Preliminary Storm Drainage Report
City of Carnation

For

Brewer Short Plat
31731 W. Commercial St.
Carnation WA, 98014

December 29, 2023

12/29/2023

Encompass Engineering Job No. 23580

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I. PROJECT OVERVIEW

Project: Brewer Construction Inc. Short Plat
Site Address: 31731 W. Commercial St., Carnation, WA 98014 (Vicinity Map below)
Tax Parcel: 865830-3300
Zoning: R6 (Single-Family Residential)
Site Area: 12,501 SF (0.29 AC)

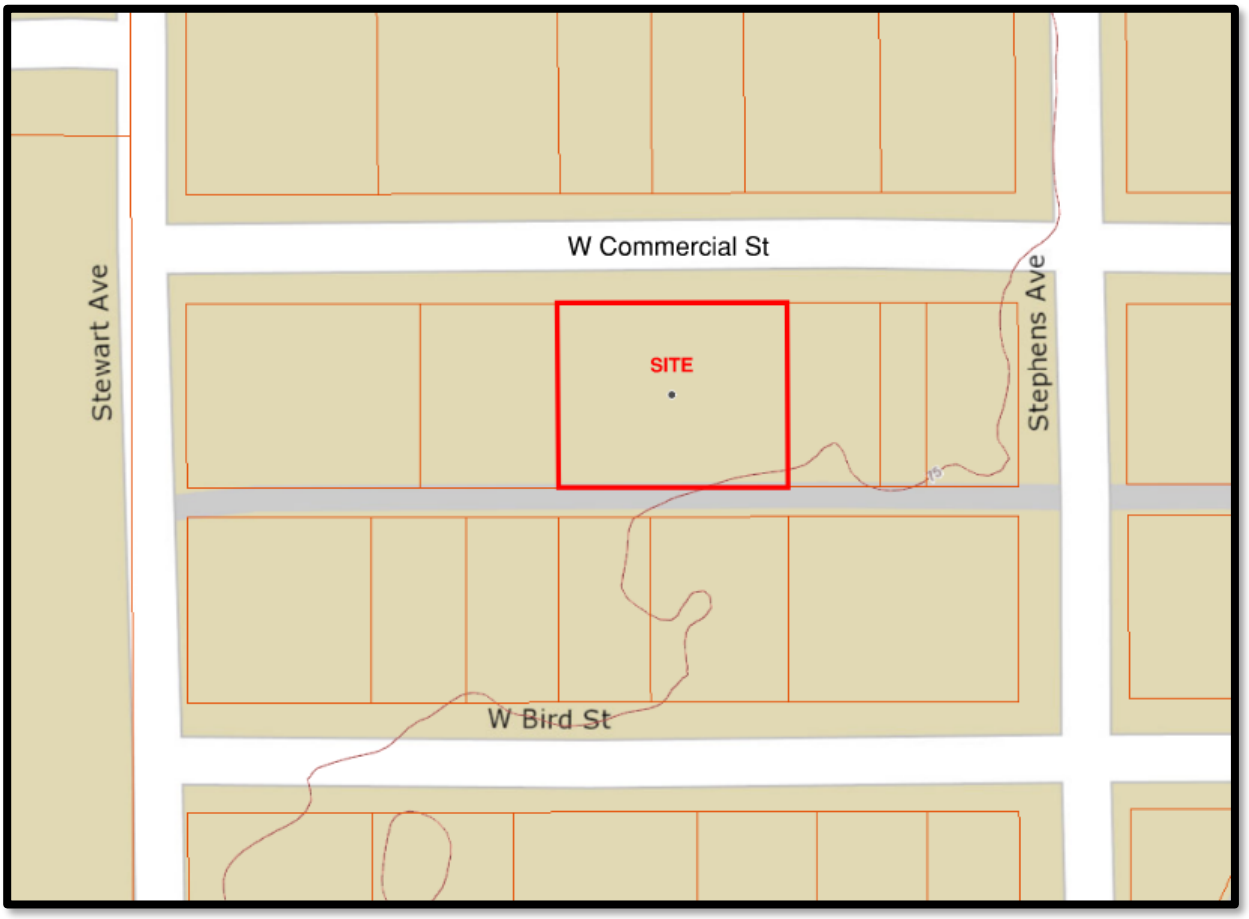


Figure 1: Vicinity Map

Existing Adjacent Development:

Existing developments adjacent to the subject site includes the following:

North – W. Commercial St.
East –Single Family Residence
West – Single Family Residence
South – Alley

Existing Conditions:

The central portion of the 0.29-acre parcel is currently developed with a single-family residence/garage structure with access from both W Commercial St. to the north and an alleyway to the south (the site currently does not contain a driveway). Apart from the single-family residence/garage, the site contains a concrete sidewalk that runs from the northern side of the residence to W Commercial Street, as well as some other miscellaneous concrete pads surrounding the garage. Runoff from the existing residence/garage roof area is discharged directly onto the surrounding lawn, where it eventually infiltrates into the ground or flows into the public right-of-way (ROW) for W Commercial Street. Runoff from the miscellaneous concrete on the site also sheet flows onto the adjacent lawn. The remainder of the site is primarily covered with lawn, shrubs, and a few trees. Please refer to the Existing Conditions Map (Figure 3) on the following page.

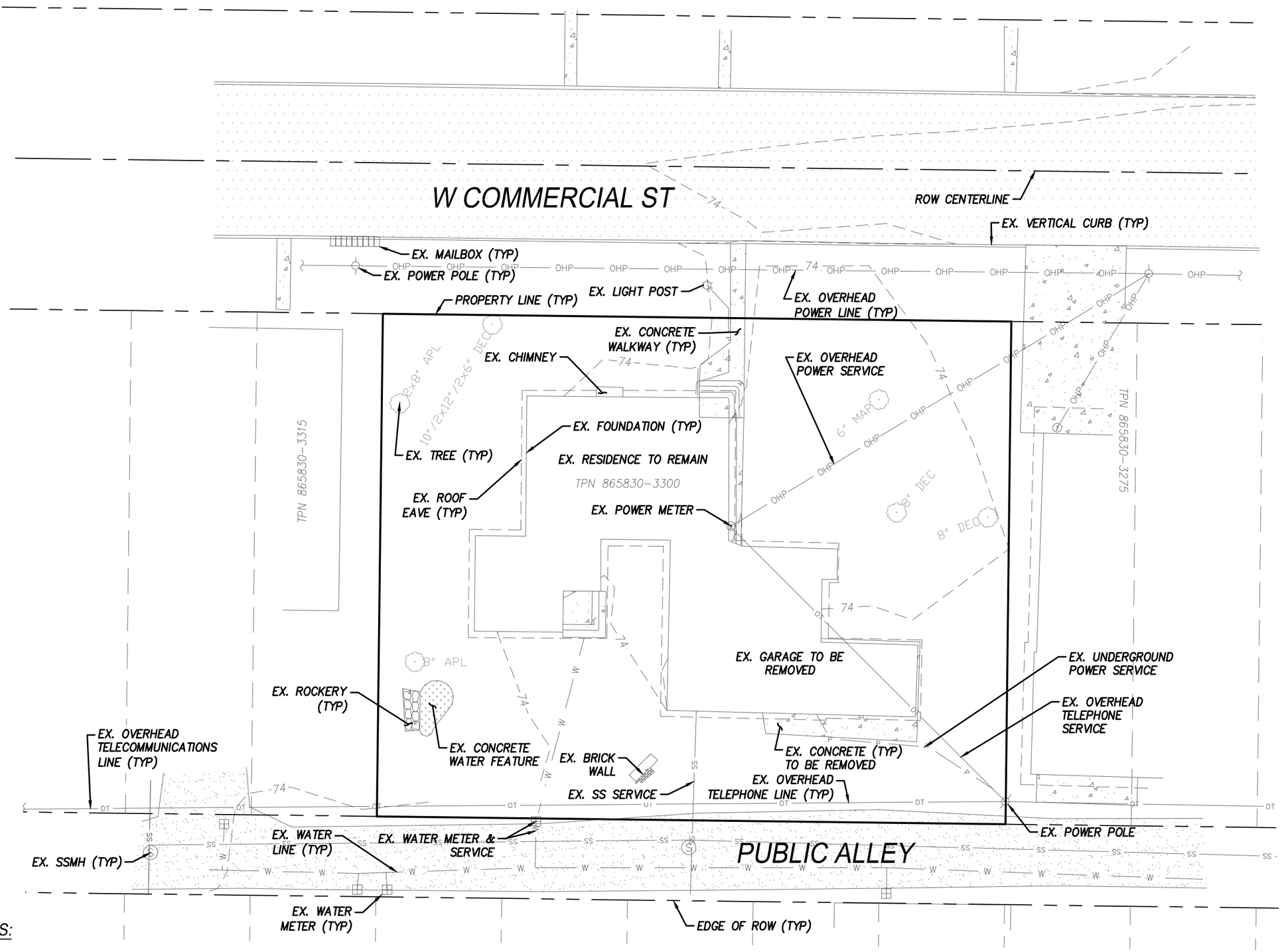
The project site is generally flat with mild slopes of 1 to 2 percent to the northwest. The *Geotechnical Evaluation* by Cobalt Geosciences dated July 19th, 2023 (Appendix A) identified the site soil as local fill and loose to medium dense, silty-fine to medium grained sand (Alluvium). Groundwater was not encountered during their site exploration, but mottled soils were noted 5 feet below grade. Based on the site soil exploration, the report atates that shallow limited infiltration is feasible at depths up to 4 feet below grade based on the “sandy loam” soil type for the design. The measured infiltration rate was 1.3 inches per hour, and the design infiltration rate is 0.41 inches/hour.

Figure 2: Existing Site Photo

NORTH

0 5 10 20

SCALE 1" = 20'



ON-SITE IMPERVIOUS AREAS:

EX. RESIDENCE (ROOF):	3,317 SF
EX. UNCOVERED CONCRETE (ON-SITE):	233 SF
TOTAL:	3,550 SF (28.40%)

JOB NO.	23580
DATE	12/29/2023
SCALE	1" = 20'
SHEET	1 of 1

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BREWER CONSTRUCTION
31731 W COMMERCIAL ST
CARNATION, WA 98014

FIG. 3: EXISTING CONDITIONS

Developed Site Conditions:
The project proposes the subdivision of the existing parcel into two (2) single-family residential lots. With the proposed short plat, the western 7,502 SF of the site will become Lot A and the eastern 5,000 SF will become Lot B.

The existing 1,857 SF residence and 161 SF of uncovered concrete walkways on Lot A are proposed to remain, and the existing garage will be demolished to comply with building setback requirements for the proposed shared lot line. Although the existing garage is being removed, a new 402 SF on-site driveway will be provided off the public Alley for Lot A to meet parking requirements for 2 cars. No improvements are proposed on Lot B at this time. Off-site improvements include replacement of approximately 188 SF of existing curb and gutter along W Commercial Street and repaving 1,594 SF of the existing gravel alley along the property's frontages. Approximately 27 SF of asphalt driveway apron is also proposed off-site in the public alley ROW. The total proposed impervious surface is 2,211 SF (includes both on- and off-site proposed impervious surfaces). The limits of disturbance associated with the short plat infrastructure is 16,454 SF (includes both on- and off-site areas), resulting in 12,225 SF of new pervious surface.

All utilities currently servicing the existing home on Lot A will be rerouted and placed into utility easements as needed. The proposal also incorporates the construction of on-site infrastructure (i.e. water, sewer, storm service) to support the future construction of a single-family residence on Lot B. Water and sewer services for Lot B will be provided from the existing public water in sewer mains in the public Alley. Stormwater from the existing 1,857 SF house and proposed 402 SF driveway on lot A, will be managed via a combination of infiltration galleries and pervious pavement. As there is insufficient space in the public ROW to mitigate stormwater from the 1,594 SF repaved asphalt alley and 27 SF asphalt driveway apron, a new infiltration system for the existing W Commercial Street (half street area is 1,875 SF) is proposed as an area swap. In addition, a Contech CDS Hydrodynamic Separator or equivalent will be designed to meet pre-treatment requirements during final engineering. A full discussion of these BMPs is included in Section III of this Report. Please refer to the Developed Conditions Map (Figure 4) on the following page.

Area Calculations:

The total site area is 12,501 SF (0.29 acres) and will be subdivided into two (2) lots. Lot A is proposed to be 7,502 SF (western lot), and Lot B is proposed to be 5,000 SF (eastern lot). The individual lot site plan and building footprint for Lot B are not available at this time, but they will be submitted during the building permit process. For the purpose of short plat application, impervious areas are assumed and identified in the summary table below. As allowed for properties zoned R6, the maximum allowed impervious surface coverage is 60%.

Impervious Surface Area Summary:

Lot A:	Existing House to Remain	1,857 SF
	Existing Miscellaneous Concrete to Remain	161 SF
	Proposed Driveway	402 SF
	Total New/Replaced Impervious	402 SF
	Total Existing Impervious to Remain	2,018 SF
	TOTAL	2,420 SF (32.26%)
Lot 2:	Future Roof/Driveway	3,000 SF (60.00%)

Off-Site:	Proposed Asphalt Driveway Apron	27 SF
	Proposed Asphalt Alley	1,594 SF
	Proposed Curb & Gutter	188 SF
	TOTAL	1,809 SF

Total New/Replaced Impervious Area (On- and Off-Site): 2,211 SF < 10,000 SF

Total New/Replaced Pervious Area (On- and Off-Site): 12,225 SF < ¾ AC

Total New/Replaced Pollution Generating Impervious Surface (PGIS): 2,211 SF < 5,000 SF

NORTH

0 5 10 20

SCALE 1" = 20'

ON-SITE IMPERVIOUS AREAS:

LOT A:

EX. RESIDENCE (ROOF):	1,857 SF
PROPOSED PERMEABLE PAVER DRIVEWAY:	402 SF
EX. UNCOVERED CONCRETE:	161 SF
TOTAL	2,420 SF (32.26%)

LOT B:

MAX PER ZONING (60%) = 3,000 SF (FUTURE)

OFF-SITE:

PROPOSED PERMEABLE PAVEMENT APRON:	27 SF
PROPOSED ALLEY ASPHALT:	1594 SF
PROPOSED CURB & GUTTER:	188 SF
TOTAL	1,809 SF

FUTURE LOT B STORM DESIGN

ON-SITE STORM SYSTEM FOR LOT B TO BE DESIGNED W/ THE FUTURE SINGLE-FAMILY BUILDING PERMIT. DESIGN TO INCLUDE PERMEABLE PAVEMENT WHEN FEASIBLE FOR HARDSCAPES AND A ROOF DOWNSPOUT INFILTRATION SYSTEM DESIGNED AT A RATIO OF 125 LF OF TRENCH PER 1,000 SF OF TRIBUTARY IMPERVIOUS SURFACE AS REQUIRED FOR SANDY LOAM SOILS PER THE 2019 DOE SWMMWM.

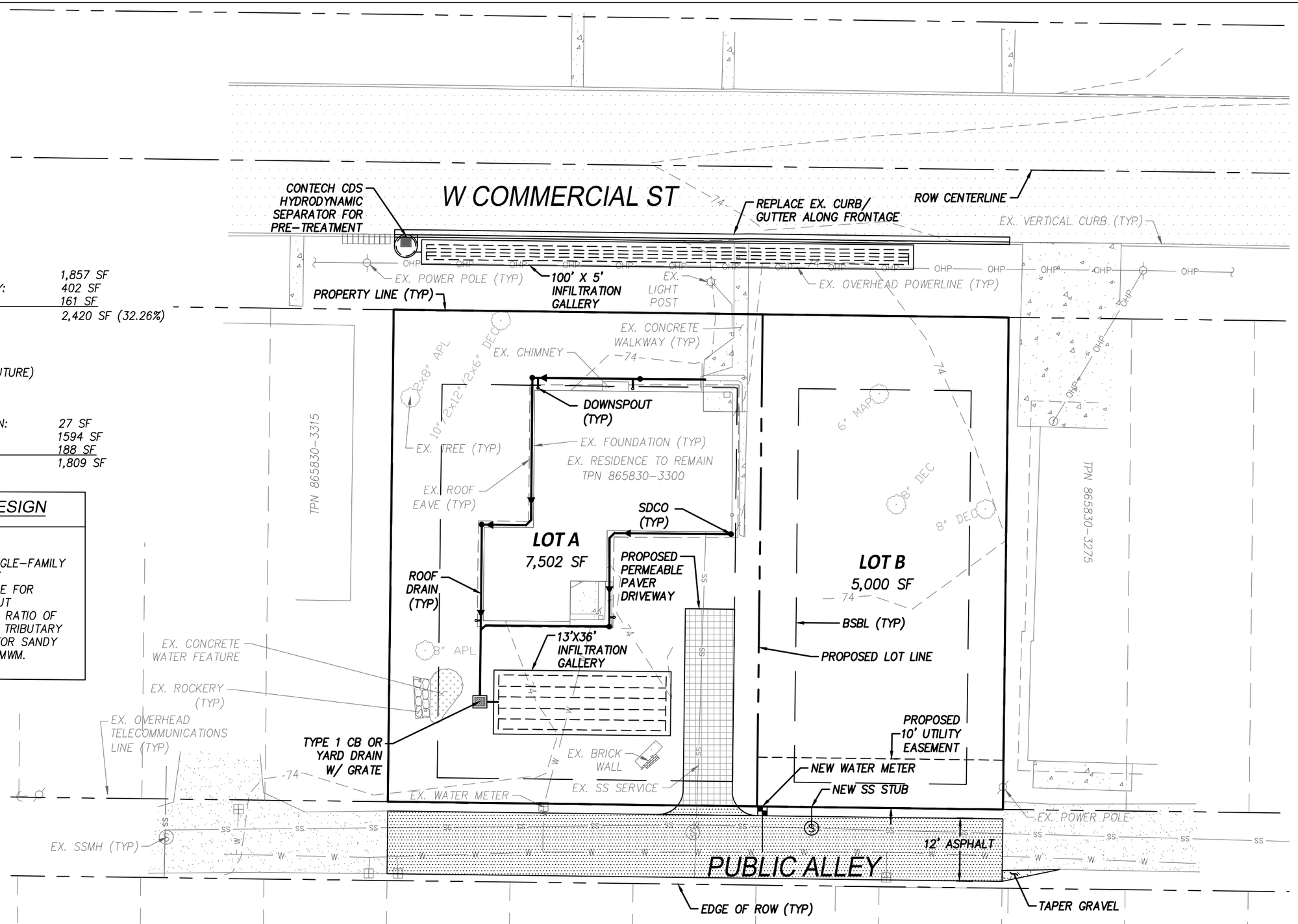

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FIG. 4: PROPOSED CONDITIONS

II. CONDITIONS AND REQUIREMENTS SUMMARY

The project site has less than 35% of existing impervious coverage and generates less than 5,000 SF of new plus replaced impervious surface area. Based on Figure I-3.1 of the 2019 Department of Ecology (DOE) Stormwater Management Manual for Western Washington (SMMWW), only Minimum Requirements 1 through 5 are applicable for this project. See Figure 5 below.

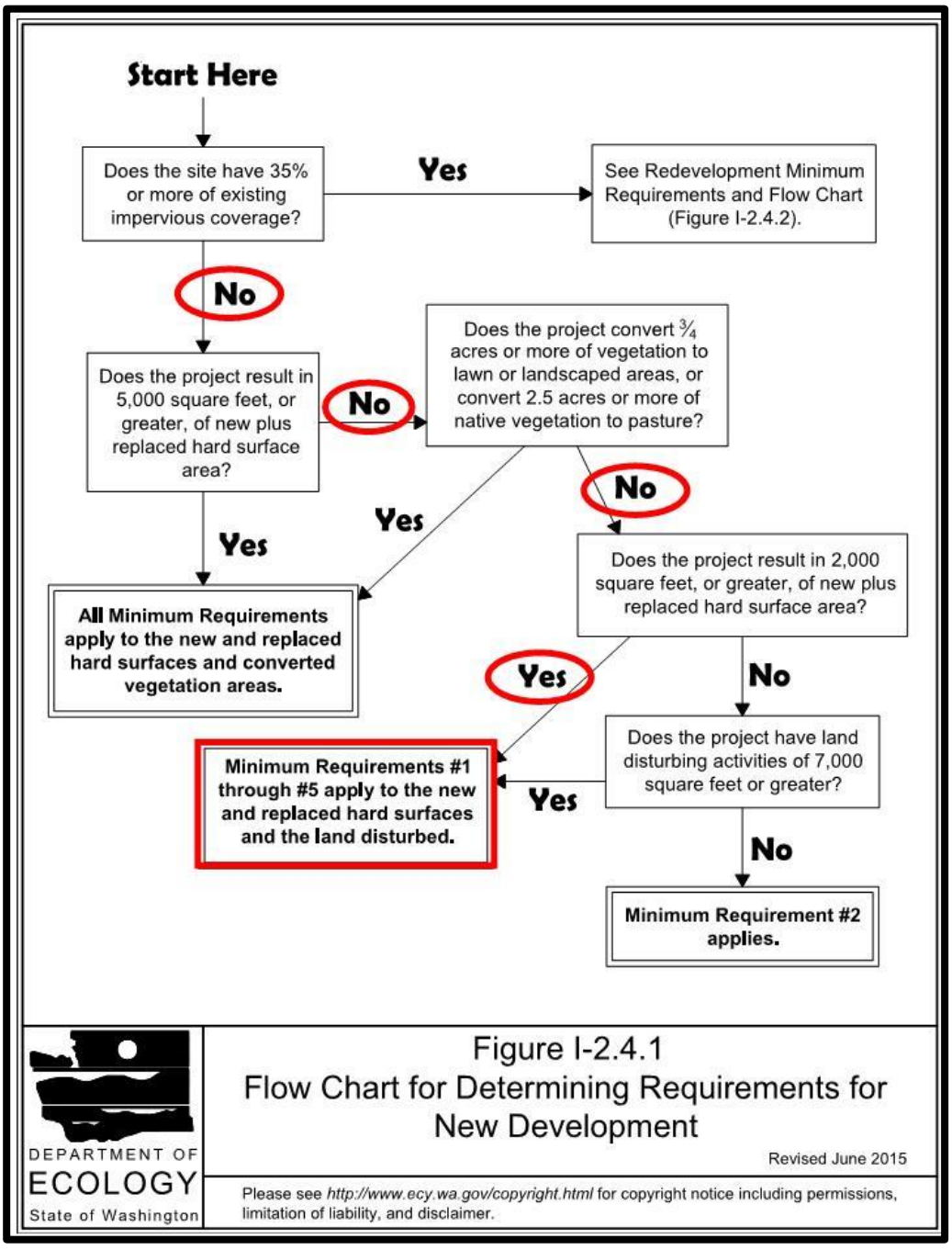


Figure 5: Flow Chart for Determining Requirements for New Development

MINIMUM REQUIREMENTS:

Minimum Requirement #1: Preparation of Stormwater Site Plans

Stormwater site plans for the proposed residence have been prepared and are included with the submittal. These plans were prepared in accordance with Chapter I-3.4.1 – Preparation of Stormwater Site Plans.

Minimum Requirement #2: Construction Stormwater Pollution Prevention (CSWPPP)

A Temporary Erosion and Sediment Control (TESC) plan has been created is included in the engineering plan set. The limits of disturbance for this project are less than 1 acre; therefore, a formal CSWPPP is not required. An abbreviated CSWPPP for small projects has been provided under Section VIII of this Report.

Minimum Requirement #3: Source Control of Pollution

Source control is not required for the construction of this small residential short plat.

Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls

The proposed on-site drainage patterns emulate those of the existing site conditions. Onsite storm water from the developed site will be fully infiltrated on-site and/or dispersed to the natural discharge location. The stormwater system has been designed to not cause significant adverse impacts to downstream receiving waters or down gradient properties.

Minimum Requirement #5: On-Site Stormwater Management

This project, per Table I-3.2, is designed to comply with the requirements of List #1 of the 2019 DOE SWMMWW. Flow control BMPs were considered and selected for all new/replaced surfaces. See the engineering plan sheets for further details.

Lawn and Landscaped Areas:

All pervious areas disturbed by construction activities shall achieve final stabilization per the requirements detailed by BMP T5.13 in the 2019 DOE SWMMWW.

Rooftop Areas:

The *Geotechnical Evaluation* by Cobalt Geosciences dated July 19th, 2023 (Appendix A) identified the site soil as local fill and loose to medium dense, silty-fine to medium grained sand (Alluvium). Groundwater was not encountered during their site exploration, but mottled soils were noted 5 feet below grade. Based on the site soil exploration, the report atates that shallow limited infiltration is feasible at depths up to 4 feet below grade based on the “sandy loam” soil type for the design. Therefore, roof downspout infiltration trenches should be sized at 125 LF of trench per 1000 SF of tributary target impervious surface per BMP T5.10A.

The existing 1,857 SF of rooftop area that is proposed to remain on Lot A will be mitigated via Downspout Full Infiltration per BMP T5.10A. Therefore, a (1,857 SF/1,000 SF)(125 FT) = 232 FT x 2FT infiltration trench is required to mitigate the 1,857 SF area. A trench of this size provides a total infiltration area of (232 FT)(2 FT)=464 SF. Due to the site width and setback requirements, this length of trench is not feasible. In order to provide an equal or greater infiltration area, a 13 FT x 36 FT infiltration gallery with an infiltration area of 468 SF is proposed for the existing house on Lot A.

The rooftop area associated with the future residential construction on Lot B will be mitigated via Downspout Full Infiltration per BMP T5.10A. The roof downspout infiltrating trench will be designed during the single-family building permit process once final site plans are known. The system should be designed based on sandy loam soils with 125 LF of 2 FT wide trench provided for every 1,000 SF of tributary rooftop area.

Other Hard Surface Areas:

The *Geotechnical Evaluation* by Cobalt Geosciences dated July 19th, 2023 (Appendix A) identified the site soil as local fill and loose to medium dense, silty-fine to medium grained sand (Alluvium). Groundwater was not encountered during their site exploration, but mottled soils were noted 5 feet below grade. Based on the site soil exploration, the report atates that shallow limited infiltration is feasible at depths up to 4 feet below grade based on the "sandy loam" soil type for the design. The measured infiltration rate was 1.3 inches per hour, and the design infiltration rate is 0.41 inches/hour.

Permeable pavement (BMP T5.15) will be utilized for the new 402 SF driveway on Lot A as well as the future driveway on Lot B. Permeable pavers are proposed for these surfaces.

As there is insufficient space in the public ROW to mitigate stormwater from the 1,594 SF repaved asphalt alley and 27 SF asphalt driveway apron, a new infiltration system for the existing W Commercial Street (half street area is 1,875 SF) is proposed as an area swap. The infiltration system for W Commercial Street has been designed based on sandy loam soils with a ratio of 125 FT of trench per 1,000 SF of tributary impervious surface. Therefore, a (1,875 SF/1,000 SF)(125 FT) = 235 FT x 2 FT infiltration trench is required to mitigate the 1,875 SF area. A trench of this size provides a total infiltration area of (235 FT)(2 FT)= 470 SF. However, the maximum trench length allowed is 100 FT. In order to provide an equal or greater infiltration area, a 100 FT x 5 FT infiltration gallery with an infiltration area of 500 SF is proposed to mitigate the existing W Commercial half street along the project's frontage. In addition, a non-filter DOE approved pre-treatment device is required prior to infiltrating runoff from W Commercial Street. A Contech CDS Hydrodynamic Separator or equivalent will be designed to meet pre-treatment requirements during final engineering.

III. OFF-SITE ANALYSIS

An Offsite Analysis was performed based on the requirements in the 2019 DOE SWMMWW. A Downstream Drainage Map (Figure 6), which summarizes the downstream drainage components for one-quarter mile, has been included at the end of this section to aid in this discussion.

Resource Review

For the Resource Review, relevant existing information was analyzed for the roughly quarter mile downstream flowpath from the site. See below for a summary of this information.

FEMA Maps

According to King County iMap, the entirety of the site is located within the unregulated 500-year floodplain for the Snoqualmie River. The site is located outside of the regulated 100-year floodplain and would not result in the creation of any depressions that could potentially trap fish or other aquatic species.

Sensitive Areas

According to King County iMap, the site does not contain any sensitive areas.

Soils Survey (United States Dept. of Agriculture/Natural Resources Conservation Service)

The NRCS Soil Survey indicates that the native soil underlying the site consists Oridia silt loam. This soil is classified as Hydrologic Soils Group 'D' per Table 3.2.4 of the 2019 SWMMWW. Type D soils typically have moderately high runoff potential. However, the *Geotechnical Evaluation* by Cobalt Geosciences dated July 19th, 2023 (Appendix A) identified the site soil as local fill and loose to medium dense, silty-fine to medium grained sand (Alluvium). Groundwater was not encountered during their site exploration, but mottled soils were noted 5 feet below grade. Based on the site soil exploration, the report atates that shallow limited infiltration is feasible at depths up to 4 feet below grade based on the "sandy loam" soil type for the design. The measured infiltration rate was 1.3 inches per hour, and the design infiltration rate is 0.41 inches/hour.

Drainage Complaints

Per King County iMap, there have been no flooding related drainage complaints within a quarter mile downstream of the site.

Upstream Tributary Basin

Due to site topography, there are no significant upstream tributary areas.

Downstream Drainage Route

Stormwater runoff from the site typically sheet flows to the northwest and onto W Commercial Street (A). From here, the runoff would flow along the existing curb line to the west until entering a catch basin located near the intersection of W Commercial Street and Stewart Avenue (B). Once entering the storm system, the runoff appears to be directed to the north towards another collection of catch basins (C). After this, the storm system appears to direct runoff in the western direction. The storm system was unable to be thoroughly

followed from this point due to private property, but it can be assumed that the stormwater is eventually discharged into the Snoqualmie River (D) about 1,800 FT to the west of the site. This is where the downstream analysis was concluded, as this location is surpassed the ¼ mile downstream limit from the site discharge location. No signs of erosion or drainage concerns were observed during the site visit. Please refer to the Downstream Drainage Map below for the referenced points of interest in the above.

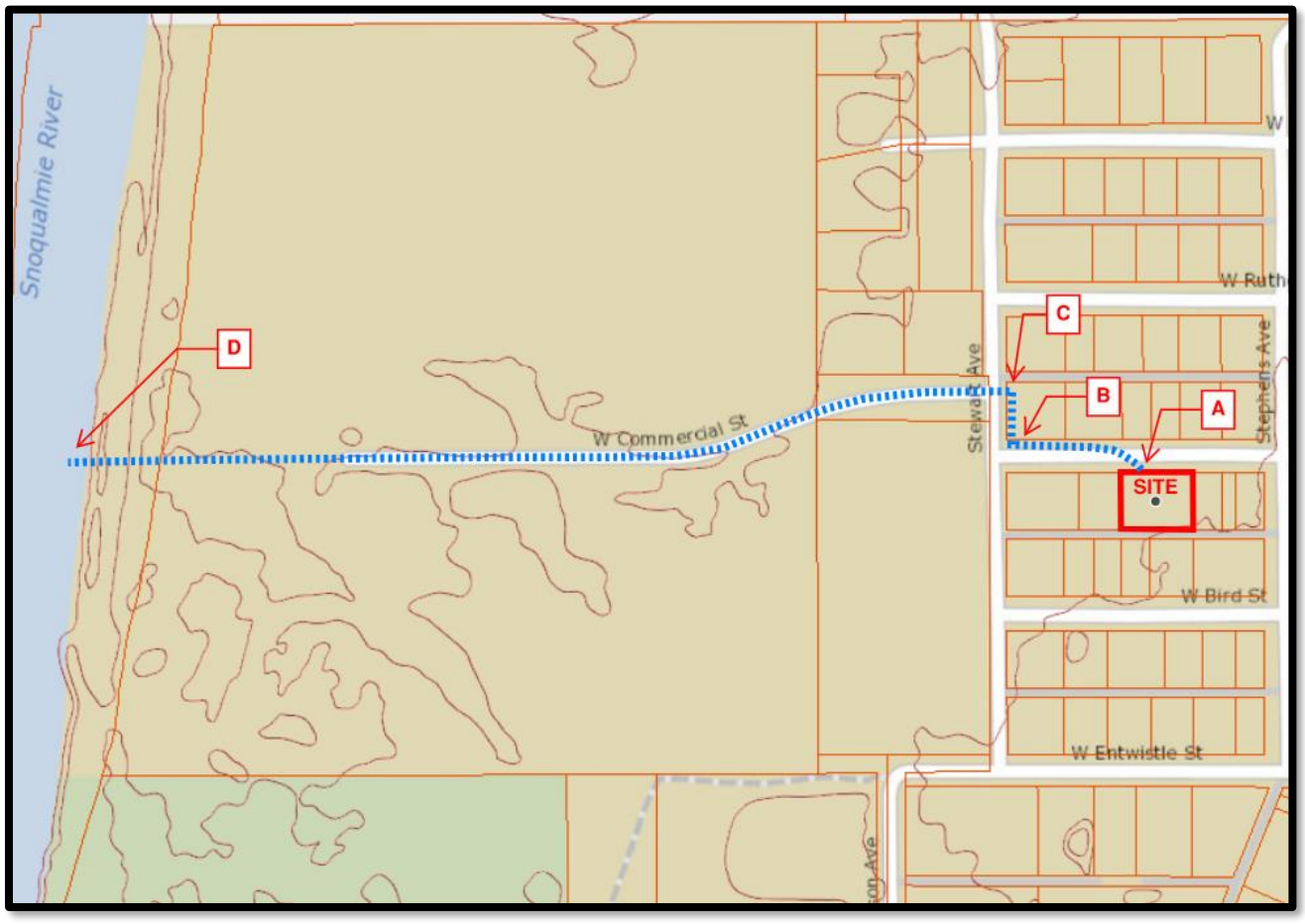


Figure 6: Downstream Drainage Map

IV. FLOW CONTROL AND WATER QUALITY FACILITY ANALYSIS AND DESIGN

The project proposes the subdivision of the existing parcel into two (2) single-family residential lots. With the proposed short plat, the western 7,502 SF of the site will become Lot A and the eastern 5,000 SF will become Lot B.

The existing 1,857 SF residence and 161 SF of uncovered concrete walkways on Lot A are proposed to remain, and the existing garage will be demolished to comply with building setback requirements for the proposed shared lot line. Although the existing garage is being removed, a new 402 SF on-site driveway will be provided off the public Alley for Lot A to meet parking requirements for 2 cars. No improvements are proposed on Lot B at this time. Off-site improvements include replacement of approximately 188 SF of existing curb and gutter along W Commercial Street and repaving 1,594 SF of the existing gravel alley along the property's frontages. Approximately 27 SF of asphalt driveway apron is also proposed off-site in the public alley ROW. The total proposed impervious surface is 2,211 SF (includes both on- and off-site proposed impervious surfaces). The limits of disturbance associated with the short plat infrastructure is 16,454 SF (includes both on- and off-site areas), resulting in 12,225 SF of new pervious surface.

The following onsite stormwater BMP's will be utilized for the project:

- Existing and Future Roofs: Downspout Full Infiltration Trench (BMP T5.10A)
- New and Future Driveway: Permeable Pavement (BMP T5.15)

The minimum length for the downspout infiltration trench is based on soil type of the site. Based on the geotechnical recommended soil type of "sandy loam", 125 LF of trench length per 1,000 sf of roof area has been utilized for the proposed infiltration trench on Lot A for the existing residence. This same ratio will be utilized to design the infiltration system for the future rooftop area on Lot B during the single-family building permit process.

As there is insufficient space in the public ROW to mitigate stormwater from the 1,594 SF repaved asphalt alley and 27 SF asphalt driveway apron, a new infiltration system for the existing W Commercial Street (half street area is 1,875 SF) is proposed as an area swap. The infiltration system for W Commercial Street has been designed based on sandy loam soils with a ratio of 125 FT of trench per 1,000 SF of tributary impervious surface. In addition, a non-filter DOE approved pre-treatment device is required prior to infiltrating runoff from W Commercial Street. A Contech CDS Hydrodynamic Separator or equivalent will be designed to meet pre-treatment requirements during final engineering.

Please refer to Minimum Requirement #5 in Section II of this report for additional information on flow control BMP sizing. Further flow control and water quality analysis is not required as this project proposes less than 10,000 SF of new/replaced impervious and less than 5,000 SF of new/replaced PGIS, respectively.

V. CONVEYANCE SYSTEM ANALYSIS AND DESIGN

Conveyance system analysis will be completed under final engineering if requested by the City of Carnation.

VI. SPECIAL REPORTS AND STUDIES

- *Geotechnical Evaluation* by Cobalt Geosciences dated July 19, 2023 (Appendix A).

VII. OTHER PERMITS

- Drainage Permit (City of Carnation)
- Clearing & Grading Permit (City of Carnation)
- Right-of-Way Use Permit (City of Carnation)
- Side Sewer Permit (City of Carnation)
- Water Service Permit (City of Carnation)
- Future Single Family Building Permit for Lot B (City of Carnation)

VIII. TESC ANALYSIS AND DESIGN

The potential for erosion within the site will be mitigated by use of erosion control measures during clearing, grading, and site development activities. Filter fences will be installed along the downhill perimeter of the site to protect adjacent properties from sediment-laden water. A rocked construction entrance will be installed at the entrance to the site to protect mud from entering the paved roadway. Stockpiles and exposed disturbed areas will be covered to protect from erosion and sediment runoff.

Element 1: Mark Clearing Limits. All clearing, grading, sensitive areas, and buffers will be clearly marked in the field prior to construction in accordance with the plans and specifications. Prior to beginning land disturbing activities, including clearing and grading, clearly mark all clearing limits, sensitive areas and their buffers, and trees that are to be preserved within the construction area. These will be clearly marked, both in the field and on the plans, to prevent damage and offsite impacts. Plastic, metal, or stake wire fence may be used to mark the clearing limits.

Element 2: Establish Construction Access. Construction access will be from the public alley. Stabilize the construction access with rock per the stormwater plans if the driveway is disturbed. Access points will be stabilized with a pad of quarry spalls, crushed rock, or equivalent BMP prior to traffic leaving the construction site to minimize the tracking of sediment onto all roads and accesses.

Element 3: Control Flow Rates. It is anticipated that construction site runoff will infiltrate into the ground naturally. To control construction flow rates if this fails to adequately infiltrate, a temporary sediment pond may be utilized. Natural drainage patterns will be protected as much as possible during construction, and concentrated flow should not be permitted. Properties and waterways downstream from development sites will be protected from erosion due to increases in the volume, velocity, and peak flow rate of stormwater runoff from the project site.

Element 4: Install Sediment Controls. Soils should be covered if not worked for 7 days during the dry season or 2 days during the wet season. The street should be swept each night or as required. If the minimum BMPs fail to retain sediment on the site, additional BMPs will be used.

Element 5: Stabilize Soils. Soils will be covered if not worked for 7 days during the dry season or 2 days during the wet season. Soil stockpiles will be covered unless worked. Soil stockpiles will be located away from drain inlets and surface water discharge locations. Soil stockpiles will be stabilized and covered as needed. Soils will be stabilized at the end of the shift before holidays or weekends if needed based on weather forecast.

Element 6: Protect Slopes. Slope protection is not proposed as there are no slopes on the site.

Element 7: Protect Drain Inlets. There are no existing grated catch basins in the immediate vicinity of the

project. Any new catch basins installed as part of the project will be protected during construction.

Element 8: Stabilize Channels and Outlets. There are no existing or proposed channels or drainage outlets associated with this project.

Element 9: Control Pollutants. Pollution generated from construction must be controlled at all times. Control of pollutants other than sediments includes the following:

- All pollutants other than sediments will be handled and disposed of in a manner that does not cause contamination of stormwater.
- Cover, containment and protection from vandalism will be provided for all chemicals, liquid products, petroleum products, and non-inert wastes present on the project site.
- Maintenance and repair of heavy equipment and vehicles involving oil changes, hydraulic system drain down, solvent and de-greasing cleaning operations, fuel tank drain down and removal, and other activities which may result in discharge or spillage of pollutants to the ground or into stormwater runoff must be conducted using spill prevention measures, such as drip pans. Contaminated surfaces will be cleaned immediately following any discharge or spill incident. Emergency repairs may be performed on-site using temporary plastic placed beneath and, if raining, over the vehicle.
- Wheel wash or tire bath wastewater will be discharged to a separate on-site treatment system or to the sanitary sewer, if available.

Element 10: Control De-Watering. De-watering is not anticipated for the site. In the event that dewatering is necessary, the waste water will be treated such that sediment remains on site. This will be done by routing the storm water through a straw filter or sediment trap.

Element 11: Maintain BMPs. BMPs will be inspected monthly and after every significant storm event, Sediment will be removed from the BMPs as necessary for them to continue operating at the required performance level. In the event that a BMPs has been damaged, it will be replaced immediately.

Element 12: Manage the Project. Construction activities will be phased such that the impact to the area will be kept at a minimum. Coordination will occur with all utility agencies that are affected by this project. BMPs will be inspected regularly and after each significant storm event. The Contractor will provide a Certified Erosion and Sediment Control Specialist. If for any reason a BMPs is not sufficient for the project, additional BMPs will be installed.

IX. OPERATION AND MAINTENANCE MANUAL

An Operation and Maintenance Manual is included in Appendix B.

Appendix A

Geotechnical Evaluation by Cobalt Geosciences dated July 19, 2023

Cobalt Geosciences, LLC
P.O. Box 82243
Kenmore, Washington 98028

July 19, 2023

Shane Brewer
shanebrewerconstruction@msn.com

RE: Proposal for Geotechnical Evaluation
Proposed Short Plat
31731 W. Commercial Street
Carnation, Washington

In accordance with your authorization, Cobalt Geosciences, LLC has prepared this letter to discuss the results of our geotechnical evaluation at the referenced site.

The purpose of our evaluation was to provide recommendations for foundation design, grading, and earthwork.

Site Description

The site is located at 31731 W. Commercial Street in Carnation, Washington. The site consists of one rectangular shaped parcel (No. 8658303300) with a total area of 12,500 square feet.

The site is developed with a single family residence and driveway. The remainder of the site is undeveloped and vegetated with grasses, bushes, shrubs, local understory, and variable diameter evergreen and deciduous trees.

The site is nearly level to very slightly sloping downward in multiple directions. The site is bordered to the east and west by residential properties, to the north by W. Commercial Street, and to the south by an alley.

The proposed development includes subdivision of the property followed by construction of a new residence in the eastern half of the site. The existing garage will be demolished but the residence will remain.

Stormwater will include infiltration or other systems depending on feasibility. Site grading may include cuts and fills of 3 feet or less and foundation loads are expected to be light.

We should be provided with the final plans to verify that our recommendations remain valid and do not require updating.

Area Geology

The Geologic Map of the Carnation Quadrangle, indicates that the site is underlain by Alluvial Fan Deposits. These materials include loose to moderately dense mixtures of silt, sand, gravel, and cobbles. They often include deposits from upslope areas that have been eroded through mass wasting.

Soil & Groundwater Conditions

As part of our evaluation, we excavated one test pit and one hand boring where accessible. The explorations encountered approximately 6 inches of grass and topsoil underlain by local fill (in TP-1 to 1.5 feet) and loose to medium dense, silty-fine to medium grained sand (Alluvium), which

continued to the termination depths of the explorations. The soils were mottled from 5 to 6 feet and became finer in this zone.

Groundwater was not encountered in the explorations; however, the soils were mottled below about 5 feet. We anticipate that groundwater will be present at relatively shallow depths during a typical wet season.

Water table elevations often fluctuate over time. The groundwater level will depend on a variety of factors that may include seasonal precipitation, irrigation, land use, climatic conditions and soil permeability. Water levels at the time of the field investigation may be different from those encountered during the construction phase of the project. It would be necessary to install a piezometer to determine groundwater depths over a typical year.

Erosion Hazard

The Natural Resources Conservation Services (NRCS) maps for King County indicate that the site is underlain by Oridia silt loam (0 to 2 percent slopes). These soils would have a slight to moderate erosion potential in a disturbed state depending on the slope magnitude.

It is our opinion that soil erosion potential at this project site can be reduced through landscaping and surface water runoff control. Typically, erosion of exposed soils will be most noticeable during periods of rainfall and may be controlled by the use of normal temporary erosion control measures, such as silt fences, hay bales, mulching, control ditches and diversion trenches. The typical wet weather season, with regard to site grading, is from October 31st to April 1st. Erosion control measures should be in place before the onset of wet weather.

Seismic Hazard

The overall subsurface profile corresponds to a Site Class *D* as defined by Table 1613.5.2 of the International Building Code (IBC). A Site Class *D* applies to an overall profile consisting of medium dense to very dense soils within the upper 100 feet.

We referenced the U.S. Geological Survey (USGS) Earthquake Hazards Program Website to obtain values for S_S, S_1, F_a, and F_v. The USGS website includes the most updated published data on seismic conditions. The following tables provide seismic parameters from the USGS web site with referenced parameters from ASCE 7-16.

Seismic Design Parameters (ASCE 7-16)

Site Class	Spectral Acceleration at 0.2 sec. (g)	Spectral Acceleration at 1.0 sec. (g)	Site Coefficients		Design Spectral Response Parameters		Design PGA
			F_a	F_v	S_{DS}	S_{D1}	
D	1.226	0.428	1.0	Null	0.825	Null	0.527

Additional seismic considerations include liquefaction potential and amplification of ground motions by soft/loose soil deposits. The liquefaction potential is highest for loose sand with a high groundwater table. The site has a relatively low likelihood of liquefaction. For items listed as "Null" see Section 11.4.8 of the ASCE.

Conclusions and Recommendations

General

The site is underlain by local fill and at depth by loose to medium dense alluvium. These deposits vary in composition and density.

The proposed residential structure may be supported on a shallow foundation system bearing on at least 12 inches of compacted crushed rock placed and compacted on medium dense or firmer native soils. Crushed rock should consist of 1-1/4 to 2 inch angular rock compacted to at least 95 percent of the modified proctor (ASTM D1557 Test Method) unless clean rock is used. The underlying subgrade should be verified to be medium dense by the geotechnical engineer prior to rock placement. Recompaction or additional overexcavation may be warranted.

We anticipate that stormwater management will need to consist of shallow on-site systems as there does not appear to be a stormwater utility system in this area. If stormwater utilities are present, we recommend perforated or direct connection to these systems. If not, the following recommendations apply: If possible, we recommend dispersion devices and permeable pavements be used for stormwater management. Shallow limited infiltration could be utilized if there is inadequate space for dispersion devices. Systems may consist of trenches set no deeper than 4 feet below grade (at least 12 inches above the mottled soils). The soils are consistent with Sandy Loam per the King County Surface Water Design Manual (SWDM).

Site Preparation

Trees, shrubs and other vegetation should be removed prior to stripping of surficial organic-rich soil and fill. Based on observations from the site investigation program, it is anticipated that the stripping depth will be 6 to 24 inches. Deeper excavations will be necessary below larger trees and foundation systems.

The native soils consist of silty-sand. Most of the native soils may be used as structural fill provided they achieve compaction requirements and are within 3 percent of the optimum moisture. Some of these soils may only be suitable for use as fill during the summer months, as they will be above the optimum moisture levels in their current state. These soils are HIGHLY moisture sensitive and may degrade during periods of wet weather and under equipment traffic.

Imported structural fill should consist of a sand and gravel mixture with a maximum grain size of 3 inches and less than 5 percent fines (material passing the U.S. Standard No. 200 Sieve). Structural fill should be placed in maximum lift thicknesses of 12 inches and should be compacted to a minimum of 95 percent of the modified proctor maximum dry density, as determined by the ASTM D 1557 test method.

Temporary Excavations

Based on our understanding of the project, we anticipate that the grading could include local cuts on the order of approximately 3 feet or less for foundation and most of the utility placement. Temporary excavations should be sloped no steeper than 1.5H:1V (Horizontal:Vertical) in loose native soils and fill and 1H:1V in medium dense native soils. If an excavation is subject to heavy vibration or surcharge loads, we recommend that the excavations be sloped no steeper than 2H:1V, where room permits.

Temporary cuts should be in accordance with the Washington Administrative Code (WAC) Part N, Excavation, Trenching, and Shoring. Temporary slopes should be visually inspected daily by a qualified person during construction activities and the inspections should be documented in daily reports. The contractor is responsible for maintaining the stability of the temporary cut slopes and reducing slope erosion during construction.

Temporary cut slopes should be covered with visqueen to help reduce erosion during wet weather, and the slopes should be closely monitored until the permanent retaining systems or slope configurations are complete. Materials should not be stored or equipment operated within 10 feet of the top of any temporary cut slope.

Soil conditions may not be completely known from the geotechnical investigation. In the case of temporary cuts, the existing soil conditions may not be completely revealed until the excavation work exposes the soil. Typically, as excavation work progresses the maximum inclination of temporary slopes will need to be re-evaluated by the geotechnical engineer so that supplemental recommendations can be made. Soil and groundwater conditions can be highly variable. Scheduling for soil work will need to be adjustable, to deal with unanticipated conditions, so that the project can proceed and required deadlines can be met.

If any variations or undesirable conditions are encountered during construction, we should be notified so that supplemental recommendations can be made. If room constraints or groundwater conditions do not permit temporary slopes to be cut to the maximum angles allowed by the WAC, temporary shoring systems may be required. The contractor should be responsible for developing temporary shoring systems, if needed. We recommend that Cobalt Geosciences and the project structural engineer review temporary shoring designs prior to installation, to verify the suitability of the proposed systems.

Foundation Design

The proposed residential structure may be supported on a shallow foundation system bearing on at least 12 inches of compacted crushed rock placed and compacted on medium dense or firmer native soils. Crushed rock should consist of 1-1/4 to 2 inch angular rock compacted to at least 95 percent of the modified proctor (ASTM D1557 Test Method) unless clean rock is used. The underlying subgrade should be verified to be medium dense by the geotechnical engineer prior to rock placement. Re-compaction or additional overexcavation may be warranted.

For shallow foundation support, we recommend widths of at least 16 and 24 inches, respectively, for continuous wall and isolated column footings supporting the proposed structure. Provided that the footings are supported as recommended above, a net allowable bearing pressure of 1,500 pounds per square foot (psf) may be used for design. We recommend NOT using isolated pier pads in crawspace areas. We suggest creating a new strip footing connected to perimeter footings for any posts.

A 1/3 increase in the above value may be used for short duration loads, such as those imposed by wind and seismic events. Structural fill placed on bearing, native subgrade should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557. Footing excavations should be inspected to verify that the foundations will bear on suitable material.

Exterior footings should have a minimum depth of 18 inches below pad subgrade (soil grade) or adjacent exterior grade, whichever is lower. Interior footings should have a minimum depth of 12 inches below pad subgrade (soil grade) or adjacent exterior grade, whichever is lower.

If constructed as recommended, the total foundation settlement is not expected to exceed 1 inch. Differential settlement, along a 20-foot exterior wall footing, or between adjoining column footings, should be less than ½ inch. This translates to an angular distortion of 0.002. Most settlement is expected to occur during construction, as the loads are applied. However, additional post-construction settlement may occur if the foundation soils are flooded or saturated. All footing excavations should be observed by a qualified geotechnical consultant.

Resistance to lateral footing displacement can be determined using an allowable friction factor of 0.40 acting between the base of foundations and the supporting subgrades. Lateral resistance for footings can also be developed using an allowable equivalent fluid passive pressure of 250 pounds per cubic foot (pcf) acting against the appropriate vertical footing faces (neglect the upper 12 inches below grade in exterior areas). The frictional and passive resistance of the soil may be combined without reduction in determining the total lateral resistance.

Care should be taken to prevent wetting or drying of the bearing materials during construction. Any extremely wet or dry materials, or any loose or disturbed materials at the bottom of the footing excavations, should be removed prior to placing concrete. The potential for wetting or drying of the bearing materials can be reduced by pouring concrete as soon as possible after completing the footing excavation and evaluating the bearing surface by the geotechnical engineer or his representative.

Concrete Retaining Walls

The following table, titled **Wall Design Criteria**, presents the recommended soil related design parameters for retaining walls with a level backslope. Contact Cobalt if an alternate retaining wall system is used. This has been included for new cast in place walls, such as vaults or short stem walls supporting backfill.

Wall Design Criteria	
"At-rest" Conditions (Lateral Earth Pressure – EFD[+])	55 pcf (Equivalent Fluid Density)
"Active" Conditions (Lateral Earth Pressure – EFD[+])	35 pcf (Equivalent Fluid Density)
Seismic Increase for "At-rest" Conditions (Lateral Earth Pressure)	14H* (Uniform Distribution)
Seismic Increase for "Active" Conditions (Lateral Earth Pressure)	7H* (Uniform Distribution)
Passive Earth Pressure on Low Side of Wall (Allowable, includes F.S. = 1.5)	Neglect upper 2 feet, then 250 pcf EFD[+]
Soil-Footing Coefficient of Sliding Friction (Allowable; includes F.S. = 1.5)	0.40

[*]H is the height of the wall; Increase based on one in 500 year seismic event (10 percent probability of being exceeded in 50 years),
[+]EFD – Equivalent Fluid Density

The stated lateral earth pressures do not include the effects of hydrostatic pressure generated by water accumulation behind the retaining walls. Uniform horizontal lateral active and at-rest pressures on the retaining walls from vertical surcharges behind the wall may be calculated using

active and at-rest lateral earth pressure coefficients of 0.3 and 0.5, respectively. A soil unit weight of 125 pcf may be used to calculate vertical earth surcharges.

To reduce the potential for the buildup of water pressure against the walls, continuous footing drains (with cleanouts) should be provided at the bases of the walls. The footing drains should consist of a minimum 4-inch diameter perforated pipe, sloped to drain, with perforations placed down and enveloped by a minimum 6 inches of pea gravel in all directions.

The backfill adjacent to and extending a lateral distance behind the walls at least 2 feet should consist of free-draining granular material. All free draining backfill should contain less than 3 percent fines (passing the U.S. Standard No. 200 Sieve) based upon the fraction passing the U.S. Standard No. 4 Sieve with at least 30 percent of the material being retained on the U.S. Standard No. 4 Sieve. The primary purpose of the free-draining material is the reduction of hydrostatic pressure. Some potential for the moisture to contact the back face of the wall may exist, even with treatment, which may require that more extensive waterproofing be specified for walls, which require interior moisture sensitive finishes.

We recommend that the backfill be compacted to at least 90 percent of the maximum dry density based on ASTM Test Method D1557. In place density tests should be performed to verify adequate compaction. Soil compactors place transient surcharges on the backfill. Consequently, only light hand operated equipment is recommended within 3 feet of walls so that excessive stress is not imposed on the walls.

Stormwater Management Feasibility

The site is underlain by relatively fine grained alluvium. We performed a small scale Pilot Infiltration Test (PIT) in TP-1 at a depth of 3 feet below grade.

The design infiltration rate was determined by applying correction factors to the observed infiltration rate as prescribed in Volume III, Section 3.3.6 of the DOE. The observed rate must be reduced through appropriate correction factors for site variability (CF_V), uncertainty of test method (CF_T), and degree of influent control (CF_M) to prevent siltation and bio-buildup.

It should be noted that construction traffic or other disturbance to the target infiltration area could compact the soil, which may decrease the effective infiltration rates. The correction factors and resulting design infiltration rate are also shown in the table below.

Test Number	Test Depth (ft)	Measured Infiltration Rate (in/hr)	Correction Factors			Design Infiltration Rate (in/hr)
			CF_V	CF_T	CF_M	
TP-1	3.0	1.3	0.7	0.5	0.9	0.41

The shallow soils are just feasible for some infiltration of runoff. These soils are consistent with Sandy Loam if prescriptive sizing per the SWDM is utilized.

We anticipate that stormwater management will need to consist of shallow on-site systems as there does not appear to be a stormwater utility system in this area.

If possible, we recommend dispersion devices and permeable pavements to manage runoff. Shallow limited infiltration could be utilized if there is inadequate space for dispersion devices. Systems may consist of trenches set no deeper than 4 feet below grade (at least 12 inches above the mottled soils).

We should be provided with final plans for review to determine if the intent of our recommendations has been incorporated or if additional modifications are needed. We must verify soil conditions during any system placement.

Slab-on-Grade

Any fill and loose soils should be removed below slab areas. The underlying medium dense subgrade may be filled with clean angular rock or other structural fill compacted to the requirements discussed above.

Often, a vapor barrier is considered below concrete slab areas. However, the usage of a vapor barrier could result in curling of the concrete slab at joints. Floor covers sensitive to moisture typically requires the usage of a vapor barrier. A materials or structural engineer should be consulted regarding the detailing of the vapor barrier below concrete slabs. Exterior slabs typically do not utilize vapor barriers.

The American Concrete Institutes ACI 360R-06 Design of Slabs on Grade and ACI 302.1R-04 Guide for Concrete Floor and Slab Construction are recommended references for vapor barrier selection and floor slab detailing.

Slabs on grade may be designed using a coefficient of subgrade reaction of 150 pounds per cubic inch (pci) assuming the slab-on-grade base course is underlain by structural fill placed and compacted as outlined above. A 4- to 6-inch-thick capillary break layer should be placed over the prepared subgrade. This material should consist of pea gravel or 5/8 inch clean angular rock.

A perimeter drainage system is recommended unless interior slab areas are elevated a minimum of 12 inches above adjacent exterior grades. If installed, a perimeter drainage system should consist of a 4-inch diameter perforated drain pipe surrounded by a minimum 6 inches of drain rock wrapped in a non-woven geosynthetic filter fabric to reduce migration of soil particles into the drainage system. The perimeter drainage system should discharge by gravity flow to a suitable stormwater system.

Exterior grades surrounding buildings should be sloped at a minimum of one percent to facilitate surface water flow away from the building and preferably with a relatively impermeable surface cover immediately adjacent to the building.

Erosion and Sediment Control

Erosion and sediment control (ESC) is used to reduce the transportation of eroded sediment to wetlands, streams, lakes, drainage systems, and adjacent properties. Erosion and sediment control measures should be implemented, and these measures should be in general accordance with local regulations. At a minimum, the following basic recommendations should be incorporated into the design of the erosion and sediment control features for the site:

- Schedule the soil, foundation, utility, and other work requiring excavation or the disturbance of the site soils, to take place during the dry season (generally May through September). However, provided precautions are taken using Best Management Practices (BMP's), grading activities can be completed during the wet season (generally October through April).

- All site work should be completed and stabilized as quickly as possible.
- Additional perimeter erosion and sediment control features may be required to reduce the possibility of sediment entering the surface water. This may include additional silt fences, silt fences with a higher Apparent Opening Size (AOS), construction of a berm, or other filtration systems.
- Any runoff generated by dewatering discharge should be treated through construction of a sediment trap if there is sufficient space. If space is limited other filtration methods will need to be incorporated.

Utilities

Utility trenches should be excavated according to accepted engineering practices following OSHA (Occupational Safety and Health Administration) standards, by a contractor experienced in such work. The contractor is responsible for the safety of open trenches. Traffic and vibration adjacent to trench walls should be reduced; cyclic wetting and drying of excavation side slopes should be avoided. Depending upon the location and depth of some utility trenches, groundwater flow into open excavations could be experienced, especially during or shortly following periods of precipitation.

In general, silty and sandy soils were encountered at shallow depths in the explorations at this site. These soils have low cohesion and density and will have a tendency to cave or slough in excavations. Shoring or sloping back trench sidewalls is required within these soils in excavations greater than 4 feet deep.

All utility trench backfill should consist of imported structural fill or suitable on site soils. Utility trench backfill placed in or adjacent to buildings and exterior slabs should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557. The upper 5 feet of utility trench backfill placed in pavement areas should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557. Below 5 feet, utility trench backfill in pavement areas should be compacted to at least 90 percent of the maximum dry density based on ASTM Test Method D1557. Pipe bedding should be in accordance with the pipe manufacturer's recommendations.

The contractor is responsible for removing all water-sensitive soils from the trenches regardless of the backfill location and compaction requirements. Depending on the depth and location of the proposed utilities, we anticipate the need to re-compact existing fill soils below the utility structures and pipes. The contractor should use appropriate equipment and methods to avoid damage to the utilities and/or structures during fill placement and compaction procedures.

CONSTRUCTION FIELD REVIEWS

Cobalt Geosciences should be retained to provide part time field review during construction in order to verify that the soil conditions encountered are consistent with our design assumptions and that the intent of our recommendations is being met. This will require field and engineering review to:

- Monitor and test structural fill placement and soil compaction
- Verify soil bearing of foundation areas
- Observe slab-on-grade preparation
- Monitor foundation drainage placement
- Verify stormwater system placement (if utilized)

- Observe excavation stability

Geotechnical design services should also be anticipated during the subsequent final design phase to support the structural design and address specific issues arising during this phase. Field and engineering review services will also be required during the construction phase in order to provide a Final Letter for the project.

CLOSURE

This report was prepared for the exclusive use of Shane Brewer and their appointed consultants. Any use of this report or the material contained herein by third parties, or for other than the intended purpose, should first be approved in writing by Cobalt Geosciences, LLC.

The recommendations contained in this report are based on assumed continuity of soils with those of our test holes and assumed structural loads. Cobalt Geosciences should be provided with final architectural and civil drawings when they become available in order that we may review our design recommendations and advise of any revisions, if necessary.

Use of this report is subject to the Statement of General Conditions provided in Appendix A. It is the responsibility of Shane Brewer who is identified as "the Client" within the Statement of General Conditions, and its agents to review the conditions and to notify Cobalt Geosciences should any of these not be satisfied.

Sincerely,

Cobalt Geosciences, LLC

7/19/2023
Phil Haberman, PE, LG, LEG
Principal

Statement of General Conditions

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Cobalt Geosciences and the Client. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Cobalt Geosciences present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Cobalt Geosciences is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

STANDARD OF CARE: Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state of execution for the specific professional service provided to the Client. No other warranty is made.

INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Cobalt Geosciences at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Cobalt Geosciences must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Cobalt Geosciences will not be responsible to any party for damages incurred as a result of failing to notify Cobalt Geosciences that differing site or sub-surface conditions are present upon becoming aware of such conditions.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Cobalt Geosciences, sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Cobalt Geosciences cannot be responsible for site work carried out without being present.

King County Imap

HB-1 **Approximate**
TP-1 **Hand Boring and Test Pit Location**

N

Not to Scale

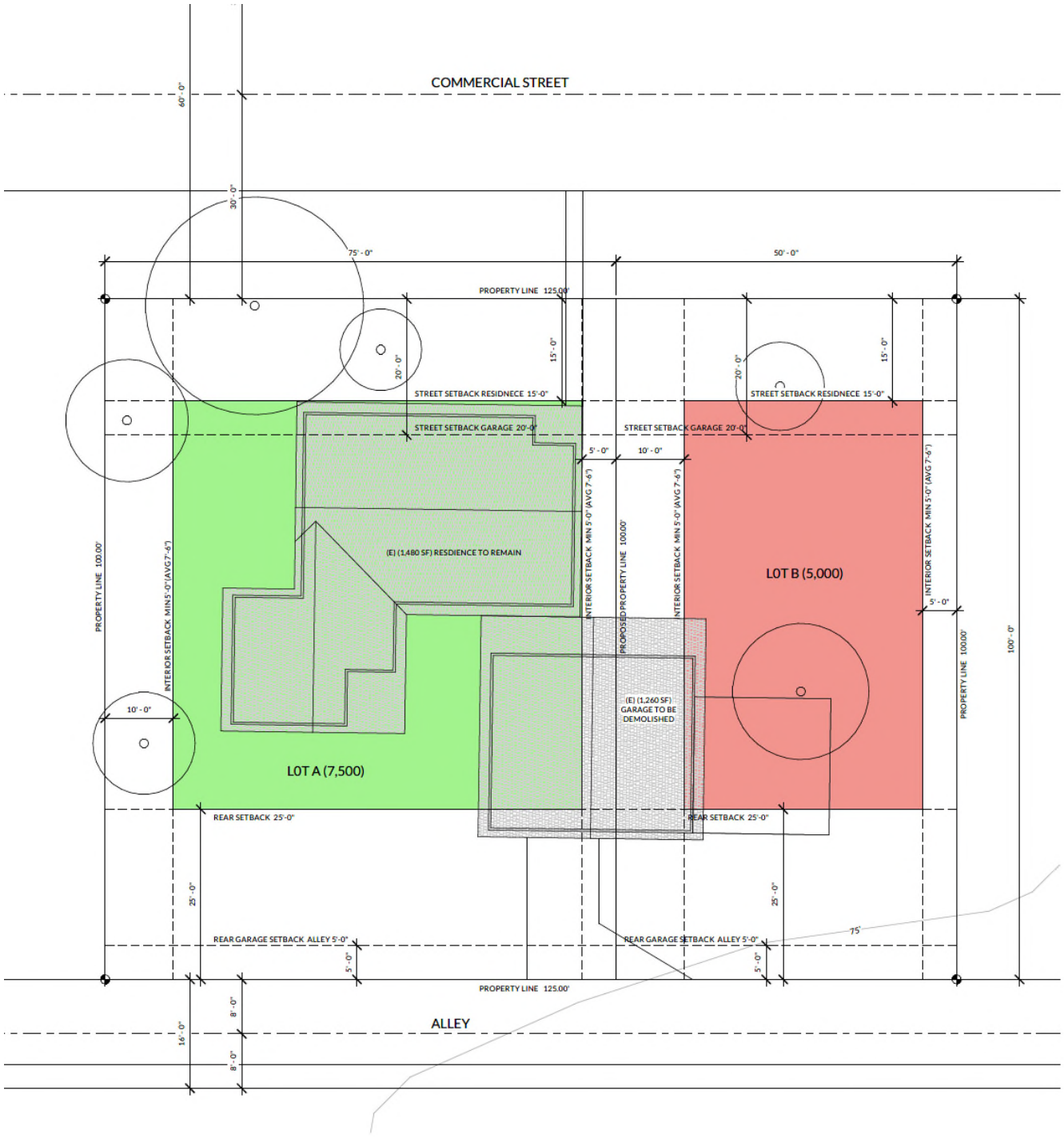
COBALT GEOSCIENCES

Proposed Two Lot Development
31731 W. Commercial Street
Carnation, Washington

SITE MAP

FIGURE 1

Cobalt Geosciences, LLC
P.O. Box 82243
Kenmore, WA 98028
(206) 331-1097
www.cobaltgeo.com
cobaltgeo@gmail.com

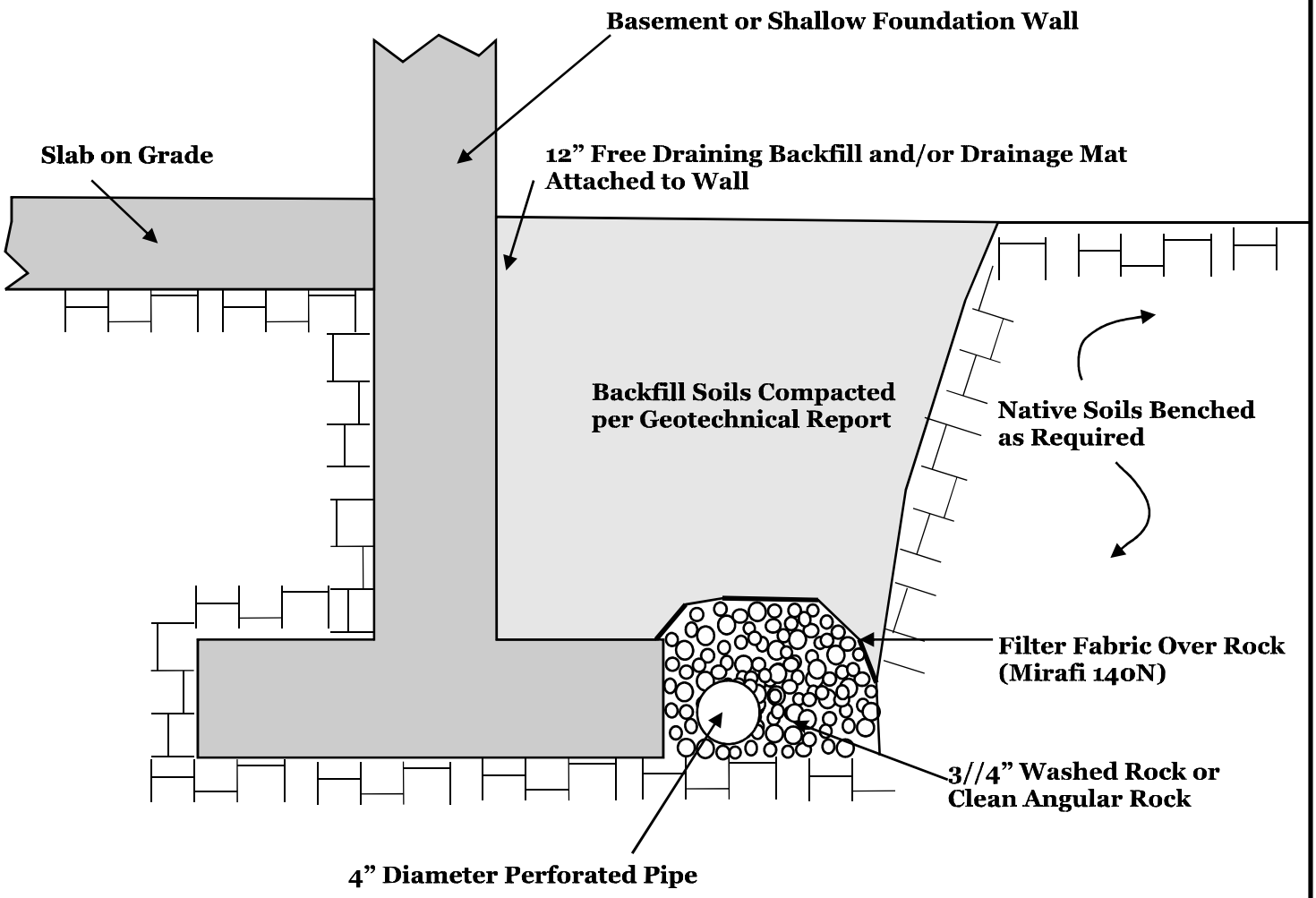


1 SITE PLAN
1" = 10'-0"

N

Not to Scale

COBALT GEOSCIENCES	Proposed Two Lot Development 31731 W. Commercial Street Carnation, Washington	**SITE PLAN** **FIGURE 2**	Cobalt Geosciences, LLC P.O. Box 82243 Kenmore, WA 98028 (206) 331-1097 www.cobaltgeo.com cobaltgeo@gmail.com



Not to Scale

COBALT GEOSCIENCES	**Typical Foundation Drain Detail**	**Attachment**	Cobalt Geosciences, LLC PO Box 1792 North Bend, WA 98045 (206) 331-1097 www.cobaltgeo.com phil@cobaltgeo.com

Unified Soil Classification System (USCS)

MAJOR DIVISIONS			SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS (more than 50% retained on No. 200 sieve)	Gravels (more than 50% of coarse fraction retained on No. 4 sieve)	Clean Gravels (less than 5% fines)	GW	Well-graded gravels, gravels, gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines
		Gravels with Fines (more than 12% fines)	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	Sands (50% or more of coarse fraction passes the No. 4 sieve)	Clean Sands (less than 5% fines)	SW	Well-graded sands, gravelly sands, little or no fines
			SP	Poorly graded sand, gravelly sands, little or no fines
		Sands with Fines (more than 12% fines)	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
FINE GRAINED SOILS (50% or more passes the No. 200 sieve)	Silts and Clays (liquid limit less than 50)	Inorganic	ML	Inorganic silts of low to medium plasticity, sandy silts, gravelly silts, or clayey silts with slight plasticity
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays silty clays, lean clays
		Organic	OL	Organic silts and organic silty clays of low plasticity
	Silts and Clays (liquid limit 50 or more)	Inorganic	MH	Inorganic silts, micaceous or diatomaceous fine sands or silty soils, elastic silt
			CH	Inorganic clays of medium to high plasticity, sandy fat clay, or gravelly fat clay
		Organic	OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor		PT	Peat, humus, swamp soils with high organic content (ASTM D4427)

Classification of Soil Constituents

MAJOR constituents compose more than 50 percent, by weight, of the soil. Major constituents are capitalized (i.e., SAND).

Minor constituents compose 12 to 50 percent of the soil and precede the major constituents (i.e., silty SAND). Minor constituents preceded by "slightly" compose 5 to 12 percent of the soil (i.e., slightly silty SAND).

Trace constituents compose 0 to 5 percent of the soil (i.e., slightly silty SAND, trace gravel).

Grain Size Definitions

Description	Sieve Number and/or Size
Fines	<#200 (0.08 mm)
Sand	
-Fine	#200 to #40 (0.08 to 0.4 mm)
-Medium	#40 to #10 (0.4 to 2 mm)
-Coarse	#10 to #4 (2 to 5 mm)
Gravel	
-Fine	#4 to 3/4 inch (5 to 19 mm)
-Coarse	3/4 to 3 inches (19 to 76 mm)
Cobbles	3 to 12 inches (75 to 305 mm)
Boulders	>12 inches (305 mm)

Relative Density (Coarse Grained Soils)

N, SPT, Blows/FT	Relative Density
0 - 4	Very loose
4 - 10	Loose
10 - 30	Medium dense
30 - 50	Dense
Over 50	Very dense

Consistency (Fine Grained Soils)

N, SPT, Blows/FT	Relative Consistency
Under 2	Very soft
2 - 4	Soft
4 - 8	Medium stiff
8 - 15	Stiff
15 - 30	Very stiff
Over 30	Hard

Moisture Content Definitions

Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, from below water table

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Soil Classification Chart

Figure C1

Test Pit TP-1

Date: July 2023	Depth: 9'	Groundwater: None
Contractor: Jim	Elevation: N/A	Logged By: PH Checked By: SC

Depth (Feet)	Interval	Graphic Log	USCS Symbol	Material Description	Groundwater
				Vegetation and Topsoil	
1			SM	Loose to medium dense, silty-fine to medium grained sand, reddish brown to yellowish brown, moist. (Fill)	
2			SM	Loose to medium dense, silty-fine to medium grained sand trace gravel, reddish brown to yellowish brown, moist. (Alluvium)	
3					
4				Mottled at 5-6' and SM-ML areas at this depth	
5					
6					
7					
8					
9				End of Test Pit 9'	
10					

Moisture Content (%)
Plastic Limit — Liquid Limit

DCP Equivalent N-Value
0 10 20 30 40 50

COBALT GEOSCIENCES

Proposed Development
31731 W. Commercial Street
Carnation, Washington

Test Pit Logs

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cobaltgeo@gmail.com

Hand Boring HB-1

Date: July 2023	Depth: 6'	Groundwater: None
Contractor: Jim	Elevation:	Logged By: PH Checked By: SC

Depth (Feet)	Interval	Graphic Log	USCS Symbol	Material Description
				Topsoil/Vegetation
1			SM	Loose to medium dense, silty-fine to medium grained sand, reddish brown to yellowish brown, moist. (Alluvium)
2				
3				Mottled at 5'
4				
5				
6				End of Hand Boring 6'
7				
8				
9				
10				

Groundwater

Moisture Content (%)
Plastic Limit — Liquid Limit

DCP Equivalent N-Value
0 10 20 30 40 50

COBALT GEOSCIENCES

Proposed Development
31731 W. Commercial Street
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Hand Boring Log

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Appendix B

Operation & Maintenance Manual

NO. 5 – CATCH BASINS AND MANHOLES

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Structure	Sediment	Sediment exceeds 60% of the depth from the bottom of the catch basin to the invert of the lowest pipe into or out of the catch basin or is within 6 inches of the invert of the lowest pipe into or out of the catch basin.	Sump of catch basin contains no sediment.
	Trash and debris	Trash or debris of more than ½ cubic foot which is located immediately in front of the catch basin opening or is blocking capacity of the catch basin by more than 10%.	No Trash or debris blocking or potentially blocking entrance to catch basin.
		Trash or debris in the catch basin that exceeds $^1/_3$ the depth from the bottom of basin to invert the lowest pipe into or out of the basin.	No trash or debris in the catch basin.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within catch basin.
		Deposits of garbage exceeding 1 cubic foot in volume.	No condition present which would attract or support the breeding of insects or rodents.
	Damage to frame and/or top slab	Corner of frame extends more than ¾ inch past curb face into the street (If applicable).	Frame is even with curb.
		Top slab has holes larger than 2 square inches or cracks wider than ¼ inch.	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than ¾ inch of the frame from the top slab.	Frame is sitting flush on top slab.
	Cracks in walls or bottom	Cracks wider than ½ inch and longer than 3 feet, any evidence of soil particles entering catch basin through cracks, or maintenance person judges that catch basin is unsound.	Catch basin is sealed and is structurally sound.
		Cracks wider than ½ inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	No cracks more than $^1/_4$ inch wide at the joint of inlet/outlet pipe.
	Settlement/ misalignment	Catch basin has settled more than 1 inch or has rotated more than 2 inches out of alignment.	Basin replaced or repaired to design standards.
	Damaged pipe joints	Cracks wider than ½-inch at the joint of the inlet/outlet pipes or any evidence of soil entering the catch basin at the joint of the inlet/outlet pipes.	No cracks more than ¼-inch wide at the joint of inlet/outlet pipes.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
Inlet/Outlet Pipe	Sediment accumulation	Sediment filling 20% or more of the pipe.	Inlet/outlet pipes clear of sediment.
	Trash and debris	Trash and debris accumulated in inlet/outlet pipes (includes floatables and non-floatables).	No trash or debris in pipes.
	Damaged	Cracks wider than ½-inch at the joint of the inlet/outlet pipes or any evidence of soil entering at the joints of the inlet/outlet pipes.	No cracks more than ¼-inch wide at the joint of the inlet/outlet pipe.

NO. 5 – CATCH BASINS AND MANHOLES

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Metal Grates (Catch Basins)	Unsafe grate opening	Grate with opening wider than $^{7}/_{8}$ inch.	Grate opening meets design standards.
	Trash and debris	Trash and debris that is blocking more than 20% of grate surface.	Grate free of trash and debris.
	Damaged or missing	Grate missing or broken member(s) of the grate. **Any open structure requires urgent maintenance**.	Grate is in place and meets design standards.
Manhole Cover/Lid	Cover/lid not in place	Cover/lid is missing or only partially in place. **Any open structure requires urgent maintenance**.	Cover/lid protects opening to structure.
	Locking mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts cannot be seated. Self-locking cover/lid does not work.	Mechanism opens with proper tools.
	Cover/lid difficult to Remove	One maintenance person cannot remove cover/lid after applying 80 lbs. of lift.	Cover/lid can be removed and reinstalled by one maintenance person.

NO. 6 – CONVEYANCE PIPES AND DITCHES

Maintenance Component	Defect or Problem	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Pipes	Sediment & debris accumulation	Accumulated sediment or debris that exceeds 20% of the diameter of the pipe.	Water flows freely through pipes.
	Vegetation/roots	Vegetation/roots that reduce free movement of water through pipes.	Water flows freely through pipes.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Damage to protective coating or corrosion	Protective coating is damaged; rust or corrosion is weakening the structural integrity of any part of pipe.	Pipe repaired or replaced.
	Damaged	Any dent that decreases the cross section area of pipe by more than 20% or is determined to have weakened structural integrity of the pipe.	Pipe repaired or replaced.
Ditches	Trash and debris	Trash and debris exceeds 1 cubic foot per 1,000 square feet of ditch and slopes.	Trash and debris cleared from ditches.
	Sediment accumulation	Accumulated sediment that exceeds 20% of the design depth.	Ditch cleaned/flushed of all sediment and debris so that it matches design.
	Noxious weeds	Any noxious or nuisance vegetation which may constitute a hazard to County personnel or the public.	Noxious and nuisance vegetation removed according to applicable regulations. No danger of noxious vegetation where County personnel or the public might normally be.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Vegetation	Vegetation that reduces free movement of water through ditches.	Water flows freely through ditches.
	Erosion damage to slopes	Any erosion observed on a ditch slope.	Slopes are not eroding.
	Rock lining out of place or missing (If Applicable)	One layer or less of rock exists above native soil area 5 square feet or more, any exposed native soil.	Replace rocks to design standards.

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NO. 11 – GROUNDS (LANDSCAPING)

Maintenance Component	Defect or Problem	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Site	Trash or litter	Any trash and debris which exceed 1 cubic foot per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size office garbage can). In general, there should be no visual evidence of dumping.	Trash and debris cleared from site.
	Noxious weeds	Any noxious or nuisance vegetation which may constitute a hazard to County personnel or the public.	Noxious and nuisance vegetation removed according to applicable regulations. No danger of noxious vegetation where County personnel or the public might normally be.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Grass/groundcover	Grass or groundcover exceeds 18 inches in height.	Grass or groundcover mowed to a height no greater than 6 inches.
Trees and Shrubs	Hazard	Any tree or limb of a tree identified as having a potential to fall and cause property damage or threaten human life. **A hazard tree identified by a qualified arborist must be removed as soon as possible.**	No hazard trees in facility.
	Damaged	Limbs or parts of trees or shrubs that are split or broken which affect more than 25% of the total foliage of the tree or shrub.	Trees and shrubs with less than 5% of total foliage with split or broken limbs.
		Trees or shrubs that have been blown down or knocked over.	No blown down vegetation or knocked over vegetation. Trees or shrubs free of injury.
		Trees or shrubs which are not adequately supported or are leaning over, causing exposure of the roots.	Tree or shrub in place and adequately supported; dead or diseased trees removed.

NO. 30 – PERMEABLE PAVEMENT BMP

Maintenance Component	Defect or Problem	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Preventative	Surface cleaning/ vegetation control	Media surface vacuumed or pressure washed annually, vegetation controlled to design maximum. Weed growth suggesting sediment accumulation.	No dirt, sediment, or debris clogging porous media, or vegetation limiting infiltration.
Porous Concrete, Porous Asphaltic Concrete, and Permeable Pavers	Trash and debris	Trash and debris on the pavement interfering with infiltration; leaf drop in fall season.	No trash or debris interfering with infiltration.
	Sediment accumulation	Sediment accumulation on the pavement interfering with infiltration; runoff from adjacent areas depositing sediment/debris on pavement.	Pavement infiltrates as designed; adjacent areas stabilized.
	Infiltration rate	Pavement does not infiltrate at a rate of 10 inches per hour.	Pavement infiltrates at a rate greater than 10 inches per hour.
	Ponding	Standing water for a long period of time on the surface of the pavement.	Standing water infiltrates at the desired rate.
	Broken or cracked pavement	Pavement is broken or cracked.	No broken pavement or cracks on the surface of the pavement.
	Settlement	Uneven pavement surface indicating settlement of the subsurface layer.	Pavement surface is uniformly level.
	Moss growth	Moss growing on pavement interfering with infiltration.	No moss interferes with infiltration.
	Inflow	Inflow to the pavement is diverted, restricted, or depositing sediment and debris on the pavement.	Inflow to pavement is unobstructed and not bringing sediment or debris to the pavement.
	Underdrain	Underdrain is not flowing when pavement has been infiltrating water.	Underdrain flows freely when water is present.
	Overflow	Overflow not controlling excess water to desired location; native soil is exposed or other signs of erosion damage are present.	Overflow permits excess water to leave the site at the desired location; Overflow is stabilized and appropriately armored.
Permeable Pavers	Broken or missing pavers	Broken or missing paving blocks on surface of pavement.	No missing or broken paving blocks interfering with infiltration.
	Level surface	Uneven surface due to settlement or scour of fill in the interstices of the paving blocks.	Pavement surface is uniformly level.
	Compaction	Poor infiltration due to soil compaction between paving blocks.	No soil compaction in the interstices of the paver blocks limiting infiltration.
	Dead grass	Grass in the interstices of the paving blocks is dead.	Healthy grass is growing in the interstices of the paver blocks.
Inspection	Frequency	Annually and after large storms, and as needed seasonally to control leaf drop, evergreen needles etc.	Permeable pavement is functioning normally.

NO. 26 – GRAVEL FILLED INFILTRATION TRENCH BMP

Maintenance Component	Defect or Problem	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Preventative	Blocking, obstructions	Debris or trash limiting flow to infiltration trench.	Infiltration trench able to receive full flow prior to and during wet season.
Site	Trash and debris	Trash or debris that could end up in the infiltration trench is evident.	No trash or debris that could get into the infiltration trench can be found.
Pipes	Inlet is plugged	The entrance to the pipe is restricted due to sediment, trash, or debris.	The entrance to the pipe is not restricted.
	Vegetation/roots	Vegetation/roots that reduce free movement of water through pipes.	Water flows freely through pipes.
	Plugged	Sediment or other material prevents free flow of water through the pipe.	Water flows freely through pipes.
	Broken or joint leaks.	Damage to the pipe or pipe joints allowing water to seep out.	Pipe does not allow water to exit other than at the outlet to the trench.
Structure	Flow not reaching trench	Flows are not getting into the trench as designed.	Water enters and exits trench as designed.
	Cleanout/inspection access does not allow cleaning or inspection of trench	The cleanout/inspection access is not available.	Cleanout/inspection access is available.
Filter Media	Filter media plugged	Filter media plugged.	Flow through filter media is normal.
Inspection	Frequency	Annually and prior to and following significant storms.	Inspect infiltration trench system for any defects of deficiencies.