APPENDIX E

Geologic Evaluation for the Idaho-Maryland Mine Project

GEOSOLUTIONS

Geology, Engineering Geology, Hydrogeology
Environmental Investigation, Monitoring & Remediation

Technical Memorandum:
Geologic Evaluation for the Idaho-Maryland Mine Project
Grass Valley, Nevada County, CA. April 15, 2008

I. Geology and Mineral Resources

Lithology, History, and Geochemistry

The Idaho-Maryland Mine is located within the distinct geologic region of California known as the Sierra Nevada geomorphic province, which includes the Sierra Nevada Mountains and the Sierra Nevada Foothills Gold Belt. The average width of the gold belt is 50 miles and it extends over a length of about 200 miles with a northwest-southeast orientation along the western frontal slope of the Sierra Nevada mountain range.

Most rocks currently exposed at the surface started their formation to today's present condition approximately 550 million years ago, and were produced by tectonic forces that caused subduction of the Pacific plate and others beneath the North American plate. During that early period marine sediments accumulated to thicknesses of up to 51,000 feet, after which hot and less dense granitic rocks rose up from great depths in the upper mantle and intruded into the older mildly metamorphosed sedimentary rocks. As this process continued throughout the upper Jurassic and lower Cretaceous periods the older sedimentary rocks were more strongly metamorphosed by tectonic heat and pressures and also hydrothermally altered by very hot acidic circulating magmatic fluids.

Older rocks that formed from the early Paleozoic Era to mid Cretaceous are referred to as the Bedrock Series, defined by the U.S. Geological Survey. These basement rocks are partially composed of ancient sea floor units, overlying highly metamorphosed sedimentary rocks and volcanic extrusive rocks that were first altered by tectonic pressures and heat, and subsequently further altered by the hydrothermal processes that are associated with development of the gold/quartz veins of the Grass Valley mining district. The rocks in the Grass Valley area and surrounding project area show evidence of having been faulted multiple times, metamorphosed during the emplacement of the Sierra Nevada batholith, then elevated and eroded during more recent geologic history. Many of the individual rock units are separated by a series of fault structures that represent suture zones reaching deep into the earth.

During the more recent Cenozoic Era the surrounding region experienced vast and numerous volcanic eruptions that covered much of the area with flows of andesitic lava. Then glacial activity etched great depressions into the terrain and regional uplifting that continues today changed the southerly flow of rivers to a direction with strong westerly components. Geologic units forming during this more recent time are categorized by the USGS as the Superjacent Series. These younger volcanic rocks, known as the Mehrten Formation, cover most of the higher terrain in the area surrounding Grass Valley and in the vicinity of the proposed Idaho-Maryland Mine project. They are the youngest in the area being deposited through a series of volcanic events starting about 25 million years ago, and do not show any signs of the hydrothermal alteration or fault movement as do the older rocks of the Bedrock Series.

Geologic units located in the area adjacent to the proposed Idaho-Maryland Mine project include four of the Bedrock Series and one of the Superjacent Series. Oldest of the Bedrock Series are the Triassic ultramafic serpentinized rocks located mostly north of the Idaho Fault and westerly of the 6-3 fault. These ferro-magnesium silicate rocks are about 245 to 200 million years old, and before being altered by variable magnitudes of hydrothermal alteration, were composed of peridotite, pyroxenite and gabbro.

Next are the lower Jurassic rocks of the Lake Combie Complex. These rocks underlie the area to the east of the New Brunswick site and south of the Nevada County airport where many of the wells included in the easterly well grouping are located. Rocks of this unit include older interbedded volcanic flows, breccias and pyroclastic tuff-breccias. These rocks are located elsewhere around Grass Valley including the Empire Mine State Park to the southwest where they grade into porphyrite and diabase with associated tuff and breccia equivalents. Mid Jurassic plutonic rocks mostly composed of gabbro but also grading into diorite and quartz diorite are located in westerly and northerly areas of the Idaho-Maryland site. These units are closely associated with rocks of the lower Jurassic unit. The fourth unit of the Bedrock Series includes upper Jurassic hypabyssal rocks called diabase. They maintain strong exposures in northerly areas of Idaho-Maryland site, but these materials grade into amphibolite schist in areas around the New Brunswick site. Most of the veins of the Idaho-Maryland ore body reside within this fourth lithic unit.

In the immediate area surrounding the subject project only one unit represents materials of the Superjacent Series. It consists of andesitic mudflows, pyroclastics, tuff and volcanic breccias of the Miocene to Pliocene Mehrten Formation. These materials cover much of the area located northwesterly of downtown Grass Valley and are also located across much of the higher terrain around the airport and along Highway 174 to the south of the project within the Cedar Ridge area.

All geologic units of the Bedrock and Superjacent Series located in the immediate area surrounding the proposed project and Grass Valley area are members of the silicate family of rocks - as are about 95% of the upper portions of the Earth's crust.

Their geochemistry includes mostly silica and oxygen with abundant amounts of iron, magnesium, calcium, aluminum, sodium and potassium.

As noted by the U.S.Geological Survey, all Bedrock Series rocks located in the Grass Valley area have been overprinted by the altering hydrothermal processes that took place for over 40 million years from the late Jurassic to lower Cretaceous periods. This hydrothermal alteration process involved deep seated mechanisms including albitization, tourmalinization, rutile development, sericitization and chloritization by low pH acidic solutions migrating slowly within very high temperature and pressure environments. In addition to these more intense mechanisms chloritization, carbonitization, sericitization, chertification, kaolinization, pyritization and doloitization also took place within outer or shallow zones where temperatures and pressures were lower.

The result of these alterations of the rocks is important with respect to their influence on the original geochemistry of the underlying rocks into which many domestic water wells in the study area are located and from which they receive potable water. Also as a result of the hydrothermal processes, all rocks located on the westerly side of the 6-3 fault (Weimar) have been altered to various degrees and include abundant minerals not usually associated with the eight mineral groups of the original silicate rocks.

Vein Development, Alteration Zoning, Geochemistry

Adding to the generalized description of geologic development within the Grass Valley mining district is the paragenesis of the vein forming minerals that now reside within many of the former thrust fault structures found in the Bedrock Series units located throughout the immediate surrounding area. The paragenetic development involved four main stages of mineralization distinguished by variable magnitudes of temperature and pressure as a function of increasing depth. These include a magmatic stage, hypothermal stage, mesothermal stage (including quartz and carbonate substages), and an oxidation stage.

Generally speaking deep seated alteration processes included albitization, tourmalinization, rutile development sericitization and chloritization that were more closely associated with magmatic and hypothermal stages. In addition, alteration processes including chloritization, carbonitization, certification, kaolinization, pyritization and doloitization were dominate during the lower temperature mesothermal and oxidation stages of vein development in the district.

The result of these alteration processes was the formation of different types of minerals that now make up the bulk of the vein forming materials. These include both ore and gangue that were defused from the surrounding country rocks. These processes involved elevated temperatures between 200^{O} to 600^{O} centigrade and pressures between 4,500 pounds per square inch (psi) to over 17,000 psi over a period of time that endured for at least 40 million years. As a result, well over 57 cubic miles of deep seated rocks once located deeper than 12,000 feet below the former ground surface were altered beneath an area of at least 25 square miles that now surrounds the town of Grass Valley.

Some of the numerous minerals developed by these low pH acidic solutions migrating through the original silicate rocks at high temperatures and pressures include: ankerite, metallic arsenic, arsenopyrite, azurite, calcite, chalcopyrite, chlorite, chromite, epidote, galena, gold, gypsum, hematite, limonite, magnetite, mariposite, molybdenite, pyrite, pyrrhotite, quartz, scheelite, sericite, silver minerals, speculartie, tellurides and wad. In addition, the original geology of the country rock situated adjacent to the gold/quartz veins of the Grass Valley mining district are likely to have been altered to some degree and now host new additional minerals including: black tourmaline, phlogopite, secondary muscovite, biotite, topaz, apatite, sillimanite, hedenbergite, hornblende, tremolite, actinolite, cummingtonite, spinels, kyanite, secondary feldspars rich in potassium, sodium and calcium, and sericite, secondary quartz, calcite, dolomite, pyrite, chlorite and clay minerals.

The Idaho-Maryland Mine, when in full production, will be a manufacturing plant producing “Gold” as an end product with by-products including tungsten, silver and ceramics, via the ceramics plant. Feed of raw ore into the mill will include up to 3,200 short tons of ore per day (stpd) composed mostly of rock from veins with minor amounts of rock from adjacent hydrothermal alteration zones. Mine development can generate up to another 2,500 stpd of waste rock during excavation of drifts, raises, and winzes, for a total daily production of about 5,700 stpd of ore and waste rock.

Most of these materials are proposed to be used in the ceramics plant, but at least 800 stpd of mill tailings will be reused as backfill in cut-fill stoping operations in the underground mine works. Placement of these tailings will need to be properly conducted since they will likely contain some of the Title 22 Cam 17 metals via sulfide minerals like arsenopyrite, chalcopyrite, galena, and sphalerite.

Detailed analyses of materials to be backfilled underground should be performed by a qualified geochemist to ensure regulatory compliance of guidelines such as those outlined in CCR Title 23, Chapter 15, for discharging wastes to lands. In addition to the raw materials outlined above, chemical additives used in the milling/flotation processes will include, but not be limited to, Flotation Agents that can include: 1) collectors; 2) modifers; 3) precipitants; 4) xanthates; and, 5) other specialty collectors for sulfide and non-sulfide ores. The waste stream will consist of sands with minor rock fragments, minor concentrations of sulfides, and chemicals that may not be completely washed from the circuit.

The Applicant proposes that most of these materials will be used in the ceramics plant, but at least 800 stpd will be reused as backfill in cut-fill stopes and in other areas of the mine. To ensure regulatory compliance, a complete characterization of these backfill materials will be required by the Central Valley Regional Water Quality Control Board (CVRWQCB) as a part of implementation of the mine reclamation plan to prevent those materials from impacting the naturally occurring quality of area ground water.

Fibrous (Asbestiform) Minerals

Asbestos is an economic term given to naturally occurring fibrous minerals that possess unique flexible yet heat resistant and high tensile strength properties. Due to its fibrous occurrence, asbestos was a commonly used heat insulator until the 1970's when it was discovered to be carcinogenic via long term respiration/exposure of airborne fibers. Although no longer used as an industrial material, it remains present in certain natural environments and when highly disturbed can become airborne.

When disturbed asbestos fibers are released into the air where they can remain suspended for extended periods. If inhaled, these fibers can become permanently lodged in body tissues and can cause lung cancer and mesothelioma. Asbestosis is another disease linked to asbestos. The California Department of Toxic Substances Control, California Air Resources Board and the California Division of Mines and Geology each have regulatory responsibilities regarding naturally occurring asbestos.

The presence of ultramafic rocks in the area around the project site indicates the possibility of naturally occurring asbestos materials. Ultramafic rocks are associated with shear zones and are considerably denser than other rock formations in the area. In most areas, ultramafic rocks are serpentinized within zones that are highly sheared and very closely fractured.

Minerals known to contain asbestos-quality (i.e., asbestiform) fibers include ultramafic minerals of the amphibole group and phyllosiliates. Fibrous varieties of the amphibole group include tremolite, actinolite, amosite, crocidolite and anthophyllite. Serpentine is a phyllosilicate that occurs in a platly variety (antigorite) and an asbestiform variety (chrysotile) and is the most common variety of commercially mined asbestos. Amphibole asbestos, when disturbed, emits needle-like fibers that can be inhaled into the lungs. Amphibole asbestos is more friable than chrysotile, which requires considerable flexing to break. Both forms of asbestos are found in the serpentine rock common in the Sierra Nevada foothills, and specifically found around the Idaho-Maryland and Round Hole Shaft sites.

If serpentine rock is disturbed, such as by grading and construction activities, asbestos fibers can be released. Amphibole schist is the primary rock type in which most of the Idaho-Maryland ore body resides but along the northerly boundary to the Idaho-Maryland site serpentine does reside along the northerly side of the Idaho Fault. If any future grading is to be performed within this limited area during mine plant construction, there could be the possibility of generating asbestos laden dusts, so special attention should be given during those operations to ensure dust suppression is maintained.

Soils and Topography

Information about soil conditions across the three sites associated with the project were previously obtained and utilized during preparation of the Master Environmental Assessment document. Most of the information utilized during preparation of that document came from the preliminary geotechnical engineering investigation conducted by H&K in October 2004. That investigation included a surface reconnaissance across the three sites, review of geologic units that underlie the parcels, use of historical references with additional review of previous reports for the property completed by others; and experience with subsurface conditions in the area. In addition, use was made of the *Soil Survey of the Nevada County Area, California* (USDA Soil Conservation Service, reissued August 1993) as the primary source for information regarding soil type(s) and occurrence.

All three sites of the project can be subdivided into two main categories with the first including areas where native soils are still exposed in a mostly undisturbed condition, and the second being areas where native soils are either totally absent or mixed with varying types and/or amounts of fill transported in from other locations.

Soils at the Idaho-Maryland Site

As characterized in the soil survey, the Idaho-Maryland site is covered by six different soil types. These include native Secco-Rock outcrop Complex, Sites loam, Boomer-Rock Outcrops and Rock Outcrops of the Dubakella Complex. The two other soil groups include man-made Placer Diggings and Cut & Fill.

Undisturbed soils rest in southwestern parts of the Idaho-Maryland site where the property is underlain by the Secca-Rock Outcrop complex (ScE). These soils are known for their poor quality topsoil, moderately slow intake rates, slow permeability and medium to low available water holding capacity. They are underlain by bedrock composed of amphibolite schist located at depths of about 45 inches beneath the surface. Outcroppings typically occupy from 10 and 40 percent of the mapped area and are designated as Seccca–Rock Outcrop on slopes from 2 to 50 percent.

Undisturbed soils are also exposed on the eastern side of the site, but consist of Sites loam (SID) resting on slopes from 15 to 20 percent. These well drained soils also produce poor topsoil overlying metamorphic rocks normally at depths of 3.5 feet to more than five feet on hillside areas sloping from 2 to 50 percent. These soils typically have moderate intake rates, and moderately slow permeability and medium to high water holding capacity. A sub-class of the Sites (SmE) is also located in the far northeastern corner of the Idaho-Maryland site. These soils also produce very stony poor topsoil and have a moderate shrink-swell potential.

A Boomer-Rock Outcrop (BrD) complex is noted in a very limited area located in the most southerly portion of the property next to Bennett Street and along the boundary of the property. Boomer outcrops produce poor topsoil and bedrock is from 3.5 to 5 feet deep beneath slopes from 5 to 50 percent. They have a moderate intake rate, moderately slow permeability and medium to high available water holding capacity.

The fourth type of native soil includes the Rock Outcrop of the Dubakella Complex (RrE). These materials are exposed in the most northwesterly corner of the site and normally reside on hillsides sloping between 5 to 50 percent. These materials normally produce poor topsoil with moderate shrink-swell potential and are mapped only within complexes with rock outcrop that are too variable for valid interpretation. These soils are usually very thin, being only 1 to 1.5 feet deep, have a slow intake rate, very slow permeability and very low available water holding capacity.

The soil survey also identified two non-native soil types located in the south-central portion of the site. The first being Cut and Fill (Ct) consisting of materials that have been altered by methods other than those associated with mining activities. These materials are usually too variable for valid interpretation and are normally mixed with deep accumulations of organic bark especially in locations previously used as logging deck yards or lumber stack yards. Finally, the last soil type found on the site includes Placer Diggings (Pr) that are also too variable for interpretation and these materials underlie most of the northwestern portions of the site. These soils occur mostly along drainages that have been placer mined and typically consist of gravel with a small fraction of fines. But on this site they may also represent former mill tailings that were disposed of during previous operations.

Topography across the Idaho-Maryland Site

The Idaho-Maryland site can be subdivided into three smaller areas including a main area, southern area, and the southeastern area. The main area is located in the northwest part of the Idaho-Maryland site and occupies the largest portion of this parcel. This area is proposed to contain the future ceramics plant and a majority of the other proposed manufacturing facilities. Its topography slopes gently to the northwest with slopes ranging from less than 5 percent along the perimeter of the main area to about 25 percent beneath the area proposed for construction of the ceramics plant. The gently sloping area (<5%) appears to have been graded and its surface is covered with waste rock, presumably associated with historic hard rock mining. Areas with steeper terrain in the vicinity of the proposed ceramics plant are covered with waste rock in piles up to 10-feet in height. A ditch also crossed this slope in the vicinity of the proposed location for the ceramics plant.

The western part of the central area is relatively flat lying and contains patchy areas of sandy material (likely mill tailings) on the surface. Site elevations range from approximately 2,490 feet above mean sea level (amsl) near the concrete towers to 2,560 feet amsl in the northeastern part of the main area (H&K, 2004).

The western end of a small, west-trending ridge dominates the topography in the southern area of the Idaho-Maryland site. The native soil had been cut from the ridge top and deposited along the edges of the newly formed plateau. A short timbered crib wall retains less than 5 feet of fill on the southern edge of a graded area located immediately north of a dirt access road. The remainder of the property appears in an undisturbed native condition with ground elevations ranging from approximately 2,620 feet amsl on the ridge near the eastern property line to approximately 2,530 feet amsl near the southwest corner of the property. Slopes range from about 2 to 8 percent on the previously graded ridge top area to a steeper 2:1 slope (horizontal to vertical) on land sloping away from the ridge (H&K, 2004).

The southeastern part of the Idaho-Maryland site also contains a graded area, cut slopes, and a steep slope along the easterly side. The southeastern area was relatively flat-lying and characterized by extensive cut and fill operations associated with past lumber milling activities. Several relic foundations associated with the former lumber mill, as well as a concrete slab-on-grade and a pile of large concrete fragments, were noted within the previously graded area. Cut slopes on the east side of the graded area approached 30 feet in height, and steepness of slopes ranges from approximately 1:1 (horizontal to vertical), to near vertical. Significant residual rock structures are exposed in cut slope faces in this area. Elevations range from approximately 2,590 feet amsl on the graded area at the toe of the cut slope to approximately 2,730 feet amsl near the eastern boundary of the property. Slopes are generally less than 10 percent, excluding the natural slope, the cut slope, and a relatively steep fill slope located on the southern end of the historic mill area (H&K, 2004).

Soils at the New Brunswick Site

Located within low lying areas of this site and mostly along the creek are soils classified as Alluvial Land, clayey (Ao). These soils have also been disturbed and modified, and are normally too variable for soil classification. Within the westerly portion of the parcel and in the immediate area next to the alluvial materials are soils termed Placer Diggings (Pr). These materials are normally too variable for valid classification but do appear to consist of mine rock likely removed from the old Union Hill mine. These materials are located along the south side of Bennett Street and are composed mostly of small angular rocks with a size distribution from small gravels to small cobbles. The type of underlying soil materials on which these materials rest is unknown.

The most southern part of the New Brunswick site adjacent to the channel of South Fork Wolf Creek is underlain by a very narrow lens of soils classified as Aiken Loam (AfE). This soil type consists of poor topsoil with bedrock at about 4 feet deep. They possess a moderately slow permeability and rest on slopes from 2 to 50 percent.

They also have a moderate intake rate and high available water holding capacity. Another group of Aiken Loam (AfC) is located in the most northerly portion of the site along Bennett Street. This group is similar to the other subgroup of Aiken Loam except topsoil is more developed. Aiken Loam soils normally reside on bedrock deeper than 4 feet that is composed of andesitic tuff and conglomerate. Most of the soils in areas with high ground elevations and located along the south side of Bennett Street are classified as Cohasset Loam (CmD). These soils rest on slopes from 15 to 30 percent and are composed of cobbly loam and cobbly clay loam on andesitic conglomerate bedrock at depths of about 5 feet. They possess a moderate shrink-swell potential and moderate intake rate with moderately slow permeability and medium to high available water holding capacity.

Topography Across the New Brunswick Site

The New Brunswick site is situated in a valley created by the South Fork Wolf Creek drainage system. The site is bound by Bennett Road to the north, a former abandoned and dismantled lumber mill with pond and associated dam to the east and southeast, and the channel of the South Fork Wolf Creek to the south. Within the boundaries of this site is located the portal to the New Brunswick shaft and adjacent concrete ore bin tower located immediately north of the shaft. These features are surrounded by a flat area totaling about 1.5 acres of land that was formerly graded flat then finished with gravel. This area is entirely surrounded by chain-link fence to prevent easy access onto this portion of the site.

The remaining portion of the site includes a flat lying pasture covered by heavy and thick growths of grasses. This lower lying area is located between the New Brunswick Shaft area to the north, former lumber mill to the east and the channel of South Fork Wolf Creek to the south and along the southwesterly boundary to the site. Elevations across the site range from 2,680 feet amsl at the western boundary to roughly 2,760 feet amsl along Bennett Street and northerly of the New Brunswick Mine shaft area.

The site consists of a flat lying surface around the New Brunswick Mine shaft, gently sloping open fields and tree covered areas extending downstream from the dam located on the adjacent lumber mill property, and steep slopes along the southern edge of the mine shaft site where deep engineered fill was placed in the mid 1990s. The gently sloping valley floor where pasture lands are covered with thick vegetation is also located along the south side of the Union Hill shaft where concrete walls and piles of mine waste rock are located next to the south side of Bennett Street. All of these features are located in the northwestern part of the New Brunswick site. These piles approach 10 feet in height and are likely associated with mining from the Cambridge shaft and from exploration efforts conducted within the immediate area (H&K, 2004).

Soils at The Round Hole Site

The Round Hole site is mostly underlain by the Secca-Rock outcrop complex (ScE) and Sites very stony loam (SmE). The southerly portion of the property, where the access roadway and turn-around are located, is on the Secca Rock Outcrop complex found on 2 to 50 percent slopes. These soils have a high shrink-swell potential and rest on meta basic bedrock normally at depths from 3 to 5 feet. They have a moderately slow intake rate, slow permeability and low to medium available water holding capacity. On the more northerly area of the Round Hole site is the Sites Very Stony loam (SmE). These soils have a moderate shrink-swell potential and bedrock is normally found at depths from 3 ½ to 5 feet deep on slopes form 2 to 50 percent. They also have a moderate intake rate, moderately slow permeability and medium to high available water holding capacity.

Topography across the Round Hole Site

The Round Hole site lies on the slope immediately north of Whispering Pines Lane, west of Brunswick Road and south of Idaho-Maryland Road. From Whispering Pines Lane a dirt roadway provides access onto the parcel and connects with a small turn-around roadway area that is centrally located. The site is positioned on a hillside that slopes mostly towards the north with both westerly and easterly components at rates from 15 to 25 percent. Elevations across the site range from 2,705 feet amsl at the top of the access road to 2,640 feet amsl along its northerly border near the Idaho-Maryland Road. Several old concrete structures and waste rock piles are located within brushy areas of the site located near the northerly property line. These features were likely associated with historic development of the Round Hole shaft (H&K, 2004).

Landslides

Recognition and identification of landsides are as complex as are the materials and processes that cause them. Sliding movements take place under the influence of geologic, topographic and climatic factors and seldom, if ever, can a landslide be attributed to a single definite cause. In most cases a number of causes exist simultaneously and so attempting to decide which one finally produced failure is not only difficult but usually incorrect. Often the final factor is nothing more than a trigger that sets in motion an earth mass that was already on the verge of failure. But with this said, all landslides involve the failure of earth materials under shear stress. The initiation of the process can therefore be reviewed according to: 1) The factors that contribute to increased shear stress; and, 2) the factors that contribute to lowered or reduced shear strength.

Because a landslide can seldom be attributed to a single definite cause the overall terrain or topography must be analyzed simultaneously while assessing individual factors and the interrelations among relevant geologic, soil(s) and moisture conditions before a potential slope movement can be recognized and identified.

In its natural condition the ground surface across the three properties presented above do appear to be relatively stable. Most of the terrain consists of nearly flat lying land or of hillsides with varying slopes. Steeper slopes are generally not tall and most drainage systems between hillsides are broad with channels that are relatively low gradient. Even most of the steeper hillsides slope at only about 30%. Based on observations of surface features and results of surface field investigations all three sites where future developments are proposed to be built are relatively free from the threat of slope failures, be they by: 1) Falls; 2) Topples; 3) Slides (Rotational or Translational); 4) Laterial Spreads; 5) Flows (In Bedrock or Soils); or, 5) Complex combination of one or more of the above five types of movement. This relative stability is dependent upon the terrain and inherent characteristics of near surface soils and underlying bedrock (Schuster & Krizek 1978).

In areas located across any one of the three sites where hillsides slope at around 30%, the layout of proposed improvements including roadways and structures should allow for enough adjacent useable space to help ensure that all cut and fill slopes will be no steeper than 2:1 (horizontal to vertical). All slopes should also be properly keyed in according to building and grading codes. Also, cut/fill areas situated on hill tops and hillsides should be designed by a professional engineer. A soils engineering report completed during the design of the project grading plan will be necessary to help ensure project designs are compatible with the engineering characteristics of underlying soils.

Liquefaction

The threat of damage to future improvements due to liquefaction appears to be minimal because subsurface materials beneath the property are mostly lacking in the combination of soil types and ground water conditions needed for this type of failure. In order for liquefaction to occur, there must be a sudden large decrease of shearing resistance in cohesionless soils caused by a shock, such as an earthquake, and associated increase in pore water pressure. Typical soils that can liquefy include low-density soils that when saturated and concurrently subjected to high intensity ground shaking, dilate due to excessive hydrostatic forces and behave as a liquid rather than a more solid soil matrix. Soils within the main drainage channels of Wolf Creek and the South Fork Wolf Creek and its tributaries may be liquefiable given adequate seismic loading. However, these alluvial soils are generally within limits of established floodplain areas and outside of the areas of any proposed future developments.

Subsidence

There is a known short drift called the 70 foot level tunnel that trends in a southeasterly direction from the Old Brunswick shaft towards an area characterized with topography that includes a deeply etched ravine situated along a portion of the north side of Bennett Street. This area is surrounded by Well Numbers 80, 120, 122 and 242 as outlined on Figure A-1 (Todd Engineering 2007).

Although this tunnel is named the 70 foot level drift its vertical distance from the ground surface is not a vertical 70 feet because lateral tunnels connected to this shaft are label by their slope distance down centerline of the declined shaft instead of their vertical distance from ground surface. Because the shaft slopes at an angle of about 50 degrees to the horizontal in a southeast direction the maximum vertical distance between top of tunnel to the ground surface is likely to be about 54 feet in the area adjacent to the portal of the shaft. Therefore, in the area beneath the ravine the vertical distance may be as little as 20 feet because the elevation of the terrain decreases substantially in the same area where portions of the tunnel are located. Because of the close proximity of the tunnel to the ground surface, subsidence may be a risk, particularly if structures will be located over this shaft or if the shaft is to be enlarged. In either case, an engineering geologist should conduct a detailed investigation to determine the need for and type of appropriate actions to prevent subsidence.

According to information provided by the applicant all other areas located across the three sites should not be susceptible to subsidence due to future mining efforts. According to geologic characteristics found in the area and intentions of the applicant to mine only at deeper levels of the mine, there should be a very low risk of subsidence at the surface as a result of future underground mining activities.

Underground mine workings will consist of six different types, including: 1) vertical shaft(s); 2) decline drifts; 3) horizontal drifts; 4) winzes; 5) raises; and, 6) stopes of various types. Because of the attitude of most veins located in the Idaho-Maryland orebody, cut-and-fill stoping methods will likely be the most preferred although other methods could be implemented including vertical retreat stoping, and shrinkage stoping. Therefore, most open areas excavated during production will be immediately backfilled thus providing support to surrounding lithic units.

Most of the existing drifts that are currently part of the underground workings are typically only about seven feet tall and six feet wide. Therefore, if caving were to occur in those excavations (for some unknown reason) the extent of upward caving would typically be not more than 70 feet before natural support is regained, assuming a final void space of 10% is achieved within the caved materials. Therefore, for these old mine workings located within deeper portions of the mine the possibility of them generating a subsidence of earth materials at the ground surface is extremely low. Only underground structures located very close to the existing ground surface, like the 70 foot level tunnel mentioned above, could cause distress to near surface earth materials.

Fault Structures and Their Seismic Potential

The Central Valley and the Sierra Nevada Mountains, like most of California, are seismically active regions. Their levels of seismicity are due to complex regional tectonic processes that include movement along major crustal plates, and uplift and volcanism in the Sierra Nevada mountain range. The Foothills Fault system is composed of numerous major faults residing within the basement rocks (Bedrock Series) of the foothills of the western Sierra Nevada. Together they make up a major regional geologic feature and were formed during the Mesozoic Era (225 to 65 million years ago) in response to the building and deformation of the Sierra Nevada geologic province. But the current relative risk of earthquakes in this region is considered to be lower than other areas of California because most faults in the region are not considered to be as seismically active.

An overall description of the foothills fault system is as follows. The Foothills fault system, which extends along the western flank of the Sierra Nevada Range, is a complex major fault zone formed 225 to 65 million years ago in response to the tectonic deformation within the Sierra Nevada province. This zone consists of a number of braided faults extending along the foothills of the Sierra Nevada Mountains from an isolated area located about 40 miles easterly of Merced to a northerly area located northerly/northeasterly of Oroville in Butte County. On the south end, this fault zone is only about 30 miles wide in an easterly-westerly direction, but widens to over a 100 miles on the northerly end located easterly of Chico.

In the south this fault zone consists of two primary faults including the Bear Mountains Fault system to the west and the Melones Fault located only a short distance to the east. Then north of Plymouth the Melones Fault starts a more northerly trend as the Bear Mountains Fault continues in a northwesterly direction towards Auburn. There it is renamed the Deadman Fault as it passes through the westerly side of town before being renamed the Spenceville Fault in western Nevada County. As this fault passes under the main branch of the Yuba River its name changes again to the Prairie Fault and a second splinter fault branches off in a more northerly direction. This splinter fault is first named the Swain Ravine Fault, but later becomes the Cleveland Hill Fault around the Oroville area where it and the Prairie Fault finally terminate or disappear beneath young Tertiary volcanic materials.

From the Auburn area the Bear Mountain Fault also splinters into a second structure with northerly trend and this system is called the Wolf Creek Fault. Following Highway 49 this structure then passes through the westerly side of Grass Valley where it splinters into a series of small faults (Grass Valley Faults) before concentrating once again into a structure called the Big Bend-Wolf Creek Fault Zone. As this structure trends in a northerly direction into a region located easterly of Lake Oroville it then swings westerly towards Chico and disappears beneath the Tertiary volcanic lava flows found throughout much of northeastern California.

As the Melones Fault trends northerly through an area located about 15 miles southeasterly of Auburn, a secondary fault splinters off in a more northwesterly direction passing under Interstate 80 located north of Auburn. This structure trends through the Colfax area and towards the easterly side of Grass Valley and the westerly side of Nevada City. Near Auburn this fault is called the Gillis Hill Fault, but as it gets closer to Grass Valley secondary subordinate splinter faults split off and away as they pass beneath the project site. One of these structures is called the Weimar Fault (or 6-3 Fault). A cluster of splinter faults associated with the Gillis Hill and Weimar Faults developed in the area easterly of Grass Valley and change their directions from northwesterly to more westerly as they pass through the area located between Grass Valley and Nevada City. North of Grass Valley they reunite with the cluster of faults called the Grass Valley Faults (noted earlier) located along a section of the Big Bend-Wolf Creek Fault zone. It is likely the Idaho Fault located along a portion of Wolf Creek north of the Idaho-Maryland and Round Hole sites is part of this larger system of faults trending through the area. The Morehouse Fault is also likely to be related to this larger system of fault structures.

Within the surrounding region of western Nevada County there are four major old faults zones that extend across the region with a northwesterly strike. The most westerly of these is the Swain Ravine Fault Zone located about 15 to 20 miles westerly of Grass Valley. Next is the Wolf Creek Fault Zone that strikes along and under Highway 49 from the County's southern boundary north to the Grass Valley area. The third set of faults includes the Weimar and Gillis Hill Fault Zones. This network of faults is about five miles wide in an area south of Grass Valley from Rollins Lake to the east, to Lake Combie to the west. Their strike continues in a northerly direction into the area located easterly of Grass Valley and beneath the area around the project. The Melones Fault Zone is located about 15 to 20 miles easterly of the Grass Valley area and also strikes in a northerly direction across the region.

Of these four structural systems only the Swain Ravine Fault Zone is considered active. A northerly extension of the fault called the Cleveland Hill Fault experienced a low magnitude seismic event on part of its trace located near Oroville, CA in the early 1970s. Although this earthquake was a low magnitude event of about 5.3 because it is part of the Swain Ravine system the entire system is now considered active by the State. To the south within the Bear River drainage this fault system is called the Spenceville Fault Zone.

The 1975 Oroville earthquake on the Cleveland Hill fault suggests that faults within the Foothills Fault System may be active. Faults within the system have been active in the past 100,000 years and activity within the last 10,000 years cannot be precluded. Nevertheless, the Foothills Fault System has not been included within the Alquist-Priolo Earthquake Fault Zoning Act.

The western half of Nevada County contains relatively inactive faults. These inactive fault structures are defined by the California Geological Survey (CGS) as fractures that may have been active several million years ago but have not experienced any relative movement along their structure within the past 2 million years.

In the project area, the three primary fault structures, defined above as sutures between rock masses, are the Idaho Fault, the Weimer Fault (6-3 fault), and the

Morehouse Fault. The Morehouse Fault branches from the Idaho Deformation Corridor in an arc shape and forms the southern contact of the Brunswick Slab. This fault extends in a southeasterly direction to the Weimar Fault therefore also including the Morehouse Fault with the larger Foothill Fault system. This structure crosses under the channel of the South Fork Wolf Creek where physical features located within the channel change drastically. In this area the bedrock becomes blocky with huge angular boulders resting on the ground with a dominant orientation in a northwesterly direction. Structures noted in the underlying bedrock are similar with dips gently sloping towards the northeast.

Two other faults located in the region that have experienced historic seismic events are located to the east of Grass Valley. They include the Dog Valley Fault located about 10 to 30 miles north of Truckee and the Northern & Western segments of the Tahoe Fault. Magnitudes of earthquakes experienced on these structures have been measured around 5.5 and have generated slight to mild ground accelerations across the northern California area.

Within the northerly segment of the Foothills Faults zone the braided network of faults located along the foothill frontal area of the Sierra Nevada from Chico to Merced are together termed the Foothills Fault Zone. In addition, within this northerly segment located north of Auburn, the Melones Fault Zone is defined as a separate structure. In any event both the Foothills Fault Zone and the Melones Fault Zone are capable of generating a 6.5 magnitude earthquake. Therefore, this structural network of faults is capable of generating a ground acceleration of about 0.39 g throughout the area surrounding Grass Valley. Three other structures located easterly of the Melones Fault Zone are also considered capable of generating 6.5 magnitude earthquakes. Their names include the Sulphur Creek Fault, Stampede Fault and the northerly and westerly segments of the Tahoe Fault. Seismic events along these shorter structures would likely generate ground accelerations throughout the Grass Valley area at about 0.2 g (Cal. DMG Open File Report 92-1).

In light of these conditions the site should be considered as being in an region with faults that are capable of producing maximum credible earthquakes up to 6.5 magnitude with peak ground accelerations at the site between 0.35g to 0.4g and these accelerations have a 1 chance in 475 of being exceeded or a 10% chance of being exceeded in 50 years. These hazards do not include ground deformation such as liquefaction, landslides, or surface fault ruptures.

Earthquake Measurement and Intensity

Earthquakes can cause strong ground shaking that may damage property and infrastructure. The severity of ground shaking at any particular point is referred to as intensity, which is a subjective measure of ground shaking effects felt by people and experienced by structures and earth materials. The intensity of shaking generally decreases with distance away from the source of an earthquake. The level of intensity is commonly defined by comparison to the Modified Mercalli Scale, which categorizes the intensity on the basis of observed effects of seismic shaking on people and objects as shown in Table 1 below. The MMI scale has a range of values from I (lowest, not felt by humans) to XII (total damage to manmade improvements and the ability to see seismic waves move on the ground surface).

Quantitative measurements of the level of ground motion during an earthquake are recorded by strong-motion seismographs that measure the ground surface acceleration of objects due to seismic shaking. Strong ground motion is described as motion of sufficient strength to affect people and their environment or any ground movement recorded on a strong motion instrument or seismograph. The most common way to describe ground motion during an earthquake is with the motion parameters of acceleration and velocity in addition to the duration of the shaking. A common measure of ground motion is the peak ground acceleration (PGA). The PGA for a given component of motion is the largest value of horizontal acceleration obtained from a seismograph.

The project is situated in a region that has experienced at least VII on the Modified Mercalli Intensity (MMI) scale. Areas experiencing this intensity of seismic activity typically experience slight to moderate damage in older (masonry) buildings and considerable damage in poorly built or inadequately designed structures. Since 1887, Nevada County and the surrounding area had experienced 25 earthquakes. These events were assigned a Modified Mercalli Scale intensity ranging from minor to moderate. Eleven of the earthquakes were measured at VI and fourteen at VII. Richter scale magnitudes recorded since 1937 ranged between 4.0 and 5.3.

In 1909, two seismic events with a Richter magnitude of 5 to 6 occurred 9 miles northeast of Nevada City or 15 miles from the project site. This location is approximately equal to the location of a segment of the Melones Fault zone. If similar seismic events were to occur in the future, the expected ground accelerations could be expected to range between 0.09g to 0.34g within the study area (Nevada County 1995).

With consideration to the Foothills Fault System and Melones Fault Zone, it is possible that a seismic event capable of shaking the ground surface may occur sometime during the expected life of the project. The Foothills Fault zone and Melones Fault zone are capable of producing a maximum credible earthquake of 6.5 magnitude. If a seismic event were to occur along the Foothills Fault zone, this event could generate around 0.4 to 0.5 PGA in certain locations within the area surrounding Grass Valley (CGS 1992).

A probabilistic seismic hazard (PSH) map shows the predicted level of hazard from earthquakes that seismologists and geologists believe could occur. The PSH analysis takes into consideration uncertainties in the size and location of earthquakes and the resulting ground motions that can affect a particular site. Probabilistic seismic hazard maps indicate that peak ground acceleration in the project area would most likely be between 0.1 to 0.2g PGA.[1]

The seismic risk in Nevada County is considered low because large earthquakes have not occurred in Nevada County and the county is located adjacent to the more tectonically stable northeastern section of California. Nevertheless, Nevada County is located in one of the most seismically active states in the country and therefore, providing the County with a “no seismic risk” status is not possible. Future sources of seismic activity might be related to the stresses of plate tectonics, volcanic activity within the southern portion of the Cascade Range and from regional tectonic activity within the Basin and Range province to the east.

[1] The PSH maps are typically expressed in terms of probability of exceeding a certain ground motion. These maps depict a 10% probability of being exceeded in 50 years. There is a 90% chance that these ground motions will NOT be exceeded. This probability level allows engineers to design buildings for larger ground motions that seismologists think will occur during a 50-year interval, making buildings safer than if there were only designed for the ground motions that are expected to occur in the 50 years. Seismic shaking maps are prepared using consensus information on historical earthquakes and faults. These levels of ground shaking are used primarily for formulating building codes and for designing buildings.

TABLE 1: MODIFIED MERCALLI INTENSITY SCALE

Intensity Value	Intensity Description	Average Peak Acceleration
I	Not felt except by a very few persons under especially favorable circumstances.	< 0.0017 g[a]
II	Felt only by a few persons at rest, especially on upper floors on buildings. Delicately suspended objects may swing.	< 0.014 g
III	Felt noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly, vibration similar to a passing truck. Duration estimated.	< 0.014 g
IV	During the day felt indoors by many, outdoors by few. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.	0.014–0.04 g
V	Felt by nearly everyone, many awakened. Some dishes and windows broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles may be noticed. Pendulum clocks may stop.	0.04–0.09 g
VI	Felt by all, many frightened and run outdoors. Some heavy furniture moved; and fallen plaster or damaged chimneys. Damage slight.	0.09–0.18 g
VII	Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars.	0.18–0.34 g
VIII	Damage slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motor cars disturbed.	0.34–0.65 g
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.	0.65–1.24 g
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from riverbanks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.	> 1.24 g
XI	Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.	> 1.24 g
XII	Damage total. Practically all works of construction are damaged greatly or destroyed. Waves seen on ground surface. Lines of sight and level are distorted. Objects are thrown upward into the air.	> 1.24 g

[a] g (gravity) = 980 centimeters per second squared. 1.0 g of acceleration is a rate of increase in speed equivalent to a car traveling 328 feet from rest in 4.5 seconds.

SOURCE: California Geological Survey, Note 32 (CDMG, 1997b)

Other Potential Geologic Hazards

The local area lacks evidence of recent past volcanic activity including magmatic eruptions of lava, mudflow, and pyroclastics. Recent volcanic activity is lacking, and no swarms of deep to shallow earthquakes have been detected in the region, thus indicating that upward flows of magma are not present. Likewise, any evidence of nearby geothermal activity is absent thus indicating there is no immediate threat to the area by developing vents. Also absent are any mechanisms related to glaciers, elevated wind velocities, and large/fast moving bodies of water. Therefore, the risk of mass wasting of terrain within boundaries of the three sites and immediate surrounding area is minimal to nonexistent.

Mineral Resources

The surface Mining and Reclamation Act of 1975 (SMARA) and its recent amendments require the State of California to inventory and classify selected mineral resources within California. The intent of the Act is to classify the absence or presence of mineral resources within a region, identify the market area of the commodity and estimate future need of the commodity within a geographic area. Areas are classified into Mineral Resource Zones (MRZ) depending on the occurrence and availability of the mineral resource. Classification of these mineral lands does not consider current land use. Once classified, the State Geologist is required to designate those mineral deposits that are significant on a regional and statewide level. Overall, the information is intended to inform local agencies and decision makers regarding the planning and development of lands that contain significant mineral resources.

For the Nevada County area that surrounds the proposed subject project, the California Department of Conservation through its Division of Mines & Geology report titled “Mineral Land Classification of Nevada County, CA” provides the required guidance for MRZ identification and classification. The criteria for establishing zones within the subject area are based on six generalized categories of which four are primary and two are secondary:

MRZ-1 designates areas where available geologic information indicates there is little likelihood for the presence of significant mineral resources;

MRZ-2a designates areas underlain by mineral deposits where geologic data indicate that significant measured or indicated resources are present. As shown on the California Mineral Land Classification Diagram, MRZ2 is divided on the basis of both degree of knowledge and economic factors. Areas classified MRZ-2a contain discovered mineral deposits that are either measured or indicated reserves as determined by such evidence as drilling records, sample analysis, surface exposure, and mine information. Land included in the MRZ-2a category is of prime importance because it contains known economic mineral deposits;

MRZ-2b designates areas underlain be mineral deposits where geologic information indicates that significant inferred resources are present. Areas classified MRZ-2b contain discovered mineral deposits that are either inferred reserves as determined by limited sample analysis, exposure, and past mining history, or are deposits that presently are sub-economic. Further exploration work and/or changes in technology or economics could results in upgrading areas classified MRZ-2b to MRZ-2a;

MRZ-3a designates areas containing known mineral occurrences of undetermined mineral resource significance. Further exploration work within these areas could result in the reclassification of specific localities into MRZ-2a or MRZ-2b categories. MRZ-3 is divided on the basis of knowledge of economic characteristics of the resources;

MRZ-3b designates areas containing inferred mineral occurrences of undetermined mineral resource significance. Land with this classification represents areas in geologic settings that appear to be favorable environments for the occurrence of specific mineral deposits. Further exploration work could result in the reclassification of all or part of these areas into the MRZ-3a category or specific localities into MRZ-2a or MRZ-2b categories; and,

MRZ-4 designates areas of no known mineral occurrences where geologic information does not rule out either the presence or absence of significant mineral resources.

Information and data regarding the mineral classification in the project area is contained in the Special Report 164 outlined above. The project area is classified by the Department of Conservation as MRZ-2b(h-10) and is located within the Grass Valley Northeast Area (lode gold).

The Grass Valley Northeast Area encompasses a complex system of cavity-filling quartz veins that occupy a network of faults and fissures situated between the Grass Valley and Weimar (6-3) faults zones. Historic mines in the area include the Idaho-Maryland mine. Although many veins have been mined to great depth, significant amounts of gold are likely to exist at yet deeper levels. Also, significant gold resources are likely to exist along some sections of the vein system which were previously uneconomic or never explored. The geology, ore deposits, selected mines and the mining history of the Grass valley district have been best described in detail by Johnston (1940). A total of 64 gold veins have been discovered – of those, 62 have been explored. The veins contain native gold in a quartz matrix with minor amounts of other minerals (Nevada County, 1995).

II. Issues of Concern and Recommendations.

The proposed project would consist of construction of numerous large buildings and facilities relating the underground mine plant installations. Based on the conceptual site designs, minor cuts and fills are anticipated to construct roads and building pads.

The following geologic hazards are not present at the site: tsunami and seiche. In addition, the project site is located within a designated Mineral Resource Zones that identify potential mineral resource significance, but this project is proposed to extract those resources for the good and added wealth of society. Thus, mineral resource issues are not expected to occur as a result of the project.

Methodology

Evaluation of geologic and soil conditions at the proposed project was based on review of Soils Reports for the Proposed Idaho-Maryland Mine project. This data base was prepared by Holdrege & Kull in October 2004, USDA Soil Survey of Nevada County, Nevada County Land Use and Development Code Zoning Regulations, and field review of the project site and surrounding area.

Complete Additional Subsurface Investigations

Issue of Concern – 1: Compatible development of the project will depend upon designs based on an adequate amount of information about subsurface characteristics. Proper development and procedures for placement of roadways, streets, buildings, and any septic disposal system(s) (specific to the New Brunswick site) will require appropriate designs based on representative information about subsurface information that can be obtained by geotechnical subsurface field investigations and perc/mantle testing.

In addition, the Idaho-Maryland site can be subdivided into three smaller areas including a main area, southern area, and the southeastern area as based on degrees of existing disturbance. The main area is located in the northwest part of the Idaho-Maryland site and occupies the largest portion of this parcel. This area is proposed to contain the future ceramics plant and a majority of the other proposed manufacturing facilities. Its topography slopes gently to the northwest with slopes ranging from less than 5 percent along the perimeter of the main area to about 25 percent beneath the area proposed for construction of the ceramics plant. The gently sloping area (<5%) appears to have been graded and variable soils and waste rock covers its surface presumably associated with historic hard rock mining. Areas with steeper terrain in the vicinity of the proposed ceramics plant are covered with waste rock in piles up to 10-feet in height. A ditch also crossed this slope in the vicinity of the proposed location for the ceramics plant.

The western part of the central area is relatively flat lying and contains patchy areas of sandy material (likely mill tailings) on the surface. Site elevations range from approximately 2,490 feet above mean sea level (amsl) near the concrete towers to 2,560 feet amsl in the northeastern part of the main area (H&K, 2004).

The western end of a small, west-trending ridge dominates the topography in the southern area of the Idaho-Maryland site. The native soil had been cut from the ridge top and deposited along the edges of the newly formed plateau. A short timbered crib wall retains less than 5 feet of fill on the southern edge of a graded area located immediately north of a dirt access road. The remainder of the property appears in an undisturbed native condition with ground elevations ranging from approximately 2,620 feet amsl on the ridge near the eastern property line to approximately 2,530 feet amsl near the southwest corner of the property. Slopes range from about 2 to 8 percent on the previously graded ridge top area to a steeper 2:1 slope (horizontal to vertical) on land sloping away from the ridge (H&K, 2004).

The southeastern part of the Idaho-Maryland site also contains a graded area, cut slopes, and a steep slope along the easterly side. The southeastern area was relatively flat-lying and characterized by extensive cut and fill operations associated with past lumber milling activities. Several relic foundations associated with the former lumber mill, as well as a concrete slab-on-grade and a pile of large concrete fragments, were noted within the previously graded area. Cut slopes on the east side of the graded area approached 30 feet in height, and steepness of slopes ranges from approximately 1:1 (horizontal to vertical), to near vertical. Significant residual rock structures are exposed in cut slope faces in this area. Elevations range from approximately 2,590 feet amsl on the graded area at the toe of the cut slope to approximately 2,730 feet amsl near the eastern boundary of the property. Slopes are generally less than 10 percent, excluding the natural slope, the cut slope, and a relatively steep fill slope located on the southern end of the historic mill area (H&K, 2004).

Recommendations:

Recommendation 1a: Detailed geotechnical subsurface investigations will be needed by utilizing either a backhoe to dig exploration trenches or hollow-stem-drilling rig to advance test borings into the subsurface across areas of the site with variable soils and surface expressions that indicate chaotic distribution of fill materials in the subsurface environment. Where appropriate, geophysical analysis may be required when assessing location and condition of near surface underground mine workings that may pose a threat of collapse resulting in surface subsidence. Subsurface soils samples should be collected and appropriate geotechnical analytical work on these samples completed to adequately define the characteristics of underlying materials. Investigation of subsurface conditions will be required in all areas where construction of structures is proposed, and particularly on steep hillsides where over-moisturizing of underlying material could generate a high probability of slope failure. Evaluation of subsurface materials and conditions will also be required via completion of perc and mantling testing in areas where a proposed septic disposal system will be placed on the New Brunswick site to serve restroom facilities required for the hoist house building. To ensure the proposed disposal system will work properly over the expected life of the project (25 plus years) subsurface hydrogeologic conditions and capacities must be determined. Also, parameters related to slope stability and failure in high bank fill areas must be defined quantitatively.

As part of improvement plans, the project applicant shall include engineering details and methods that ensure stable slope conditions on the site during and after construction. No slope, either fill or cut slope will be steeper than 2:1 (horizontal to vertical) unless otherwise stated as appropriate by a qualified licensed professional.

Field investigations, sampling and laboratory testing of samples will assist geotechnical evaluations of subsurface materials in areas where other types of improvements are proposed. The bearing capacities of earth materials beneath roadways and building will be required for adequate foundation design. Where unsuitable materials prone to expansion or consolidation are located, these materials may be conditioned or removed and replaced with materials more suitable for future structures. If retaining walls or road cuts are proposed, then future investigations must provide the required information needed for their design.

Timing/Implementation: Prior to issuance of grading permits.

Enforcement/Monitoring: Nevada County Department of Transportation and Sanitation and Building Department; City of Grass valley Department of Engineering

Recommendation 1b: The project applicant shall submit an erosion control plan to the County for approval pursuant to Chapter XV of the Nevada County Land Use and Development Code Zoning Regulations for the New Brunswick site and to the City Department of Engineering for Idaho-Maryland and Round Hole sites. Both local agencies shall review the erosion control plan prior to the issuance of a grading permit. Erosion control measures will include techniques such as physical and vegetative stabilization measures and runoff diversion measures. Additionally the plan will specify measures for reuse or disposal of excavated materials. If excavated material is suitable for use at the project site, the plan shall minimize the elapsed time between excavation and reuse and provide adequate stockpile coverage and protection from wind and water erosion during the entire storage period. If excavated material is unsuitable for reuse at the project site, the plan will include specific information regarding the eventual reuse or disposal site, transportation methods, disposal reuse management, and schedule. The erosion control plan will be in conformance with County standards and standards of the Nevada County Resource Conservation District and City guidelines.

The project applicant shall stabilize grading areas left unprotected during the rainy season, as specified by County standards set forth in County's Land Use and Development Code Zoning Regulation (Chapter XV). Stabilization measures may include National Pollutant Discharge Elimination System (NPDES) Construction

Activities, best management practices such as hydroseeding, geotextiles and mats, and straw bales or sand bag barriers. The City shall be the monitoring agency and the erosion control plan should be issued to relevant agencies prior to issuance of grading permits. In addition, appropriate perc/mantling testing should be performed to ensure design of future septic systems are completed per local County standards.

Implementation of the above recommendations would mitigate potential effects from erosion and failures of the septic system. This information and its use during design, construction and operation of the mine plant facilities will help mitigate any potential issues to less than significant.

Naturally Occurring Asbestos

Issue of Concern – 2: Driving over existing dirt roads, trenching, grading, and other excavations could expose zones of asbestos containing rock and possibly cause airborne releases of fibrous minerals.

Asbestiform minerals may be encountered in areas of the site identified as ultramafic rocks in veins or veinlets in portions of the ultramafic rock on site. Land disturbance activities are expected to occur in the ultramafic areas, and disturbance of fibrous minerals within these rocks may result in dust containing potentially harmful asbestos fibers if inhaled over extended periods.

Recommendations

Recommendation 2a: Before issuance of grading permits, the project applicant shall determine if asbestiform minerals are present. If present the applicant shall prepare and submit to Nevada County Public Works Department and Environmental Health Department for review and approval an Asbestos Hazard Dust Mitigation Plan. The Asbestos Hazard Dust Mitigation Plan shall include practices to eliminate, to the greatest extent possible, the emission of fugitive dust from grading, excavation, and construction activity in order to protect workers and area residents. These practices may include, but are not limited to the following:

- Pre-wet work area and immediately follow with fine spray application preferably on the immediate area being worked to eliminate visible dust to the greatest extent possible.

- Limit vehicle access and speed on exposed serpentine and rock containing asbestos material areas to reduce fiber releases.

- Cover areas exposed to vehicle travel with non-asbestos cover material.

- Maintain a high moisture condition of the disturbed surface or treat the disturbed surface of the work area with an approved “palliative” material to seal loose fibers together to the parent rock particle. Dust palliatives, such as lignin sulfonate, magnesium chloride, pitch, rosin and polymer emulsions, can be effectively utilized in a variety of applications.

- Material transfers or stockpiles of loose material shall be kept adequately wet, and sealed by a palliative or covered where conditions warrant.
- Provide employee notification of potential health risk of airborne asbestos and the requirements of the asbestos dust mitigation plan.
- Worker safety precautions and exposure monitoring shall be considered, but may not specifically be required in all cases. Other relevant regulations from the County and State agencies may also be used when applicable according to their provisions.
- Air monitoring shall be performed both upwind (background) and downwind and in close proximity to the excavation to detect significant concentrations of asbestos fibers. Construction activities shall be stopped and additional dust control measures shall be implemented if excessive asbestos levels are detected based on agency consultations.

Recommendation 2b: Prior to commencement of project grading and construction activities, any asbestos containing serpentine road base on existing roads shall be left in place but covered with a clean “Oil and Chip” capping or shall be paved over with an asphaltic concrete. Implementation of this recommendation would minimize the amount of asbestos fiber emissions into the atmosphere during grading and construction, and reduce exposure of construction workers to asbestos.

Soil Erosion and Ground Stability

Issue of Concern – 3: Development of the project would include minor grading over large areas of land that could result in ground instability and soil erosion.

Development at the proposed project would include grading of the site, including areas on moderate to steep slopes. Construction of the future building and mine plant facilities would also result in potential increased in soil erosion rates. Construction activities could result in sedimentation of Wolf Creek and adjoining waterways.

In addition there is a known short drift called the 70 foot level tunnel that trends in a southeasterly direction from the Old Brunswick shaft towards an area characterized with topography that includes a deeply etched ravine situated along a portion of the north side of Bennett Street. This area is surrounded by Well Numbers 80, 120, 122 and 242 as outlined on Figure A-1 (Todd Engineering 2007).

Although this tunnel is named the 70 foot level drift its vertical distance from the ground surface is not a vertical 70 feet because lateral tunnels connected to this shaft are label by their slope distance down centerline of the declined shaft instead of their vertical distance from ground surface. Because the shaft slopes at an angle of about 50 degrees to the horizontal in a southeast direction the maximum vertical distance between top of tunnel to the ground surface is likely to be about 54 feet in the area adjacent to the portal of the shaft. Therefore, in the area beneath the ravine the vertical distance may be as little as 20 feet because the elevation of the terrain decreases substantially in the same area where portions of the tunnel are located.

Recommendations

See Recommendations 1a and 1b For Ground Instability and Soil Erosion Issues.

Recommendation 3: Because of the close proximity of the tunnel to the ground surface, subsidence may be a risk, particularly if structures will be located over this shaft or if the shaft is to be enlarged. In either case, an engineering geologist should conduct a detailed investigation to determine the need for and type of appropriate actions to prevent subsidence in the area over the top of the tunnel in the event development is intended at the ground surface over the top of the tunnel.

IV. Signatures and Certifications

Information contained within this technical memorandum reflects the professional opinions of GeoSolutions, and was developed in accordance with currently available information and accepted geologic practices at this time for this subject project. This report has been prepared solely for the use of ESA and its client, the City of Grass Valley. Any reliance on this report by parties other than ESA and the City of Grass Valley shall be at such parties' sole risk.

The work described in this report was conducted under the direct supervision of the registered professional geologist, certified engineering geologist, certified hydrogeologist, and registered environmental assessor with the State of California, whose signature appears below.

GeoSolutions

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