Preliminary
Master Drainage Plan

FOR

Bullfrog Flats

Cle Elum, Washington

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REGISTERED PROFESSIONAL ENGINEER
PRELIMINARY

2024/08/26

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1. Introduction

Bullfrog Flats is an approximately 1,100-acre property located in the southwestern portion of the City of Cle Elum, generally bounded by I-90, Bullfrog Road, and SR903. In 2002, the City of Cle Elum approved a Subarea Plan, Master Site Plan, and Development Agreement for the property, and it was annexed to the City that same year. Proposed development is mixed use, including 1334 residential units, a business park, and various recreational areas. The project is planned to be developed in phases, starting with three residential phases designated as S-1, J and S-2. At this time preliminary designs for the first three phases, including proposed stormwater systems and facilities, have been completed.

Condition 50 of the original 2002 development agreement requires the creation of a Master Drainage Plan. This report builds off the previously created Master Drainage Plan Update in 2002 to fulfill this requirement. Detailed design of proposed drainage facilities is not included in this report and is provided in the Stormwater Site Plan for each project phase.

2. Background

In 1999 a Master Drainage Plan was developed for a large Master Planned Resort development, originally called MountainStar, and now known as Suncadia. This project extended from Bullfrog Road northwest towards Cle Elum Lake and totaled over 6,000 acres in size. The Bullfrog flats area was included in the drainage basin for this project but was not part of the proposed development area. In 2002 a separate Master Drainage Plan Update (2002 MDP) was created for the Bullfrog Flats area. This formed the basis for the stormwater modeling and management for Bullfrog Flats.

Between 2002 and 2024 small areas of Bullfrog Flats have been developed or dedicated to the City of Cle Elum. The most notable development was the Horse Park, bordering I-90 on the south side of Bullfrog Flats. 918.9 of the original 1,100 acres currently remain.

3. Existing Conditions

Bullfrog Flats is primarily second growth forest with open understory. Climate is characterized by warm, dry summers and cold, wet winters with snow cover. The site generally drains to the southeast and drainage basins are split by topography consisting of gently sloping plateaus, steep slopes and gullies. Soils on site vary, consisting of alluvium, glacial drift and outwash. The majority of the project site soils are well suited for infiltration, with the exception of the areas of phases P-1 and P-2 which are located in areas of alpine till and dirty glacial outwash. Refer to figure 6 of Appendix B - 2020 AESI Technical Report: Geology, Soils and Groundwater for a map of the site soils and infiltration potential. The existing project site conditions have been extensively documented, including an Environmental Impact Statement in 2002 (2002 FEIS), as well as a Final Supplemental Environmental Impact Statement in 2021 (2021 FSEIS). For more information on the existing site conditions reference Appendix B and Appendix C - 2024 AESI Bullfrog Flats Geotechnical Report.

BULLFROG FLATS - MASTER DRAINAGE PLAN

EXISTING CONDITIONS EXHIBIT

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4. Proposed Conditions

The Bullfrog Flats Master Plat proposes a boundary line adjustment to split the existing 918.9 acres into separate parcels for phased development. Condition 49 of the 2002 development agreement required all construction to comply with the WA DOE 2001 Stormwater Management Manual for Western Washington or the equivalent Eastern Washington manual, once published. Each phase developed will include a Stormwater Site Plan for that phase demonstrating how the proposed stormwater system meets all requirements of the development agreement, the City of Cle Elum, and the current 2024 Stormwater Management Manual for Eastern Washington (2024 SWMMEW).

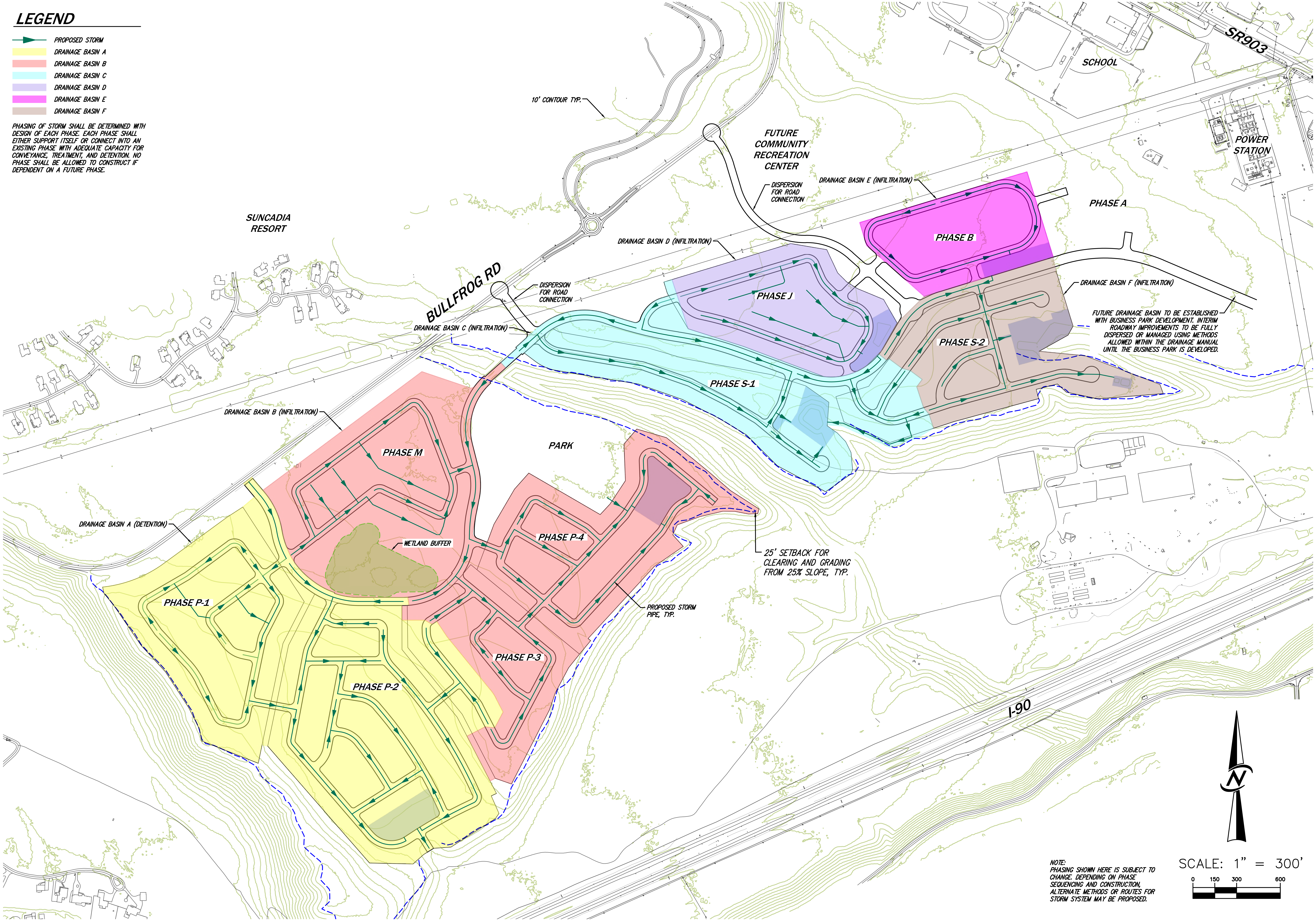
4.1 Stormwater Collection Systems

Stormwater from impervious surfaces, including roadways and sidewalks, will be routed to catch basins and through piped conveyance systems to runoff treatment and flow control Best Management Practices (BMPs). The development agreement provides road cross sections to be used for all project roadways. Because these include curb and gutter it is not currently anticipated that runoff from any project roadways will directly disperse with the exception of temporary roadways.

4.2 Phasing

The proposed drainage basins overlap multiple phase boundaries, requiring partial stormwater infrastructure to be constructed prior to full utility and roadway construction of some phases. At this time exact stormwater phasing is still being determined. No individual phase will be allowed to proceed with construction prior to stormwater conveyance, treatment and detention, or a plan to provide these within that phase, being completed.

It is currently proposed that a continuous fire department access road be provided between Bullfrog Road and SR903 with construction of the first project phase (S-1). This road will meet current IFC standards and be a minimum of 26’ paved width. As curb, gutter and sidewalk are not required until a later phase of construction this roadway may temporarily utilize dispersion to manage stormwater. Details on the temporary stormwater design for this roadway will be provided in a separate Stormwater Site Plan. The final roadway alignment is dependent on future phased development in the business park, and final stormwater management will be determined at that time.



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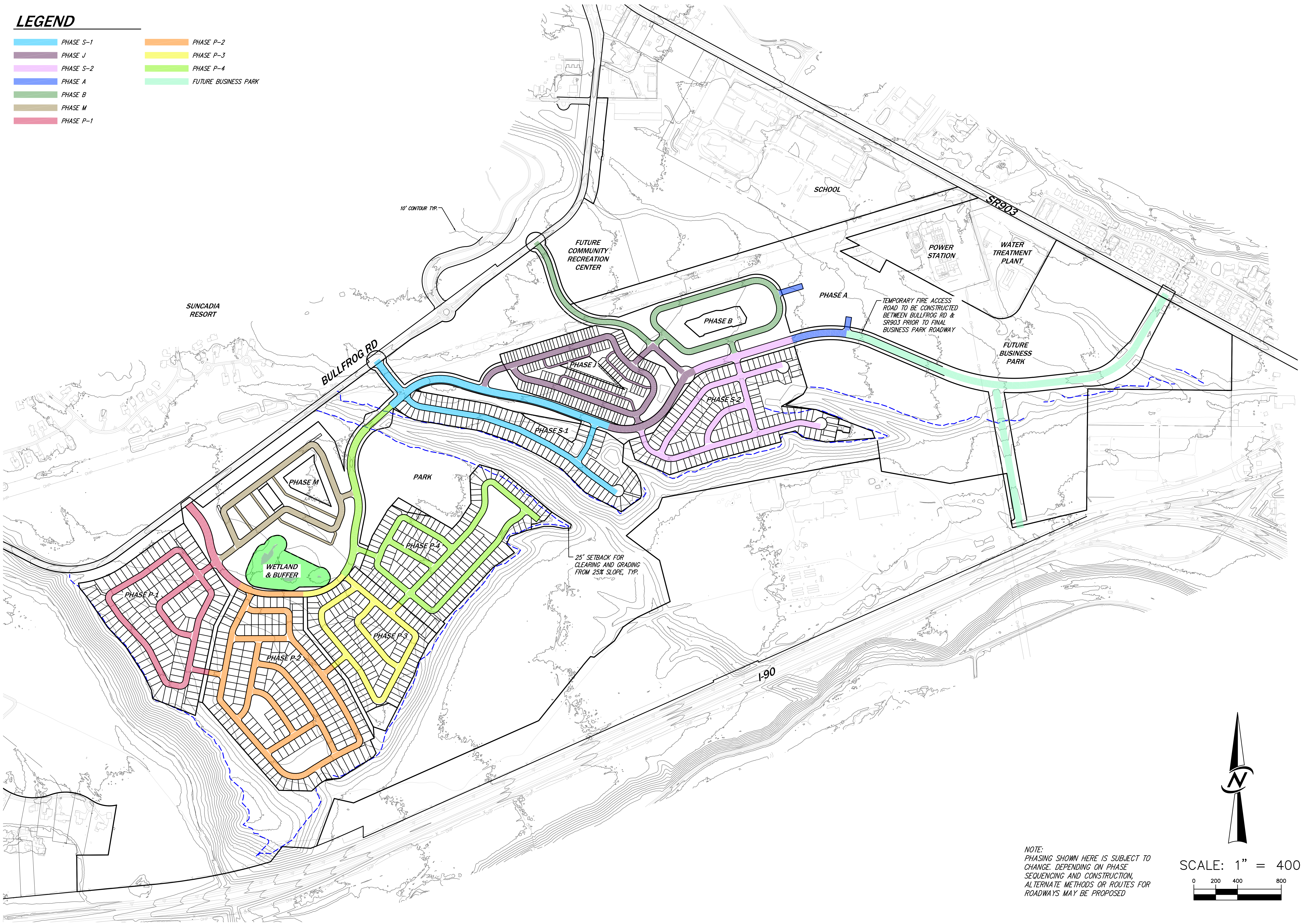
BULLFROG FLATS - MASTER DRAINAGE PLAN
PROPOSED CONDITIONS EXHIBIT



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BULLFROG FLATS - MASTER DRAINAGE PLAN
ROAD PHASING EXHIBIT

4.3 Impervious Surfaces

Impervious surfaces proposed include public roadways and sidewalks, as well as private roofs and driveways. Each phase of the project will propose handling the stormwater from public and private impervious surfaces depending on the area of impervious surface proposed, and the applicability and space available for BMPs. The specific breakdown will be detailed in the Stormwater Site Plan for each phase of development.

A preliminary inventory of proposed impervious surfaces for each phase of development is provided in table 4-1 below. The development agreement stipulates the maximum impervious surface coverage for each lot type. For single-family Lots, the maximum allowed is 55% and for multi-family the maximum allowed is 85%. Some single-family lot types require a lower maximum impervious surface coverage of 50%. For the purposes of preliminary design 55% of the area of each single-family lot has been assumed impervious. The first multi-family phase being developed, Phase J, includes proposed building envelopes which have been used to determine the proposed impervious area. All other multi-family phases assume a lot impervious surface coverage of 85%.

Table 4-1 Proposed Impervious Surface Areas

Phase	Use	Total Area	Total Proposed Impervious Area	Proposed Public Impervious Area*	Proposed Private Impervious Area
P-1	Single Family	28.89 ac	16.76 ac	6.68 ac	10.08 ac
P-2	Single Family	42.09 ac	24.97 ac	10.28 ac	14.68 ac
P-3	Single Family	21.21 ac	12.47 ac	5.07 ac	7.40 ac
P-4	Single Family	29.22 ac	19.48 ac	9.29 ac	10.19 ac
S-1	Single Family	18.62 ac	16.36 ac	9.87 ac	6.50 ac
S-2	Single Family	27.50 ac	13.85 ac	4.26 ac	9.59 ac
J	Townhomes	20.38 ac	9.85 ac	5.11 ac	4.74 ac
M	Townhomes	25.30 ac	13.46 ac	4.99 ac	8.47 ac
B	Apartments	15.80 ac	11.50 ac	5.54 ac	5.97 ac
A	Affordable Units	7.50 ac	4.49 ac	1.88 ac	2.62 ac

**Includes proposed impervious area for the portion of spine road which will be constructed with this project phase. Note that this area is outside all phase boundaries and therefore is not included in the Total Area column. Some areas of the spine road are not included in this table as they are outside the main project drainage basins. These can be seen on Figure 4-1 Proposed Storm Plan.*

4.4 Runoff Treatment (Water Quality)

The 2002 FEIS and MDP assigned different water quality treatment requirements to four separate delineated basins, named A, B, C and D. These basins are shown on Figure 5 of Appendix A - 2002 Master Drainage Plan Update. Recommendations for runoff treatment were based on the 2001 Stormwater Management Manual for Western Washington, the most current stormwater guidance manual available at that time. Table 4-2 below summarizes these recommendations.

Table 4-2 2002 Water Quality Recommendations

Basin	2002 Water Quality Recommendation
A	Enhanced Treatment
B	Enhanced Treatment
C	None Provided
D	Basic Treatment

In accordance with development agreement condition 49, the project water quality treatment requirements have been re-evaluated to comply with the 2024 SWMMEW.

The 2024 SWMMEW provides specific thresholds for determining the required level of water quality treatment, which is now called runoff treatment. Enhanced treatment is now called metals treatment.

It is anticipated that all project phases for Bullfrog Flats will propose more than 5,000 square feet of pollution-generating hard surface (PGHS), requiring basic treatment of all PGHS.

The 2024 SWMMEW only requires metals treatment for projects with one of the following types of discharge:

1. Discharge directly to fresh waters designated for aquatic life use or that have an existing aquatic life use.
2. Discharge to conveyance systems that are tributary to fresh waters designated for aquatic life use or that have an existing aquatic life use.
3. Infiltrate stormwater within ¼ mile of a fresh water designated for aquatic life use or that has an existing aquatic life use.

The first three phases designed (S-1, J and S-2) do not require metals treatment. However, the runoff treatment BMPs proposed do provide metals treatment. All three phases propose the use of bioretention areas (BMP F6.23) which provide both basic and metals treatment by infiltrating stormwater through bioretention soil mix. Details on the designs of each bioretention area are provided in the Stormwater Site Plan for each phase of development.

It is not anticipated that oil or phosphorous treatment will be required for any development within Bullfrog Flats.

The required level of runoff treatment and proposed BMPs for future phases will be determined as designs for those phases progress, and this Master Drainage Plan will be updated as required. Preliminary analysis of the Bullfrog Flats project area indicates that bioretention and dispersion can provide the majority of runoff treatment for all project phases. Both bioretention and full dispersion (BMP F6.42) can provide enhanced treatment if required. In areas where infiltration and dispersion are not applicable due to site conditions, alternative BMPs will be proposed. These will be determined during the preliminary design of each phase, and may include bioretention areas with underdrains, biofiltration swales, sand filters, emerging technologies, or other appropriate BMPs.

At this time all runoff treatment BMPs are proposed to be located within parcels created by the Master Plat boundary line adjustment. As the design of each phase progresses, parcel boundaries may be adjusted as required to provide adequate space for facilities.

4.5 Flow Control

The 2002 MDP proposed infiltration for flow control of all site stormwater. Additional documentation of the existing site soils since 2002 has determined that infiltration is not feasible for some phases of Bullfrog Flats. At this point in preliminary design, phases S-1, J and S-2 have proposed infiltration ponds (BMP F6.21) to infiltrate 100% of the design storm. Future project phases in areas where infiltration or dispersion are applicable will utilize these methods for flow control wherever possible.

Phases P-1 and P-2 are located within low infiltration potential soils, including alpine till and dirty glacial outwash. Preliminary analysis of these phases indicates that detention ponds or vaults may be appropriate for providing flow control. The specific BMPs proposed will be determined during the preliminary design of each phase.

At this time all flow control BMPs are proposed to be located within parcels created by the Master Plat boundary line adjustment. As the design of each phase progresses, parcel boundaries may be adjusted as required to provide adequate space for facilities.

4.6 Stormwater Facility Ownership

Piped conveyance systems which collect stormwater from public roads and sidewalks are proposed to be owned and maintained by the City of Cle Elum. Regional stormwater facilities that provide runoff treatment or flow control, including, but not limited to, bioretention areas, dispersion trenches, and detention ponds are also proposed to be owned and maintained by the City of Cle Elum. In some phases of project development impervious surfaces located on private property are proposed to connect to publicly owned regional facilities. In others, runoff from private roofs and driveways will be collected and managed on each lot by privately owned facilities. Stormwater Site Plans prepared for each project phase will clearly delineate which impervious surfaces drain to publicly owned facilities.

4.7 Stormwater Facility Operation and Maintenance

Maintenance and operation of all stormwater facilities will be the responsibility of the owner. Operation and maintenance manuals will be provided as appendices to the Stormwater Site Plan for each project phase.

5. Modeling

5.1 Precipitation Data

The 2002 MDP developed 24-hour design storm precipitation depths by scaling Easton, WA rainfall data from 1948-1996 to four separate precipitation zones across Bullfrog Flats. Generally, the west side of Bullfrog Flats receives more precipitation than the east side. Depths for 2-year through 100-year storm frequencies are presented in Table 2 of Appendix A - 2002 Master Drainage Plan Update. A comparison of this data to current NOAA Atlas 2 Precipitation Frequency Estimates showed that NOAA precipitation depths were higher for all locations across the project site. NOAA data was chosen to be used for designing all stormwater facilities. The Stormwater Site Plan for each phase of development provides additional detail on the precipitation depths used in each drainage basin.

5.2 Infiltration Rates

AESI provided infiltration testing recommendations in Appendix A of the 2002 MDP. Preliminary infiltration testing was also completed at this time and resulted in field rates of 2 to 82 inches per hour. In locations where well-drained soil is overlaid by finer grained loess infiltration rates can vary based on the proposed infiltration facility depth. For preliminary infiltration facility design in phases S-1, J and S-2, a design infiltration rate of 4 in/hr has been used. AESI is currently completing infiltration testing, following the procedures of the 2024 SWMMEW, at each proposed facility location and depth for these first three phases. This will provide final design infiltration rates for sizing each facility. In locations where bioretention facilities are proposed the design infiltration rate will be the lesser of the infiltration rate of the underlying soil or 3 in/hr as recommended by the 2024 SWMMEW.

5.3 Water Quality Design Storm

Cle Elum is located in the TR-55 type IA rainfall distribution area. Cle Elum Municipal Code 16.12A.060.B.2 designates the water quality design storm as sixty-four percent of the two-year recurrence interval, 24-hour storm runoff event. Preliminary discussions with the City indicate this code will likely get updated during the phased development of Bullfrog Flats. Any change in the required water quality design storm will be accounted for in phases currently in design and future phases at the time of the code change.

5.4 Ultimate Design Storm

Cle Elum Municipal Code 16.12A.060.B.2 designates the ultimate design storm, for peak flow and peak volume storage requirements, as the ten-year storm runoff event. The development agreement, 2024 SWMMEW, and 2002 MDP do not require a specific storm runoff event be used for Bullfrog Flats. However, the city has requested all infiltration ponds be sized to accommodate the 100-year storm runoff event and Core Design has voluntarily agreed to this request. Currently, infiltration ponds are the only flow control BMP for which preliminary sizing has been completed. Future infiltration ponds will be sized for the 100-year storm runoff event. As other future flow control BMPs are proposed they will be sized to meet the current requirements of the Cle Elum Municipal Code.

5.5 Snowmelt

The 2024 SWMMEW recommends BMPs be sized to accommodate additional runoff from snowmelt in colder climates. Discussions with the City of Cle Elum have also supported inclusion of snowmelt during design. All infiltration ponds will be sized to account for snowmelt representative of the Bullfrog Flats region. The Stormwater Site Plans for each phase provide specific details on how snowmelt will be incorporated into BMP modeling and design. Inclusion of snowmelt for different BMPs proposed in future project phases will be decided at that time, in conjunction with discussions with the City of Cle Elum.

5.6 Hydrologic Model Comparison

The 2002 MDP for Bullfrog Flats used the MountainStar Runoff Time Series Model (MSRTS) for hydrologic modeling. This Hydrological Simulation Program Fortran (HSPF) model was developed and calibrated specifically for the 19.5 square mile watershed encompassing the Suncadia development and Bullfrog Flats. Additional details on the development and calibration of the MSRTS model are included in Appendix A - 2002 Master Drainage Plan Update. The MSRTS model has been used to size stormwater facilities throughout Suncadia over the last two decades and is still in use today.

Suncadia is located within the jurisdiction of Kittitas County, thus the MSRTS model has never been used for a project under jurisdictional review by the City of Cle Elum. Neither the City of Cle Elum Municipal Code, nor the 2024 SWMMEW require the use of a specific hydrologic analysis method for runoff treatment or flow control BMP design.

Prior to beginning design of the stormwater facilities for Bullfrog Flats a modeling comparison was completed to determine if the MSRTS model should be used. A regional infiltration pond facility was designed using two different hydrologic models to determine the required facility size. The second model used was HydroCAD, a single event hydrologic model as opposed to MSRTS, which uses a continuous precipitation record. Multiple storm types and precipitation depths were evaluated in HydroCAD, as well as the optional inclusion of snowmelt which MSRTS natively includes. These inputs and results are summarized in Appendix D - MSRTS & HydroCAD Modeling Comparison.

When using NOAA precipitation data, Santa Barbara Unit Hydrograph Method, and a 24-hour type IA 100-year storm with snowmelt, the resulting infiltration pond had a 38% larger base area and 34% more volume at maximum stage than the same pond sized by MSRTS.

Due to its more conservative sizing, HydroCAD was chosen to model all regional stormwater infiltration facilities for the Bullfrog Flats project.

Appendix A - 2002 Master Drainage Plan Update

Draft

Master Drainage Plan Update

Cle Elum UGA
Trendwest Master Site Plan

For

Trendwest Properties, Inc.

July 2002

By

W&H Pacific, Inc.
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■ TRANSMITTAL

To: Jon Barkee
Trendwest Investments, Inc.
P.O. Box 887, 109 So. 1st Street
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Date: July 30, 2002
Project Number: 834716.34100000
Project Name: Cle Elum UGA – Draft Master Drainage Plan Update

From: Larry Grimm
Phone No. (425) 951-4830
Fax No. (425) 951-4808

We are Sending:

- ■ Attached
- ❒ Facsimile
- # of Pages Including Cover

These are Transmitted:

- ❒ For Your Use
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- ■ For Review & Comment

Copied To:

Ray Miller (w/ encl.)

Copies	Description
1	Cle Elum UGA Master Drainage Plan Update dated July 2002

Comments:

Jon and Ray – Please let me know if you have questions or comments on the draft. We'll then update the draft as needed and transmit to the City for review. Thanks.

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Introduction

A Master Drainage Plan (MDP) for the Trendwest Properties Cle Elum UGA was prepared by American Engineering in July 1999. Subsequent to the preparation of the July 1999 MDP, there has been additional site planning, environmental review and analysis, and agency requirements. Five development plans were evaluated in the EIS for the UGA, with the first alternative being no action. Alternative 5 is currently the preferred alternative and was submitted as the Master Site Plan for the Planned Mixed Use Permit Application prepared for the City of Cle Elum. The purpose of the MDP Update is to serve as a stand-alone document that provides updated drainage information pertaining to the current drainage-related policies, agency requirements and planning efforts for the Cle Elum UGA Trendwest Master Site Plan. This update does not provide detailed drainage planning or runoff modeling for the Master Site Plan. This information will be developed as a part of the Master Plat and individual plat engineering efforts.

Policies and Agency Requirements

A number of policies have been adopted regarding drainage for the Cle Elum UGA Trendwest Master Site Plan. These policies are outlined in the following documents:

- City of Cle Elum Comprehensive Plan, Draft Bullfrog Subarea Plan, April 2001
- Draft Conditions for Planned Mixed Use Approval, Bullfrog Subarea, December 2001
- Draft Cle Elum UGA Development Standards, May 2002
- Department of Ecology Stormwater Management Manual for Western Washington, August 2001

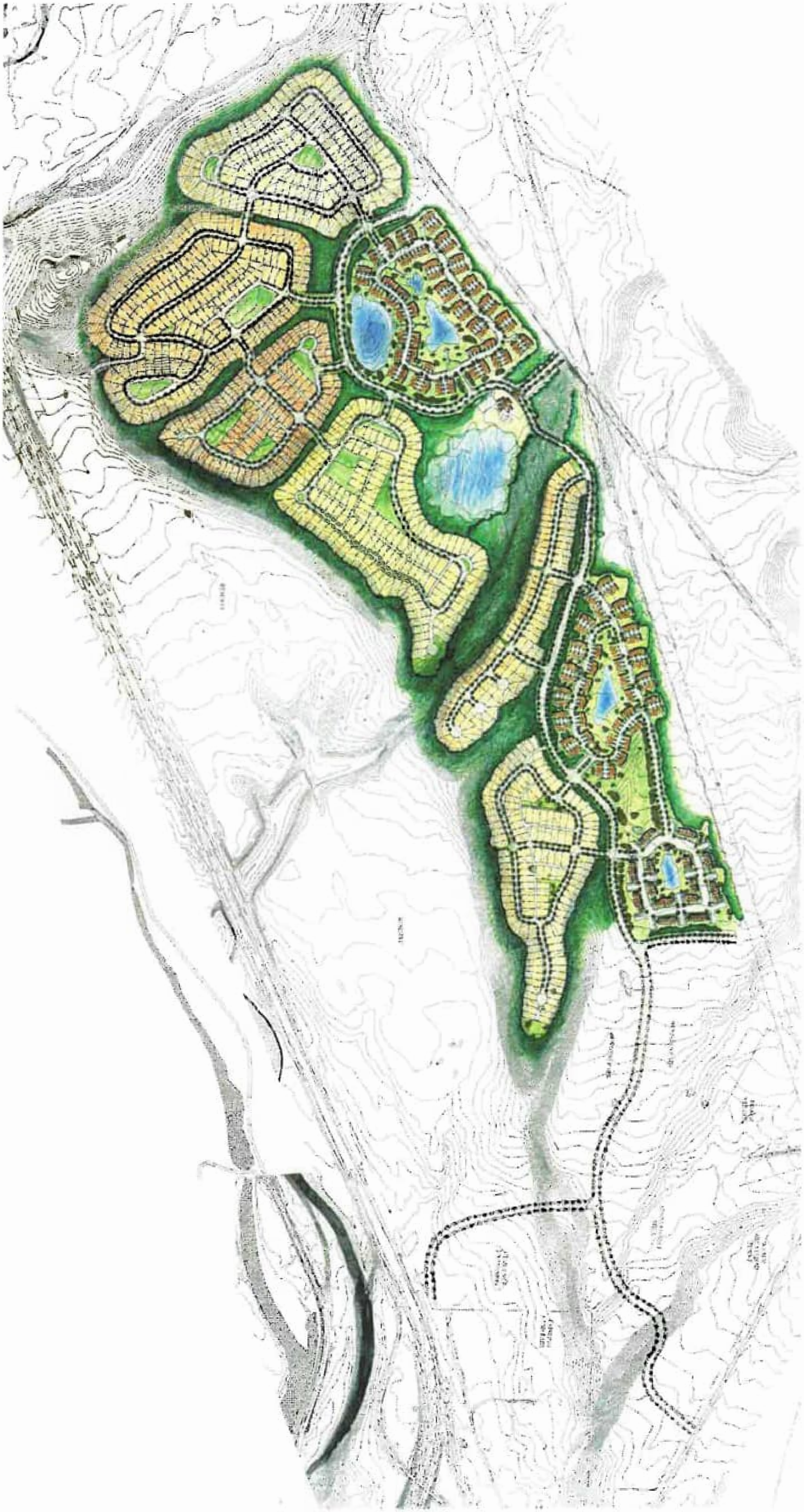
The requirements provided in the *Stormwater Manual for Western Washington* may be modified once the *Stormwater Manual for Eastern Washington* has been prepared, reviewed and adopted by the City.

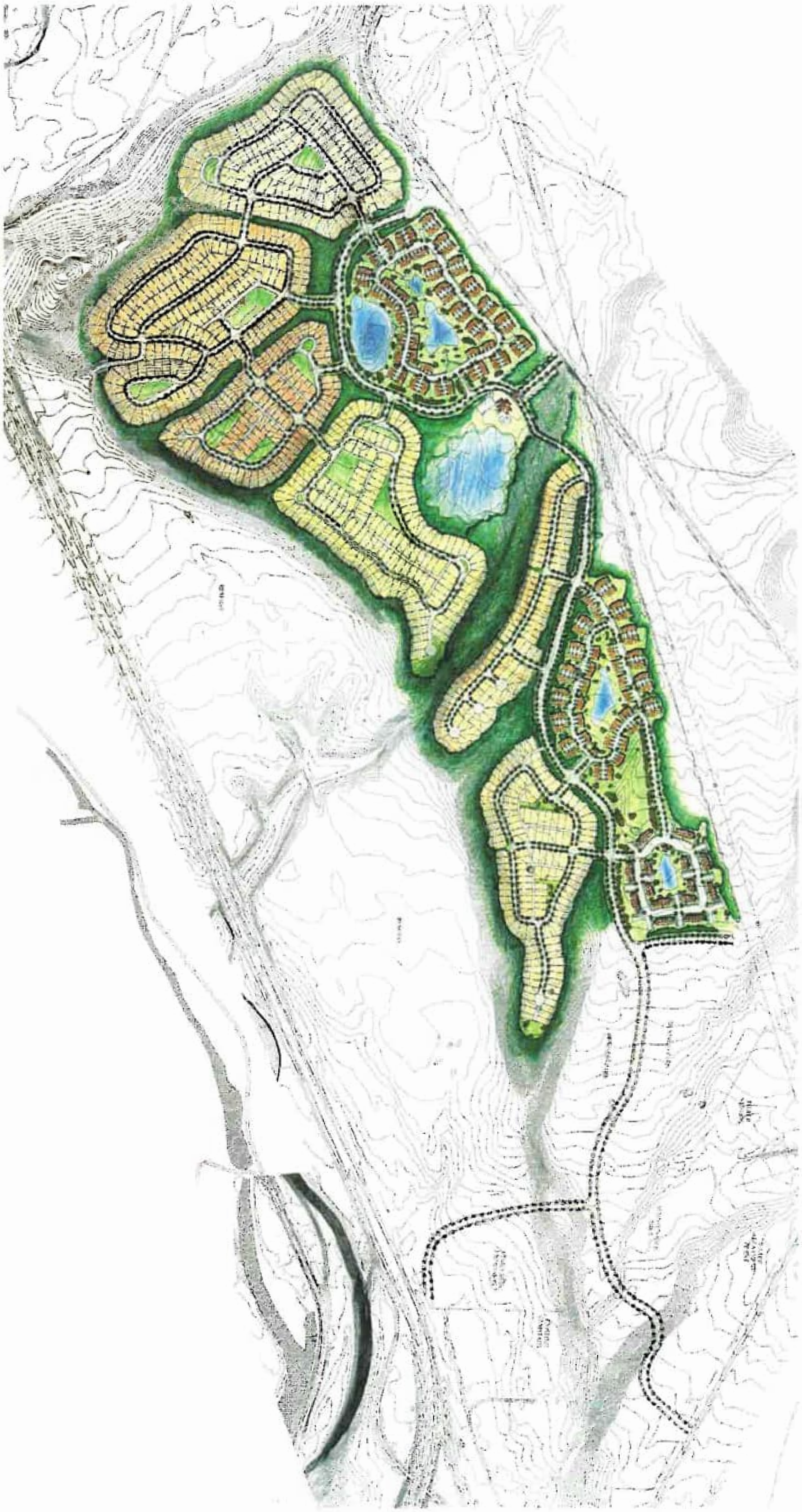
Existing Conditions

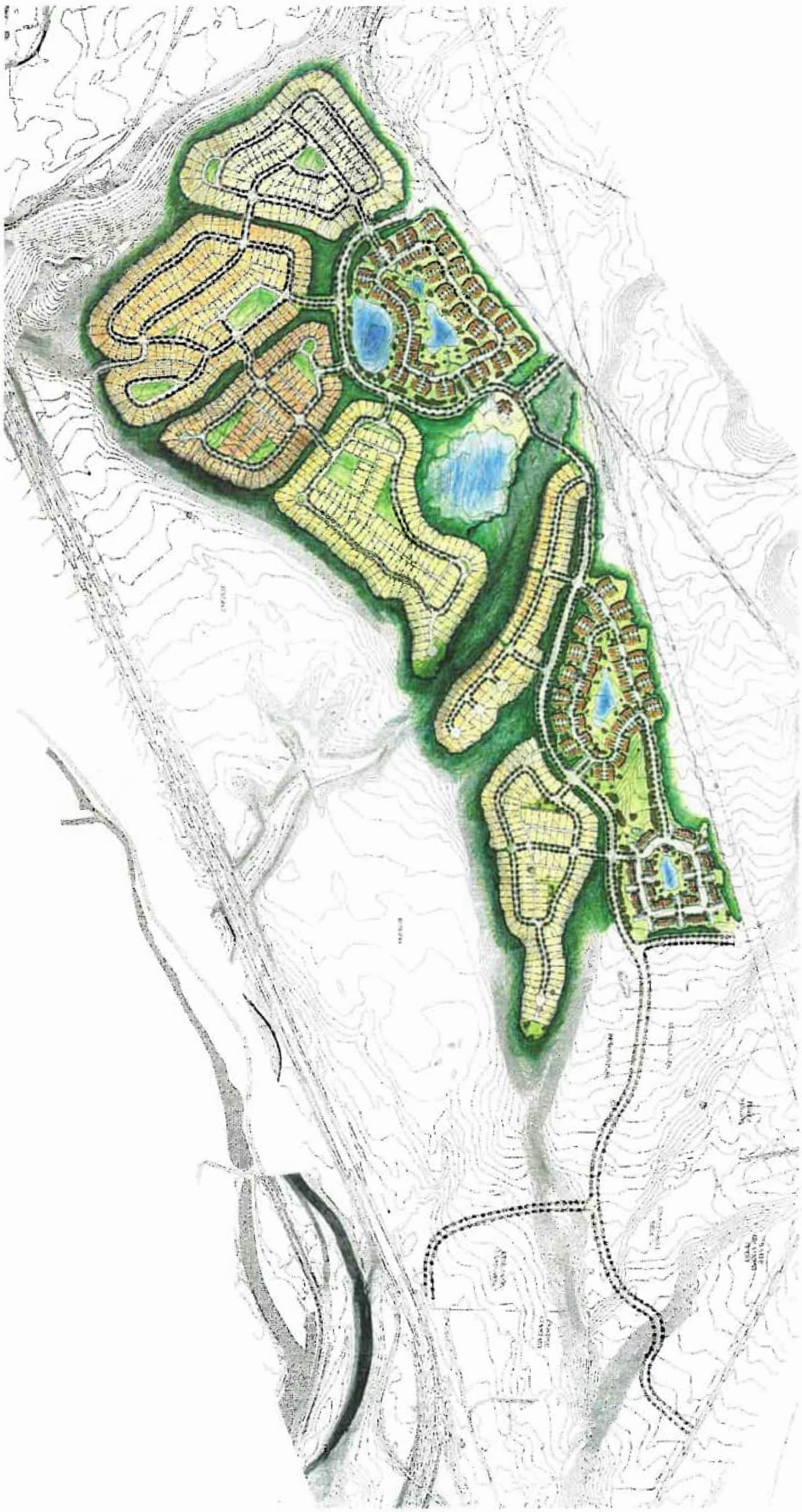
The existing site conditions of the UGA are described in both the March 2001 Draft EIS and the Final EIS published in April 2002. The site consists of approximately 1,100 acres located within the Bullfrog Subarea of the City of Cle Elum. The area is currently zoned Forest and Range. The climate of the site is characterized by warm, dry summers and cold, wet winters with snow cover. Precipitation zones for the site are shown in **Figure 1**. These zones were established by evaluations performed by W&H Pacific for the MountainStar MPR MDP and the UGA.

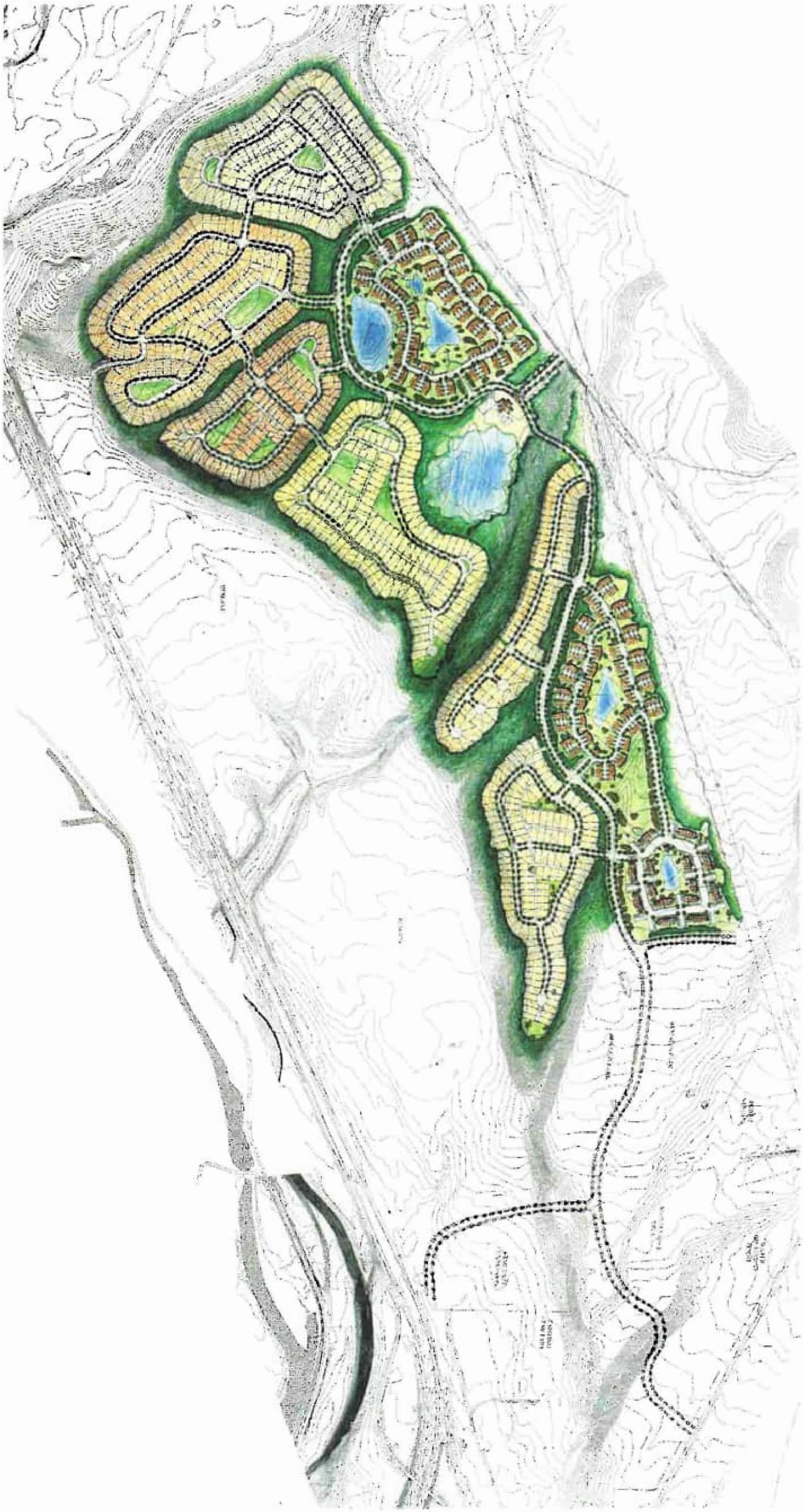
Sensitive areas on the project site include wetlands and their buffers, and stream corridors. These areas are shown on **Figure 2**. The FEMA 100-year floodplain boundary for the Cle Elum River is also shown on **Figure 2**.

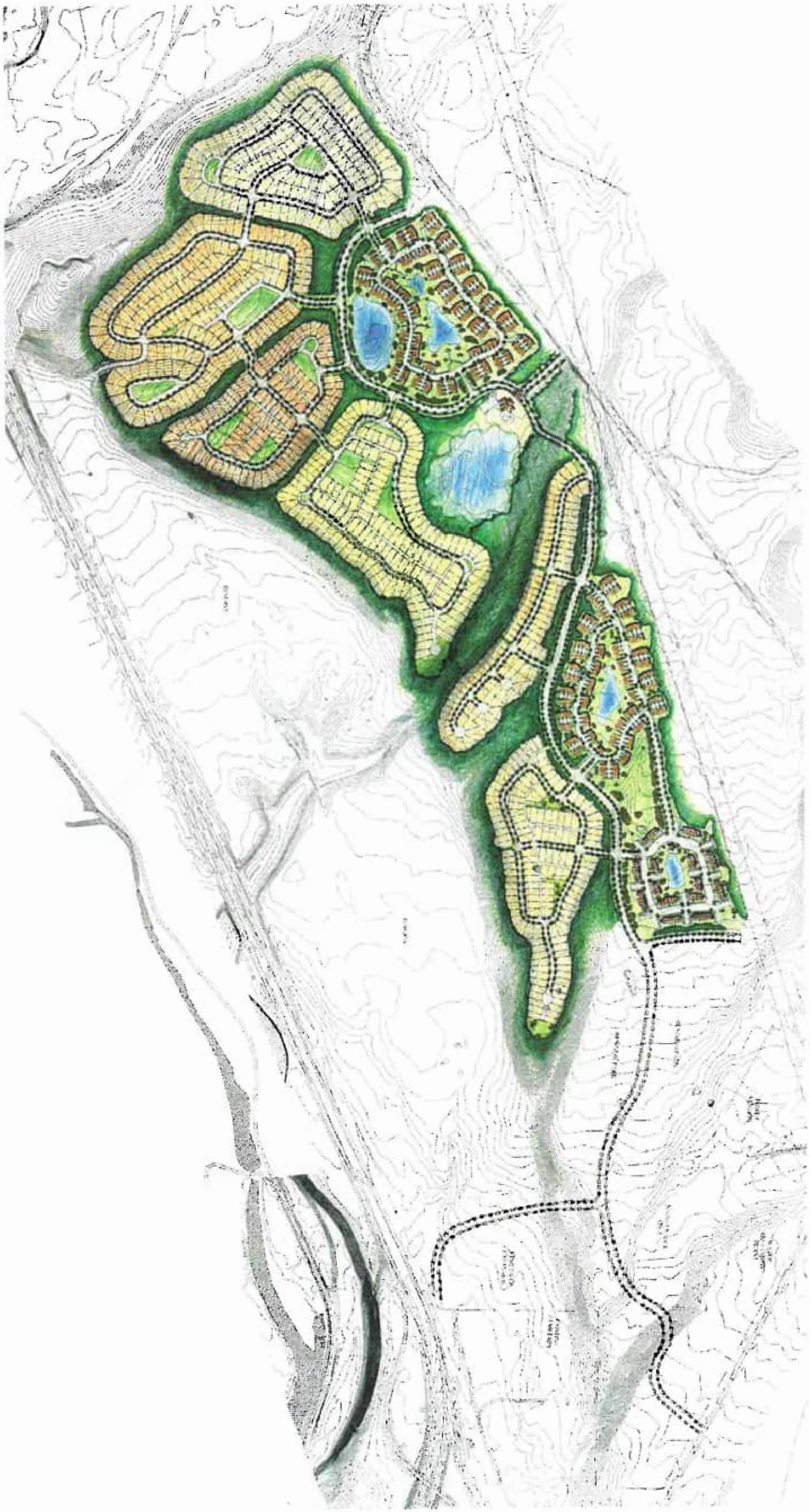
CDM (formerly AGI Technologies) characterized soil types throughout the UGA. These soil types and their locations are shown in **Figure 3**.

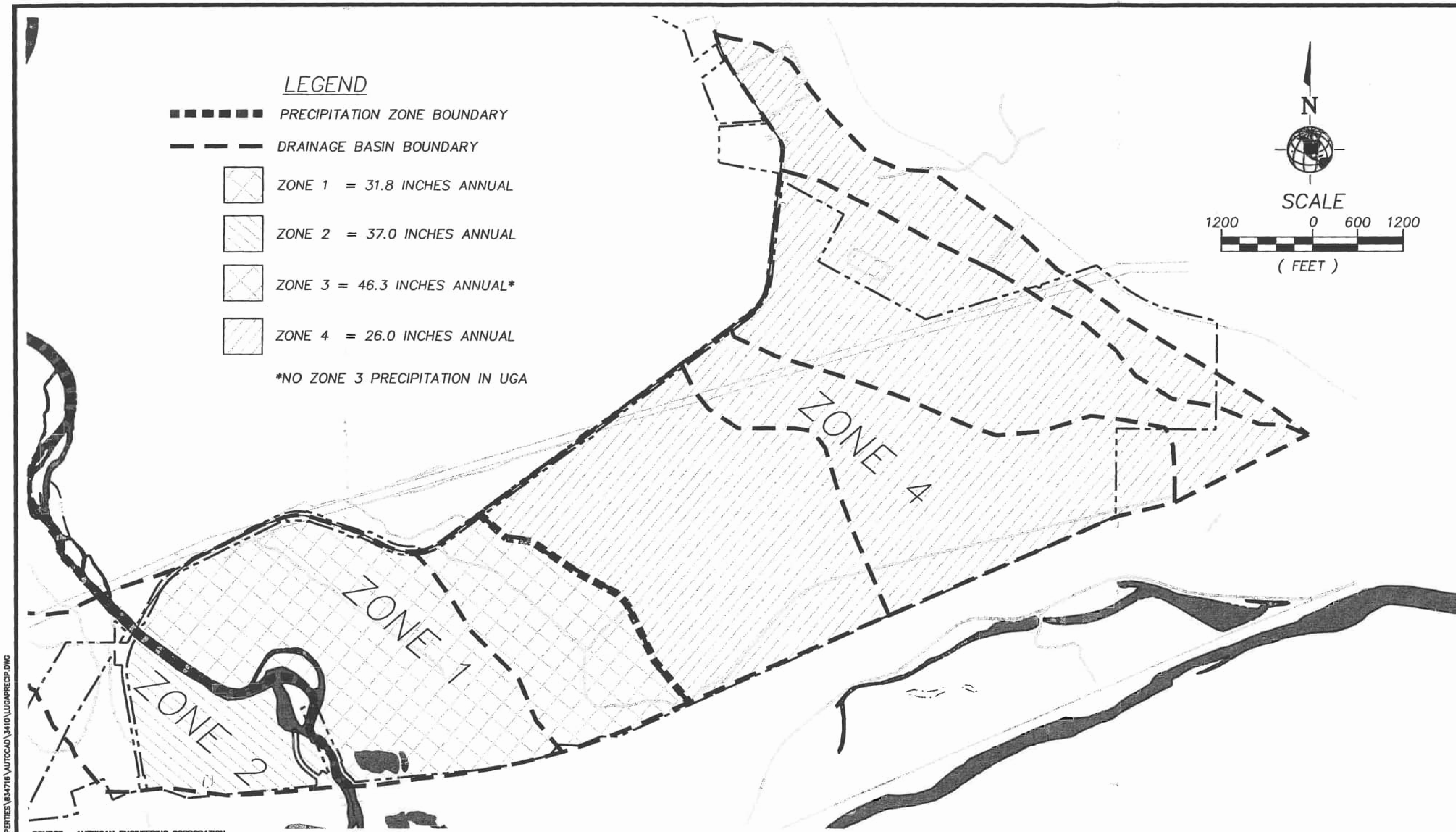








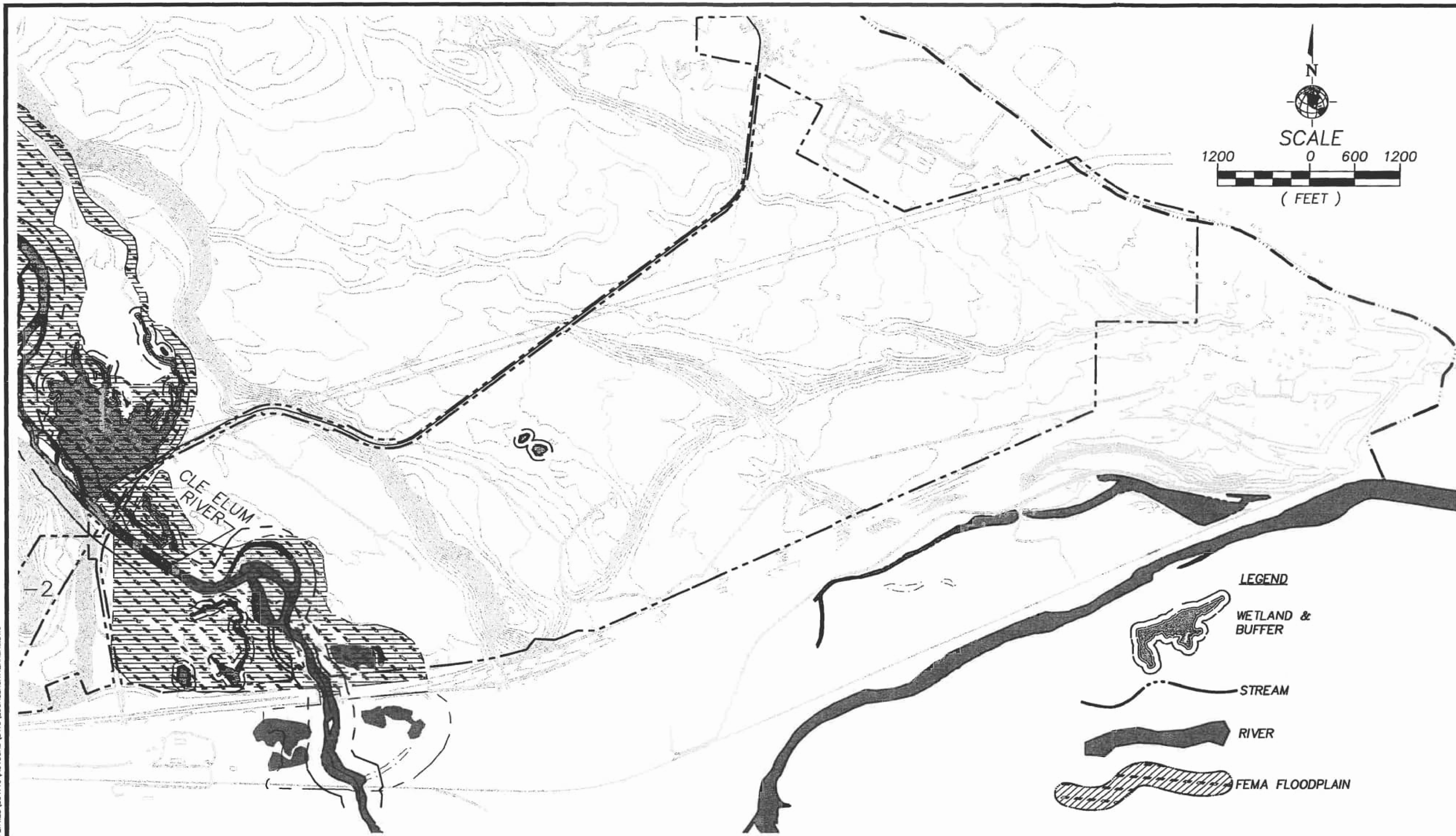




W&H PACIFIC

Cle Elum Urban Growth Area

Figure 1
Precipitation Zones



W&H PACIFIC

Cle Elum Urban Growth Area

Figure 2
Sensitive Areas

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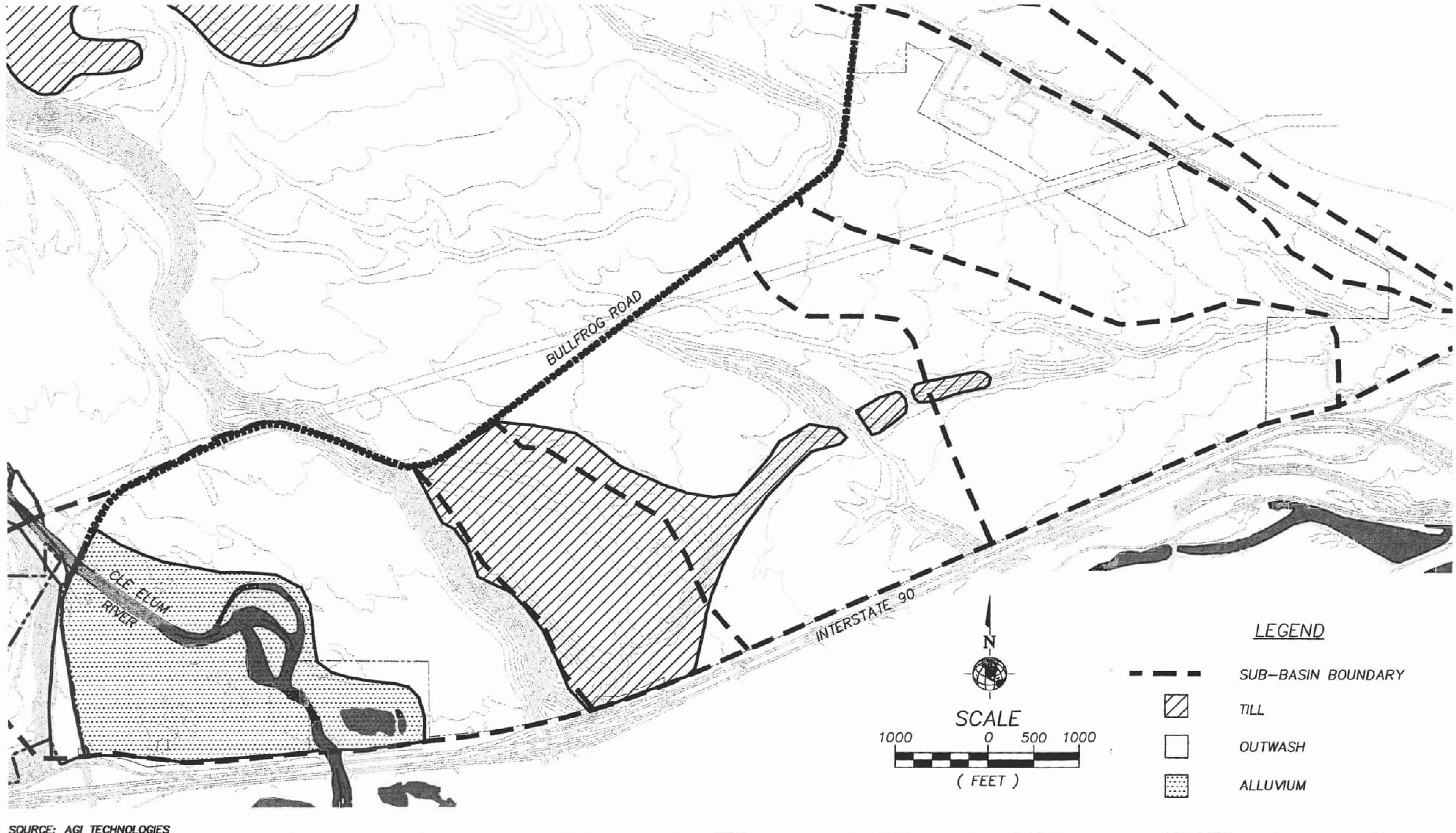

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W&H PACIFIC

Cle Elum Urban Growth Area

Figure 3
Soil Types

Previous Hydrologic Modeling

Hydrologic modeling for the pre-development conditions in the UGA was performed using the Hydrologic Simulation Program – Fortran (HSPF) Release 11 and 12. This model was used to gain an understanding of the existing hydrology of the site and estimate the hydrologic impacts of the proposed development. The model continuously simulates the rainfall-runoff response of a watershed by simulating the physical process response to changing conditions. HSPF is a standard hydrologic computational tool. Washington State Department of Ecology (WSDOE) notes that HSPF is relatively complex to use, and is best suited for basin plans and master drainage plans. WSDOE requires the use of a continuous simulation model for basin plans. Due to the large size of the MPR and UGA watershed (19.5 square miles) and environmental review considerations, the HSPF model was selected.

Input to the model includes land segment information such as soil parameters, elevation and vegetation parameters, as well as several continuous climatological time series for the period being simulated. The climatological parameters required by HSPF for runoff and snow simulations are:

- Precipitation
- Evaporation
- Air temperature
- Dew point temperature
- Soar radiation
- Wind movement

The simulation period was January 1961 through December 1990 with the period being governed by the availability of solar radiation data. Model output was provided on an hourly basis.

Runoff is modeled as the combined effect of surface flow, shallow subsurface flow (interflow) and groundwater flow response to climatological conditions. The distribution of flow between runoff mechanisms is determined by land segment characteristics such as soil moisture content, infiltration rate, and interception storage. The model generated flow from pervious and impervious land segments, and toed it through the drainage network. The drainage network can include pipes, streams, vaults, detention ponds, lakes and wetlands.

Snow accumulation and melt are simulated based on energy balance equations. Snow pack conditions, including ice content, density, albedo (reflectivity of the snow) and temperature, change over time according to climate conditions. Snowmelt water is added to precipitation inputs to the land segment and is routed through the land segment runoff mechanisms before entering the drainage network.

Output from the model can include, for example: groundwater, interflow and surface flows, snow pack and snow water equivalent, and wetland or detention pond stage.

The project is located in a region experiencing subfreezing conditions for much of the winter months, and the ground is frozen for much of the winter and to some degree during spring runoff. Rain and melt occurring on frozen ground leads to increased stormwater runoff because the soil infiltration capacities are reduced. For this reason, the HSPF subroutine ICING was made operational for both the existing and developed condition modeling. The purpose of subroutine ICING is to simulate the possible freezing of water that would otherwise leave the snow pack. In this subroutine, the ice can be considered to be at the bottom of the pack or frozen in the ground below the snow portion of the pack, thereby extending the total pack into the soil.

Preliminary existing conditions HSPF logic models were developed for each of the UGA subbasins. Bullfrog road is the northerly limit of the subbasin. The basins were modeled as basins without streams because of their lack of active stream systems. The pre-development basins and subbasins for the UGA are shown in **Figure 4**. Mitigated developed conditions were also modeled and compared to existing condition annual runoff volumes. These results along with estimated annual runoff volumes for Alternatives 2, 3, 4 and 5 are presented in Section 2 of Appendix E of the UGA FEIS.

Project Drainage Concepts

Outlined in this section are the drainage concepts and criteria for the UGA.

General Concepts

The general drainage concept involves collection and conveyance facilities; water quality facilities; detention facilities; infiltration facilities; and overflow facilities. All runoff is proposed to be infiltrated on site. No offsite discharges are planned.. As mentioned previously, the drainage standards for the project are those set forth in the Washington State Department of Ecology's *Stormwater Management Manual for Western Washington*, August 2001 (DOE SMM).

Specific Drainage Protocols and Design Criteria

Stormwater Collection and Conveyance. Collection and conveyance will be by conventional methods of curbs and gutters, catchbasins, and buried storm drains, depending on the development area. Where appropriate to specific site design, conveyance by grass-lined ditches and swales may be considered.

DOE SMM does not contain criteria for stormwater collection and conveyance. Designs should conform to criteria contained in recognized standards such as "ASCE Manuals and Reports of Engineering Practice No. 77, Design and Construction of Urban Stormwater Management Systems", 1992.

Water Quality. Water quality protocols developed for the UGA are discussed in Appendix A of the UGA FEIS. Key information from that document is presented in this section. Water quality treatment will be provided for runoff from impervious road and parking surfaces. Treatment will be provided in one of several Department of Ecology approved facility types. Runoff treatment BMPs, their descriptions, and design information are found in Volume V of the DOE SMM (August, 2001).

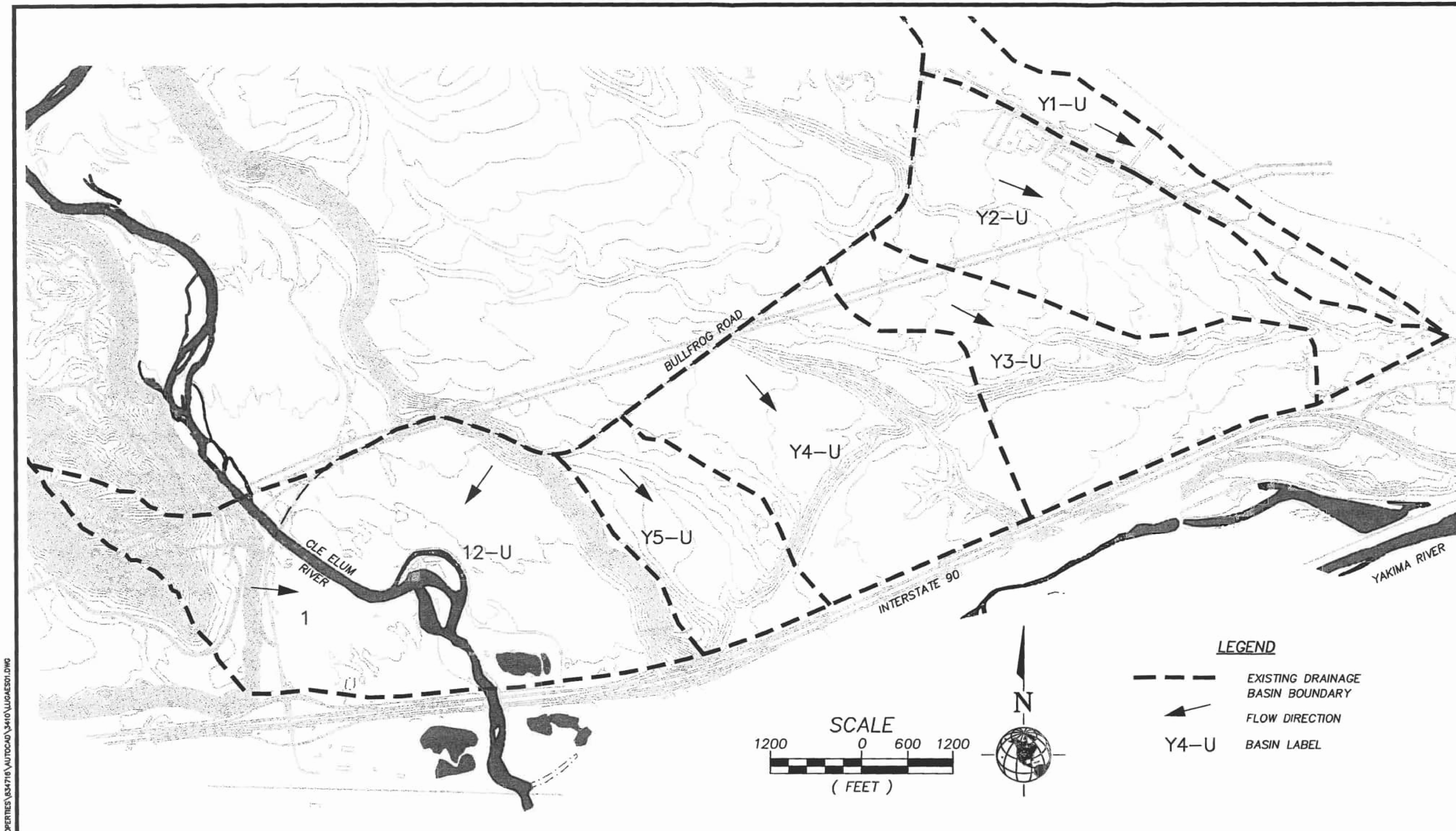
The proposed UGA site is divided into four water quality management zones named A, B, C, and D, as a result of underlying geology and the groundwater flow patterns. The developed condition basin boundaries were established by an analysis of existing drainage basins, proposed roadway locations, and areas suitable for stormwater infiltration. The water quality management zones and associated subbasins for the developed conditions are shown in **Figure 5**. The alluvial soils found adjacent to the Cle Elum River represent Management Zone C. The main central portion of the UGA site is Management Zone D, which has areas of both till and outwash soils at the surface. Further east, under Management Zones A and B, the surface soils are similar to Zone D. However, Zones A and B are distinguished from D because the thick lacustrine aquitard is absent. Zone A is more proximate to the Yakima River and the associated Yakama Hatchery intake wells, which is why the two zones are separated.

Management Zone D runoff requires the basic level of treatment. This requirement can be satisfied by the use of a single facility such as a biofiltration swale or wetpond. Zone C does not have development proposed and thus has no direct influence on water quality. Zones A and B have less natural filtration afforded from the underlying sediments. Runoff from these zones requires enhanced treatment to further reduce dissolved metals and other contaminants prior to infiltration.

Alternative treatment facilities for Managment Zones A and B and D are identified below:

- ➢ Management Zones A and B – "Enhanced Treatment Menu" with two-facility treatment trains. Allowable facilities include:

  - A biofiltration swale followed by a sand filter or media filter
  - A filter strip followed by a sand filter (or in reverse order)
  - A basic wet pond followed by a sand filter or media filter
  - A wet vault followed by a sand filter or media filter
  - A basic combined detention and wet pond followed by a sand filter or a media filter
  - A presettling or detention basin, sand filter, and media filter in that sequence



W&H PACIFIC

Cle Elum Urban Growth Area

Figure 4
Pre-Development Basins

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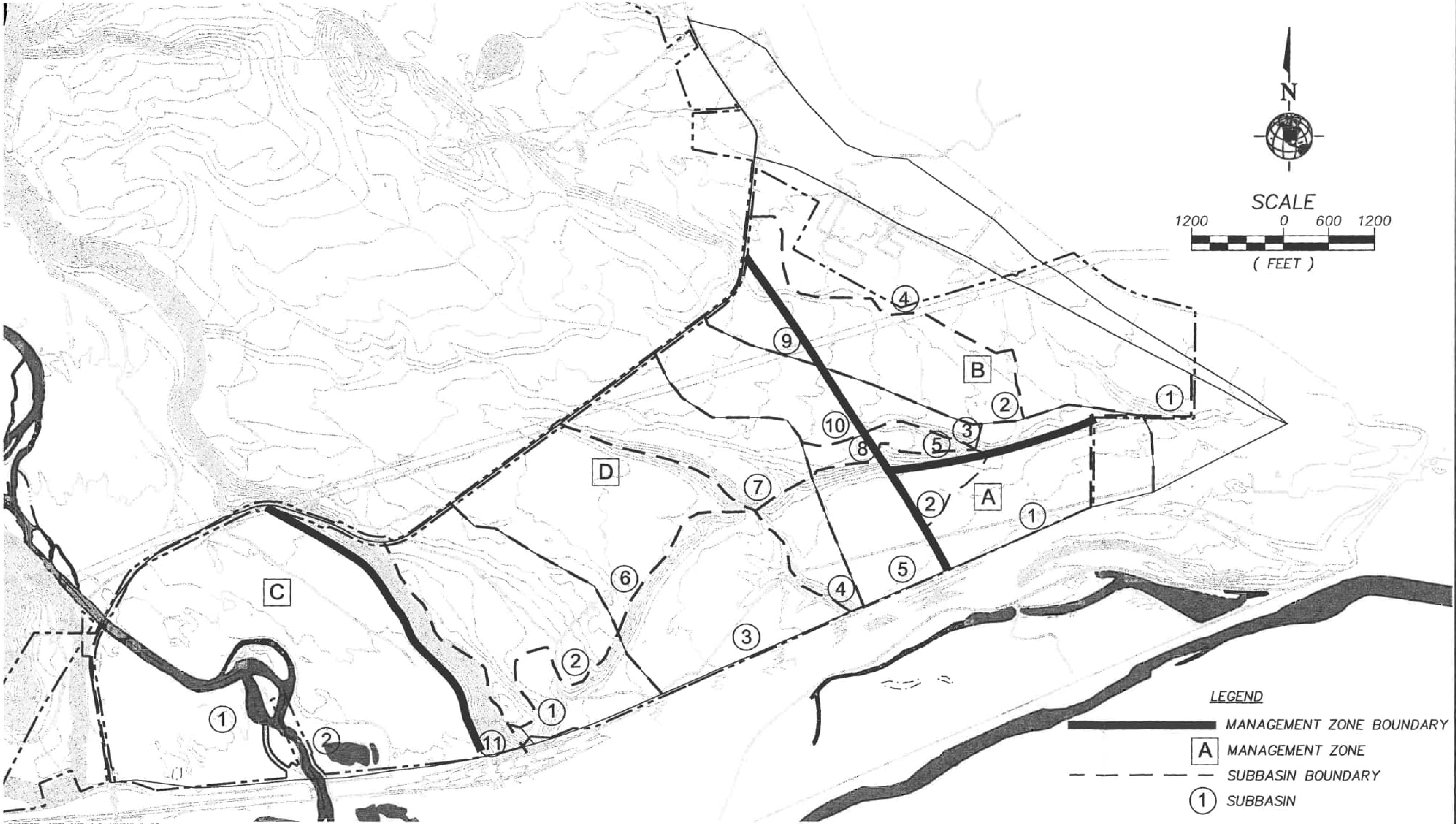

W&H PACIFIC

Cle Elum Urban Growth Area

Figure 5
Developed Condition Basin Boundaries and Management Zones

Of the allowable facility alternatives, the wet pond followed by a sand filter facility is preferred where appropriate to site design.

➤ Management Zone D – Allowable facilities include:

- Biofiltration swales
- Filter strips
- Basic wet ponds
- Wet vaults
- Stormwater wetlands
- Combined detention and wet ponds
- Sand filters

Of the allowable alternatives, stormwater wetlands are preferred where appropriate to site design.

Detention ahead of the treatment facilities may be appropriate to minimize the size of the treatment and subsequent infiltration facilities.

A description of each of the proposed facilities is provided below:

Wetponds (BMP T10.10) and Wetvaults (BMP T10.20). Wetponds and wetvaults provide runoff treatment by allowing the settling of particulates during quiescent conditions, and when a shallow marsh are is provided for a wetpond, by biological uptake through plant growth and by vegetative filtration. Wetponds contain a permanent pool of water and a wetpool equal to the runoff volume of the water quality storm event. Wetpond facilities are sized based upon the volume from the 6-month, 24-hour storm which for Cle Elum is 1.06 inches.

Biofiltration Swales (BMP T9.10). Biofiltration uses vegetation in conjunction with slow and shallow-depth flow for runoff treatment. As runoff passes through the vegetation, pollutants are removed through the combined effects of sedimentation filtration, soil sorption and plant uptake.

Sand Filters (BMP T8.10 and .20). Sand filters provide treatment from filtration, which removes particulates and associated contaminants, and from adherence of contaminants within the filter.

Filter Strips (BMP T9.40 and .50). Filter strips provide biofiltration of runoff. They are typically installed adjacent to paved areas (road, parking, drives), receive runoff directly from those areas, and discharge to a collection system.

Combined Detention and Wetpond facilities (BMP T10.40). These facilities combine a water quality wetpool facility (wetpond, wetvault, stormwater wetland) and detention into one facility.

Stormwater Wetlands (BMP T10.30). Stormwater wetlands are shallow, man-made wetlands that use the biological processes associated with wetland plants to treat stormwater. Stormwater wetlands require an adequate supply of water for most of the year.

Infiltration. Infiltration systems will be installed in areas where permeable soils exist. Prior to infiltration, flows will be treated. Infiltration basin surfaces should be planted with grass to enhance infiltration rates. In areas where soils consist of low permeability till soils, project runoff will be conveyed to areas of more permeable soils for infiltration.

Roof runoff in outwash areas will be infiltrated where lot sizes are sufficiently large enough to allow infiltration. In till areas with small lots, roof runoff will typically be conveyed via the roadway storm drains to areas suitable for infiltration.

Recommended procedures for infiltration facility exploration and testing for design prepared by Associated Earth Sciences, Inc., are contained in **Appendix A**.

Cold Climates Design Considerations on BMPs. Cold climate conditions can affect the performance of BMPs. As described in the publication "Stormwater BMP Design Supplement for Cold Climates" prepared for EPA Region 5 by the Center for Watershed Protection, 1997, the cold climate challenges include ice formation in the stormwater management facilities, rain-on-snow events, and the spring snowmelt effect. Cold climate modifications for conveyance systems to minimize freezing problems will include: burying pipes below the frost line; increasing slope of facility inlet pipes to one percent (1%) where feasible; increasing the minimum inlet pipe diameter; avoiding submerged inlet pipes; setting outlet weir bases below the frost line and keeping a minimum weir slot width of three inches.

For water quality, infiltration and detention facilities, the considerations include:

- Using a minimum 20-foot setback between the road subgrade and infiltration facilities.
- Lining the bottom of the infiltration basins or trenches with an 18-inch minimum thickness layer of large pore gravel (>75 inches/hour) to prevent ice formation in the pore spaces that would significantly reduce infiltration capacity.
- Ice formation in stormwater wetlands and seasonal adjustment of water levels to maintain treatment.
- Placing sand filtration beds below the frost line.
- Placing parking lot perimeter infiltration trench systems underground.

Draft City Stormwater Standards. Draft stormwater management development standards for the UGA and draft City of Cle Elum Stormwater Construction Standards for the UGA (both dated May 2002) are contained in **Appendix B**.

Operation and Maintenance

Suggested operation and maintenance practices for the various types of facilities that may be constructed in the UGA is provided in **Appendix C**.

Developed Conditions Modeling

The design tool used in the runoff modeling of this project is called the MountainStar Runoff Time Series Model (MSRTS). This model is based on King County's Runoff Time Series Model (KCRTS). The calibrated HSPF model developed for the MountainStar site was used to generate the land segment runoff input for the MSRTS program. The MSRTS program is used as a design tool to size infiltration facilities, detention facilities, and conveyance systems. The procedure for the use of this hydrologic program is similar to most hydrologic models:

- Determine the drainage basin boundaries.
- Determine land use within basin (area of each segment type).
- Route combined runoff from each land segment type to stormwater facility.
- Modify size and properties of facility until design requirements are achieved.

A user's guide, example drainage facility calculations using the MSRTS program, and a CD containing the model are provided in **Appendix D**.

The hourly runoff input files to the runoff time series model for each precipitation zone is based on an HSPF precipitation record that includes:

- 100-year, 7-day melt/rain event
- 100-year, 24-hour rainfall event
- 100-year, 1-, 2- and 3-hour thunderstorm events

Information on the development of these events and their precipitation values are provided in the following sections.

100-year, 7-day Storm. Storm events involving significant snowmelt and rainfall have been found to supply the largest volume of water to the land segments. HSPF was used to determine the total water supply (sum of snowmelt and rainfall) in the units of inches/hour over the site. HSPF utilized the historical temperature, dewpoint, rainfall, solar radiation and evaporation time series to determine snowpack and snowmelt. The HSPF model was run with the snow pack ice formation subroutine operational. The rain/melt storm analysis was based on historical climate data from 1961-1990. Through analysis of this record the 100-year, 7-day rainfall/melt and 100-year, 1-day rainfall/melt events were determined for the site. The storm events were determined from a frequency analysis similar to that described above for the 24-hour storms. The 100-year, 7-day water supply rainfall/melt event corresponds to a 7-day water supply of 13.76 inches. The 100-year, 7-day rainfall/melt design storm was created by scaling the rainfall of the November 1990 storm. The 100-year, 1-day rainfall/melt event corresponds to 7.94 inches. The 100-year, 1-day rainfall/melt design storm was created by scaling the largest 24-hour rainfall event of the November 1990 storm. The rainfall values given are for Easton/Site Zone 3.

As mentioned, the rainfall record for the analysis was hourly data from the Easton rainfall station. Water supply to the basin in the form of snow melt was generated by the HSPF program using historical climate data from 1961-1990. Rainfall and snow melt were summed, and this data series was searched in 168-hour blocks to locate 7-day rainfall and melt supply by a program developed by Northwest Hydraulic Consultants, Inc.

24-Hour Precipitation Events. The 24-hour precipitation events were developed using the 1948-1996 Easton hourly rainfall record. Missing data in the original NOAA record were previously patched by W&H Pacific for use in the HSPF modeling. A Log Pearson III frequency analysis was performed on the maximum annual 24-hour precipitation values in the 49-year record to determine the values.

The storm precipitation amounts have been scaled from the Easton Station to each of the four precipitation zones on the project site. As discussed previously, the UGA project watershed has three precipitation zones. The average annual rainfall quantities for the Easton site and each of the climate zones on the MountainStar and UGA sites are provided in **Table 1**. The 2-year thought 100-year storm precipitation for each of the zones was determined by scaling the Easton year storm precipitation by the ratio of te annual rainfall quantities. The results of this analysis are also shown in **Table 2**.

Table 1: Average Annual Rainfall, Inches

	MountainStar and UGA Sites			
Easton	**Zone 4**	**Zone 1**	**Zone 2**	**Zone 3**
46.3	26.0	31.8	37.0	46.3

Table 2: 24-Hour Design Storm Precipitation, Inches

Storm Frequency	Easton	MPR/UGA Zone 1	MPR/UGA Zone 2	MPR/UGA Zone 3	MPR/UGA Zone 4
2-Year	2.98	2.05	2.38	2.98	1.67
5-Year	4.07	2.79	3.25	4.07	2.28
10-Year	4.78	3.28	3.82	4.78	2.68
25-Year	5.66	3.89	4.53	5.66	3.18
50-Year	6.32	4.34	5.05	6.32	3.55
100-Year	6.97	4.79	5.57	6.97	3.91

Thunderstorm, 1-Hour, 2-Hour, 3-Hour Rainfall Storms. The Cle Elum UGA site is within the Department of Ecology Dam Safety Section thunderstorm design region. Thus 100-year thunderstorm events of 1-hour, 2-hour, 3-hour rainfalls were anlyzed. Ecology's design procedures were followed to generate the following thunderstorm rainfall amounts:

- 1-hour storm = 1.29 inches
- 2-hour storm = 1.72 inches
- 3-hour storm = 2.09 inches

A single 3-hour storm with 0.43 inches the first hour, 1.29 inches the second hour, and 0.37 inches the third hour was created as the thunderstorm event. This event applies to all precipitation zones on-site. The largest thunderstorm rainfall event in the Easton record was 1.8 inches in two hours. That event occurred in August of 1983.

Appendices

Appendix A

Infiltration Testing Procedures

Technical Memorandum

Date	April 30, 2002		
To:	Paul Bennett, Kittitas County Jon Barkee, MountainStar Resort Larry Grimm, W&H Pacific Jay Decker, W&H Pacific	**From:**	Otto Paris
Project Name:	MountainStar MPR and Cle Elum UGA	**Project No:**	KH00748F
Subject:	Field Explorations and Infiltration Testing for Proposed Infiltration Facilities		

This technical memorandum outlines Associated Earth Sciences, Inc.'s (AESI's) proposed methodology for characterizing subsurface conditions and developing design infiltration rates for proposed infiltration facilities located on the MountainStar Master Planned Resort (MPR) and Cle Elum Urban Growth Area (UGA) project sites. The proposed methodology is based on the criteria and guidelines described in the Washington State Department of Ecology Stormwater Management Manual for Western Washington (Ecology Manual) dated August 2001. Although the stormwater manual currently being prepared for eastern Washington would likely be more applicable to the MPR and UGA sites, it is AESI's understanding that Kittitas County will be using the current Ecology Manual as a framework for developing a methodology to determine long-term design infiltration rates.

During our meeting at you office on April 17, 2002, we discussed some of the key issues for applying some of the specific guidelines described in the Ecology Manual to proposed sites for MPR and UGA infiltration facilities. The MountainStar design team is currently in the process of developing site plans for the 2002 and first quarter 2003 MPR Phase 1 Project Design. Field testing of infiltration rates for proposed facilities included in this phase of MPR project design is scheduled to begin by May 1, 2002. Although this memorandum was prepared in support of obtaining approval from Kittitas County for this MPR Phase 1 Project Design, we are planning on using a similar approach for developing design infiltration rates for other phases of the MPR and UGA projects. We anticipate that additional field explorations and infiltration testing will be completed during spring of 2003 in support of subsequent Phase 1 design.

As requested by you during our April 17 meeting, this technical memorandum summarizes the following:

- Key criteria and guidelines described in the Ecology Manual for subsurface characterization and calculation of design infiltration rates for proposed stormwater infiltration facilities.
- The practical limitations for applying some of the Ecology Manual criteria and guidelines for field explorations and testing to the MPR and UGA sites given known subsurface conditions at the sites.
- AESI's proposed approach for evaluating subsurface conditions and developing design infiltration rates, and identifying specific scope of work items which appear to differ from the recommended guidelines stated in the Ecology Manual.
- A discussion of correction factors and additional analysis that will be applied to developing long-term design infiltration rates to account for (1) the potential range of subsurface variables that control soil infiltration, and (2) any additional uncertainties associated with deviating from the recommended guidelines stated in the Ecology Manual.

The overall objective of our soil infiltration testing and design is to develop reasonable long-term design infiltration rates for each of the proposed facilities using: (1) site-specific explorations and field testing; (2) our knowledge of existing subsurface site conditions at the MPR and UGA project sites; (3) AESI's collective experience on similar projects; and (4) the underlying intent of the criteria and guidelines described in the Ecology Manual.

Ecology Manual Criteria and Guidelines

The Ecology Manual provides criteria and guidelines for a site characterization study and design infiltration rate determination to be considered during siting and design of infiltration facilities. These criteria and guidelines are described in Sections 3.3.4 and 3.3.5 of Volume III of the Ecology Manual. The Pilot Infiltration Test (PIT) procedure is included as Appendix V-B of Volume V. Copies of these sections of the Ecology Manual are attached to this memorandum.

The following sections summarize the key criteria and guidelines described in the Ecology Manual.

<u>Site Characterization</u>

- Subsurface explorations should extend to a depth below the base of the facility of at least 5 times the maximum design ponded water depth. Subsurface soils should be continuously sampled to a depth of at least 6 feet below the base of the facility, or 2.5 times the maximum design ponded water depth.
- One exploration should be completed per 5,000 square feet (sq. ft.) of pond bottom area, with a minimum of two explorations per infiltration facility.
- Detailed logging of explorations including stratification and depth to water (if observed).
- Installation of monitoring wells unless the highest ground water level is at least 50 feet below pond bottom.

- Laboratory testing of soil samples for grain-size distribution and soil classification.
- Estimate the lateral extent and capacity of receptor soils using various analytical methods.
- Depth to ground water table and to underlying impermeable layers or bedrock.
- Ground water flow direction and estimates of hydraulic properties of receptor soils (water table aquifer).

Several notes included in this section of the Ecology Manual state that (1) previously-gathered site information can be used for site characterization, and (2) the depth and number of site-specific explorations needed to characterize subsurface conditions can be increased or decreased according to the "licensed professional's" opinion regarding the variability of known subsurface conditions relative to design of the infiltration facilities.

Design Infiltration Rate

One of three methods can be used to develop long-term design infiltration rates. Two of the methods are based on data obtained from laboratory testing of soil samples. The third method is direct field measurement of the soil infiltration rate using a relatively large-scale field infiltration test, such as the test pit method described as the Pilot Infiltration Test (PIT) procedure in the Ecology Manual. The guidelines suggest a range of correction factors to be used for each of the methods to account for variability in subsurface conditions and long-term clogging from siltation and biomass buildup. The guidelines recommend that the results of field infiltration testing be compared with results from the laboratory testing.

- Method 1: USDA Soil Textural Classification. Utilizes grain-size analysis and USDA soil classification to estimate the soil infiltration rate.
- Method 2: ASTM Gradation Testing. Utilizes some limited studies in three western Washington counties to develop a relationship between soil grain-size analysis and estimated long-term infiltration rates.
- Method 3: Field (In-Situ) Infiltration Tests. Recommends larger-scale field infiltration tests, such as the test pit method, be used to measure infiltration rates. The pilot infiltration test procedure described in the guidelines is based on discharging water at a known rate into a test pit of known dimensions. The saturated infiltration rate is measured using a constant head and/or falling head analysis.

Subsurface Conditions and Site Constraints Relative to Ecology Manual Criteria

AESI and other geotechnical firms have previously collected a significant amount of subsurface soil and ground water data at the MPR and UGA project sites in support of EIS studies, site planning, and preliminary project design. We have obtained a relatively complete understanding of subsurface soil and ground water conditions in the MPR Phase 1 area and the UGA, and have previously worked with the project design team in identifying potential issues regarding the feasibility of utilizing infiltration facilities in these areas of the project sites.

It is our understanding that most, if not all, of the proposed infiltration facilities for 2002 and first quarter 2003 MPR Phase 1 Project Design will be located in upland areas underlain primarily by glacial outwash deposits. The infiltration receptor (receptor soil) for each of the proposed facilities would be comprised of the glacial outwash deposits. Based on our previous field explorations, the glacial outwash deposits consist primarily of sand, gravel and cobbles, with varying amounts of silt. A typical sequence of glacial outwash as observed in the test pit explorations consists of a few feet of silty sandy gravel with cobbles, underlain by a sandy gravel or gravelly sand with cobbles. Some of the glacial outwash deposits consist almost entirely of gravel and cobbles with less than 20 percent sand. Discrete layers of fine-grained sand, silty sand and sandy silt were encountered within the glacial outwash sequence in several of the exploration pits. It is likely that these laterally discontinuous, finer-grained layers are scattered throughout the glacial outwash sequence. Approximately 1 to 3 feet of loess deposits consisting of sandy silt and silty fine sand typically overlies the glacial outwash deposits.

The thickness of the outwash receptor soils typically ranges from about 150 to 200 feet beneath most of the MPR Phase 1 area. Based on data obtained collected to-date, the outwash deposits in the Phase 1 area are underlain by either glaciolacustrine deposits or bedrock. The outwash deposits comprise the regional water table aquifer, which is located at depths ranging from about 140 to 180 feet beneath most of the Phase 1 area.

Some preliminary infiltration tests were completed in the MPR Phase 1 area during 1999 using the test pit method. Field-measured rates ranged from about 2 to 82 inches per hour (in/hr) in the upper 10 feet of the outwash deposits. The lower infiltration rates corresponded to either layers of outwash deposits with slightly higher silt/clay content, or sites underlain by a shallow, and possibly perched, water table. The higher infiltration rates (23 to 82 in/hr) were measured at sites located in the southern portion of the MPR Phase 1 area. It is our understanding that most of the currently proposed infiltration facility sites for the MPR Phase 1 area are located in the southern portion of the MPR project site.

As described in the following section of this memorandum, AESI recommends that a large trackhoe be used to complete the field explorations needed to characterize subsurface conditions beneath each of the proposed infiltration facility sites. The alternative of using soil drilling equipment for evaluating subsurface soils beneath each of the proposed infiltration sites is not practical given our current understanding of the receptor soil characteristics. Based on our previous experience drilling the on-site monitoring wells, using typical drilling techniques will not result in gaining any significant additional information beneath specific sites (Note: As discussed later in our proposed approach, some site-specific conditions might warrant the drilling of soil borings). Our assessment of the limited usefulness of drilling borings as the standard method for completing a subsurface characterization beneath each proposed infiltration facility is based on the following:

- The high gravel and cobble content of the outwash soils is not conducive for using hollow-stem auger drilling techniques, and would result in significant damage to the drilling equipment.
- Driving samples using typical soil sampling equipment will likely result in poor sample recovery given the high gravel and cobble content of the outwash deposits.
- The slight changes in interstitial silt/clay content that appears to be controlling the infiltration capacity of the outwash deposits would not be detected with any certainty using air-rotary drilling equipment.

Maintaining the existing infiltration characteristics of the receptor soils beneath proposed infiltration sites is a potential issue when evaluating the number and depths of trackhoe test pit explorations completed at each site. The depth of the explorations will be somewhat limited by the reach of a large trackhoe operating from the existing ground surface. Obtaining samples from depths greater than about 18 to 20 feet will require enlarging the excavations to create temporary benches to extend the reach of the trackhoe. The larger the test pit excavation, the greater the possibility that backfilling of the excavation could impair the existing infiltration rates of the receptor soils.

Although a field infiltration test is not specifically needed to meet the Ecology Manual criteria, our proposed approach for developing long-term design infiltration rates includes completing a field infiltration test for each of the proposed facilities as outlined in the following section of this memorandum. However, the highly permeable characteristics of most of the targeted receptor soils will require a large volume of continuous water supply at each of the sites. It is likely that the available source of water supply (large water truck) will limit the duration of field tests completed in soils having measured field infiltration rates of greater than about 15 to 20 in/hr.

Proposed Approach for Subsurface Characterization and Field Infiltration Tests

AESI recommends that site-specific field explorations and testing be completed for each proposed infiltration facility location prior to final siting and design. The proposed approach for characterizing subsurface conditions beneath proposed infiltration facility sites is based on the premise of incorporating site-specific data essential for design of the proposed infiltration facilities into our current understanding of soil and ground water conditions beneath the MPR and UGA sites. Using this approach will allow for a more complete analysis of the infiltration receptor(s) on an area-wide basis, which is more commensurate with the scale of the proposed MPR and UGA projects. Although site-specific data will be collected for each of the proposed infiltration facilities, our recommended field testing program does not consider each of the proposed facilities as a separate "stand-alone" design project as implied in some of the criteria and guidelines stated in the Ecology Manual.

The proposed approach for gathering site-specific subsurface data conforms with almost all of the Ecology Manual criteria and guidelines. Completing multiple subsurface explorations to the maximum depths recommended in the Ecology Manual is the most problematic criteria given existing site conditions. However, our overall approach should provide a more comprehensive evaluation of infiltration receptor capacity given the combination of: (1) our existing understanding of subsurface conditions; and (2) the application of conservative, but reasonable, assumptions in addressing uncertainties when analyzing the resulting field data relative to design of the proposed facilities.

If practicable, field explorations and infiltration testing should be completed during periods of high seasonal groundwater elevations, which likely occur sometime between the middle of March and late May in most of the upland areas of the site. A series of backhoe/trackhoe test pits will be excavated and sampled at each proposed infiltration facility location to evaluate the characteristics and thickness of the receptor soils, and identify any soil or groundwater conditions which could adversely impact soil infiltration capabilities. An appropriate number of test pit explorations will be completed at each proposed location to evaluate (1) the nature and continuity of receptor outwash soils conducive for infiltration, and (2) the locations and lateral continuity of any observed fine-grained layers. The number of test pit explorations completed at each site would likely depend on the specific location and size of the proposed pond relative to known subsurface soil and ground water conditions. The minimum number of test pits excavated at each proposed infiltration facility site will meet the Ecology Manual criteria for the recommended number of explorations. An AESI field geologist will complete detailed logs of each of the test pits, and soil samples will be collected for laboratory analysis of soil textural characteristics.

The total depths of each of the test pits will depend on (1) the elevation of the base of the proposed infiltration facility, (2) the reach of the trackhoe, (3) caving of the excavation sidewalls, and (4) the depth of any observed ground water seepage or lower-permeability soils. Working from existing ground surface (pre-pond excavation), it appears unlikely that the trackhoe test pits can be completed at depths greater than about 2 to 2.5 times the maximum design ponded water depth as recommended in the Ecology Manual. Extending the pits to greater depths will require a larger excavation to allow for the construction of lower elevation trackhoe operating pads. Because of the likely caving of materials at these excavation depths, extending the test pits to even greater depths will likely result in disturbing a significant proportion of the receptor soils beneath the based of the proposed facility by subsequent backfilling of the pits with the excavated soils. AESI recommends that the potential detrimental effect on existing soil infiltration rates that might be caused by increasing the depth and surface area of the backfilled test pits be considered when the exploration program is implemented. At a minimum, the loess and loess/outwash deposit mixtures should be segregated during excavation of the pits to ensure that this less-desirable material is used as backfill only at depths that are shallower than the proposed pond bottom elevations.

Relative to soils borings, the trackhoe test pit excavations will allow for more direct visual observations, larger soil sample size, and more comprehensive logging of the receptor soils given the known characteristics of the outwash deposits. However, soil borings might be warranted at some of the proposed infiltration locations if existing information indicates the potential presence of less permeable subsurface soils at depths greater than the practical reach of the trackhoe, but less than 40 to 50 feet below ground surface. An example of this scenario would be outwash deposits located near glacial end moraines. Drilling and sampling of several soil borings might be useful in evaluating the thickness of the receptor soils and/or shallow lower-permeability soil layers. Soil borings might also be warranted in areas underlain by shallow bedrock to evaluate the thickness of receptor soils (outwash deposits) between the base of the proposed facility and the top of the bedrock surface.

Existing on-site monitoring wells combined with other existing subsurface data provide a sufficient understanding of the regional water table aquifer beneath most of the MPR Phase 1 Area and the UGA with respect to siting of infiltration facilities. As stated previously, the shallowest ground water is at least 100 feet below ground surface below most of the MPR Phase 1 Area identified as potential sites for infiltration facilities. Although not anticipated at this time, installation of groundwater monitoring wells might be warranted at proposed sites where shallow ground water mounding could significantly reduce infiltration rates. This scenario might be applicable for infiltration facilities located within the vicinity of the No. 9 Mine area where a shallow seasonal perched water table has been observed in several previous explorations.

Selected soil samples obtained from the test pits will be submitted for laboratory testing of grain-size analysis and textural classification using ASTM Method D-422. Soils will be classified using both the Unified Soil Classification System (USCS) and the U.S. Department of Agriculture (USDA) classification systems.

The site-specific field data will be incorporated into our current understanding of subsurface site conditions to analyze infiltration receptor characteristics as described in the Ecology Manual. The analysis will include any anticipated adverse impacts to ground water levels downgradient of the proposed facilities, an assessment of the receptor soil capacity, and an evaluation of potential impacts to infiltration capacity resulting from ground water mounding.

Long-term design infiltration rates for each of the proposed infiltration facilities will be based on (1) the results of our subsurface explorations, (2) textural analysis of selected soil samples, and (3) field infiltration tests. Infiltration rates derived from soil grain size analysis (textural analysis) will follow the guidelines described in the Ecology Manual. Appropriate correction factors will be applied based on the results of our subsurface explorations and sampling. One of the primary objectives of our analyses will be to correlate the estimated infiltration rates derived from the soil grain size analysis with the rates measured in the field infiltration tests.

AESI recommends the test pit method be used to measure field infiltration rates in the glacial outwash deposits. The test pit methodology proposed for use on the MountainStar MPR and Cle Elum UGA sites corresponds approximately to the procedure described as a pilot infiltration test (PIT) in the Ecology Manual. In summary, water is discharged at a known rate into a test pit of known dimensions, and the saturated vertical hydraulic conductivity is measured using constant head and/or falling head analysis. Empirical relationships are then used to estimate long-term soil infiltration rates.

The base of the test pit used for infiltration testing should correspond to the design elevation of the infiltration facility, or deeper if warranted by observed subsurface soil conditions. The base and sidewalls of the excavation should be measured twice: before discharging water into the test pit, and again at the conclusion of the test. Water should be discharged into the test pit to maintain a water depth of at least 2 feet in the excavation. A flow meter will be used to monitor the water discharge rate, and a staff gage will be placed in the pit to monitor water levels.

A water tank truck (3,000 gallon capacity) will be used to supply the water needed for the infiltration test. Because the outwash deposits are likely characterized as having a moderate to high permeability, the duration of the infiltration test will be somewhat dependent on the available water supply. Discharge of water into the test pit should continue for a period of at least 2 hours, with a desired minimum test period of 4 hours. However, shorter test durations might occur if the soils are highly permeable (infiltration rate greater than 20 in/hr) and the infiltration test pit is relatively large (i.e. greater than about 50 sq. ft.). The test pit dimensions will be decreased if highly permeable soils are encountered for the purpose of maximizing the duration of a test given the limited available water supply. Based on our current estimates of potential soil infiltration rates and the available water supply, we anticipate that infiltration test pit dimensions will range from about 25 to 65 sq. ft., and individual infiltration tests will range from about 1.5 hours (very high soil permeability) to 6 hours (low permeability).

The rate of water level decline in the excavation will be measured after stopping the discharge of water into the test pit. After measuring the falling water levels in the test pits, the base of the pit will be over-excavated to (1) document the types of soils the water infiltrated through relative to the measured infiltration rate, and (2) identify any soil layers which would restrict the downward flow of infiltrating water.

The results of the field exploration and testing program will be used to develop recommended long-term design infiltration rates for each of the proposed facilities. AESI anticipates that some modifications to the field exploration and testing program will likely occur in response to (1) subsurface conditions encountered at each of the proposed sites, (2) potential site constraints and/or impacts associated with siting of specific infiltration facilities, and (3) the development of correlations between the soil grain size analysis and the field infiltration tests.

Additional Analysis and Development of Long-Term Design Infiltration Rates

Determining the potential long-term infiltration rate of specific infiltration facilities requires the use of various correction factors (safety factors) during the evaluation of the available field and laboratory data. The Ecology Manual provides a range of suggested correction factors for general guidance purposes when using each of the three specific methods for determining soil infiltration rates. The field testing program described in this memorandum will incorporate data from two or possibly three of the methods described in the Ecology Manual. In addition, there will be more available area-wide subsurface data incorporated into our analysis than suggested in the Ecology Manual because of the breadth of the MPR and UGA projects and the relatively large number of proposed infiltration facilities. Therefore, the total correction factor used to develop design infiltration rates for each specific facility will be based on (1) the range of Ecology Manual corrections factors, (2) the range of available data for assessing infiltration receptor capacity, and

(3) other correction factors or assumptions used in our infiltration rate analysis.

AESI anticipates that development of design infiltration rates will be relatively straightforward for many of the proposed infiltration facilities give our current understanding of site conditions. We anticipate that in areas of thick outwash and a deep water table, the Ecology Manual suggested correction factors will likely be used without additional analysis to determine a long-term infiltration rate for a specific facility. Some additional analysis and application of corresponding correction factors might be warranted for facilities located in areas underlain by receptor soils with known, or suspected, limited infiltration capacity.

If needed for specific infiltration facilities, a more detailed analysis of soil infiltration capacity and ground water mounding will be completed using computer modeling techniques (MODRET computer program). The MODRET program uses receptor soil characteristics, aquifer characteristics and infiltration facility design parameters to evaluate design infiltration rates and volumes for simulated design storm events. A range of correction factors and assumed aquifer hydraulic parameters can be input into the program to evaluate the relative sensitivity of these parameters to proposed infiltration facility design. Use of this analytical tool (or other similar modeling programs) can provide some additional assurance towards evaluating whether or not the combination of infiltration facility capacity and receptor soil characteristics will be sufficient to completely infiltrate the design storm event. Similar techniques can be applied towards evaluating potential downgradient impacts caused by the additional ground water recharge via the proposed infiltration facilities.

AESI anticipates working closely with the MountainStar project team during siting and design of proposed infiltration facilities to ensure that final design accounts for subsurface soil and ground water conditions and reasonable long-term soil infiltration rates. I hope this memorandum provides the necessary information for you to evaluate our approach for determining soil infiltration rates relative to Kittitas County criteria. Please call me if you have any questions about our proposed field exploration and testing program.

Appendix B

UGA Stormwater Draft
Development and Construction Standards

Draft Development Standards
Cle Elum UGA
Trendwest Master Site Plan

Trendwest Properties, Inc.

May 2002

General Description and Requirements

Drainage plans for parcels within the UGA shall be consistent with the Master Drainage Plan (MDP) for the UGA Land Use Master Plan. Stormwater retention/detention, infiltration and water quality facilities, as required in the UGA MDP, shall be included in the final drainage plans for each applicable division. Drainage facility locations shall be based on detailed design studies for individual proposed developments.

The proposed stormwater runoff and water quality control plans for managing stormwater runoff shall be designed to minimize the impacts of development on the Cle Elum and Yakima Rivers and groundwater in the area. The stormwater management facilities shall be designed to meet DOE SWMM standards, and the requirements and protocols of the UGA MDP.

The UGA MDP will likely identify stormwater management plans with central facilities to serve one or more planning sub-areas. Stormwater from private parking lots or other impervious surfaces shall be collected, treated and disposed of by private facilities that need not necessarily be located on the same site.

Governing documents for design and construction of stormwater facilities shall include the following:

- *City of Cle Elum, Construction Standards for Private Construction of Public Facilities for Properties Subject to the Cle Elum UGA Master Site Plan,* May 2002.
- *Stormwater Management Manual for Western Washington 2001* (August 2001), Washington State Department of Ecology (or, after City review and acceptance, the Final Stormwater Manual for Eastern Washington when published by the Department of Ecology).
- *Standard Specifications for Road, Bridge and Municipal Construction*, Washington State Department of Transportation and the Washington Chapter of the American Public Works Association, latest edition (English Units).

The construction of storm drainage facilities shall be done in accordance with plans that have been approved by the City Engineer.

A draft Stormwater Operations and Maintenance Manual for the UGA shall be prepared and approved by the City prior to submittal of the final drainage plans for the initial plat.

CITY OF CLE ELUM

CONSTRUCTION STANDARDS

FOR THE PRIVATE CONSTRUCTION OF PUBLIC FACILITIES FOR PROPERTIES SUBJECT TO THE CLE ELUM UGA MASTER SITE PLAN

MAY 2002

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f. Air and vacuum release valve assemblies
g. Pressure reducing valves
h. Fire sprinkler system lines
I. Backflow prevention devices
j. Post indicator valves
k. Thrust blocking

2. Identify all joint connections; provide detail of all non-standard joints.

3. Station or dimension the location of all fire hydrants, tees, crosses, services relative to centerlines or property lines.

4. Indicate all easements required for the water main extensions and future extensions.

5. Show the length, size, and pipe type for all main extensions, fire sprinkler system services, and domestic services where applicable.

6. Show the water system and the sanitary sewer system on the same plan and profile view for verification of minimum separation requirements. The design information for each system may be on individual drawings for that system.

7. A profile view shall be shown for all City water main extensions, aligned if practical with the plan view. Clearly indicate the horizontal and vertical scales.

8. Show the minimum cover and minimum separation on each sheet.

9. In the profile view, show all utilities crossing the proposed water main.

STORM DRAIN SYSTEM PLAN REQUIREMENTS

1. Show all existing features if known and all proposed storm drain system features including but not limited to:

   a. Storm drain mains
   b. Catch basins
   c. Inlets
   d. Drywells
   e. Retention systems
   f. Biofiltration swales
   g. Culverts
   h. Streams
   I. Ditches
   j. Natural drainage swales
   k. Headwalls
   l. Oil/water separator assembly

2. Show slope, length, size, and pipe material for all storm drain mains and lines.

3. All catch basins and inlets shall be uniquely numbered and shall be clearly labeled. Stationing and offsets shall be indicated from referenced centerline. Show all proposed storm drain features within the right of way in a profile.

4. Indicate all grate, rim, and invert elevations in the profile view.

5. Show all horizontal measurements and control in the plan view.

6. Indicate all easements required for the storm drainage system.

7. The plan shall clearly indicate the location of the storm drainage items stationed from a referenced centerline.

8. Provide storm water runoff and drainage calculations as described in Chapter 8.

STREET PLAN REQUIREMENTS

1. Show all existing and proposed roadway improvements including but not limited to:

   a. Pavement
   b. Concrete curb and gutter
   c. Edge of pavement
   d. Sidewalk
   e. Utilities (manholes, power poles, signs, valves, etc.)
   f. Handicap ramps
   g. Barricades
   h. Driveways
   I. Rockery or retaining walls
   j. Mailboxes
   k. Monuments
   l. Streetlights
   m. Compliance with ADA requirements.

2. Show all right of way lines, centerlines, and roadway widths for all rights of way.

3. Clearly differentiate between areas of existing pavement, areas of new pavement, and areas to be overlaid.

4. Provide a cross section or typical section of all rights of way indicating right of way width, centerline, pavement width, sidewalk, curb and gutter, pavement, and base thickness of new and existing pavement.

5. Provide a profile of all new public roadways or extensions of existing roadways. Indicate all vertical curve data, percent of grade, centerline stationing, finish grade elevations, and existing ground line. The profile of the existing centerline ground should extend a minimum of 100 feet before the beginning and at the end of the proposed improvements to show the gradient blend.

CHAPTER 3 - STANDARD SPECIFICATIONS

FORWARD

The City of Cle Elum has adopted the Standard Specifications for Road, Bridge, and Municipal Construction prepared by the Washington State Department of Transportation, and the Washington State Chapter of the American Public Works Association as the standard specifications governing all design and construction of public improvements by private developers.

All references hereinafter made to the "Standard Specifications" shall refer to the latest edition of the Standard Specifications described above. Except as may be amended, modified, or supplemented hereinafter, each section of the Standard Specifications shall be considered as much a part of these requirements as if they were actually set forth herein.

The Standard Specifications, Special Provisions, and City Standard Details contained in these **City Construction Standards** shall apply in their entirety to all City of Cle Elum public works projects. These Standards have been prepared to form a compiled document intended to assist and inform developers, consultants, and contractors of the construction requirements to be used on public works improvements.

The Standard Specifications, Special Provisions, and City Standard Details shall periodically be revised and updated. It shall be the responsibility of each user of this information to verify that he has the latest revisions prior to submitting any work covered by these specifications and details.

Developers and contractors are encouraged to contact the City of Cle Elum Public Works Department regarding these standards.

City of Cle Elum
Public Works Department
119 West 1st
Cle Elum, WA 98922

Telephone:	(509) 674-2262
Fax:	(509) 674-4097

CHAPTER 8 - STORM DRAINAGE

GENERAL REQUIREMENTS FOR STORM DRAINAGE IMPROVEMENTS

All City of Cle Elum storm sewer improvements shall conform to the following design standards of the City:

Storm runoff occurring on all new lots and developments (private property) shall be retained and disposed of on-site. No storm runoff will be allowed to enter public property or public storm drainage system.

Storm runoff for new public streets shall be designed and constructed as required to the point where the adjoining property owner's responsibility for further extension begins. This typically requires an extension across the entire frontage of the property to the property line of the adjoining owner.

All storm sewer designs for new public streets shall be based upon an engineering analysis which takes into account total drainage areas, runoff rates, pipe and inlet capacities, and any other factors pertinent to the design

All new storm drainage facilities, public or private, shall be designed by a Professional Engineer licensed in the State of Washington. Complete storm water runoff and drainage facilities sizing calculations shall be submitted to the City of Cle Elum for review and comment.

Storm sewer facilities and pipelines shall be designed to meet a minimum 10-year storm criteria. Small private developments may be designed to accommodate 1-inch of precipitation over the on-site impervious surfaces. Small developments are defined to be 20,000 SF or less of impervious surface area. Impervious surfaces must be clearly noted and shown on the project site plan.

All storm water facilities shall have oil and silt separation.

Inlet spacing shall be designed in accordance with the WSDOT Hydraulics Manual, Chapter 5. Generally, inlet spacing shall not exceed 300 feet. There shall be installed a manhole or Type II catch basin at the intersection of two collector storm sewers. A collector storm sewer is a sewer servicing more than one catch basin.

SPECIAL PROVISIONS FOR STORM SEWERS

The following Sections of the Standard Specifications have been amended or supplemented as described below:

7-02 CULVERTS

7-02.4 Materials

Add the following:

Culvert pipe approved for use on this project shall be as follows:

Corrugated Aluminum Alloy Culvert Pipe meeting the requirements of SECTION 9-05.5 of the Standard Specifications.

OR

Aluminized Corrugated Steel Culvert Pipe meeting the requirements of SECTION 9-05.4 of the Standard Specifications.

7-04 STORM SEWERS

7-04.2 Materials

Add the following:

The storm drain pipe approved for use on this project shall be as follows:

36-INCH AND LARGER PIPE

Corrugated Aluminum Alloy Storm Sewer Pipe: All corrugated aluminum alloy storm sewer pipe shall comply with the requirements specified in SECTION 9-05.11 of the Standard Specifications and shall be 16 gauge with helical corrugations. A protective coating shall not be required.

15-INCH THROUGH 36-INCH PIPE

Corrugated Aluminum Alloy Storm Sewer Pipe: All corrugated aluminum alloy storm sewer pipe shall comply with the requirements specified in SECTION 9-05.11 of the Standard Specifications and shall be 16 gauge with helical corrugations. A protective coating shall not be required. All corrugated metal pipe joints shall be flexible using rubber gasket joints. Gaskets shall be made of 3/8-inch thick by 12-inch minimum width closed cell synthetic sponge rubber, per ASTM D 1056, Grade SCE-43, fabricated in the form of a cylinder with a diameter of approximately 10 percent less than the nominal pipe size. The gasket shall be centered under the band and lapped an equal distance on the ends of the adjoining pipe sections. Coupling bands shall be used and shall conform to the provisions of SECTION 9-05.11(1) of the Standard Specifications. Coupling bands shall be made by the same manufacturer as the pipe and shall be made of the same base material as the pipe which it connects.

PE Pipe: Corrugated High Density Polyethylene (CPEP) pipe, couplings, and fittings shall comply with the requirements of SECTION 9-05.20 of the Standard Specifications.

12-INCH AND SMALLER PIPE

PVC Pipe: Polyvinyl chloride (PVC) pipe shall conform with requirements specified in SECTION 9-05.12 of the Standard Specifications (ASTM D 3034, SDR 35). The pipe joint type shall be restrained gasket.

OR

PE Pipe: Corrugated High Density Polyethylene (CPEP) pipe, couplings, and fittings shall comply with all the requirements of AASHTO M-252-85I. Joints shall be water-tight.

Pipe shall be as manufactured by Hancor, Advanced Drainage Systems, Inc., or approved equal.

The perforated storm drain pipe approved for use shall be as follows:

PE Pipe: Corrugated High Density Polyethylene (CPEP) pipe, couplings, and fittings shall comply with all the requirements of SECTIONS 9-05.1(6) or 9-05.1(7) of the Standard Specifications.

DRAIN ROCK: Drain rock for use as backfill for the perforated storm drain pipe shall be coarse aggregate conforming to the requirements for gravel backfill for drywells as specified in SECTION 9-03.12(5) of the Standard Specifications.

7-04.3(1) Cleaning and Testing

7-04.3(1)A General

No infiltration or exfiltration test will be required for the storm drain pipe.

7-05 MANHOLES, INLETS, CATCH BASINS, AND DRYWELLS

7-05.2 Materials

Section 7-05.2 of the Standard Specifications shall be revised as follows:

Gravel Backfill for Drywells: Gravel backfill for drywells shall be as specified in Section 9-03.12(5) of the Standard Specifications.

Manhole Metal Castings: All cast iron frames and covers shall be as specified in SECTION 9-05.15(1) of the Standard Specifications. All cast iron frames and covers to be used on this project shall be of the type, weight, and size approved by the City of Cle Elum, and shall be furnished by the Contractor. Covers for sanitary sewer shall be stamped "SEWER." Covers for storm drain shall be stamped "STORM."

Precast Concrete Catch Basin: Catch basins shall be constructed as shown on the detail sheet of the Plans.

Catch basins shall be constructed of thirty (30) inch I.D. Washington State standard reinforced concrete culvert pipe using cast iron grating and frames as shown on the Plans.

Catch Basin Metal Castings: All frames and grates shall be capable of withstanding, with a reasonable margin of safety, a concentrated load of 20,000 pounds and shall be as specified in SECTION 9-05.15(2) of the Standard Specifications. The grate shall be ductile iron and "bicycle safe." The contact surfaces of the frame and grate shall be machine finished to a common plane and shall be so cast as to prevent rocking. Frames and grates shall be Inland Foundry Co., Inc., No. 433 Round Base, 20" x 24" or approved equal.

7-05.3(1) Adjusting Manholes and Catch Basins to Grade

Delete and replace with the following:

Manholes and similar structures shall not be adjusted until the pavement is completed, **at which time the center of each structure shall be relocated from references previously established by the Contractor.**

The asphalt concrete pavement shall be cut and removed to a neat circle, the diameter of which shall be equal to the outside diameter of frame plus 2 feet. The frame shall be placed on cement concrete blocks or adjustment rings and wedged up to the desired grade. The base materials shall be removed and Class 3000 cement concrete shall be placed within the entire volume of the excavation up to, but not to exceed, 1½ inches below the finished pavement surface.

On the following day, the concrete, the edges of the asphalt concrete pavement, and the outer edge of the casting shall be painted with hot asphalt cement. Class G asphalt concrete shall then be placed and compacted with hand tampers and a patching roller.

The completed patch shall match the existing paved surface for texture, density, and uniformity of grade. The joint between the patch and the existing pavement shall then be painted with hot asphalt cement or asphalt emulsion and shall be immediately covered with dry paving sand before the asphalt cement solidifies.

7-05.3(2) Abandon Existing Manholes

Replace the entire section with the following:

Where shown on the Plans, existing sanitary sewer manholes shall be abandoned in place after the new sanitary sewer collection system is in place and all side sewers have been transferred to the new sanitary sewer pipeline. The following new section shall be added to the Standard Specifications:

At least the top 3 feet of each manhole, or the top conical section in precast concrete manholes, shall be removed, including the cast iron ring and cover and concrete pad, if any. Debris resulting from breaking of the upper portion of the manhole may be mixed with backfill subject to the approval of the Engineer. Ring and cover will become property of the Contractor and all other surplus material shall be disposed of.

The existing pipe openings shall be plugged watertight with Class 3000 concrete and the manhole bottom slabs shall be broken to promote drainage. The remaining manhole structure shall be backfilled with granular material conforming to SECTION 9-03.9(3) CRUSHED SURFACING BASE COURSE. Place backfill in uniform layers and compact to 95% maximum dry density, as determined by ASTM D 1557 (Modified Proctor).

Excavations resulting from manhole abandonment shall be backfilled with suitable, job-excavated material to top of subgrade. Compact to 95% maximum dry density as determined by ASTM D 698 (Standard Proctor). Restore surface to the condition existing prior to excavation with native material, gravel surfacing, or asphalt concrete pavement as shown for trench repair on the plans.

Appendix C

Operation and Maintenance Standards

Maintenance Standards for Catch Basins

Defect	Conditions When Maintenance Needed	Maintenance Results
Trash and debris including sediment	Trash or debris of more than 1/2 ft^3 located in front of the catch basin opening or blocking capacity of basin by >10%.	No trash or debris located immediately in front of catch basin opening.
	Trash or debris in the basin that exceeds 1/3 - 1/2 the depth from the bottom of basin to invert of the lowest pipe into or out of the basin.	No trash or debris in catch basin.
	Trash or debris in any inlet or outlet pipe blocking more than 1/3 of the height.	Inlet and outlet pipes free of trash or debris
	Dead animals or debris that could generate odors that would cause complaints or dangerous gases.	No dead animals or vegetation present.
	Deposits of garbage exceeding 1 ft^3 in volume.	No garbage in catch basin.
Structural damage to frame and/or top slab	Corner of frame extends more than 3/4 inch past curb face into the street (if applicable).	Frame is even with curb.
	Top slab has holes larger than 2 in^2 or cracks wider than 1/4 inch (intent is to make sure all material runs into basin).	Top slab is free of holes and cracks.
	Frame not sitting flush on top slab (i.e., separation of >3/4 inch of the frame from top of slab).	Frame is sitting flush on top of slab.
Cracks in basin walls or bottom	Cracks wider than 1/2 inch and longer than 3 feet, any evidence of soil particles entering catch basin through cracks, or structure is unsound.	Basin replaced or repaired to design standards.
	Cracks wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through crack.	No cracks more than 1/4 inch wide at joint of inlet/outlet pipe.
Settlement/ misalignment	Basin has settled more than 1 inch or has rotated more than 2 inches out of alignment.	Basin replaced or repaired to design standard.
Fire hazard	Presence of chemicals such as natural gas, oil and gasoline.	No flammable chemicals present.
Vegetation	Vegetation growing across and blocking more than 10% of basin.	No vegetation blocking opening to basin.
	Vegetation (or roots) growing in inlet/outlet pipe joints that is >6 in. tall and <6 in. apart.	No vegetation or root growth present.
Pollution	Nonflammable chemicals of 1/2 ft^3 per 3 feet of basin length.	No pollution present other than surface film.

Maintenance Standards for Catch Basins (continued)

Defect	Conditions When Maintenance Needed	Maintenance Results
Catch Basin Cover	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed
Catch Basin Cover Locking Mechanism Not Working	Mechanism cannot be opened by on maintenance person with proper tools. Bolts into frame have less than ½ inch of thread.	Mechanism opens with proper tools.
Catch Basin Cover Difficult to Remove	One maintenance person cannot remove lid after applying 80 lbs. of lift; intent is keep cover from sealing access to maintenance.	Cover can be removed by one maintenance person.
Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
Trash and Debris on Metal Grates	Trash and debris that is blocking more than 20% of grate surface.	Grate free trash and debris.
Damaged or Missing	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

Maintenance Standards for Pipes, Culverts, and Overflow Systems

Defect	Conditions When Maintenance Needed	Maintenance Results
Sediment and debris	Accumulated sediment that exceeds 20% of the diameter of the pipe.	Pipe cleaned of all sediment and debris.
Vegetation	Vegetation that reduces free movement of water through pipes.	All vegetation removed so water flows freely through pipes.
Damaged	Protective coating is damaged; rust is causing more than 50% of deterioration to any part of pipe.	Pipe repaired or replaced.
Debris barriers	Trash or debris that is plugging more than 20% of the openings in the barrier.	Barrier clear to receive capacity flow.
Damaged/missing bars	Bars are bend out of shape more than 3 inches.	Bars in place with no bends > 3/4 inch.
	Bars are missing or entire barrier is missing.	Bars in place according to design.
	Bars are loose and rust is causing 50% deterioration to any part of barrier.	Repair or replace barrier to design standards.

Maintenance Standards for Wet Ponds, Water Quality Wet Ponds, Extended Detention Dry Ponds, and Presettling Basins

Defect	Conditions When Maintenance Needed	Maintenance Results
Trash and debris	Any trash or debris that exceeds 1 $ft^3/1000\ ft^2$. There should be no evidence of dumping.	Trash and debris cleared from site.
Poisonous	Presence of any poisonous vegetation that constitutes a hazard to maintenance personnel or the public	No evidence of poisonous vegetation where personnel or public might be. Coordinate with local health department.
Pollution	One gallon or more of oils, gas, or contaminants, or any amount that could: (1) cause damage to plant, animal, or aquatic life, (2) constitute a fire hazard, (3) be flushed downstream during storms.	No contaminants present other than a surface film. Coordinate with local health department.
Unmowed grass/ ground cover	In residential areas, mowing is needed when the cover exceeds 18 inches in height. Otherwise, match facility cover with adjacent ground cover and terrain as long as there is no decrease in facility function.	Grass/ground cover should be mowed to 2 inches. Maintain dense cover on slopes, and in bottom of dry ponds.
Rodent holes	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. Coordinate with local health department.
Insects	When insects such as wasps or hornets interfere with maintenance activities.	Insects destroyed or removed from site.
Tree growth	Tree growth does not allow maintenance access or interferes with maintenance activity. If trees are not interfering with access, leave trees alone.	Trees do not hinder maintenance activities.
Erosion of pond side slopes	Eroded damage > 2 inches deep where cause of damage is still present, or where there is potential for continued erosion.	Slopes stabilized with appropriate erosion control BMPs (e.g., seeding, mats, riprap).
Sediment accumulation in forebay/pond	Accumulated sediment that exceeds 10% of the design forebay/pond depth, or every 3 years.	Sediment cleaned out to design depth. Reseed if necessary for erosion control.
Dike settling	Any part of dike that has settled more than 4 inches.	Dike is rebuilt to design elevation.
Rocks missing from overflow spillway	Only one layer of rock above native soil in an area of 5 ft^2 or greater, or any exposed soil.	Rock replaced to design standard.

Maintenance Standards for Closed Detention Systems (Vaults/Tanks)

Defect	Conditions When Maintenance Needed	Maintenance Results
Plugged air vents	Half of the end area of a vent is blocked at any point with debris and sediment.	Vents free of debris and sediment.
Debris and sediment in storage area	Accumulated sediment depth is > 10% of the diameter of the storage area for 1/2 the length of storage vault or any point exceeds 15% of the diameter. Example: 72-inch storage tank would require cleaning when sediment reaches a depth of 7 inches for more than 1/2 the tank length.	All sediment and debris removed from storage area.
Cracks in joints between tank/pipe sections	Any crack allowing material to be transported into the facility.	All joints between tanks/pipe sections are sealed.
Problems with manhole cover	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed and secured.
Problems with manhole cover (continued)	Locking mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have < 1/2 inch of thread (may not apply to self-locking lids).	Mechanism is repaired or replaced so it functions properly.
	Cover difficult to remove by one maintenance person applying 80 pounds of lift.	Cover can be removed and reinstalled by one maintenance person.
Ladder rungs of manhole unsafe	Local government safety officer or maintenance person judges that ladder is unsafe due to missing rungs, misalignment, rust, or cracks.	Ladder meets design standards and allows for maintenance access.

Maintenance Standards for Infiltration

Defect	Conditions When Maintenance Needed	Maintenance Results
Sediment buildup in system	Infiltration or soil texture test indicates facility is not functioning as designed. If two inches of sediment is present, remove.	Sediment is removed and/or facility is cleaned so that system works according to design.
Sump filled with sediment and debris (If applicable)	Any sediment and debris filling vault to 10% of depth from sump bottom of outlet pipe or obstructing flow into the connector pipe.	Clean out sump to design depth.
Sediment trapping area	Sediment and debris fill more than 10% of infiltration or sediment trapping facility or sump.	Clean-out.
Sediment in settling ponds and vaults	Remove when 6" inches or more.	
Sediment and debris in rock filters	By visual inspection, little or no water flows through filter during heavy rain storms.	Replace gravel in rock filter.

Maintenance Standards for Structure/Flow Restrictor

Defect	Conditions When Maintenance Needed	Maintenance Results
Trash and Debris (Includes Sediment)	Distance between debris build-up and bottom of orifice plate is less than 1½ feet.	All trash and debris removed.
Structural Damage	Structure is not securely attached to manhole wall and outlet pipe structure should support at least 1,000 lbs. of up or down pressure.	Structure securely attached to wall and outlet pipe.
	Structure is not in upright position (allow up to 10 percent from plumb).	Structure in correct position.
	Connections to outlet pipe are not watertight and show signs of rust.	Connections to outlet pipe are watertight; structure repaired or replaced and works as designed.
	Any holes – other than designed holes – in the structure.	Structure has no holes other than designed holes.
Clean-out gate damaged or missing	Cleanout is not watertight or is missing.	Gate is watertight and works as designed.
Office plate damaged or missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
Overflow pipe obstructions	Any trash, debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.

Maintenance Standards for Water Quality Facilities

Defect	Conditions When Maintenance Needed	Maintenance Results
	Biofiltration Swale	
Sediment accumulation	Sediment depth exceeds 2-inches	No sediment deposits on grass layer of the bio-swale, which would impede filtration of runoff.
Vegetation	When the grass becomes excessively tall (greater then 10-inches); when nuisance weeds and other vegetation starts to take over.	Vegetation is mowed or nuisance vegetation is eradicated, such that flow not impeded. Grass should be mowed to a height between 4 inches and 9 inches.
Inlet outlet pipe	Inlet/outlet pipe clogged with sediment and/or debris.	No clogging or blockage removed from bioswale.
Trash and debris accumulation	Trash and debris accumulated in the bio-swale.	Trash and debris removed from bio-swale.
Erosion/ Scouring	Where the bio-swale has eroded or scoured the bottom due to flow channelization, or higher flows.	Bio-swale should be re-graded and re-seeded to specification, to eliminated channeled flow. Overseeded when bare spots are evident.
	Filter Strip	
Sediment Accumulation on Grass Layer	Sediment depth exceeds 2 inches.	No sediment deposits on grass layer of the filter strip, which would impede filtration runoff.
Vegetation	When the grass becomes excessively tall (greater than 10 inches); when nuisance weeds and other vegetation start to take over.	Vegetation is mowed or nuisance vegetation is eradicated, such that flow is not impeded. Grass should be mowed to a height between 4 inches and 9 inches.
Trash and Debris Accumulation	Trash and debris accumulation on the filter strip.	Trash and debris removed from filter.
Erosion/Scouring	Where the filter strip has eroded or scoured due to flow channelization, or higher flows.	Strip should be re-graded and re-seeded per specification, to eliminate channeled flow. Overseeded when bare spots are evident.

Maintenance Standards for Water Quality Facilities (continued)

Defect	Conditions When Maintenance Needed	Maintenance Results
	Filter Strip	
V-Notch Pipe Weir	When the V-Notch pipe becomes damaged or clogged with sediment/debris.	Cleaned and properly functioning weir, such that flows uniformly spread.
	Wetpond	
Vegetation	Vegetation such as grass and weeds need to be mowed when it starts to impede aesthetics of pond. Mowing is generally required when height exceeds 18 inches. Mowed vegetation should be removed from areas where it could enter the pond, either when the pond level rises, or by rainfall runoff.	Vegetation should be mowed to 4 to 5 inches in height. Trees and bushes should be removed where they are interfering with pond maintenance activities.
Trash and Debris	Accumulation that exceeds 1 CF per 1000 SF of pond area.	Trash and debris removed from pond.
Inlet/Outlet Pipe	Inlet/outlet pipe clogged with sediment and/or debris material.	No clogging or blockage in the inlet and outlet piping.
Sediment Accumulation in Pond Bottom	Sediment accumulations in pond bottom that exceed the depth of sediment zone plus 6 inches, usually the first cell.	Removal of sediment from pond bottom.
Oil Sheen on Water	Prevalent and visible oil sheen.	Removal of sediment from pond bottom.
Erosion	Erosion of the pond's side slopes and/or scouring of the pond bottom, that exceeds 6 inches, or where continued erosion is prevalent.	Slopes should be stabilized by using proper erosion control measures, and repair methods.
Settlement of Pond Dike/Berm	Any part of these components that has settled 4 inches or lower than the design elevation, or inspector determines dike/berm is unsound.	Dike/berm is repaired to specifications.
Rock Window	Rock window is clogged with sediment.	Window is free of sediment and debris.
Overflow Spillway	Rock is missing and soil is exposed at top of spillway or outside slope.	Replace rocks to specifications.

Maintenance Standards for Energy Dissipators

Defect	Conditions When Maintenance Needed	Maintenance Results
	Rock Pad	
Missing or Moved Rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Replace rocks to design standards.
	Dispersion Trench	
Pipe Plugged with Sediment	Accumulated sediment that exceeds 20 percent of the design depth.	Pipe cleaned/flushed so that it matches design.
Not Discharging Water Properly	Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow" of water along trench). Intent is to prevent erosion damage.	Trench must be redesigned or rebuilt to standards.
Perforations Plugged.	Over ½ of perforations in pipe are plugged with debris and sediment.	Clean or replace perforated pipe.
Water Flows Out Top of "Distributor" Catch Basin	Maintenance person observes water flowing out during any storm less than the design storm or it's causing or appears likely to cause damage.	Facility must be rebuilt or redesigned to standards.
Receiving Area Over-Saturated	Water in receiving area is causing or has potential of causing landslide problems.	No danger of landslides.
Worn or Damaged Post, Baffles, Side Manhole or Chamber	Structure dissipating flow deteriorates to ½ of original size or any concentrated worn spot exceeding one square foot which would make structure unsound.	Replace structure to design standards.

Maintenance Standards for Grounds (Landscaping)

Defect	Conditions When Maintenance Needed	Maintenance Results
Weeds (nonpoisonous)	Weeds growing in more than 20% of the landscaped area (trees and shrubs only).	Weeds present in less than 5% of the landscaped area.
Safety hazard	Any presence of poison ivy or other poisonous vegetation.	No poisonous vegetation present in a landscaped area.
Trash or litter	Paper, cans, bottles, totaling more than 1 cubic foot within a landscaped area (trees and shrubs only) of 1,000 square feet.	Area clear of litter.
Damage	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 the total foliage with split or broken limbs.
	Trees or shrubs that have been blown down or knocked over.	Tree or shrub in place 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; remove any dead or diseased trees.

Maintenance Standards for Fencing and Gates

Defect	Conditions When Maintenance Needed	Maintenance Results
	Fencing	
Missing or broken parts	Any defect in the fence that permits easy entry to a facility.	Parts in place to provide adequate security.
	Parts broken or missing.	Broken or missing parts replaced.
Erosion	Erosion more than 4 inches high and 12-18 inches wide, permitting an opening under a fence.	No opening under the fence that exceeds 4 inches in height.
Damaged parts	Posts out of plumb more than 6 inches.	Posts plumb to within 1½ inches.
	Top rails bent more than 6 inches.	Top rail free of bends greater than 1 inch.
	Any part of fence (including posts, top rails, and fabric) more than 1 foot out of design alignment.	Fence is aligned and meets design standards.
	Missing or loose tension wire.	Tension wire in place and holding fabric.
	Missing or loose barbed wire that is sagging more than 2½ inches between posts.	Barbed wire in place with less than ¾-inch sag between posts.
	Extension arm missing, broken, or bent out of shape more than 1½ inches.	Extension arm in place with no bends larger than ¾ inch.
Deteriorated paint or protective coating	Part or parts that have a rusting or scaling condition that has affected structural adequacy.	Structurally adequate posts or parts with a uniform protective coating.
Openings in fabric	Openings in fabric are such that an 8-inch-diameter ball could fit through.	No openings in fabric.
	Gates	
Missing or broken parts	Any defect in the fence that permits easy entry to a facility.	Parts in place to provide adequate security.
Damaged or missing members	Missing gate or locking devices.	Gates and locking devices in place.
Missing or broken parts	Any defect in the fence that permits easy entry to a facility.	Parts in place to provide adequate security.
Damaged or missing members	Missing gate or locking devices.	Gates and locking devices in place.

Maintenance Standards for Fencing and Gates (continued)

Defect	Conditions When Maintenance Needed	Maintenance Results
	Gates Broken or missing hinges such that gate cannot be easily opened and closed by a maintenance person.	Hinges intact and lubed. Gate is working freely.
Damaged or missing members (continued)	Gate is out of plumb more than 6 inches and more than 1 foot out of design alignment.	Gate is aligned and vertical.
	Missing stretcher bar, stretcher bands, and ties.	Stretcher bar, bands, and ties in place.
Openings in fabric.	Openings in fabric are such that an 8-inch-diameter ball could fit through.	No openings in fabric.

Maintenance Standards for Access Roads/Easements

Defect	Conditions When Maintenance Needed	Maintenance Results
Trash and debris	Trash and debris exceed 1 cubic foot per 1,000 square feet, i.e., trash and debris would fill up one standard-size garbage can.	Trash and debris cleared from site.
Blocked roadway	Debris which could damage vehicle tires (glass or metal).	Roadway free of debris which could damage tires.
	Any obstructions which reduce clearance above road surface to less than 14 feet.	Obstruction removed to allow at least a 12-foot access.
	Any obstructions restricting the access to a 10- to 12-foot width for a distance of more than 12 feet or any point restricting access to less than a 10-foot width.	Obstruction removed to allow at least a 12-foot access.
Settlement, potholes, mush spots, ruts	When any surface defect exceeds 6 inches in depth and 6 square feet in area. In general, any surface defect which hinders or prevents maintenance access.	Road surface uniformly smooth with no evidence of settlement, potholes, mush spots, or ruts.
Vegetation in road surface	Weeks growing in the road surface that are more than 6 inches tall and less than 6 inches apart within a 400-square foot area.	Road surface free of weeks taller than 2 inches.
Erosion Damage	Erosion within 1 foot of the roadway more than 8 inches wide and 6 inches deep.	Shoulder free of erosion and matching the surrounding road.
Weeds and brush	Weeds and brush exceed 19 inches in height or hinder maintenance access.	Weeds and brush out to 1 inches in height or cleared in such a way as to allow maintenance access.

Appendix D

MountainStar Runoff Time Series Model and Users Guide

MSRTS USER'S GUIDE

Note: The following guidelines are intended for designers experienced with the use of the King County Runoff Time Series (KCRTS). Both MSRTS and KCRTS basically work the same way, with some minor, but significant changes.

- Create time series files as in KCRTS. However, two changes are apparent with the use of MSRTS. The first being the requirement to select the zone of which the basin is to be modeled. Select the proper precipitation zone. After selecting the precipitation zone, the land use options are available. MSRTS displays more options than KCRTS. Enter acreage values for all that apply. Create the time series and name the file. Take notice that the entire historical record is computed. The option of running the reduced 8-year record does not exist with MSRTS.
- Do a flow frequency analysis for that file and other files created for the project. Pay special attention to the ranking. The 100-year return period may not necessarily correspond with the highest peak flow. In some cases, the 84.14-year return period may result in the highest peak flow based on program input parameters. This information is critical when selecting primary discharge hydrographs later in the program.
- Sizing a retention/detention facility is done the same way for both MSRTS and KCRTS. As with KCRTS, begin in automatic sizing mode. When sizing an infiltration pond, the Riser Head and Riser Diameter values must be entered in order for the program to execute. The Point of Compliance is the same as in KCRTS. When setting hydrographs, set the target discharge to zero for whatever storm event you attempting to infiltrate. The specific storm event is found at the bottom of the screen as you move down the entry column representing eight different primary discharge hydrographs. If you want to infiltrate the 25-year event, the closest hydrograph to that event is likely the 30.2-year event. However, if you want to infiltrate the 100-year event, or hydrograph 1, simply setting the primary discharge to zero and running the sizing routine does not necessarily mean the true 100-year event was infiltrated. If the 84.14-year event yielded the highest peak flow in the flow frequency analysis, you won't have the option of selecting this event as the primary design hydrograph, and thus the infiltration pond will be undersized and will need modified in manual mode.
- When running the automatic sizing routine, sometimes it becomes necessary to shake the bottom scroll bar occasionally so that the sizing gets completed and the words "iteration converged" appear.
- Once finished with the automatic sizing routine, it becomes necessary to check the facility's performance in manual mode. Back out to the Size Facility Menu and enter the facility under the manual mode. Revise the facility and select the Modify Auto-Analysis Setup. Keep 'calculate peaks' highlighted and turn off 'notify event changes'. On the next screen, highlight view peak list. Return to the facility design menu and Overwrite the file. Select the Route Time Series and Perform Auto-Analysis. At the very bottom of the screen should be the flow frequency analysis for the output file from the facility that is being sized. Check to make sure there is zero flow for the highest return period. The flow frequency analysis should always be reviewed when designing infiltration facilities.

Example Drainage Facility Calculations

Example 1

A 20-acre parcel was modeled using MSRTS for infiltration pond sizing. The pond is designed to infiltrate the 100-year event. The basic assumptions are as follows:

- Till soils
- Precipitation Zone 1
- Density of 7 DU/acre => therefore, assume the site to be 56% impervious per Table 2.3 in the DOE SMM
- Runoff from this parcel is being conveyed to a site with soils conducive to infiltration

Land Use

Impervious: 11.2 acres
Flat till open (landscape): 8.8 acres

Facility size (bottom w/ 3:1 sideslopes): 155' x 78'
Peak inflow: 9.58 cfs
Peak infiltration rate: 2.77 cfs
Modeled infiltration rate: 10 in/hr
Peak stage (depth): 5.0'

MSRTS file names

Basin name: b-20till
Infiltration pond: pond20till
Facility outflow: rdout

Example 2

A 20-acre parcel was modeled using MSRTS for infiltration pond sizing. The pond is designed to infiltrate the 100-year event. The basic assumptions are as follows:

- Outwash soils
- Precipitation Zone 4
- 2,800 sf impervious coverage/lot (7.71 acres)
- 450 sf impervious driveway/lot (1.24 acres)
- 120 lots
- Lot areas will infiltrate with the exception of driveways

Land use

Assume road and sidewalk impervious = 11.2 acres – 7.7 acres = 3.5 acres
After adding driveway impervious area, total impervious area being routed to the infiltration pond = 3.5 + 1.24 => **4.74 acres**

Facility size (bottom w/ 3:1 sideslopes): 74' x 37'
Peak inflow: 3.29 cfs
Peak infiltration rate: 0.62 cfs
Modeled infiltration rate: 10 in/hr
Peak stage (depth): 5.0'

MSRTS file names

Basin name: b-20outw
Infiltration pond: pond20outw
Facility outflow: rdout-outw

Appendix B - 2020 AESI Technical Report: Geology, Soils and Groundwater

associated earth sciences incorporated

Technical Report: Geology, Soils, and Groundwater

47° NORTH MASTER SITE PLAN SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

Cle Elum, Washington

Prepared For:

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

Project No. 20190414H001
September 2020

Associated Earth Sciences, Inc.
911 5th Avenue
Kirkland, WA 98033
P (425) 827 7701

September 2020
Project No. 20190414H001

EA Engineering, Science, and Technology, Inc.
2200 6th Avenue, #707
Seattle, Washington 98121

Attention: Ms. Gretchen Brunner
Mr. Rich Schipanski

Subject: 47° North Master Site Plan
Supplemental Environmental Impact Statement
Technical Report: Geology, Groundwater, and Soils
Cle Elum, Washington

Dear Ms. Brunner and Mr. Schipanski:

We are pleased to present the enclosed Supplemental Environmental Impact Statement (SEIS) report addressing geology, groundwater, and soils for the 47° North Master Site Plan. We have enjoyed working with you on this study. If you should have any questions or if we can be of additional help to you, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

Curtis J. Koger, L.G., L.E.G., L.Hg.
Senior Principal Geologist/Hydrogeologist

CJK/ld
20190414H001-5

47° NORTH MASTER SITE PLAN
SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

TECHNICAL REPORT:
GEOLOGY, SOILS, AND GROUNDWATER

Cle Elum, Washington

Prepared for:
EA Engineering, Science, and Technology, Inc.
2200 6th Avenue, #707
Seattle, Washington 98121

Prepared by:
Associated Earth Sciences, Inc.
911 5th Avenue
Kirkland, Washington 98033
425-827-7701

September 2020
Project No. 20190414H001

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I. INTRODUCTION

1.0 PURPOSE AND SCOPE

The Bullfrog Flats property is an approximately 1,000-acre property located in the western portion of Cle Elum, Washington in an area of the city known as the Urban Growth Area (UGA). The property is generally bounded to the north and west by Bullfrog Road, to the south by Interstate 90 and the Washington State Horse Park, and to the east by SR903 and the Cle Elum cemetery. The location of the site is shown on the "Vicinity Map," Figure 1.

In 2002 Trendwest Properties, who owned the property at that time, prepared a Master Site Plan for the development of the property. The Master Site Plan generally consisted of a mixed residential/commercial/recreational/public facilities development. An Environmental Impact Statement (EIS) was prepared for the project in 2002 and the City of Cle Elum approved the Master Plan, a Subarea Plan, and a Development Agreement for the project; the property was subsequently annexed to the City. The property is currently owned by New Suncadia, LLC (Suncadia). Sun Communities is in the process of acquiring 824 acres of the property from Suncadia and is proposing revisions to the Approved Master Plan; the project is known as 47° North. Suncadia is retaining a portion of the property and intends, in the future, to develop approximately 25 acres for commercial use.

The purpose of our study was to obtain and review geologic, hydrogeologic, and soils data to assess existing conditions at the site (updating as necessary from the 2002 UGA EIS), and to interpret those conditions with respect to potential environmental impacts resulting from the Supplemental Environmental Impact Study (SEIS) alternatives: SEIS Alternative 6 - Proposed 47° North Master Site Plan Amendment and SEIS Alternative 5 (No Action Alternative) - Approved Bullfrog Flats Master Site Plan, as compared to the impacts under the 2002 Final EIS (FEIS) Alternative 5 - Original Bullfrog Flats Master Site Plan. Our scope of work included the following tasks:

- Review, compile, and analyze existing geologic, soil, and groundwater data for the project site.
- Complete a geologic and geomorphic reconnaissance of the site.
- Review exploration logs for 10 exploration pits and 6 exploration borings advanced on the subject site and the adjacent properties by Associated Earth Sciences, Inc. (AESI) in 1997 and 1998 during fieldwork performed for the 1999 MountainStar (now Suncadia) Master Planned Resort Environmental Impact Statement (MountainStar EIS). All 6 of the exploration borings were completed as observation wells.
- Review of exploration logs for 35 test pits and 6 hand-auger explorations advanced on the subject site and adjoining properties by AGI Technologies (AGI) in 1999 for the

Trendwest Properties Cle Elum Draft UGA Environmental Impact Statement, dated 2001 (2001 Draft UGA EIS).

- Review of driller's logs obtained from Washington State Department of Ecology (Ecology) records for 2 water supply wells and 4 "test holes" drilled at the Cle Elum fish hatchery, located on the south side of Interstate 90, south of the project site.

- Advance and sample 47 additional exploration pits and 4 exploration borings to assess the distribution and physical characteristics of the sediments underlying the site.

- Identify and assess erosion, landslide, seismic, coal mine, and volcanic hazards.

- Identify and assess potential impacts from the proposed project (SEIS Alternative 6 - Proposed 47° North Master Site Plan Amendment) and the No Action alternative (SEIS Alternative 5 - Approved Bullfrog Flats Master Site Plan) with respect to geologic hazards and shallow groundwater, as compared to the impacts under FEIS Alternative 5 - Original Bullfrog Flats Master Site Plan.

- Identify mitigation measures, if appropriate, for the proposed project and the alternative.

2.0 SITE AND PROJECT DESCRIPTION

The site is largely undeveloped and vegetated by second- and third-growth forest. Exceptions include: 1) two Puget Sound Energy powerline easements, and 2) a sanitary sewer easement in the eastern portion of the site, 3) an existing road in the western portion of the site (Wood Duck Road), 4) some scattered unimproved access roads, and 5) horse trails and related amenities. The equestrian amenities include a small building and parking area in the north-central portion of the site. A site plan showing the existing site conditions is included in Appendix A.

The site contains three distinct geomorphic areas. These include a relatively flat-lying area at the west end of the property known as Bullfrog Flats, an elevated area in the eastern portion of the site known as Bullfrog Heights, and a low-lying, relatively flat-lying area south of Bullfrog Heights known as Cle Elum Terrace. The three geomorphic areas, and other prominent site features are identified on Figures 2 through 6.

The Cle Elum River flows in a southerly direction through Bullfrog Flats, discharging into the Yakima River approximately 0.7 miles south of the site. East of Bullfrog Flats, the topography slopes steeply up toward the east-northeast, forming an elevated glacial feature known as the Bullfrog Moraine. The Bullfrog Moraine is located at the west end of Bullfrog Heights. The portion of Bullfrog Heights east of the Bullfrog Moraine generally consists of a relatively flat to gently sloping glacial outwash plain. The south margin of Bullfrog Heights consists of a steep, south- to southeast-facing slope that extends down to Cle Elum Terrace. Cle Elum Terrace lies outside of the project boundaries with the exception of a small area at the southeast end of the property.

Six wetland areas have been identified at the site by Raedeke Associates (five of these were described in the 2002 FEIS; an additional wetland was identified during site reconnaissance for this SEIS). Three of these are located in Bullfrog Flats near the Cle Elum River and the remaining three are located in the west-central portion of the site. The wetland locations are shown on the Existing Site Conditions plan included in Appendix A. The three wetlands in the west-central portion of the site are all located in close proximity to each other and occupy shallow depressions in the surface of the Bullfrog Moraine (Figure 3). It is our opinion that these wetlands were likely formed as a result of seasonal accumulation of ponded water within the depressions on the surface of the low-permeability sediments underlying this portion of the site. At the time of our visits to the site in October and November of 2019, there was no surface water in the wetlands located on the Bullfrog Moraine. The wetlands located in Bullfrog Flats lie outside of the portion of the site to be developed and no reconnaissance of this area was completed by AESI.

The glacial outwash plain located east of the Bullfrog Moraine is incised at three locations by drainage ravines. These ravines are located in the central and eastern portions of the site and are identified on Figures 3 through 6 as Ravines 1, 2, and 3. During our reconnaissance of these ravines, all three were observed to be dry and well vegetated with no exposed streambed or other indications of recent or seasonal flow. In our opinion, these ravines consist of paleo-drainages, which are no longer active.

The Preferred Alternative in the 2002 UGA FEIS was Alternative 5; it is referred to in the SEIS as "FEIS Alternative 5 - Original Bullfrog Flats Master Site Plan." A modified version of the FEIS Alternative 5 Master Site Plan was subsequently adopted as part of a Development Agreement reached with the City of Cle Elum. This plan is referred to in the SEIS as "SEIS Alternative 5 - Approved Bullfrog Flats Master Site Plan." Consistent with this nomenclature, the currently proposed 47° North Master Site Plan Amendment is referred to in the SEIS as "SEIS Alternative 6."

The Approved Bullfrog Flats Master Site Plan (SEIS Alternative 5) provided for the construction of 1,334 residential dwelling units, including 810 single-family units, 524 multi-family units, a 75-acre business park, and 7.5 acres for the construction of 50 affordable housing units. As part of the approved Development Agreement, 12 acres of the property were dedicated to the City for construction of the water treatment plant, 35 acres were dedicated to the Cle Elum School District, and 175 acres were dedicated to establish the Washington State Horse Park. The current Proposed 47° North Master Site Plan Amendment (SEIS Alternative 6) proposed by Sun Communities maintains the same number of residential dwelling units as the original Adopted Master Plan, but reduces the number of single-family residences to 527 units, reduces the number of multi-family units to 180, and adds a Recreational Vehicle (RV) resort with 627 RV sites. SEIS Alternative 6 would also include construction of parks and trails, and would reserve and dedicate areas for a future municipal recreation center, affordable housing, and expansion of the adjoining Cle Elum cemetery. The project would be constructed in 4 phases over a period of 7 years.

In summary, the alternatives to FEIS Alternative 5 addressed in the SEIS include:

- SEIS Alternative 5 - Approved Bullfrog Flats Master Site Plan; and,
- SEIS Alternative 6 - Proposed 47° North Master Site Plan Amendment

Review of the Stormwater Drainage Plan prepared for SEIS Alternative 6 indicates that stormwater runoff collected over the majority of the site will be discharged into infiltration ponds to be located in the eastern (Bullfrog Heights) portion of the property. Stormwater runoff collected in the western portion of the proposed development area (Tract REC 1), will discharge to a detention pond to be located within this tract. The detention pond will detain flow to the pre-developed condition. Discharge from the detention pond will be dispersed to the natural drainage location south of the pond. Dispersion of stormwater is also proposed in naturally vegetated areas located east of this tract. The Storm Drainage Plan developed for SEIS Alternative 6 has been designed to meet the requirements of the 2019 *Stormwater Management Manual for Eastern Washington* (2019 Ecology Manual). No drainage plans were prepared for FEIS or SEIS Alternative 5. However, hydrologic modeling completed for the FEIS assumed all stormwater would be infiltrated onsite. It is also assumed that stormwater runoff for SEIS Alternative 5 would be infiltrated onsite.

Copies of the FEIS Alternative 5 - Original Bullfrog Flats Master Site Plan and the SEIS Alternative 5 - Approved Bullfrog Flats Master Site Plan are included in Appendix B. Copies of the SEIS Alternative 6 - Proposed 47° North Master Site Plan Amendment, as well as the SEIS Alternative 6 Phasing Plan, Parks and Trails Plan, Storm Drainage Plan, and Grading Plan are included in Appendix C. A summary of land use under each of the three alternatives is provided below in Table 1. Summaries of earthwork quantities and impervious surface areas for each of the three alternatives are shown below in Tables 2 and 3, respectively.

Table 1
Summary of Land Use by Alternative

	FEIS Alt. 5		**SEIS Alt. 5**		**SEIS Alt. 6**	
	Ac.	**Units**	**Ac.**	**Units**	**Ac.**	**Units**
Residential Uses						
Single-Family	213	810	165	810	124.7	527
Multi-Family	78	524	56	524	18.6	180
RV Resort	---	---	---	---	145.6	627
Affordable Housing Site	---	---	7.5	(50)[2]	6.8	---[1]
Subtotal	**291**	**1,334**	**228.5**	**1,334[2]**	**295.7**	**1,334**

	FEIS Alt. 5		SEIS Alt. 5		SEIS Alt. 6	
	Ac.	**Units**	**Ac.**	**Units**	**Ac.**	**Units**
Non-Residential Uses						
Neighborhood Clubhouse & Lake (Amenity/Adventure Centers)	22		18		16.9	
Recreation Expansion	11		10.5		---	
Subtotal	**33**		**28.5**		**16.9**	
Other Uses						
Community (Municipal) Recreation Center	12		12		12.2	
School Expansion Site	35		35		---[3]	
Cemetery Expansion Site	10		10		13.4	
Commercial Development	80		75		(25.4)[4]	
Water Treatment Plant Site	12		12		---[3]	
Reserve: Horse Park, Open Space, Buffer	175[5]		175[5]		---[5]	
Maintenance Area	2		---		---	
Connector Road	---[6]		---[6]		9.5	
Subtotal	**326**		**319**		**35.1**	
Open Space						
Undeveloped Open Space	287		246		436.1[7]	
Steep Slope Areas/Buffers	126		172		---[8]	
Wetlands/Buffers	---[9]		---[9]		3.4	
Powerline Right-of-Way	37		37		37.2	
Residential Buffers	---		69		---[10]	
Subtotal	**450**		**524**		**476.7**	
TOTAL	**1,100**	**1,334**	**1,100**	**1,334[2]**	**824.4**	**1,334**
TOTAL CLEARED AREA	**403[11]**		**401**		**333.3**	

Source: Shapiro and Associates, Inc., 2001; 2002 Development Agreement; ESM, 2020.
Note: Any discrepancies in addition in Table 1 are due to rounding.
FEIS Alt. 5 = Final Environmental Impact Statement Alternative 5.
SEIS Alt. 5 = Supplemental Environmental Impact Statement Alternative 5.
SEIS Alt. 6 = Supplemental Environmental Impact Statement Alternative 6.
Ac. = acres
[1]No development of affordable housing units are assumed at this time under SEIS Alt. 6.
[2]The affordable housing units are not included in the total residential unit count under SEIS Alt. 5.
[3]The school expansion and water treatment sites have been dedicated to the Cle Elum Roslyn School District and the City of Cle Elum, respectively. Therefore, these areas are not included under SEIS Alt. 6.
[4]The commercial development is not included in SEIS Alt. 6 because it is currently owned by Suncadia. The cleared area (18.0 acres) is included in the SEIS Alt. 6 total cleared area.
[5]The reserve area consists of the Horse Park (112 ac.) to the south of the 47° North site, open space between the Horse Park and the 47° North site (55 ac.), and the buffer along Interstate 90 (8 ac.). The reserve area is not included as cleared or impervious in FEIS Alt. 5, SEIS Alt. 5, or SEIS Alt. 6.
[6]The connector road is incorporated into the other developed areas under FEIS Alt. 5 and SEIS Alt. 5.
[7]The undeveloped open space includes: river corridor open space (160.0 ac.), managed open space (103.9 ac.), and natural open space (172.2 ac.) under SEIS Alt. 6.
[8]The steep slope areas and the buffers in Tract RV-1 are included in the undeveloped open space under SEIS Alt. 6; other wetlands/buffers are included in the river corridor open space.
[9]The wetlands/buffers are included in the river corridor open space.
[10]While some vegetation would be preserved/provided in the residential areas under SEIS Alt. 6, these areas are not included in the open space calculations.
[11]Cleared area for FEIS Alt. 5 was obtained from the 2002 UGA EIS Appendix E, Site Engineering Technical Report, Table 1-1.

Table 2
Summary of Estimated Earthwork Quantities (Cubic Yards)

Land Use	FEIS and SEIS Alt. 5		SEIS Alt. 6	
	Cut	Fill	Cut	Fill
Residential	116,000	75,000	126,000	164,000
Residential Amenity Center	0	0	4,000	14,000
Adventure Center	0	0	3,000	16,000
Roads	79,000	16,000	2,000	4,000
Public Facilities	82,000	15,000	0	0
Community Recreation Center	19,000	19,000	0	0
School Expansion	37,000	37,000	0	0
Cemetery Expansion	8,000	16,000	0	0
Business Park	303,000	242,000	99,000	2,000
RV Park	0	0	106,000	108,000
RV Amenity Center	0	0	11,000	2,000
TOTAL	**644,000**	**420,000**	**351,000**	**310,000**

Notes:
FEIS and SEIS Alt. 5 = Final Environmental Impact Statement and Supplemental Environmental Impact Statement Alternative 5.
SEIS Alt. 6 = Supplemental Environmental Impact Statement Alternative 6.
Alternative 5 quantities exclude reserve area.
Totals may not sum due to rounding.
(Source: ESM, 2020).

Table 3
Summary of Estimated Cleared and Impervious Surface Areas (Acres)

Land Use	FEIS and SEIS Alt. 5		SEIS Alt. 6	
	Area Cleared	Impervious Area	Area Cleared	Impervious Area
Residential	161	104	143	71
Residential Amenity Center	0	0	6	5
Adventure Center	0	0	6	5
Roads	122	61	10	8
Public Facilities	23	4	0	0
Community Recreation Center	10	6	0	0
School Expansion	17	8	0	0
Cemetery Expansion	8	1	0	0
Business Park	62	63	18	17
RV Park	0	0	146	57
RV Amenity Center	0	0	5	4
TOTAL	**403**	**247**	**333**	**166**

Notes:
FEIS and SEIS Alt. 5 = Final Environmental Impact Statement and Supplemental Environmental Impact Statement Alternative 5.
SEIS Alt. 6 = Supplemental Environmental Impact Statement Alternative 6.
Alternative 5 quantities exclude reserve area.
Some of the areas assumed to be cleared and in impervious surfaces differ between the alternatives (public facilities, community recreation center, school expansion, and cemetery expansion) because different assumptions were made for these areas in the 2002 FEIS for FEIS Alternative 5, the SEIS Alternative 5, and the current revised plan for SEIS Alternative 6.
Totals may not sum due to rounding.
(Source: ESM, 2020)

2.1 Business Park

A 25-acre off-site property, located adjacent to the site's eastern boundary could be developed in commercial uses at some point in the future by the property owner, Suncadia. A total of 150,000 square feet of commercial uses could be developed on the property in phases over 17 years. Development of this area, which is identified on the SEIS Alternative 6 - Proposed 47° North Master Site Plan Amendment in Appendix C as the "Business Park," is included in the SEIS. The conceptual site plan for future commercial development of the Business Park is included in Appendix C.

3.0 SUBSURFACE EXPLORATION

Field exploration completed for this study included excavating 47 exploration pits and drilling 4 exploration borings in October 2019 to gain subsurface information about the site. Subsurface information obtained from these explorations was supplemented by additional subsurface data included on exploration logs and water well reports from explorations and water supply wells previously advanced at the site and on nearby properties. These previous explorations included the following:

- Two water supply wells and four "test holes" drilled in 1996 and 1997 for the Cle Elum fish hatchery, located near the south side of Interstate 90 south of the subject site.
- Ten exploration pits and six observation wells advanced on the subject site and adjacent properties in 1997 and 1998 by AESI for the 1999 MountainStar EIS.
- Thirty-five test pits and six hand-auger borings advanced on the subject site and the adjacent properties by AGI for the 2001 Draft UGA EIS.

Copies of the exploration logs are included in Appendix D. The approximate locations of the explorations are shown on Figures 2 through 5 and 7.

3.1 Exploration Pits

Exploration pits EP-1 through EP-47 were excavated in October 2019 using track-mounted excavators. The pits permitted direct, visual observation of subsurface conditions. Materials encountered in the exploration pits were studied and classified in the field by geologists from our firm. All of the exploration pits were backfilled immediately after examination and logging. Samples collected from the exploration pits 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.

Similar exploration methods were used for the exploration/test pits advanced at the site in 1997 by AESI for the 1999 MountainStar EIS and in 1999 by AGI for the 2001 Draft UGA EIS.

3.2 Exploration Borings

Exploration borings EB-1 through EB-4 were drilled in October 2019 using a track-mounted, sonic drilling rig. The exploration borings were continuously observed and logged by a geologist from our firm. The sonic drilling method produces a continuous core of the subsurface sediments by advancing a 7-inch outside-diameter core barrel and drilling inside of the 7-inch barrel with a 5-inch-diameter sample barrel. During the drilling process, the samples/cuttings are extracted so that a continuous lithologic sequence could be observed. Select portions of the sample were retained for further visual classification.

Borings/observation wells advanced for the 1999 MountainStar EIS were drilled using air-rotary and Tubex™ drilling methods. The water supply wells and test holes drilled at the Cle Elum fish hatchery were drilled using cable tool and rotary methods.

4.0 AFFECTED ENVIRONMENT: GEOLOGY AND SOILS

4.1 Physiography and Regional Geologic Setting

The subject site is located on the east flank of the central Cascade Range. The geology of this area consists primarily of Tertiary sedimentary and volcanic rocks overlain by Pleistocene glacial deposits. Post-glacial (Holocene) alluvial sediments overlie the older Pleistocene deposits and bedrock in the Cle Elum and Yakima River valleys. The Pleistocene glaciers carved steep-sided bedrock valleys that are generally oriented in a northwest-southeast direction. From west to east these include the basins occupied by Lakes Keechelus, Kachess, and Cle Elum. Two steep, bedrock ridges border the site. These include Cle Elum Ridge, which bounds the northeast side of the Cle Elum River valley northeast of the subject site, and Easton Ridge, which bounds the southwest side the Cle Elum River valley west of the site.

4.2 Regional Geology

Our understanding of the regional geology of the area is based on review of published geologic mapping and reports, review of the *Trendwest Properties: Cle Elum UGA Draft EIS, Appendix A - Earth* (AGI, 2001), and on review of the *MountainStar Master Planned Resort Environmental Impact Statement, Technical Report: Geology, Groundwater, and Soils* (AESI, 1999). The following is a description of the regional geology of the area.

4.2.1 Post-Glacial Sediments

Post-glacial (Holocene) sediments in the project region mostly consist of alluvial deposits in the modern Cle Elum and Yakima River floodplains. These sediments are primarily reworked glacial deposits (Porter, 1976). Other post-glacial sediments present in the vicinity (but outside of the area of the subject site) include talus, colluvium, and other mass wasting deposits on or at the base of steep slopes.

4.2.2 Glacial Geology

Three major glacial advances have been identified in the project region. From youngest to oldest, the sediments associated with these glacial advances are known as the Lakedale, Kittitas, and Thorp Drifts. The Lakedale Drift was subdivided by Porter (1976) into four members. From youngest to oldest, these include the Hyak, Domerie, Ronald, and Bullfrog members. The furthest glacial advance during Lakedale time was the Bullfrog advance, as indicated by the Bullfrog Moraine, which consists of an elevated area in the western portion of the site. Cosmogenic dating of glacial boulders from the Bullfrog Moraine indicate that it is at least 90,000 to 100,000 years old. However, based on geomorphic relationships and correlations with similar glacial deposits in the Cascade Range and Puget Lowland it has been estimated that the Bullfrog glacial advance probably occurred about 140,000 to 170,000 years ago (Porter, 1998, personal communication).

4.2.3 Bedrock Geology

Pre-Tertiary rocks form the basement below the younger, Tertiary-aged rocks exposed in the area of the site (Tabor et al., 1982). The pre-Tertiary rocks in the Central Cascade Range are a complex assemblage of metamorphic and igneous rocks. The bedrock geology of this area is composed of several tectonic blocks, or terranes. The subject site is located in the terrane known as the Teanaway River Block (Frizzell et al., 1984). The oldest pre-Tertiary rock exposed in the area is the Cretaceous-aged Easton Schist. Surface exposures of the Easton Schist are present southwest of the site, south of the Yakima River.

In the Cle Elum area, the Easton Schist is unconformably overlain by Tertiary rocks of Eocene age (Walker, 1980). These rocks were deposited in a sedimentary basin, known as the Swauk Basin, which formed as a result of tectonic activity between the Cretaceous and mid-Tertiary periods. The Eocene bedrock deposited in the Swauk Basin includes, from youngest to oldest, the Roslyn, Teanaway, and Swauk Formations. The Roslyn Formation conformably overlies the Teanaway Formation and consists of non-marine sedimentary rock, including sandstone, conglomerate, and coal (Frizzell et al., 1984). The Teanaway Formation unconformably overlies the Swauk Formation and consists of volcanic and volcaniclastic rocks including andesite, basalt, tuff, and breccia with minor rhyolite. The Swauk Formation consists of non-marine sedimentary deposits (sandstone, siltstone, and conglomerate) with interbeds of volcanic and volcaniclastic rocks including dacite, andesite, breccia, and tuff.

The Miocene-aged Grand Ronde Basalt of the Columbia River Basalt Group overlies the Teanaway and Roslyn Formations east of the project area. The Ellensburg Formation, which consists of volcaniclastic and sedimentary deposits, overlies and is interlayered with the Grand Ronde Basalt (Waitt, 1979).

4.2.4 Geologic Structures

Ridges, valleys, faults, and the axes of folds in the area rocks all generally follow a northwest-southeast orientation. This orientation is generally parallel to the Olympic-Wallowa Lineament (OWL), a linear, physiographic feature that spans from the north side of the Olympic Mountains in northwest Washington to the Wallowa Mountains in northeastern Oregon, extending through the Cle Elum area. The OWL was first identified in 1945 and its significance relative to the tectonic history of the region is not well understood.

Folds and faults are present in all three of the Tertiary bedrock formations in the area (Roslyn, Teanaway, and Swauk Formations). The oldest of these geologic units, the Swauk Formation, is more tightly folded and faulted than the Teanaway and Roslyn Formations, indicating a period of more intense tectonic activity prior to the deposition of the two younger units (Frizzell et al., 1984).

The most prominent fault in the region is the Straight Creek Fault, located northwest of the site near Lake Kachess. The Straight Creek Fault is a major north-south-trending, right-lateral, strike-slip fault with estimated displacements ranging from 55 to 118 miles (Geomatrix Consultants, Inc. [Geomatrix], 1988). The Straight Creek Fault is believed to be dormant with no movement occurring since the mid-Tertiary period (Geomatrix, 1988). The Straight Creek Fault extends south from Canada and appears to merge with structural features associated with the OWL southwest of the site (Tabor el al., 1984). This fault forms the western boundary of the Teanaway River Block.

The closest fault to the subject site is the Easton Ridge Thrust Fault, located along the east side of Easton Ridge. This fault was identified by Walker (1980) who interpreted it to be part of the OWL. Haugerud and Tabor (2009) mapped the fault as extending through the western portion of the subject site near the Cle Elum River (Figures 2 and 6). The Easton Ridge Thrust Fault is a high-angle reverse fault with an upthrown western block. Mapping of this fault was primarily based on a regional aeromagnetic survey of bedrock structures (Walsh 1998, personal communication). During our previous work in the project area, we did not observe any visual indications of the Easton Ridge Thrust Fault at its mapped location, and no evidence of recent fault movement was observed. Walker (1980) describes the movement on this fault as primarily dip-slip. No evidence of displacement of the Pleistocene deposits along this fault have been documented to date.

4.3 Site Geology

Subsurface conditions described in the Draft UGA EIS (AGI, 2001) were based on data obtained from subsurface explorations advanced on the subject site and nearby properties by AESI for the 1999 MountainStar EIS and from 41 additional explorations advanced for the 2001 study by AGI. These previous explorations included 10 exploration pits and 3 exploration borings completed by AESI in 1997 and 1998 (AESI, 1999), and 35 test pits and 6 hand-auger explorations completed by AGI in 1999 (AGI, 2001). Additional subsurface data was obtained from well reports on file with Ecology. For our current study, 51 additional explorations were advanced at the site in November 2019. These explorations include 47 exploration pits advanced using a track-mounted excavator, and 4 exploration borings drilled using a track-mounted, sonic drill rig. Our November 2019 exploration was limited to the portions of the site currently proposed for development. The additional field reconnaissance and subsurface exploration completed by AESI for the SEIS was intended to better define the distribution of the low-permeability till previously identified in the Bullfrog Moraine and to better define the physical characteristics of the glacial outwash deposits present within the proposed development area with respect to stormwater infiltration feasibility. The approximate locations of the explorations are shown on Figures 2 through 5 and 7. Copies of the exploration logs are included in Appendix D.

4.3.1 Stratigraphy

Eight distinct geologic units have been identified below the site. Only four of these units are exposed at the ground surface. The mapped surficial distribution of these geologic units is shown on Figures 2 through 6. Each of the eight geologic units are described below in order of youngest to oldest. Geologic cross-sections through the site are included on Figures 8 through 12. The locations of the cross-sections are depicted on Figure 13.

4.3.1.1 Recent Alluvium (Qal)

Recent (post-glacial) alluvial sediments underlie the western portion of the site, adjacent to the Cle Elum River. Explorations completed by AGI (2001) indicate that these sediments generally consist of sand, gravel, and cobbles. The recent alluvium also likely includes minor quantities of fine-grained deposits, such as silt, clay, and possibly peat, although these were not described on any of the exploration logs reviewed. As shown on Figure 2, the distribution of the recent alluvium at the site is limited to the western portion of Bullfrog Flats, adjacent to the Cle Elum River. The portion of the site underlain by alluvium lies entirely within the area identified on the Proposed 47° North Master Site Plan Amendment (SEIS Alternative 6) as River Corridor Open Space (Appendix B).

4.3.1.2 Loess (Qlo)

The majority of the site east of the recent alluvium is mantled by loess deposits. The loess typically consists of relatively loose to stiff, tan to brown, silt and silty fine sand. The loess was deposited by wind deflation of glacial outwash during the Lakedale glacial advance. Because of its fine-grained texture, the loess exhibits a low permeability. Although the distribution of loess at the site is widespread, it is also discontinuous. Where encountered in our explorations, the loess generally extended to depths ranging from approximately 2 to 4 feet but extended to depths of 6 to 12 feet at a few of the exploration locations. Because the distribution of loess is relatively thin and discontinuous, it is not depicted on Figures 2 through 6.

4.3.1.3 Glacial Outwash (Qow)

Sediments encountered either directly below the ground surface or below the surficial loess deposits in the portion of the site east of the Bullfrog Moraine generally consisted of medium dense, stratified sand and gravel with abundant cobbles, scattered boulders, and minor to moderate silt and clay content. We interpret these sediments to be representative of glacial outwash. The glacial outwash consists of sediments deposited by meltwater streams flowing off the glacial ice during the Lakedale glacial advance. Although the glacial outwash generally contains minor quantities of fine-grained sediments (silt and clay), areas of silty outwash were encountered in our explorations. In the portion of the site east of the Bullfrog Moraine, this was typically limited to the upper several feet of the outwash where it appeared to be mixed with loess. Localized silty strata within the outwash were also observed in some locations.

An area of glacial outwash was also identified within the Bullfrog Moraine. The glacial outwash within the Bullfrog Moraine typically contained a higher percentage of silt than the outwash encountered east of the moraine. This portion of the outwash is designated as “dirty outwash” on Figures 3 and 6.

Based on the exploration data, the maximum thickness of the outwash underlying the subject site east of the Bullfrog Moraine is about 250 feet. Within our explorations, the thickness of the “dirty outwash” within the Bullfrog Moraine ranged from approximately 7.5 feet at the location of boring EB-2, to greater than 50 feet at the location of boring EB-1.

4.3.1.4 Alpine Till (Qgm)

The Bullfrog Moraine is a terminal moraine composed of glacial sediments deposited at the point of the farthest advance of the glacial ice. The Bullfrog Moraine is composed predominantly of alpine till, which generally consists of a non-stratified mixture of very silty, gravelly sand with cobbles and scattered boulders that was deposited directly from the glacial ice. Much of the alpine till encountered in our explorations was dense to very dense, indicating that it was overridden and consolidated by the weight of the glacial ice from which it was deposited. Such till is referred to as "lodgement till." The density of portions of the till appeared to be relatively low, indicating that it has been subjected to little or no consolidation by glacial ice. This could be due to either deposition near the glacial margin where the glacial ice was thin, or deposition due to glacial ablation. The alpine till contains scattered large boulders, known as glacial erratics. A large glacial erratic was encountered in exploration pit EP-15, located near the eastern margin of the moraine. This erratic is estimated to be more than 50 feet wide.

The western margin of the Bullfrog Moraine consists of a steep, west-facing slope with a maximum height of approximately 180 feet. Based on sediment exposures on the face of this slope, it appears that the base of the till in this area is located at approximately elevation 2,080 feet. Given the elevation of the top of the moraine, the maximum thickness of the alpine till is estimated to be approximately 100 feet. Glacial outwash sediments are exposed on the lower portion of this slope, below the base of the till.

4.3.1.5 Glaciolacustrine Sediments (Qgl)

Observation well OW-8, located south of the subject site within the Washington State Horse Park, encountered sediments generally consisting of interbedded sandy silt and silty clay at a depth of approximately 89 feet. Similar sediments were encountered at a depth of approximately 158 feet during drilling for observation well OW-5, located on the Suncadia property approximately 1,500 feet north of the subject site. The locations of observation wells OW-5 and OW-8 are shown on Figures 4 and 5, respectively. These sediments are interpreted to have been deposited in a glacial lake (glaciolacustrine) environment prior to the Bullfrog ice advance. Based on the distribution of similar sediments encountered in explorations north of the subject site and in the Yakima Valley to the south, it is inferred that the glaciolacustrine sediments underlie the glacial outwash below much of the subject site. At the location of observation well OW-8, the glaciolacustrine sediments extended to a depth of approximately 176 feet where they were underlain by older (Qu) outwash deposits (Figure 5). The glaciolacustrine sediments extended beyond the maximum depth explored of approximately 230 feet in OW-5 (Figure 4). The glaciolacustrine sediments were not encountered in observation well OW-7, located in the horse park approximately 1,600 feet east of OW-8.

4.3.1.6 Undifferentiated Glacial Deposits (Qu)

Glacial deposits encountered in some of the AESI MountainStar borings (AESI, 1999), and described on some of the driller's logs for wells completed at the Cle Elum fish hatchery, are identified in this report as "undifferentiated glacial deposits." This term is used in reference to deposits encountered below the glaciolacustrine sediments (Qgl) and above the underlying bedrock. The descriptions of these sediments are similar to the glacial outwash (Qow) overlying the Qgl sediments and it is likely that much, if not all of the Qu sediments consist of glacial outwash. At the location of AESI observation well OW-7, no Qgl sediments were encountered and no distinguishing characteristics were observed between the Qow/Qu sediments (Figure 9).

4.3.1.7 Roslyn Formation (Tr)

The Roslyn Formation generally consists of sandstone, siltstone, shale, and coal seams. This formation is the source of coal for all of the coal mines in the Cle Elum-Roslyn area. Some abandoned coal mine workings in the Roslyn Formation underlie the eastern portion of the site. The Roslyn Formation is at least 6,500 feet thick and is Eocene in age (Tuck and Boyd, 1966; Tabor et al., 1984). Although the Roslyn Formation underlies the entire site, it is overlain by Pleistocene glacial deposits across the entire project area. The depth to the Roslyn Formation below the site is estimated to range from approximately 200 feet near the east end of the property to approximately 600 feet below the Bullfrog Moraine. A contour map of the bedrock surface, based on review of existing boring logs and coal mine mapping completed for the 1999 MountainStar EIS, is included on Figure 13.

4.3.1.8 Teanaway Formation (Tt)

The Teanaway Formation consists of volcanic and volcaniclastic rocks and is of Eocene age. These rocks consist primarily of basalt, basaltic tuff and breccia with minor andesite, dacite, rhyolite, and clastic sedimentary rocks (Frizzell et al., 1984). No surface exposures of the Teanaway Formation are present within the project boundaries, but surface exposures are present on Easton Ridge west of the site. The Teanaway Formation is inferred to underlie the Quaternary deposits in the western portion of the 47° North property, west of the Easton Ridge Thrust Fault. The surface of the Teanaway Formation in this area is estimated to range from approximately 100 to 400 feet below the ground surface. The Teanaway Formation is also inferred to underlie the younger Roslyn Formation below the remainder of the site.

4.4 Surface Soils

Physical and chemical weathering of surficial glacial and non-glacial sediments at the site has resulted in the formation of various types of surface soils. Soil types have been mapped for Kittitas County by the U.S. Department of Agriculture's (USDA's) Natural Resources Conservation Service (NRCS). A map of surface soils at the subject site based on mapping obtained from the NRCS *Web Soil Survey* is included on Figure 14. Four soil types are mapped within the area of the subject site. General characteristics of each of these soil types obtained from the published NRCS data are summarized in Table 4.

Table 4
Summary of Soil Types and Characteristics

Soil Name	Parent Material	Landform	NRCS Erosion Hazard Rating
Roslyn ashy sandy loam, 0 to 5% slopes	Glacial drift with a mantle of loess and volcanic ash	Terraces	Slight
Xerofluvents, 0 to 5% slopes	Alluvium	Flood plains, stream terraces	Slight
Dystroxerepts, 45 to 65% slopes	Glacial outwash w volcanic ash influence	Escarpments	Severe
Racker ashy sandy loam, 0 to 5% slopes	Glacial drift with a mantle of volcanic ash	Terraces	Slight

NRCS = Natural Resources Conservation Service

4.5 Geologic Hazards

4.5.1 Erosion Hazards and Mitigation

4.5.1.1 FEIS Alternative 5 - Original Bullfrog Flats Master Site Plan Erosion Hazards and Mitigation

Critical area development regulations are defined in Title 18 of the *Cle Elum Municipal Code* (CMC). The critical area code in effect at the time of the 2002 UGA EIS, hereafter referred to as the "vested code," defined Erosion Hazard Areas as "…those geologically hazardous areas containing soils which may experience or have experienced a severe to very severe surface erosion process." The vested code further defined erosion hazard risk based on slope inclination, where areas with slopes of 0 to 25 percent slope were rated as low risk, areas with slopes of 25 to 59 percent were rated as moderate risk, and areas with slopes of 60 percent or steeper were rated as high risk. Design standards specified in the vested code state that building code provisions should adequately mitigate erosion hazards and projects in moderate and high risk areas must comply with the City building code.

Erosion hazard risks are discussed in the 2001 Draft UGA EIS for Alternatives 1 through 4. Alternative 5 was not introduced until the 2002 Final UGA EIS. The 2002 Final UGA EIS does not directly address geologic hazards, but refers to the information presented in the 2001 Draft UGA EIS. Although erosion hazard risks were not specifically discussed for Alternative 5, it is our opinion that the assessment of erosion hazard risks completed for Alternative 4 is also applicable to Alternative 5 because Alternative 4 included development of a larger portion of the property than Alternative 5. Recommendations for mitigation of erosion hazard risks presented in the 2001 Draft UGA EIS generally included:

- Preparation of a Temporary Erosion and Sedimentation Control (TESC) plan.
- Avoiding construction on steep slopes.
- Establishing suitable buffers and setbacks from steep slope areas during the planning phases of the project.
- Monitoring of erosion control measures and grading plans by a geotechnical engineer.
- Implementing appropriate erosion control management practices during construction, such as phasing clearing activities, managing surface water runoff, use of sediment traps, cover measures, silt fencing, and check dams, and covering stockpiles.

The 2001 Draft UGA EIS concluded that implementation of the appropriate mitigation measures would result in no significant unavoidable adverse impacts.

4.5.1.2 SEIS Alternative 5 - Approved Bullfrog Flats Master Site Plan Erosion Hazards and Mitigation

SEIS Alternative 5 is subject to the current municipal code requirements. Section 18.01.030 of the current CMC defines Erosion Hazard Areas as "*…those areas identified by the U.S. Department of Agriculture's Natural Resources Conservation Service as having a 'moderate to severe,' 'severe,' or 'very severe' rill and inter-rill erosion hazard. Erosion Hazard Areas are also those areas impacted by shore land and/or stream bank erosion and those areas within a river's channel migration zone."*

Portions of the site that classify as Erosion Hazard Areas under the current CMC include:

- The steep slope areas along the western and southern edge of the Bullfrog Moraine, and along a portion of the south edge of Bullfrog Heights.
- The area within the channel migration zone of the Cle Elum River.

The other steep slopes on the site, including those on the flanks of the abandoned (paleo) stream channels, are not depicted on the NRCS mapping as being underlain by soils with erosion hazard ratings meeting the criteria for Erosion Hazard Areas as specified in the CMC. However, the topographic and soil conditions in these areas are consistent with the characteristics of areas typically classified as Erosion Hazard Areas.

Performance standards in the current CMC for development in geologically hazardous areas, including Erosion Hazard Areas, include the following:

1. Structures and improvements shall minimize alterations to the natural contour of the slope, and foundations shall be tiered where possible to conform to the existing topography.

2. Structures and improvements shall be located to preserve the most critical portion of the site and its natural landforms and vegetation.

3. The proposed development shall not result in greater risk or a need for increased buffers on neighboring properties.

4. Development shall be designed to minimize impervious surfaces within the critical area and critical area buffer.

Review of the SEIS Alternative 5 - Approved Bullfrog Flats Master Site Plan in Appendix B indicates that all of the areas of the site that classify as Erosion Hazard Areas under the current CMC lie outside of the areas proposed for development. The steep slopes on the flanks of the paleo stream channels also lie outside of the areas proposed for development. Consequently, no mitigation of erosion hazards in these areas is warranted.

Although site conditions outside of the designated Erosion Hazard Areas reduce erosion hazard risks, these risks will not be completely eliminated. Erosion hazard risks and associated adverse impacts in these areas can be mitigated by using Best Management Practices (BMPs) and construction practices similar to those discussed below for SEIS Alternative 6. Provided that these BMPs and construction practices are properly followed, it is our opinion that SEIS Alternative 5 will result in no significant unavoidable adverse impacts associated with erosion hazards.

4.5.1.3 SEIS Alternative 6 - Proposed 47° North Master Site Plan Amendment Erosion Hazards and Mitigation

Review of the SEIS Alternative 6 - Proposed 47° North Master Site Plan Amendment included in Appendix C indicates that all of the areas of the site that classify as Erosion Hazard Areas under the current CMC lie outside of the areas proposed for development. The steep slopes on the flanks of the paleo stream channels also lie outside of the areas proposed for development. Consequently, no mitigation of erosion hazards in these areas is warranted.

Within the proposed development area, topographic conditions and soil conditions will reduce, but not eliminate erosion hazard risks. The NRCS erosion hazard rating for the soil types within the development area is “slight.” In order to mitigate this hazard, we recommend that a TESC Plan and a Stormwater Pollution Prevention Plan (SWPPP) be developed for the project, and erosion and sedimentation control BMPs be implemented during construction as described in

Chapter 7 of the 2019 Ecology Manual. Such BMPs may include, but are not necessarily limited to the following:

- Use of stabilized construction entrances.
- Stabilization of construction roads and parking areas.
- Applying water to exposed soil surfaces to control dust.
- Use of wheel washes for construction traffic leaving the site.
- Use of sediment traps, and inlet/outlet control where applicable.
- Use of perimeter silt fencing.
- Use of temporary cover measures, such as sheet plastic, mulch, and hydroseed.

In addition to the use of BMPs, monitoring of erosion and sediment control by a Certified Erosion and Sediment Control Lead (CESCL) will be required for the project by Ecology. The CESCL will verify compliance with the TESC Plan and SWPPP, assess the effectiveness of the BMPs used, monitor turbidity and pH of off-site discharge of stormwater during construction (if any), and provide recommendations for alteration of the erosion control BMPs in use at the site, if warranted by site conditions.

Review of the Stormwater Drainage Plan for the project indicates that stormwater runoff collected over the majority of the site will be discharged into infiltration ponds to be located in the eastern (Bullfrog Heights) portion of the property. Stormwater runoff collected in the REC 1 tract, located in the Bullfrog Moraine, will discharge to a detention pond to be located within this tract. The detention pond will detain flow to the pre-developed condition. Discharge from the detention pond will be dispersed to the natural drainage location south of the pond. Dispersion of stormwater is also proposed in naturally vegetated areas located along the west edge of the RV Tract (RV-1). The Storm Drainage Plan developed for the project reduces the potential for off-site discharge of turbid runoff by avoiding off-site discharge of stormwater. A copy of the Stormwater Drainage Plan developed for SEIS Alternative 6 is included in Appendix C.

Slope inclinations in the dispersion areas west of Tract RV-1 and south of the REC 1 detention pond are approximately 15 percent or flatter. Given the gentle inclinations present in this area, it is our opinion that the risk of accelerated erosion or landslide risk resulting from the dispersion of stormwater in these areas is low. No additional assessment of landslide or erosion hazard risks associated with stormwater dispersion in these areas is required under the 2019 Ecology Manual.

Provided that the BMPs and construction practices discussed above are properly followed, it is our opinion that SEIS Alternative 6 will result in no significant unavoidable adverse impacts associated with erosion hazards. This includes the area within the 47° North property, and on the adjacent Business Park property. Given that all three development alternatives avoid

Erosion Hazard Areas as defined by the CMC, it is our opinion that with the recommended mitigation, erosion hazard risks for all three alternatives are equivalent.

4.5.2 Landslide Hazards

4.5.2.1 FEIS Alternative 5 - Original Bullfrog Flats Master Site Plan Landslide Hazards and Mitigation

Landslide Hazard Areas are defined in the vested CMC as "*geologically hazardous areas subject to severe risk of landslide based on a combination of geologic, topographic, and hydrologic factors, including bedrock, soil, slope gradient, slope aspect, geologic structure, groundwater, or other factors.*" Design standards specified in the vested code are similar to those previously described for Erosion Hazard Areas for FEIS Alternative 5.

Landslide hazard risks are discussed in the 2001 Draft UGA EIS for Alternatives 1 through 4. Alternative 5 was not introduced until the 2002 Final UGA EIS. The 2002 Final UGA EIS does not directly address geologic hazards, but refers to the information presented in the 2001 Draft UGA EIS. Although landslide hazard risks were not specifically discussed in the Final UGA EIS for Alternative 5, it is our opinion that the assessment of landslide hazard risks completed for Alternative 4 is also applicable to Alternative 5 because it includes the same area proposed for development under FEIS Alternative 5. The 2001 Draft UGA EIS concluded that the steep slope on the west side of the Bullfrog Moraine poses a high landslide hazard risk and that clearing on or above moderate to steep slopes on the site could increase landslide risk. Recommendations for mitigation of landslide hazard risks presented in the 2001 Draft UGA EIS generally consisted of:

- Avoiding placement of fill, topsoil, or other debris on or above slopes greater than 40 percent.

- Requiring site-specific geotechnical studies where placement of fill is planned on slopes steeper than 15 percent.

- Establishing setbacks and buffers from steep slopes during the project planning process.

- Designing and locating stormwater management facilities to avoid areas of moderate or steep slopes to minimize landslide potential associated with increase spring activity on slope faces and/or added weight to the soil mass.

- Avoiding cuts on or at the toe of moderately steep to steep slopes unless approved by a geotechnical engineering study.

The 2001 Draft UGA EIS concluded that implementation of the appropriate mitigation measures would not increase geologic hazard risk and result in no significant unavoidable adverse impacts.

4.5.2.2 SEIS Alternative 5 - Approved Bullfrog Flats Master Site Plan Landslide Hazards and Mitigation

Landslide Hazard Areas are defined in the current CMC as *"areas potentially subject to landslides based on a combination of geologic, topographic, and hydrologic factors. They include areas susceptible because of any combination of bedrock, soil, slope (gradient), slope aspect, structure, hydrology, or other factors."* Performance standards specified in the current CMC for Landslide Hazard Areas are identical to those previously discussed for Erosion Hazard Areas.

During our reconnaissance of the site in October 2019 , we did not observe any indications of historical landslide activity or springs. Given the lack of these features, Landslide Hazard Areas at the site are limited to areas of steep slopes and areas potentially unstable due to rapid stream incision or streambank erosion. Some areas of steep slopes exist on and adjacent to the site. These include the steep slope located along the western and southern margins of the Bullfrog Moraine, along the southern margin of Bullfrog Terrace, and along portions of the flanks of the paleo drainage ravines.

Development proposed under the SEIS Alternative 5 is limited to the more gently or moderately sloping portions of the site with inclinations of approximately 33 percent or less. Given the subsurface conditions present (i.e., alpine till and granular outwash with a thin, discontinuous veneer of loess; no emergent seepage) the risk of landsliding under these topographic conditions is low. The SEIS Alternative 6 maintains the area west of the Bullfrog Moraine as open space. This includes the area in and around the channel migration zone associated with the Cle Elum River. The proposed development lies outside of the channel migration zone of the river, mitigating the risk of damage to the development by landslides due to streambank erosion and incision associated with the Cle Elum River. No other active streams are present on or adjacent to the subject site.

The area proposed for development in SEIS Alternative 5 is similar to the area proposed for development under FEIS Alternative 5 and it is our opinion that landslide hazard risks for both alternatives are similar. In order to mitigate landslide hazard risks associated with this alternative, we recommend the following:

1. Foundation setbacks for buildings and other structures should comply with criteria established in Section 1808.7 of the 2015 *International Building Code* (IBC) as depicted graphically on Figure 15 and summarized below.

a. For foundations located adjacent to the top of steep (>33.3 percent) slopes, the face of the foundations should be set back from the steep slope a distance equal to or greater than the lesser of 40 feet or H/3 where "H" is equal to the height of the steep slope.

b. For structures located adjacent to the toe of steep (>33.3 percent) slopes, the face of the structures should be set back from the toe of the steep slope a distance equal to or greater than the lesser of 15 feet or H/2 where "H" is equal to the height of the steep slope.

2. Placement of structural fill should be avoided on or adjacent to the top of steep (greater) than 40 percent slopes.

3. Permanent cut or fill slopes should not exceed a maximum inclination of 50 percent.

4. Infiltration facility setbacks from steep slopes should comply with requirements outlined in the 2019 Ecology Manual. Specifically, the 2019 Ecology Manual requires that infiltration ponds be set back from the top of a slope of 15 percent or steeper a distance equal to or greater than the height of the slope. The 2019 Ecology Manual allows for lesser or greater setbacks where a comprehensive site assessment indicates that the alternate setback is justified based on the site conditions.

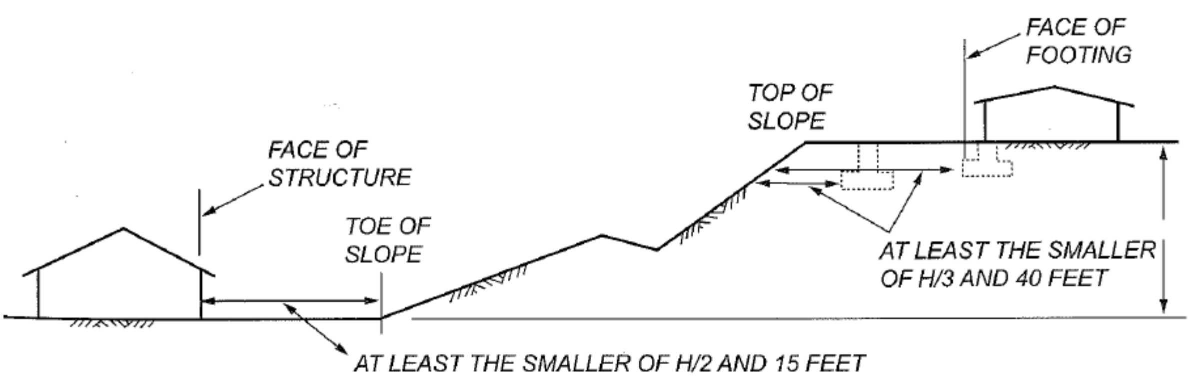


Figure 15. Recommended Setbacks

Provided that the above recommendations are properly followed, it is our opinion that SEIS Alternative 5 will result in no significant unavoidable adverse impacts associated with landslide hazards.

4.5.2.3 SEIS Alternative 6 - Proposed 47° North Master Site Plan Amendment Landslide Hazards and Mitigation

Consistent with FEIS Alternative 5 and SEIS Alternative 5, development proposed under the SEIS Alternative 6 is limited to the more gently to moderately sloping portions of the site with inclinations of approximately 33 percent or less. Given the subsurface conditions present, the risk of landsliding under these topographic conditions is low. SEIS Alternative 6 maintains the area west of the Bullfrog Moraine as open space. This includes the area in and around the channel migration zone associated with the Cle Elum River. The proposed development lies outside of the channel migration zone of the river, mitigating the risk of damage to the development by landslides due to streambank erosion and incision associated with the Cle Elum River. No other active streams are present on or adjacent to the subject site.

Although no steep (greater than 40 percent) slopes are located within the proposed development areas, steep slopes are located near the limits of proposed improvements in some areas. In order to mitigate landslide hazard risks in these areas, we recommend the following:

1. Foundation setbacks for buildings and other structures should comply with criteria established in Section 1808.7 of the 2015 IBC as depicted graphically in Figure 15 and summarized below.

    a. For foundations located adjacent to the top of steep (>33.3 percent) slopes, the face of the foundations should be set back from the steep slope a distance equal to or greater than the lesser of 40 feet or H/3 where "H" is equal to the height of the steep slope.

    b. For structures located adjacent to the toe of steep (>33.3 percent) slopes, the face of the structures should be set back from the toe of the steep slope a distance equal to or greater than the lesser of 15 feet or H/2 where "H" is equal to the height of the steep slope.

2. Placement of structural fill should be avoided on or adjacent to the top of steep (greater) than 40 percent slopes.

3. Permanent cut or fill slopes should not exceed a maximum inclination of 50 percent.

4. Infiltration facility setbacks from steep slopes should comply with requirements outlined in the 2019 Ecology Manual. Specifically, the 2019 Ecology Manual requires that infiltration ponds be set back from the top of a slope of 15 percent or steeper a distance equal to or greater than the height of the slope. The 2019 Ecology Manual allows for lesser or greater setbacks where a comprehensive site assessment indicates that the alternate setback is justified based on the site conditions. Slopes in excess of 15 percent

exist in the Business Park and the Municipal Recreation Center tract. Siting of infiltration facilities in these areas should consider the slope setback requirements of the 2019 Ecology Manual.

Although building locations are not identified in the existing project documents, the proposed lot configurations shown on the Grading Plan in Appendix C are compatible with the above-recommended building setbacks. The Grading Plan and Storm Drainage Plan also comply with recommendations 2 through 4. Copies of these documents are included in Appendix C.

The recommended building setbacks are conservative and intended for preliminary planning purposes. The IBC allows for alternate building setbacks based on site-specific geotechnical engineering studies beyond the scope this study. Based on the LIDAR-based topography shown on Figure 5 maximum slope inclinations along the southwest margin of the Business Park approach 30 percent. If more detailed future topographic mapping in this area determines that portions of this slope exceed 33.3 percent, then building setbacks above and below this slope should comply with the requirements of the IBC. This includes areas both within the Business Park and within Tract SF-1 within the 47° North property.

Provided that the above recommendations are properly followed, it is our opinion that SEIS Alternative 6 will result in no significant unavoidable adverse impacts associated with landslide hazards. This includes the area within the 47° North property, and on the adjacent Business Park property. Given that all three development alternatives avoid development in the more steeply sloping portions of the site, it is our opinion that with the recommended mitigation, landslide hazard risks for all three alternatives are equivalent.

4.5.3 Seismic Hazards

4.5.3.1 FEIS Alternative 5 - Original Bullfrog Flats Master Site Plan Seismic Hazards and Mitigation

Seismic hazard areas are defined in the vested CMC as "*geologically hazardous areas subject to risk of earthquake damage*." The code states that construction of structures for predicted Kittitas County seismic events are regulated by the *Uniform Building Code*. The 2001 Draft UGA EIS states that the subject site is located in an area of relatively low historic seismicity and concludes that the potential for seismic hazards such as landslides, liquefaction, and ground motion is low. Recommendations for mitigation of seismic hazards include:

- Having a geotechnical engineer review structure locations relative to areas susceptible to seismic impacts before final planning.
- Following appropriate *Uniform Building Code* guidelines.

The 2001 Draft UGA EIS concluded that with implementation of the appropriate mitigation measures, the project would not increase geologic hazard risk and result in no significant unavoidable adverse impacts.

4.5.3.2 SEIS Alternative 5 - Approved Bullfrog Flats Master Site Plan Seismic Hazards and Mitigation

Seismic Hazard Areas are defined in the current CMC as *"areas subject to severe risk of damage as a result of earthquake induced ground shaking, slope failure, settlement, soil liquefaction, lateral spreading, or surface faulting. Settlement and soil liquefaction conditions occur in areas underlain by cohesionless, loose or soft, saturated soils of low density, typically in association with a shallow water table."* Performance standards specified in the current CMC for Seismic Hazard Areas are identical to those previously discussed for Erosion Hazard Areas.

Structural design criteria to mitigate hazards associated with ground shaking and slope failure should comply with the requirements of the 2015 IBC.

Liquefaction is a process through which unconsolidated soil loses strength as a result of vibratory shaking, such as occurs during a seismic event. During normal conditions, the weight of the soil is supported by both grain-to-grain contacts, and by the hydraulic pressure within the pore spaces of the soil below the water table. Extreme vibratory shaking can disrupt the grain-to-grain contact, increase the pore pressure, and result in a decrease in soil shear strength. The soil is said to be liquefied when nearly all of the weight of the soil is supported by pore pressure alone. Liquefaction can result in deformation of the sediment, and settlement of overlying structures. In sloping areas, liquefaction can result in lateral movement of sediments. This process is known as lateral spreading.

Areas most susceptible to liquefaction include those areas underlain by coarse silt and clean sand with low relative densities, accompanied by a shallow water table. Because overburden pressures increase with increasing depth, soil density also tends to increase with depth. For this reason, liquefaction risk also tends to decrease with depth. Recent studies (Cetin et al., 2009; Ishihara et al., 2015) have demonstrated that the impact of post-seismic differential settlement due to reconsolidation of liquefied soil deposits on shallow foundations is negligible for layers deeper than approximately 50 feet. Groundwater is present in the glacial outwash sediments underlying the site. Based on the groundwater levels observed in area monitoring wells, and the elevation of the Cle Elum River in the western portion of the site, the depth to the groundwater below the area proposed for development is in excess of 100 feet. Due to the lack of adverse groundwater conditions, it is our opinion that the risk of liquefaction in this area is low and no mitigation of liquefaction hazards is warranted.

There are no known active earthquake faults in the vicinity of the project site. For this reason, the risk of surficial faulting/rupture on the site is low and no mitigation is warranted.

It is our opinion that SEIS Alternative 5 will result in no significant unavoidable adverse impacts associated with seismic hazards.

4.5.3.3 SEIS Alternative 6 - Proposed 47° North Master Site Plan Amendment Seismic Hazards and Mitigation

It is our opinion that SEIS Alternative 6 will result in no significant unavoidable adverse impacts associated with seismic hazards for the same reasons previously discussed for SEIS Alternative 5. This opinion applies to both the subject site and the Business Park. It is also our opinion that the seismic hazard risks are comparable for all three alternatives.

4.5.4 Coal Mine Hazards

4.5.4.1 FEIS Alternative 5 - Original Bullfrog Flats Master Site Plan Coal Mine Hazards and Mitigation

The vested CMC defines Mine Hazard Areas as "geologically hazardous areas directly underlain by, adjacent to, or affected by abandoned mine workings such as adits, tunnels, ducts, or airshafts with the potential for creating large underground voids susceptible to collapse." Design standards provided in the vested code for Mine Hazard Areas include:

- Avoiding siting structures on known or individual mine hazard areas.
- In siting and design of structures, etc. in known mine hazard areas, consider the danger of the hazard.

The 2001 Draft UGA EIS identified the presence of abandoned coal mine workings below an area in the eastern portion of the site. The Draft UGA EIS concluded that the hazard risks associated with the identified coal mine workings are low because the workings are more than 200 feet below the ground surface. Recommendations for mitigation of the hazard included:

- Constructing buildings, roadways, storm drainage systems, and underground utilities to accommodate the maximum anticipated tilts and strains.
- Following appropriate *Uniform Building Code* guidelines.

The 2001 Draft UGA EIS concluded that implementation of the appropriate mitigation measures would not increase geologic hazard risk and result in no significant unavoidable adverse impacts.

4.5.4.2 SEIS Alternative 5 - Approved Bullfrog Flats Master Site Plan Coal Mine Hazards and Mitigation

The current CMC defines Mine Hazard Areas as "those areas underlain by or affected by mine workings such as adits, gangways, tunnels, drifts, or airshafts, and those areas of probable sink holes, gas releases, or subsidence due to mine workings." Performance standards specified in the current CMC for Mine Hazard Areas are identical to those previously discussed for Erosion Hazard Areas.

Coal seams in the Roslyn Formation were mined in the Cle Elum-Roslyn area beginning in the late 1800s, extending into the early 1960s. A coal mine hazard assessment was prepared for the 1999 MountainStar EIS by Icicle Creek Engineers, Inc. (ICE), and referenced in the 2001 Draft UGA EIS. The ICE study identified the presence of abandoned coal mine workings related to mining of the Roslyn Seam below the eastern portion of the subject site. The depths of the workings below the 47° North property are estimated to range from approximately 475 to 2,000 feet below the existing ground surface. The depth to coal mine workings below the subject site are shown on the figure included in Appendix E.

In their study of coal mine hazards in the project area, ICE divided coal mine hazards into High and Low Coal Mine Hazard Areas. Low Coal Mine Hazard Areas are areas where the underground mine workings are greater than 200 feet below the ground surface. This includes the portion of the 47° North property underlain by coal mine workings. Low Coal Mine Hazard Areas can be susceptible to regional subsidence of the ground surface. Regional subsidence is caused by plastic deformation of the strata overlying the mine workings as the roof sags into the mine. Subsidence typically occurs within a few days to years following mine abandonment. Knuppe and Sisson (1923) noted that ground subsidence was more apparent in areas where underground mine workings are located within 400 feet of the ground surface and damage to structures in the Cle Elum area where mine workings are greater than 500 feet below ground surface is relatively small. Such damage was noted to typically be limited to cracks in building walls, pavement, and sidewalks. This type of structural damage is typical of damage resulting from poor subgrade preparation and it is possible that the reported cracking identified in the study was not related to mining-related subsidence. No evidence of regional subsidence was observed during our reconnaissance of the site.

Based on the available data, it is our opinion that the risk of damage to the proposed structures from subsidence of underground mine workings is low for SEIS Alternative 5. Mitigation of this risk could be achieved by using building methods and construction materials that would reduce the risk of structural damage such as:

- Reinforce concrete foundations supporting a flexible superstructure (e.g., wood framing or other flexible building materials).

- Use of flexible (asphalt) pavement for road construction.

- Use of flexible pipes, couplings, and fittings for underground utilities.

Provided that the above recommendations are properly followed, it is our opinion that SEIS Alternative 5 will result in no significant unavoidable adverse impacts associated with coal mine hazards.

4.5.4.3 SEIS Alternative 6 - Proposed 47° North Master Site Plan Amendment Coal Mine Hazards and Mitigation

It is our opinion that SEIS Alternative 6 will result in no significant unavoidable adverse impacts associated with coal mine hazards for the same reasons previously discussed for SEIS Alternative 5. This opinion applies to both the subject site and the Business Park. It is also our opinion that the coal mine hazard risks are comparable for all three alternatives.

4.5.5 Volcanic Hazards

4.5.5.1 FEIS Alternative 5 - Original Bullfrog Flats Master Site Plan Volcanic Hazards and Mitigation

The vested CMC defines Volcanic Hazard Areas as “geologically hazardous areas that are subject to inundation by pyroclastic flows, lava flows, debris flows, mud flows, lahars, or related flooding resulting from volcanic activity.” The design standards in the vested CMC state that the danger to the city from volcanic activity is remote and planning to protect against loss from volcanic hazards should be addressed by Kittitas County emergency management procedures. The design standards also state that city building standards provide for roof carrying loads to accommodate volcanic ash. Volcanic hazards were not addressed in the 2001 Draft UGA EIS.

4.5.5.2 SEIS Alternative 5 - Approved Bullfrog Flats Master Site Plan Volcanic Hazards and Mitigation

The current CMC defines Volcanic Hazard Areas as “areas subject to pyroclastic flows, lava flows, debris avalanche, and inundation by debris flows, lahars, mudflows, or related flooding resulting from volcanic activity.” Performance standards specified in the current CMC for Volcanic Hazard Areas are identical to those previous discussed for Erosion Hazard Areas.

The project area does not lie within an area identified by the Washington State Department of Natural Resources as a Volcanic Hazard Area. No mitigation of volcanic hazards is warranted. It is our opinion that SEIS Alternative 5 will result in no significant unavoidable adverse impacts associated with volcanic hazards.

4.5.5.3 SEIS Alternative 6 - Proposed 47° North Master Site Plan Amendment Volcanic Hazards and Mitigation

For the same reasons previously discussed for SEIS Alternative 5, no mitigation of volcanic hazards is warranted for SEIS Alternative 6 and it is our opinion that this alternative will result in no significant unavoidable adverse impacts associated with volcanic hazards. This opinion applies to both the 47° North property and the Business Park property. It is also our opinion that volcanic hazard risks are comparable for all three alternatives.

5.0 AFFECTED ENVIRONMENT: GROUNDWATER

Groundwater conditions in the project area described in the 2002 Final UGA EIS were primarily based on information presented in documents previously prepared for the MountainStar MPR EIS, the Draft UGA EIS, as well as other technical reports and water well logs on file with Ecology. These reports included the following:

- *Soils, Geology, and Groundwater Technical Report* (AESI, 1999).
- *MountainStar MPR EIS* (Kittitas County, 2000).
- *Site Engineering Technical Report, Cle Elum UGA* (W&H Pacific, Inc., 2001).
- *Draft Master Drainage Plan for the Cle Elum UGA* (American Engineering Corporation, 1999).
- *Groundwater Resource Evaluation, Cle Elum River Water Project* (Applied Geotechnology, Inc., 1992).
- *Test Well Drilling and Aquifer Testing, Cle Elum River Project* (Applied Geotechnology, Inc., 1993).

No additional subsurface exploration or testing was conducted for this portion of the 2002 Final UGA EIS beyond a reconnaissance of the site and nearby river corridors. The information presented below is based on the existing data and information presented in the MountainStar MPR EIS, the 2001 Draft UGA EIS, the 2002 Final UGA EIS, area well logs, and groundwater monitoring and infiltration testing data collected by AESI for the MountainStar MPR project subsequent to the MountainStar MPR EIS.

Groundwater is present within the recent alluvium (Qal), glacial outwash (Qow), the undifferentiated glacial deposits (Qu), and in the bedrock (Tr, Tt) underlying the site. The groundwater in the alluvium and glacial outwash is in hydraulic continuity with the Cle Elum and Yakima Rivers.

Although no observation wells are located on the subject site, several observation wells were installed in nearby areas during work completed for the 1999 MountainStar EIS, as referenced in the 2001 Draft UGA EIS. The closest of these wells are OW-1, OW-4, OW-5, and OW-9, completed in the outwash (Qow) on the Suncadia property approximately 1,500 to 4,500 feet north of Bullfrog Road, and wells OW-7 and OW-8, both of which are completed in the outwash (Qow/Qu) approximately 300 to 1,000 feet south of the subject site on the Washington State Horse Park property. In addition to these observation wells, additional subsurface information was obtained from water well reports obtained from Ecology for wells installed south of Interstate 90 at the Cle Elum fish hatchery. The approximate locations of these wells are shown on Figures 4, 5, and 8.

The Qal and Qow deposits form the water table aquifer below the site. The underlying Qu deposits are confined or semi-confined in some areas by the glaciolacustrine deposits (Qgl). Flowing artesian conditions are noted on the water well reports for wells CE-2A and CE-4A, which were completed in the Qu deposits south of the site at the Cle Elum fish hatchery (Figure 8). In other areas, such as the location of observation well OW-7 in the Washington State Horse Park, the Qgl deposits are absent and groundwater in the Qu deposits is unconfined and in continuity with the Qow deposits (Figure 10). Yields for the hatchery wells completed in the Qow and Qu deposits are high. The water well reports for hatchery wells CE-2A, CE-4A, and CE-5 indicate that flow rates achieved during short-term pump tests ranged from 1,460 to 1,600 gallons per minute (gpm).

Groundwater is also present in fractures and low-permeability pore spaces within the Roslyn and Teanaway Formations. Yields reported for wells completed in the bedrock in the Cle Elum area are typically much lower than the yields achievable in the Qal, Qow, and Qu aquifers. Typical yields for wells completed in the bedrock aquifer are less than 10 gpm.

The 1999 MountainStar EIS concluded that sources of recharge to the Qow aquifer include:

1. Water flowing from Cle Elum Lake through and below Cle Elum Dam;
2. The Cle Elum River and tributary streams;
3. Shallow groundwater flowing off of Cle Elum and Easton Ridges on shallow bedrock surfaces;
4. Direct precipitation; and,
5. Seasonal discharge of water flowing in abandoned coal mines.

Recharge to the Qu aquifer was attributed to:

1. Leakage of groundwater through the Qgl aquitard;
2. Through the Qow in those areas where the Qgl aquitard is absent; and,
3. Groundwater flowing in a deeper aquifer underlying the Qgl aquitard below Cle Elum Lake.

Groundwater levels in observation well OW-1 were monitored by AESI for the MountainStar project beginning in December 1997 and continuing until July of 2002. Groundwater levels declined steadily through the monitoring period from a high of elevation 1,992.30 feet in December 1997 to a low of elevation 1,985.71 feet in July 2002 (169.2 to 175.8 feet below the ground surface).

Groundwater levels in observation well OW-4 were monitored by AESI from September 1998 until February 2003. The groundwater levels in this well exhibited an overall declining trend through the monitoring period with some seasonal fluctuations. Seasonal high groundwater levels typically occurred around the beginning of August and seasonal low levels occurred around the beginning of May. Groundwater levels through the monitoring period ranged from a low of elevation 2,016.01 feet in June 2002 to a high of elevation 2,021.33 in September 1998 (223.0 to 228.3 feet below the ground surface).

Groundwater levels in observation well OW-5 were monitored by AESI beginning in September 1998 and continuing until late December 2002. Groundwater levels recorded in this well remained relatively stable throughout the monitoring period, ranging from a low of elevation 2,044.94 feet to a high of elevation 2,045.74 feet (151.5 to 152.3 feet below the ground surface).

Groundwater levels in observation wells OW-7 and OW-8 were monitored by AESI beginning in September 1998 and continuing until late January 2003 (OW-7) and early February 2003 (OW-8). Groundwater levels recorded in observation well OW-7 through this monitoring period ranged from a low of elevation 1,896.53 feet to a high of elevation 1,935.96 feet (105.8 to 145.2 feet below the ground surface). Groundwater levels recorded in observation well OW-8 through this monitoring period ranged from a low of elevation 1,898.94 feet to a high of elevation 1,940.62 feet (109.0 to 150.7 feet below the ground surface). These wells were gauged during our visit to the site on October 15, 2019. Groundwater elevations of 1,942.01 feet and 1,925.16 feet were measured on this date in wells OW-7 and OW-8, respectively. The groundwater level measured in well OW-8 at the time of our October 2019 site visit was within the range of water levels previously recorded at this location, but the water level measured in well OW-7 on this date was 6.05 feet higher than the previously recorded high.

Groundwater levels in observation well OW-9 were monitored from September 1998 until February 2003. The groundwater levels in the well exhibited an overall declining trend through the monitoring period with some seasonal fluctuations. Seasonal high groundwater levels during the monitoring period occurred in late May to mid-July and seasonal low levels occurred in late January to mid-March. Groundwater levels through the monitoring period ranged from a low of elevation 2,014.43 feet in March 2002 to a high of elevation 2,033.76 in June 1999 (128.6 to 148.0 feet below the ground surface).

Work completed for the 1999 MountainStar EIS indicated that groundwater levels at the locations of wells OW-7 and OW-8 are influenced by pumping of wells in the Cle Elum fish hatchery well field, located near the south side of Interstate 90 south of the subject site. Hydrographs of the groundwater levels recorded in observation wells OW-1, OW-4, OW-5, OW-7, OW-8, and OW-9 are included in Appendix F. The maximum and minimum groundwater levels recorded in each of the wells are summarized below in Table 5.

Table 5
Summary of Maximum and Minimum Groundwater Levels

Well ID	Ground Surface Elevation (feet)	Maximum Water Level			Minimum Water Level		
		Date	Elevation (feet)	Depth bgs (feet)	Date	Elevation (feet)	Depth bgs (feet)
OW-1	2,161.54	12/11/97	1,992.30	169.24	7/10/02	1,985.71	175.83
OW-4	2,244.28	9/11/98	2,021.33	222.95	6/6/02	2,016.01	228.27
OW-5	2,197.24	8/25/99	2,045.74	151.50	5/6/02	2,044.94	152.30
OW-7	2,041.73	10/15/19	1,942.01	99.72	9/21/02	1,896.53	145.20
OW-8	2,049.62	4/22/99	1,940.62	109.00	7/31/01	1,898.94	150.68
OW-9	2,162.39	6/8/99	2,033.76	128.63	3/22/02	2,014.43	147.96

bgs = below ground surface

Groundwater flow below the site, inferred from area water level data collected for the 1999 MountainStar EIS, and referenced in the 2001 Draft UGA EIS, is generally toward the south (toward the Yakima and Cle Elum Rivers).

5.1 FEIS Alternative 5 - Original Bullfrog Flats Master Site Plan: Groundwater Impacts and Mitigation

Potential groundwater impacts associated with site development include impacts to groundwater recharge and water quality. Groundwater recharge and water quality impacts, as well as assumed or conceptual stormwater management approaches for each of the three alternatives are discussed below.

5.1.1 FEIS Alternative 5: Stormwater Management

No stormwater drainage plan was prepared for FEIS Alternative 5. However, hydrologic analysis completed for the 2002 Final UGA EIS assumed that stormwater runoff for this alternative would be fully infiltrated (W&H Pacific, Inc. [W&H Pacific], 2002). The suitability of subsurface conditions at the site for stormwater infiltration is discussed in Section 5.3.

5.1.2 FEIS Alternative 5: Groundwater Resources

Hydrologic modeling of the UGA basins by W&H Pacific (2002) included pre-developed or existing conditions and mitigated-developed conditions under FEIS Alternative 2. W&H Pacific modeled Alternative 2 based on the November 1999 conceptual land use cover assumptions of 524 landscape acres and 237 impervious acres. Alternative 2 had higher impervious and landscape area coverage than Alternative 5 in the 2002 Final UGA EIS and was considered to be the most conservative alternative for the analysis of potential impacts to groundwater resources due to its relatively higher irrigation demand. A copy of the findings of the 2002 W&H Pacific study is included in Appendix G.

Under existing conditions, W&H Pacific modeled the distribution of flow across the UGA basins at the drainage boundary to average 3.0 percent surface flow, 5.4 percent interflow, and 91.5 percent groundwater. Their existing conditions model had a proportional relationship between the percentage of till within a basin and the percentage of interflow calculated in that basin, and a proportional relationship between the percentage of impervious surface within a basin and the percentage of surface flow calculated in that basin. Under mitigated-developed conditions, W&H Pacific modeled the distribution of flow across the UGA basins under Alternative 2 to average 1.5 percent surface flow, 0.4 percent interflow, and 98.1 percent groundwater. The modeled mitigated-developed conditions increased annual flow volumes by approximately 20 percent and groundwater flow by approximately 29 percent. Surface flow runoff generated from impervious surfaces under mitigated-developed conditions was assumed to be fully infiltrated. The net effect resulted in reduced surface flow and interflow and increased groundwater recharge. W&H Pacific concluded that outwash landscape in the hydrologic model generated an average of one-tenth the runoff of impervious surface per year. W&H Pacific then approximated an effective impervious area (EIA), determined as the sum of impervious area and 10 percent of the landscaped area. Table 6 shows the results of the estimated EIA for the 2002 FEIS for Alternative 2 and FEIS Alternative 5.

Table 6
Impervious and Landscape Summary and Estimated
Effective Impervious Area, Alternative 2 and FEIS Alternative 5

Surface Type (Acres)	Alternative			
	FEIS Alternative 2		FEIS Alternative 5	
	Impervious Area	Landscape Area	Impervious Area	Landscape Area
Roadways	32	32	61	61
Residential	53	21	104	50
Lodging	5	1	0	0
Golf Course	12	142	0	0
Public Facilities	17	11	19	22
Business Park	60	18	63	7
Horse Park	90	43	0	0
RV Park	10	2	0	0
Total	**279**	**270**	**247**	**140**
Effective Impervious Area (Acres)	**306**		**263**	

Source: Tables 2-8 and 2-9, W&H Pacific, Inc. (2002)
FEIS = Final Environmental Site Assessment

Mitigation measures identified in the 2002 FEIS include stormwater infiltration. Infiltration of all stormwater runoff collected from impervious surfaces, as assumed in the hydrologic model would result in increased groundwater recharge (above the existing condition) for both FEIS Alternative 2 and FEIS Alternative 5; however, due to the lower EIA estimated for FEIS Alternative 5, the increase in groundwater recharge would be less under this alternative than under FEIS Alternative 2. The FEIS concluded that the identified mitigation measures would prevent significant adverse impacts.

5.1.3 FEIS Alternative 5: Groundwater Quality

The vested CMC states that the City of Cle Elum has been preliminarily identified as an aquifer recharge area. The vested code included design standards for aquifer recharge protection. These design standards include land use intensity limitations, regulation of hazardous material transportation, disposal, handling, and storage, use of BMPs for agricultural activities concerning animal waste disposal, fertilizer and pesticide use, connection to municipal sewer and water supply systems, and evaluation of water quality impacts associated with land development.

An assessment of potential water quality impacts associated with FEIS Alternative 5 was completed for the 2002 Final UGA EIS. Recommended mitigation measures included in the Final UGA EIS included:

- Implementation of a SWPPP.
- Implementation of a TESC plan.
- Preparation of a Master Drainage Plan.
- Siting stormwater infiltration facilities to avoid increasing the potential for landslides.
- Use of water quality treatment requirements in accordance with the Ecology 2001 *Stormwater Management Manual for Western Washington.*
- Avoiding use of unsealed external copper or galvanized metal.
- Encouraging use of native vegetation in landscaping areas.
- Minimizing use of pesticides, herbicides, and fertilizers.
- Use of covered parking areas in multi-family and office areas.

The FEIS concluded that impacts on water quality or wetlands would be short term with no broad or cumulative effects. Implementation of a comprehensive TESC Plan and a SWPPP would provide for containment and cleanup of isolated spills or releases of turbid water in construction areas. With the proposed mitigation for water quality, the FEIS concluded that no adverse direct or indirect changes to aquatic habitat value are anticipated.

5.2 SEIS Alternative 5: Approved Bullfrog Flats Master Site Plan Groundwater Impacts and Mitigation

5.2.1 SEIS Alternative 5: Stormwater Management

No stormwater drainage plan was prepared for SEIS Alternative 5. It is assumed that stormwater runoff for this alternative would be fully infiltrated, similar to FEIS Alternative 5. The suitability of subsurface conditions at the site for stormwater infiltration is discussed in Section 5.3.1.

5.2.2 SEIS Alternative 5: Groundwater Recharge and Water Supply

We assessed potential impacts of SEIS Alternative 5 to groundwater resources including changes in recharge due to impervious coverage and changes in water demand. Both clearing and impervious surface areas and water demand for SEIS Alternative 5 are assumed to be identical to FEIS Alternative 5 (ESM, 2020). Groundwater recharge and water supply impacts under SEIS Alternative 5 are comparable with FEIS Alternative 5 with no significant adverse impacts anticipated.

5.2.3 SEIS Alternative 5: Groundwater Quality

Section 18.01.070 of the CMC states that the City of Cle Elum is considered to be located in an aquifer recharge area. The code states that this designation is preliminary and designation of individual properties as Critical Aquifer Recharge Areas (CARAs) should be based on further studies. The glacial outwash underlying the site is generally composed of permeable sand and gravel with variable quantities of silt. In our opinion, groundwater in the glacial outwash is partially recharged by direct infiltration of precipitation.

In order to mitigate potential water quality impacts associated with site development, we recommend that stormwater management for the project incorporate water quality treatment practices as required in the 2019 Ecology Manual. In addition to water treatment requirements, guidelines for infiltration facility setbacks should also be followed. Specific guidelines regarding infiltration facility setbacks are discussed in greater detail in Section 5.3: "SEIS Alternative 6." Provided that the guidelines and requirements presented in the 2019 Ecology Manual are properly implemented, no significant adverse impacts to water quality are anticipated. Water quality impacts associated with SEIS Alternative 5 are anticipated to be comparable to water quality impacts associated with FEIS Alternative 5.

5.3 SEIS Alternative 6: Proposed 47° North Master Site Plan Amendment Groundwater Impacts and Mitigation

5.3.1 SEIS Alternative 6: Stormwater Management

Preliminary project plans include on-site infiltration of stormwater runoff collected from the developed portion of the site. Some stormwater dispersion is also planned in the area west of Tract RV-1. The surficial sediments in the proposed development area consist predominantly of glacial outwash with alpine till exposed at or near the ground surface throughout most of the Bullfrog Moraine. Both the outwash and the alpine till sediments are mantled by fine-grained loess deposits in most areas of the site. Due to their elevated silt contents, the permeabilities of the loess and alpine till are low and these sediments are not considered to be suitable receptor soils for stormwater infiltration. In some areas, the loess has penetrated the upper several feet of the outwash, decreasing the permeability of the near-surface portion of the outwash.

Subsurface exploration completed at the site by AESI in October 2019 indicates that the glacial outwash east of the Bullfrog Moraine generally consists of stratified sand and gravel with abundant cobbles, scattered boulders, and relatively minor quantities of silt. Although the textural composition of the outwash east of the Bullfrog Moraine varies with location, the permeability of these sediments is generally high and they are considered to be suitable receptor soils for stormwater infiltration. Laboratory sieve analyses were conducted on selected samples of the glacial outwash collected east of the Bullfrog Moraine. Copies of the laboratory testing results are included in Appendix H. Based on comparison of these testing results with laboratory sieve data for outwash samples collected at infiltration testing locations within the Suncadia property, we anticipate that long-term infiltration rates achievable within the outwash will generally range from approximately 5 to 10 inches per hour. These estimated rates assume infiltration facility subgrades extend beyond the depth of loess-penetrated outwash.

The glacial outwash overlying the alpine till within the Bullfrog Moraine generally contains a higher silt content than the outwash east of the moraine. The outwash in this area is identified as “dirty glacial outwash” on Figures 3 and 6. The elevated silt content, and presence of low-permeability strata within the outwash in this area will reduce infiltration rates achievable in this area. However, some areas of clean outwash were encountered within the Bullfrog Moraine and it is likely that portions of the “dirty outwash” have favorable characteristics for stormwater infiltration. The distribution of the outwash within the project area is shown on Figures 2 through 6.

Stormwater infiltration for the project is proposed at 13 infiltration pond locations in the RV-1 and single-family tracts. A copy of the Storm Drainage Plan showing the locations of the proposed infiltration ponds is included in Appendix C. Design-level infiltration testing is outside of our current scope of work. We recommend that additional exploration and infiltration testing be conducted to confirm the suitability of the subsurface conditions at each of the pond locations and to assess suitable infiltration rates for infiltration facility design as described in the 2019 Ecology Manual.

5.3.2 SEIS Alternative 6: Groundwater Recharge and Water Supply

We assessed potential impacts to groundwater resources under proposed SEIS Alternative 6 including: 1) the change in recharge due to impervious coverage, and 2) the water system demand volumes. SEIS Alternative 6 was compared to the previous hydrologic analysis completed for the 2002 UGA EIS by W&H Pacific. A copy of the findings of the 2002 W&H Pacific study is included in Appendix G. Table 7 shows the results of the estimated EIA for SEIS Alternative 6 estimated using the EIA method derived by W&H Pacific (2002) applied to the estimated cleared and impervious surface areas for SEIS Alternative 6 shown in Table 3. For comparison, the estimated impervious areas for Alternatives 2 and 5 are also included in Table 7. The estimated impervious areas shown in Table 7 for Alternative 5 apply to both FEIS Alternative 5 and SEIS Alternative 5.

Potential groundwater quantity impacts influenced by impervious cover and water demand would be mitigated under SEIS Alternative 6. Groundwater resource mitigation identified in the 2002 FEIS applicable to SEIS Alternative 6 include stormwater infiltration. Groundwater recharge will increase under Alternative 6 relative to the existing condition since all stormwater will infiltrate onsite. The amount of stormwater infiltration recharge under Alternative 6 will be somewhat less when compared to Alternative 2 or Alternative 5 in the 2002 FEIS because the amount of impervious surface coverage will be less. Stormwater infiltration is currently proposed for SEIS Alternative 6 using infiltration ponds and dispersion systems designed to recharge groundwater. Enough water rights have been acquired to serve the UGA under the demand estimates incorporated into the 2002 FEIS. Water demand under SEIS Alternative 6 will be less than water demand identified in the 2002 FEIS for Alternative 5 for the combined indoor and irrigation uses (ESM, 2020). Water rights research by EA Engineering, Science, and Technology, Inc. has concluded that the acquisition of water rights exceeded the demand for the combined UGA/MPR projects and is sufficient to provide water for a number of water banks. The analysis indicates potential impacts to groundwater resources under SEIS Alternative 6 will be mitigated, similar to impacts previously considered in the 2002 FEIS, and no significant adverse impacts to groundwater resources have been identified.

Table 7
Impervious and Landscape Summary and Estimated Effective Impervious Area

	Project Alternative					
	2*		**5***		**6(1)**	
Surface Type, Acres	**Impervious Area**	**Landscape Area**	**Impervious Area**	**Landscape Area**	**Impervious Area**	**Landscape Area**
Roadways	32	32	61	61	7.6	1.9
Residential	53	21	104	50	70.9	72.4
Lodging	5	1	0	0	0	0
Golf Course	12	142	0	0	0	0
Public Facilities	17	11	19	22	13.5	3.4
Business Park	60	18	63	7	17	1
Horse Park	90	43	0	0	0	0
RV Park	10	2	0	0	0	0
RV/REC Sites	0	0	0	0	57.3	88.3
Total	**279**	**270**	**247**	**140**	**166.3**	**167**
Effective Impervious Area (Acres)	**306**		**263**		**183**	

*Modified from Tables 2-8 and 2-9 (W&H Pacific, Inc., 2002)
(1) (ESM, 2020).

5.3.3 SEIS Alternative 6: Groundwater Quality

SEIS Alternative 6 would be subject to the same CMC requirements previously described in Section 5.2.3 for SEIS Alternative 5. Similar to SEIS Alternative 5, water quality impacts associated with site development will be mitigated by incorporating water quality treatment practices as required in the 2019 Ecology Manual.

Section 5.4.3 of the 2019 Ecology Manual provides the following guidelines for setbacks from water supply sources and septic systems:

- Infiltration BMPs should be located outside of the sanitary control area of public drinking water systems and >100 feet from drinking water wells, septic tanks, and drain fields.

- Infiltration BMPs should be set back at least 200 feet from springs used for public drinking water supplies.

- Infiltration BMPs upgradient of drinking water supplies and within 1-, 5-, and 10-year time of travel zones of a public drinking water well must comply with local ordinances.

Review of water well records on file with Ecology indicates that there are several domestic water supply wells in the Bullfrog Flats area along Wood Duck Road. These appear to be associated with residential properties outside of the property boundary. One additional domestic supply well is located east of the site at the solid waste transfer station on the east side of SR903. All these domestic wells lie beyond the recommended setback of 100 feet from the project area. Review of the Washington State Department of Health Office of Drinking Water Source Water Assessment Program (SWAP) online mapping application indicates that the site lies outside of the assigned time of travel for all Group A public water supply wells. The assigned times of travel for two Group B public supply wells extend slightly beyond the property boundaries in the eastern portion of the site. A copy of the SWAP map showing the assigned travel times for public water supply wells in the vicinity of the subject site is included in Appendix I. For public water supply wells where specific travel times have not been calculated, the SWAP map depicts a default “assigned time of travel.” For Group A wells, the default time of travel is depicted on the SWAP map as a 1,000-foot radius around the well location. For Group B wells, the default time of travel is depicted as a 600-foot radius around the well location. To the best of our knowledge, there are no existing septic systems, drinking water wells, or springs used for public drinking water supply either in the project area, or within the specified setback guidelines of the project area.

Section 5.4.3 of the 2019 Ecology Manual also states that the following stormwater infiltration BMP setbacks should be considered if roadway deicing chemicals or herbicides are likely to be present in the influent to the infiltration system:

1. At least 20 feet downslope and at least 100 feet upslope from building foundations.

2. At least 20 feet from a native growth protection easement.

3. At least 50 feet from the top of a slope with an inclination of 15 percent or more, or as determined by a licensed professional.

Potential water quality impacts to groundwater associated with stormwater infiltration will be mitigated by incorporating water quality treatment as required by the 2019 Ecology Manual. Regarding the referenced portion of Section 5.4.3 of the Ecology Manual, the proposed infiltration facilities will not be located within 50 feet of the top of a slope with an inclination of 15 percent or more and will not be located within 20 feet of a native growth protection easement. The infiltration facilities will be located more than 20 feet from building foundations, but some building foundations may be located within 100 feet of infiltration facilities. In our opinion, deicing compounds and herbicides do not pose a risk to concrete building foundations and the primary concern would be that infiltrated water containing herbicides or deicing compounds could migrate laterally where it could potentially flow into footing or yard drains and ultimately discharge to surface water. Because no stormwater from the project will be discharged to surface water, it is our opinion that the risk of adverse impacts associated with the reduced upslope infiltration facility setback is low. In addition, lateral migration of infiltrated stormwater will be moderated by the relatively high permeability of the outwash at the subject site.

6.0 SIGNIFICANT UNAVOIDABLE IMPACTS

With implementation of the measures listed above, no significant unavoidable adverse impacts to water supply, water quality, or geologic hazards are anticipated. Given that project characteristics (cleared and impervious surface areas, assumed stormwater management) associated with SEIS Alternative 5 are similar to FEIS Alternative 5, we conclude that impacts are similar for both alternatives with no significant unavoidable impacts anticipated. Potential impacts to groundwater resources under SEIS Alternative 6 will be mitigated, similar to impacts previously considered in the 2002 FEIS, and no significant adverse impacts to groundwater resources associated with this alternative have been identified. Our conclusions regarding significant unavoidable impacts associated with SEIS Alternative 6 apply to the Business Park, as well as the 47° North property.

6.1 Summary of Recharge and Water Supply Impacts and Mitigation

Water supply mitigation measures identified in the 2002 FEIS included stormwater infiltration, on-site storage releases, and acquisition of water rights by Trendwest Properties. Infiltration of all stormwater runoff collected from impervious surfaces as assumed for this alternative would result in more groundwater recharge, increasing groundwater levels relative to the existing undeveloped condition. The FEIS concluded that the subsurface returns of infiltrated water would increase project streamflow contributions throughout the remainder of the year and would prevent significant adverse impacts to net flow in the Yakima River. The 2002 FEIS proposed on-site storage releases from golf course water features to mitigate streamflow deficits. SEIS Alternative 6 does not include a golf course and therefore this mitigation option does not apply. In the 2002 FEIS, the intent of water right acquisition was to transfer them to instream flows to offset seasonal deficits and mitigate for projected increases in consumptive use. Since then, enough water rights have been acquired to serve the project and provide water to several water banks. The acquired water rights they purchased were retired because there has been no new net consumption of water in the upper basin and less water is being consumed now than it was before the water rights were acquired. Water demand is projected to be less under SEIS Alternative 6 than FEIS Alternative 5 (ESM, 2020). No significant adverse impacts to water resources are anticipated under the proposed SEIS Alternative 6.

6.2 Summary of Water Quality Impacts and Mitigation

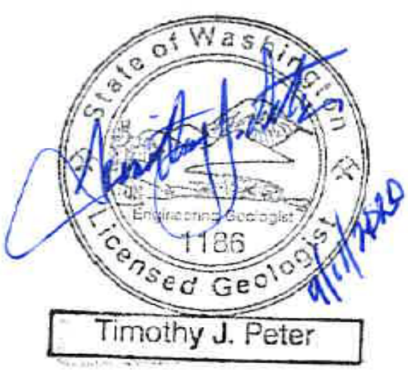
Like that concluded in the 2002 FEIS, impacts to water quality, if any, would be short term with no broad or accumulative effects. With the proposed treatments for water quality, no adverse direct or indirect changes to aquatic habitat value are anticipated. Provided that the guidelines and requirements presented in the 2019 Ecology Manual are properly implemented, no significant adverse impacts to water quality are anticipated for either SEIS Alternative 5 or SEIS Alternative 6. As previously discussed, review of the Grading and Storm Drainage Plans proposed for Alternative 6 are consistent with design standards and applicable guidelines presented in the 2019 Ecology Manual.

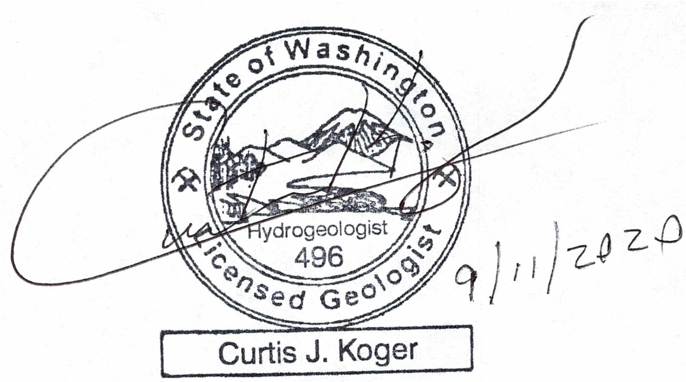
6.3 Summary of Geologic Hazards and Mitigation

The 2002 Final UGA EIS concluded that no significant unavoidable impacts associated with geologic hazards are anticipated under FEIS Alternative 5. With implementation of the recommended mitigation, no significant unavoidable impacts associated with geologic hazards are anticipated under SEIS Alternatives 5 and 6 with mitigated hazard risks low and comparable for all three alternatives.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

Matthew J. Porter, G.I.T.
Staff Geologist





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Senior Engineering Geologist

Curtis J. Koger, L.G., L.E.G, L.Hg.
Senior Principal Geologist, Hydrogeologist

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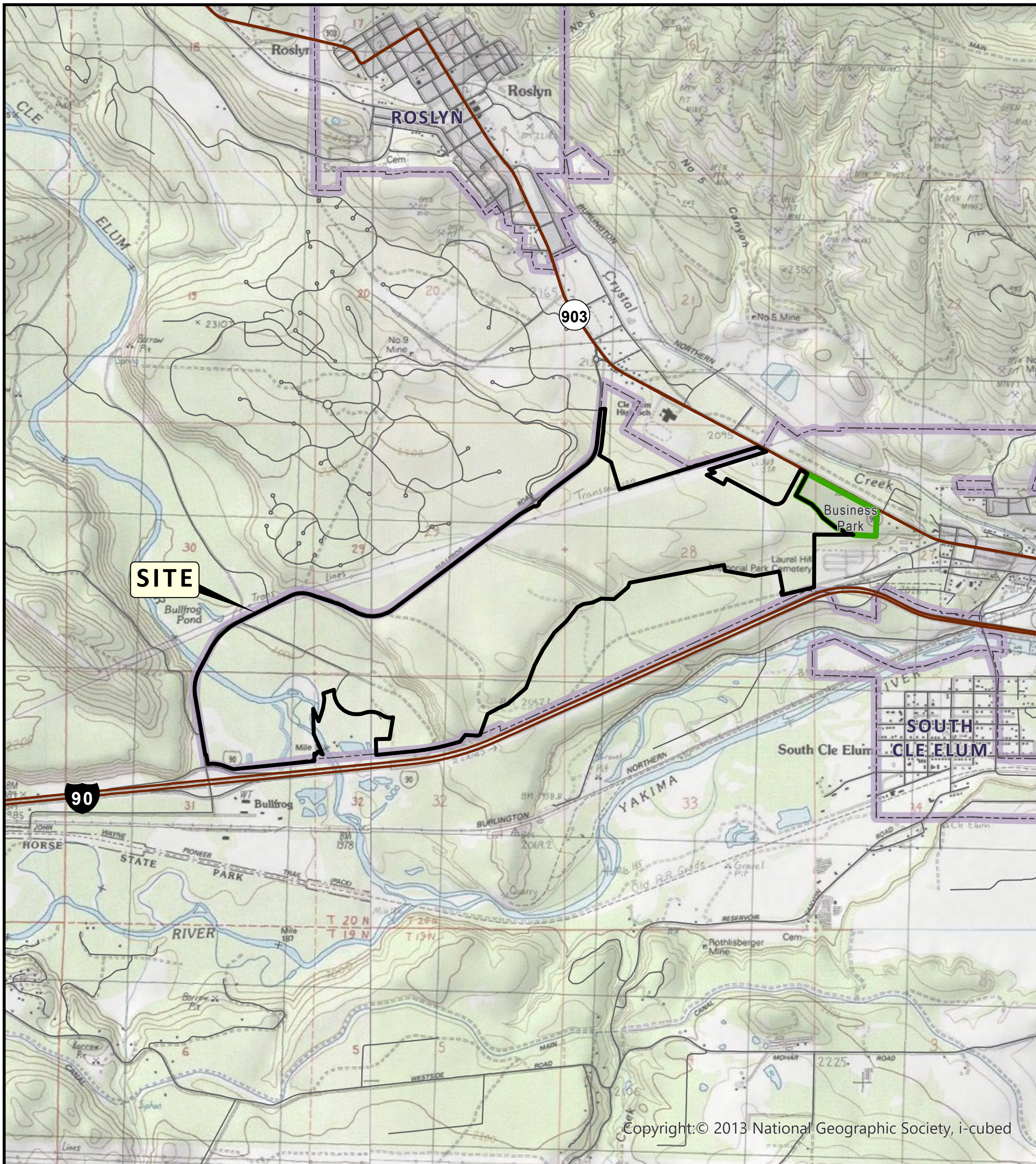

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KITTITAS CO: STREETS, CITY LIMITS, PARCELS 10/19
LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

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VICINITY MAP

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CLE ELUM, WASHINGTON

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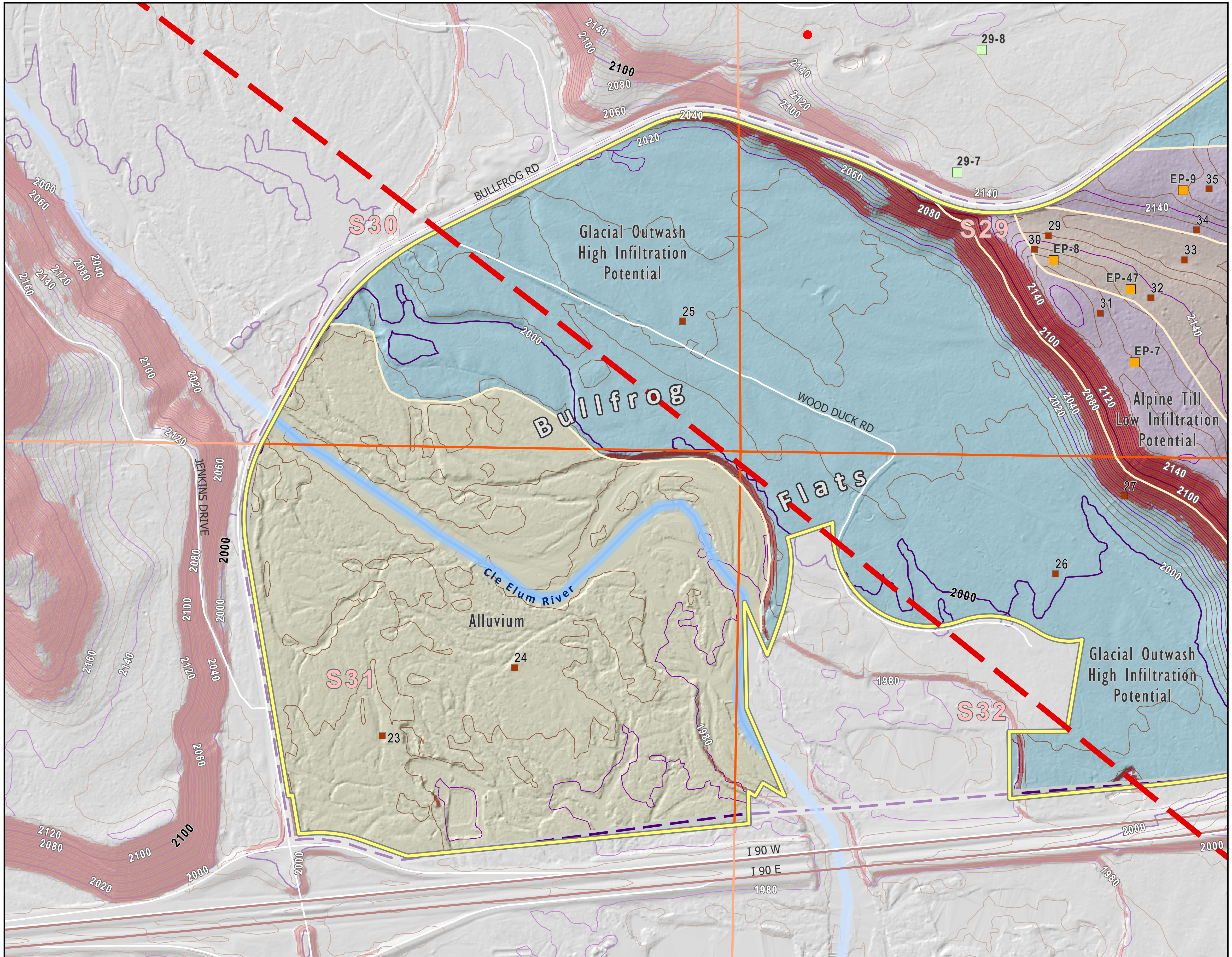

PROJECT BOUNDARY
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OFFSITE EXPLORATION PIT (AESI, 1997)
EXPLORATION PIT (AGI, 1999)
EASTON RIDGE THRUST FAULT
ALLUVIUM
ALPINE TILL
DIRTY GLACIAL OUTWASH
GLACIAL OUTWASH
CITY BOUNDARY
SECTION
CONTOUR 100 FT
CONTOUR 20 FT
CONTOUR 5 FT
≤ 33% SLOPE (NO COLOR)
>33% SLOPE

DATA SOURCES / REFERENCES:
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KITTITAS CO: ROADS, PARCELS, CITY 10/19
ESM: SURVEYED PROJECT BOUNDARY 11/19
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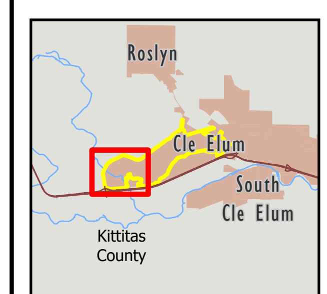
LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE



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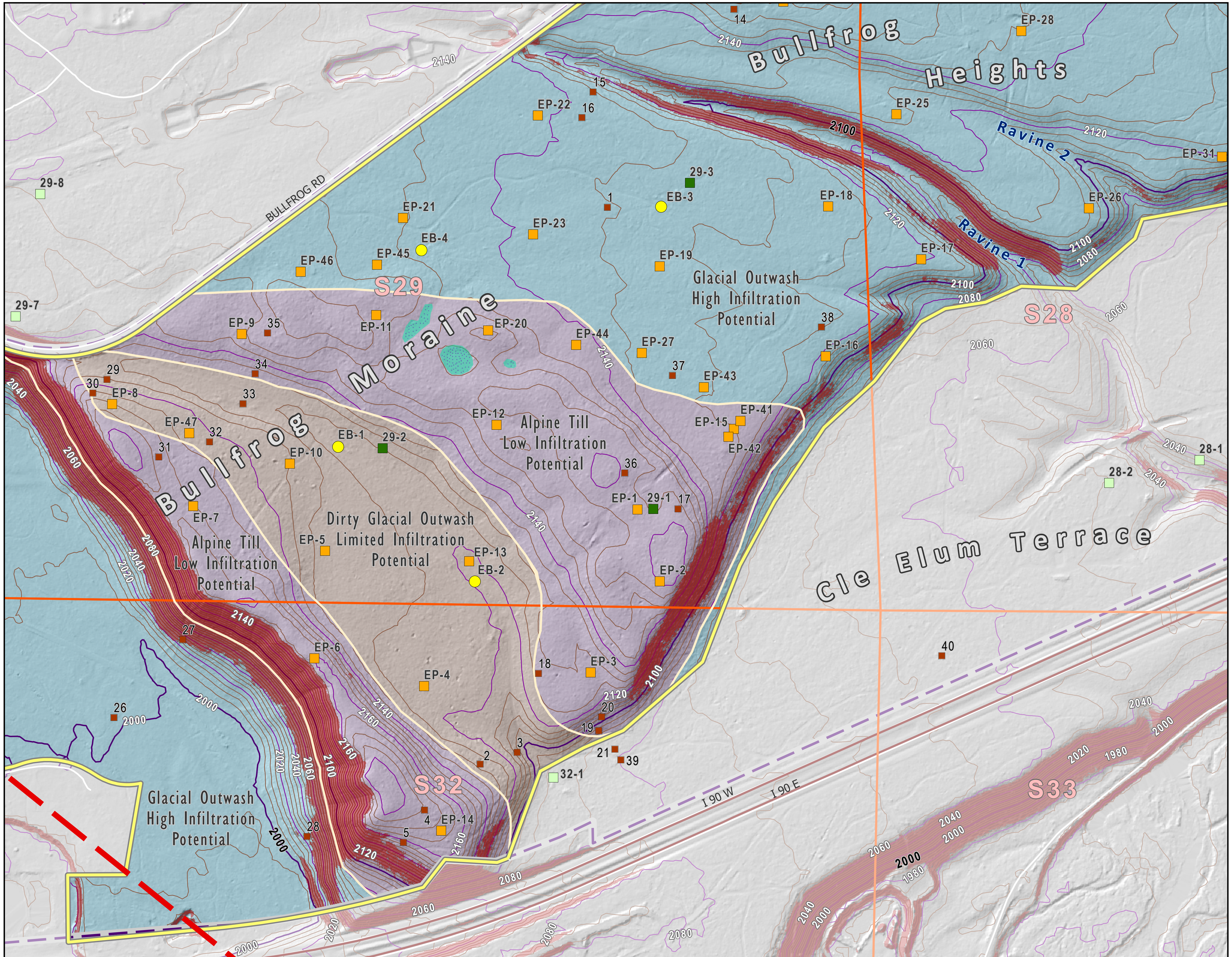

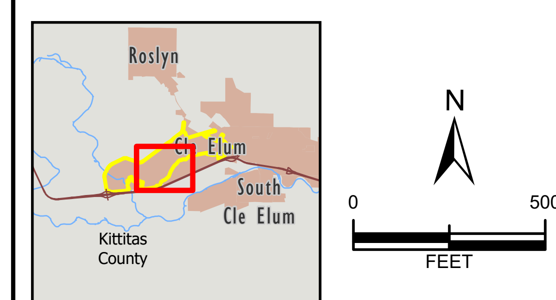

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- EXPLORATION PIT (AESI, 1997)
- OFFSITE EXPLORATION PIT (AESI, 1997)
- EXPLORATION PIT (AGI, 1999)
- EASTON RIDGE THRUST FAULT
- PRELIMINARY WETLAND
- ALPINE TILL
- DIRTY GLACIAL OUTWASH
- GLACIAL OUTWASH
- CITY BOUNDARY
- SECTION
- CONTOUR 100 FT
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DATA SOURCES / REFERENCES:
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KITTITAS CO: ROADS, PARCELS, CITY 10/19
ESM: SURVEYED PROJECT BOUNDARY 11/19
WADNR: 24K, THRUST FAULT, OFR 80-1, RONALD QUADRANGLE, ADJUSTED AS PER USGS SIM 2940, 2009

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

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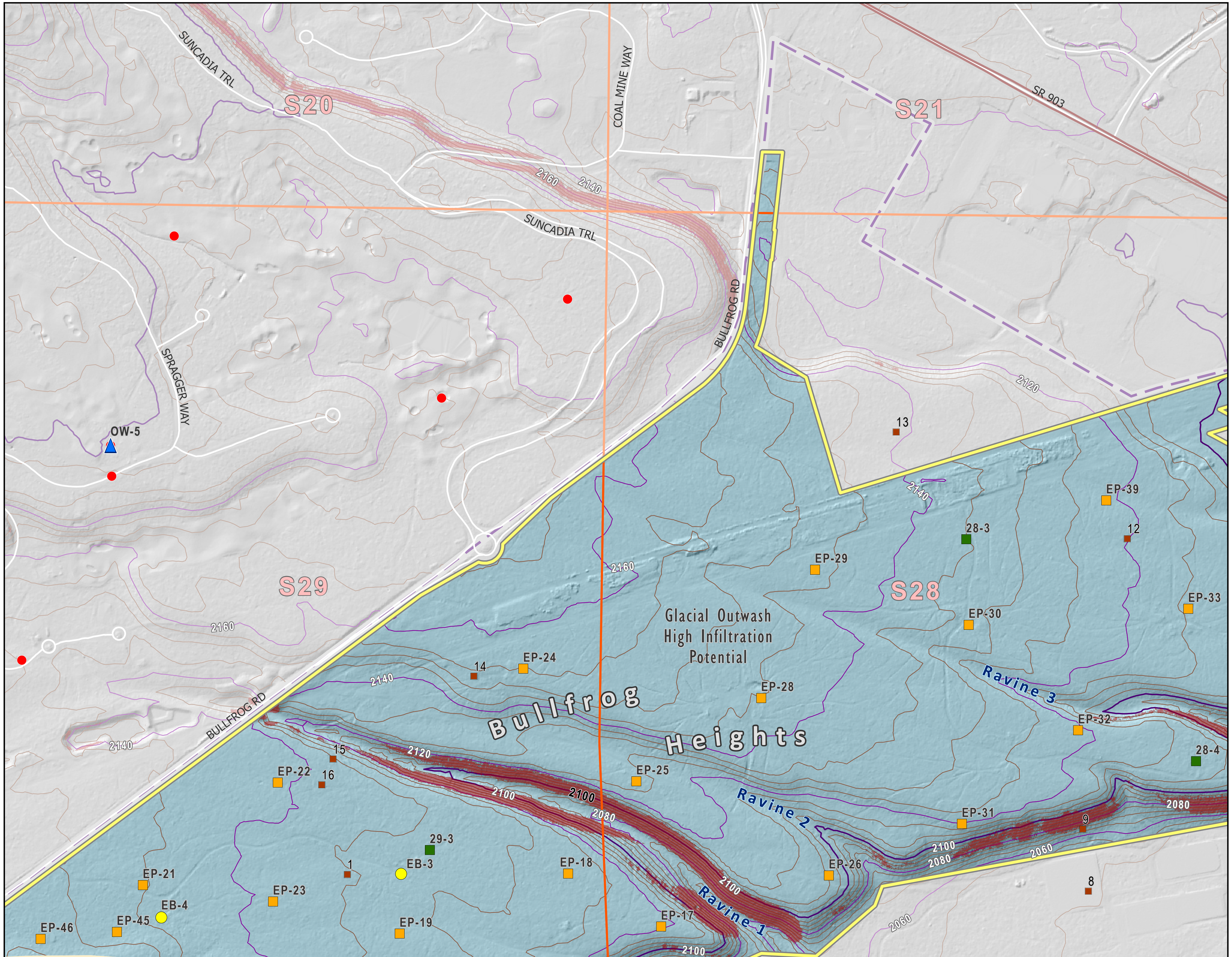

PROJECT BOUNDARY
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OBSERVATION WELL (AESI, 1997, 1998)
EXPLORATION PIT (AGI, 1999)
ALPINE TILL
GLACIAL OUTWASH
CITY BOUNDARY
SECTION
CONTOUR 100 FT
CONTOUR 20 FT
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≤ 33% SLOPE (NO COLOR)
>33% SLOPE

DATA SOURCES / REFERENCES:
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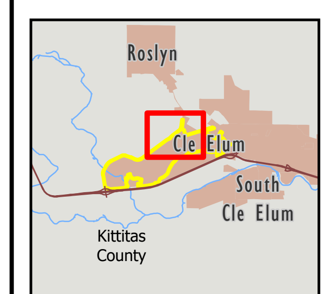

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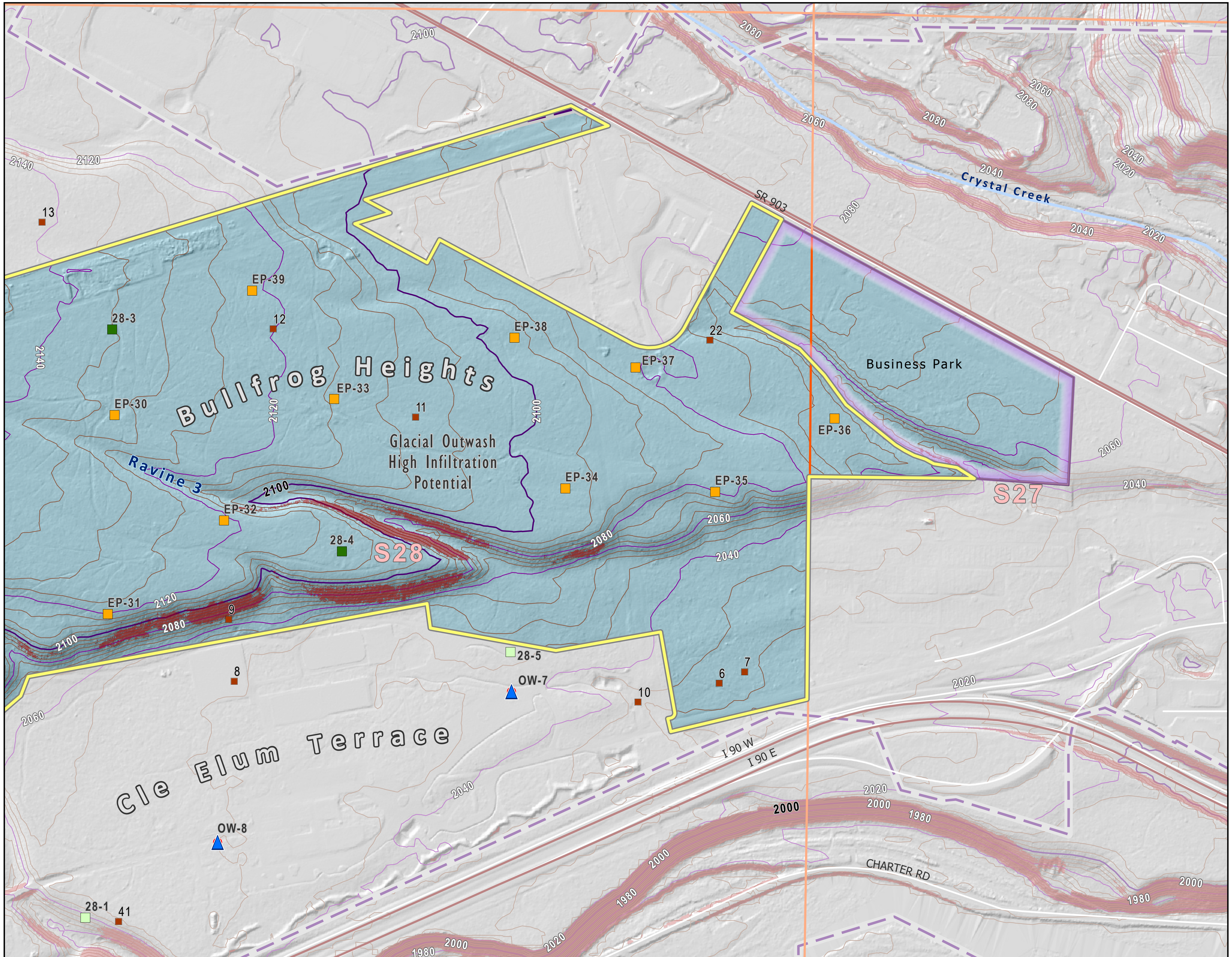

PROJECT BOUNDARY

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EXPLORATION PIT (AESI, 1997)

OBSERVATION WELL (AESI, 1997, 1998)

OFFSITE EXPLORATION PIT (AESI, 1997)

EXPLORATION PIT (AGI, 1999)

GLACIAL OUTWASH

OFF PROPERTY BUSINESS PARK

CITY BOUNDARY

SECTION

CONTOUR 100 FT

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CONTOUR 5 FT

≤ 33% SLOPE (NO COLOR)

>33% SLOPE

DATA SOURCES / REFERENCES:
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KITTITAS CO: ROADS, PARCELS, CITY 10/19
ESM: SURVEYED PROJECT BOUNDARY 11/19
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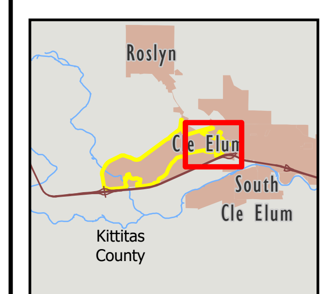
LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE



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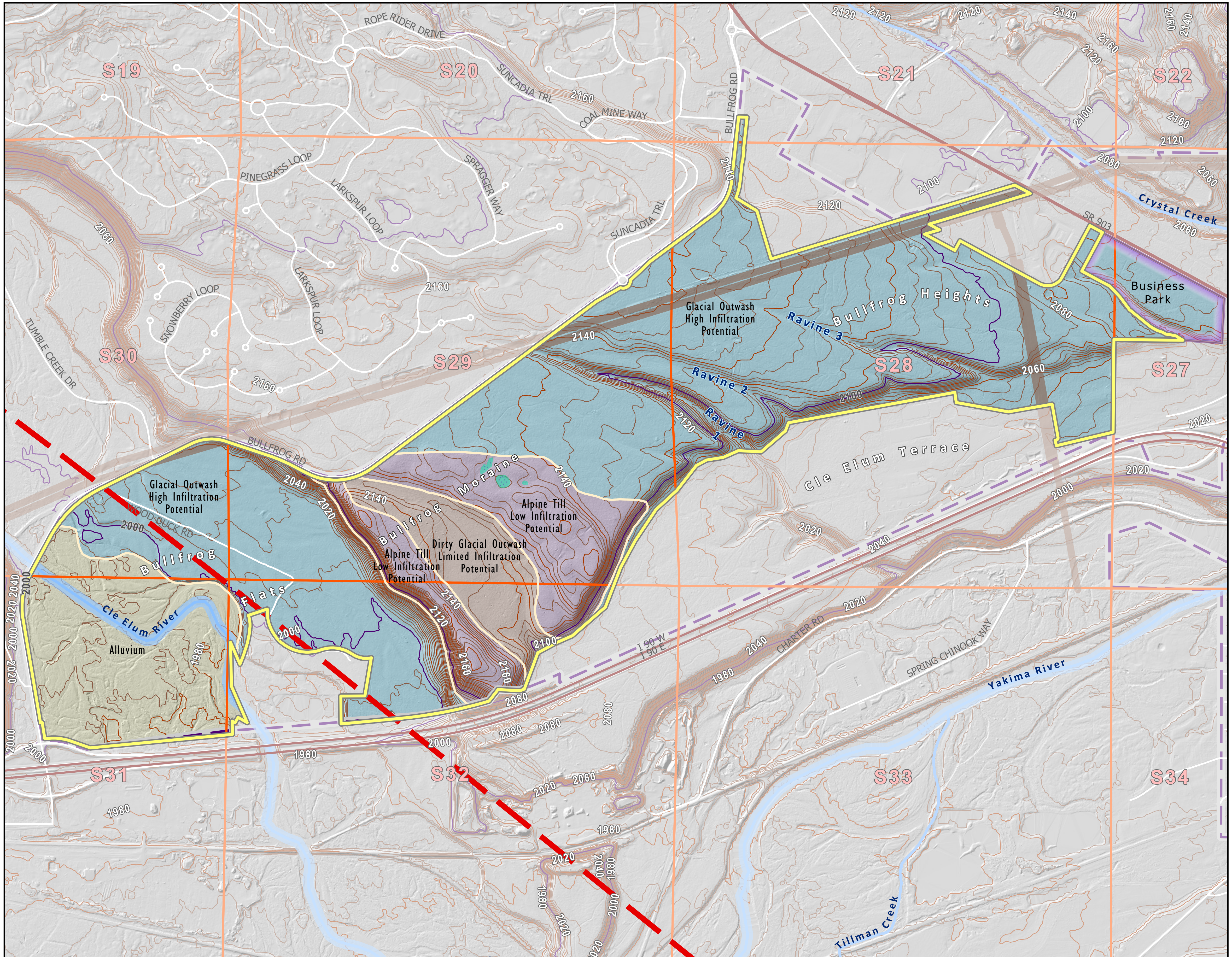


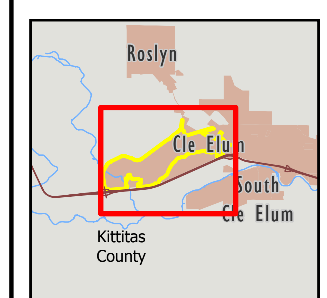
- PROJECT BOUNDARY
- PRELIMINARY WETLAND
- EASTON RIDGE THRUST FAULT

GEOLOGY DESCRIPTION

- ALLUVIUM
- ALPINE TILL
- DIRTY GLACIAL OUTWASH
- GLACIAL OUTWASH
- TRANSMISSION LINES
- OFF PROPERTY BUSINESS PARK
- CITY BOUNDARY
- SECTION
- CONTOUR 100 FT
- CONTOUR 20 FT
- CONTOUR 5 FT

DATA SOURCES / REFERENCES:
WASHINGTON STATE LIDAR PORTAL: YAKIMA 2014, NO REPORT AVAILABLE. CONTOURS FROM LIDAR
KITTITAS CO: ROADS, PARCELS, CITY 10/19
ESM: SURVEYED PROJECT BOUNDARY 11/19
WADNR: 24K, THRUST FAULT, OFR 80-1, RONALD QUADRANGLE, ADJUSTED AS PER USGS SIM 2940, 2009

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE



0 1200
FEET

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

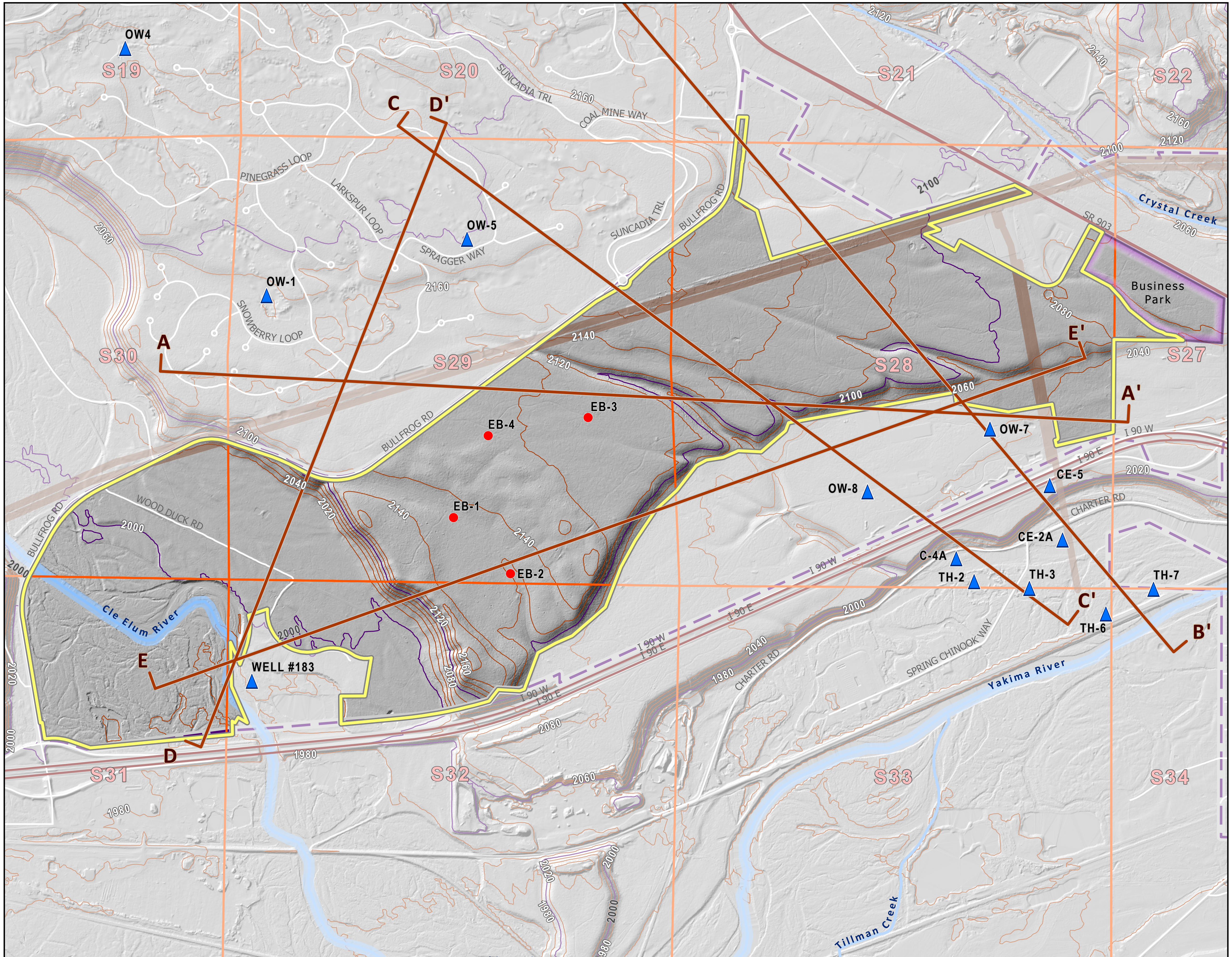
associated earth sciences incorporated

GEOLOGY AND INFILTRATION POTENTIAL

47° NORTH SEIS
CLE ELUM, WASHINGTON

PROJ NO.	DATE:	FIGURE:
20190414H001	4/20	6

G:\GIS_Projects\aaY2019\190414 47 Degrees N\aprx_mxd\EIS0320\190414H001 F6 GEO_1pg_47Deg.aprx



PROJECT BOUNDARY
OBSERVATION WELL (AESI, 1997, 1998)
EXPLORATION BORING (AESI 2020)
CROSS SECTION
TRANSMISSION LINES
OFF PROPERTY BUSINESS PARK
CITY BOUNDARY
SECTION
CONTOUR 100 FT
CONTOUR 20 FT

NOTE: ENTIRE PROJECT AREA IS WITHIN A GROUP A SURFACE WATER PROTECTION AREA

DATA SOURCES / REFERENCES:
WASHINGTON STATE LIDAR PORTAL: YAKIMA 2014, NO REPORT AVAILABLE. CONTOURS FROM LIDAR
KITTITAS CO: ROADS, PARCELS, CITY 10/19
ESM: SURVEYED PROJECT BOUNDARY 11/19
WELLS, VARIOUS SOURCES

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

Roslyn
Cle Elum
South Cle Elum
Kittitas County

0 1200
FEET

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

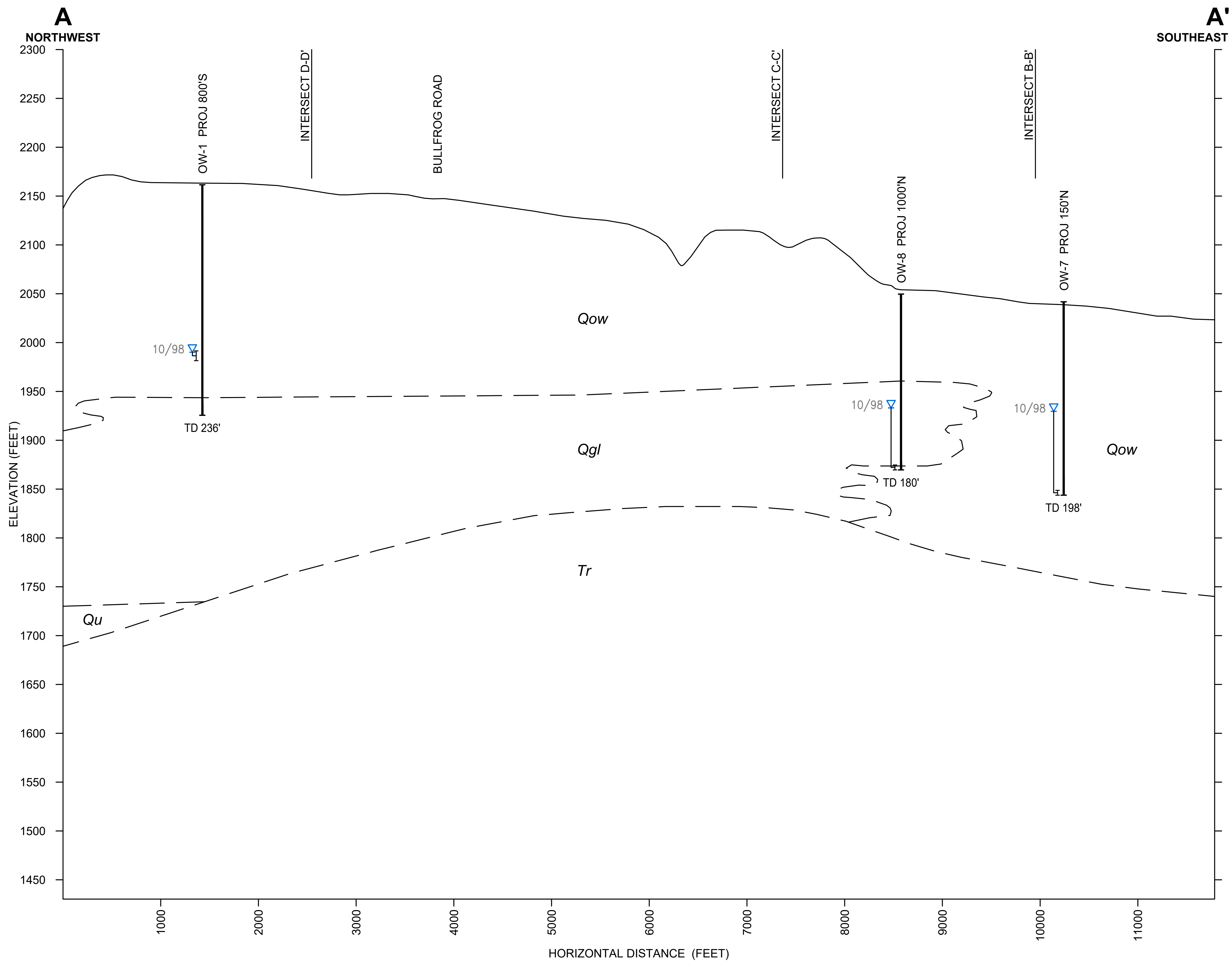
associated earth sciences incorporated

WELLS AND CROSS-SECTIONS

47° NORTH SEIS
CLE ELUM, WASHINGTON

PROJ NO.	DATE:	FIGURE:
20190414H001	4/20	7

G:\GIS_Projects\aaY2019\190414 47 Degrees N\aprx_mxd\EIS0320\190414H001 F7 WELLS_1pg_47Deg.aprx



LEGEND:

Qal	ALLUVIUM
Qow	GLACIAL OUTWASH DEPOSITS
Qgm	GLACIAL MORAINE DEPOSITS
Qgl	GLACIOLACUSTRINE DEPOSITS
Qu	UNDIFFERENTIATED GLACIAL DEPOSITS - PRIMARILY GLACIAL OUTWASH
Tr	ROSLYN FORMATION - BEDROCK
Tt	TEANAWAY FORMATION - BEDROCK

EXPLORATION / WELL

STATIC WATER LEVEL

SCREENED INTERVAL

TD TOTAL DEPTH OF BORING

GEOLOGIC CONTACT

VERTICAL EXAGGERATION = 10X

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE

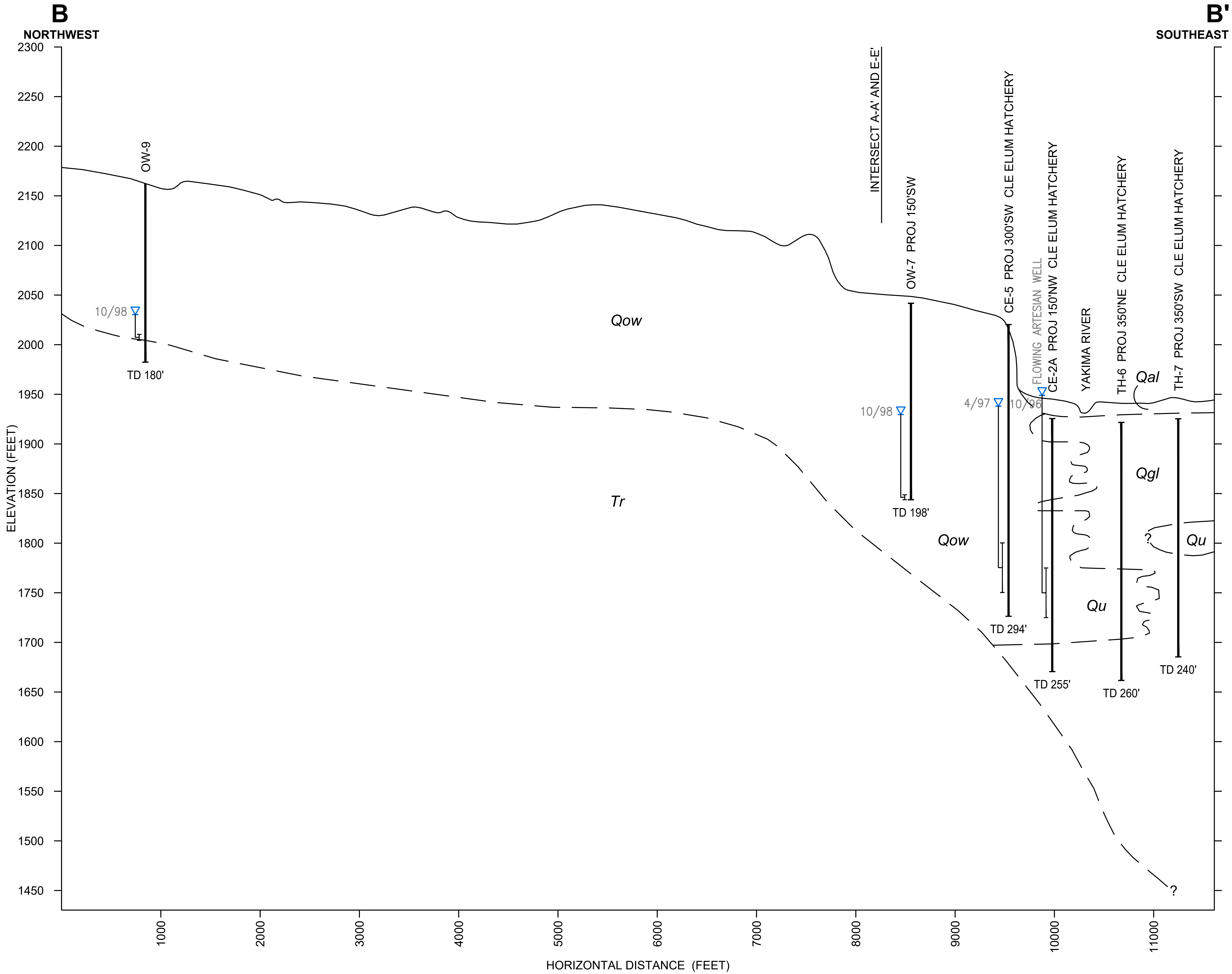
NOTES:
1. THE SUBSURFACE CONDITIONS PRESENTED IN THIS GEOLOGIC CROSS-SECTION ARE BASED ON AN INTERPRETATION OF CONDITIONS ENCOUNTERED IN WIDELY SPACED EXPLORATIONS COMPLETED AT THE SUBJECT SITE AND RELEVANT SITE INFORMATION DEVELOPED AND PROVIDED BY OTHERS. THE SUBSURFACE INTERPRETATIONS PRESENTED IN THIS GEOLOGIC CROSS-SECTION SHOULD NOT BE CONSTRUED AS A WARRANTY OF ACTUAL SUBSURFACE CONDITIONS AT THE SITE. OUR EXPERIENCE HAS SHOWN THAT SOIL AND GROUNDWATER CONDITIONS CAN VARY SIGNIFICANTLY OVER SMALL DISTANCES.

associated earth sciences incorporated

GEOLOGIC CROSS-SECTION A - A'
47° NORTH
CLE ELUM, WASHINGTON

PROJ NO.	DATE:	FIGURE:
20190414H001	4/20	8

190414 47 Degree \ 190414 GeoSects.dwg LAYOUT: F8 Sect A-A 4-20



LEGEND:

Qal	ALLUVIUM
Qow	GLACIAL OUTWASH DEPOSITS
Qgm	GLACIAL MORAINE DEPOSITS
Qgl	GLACIOLACUSTRINE DEPOSITS
Qu	UNDIFFERENTIATED GLACIAL DEPOSITS - PRIMARILY GLACIAL OUTWASH
Tr	ROSLYN FORMATION - BEDROCK
Tt	TEANAWAY FORMATION - BEDROCK
	EXPLORATION / WELL
	STATIC WATER LEVEL
	SCREENED INTERVAL
TD	TOTAL DEPTH OF BORING
	GEOLOGIC CONTACT

VERTICAL EXAGGERATION = 10X

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE

NOTES:
1. THE SUBSURFACE CONDITIONS PRESENTED IN THIS GEOLOGIC CROSS-SECTION ARE BASED ON AN INTERPRETATION OF CONDITIONS ENCOUNTERED IN WIDELY SPACED EXPLORATIONS COMPLETED AT THE SUBJECT SITE AND RELEVANT SITE INFORMATION DEVELOPED AND PROVIDED BY OTHERS. THE SUBSURFACE INTERPRETATIONS PRESENTED IN THIS GEOLOGIC CROSS-SECTION SHOULD NOT BE CONSTRUED AS A WARRANTY OF ACTUAL SUBSURFACE CONDITIONS AT THE SITE. OUR EXPERIENCE HAS SHOWN THAT SOIL AND GROUNDWATER CONDITIONS CAN VARY SIGNIFICANTLY OVER SMALL DISTANCES.

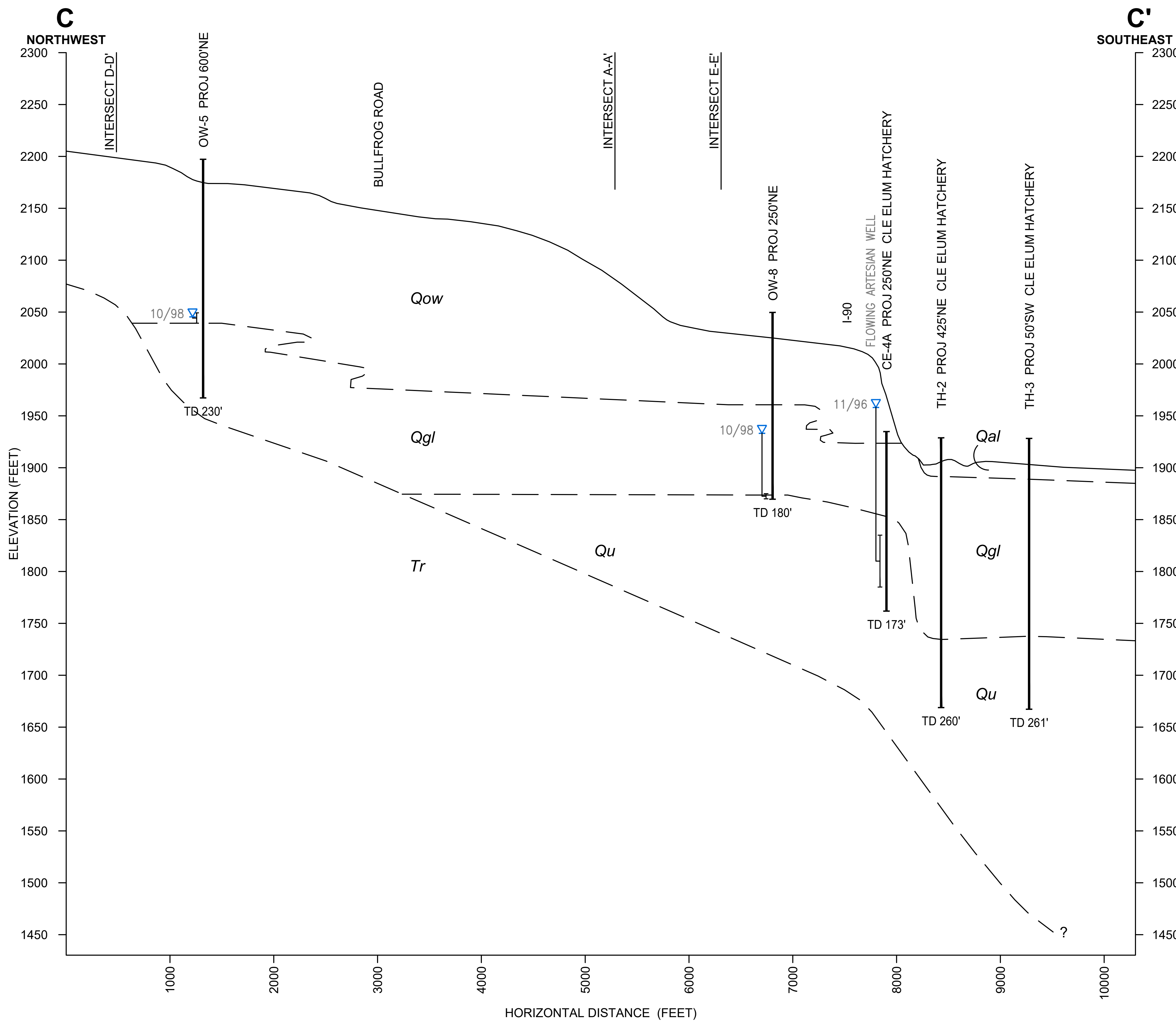
associated earth sciences incorporated

GEOLOGIC CROSS-SECTION B - B'

47° NORTH
CLE ELUM, WASHINGTON

PROJ NO.	DATE:	FIGURE:
20190414H001	4/20	9

190414 47 Degree \ 190414 GeoSects.dwg LAYOUT: F9 Sect B-B 4-20



LEGEND:

Qal	ALLUVIUM
Qow	GLACIAL OUTWASH DEPOSITS
Qgm	GLACIAL MORAINE DEPOSITS
Qgl	GLACIOLACUSTRINE DEPOSITS
Qu	UNDIFFERENTIATED GLACIAL DEPOSITS - PRIMARILY GLACIAL OUTWASH
Tr	ROSLYN FORMATION - BEDROCK
Tt	TEANAWAY FORMATION - BEDROCK

EXPLORATION / WELL

STATIC WATER LEVEL

SCREENED INTERVAL

TD TOTAL DEPTH OF BORING

GEOLOGIC CONTACT

VERTICAL EXAGGERATION = 10X

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE

NOTES:
1. THE SUBSURFACE CONDITIONS PRESENTED IN THIS GEOLOGIC CROSS-SECTION ARE BASED ON AN INTERPRETATION OF CONDITIONS ENCOUNTERED IN WIDELY SPACED EXPLORATIONS COMPLETED AT THE SUBJECT SITE AND RELEVANT SITE INFORMATION DEVELOPED AND PROVIDED BY OTHERS. THE SUBSURFACE INTERPRETATIONS PRESENTED IN THIS GEOLOGIC CROSS-SECTION SHOULD NOT BE CONSTRUED AS A WARRANTY OF ACTUAL SUBSURFACE CONDITIONS AT THE SITE. OUR EXPERIENCE HAS SHOWN THAT SOIL AND GROUNDWATER CONDITIONS CAN VARY SIGNIFICANTLY OVER SMALL DISTANCES.

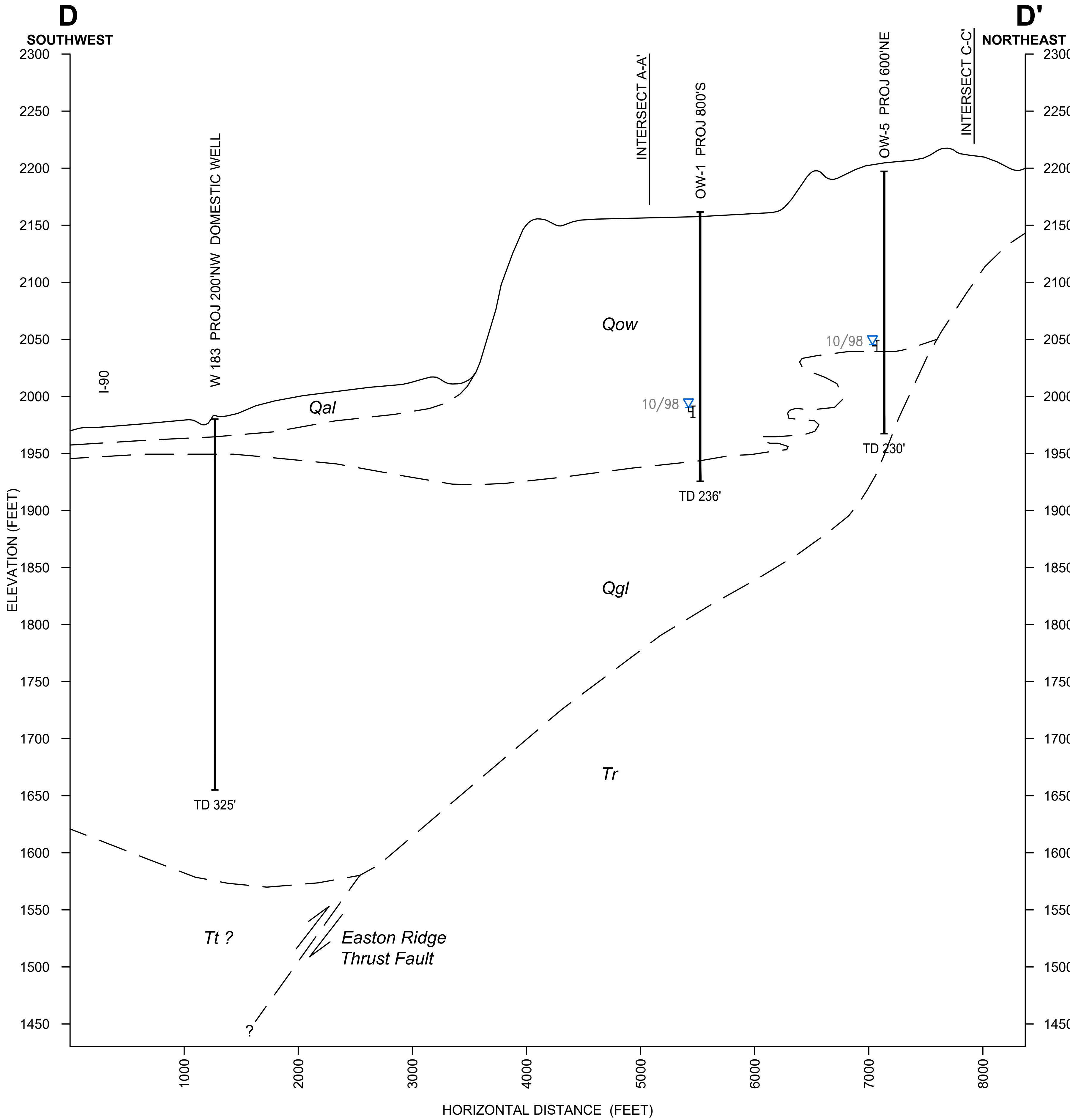
associated earth sciences incorporated

GEOLOGIC CROSS-SECTION C - C'

47° NORTH
CLE ELUM, WASHINGTON

PROJ NO.	DATE:	FIGURE:
20190414H001	4/20	10

190414 47 Degree \ 190414 GeoSects.dwg LAYOUT: F10 Sect C-C 4-20



LEGEND:

Qal	ALLUVIUM
Qow	GLACIAL OUTWASH DEPOSITS
Qgm	GLACIAL MORAINE DEPOSITS
Qgl	GLACIOLACUSTRINE DEPOSITS
Qu	UNDIFFERENTIATED GLACIAL DEPOSITS - PRIMARILY GLACIAL OUTWASH
Tr	ROSLYN FORMATION - BEDROCK
Tt	TEANAWAY FORMATION - BEDROCK

EXPLORATION / WELL

STATIC WATER LEVEL

SCREENED INTERVAL

TD TOTAL DEPTH OF BORING

GEOLOGIC CONTACT

VERTICAL EXAGGERATION = 10X

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE

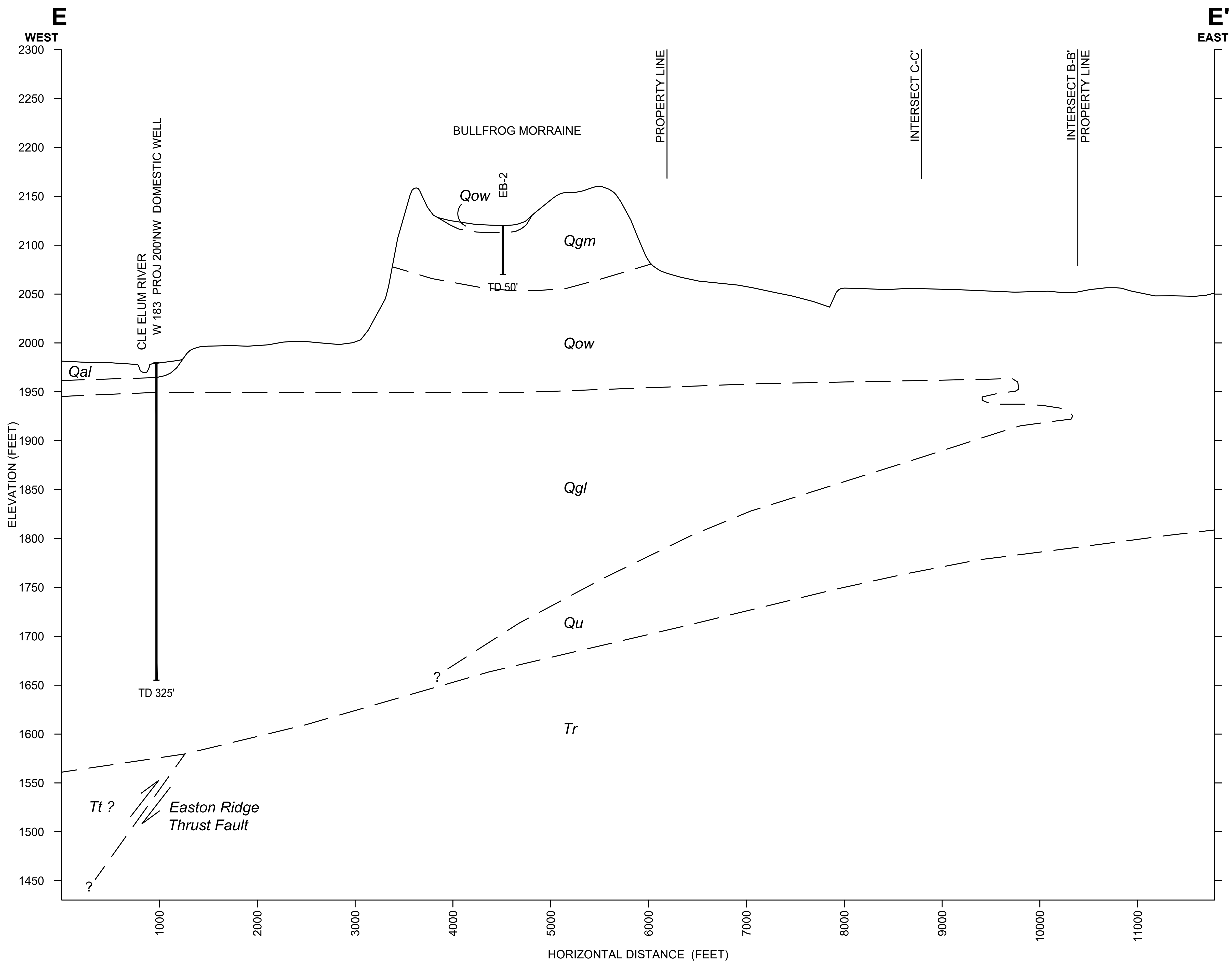
NOTES:
1. THE SUBSURFACE CONDITIONS PRESENTED IN THIS GEOLOGIC CROSS-SECTION ARE BASED ON AN INTERPRETATION OF CONDITIONS ENCOUNTERED IN WIDELY SPACED EXPLORATIONS COMPLETED AT THE SUBJECT SITE AND RELEVANT SITE INFORMATION DEVELOPED AND PROVIDED BY OTHERS. THE SUBSURFACE INTERPRETATIONS PRESENTED IN THIS GEOLOGIC CROSS-SECTION SHOULD NOT BE CONSTRUED AS A WARRANTY OF ACTUAL SUBSURFACE CONDITIONS AT THE SITE. OUR EXPERIENCE HAS SHOWN THAT SOIL AND GROUNDWATER CONDITIONS CAN VARY SIGNIFICANTLY OVER SMALL DISTANCES.

associated earth sciences incorporated

GEOLOGIC
CROSS-SECTION D - D'
47° NORTH
CLE ELUM, WASHINGTON

PROJ NO. 20190414H001 | DATE: 4/20 | FIGURE: 11

190414 47 Degree \ 190414 GeoSects.dwg LAYOUT: F11 Sect D-D 4-20



LEGEND:

Qal	ALLUVIUM
Qow	GLACIAL OUTWASH DEPOSITS
Qgm	GLACIAL MORAINE DEPOSITS
Qgl	GLACIOLACUSTRINE DEPOSITS
Qu	UNDIFFERENTIATED GLACIAL DEPOSITS - PRIMARILY GLACIAL OUTWASH
Tr	ROSLYN FORMATION - BEDROCK
Tt	TEANAWAY FORMATION - BEDROCK
	EXPLORATION / WELL
	STATIC WATER LEVEL
	SCREENED INTERVAL
TD	TOTAL DEPTH OF BORING
	GEOLOGIC CONTACT

VERTICAL EXAGGERATION = 10X

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE

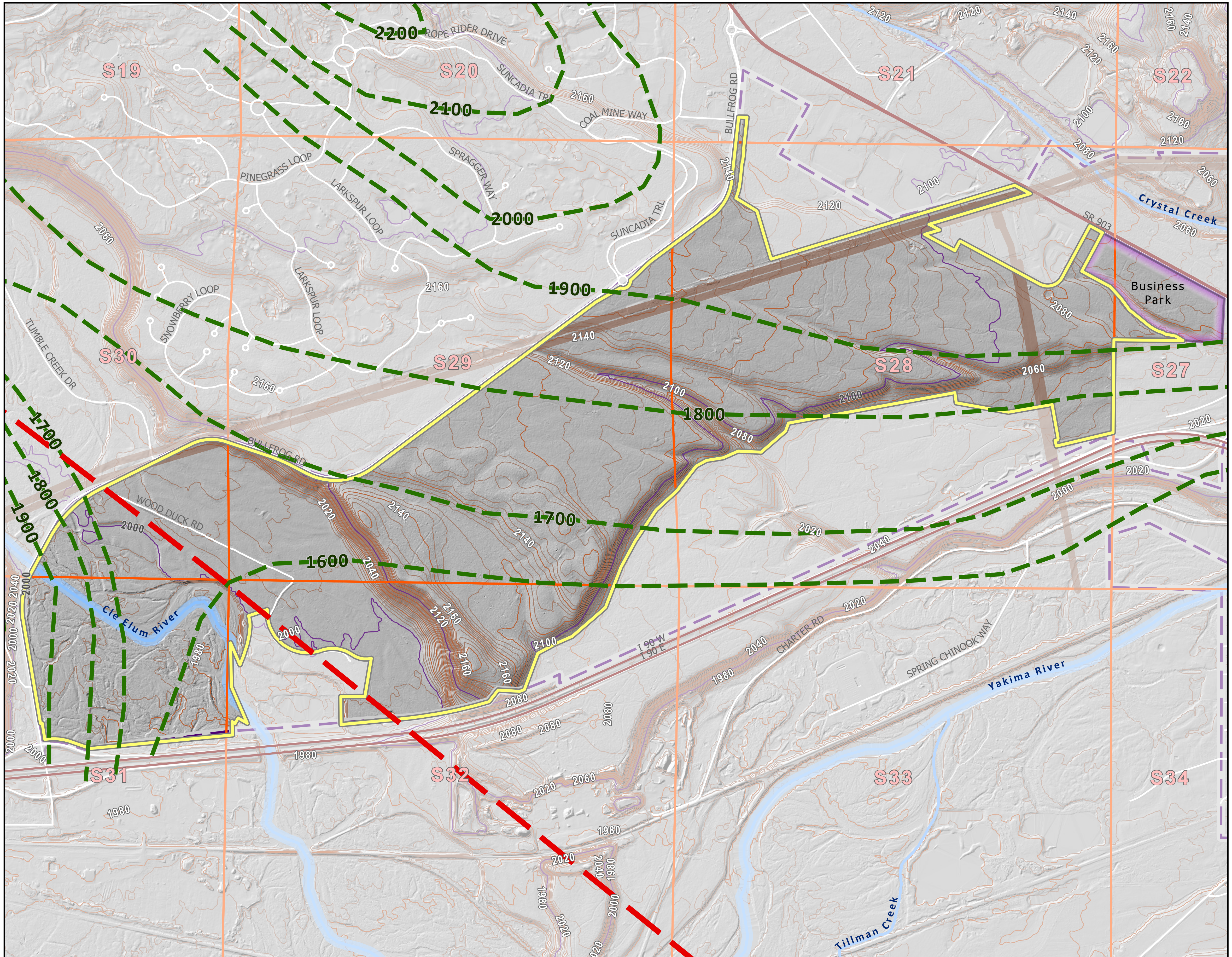
NOTES:
1. THE SUBSURFACE CONDITIONS PRESENTED IN THIS GEOLOGIC CROSS-SECTION ARE BASED ON AN INTERPRETATION OF CONDITIONS ENCOUNTERED IN WIDELY SPACED EXPLORATIONS COMPLETED AT THE SUBJECT SITE AND RELEVANT SITE INFORMATION DEVELOPED AND PROVIDED BY OTHERS. THE SUBSURFACE INTERPRETATIONS PRESENTED IN THIS GEOLOGIC CROSS-SECTION SHOULD NOT BE CONSTRUED AS A WARRANTY OF ACTUAL SUBSURFACE CONDITIONS AT THE SITE. OUR EXPERIENCE HAS SHOWN THAT SOIL AND GROUNDWATER CONDITIONS CAN VARY SIGNIFICANTLY OVER SMALL DISTANCES.

associated
earth sciences
incorporated

GEOLOGIC CROSS-SECTION E - E'
47° NORTH
CLE ELUM, WASHINGTON

PROJ NO.	DATE:	FIGURE:
20190414H001	4/20	12

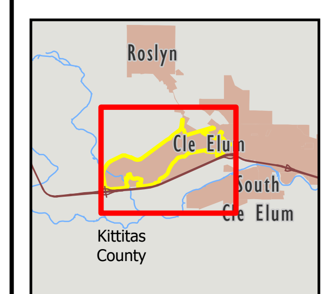
190414 47 Degree \ 190414 GeoSects.dwg LAYOUT: F12 Sect E-E 4-20



PROJECT BOUNDARY
EASTON RIDGE THRUST FAULT
TOP OF BEDROCK ELEVATION
TRANSMISSION LINES
OFF PROPERTY BUSINESS PARK
CITY BOUNDARY
SECTION
CONTOUR 100 FT
CONTOUR 20 FT
CONTOUR 5 FT

DATA SOURCES / REFERENCES:
WASHINGTON STATE LIDAR PORTAL: YAKIMA 2014, NO REPORT AVAILABLE. CONTOURS FROM LIDAR
KITTITAS CO: ROADS, PARCELS, CITY 10/19
ESM: SURVEYED PROJECT BOUNDARY 11/19
DEPTH TO BEDROCK:
MOUNTAIN STAR MASTER PLANNED RESORT EIS, F 4-10, AESI, 2002
WADNR: 24K, THRUST FAULT, OFR 80-1, RONALD QUADRANGLE

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE



0 1200
FEET

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

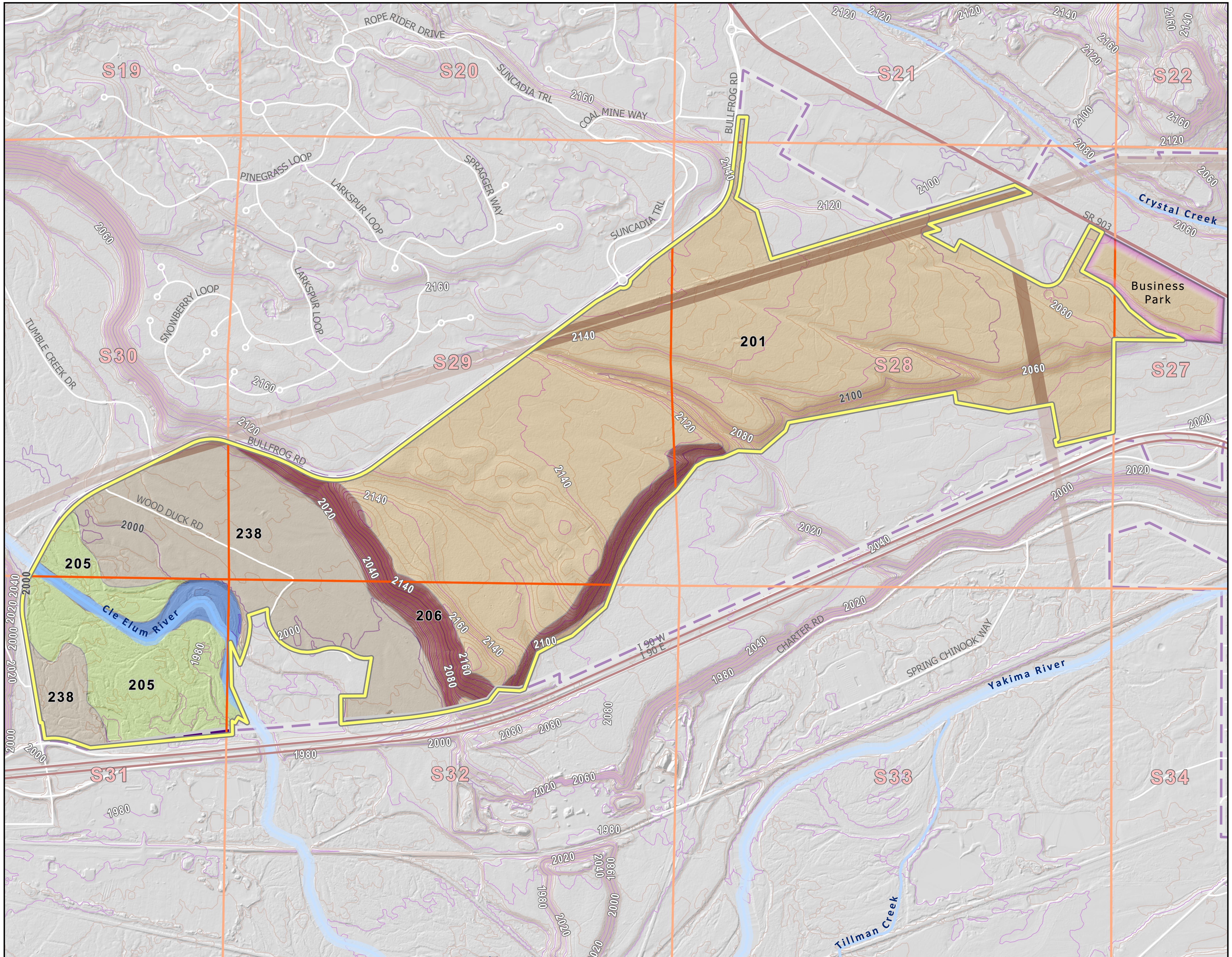
associated earth sciences incorporated

TOP OF BEDROCK

47° NORTH SEIS
CLE ELUM, WASHINGTON

PROJ NO.	DATE:	FIGURE:
20190414H001	4/20	13

G:\GIS_Projects\aaY2019\190414 47 Degrees N\aprx_mxd\EIS0320\190414H001 F13 TOB_1pg_47Deg.aprx



PROJECT BOUNDARY

SOIL UNIT

WATER

205 - XEROFLUVENTS, 0 TO 5% SLOPE

206 - DYSTROXEREPTS, 45 TO 65% SOUTH SLOPE

238 - RACKER ASHY SANDY LOAM, 0 TO 5% SLOPE

201 - ROSLYN ASHY SANDY LOAM, 0 TO 5% SLOPE

TRANSMISSION LINES

OFF PROPERTY BUSINESS PARK

CITY BOUNDARY

SECTION

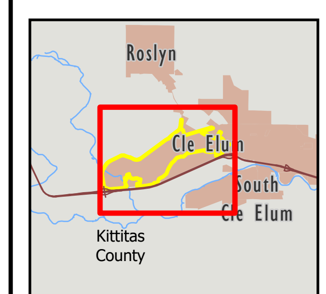
CONTOUR 100 FT

CONTOUR 20 FT

CONTOUR 5 FT

DATA SOURCES / REFERENCES:
WASHINGTON STATE LIDAR PORTAL: YAKIMA 2014, NO REPORT AVAILABLE. CONTOURS FROM LIDAR
KITTITAS CO: ROADS, PARCELS, CITY 10/19
ESM: SURVEYED PROJECT BOUNDARY 11/19
NRSC: SOILS

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE



0 1200
FEET

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

associated earth sciences incorporated

SURFICIAL SOIL MAP

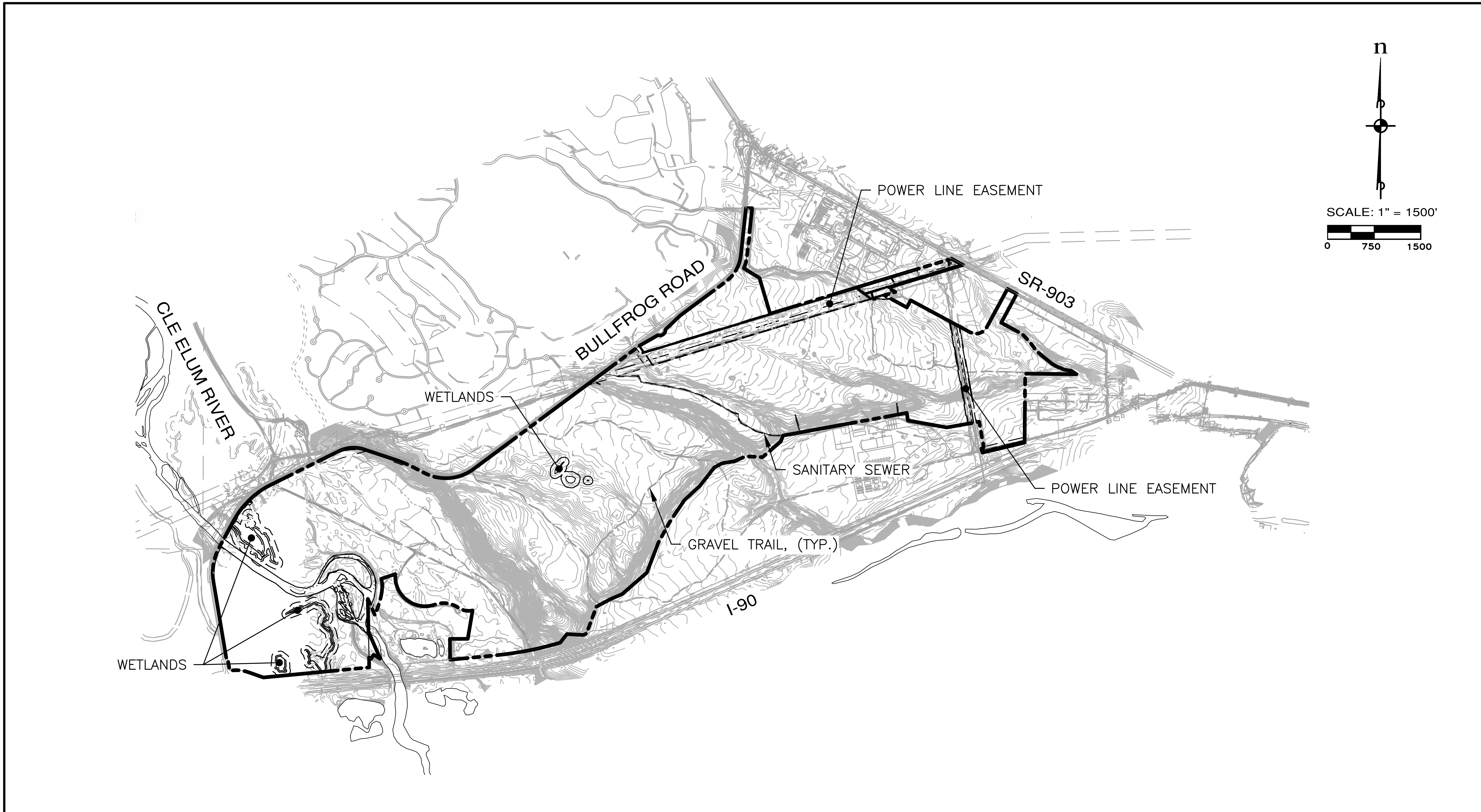
47° NORTH SEIS
CLE ELUM, WASHINGTON

PROJ NO.	DATE:	FIGURE:
20190414H001	4/20	14

G:\GIS_Projects\aaY2019\190414 47 Degrees N\aprx_mxd\EIS0320\190414H001 F14 SOILS_1pg_47Deg.aprx

APPENDIX A

Existing Site Conditions



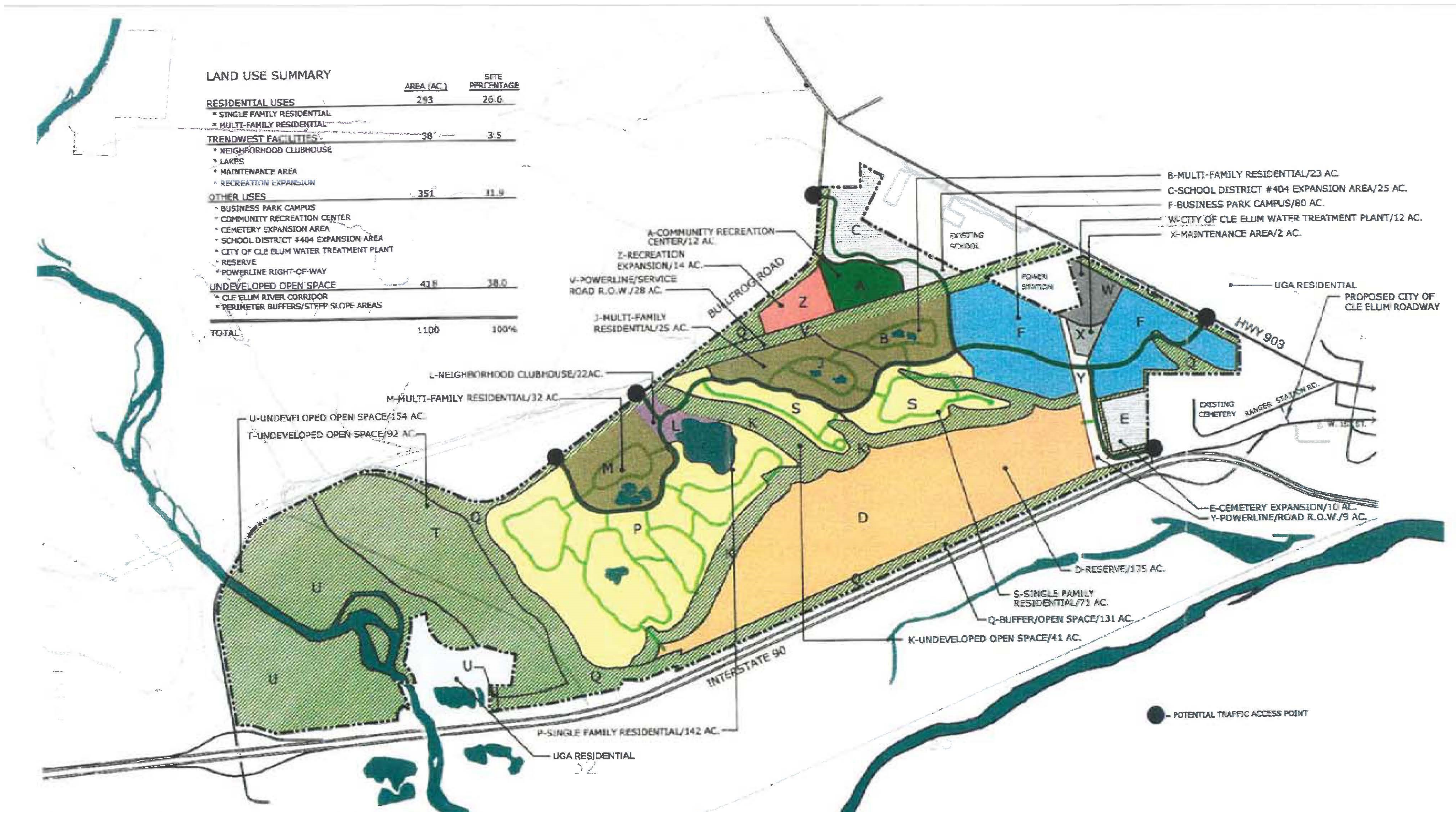
Source: ESM Consulting Engineers, 2020.

Figure 2-3

Existing Site Conditions

APPENDIX B

FEIS Alternative 5 - Original Bullfrog Flats Master Site Plan
and
SEIS Alternative 5 - Approved Bullfrog Flats Master Site Plan



North

Note: This figure is not to scale

Source: City of Cle Elum, 2002.

Figure 2-4

Original Bullfrog Flats Master Site Plan—FEIS Alternative 5

EA Engineering, Science, and Technology, Inc., PBC

LAND USE SUMMARY

	AREA (Acres)	Quantity Proposed
RESIDENTIAL USES		
Single Family Residential	165	810 Units
Multi-Family Residential	56	524 Units
Affordable Residential	7.5	*
Subtotal	228.5 (20.8%)	1334 Units
NON-RESIDENTIAL USES: Trendwest Facilities		
Neighborhood Clubhouse & Lake	18	
Recreation Expansion	10.5	
Subtotal	28.5 (2.6%)	
OTHER USES		
Community Recreation Center	12	
School Expansion	35	
Cemetery Expansion	10	
Business Park	75	950,000 SF
Water Treatment Plant	12	
Reserve	175	
Subtotal	319 (29.0%)	
OPEN SPACE		
Undeveloped Open Space	246	
Buffers / Steep Slope Areas	172	
Powerline R.O.W.	37	
Residential Buffers	69	
Subtotal	524 (47.6%)	
Total	1100 (100%)	1334 Units

* 50 Units of Affordable Housing not included in total units

RESIDENTIAL USES

Housing Type	Gross Acreage (Acres)	Approximate Unit Yield	Density (Dwelling Units Per Acre)
Single Family			
Parcel P-1	30.1	120	2-5 DU/Acre
Parcel P-2	39.3	184	2-5 DU/Acre
Parcel P-3	19.4	118	3-7 DU/Acre
Parcel P-4	31.1	144	3-7 DU/Acre
Parcel S-1	17.7	96	3-7 DU/Acre
Parcel S-2	27.4	148	3-7 DU/Acre
Multi-Family			
Parcel B	17.3	150	8-15 DU/Acre
Parcel J	17.6	164	8-15 DU/Acre
Parcel M	21.1	210	8-15 DU/Acre
Affordable			
Parcel A	7.5	*	5-8 DU/Acre
Total	228.5	1334	2-15 DU/Acre

* 50 Units of Affordable Housing not included in total units

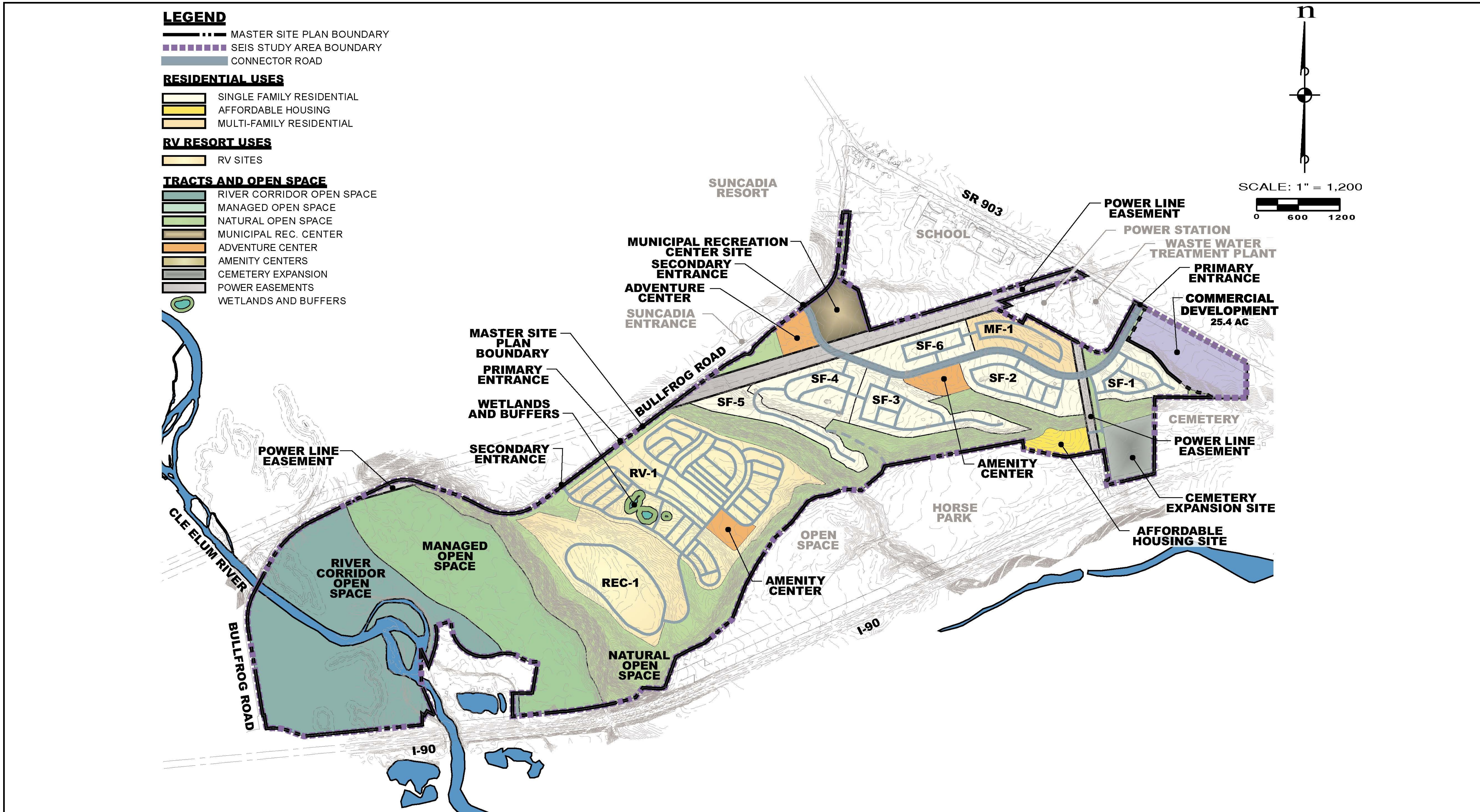
Source: City of Cle Elum, 2002.

Figure 2-5

Approved Bullfrog Flats Master Site Plan—SEIS Alternative 5

APPENDIX C

Proposed 47° North Master Site Plan Amendment, Parks and Trails Plan, Phasing Plan, Storm Drainage Plan, Grading Plan, and Business Park Conceptual Site Plan



Source: *ESM Consulting Engineers, 2020.*

EA Engineering, Science, and Technology, Inc., PBC

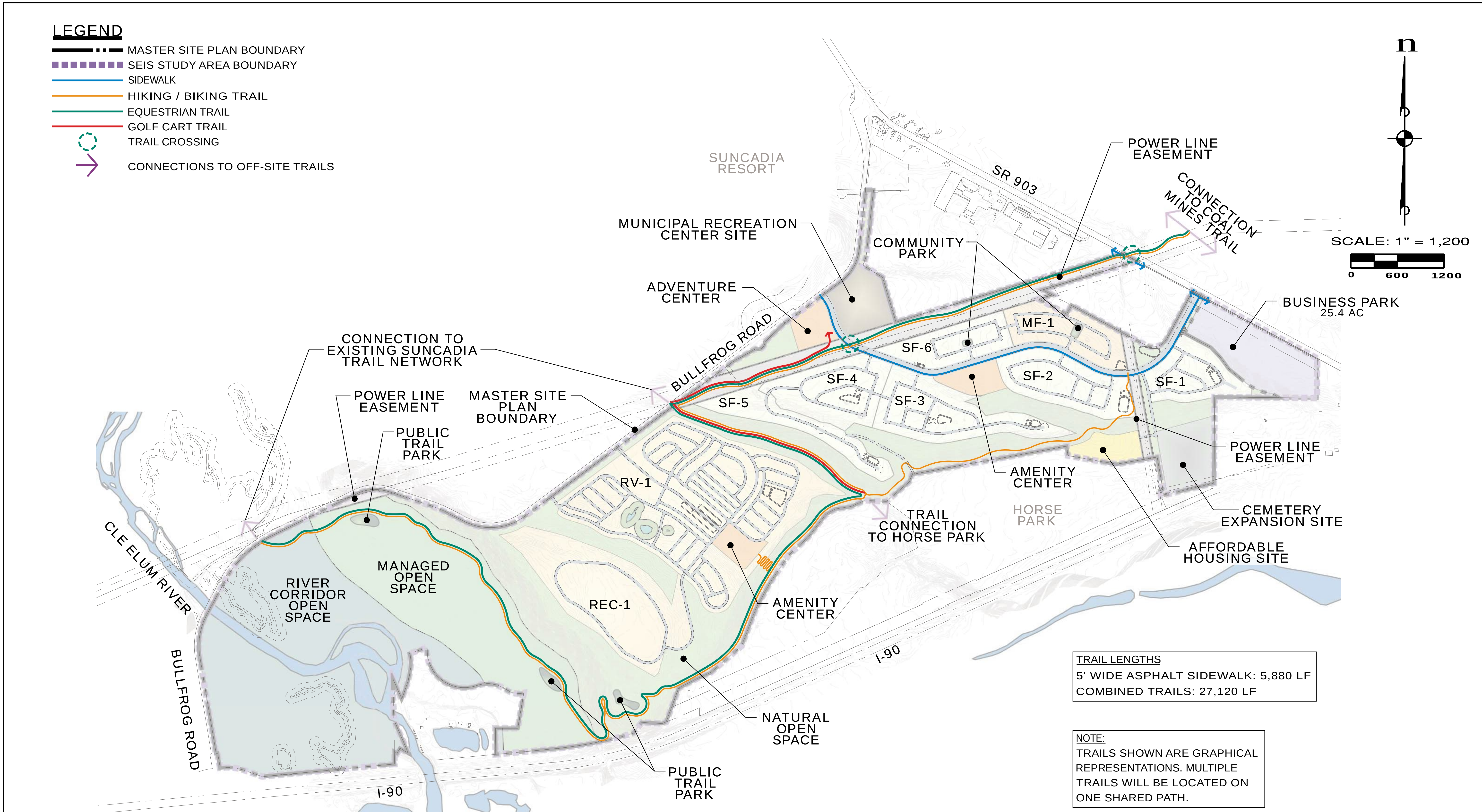
Figure 2-6

Proposed 47° North Master Site Plan Amendment—SEIS Alternative 6

Source: ESM Consulting Engineers, 2020.

Figure 2-7

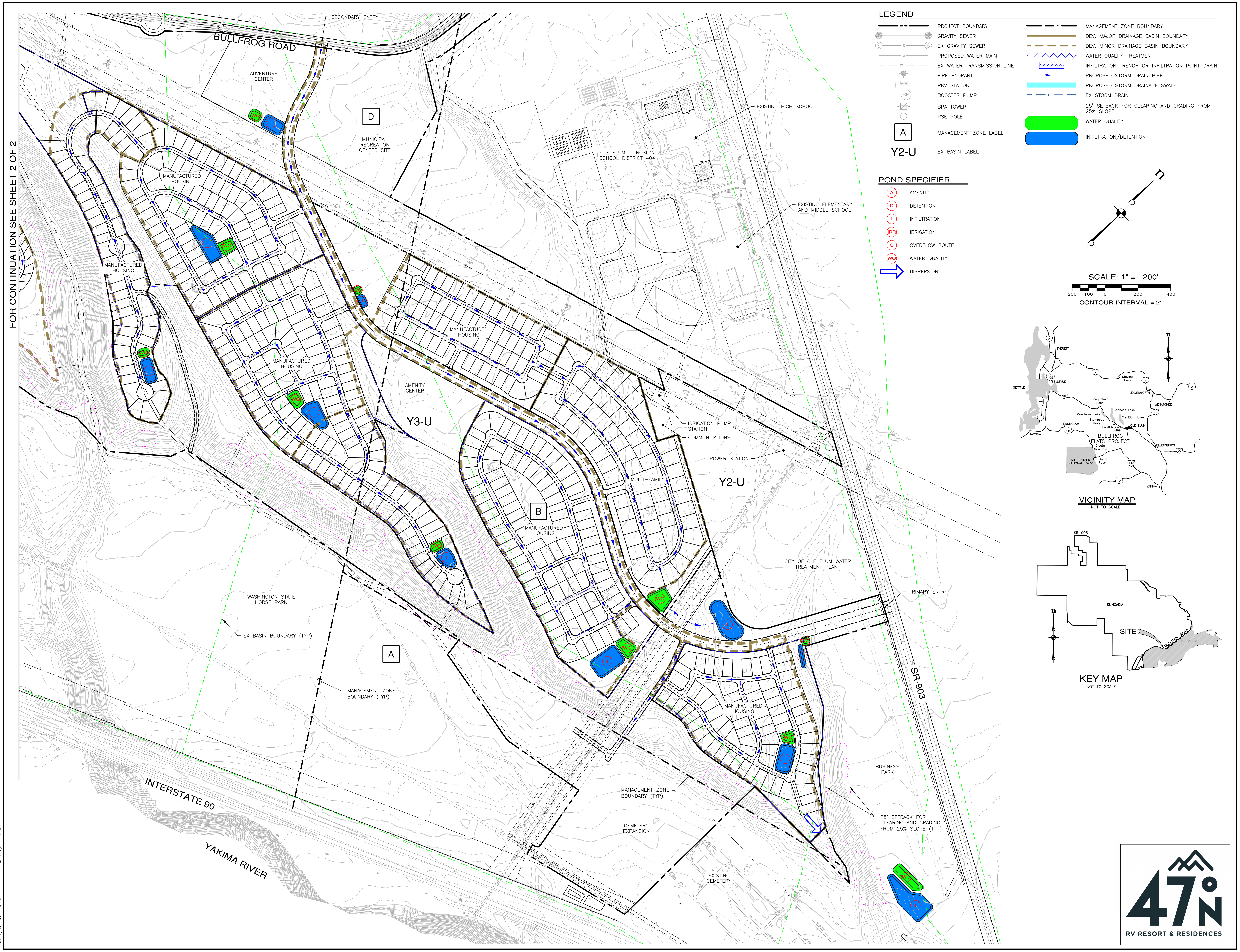
Phasing Plan



Source: ESM Consulting Engineers, 2020.

Figure 2-8

Parks and Trails Plan



REVISIONS

NO.	DESCRIPTION/DATE	BY

ESM CONSULTING ENGINEERS LLC
33400 8th Ave S, Suite 205
Federal Way, WA 98003
www.esmcivil.com
Civil Engineering | Public Works | Land Surveying | Project Management | Land Planning | Landscape Architecture

SUN COMMUNITIES INC

47° NORTH

COMCEPTUAL STORM DRAINAGE PLAN

CITY OF CLE ELUM | WASHINGTON

JOB NO.	2050-001-018
DWG. NAME	EN-14
DESIGNED BY:	LGB
DRAWN BY:	JJH
CHECKED BY:	
DATE:	03/30/2020

FIG 2-6

1 OF 2 SHEETS

LEGEND

PROJECT BOUNDARY	MANAGEMENT ZONE BOUNDARY	A	MANAGEMENT ZONE LABEL
GRAVITY SEWER	DEV. MAJOR DRAINAGE BASIN BOUNDARY	Y2-U	EX BASIN LABEL
EX GRAVITY SEWER	DEV. MINOR DRAINAGE BASIN BOUNDARY		
PROPOSED WATER MAIN	WATER QUALITY TREATMENT		
EX WATER TRANSMISSION LINE	INFILTRATION TRENCH OR INFILTRATION POINT DRAIN		
FIRE HYDRANT	PROPOSED STORM DRAIN PIPE		
PRV STATION	PROPOSED STORM DRAINAGE SWALE		
BOOSTER PUMP	EX STORM DRAIN		
BPA TOWER	25' SETBACK FOR CLEARING AND GRADING FROM 25% SLOPE		
PSE POLE	WATER QUALITY		
	INFILTRATION/DETENTION		

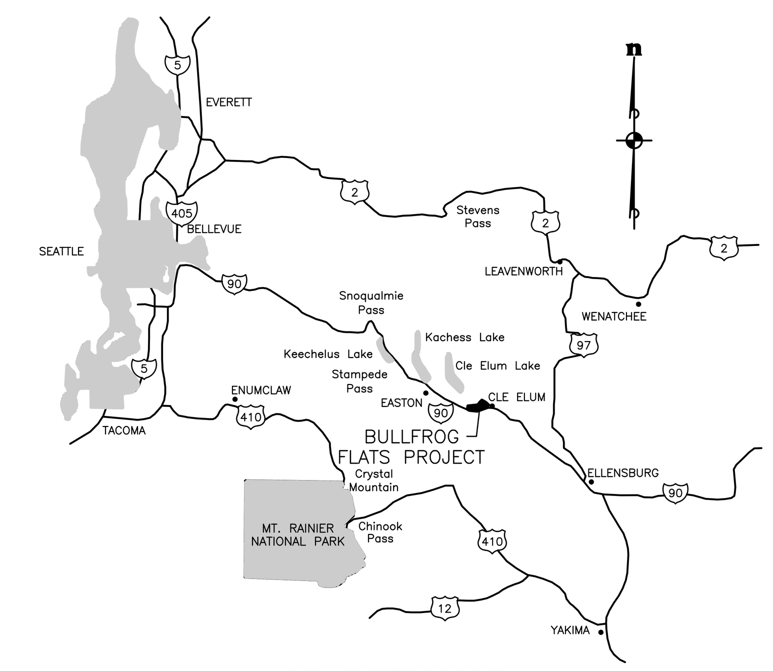
POND SPECIFIER

- A AMENITY
- D DETENTION
- I INFILTRATION
- IRR IRRIGATION
- O OVERFLOW ROUTE
- WQ WATER QUALITY
- DISPERSION

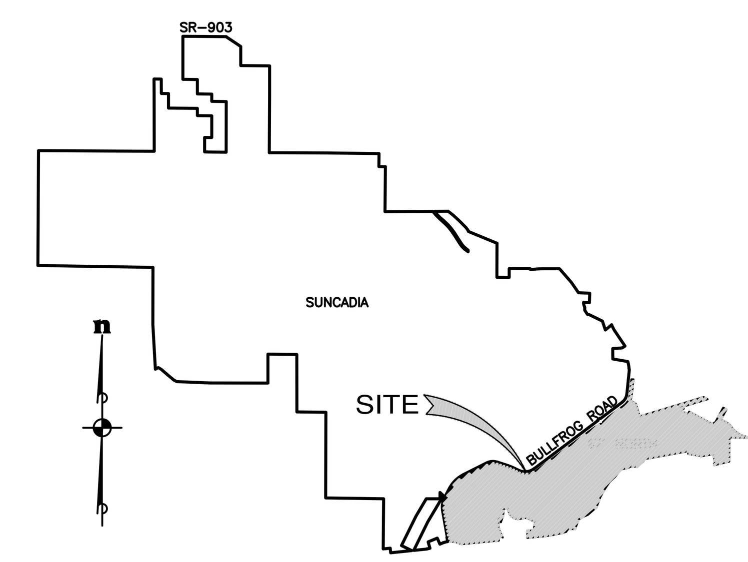
SCALE: 1" = 200'

200 100 0 200 400

CONTOUR INTERVAL = 2'



VICINITY MAP
NOT TO SCALE



KEY MAP
NOT TO SCALE

47° N
RV RESORT & RESIDENCES

REVISIONS

NO.	DESCRIPTION/DATE	BY

ESM CONSULTING ENGINEERS LLC
33400 8th Ave S, Suite 205
Federal Way, WA 98003
FEDERAL WAY (253) 838-6113
EVERETT (425) 297-9900
www.esmcivil.com
Civil Engineering | Land Surveying | Land Planning
Public Works | Project Management | Landscape Architecture

SUN COMMUNITIES INC

47° NORTH

CONCEPTUAL STORM DRAINAGE PLAN

CITY OF CLE ELUM WASHINGTON

JOB NO.	2050-001-018
DWG. NAME	EN-14
DESIGNED BY:	LGB
DRAWN BY:	JJH
CHECKED BY:	
DATE:	03/30/2020

FIG 2-6

SCALE: 1" = 200'

200 100 0 200 400

CONTOUR INTERVAL = 2'

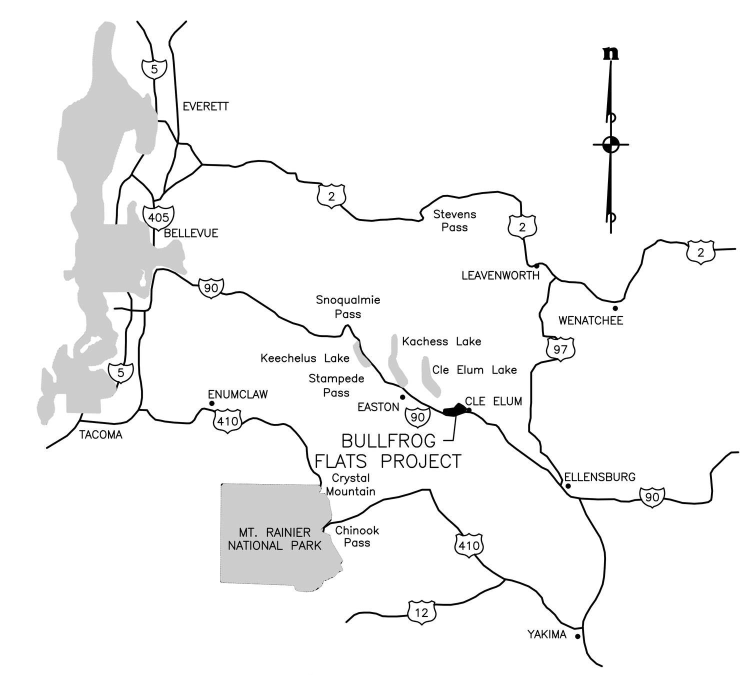
PRELIMINARY GRADING VOLUMES

RESIDENTIAL UNITS & BUSINESS PARK
CUT: 234,068 CY
FILL: 199,435 CY
NET: 34,633 CY (CUT)

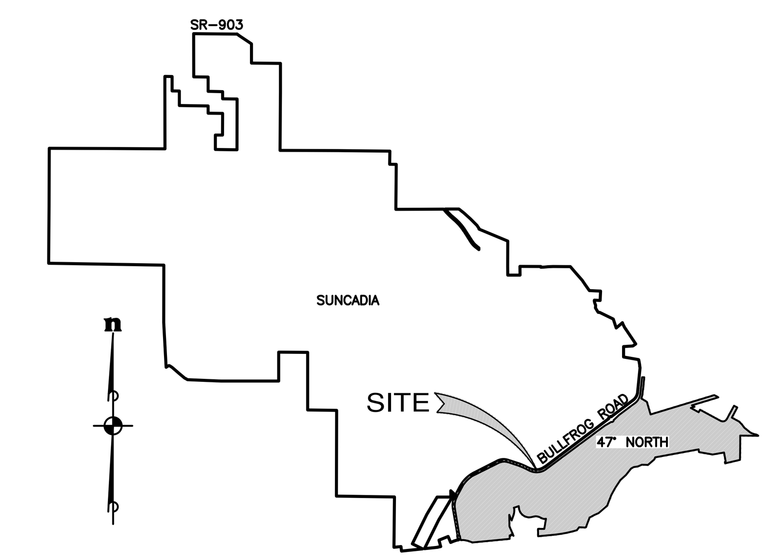
12" STRIPPING: 252,333 CY

RV & REC–1 UNITS
CUT: 116,741 CY
FILL: 110,122 CY
NET: 6,619 CY (CUT)

12" STRIPPING: 138,389 CY



VICINITY MAP
NOT TO SCALE



KEY MAP
NOT TO SCALE

47° N RV RESORT & RESIDENCES

REVISIONS		
NO.	DESCRIPTION/DATE	BY

ESM CONSULTING ENGINEERS LLC
33400 8th Ave S, Suite 205
Federal Way, WA 98003
FEDERAL WAY (253) 838–6113
EVERETT (425) 297–9900
www.esmcivil.com
Civil Engineering | Land Surveying | Land Planning
Public Works | Project Management | Landscape Architecture

SUN COMMUNITIES INC

47° NORTH

CONCEPTUAL GRADING PLAN

WASHINGTON

CITY OF CLE ELUM

JOB NO.	2050–001–018
DWG. NAME	EN–19
DESIGNED BY:	LGB
DRAWN BY:	JJH
CHECKED BY:	
DATE:	03/30/2020

FIG 1-1

1 OF 2 SHEETS

47°N
RV RESORT & RESIDENCES

REVISIONS		
NO.	DESCRIPTION/DATE	BY

ESM CONSULTING ENGINEERS LLC
33400 8th Ave S, Suite 205
Federal Way, WA 98003
FEDERAL WAY (253) 838-6113
EVERETT (425) 297-9900
www.esmcivil.com
Civil Engineering | Land Surveying | Land Planning
Public Works | Project Management | Landscape Architecture

SUN COMMUNITIES INC

47° NORTH

CONCEPTUAL GRADING PLAN

CITY OF CLE ELUM

WASHINGTON

JOB NO.	2050-001-018
DWG. NAME	EN-19
DESIGNED BY:	LGB
DRAWN BY:	JJH
CHECKED BY:	
DATE:	03/30/2020

FIG 1-1

2 OF 2 SHEETS

Note: No commercial development is proposed on the adjacent 25-acre property at this time. This conceptual site plan represents a possible layout of land uses that could be built on the property in the future.

Source: ESM Consulting Engineers, 2020.

EA Engineering, Science, and Technology, Inc., PBC

Figure 2-11

Future Commercial Development Conceptual Site Plan

APPENDIX D

Exploration Logs

			Symbol	Description
Coarse-Grained Soils - More than 50%(1) Retained on No. 200 Sieve	Gravels - More than 50%(1) of Coarse Fraction Retained on No. 4 Sieve	≤5% Fines(5)	GW	Well-graded gravel and gravel with sand, little to no fines
			GP	Poorly-graded gravel and gravel with sand, little to no fines
		≥12% Fines(5)	GM	Silty gravel and silty gravel with sand
			GC	Clayey gravel and clayey gravel with sand
	Sands - 50%(1) or More of Coarse Fraction Passes No. 4 Sieve	≤5% Fines(5)	SW	Well-graded sand and sand with gravel, little to no fines
			SP	Poorly-graded sand and sand with gravel, little to no fines
		≥12% Fines(5)	SM	Silty sand and silty sand with gravel
			SC	Clayey sand and clayey sand with gravel
Fine-Grained Soils - 50%(1) or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less than 50		ML	Silt, sandy silt, gravelly silt, silt with sand or gravel
			CL	Clay of low to medium plasticity; silty, sandy, or gravelly clay, lean clay
			OL	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50 or More		MH	Elastic silt, clayey silt, silt with micaceous or diatomaceous fine sand or silt
			CH	Clay of high plasticity, sandy or gravelly clay, fat clay with sand or gravel
			OH	Organic clay or silt of medium to high plasticity
Highly Organic Soils			PT	Peat, muck and other highly organic soils

Terms Describing Relative Density and Consistency

	Density	SPT(2) blows/foot
Coarse-Grained Soils	Very Loose	0 to 4
	Loose	4 to 10
	Medium Dense	10 to 30
	Dense	30 to 50
	Very Dense	>50

	Consistency	SPT(2) blows/foot
Fine-Grained Soils	Very Soft	0 to 2
	Soft	2 to 4
	Medium Stiff	4 to 8
	Stiff	8 to 15
	Very Stiff	15 to 30
	Hard	>30

Test Symbols

G = Grain Size
M = Moisture Content
A = Atterberg Limits
C = Chemical
DD = Dry Density
K = Permeability

Component Definitions

Descriptive Term	Size Range and Sieve Number
Boulders	Larger than 12"
Cobbles	3" to 12"
Gravel	3" to No. 4 (4.75 mm)
Coarse Gravel	3" to 3/4"
Fine Gravel	3/4" to No. 4 (4.75 mm)
Sand	No. 4 (4.75 mm) to No. 200 (0.075 mm)
Coarse Sand	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	Smaller than No. 200 (0.075 mm)

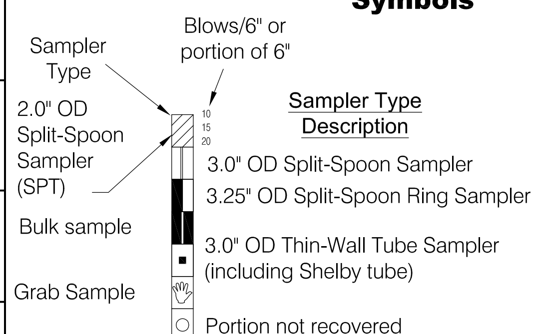
(3) Estimated Percentage

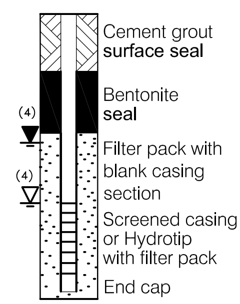
Component	Percentage by Weight
Trace	<5
Some	5 to <12
Modifier (silty, sandy, gravelly)	12 to <30
Very *modifier* (silty, sandy, gravelly)	30 to <50

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





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

Classifications of soils in this report are based on visual field and/or laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification methods of ASTM D-2487 and D-2488 were used as an identification guide for the Unified Soil Classification System.

blocks \ dwg \ log_key.dwg LAYOUT: Layout 4 -2014 Qty Chng

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EXPLORATION LOG KEY

FIGURE A1

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Exploration Boring

Project Number	Exploration Number	Sheet
190414H001	EB-1	1 of 1

Project Name	47° North	Ground Surface Elevation (ft)	2124
Location	Cle Elum, WA	Datum	NAVD 88
Driller/Equipment	Holt / Sonic Drill Rig	Date Start/Finish	10/28/19,10/28/19
Hammer Weight/Drop	N/A	Hole Diameter (in)	6

Depth (ft)	DESCRIPTION
	Topsoil
	Loess
	Moist, reddish tan to tan, fine sandy, SILT, trace gravel; nonplastic (ML).
	Outwash
5	Moist, reddish brown, silty, GRAVEL, some sand (GM).
	Becomes grayish brown, some silt with abundant cobbles (GW-GM).
10	Moist, reddish brown, silty, gravelly, SAND (SM).
15	Moist, reddish brown, very gravelly, fine to medium SAND, trace silt; contains interbeds (~3 to 10 inches thick) of very moist silt (SP).
20	Very moist, brown, sandy, SILT, trace fine gravel (ML).
25	Moist, grayish brown, silty, very gravelly, SAND (SM).
	Becomes silty to very silty; stratified.
30	Very moist, brown, SILT; laminated; thin lenses (<2 inches thick) of gravelly, silty, sand (ML).
35	
	Moist, grayish brown, very sandy, GRAVEL, some silt (GW-GM).
40	Becomes silty below 40 feet (GM).
	Some silt below 43 feet (GM-GW).
45	
	Very moist, brown, very gravelly, silty, SAND (SM).
50	Bottom of exploration boring at 50 feet No groundwater encountered.

Column headings: S T | Samples | Graphic Symbol | Well Completion | Water Level | Blows/6" | Blows/Foot (10, 20, 30, 40) | Other Tests

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

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Approved by: CJK

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Exploration Boring

Project Number	Exploration Number	Sheet
190414H001	EB-2	1 of 1

Project Name	47° North	Ground Surface Elevation (ft)	2120
Location	Cle Elum, WA	Datum	NAVD 88
Driller/Equipment	Holt / Sonic Drill Rig	Date Start/Finish	10/29/19,10/29/19
Hammer Weight/Drop	N/A	Hole Diameter (in)	6

Depth (ft)	ST	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10, 20, 30, 40)	Other Tests
0				**Topsoil**					
				Outwash Slightly moist, reddish tan, silty, GRAVEL, some sand; scattered cobbles and boulders (GW).					
5	Grab								
				Alpine Till Very moist, brown, very silty, very gravelly, SAND; with cobbles; nonstratified (SM). Easy drilling.					
10	Grab								
15	Grab								
20	Grab								
25	Grab								
30	Grab								
				Becomes moist, grayish brown, and silty.					
35	Grab								
				Becomes very moist, brown, and very silty.					
40	Grab								
45	Grab								
50	Grab			Bottom of exploration boring at 50 feet No groundwater encountered.					

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

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Approved by: CJK

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Exploration Boring

Project Number	Exploration Number	Sheet
190414H001	EB-3	1 of 1

Project Name: 47° North
Location: Cle Elum, WA
Driller/Equipment: Holt / Sonic Drill Rig
Hammer Weight/Drop: N/A

Ground Surface Elevation (ft): 2133
Datum: NAVD 88
Date Start/Finish: 10/28/19,10/28/19
Hole Diameter (in): 6

Depth (ft)	DESCRIPTION
	Topsoil
	Loess
	Moist to slightly moist, reddish tan, fine sandy, SILT (ML).
	Outwash
	Moist, reddish tan, silty, GRAVEL, some sand; contains abundant cobbles (inferred from drilling action) (GM).
5	Becomes slightly moist and tan below 4 feet.
	Becomes moist, reddish brown, and sandy below 8.5 feet.
10	
	Boulder at ~12 to 13 feet.
	Moist, grayish brown, very gravelly, fine to medium SAND, trace silt (SP).
15	
	Moist, grayish brown, very sandy, GRAVEL, trace silt (GW).
	Moist, grayish brown, silty, sandy, GRAVEL (GM).
20	Trace silt (GW) below 20 feet.
	Some silt (GW-GM) below 23 feet.
25	
	Moist, grayish brown, very gravelly, fine to medium SAND, trace silt (SP).
	Moist, grayish brown, very sandy, GRAVEL, trace silt; abundant cobbles (GW).
30	Some silt (GW-GM).
	Becomes silty (GM) at ~32 to 33 feet.
	Some silt (GW-GM) below 33 feet.
35	
40	
	Moist, brownish gray, very gravelly, fine to medium SAND, trace silt (SP).
	Moist, grayish brown, very sandy, GRAVEL, some silt (GW-GM).
45	
50	
	Bottom of exploration boring at 50 feet No groundwater encountered.

Column headings: Depth (ft) | ST | Samples | Graphic Symbol | DESCRIPTION | Well Completion | Water Level | Blows/6" | Blows/Foot (10, 20, 30, 40) | Other Tests

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

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Exploration Boring

Project Number	Exploration Number	Sheet
190414H001	EB-4	1 of 1

Project Name: 47° North
Location: Cle Elum, WA
Driller/Equipment: Holt / Sonic Drill Rig
Hammer Weight/Drop: N/A

Ground Surface Elevation (ft): 2144
Datum: NAVD 88
Date Start/Finish: 10/29/19,10/29/19
Hole Diameter (in): 6

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
				Topsoil					
				Outwash					
				Slightly moist, reddish tan to tan, silty, GRAVEL, some sand (GM).					
5	Grab								
10	Grab			Slightly moist, orangish brown, very gravelly, fine to medium SAND, trace silt (SP).					
				Moist, grayish brown, sandy, GRAVEL, some silt (GW-GM).					
				Very moist, grayish brown, silty, GRAVEL, some sand (GM).					
15	Grab								
20	Grab			Increased gravel content; abundant cobbles.					
25	Grab			Very moist, brown, very gravelly, silty, SAND (SM).					
	Grab			Very moist, brown, silty, GRAVEL, some sand (GM).					
30	Grab			Becomes sandy with some silt below 29 feet.					
	Grab			Moist, grayish brown, very gravelly, well graded SAND, trace silt (SW).					
35	Grab			Very moist, brown, very gravelly, silty, SAND (SM).					
				Some silt (SW-SM) below 36.5 feet.					
40	Grab			Becomes silty (SM) below 40 feet.					
45	Grab								
50	Grab			Bottom of exploration boring at 50 feet No groundwater encountered.					

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

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Approved by: CJK

EXPLORATION PIT NO. EP-1

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Topsoil
1	**Loess** Very stiff, slightly moist, light tan, SILT; non-plastic (ML).
2	**Alpine Till** Medium dense, slightly moist, light tan, gravelly, very silty, SAND; nonstratified (SM).
3	
4	Becomes very dense, contains scattered cobbles.
5	
6	Becomes moist and brown below 6 feet.
7	
8	
9	
10	
11	
12	
13	
14	Bottom of exploration pit at depth 14 feet No seepage. No caving.
15	
16	
17	
18	
19	
20	

KCTP3 190414H001.GPJ April 17, 2020

47° North
Cle Elum, WA

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EXPLORATION PIT NO. EP-2

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Topsoil
1	**Alpine Till**
2	Medium dense, slightly moist, light tan, very silty, gravelly, SAND; scattered cobbles and boulders; nonstratified (SM).
3	Abundant roots 0 to 3 feet.
4	
5	
6	Becomes very dense, slightly moist to moist, brown and very gravelly below 5.5 feet. Cobbles and boulders at north end of pit.
7	
8	
9	
10	
11	
12	
13	
14	Bottom of exploration pit at depth 13 feet No seepage. No caving.
15	
16	
17	
18	
19	
20	

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EXPLORATION PIT NO. EP-3

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Topsoil
1	**Loess**
	Very stiff to hard, slightly moist, light tan, SILT, some gravel below 2 feet; non-plastic (ML).
2	
	Alpine Till
3	Medium dense, slightly moist, light tan, very silty, gravelly, SAND; nonstratified (SM).
4	
5	
6	Becomes very dense and brown with scattered cobbles and boulders.
7	
8	Becomes moist below 8 feet.
9	
10	
11	
12	
13	Becomes very moist below ~13 feet.
14	
15	
16	Bottom of exploration pit at depth 15 feet No seepage. No caving.
17	
18	
19	
20	

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EXPLORATION PIT NO. EP-4

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Topsoil
1	**Loess**
2	Very stiff to hard, slightly moist, tan, SILT; non-plastic (ML).
3	
4	Some gravel below ~4 feet.
5	
6	**Outwash** Medium dense, slightly moist, tan, very sandy, GRAVEL, trace silt; abundant cobbles; stratified (GW).
7	
8	Trace to some silt below 8 feet (GW/GM).
9	
10	
11	
12	
13	
14	Bottom of exploration pit at depth 13 feet No seepage. Minor caving throughout.
15	
16	
17	
18	
19	
20	

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EXPLORATION PIT NO. EP-5

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Topsoil - 10 inches
1	**Loess** Very stiff to hard, slightly moist, tan, SILT; non-plastic (ML).
2	
3	
4	
5	
6	**Outwash**
7	Medium dense, slightly moist, grayish tan, sandy, GRAVEL, some silt; abundant cobbles; contains lenses of fine gravel; stratified (GW-GM). Trace silt below 7 feet (GW).
8	
9	
10	
11	
12	
13	
14	Bottom of exploration pit at depth 13 feet No seepage. No caving.
15	
16	
17	
18	
19	
20	

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10/21/19

EXPLORATION PIT NO. EP-6

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
0–1	**Topsoil**
1–12	**Loess** Very stiff to hard, slightly moist, tan, SILT; non-plastic (ML).
12–14	**Alpine Till** Very dense, slightly moist, tan, gravelly, very silty, SAND; scattered cobbles; nonstratified (SM).
14–20	Bottom of exploration pit at depth 14 feet No seepage. No caving.

Depth scale: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

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10/21/19

EXPLORATION PIT NO. EP-7

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Topsoil
1	**Loess**
	Very stiff, slightly moist, tan, SILT; non-plastic (ML).
2	
3	
4	
5	
6	
7	
8	**Alpine Till**
	Dense to very dense, slightly moist, tan, very gravelly, very silty, SAND; nonstratified (SM).
9	
10	
11	
12	Abundant cobbles and boulders above 12 feet Some gravel below 12 feet.
13	Bottom of exploration pit at depth 13 feet No seepage. No caving.
14	
15	
16	
17	
18	
19	
20	

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EXPLORATION PIT NO. EP-8

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Topsoil
1	**Outwash**
2	Medium dense, slightly moist, tan, gravelly, silty, SAND (SM).
3	
4	
5	
6	Medium dense, slightly moist, grayish tan, very sandy, GRAVEL, some silt; abundant cobbles; stratified (GW-GM).
7	
8	
9	
10	Becomes silty below 10 feet.
11	
12	
13	Bottom of exploration pit at depth 12 feet No seepage. Minor caving throughout.
14	
15	
16	
17	
18	
19	
20	

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Cle Elum, WA

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10/21/19

EXPLORATION PIT NO. EP-9

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
0–1	**Topsoil**
1–5.5	**Loess** Very stiff, slightly moist, tan, SILT; non-plastic (ML).
5.5–11	**Alpine Till** Dense, slightly moist, tan, gravelly, very silty, SAND; scattered cobbles; nonstratified (SM).
11	Bottom of exploration pit at depth 11 feet No seepage. No caving.

Depth scale: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

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Cle Elum, WA

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Project No. 190414H001

10/21/19

EXPLORATION PIT NO. EP-10

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Topsoil
1	**Outwash**
2	Medium dense, slightly moist, tan, gravelly, very silty, SAND (SM).
3	
4	
5	Medium dense, slightly moist, grayish tan, sandy, GRAVEL, some silt to silty (GM-GW).
6	
7	Dense, slightly moist, tan, gravelly, very silty, SAND; till-like (SM).
8	Medium dense to dense, slightly moist, tan, silty, GRAVEL, some sand; abundant cobbles; scattered boulders (GM).
9	
10	
11	Bottom of exploration pit at depth 10 feet No seepage. No caving.
12	
13	
14	
15	
16	
17	
18	
19	
20	

47° North
Cle Elum, WA

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Project No. 190414H001

10/21/19

EXPLORATION PIT NO. EP-11

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Topsoil
1	**Loess**
2	Medium dense, slightly moist, light brown to tan, SILT, trace fine sand; minor rootlets; non-cohesive (ML).
3	**Alpine Till** Medium dense, slightly moist to moist, light brownish gray to brown, very silty, fine to medium SAND, some gravel; occasional cobbles; small void spaces above 3 feet; unsorted (SM).
4	Harder digging at ~3 feet.
5	Very hard digging at 5 feet.
6	
7	Becomes moist and slightly darker brown 6.5 to 7 feet.
8	
9	
10	
11	
12	
13	Bottom of exploration pit at depth 12 feet No seepage. No caving.
14	
15	
16	
17	
18	
19	
20	

47° North
Cle Elum, WA

Logged by: TG

Approved by: CJK

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Project No. 190414H001

10/22/19

EXPLORATION PIT NO. EP-12

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Topsoil
1	**Alpine Till**
2	Loose, slightly moist, light brown to light brownish gray, very silty, fine to medium SAND, some gravel; occasional cobbles; minor rootlets; unsorted (SM).
3	
4	Occasional boulders 3 to 5 feet.
5	Becomes brown with some coarse sand in till matrix.
6	Harder digging at 6 feet.
7	
8	Increase in moisture at ~8 feet.
9	Becomes slightly darker brown with more gravel.
10	
11	Color turns slightly lighter.
12	Contains interbeds of hard, moist, light brownish gray, laminated, SILT (ML) and dense, fine to medium SAND, some silt (SP-SM).
13	
14	
15	
16	
17	Bottom of exploration pit at depth 16.5 feet No seepage. No caving.
18	
19	
20	

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47° North
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EXPLORATION PIT NO. EP-13

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Topsoil
1	**Outwash**
2	Medium dense, slightly moist, brown to brownish gray, very gravelly, silty, fine to coarse SAND (SM) to very sandy, silty, GRAVEL (GM); minor rootlets; frequent cobbles; moderate stratification.
3	
4	Material gets siltier with less gravel and more fine sand, frequent cemented clasts and occasional cobbles.
5	
6	
7	
8	Increase in moisture at ~8 feet.
9	Layer (~2 feet thick) of till-like material.
10	
11	
12	
13	Sand and gravel are coated with silt/clay with occasional silt and clay lenses containing higher moisture.
14	
15	
16	Bottom of exploration pit at depth 15 feet No seepage. Minimal caving 0 to 15 feet.
17	
18	
19	
20	

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EXPLORATION PIT NO. EP-14

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
0–1	**Topsoil**
1–3	**Loess** Very stiff, slightly moist, light tan, SILT; non-plastic (ML).
3–8	**Alpine Till** Very dense, slightly moist, tan, very gravelly, very silty, SAND; abundant cobbles and boulders (up to ~3 feet in diameter); nonstratified (SM).
8	Bottom of exploration pit at depth 8 feet No seepage. No caving.

Depth scale: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

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EXPLORATION PIT NO. EP-15

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Rocky Topsoil
1	**Glacial Erratic**
2	Highly fractured, hard, pink brown, volcanic rock; rock is in a silty matrix from 1 to 2 feet.
	Non-rippable with John Deere 135 G below 3 feet.
3	
4	Bottom of exploration pit at depth 3 feet No seepage. No caving.
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
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19	
20	

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EXPLORATION PIT NO. EP-16

Depth (ft)	DESCRIPTION
	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.
	Topsoil
1	
	Outwash
2	Medium dense, slightly moist, silty, GRAVEL, some sand; abundant cobbles; scattered boulders; contains lenses of clean fine gravel; stratified (GM).
3	
4	Becomes sandy with trace silt below 4 feet (GW).
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	Bottom of exploration pit at depth 14 feet No seepage. Minor caving throughout.
16	
17	
18	
19	
20	

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Project No. 190414H001

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EXPLORATION PIT NO. EP-17

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Topsoil
1	**Outwash**
2	Medium dense to dense, slightly moist, tan, very gravelly, very silty, SAND; abundant cobbles; stratified (SM).
3	
4	Becomes silty below 4 feet.
5	
6	
7	
8	Medium dense, slightly moist, grayish tan, sandy, GRAVEL, trace to some silt; abundant cobbles; scattered boulders (GW-GM).
9	
10	Becomes sandy to very sandy with trace silt below 10 feet.
11	
12	
13	
14	
15	Bottom of exploration pit at depth 14 feet No seepage. No caving.
16	
17	
18	
19	
20	

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EXPLORATION PIT NO. EP-18

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Topsoil - 10 inches
1	**Loess**
	Very stiff, slightly moist, tan, SILT, trace gravel; moderately abundant roots; non-plastic (ML).
2	
3	
4	**Outwash**
	Medium dense, slightly moist, tan, silty, GRAVEL, some sand; stratified (GM).
5	
6	Medium dense, slightly moist, grayish tan, sandy, GRAVEL, trace silt; abundant cobbles and small boulders (GW).
7	
8	
9	
10	Becomes grayish brown below 10 feet.
11	
12	
13	
14	
15	
16	Bottom of exploration pit at depth 15 feet No seepage. Minor caving throughout.
17	
18	
19	
20	

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Project No. 190414H001

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EXPLORATION PIT NO. EP-19

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Topsoil
1	
	Loess
2	Very stiff, slightly moist, tan, SILT, trace gravel; non-plastic (ML).
3	**Outwash**
4	Medium dense, slightly moist, tan, silty, GRAVEL, some sand (GM).
5	
	Medium dense, slightly moist, grayish brown, sandy, GRAVEL, trace silt; abundant cobbles and scattered small boulders; stratified (GW).
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	Bottom of exploration pit at depth 15 feet No seepage. Moderately severe caving.
17	
18	
19	
20	

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EXPLORATION PIT NO. EP-20

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Topsoil
1	**Alpine Till**
2	Medium dense, slightly moist, light brown to light brownish gray, very silty, fine to medium SAND, some gravel; minor rootlets; unsorted (SM).
3	
4	
5	Harder digging at ~5 feet. Becomes very gravelly with occasional cobbles (up to ~12 inches in diameter).
6	
7	Becomes moist, brown, and gravelly with some coarser sand.
8	
9	
10	Occasional boulders 9 to 10 feet.
11	
12	
13	Bottom of exploration pit at depth 13 feet No seepage. No caving.
14	
15	
16	
17	
18	
19	
20	

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EXPLORATION PIT NO. EP-21

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Topsoil
1	**Loess**
2	Loose, slightly moist, light brown to tan, SILT, some fine to medium sand, trace gravel; minor rootlets; non-cohesive (ML).
3	**Outwash** Medium dense, slightly moist, brownish gray to brown, very fine to coarse very sandy, GRAVEL, some silt; frequent cobbles; moderately stratified (GW-GM).
4	
5	
6	
7	Becomes moist ~7 to 8 feet.
8	
9	
10	
11	
12	Occasional boulders ~12 to 15 feet.
13	
14	Slightly increased moisture and becomes silty at ~14 feet.
15	Bottom of exploration pit at depth 15 feet No seepage. Minimal caving 0 to 3 feet. Moderate caving 3 to 15 feet.
16	
17	
18	
19	
20	

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Project No. 190414H001

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EXPLORATION PIT NO. EP-22

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Topsoil
1	**Loess**
2	Loose, slightly moist, light brown to brown, SILT, some fine sand, trace gravel; minor rootlets; noncohesive (ML).
3	**Outwash** Medium dense, slightly moist, very fine to coarse sandy, GRAVEL, trace silt; frequent cobbles (up to 18 inches in diameter); moderately stratified (GW).
4	
5	
6	
7	
8	Increased moisture at ~8 feet.
9	
10	Medium dense, moist to very moist, brownish gray, very gravelly, silty, fine to coarse SAND; occasional cobbles; silt/clay coated gravels; moderately stratified (SM).
11	
12	Becomes less silty with frequent cobbles 11 to 12 feet.
13	
14	
15	Medium dense, moist, brown to brownish gray, very sandy, GRAVEL, trace to some silt; frequent cobbles; moderately stratified (GP-GM).
16	Bottom of exploration pit at depth 15 feet No seepage. Minimal caving 0 to 3 feet. Moderate caving 3 to 15 feet.
17	
18	
19	
20	

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EXPLORATION PIT NO. EP-23

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
0–1	**Topsoil**
1–3.5	**Loess** Loose, slightly moist, light brown to tan, SILT, some fine to medium sand, trace gravel; minor rootlets; non-cohesive (ML).
3.5–15	**Outwash** Digging becomes gravelly at 3.5 feet, contact is indistinct. Medium dense, slightly moist, light brown, silty, very gravelly, fine to coarse SAND (SM), to very sandy GRAVEL, some silt; frequent cobbles (GP-GM); moderately stratified. Medium dense, slightly moist, light brown, very sandy, GRAVEL, trace silt; moderately stratified (GW). Becomes moist at ~8 feet with frequent large cobbles. Occasional boulders 9 to 11 feet.
15	Bottom of exploration pit at depth 15 feet Seepage?? Minimal caving 0 to 5 feet. Moderate caving 5 to 15 feet.

Depth scale: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

EXPLORATION PIT NO. EP-24

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Gravelly Topsoil
1	
	Outwash
2	Medium dense, slightly moist, light tan, silty, GRAVEL, some sand (GM).
3	
4	
5	Medium dense, slightly moist, grayish tan, sandy, GRAVEL, trace silt; abundant cobbles and scattered boulders (up to ~2.5 feet in diameter); stratified (GW).
6	
7	
8	
9	
10	
11	Becomes grayish brown and very sandy below 11 feet.
12	
13	
14	
15	Bottom of exploration pit at depth 14 feet No seepage. Minor caving throughout.
16	
17	
18	
19	
20	

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EXPLORATION PIT NO. EP-25

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Topsoil
1	Abundant roots.
2	**Outwash**
	Medium dense, slightly moist, tan, silty, GRAVEL, some sand (GM).
3	
4	
5	
6	Medium dense, slightly moist, grayish tan, sandy, GRAVEL, trace silt; contains abundant cobbles and scattered boulders (up to ~2 feet in diameter); stratified (GW).
7	
8	
9	
10	
11	Becomes grayish brown below 10.5 feet.
12	
13	
14	
15	Bottom of exploration pit at depth 14 feet No seepage. Minor caving throughout.
16	
17	
18	
19	
20	

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EXPLORATION PIT NO. EP-26

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Gravelly Topsoil
1	
2	**Outwash** Medium dense, slightly moist, tan, silty, GRAVEL, some sand; abundant cobbles (GM).
3	Scattered roots 0 to 3 feet.
4	
5	Medium dense, slightly moist, tan, sandy, GRAVEL, some silt; abundant cobbles; scattered boulders (up to ~18 inches in diameter); stratified (GW-GM).
6	
7	
8	
9	
10	
11	
12	
13	
14	Becomes moist to very moist and silty to some silt below ~13.5 feet.
15	
16	Bottom of exploration pit at depth 15 feet No seepage. No caving.
17	
18	
19	
20	

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EXPLORATION PIT NO. EP-27

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Topsoil
1	**Loess**
2	Loose, slightly moist, light brown to tan, SILT, some fine sand, trace gravel; minor rootlets; non-cohesive (ML).
3	**Outwash**
4	
5	Medium dense, slightly moist, brownish gray, sandy, silty, GRAVEL; frequent cobbles; moderately stratified (GM).
6	
7	Becomes moist at 7 feet.
8	Less cobbles 8 to 11 feet.
9	
10	
11	Becomes very sandy with more fine gravel at 11 feet.
12	
13	Medium dense, moist, brown, very gravelly, fine to coarse SAND, some silt (SP-SM) ranging to very sandy, GRAVEL, some silt (GP-GM); moderately stratified.
14	
15	Bottom of exploration pit at depth 14 feet No seepage. Minimal caving 0 to 3 feet. Moderate caving 3 to 14 feet.
16	
17	
18	
19	
20	

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EXPLORATION PIT NO. EP-28

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
0–1	**Topsoil**
1–2	**Loess** Very stiff, slightly moist to moist, reddish tan to tan, SILT, trace gravel; non-plastic (ML).
2–14.5	**Outwash** Medium dense, slightly moist, tan, silty, GRAVEL, some sand (GM). (~8) Medium dense, slightly moist, grayish tan, sandy, GRAVEL, trace silt; contains abundant cobbles and scattered boulders (up to ~18 inches in diameter) (GW). (~12) Becomes moist and grayish brown below ~12 feet.
14.5	Bottom of exploration pit at depth 14.5 feet No seepage. Minor caving throughout. Note: fill soil present in eastern corner of pit to ~5 feet.

Depth scale: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

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EXPLORATION PIT NO. EP-29

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. DESCRIPTION
	Topsoil
1	**Loess**
2	Very stiff, slightly moist, light tan, SILT, trace gravel; non-plastic; abundant roots (ML).
3	
4	**Outwash** Medium dense, slightly moist, tan, silty, GRAVEL, some sand (GM).
5	
6	Medium dense, slightly moist, grayish tan, very sandy, GRAVEL, trace to some silt; abundant cobbles and scattered boulders; stratified (GW-GM).
7	
8	
9	
10	
11	Becomes grayish brown below 11 feet.
12	
13	
14	
15	Bottom of exploration pit at depth 14.5 feet No seepage. Minor caving throughout.
16	
17	
18	
19	
20	

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EXPLORATION PIT NO. EP-30

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Topsoil - 10 inches
1	**Outwash**
	Medium dense, moist, brown, silty, GRAVEL, some sand (GM).
2	Abundant roots 0 to 2 feet.
	Becomes slightly moist and tan below 2 feet.
3	
4	
5	
	Abundant cobbles, scattered small boulders, and scattered large roots to 6 feet.
6	Medium dense, slightly moist, grayish tan, very sandy, GRAVEL, trace silt; abundant cobbles; scattered small boulders; stratified (GW).
7	
8	
9	
10	
11	
12	Becomes grayish brown and a slight increase in moisture content below ~12 feet.
13	
14	
15	
16	Bottom of exploration pit at depth 15 feet No seepage. Minor caving throughout.
17	
18	
19	
20	

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EXPLORATION PIT NO. EP-31

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Gravelly Topsoil
1	**Outwash**
2	Medium dense, moist, brown, very silty, GRAVEL, some sand; abundant cobbles; scattered small boulders (GM).
3	Abundant roots 0 to 2 feet. Becomes slightly moist and tan below 2 feet.
4	Becomes silty and sandy below ~4 feet.
5	
6	
7	
8	
9	
10	
11	Becomes slightly more moist and grayish brown with some silt (GM-GW) below 11 feet.
12	Becomes moist with trace clay below 12 feet
13	
14	
15	Becomes very moist and silty below 15 feet.
16	
17	Bottom of exploration pit at depth 16 feet No seepage. Minor caving throughout.
18	
19	
20	

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EXPLORATION PIT NO. EP-32

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Forest Duff / Topsoil
1	**Outwash**
2	
3	Medium dense, slightly moist, light brown to light brownish gray, very sandy, GRAVEL, some silt; minor rootlets; moderately stratified (GW-GM).
4	
5	Frequent large cobbles with trace silt (GP) at 5 feet.
6	
7	Becomes moist and brownish gray at ~7 feet.
8	
9	Ranges to sandy, gravel, trace silt with increased gravel and cobbles (GW) at 8 feet.
10	
11	
12	Increases to some silt (GP-GM) at 12 feet.
13	
14	Ranges to very moist at 14 feet.
15	
16	
17	Bottom of exploration pit at depth 16 feet No seepage. Minimal caving 0 to 2 feet. Moderate caving 2 to 16 feet.
18	
19	
20	

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EXPLORATION PIT NO. EP-33

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Topsoil
1	
2	**Outwash**
3	Medium dense, dry to slightly moist, light brown, very fine to medium sandy, silty, GRAVEL; minor rootlets; moderately stratified (GM).
4	
5	Material is brownish gray and contains less silt with occasional cobbles (GW-GM) at 5 feet.
6	
7	
8	Slightly increased moisture with less silt (GW) 8 to 9 feet.
9	
10	Frequent cobbles at 10 feet.
11	
12	
13	
14	
15	Material is moist with some silt (GP-GM) at 15 feet.
16	
17	Bottom of exploration pit at depth 16 feet No seepage. Minimal caving 0 to 2 feet. Moderate caving 2 to 16 feet.
18	
19	
20	

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EXPLORATION PIT NO. EP-34

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Forest Duff / Topsoil
1	**Outwash**
2	Medium dense, slightly moist, light brown, very fine sandy, silty, GRAVEL; minor rootlets; faintly stratified (GM).
3	
4	Color turns brownish gray, silt decreases, frequent cobbles, ranges to sandy, and becomes moderately stratified (GW) at 4 feet.
5	
6	Frequent large cobbles ~6 to 7 feet.
7	
8	
9	Becomes moist and very sandy with some silt at ~9 feet.
10	
11	
12	
13	
14	Ranges from moist to very moist and slightly increased silt content at 14 feet.
15	
16	
17	Bottom of exploration pit at depth 16.5 feet No seepage. Minor caving 0 to 2 feet. Moderate caving 2 to 16.5 feet.
18	
19	
20	

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10/23/19

EXPLORATION PIT NO. EP-35

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Forest Duff / Topsoil
1	
	Outwash
2	
3	Medium dense, dry to slightly moist, light brown to tan, very silty, fine SAND, some gravel; minor rootlets; cemented; massive (SM).
4	
5	
6	Sand grain size ranges to medium with slightly more gravel; cemented.
7	
8	Medium dense, slightly moist, light brown to light brownish gray, very fine to coarse sandy, GRAVEL, some silt; occasional cobbles; moderately stratified (GW-GM).
9	Less silt with frequent cobbles (GW) at 9 feet.
10	
11	Becomes moist with more sand ranging to very sandy gravel (GP) to very gravelly sand (SP).
12	
13	
14	Becomes moist to very moist and increases to some silt (GP-GM).
15	
16	
17	
18	Bottom of exploration pit at depth 17 feet No seepage. Minor caving 0 to 7 feet. Moderate caving 7 to 17 feet.
19	
20	

47° North
Cle Elum, WA

Logged by: TG
Approved by: CJK

associated earth sciences incorporated

Project No. 190414H001
10/23/19

EXPLORATION PIT NO. EP-36

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Topsoil
1	**Outwash**
2	Medium dense, dry to slightly moist, light brown to brownish gray, sandy, GRAVEL, some silt; minor rootlets; frequent cobbles (up to ~24 inches in diameter); faintly stratified (GW-GM).
3	
4	
5	Color turns more gray, becomes moderately stratified.
6	
7	
8	Becomes moist to very moist and very fine to coarse sandy.
9	
10	
11	
12	
13	Very moist 12 to 13 feet.
14	
15	
16	Bottom of exploration pit at depth 15.5 feet No seepage. Minor caving 0 to 1 feet. Moderate caving 0 to 15.5 feet.
17	
18	
19	
20	

KCTP3 190414H001.GPJ April 17, 2020

47° North
Cle Elum, WA

Logged by: TG

Approved by: CJK

associated earth sciences incorporated

Project No. 190414H001

10/23/19

EXPLORATION PIT NO. EP-37

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
0	**Forest Duff / Topsoil**
1	**Loess**
2	
3	Loose, dry to slightly moist, light brown to tan, SILT, some fine sand, trace gravel; minor rootlets; non-cohesive (ML).
4	**Outwash** Loose to medium dense, slightly moist, brownish gray, very fine to coarse very sandy, GRAVEL, some silt; frequent cobbles; moderately stratified (GW-GM).
5	
6	
7	Becomes moist and color becomes darker at 7 feet.
8	
9	
10	Color ranges to dark brownish gray to black.
11	
12	Becomes moist to very moist at 12 feet.
13	Bottom of exploration pit at depth 13 feet No seepage. Minor caving 0 to 3 feet. Moderate caving 3 to 13 feet.
14	
15	
16	
17	
18	
19	
20	

KCTP3 190414H001.GPJ April 17, 2020

47° North
Cle Elum, WA

Logged by: TG
Approved by: CJK

associated earth sciences incorporated

Project No. 190414H001

10/23/19

EXPLORATION PIT NO. EP-38

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Forest Duff / Topsoil
1	**Outwash**
2	Medium dense, dry to slightly moist, light brown to light brownish gray, very fine to coarse sandy, GRAVEL, some silt; frequent cobbles; minor rootlets; faintly stratified (GW-GM).
3	
4	Moderately stratified at 4 feet.
5	
6	
7	
8	Becomes slightly moist to moist and trace silt (GW) at 8 feet.
9	
10	Increases to some silt (GW-GM) at 10 feet.
11	
12	Color turns darker with less silt (GW) at 12 feet.
13	
	Becomes some silt (GW-GM) 13 to 14 feet.
14	
15	Bottom of exploration pit at depth 14 feet No seepage. Minor caving 0 to 2 feet. Moderate caving 2 to 14 feet.
16	
17	
18	
19	
20	

KCTP3 190414H001.GPJ April 17, 2020

47° North
Cle Elum, WA

Logged by: TG

Approved by: CJK

associated earth sciences incorporated

Project No. 190414H001

10/23/19

EXPLORATION PIT NO. EP-39

Depth (ft)

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Forest Duff / Topsoil
1	**Outwash**
2	Medium dense, dry to slightly moist, light brown, very fine sandy, silty, GRAVEL; frequent cobbles; minor rootlets; faintly stratified (GM).
3	
4	
5	
6	Color turns more gray, becomes medium to coarse sand and moderately stratified at ~6 feet.
7	Becomes some silt (GW) at 7 to 8 feet.
8	
9	
10	Increased moisture, color turns darker and less silt (GW) at 10 feet.
11	
12	
13	Becomes moist to very moist at 13 feet.
14	
15	Bottom of exploration pit at depth 15 feet No seepage. Minor caving 0 to 2 feet. Moderate caving 2 to 15 feet.
16	
17	
18	
19	
20	

47° North
Cle Elum, WA

Logged by: TG
Approved by: CJK

associated earth sciences incorporated

Project No. 190414H001

10/23/19

EXPLORATION PIT NO. EP-40

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Topsoil
1	**Loess**
2	
3	Loose, dry to slightly moist, light brown to brown, SILT, some fine to medium sand; minor rootlets; non-cohesive (ML).
4	**Outwash**
5	Medium dense, slightly moist to moist, light brown to light brownish gray, very fine to medium sandy, gravelly, SILT; minor rootlets; unsorted (ML).
6	
7	
8	Dense, moist, light brownish gray with minor oxidation, very silty, gravelly, fine to medium SAND, some coarse sand (SM).
9	
10	
11	Ranges to sandy, silty, GRAVEL (GM).
12	Occasional boulders (up to ~4 feet in diameter) 11 to 12 feet.
13	Bottom of exploration pit at depth 12.5 feet No seepage. No caving.
14	
15	
16	
17	
18	
19	
20	

KCTP3 190414H001.GPJ April 17, 2020

47° North
Cle Elum, WA

Logged by: TG

Approved by: CJK

associated earth sciences incorporated

Project No. 190414H001

10/24/19

EXPLORATION PIT NO. EP-41

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Gravelly Topsoil
1	
	Alpine Till
2	Medium dense, moist, grayish brown to brown, very silty, SAND, some gravel (SM).
3	
4	Becomes dense to very dense below 3.5 feet.
5	
6	**Outwash**
7	Medium dense to dense, slightly moist, sandy, silty, GRAVEL; stratified (GM).
8	
9	
10	
11	
12	
13	
14	
15	
16	Bottom of exploration pit at depth 15 feet No seepage. No caving.
17	
18	
19	
20	

KCTP3 190414H001.GPJ April 17, 2020

47° North
Cle Elum, WA

associated earth sciences incorporated

Logged by: TJP
Approved by: CJK

Project No. 190414H001

10/24/19

EXPLORATION PIT NO. EP-42

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
0–1	**Topsoil**
1–2	**Loess** Very stiff, moist, tan, fine sandy, SILT (ML).
2–14	**Alpine Till** Medium dense, slightly moist, very silty, SAND, some gravel; non stratified (SM). Becomes gravelly below 4 feet. Becomes medium dense to dense below ~8 feet. Contains scattered cobbles and boulders and becomes very dense below ~10 feet.
14	Bottom of exploration pit at depth 14 feet No seepage. No caving.

Depth scale: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

47° North
Cle Elum, WA

Logged by: TJP
Approved by: CJK

associated earth sciences incorporated

Project No. 190414H001

10/24/19

EXPLORATION PIT NO. EP-43

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Topsoil
1	**Loess**
2	Loose, slightly moist to moist, light brown to brown, SILT, some fine sand; minor rootlets; non-cohesive (ML).
3	**Outwash**
4	Medium dense, slightly moist, light brown, very fine to medium sandy, GRAVEL, some silt; minor rootlets; frequent cobbles; moderately stratified (GW-GM).
5	
6	
7	
8	Color turns more brownish gray, more coarse sand, and frequent large cobbles (up to ~24 inches in diameter).
9	
10	
11	
12	
13	
14	Moisture increases and more fine gravel at 13 feet.
15	Bottom of exploration pit at depth 14 feet No seepage. Minimal caving 0 to 3 feet. Moderate caving 3 to 14 feet.
16	
17	
18	
19	
20	

47° North
Cle Elum, WA

Logged by: TG
Approved by: CJK

associated earth sciences incorporated

Project No. 190414H001
10/24/19

EXPLORATION PIT NO. EP-44

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Topsoil
1	
	Alpine Till
2	
3	Medium dense, slightly moist to moist, light brownish gray, sandy, SILT, some gravel; minor rootlets; unsorted (ML).
4	
5	Becomes moist, darker brown, and harder digging at 5 feet.
6	
7	
8	Dense, moist, brownish gray, very silty, gravelly, fine to coarse SAND; occasional cobbles; unsorted (SM).
9	
10	
11	
12	
13	Becomes very sandy.
14	
15	Bottom of exploration pit at depth 14 feet No seepage. No caving.
16	
17	
18	
19	
20	

KCTP3 190414H001.GPJ April 17, 2020

47° North
Cle Elum, WA

Logged by: TG

Approved by: CJK

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Project No. 190414H001

10/24/19

EXPLORATION PIT NO. EP-45

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Topsoil
1	**Loess**
2	Very stiff, slightly moist to moist, SILT; non-plastic (ML).
3	
4	**Outwash**
5	Moist, tan, very gravelly, silty, SAND (SM).
6	
7	
8	Medium dense, slightly moist, grayish tan, very sandy, GRAVEL, trace to some silt; stratified (GM-GW).
9	
10	Becomes slightly more moist and grayish brown with trace silt below 10 feet (GW).
11	
12	Contains abundant cobbles and scattered small boulders and becomes moist below 12 feet.
13	Becomes very moist below 13 feet.
14	
15	Trace clay below 15 feet; sticky.
16	Bottom of exploration pit at depth 15.5 feet No seepage. No caving.
17	
18	
19	
20	

KCTP3 190414H001.GPJ April 17, 2020

47° North
Cle Elum, WA

Logged by: TJP
Approved by: CJK

associated earth sciences incorporated

Project No. 190414H001

10/24/19

EXPLORATION PIT NO. EP-46

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
0–1	**Topsoil**
1–4	**Loess** Very stiff, slightly moist to moist, tan to brown, SILT, trace gravel; non-plastic (ML).
4–15	**Outwash** Medium dense, slightly moit, tan, silty, GRAVEL, some sand (GM).
11	Medium dense, slightly moist, grayish brown, very sandy, GRAVEL, trace silt; stratified (GW).
12	Medium dense, moist to very moist, brown, gravelly, very silty, SAND; till-like (SM).
15	Medium dense, wet, grayish brown, very gravelly, fine to medium SAND, trace silt (SP).
15–20	Bottom of exploration pit at depth 15 feet No seepage. Minor caving throughout.

47° North
Cle Elum, WA

Logged by: TJP

Approved by: CJK

associated earth sciences incorporated

Project No. 190414H001

10/24/19

EXPLORATION PIT NO. EP-47

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
0–1.5	**Topsoil**
1.5–3	**Loess** Loose, slightly moist, light brown to brown, SILT, trace fine sand; minor rootlets; non-cohesive (ML).
3–13	**Outwash** Medium dense, dry to slightly moist, light brown, very fine to coarse sandy, GRAVEL, trace silt; moderately stratified (GW). Turns to gravelly, fine to medium sand with trace silt (SP). Medium dense, moist, light brown to tan, silty, fine SAND, trace medium sand; stratified (SM). Medium dense to dense, moist, brown to brownish gray, very silty, very gravelly, fine to coarse SAND (SM) ranging to silty, GRAVEL (GM); unsorted; till-like. Medium dense, moist to very moist, brownish gray to dark brownish gray, silty, very sandy, GRAVEL; gravels are silt/clay coated; moderately stratified (GM).
13	Bottom of exploration pit at depth 13 feet No seepage. Minimal caving 0 to 10 feet. Moderate caving 10 to 13 feet.

Depth scale: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

47° North
Cle Elum, WA

Logged by: TG
Approved by: CJK

associated earth sciences incorporated

Project No. 190414H001

10/24/19

LEGEND

- Sandy gravel with cobbles
- Sandy gravel
- Poorly sorted sand
- Well sorted sand
- Bedrock
- Diamicton
- Peat
- Silt-clay
- Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Tubex Air-Rotary, Portadrill Rig/IRT3W
Sampling Method: Grab
Elevation: 2161.54’
Boring Diameter: 6 inch
Drilling Contractor: Bach Drilling Company/Cascade Drilling, Inc.
Page 1 of 5 Boring No. *OW-1*

Water Level	169.00'	171.42	
Date	12/11/97	10/7/98	
Time	3:45 pm	1051	

Strata	Depth	Description	Well Compl..
		Brown SAND with silt, occasional gravel	
	10 X	Brown, silty, sandy, sub-rounded GRAVEL (Glacial Outwash)	
	20 X	Brown, sandy, sub-rounded GRAVEL with silt	
		grades to gray	
	30 X		
	X		
	40	occasional cobbles	
	X		
	50	Gray, rounded GRAVEL with sand and silt	

Bentonite slurry sanitary surface seal

10" borehole 0 - 18'

6" Steel Casing

NOTES: X = sample location

Drilling started: November 7, 1997 (Bach Drilling)
Well completed: November 18, 1997 (Bach Drilling)

Heave (native sand) detected in well.
Well rehibilitation started: August 25, 1998 (Cascade Drilling)
Well reconstruction completed: August 26, 1998 (Cascade Drilling)

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND

- Sandy gravel with cobbles
- Sandy gravel
- Poorly sorted sand
- Well sorted sand
- Bedrock
- Diamicton
- Peat
- Silt-clay
- Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Tubex Air-Rotary, Portadrill Rig/IRT3W
Sampling Method: Grab
Elevation: 2161.54’
Boring Diameter: 6 inch
Drilling Contractor: Bach Drilling Company/Cascade Drilling, Inc.
Page 2 of 5 Boring No. *OW-1*

Water Level	
Date	
Time	

Strata	Depth	Description	Well Compl..
	X		
	60		
	X		*6" Steel Casing*
	70		
	X	Gray, rounded GRAVEL with sand	
	80		
	X	grading to gray SAND with gravel	
	90		
	X	Gray, rounded GRAVEL with sand	
	100		

NOTES: X = sample location

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND	
Sandy gravel with cobbles	
Sandy gravel	
Poorly sorted sand	
Well sorted sand	Bedrock
Diamicton	Peat
Silt-clay	Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Tubex Air-Rotary, Portadrill Rig/IRT3W
Sampling Method: Grab
Elevation: 2161.54’
Boring Diameter: 6 inch
Drilling Contractor: Bach Drilling Company/Cascade Drilling Inc.
Page 3 of 5 Boring No. *OW-1*

Water Level	
Date	
Time	

Strata	Depth	Description	Well Compl..
	X	Gray SAND with gravel	
	110	Gray, sub-rounded GRAVEL with sand	
	X	Gray, sandy, sub-rounded GRAVEL	*6" Steel Casing*
	120		
		Gray, sub-rounded GRAVEL with silt and sand	
	X	Gray, fine to medium SAND with gravel, trace silt	
	X 130	Gray, fine to medium SAND with trace gravel	
	X	Gray, rounded GRAVEL with sand	
	140	grading to gray, sandy, sub-rounded GRAVEL	
	X		
	150		

NOTES: X = sample location

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND

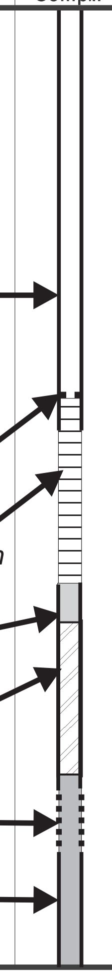
- Sandy gravel with cobbles
- Sandy gravel
- Poorly sorted sand
- Well sorted sand
- Bedrock
- Diamicton
- Peat
- Silt-clay
- Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Tubex Air-Rotary, Portadrill Rig/IRT3W
Sampling Method: Grab
Elevation: 2161.54’
Boring Diameter: 6 inch
Drilling Contractor: Bach Drilling Company/Cascade Drilling Inc.
Page 4 of 5 Boring No. *OW-1*

Water Level	
Date	
Time	

Strata	Depth	Description
Poorly sorted sand	X	Gray, medium to coarse SAND, trace small gravel
	160 X	grading to fine to medium SAND
Sandy gravel	170 X	Gray, sandy, sub-rounded GRAVEL
Poorly sorted sand	180	Brownish-gray, fine SAND
	X 190 X	
	200	

Well Compl..



NOTES: X = sample location
Bottom of casing filled with native fine sand with silt due to "heaving" soil conditions.
Casing cut at 180’ and lifted to 172’ to recomplete the well. Well screen interval: 170’ - 180’.

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND

- Sandy gravel with cobbles
- Sandy gravel
- Poorly sorted sand
- Well sorted sand
- Bedrock
- Diamicton
- Peat
- Silt-clay
- Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Tubex Air-Rotary, Portadrill Rig/IRT3W
Sampling Method: Grab
Elevation: 2161.54’
Boring Diameter: 6 inch
Drilling Contractor: Bach Drilling Company/Cascade Drilling Inc.

 Boring No. OW-1

Water Level	
Date	
Time	

Strata	Depth	Description	Well Compl..
Poorly sorted sand		Brownish-gray, very fine to fine SAND, trace silt	
	210		
	X		6" Steel casing filled with native sand
Silt	220	Brownish-gray, sandy SILT (Glaciolacustrine Deposits)	
	X		
Poorly sorted sand	230	Brownish-gray, silty, fine SAND	
	X		
		BOH @ 236'	Open bottom
	240		
	250		

NOTES: X = sample location
Bottom of casing filled with native fine sand with silt due to "heaving" soil conditions.

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND

- Sandy gravel with cobbles
- Sandy gravel
- Poorly sorted sand
- Well sorted sand
- Bedrock
- Diamicton
- Peat
- Silt-clay
- Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air Rotary (IR T3W)
Sampling Method: Grab
Elevation: 2244.28’
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
Page 1 of 7 Boring No. OW-4

Water Level	229’	223.06’
Date	8/27/98	10/8/98
Time	1745	

Strata	Depth	Description	Well Compl..
		Damp, brown, gravelly SAND with silt; grades to sandy, sub-rounded GRAVEL with silt.	*Bentonite slurry sanitary surface seal*
			10" borehole 0 - 30’
	10 X		
		becomes moist, occasional cobbles and boulders	
	20 X	Damp, brown, silty, sandy, sub-rounded GRAVEL, occasional cobbles and boulders	
	30 X	Moist, brown, sandy, sub-rounded GRAVEL with silt, occasional cobbles and boulders	
		Moist, brown, sandy, sub-rounded GRAVEL with silt	*6" Steel Casing*
	40 X	grades to gray	
		boulder at 48’	
	50 X	decreasing sand content	

NOTES: X = sample location
Drilling started August 10, 1998
Well completed August 31, 1998

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND	
Sandy gravel with cobbles	
Sandy gravel	
Poorly sorted sand	
Well sorted sand	Bedrock
Diamicton	Peat
Silt-clay	Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air-Rotary (IR T3W)
Sampling Method: Grab
Elevation: 2244.28'
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
Page 2 of 7 Boring No. *OW-4*

Water Level		
Date		
Time		

Strata	Depth	Description	Well Compl..
		Moist, gray, sub-rounded GRAVEL with sand and silt	
	60 X		*6" Steel Casing*
		grades to trace silt	
	70 X		
	80 X		
	90 X		
	100 X		

NOTES: X = sample location

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND

Sandy gravel with cobbles

Sandy gravel

Poorly sorted sand

Well sorted sand

Bedrock

Diamicton

Peat

Silt-clay

Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air Rotary (IR T3W)
Sampling Method: Grab
Elevation: 2244.28'
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
Page 3 of 7 Boring No. *OW-4*

Water Level		
Date		
Time		

Strata	Depth	Description	Well Compl..
		Gray, sub-rounded GRAVEL with sand, trace silt	
	110 X		*6" Steel Casing*
	120 X		
	130 X		
	140 X		
	150 X		

NOTES: X = sample location

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND	
Sandy gravel with cobbles	
Sandy gravel	
Poorly sorted sand	
Well sorted sand	Bedrock
Diamicton	Peat
Silt-clay	Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air Rotary (IR T3W)
Sampling Method: Grab
Elevation: 2244.28'
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
Page 4 of 7 Boring No. *OW-4*

Water Level		
Date		
Time		

Strata	Depth	Description	Well Compl..
	160 X	Gray, sandy, sub-rounded GRAVEL, trace silt	*6" Steel Casing*
		Gray, sub-rounded GRAVEL with sand, trace silt	
	170 X		
	180 X		
	190 X		
		thin lense of tan silty gravel with sand 195' - 196'	
		Gray, gravelly, medium to coarse SAND, trace silt	
	200 X		

NOTES: X = sample location

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND	
Sandy gravel with cobbles	
Sandy gravel	
Poorly sorted sand	
Well sorted sand	Bedrock
Diamicton	Peat
Silt-clay	Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air Rotary (IR T3W)
Sampling Method: Grab
Elevation: 2244.28’
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
 Boring No. *OW-4*

Water Level		
Date		
Time		

Strata	Depth	Description	Well Compl..
		decreasing gravel content	
	210 X	Gray, fine to medium SAND, occasional gravel, trace silt	*6" Steel Casing*
		Tan-gray, silty, fine SAND.	
	X		
	220		
			10/8/98 (223.06’)
	X		
	230	Gray, fine to medium SAND with silt	
	X		
	240 X	Gray, fine to medium SAND, trace silt	*Bottom of casing at 244’*
			Neoprene “K” packer
		Tan, fine SAND.	*5” Stainless steel continuous slot screen; 0.010 slot width*
	250 X		

NOTES: X = sample location

Casing extends to 244.
Well screen interval: 242.5’ - 252.5’.

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND

- Sandy gravel with cobbles
- Sandy gravel
- Poorly sorted sand
- Well sorted sand
- Bedrock
- Diamicton
- Peat
- Silt-clay
- Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air Rotary (IR T3W)
Sampling Method: Grab
Elevation: 2244.28'
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
Page 6 of 7 Boring No. *OW-4*

Water Level		
Date		
Time		

Strata	Depth	Description	Well Compl..
		increasing silt content	
	260		
		Gray, silty, fine SAND	
	X		
	270		*Borehole collapsed to 252-1/2'*
	X		
	280		
	X	Gray, sandy SILT	
	290	occasional wood fragments	
	X		
	300		

NOTES: X = sample location

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND

- Sandy gravel with cobbles
- Sandy gravel
- Poorly sorted sand
- Well sorted sand
- Bedrock
- Diamicton
- Peat
- Silt-clay
- Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air Rotary (IR T3W)
Sampling Method: Grab
Elevation: 2244.28'
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
Page 7 of 7 Boring No. *OW-4*

Water Level		
Date		
Time		

Strata	Depth	Description	Well Compl..
	X	Gray SILT/CLAY (Glaciolacustrine Deposits)	
	310 X		
	X		
	320	*Borehole collapsed to 252-1/2'*	
	X		
	330 X		
		BOH @ 330' on 8/17/98	
	340		
	350		

NOTES: X = sample location

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND

- Sandy gravel with cobbles
- Sandy gravel
- Poorly sorted sand
- Well sorted sand
- Bedrock
- Diamicton
- Peat
- Silt-clay
- Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air-Rotary (IR T3W)
Sampling Method: Grab
Elevation: 2197.24’
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
Page 1 of 5 Boring No. OW-5

Water Level	154.5’	151.91’
Date	8/27/98	10/7/98
Time	1720	1041

Strata	Depth	Description	Well Compl..
		Damp, brown, sandy, sub-rounded GRAVEL with silt, occasional cobbles and boulders.	Bentonite slurry sanitary surface seal
	X 10		10" borehole 0 - 20’
	X 20	Moist, gray to brown, sub-rounded GRAVEL with sand and silt.	
		increasing sand content	
	X 30	Moist, brown to gray, sandy, sub-rounded GRAVEL with silt	6" Steel Casing
		Moist, gray, gravelly, medium SAND with silt	
	X 40	Moist, gray, sandy, sub-rounded GRAVEL with silt	
	X 50		

NOTES: X = sample location
Drilling started: August 17, 1998
Well completed: September 3, 1998

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND	
Sandy gravel with cobbles	
Sandy gravel	
Poorly sorted sand	
Well sorted sand	Bedrock
Diamicton	Peat
Silt-clay	Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air-Rotary (IR T3W)
Sampling Method: Grab
Elevation: 2197.24’
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
Page 2 of 5 Boring No. *OW-5*

Water Level	
Date	
Time	

Strata	Depth	Description	Well Compl..
	60 X		
	70 X		*6" Steel Casing*
	80 X	Gray, sub-rounded GRAVEL with sand, trace silt	
	90 X		
	100 X		

NOTES: X = sample location

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND

- Sandy gravel with cobbles
- Sandy gravel
- Poorly sorted sand
- Well sorted sand
- Bedrock
- Diamicton
- Peat
- Silt-clay
- Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air-Rotary (IR T3W)
Sampling Method: Grab
Elevation: 2197.24'
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
 Boring No. *OW-5*

Water Level		
Date		
Time		

Strata	Depth	Description	Well Compl..
		increasing sand and silt content	
	110 X		*6" Steel Casing to 160'*
		decreasing sand and silt content	
	120 X		
	130 X		
		Gray, medium SAND, occasional gravel, trace silt	
	140 X	increasing gravel and silt contect	
		Gray, gravelly, medium SAND with silt	
	150 X	Gray, sandy, sub-rounded GRAVEL, trace silt	*Perforated casing (148' - 158')*

NOTES: X = sample location
Perforated casing: 148'-158'.

ASSOCIATED EARTH SCIENCES, INC

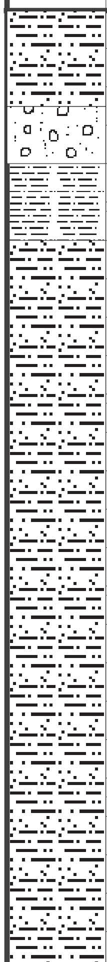
Drilling Log

LEGEND

- Sandy gravel with cobbles
- Sandy gravel
- Poorly sorted sand
- Well sorted sand
- Bedrock
- Diamicton
- Peat
- Silt-clay
- Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air-Rotary (IR T3W)
Sampling Method: Grab
Elevation: 2197.24'
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
Page 4 of 5 Boring No. *OW-5*

Water Level		
Date		
Time		

Strata	Depth	Description	Well Compl..
	160 X 170 X 180 X 190 X 200 X	10/7/98 (151.91') Tan-gray, silty, sub-rounded GRAVEL with sand Gray silt/clay Gray, gravelly SILT with sand boulder at 175'-177' Gray, sandy SILT with gravel	*Perforated Casing 148' - 158'* *Silica sand 160' - 162'* *Bentonite 162' - 166-1/2'* *Borehole collapsed to 166-1/2'* 

NOTES: X = sample location

Casing perforated: 148' - 158'
Casing extends to 160'.
Drilled open-hole air rotary from 160' to 230'.

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND

- Sandy gravel with cobbles
- Sandy gravel
- Poorly sorted sand
- Well sorted sand
- Bedrock
- Diamicton
- Peat
- Silt-clay
- Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air-Rotary (IR T3W)
Sampling Method: Grab
Elevation: 2197.24’
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
Page 5 of 5 Boring No. *OW-5*

Water Level		
Date		
Time		

Strata	Depth	Description	Well Compl..
		Borehole collapsed to 166-1/2’ →	
	210 X	Brown to gray, gravelly, sandy SILT	
	220 X		
	230 X	BOH @ 230’	
	240		
	250		

NOTES: X = sample location
BOH @ 230’ on 8/18/98

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND	
Sandy gravel with cobbles	
Sandy gravel	
Poorly sorted sand	
Well sorted sand	Bedrock
Diamicton	Peat
Silt-clay	Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air-Rotary (IR T3W)
Sampling Method: Grab
Elevation: Approx. 2041.73’
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
Page 1 of 4 Boring No. *OW-7*

Water Level	105.6	112.12’
Date	8/27/98	10/8/98
Time	1820	0730

Strata	Depth	Description	Well Compl..
		Damp, brown, sandy, sub-rounded GRAVEL with silt	*Bentonite slurry sanitary surface seal*
	X 10		
		Moist, gray to brown, sandy, sub-rounded GRAVEL with silt, occasional cobbles	*10" borehole 0 - 20’*
	X 20		
		grades to gray	
	X 30		
			6" Steel Casing
	X 40		
	X 50		

NOTES: X = sample location
Drilling started: August 19, 1998
Well completed: August 20, 1998

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND

- Sandy gravel with cobbles
- Sandy gravel
- Poorly sorted sand
- Well sorted sand
- Bedrock
- Diamicton
- Peat
- Silt-clay
- Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air-Rotary (IR T3W)
Sampling Method: Grab
Elevation: Approx. 2041.73'
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
Page 2 of 4 Boring No. *OW-7*

Water Level	
Date	
Time	

Strata	Depth	Description	Well Compl..
	60 X	Gray, sub-rounded GRAVEL with sand, trace silt	
	70 X		*6" Steel Casing*
	80 X		
	90 X		
	100 X		

NOTES: X = sample location

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND	
Sandy gravel with cobbles	
Sandy gravel	
Poorly sorted sand	
Well sorted sand	Bedrock
Diamicton	Peat
Silt-clay	Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air-Rotary (IR T3W)
Sampling Method: Grab
Elevation: Approx. 2041.73'
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
Page 3 of 4 Boring No. OW-7

Water Level	
Date	
Time	

Strata	Depth	Description	Well Compl..
		Gray to brown, sub-rounded GRAVEL with sand and silt (Older Glacial Deposits)	
	110 X		10/8/98 (112.12')
	120 X	saturated	6" Steel Casing
	130 X		
	140 X		
		Saturated, gray to brown, sandy, sub-rounded GRAVEL with silt	
	100 X		

NOTES: X = sample location

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND	
Sandy gravel with cobbles	
Sandy gravel	
Poorly sorted sand	
Well sorted sand	Bedrock
Diamicton	Peat
Silt-clay	Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air-Rotary (IR T3W)
Sampling Method: Grab
Elevation: Approx. 2041.73'
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
Page 4 of 4 Boring No. OW-7

Water Level	
Date	
Time	

Strata	Depth	Description	Well Compl..
	160 X	Brown to gray, medium to coarse SAND with gravel and silt	
		grades to medium sand	
	170 X	Gray, gravelly, medium to coarse SAND with silt	6" Steel Casing
	180 X		
		Brown to gray, fine to medium, micaceous SAND with gravel and silt	Neoprene "K" packer
	190 X		Bottom of casing at 191'
			5" Stainless steel continuous slot screen; 0.010-inch slot width
	200	BOH @ 198'	

X

NOTES: X = sample location

Well screen interval: 188' - 198'.

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND

- Sandy gravel with cobbles
- Sandy gravel
- Poorly sorted sand
- Well sorted sand
- Bedrock
- Diamicton
- Peat
- Silt-clay
- Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air-Rotary (IR T3W)
Sampling Method: Grab
Elevation: Approx. 2049.62'
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
Page 1 of 4 Boring No. *OW-8*

Water Level	128.5	116.52'
Date	8/27/98	10/8/98
Time	1810	0715

Strata	Depth	Description	Well Compl..
		Damp, brown, sandy, sub-rounded GRAVEL with silt, occasional cobbles, and boulders	*Bentonite slurry surface seal*
	10 X		
		Moist, brown, silty, sandy, sub-rounded GRAVEL	*10" borehole 0 - 30'*
	20 X	Moist, brown, sandy, sub-rounded GRAVEL with silt, occasional cobbles and boulders	
		grades to gray	
	30 X	no boulders	
			6" Steel Casing
	40 X		
	50 X		

NOTES: X = sample location
Drilling started: August 20, 1998
Well completed: August 24, 1998

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND	
Sandy gravel with cobbles	
Sandy gravel	
Poorly sorted sand	
Well sorted sand	Bedrock
Diamicton	Peat
Silt-clay	Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air-Rotary (IR T3W)
Sampling Method: Grab
Elevation: Approx. 2049.62'
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
Page 2 of 4 Boring No. OW-8

Water Level	
Date	
Time	

Strata	Depth	Description	Well Compl..
		Gray, sandy, sub-rounded GRAVEL with silt	
	60 X		
	70 X	Tan to gray, fine SAND with silt, occasional gravel (Older Glacial Deposits)	
		Gray, silty, fine SAND	6" Steel Casing
	80 X		
	90 X	Gray, sandy SILT	
	100 X	occasional wood fragments	

NOTES: X = sample location

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND

- Sandy gravel with cobbles
- Sandy gravel
- Poorly sorted sand
- Well sorted sand
- Bedrock
- Diamicton
- Peat
- Silt-clay
- Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air-Rotary (IR T3W)
Sampling Method: Grab
Elevation: Approx. 2049.62’
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
Page 3 of 4 Boring No. *OW-8*

Water Level	
Date	
Time	

Strata	Depth	Description	Well Compl..
		Gray, silty CLAY	
	X 110		
		10/8/98 (116.52’)	
	X 120	*6" Steel Casing*	
	X 130		
	X 140	Gray, sandy, silty CLAY	
		Gray, silty CLAY with gravel, occasional sand (Lodgement Till)	
	X 100		

NOTES: X = sample location

ASSOCIATED EARTH SCIENCES, INC

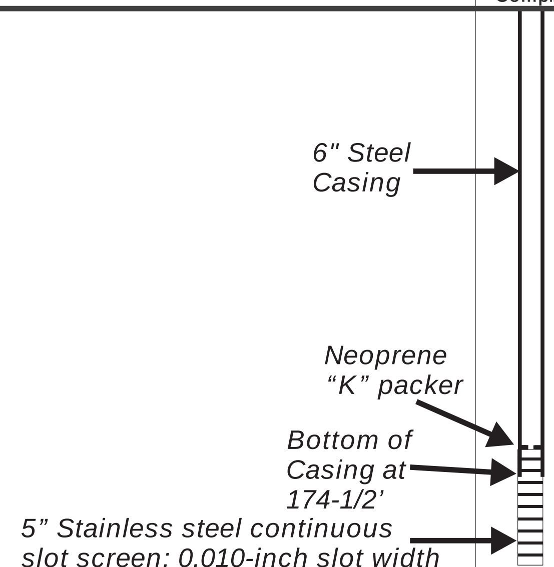
Drilling Log

LEGEND	
Sandy gravel with cobbles	
Sandy gravel	
Poorly sorted sand	
Well sorted sand	Bedrock
Diamicton	Peat
Silt-clay	Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air-Rotary (IR T3W)
Sampling Method: Grab
Elevation: Approx. 2049.62'
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
Page 4 of 4   Boring No. *OW-8*

Water Level	
Date	
Time	

Strata	Depth	Description	Well Compl..
	160 X	Gray, silty CLAY	
	170 X	Gray, sandy SILT, occasional gravel	
	180 X	Gray, silty, fine to medium quartz and basaltic SAND	
		BOH @ 180'	
	190		
	200		



X

NOTES: X = sample location

Well screen interval: 174' - 179'.

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND

- Sandy gravel with cobbles
- Sandy gravel
- Poorly sorted sand
- Well sorted sand
- Bedrock
- Diamicton
- Peat
- Silt-clay
- Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air-Rotary (IR T3W)
Sampling Method: Grab
Elevation: Approx. 2162.39'
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
Page 1 of 4 Boring No. *OW-9*

Water Level	130.9	132.10'
Date	8/28/98	10/7/98
Time	0705	1159

Strata	Depth	Description	Well Compl..
		Bentonite slurry sanitary surface seal	
	10 X	Damp, brown, sandy, sub-rounded GRAVEL with silt, occasional cobbles and boulders	
		10" borehole 0 - 30'	
		increases silt content	
	20 X	Moist, gray, sandy, sub-rounded GRAVEL with silt	
		@ 24'-26' Moist, gray, gravelly SAND with silt	
	30 X		
		increasing silt content	
		Gray, sandy, sub-rounded GRAVEL with silt	
		6" Steel Casing	
	40 X		
	50 X		

NOTES: X = sample location
Drilling started: August 26, 1998
Well completed: August 27, 1998

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND	
Sandy gravel with cobbles	
Sandy gravel	
Poorly sorted sand	
Well sorted sand	Bedrock
Diamicton	Peat
Silt-clay	Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air-Rotary (IR T3W)
Sampling Method: Grab (Cyclone)
Elevation: Approx. 2162.39'
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
 Boring No. *OW-9*

Water Level	
Date	
Time	

Strata	Depth	Description	Well Compl..
		Moist, gray, sandy, sub-rounded GRAVEL with silt	
	60 X		
	70 X		
		6" Steel Casing →	
	80 X		
	90 X		
	100 X		

NOTES: X = sample location

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

LEGEND

- Sandy gravel with cobbles
- Sandy gravel
- Poorly sorted sand
- Well sorted sand
- Bedrock
- Diamicton
- Peat
- Silt-clay
- Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air-Rotary (IR T3W)
Sampling Method: Grab
Elevation: Approx. 2162.39'
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
Page 3 of 4 Boring No. *OW-9*

Water Level	
Date	
Time	

Strata	Depth	Description	Well Compl..
		Moist, gray, sandy, sub-rounded GRAVEL with silt	
	110 X		
	120 X		*6" Steel Casing*
	130 X	Gray, silty SAND with gravel	10/7/98 (132.10')
		Gray, sandy, sub-rounded GRAVEL with silt	
	140 X		
	150 X		

NOTES: X = sample location

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

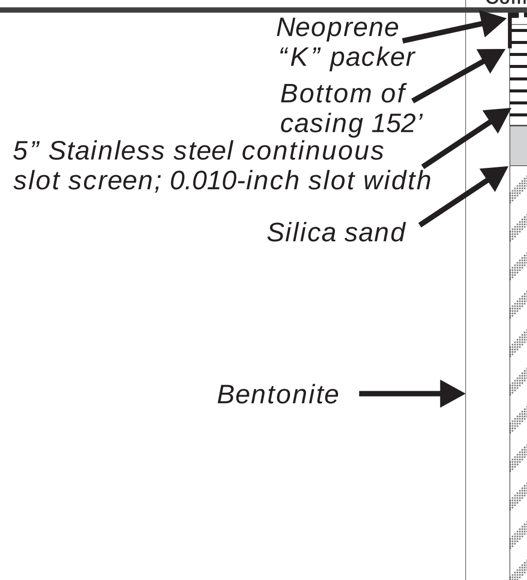
LEGEND

- Sandy gravel with cobbles
- Sandy gravel
- Poorly sorted sand
- Well sorted sand
- Bedrock
- Diamicton
- Peat
- Silt-clay
- Silt

Project Name: Mountain Star
Project Number: KG97186D
Drilling Method: Air-Rotary (IR T3W)
Sampling Method: Grab
Elevation: Approx. 2162.39'
Boring Diameter: 6 inch
Drilling Contractor: Cascade Drilling Inc.
Page 4 of 4 Boring No. *OW-9*

Water Level	
Date	
Time	

Strata	Depth	Description	Well Compl..
	160 X	Green-gray SILTSTONE.	
		Coal	
	170 X	Gray/greenSILTSTONE (Roslyn Formation)	
	180 X	BOH @ 180'	
	190		
	200		



X

NOTES: X = sample location

Drilled open-hole air rotary from 160' - 180'.
Well screen interval: 151' - 156'.

ASSOCIATED EARTH SCIENCES, INC

Drilling Log

EXPLORATION PIT LOG

Number EP-28-1

Depth (ft)	Description
0–2.5	Soft, dry, reddish-brown to yellowish-brown, sandy SILT with gravel and cobbles. (Loess and Glacial Outwash)
2.5–4	Loose to medium dense, dry, reddish-brown to brown, sandy GRAVEL with cobbles, few boulders; poorly sorted. (Glacial Outwash)
4–12	Medium dense, dry grading to moist, yellowish-brown to brown, silty, sandy GRAVEL with cobbles, boulders; subangular to subrounded; very poorly sorted. (Glacial Outwash)
12–13.5	Medium dense, moist, light brown, coarse-grained SAND with silt, gravel; subrounded. (Glacial Outwash)
13.5	BOH @ 13-1/2'

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26

Reviewed By

EXPLORATION PIT LOG

Number EP-28-2

Depth (ft)	Description
0 – 1/2	Forest Duff/Topsoil.
1/2 – 4	Stiff, dry, reddish-brown SILT with sand and few gravels. (Loess)
4 – 12	Medium dense, dry, reddish-brown to brown, sandy GRAVEL with cobbles, boulders; subangular to subrounded; poorly sorted. (Glacial Outwash)
12 – 14-1/2	Medium dense, moist, brown, medium-grained to coarse-grained sandy GRAVEL with cobbles, few boulders; poorly sorted. (Glacial Outwash)
14-1/2	BOH @ 14-1/2'

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26

Reviewed By

EXPLORATION PIT LOG

Number EP-28-3

Depth (ft)	Description
0	Forest Duff/Topsoil.
	Soft, dry, yellowish-brown, clayey SILT with sand, few gravel and cobbles. (Loess and Glacial Outwash)
2	
4	Loose, dry, yellowish-brown, silty, sandy GRAVEL wtih cobbles, boulders; subangular to subrounded; poorly sorted. (Glacial Outwash)
6	
8	
10	Loose to medium dense, moist, brown, sandy GRAVEL with cobbles, boulders; subangular to subrounded; poorly sorted. (Glacial Outwash)
12	
14	BOH @ 13'
16	
18	
20	
22	
24	
26	

Subsurface conditions depicted represent our observation at the time and location of this exploratory hole, modified by geologic interpretation, engineering analysis, and judgment. They are not necessarily representative of other times and location. We will not accept responsibility for the use or interpretation by others of information presented on this log.

Reviewed By

ASSOCIATED EARTH SCIENCES, INC

MountainStar MPR
Kittitas County, Washington
Project No. H97186A
September-November 1997

EXPLORATION PIT LOG

Number EP-28-4

Depth (ft)	Description
0	Forest Duff/Topsoil.
	Soft, dry, yellowish-brown, clayey SILT with sand, few gravel and cobbles. (Loess and Glacial Outwash)
	Loose, dry, yellowish-brown, silty, sandy GRAVEL with cobbles, boulders; subangular to subrounded; poorly sorted. (Glacial Outwash)
8	Loose to medium dense, moist, brown, sandy GRAVEL with cobbles and boulders; subangular to subrounded; poorly sorted. (Glacial Outwash)
	BOH @ 11'

0 2 4 6 8 10 12 14 16 18 20 22 24 26

Subsurface conditions depicted represent our observation at the time and location of this exploratory hole, modified by geologic interpretation, engineering analysis, and judgment. They are not necessarily representative of other times and location. We will not accept responsibility for the use or interpretation by others of information presented on this log.

Reviewed By

ASSOCIATED EARTH SCIENCES, INC

MountainStar MPR
Kittitas County, Washington
Project No. H97186A
September-November 1997

EXPLORATION PIT LOG

Number EP-28-5

Depth (ft)	Description
0	Forest Duff/Topsoil.
	Soft, dry, yellowish-brown, sandy, clayey SILT with few gravels, cobbles. (Loess)
2	
4	Loose, dry, yellowish-brown, silty, sandy GRAVEL with cobbles and few boulders; subangular to subrounded; poorly sorted. (Glacial Outwash)
6	
8	
10	Loose to medium dense, moist, brown, sandy GRAVEL with cobbles; subangular to subrounded; poorly sorted. (Glacial Outwash)
12	
14	
16	BOH @ 14-1/2'
18	
20	
22	
24	
26	

Subsurface conditions depicted represent our observation at the time and location of this exploratory hole, modified by geologic interpretation, engineering analysis, and judgment. They are not necessarily representative of other times and location. We will not accept responsibility for the use or interpretation by others of information presented on this log.

Reviewed By

ASSOCIATED EARTH SCIENCES, INC

MountainStar MPR
Kittitas County, Washington
Project No. H97186A
September-November 1997

EXPLORATION PIT LOG

Number EP-29-1

Depth (ft)	Description
0–1	Forest Duff/Topsoil.
1–7	Dense to very dense, dry to moist, reddish-brown, silty, fine-grained to coarse-grained SAND with gravel, few cobbles and boulders; very poorly sorted. (Lodgement Till)
7–9	Very stiff to hard, moist, brown, sandy SILT with gravel. (Lodgement Till)
9–10.5	Dense to very dense, dry to moist, reddish-brown, silty, fine-grained to coarse-grained SAND with gravel, few cobbles and boulders; very poorly sorted. (Lodgement Till)
10.5–14.5	Stiff to hard, moist, reddish-brown, sandy SILT with gravel, few cobbles and boulders. (Lodgement Till)
14.5	BOH @ 14-1/2'

Depth scale: 0 2 4 6 8 10 12 14 16 18 20 22 24 26

Subsurface conditions depicted represent our observation at the time and location of this exploratory hole, modified by geologic interpretation, engineering analysis, and judgment. They are not necessarily representative of other times and location. We will not accept responsibility for the use or interpretation by others of information presented on this log.

Reviewed By

ASSOCIATED EARTH SCIENCES, INC

MountainStar MPR
Kittitas County, Washington
Project No. H97186A
September-November 1997

EXPLORATION PIT LOG

Number EP-29-2

Depth (ft)	Description
0	Forest Duff/Topsoil.
	Loose, dry grading to moist, reddish-brown, silty, fine-grained SAND. (Loess)
2	
4	
6	Medium dense, moist, dark reddish-brown, silty, medium-grained SAND with gravel, cobbles, boulders; poorly sorted. (Glacial Outwash)
8	
10	
12	Medium dense, moist to wet, brown, fine-grained to coarse-grained SAND with silt, gravel; poorly sorted; seepage observed at 10-1/2'. (Glacial Outwash)
14	
16	Loose, wet (saturated), brown, coarse-grained sandy GRAVEL; well sorted. (Glacial Outwash)
	BOH @ 16-1/2'
18	
20	
22	
24	
26	

Subsurface conditions depicted represent our observation at the time and location of this exploratory hole, modified by geologic interpretation, engineering analysis, and judgment. They are not necessarily representative of other times and location. We will not accept responsibility for the use or interpretation by others of information presented on this log.

Reviewed By

EXPLORATION PIT LOG

Number EP-29-3

Depth (ft)	Description
0	Forest Duff/Topsoil.
	Soft, dry, reddish-brown, sandy SILT with trace gravel. (Loess)
2	
	Loose, dry to moist, reddish-brown, silty GRAVEL with fine-grained to medium-grained sand, few cobbles and boulders; subangular to subrounded; poorly sorted. (Glacial Outwash)
4	
	Medium dense, moist, brown, fine-grained to medium-grained sandy GRAVEL with silt, cobbles, boulders; very poorly sorted. (Glacial Outwash)
6	
8	
10	
12	grading to less silt; increasing moisture
	BOH @ 12-1/2'
14	
16	
18	
20	
22	
24	
26	

Subsurface conditions depicted represent our observation at the time and location of this exploratory hole, modified by geologic interpretation, engineering analysis, and judgment. They are not necessarily representative of other times and location. We will not accept responsibility for the use or interpretation by others of information presented on this log.

Reviewed By

ASSOCIATED EARTH SCIENCES, INC

MountainStar MPR
Kittitas County, Washington
Project No. H97186A
September-November 1997

EXPLORATION PIT LOG

Number EP-29-7

Depth (ft)	Description
0	Forest Duff/Topsoil.
2	Medium stiff to very stiff/medium dense to dense, dry grading to moist, light reddish-brown, very fine-grained sandy SILT to silty SAND with trace gravel. (Loess)
6	Medium dense, moist, yellowish-brown, silty, fine-grained to medium-grained sandy GRAVEL with cobbles; subangular to subrounded; poorly sorted. (Glacial Outwash)
8	Medium dense, moist, brown, gravelly, medium-grained to coarse-grained SAND with few cobbles; subangular to subrounded; moderately well sorted. (Glacial Outwash)
16	layer of sandy gravel @ 16' to 16-1/2'
16-1/2	BOH @ 16-1/2'

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26

Subsurface conditions depicted represent our observation at the time and location of this exploratory hole, modified by geologic interpretation, engineering analysis, and judgment. They are not necessarily representative of other times and location. We will not accept responsibility for the use or interpretation by others of information presented on this log.

Reviewed By

ASSOCIATED EARTH SCIENCES, INC

MountainStar MPR
Kittitas County, Washington
Project No. H97186A
September-November 1997

EXPLORATION PIT LOG

Number EP-32-1

Depth (ft)	Description
0	Forest Duff/Topsoil.
2	Soft to stiff, dry, yellowish-brown, sandy SILT with gravel, cobbles, boulders; poorly sorted. (Loess and Glacial Outwash)
4	
6	(gradational contact)
	Loose to medium dense, dry, brown, silty, fine-grained SAND with gravel, cobbles, boulders; poorly sorted. (Glacial Outwash)
8	
10	Medium dense, moist, brown, medium-grained to coarse-grained sandy GRAVEL with cobbles; subangular to rounded; poorly sorted. (Glacial Outwash)
12	
14	BOH @ 14'
16	
18	
20	
22	
24	
26	

Subsurface conditions depicted represent our observation at the time and location of this exploratory hole, modified by geologic interpretation, engineering analysis, and judgment. They are not necessarily representative of other times and location. We will not accept responsibility for the use or interpretation by others of information presented on this log.

Reviewed By

ASSOCIATED EARTH SCIENCES, INC

MountainStar MPR
Kittitas County, Washington
Project No. H97186A
September-November 1997

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

52135

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. W072137
UNIQUE WELL I.D. # ACK 141
Water Right Permit No:

(1) OWNER: Name BPA Address N/A

(2) LOCATION OF WELL: County Kittitas ~~NE~~ SE 1/4 SE 1/4 Sec 28 T. 19 20 N., R 15 E W.M.

(2a) STREET ADDRESS OF WELL (or nearest address) Cle Elum Hatchery CE 2A

(3) PROPOSED USE: ☐ Domestic ☐ Irrigation ☐ DeWater Industrial ☐ Test Well ☐ Municipal ☐ Other ☒

(4) TYPE OF WORK: Owner's number of well (If more than one) CE 2A
Abandoned ☐ New well ☒ Deepened ☐ Reconditioned ☐
Method: Dug ☐ Cable ☒ Rotary ☐ Bored ☐ Driven ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 16" inches.
Drilled 255 feet. Depth of completed well 215 ft.

(6) CONSTRUCTION DETAILS:
Casing Installed: 16" Diam. from +2 ft. to 152 ft.
Welded ☒ " Diam. from ft. to ft.
Liner installed ☐ " Diam. from ft. to ft.
Threaded ☐

Perforations: Yes ☐ No ☒
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☒ No ☐
Manufacturer's Name Cook
Type 304 Model No.
Diam. 14 Slot size 125 from 155 ft. to 205 ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☒ Size of gravel
Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 65' ft.
Material used in seal Bentonite
Did any strata contain unusable water? Yes ☐ No ☐
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level 1925.53 ft.
Static level Flowing ft. below top of well Date
Artesian pressure Approx 10 PSI lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☒ No ☐ If yes, by whom? Driller
Yield: 1600 gal./min. with 95' ft. drawdown after 24 hrs.
" " " "
" " " "
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test gal./min. with ft. drawdown after hrs.
Airtest gal./min. with stem set at ft. for hrs.
Artesian flow g.p.m. Date
Temperature of water 47 Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
Brown sand + gravel	0	18
Gray silt + clay	18	45
Silty sand + gravel	45	70
Sand + gravel some silt	70	102
Gray silt	102	110
Sand + gravel sandy layers	110	165
Fine sand some gravel	165	180
sand + gravel sandy layers	180	215
Fine silty dirty sand	215	255
Northing 678066.00		
Easting 1884277.95		

RECEIVED JAN 24 1997 DEPARTMENT OF ECOLOGY CENTRAL REGION OFFICE

Work Started 8-1-96 19 Completed 10-1-96 19

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME Holt Drilling Inc (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)
Address 10621 Todd Rd E
(Signed) Rudy Holt (WELL DRILLER) License No. 1099
Contractor's Registration No. HOLDI 1360G Date 12-12-96, 19

(USE ADDITIONAL SHEETS IF NECESSARY)

Ecology is an Equal Opportunity and Affirmative Action employer. For special accommodation needs, contact the Water Resources Program at (206) 407-6600. The TDD number is (206) 407-6006.

ECY 050-1-20 (9/93)

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. N072150
UNIQUE WELL I.D. # ACK-139
Water Right Permit No.

(1) OWNER: Name BPA Address N/A SW

(2) LOCATION OF WELL: County Kittitas ~~NE~~ 1/4 SE 1/4 Sec 28 T. ~~19~~ 20 N., R 15 W.M.

(2a) STREET ADDRESS OF WELL (or nearest address) Cle Elum Hatchery CE 4A

(3) PROPOSED USE: ☐ Domestic ☐ Irrigation ☐ DeWater Industrial ☐ Test Well ☐ Municipal ☐ Other ☒

(4) TYPE OF WORK: Owner's number of well (If more than one) CE 4
Abandoned ☐ New well ☒ Deepened ☐ Reconditioned ☐ Method: Dug ☐ Cable ☒ Rotary ☐ Bored ☐ Driven ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 16" inches.
Drilled 173 feet. Depth of completed well 160 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 16" Diam. from +2 ft. to 96 ft.
Welded ☒ " Diam. from ft. to ft.
Liner installed ☐ " Diam. from ft. to ft.
Threaded ☐

Perforations: Yes ☐ No ☒
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☒ No ☐
Manufacturer's Name Cook
Type 304 Model No.
Diam. 14 Slot size 200 from 100 ft. to 125 ft.
Diam. 14 Slot size 100 from 125 ft. to 150 ft.

Gravel packed: Yes ☐ No ☒ Size of gravel
Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 40' ft.
Material used in seal Bentonite
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level 1934.85 ft.
Static level Flowing ft. below top of well Date
Artesian pressure Approx 10 PSI lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☒ No ☐ If yes, by whom? Driller
Yield: 1460 gal./min. with 67 ft. drawdown after 24 hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test gal./min. with ft. drawdown after hrs.
Airtest gal./min. with stem set at ft. for hrs.
Artesian flow g.p.m. Date
Temperature of water 48.5 Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
Brown + Blue Silt	0	25
Gray clay	25	63
Sand + gravel sand layers	63	150
Silty sand	150	173
Northing 677863.59		
Easting 1882946.96		

RECEIVED ... 1996
DEPARTMENT OF ECOLOGY
CENTRAL REGION OFFICE

Work Started 9-15-96, 19. Completed 11-15-96, 19

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME Holt Drilling Inc (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)
Address 10621 Todd Rd E
(Signed) [signature] (WELL DRILLER) License No. 1099
Contractor's Registration No. HOLTDI 136O6 Date 12-12, 1996

(USE ADDITIONAL SHEETS IF NECESSARY)

Ecology is an Equal Opportunity and Affirmative Action employer. For special accommodation needs, contact the Water Resources Program at (206) 407-6600. The TDD number is (206) 407-6006.

ECY 050-1-20 (9/93)

Well Report Change Form

IMPORTANT: GET AS MUCH INFORMATION AS POSSIBLE. THIS FORM WILL BE USED TO FIND THE WELL REPORT. ALL REQUIRED FIELDS MUST BE FILLED IN. USE INK PEN ONLY WHEN FILLING OUT THIS FORM.

(REQUIRED) This Well Report has been changed on (Date) ____/____/____

(Required) Person Requesting Change ____________________

(Required) Contact Phone No. (____) ____________

(REQUIRED) ☑ Not in NITS ☐ NITS Log ID#____________

Regional Office: ☐ CRO ☐ ERO ☐ NWRO ☐ SWRO

Well Type: ☐ Water Well ☐ Resource Protection Well

Notice of Intent #:____________ Unique Ecy Well ID Tag No:____________

(Required) Original Owner Name:____________

Well Street Address:____________

City:____________ County:____________ Zip Code:____________

Geographic Location:

(Required) ____ 1/4 of the ____ 1/4 Section____ Township____ Range____ EWM or WWM *(circle one)*

(Optional) Lat Degrees ____ Lat Time ____ Horizontal collection method code ____

Long Degrees ____ Long Time ____

Tax Parcel No (include all zeros and dashes):____________

Type of Work: ☐ New Well ☐ Reconditioned ☐ Deepened

Well Report Recvd Date:____/____/____ Well Completed Date:____/____/____

Well Diameter (in):____ Well Depth (ft):____ Other:____________

Driller License No:____________ Trainee License No:____________

Other (Specify):____________

(Required) Reason for Change image/record NOT changed

(Required) Tracker Signature: JMRamsey

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

52143

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. W 072146
UNIQUE WELL I.D. #
Water Right Permit No.

(1) OWNER: Name BPA Address N/A NW NE 20

(2) LOCATION OF WELL: County Kittitas NE 1/4 SE 1/4 Sec 33 T. 19 N., R. 15 E W.M.

(2a) STREET ADDRESS OF WELL (or nearest address) CleElum Fish Hatchery TH 2 B

(3) PROPOSED USE: ☐ Domestic ☐ Irrigation ☐ DeWater Industrial ☐ Test Well ☒ Municipal ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (If more than one) TH-2
Abandoned ☐ New well ☐ Deepened ☐ Reconditioned ☐ Method: Dug ☐ Cable ☐ Rotary ☒ Bored ☐ Driven ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 8" inches.
Drilled 260 feet. Depth of completed well 260 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 8" Diam. from +2 ft. to 260 ft.
Welded ☒ " Diam. from ___ ft. to ___ ft.
Liner installed ☐
Threaded ☐ " Diam. from ___ ft. to ___ ft.

Perforations: Yes ☐ No ☒
Type of perforator used
SIZE of perforations ___ in. by ___ in.
___ perforations from ___ ft. to ___ ft.
___ perforations from ___ ft. to ___ ft.
___ perforations from ___ ft. to ___ ft.

Screens: Yes ☐ No ☒
Manufacturer's Name
Type ___ Model No. ___
Diam. ___ Slot size ___ from ___ ft. to ___ ft.
Diam. ___ Slot size ___ from ___ ft. to ___ ft.

Gravel packed: Yes ☐ No ☒ Size of gravel
Gravel placed from ___ ft. to ___ ft.

Surface seal: Yes ☐ No ☒ To what depth? ___ ft.
Material used in seal
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? ___ Depth of strata ___
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: ___ H.P. ___

(8) WATER LEVELS: Land-surface elevation above mean sea level 1928.83 ft.
Static level N/A ft. below top of well Date
Artesian pressure / lbs. per square inch Date
Artesian water is controlled by ___ (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes, by whom?
Yield: ___ gal./min. with ___ ft. drawdown after ___ hrs.
" " "
" " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
	N/A				

Date of test
Bailer test ___ gal./min. with ___ ft. drawdown after ___ hrs.
Airtest ___ gal./min. with stem set at ___ ft. for ___ hrs.
Artesian flow ___ g.p.m. Date
Temperature of water ___ Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
Silt	0	3
well graded gravel	3	12
Clay + Silt	12	167
silty gravel	167	199
well graded gravel with silty layers	199	245
Silty Sand	245	260
RECEIVED JAN 24 1997 DEPARTMENT OF ECOLOGY CENTRAL REGION OFFICE		
Northing 677264.79		
Easting 1883060.53		

Work Started 8-20-96 19 Completed 9-20-96 19

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME Holt Drilling Inc (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)

Address 10621 Todd Rd E

(Signed) Rudy Holt (WELL DRILLER) License No. 1099

Contractor's Registration No. HOLTDI 136OG Date 1-20-97 19

(USE ADDITIONAL SHEETS IF NECESSARY)

Ecology is an Equal Opportunity and Affirmative Action employer. For special accommodation needs, contact the Water Resources Program at (206) 407-6600. The TDD number is (206) 407-6006.

ECY 050-1-20 (9/93)

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

52142

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. W072145
UNIQUE WELL I.D. # ______
Water Right Permit No. ______

(1) OWNER: Name BPA Address N/A

(2) LOCATION OF WELL: County Kittitas NE ~~NW~~ 1/4 NE ~~SE~~ 1/4 Sec 33 T. 19 N., R 15 E W.M.

(2a) STREET ADDRESS OF WELL (or nearest address) CleElum Fish Hatchery TH 3 20 A

(3) PROPOSED USE: ☐ Domestic ☐ Irrigation ☐ DeWater Industrial ☐ Test Well ☒ Municipal ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (If more than one) TH 3
Abandoned ☐ New well ☐ Deepened ☐ Reconditioned ☐ Method: Dug ☐ Cable ☐ Rotary ☒ Bored ☐ Driven ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 8 inches.
Drilled 261 feet. Depth of completed well 261 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 8" Diam. from +2 ft. to 261 ft.
Welded ☒ ____" Diam. from ____ ft. to ____ ft.
Liner installed ☐
Threaded ☐ ____" Diam. from ____ ft. to ____ ft.

Perforations: Yes ☐ No ☒
Type of perforator used ______
SIZE of perforations ______ in. by ______ in.
______ perforations from ______ ft. to ______ ft.
______ perforations from ______ ft. to ______ ft.
______ perforations from ______ ft. to ______ ft.

Screens: Yes ☐ No ☒
Manufacturer's Name ______
Type ______ Model No. ______
Diam. ____ Slot size ____ from ____ ft. to ____ ft.
Diam. ____ Slot size ____ from ____ ft. to ____ ft.

Gravel packed: Yes ☐ No ☒ Size of gravel ______
Gravel placed from ______ ft. to ______ ft.

Surface seal: Yes ☐ No ☒ To what depth? ______ ft.
Material used in seal ______
Did any strata contain unusable water? Yes ☐ No ☐
Type of water? ______ Depth of strata ______
Method of sealing strata off ______

(7) PUMP: Manufacturer's Name ______
Type: ______ H.P. ______

(8) WATER LEVELS: Land-surface elevation above mean sea level 1928.26 ft.
Static level N/A ft. below top of well Date ______
Artesian pressure ______ lbs. per square inch Date ______
Artesian water is controlled by ______ (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes, by whom? ______
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
N/A					

Date of test ______
Bailer test ______ gal./min. with ______ ft. drawdown after ______ hrs.
Airtest ______ gal./min. with stem set at ______ ft. for ______ hrs.
Artesian flow ______ g.p.m. Date ______
Temperature of water ______ Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
Sand + gravel silt	0	14
Clay + silt	14	190
Sand + gravel silty layers	190	252
Clay + silt	252	261
Northing 677095.61		
Easting 1883964.81		

RECEIVED JAN 24 1997 DEPARTMENT OF ECOLOGY CENTRAL REGION OFFICE

Work Started 8-20-96 19 Completed 9-20-96 19

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME Holt Drilling Inc (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)
Address 10621 Todd Rd E
(Signed) Rudy Holt (WELL DRILLER) License No. 1099
Contractor's Registration No. HOLTDI1360G Date 1-20, 1997

(USE ADDITIONAL SHEETS IF NECESSARY)

Ecology is an Equal Opportunity and Affirmative Action employer. For special accommodation needs, contact the Water Resources Program at (206) 407-6600. The TDD number is (206) 407-6006.

ECY 050-1-20 (9/93)

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

R026901

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

12658

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. ~~W072138~~

UNIQUE WELL I.D. # ~~W072138~~ ACK 128

Water Right Permit No. ______

(1) OWNER: Name BPA Address N/A

(2) LOCATION OF WELL: County Kittitas ~~SE~~ NE 1/4 ~~SE~~ NE 1/4 Sec ~~27~~ 33 T. ~~19~~ 20 N., R 15 E W.M.

(2a) STREET ADDRESS OF WELL (or nearest address) Cle Elum Fish Hatchery TH 6

A

(3) PROPOSED USE: ☐ Domestic ☐ Irrigation ☐ DeWater Industrial ☐ Test Well ☒ Municipal ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (If more than one) TH-6

Abandoned ☐ New well ☒ Deepened ☐ Reconditioned ☐ Method: Dug ☐ Cable ☐ Rotary ☒ Bored ☐ Driven ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 8" inches.
Drilled 260 feet. Depth of completed well 237 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 2" Diam. from +2 ft. to 237 ft.
Welded ☐ ____ " Diam. from ____ ft. to ____ ft.
Liner installed ☐
Threaded ☒ ____ " Diam. from ____ ft. to ____ ft.

Perforations: Yes ☐ No ☒
Type of perforator used ______
SIZE of perforations ______ in. by ______ in.
______ perforations from ______ ft. to ______ ft.
______ perforations from ______ ft. to ______ ft.
______ perforations from ______ ft. to ______ ft.

Screens: Yes ☒ No ☐
Manufacturer's Name Johnson
Type PVC Model No. ______
Diam. 2" Slot size 10 from 230 ft. to 235 ft.
Diam. ____ Slot size ____ from ____ ft. to ____ ft.

Gravel packed: Yes ☐ No ☒ Size of gravel ______
Gravel placed from ______ ft. to ______ ft.

Surface seal: Yes ☒ No ☐ To what depth? 60' ft.
Material used in seal Bentonite
Did any strata contain unusable water? Yes ☐ No ☐
Type of water? ______ Depth of strata ______
Method of sealing strata off ______

(7) PUMP: Manufacturer's Name ______
Type: ______ H.P. ______

(8) WATER LEVELS: Land-surface elevation above mean sea level 1921.66 ft.
Static level Flowing ft. below top of well Date ______
Artesian pressure Approx 10 PSI lbs. per square inch Date ______
Artesian water is controlled by ______ (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes, by whom? ______
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ______
Bailer test ______ gal./min. with ______ ft. drawdown after ______ hrs.
Airtest ______ gal./min. with stem set at ______ ft. for ______ hrs.
Artesian flow ______ g.p.m. Date ______
Temperature of water ______ Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
Brown silt	0	3
Silty sand + gravel	3	15
Gray clay	15	150
Silty gravel	150	157
Sand with some silt	157	227
Sand + gravel	227	236
Silt Stone	236	260
Northing 677450.70		
Easting 1885465.64		

RECEIVED
JAN 24 1997
DEPARTMENT OF ECOLOGY
CENTRAL REGION OFFICE

Work Started 9-15-94, 19__ Completed 10-15-96, 19__

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME Holt Drilling Inc (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)
Address 10621 Todd Rd E
(Signed) [signature] (WELL DRILLER) License No. 1094
Contractor's Registration No. HOLDI 13606 Date 12-12-1996

(USE ADDITIONAL SHEETS IF NECESSARY)

Ecology is an Equal Opportunity and Affirmative Action employer. For special accommodation needs, contact the Water Resources Program at (206) 407-6600. The TDD number is (206) 407-6006.

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

52139

WATER WELL REPORT
STATE OF WASHINGTON

Start Card No. W072142
UNIQUE WELL I.D. #
Water Right Permit No.

(1) OWNER: Name BPA Address N/A

(2) LOCATION OF WELL: County Kittitas SW 1/4 SW 1/4 Sec 27 T. 20 N., R 15 E W.M.

(2a) STREET ADDRESS OF WELL (or nearest address) Cle Elum Fish Hatchery TH-7

(3) PROPOSED USE: ☐ Domestic ☐ Irrigation ☐ DeWater Industrial ☐ Test Well ☒ Municipal ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (If more than one) TH-7
Abandoned ☐ New well ☐ Deepened ☐ Reconditioned ☐ Method: Dug ☐ Cable ☐ Rotary ☒ Bored ☐ Driven ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 8" inches.
Drilled 240 feet. Depth of completed well 240 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 8" Diam. from +2 ft. to 240 ft.
Welded ☒ ____" Diam. from ____ ft. to ____ ft.
Liner installed ☐
Threaded ☐ ____" Diam. from ____ ft. to ____ ft.

Perforations: Yes ☐ No ☒
Type of perforator used
SIZE of perforations ____ in. by ____ in.
____ perforations from ____ ft. to ____ ft.
____ perforations from ____ ft. to ____ ft.
____ perforations from ____ ft. to ____ ft.

Screens: Yes ☐ No ☒
Manufacturer's Name
Type ____ Model No.
Diam. ____ Slot size ____ from ____ ft. to ____ ft.
Diam. ____ Slot size ____ from ____ ft. to ____ ft.

Gravel packed: Yes ☐ No ☒ Size of gravel
Gravel placed from ____ ft. to ____ ft.

Surface seal: Yes ☐ No ☒ To what depth? ____ ft.
Material used in seal
Did any strata contain unusable water? Yes ☐ No ☐
Type of water? ____ Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: ____ H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level 1921.66 ft.
Static level N/A ft. below top of well Date
Artesian pressure ____ lbs. per square inch Date
Artesian water is controlled by ____ (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes, by whom?
Yield: ____ gal./min. with ____ ft. drawdown after ____ hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
N/A					

Date of test
Bailer test ____ gal./min. with ____ ft. drawdown after ____ hrs.
Airtest ____ gal./min. with stem set at ____ ft. for ____ hrs.
Artesian flow ____ g.p.m. Date
Temperature of water ____ Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
Silty gravel	0	14
Clay + silt	14	92
Silty gravel	92	119
Sandy silt	119	189
Silty gravel	189	204
clay	204	240
Northing 677450.70		
Easting 1885465.64		

RECEIVED
JAN 24 1997
DEPARTMENT OF ECOLOGY
CENTRAL REGION OFFICE

Work Started 9-20-96 19 . Completed 10-10-96 19

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME Holt Drilling Inc (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)
Address 10621 Todd Rd E
(Signed) Ken Holt (WELL DRILLER) License No. 1099

Contractor's Registration No. HOLTDI136OG Date 1-20, 1997

(USE ADDITIONAL SHEETS IF NECESSARY)

Ecology is an Equal Opportunity and Affirmative Action employer. For special accommodation needs, contact the Water Resources Program at (206) 407-6600. The TDD number is (206) 407-6006.

ECY 050-1-20 (9/93)

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS				TYPICAL NAMES
COARSE GRAINED SOILS More than half is larger than No. 200 Sieve	GRAVELS More than half coarse fraction is larger than No. 4 sieve size	Clean gravels with little or no fines	GW	Well graded gravels, gravel-sand mixtures
			GP	Poorly graded gravels, gravel-sand mixtures
		Gravels with over 12% fines	GM	Silty gravels, poorly graded gravel-sand-silt mixtures
			GC	Clayey gravels, poorly graded gravel-sand-clay mixtures
	SANDS More than half coarse fraction is smaller than No. 4 sieve size	Clean sands with little or no fines	SW	Well graded sands, gravelly sands
			SP	Poorly graded sands, gravelly sands
		Sands with over 12% fines	SM	Silty sand, poorly graded sand-silt mixtures
			SC	Clayey sands, poorly graded sand-clay mixtures
FINE GRAINED SOILS More than half is smaller than No. 200 Sieve	SILTS AND CLAYS Liquid limit less than 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic clays and organic silty clays of low plasticity
	SILTS AND CLAYS Liquid limit greater than 50		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils

SAMPLE

- ■ "Undisturbed"
- ▨ Bulk/Grab
- ◫ Not Recovered
- ▥ Recovered, Not Retained

CONTACT BETWEEN UNITS

- Well Defined Change
- Gradational Change
- Obscure Change
- End of Exploration

BLOWS PER FOOT

Hammer is 140 pounds with 30-inch drop, unless otherwise noted

- S - SPT Sampler (2.0-Inch O.D.)
- T - Thin Wall Sampler (2.8-Inch Sample)
- H - Split Barrel Sampler (2.4-Inch Sample)

MOISTURE DESCRIPTION

- Dry - Considerably less than optimum for compaction
- Moist - Near optimum moisture content
- Wet - Over optimum moisture content
- Saturated - Below water table, in capillary zone, or in perched groundwater

PHYSICAL PROPERTY TESTS

Consol	-	Consolidation
LL	-	Liquid Limit
PL	-	Plastic Limit
Gs	-	Specific Gravity
SA	-	Size Analysis
TxS	-	Triaxial Shear
TxP	-	Triaxial Permeability
Perm	-	Permeability
Po	-	Porosity
MC	-	Moisture Content
MD	-	Moisture/Density
DS	-	Direct Shear
VS	-	Vane Shear
Comp	-	Compaction
UU	-	Unconsolidated, Undrained
CU	-	Consolidated, Undrained
CD	-	Consolidated, Drained

AGI TECHNOLOGIES

Soil Classification/Legend

Trendwest Properties: Cle Elum UGA Draft EIS
Cle Elum, Washington

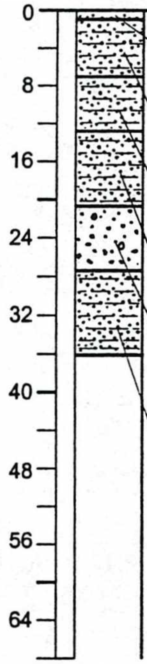
PLATE 1

	PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
soilcleg.cdr	14,887.011	PJS	7/20/99			

Laboratory Tests | Moisture Content (%) | Depth (inches) | Sample

Test Pit Number 1

Land Surface Elevation ~2,130 feet Date 5/11/99



0" - 1" Dark Brown (7.5 YR 3/2) Sandy Loam (SM), loose, forest duff and leaf litter, fine grained.

1" - 7" Dark Brown (7.5 YR 3/4) Sandy Loam (SM), fine grained, with 5% fine to medium gravel, common fine-medium roots.

7" - 13" Dark Brown (7.5 YR 3/4) Sandy Loam (SM), fine grained, with 5% fine to medium gravel, common fine roots.

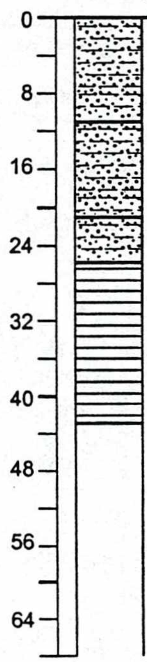
13" - 21" Dark Yellowish Brown (10 YR 3/4) Sandy Loam (SM), fine grained, common fine roots, with 5% fine to medium gravel.

21" - 27" Dark Yellowish Brown (10 YR 3/4) Gravelly Sandy Loam (SW), fine to coarse grained, gravel - fine to coarse with cobbles, with many fine roots.

27" - 36" Dark Yellowish Brown (10 YR 3/6) Gravelly Sandy Loam (SM), with pockets of clean gray sand, with cobbles and fine roots, 12% clay.

Test Pit Number 2

Land Surface Elevation ~2,130 feet Date 5/11/99



0" - 11" Dark Brown (10 YR 3/3) Sandy Loam (SM), loose, with black mottling, many fine roots, fine grained with some coarser sand.

11" - 21" Dark Brown (7.5 YR 3/4) Sandy Loam (SM), loose, fine to medium grained, with 1% to 2% of gravel, and fine roots.

21" - 26" Brown (10 YR 4/3) Sandy Loam (SM), soft, with 1% to 2% gravel, fine grained.

26" - 43" Dark Yellowish Brown (10 YR 4/4) Sandy Clay Loam (CL), slightly hard, with fine tubular pores, slight mottling.

AGI TECHNOLOGIES

Exploration Logs

Trendwest Properties: Cle Elum UGA Draft EIS
Cle Elum, Washington

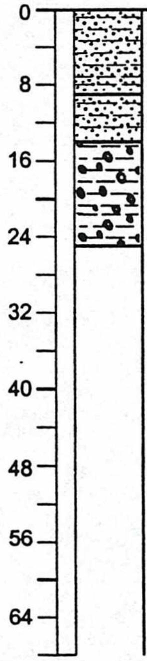
PLATE **2**

	PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
4887011tp.cdr	14,887.011	PJS	7/19/99			

Laboratory Tests | Moisture Content (%) | Depth (inches) | Sample

Test Pit Number 3

Land Surface Elevation ~2,120 feet Date 5/11/99



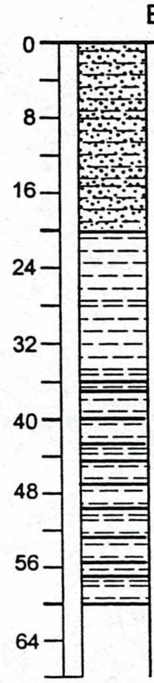
0" - 9" Brown (10 YR 4/3) Sandy Loam (SM), soft, with many fine roots, fine grained.

9" - 14" (7.5 YR 3/4) Sandy Loam (SM), soft, fine grained, 1% gravel.

14" - 25" Dark Yellowish Brown (10 YR 4/4) Very Gravelly Sandy Loam (GM), fine to coarse grained, fine to coarse gravel.

Hand Auger Number 4

Land Surface Elevation ~2,170 feet Date 5/11/99



0" - 20" Dark Yellowish Brown (10 YR 3/4) Sandy Loam (SM), soft, fine grained.

20" - 36" Dark Yellowish Brown (10 YR 4/4) Silt Loam (ML), slightly hard, trace gravel, 20% clay, slightly mottled.

36" - 60" Dark Yellowish Brown (10 YR 4/4) Silt Loam (ML-CL), slightly hard, trace gravel, 20% to 25% clay, slightly mottled.

AGI TECHNOLOGIES

Exploration Logs

Trendwest Properties: Cle Elum UGA Draft EIS
Cle Elum, Washington

PLATE 3

	PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
4887011tp.cdr	14,887.011	PJS	7/19/99			

Laboratory Tests	Moisture Content (%)	Depth (inches)	Sample	

Hand Auger Number 5

Land Surface Elevation ~2,150 feet Date 5/11/99

Depth (inches): 0, 8, 16, 24, 32, 40, 48, 56, 64

0" - 6" Very Dark Grayish Brown (7.5 YR 3/2) Sandy Loam (SM), loose, fine grained, with trace coarse sand and many fine roots.

6" - 12" (10 YR 4/3) Sandy Loam (SM).

Refusal on gravel at 12".

Hand Auger Number 6

Land Surface Elevation ~2,030 feet Date 5/12/99

Depth (inches): 0, 8, 16, 24, 32, 40, 48, 56, 64

0" - 1" Duff.

1" - 24" Dark Brown (7.5 YR 3/4) Loam (SM), fine grained, with 5% gravel, many fine roots.

Refusal at 24".

AGI TECHNOLOGIES

Exploration Logs

Trendwest Properties: Cle Elum UGA Draft EIS

Cle Elum, Washington

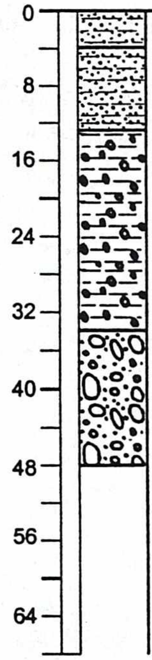
PLATE 4

	PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
4887011tp.cdr	14,887.011	PJS	7/19/99			

Laboratory Tests | Moisture Content (%) | Depth (inches) | Sample

Test Pit Number 7

Land Surface Elevation ~2,030 feet Date 5/12/99



0" - 4" Very Dark Brown (10 YR 2/2) Loam and Forest Duff, fine roots.

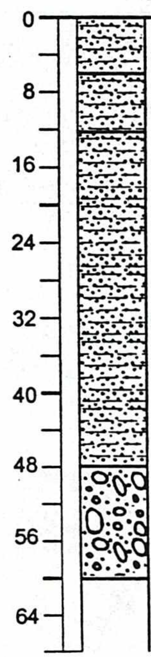
4" - 13" Dark Brown (7.5 YR 3/4) Sandy Loam (SM), 5% of gravel, fine-grained sand.

13" - 34" (7.5 YR 4/6) Very Gravelly Loam (GM), 15% clay.

34" - 48" Dark Yellowish Brown (10 YR 3/4) Extremely Gravelly Sandy Loam (GW), with cobbles, medium- to coarse-grained sand.

Test Pit Number 8

Land Surface Elevation ~2,045 feet Date 5/12/99



0" - 6" Very Dark Grayish Brown (7.5 YR 3/2) Sandy Loam (SM), loose, with fine roots, 5% to 10% clay.

6" - 12" Dark Brown (7.5 YR 3/4) Sandy Loam (SM), soft, fine roots.

12" - 48" (7.5 YR 4/6) Sandy Loam (SM), 10% to 15% clay, 5% gravel (fine to medium).

48" - 60" Dark Yellowish Brown (10 YR 3/4) Very Gravelly/Cobbly Loamy Sand (GW).

AGI TECHNOLOGIES

Exploration Logs

Trendwest Properties: Cle Elum UGA Draft EIS
Cle Elum, Washington

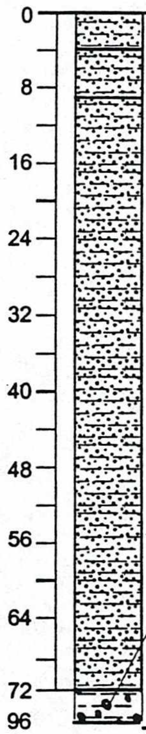
PLATE **5**

	PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
4887011tp.cdr	14,887.011	PJS	7/19/99			

Laboratory Tests | Moisture Content (%) | Depth (inches) | Sample

Test Pit Number 9

Land Surface Elevation ~2,075 feet Date 5/12/99



0" - 4" Very Dark Grayish Brown (10 YR 3/2) Sandy Loam (SM) and Forest Duff, many fine roots.

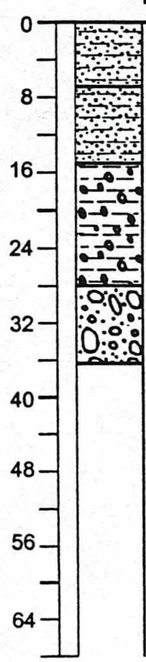
4" - 9" Dark Brown (7.5 YR 3/4) Sandy Loam (SM), 5% to 10% gravel.

9" - 72" Dark Yellowish Brown (10 YR 3/4) Sandy Loam (SM), 5% gravel.

72" - 96" Dark Yellowish Brown (10 YR 4/4) Gravelly Loam (GM), few cobbles, gradual transition.

Test Pit Number 10

Land Surface Elevation ~2,030 feet Date 5/12/99



0" - 7" Very Dark Brown (10 YR 2/2) Sandy Loam (SM), loose, many fine roots, fine grained.

7" - 15" Dark Reddish Brown (5 YR 3/2) Sandy Loam (SM), soft, 10% gravel, fine grained.

15" - 28" Dark yellowish brown (10 YR 4/4) Very Gravelly Sandy Loam (GM), fine grained.

28" - 36" Dark Yellowish Brown (10 YR 4/4) Extremely Cobbly Loamy Sand (GW), fine- to coarse-grained sand.

AGI TECHNOLOGIES

Exploration Logs

Trendwest Properties: Cle Elum UGA Draft EIS
Cle Elum, Washington

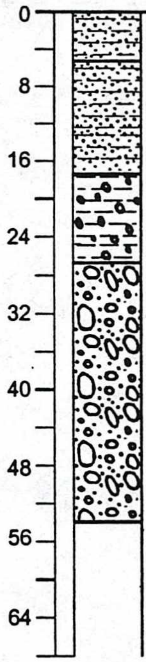
PLATE 6

	PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
4887011tp.cdr	14,887.011	PJS	7/19/99			

Laboratory Tests | Moisture Content (%) | Depth (inches) | Sample

Test Pit Number 11

Land Surface Elevation ~2,105 feet Date 5/12/99



0" - 5" Very Dark Brown (10 YR 2/2) Sandy Loam (SM), loose, with many fine roots.

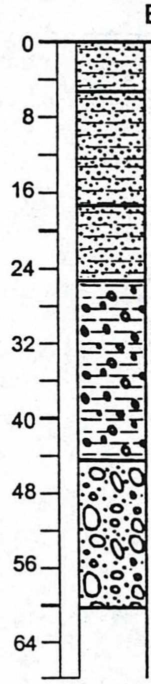
5" - 17" Dark Yellowish Brown (10 YR 3/4) Sandy Loam (SM), soft, with many fine roots.

17" - 27" Dark Yellowish Brown with black organic mottling (10 YR 3/4) Gravelly Loam (GM), with many fine roots.

27" - 54" Dark Yellowish Brown (10 YR 3/6) Extremely Cobbly Loamy Sand (GW), fine to coarse grained.

Test Pit Number 12

Land Surface Elevation ~2,115 feet Date 5/12/99



0" - 5" Very Dark Grayish Brown (10 YR 3/2) Sandy Loam (SM), with 20% gravel, many fine roots.

5" - 18" Dark Yellowish Brown (10 YR 3/4) Sandy Loam (SM), 2% gravel, many fine roots.

18" - 25" Dark Yellowish Brown (10 YR 3/4) Sandy Loam (SM),12% to 15% clay.

25" - 45" Dark Yellowish Brown (10 YR 3/4) Very Gravelly/Cobbly Sandy Loam (GM).

45" - 60" Dark Yellowish Brown (10 YR 3/6) Extremely Gravelly/Cobbly Sand (GW).

AGI TECHNOLOGIES

Exploration Logs

Trendwest Properties: Cle Elum UGA Draft EIS
Cle Elum, Washington

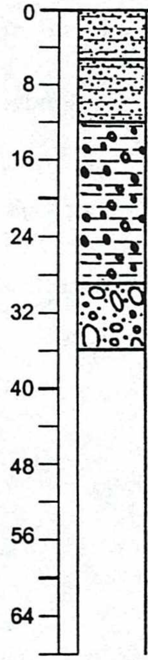
PLATE 7

	PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
4887011tp.cdr	14,887.011	PJS	7/19/99			

Laboratory Tests | Moisture Content (%) | Depth (inches) | Sample

Test Pit Number 13

Land Surface Elevation ~2,135 feet Date 5/12/99



0" - 5" Very Dark Brown (10 YR 2/2) Sandy Loam (SM), loose, with many fine roots.

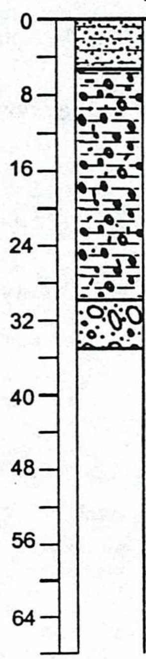
5" - 12" Dark Yellowish Brown (10 YR 3/4) Sandy Loam (SM), loose, 5% gravel, many fine roots.

12" - 29" Dark Yellowish Brown (10 YR 4/6) Very Gravelly/Cobbly Sandy Loam (GM).

29" - 36" Dark Yellowish Brown (10 YR 3/6) Extremely Gravelly/Cobbly Loamy Sand (GW).

Test Pit Number 14

Land Surface Elevation ~2,150 feet Date 5/12/99



0" - 5" Very Dark Brown (10 YR 2/2) Sandy Loam (SM), loose, fine roots.

5" - 30" Dark Yellowish Brown (10 YR 3/6) Gravelly Sandy Loam (GM-SM).

30" - 35" Dark Yellowish Brown (10 YR 3/6) Extremely Gravelly Loamy Sand (GW), with rocks.

AGI TECHNOLOGIES

Exploration Logs

Trendwest Properties: Cle Elum UGA Draft EIS
Cle Elum, Washington

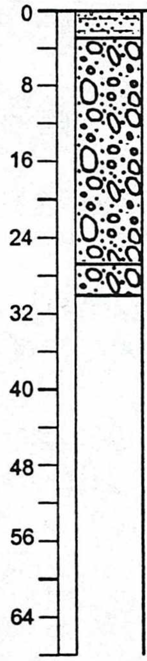
PLATE 8

	PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
4887011tp.cdr	14,887.011	PJS	7/19/99			

Laboratory Tests | Moisture Content (%) | Depth (inches) | Sample

Test Pit Number 15

Land Surface Elevation ~2,130 feet Date 5/12/99



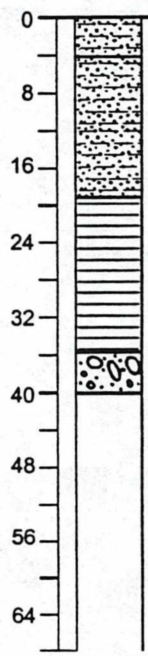
0" - 3" Dark Brown (7.5 YR 3/2) Sandy Loam (SM), fine grained, with fine roots.

3" - 27" Dark Brown (7.5 YR 3/4) Very Cobbly Sandy Loam (GW), with large rocks, fine grained.

27" - 30" Dark Yellowish Brown (10 YR 4/4) Very Gravelly Loamy Sand (GW), with large rocks, medium to coarse grained.

Test Pit Number 16

Land Surface Elevation ~2,135 feet Date 5/12/99



0" - 4" Very Dark Brown (10 YR 2/2) Sandy Loam (SM), loose, with fine roots.

4" - 19" Brown (10 YR 4/3) Sandy Loam (SM), soft, 5% gravel.

19" - 36" Dark Yellowish Brown (10 YR 4/4) Clay Loam (CL), soft, 5% gravel.

36" - 40" Dark Yellowish Brown (10 YR 3/4) Extremely Cobbly Sandy Loam (GW).

AGI TECHNOLOGIES

Exploration Logs

Trendwest Properties: Cle Elum UGA Draft EIS
Cle Elum, Washington

PLATE 9

	PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
4887011tp.cdr	14,887.011	PJS	7/19/99			

Laboratory Tests	Moisture Content (%)	Depth (inches)	Sample	

Test Pit Number 17

Land Surface Elevation ~2,150 feet Date 5/12/99

Depth (inches)	Description
0	0" - 2" Very Dark Grayish Brown (10 YR 3/2) Sandy Loam (SM), loose, many fine roots, fine grained.
8	2" - 17" Dark Brown (10 YR 3/3) Cobbly Sandy Loam (SM), loose, fine-grained sand, rounded subangular cobbles, 9% to 10% clay.
16	
24	17" - 27" Dark Yellowish Brown (10 YR 4/4) Gravelly Sandy Loam (SM), loose, 12% to 15% clay, with rounded and angular rocks, cobbles, gravel.
32	27" - 50" Dark Yellowish Brown (10 YR 4/4) Sandy Clay Loam (CL), soft, 20% to 25% clay, slightly mottled, with gravel.
40	
48	
56	50+" Brown (10 YR 5/3) Sandy Clay Loam (CL), 20% to 25% clay, with iron-oxide mottling and light brownish gray (10 YR 1/2) mottled, few fine roots, gravel.
64	

Hand Auger Number 18

Land Surface Elevation ~2,120 feet Date 5/12/99

Depth (inches)	Description
0	0" - 34" Brown Sandy Loam (SM).
8	
16	
24	
32	34" - 51" Brown Sandy Clay Loam (CL).
40	
48	51" - 66" Becomes wet, slightly mottled.
56	
64	66" - 70" Strong mottling, very wet.
70	

AGI TECHNOLOGIES

4887011tp.cdr

Exploration Logs

Trendwest Properties: Cle Elum UGA Draft EIS
Cle Elum, Washington

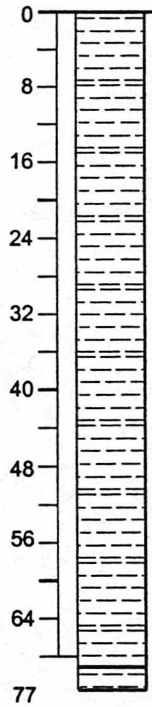
PLATE 10

PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
14,887.011	PJS	7/19/99			

Laboratory Tests | Moisture Content (%) | Depth (inches) | Sample

Hand Auger Number 19

Land Surface Elevation ~2,090 feet Date 5/12/99

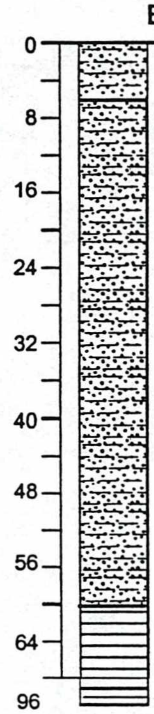


0" - 72" Very Dark Brown Loam (ML), fine grained.

72" - 77" Becomes dark brown with fine gravel.

Hand Auger Number 20

Land Surface Elevation ~2,100 feet Date 5/12/99



0" - 6" Dark Brown Sandy Loam (SM), with many fine roots.

6" - 60" Dark Brown (7.5 YR 3/4) Sandy Loam (SM).

60" - 94" Dark Yellowish Brown (10 YR 4/4) Sandy Clay Loam (CL), wet, with slight mottling.

94" - 96" Dark Yellowish Brown (10 YR 4/4) Sandy Clay Loam (CL), with slightly less clay.

AGI TECHNOLOGIES

Exploration Logs

Trendwest Properties: Cle Elum UGA Draft EIS
Cle Elum, Washington

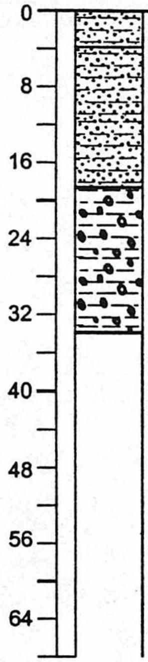
PLATE **11**

	PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
4887011tp.cdr	14,887.011	PJS	7/19/99			

Laboratory Tests | Moisture Content (%) | Depth (inches) | Sample

Test Pit Number 21

Land Surface Elevation ~2,075 feet   Date 5/12/99



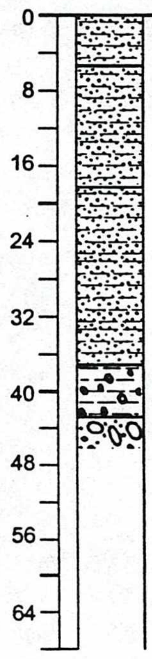
0" - 4" Very Dark Grayish Brown (10 YR 3/2) Sandy Loam (SM), with many fine roots.

4" - 18" Dark Brown (7.5 YR 3/2) Sandy Loam (SM), 5% gravel.

18" - 34" Dark Brown (7.5 YR 3/4) Gravelly Sandy Clay Loam (GM).

Test Pit Number 22

Land Surface Elevation ~2,070 feet   Date 5/12/99



0" - 5" Very Dark Brown (10 YR 2/2) Loam (SM), fine grained, with many fine roots.

5" - 18" Dark Yellowish Brown (10 YR 3/4) Sandy Loam (SM), 10% clay, many fine roots, fine-grained sand.

18" - 37" Dark Yellowish Brown (10 YR 4/4) Loam (SM), 10% to 15% clay.

37" - 43" Dark Yellowish Brown (10 YR 4/4) Cobbly Loam (GM).

43+" Brown (10 YR 5/4) Extremely Cobbly Loamy Sand (GW).

AGI TECHNOLOGIES

Exploration Logs

Trendwest Properties: Cle Elum UGA Draft EIS
Cle Elum, Washington

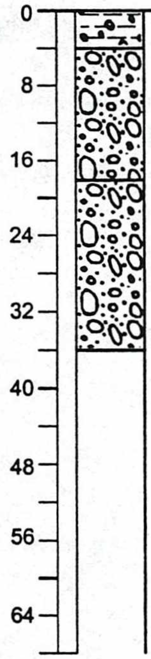
PLATE **12**

	PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
4887011tp.cdr	14,887.011	PJS	7/19/99			

Laboratory Tests | Moisture Content (%) | Depth (inches) | Sample

Test Pit Number 23

Land Surface Elevation ~1,980 feet Date 5/13/99



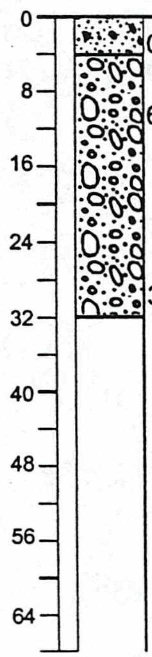
0" - 4" Dark Brown (10 YR 3/3) Gravelly Sandy Loam (GM), soft, platy structure, fine to coarse sand, with fine to coarse roots.

4" - 17" Dark Yellowish Brown (10 YR 3/4) Extremely Cobbly Sandy Loam (GW), soft, fine to coarse grained.

17" - 36" Dark Grayish Brown (2.5 YR 4/2) Extremely Cobbly Loamy Sand (GW), becomes rocky at 25".

Test Pit Number 24

Land Surface Elevation ~1,980 feet Date 5/13/99



0" - 6" Black (10 YR 2/1) Very Gravelly/Cobbly Loamy Sand (GW), 5% silt with many fine roots.

6" - 32" Dark Brown (10 YR 3/3) Very Gravelly Sand (GW), 3% fines, with coarse roots.

32" Becomes rocky/bouldery.

AGI TECHNOLOGIES

Exploration Logs

Trendwest Properties: Cle Elum UGA Draft EIS
Cle Elum, Washington

PLATE 13

	PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
4887011tp.cdr	14,887.011	PJS	7/19/99			

Laboratory Tests	Moisture Content (%)	Depth (inches)	Sample

Test Pit Number 25

Land Surface Elevation ~2,005 feet   Date 5/13/99

Depth (inches): 0, 8, 16, 24, 32, 40, 48, 56, 64

0" - 4" Very Dark Brown (10 YR 2/2) Sandy Loam (SM), with many fine roots, 10% gravel, 9% clay.

4" - 12" Dark Brown (10 YR 3/3) Gravelly Sandy Loam (SM), 15% to 20% fine to coarse gravel.

12" - 20" Dark Brown (7.5 YR 3/4) Gravelly Sandy Loam (SM), 15% to 20% fine to coarse gravel.

20" - 39" Dark Yellowish Brown (10 YR 3/4) Extremely Cobbly/Rocky Sandy Loam (GP).

39" - 48" Extremely Cobbly/Rocky Loamy Sand (GP), medium to coarse grained.

Test Pit Number 26

Land Surface Elevation ~1,990 feet   Date 5/13/99

Depth (inches): 0, 8, 16, 24, 32, 40, 48, 56, 64

0" - 3" Black (10 YR 2/1) Gravelly Sandy Loam (SM), 15% to 20% gravel.

3 - 14" Dark Brown (10 YR 3/3) Very Cobbly Sandy Loam (GM), fine- to medium-grained sand.

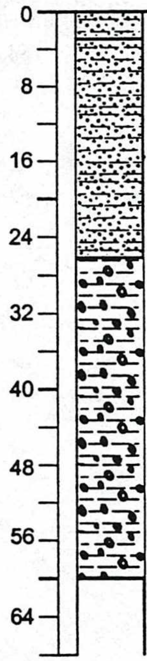
14" - 23" Dark Brown (10 YR 3/3) Very Cobbly Sandy Loam (GM), fine- to medium-grained sand.

23" - 42" Dark Grayish Brown (2.5 YR) Extremely Cobbly Sand (GP), <3% fines, medium to coarse sand.

Laboratory Tests | Moisture Content (%) | Depth (inches) | Sample

Test Pit Number 27

Land Surface Elevation ~2020 feet Date 5/13/99



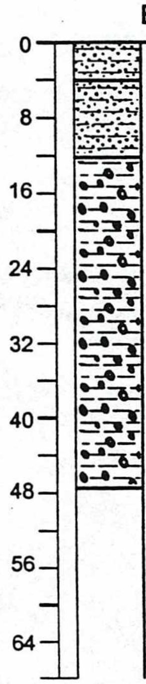
0" - 3" Black (10 YR 2/1) Sandy Loam (SM), 5% to 10% clay.

3" - 26" Dark Brown (7.5 YR 3/4) Gravelly Sandy Loam (SM), fine- to coarse-grained sand, fine to medium gravel.

26" - 60" Dark Yellowish Brown (10 YR 3/4) Very Gravelly/Cobbly Sandy Loam (GM), 10% to 15% clay, with boulders up to 24".

Test Pit Number 28

Land Surface Elevation ~2,015 feet Date 5/13/99



0" - 3" Very Dark Brown (10 YR 2/2) Gravelly Sandy Loam (SM), 25% to 35% fine to coarse gravel, fine to coarse sand.

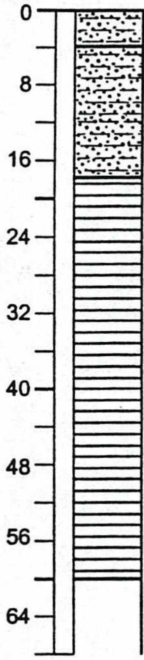
3" - 12" Dark Yellowish Brown (10 YR 3/4) Gravelly Sandy Loam (SM), with fine to coarse roots, 10% fines, fine to medium sand.

12" - 48" Dark Yellowish Brown (10 YR 4/4) Very Gravelly Sandy Loam (GM), with 10% to 15% cobbles, 10% clay, fine to coarse sand.

Laboratory Tests | Moisture Content (%) | Depth (inches) | Sample

Test Pit Number 29

Land Surface Elevation ~2,120 feet Date 5/13/99



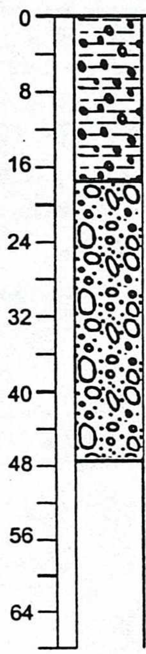
0" - 4" Dark Brown (10 YR 2/2) Loam (SM), with many fine roots.

4" - 18" Dark Brown (7.5 YR 4/4) Sandy Loam (SM), 10% to 15% clay.

18" - 60" Strong Brown (7.5 YR 4/6) Sandy Clay Loam (CL), with slight mottling, 25% clay.

Test Pit Number 30

Land Surface Elevation ~2,140 feet Date 5/13/99



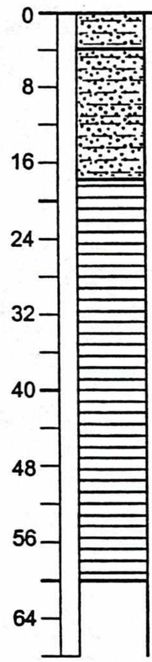
0" - 17" Dark Brown (7.5 YR 3/4) Very Cobbly Sandy Loam (GM), fine- to medium- grained sand, with many fine to medium roots, 7% clay, with rocks.

17" - 48" Yellowish Brown (10 YR 5/4) Extremely Gravelly Sandy Loam (GW), 9% clay, with rocks and boulders, stratified, clay sticking to faces of rocks and sand slightly mottled.

Laboratory Tests | Moisture Content (%) | Depth (inches) | Sample

Test Pit Number 31

Land Surface Elevation ~2,160 feet   Date 5/13/99



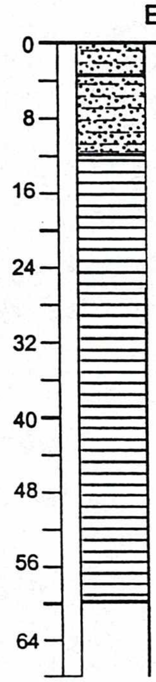
0" - 4" Dark Brown (10 YR 2/2) Loam (SM), with many fine roots.

4" - 18" Dark Brown (7.5 YR 4/4) Sandy Loam (SM), 10% to 15% clay.

18" - 60" Strong Brown (7.5 YR 4/6) Sandy Clay Loam (CL), with slight mottling, 25% clay.

Test Pit Number 32

Land Surface Elevation ~2,130 feet   Date 5/13/99



0" - 3" Black (10 YR 2/1) Loam (SM).

3" - 12" Dark Brown (7.5 YR 3/4) Sandy Loam (SM), with fine roots.

12" - 26" Strong Brown (7.5 YR 4/6) Sandy Clay Loam (CL), 10% to 15% gravel.

26" -60" Dark Yellowish Brown (10 YR 3/4) Sandy Clay Loam (CL), slightly mottled, 5% to 10% gravel.

Laboratory Tests | Moisture Content (%) | Depth (inches) | Sample

Test Pit Number 33

Land Surface Elevation ~2,110 feet Date 5/13/99

Depth (inches): 0, 8, 16, 24, 32, 40, 48, 56, 64, 80

0" - 4" Dark Brown (10 YR 2/2) Loam (SM), with many fine roots.

4" - 18" Dark Brown (7.5 YR 4/4) Sandy Loam (SM), 10% to 15% clay.

18" - 80" Strong Brown (7.5 YR 4/6) Sandy Clay Loam (CL), with slight mottling, 25% clay, few 18" - 24" rocks.

80" Very Gravelly (10 YR 4/4) Loamy Sand (GW), medium to coarse grained.

Test Pit Number 34

Land Surface Elevation ~2,140 feet Date 5/13/99

Depth (inches): 0, 8, 16, 24, 32, 40, 48, 56, 64, 84

0" - 4" Dark Brown (10 YR 2/2) Loam (SM), with many fine roots.

4" - 18" Dark Brown (7.5 YR 4/4) Sandy Loam (SM), 10% to 15% clay.

18" - 72" Strong Brown (7.5 YR 4/6) Sandy Clay Loam (CL), with slight mottling, 25% clay, few 18- to 24-inch rocks.

72" - 84" Becomes Clay Loam (CL).

AGI TECHNOLOGIES

Exploration Logs

Trendwest Properties: Cle Elum UGA Draft EIS
Cle Elum, Washington

PLATE 18

	PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
4887011tp.cdr	14,887.011	PJS	7/19/99			

Laboratory Tests | Moisture Content (%) | Depth (inches) | Sample

Test Pit Number 35

Land Surface Elevation ~2,145 feet Date 5/13/99

Depth (inches)	Description
0" - 4"	Dark Brown (10 YR 2/2) Loam (SM), with many fine roots.
4" - 18"	Dark Brown (7.5 YR 4/4) Sandy Loam (SM), 10% to 15% clay.
18" - 48"	Strong Brown (7.5 YR 4/6) Sandy Clay Loam (CL), with slight mottling, 25% clay.
48" - 60"	With 5% to 10% cobbles and 18" rocks.

Test Pit Number 36

Land Surface Elevation ~2,155 feet Date 5/13/99

Depth (inches)	Description
0" - 4"	Dark Brown (10 YR 2/2) Loam (SM), with many fine roots.
4" - 18"	Dark Brown (7.5 YR 4/4) Sandy Loam (SM), 10% to 15% clay.
18" - 72"	Strong Brown (7.5 YR 4/6) Sandy Clay Loam (CL), with slight mottling, 25% clay.
48" - 60"	With 5% to 10% cobbles and 18-inch rocks.
60+"	Strong mottling.

Exploration Logs

Trendwest Properties: Cle Elum UGA Draft EIS
Cle Elum, Washington

PLATE 19

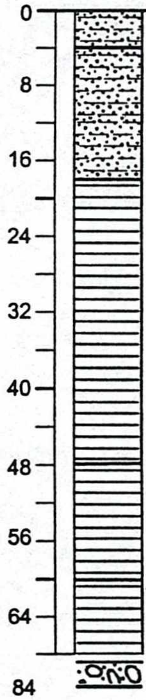
AGI TECHNOLOGIES

	PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
4887011tp.cdr	14,887.011	PJS	7/19/99			

Laboratory Tests | Moisture Content (%) | Depth (inches) | Sample

Test Pit Number 37

Land Surface Elevation ~2,125 feet Date 5/13/99



0" - 4" Dark Brown (10 YR 2/2) Loam (SM), with many fine roots.

4" - 18" Dark Brown (7.5 YR 4/4) Sandy Loam (SM), 10% to 15% clay.

18" - 48" Strong Brown (7.5 YR 4/6) Sandy Clay Loam (CL), with slight mottling, 25% clay.

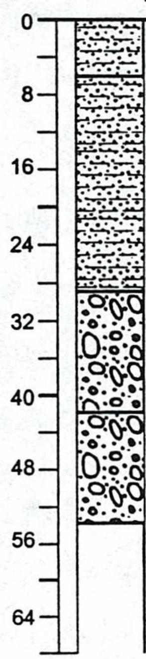
48" - 60" With 5% to 10% cobbles.

60" - 72" Strong mottling.

72" - 84" Very Gravelly Sand (GW).

Test Pit Number 38

Land Surface Elevation ~2,120 feet Date 5/13/99



0" - 6" Dark Yellowish Brown (10 YR 3/4) Sandy Loam (SM), 15% clay, 5% to 10% fine gravel.

6" - 29" Dark Yellowish Brown (10 YR 3/4) Sandy Loam (SM), 15% to 20% clay, 5% fine gravel.

29" - 42" Dark Yellowish Brown (10 YR 4/4) Very Gravelly/Cobbly Sandy Loam (GW), fine grained.

42" - 54" Very Gravelly Sand (GW), trace silt, medium to coarse grained, with cobbles.

AGI TECHNOLOGIES

Exploration Logs

Trendwest Properties: Cle Elum UGA Draft EIS
Cle Elum, Washington

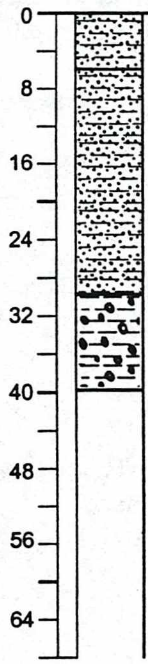
PLATE 20

4887011tp.cdr	PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
	14,887.011	PJS	7/19/99			

Laboratory Tests | Moisture Content (%) | Depth (inches) | Sample

Test Pit Number 39

Land Surface Elevation ~2,075 feet Date 5/13/99



0" - 6" Dark Brown Loam (SM), with many fine roots, 5% gravel.

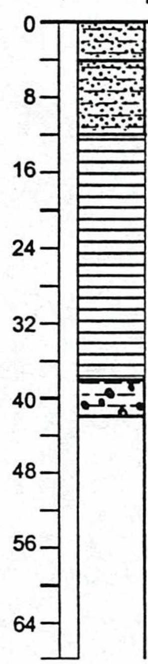
6" - 30" Dark Brown (7.5 YR 3/4) Sandy Loam (SM), 2% to 5% gravel, fine grained.

30" - 40" Dark Yellowish Brown (10 YR 4/4) Very Gravelly Sandy Loam (GM), fine grained.

40" Very Gravelly Sand, medium to coarse grained.

Test Pit Number 40

Land Surface Elevation ~2,070 feet Date 5/13/99



0" - 4" Forest Duff.

4" - 12" Very Dark Grayish Brown (10 YR 3/2) Sandy Loam (SM), 10% to 15% fines.

12" - 38" Dark Yellowish Brown (10 YR 3/4) Sandy Clay Loam (CL), 5% gravel.

38" - 42" Dark Yellowish Brown (10 YR 3/4) Very Gravelly Sandy Loam (GM), 15% clay, with cobbles.

AGI TECHNOLOGIES

Exploration Logs

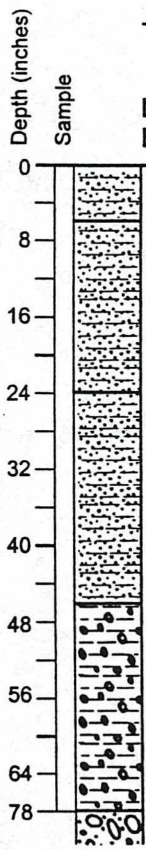
Trendwest Properties: Cle Elum UGA Draft EIS
Cle Elum, Washington

PLATE **21**

File	PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
4887011tp.cdr	14,887.011	PJS	7/19/99			

Test Pit Number 41

Land Surface Elevation ~2,040 feet Date 5/13/99



0" - 6" Very Dark Brown (10 YR 2/2) Loam (SM), many fine roots.

6" - 24" Dark Yellowish Brown (10 YR 3/4) Sandy Loam (SM), 10% to 15% clay, 10% gravel, fine grained.

24" - 46" Dark Yellowish Brown (10 YR 3/6) Sandy Loam (SM), with 5% gravel, 15% to 20% clay, fine-grained sand.

46" - 78" Dark Yellowish Brown (10 YR 3/4) Gravelly Sandy Loam (GM), with cobbles to 8", fine-grained sand.

78" - 90" Gravelly Sand (GW).

AGI TECHNOLOGIES

Exploration Logs

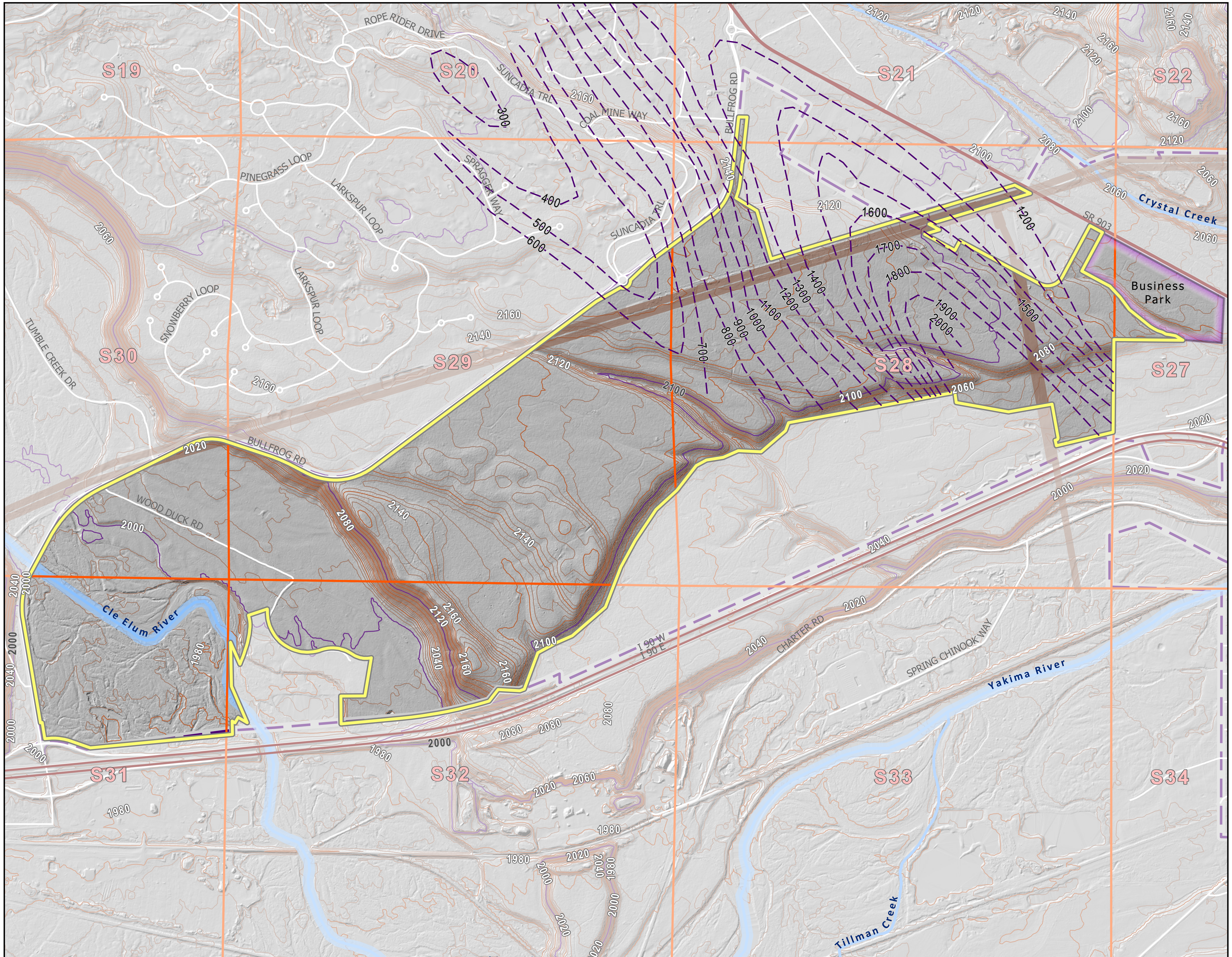
Trendwest Properties: Cle Elum UGA Draft EIS
Cle Elum, Washington

PLATE 22

	PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
4887011tp-41.cdr	14,887.011	PJS	7/19/99			

APPENDIX E

Roslyn Seam Mine Workings



PROJECT BOUNDARY

DEPTH TO UNDERGROUND MINE (ICE, 1999)

TRANSMISSION LINES

OFF PROPERTY BUSINESS PARK

CITY BOUNDARY

SECTION

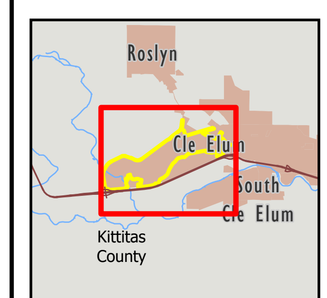
CONTOUR 100 FT

CONTOUR 20 FT

CONTOUR 5 FT

DATA SOURCES / REFERENCES:
WASHINGTON STATE LIDAR PORTAL: YAKIMA 2014, NO REPORT AVAILABLE. CONTOURS FROM LIDAR
KITTITAS CO: ROADS, PARCELS, CITY 10/19
ESM: SURVEYED PROJECT BOUNDARY 11/19
DEPTH TO UNDERGROUND WORKINGS:
MOUNTAIN STAR MASTER PLANNED RESORT EIS,
COAL MINE HAZARD ASSESSMENT, KITTITAS CO. WA.
PREPARED BY ICICLE CREEK ENGINEERS, INC. JUNE 1, 1999

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE



0 1200
FEET

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

associated earth sciences incorporated

COAL MINE HAZARD ASSESSMENT

47° NORTH SEIS
CLE ELUM, WASHINGTON

PROJ NO.	DATE:	FIGURE:
20190414H001	4/20	E

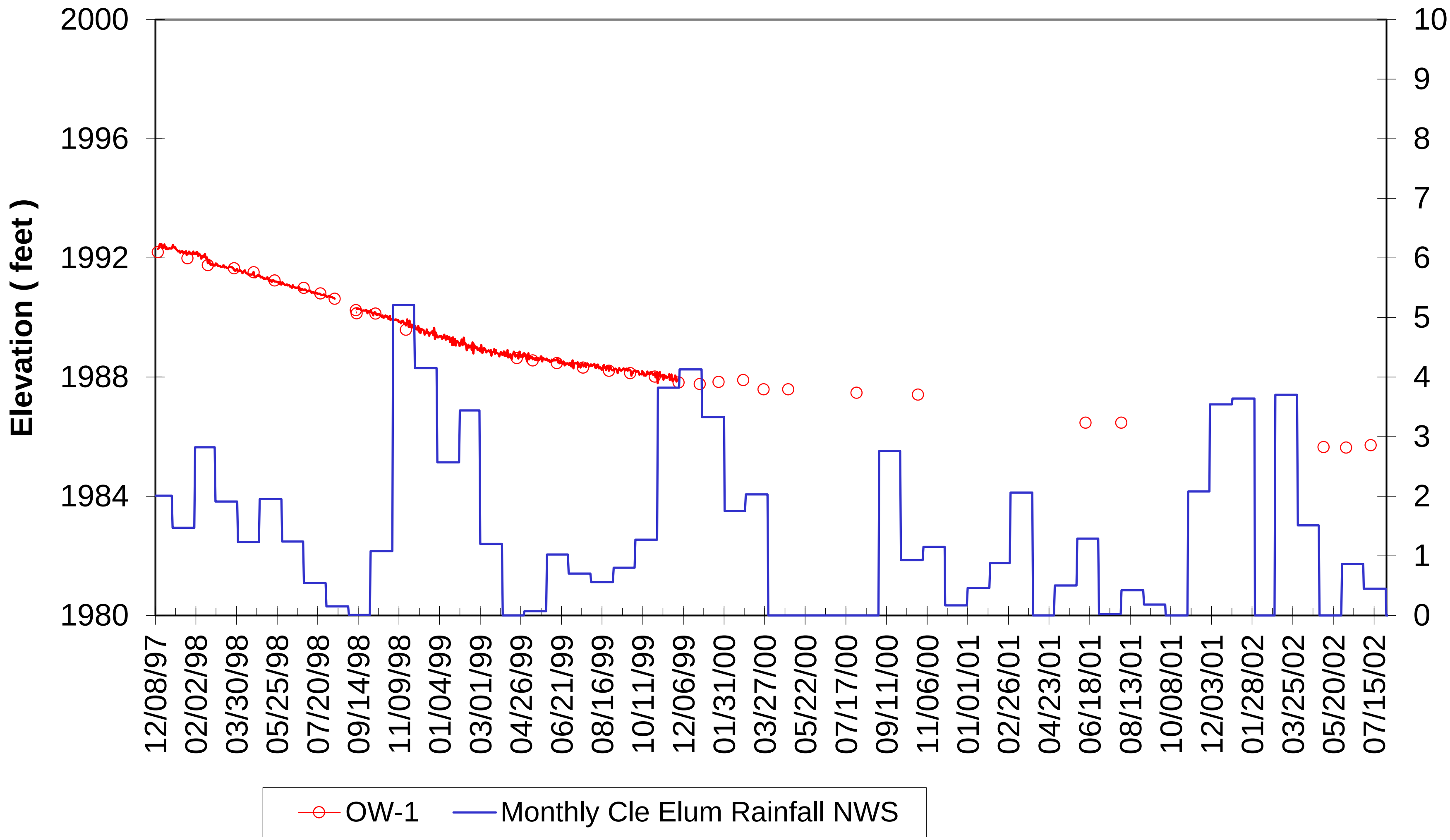
G:\GIS_Projects\aaY2019\190414 47 Degrees N\aprx_mxd\EIS0320\190414H001 AE MineHaz_1pg_47Deg.aprx

APPENDIX F

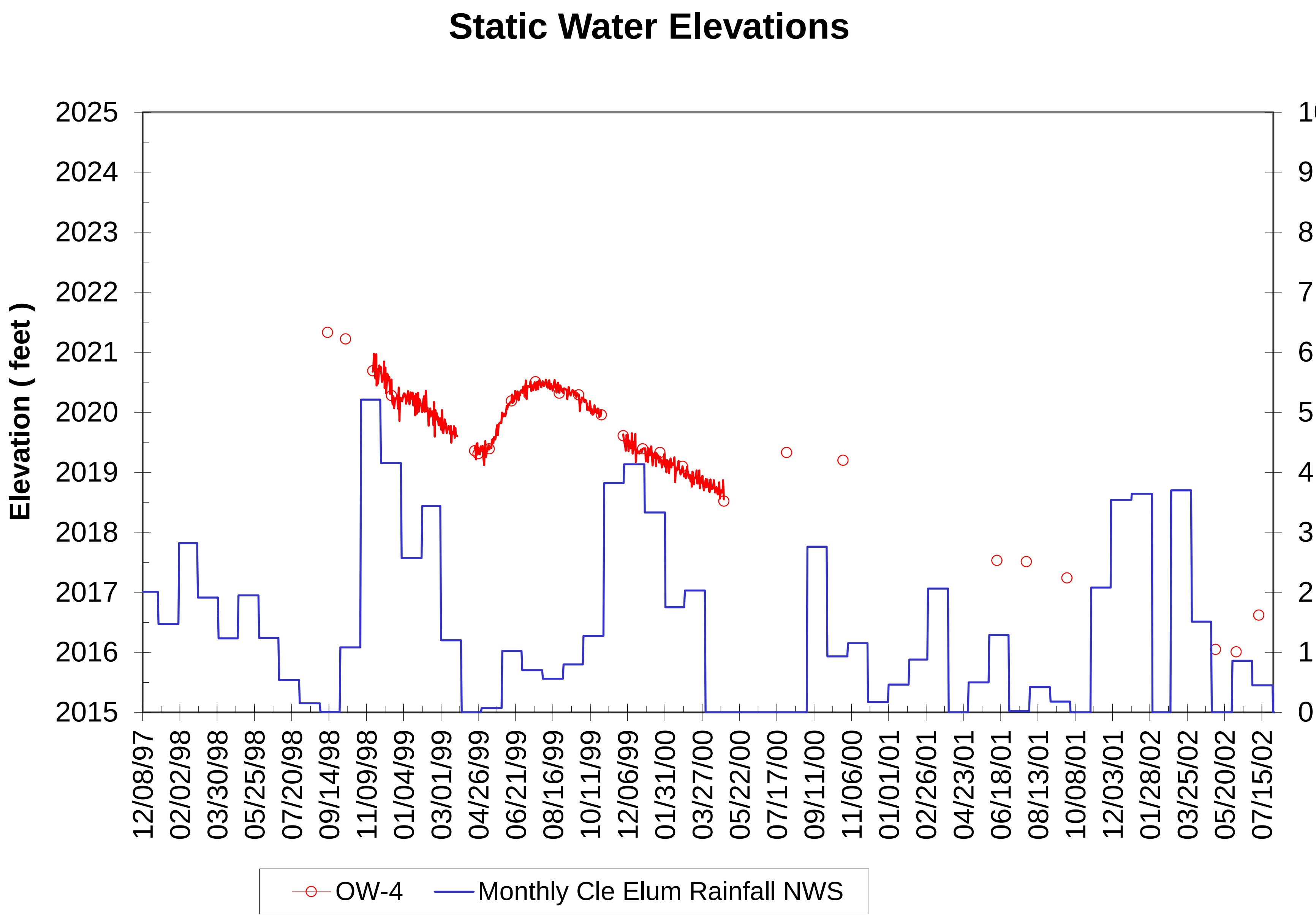
Observation Well Hydrographs

Monitoring Started 12/11/97

Static Water Elevations

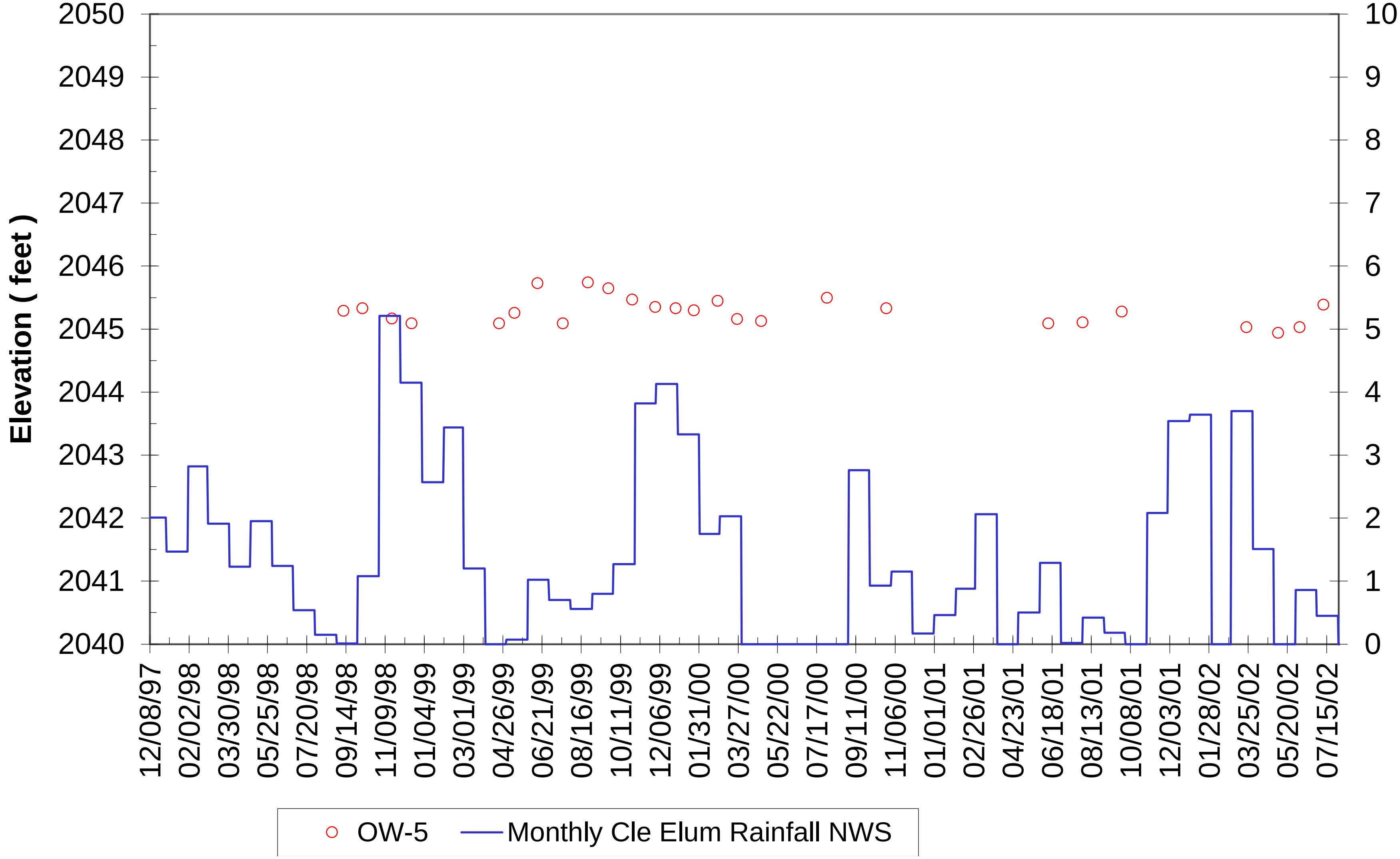


Monitoring Started 12/11/97



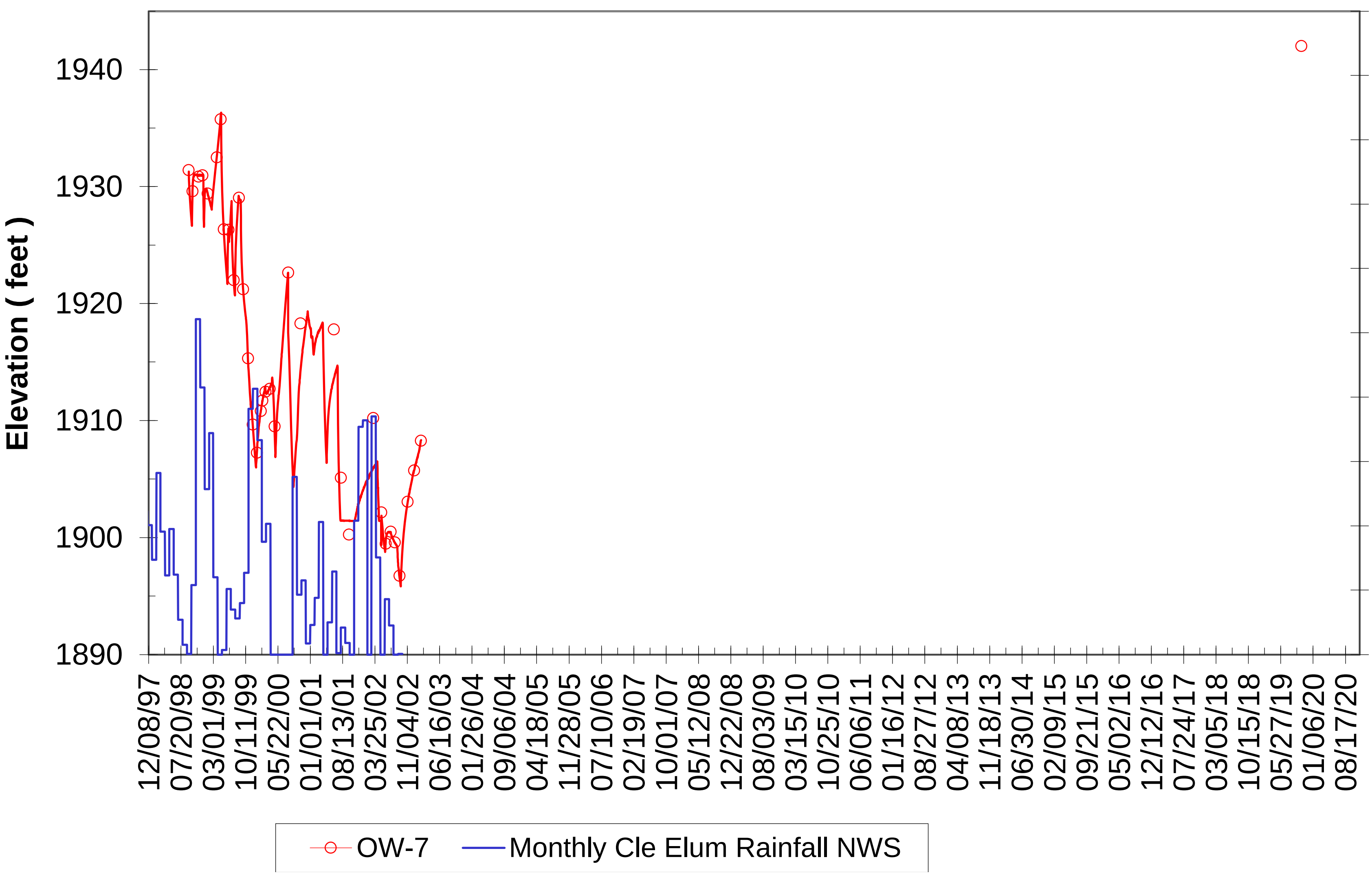
Monitoring Started 12/11/97

Static Water Elevations



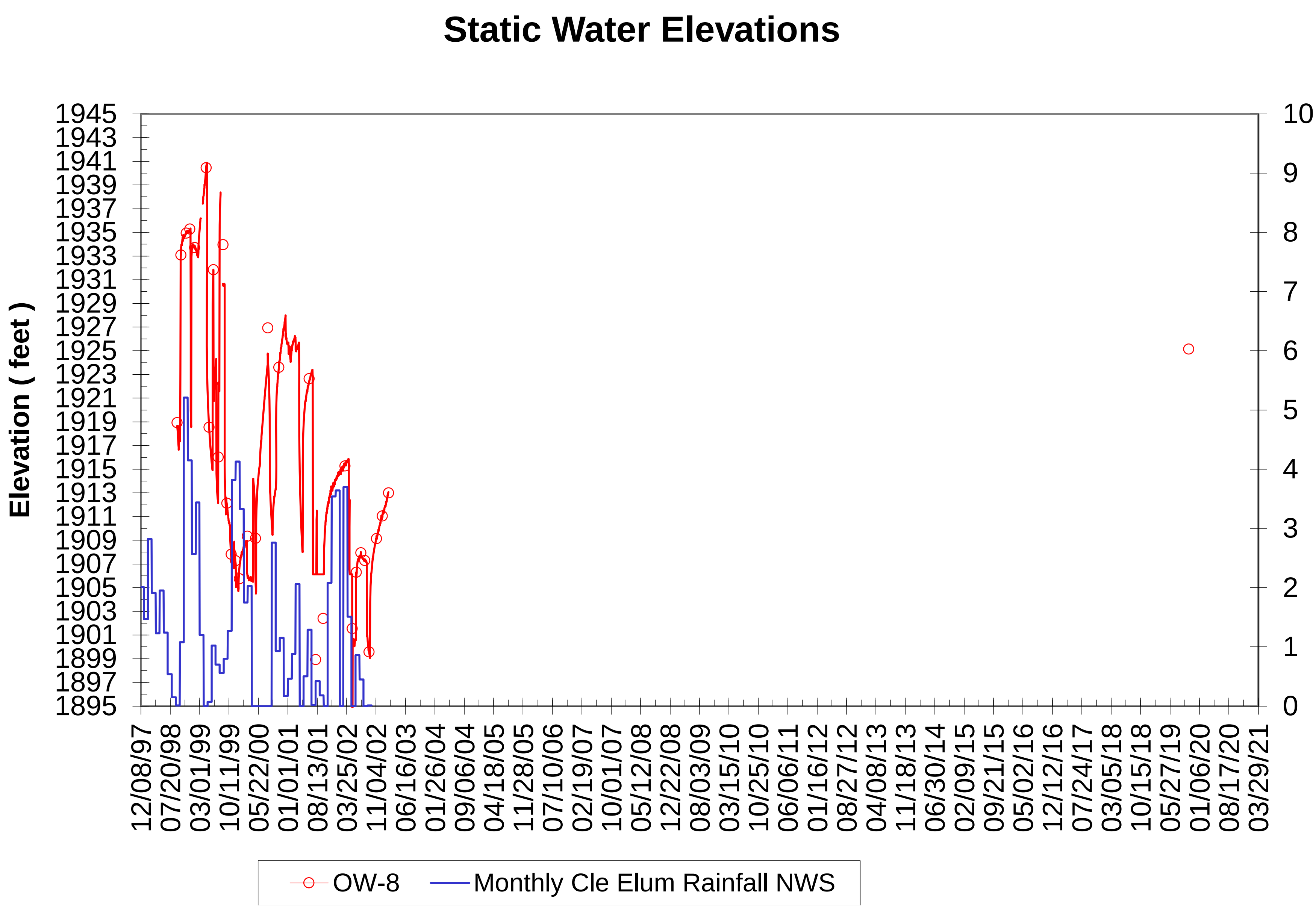
Monitoring Started 12/11/97

Static Water Elevations



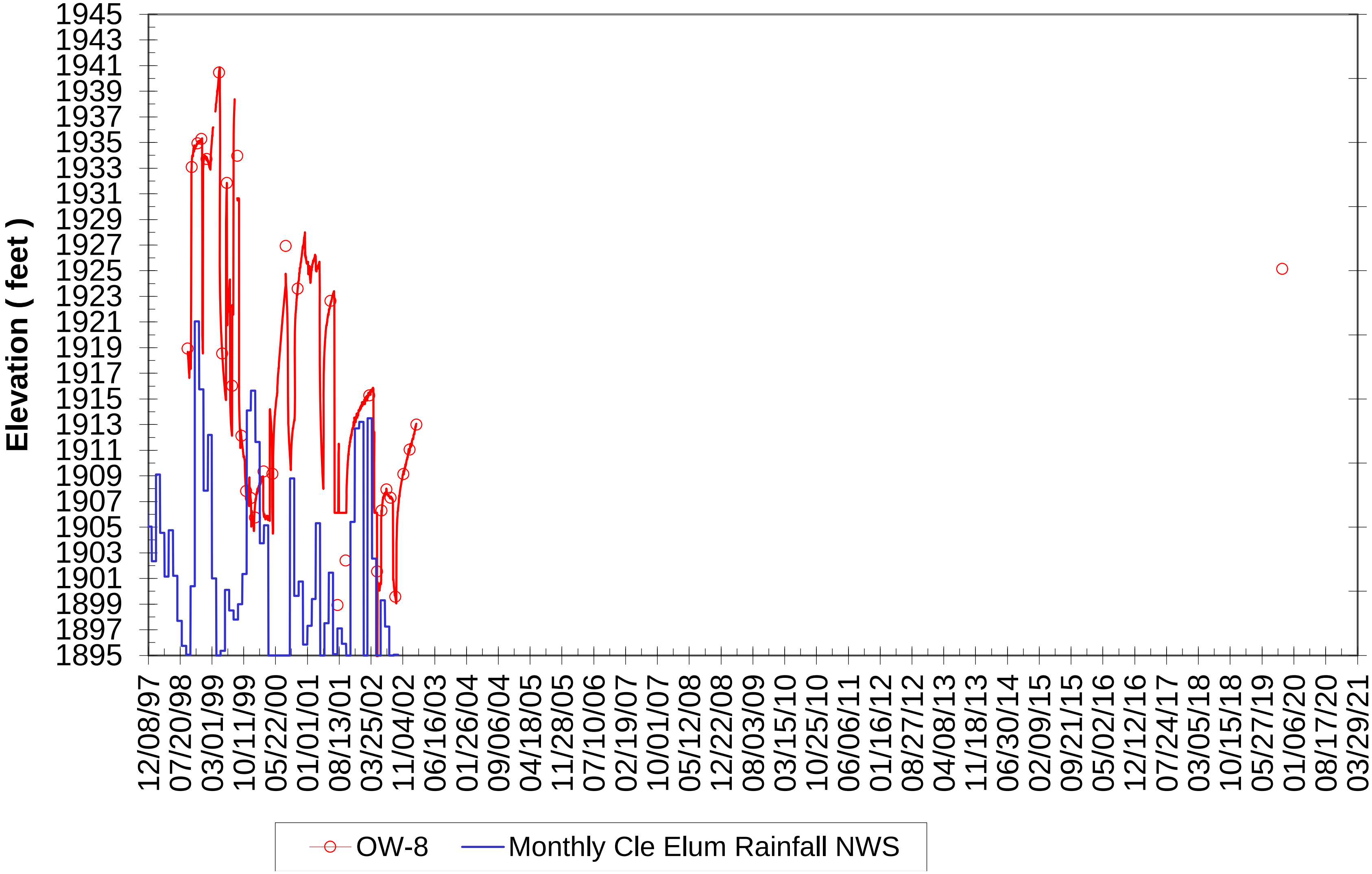
Associated Earth Sciences, Inc. 3/13/2020 11:59 AM Mountain Star Water Levels

Monitoring Started 12/11/97



Monitoring Started 12/11/97

Static Water Elevations



Associated Earth Sciences, Inc.

3/13/2020 12:00 PM Mountain Star Water Levels

APPENDIX G

2002 W&H Pacific Hydrologic Modeling

Hydrologic modeling was performed for the UGA (Alternative 2) to: (1) gain an understanding of the existing or pre-development hydrology of the site; and (2) estimate the hydrologic impacts of the proposed development for use in developing proposed mitigations. Alternative 2 represents the highest impact alternative. The results of the hydrologic modeling performed to simulate existing and developed condition flows for the project are presented below, and analyzed comparatively for Alternatives 3, 4, and 5. The simulation model is described first, followed by a summary of the data inputs to the model. The results of existing and developed conditions flow analyses are then presented for each of the UGA subbasins.

Hydrologic Model

The hydrologic simulation model used for the UGA is the same model used by W&H Pacific for the neighboring MountainStar Master Planned Resort project. The model is the Hydrologic Simulation Program – Fortran (HSPF) Release 11, (United States Environmental Protection Agency, 1996). The model continuously simulates the rainfall-runoff response of a watershed by simulating the physical process response to changing climatic conditions. HSPF is a standard hydrologic computational tool. The Washington State Department of Ecology (Ecology) notes that HSPF is relatively complex to use, and is best suited for basin plans and master drainage plans. Ecology requires the use of a continuous simulation model for basin plans. Due to the large size of the MountainStar watershed (19.5 square miles) and environmental review considerations, the HSPF model was selected for that project.

Input to the model includes land segment information such as soil parameters, elevation and vegetation parameters, as well as several continuous climatological time series for the time period being simulated. The climatological parameters required by HSPF for runoff and snow simulation are:

- Precipitation
- Evaporation
- Air temperature
- Dewpoint temperature
- Solar radiation
- Wind movement

Runoff is modeled as the combined effect of surface flow, shallow subsurface flow (interflow) and groundwater flow response to climatological conditions. The distribution of flow between runoff mechanisms is determined by land segment characteristics such as soil moisture content, infiltration rate, and interception storage. The model generates flow from pervious and impervious land segments, and routes it through the drainage network. The drainage network can include pipes, streams, vaults, detention ponds, lakes and wetlands.

Snow accumulation and melt are simulated based on energy balance equations. Snow pack conditions, including ice content, density, albedo (reflectivity of the snow) and temperature, change over time according to climate conditions. Snowmelt water is added to precipitation inputs to the land segment and is routed through the land segment runoff mechanisms before entering the drainage network.

Output from the model can include, for example: groundwater, interflow and surface flows, snow pack and snow water equivalent, and wetland or detention pond storage.

The land segments used in the model are organized into soil-cover-slope complexes. The coding used in the complexes for the site is summarized below.

Soil Type	Cover	Slope
B = Bedrock T = Till O = Outwash S = Saturated	F = Forest G = Grassed O = Open	F = Flat (0 – 6%) G = Gradual (Moderate) (6 – 15 %) S = Steep (>15%)

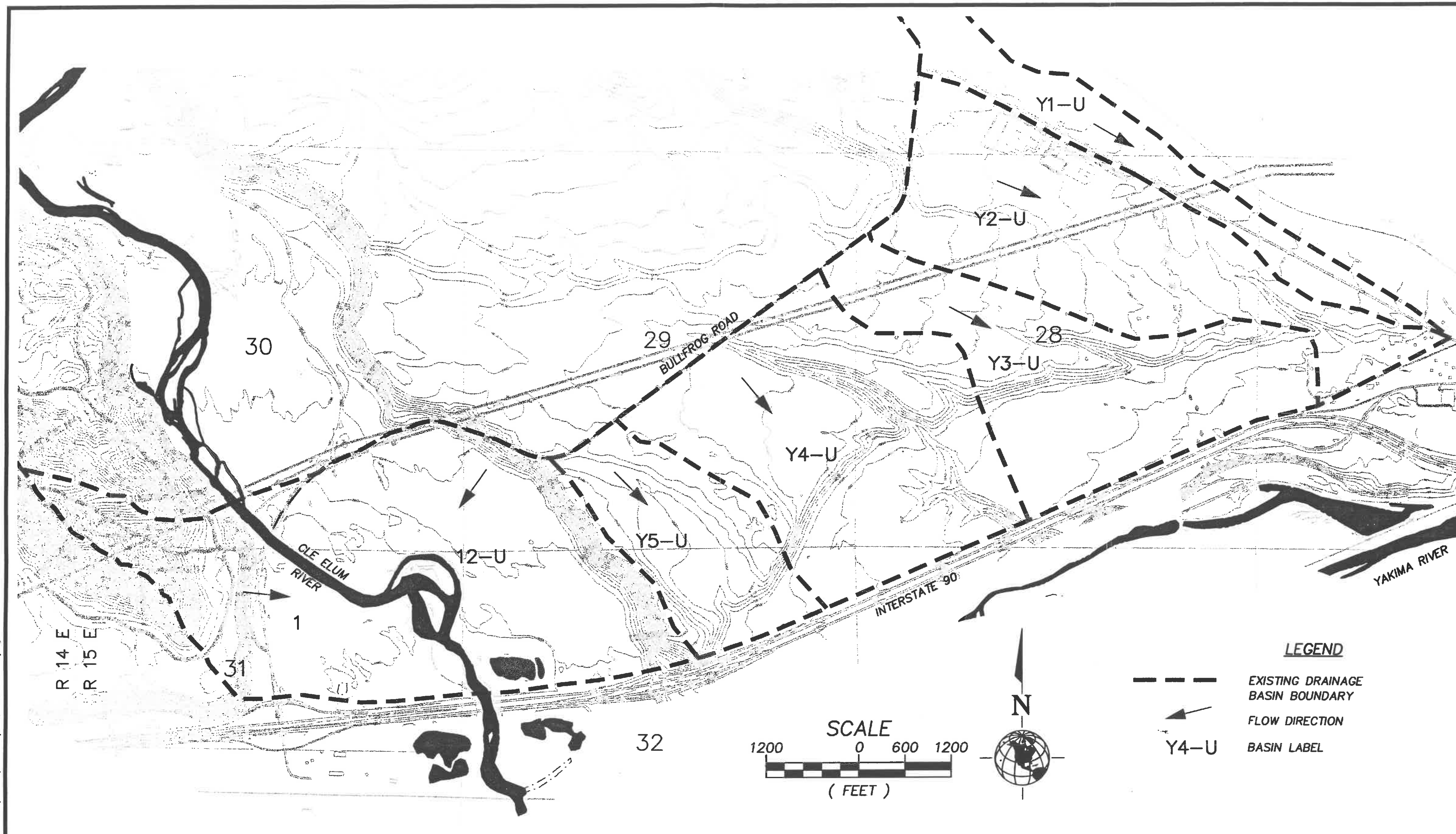
Preliminary Existing Condition Models

Preliminary existing conditions HSPF logic models have been developed for each of the UGA subbasins. Bullfrog road is the northerly limit of the subbasin. The basins are being modeled as basins without streams because of their lack of active stream systems. These include Subbasin 12-U and Subbasins Y1-U through Y5-U. Subbasins boundaries for each of the models are shown in **Figure 2-1**.

Land Segments

The drainage basins were broken into homogeneous land segments according to soil type, vegetative cover, and average slope conditions. The categories chosen for land segment classification are based on classifications by Dinicola[a]. The categories and the resulting shorthand nomenclature are contained in **Table 2-1**. The nomenclature is based on the first letter of the soil type, vegetative cover, and slope in order.

[a] Dinicola, R.S. *Characterization and Simulation of Rainfall-Runoff Relations for Headwater Basins in Western King and Snohomish Counties, Washington.* U.S. Geological Survey. 1990.



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Cle Elum Urban Growth Area

Figure 2-1
Existing Subbasins

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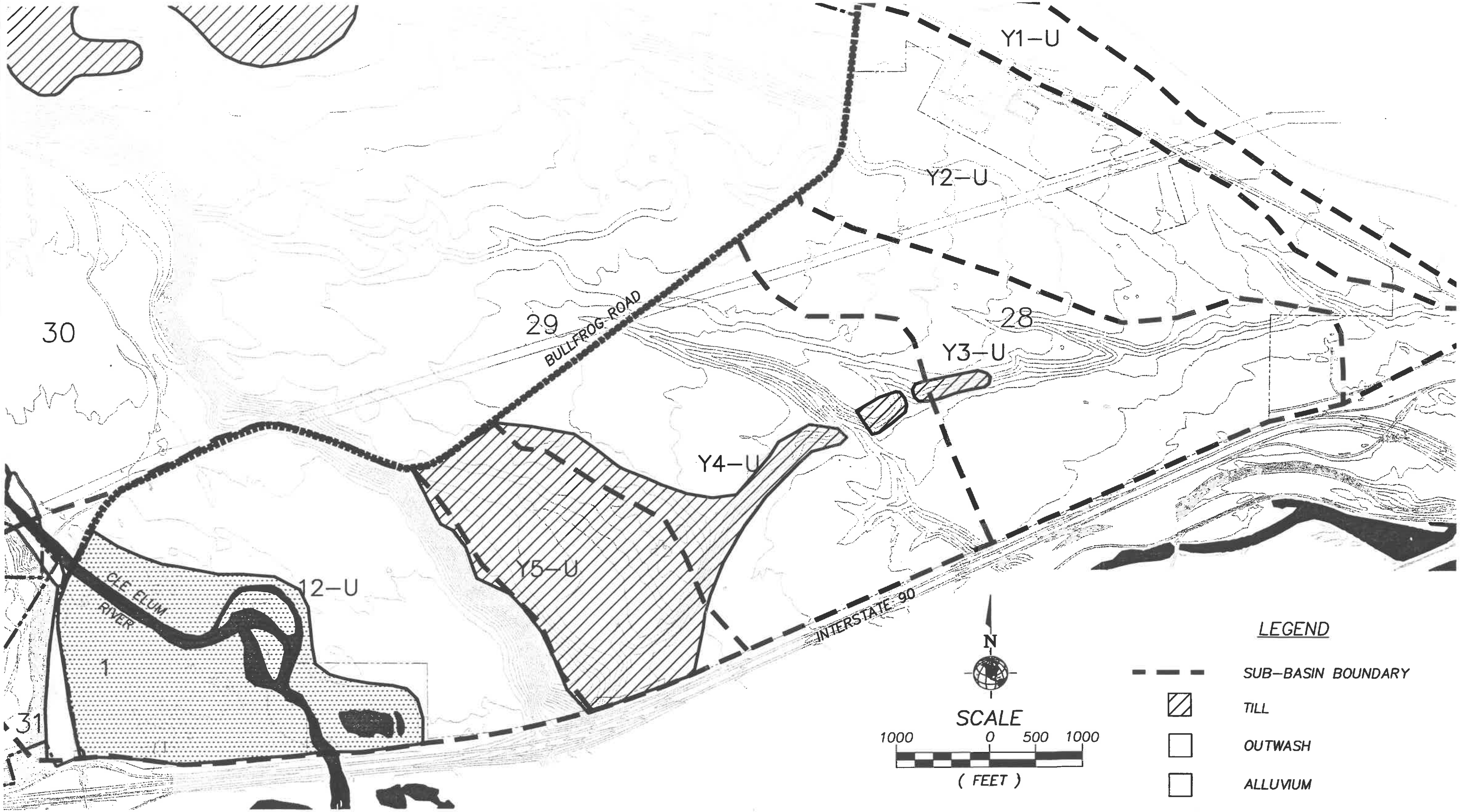
Table 2-1: Soil-Cover-Slope Complexes

Nomenclature	Soil Type	Vegetative Cover	Slope
OFF	Outwash	Forest	Flat
OFG	Outwash	Forest	Gradual
OFS	Outwash	Forest	Steep
OOF	Outwash	Successional[a]	Flat
OOG	Outwash	Successional[a]	Gradual
OOS	Outwash	Successional[a]	Steep
BFF	Bedrock	Forest	Flat
BFG	Bedrock	Forest	Gradual
BFS	Bedrock	Forest	Steep
BOG	Bedrock	Successional[a]	Gradual
BOS	Bedrock	Successional[a]	Steep
SFF	Saturated	Forest	Flat
SFG	Saturated	Forest	Gradual
SFS	Saturated	Forest	Steep
SOF	Saturated	Successional[a]	Flat
SOG	Saturated	Successional[a]	Gradual
SOS	Saturated	Successional[a]	Steep
TFF	Till	Forest	Flat
TFG	Till	Forest	Gradual
TFS	Till	Forest	Steep
TOF	Till	Successional[a]	Flat
TOG	Till	Successional[a]	Gradual
TOS	Till	Successional[a]	Steep

[a] Early Forest Successional.

Soil Type. CDM (formerly AGI Technologies) characterized soil types throughout the UGA site. These soil types were aggregated by American Engineering Corporation into four general soil types for the hydrologic model. The four model soil types are bedrock, till, outwash and saturated. **Table 2-2** summarizes the soil types present in each of the subbasins. The soil types for the UGA watershed are shown in **Figure 2-2**.

Cover. Vegetative cover information obtained from aerial photos was field verified and analyzed by Raedeke Associates, Inc. The cover classes identified by Raedeke were reduced to two general cover classes for the hydrologic model. W&H Pacific, Inc., performed aggregation. The two classes were early forest successional and forested. The early forest successional class is composed of grassland, bare ground, shrubs, riparian shrubs, forest harvest and sections of forest early secessional cover classes identified by Raedeke Associates, Inc. The forest cover class is composed of mixed, coniferous, thinned coniferous, and deciduous forest classes identified by Raedeke Associates, Inc. The vegetative cover types for the UGA watershed are shown in **Figure 2-3**.



SOURCE: AGI TECHNOLOGIES

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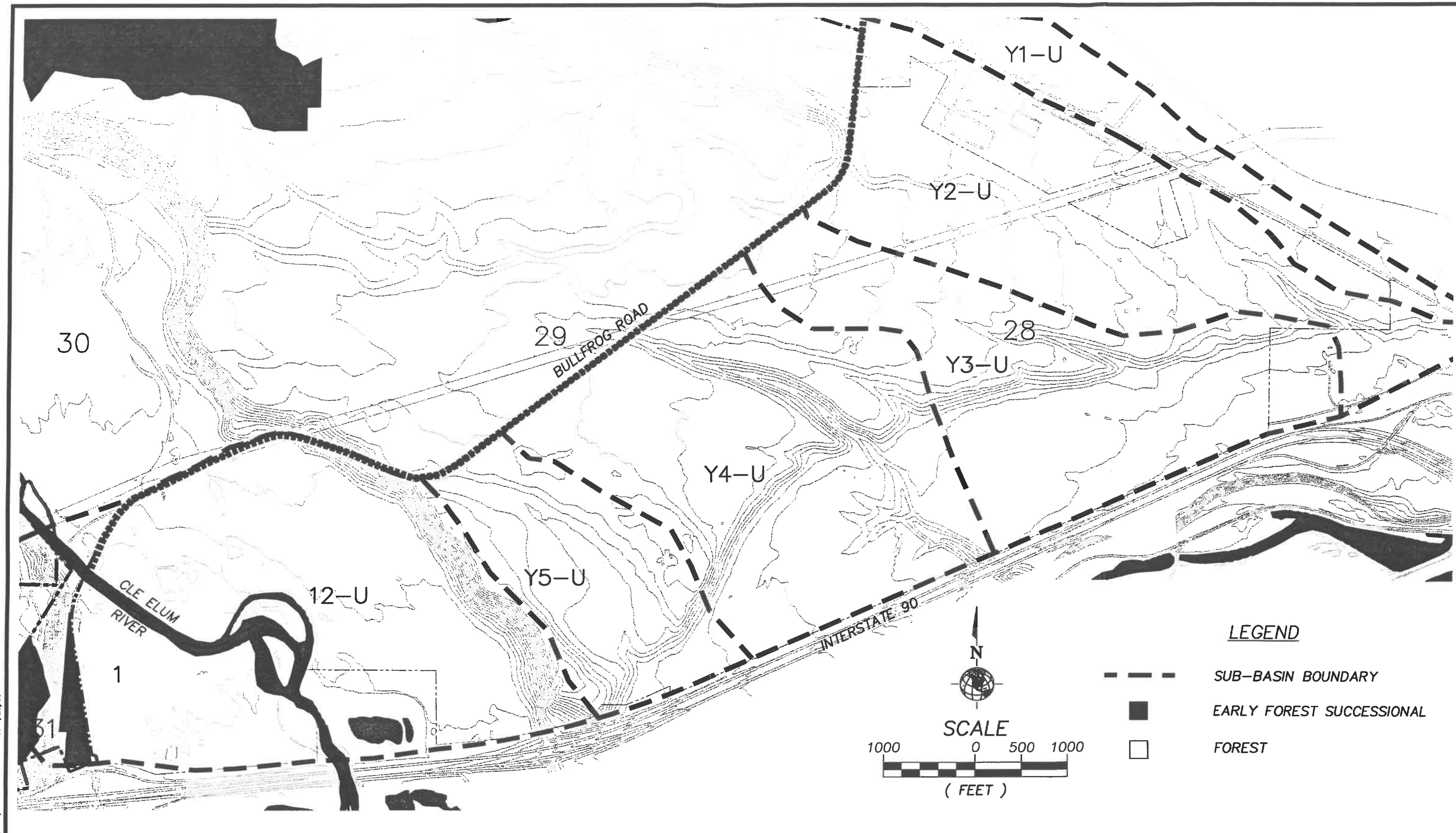
Cle Elum Urban Growth Area

Figure 2-2
Soil Types



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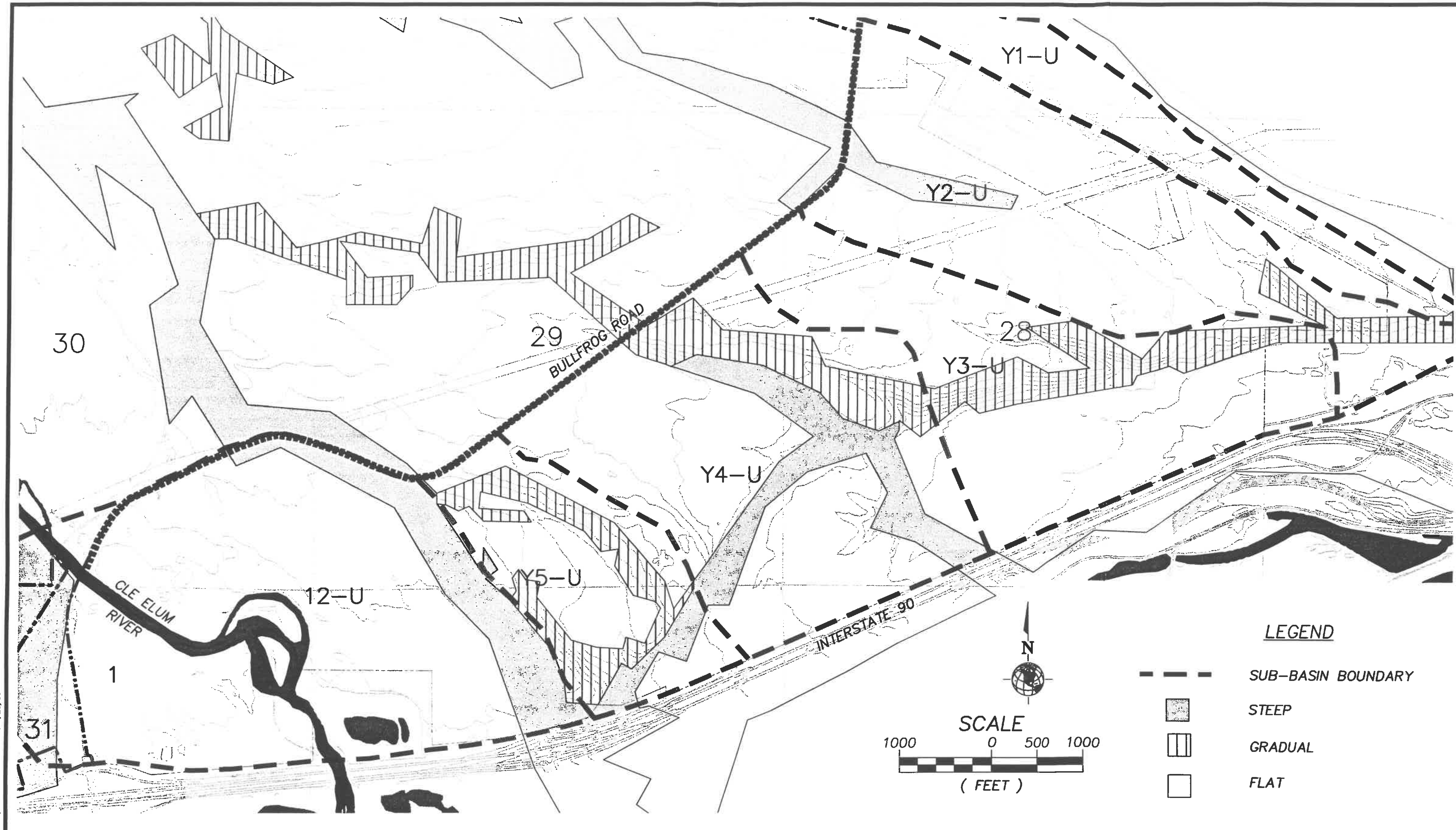
Cle Elum Urban Growth Area

Figure 2-3
Existing Vegetative Cover



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Cle Elum Urban Growth Area

Figure 2-4
Slope Map

Table 2-2: Existing Subbasin Soil Types

Subbasin	Basin Area (acres)	Till (acres)	Outwash (acres)	Bedrock Area (acres)	Saturated (acres)	Impervious (acres)
Basin 1-1U	90	-	90	-	-	-
Basin 1-2U	85	-	40	45	-	-
Basin 12-U	248	2	246	-	-	-
Basin Y1-U	100	-	94	-	-	6
Basin Y2-U1	97	-	97	-	-	-
Basin Y2-U2	57	-	57	-	-	-
Basin Y2-U3	28	-	28	-	-	-
Basin Y2-U4	102	-	93	-	-	9
Basin Y3-U1	70	-	70	-	-	-
Basin Y3-U2	15	-	15	-	-	-
Basin Y3-U3	61	2	59	-	-	-
Basin Y3-U4	65	-	65	-	-	-
Basin Y3-U5	20	-	20	-	-	-
Basin Y4-U1	105	26	79	-	-	-
Basin Y4-U2	93	11	82	-	-	-
Basin Y4-U3	64	1	63	-	-	-
Basin Y4-U4	26	1	25	-	-	-
Basin Y5-U1	96	96	-	-	-	-
Basin Y5-U2	31	26	5	-	-	-

Slope. Three slope categories were used for the analysis: Flat (0-6 percent), Gradual (Moderate) (6-15 percent) and Steep (+15 percent). Average slope was analyzed in SoftDesk v.8 using 10-ft contours for the project site. W&H Pacific, Inc. performed the slope analysis. The results of the slope category delineation for the project watershed are shown in **Figure 2-4**.

Soil-Cover-Slope-Complex Summary. The dominate soil-cover-slope class is OFF. Other classes occupying more than 3 percent of the site include OFG, OFS, TFF and TFS.

A summary of the existing conditions land use for the site is contained in **Table 2-3**.

Table 2-3: Pre-Development Condition Subbasin Land-Use/Land Cover

Subbasin	Basin Area (acres)	Undisturbed Area (acres)	Total Converted (acres)	Landscape Area (acres)	Impervious Roads (acres)	Impervious Other (acres)
Basin 1-1U	90.0	90.0	-	-	-	-
Basin 1-2U	85.0	85.0	-	-	-	-
Basin 12-U	248.0	248.0	-	-	-	-
Basin Y1-U	100.0	94.0	6.0	-	-	6.0
Basin Y2-U1	97.0	97.0	-	-	-	-
Basin Y2-U2	57.0	57.0	-	-	-	-
Basin Y2-U3	28.0	28.0	-	-	-	-
Basin Y2-U4	102.0	93.0	9.0	-	-	9.0
Basin Y3-U1	70.0	70.0	-	-	-	-
Basin Y3-U2	15.0	15.0	-	-	-	-
Basin Y3-U3	61.0	61.0	-	-	-	-
Basin Y3-U4	65.0	65.0	-	-	-	-
Basin Y3-U5	20.0	20.0	-	-	-	-
Basin Y4-U1	105.0	109.0	-	-	-	-
Basin Y4-U2	93.0	93.0	-	-	-	-
Basin Y4-U3	64.0	64.0	-	-	-	-
Basin Y4-U4	26.0	26.0	-	-	-	-
Basin Y5-U1	96.0	96.0	-	-	-	-
Basin Y5-U2	31.0	31.0	-	-	-	-

Existing Condition Modeling Results

Model output consists of 29 water years of hourly runoff data for each drainage basin (October 1961 through December 1990). This period was governed by the availability of solar radiation data, a required input to the model. The runoff data were used to perform an annual flood frequency and flow duration analysis. Peak flows were developed according to the procedures outlined in U.S. Water Resources Council Bulletin 17B.

Annual flow and peak flow summaries for each subbasin, are presented in **Tables 2-4** and **2-5**, respectively. Peak flow for these subbasins, which do not contain streams, is the sum of groundwater, shallow surface, and surface flow for all land segments within the basin. This flow can be thought of, potentially, as the subbasin's contribution to either the Cle Elum River or the Yakima River depending on location.

Table 2-4: Pre-Developed Condition Annual Flow Volumes for UGA Basins at the Drainage Boundary

Drainage Basin	Total Basin Area (ac)	Average Annual Flow					Flow Distribution (as percentage of total flow)		
		Total Flow (ac-ft)	Total Flow/ Unit Area (ac-ft/ac)	Surface Flow (ac-ft)	Interflow (ac-ft)	Groundwater Flow (ac-ft)	Surface	Interflow	Groundwater
Basin 1	175	323.2	1.9	0.5	9.1	313.7	0%	3%	97%
Basin 12	248	310.7	1.3	18.8	0.0	292.0	6%	0%	94%
BSN Y1-U	100	110.6	1.1	12.5	0.0	98.2	11%	0%	89%
BSN Y2-U	284	311.2	1.1	18.8	0.0	292.4	6%	0%	94%
BSN Y3-U	231	240.5	1.0	0.2	0.7	239.7	0%	0%	100%
BSN Y4-U	288	299.6	1.0	0.6	13.7	285.3	0%	5%	95%
BSN Y5-U	127	184.3	1.4	2.9	73.5	107.9	2%	40%	59%

Note: Percentages may not add up to 100 percent due to rounding.

Table 2-5: Pre-Developed Condition Peak Flow Analysis

	Flow from Melt and Rain Events: January 1 – December 31 (cfs)					
	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
Basin 1	1.70	2.46	2.91	3.43	3.77	4.09
Basin 12	1.51	2.22	2.80	3.66	4.40	5.25
BSN Y1-U	1.37	1.84	2.18	2.63	2.99	3.36
BSN Y2-U	2.43	3.21	3.75	4.45	5.00	5.56
BSN Y3-U	0.90	1.38	1.77	2.36	2.87	3.46
BSN Y4-U	1.19	1.81	2.30	3.00	3.60	4.27
BSN Y5-U	1.47	2.36	3.06	4.05	4.88	5.77

Developed Condition Modeling

Modeling Concept

The developed condition drainage concept includes collection and conveyance facilities, water quality treatment facilities, infiltration basins, and detention basins. The HSPF developed condition models include basin area reaches, routing protocols (describing locations to where stormwater is routed), detention basins, and infiltration basins. The water quality facilities do not significantly alter the peak flows or flow volumes and, therefore, are not constructed in the modeling. To be conservative the interflow and surface flow of the subbasin area upstream of the roadside ditches is routed to the subbasin stormwater facility. This is a conservative approach because the roadside ditches are not modeled as losing reaches, whereas in reality some of the upslope basin interflow and surface flow would infiltrate prior to reaching the infiltration basins. Groundwater discharges are routed to the outlet of the basin in which they are generated.

A typical HSPF model includes the basin area containing slope, vegetation, soil, and climate characteristics; a routing description indicating the detention facility, stream, or wetland to which the contributing area is routed; and the detention or infiltration facility (for mitigated developed condition models).

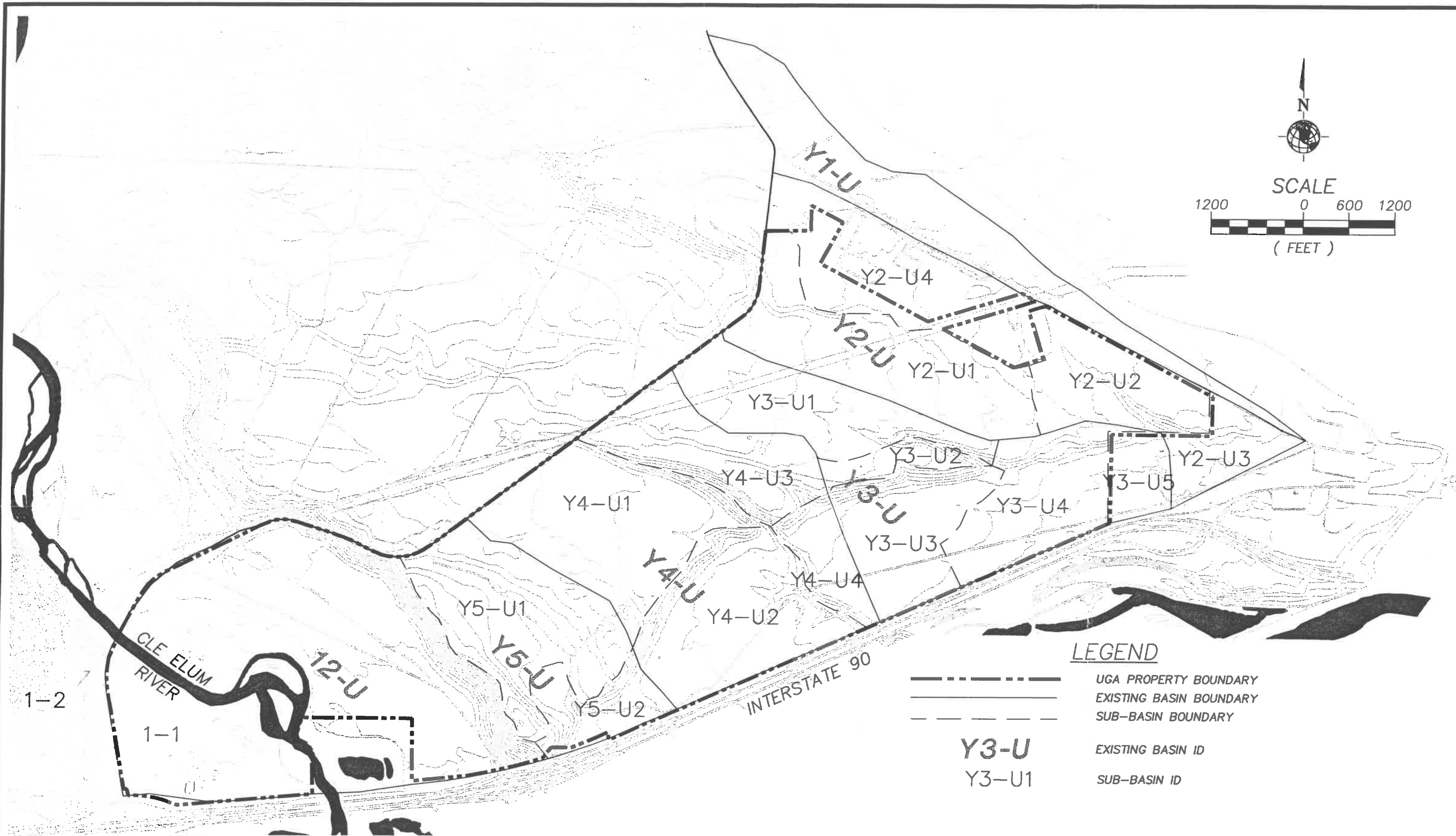
Models

To estimate the developed site runoff volumes and runoff rates, developed condition models were generated. These models contain developed land use/land cover characteristics, developed basin conveyance systems, and infiltration and detention ponds. The purpose of these models is to evaluate the effectiveness of the proposed stormwater detention facilities to provide developed condition runoff characteristics equivalent to existing basins stormwater runoff characteristics. **Table 2-6** provides a summary of land use/land cover for developed conditions. The runoff volumes at both the existing drainage basin boundaries and the discharge from the stormwater facilities were determined. The HSPF model results will be used to evaluate the effect of the development on stream flow volumes.

Routing

The stormwater routing for the developed condition modeling was developed based on two different sets of tributary areas: pond tributary areas and undisturbed existing basins. Developed condition basin boundaries are shown in **Figure 2-5**. Pond tributary areas include all areas that are tributary to an infiltration or detention pond. Pond tributary areas consist of pervious land segments representing landscaping and undisturbed areas that are upstream of interceptor swales and impervious land segments representing roads, parking lots, roofs, and driveways. The pond tributary areas are labeled sequentially according to the existing basin in which they discharge. For example, pond Y4-U4 is the fourth pond discharging to the existing drainage basin Y4-U. Only one pond is modeled for each tributary area in order to compute total storage necessary. In practice, the total storage may be divided into multiple ponds. Undisturbed existing basins consist of the portions of the existing condition basins that are not tributary to a pond. Undisturbed existing basins contain mostly pervious land segments.

HSPF models three different types of runoff for pervious land: surface flow, interflow, and groundwater flow. Runoff from impervious land occurs only as surface flow. Each of these runoff types can be routed independently for each land segment. The stormwater routing for developed basins and pond tributary areas is shown in **Figure 2-6** and is explained in further detail in the following paragraphs.



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Cle Elum Urban Growth Area

Figure 2-5
Developed Condition Basin Boundaries

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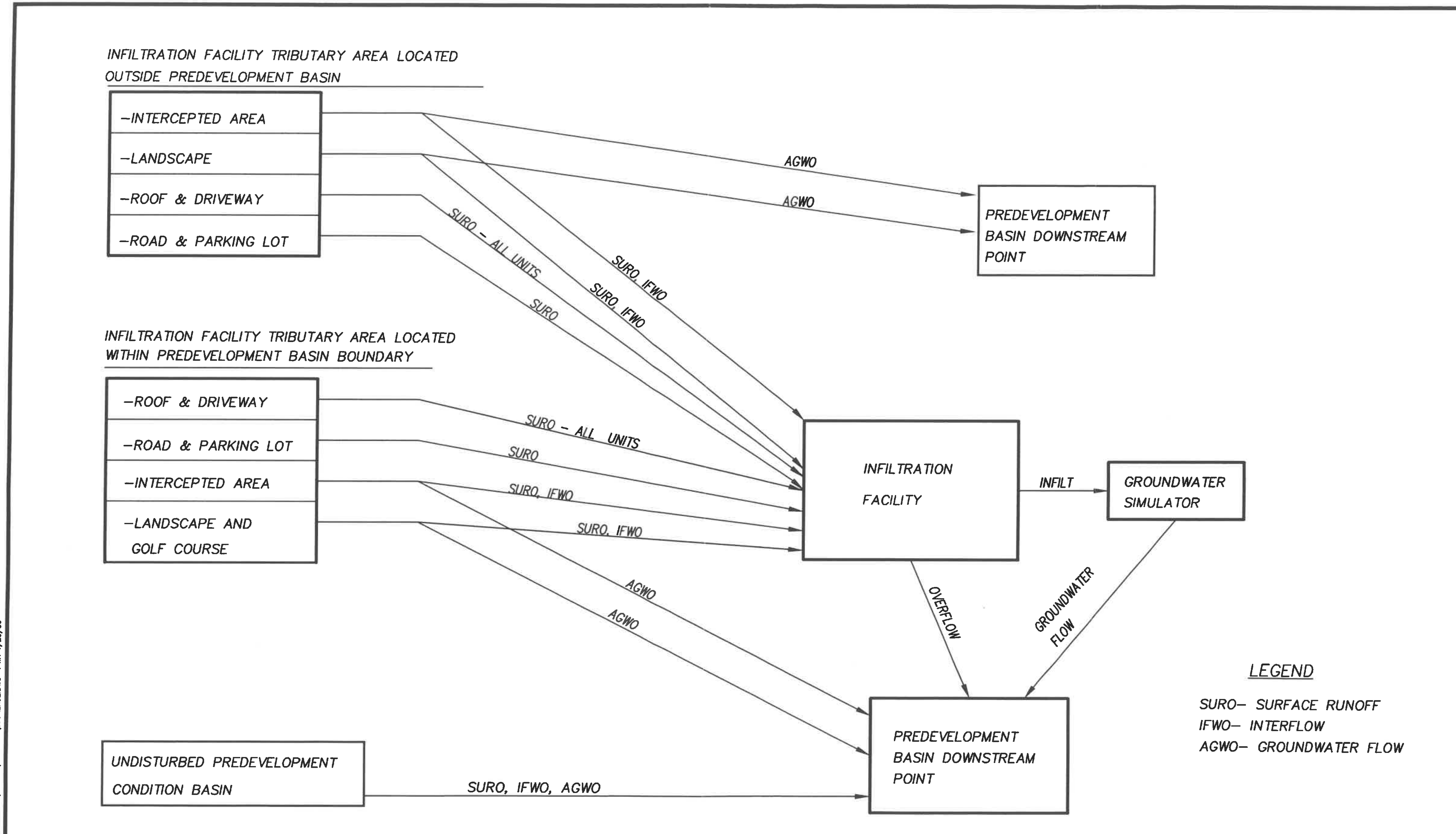

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Cle Elum Urban Growth Area

Figure 2-6
Permeable and Impermeable Area Model Schematic

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Table 2-6: Developed Condition Subbasin Land-use/Land Cover, Alternative 2[a]

Subbasin	Basin Area (acres)	Undisturbed Area (acres)	Total Converted (acres)	Landscape Area (acres)	Impervious Roads (acres)	Impervious Other (acres)
Basin 1-1U	90.0	42.8	47.2	36.5	6.0	4.7
Basin 1-2U	85.0	85.0	0.0	0.0	0.0	0.0
Basin 12-U	248.0	210.2	37.8	15.6	8.5	13.7
Basin Y1-U	100.0	94.0	6.0	0.0	0.0	6.0
Basin Y2-U1	97.0	19.0	78.0	39.0	19.5	19.5
Basin Y2-U2	57.0	17.0	40.0	23.0	7.0	10.0
Basin Y2-U3	28.0	28.0	0.0	0.0	0.0	0.0
Basin Y2-U4	102.0	93.0	9.0	0.0	0.0	9.0
Basin Y3-U1	70.0	14.0	56.0	28.0	14.0	14.0
Basin Y3-U2	15.0	0.0	15.0	8.0	1.7	5.3
Basin Y3-U3	61.0	13.0	48.0	36.0	3.1	8.9
Basin Y3-U4	65.0	7.0	58.0	15.0	30.0	13.0
Basin Y3-U5	20.0	20.0	0.0	0.0	0.0	0.0
Basin Y4-U1	105.0	4.0	101.0	85.5	3.9	11.6
Basin Y4-U2	93.0	14.0	79.0	76.0	3.0	0.0
Basin Y4-U3	64.0	8.0	56.0	48.0	2.6	5.4
Basin Y4-U4	26.0	3.0	23.0	22.0	0.9	0.1
Basin Y5-U1	96.0	10.0	86.0	71.0	3.8	11.2
Basin Y5-U2	31.0	10.0	21.0	20.5	0.0	0.5
	1453.0	692.0	761.0	524.1	104.0	132.9

a. Based on November 1999 land use/cover definition.

Existing Basin Routing. The routing for the undisturbed portion of existing basins is straightforward - all runoff (surface flow, interflow, and groundwater flow) originating within the basin is routed to the existing basin downstream point.

Pond Tributary Area Routing. Pervious undisturbed, impervious, and landscape areas as provided by American Engineering were used to model the tributary pond areas.

Pond tributary area runoff is the sum of runoff from development areas and from intercepted upslope undeveloped areas. The roadside ditches alter the existing drainage path for the surface runoff and interflow. The groundwater flow from the intercepted upslope area, pervious area, and landscape area is routed to the existing basin downstream point. Groundwater flow from intercepted areas in other basins is routed to the existing downstream point of the basin in which it originated. Surface flow and interflow runoff from golf course areas in the modeled Alternative 2 are routed to the developed basin infiltration ponds. Groundwater flow from the golf course areas is routed to the existing basin downstream point of the basin in which that portion of the golf course is located. Golf course runoff may be modified in the future depending on choice of mitigation techniques.

The roadside ditches are expected to intercept the surface flow and interflow from basin developed and undeveloped areas. Thus, the surface runoff from pervious areas, roads, parking lots, other impervious surfaces, landscape, intercepted area within the basin, and intercepted area from adjacent basins is routed to the basin infiltration pond. Interflow from pervious areas, landscape area, intercepted area within the basin, and intercepted area from adjacent basins is also routed to the infiltration pond.

Surface runoff from driveways and commercial roofs will be routed to the developed basin infiltration pond. Infiltrated stormwater from infiltration ponds will be routed to the existing basin groundwater.

A groundwater simulator is used to simulate the behavior of water infiltrated from infiltration ponds. The groundwater simulator is different from groundwater flow simulation of HSPFs. The groundwater simulator is used to extend the ability of HSPF to model surface flows that are returned to the ground through infiltration. The groundwater simulator is a reservoir with a large storage capacity. It simulates a groundwater recession curve using a linear relationship between storage and discharge. The slope of the recession curve is set equal to the HSPF recession parameter for the surrounding soil type. For purposes of hydrologic modeling of the UGA basins, it has been assumed that each subbasin will have multiple infiltration facilities. Therefore, runoff infiltrated to groundwater will be attenuated as assumed with the use of the groundwater simulator. For basins without streams, volumes calculated are compared only on an annual basis. This is because the groundwater simulator is used on the developed condition models and not on the existing condition models.

Mitigated Developed Condition Model Results

Developed mitigated condition annual flow volumes at basin boundaries is provided in **Table 2-7**. The comparison between existing and developed annual runoff volumes is provided as a percentage of existing flow in the table. The mitigated volumes were based on fully infiltrating surface flows in infiltration ponds. The exception is runoff from existing impervious areas not modified by project development or captured by project stormwater management facilities. These ponds had preliminary design rates of 2 to 10 inches per hour.

It should be noted that the modeling described in this section is based on the November 1999 land use/cover definitions for Alternative 2. Due to the evolving nature of conceptual land use plans, modifications have occurred since that time. However, HSPF modeling for the latest revision of the UGA project description has not been performed. This is because stormwater runoff volumes can be reasonably estimated for impact purposes based on the original modeling effort and the current proposed site plan.

Table 2-7: Mitigated Developed Condition Annual Flow Volumes for UGA Basins, Alternative 2

Drainage Basin	Total Basin Area (Ac.)	Average Annual Flow					Flow Distribution (as percentage of total flow)			Comparison to Existing Conditions	
		Total Flow (ac-ft)	Total Flow/Unit Area (ac-ft/ac)	Surface (ac-ft)	Interflow (ac-ft)	Groundwater (ac-ft)	Surface	Interflow	Groundwater	Percent Increase in Annual Flow	Percent Decrease in Surface Flow
Basin 1	175	348.5	2.0	0.3	9.1	339.2	0%	3%	97%	8%	40%
Basin 12	248	353.6	1.4	0.1	0.0	353.6	0%	0%	100%	14%	100%
BSN Y1	100	110.6	1.1	12.5	0.0	98.2	11%[1]	0%	89%	0%	0%
BSN Y2	284	376.1	1.3	18.7	0.0	357.4	5%[1]	0%	95%	21%	1%
BSN Y3	231	348.3	1.5	0.0	0.0	348.2	0%	0%	100%	45%	92%
BSN Y4	288	375.4	1.3	0.0	0.0	375.4	0%	0%	100%	25%	99%
BSN Y5	127	229.8	1.8	0.0	0.0	229.8	0%	0%	100%	25%	100%

1. Positive values reflect runoff from existing impervious areas not modified by project development or captured by project stormwater management facilities.
2. Based on November 1999 land use/cover definition.

Impervious and landscaped areas for Alternatives 2, 3, 4, and 5 are summarized in Table 2-8. The development alternatives have similar impervious area to that modeled and would, therefore, be expected to generate comparable stormwater volume for infiltration.

Table 2-8: Impervious and Landscape Area Summaries[b]

Surface Type, Acres	Project Alternative							
	2		3		4		5[c]	
	Impervious Area	Landscape Area	Impervious Area	Landscape Area	Impervious Area	Landscape Area	Impervious Area	Landscape Area
Roadways	32	32	43	43	35	35	61	61
Residential	53	21	75	36	45	21	104	50
Lodging	5	1	5	1	5	1	0	0
Golf Course	12	142	12	142	12	142	0	0
Public Facilities [a]	17	11	17	11	16	8	19	22
Business Park	60	18	44	12	22	6	63	7
Horse Park	90	43	0	0	90	43	0	0
RV Park	10	2	10	2	10	2	0	0
Total	279	271	205	247	235	257	247	140

[a] Maintenance area, water treatment plant, Community Recreation Center, School Expansion, and Cemetery Expansion.
[b] Note: Numbers may not sum to totals shown due to rounding.
[c] Excludes Reserve Area.

As previously described, modeling was performed based on November 1999 conceptual land use cover assumptions for Alternative 2. Alternative 2, as modeled, had 524 acres of landscape and 237 acres of impervious surface. Subsequent site planning modifications resulted in changes in impervious and landscape areas that are shown in Table 2-8. Landscaped area ranges from 140 acres (Alternative 5) to between 247 and 271 acres for Alternatives 2, 3, and 4. Impervious surface under Alternatives 2, 3, 4, and 5 ranges from 205 to 279 acres.

Based on the HSPF model used to model runoff, outwash landscape generates an average of about one-tenth the runoff of impervious surface per year. Using this approximation, the total runoff can be estimated using an equivalent impervious area. For the modeled Alternative 2, the equivalent impervious area is about 289 acres. The average annual surface flow and interflow components of runoff were estimated at 2,142 acre-feet for the modeled Alternative 2. This equates to an average of 7.40 acre-feet per acre of equivalent impervious area.

Using this estimated runoff per acre the stormwater runoff for the currently proposed alternatives 2, 3, 4 and 5 can be estimated. The equivalent impervious area and estimated runoff for each alternative are summarized in **Table 2-9**.

Table 2-9: Estimated Annual Runoff, Alternatives 2, 3, 4 and 5

Alternative	Equivalent Impervious Area, Acres	Estimated Average Runoff (Surface and Interflow), Ac-Ft
2	306	2,264
3	230	1,702
4	261	1,931
5	263	1,946

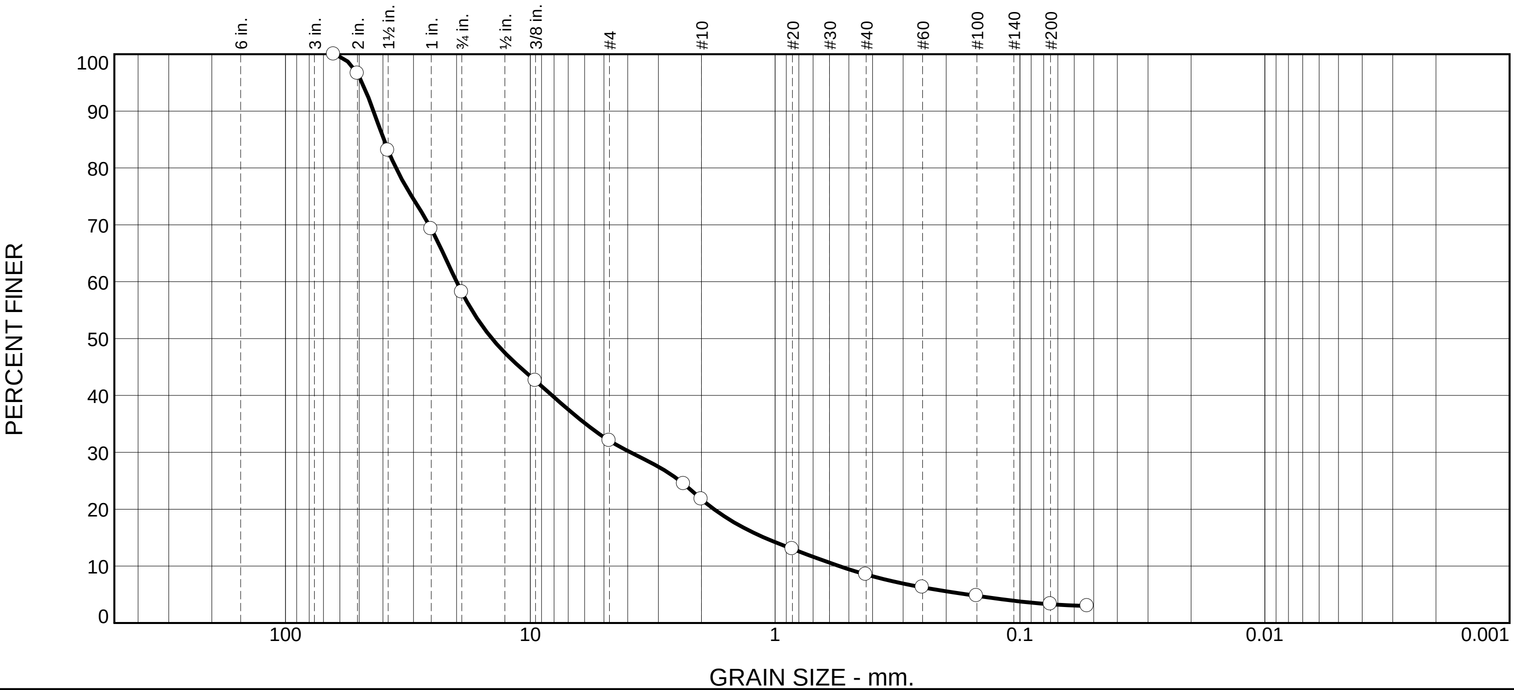
As can be noted from the table above, the estimated stormwater runoff for Alternative 2, as analyzed in the Draft EIS, is about 6 percent greater than the runoff estimated for the November 1999 Alternative 2. Alternatives 3, 4, and 5 are expected to generate less runoff than was estimated for the November 1999 Alternative 2.

A variation in stormwater runoff estimates for a particular drainage basin would be addressed with fewer or more stormwater quality and runoff control facilities depending on whether the estimated runoff for that basin increased or decreased.

APPENDIX H

Laboratory Sieve Analyses

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	41.8	26.2	10.3	13.2	5.2	3.3	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
2.5"	100.0		
2"	96.6		
1.5"	83.1		
1"	69.3		
3/4"	58.2		
3/8"	42.6		
#4	32.0		
#8	24.4		
#10	21.7		
#20	13.0		
#40	8.5		
#60	6.3		
#100	4.8		
#200	3.3		
#270	3.0		

* (no specification provided)

Material Description

Sandy GRAVEL trace silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= GW **AASHTO (M 145)=** A-1-a

Coefficients

D_{90}= 43.6924 D_{85}= 39.6567 D_{60}= 20.0058
D_{50}= 14.3370 D_{30}= 3.9002 D_{15}= 1.1061
D_{10}= 0.5475 C_u= 36.54 C_c= 1.39

Remarks

Date Received: 10/1/19 **Date Tested:** 11/7/19
Tested By: ALM
Checked By: TP
Title:

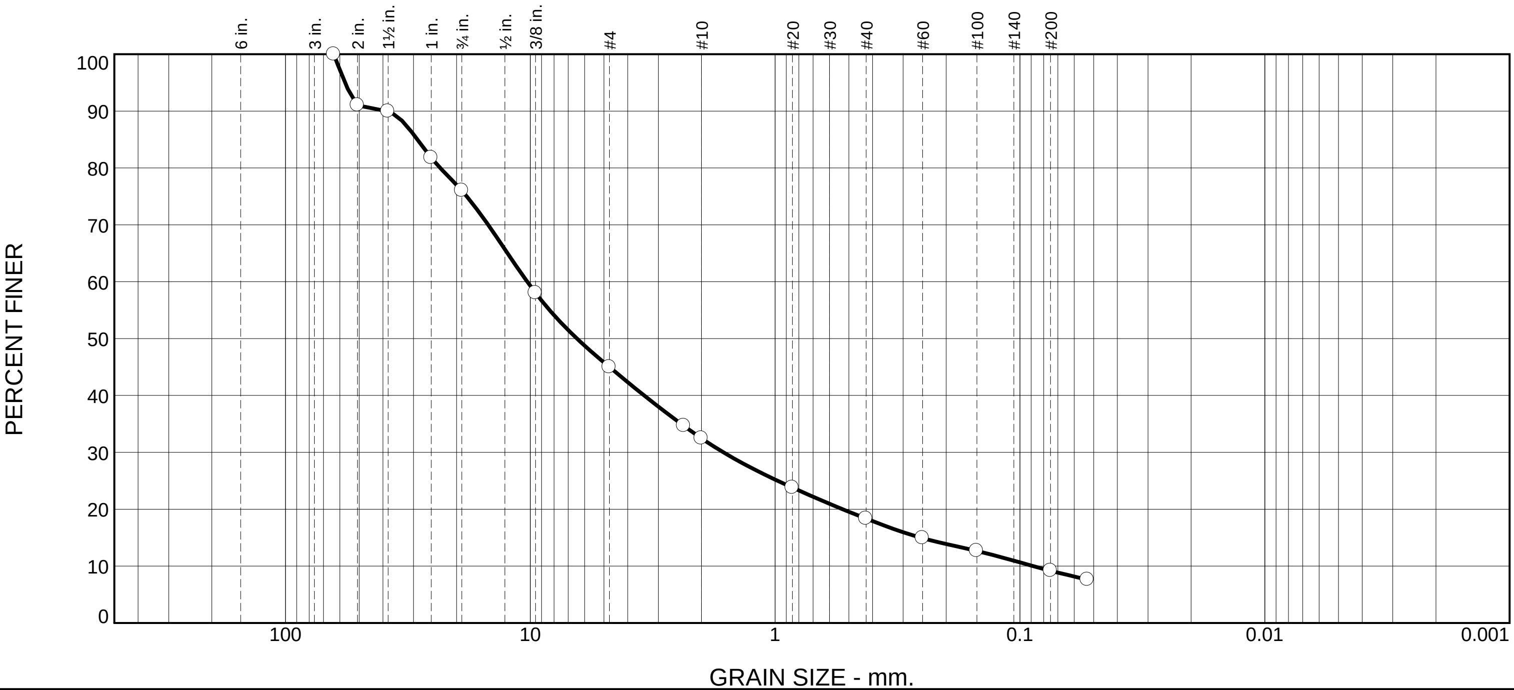
Location: Onsite
Sample Number: EP-17 **Depth:** 8-14'
Date Sampled: 10/22/19

associated earth sciences incorporated

Client: EA Engineering, Science and Technology
Project: 47° North

Project No: 20190414 H001 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	24.0	31.0	12.5	14.2	9.1	9.2	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
2.5"	100.0		
2"	91.0		
1.5"	89.9		
1"	81.8		
3/4"	76.0		
3/8"	58.0		
#4	45.0		
#8	34.7		
#10	32.5		
#20	23.8		
#40	18.3		
#60	14.9		
#100	12.7		
#200	9.2		
#270	7.6		

* (no specification provided)

Material Description

Very sandy GRAVEL some silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= GW-GM **AASHTO (M 145)=** A-1-a

Coefficients

D_{90}= 38.8343 D_{85}= 28.9149 D_{60}= 10.2974
D_{50}= 6.4512 D_{30}= 1.6278 D_{15}= 0.2544
D_{10}= 0.0883 C_u= 116.57 C_c= 2.91

Remarks

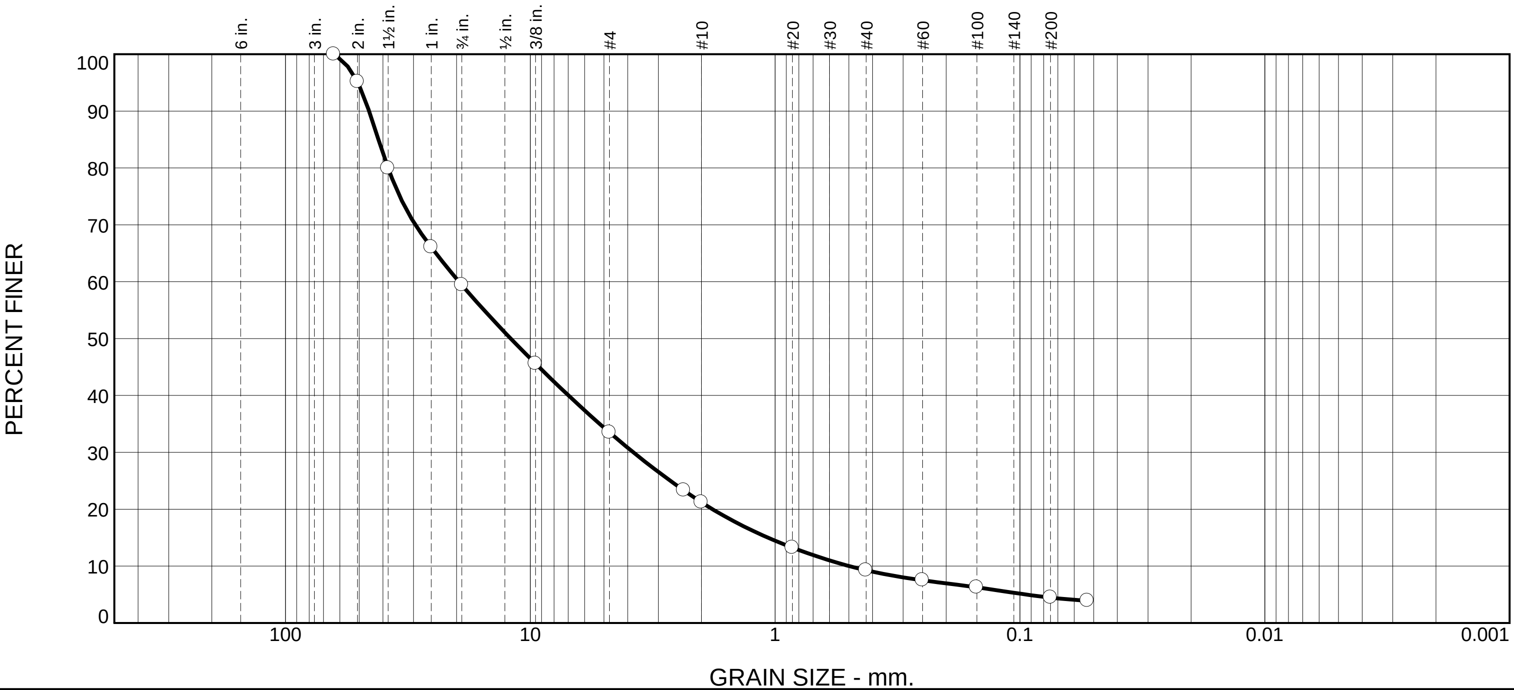
Date Received: 11/1/19 **Date Tested:** 11/7/19
Tested By: ALM
Checked By: TP
Title:

Location: Onsite
Sample Number: EP-21 **Depth:** 3-14'
Date Sampled: 10/22/19

associated earth sciences incorporated

Client: EA Engineering, Science and Technology
Project: 47° North
Project No: 20190414 H001 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	40.6	25.9	12.3	11.9	4.8	4.5	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
2.5"	100.0		
2"	95.2		
1.5"	80.0		
1"	66.1		
3/4"	59.4		
3/8"	45.6		
#4	33.5		
#8	23.3		
#10	21.2		
#20	13.2		
#40	9.3		
#60	7.5		
#100	6.3		
#200	4.5		
#270	3.9		

* (no specification provided)

Material Description

Sandy GRAVEL trace silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= GW **AASHTO (M 145)=** A-1-a

Coefficients

D_{90}=	45.5570	D_{85}=	41.7182	D_{60}=	19.5503
D_{50}=	12.0237	D_{30}=	3.7954	D_{15}=	1.0707
D_{10}=	0.4983	C_u=	39.23	C_c=	1.48

Remarks

Date Received: 11/1/19 **Date Tested:** 11/7/19

Tested By: ALM

Checked By: TP

Title:

Location: Onsite

Sample Number: EP-22 **Depth:** 3-15'

Date Sampled: 10/22/19

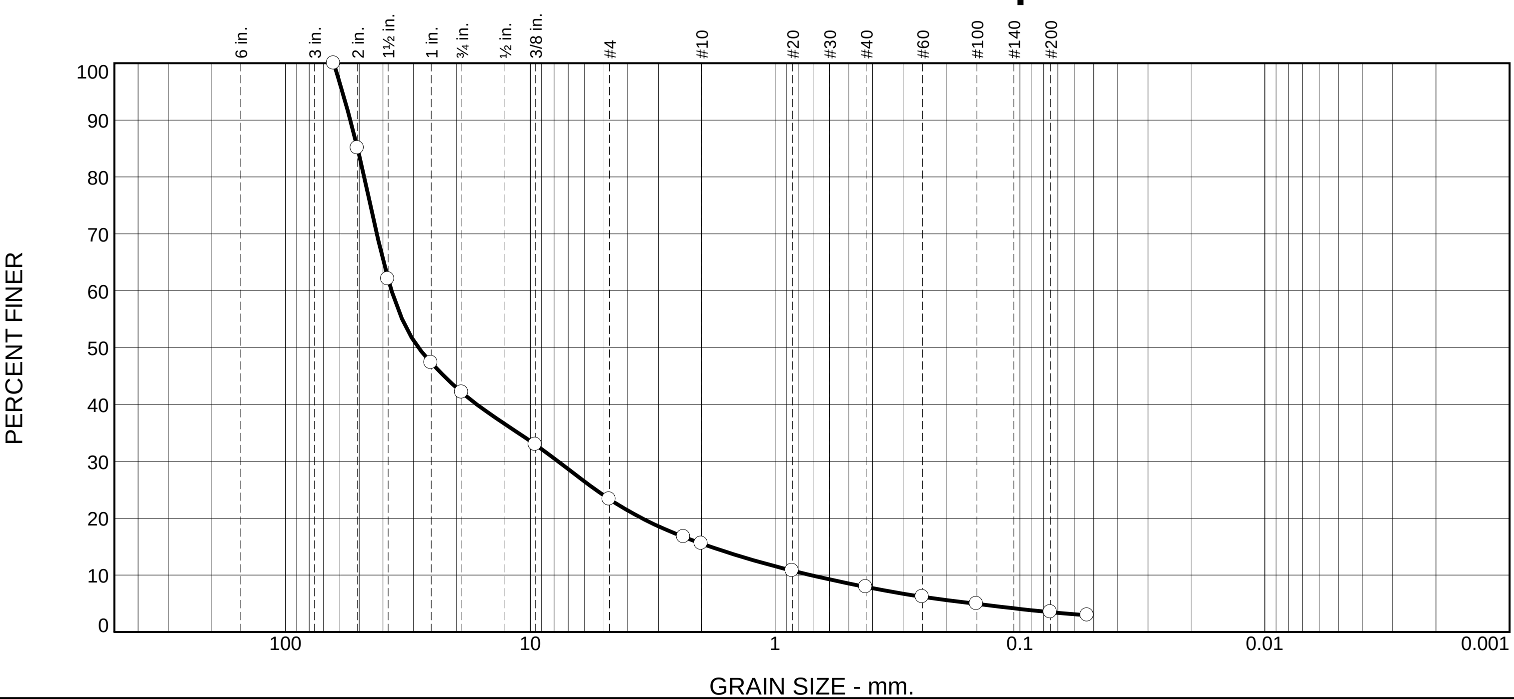
associated earth sciences incorporated

Client: EA Engineering, Science and Technology

Project: 47° North

Project No: 20190414 H001 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	57.9	18.8	7.8	7.6	4.4	3.5	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
2.5"	100.0		
2"	85.1		
1.5"	62.1		
1"	47.3		
3/4"	42.1		
3/8"	32.9		
#4	23.3		
#8	16.7		
#10	15.5		
#20	10.8		
#40	7.9		
#60	6.2		
#100	4.9		
#200	3.5		
#270	2.9		

* (no specification provided)

Material Description

Sandy GRAVEL trace silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= GW **AASHTO (M 145)=** A-1-a

Coefficients

$D_{90}=$ 54.3534 $D_{85}=$ 50.7549 $D_{60}=$ 36.8710
$D_{50}=$ 28.6632 $D_{30}=$ 7.7089 $D_{15}=$ 1.8412
$D_{10}=$ 0.7167 $C_u=$ 51.44 $C_c=$ 2.25

Remarks

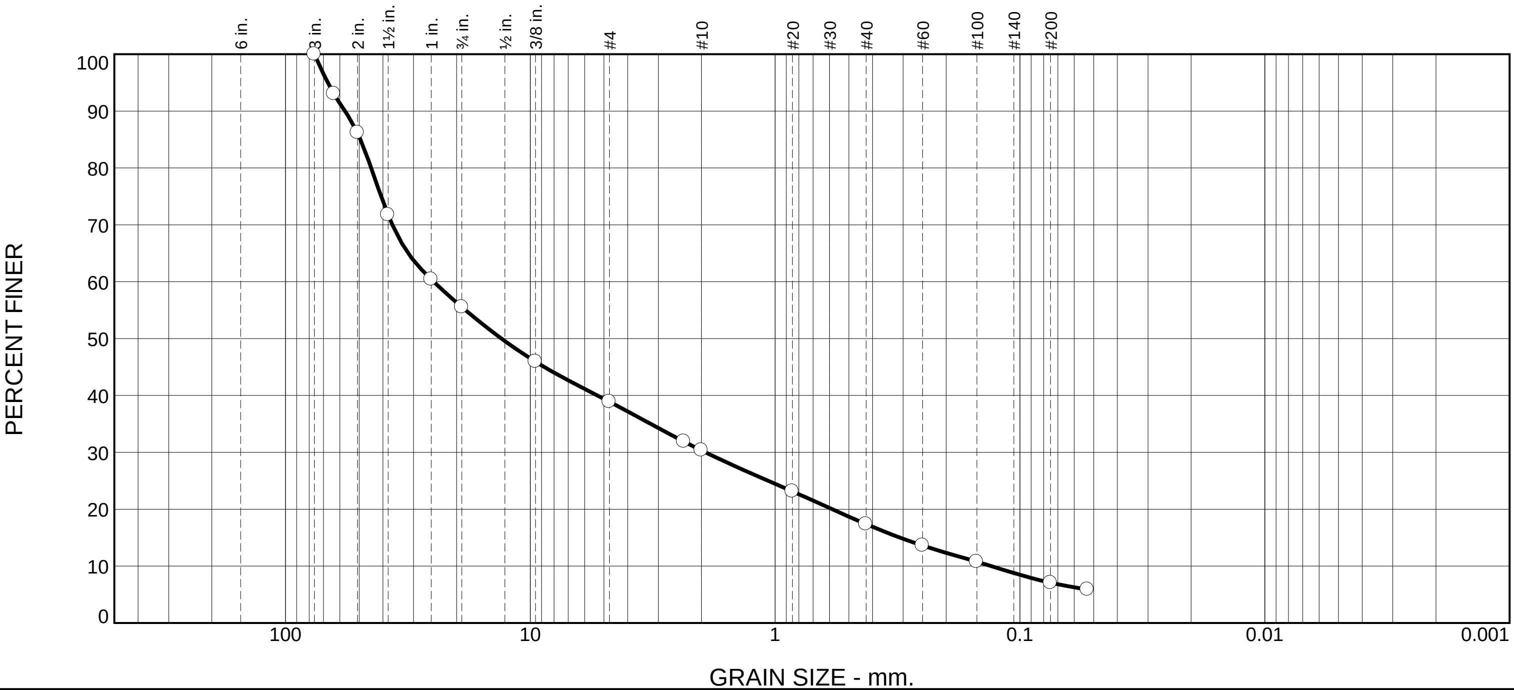
Date Received: 11/1/19 **Date Tested:** 11/7/19
Tested By: ALM
Checked By: TP
Title:

Location: Onsite
Sample Number: EP-24 **Depth:** 4.5-15' **Date Sampled:** 10/22/19

associated earth sciences incorporated

Client: EA Engineering, Science and Technology
Project: 47° North
Project No: 20190414 H001 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	44.5	16.6	8.6	12.9	10.3	7.1	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0		
2.5"	93.0		
2"	86.2		
1.5"	71.8		
1"	60.4		
3/4"	55.5		
3/8"	45.9		
#4	38.9		
#8	31.9		
#10	30.3		
#20	23.1		
#40	17.4		
#60	13.6		
#100	10.8		
#200	7.1		
#270	5.9		

* (no specification provided)

Material Description

Very sandy GRAVEL some silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= GW-GM **AASHTO (M 145)=** A-1-a

Coefficients

$D_{90}=$ 57.1295 $D_{85}=$ 49.3648 $D_{60}=$ 24.8353
$D_{50}=$ 13.1174 $D_{30}=$ 1.9284 $D_{15}=$ 0.3089
$D_{10}=$ 0.1312 $C_u=$ 189.33 $C_c=$ 1.14

Remarks

Date Received: 11/1/19 **Date Tested:** 11/7/19

Tested By: ALM

Checked By: TP

Title:

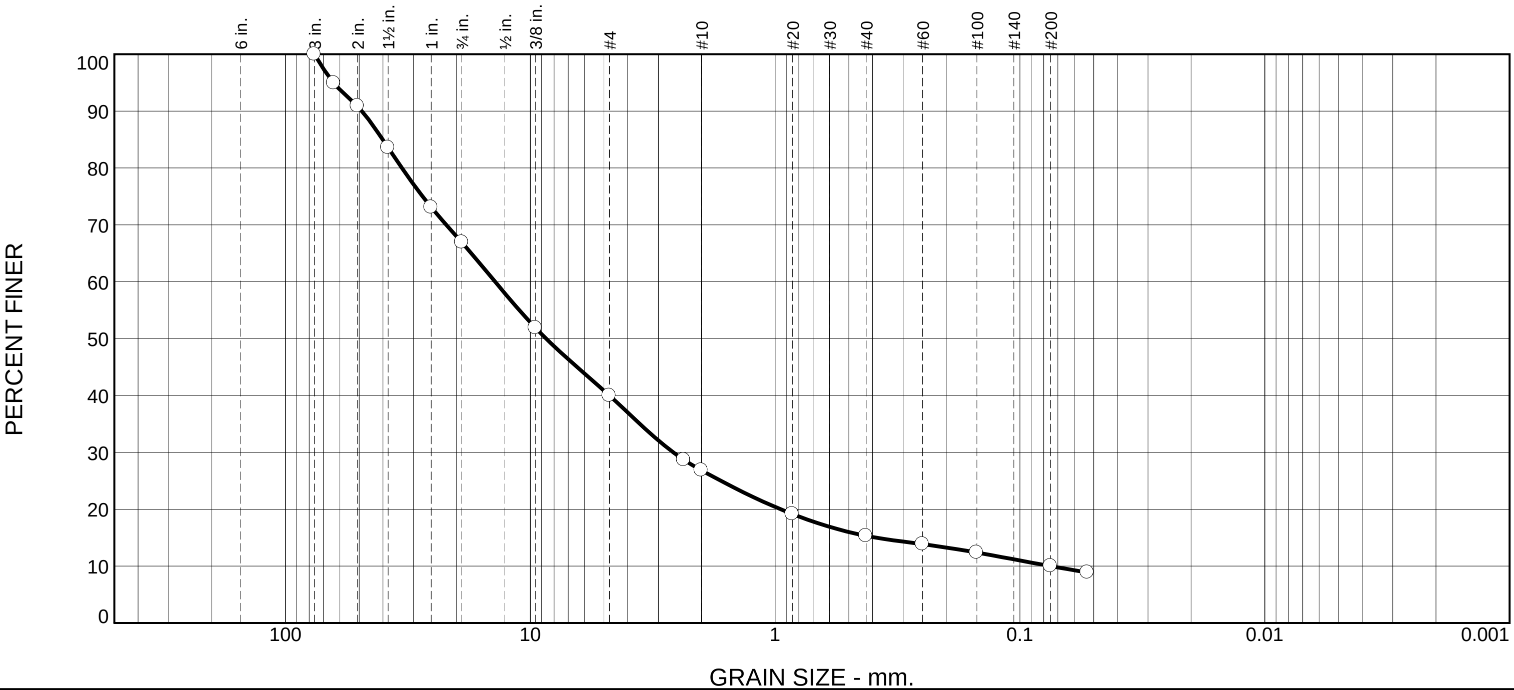
Location: Onsite
Sample Number: EP-29 **Depth:** 5.5-14.5'
Date Sampled: 10/22/19

associated earth sciences incorporated

Client: EA Engineering, Science and Technology
Project: 47° North

Project No: 20190414 H001 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	33.1	26.9	13.2	11.5	5.3	10.0	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3"	100.0		
2.5"	94.9		
2"	90.9		
1.5"	83.6		
1"	73.1		
3/4"	66.9		
3/8"	51.9		
#4	40.0		
#8	28.7		
#10	26.8		
#20	19.1		
#40	15.3		
#60	13.9		
#100	12.4		
#200	10.0		
#270	8.9		

* (no specification provided)

Material Description

Very sandy GRAVEL some silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= GP-GM **AASHTO (M 145)=** A-1-a

Coefficients

D_{90}= 48.7186 D_{85}= 40.0843 D_{60}= 13.9279
D_{50}= 8.6223 D_{30}= 2.6102 D_{15}= 0.3872
D_{10}= 0.0752 C_u= 185.31 C_c= 6.51

Remarks

Date Received: 11/1/19 **Date Tested:** 11/7/19
Tested By: ALM
Checked By: TP
Title:

Location: Onsite
Sample Number: EP-37 **Depth:** 3-13'
Date Sampled: 10/22/19

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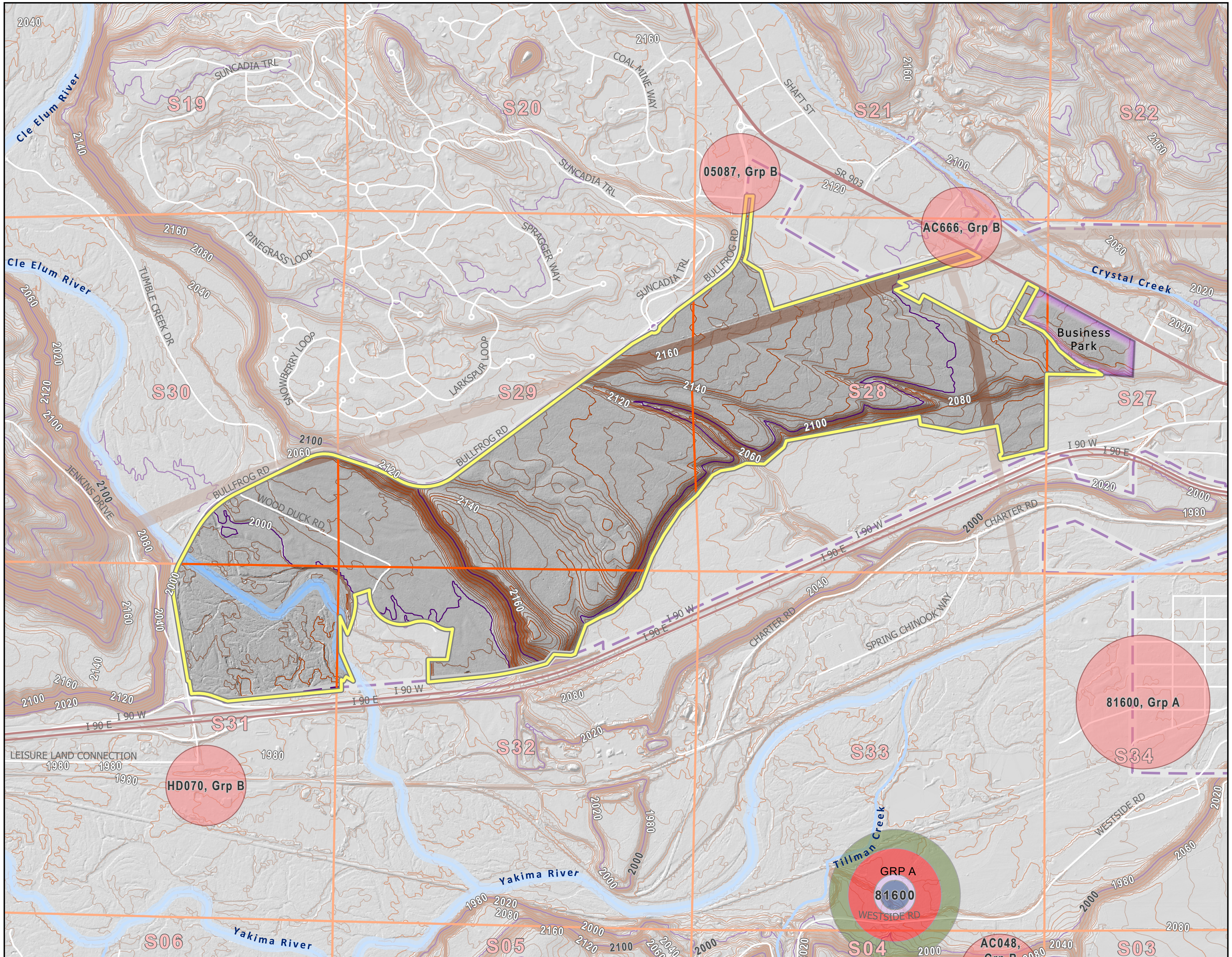
Client: EA Engineering, Science and Technology
Project: 47° North

Project No: 20190414 H001 **Figure**

APPENDIX I

Source Water Assessment Program Mapping

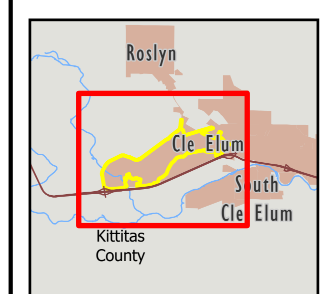


- PROJECT BOUNDARY
- TRANSMISSION LINES
- OFF PROPERTY BUSINESS PARK
- CITY BOUNDARY
- SECTION
- CONTOUR 100 FT
- CONTOUR 20 FT
- CONTOUR 5 FT
- ASSIGNED ASSIGNED TIME OF TRAVEL, LABELED WITH PWSID AND SYSTEM GROUP
- 6 MONTH TIME OF TRAVEL
- 1 YEAR TIME OF TRAVEL
- 5 YEAR TIME OF TRAVEL
- 10 YEAR TIME OF TRAVEL

NOTE: ENTIRE PROJECT AREA IS WITHIN A GROUP A SURFACE WATER PROTECTION AREA

DATA SOURCES / REFERENCES:
WASHINGTON STATE LIDAR PORTAL: YAKIMA 2014, NO REPORT AVAILABLE. CONTOURS FROM LIDAR
KITTITAS CO: ROADS, PARCELS, CITY 10/19
ESM: SURVEYED PROJECT BOUNDARY 11/19
DOH: WELLS 2019

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE



0 1500
FEET

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

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PUBLIC WATER SUPPLY WELLS
TIME OF TRAVEL
47° NORTH SEIS
CLE ELUM, WASHINGTON

PROJ NO.	DATE:	FIGURE:
2090414H001	4/20	I

G:\GIS_Projects\aaY2019\190414 47 Degrees N\aprx_mxd\EIS0320\190414H001 AI Wells_1pg_47Deg.aprx

Appendix C - 2024 AESI Bullfrog Flats Geotechnical Report

(Currently in progress and will be added when complete.)

Appendix D - MSRTS & HydroCAD Modeling Comparison

MSRTS & HydroCAD Inputs	
Total Impervious Area	9.9 ac
Facility Side Slopes	3H:1V
Infiltration Rate	4.0 in/hr
Infiltration Type	Vertical Surface Area

HydroCAD Only Inputs	
Method	SBUH
Storm Type	IA
Tc	5 min

	Name	Model	Storm Duration	Return Period	Precipitation Depth (in)	Snowmelt	AMC	Bottom Length	Bottom Width	Required Base Area	Precent of MSRTS Base Area	Maximum Stage	Max. Stage Volume	Precent of MSRTS Volume
	Facility #1	MSRTS	N/A (HSPF)	100-yr	N/A (HSPF)	Yes	N/A (HSPF)	125.00'	70.00'	8750 sf	100%	4.79'	1.32 ac-ft	100%
	Facility #2	HydroCAD	24-hr	100-yr	3.91 (MDP)	No	2	106.70'	70.00'	7469 sf	85%	4.79'	1.15 ac-ft	87%
	Facility #3	HydroCAD	24-hr	100-yr	4.5 (NOAA)	No	2	126.30'	70.00'	8841 sf	101%	4.79'	1.33 ac-ft	101%
	Facility #4	HydroCAD	24-hr X2	100-yr	4.5 (NOAA)	No	2	166.70'	70.00'	11669 sf	133%	4.79'	1.71 ac-ft	130%
Chosen Model Inputs	Facility #5	HydroCAD	24-hr	100-yr	4.5 (NOAA)	1.39 in	2	173.00'	70.00'	12110 sf	138%	4.79'	1.77 ac-ft	134%
	Facility #6	HydroCAD	36-hr	100-yr	5.22 (NOAA)	No	2	125.60'	70.00'	8792 sf	100%	4.79'	1.32 ac-ft	100%
	Facility #7	HydroCAD	36-hr X2	100-yr	5.22 (NOAA)	No	2	141.10'	70.00'	9877 sf	113%	4.79'	1.47 ac-ft	111%
	Facility #8	HydroCAD	36-hr	100-yr	5.22 (NOAA)	.93 in	2	151.80'	70.00'	10626 sf	121%	4.79'	1.57 ac-ft	119%
	Facility #9	HydroCAD	36-hr	100-yr	5.22 (NOAA)	.93 in	3	153.50'	70.00'	10745 sf	123%	4.79'	1.58 ac-ft	120%