td>129</td>
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<td>0</td>
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<tr>
<td>Service ...............................................</td>
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<td>39</td>
<td>599</td>
<td>266</td>
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<tr>
<td>Warehouse and Storage ..............................</td>
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<td>352</td>
<td>181</td>
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<tr>
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<td>162</td>
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<td>0</td>
</tr>
</tbody>
</table>

## Section II: Pavement

| Pavement................................................| 18.05    | 903                                      |          |        |               |                             |

**Total Project Emissions:** 903
### Definition of Building Types

<table>
<thead>
<tr>
<th>Type (Residential) or Principal Activity (Commercial)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-Family Home</td>
<td>Unless otherwise specified, this includes both attached and detached buildings</td>
</tr>
<tr>
<td>Multi-Family Unit in Large Building</td>
<td>Apartments in buildings with more than 5 units</td>
</tr>
<tr>
<td>Multi-Family Unit in Small Building</td>
<td>Apartments in building with 2-4 units</td>
</tr>
<tr>
<td>Mobile Home</td>
<td>Buildings used for academic or technical classroom instruction, such as elementary, middle, or high schools, and classroom buildings on college or university campuses. Buildings on education campuses for which the main use is not classroom are included in the category relating to their use. For example, administration buildings are part of &quot;Office,&quot; dormitories are &quot;Lodging,&quot; and libraries are &quot;Public Assembly.&quot;</td>
</tr>
<tr>
<td>Education</td>
<td>Buildings used for academic or technical classroom instruction, such as elementary, middle, or high schools, and classroom buildings on college or university campuses. Buildings on education campuses for which the main use is not classroom are included in the category relating to their use. For example, administration buildings are part of &quot;Office,&quot; dormitories are &quot;Lodging,&quot; and libraries are &quot;Public Assembly.&quot;</td>
</tr>
<tr>
<td>Food Sales</td>
<td>Buildings used for retail or wholesale of food.</td>
</tr>
<tr>
<td>Food Service</td>
<td>Buildings used for preparation and sale of food and beverages for consumption.</td>
</tr>
<tr>
<td>Health Care Inpatient</td>
<td>Buildings used as diagnostic and treatment facilities for inpatient care.</td>
</tr>
<tr>
<td>Health Care Outpatient</td>
<td>Buildings used as diagnostic and treatment facilities for outpatient care. Doctor's or dentist's office are included here if they use any type of diagnostic medical equipment (if they do not, they are categorized as an outpatient health care building).</td>
</tr>
<tr>
<td>Lodging</td>
<td>Buildings used to offer multiple accommodations for short-term or long-term residents, including skilled nursing and other residential care buildings.</td>
</tr>
<tr>
<td>Retail (Other Than Mall)</td>
<td>Buildings used for the sale and display of goods other than food.</td>
</tr>
<tr>
<td>Office</td>
<td>Buildings used for general office space, professional office, or administrative offices. Doctor's or dentist's office are included here if they do not use any type of diagnostic medical equipment (if they do, they are categorized as an outpatient health care building).</td>
</tr>
<tr>
<td>Public Assembly</td>
<td>Buildings in which people gather for social or recreational activities, whether in private or non-private meeting halls.</td>
</tr>
<tr>
<td>Public Order and Safety</td>
<td>Buildings used for the preservation of law and order or public safety.</td>
</tr>
<tr>
<td>Religious Worship</td>
<td>Buildings in which people gather for religious activities, (such as chapels, churches, mosques, synagogues, and temples).</td>
</tr>
<tr>
<td>Service</td>
<td>Buildings in which some type of service is provided, other than food service or retail sales of goods.</td>
</tr>
<tr>
<td>Warehouse and Storage</td>
<td>Buildings used to store goods, manufactured products, merchandise, raw materials, or personal belongings (such as self-storage).</td>
</tr>
<tr>
<td>Other</td>
<td>Buildings that are industrial or agricultural with some retail space; buildings having several different commercial activities that, together, comprise 50 percent or more of the floorspace, but whose largest single activity is agricultural, industrial/manufacturing, or residential; and all other miscellaneous buildings that do not fit into any other category.</td>
</tr>
<tr>
<td>Vacant</td>
<td>Buildings in which more floorspace was vacant than was used for any single commercial activity at the time of interview. Therefore, a vacant building may have some occupied floorspace.</td>
</tr>
</tbody>
</table>

**Sources:**

**Residential**
- 2001 Residential Energy Consumption Survey
- Square footage measurements and comparisons
  - [http://www.eia.doe.gov/emeu/recs/sqft-measure.html](http://www.eia.doe.gov/emeu/recs/sqft-measure.html)

**Commercial**
- Commercial Buildings Energy Consumption Survey (CBECS), Description of CBECS Building Types
### Embodied Emissions Worksheet

**Section I: Buildings**

<table>
<thead>
<tr>
<th>Type (Residential) or Principal Activity (Commercial)</th>
<th># thousand sq feet/unit or building</th>
<th>Life span related embodied GHG missions (MTCO₂e/unit)</th>
<th>Life span related embodied GHG missions (MTCO₂e/thousand square feet) - See calculations in table below</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-Family Home</td>
<td>2.53</td>
<td>98</td>
<td>39</td>
</tr>
<tr>
<td>Multi-Family Unit in Large Building</td>
<td>0.85</td>
<td>33</td>
<td>39</td>
</tr>
<tr>
<td>Multi-Family Unit in Small Building</td>
<td>1.39</td>
<td>54</td>
<td>39</td>
</tr>
<tr>
<td>Mobile Home</td>
<td>1.06</td>
<td>41</td>
<td>39</td>
</tr>
<tr>
<td>Education</td>
<td>25.5</td>
<td>99</td>
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<tr>
<td>Food Sales</td>
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<tr>
<td>Food Service</td>
<td>1.9</td>
<td>217</td>
<td>39</td>
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<tr>
<td>Health Care Inpatient</td>
<td>241.6</td>
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<tr>
<td>Health Care Outpatient</td>
<td>10.4</td>
<td>403</td>
<td>39</td>
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<tr>
<td>Lodging</td>
<td>35.9</td>
<td>1,386</td>
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<tr>
<td>Retail (Other Than Mall)</td>
<td>0.7</td>
<td>378</td>
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<tr>
<td>Office</td>
<td>1.8</td>
<td>573</td>
<td>39</td>
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<tr>
<td>Public Assembly</td>
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<td>556</td>
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<td>Public Order and Safety</td>
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</tr>
<tr>
<td>Service</td>
<td>9.5</td>
<td>394</td>
<td>39</td>
</tr>
<tr>
<td>Warehouse and Storage</td>
<td>18.9</td>
<td>654</td>
<td>39</td>
</tr>
<tr>
<td>Other</td>
<td>11.1</td>
<td>546</td>
<td>39</td>
</tr>
<tr>
<td>Vacant</td>
<td>14.1</td>
<td>546</td>
<td>39</td>
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**Section II: Pavement**

<table>
<thead>
<tr>
<th>All Types of Pavement</th>
<th>Average GWP (lbs CO₂e/sq ft): Vancouver, Low Rise Building</th>
<th>Average Materials in a 2,272-square foot single family home</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Columns and Beams</td>
<td>MTCO₂e</td>
</tr>
<tr>
<td></td>
<td>Intermediate Floors</td>
<td>Total Embedded Emissions (MTCO₂e/thousand sq feet)</td>
</tr>
<tr>
<td></td>
<td>Exterior Walls</td>
<td>Total Embedded Emissions (MTCO₂e)</td>
</tr>
<tr>
<td></td>
<td>Windows</td>
<td>Emissions (MTCO₂e)</td>
</tr>
<tr>
<td></td>
<td>Interior Wall</td>
<td>MTCO₂e</td>
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<td></td>
<td>Roofs</td>
<td>MTCO₂e</td>
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<td>MTCO₂e</td>
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<td></td>
<td>MTCO₂e</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MTCO₂e</td>
</tr>
</tbody>
</table>

**Sources**

- All data in black text
- King County, DNRP. Contact: Matt Kuharic, matt.kuharic@kingcounty.gov
- Residential floorspace per unit: 2001 Residential Energy Consumption Survey (National Average, 2001)
- Square footage measurements and comparisons: http://www.eia.doe.gov/emeu/recs/soft-measure.html
- Average GWP (lbs CO₂e/sq ft): Vancouver, Low Rise Building: Athena EcoCalculator
- Athena Assembly Evaluation Tool v2.3: Vancouver Low Rise Building
- Assembly Average GWP (kgs) per square meter: http://www.athenasmi.ca/tools/ecoCalculator/index.html
- Lbs per kg: 2.20
- Square feet per square meter: 10.76
- Average Materials in a 2,272-square foot single family home: Buildings Energy Data Book: 7.3 Typical/Average Household
- Average window size: Energy Information Administration/Housing Characteristics 1993
- Appendix B. Quality of the Data. Pg. 5.
Four recent life cycle assessments of the environmental impacts of roads form the basis for the per unit embodied emissions of pavement. Each study is constructed in slightly different ways; however, the aggregate results of the reports represent a reasonable estimate of the GHG emissions that are created from the manufacture of paving materials, construction related emissions, and maintenance of the pavement over its expected life cycle.

The results of the studies are presented in different units and measures; considerable effort was undertaken to be able to compare the results of the studies in a reasonable way. For more details about the below methodology, contact matt.kuharic@kingcounty.gov.

The four studies, Meil (2001), Park (2003), Stripple (2001) and Treolar (2001) produced total GHG emissions of 4-34 MTCO2e per thousand square feet of finished paving (for similar asphalt and concrete based pavements). This estimate does not including downstream maintenance and repair of the highway. The average (for all concrete and asphalt pavements in the studies, assuming each study gets one data point) is ~17 MTCO2e/thousand square feet.

Three of the studies attempted to thoroughly account for the emissions associated with long term maintenance (40 years) of the roads. Stripple (2001), Park et al. (2003) and Treolar (2001) report 17, 81, and 68 MTCO2e/thousand square feet respectively, after accounting for maintenance of the roads.

Based on the above discussion, King County makes the conservative estimate that 50 MTCO2e/thousand square feet of pavement (over the development's life cycle) will be used as the embodied emission factor for pavement until better estimates can be obtained. This is roughly equivalent to 3,500 MTCO2e per lane mile of road (assuming the lane is 13 feet wide).

It is important to note that these studies estimate the embodied emissions for roads. Paving that does not need to stand up to the rigors of heavy use (such as parking lots or driveways) would likely use less materials and hence have lower embodied emissions.

Sources:


### Energy Emissions Worksheet

<table>
<thead>
<tr>
<th>Type (Residential) or Principal Activity (Commercial)</th>
<th>Energy consumption per building per year (million Btu)</th>
<th>Carbon Coefficient for Buildings</th>
<th>MTCO2e per building per year</th>
<th>Floorspace per Building (thousand square feet)</th>
<th>MTCE per thousand square feet per year</th>
<th>MTCO2e per thousand square feet per year</th>
<th>Average Building Life Span</th>
<th>Lifespan Energy Related MTCO2e emissions per unit</th>
<th>Lifespan Energy Related MTCO2e emissions per thousand square feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-Family Home</td>
<td>107.3</td>
<td>0.106</td>
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<td>672</td>
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<td>Multi-Family Unit in Large Building</td>
<td>41.0</td>
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<td>4.44</td>
<td>0.85</td>
<td>5.2</td>
<td>19.2</td>
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<td>422</td>
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<tr>
<td>Multi-Family Unit in Small Building</td>
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<td>0.108</td>
<td>8.45</td>
<td>1.39</td>
<td>6.1</td>
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<td>80.5</td>
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<td>489</td>
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<tr>
<td>Mobile Home</td>
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<td>0.106</td>
<td>8.21</td>
<td>1.06</td>
<td>7.7</td>
<td>28.4</td>
<td>57.9</td>
<td>475</td>
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<td>0.124</td>
<td>264.2</td>
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<td>10.3</td>
<td>37.9</td>
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<td>646</td>
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<td>Food Sales</td>
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<td>24.6</td>
<td>90.4</td>
<td>62.5</td>
<td>8,632</td>
<td>1,541</td>
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<tr>
<td>Food Service</td>
<td>1,436.0</td>
<td>0.124</td>
<td>178.5</td>
<td>5.6</td>
<td>31.9</td>
<td>116.9</td>
<td>62.5</td>
<td>11,168</td>
<td>1,994</td>
</tr>
<tr>
<td>Health Care Inpatient</td>
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<td>0.124</td>
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<td>241.4</td>
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<td>113.6</td>
<td>62.5</td>
<td>467,794</td>
<td>1,938</td>
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<tr>
<td>Health Care Outpatient</td>
<td>985.0</td>
<td>0.124</td>
<td>122.5</td>
<td>10.4</td>
<td>11.8</td>
<td>43.2</td>
<td>62.5</td>
<td>7,860</td>
<td>737</td>
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<tr>
<td>Lodging</td>
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<td>0.124</td>
<td>444.9</td>
<td>35.8</td>
<td>12.4</td>
<td>45.6</td>
<td>62.5</td>
<td>27,826</td>
<td>777</td>
</tr>
<tr>
<td>Retail (Other Than Mall)</td>
<td>720.0</td>
<td>0.124</td>
<td>89.5</td>
<td>9.7</td>
<td>9.2</td>
<td>33.8</td>
<td>62.5</td>
<td>5,599</td>
<td>577</td>
</tr>
<tr>
<td>Office</td>
<td>1,376.0</td>
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<td>171.1</td>
<td>14.8</td>
<td>11.6</td>
<td>42.4</td>
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<td>723</td>
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<td>166.4</td>
<td>14.2</td>
<td>11.7</td>
<td>43.0</td>
<td>62.5</td>
<td>10,405</td>
<td>733</td>
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<tr>
<td>Public Order and Safety</td>
<td>1,791.0</td>
<td>0.124</td>
<td>222.7</td>
<td>15.5</td>
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<tr>
<td>Religious Worship</td>
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<td>54.7</td>
<td>10.1</td>
<td>5.4</td>
<td>19.9</td>
<td>62.5</td>
<td>3,422</td>
<td>339</td>
</tr>
<tr>
<td>Service</td>
<td>501.0</td>
<td>0.124</td>
<td>62.3</td>
<td>6.5</td>
<td>9.6</td>
<td>35.1</td>
<td>62.5</td>
<td>3,896</td>
<td>599</td>
</tr>
<tr>
<td>Warehouse and Storage</td>
<td>764.0</td>
<td>0.124</td>
<td>95.0</td>
<td>16.9</td>
<td>5.6</td>
<td>20.6</td>
<td>62.5</td>
<td>5,942</td>
<td>352</td>
</tr>
<tr>
<td>Other</td>
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<td>0.124</td>
<td>447.6</td>
<td>21.9</td>
<td>20.4</td>
<td>74.9</td>
<td>62.5</td>
<td>27,997</td>
<td>1,278</td>
</tr>
<tr>
<td>Vacant</td>
<td>294.0</td>
<td>0.124</td>
<td>36.6</td>
<td>14.1</td>
<td>2.6</td>
<td>9.5</td>
<td>62.5</td>
<td>2,286</td>
<td>162</td>
</tr>
</tbody>
</table>

### Sources

All data in black text

- King County, DNRP. Contact: Matt Kuharic, matt.kuharic@kingcounty.gov

**Energy consumption for residential buildings**

2007 Buildings Energy Data Book: 6.1 Quad Definitions and Comparisons (National Average, 2001)

Table 6.1.4: Average Annual Carbon Dioxide Emissions for Various Functions

http://buildingsdatabook.eren.doe.gov/

Data also at: http://www.eia.doe.gov/emeu/recs/recs2001_ce/ce1-4c_housingunits2001.html

**Energy consumption for commercial buildings**


and

Table C3. Consumption and Gross Energy Intensity for Sum of Major Fuels for Non-Mall Buildings, 2003


**Note:** Data in plum color is found in both of the above sources (buildings energy data book and commercial buildings energy consumption survey).

**Carbon Coefficient for Buildings**

Buildings Energy Data Book (National average, 2005)

Table 3.1.7: 2005 Carbon Dioxide-Emission Coefficients for Buildings (MMTCO2e per Quadrillion Btu)

http://buildingsdatabook.eere.energy.gov/?id=view_book_table&TableID=2057

Note: Carbon coefficient in the Energy Data book is in MTCE per Quadrillion Btu.

To convert to MTCO2e per million Btu, this factor was divided by 1000 and multiplied by 44/12.

**Residential floorspace per unit**

2001 Residential Energy Consumption Survey (National Average, 2001)

Square footage measurements and comparisons

http://www.eia.doe.gov/emeu/recs/sqft-measure.html
The average lifespan of buildings is estimated by replacement time method, as follows:

<table>
<thead>
<tr>
<th></th>
<th>Single Family Homes</th>
<th>Multi-Family Units in Large and Small Buildings</th>
<th>All Residential Buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Housing Construction, 2001</td>
<td>1,273,000</td>
<td>329,000</td>
<td>1,602,000</td>
</tr>
<tr>
<td>Existing Housing Stock, 2001</td>
<td>73,700,000</td>
<td>26,500,000</td>
<td>100,200,000</td>
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<tr>
<td>Replacement time</td>
<td>57.9</td>
<td>80.5</td>
<td>62.5</td>
</tr>
</tbody>
</table>

(average, 2001)

Note: Single family homes calculation is used for mobile homes as a best estimate life span.
Note: At this time, KC staff could find no reliable data for the average life span of commercial buildings. Therefore, the average life span of residential buildings is being used until a better approximation can be ascertained.

Sources:

New Housing Construction,

- 2001 Quarterly Starts and Completions by Purpose and Design - US and Regions (Excel)
  http://www.census.gov/const/quarterly_starts_completions_cust.xls
- See also: http://www.census.gov/const/www/newresconstindex.html

Existing Housing Stock,

- 2001 Residential Energy Consumption Survey (RECS) 2001
  Tables HC1: Housing Unit Characteristics, Million U.S. Households 2001
  Table HC1-4a. Housing Unit Characteristics by Type of Housing Unit, Million U.S. Households, 2001
  Million U.S. Households, 2001
<table>
<thead>
<tr>
<th>Type (Residential) or Principal Activity (Commercial)</th>
<th># people/ unit or building</th>
<th># thousand sq feet/ unit or building</th>
<th># people or employees/ thousand square feet</th>
<th>vehicle related GHG emissions (metric tonnes CO2e per person per year)</th>
<th>MTCO2e/ year/ unit</th>
<th>MTCO2e/ year/ thousand square feet</th>
<th>Average Building Life Span</th>
<th>Life span transportation related GHG emissions (MTCO2e/ per unit)</th>
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</tbody>
</table>

**Sources**

All data in black text

King County, DNRP. Contact: Matt Kuharic, matt.kuharic@kingcounty.gov

- **# people/ unit**
  - Washington State Office of Financial Management
  - Note: This analysis combines Multi Unit Structures in both large and small units into one category; the average is used in this case although there is likely a difference

- **Residential floorspace per unit**
  - 2001 Residential Energy Consumption Survey (National Average, 2001)
  - Square footage measurements and comparisons
  - http://www.eia.doe.gov/emeu/recs/sqft-measure.html

- **# employees/thousand square feet**
  - Commercial Buildings Energy Consumption Survey commercial energy uses and costs (National Median, 2003)
  - Table B2 Totals and Medians of Floorspace, Number of Workers, and Hours of Operation for Non-Mall Buildings, 2003
  - Note: Data for # employees/thousand square feet is presented by CBECs as square feet/employee.
  - In this analysis employees/thousand square feet is calculated by taking the inverse of the CBECs number and multiplying by 1000.
vehicle related GHG emissions

Estimate calculated as follows (Washington state, 2006)

56,531,930,000 2006 Annual WA State Vehicle Miles Traveled
Data was daily VMT. Annual VMT was 365*daily VMT.
http://www.wsdot.wa.gov/mapsdata/tdo/annualmileage.htm

6,395,798 2006 WA state population
http://quickfacts.census.gov/qfd/states/53000.html

8839 vehicle miles per person per year

0.0506 gallon gasoline/mile

This is the weighted national average fuel efficiency for all cars and 2 axle, 4 wheel light trucks in 2005. This includes pickup trucks, vans and SUVs. The 0.051 gallons/mile used here is the inverse of the more commonly known term "miles/per gallon" (which is 19.75 for these cars and light trucks).

Note: This report states that in 2005, 92.3% of all highway VMT were driven by the above described vehicles.
http://cta.ornl.gov/data/tebd26/Spreadsheets/Table3_04.xls

24.3 lbs CO2e/gallon gasoline
The CO2 emissions estimates for gasoline and diesel include the extraction, transport, and refinement of petroleum as well as their combustion.
Life-Cycle CO2 Emissions for Various New Vehicles. RENew Northfield.
Note: This is a conservative estimate of emissions by fuel consumption because diesel fuel,

2205
with a emissions factor of 26.55 lbs CO2e/gallon was not estimated.

4.93 lbs/metric tonne
vehicle related GHG emissions (metric tonnes CO2e per person per year)

average life span of buildings, estimated by replacement time method
See Energy Emissions Worksheet for Calculations

Commercial floorspace per unit
Table C3. Consumption and Gross Energy Intensity for Sum of Major Fuels for Non-Mall Buildings, 2003
APPENDIX C

Arborist Report
Arborist Report

To: Berger Partnership, c/o Jason Henry
Site: Western Washington University – Electrical Engineering & Computer Science Parking
Re: Tree Inventory & Assessment
Date: July 23, 2021
Project Arborist: Josh Petter
ISA Board Certified Master Arborist #PN- 8406B
ISA Qualified Tree Risk Assessor
Referenced Documents: WWU EE/CS Parking Lot Schematic Design: One-Way 45° Angled Parking (Perkins & Will) – See attached plans
Attached: Table of Trees
Tree Site Map
Parking lot layout

Summary
Katie Hogan, of Tree Solutions Inc, inventoried and assessed 40 trees adjacent to the proposed parking lot remodel for the Electrical Engineering & Computer Science Building at Western Washington University (WWU). She assessed all trees greater than 6 inches diameter at standard height (DSH) that may be impacted by the development.

The project has a one-way parking lot that will be constructed on an existing gravel parking area.

The proposed option has 43 parking stalls and 87.5-percent tree retention, with five trees requiring removal.
Assignment and Scope of Work
This report documents the visit by Katie Hogan of Tree Solutions Inc. on February 25, 2021 to the above referenced site. She was asked to complete a tree inventory and assessment by Berger Partnership in preparation for construction of a parking lot. This report is a revision of the initial report based on the selection of a final design plan.

Observations
Site
The site sits within the 196 acre campus and is located just east of the Gamma Building adjacent to W College Way. The property is owned by WWU and located in the City of Bellingham.

The subject trees are located in a greenspace that is relatively undisturbed and has multiple dirt or gravel paths leading from the lower road to the Gamma Building. The project area is approximately 15,000 square feet.

There is a temporary gravel parking area on site that is currently used as parking for construction crews.

Trees
The site consists of mostly native tree species, including: Douglas-fir (*Pseudotsuga menziesii*), bigleaf maple (*Acer macrophyllum*), red alder (*Alnus rubra*), western redcedar (*Thuja plicata*), Oregon ash (*Fraxinus latifolia*), bitter cherry (*Prunus emarginata var. mollis*), and giant sequoia (*Sequoiadendron giganteum*).

The majority of mature trees were located on the south and north ends of the project area. The area west of the existing gravel parking lot included mostly early-successional tree species and invasive plants, mainly Himalayan blackberry (*Rubus bifrons*).

A table of trees is attached with detailed information about each tree.

Proposed Plans
The most recent plans (WWU Electrical Engineering and Computer Science Building, Perkins & Will – See attached layout) propose a one-way angled parking lot.

*One-Way, 45° Angled Parking*
This option proposes 43 angled parking stalls. The footprint for the parking is similar to the existing gravel parking area and does not encroach substantially within the existing tree line. These plans would necessitate the removal of 6 trees: 1, 9, 18, 32, and 33.

Tree 9 is a mature 23.3-inch DSH Douglas-fir located at the west edge of the existing gravel parking lot and will require removal due to condition and proximity to construction disturbance. This tree has a canopy with stunted growth and low live crown ratio, possibly from the previous disturbance of gravel installation. A catch basin and drainage are proposed in close proximity to this tree which will lead to further disturbance and decline.

The remainder of the trees are small (less than 13-inch DSH) red alder or western redcedar trees. All of these trees are on the edge of construction and require removal to accommodate the parking.
This design option supports a high level of tree retention on the site, resulting in 87.5-percent tree retention for the project area.

**Recommendations**

- Install tree protection fencing around all protected trees. See Appendix F - Tree Protection Specifications for more details.

- All pruning should be conducted by an ISA certified arborist and following ANSI A300 specifications.¹

- Remove invasive plant species and replace with 4 inches of coarse arborist woodchips.

Respectfully submitted,
Josh Petter,
Consulting Arborist
Appendix A  Glossary

ANSI A300:  American National Standards Institute (ANSI) standards for tree care

DBH or DSH:  diameter at breast or standard height; the diameter of the trunk measured 54 inches (4.5 feet) above grade (Council of Tree and Landscape Appraisers 2019)

ISA:  International Society of Arboriculture

Regulated Tree:  A tree required by municipal code to be identified in an arborist report.

Visual Tree Assessment (VTA):  method of evaluating structural defects and stability in trees by noting the pattern of growth. Developed by Claus Mattheck (Harris, et al 1999)
Appendix B References


Appendix C  Photographs

Photo 1. Looking west toward subject area showing existing conditions
Tree 9 - Remove

Photo 2. Looking west toward subject area. Tree 9 is shown in foreground and will require removal.
Photo 3. Looking west toward subject area at north end of site. Grove of giant sequoia trees are high value retention trees and are proposed for retention.
Photo 4. Looking west toward subject area at north end of site. Several smaller trees are growing within 10 feet of existing gravel parking lot. Trees 31, 32, and 33 are proposed for removal for either design option. Tree 31 may be suitable for retention as impacts will be minimal.
Photo 5. Looking northwest toward subject area at north end of site showing existing conditions. Many healthy conifers exist in this portion of the site that are high value retention trees.
Appendix D  Assumptions & Limiting Conditions

1. Consultant assumes that the site and its use do not violate, and is in compliance with, all applicable codes, ordinances, statutes or regulations.

2. The consultant may provide a report or recommendation based on published municipal regulations. The consultant assumes that the municipal regulations published on the date of the report are current municipal regulations and assumes no obligation related to unpublished city regulation information.

3. Any report by the consultant and any values expressed therein represent the opinion of the consultant, and the consultant’s fee is in no way contingent upon the reporting of a specific value, a stipulated result, the occurrence of a subsequent event, or upon any finding to be reported.

4. All photographs included in this report were taken by Tree Solutions, Inc. during the documented site visit, unless otherwise noted. Sketches, drawings and photographs (included in, and attached to, this report) are intended as visual aids and are not necessarily to scale. They should not be construed as engineering drawings, architectural reports or surveys. The reproduction of any information generated by architects, engineers or other consultants and any sketches, drawings or photographs is for the express purpose of coordination and ease of reference only. Inclusion of such information on any drawings or other documents does not constitute a representation by the consultant as to the sufficiency or accuracy of the information.

5. Unless otherwise agreed, (1) information contained in any report by consultant covers only the items examined and reflects the condition of those items at the time of inspection; and (2) the inspection is limited to visual examination of accessible items without dissection, excavation, probing, climbing, or coring.

6. These findings are based on the observations and opinions of the authoring arborist, and do not provide guarantees regarding the future performance, health, vigor, structural stability or safety of the plants described and assessed.

7. Measurements are subject to typical margins of error, considering the oval or asymmetrical cross-section of most trunks and canopies.

8. Tree Solutions did not review any reports or perform any tests related to the soil located on the subject property unless outlined in the scope of services. Tree Solutions staff are not and do not claim to be soils experts. An independent inventory and evaluation of the site’s soil should be obtained by a qualified professional if an additional understanding of the site’s characteristics is needed to make an informed decision.

9. Our assessments are made in conformity with acceptable evaluation/diagnostic reporting techniques and procedures, as recommended by the International Society of Arboriculture.
Appendix E  Methods

Measuring
I measured the diameter of each tree at 54 inches above grade, diameter at standard height (DSH). If a tree had multiple stems, I measured each stem individually at standard height and determined a single-stem equivalent diameter by using the method outlined in the Guide for Plant Appraisal, 10th Edition Second Printing published by the Council of Tree and Landscape Appraisers. A tree is regulated based on this single-stem equivalent diameter value. Because this value is calculated in the office following field work, some trees in our data set may have diameters smaller than 6 inches. These trees are included in the tree table for informational purposes only and not factored into tree totals discussed in this report.

Evaluating
I evaluated tree health and structure utilizing visual tree assessment (VTA) methods. The basis behind VTA is the identification of symptoms, which the tree produces in reaction to a weak spot or area of mechanical stress. A tree reacts to mechanical and physiological stresses by growing more vigorously to re-enforce weak areas, while depriving less stressed parts. An understanding of the uniform stress allows the arborist to make informed judgments about the condition of a tree.

Rating
When rating tree health, I took into consideration crown indicators such as foliar density, size, color, stem and shoot extensions. When rating tree structure, I evaluated the tree for form and structural defects, including past damage and decay. Tree Solutions has adapted our ratings based on the Purdue University Extension formula values for health condition (Purdue University Extension bulletin FNR-473-W - Tree Appraisal). These values are a general representation used to assist arborists in assigning ratings.

Excellent - Perfect specimen with excellent form and vigor, well-balanced crown. Normal to exceeding shoot length on new growth. Leaf size and color normal. Trunk is sound and solid. Root zone undisturbed. No apparent pest problems. Long safe useful life expectancy for the species.

Good - Imperfect canopy density in few parts of the tree, up to 10% of the canopy. Normal to less than ¾ typical growth rate of shoots and minor deficiency in typical leaf development. Few pest issues or damage, and if they exist they are controllable or tree is reacting appropriately. Normal branch and stem development with healthy growth. Safe useful life expectancy typical for the species.

Fair - Crown decline and dieback up to 30% of the canopy. Leaf color is somewhat chlorotic/necrotic with smaller leaves and “off” coloration. Shoot extensions indicate some stunting and stressed growing conditions. Stress cone crop clearly visible. Obvious signs of pest problems contributing to lesser condition, control might be possible. Some decay areas found in main stem and branches. Below average safe useful life expectancy

Poor - Lacking full crown, more than 50% decline and dieback, especially affecting larger branches. Stunting of shoots is obvious with little evidence of growth on smaller stems. Leaf size and color reveals overall stress in the plant. Insect or disease infestation may be severe and uncontrollable. Extensive decay or hollows in branches and trunk. Short safe useful life expectancy.
Appendix F  Tree Protection Specifications

The following is a list of protection measures that must be employed before, during and after construction to ensure the long-term viability of retained trees.

1. **Project Arborist:** The project arborists shall at minimum have an International Society of Arboriculture (ISA) Certification and ISA Tree Risk Assessment Qualification.

2. **Tree Protection Area (TPA):** TPA is the area within the dripline of all retained trees. The TPA for non-exceptional trees may be reduced to within the dripline based on the recommendation of the project arborist. The TPA for exceptional trees may be reduced to within the dripline based on the recommendation of the project arborist and approval by the City of Seattle.

3. **Tree Protection Fencing:** Tree protection fencing shall consist of 6-foot tall chain-link fencing installed at the edge of the TPA as approved by the project arborist. Fence posts shall be anchored into the ground or bolted to existing hardscape surfaces.
   a. Where trees are being retained as a group the fencing shall encompass the entire area including all landscape beds or lawn areas associated with the group.
   b. Per arborist approval, TPA fencing may be placed at the edge of existing hardscape within the TPA to allow for staging and traffic.
   c. Where work is planned within the TPA, install fencing at edge of TPA and move to limits of disturbance at the time that the work within the TPA is planned to occur. This ensures that work within the TPA is completed to specification.
   d. Where trees are protected at the edge of the project boundary, construction limits fencing shall be incorporated as the boundary of tree protection fencing.

4. **Tree Protection Signage:** Tree protection signage shall be affixed to fencing every 20 feet. Signage shall be fluorescent, at least 2’ x 2’ in size.

5. **Filter / Silt Fencing:** Filter / silt fencing within, or at the edge of the TPA of retained trees shall be installed in a manner that does not sever roots. Install so that filter / silt fencing sits on the ground and is weighed in place by sandbags or gravel. Do not trench to insert filter / silt fencing into the ground.

6. **Soil Protection:** Retain existing paved surfaces within or at the edge of the TPA for as long as possible. No parking, foot traffic, materials storage, or dumping (including excavated soils) are allowed within the TPA. Heavy machinery shall remain outside of the TPA. Access to the tree protection area will be granted under the supervision of the project arborist. If project arborist allows, heavy machinery can enter the area if soils are protected from the load. Acceptable methods of soil protection include placing 3/4-inch plywood over 4 to 6 inches of wood chip mulch, or use of AlturnaMats® (or equivalent product approved by the project arborist). Compaction of soils within the TPA must not occur.

7. **Soil Remediation:** Soil compacted within the TPA of retained trees shall be remediated using pneumatic air excavation according to a specification produced by the project arborist.

8. **Canopy Protection:** Where fencing is installed at the limits of disturbance within the TPA, canopy management (pruning or tying back) shall be conducted to ensure that vehicular traffic does not damage canopy parts. Exhaust from machinery shall be located 5 feet outside the dripline of retained trees. No exhaust shall come in contact with foliage for prolonged periods of time.

9. **Duff/Mulch:** Apply 6 inches of arborist wood chip mulch or hog fuel over bare soil within the TPA to prevent compaction and evaporation. TPA shall be free of invasive weeds to facilitate mulch application. Keep mulch 1 foot away from the base of trees and 6 inches from retained understory vegetation. Retain and protect as much of the existing duff and understory vegetation as possible.
10. **Excavation:** Excavation done within the TPA shall use alternative methods such as pneumatic air excavation or hand digging. If heavy machinery is used, use flat front buckets with the project arborist spotting for roots. When roots are encountered, stop excavation and cleanly sever roots. The project arborist shall monitor all excavation done within the TPA.

11. **Fill:** Limit fill to 1 foot of uncompacted well-draining soil, within the TPA of retained trees. In areas where additional fill is required, consult with the project arborist. Fill must be kept at least 1 foot from the trunks of trees.

12. **Root Pruning:** Limit root pruning to the extent possible. All roots shall be pruned with a sharp saw making clean cuts. Do not fracture or break roots with excavation equipment.

13. **Root Moisture:** Root cuts and exposed roots shall be immediately covered with soil, mulch, or clear polyethylene sheeting and kept moist. Water to maintain moist condition until the area is back filled. Do not allow exposed roots to dry out before replacing permanent back fill.

14. **Tree Removal:** All trees to be removed that are located within the TPA of retained trees shall not be ripped, pulled, or pushed over. The tree should be cut to the base and the stump either left or ground out. A flat front bucket can also be used to sever roots around all sides of the stump, or the roots can be exposed using hydro or air excavation and then cut before removing the stump.

15. **Irrigation:** Retained trees with soil disturbance within the TPA will require supplemental water from June through September. Acceptable methods of irrigation include drip, sprinkler, or watering truck. Trees shall be watered three times per month during this time.

16. **Pruning:** Pruning required for construction and safety clearance shall be done with a pruning specification provided by the project arborist in accordance with American National Standards Institute ANSI-A300 2017 Standard Practices for Pruning. Pruning shall be conducted or monitored by an arborist with an ISA Certification.

17. **Plan Updates:** All plan updates or field modification that result in impacts within the TPA or change the retained status of trees shall be reviewed by the senior project manager and project arborist prior to conducting the work.

18. **Materials:** Contractor shall have the following materials on-site and available for use during work in the TPA:
   - Sharp and clean bypass hand pruners
   - Sharp and clean bypass loppers
   - Sharp hand-held root saw
   - Reciprocating saw with new blades
   - Shovels
   - Trowels
   - Clear polyethylene sheeting
   - Burlap
   - Water
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<th>Structural Condition</th>
<th>Dripline Radius (feet)</th>
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<th>Recommended TPZ per Industry Standards (feet)</th>
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<td>Good</td>
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<td>Remove</td>
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<td>Good</td>
<td>8.3</td>
<td>Retain</td>
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<td>Bigleaf maple</td>
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<td>Fair</td>
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<td>Retain</td>
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<td>Broken parts in canopy. Canopy asymmetrical to east with some weak attachments</td>
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<td>Good</td>
<td>11.2</td>
<td>Retain</td>
<td>19</td>
<td>Low live crown ratio approximately 40 to 50%. Some visible structural roots, overall in good condition</td>
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<td>Pseudotsuga menziesii</td>
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<td>Good</td>
<td>Good</td>
<td>4.9</td>
<td>Retain</td>
<td>14</td>
<td>Stunted canopy with low live crown ratio. Structural roots visible. May not be ideal for retention if any adjacent trees are removed</td>
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<td>15.4</td>
<td>Fair</td>
<td>Poor</td>
<td>18.6</td>
<td>Retain</td>
<td>10</td>
<td>Broken top with one main branch to northeast, not ideal structure</td>
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<td>7</td>
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<td>Western redcedar</td>
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<td>Good</td>
<td>Good</td>
<td>19.3</td>
<td>Retain</td>
<td>20</td>
<td>Dominant tree on slope. Some small surface roots visible on dirt trail. Canopy asymmetrical to northeast</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Acer macrophyllum</td>
<td>Bigleaf maple</td>
<td>16.6</td>
<td>Good</td>
<td>Good</td>
<td>20.7</td>
<td>Retain</td>
<td>11</td>
<td>Canopy slightly suppressed beneath adjacent fir trees. Minimal interior sprouts, located directly northeast of dirt trail</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Pseudotsuga menziesii</td>
<td>Douglas-fir</td>
<td>23.3</td>
<td>Fair</td>
<td>Fair</td>
<td>9.0</td>
<td>Retain</td>
<td>16</td>
<td>Stunted canopy with low live crown ratio. Located just west of gravel parking lot. Retention not likely feasible</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Fraxinus latifolia</td>
<td>Oregon ash</td>
<td>9.5</td>
<td>4,9,8.1</td>
<td>Good</td>
<td>Fair</td>
<td>20.4</td>
<td>Retain</td>
<td>6 Damaged by fir tree failure. Canopy asymmetrical to east. Surface roots visible</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Prunus emarginata var. mollis</td>
<td>Bitter cherry</td>
<td>6.7</td>
<td>3,6</td>
<td>Good</td>
<td>Good</td>
<td>10.3</td>
<td>Retain</td>
<td>4 Cherry tree that’s multi-stemmed located about 15 ft north of tree 10, overall good condition</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Prunus emarginata var. mollis</td>
<td>Bitter cherry</td>
<td>12.0</td>
<td>Good</td>
<td>Fair</td>
<td>18.5</td>
<td>Retain</td>
<td>8 Base damaged from tree failure, strongly swept base, overall condition is good</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Acer macrophyllum</td>
<td>Bigleaf maple</td>
<td>10.5</td>
<td>Good</td>
<td>Good</td>
<td>12.4</td>
<td>Retain</td>
<td>7</td>
<td>Stump sprout maple located about 10 to 12 ft north of tree 12</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Fraxinus latifolia</td>
<td>Oregon ash</td>
<td>15.5</td>
<td>8,2,10,8.5</td>
<td>Good</td>
<td>Good</td>
<td>18.6</td>
<td>Retain</td>
<td>10 Ash tree growing on slope located about 35 feet from west edge of gravel parking lot</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Acer macrophyllum</td>
<td>Bigleaf maple</td>
<td>13.1</td>
<td>5,6,4,4,4.5</td>
<td>Good</td>
<td>Fair</td>
<td>20.5</td>
<td>Retain</td>
<td>9 Stump sprout maple located about 20 ft from west edge of gravel parking</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Acer macrophyllum</td>
<td>Bigleaf maple</td>
<td>6.3</td>
<td>Good</td>
<td>Good</td>
<td>22.3</td>
<td>Retain</td>
<td>4 Small maple about 15 ft from west edge of gravel parking lot. Canopy barely overhangs parking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Acer macrophyllum</td>
<td>Bigleaf maple</td>
<td>17.8</td>
<td>14,11</td>
<td>Good</td>
<td>Fair</td>
<td>21.7</td>
<td>Retain</td>
<td>12 Maple growing about 18 ft from west edge of parking. Some decay visible at base otherwise good condition</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Alnus rubra</td>
<td>Red alder</td>
<td>6.0</td>
<td>Good</td>
<td>Good</td>
<td>10.3</td>
<td>Remove</td>
<td>4</td>
<td>Alder tree surrounded by blackberry located three feet from west edge of gravel parking. Retention not likely feasible</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Alnus rubra</td>
<td>Red alder</td>
<td>9.0</td>
<td>Good</td>
<td>Fair</td>
<td>13.4</td>
<td>Retain</td>
<td>6 Alder tree 26 ft from west edge of gravel. Previously broken top</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Alnus rubra</td>
<td>Red alder</td>
<td>12.0</td>
<td>Poor</td>
<td>Poor</td>
<td>10.5</td>
<td>Retain</td>
<td>8 Alder tree 29 ft from west edge of gravel parking. Main stem completely dead with some living branches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Thuja plicata</td>
<td>Western redcedar</td>
<td>11.5</td>
<td>Good</td>
<td>Good</td>
<td>10.5</td>
<td>Retain</td>
<td>8 Healthy cedar tree located about 20 feet from west edge of gravel parking. High priority for retention</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Pseudotsuga menziesii</td>
<td>Douglas-fir</td>
<td>10.2</td>
<td>Good</td>
<td>Good</td>
<td>12.4</td>
<td>Retain</td>
<td>7 Healthy fir tree about 15 feet from west edge of gravel parking. High priority for retention</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Thuja plicata</td>
<td>Western redcedar</td>
<td>13.7</td>
<td>Good</td>
<td>Good</td>
<td>11.6</td>
<td>Retain</td>
<td>9 Healthy cedar tree about 25 ft from west edge of gravel. Parking. High priority for retention</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Thuja plicata</td>
<td>Western redcedar</td>
<td>11.5</td>
<td>Good</td>
<td>Good</td>
<td>13.5</td>
<td>Retain</td>
<td>8 Healthy cedar tree about 30 ft from west edge of gravel parking lot. High priority for retention</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tree ID</td>
<td>Scientific Name</td>
<td>Common Name</td>
<td>DBH (inches)</td>
<td>Health Condition</td>
<td>Structural Condition</td>
<td>Dripline Radius (feet)</td>
<td>Parking - 45 Deg Parking</td>
<td>Recommended TPZ per Industry Standards (feet)</td>
<td>Notes</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------</td>
<td>-------------</td>
<td>--------------</td>
<td>------------------</td>
<td>----------------------</td>
<td>------------------------</td>
<td>--------------------------</td>
<td>-------------------------------------------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Acer macrophyllum</td>
<td>Bigleaf maple</td>
<td>10.5</td>
<td>Good</td>
<td>Good</td>
<td>18.4</td>
<td>Retain</td>
<td>7</td>
<td>Maple tree with swept base about 20 feet from west edge of gravel parking lot.</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Pseudotsuga menziesii</td>
<td>Douglas-fir</td>
<td>7.0</td>
<td>Good</td>
<td>Good</td>
<td>8.3</td>
<td>Retain</td>
<td>5</td>
<td>Young fir tree located about 15 ft from west edge of gravel parking lot. High priority for retention</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Alnus rubra</td>
<td>Red alder</td>
<td>12.8</td>
<td>Good</td>
<td>Fair</td>
<td>15.5</td>
<td>Retain</td>
<td>9</td>
<td>Broken top Alder tree about 25 feet from west edge of gravel parking lot</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Pseudotsuga menziesii</td>
<td>Douglas-fir</td>
<td>8.5</td>
<td>Good</td>
<td>Good</td>
<td>10.4</td>
<td>Retain</td>
<td>6</td>
<td>Young fir tree with high live crown ratio. Surface roots visible, located 15 to 18 feet from west edge of gravel parking lot</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Alnus rubra</td>
<td>Red alder</td>
<td>12.1</td>
<td>Fair</td>
<td>Fair</td>
<td>12.5</td>
<td>Retain</td>
<td>8</td>
<td>Top dead, may not be suitable for retention if usage increases</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Acer macrophyllum</td>
<td>Bigleaf maple</td>
<td>11.1</td>
<td>Good</td>
<td>Good</td>
<td>20.5</td>
<td>Retain</td>
<td>7</td>
<td>Healthy maple tree some surface roots visible</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Alnus rubra</td>
<td>Red alder</td>
<td>6.3</td>
<td>Fair</td>
<td>Fair</td>
<td>14.3</td>
<td>Retain</td>
<td>4</td>
<td>Alder tree with structure that's not ideal, surface roots visible, removal recommended</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Thuja plicata</td>
<td>Western redcedar</td>
<td>6.3</td>
<td>Good</td>
<td>Good</td>
<td>9.3</td>
<td>Remove</td>
<td>4</td>
<td>Located 4 ft from west edge of gravel path, retention not likely feasible</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Thuja plicata</td>
<td>Western redcedar</td>
<td>12.0</td>
<td>Good</td>
<td>Good</td>
<td>11.5</td>
<td>Remove</td>
<td>8</td>
<td>Healthy cedar tree located 8 ft from existing gravel parking lot to West. Retention unlikely feasible</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>Acer macrophyllum</td>
<td>Bigleaf maple</td>
<td>9.0</td>
<td>Good</td>
<td>Good</td>
<td>20.4</td>
<td>Retain</td>
<td>6</td>
<td>Healthy maple tree located about 23 ft from gravel parking</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Acer macrophyllum</td>
<td>Bigleaf maple</td>
<td>6.5</td>
<td>Good</td>
<td>Good</td>
<td>16.3</td>
<td>Retain</td>
<td>4</td>
<td>Maple tree stilted root</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Sequoiadendron giganteum</td>
<td>Giant sequoia</td>
<td>28.0</td>
<td>Good</td>
<td>Good</td>
<td>13.2</td>
<td>Retain</td>
<td>19</td>
<td>Sequoia tree surrounded by blackberry located about 15 feet from west edge of gravel parking. High priority for retention</td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>Sequoiadendron giganteum</td>
<td>Giant sequoia</td>
<td>35.2</td>
<td>Good</td>
<td>Good</td>
<td>14.5</td>
<td>Retain</td>
<td>23</td>
<td>Sequoia tree located along gravel path about 15 ft from west edge of parking. High priority for retention</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>Pseudotsuga menziesii</td>
<td>Douglas-fir</td>
<td>8.2</td>
<td>Good</td>
<td>Good</td>
<td>13.3</td>
<td>Retain</td>
<td>5</td>
<td>Tree tree located a few feet north of gravel trail. High priority for retention</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>Acer macrophyllum</td>
<td>Bigleaf maple</td>
<td>7.2</td>
<td>Good</td>
<td>Good</td>
<td>12.3</td>
<td>Retain</td>
<td>5</td>
<td>Located adjacent to Tree 38. High priority for retention</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Sequoiadendron giganteum</td>
<td>Giant sequoia</td>
<td>29.0</td>
<td>Good</td>
<td>Good</td>
<td>12.0</td>
<td>Retain</td>
<td>15</td>
<td>Sequoia located about 15 feet from road. High priority for retention</td>
<td></td>
</tr>
</tbody>
</table>

**Tree Retention and Removal**

<table>
<thead>
<tr>
<th>Total Trees Removed</th>
<th>Total Trees Retained</th>
<th>Retention Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>35</td>
<td>87.5%</td>
</tr>
</tbody>
</table>

**Table of Trees**

WWU EE/CS Parking Lot

5 W College Way, Bellingham, WA 98225

Arborist: K. Hogan

Date of Inventory: 02.25.2021

Table Prepared: 03.16.2021, revised 07.23.2021
GENERAL NOTES
1. THIS EXHIBIT IS BASED ON SURVEY PRODUCED BY LARRY STEELE & ASSOCIATES ON 4/2/2021.
2. SEE WWU EE/CS PARKING LOT TREE INVENTORY REPORT BY TREE SOLUTIONS INC. ON 3/16/2021 FOR MORE TREE INFORMATION AND WWU TO CONFIRM IF TREE REMOVAL & ACCEPTABLE BASED ON ARBONET REPORT.

DRAINAGE REQUIREMENTS
1. FLOW CONTROL AND WATER QUALITY ARE REQUIRED FOR THIS PROJECT. STORM DRAINAGE DESIGN WILL BE COMPLETED PRIOR TO FINAL.
2. THE DETENTION VOLUME NEEDED IS APPROXIMATELY 4,000 CF AND THE SYSTEM WILL NEED TO BE A SHALLOW. WE RECOMMEND THE STORMTECH 50-310 CHAMBER, THE DETENTION VOLUME PER CHAMBER IS 220 CF.
3. FOR PRELIMINARY PRICING, ASSUME THE FOLLOWING:
   • (200) STORMTECH 50-310 CHAMBERS
   • (5) TYPE I CATCH BASINS
   • 250 LF 8" PVC STORM DRAINAGE PIPE

PARKING STANDARDS
TOTAL PARKING STALLS = 43
MINIMUM PARKING STANDARDS PER CITY OF BELLINGHAM MUNICIPAL CODE (20.08.020)

Fig. 10 One-Way Traffic