PRELIMINARY GEOLOGY AND GEOTECHNICAL EVALUATION

Proposed City Heights Development, Cle Elum, Washington

Prepared for: Northland Resources, LLC

Project No. 090081-001 • October 1, 2009

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1 Introduction

This report presents the results of a planning-level engineering geology and geotechnical study performed by Aspect Consulting, LLC (Aspect) for the master planning effort being led by Northland Resources, LLC (Northland Resources) for the proposed City Height development project (Site) within the City of Cle Elum Urban Growth Area (UGA), Kittitas County, Washington. The Site location is illustrated on Figure 1. The results of this study will be used to support preparation of the Environmental Impact Statement (EIS) for the annexation and Development Agreement, and to obtain the necessary permits for developing the Site.

The purpose of this study is to identify geologic hazards and geotechnical issues that could present constraints to the conceptual development plans. Conceptual-level recommendations are presented to mitigate identified constraints and support Site development where feasible. Recommendations for further study are provided where appropriate.

This report summarizes the results of our data collection and evaluations for this phase of the project. The preliminary conclusions and recommendations presented herein are appropriate for the environmental review and planning phase of the project. Additional explorations, evaluations, and recommendations will be necessary to support final design and construction.

1.1 Scope/Authorization

This evaluation was completed in accordance with our proposal dated May 15, 2009 and authorized on May 18, 2009. Our initial scope included preparation of this Geology and Geotechnical Evaluation of the Site, and technical support for preparation of an Environmental Impact Statement (EIS). Scope amendments were later authorized for a Phase I Environmental Site Assessment (ESA) and data collection to support an Abandoned Mine Lands (AML) Report prepared by SubTerra, Inc. (SubTerra). Deliverables for the EIS support, Phase I ESA and mine hazard assessment support are provided under separate cover.

1.2 Project Understanding

We understand that Northland Resources is seeking approval for annexation and a Development Agreement with the City of Cle Elum for the Site that is comprised of approximately 358 acres located within the UGA north of the city limits of Cle Elum, in Kittitas County, Washington. The City Heights development is proposed to include 875 to 985 attached and detached dwelling units, 20,000 to 40,000 square feet of neighborhood commercial space, and 150 to 160 acres of open space, parks, trails and public amenities.

The conceptual land use plan for the Preferred Alternative prepared by Geyer Coburn Hutchins LLC (GCH) is illustrated on Figure 2. Proposed development areas and subareas are identified alphabetically and numerically on the GCH plan. These proposed development areas are used for discussion purposes throughout this report.

For the purposes of this study, we made the following assumptions:

- Specific plans for large-scale earthwork activities (significant cuts and fills) are not known at this time.
- Buildings will be for residential and commercial use, and will have foundation loads that are typical for that type of construction.
- Building setbacks from steep slopes will comply with local agency requirements. If there are any specific areas of the Site where reduced setbacks are to be requested, this is not known at the time of this writing.
- Roadway design and construction will be typical for the type of planned development. There will possibly be culverts and/or bridges used to cross streams and low-lying areas. We assume bridges will be single-spans of less than about 100 feet.
- Utilities will generally involve trenching that is less than about 15 feet deep.

2 Methodology

2.1 Document Review

Aspect conducted a review of available existing information to examine existing conditions, which include both undisturbed (natural) and disturbed conditions (based on historical Site use) to guide data collection in the field. Existing information obtained from public and private sources, and reviewed by Aspect staff included topographic and geologic maps and data, well logs, mine records (including development reports, hazard assessment, and reclamation), and current and historic air photos. A listing of key references reviewed is contained in the References section of this report. Additionally, we coordinated with Northland Resources and Encompass Engineering and Surveying (Encompass) to understand proposed conceptual roadway and utility alignments and residential development areas.

An AML Report for the Site and proposed development was completed by SubTerra and is included as Appendix A of this report. The SubTerra report contains detailed information about the mining history at the Site and remaining subsurface hazards. It also contains the field data report (i.e. field methodology and boring logs), completed by Aspect to support SubTerra's work.

2.2 Field Exploration

Our field exploration included a surface reconnaissance and a limited subsurface exploration consisting of excavator test pits. Subsurface data were also obtained from observations of boreholes drilled during the abandoned mine hazard assessment. Limited geotechnical laboratory tests were completed on selected soil samples to determine certain physical properties of selected soils.

2.2.1 Reconnaissance

A surface reconnaissance was conducted by Aspect staff on June 9, 2009 to characterize general Site geologic conditions, identify potential geologic hazards, and to confirm conditions identified during the document review. The surface reconnaissance consisted of Site traverses and an aerial reconnaissance using a helicopter operated by Northland Resources. Several hand-dug test pits were excavated to examine surface soil conditions.

2.2.2 Test Pits

Test pits were excavated on June 15, 2009 to examine subsurface conditions at selected locations identified during the surface reconnaissance. A total of 12 test pits were excavated mostly in the western half of the Site, west of Deer Creek. Details of the test pit explorations and test pit logs are provided in Appendix B of this report. Test pit locations are shown on Figure 3. Limited geotechnical laboratory testing was completed on samples collected from our test pits to determine certain physical characteristics of selected Site soils. Laboratory testing results are provided in Appendix C of this report.

2.2.3 Borings

A total of 14 boreholes were drilled on July 17 and 18, 2009 in the eastern half of the Site. Borehole locations are shown on Figure 3. The primary purpose of the boreholes was to examine the condition of abandoned underground mine workings where these features have been mapped by others. Data from boreholes, including drilling observations and data collected from down-hole cameras inserted into selected boreholes, were used by SubTerra to support their AML Report. Borehole drilling was coordinated and observed by Aspect staff to support SubTerra's mine hazard assessment. Descriptions of these observations are contained in Appendix A of this report.

3 Site Conditions

The Site is approximately 2.4 miles long by about 0.2 to 0.5 miles wide, and consists of approximately 380 acres total (358 acres currently outside the Cle Elum city limits), spanning a mostly undeveloped area on the north side of Cle Elum. A small portion of the Site (approximately 24 acres) lies within the Cle Elum city limits. The property is generally bound to the south by The Mine Heritage Trail (locally known as the Coal Mines Trail), West 6th Street, 7th Street, East Russ Street, and West Cemetery Road. The property is bounded to the north by undeveloped woodlands and former mine areas. The following sections describe the Site conditions in greater detail.

3.1 Existing Site Development

The Site is mostly undeveloped, with no buildings identified on the property. Much of the Site was commercially harvested for timber within the past 10 years. Existing land use at the Site is primarily defined by Kittitas County as Rural.

Site improvements consist of four County roads oriented mostly north to south that were constructed in about 2003 to connect the City of Cle Elum with rural developments lying north of the Site (Figure 1). These roads comprise the existing primary access to the Site. Stafford Street/Summit View Road and Montgomery Avenue/Deer Creek Road are asphalt-paved roadways located in the western one-third and middle one-third of the Site, respectively. Sunridge Drive and Jackpine Drive are gravel-surfaced roads located in the eastern one-third of the Site.

Ditches, culverts and underground utilities including electrical and communications services are located within rights-of-way for each road. A dirt-surfaced access road is located within the two power line corridors (Puget Sound Energy and Bonneville Power Administration) that cross the Site in a roughly east-west orientation across the northern half of the Site (Figure 1).

Existing structures consist of steel towers and wooden power poles within the two power transmission corridors. The steel and wooden power transmission towers are situated parallel to each other, with about 100 feet between them. Structures adjacent to the property include a cellular phone tower facility and three water towers to the south as well as several single-family residences located along the north perimeter of Cle Elum.

Adjacent land use can be summarized as follows:

North and East: Land use immediately north and east of the Site is designated by Kittitas County as Rural. This region is currently comprised of undeveloped land and low-density development.

South: The incorporated area of the City of Cle Elum lies immediately south of the Site. The existing City limit roughly follows the southern Site boundary. Approximately 24 acres of the Site lies within City limits. Adjoining properties to the south are developed as suburban residential neighborhoods.

The historical Independent Mine, located south of the eastern portion of the subject property, is currently developed with a small park and ball field (Centennial Park). Mounds of waste rock west of the park are still apparent in this area.

West: Land use immediately west of the Site is designated by Kittitas County as Rural and Cle Elum UGA. Large coal waste piles and the former City of Roslyn Wastewater Lagoon No. 1 lie immediately west of the Site.

3.2 Historical Site Use

A detailed description of historical Site use and ownership is contained in the Phase 1 Environmental Site Assessment (Aspect 2009a). A detailed history of Cle Elum coal mining including activities at the Site can be found in the AML Report prepared by SubTerra (SubTerra 2009), attached to this report as Appendix A.

The Site is underlain in most places by abandoned underground mine workings. Coal mining in the Cle Elum area began in the early 1890s and continued until about 1950. During this period, at least three coal mines operated beneath portions of the Site from which approximately 19 million tons of coal was mined from a single, approximately 4- to 6-foot-thick coal seam. In the decades since mining activities ceased, the Site has been used for commercial timber harvest and informal recreation.

3.3 Surface

3.3.1 Topography

The Site is located in an upland region above the Yakima River valley, on the south face of Cle Elum Ridge, approximately 0.7 miles north of the river. A 100-foot high slope oriented roughly parallel to the southern Site boundary rises above the Yakima River flood plain. The Site lies on and above this slope. Elevation increases to the north across the Site toward Cle Elum Ridge. Ground surface elevations at the Site generally range from 2,000 to 2,300 feet. Total relief is approximately 360 feet. Four north-to-south oriented drainages transect the property creating local relief up to 200 feet. Steep slopes on the Site are described in more detail below in the Geological Hazards section of this report.

3.3.2 Modified Topography

Past topographic modifications to the Site have included grading, cuts, and fills that likely began with mining activities in the late 1800s or early 1900s. Mining activities have resulted in modification to topography, primarily from placement of uncontrolled fills involving mine waste located in the western one-third of the Site. Mine waste consists of fine-grained coal waste and coarser-grained waste rock.

Other modifications to topography resulting from mining activities include: a former haul road or rail grade on the western end of the Site; a series of terraces observed in the hillside along the southern Site boundary, west of Deer Creek; and grading resulting from the reclamation of mine openings along the northern Site boundary, west of Deer Creek. Recent modifications to topography include cut slopes and embankments related to road construction that occurred in about 2003.

3.3.3 Drainage

Site drainage with respect to surface water management is being addressed by Encompass Engineering and Surveying. Four natural surface water drainages are oriented mostly north-to-south across the Site (Figure 1). Water was observed to be flowing in all four drainages during our field explorations in June 2009. From west to east, the drainages consist of an unnamed canyon near the western edge of the Site, a gently-sloping drainage along Summit View Road, Greens Canyon/Deer Creek, and Balmers Canyon. Deer Creek appears to be the only potentially perennial stream. The Summit View drainage has been diverted to the west via a small earthen dam**,** approximately 8 feet high and 50 feet long. The dam is located approximately 200 feet east of Summit View Road, north of proposed Development Area D2. The region behind the dam is partially filled with sediment.

Two small drainages initiate on the Site. One of these, located east of Deer Creek and north of the power line corridor, likely drains a former underground mine working (SubTerra 2009). The origin of the other small drainage, located along the south Site boundary, north of the intersection of Sixth and Reid Streets, is not known.

3.3.4 Vegetation

Vegetation throughout the Site primarily consists of pine forests in the upland region, riparian vegetation along drainages, and areas with little to no vegetation. Upland vegetation includes grass, pine trees of varying age, shrubs and willows. Timber was removed during commercial harvest across much of the Site using selective and clear cut methods. No timber is present within the power line corridors. Riparian vegetation occurs in narrow bands along drainages and includes willows, cottonwood and aspen. Areas with little or no vegetation are present on bedrock outcrops, mine waste piles, mine opening reclamation areas, and along unimproved dirt roads.

3.4 Regional Geology

The Site is located in the upper Kittitas Valley, in the foothills of the eastern flank of the Cascade Mountain Range. The Cascades were tectonically uplifted beginning in the late Eocene epoch (approximately 37 million years ago) as a result of the collision of offshore oceanic tectonic plates at the Cascadia subduction zone (CSZ). Coincident volcanism emplaced igneous rocks including intrusives, lava flows, and ash throughout the Cascades.

The Yakima Fold Belt subprovince of the Columbia Basin was sculpted by tectonic forces beginning during mid- to late-Miocene time (approximately 15to 10 million years ago), and continued into the Quaternary (approximately 2 million years ago to present time) (U.S. Department of Energy 1988). Structural folds control much of the topography in Kittitas, Chelan, and Yakima Counties. Active tectonic folding and faulting has slowed since the Pliocene (approximately 5to 2 million years ago) and incised river valleys and fault scarps have since filled in with sediments. Several tectonic structures are present in the Site vicinity. Two synclines (A fold of rock layers that slope upward on both sides of a common low point) and one anticline (a fold of rock layers that slope downward on both sides of a common crest) are mapped within one to two miles south and southwest of the Site (Tabor et al. 1982).

Upper Kittitas Valley at Cle Elum underwent several alpine glaciations during the Pleistocene epoch, ending approximately 14,000 years ago. Glacial sediments including outwash, till and lacustrine deposits are mapped in the vicinity of Cle Elum. Lowlands in the Site vicinity are underlain by unconsolidated and weakly-consolidated valley fill consisting of glacial sediments, alluvial deposits, and locally, loess deposits (USGS 2006).

3.5 Seismic Setting

The Site is located within a region subject to earthquakes on shallow crustal faults and in the CSZ. Evidence exists of Quaternary movement along faults in the Yakima Fold Belt, and earthquakes have recently occurred in the central Columbia Basin within basalts of the Yakima Fold Belt (U.S. Department of Energy 1988).

The largest known earthquake in the Columbia Basin occurred in 1936, southeast of the Site at Milton-Freewater, Oregon (U.S. Department of Energy 1988). It had a magnitude estimated as high as 6.1 (Woodward-Clyde Consultants 1980). The largest recorded Columbia Basin earthquake occurred in 1973, east of the Site near Othello. It had a magnitude of 4.4 (Noson, et al. 1988). A shallow earthquake within the Cascade Mountains occurred in 1872, north of the Site, near Entiat, with an estimated magnitude of 6.8 (Bakun, et al. 2002). According to the U.S Geological Survey, future earthquakes within the Cascade Mountains would likely be shallow and could exceed magnitude 7 (USGS 1988).

Other large earthquakes in Washington and Oregon have been associated with the CSZ, which lies approximately 150 miles to the west of the Site (Washington Department of Natural Resources, 2008). Hazards associated with the CSZ include deep (Benioff zone) earthquakes and subduction zone earthquakes. Deep earthquakes generally originate during rupture of the sinking oceanic plate, have magnitude 7.5 or less, and occur approximately every 10 years to 30 years. The subduction zone earthquakes occur due to rupture between the subducting oceanic plate and the overlying continental plate. These earthquakes have magnitude up to 9 and a recurrence interval on the order of 500 years.

No faults have been mapped or observed on the Site. Several east-west trending faults are mapped in the Site vicinity. Faults present in the Site vicinity are associated with uplift of the Cascades Mountains and the Yakima Fold Belt.

3.6 Site Geology

Upper Kittitas Valley is one of several large synclinal (trough-like) structural basins within the Yakima Fold Belt. The Site lies in the lower elevations of the south face of Cle Elum Ridge, on a limb of an asymmetric anticline in Tertiary sedimentary bedrock. Bedrock strata generally dip to the south at angles generally less than 30 degrees. Bedrock at the Site is mapped as the arkosic non-marine sedimentary upper member of the Roslyn Formation, deposited during the Eocene epoch approximately 37 million years ago (Tabor et al. 1982). The Roslyn Formation generally consists of fine- to medium-grained sandstone and thinly bedded to laminated siltstone. The Roslyn formation contains up to 16 bands of bituminous coal from less than one foot to up to 20 feet thick

(Tabor et al. 1982). A coal seam 4 feet to 6 feet thick within the Roslyn Formation was extensively mined beneath the Site and in the greater Cle Elum vicinity.

Unconsolidated sediments, primarily consisting of bedrock residuum and glacial deposits, occupy most of the Site. Bedrock residuum resulting from weathering of Roslyn Formation rocks overlies bedrock to varying depths. Glacial Deposits up to 100 feet thick locally occur above bedrock and bedrock residuum. Glacial Deposits are most evident in several low-gradient terraces present above bedrock in lower elevation portions of the Site. Other geologic units include minor alluvium occupying local drainage bottoms and artificial fill (coal mining waste) at the western end of the Site.

3.6.1 Mapped Surface Soils

Nine soil types are mapped at the Site by the U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS), including soil units associated with mining activities. Soils at the Site are mostly classified as loam, and are derived from the weathering of underlying parent material such as glacial deposits and sedimentary bedrock that are mixed with loess and volcanic ash. These soils typically extend from surface to a depth of 3 to 5 feet. Teanaway loam, found on 10% to 25% slopes, is the most common soil type.

3.6.2 Site Engineering Geologic Units

Six general soil units are present at the Site and are generally distributed as shown on Figure 3. A conceptual illustration of onsite subsurface conditions is provided on Figure 4. The soil units are described below based upon origin and general engineering characteristics, and in order from youngest to oldest. We based our interpretations of subsurface conditions on the results of our field exploration, review of available geologic and geotechnical data, and our general experience in similar geologic settings.

Coal Waste

A coal waste pile located in proposed Development Area A (Figure 2) appears to have originated as fines and pond sediment resulting from coal processing operations. The waste pile was placed over Glacial Deposits.

The thickness of coal waste generally ranges from about 8 to 12 feet. Examination of the southern boundary of Development Area A2 indicates coal waste could be as thick as 20 feet or more in that area. Coal waste is generally less than one foot thick in the southern half of proposed Development Area A1 and is absent in the eastern quarter of proposed Development Area A2.

Coal waste in proposed Development Area A generally consists of very soft to soft, dark gray to black, clayey silt, silty clay and sandy silt containing abundant angular fragments of coal. The coal waste is composed predominantly of fine-grained organic (coal) fragments with a lesser component of mineral grains. The fine-grained coal waste is considered weak and compressible.

Coarse-grained coal waste was observed in several piles heaped on top of the “Red Rock” waste rock pile, north of proposed Development area D2, consisting of sandy silt-sized particles with angular fragments of coal, overlying waste rock. Our observations suggest that pockets of coal waste may be present within the waste rock pile.

Waste Rock

A substantial waste rock pile is present within proposed Development area D2 and in the area adjacent to the north side of D2 (referred to as the "Red Rock" waste rock pile). It originated as overburden from mining operations during the first half of the 20th Century. Waste rock generally consists of red to brown, angular, silt, sand and gravel-size rock fragments. Rock fragments are predominantly comprised of relatively weak siltstone and sandstone. The waste rock pile overlies glacial deposits. The thickness of waste ranges from a few feet up to 100 feet in the interior of the waste rock pile.

The waste rock was presumably placed without compaction, and is characterized as very loose to loose.

Alluvium

Alluvium was deposited by streams and rivers in local drainages during recent geologic times. Alluvium generally consists of sand with gravel and cobbles. Alluvium was observed within the Crystal Creek flood plain, in a region mapped as side-stream alluvium, composed of "moderately-sorted pebble to boulder gravel" by Tabor et al. (1982). Clasts within alluvium are generally rounded to sub-rounded. Alluvium was encountered along the southern boundary of proposed Development Area A in thicknesses of greater than 10 feet.

Glacial Deposits

Glacial Deposits originated from alpine glaciations in the Upper Kittitas Valley, and were mapped onsite based on subsurface exploration observations, the expression of topographic features, and correlation of glacial deposit elevations mapped by Tabor et al. (1982). Glacial Deposits generally overlie residuum. The thickness of Glacial Deposits observed in our explorations ranged from 5 feet to 45 feet. Glacial Deposits across the Site likely range in thickness from a few feet to more than 100 feet.

Glacial Deposits onsite generally consist of mixtures of clay to cobble-size particles in varying percentages. Our observations suggest the majority of Glacial Deposits at the surface are course-grained outwash soils. However, tills and lacustrine deposits are mapped nearby and could also exist onsite. It is not clear whether or not the Glacial Deposits were overridden by glaciers. In general, the Glacial Deposits can be characterized as medium dense to dense.

Residuum

Residuum consists of soil-like deposits formed from the in-situ weathering of sedimentary bedrock. It generally becomes less weathered with depth, eventually grading to bedrock. Residuum generally consists primarily of medium dense to dense, silty fine to medium sand. Residuum color typically grades from brown to gray with depth.

Our explorations indicate the thickness of residuum varies from being absent to 39 feet. Typical residuum thickness encountered is 6 to 12 feet.

Sedimentary Bedrock

Sedimentary bedrock at the Site is the upper member of the Roslyn Formation (Tabor et al.1982). Estimates for the total thickness of the upper member of the Roslyn formation range from 1,500 feet to 2,400 feet. Bedrock consists of relatively weak, interbedded sandstone, siltstone, and mudstone with occasional coal seams. Bedrock is observed at the surface in an outcrop at the “Slick Rock” area west of proposed Development Area F3, in road cuts along Deer Creek Road, and in the northern portion of Development Area E (see Figure 2).

During borehole drilling in bedrock, driller observations in several boreholes indicated the presence of voids at various depths. The voids are believed to be remnants of coal mining operations. Borehole inspection using a down-hole camera (SubTerra 2009) revealed many of these voids to be rubble zones containing numerous void spaces each no more than a few inches thick. Layers of coal ranging from 1 foot to 6 feet thick or coal-rich siltstone and mudstone up to 18 feet thick were encountered at various depths in on-site explorations.

3.7 Groundwater

In the Cle Elum area, groundwater generally occurs in two primary hydrogeologic units: unconsolidated alluvial and glacial sediments, and bedrock. Coarse-grained portions of the unconsolidated deposits in the lower elevations can produce quantities of water sufficient for group domestic or municipal water supply. The bedrock typically yields water sufficient only for single domestic or small group domestic use.

Most of the Site is about 100 to 300 feet above the Yakima River valley and is underlain by a relatively thin veneer (generally less than 25 feet thick) of unconsolidated deposits overlying bedrock (Figure 4). In these areas, the unconsolidated deposits are generally unsaturated and groundwater occurrence is limited to the bedrock. Lower elevation portions of the Site, for example the western end of the Site or the bottom of the stream drainages, may contain groundwater within the unconsolidated deposits. Shallow groundwater was encountered at one location, in a test pit (TP-2) located along the southern Site boundary within Development Area A. Groundwater was encountered in TP-2 at a depth of 5 feet below ground surface.

Groundwater was observed in the bedrock during drilling in four of the 14 borings (B-1, B-7, B-8, B-11, and D-1) completed at the Site. Where encountered, groundwater was generally limited to discrete fracture zones in the bedrock, while non-fractured bedrock typically did not contain observable quantities of water.

Groundwater at the Site is expected to flow generally to the south, discharging to the unconsolidated deposits in the Yakima River valley and ultimately to the Yakima River. Groundwater flow in the bedrock likely occurs primarily through interconnected fractures and joints, with only minor flow occurring through the rock matrix. No tests have been performed to estimate the hydraulic conductivity of the bedrock; however, it is expected to be low relative to the more coarse-grained unconsolidated deposits.

4 Geologic Features, Hazards and Mitigation

Geological hazards at the Site were evaluated based on our data collection, local agency ordinance considerations, and our understanding of the proposed development. Pertinent critical areas ordinances reviewed include Title 18.01.310, City of Cle Elum Municipal Code and Chapter 17A.06, Kittitas County Code. Figure 5 shows locations of geologic features and hazards discussed below. No project-specific geological hazards are present from talus slopes, snow avalanche, or volcanic activity.

4.1 Seismic Hazards

Surface fault rupture, amplification of strong shaking, liquefaction and seismic slope failure were considered as potential seismic hazards that could affect the Site. These are discussed below.

4.1.1 Surface Fault Rupture

No surface faults are mapped and no evidence of surface fault rupture was observed onsite. Two faults are mapped approximately 4½ and 6 miles south of the Site (Tabor et al. 1982). These faults trend west-northwest to east-southeast and dip nearly vertically down-to-the-north. A fault of unknown age was identified in underground mine workings in the Roslyn No. 5 Mine, west of the Site (Saunders 1914).

In our opinion, the relative risk of fault rupture at the surface of the Site is low due to the distance to known active faults, and it is unlikely that development plans will require explicit design for this risk.

4.1.2 Ground Response

Earthquakes are likely to occur at the site over the design life of the project. Building codes require designing structures to a specific level of seismic risk, typically ranging from a 2 to 10 percent probability of being exceeded within a 50-year period. These probabilities of exceedance can also be expressed as 2,475 and 475 return-period events, respectively.

Based on the United States Geologic Survey (USGS) 2002 *National Seismic Hazards Mapping Project*, the peak bedrock acceleration indicated for a 475-year event at the Site is 15 percent of gravitational acceleration (0.15g). A 2,475-year return period seismic design event would yield a peak bedrock acceleration of 0.30g.

Site response describes how the surface responds to seismic accelerations in bedrock. Near-surface conditions can tend to amplify or dampen bedrock accelerations. Softer ground tends to amplify site response more than firm conditions. Site response is addressed in the design of most buildings using International Building Code (IBC) methodology (IBC 2006). Transportation structures are often designed using American Association of State Highway and Transportation Officials (AASHTO) methodology

(AASHTO 2002). These codes utilize a Site Class that is based on near-surface ground conditions to characterize the site response for design.

Based on the current 2006 edition of the IBC and published Site classification maps of Kittitas County, most of the Site is characterized as a Site Class B. A Site Class B designation represents a soft rock condition where earthquake shaking is neither amplified nor reduced by the near-surface geology. Earthquake design and construction for structures located in Site Class B areas would follow standard procedures.

The coal waste piles in proposed Development Areas A and D classify as Site Class E. These would require a more robust seismic design, such as soil densification and/or deep foundations (piling) for buildings if this material is not removed from the site prior to construction.

4.1.3 Liquefaction

Liquefaction occurs when loose, saturated and relatively cohesionless soil deposits temporarily lose strength as a result of earthquake shaking. Potential effects of soil liquefaction include temporary loss of bearing capacity and lateral soil resistance, and liquefaction-induced settlement, any of which could result in significant structural damage. Primary factors controlling the development of liquefaction include intensity and duration of strong ground motion, characteristics of subsurface soil, in-situ stress conditions and the depth to groundwater.

Based on our characterization of Site conditions, it is our opinion that the potential for liquefaction to impact the proposed City Heights development is low. Most of the surface conditions across the Site consists of medium dense to dense soil or bedrock. The uncontrolled fills in Development Areas A, D2 and the area north of D2 are generally either fine-grained or unsaturated, making them unlikely to liquefy in a seismic event. However, if development plans call for buildings in these areas[1], specific geotechnical evaluations will be necessary to confirm the lack of liquefaction hazards.

4.1.4 Seismic Slope Failure

Seismic shaking could lead to slope failure in slopes comprised of loose, unconsolidated sediments. The greatest hazard from seismic slope failure exists in steep slopes where glacial deposits overlie bedrock and in uncontrolled fills such as the coal waste and waste rock piles, in proposed Development Area A and D2. Seismic slope failure hazards can be minimized by development setbacks. Hazards from steep slopes are discussed in greater detail below.

4.2 Steep Slopes

The City of Cle Elum Municipal Code Title 18.01.320 identifies slopes greater than 25 percent as presenting a moderate to high risk of erosion or landslide. On-site slopes greater than 25 percent are primarily located in drainages and along the southern boundary of the Site (Figure 5). The steepest natural slopes include:

[1] Refer to the Uncontrolled Fills section for further discussions on development limitations in these areas.

- 60 percent slopes in glacial deposits and residuum overlying bedrock on the west side of Greens Canyon (Deer Creek) and the east side of the unnamed canyon, west of proposed Development Area B
- 35 percent slopes in glacial deposits overlying bedrock and exposed bedrock along the southern boundary of the Site (south of proposed Development Area F3)
- A near-vertical outcropping of weathered bedrock standing 15 to 20 feet in relief on the north side of proposed Development Area E.

Steep slopes were also observed in the coal waste pile (up to 60 percent) in proposed Development Area A, and in the waste rock pile (65 percent) in proposed Development Area D2.

4.2.1 Setbacks and Permanent Slope Cuts

The development should avoid plans that could exacerbate slope instability, including diverting runoff onto slopes and directing surface water in a way that could undercut slopes. Local ordinances reference the IBC to establish setbacks for buildings proposed near slopes. Setbacks for structures from tops and bottoms of slopes exceeding 33percent should be as follows:

Tops of slopes: The face of foundation footings should be no closer than a horizontal distance of one-third of the slope height from the tops of slopes, not to exceed 40 feet.

Bottoms of slopes: Foundations should be no closer than H/2, measured from the top of the foundation horizontally to a 45 degree tangent with the slope, not to exceed 15 feet.

Where development is proposed closer to steep slopes than described above, a site-specific geotechnical evaluation will be required. Such evaluations may result in recommendations for reduced setbacks in areas of relatively low hazard, or potentially increased setbacks if elevated hazards are identified in specific areas.

Observations of soils and existing slopes on the Site indicate permanent slopes in unconsolidated soils including residuum and glacial deposits overlying bedrock should be excavated to 30 percent or flatter assuming the proposed cut slope is not fully saturated and/or perched groundwater is not present. Where cut slopes are made in bedrock, steeper slopes may be feasible depending on bedrock lithology and structure. Cut slopes in bedrock may be subject to dip slope failure where bedrock dips toward the cut face. In general, cut slopes greater than 15 feet in height should be evaluated on a case-by-case basis to determine a stable slope angle.

4.3 Landslides

No landslides are mapped on the Site in previous studies. A relatively large landslide is mapped approximately 1 mile northeast of the Site (Tabor et al. 1982). Slope failures (landslides) observed during field exploration are summarized below.

4.3.1 Road Cuts

Several shallow slope failures were observed during our June 2009 field exploration (Figure 5) in road cuts excavated approximately 6 years ago along Summit View and Deer Creek Roads (Figure 5). Failures occurred in glacial deposits and residuum overlying bedrock with cuts of approximately 60 percent. Similar failures will likely continue, triggered by soil saturation, until slopes in the road cut reach equilibrium or the slopes are stabilized by construction. Stabilization options may include slope flattening if the road cut geometry allows, or maintenance when slough is deposited onto the roadway. In-situ stabilization techniques such as reinforcement with soil nails and slope netting would likely be cost-prohibitive. Additional geotechnical investigation will be required to develop specific, in-situ stabilization measures for existing and proposed road cuts.

4.3.2 Balmers Canyon

A recent shallow slope failure was observed in unconsolidated soils along a steep slope (approximately 60 percent) in the lower portion of the Balmers Canyon drainage, east of proposed Development Area I2. The conceptual land use plans show development proposed in this area, and it is unlikely that the failure will impact the proposed City Heights development..

4.3.3 Deer Creek

Shallow slope creep was observed in Glacial Deposits along the west side of the Deer Creek drainage, south of the power line corridor and east of proposed Development Area F2. Soil movement at this location may be caused by Deer Creek undercutting the base of the slope. Observations of growth patterns in mature trees indicate slope movement initiated within the past few decades and likely continues at the present time. Conceptual land use plans show no development proposed in this area; therefore, no mitigation is recommended.

4.3.4 Waste Piles

Steep slopes were also observed along the margins of the coal waste pile (up to 60 percent) and in the waste rock pile (65 percent). Slopes on these waste piles are likely near their respective angles of repose because more than 50 years have elapsed since placement of these waste piles. However, at least one failure was observed in the coal waste pile, and both waste piles have the potential for failure where steep slopes exist. A slump failure approximately 30 feet wide is present within the coal waste, on a 60 percent slope, along the southern Site boundary where coal waste overlies glacial deposits. Periodic failure in the coal waste on slopes greater than 30 percent will likely continue.

Mitigation options may include slope flattening in the coal waste pile to approximately 30 percent or flatter, maintenance when sloughing occurs, and development buffers at the top and bottom of steep slopes. Additional geotechnical investigation will be necessary to develop specific slope stabilization recommendations if development is planned in and around proposed Development Areas A and D2.

4.3.5 Montgomery Avenue/Proposed Development Area G

A recent shallow slope failure in Glacial Deposits occurred along the southern Site boundary, near proposed Development Area G. Our observations indicate the toe of this slope was recently excavated up to 12 feet high at approximately 80 percent to accommodate development of a building lot for a residence located west of Montgomery Avenue. Evidence of a rockery of unknown height was observed in the slope failure debris that protruded into the residential lot. The natural slope above the cut slope ranges from 5 percent to 28 percent. The recent excavation likely contributed to instability of the slope during a period of high soil saturation. Provided stormwater best management practices are followed in the design and construction of the City Heights project, it is out opinion that this slope failure will not adversely impact the proposed development.

Field observations indicate that the south-facing hillside in Development Area G has been graded into a series of approximately 12 terraces measuring roughly 4 feet high by 8 feet deep. Surface soils are silty sand. The presence of the terraces and vegetation that is substantially younger than the surrounding area suggests that soils on this hillside have been disturbed. It is not clear whether the soil disturbance was caused by grading or placement of fill. Further investigation is recommended to determine whether the slope in proposed Development Area G contains uncontrolled fills.

4.4 Uncontrolled Fills

This section discusses planning-level considerations related to the coal waste pile in proposed Development Area A, and the waste rock pile within and to the north of proposed Development Area D2. Smaller waste piles may exist at other locations throughout the property where they were unidentified due to vegetation cover. Site-specific engineering evaluations will likely be necessary for design of developments in areas containing significant uncontrolled fills.

We understand that current development plans in proposed Development Area A include the construction of a roadway, at a minimum. Residential buildings are desired in proposed Development Area A to the extent that is economically feasible. The majority of the waste rock pile is located in an area designated as open space. However, the waste rock extends into the northern portion of proposed Development Area D2, where residential buildings are planned.

4.4.1 Coal Waste Pile in Proposed Development Area A

The coal waste pile in proposed Development Area A covers approximately 15 acres, and generally varies in thickness from about 5 to 20 feet. Competent Glacial Deposits are present beneath the coal waste. The consistency of the coal waste is very soft, and this material is considered to be weak and compressible. Considerable costs would be necessary to make the soil conditions in this area geotechnically suitable for development.

The chemical properties of the coal waste are unknown. Similar materials have the potential to contain contaminants, produce hazardous gasses, and/or have the potential to spontaneously combust (NAS 1975). However, preliminary research suggests a low potential for the material to be contaminated from a regulatory perspective (Aspect 2009a). Coal waste fires are reported to have occurred in waste piles nearby; however, there are no obvious indications of such fires onsite (Aspect, 2009a). We recommend evaluating the chemical properties of the waste to identify characteristics that may control development on top of, removal of or containment of the waste prior to exploring the structural feasibility of development in this area.

Mitigation Options - Buildings

Assuming the coal waste has no adverse chemical properties, development within Area A shown on conceptual land use plans (Figure 2) will require either removal of the coal waste or engineering solutions to provide structural support. Engineering solutions could involve efforts to either strengthen the soil or to transmit structural loads to the underlying native soil. Capping of the waste with about a 2-foot layer of clean soil would likely be necessary if engineering solutions are employed. Further engineering evaluations would be required for specific design of mitigation measures described herein.

Removal of the coal waste beneath planned buildings could be a viable option where the thickness of the coal waste is less than about 5 to 8 feet. Unit costs for removal should be developed based on local experience and distance to an acceptable waste disposal site. In areas with coal waste depths greater than about 8 feet, it would likely be more practical to support buildings on piles or to consider a ground improvement program to strengthen the waste material.

Driven pin piles are a typical solution for supporting residential structures located on weak soil. Pin piles consist of 2 to 6-inch diameter steel pipe driven through the weak material and penetrating into a competent bearing stratum. For feasibility purposes, the cost of 2-inch diameter pin piles can be assumed to be about $15 per lineal foot of pile. The typical allowable capacity of a 2-inch diameter pin pile is 2 tons. A minimum pile embedment of 3 feet into the bearing stratum should be assumed for the piles. Therefore, for a hypothetical coal waste thickness of 10 feet, a minimum pile length of 13 feet should be assumed, with each pile costing about $200. Assuming a typical residential foundation load of 1,500 pounds per lineal foot, one pile would be needed for approximately every 2.5 lineal feet of foundation. For a typical house with a 50 by 50-foot footprint on a 10-foot thick coal waste fill, 80 piles would be required and the approximate piling cost would be on the order of $20,000. Additional costs for structural slabs and capping of the coal waste with clean fill should be considered. The feasibility of pin piles to support residential structures should be further evaluated by the planning team to determine if development in this area of the site would be cost-effective.

Ground improvement options could include a preload surcharge, where excess fill is placed on the proposed building areas to compress and densify the soil over time, producing a stronger, less compressible subgrade. A preload surcharge program would be designed specifically for proposed development plans. A typical program would involve a surcharge of 10 to 20 feet of fill on top of the proposed subgrade, which would be monitored for a period of time until the subgrade stops settling. Costs would include moving the surcharge soil to and from the building site, establishing and implementing the monitoring program, and placing a clean soil cap of about 2 feet thick. Other ground improvement technologies may be applicable. The feasibility of specific ground improvement options to support residential structures should be further evaluated by the planning team to determine if development would be cost-effective.

Mitigation Options – Roads and Utilities

The coal waste fill will provide a weak subgrade for pavements and utilities. Ground improvement, overexcavation or a combination of these methods would likely be required to provide a stable subgrade for these features. Specific geotechnical recommendations for pavements and utilities should be developed in the design phase if development is proposed within Area A.

4.4.2 Waste Rock Pile near Proposed Development Area D2

The waste rock pile within and to the north of proposed Development Area D covers approximately 10 acres and ranges in thickness up to 100 feet. The composition of this waste rock pile is generally more favorable than the coal waste pile in that it is generally non-organic and coarse grained. However, piles of coal waste were observed on the waste rock; therefore, it is reasonable to assume that pockets of coal waste likely occur within the waste pile.

An uncontrolled fill of this magnitude will require further characterization to support development. Given the thickness of the pile, it is possible that removing a portion of the pile to expose preloaded, consolidated material could produce an adequate subgrade for development. The material comprising the pile could provide a source of fill for other locations of the site (see Earthwork section below).

Further evaluations should focus on the feasibility of soil removal to expose suitable subgrade, the potential need for a soil cap, and possible pile foundations for structures located in this area.

4.5 Subsurface Abandoned Mine Hazards

Underground coal mining occurred beneath the majority of the Site between the early 1890s and approximately 1950. An AML hazard assessment was performed by SubTerra (Appendix A), which identifies underground mine features, surface features associated with underground mining, and recommendations for buffers and hazard mitigation. One area where mine lands reclamation has occurred onsite is along the northern boundary within proposed Development Area E. According to SubTerra (2009), this area is not recommended for development based on the presence of shallow underground mine workings. SubTerra also provides buffer recommendations for development adjacent to potential AML hazards.

Should subsequent investigations in proposed development areas discover AML hazards that were not previously identified, additional geotechnical investigations may be warranted.

4.6 Erosion Hazard

If stripped of vegetation, the erosion hazard of most natural surface soils onsite is considered moderate to severe, particularly on most steep slopes along the southern Site boundary and in drainages. Soils found on 45 to 65 percent slopes occurring in the western-most drainage between proposed Development Areas A and B present a severe to very severe erosion hazard. Erosion potential for the uncontrolled fills is considered moderate. Erosion mitigation during earthwork activities can be appropriately addressed by implementing Best Management Practices outlined in Ecology’s Eastern Washington Stormwater Management Manual.

Minor erosion was encountered in unimproved dirt roads, especially where exacerbated by vehicle rutting in the power line corridor access road. Minor erosion was also observed in road cuts and roadside ditches. A small gully, 2 feet to 4 feet wide, has formed in a portion of the coal waste pile where water flows across coal waste from an off-site catchment.

Substantial gully erosion was observed in the southern portion of proposed Development Area D1 near the southern Site boundary where the seasonal stream crossing under Summit View Road is down-cutting into the underlying Glacial Deposit terrace. Erosion has created a vertical-walled gully up to 10 feet high, 15 feet wide and approximately 200 feet long. Observations of local topography indicate this stream was diverted from its natural watercourse by an earthen dam located approximately 300 feet upstream, east of Summit View Road. The watercourse diversion was likely related to mining activities involving placement of the waste rock pile. Head-cut erosion of the upstream migration of the gully will continue until stream gradient equilibrium is achieved. This erosion has the potential to reach the existing Summit View Road that lies approximately 100 feet upstream from the current gully initiation point. Channel stabilization is recommended to mitigate erosion of the gully. Specific design of channel stabilization measures will require further study.

4.7 Debris Flows

Debris flows are common in the Kittitas Valley, typically resulting from rapid snow melt or high intensity rainstorms. Potential for debris flows exists in all drainages through the Site. Deer Creek and the Balmers Canyon drainage likely have the greatest potential for debris flows.

Limited evidence of debris flows was observed across the Site at the time of this writing, such as south of proposed Development Area D1, along and south of the southern Site boundary. Flow lobes and levees at this location comprised of poorly-sorted sand, gravel and cobbles were deposited during exceptionally high flow events in the seasonal stream located near Summit View Road. The source of debris lies immediately upstream where the diverted drainage is down-cutting into a glacial deposit terrace as described above. Similar events may periodically occur during exceptionally high flows in this stream.

Mitigation for debris flows includes avoiding development in potential floodways, minimizing erosion, and proper sizing of hydraulic structures at stream crossings. Site-specific engineering analysis is recommended for development within and adjacent to floodways. Properly siting and design of developments near floodways will minimize risks to proposed improvements.

5 Geotechnical Considerations

5.1 Earthwork

5.1.1 Excavations and Trenching

We anticipate that the majority of the earthwork to be performed for the project will consist of minor cuts and fills. However, temporary excavations for underground utilities and foundations will also be required, and should be performed in accordance with the current requirements of Federal, State and/or local agencies.

Based on the soil conditions encountered in our explorations and our experience in similar geologic environments, we anticipate that the majority of on-site soils can be excavated with conventional excavating equipment. However, test pits completed across the Site indicate there are areas where shallow bedrock may be encountered during excavation and trenching activities.

In the western third of the Site (proposed Development Areas A through D), bedrock was not encountered. In the middle third of the Site (proposed Development Areas E and F), bedrock is typically 5 to 8 feet below the ground surface with the exception of the higher elevations of proposed Development Area F3 where rock outcroppings were noted. In the eastern third of the Site, bedrock is likely 5 to 8 feet below the ground surface except in proposed Development Areas K and J where bedrock is 11 feet or more below ground surface.

Surficial soils are typically residual, gradually increasing in hardness with depth. Shallow excavations into residuum and weathered bedrock can generally be excavated with a large, track-mounted excavator equipped with a rock excavation bucket and rock teeth or by ripping with a ripper tooth attached to bulldozer. Alternative methods, such as hydraulic splitters or pneumatic hammers, may be needed to excavate the rock in areas where competent bedrock is shallow such as in proposed Development Area F3. Deeper excavations into competent bedrock may require controlled rock fracturing methods prior to excavating. When specific excavation areas in bedrock are identified, further rock characterization should be completed to assess the effort necessary for rock fracturing and excavation.

5.1.2 Construction Dewatering

Shallow groundwater conditions were not observed across the majority of the Site. However, consideration should be made for relatively shallow groundwater and/or perched groundwater conditions in low elevations of the Site such as local drainage ravines or stream-bottoms. While residential buildings are not anticipated in these low area, transportation improvements and hydraulic structures will likely follow or cross low areas. Details on the locations of these improvements are not known at the time of this writing.

Deep excavations (for example greater than about 15 feet) should be avoided in low-lying areas. If deep excavations are necessary in these areas, construction dewatering and/or special shoring will be necessary. Dewatering systems should be designed to maintain the groundwater level at least 2 feet below the bottom of the excavation. Dewatering effluent should be directed to a suitable discharge point.

Groundwater was observed at 5 feet below ground surface along the southern boundary of proposed Development Area A, near Crystal Creek. Shallow groundwater could limit the depth in which excavations can be made for basements and utilities. Further evaluation will be necessary to assess the potential impacts of shallow groundwater on these improvements.

5.1.3 Fill and Backfill

Subgrade preparation in areas supporting new fills, structures, and pavement should begin with the removal of all deleterious matter, asphalt, concrete and vegetation. Based on the results of our field exploration and laboratory testing program, we anticipate that certain onsite surficial geologic units will be suitable for producing structural fill for the proposed development. Glacial Deposits, natural onsite soils consisting of sands and gravels (see Figure 3), are generally considered suitable sources for structural fill since they contain a relatively low percentage of fines (silt and clay-sized particles). Other natural soils found on the surface of the Site, including residuum, contain a relatively high percentage of fines and will be moisture sensitive, making them difficult to work in wet weather. Residuum can be used for structural fill if the earthwork is performed during dry weather conditions and the contractor’s methods are conducive to proper compaction of the soil.

A large waste rock pile located north of proposed Development Area D2 was identified during our explorations. Our observations indicate the waste rock is also moisture sensitive and contains some coal waste. Laboratory particle size distribution and compaction tests were completed on this material, and the results are provided in Appendix C. The results confirm that this material has a high fines content and is moisture sensitive. In addition, the particle strength of the waste rock is low, making it susceptible to degradation during compaction, and possible collapse if it is improperly placed and compacted. Using the waste rock as structural fill may be acceptable under favorable weather conditions and assuming appropriate workmanship. It will be necessary to segregate unsuitable material, such as coal waste, from the waste rock prior to using it as structural fill.

If weather conditions and/or other factors make it impractical to use onsite-derived moisture-sensitive soils for structural fill, they may be used as general fill in areas not sensitive to settlement, or for landscaping applications.

In our opinion, the material comprising the coal waste pile in proposed Development Area A is not suitable for use as structural fill due to its predominantly fine-grained and organic composition. Conventional earthwork practices favor structural fills that are composed of inorganic, coarse-grained material. Even a carefully placed fill composed of coal waste would produce a product with uncertain performance characteristics. Aside from the potential chemical concerns discussed in the Uncontrolled Fills section, the coal-waste fill would have the potential to degrade, settle and produce flammable gasses.

Further evaluation would be necessary to determine if the coal waste would be suitable for non-structural fill, or if amending the waste with cementitious material could be feasible to produce an acceptable fill.

If imported material is necessary to produce structural fill, we recommend utilizing imported soils that comply with locally-accepted specifications for Common Borrow. Soils meeting these specifications are commonly available and meet criteria necessary for constructing a quality structural fill, assuming good workmanship and appropriate weather conditions during placement.

Select fills for retaining wall backfill, pipe bedding and other specialty applications will likely have to be imported.

The procedure to achieve appropriate compaction depends on the size and type of compacting equipment, the number of passes, thickness of the layer being compacted, and certain soil properties. When size of the excavation restricts the use of heavy equipment, smaller equipment can be used, but the soil must be placed in thin enough lifts to achieve the required compaction.

5.2 Foundations

5.2.1 Residential and Commercial Buildings

Based on the results of our explorations, shallow conventional spread footings may be used to support residential and commercial structures across the majority of the Site. For areas where uncontrolled fill was formerly placed by others, such as the coal waste pile in proposed Development Area A, and the waste rock pile in proposed Development Area D, additional considerations will be necessary as discussed in the Uncontrolled Fills section.

5.2.2 Water Reservoir

If a water tower or water reservoir is to be constructed along the northern edge of the Site in the western extents of proposed Development Area E, we anticipate that shallow conventional spread footings may be used for foundation support in this area. This area was identified as underlain by shallow underground mine workings (SubTerra 2009). Reservoir siting should be consistent with development recommendations provided by SubTerra in the AML Report.

5.2.3 Bridges

Bridges at stream crossings will likely be located in alluvial environments that are typically characterized by weak, compressible shallow soils and a shallow groundwater table. To accommodate the relatively high foundation loads of a bridge, we anticipate the use of deep foundations in the form of driven piles or drilled shafts to transfer loads to more competent soil or rock at depth. As the design evolves, additional geotechnical investigation will be necessary to evaluate specific soil conditions at proposed bridge locations, and to provide appropriate foundation recommendations.

5.3 Underground Utilities

Based on the results of our field exploration program, we anticipate that subsurface conditions across the Site will generally provide suitable support for pipes, vaults, and other underground utilities. Excavation considerations for trenching are covered in the Excavation and Trenching section above. Underground utilities crossing the uncontrolled fills will require special support considerations, which should be developed as the design evolves. Bedding and backfill of utilities are expected to utilize standard construction practices. Pipes that descend steep slopes should incorporate trench dams to reduce the potential for water to follow the trench line. Further evaluation will be necessary to assess utility considerations in steep slope areas.

5.4 Stormwater Infiltration

Stormwater infiltration rates are primarily controlled by the permeability properties of near-surface soils and the depth to hydraulic barriers such as impermeable layers and the groundwater table. Soils mapped at the Site by NRCS indicate that the permeability of most natural soils is moderate to high. We characterize the permeability of the coal waste pile and waste rock pile as low and high, respectively.

Underlying geologic units may have different infiltration properties; for example, where residuum overlies bedrock. At these locations, infiltration into geologic units underlying near-surface soils will depend on the thickness of sediments overlying less permeable bedrock. Glacial Deposits and residuum units likely facilitate relatively high infiltration rates, which will be important in siting stormwater infiltration facilities. Locations where shallow groundwater occurs will also inhibit infiltration.

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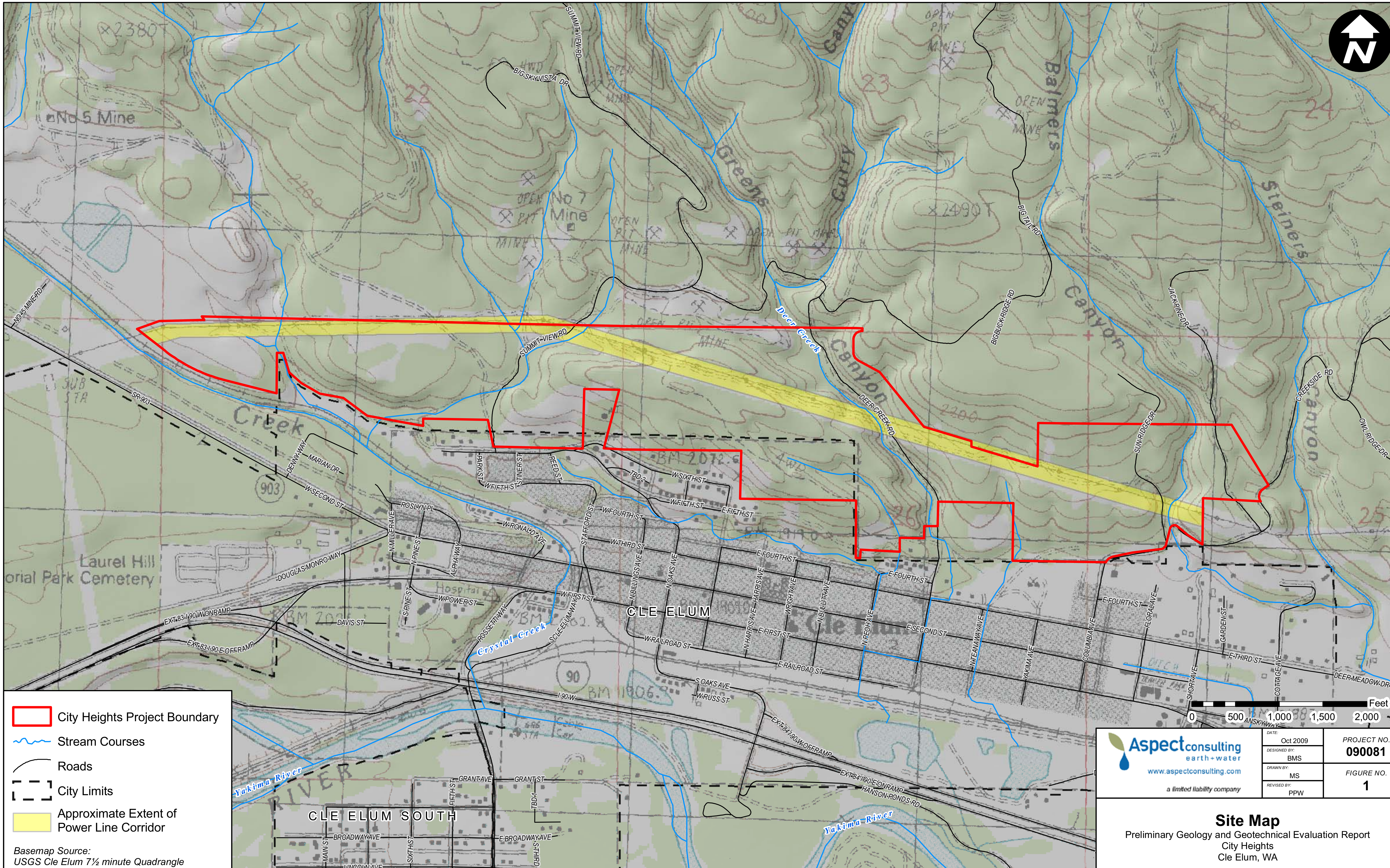
Limitations

Work for this project was performed, and this report prepared, in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. It is intended for the exclusive use of Northland Resources, LLC for specific application to the referenced property. This report does not represent a legal opinion. No other warranty, expressed or implied, is made. This report is issued with the understanding that it is preliminary in nature and that additional geotechnical studies will be necessary to support future designs.

The scope of our work did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous or toxic substances in the soil, surface water, or groundwater at this Site.



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DATE: Oct 2009	PROJECT NO. 090081	
DESIGNED BY: BMS		
DRAWN BY: MS	FIGURE NO. 1	
REVISED BY: PPW		

Site Map
Preliminary Geology and Geotechnical Evaluation Report
City Heights
Cle Elum, WA

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CITY HEIGHTS CLE ELUM, WASHINGTON

Development Parcel	Acreage	Building Type	Dwelling Units Per Acre	Dwelling Units
A1	2.8	Attached / Detached	7.0	20
A2	5.2	Attached / Detached	7.0	36
B	3.8	Detached	5.0	19
C1	3.3	Attached	9.0	30
C2	5.6	Attached	9.0	50
C3	3.2	Attached	9.0	29
C4	6.7	Attached	9.0	60
D1	10.2	Detached	5.0	51
D2	7.1	Detached	5.0	36
E	15.9	Attached / Detached	7.0	111
F1	13.5	Attached / Detached	7.0	95
F2	17.4	Detached	5.0	87
F3	11.8	Detached	5.0	59
F4	5.0	Detached	5.0	25
G	4.8	Detached	5.0	24
H	4.1	Detached	5.0	21
I1	11.5	Detached	5.0	58
I2	6.0	Detached	5.0	30
J1	6.7	Detached	5.0	34
J2	12.8	Detached	5.0	64
K1	4.0	Detached	5.0	20
K2	5.6	Detached	5.0	28
NC 1	2.0	Commercial		
NC2	2.2	Commercial		
Total Development Area	171.2		5.8	985
Open Space /Parks	154.8			
Primary Roads	32.0			
TOTAL SITE AREA	358.0			
Total Commercial Area	4.2			
Commercial Floor Space		20000 sf.		
Total Detached				690
Total Attached				295
TOTAL RESIDENTIAL	167.0		5.9	985

OPEN SPACE

- OPEN SPACE / BUFFERS / AREAS OF RECREATION
- OPEN SPACE / BUFFERS / AREAS OF RECREATION (PSE EASEMENT)
- PARKS / PUBLIC AMENITY AREAS

PATH TYPES

- MULTI-USE PATH / BIKE ACCESS
- WALKING PATH
- HIKING TRAIL

Alternative 1

Conceptual Land Use Plan
City Heights, Cle Elum, Washington

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DATE:	PROJECT NO.
Oct 2009	090081
DESIGNED BY: GCH	
DRAWN BY: GCH	FIGURE NO.
REVISED BY: PPW	2

Conceptual Land Use Plan
Preliminary Geology and Geotechnical Evaluation Report
City Heights
Cle Elum, WA

Map Source: GCH Planning and Landscape Architecture

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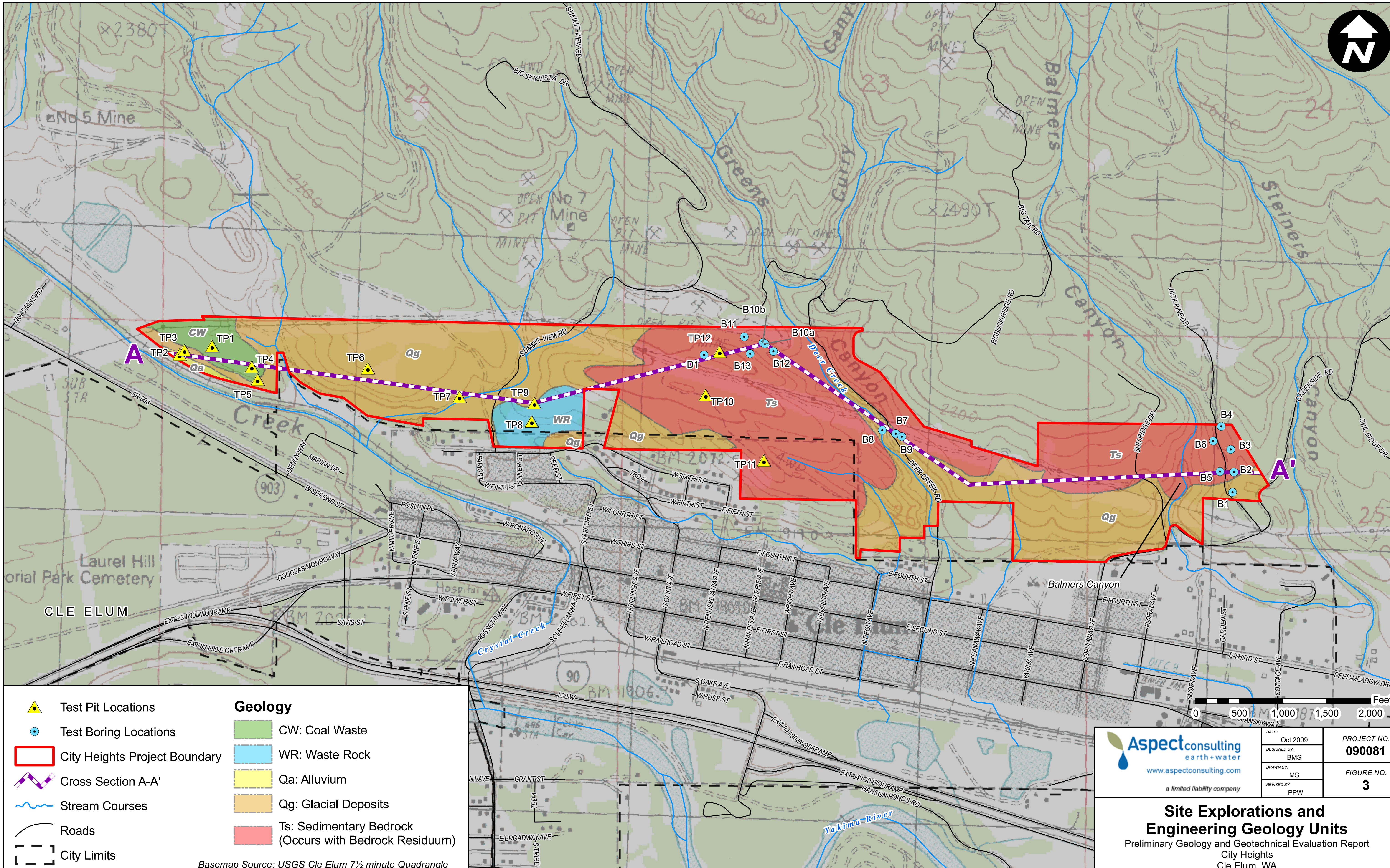
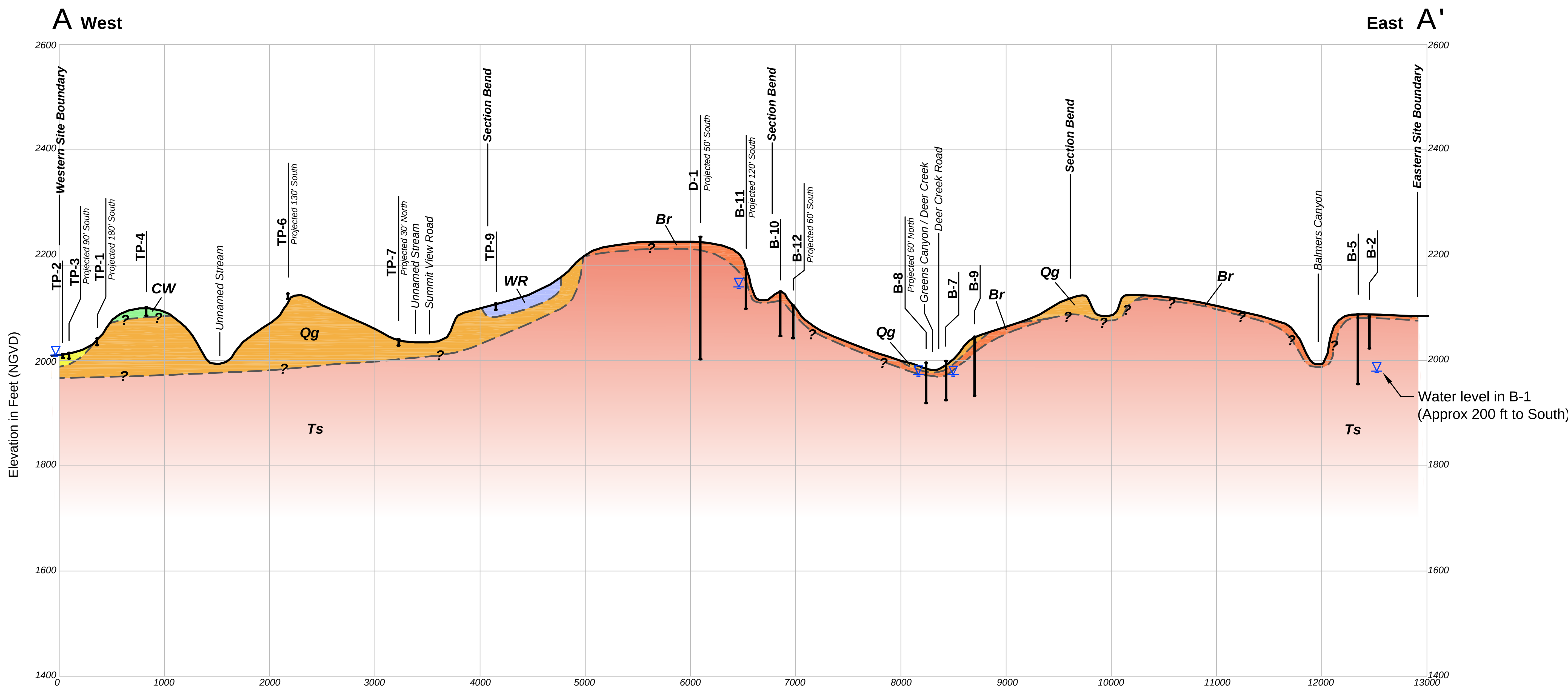


Site Explorations and Engineering Geology Units

Preliminary Geology and Geotechnical Evaluation Report
City Heights
Cle Elum, WA



Geology

	CW	- Coal waste
	WR	- Waste rock
	Qa	- Alluvium
	Qg	- Glacial Deposits
	Br	- Sedimentary Bedrock Residuum
	Ts	- Sedimentary Bedrock

0 1000 2000
Feet

Scale: 1" = 1000' Horiz
1" = 200' Vert
Vertical Exaggeration = 5X

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DATE: October 2009	PROJECT NO. 090081
DESIGNED BY: AAE	
DRAWN BY: PMB	FIGURE NO. 4
REVISED BY:	

Cross Section A-A'

Preliminary Geology and Geotechnical Evaluation Report

City Heights

Cle Elum, Washington

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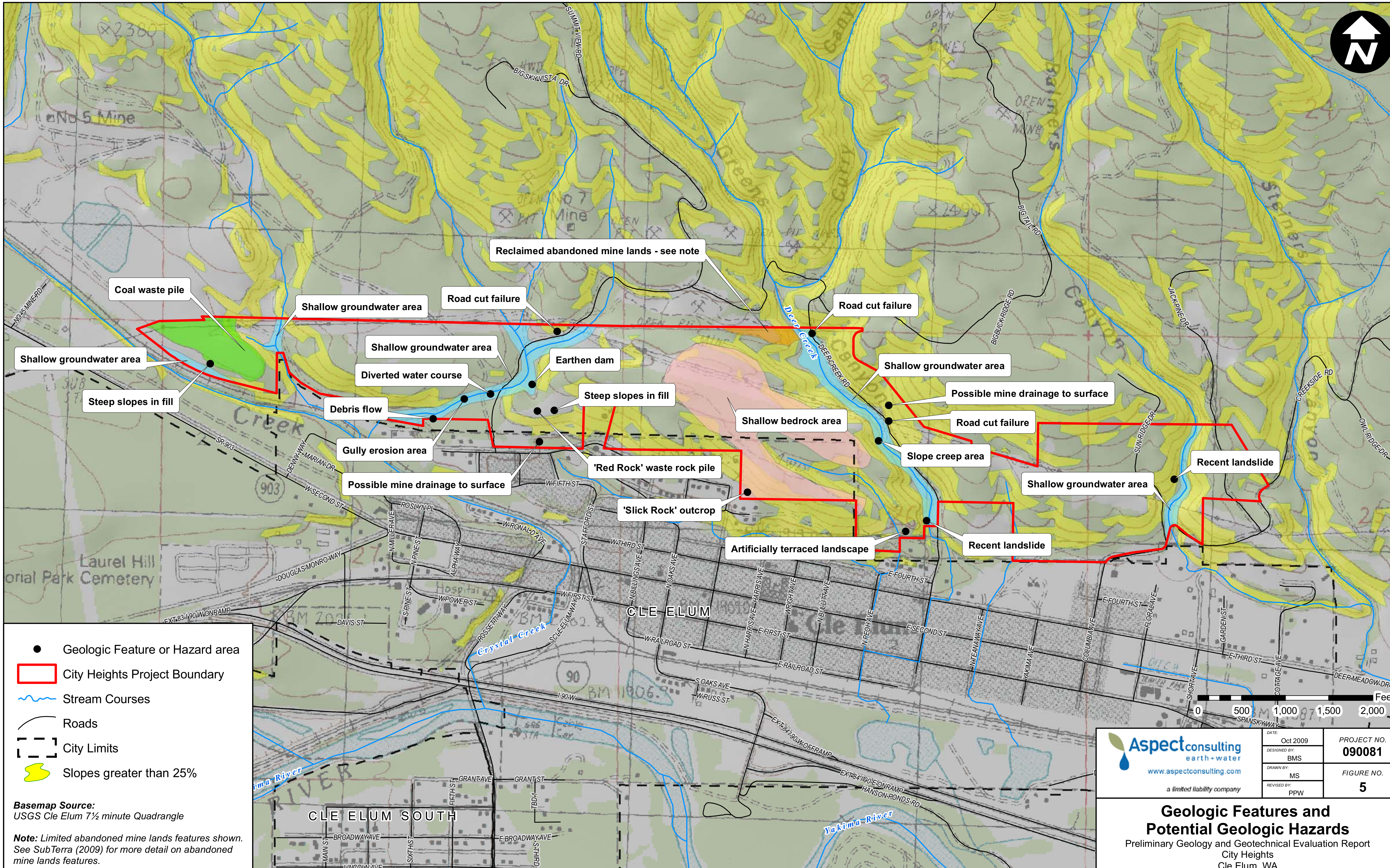

Basemap Source:
USGS Cle Elum 7½ minute Quadrangle

Note: *Limited abandoned mine lands features shown. See SubTerra (2009) for more detail on abandoned mine lands features.*

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Oct 2009	090081
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REVISED BY: PPW	5

Geologic Features and Potential Geologic Hazards

Preliminary Geology and Geotechnical Evaluation Report
City Heights
Cle Elum, WA

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APPENDIX A

Abandoned Mine Lands Report by SubTerra, Inc.

APPENDIX B

Test Pit Explorations

Subsurface conditions at the site were explored in part by excavating test pits at the locations shown on Figure 3 in the main text. Test pit locations were recorded using map-grade handheld GPS units. Twelve test pits were excavated up to 12 feet using a Case 308 track excavator operated by Rayfield Brothers Construction of Leavenworth, Washington. Test pits were observed by Aspect staff to examine subsurface conditions in the western half of the site.

Test Pit Observations

TP-1

Test Pit 1 was excavated to a depth of 11 feet. Soft, slightly moist, pockets of very moist, dark gray to black, clayey SILT, thinly-laminated, USCS designation of MH to 9 feet. Medium dense, moist, brown, slightly silty, medium to coarse SAND with fine to coarse rounded gravel (30%) and rounded cobbles up to 10 inches (20%), USCS designation of SP to 11 feet. Completion depth was determined based on encountering the underlying soil unit.

TP-2

Test Pit 2 was excavated to a depth of 5 feet. Soft, slightly moist, dark gray to black clayey SILT, USCS designation of MH to 1.5 feet. Loose, moist, brown, clayey, silty fine SAND, USCS designation of SM to 4 feet. Loose, wet, brown, slightly silty, sandy fine to coarse rounded GRAVEL with rounded cobbles up to 10 inches (20%), USCS designation of GP to 5 feet. Sidewalls sloughing. GROUNDWATER encountered at 4 feet. Completion depth was determined based on obtaining sufficient data.

TP-3

Test Pit 3 was excavated to a depth of 8 feet. Soft, slightly moist, dark gray to black, slightly clayey, SILT with angular fragments of coal up to 1 inch (10%), USCS designation of MH to 1 foot. Medium dense, slightly moist, red brown to brown, slightly silty, fine to medium rounded gravelly, fine to medium SAND with rounded cobbles up to 8 inches (20%), USCS designation of SP to 8 feet. Completion depth was determined based on obtaining sufficient data.

TP-4

Test Pit 4 was excavated to a depth of 12 feet. Soft, slightly moist, pockets of very moist, dark gray to black, clayey SILT, thinly-laminated, USCS designation of MH to 5 feet. Very soft, very moist, dark gray silty CLAY, USCS designation of CL to 12 feet. Sidewalls sloughing. Completion depth was determined based on limits of excavator.

TP-5

Test Pit 5 was excavated to a depth of 4 feet. Soft, slightly moist, dark gray to black, slightly clayey, SILT with angular fragments of coal up to 1 inch (10%), USCS designation of MH to 1 foot. Medium stiff, slightly moist, brown to brown yellow, silty, clayey SAND with fine to coarse rounded gravel (10%) and cobbles up to 6 inches (10%), USCS designation of SM to 4 feet. Completion depth was determined based on obtaining sufficient data.

TP-6

Test Pit 6 was excavated to a depth of 10 feet. Medium stiff, slightly moist, red-brown to brown, slightly clayey, fine sandy SILT, USCS designation of MH to 5 feet. Same with coarse rounded gravel (10%) and rounded cobbles up to 5 inches (5%) to 10 feet. Sidewalls sloughing. Completion depth was determined based on obtaining sufficient data.

TP-7

Test Pit 7 was excavated to a depth of 10 feet. Soft, slightly moist, brown, clayey SILT, USCS designation of ML to 4 feet. Same with coarse, rounded gravel (10%) to 5 feet. Medium dense, slightly moist, slightly silty, coarse, rounded gravelly medium SAND with cobbles up to 8 inches (20%), USCS designation of SP to 10 feet. Completion depth was determined based on obtaining sufficient data.

TP-8

Test Pit 8 was excavated to a depth of 4 feet. Loose, slightly moist, brown to dark brown, silty, fine to coarse angular SAND with angular GRAVEL (30%), USCS designation of SM to 4 feet. Completion depth was determined based on obtaining sufficient data.

TP-9

Test Pit 9 was excavated to a depth of 3 feet. Loose, dry, gray to dark gray, silty fine to medium angular SAND comprised of coal and vesicular slag with angular sandstone cobbles up to 12 inches (5%), USCS designation of SM to 3 feet. Contains metal and wood waste including fragments of railroad ties. Completion depth was determined based on obtaining sufficient data.

TP-10

Test Pit 10 was excavated to a depth of 6 feet. Medium dense, slightly moist, light brown to brown, silty fine SAND, USCS designation of SM to 4.5 feet. Same except very dense and brown to 6 feet. Completion depth was determined based on refusal.

TP-11

Test Pit 11 was excavated to a depth of 3 feet. Dense, slightly moist, light brown to brown, silty fine SAND, USCS designation of SM to 3 feet. Sandstone bedrock at 3 feet. Completion depth was determined based on refusal.

TP-12

Test Pit 12 was excavated to a depth of 6 feet. Soft, slightly moist, brown, clayey, SILT, USCS designation of ML to 2 feet. Medium stiff, light brown to brown, fine sandy SILT, USCS designation of MH to 4.5 feet. Medium stiff, light brown to brown yellow, clayey SILT with coarse angular gravel (20%) and fragments of dark wood, USCS designation of ML to 6 feet. Completion depth was determined based on refusal.

APPENDIX C

Geotechnical Laboratory Testing Program

Soil samples were collected from two locations: the coal waste pile in proposed Development Area A and the waste rock pile in proposed Development Area D. Samples were submitted to the Hammond Collier Wade Livingstone geotechnical laboratory in Wenatchee, Washington for geotechnical laboratory testing including sieve analysis, moisture content and Modified Proctor tests. The laboratory tests were conducted in general accordance with appropriate ASTM test methods. Test procedures and results are discussed below. The test reports are attached to this appendix.

Natural Water Content

Natural water content determinations were made on all soil samples in general accordance with ASTM D-2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

Grain Size Distribution

The grain size distribution of selected samples was analyzed in general accordance with ASTM D-422, Standard Test Method for Particle-Size Analysis of Soils.

Modified Proctor

The optimum moisture/maximum dry density relationship of two samples was determined in general accordance with ASTM D-1557 (Modified Proctor).

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SOIL CLASSIFICATION SIEVE ANALYSIS ASTM D-422

CLIENT: Aspect Consulting
PROJECT NO: 09-30-047
PROJECT: Cle Elum
CONTRACTOR: Client
SAMPLE LOCATION: TP-4

LAB NO: 9W-8802
DATE RCVD: 6/24/2009
DATE TESTEI 6/25/2009
SUBMITTED I Bill Sullivan
SAMPLE DEP -4.0'

SAMPLE DESC.: Coal Waste

SIEVE SIZE (in.)	SIEVE SIZE (mm)	ACC. WEIGHT RETAINED (grams)	PERCENT MATERIAL RETAINED	PERCENT MATERIAL PASSING	SPECIFICATION REQUIRED	MATERIAL DESCRIPTION
4"	*101.60*		0			**COBBLES**
3"	*76.20*		0			**COBBLES**
2 1/2"	*63.50*		0			**COARSE GRAVEL**
2"	*50.80*		0			**COARSE GRAVEL**
1-1/2"	*38.10*		0			**COARSE GRAVEL**
1"	*25.40*		0			**COARSE GRAVEL**
3/4"	*19.10*		0			**COARSE GRAVEL**
5/8"	*15.88*		0			**COARSE GRAVEL**
1/2"	*12.70*		0			**FINE GRAVEL**
3/8"	*9.50*		0			**FINE GRAVEL**
1/4"	*6.40*		0			**FINE GRAVEL**
No. 4	*4.75*	0	0	100		**FINE GRAVEL**
No. 8	*2.36*		0			**COARSE SAND**
No. 10	*2.00*	1.1	0	100		**COARSE SAND**
No. 16	*1.18*	2.6	0	100		**COARSE SAND**
No. 20	*850um*		0			**MEDIUM SAND**
No. 30	*600um*	6.0	1	99		**MEDIUM SAND**
No. 35	*500um*		0			**MEDIUM SAND**
No. 40	*425um*	9.1	2	98		**MEDIUM SAND**
No. 50	*300um*		0			**FINE SAND**
No. 60	*250um*		0			**FINE SAND**
No. 80	*180um*	64.0	12	88		**FINE SAND**
No.100	*150um*	118.6	22	78		**FINE SAND**
No.200	*75um*	230.7	43.7	56.3		**FINE SAND**
No.300	*50um*	258.7	48.9	51.1		**SILT**
TOTAL		528.5				

PERCENT MOISTURE:

REMARKS: Coal Waste Field Moisture = 28.5

TECHNICIAN R. GILL PROJ. MGR. J.HILLS

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CLASSIFICATION SIEVE ANALYSIS ASTM C-136 OR D-422

CLIENT: Aspect Consulting
LAB NO: 9W-8803
PROJ. NO: 09-30-047
DATE REC'D: 6/24/2009
PROJECT: Cle Elum
DATE TESTED: 6/25/2009
CONTRACT Client
SUBMITTED BY: Bill Sullivan
LOCATION: TP-8
DEPTH: -4.0'

PERCENT MOISTURE OF FINES: 7.4%
SAMPLE DESCRIPTION: Silty SAND w/Gravel (SM)

SCREEN SIZE	ACC. WT. RETAINED	PERCENT RETAINED	PERCENT PASSING	FRACTURE COUNT		TOTAL PERCENT	
3	0	0	100%			**100%**	
2	201	2%	98%			**98%**	
1 1/2	201	2%	98%			**98%**	
1	418	5%	95%			**95%**	
3/4	803	9%	91%			**91%**	
3/8	1874	22%	78%			**78%**	
4	3274	38%	61.5%			**61.5%**	
TOTAL	8511						
SIEVE	ACC. WT. RETAINED	PERCENT RETAINED	PERCENT PASSING	X-FACTOR			
10	159.9	23%	77%	0.615		**48%**	
16	236.8	33%	67%	0.615		**41%**	
30	313.0	44%	56%	0.615		**34%**	
40	350.1	50%	50%	0.615		**31%**	
80	430.7	61%	39%	0.615		**24%**	
100	444.4	63%	37%	0.615		**23%**	
200	486.7	69%	31%	0.615		**19.2%**	
TOTAL	707.2						

		PAN I.D & WGT..:	J	294.8
WGT. OF PAN SAMPLE:	5625	WGT. PAN & WET SOIL		1054.4
WGT. OF PAN SAMPLE - MOISTURE:	5237	WGT. PAN & DRY SOIL:		1002.0

REMARKS: Waste rock Field Moisture = 12.3% Assume fines as SILT
TECHNICIAN: R. GILL
PROJ. MGR: J.HILLS

Note: All sample material will be discarded after 30 days of receipt unless otherwise notified.

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MOISTURE DENSITY RELATIONSHIP ASTM-D1557 or ASTM D-698 PROCTOR UNIT WEIGHT AND WATER CONTENT CORRECTIONS FOR SOILS CONTAINING OVERSIZE PARTICLES - ASTM D-4718

CLIENT:	Aspect Consulting	LAB NO:	9W-8822
PROJ. NO:	09-30-047	SIEVE NO:	9W-8803
PROJECT:	Cle Elum	DATE TESTED:	7/3/2009
CONTRACTOR:	NA	TEST METHOD:	D1557-C
LOCATION:	TP-8 @4'	SUBMITTED BY:	Bill S

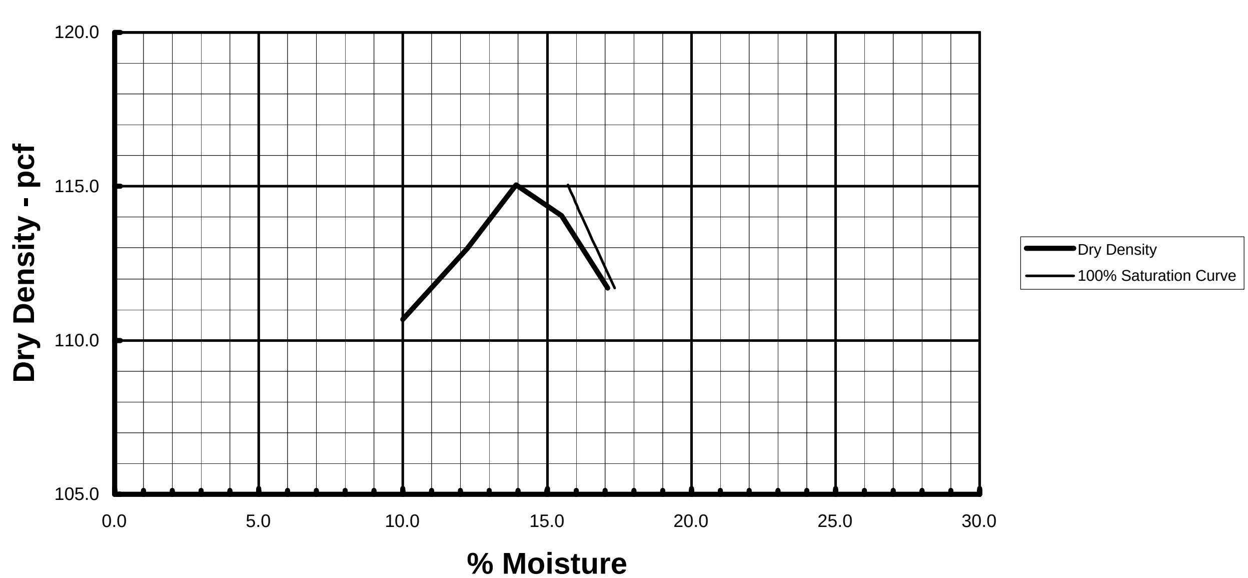
SAMPLE DESCRIPTION: Silty SAND w/Gravel (Waste Rx)

OPTIMUM MOISTURE:	14.3	**13.5**	PCT. + #4 =	39
MAXIMUM DRY DENSITY:	115.9	* **119.0**	PCT. + 3/8" =	22
			PCT. + 3/4" =	9

PREPARATION METHOD: DRY ____ MOIST X

WATER ADDED	100	200	300	400	500		
MOLD + WET SOIL	21.61	21.99	22.31	22.36	22.29		
WEIGHT OF MOLD	12.48	12.48	12.48	12.48	12.48		
WT. OF WET SOIL	9.13	9.51	9.83	9.88	9.81		
WET DENSITY PCF	121.7	126.8	131.1	131.7	130.8		

PAN/PAN NUMBER	B	H	C	F	E-1		
PAN + WET SOIL	819.3	1151.5	1289.90	1347.2	1287.2		
PAN + DRY SOIL	762.1	1046.6	1155.40	1191.8	1127.0		
WEIGHT OF PAN	189.9	189.0	190.00	189.8	190.3		
WT. OF WATER	57.2	104.9	134.50	155.4	160.2		
WT. OF DRY SOIL	572.2	857.6	965.40	1002.0	936.7		
PERCENT WATER	10.0	12.2	13.9	15.5	17.1		
DRY DENSITY PCF	110.7	113.0	115.0	114.0	111.7		



* Rock Correction using Bulk Specific Gravity of 2.60 Calculated ____ Estimated X

* Moisture Correction = 5.41 %

Field Moisture = 12.3 % Rammer: Manual ____ Mechanical X

REMARKS:

TECHNICIAN: R. GILL PROJECT MGR: J.HILLS

Note: All sample material will be discarded after 30 days of receipt unless otherwise notified.