F. GEOLOGY, SOILS AND SEISMICITY

This section describes the Truckee Railyard Draft Master Plan Project's (project) geologic environment based on a site reconnaissance, published and unpublished regional geologic reports and maps, and site-specific technical reports. In addition, this section assesses potential impacts from seismically-induced fault rupture, strong ground shaking, liquefaction, slope failure, lateral slope deformation, differential settlement and unstable or expansive soils. Mitigation measures for the identified significant impacts are provided, as feasible and appropriate.

1. Setting

This section describes the existing geologic and seismic conditions of the project and the vicinity and associated hazards.

a. Geologic Conditions. The geology, topography and soils of the Plan Area and vicinity are described below.

(1) Geology. The Plan Area is located in the east-central portion of the Sierra Nevada Geomorphic Province of Northern California, which is part of a relatively geologically young and seismically-active region on the western portion of the North American plate. The Sierra Nevada Mountains were formed by large intrusions of molten granitic rock, and subsequent faulting and volcanic activity raised the range to its current position.[1] The Sierra Nevada Geomorphic Province is a relatively narrow, northwest trending, approximately 400-mile-long tilted fault block. The western margin of the province originates under the sediments of California's Great Valley province. The block rises to the east with an average slope of approximately 2 percent to form the western face of the Sierra Nevada Mountains. Because of the tilted nature of the block the eastern face is more abrupt and comprised largely of rugged steep scarps which front the Basin and Range province to the east of northern Nevada.[2]

More specifically, the site is located within the Truckee River Basin in the Martis Valley. The geology of the Truckee area is dominated by volcanic rocks while the floor of the valley is layered in glacial till and outwash from the repeated cycles of Sierra Nevada glacial ice fields spilling over into the Donner Lake and Truckee area. In the area of the project, this glacial till and outwash consist of silty sandy gravels and gravelly sand with cobbles and boulders. Locally, areas near the historic Trout Creek alignment were underlain by 1 to 3 feet of clay of alluvial or flood deposit origin, which included areas with high percentages of organic materials.[3] As part of the research for the site-specific geotechnical report for the original

[1] Norris, Robert M., Webb, Robert W., 1990, *Geology of California, 2nd Edition*, Wiley.

[2] California Geographic Survey (CGS), 2002, California Geomorphic Provinces, Note 36.

[3] Treadwell & Rollo, 2003, Preliminary Geotechnical Report, River Street Property, Truckee, CA, Project No. 3822.01.

western-most portion of the Plan Area, 21 individual test pits, ranging from 1.5 to 10.5 feet in depth, were excavated at the Plan Area. In addition, the excavation of seven additional pits inside of the current balloon track conducted for the 2006 investigation by Broadbent and Associates to evaluate soils and water for contamination from past land uses for the site were also excavated and logged. In general, the various test pits revealed 1 to 4 feet of existing non-engineered silty-sandy fill at the site which included debris, asphalt, wood and organic materials. Underlying the surficial fill, the observed geologic materials were found to be glacial till, as described above.[4]

(2) Topography. The approximately 75-acre Plan Area is located just east of the Town of Truckee's historic Downtown area. The site slopes approximately 1.5 percent to the east from an elevation of approximately 5,820 feet National Geodetic Vertical Datum (NGVD) near Bridge Street to 5,765 feet at the east end of the Plan Area.[5] The exception would be the hillside above Trout Creek which rises to approximately 5,920 feet above where the proposed Glenshire Drive realignment would be placed. Railroad operations at the Plan Area started around 1860 and Trout Creek was redirected from its original north to south channel in central Truckee to a west to east channel to facilitate rail and lumber operations. Trout Creek was moved again in the 1950s to its current location in an incised channel approximately 6 to 12 feet in depth near the north edge of the Plan Area.[6] The Truckee River is approximately 200 feet south of, and parallel to, the southern boundary of the Plan Area.

Generally, the area surrounding the Plan Area is characterized by gently rolling hills with some steeper hills rising to the north and northeast.[7] At least three volcanic "plugs"[8] rise out of the relatively flat-lying deposits in the vicinity of the Plan Area; at the northeast corner of the existing balloon track, the corner of Church Street and Donner Pass Road and just south of the site near the railroad tracks.[9] The tops of these erosion-resistant volcanic features are approximately 5 to 15 feet above the surrounding grade. More of these volcanic plugs may occur just under the surface.

(3) Soils. Surface soils at the Plan Area are mapped by the Natural Resource Conservation Service as Inville-Riverwash-Aquolls complex and Martis-Euer Variant complex. These soils are rated as "low" for shrink swell potential and "moderate to high" for corrosivity to concrete and steel. They are generally coarse-grained soils with cobbles and well drained, with the exception of the Aquolls type, which forms in swamp-like

[4] Holdrege & Kull, 2006, op. cit.

[5] United States Geological Survey (USGS), 1992, *Truckee Quadrangle,* 7.5' USGS Topographic Map.

[6] Holdrege & Kull, 2006, op. cit.

[7] USGS, 1992, op. cit.

[8] A volcanic plug, also called a volcanic neck or lava neck, is a volcanic landform created when lava hardens within a vent on an active volcano.

[9] Holdrege & Kull, 2006, op. cit.

environments. The Aquolls soil type is present in approximately 9 acres toward the west end of the site and is finer grained with higher clay content than the other soils present.[10]

b. Seismic Conditions. The regional and site-specific seismic conditions are described below.

(1) Regional Seismicity. Truckee is located towards the eastern edge of the Sierra Nevada Mountains and is subject to the ground motion and seismic activity of both western Nevada and eastern California. Sub-region areas have been named based on similar geology and related seismicity; these include the East California Seismic Zone, Walker Lane Belt (roughly a broad band of western Nevada paralleling the shared border with California), and the Central Nevada Seismic Zone. The movements of the North American and Pacific lithospheric plates relative to one another result in the accumulation of strain along the faults which is released during earthquakes. Up to approximately 25 percent of the relative plate motion between the North American and Pacific plates is accommodated across this region, with most of that by active faults in the Walker Lane Belt.[11] Regionally, most of the past seismic activity in the area has occurred along the Sierra Nevada frontal fault zone at the edge of the Walker Lane Belt; that area about 19 miles east of the Plan Area where the Sierra Nevada Geomorphic province meets the Basin and Range province.

(2) Site-Specific Seismicity. The California State Mining and Geology Board define an "active fault" as one that has had surface displacement within the last 11,000 thousand years (Holocene). Potentially active faults are defined as those that have ruptured between 11,000 thousand and 1.6 million years ago (Quaternary). If a fault has not shown activity within this time, it is generically considered inactive.[12] The primary faults in the vicinity of the Plan Area are the Mohawk Valley Fault, the southern section of which lies approximately 20 miles northwest of Truckee in Sierra County, and the Dog Valley (Steadman) Fault, which extends from Dog Valley (approximately 20 miles northeast of Truckee) southwest to near Donner Lake (Figure IV.F-1). The Town of Truckee General Plan notes that a seismic event on the Dog Valley fault or Mohawk Valley fault would result in a maximum credible

[10] Natural Resources Conservation Service (NRCS), 2007, Web Soils Survey, accessed 9/27/07 at: U.S. Department of Agriculture (USDA).

[11] Louie, John N., et al., 2004, The Northern Walker Lane Refraction Experiment: Pn Arrivals and the Northern Sierra Nevada root, as published in Tectonophysics #388.

[12] California Geological Survey, Interim Revision 2007, Special Publication 42: Fault-Rupture Hazard Zones in California. Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zones Maps, Dept. of Conservation.

earthquake of 6.75 and 7.0 magnitude respectively.[13] Truckee has been subject to noticeable seismicity in recent years, including a magnitude 6.0 to 6.5 earthquake in 1966, a magnitude 3.6 earthquake in 1998, and a magnitude 4.5 earthquake, centered 6 miles south of Truckee, in June, 2004.[14] There are no known active faults crossing the Plan Area[15] and none of the faults in the vicinity of the site have been determined by the California Geological Survey under the Alquist-Priolo Earthquake Fault Zoning Act (A-PEFZA) to be "active" (i.e., to have evidence of fault rupture in the past 11,000 years). Figure SAF-1 of the General Plan shows the location of known earthquake faults and epicenters in Nevada County. The Plan Area vicinity has not been included (and is not yet scheduled to be included) in the State of California Seismic Hazards Mapping Act, which maps liquefaction and slope stability hazards for particular areas of California.[16]

c. Seismic and Geologic Hazards. Seismic and geologic hazards relevant to the Plan Area are described below.

(1) Surface Rupture. Surface rupture occurs when the ground surface is broken due to fault movement during an earthquake. The location of surface rupture generally can be assumed to be along an active or potentially active major fault trace. No A-PEFZA-active faults have been mapped at or in the vicinity of the Plan Area. Discussions of recent earthquake events and fault structure in the region do not note the presence of active faults in the town of Truckee.[17,18,19] No portion of the site is located within an Alquist-Priolo Earthquake Fault Zone, as a result, the potential for fault rupture at the site is low.

(2) Ground Shaking. Ground shaking is a general term referring to all aspects of motion of the earth's surface resulting from an earthquake, and is normally the major cause of damage in seismic events. The extent of ground shaking is controlled by the magnitude and intensity of the earthquake, distance from the epicenter, and local geologic conditions. The Modified Mercalli Intensity Scale (MMI) is the most commonly used scale for measurement of the subjective effects of earthquake intensity (Table IV.F-1). A related concept,

[13] Town of Truckee, 2007, General *Plan* 2025.

[14] California Integrated Seismic Network, 2008, *Earthquake Lists,* accessed at: http://www.cisn.org/.

[15] Town of Truckee, 2007, op. cit.

[16] California Department of Conservation (CDC), 2002, *Seismic Hazard Zones Maps.*

[17] Town of Truckee, 2007, op. cit.

[18] Ichinose, Gene A., et al., 1997, Source Parameters of the 15 November 1995 Border Town, Nevada, Earthquake Sequence, Bulletin Seismological Society of America, Vol. 87, No. 3, June. See: http://www.seismo.unr.edu/htdocs/WGB/BorderTown95/Regional.html.

[19] Stover, Carl W., Coffman, Jerry L., 1993, Seismicity of the United States, 1568-1989 (Revised), USGS PP 1527.

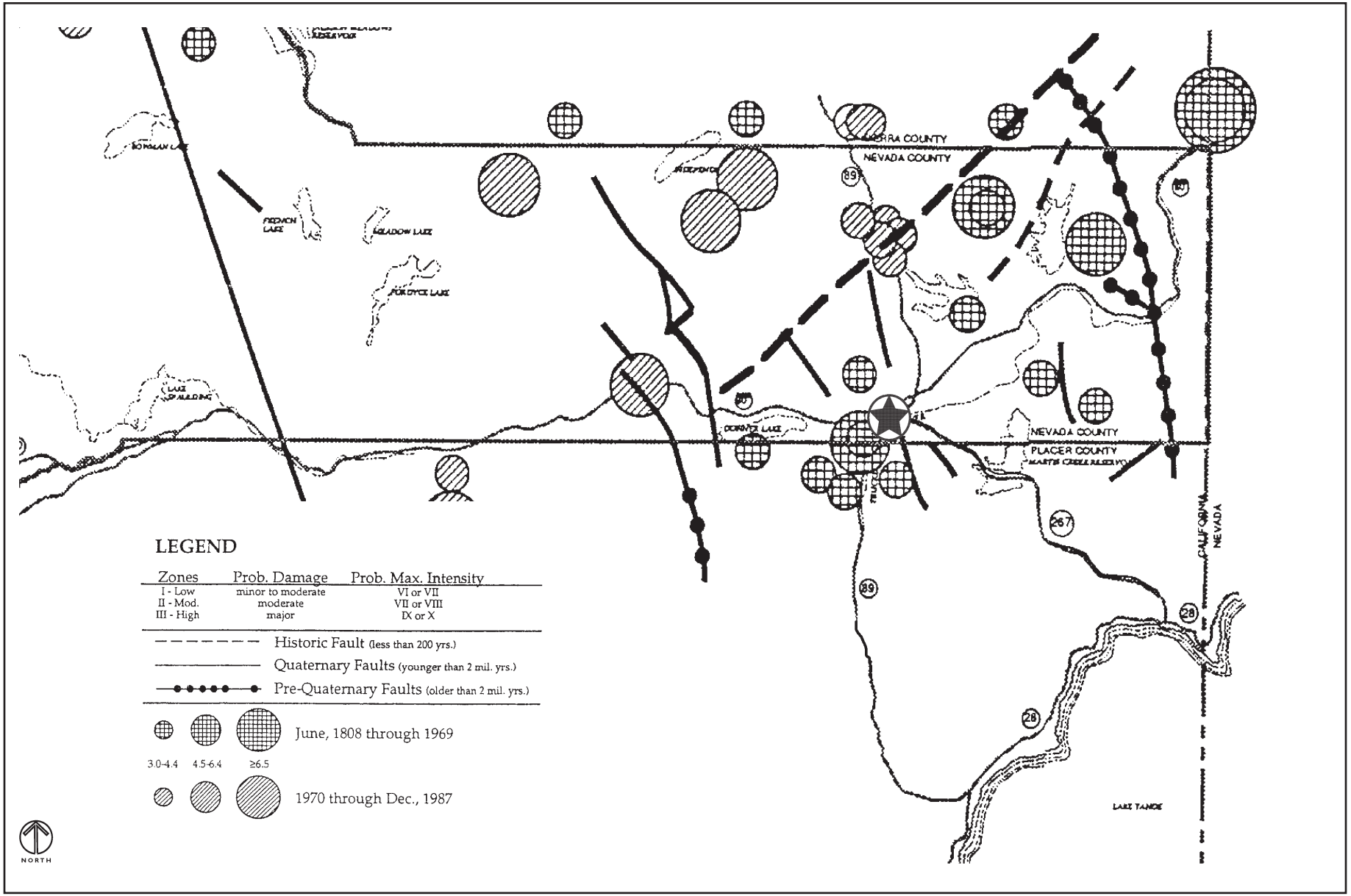

FIGURE IV.F-1

Truckee Railyard Master Plan EIR

Earthquake Faults and Seismic Activity in Nevada County

SOURCE: NEVADA COUNTY GENERAL PLAN MASTER ENVIRONMENTAL ASSESSMENT

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acceleration, is measured as a fraction or percentage of the acceleration under gravity (g). The maximum credible earthquake for the Dog Valley Fault and Mohawk Valley Faults are 6.75 and 7.0 magnitude respectively. Either of these events would generate very strong seismic shaking (MMI VIII) at the Plan Area.[20]

(3) Peak Acceleration. Estimates of the peak ground acceleration from earthquakes have been made for the Plan Area based on probabilistic models that account for multiple seismic sources. Under these models, consideration of the probability of expected seismic events is incorporated into the determination of the level of ground shaking at a particular location. The expected peak horizontal acceleration (with a 10 percent chance of being exceeded in the next 50 years) generated by any of the seismic sources potentially affecting the Truckee vicinity, including the Plan Area, is estimated by the California Geological Survey as 0.33.[21] This level of ground acceleration at the Plan Area is a potentially significant hazard.

(4) Liquefaction and Lateral Spreading. Liquefaction is the temporary transformation of loose, saturated granular sediments from a solid state to a liquefied state as a result of seismic ground shaking. In the process, the soil undergoes transient loss of strength, which commonly causes ground displacement or ground failure to occur. Since saturated soils are a necessary condition for liquefaction, soil layers in areas where the groundwater table is near the surface have higher liquefaction potential than those in which the water table is located at greater depths.

Lateral spreading is a form of horizontal displacement of soil toward an open channel or other "free" face, such as an excavation boundary. Lateral spreading can result from either the slump of low cohesion unconsolidated material or more commonly by liquefaction of either the soil layer or a subsurface layer underlying soil material on a slope.[22] Earthquake shaking leading to liquefaction of saturated soil can result in lateral spreading where the soil undergoes a temporary loss of strength. The lateral spreading hazard will tend to mirror the liquefaction hazard for the project, and by definition needs an open channel or "free" face to expand into; this can include temporary excavations resulting from the construction process.

[20] USGS, 2008, Earthquake Hazards Program, ShakeMaps, accessed 2/11/08 at: earthquake.usgs.gov.

[21] California Geological Survey (CGS), 2006, *Probabilistic Seismic Hazards Mapping Ground Motion Page*, accessed 11 February 2008, www.consrv.ca.gov/cgs/rghm/pshamap/pshamain.html.

[22] Rauch, Alan F., 1997, EPOLLS: An Empirical Method for Predicting Surface Displacements due to Liquefaction-Induced Lateral Spreading in Earthquakes, Ph. D. Dissertation, Virginia Tech, Blacksburg, VA.

Table IV.F-1 Modified Mercalli Scale

I	Not felt except by a very few under especially favorable circumstances.
II	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
III	Felt quite 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 like passing of truck. Duration estimated.
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.
V	Felt by nearly everyone, many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.
VI	Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.
VII	Everybody runs outdoors. Damage negligible in building 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.
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.
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.
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.
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.
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.

Source: California Geological Survey, 2002, How Earthquakes and Their Effects are Measured.

A site-specific preliminary geotechnical investigation included test pits at the site and review of previously prepared boring logs. The pits were excavated during December 2003 and ground water was found as shallow as 3 feet below ground surface. Generally, 2 to 4 feet of non-engineered fill was found to overlie dense glacial moraine deposits consisting of boulders, cobbles, gravel and silt. The sub-surface materials were evaluated for liquefaction potential, and based on the characteristics of the sub-surface materials, the investigation determined the liquefaction and lateral spreading potential at the site to be low.[23]

(5) Expansive Soils. Expansion and contraction of volume can occur when expansive soils undergo alternating cycles of wetting (swelling) and drying (shrinking). During these cycles, the volume of the soil changes markedly. As a consequence of such volume changes, structural damage to building and infrastructure may occur if the potentially expansive soils were not considered in project design and during construction. Surface soils at the Plan Area are mapped as Inville-Riverwash-Aquolls complex and Martis-Euer Variant complex. These soils are rated as low for shrink swell potential.[24]

(6) Slope Stability. Slope failure can occur as either rapid movement of large masses of soil ("landslide") or slow, continuous movement ("creep"). The primary factors influencing the stability of a slope are: 1) the nature of the underlying soil or bedrock, 2) the geometry of the slope (height and steepness), 3) rainfall, and 4) the presence of previous landslide deposits. The Plan Area is nearly flat and located in on a large glacial moraine plain. Due to the lack of moderate to steep slopes at the Plan Area, slope stability hazards are low. Adjacent areas to the north, across Trout Creek, are upslope and in places have significant slope; however, with the exception of the Glenshire Drive realignment, these areas are not expected to affect the Plan Area because the slopes rise beyond the site boundary and are on the opposite site of Trout Creek.

(7) Settlement and Differential Settlement. Differential settlement or subsidence could occur if buildings or other improvements were built on low-strength foundation materials (including imported fill) or if improvements straddle the boundary between different types of subsurface materials (e.g., a boundary between native material and fill). Although differential settlement generally occurs slowly enough that its effects are not dangerous to inhabitants, it can cause significant building damage over time. Portions of the Plan Area that may contain loose or uncontrolled (non-engineered) fill could be susceptible to differential settlement. Truckee was first settled in the latter half of the 1800's, and Plan Area development (and associated ground disturbance and fill placement) has been occurring since at least the early 1900s.[25] Several underground storage tanks have been operated and subsequently removed from the Plan Area (see the Hazardous Materials

[23] Treadwell & Rollo, 2003, op cit.

[24] USDA, 1968, op. cit.

[25] , Coates, Guy H., undated. *History of Truckee Area,* Truckee Donner Historical Society. Website: truckeehistory.org/history2.htm.

section of this EIR for further details). The backfill of these tank excavations potentially adjacent to old fill and/or native soils may pose a risk of settlement or differential settlement.

d. Regulatory Framework. State and local regulations related to geology, soils and seismicity are described below.

(1) California Building Code. The Uniform Building Code (UBC) is published by the International Conference of Building Officials (ICBO), and is the widely adopted model building code in the United States. The California Building Code (CBC) is another name for the body of regulations known as the California Code of Regulations (CCR), Title 24, Part 2, which is a portion of the California Building Standards Code (CBSC). The CBC incorporates by reference the UBC with necessary California amendments. Title 24 is assigned to the California Building Standards Commission, which, by law, is responsible for coordinating all building standards. Under State law, all building standards must be centralized in Title 24 or they are not enforceable.

The Plan Area is expected to experience earthquake ground shaking and therefore has stringent requirements for seismic design. The national model code standards adopted into Title 24 apply to all occupancies in California, except for modifications adopted by state agencies and local governing bodies. The Town of Truckee adopted the 2007 Edition California Building Code Building Codes effective January 1, 2008. Seismic Design requirements are as detailed in CBC Section 1613 and ASCE 7-05 Chapter 11. Foundation and soils investigation reports are normally required (CBC 1802.2).

(2) 2025 General Plan Policies: Safety Element.[26] All construction in Truckee (with limited exceptions) must comply with the Uniform Building Code (UBC), which specifies requirements for seismic design, foundations and drainage systems, among other aspects. The following are policies from the Town's General Plan relevant to geology, soils and seismicity.

> **Goal SAF-1:** Reduce the risk of injury, loss of life and property damage from earthquakes, landslides and other geologic hazards.
>
> **Policies**
> P1.1: Group and locate new residential development in such a way as to avoid areas of hazard including steep slopes and areas of unstable soils.
>
> P1.2: Encourage retrofitting of structures, particularly older buildings, to withstand earthquake shaking and landslides. Ensure that new development incorporates design and engineering that minimizes the risk of damage from seismic events and land sliding.

[26] Town of Truckee, 2007, General *Plan* 2025.

P1.3: Require soils reports for new development in areas where geologic risks are known to exist. Such reports should include recommendations for appropriate engineering and other measures to address identified risks.

1997 Downtown Specific Plan (DSA).

Policy: Erosion Natural Hazard
7H.1: New development shall be clustered away from slopes in excess of 25 percent. New development on all slopes in excess of 15 percent shall have a site specific review of soil type, vegetation, drainage, slope and building placement to determine proper site design.

2. Relevant Railyard Draft Master Plan Policies

The Draft Master Plan does not include specific polices related to geology, soils and seismicity.

3. Impacts and Mitigation Measures

This section analyzes the impacts related to geology, soils and seismicity that could result from implementation of the Draft Master Plan. The subsection begins with criteria of significance, which establishes the thresholds for determining whether a project impact is significant. The latter part of this section presents the potential impacts and recommends mitigation measures as appropriate.

a. Criteria of Significance. The proposed project would result in a significant geologic, soils or seismic impact if it would have any of the following effects:

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
  - Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault.
  - Strong seismic ground shaking.
  - Seismic-related ground failure, including liquefaction.
  - Landslides.
- Result in substantial soil erosion or the loss of topsoil.
- Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.
- Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property.

- Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water.

The significance criteria identified above are based on Section 15065 and Appendix G of the CEQA Guidelines.

b. Less-Than-Significant Geology, Soils and Seismicity Impacts. The proposed project would not be expected to expose people or structures to substantial risk of loss, injury or death from rupture of a known earthquake fault as delineated by the State Geologist, as the site is not located within an active or potentially active fault zone as defined by the A-PEFZA. The proposed project is not located on an unstable geologic unit, the development of which would be subject to, or contribute to, on- or off-site fault rupture, landslide, or subsidence.

The site is served by Truckee Sanitary District sanitary sewer system and onsite wastewater disposal systems are not proposed as part of the project. Therefore, potential on-site impacts associated with wastewater disposal would not be applicable. Further discussion of wastewater management is included in the Utilities section of this EIR. Potential impacts associated with erosion and loss of topsoil is discussed in Section IV.G, Hydrology and Water Quality, of this EIR.

The sub-surface materials of the Plan Area are glacial moraine deposits mixed with limited amounts of organic material and clays and sands. Based on boring logs and observation of site-specific materials in test pits, the preliminary geotechnical investigation determined that the liquefaction hazard at the site is low. Therefore, potential impacts related to liquefaction would be less-than-significant.

The Plan Area soils and sub-surface layers have a low shrink-swell potential and therefore potential impacts associated with expansive soils to the proposed project improvements would be less than significant. Subsidence and collapse of surface materials may result from sub-surface mining and/or over-pumping of groundwater or petroleum resources. No historic subsurface mining activities have been identified at the Plan Area and the proposed project does not propose mining. Similarly, no historic oil or gas extraction has been identified to occur at the site. Groundwater in the area of Martis Valley is withdrawn for municipal use, however, the Truckee Donner Public Utilities District monitors the rate of withdrawal and based on recent studies has concluded that the area is not subject to overdrafting.[27,28] Subsidence and/or collapse hazards at the site would be less than significant.

[27] California Department of Water Resources, 2006, California's Groundwater Bulletin 118, North Lahontan Hydrologic Region, Martis Valley Groundwater Basin: Technical Bulleting, 20 January.

[28] Nimbus Engineers, 2001, Ground Water Availability in the Martis Valley Ground Water Basin.

c. Significant Geology, Soils and Seismicity Impacts. The following two potentially significant impacts associated with the project have been identified.

Impact GEO-1: Seismically-induced ground shaking at the project could result in damage to life and/or property. (S)

All structures in California could potentially be affected by ground shaking in the event of an earthquake along regional or locally active faults. The amount of ground shaking depends on the magnitude of the earthquake, the distance from the epicenter, and the type of earth materials in between. Very strong ground shaking is expected at the Plan Area during expected earthquakes on the Mohawk Valley or Dog Valley (Steadman) faults or other regional faults. This level of seismic shaking could cause extensive non-structural damage in buildings at the site. In addition, limited structural damage may occur.

Mitigation Measure GEO-1: Prior to the issuance of any site-specific grading or building permits, a design-level geotechnical investigation shall be prepared by a licensed professional and submitted to the Town of Truckee Building and Safety Division for review and confirmation that the proposed development fully complies with the California Building Code of 2007 or latest version in effect. Compliance with the 2007 California Building Code (CBC) requires that (with very limited exceptions) structures for human occupancy be designed and constructed to resist the effects of earthquake motions. The Seismic Design Category for a structure is determined in accordance with either; CBC Section 1613 - Earthquake Loads or American Society of Civil Engineers (ASCE) Standard No. 7-05, Minimum Design Loads for Buildings and Other Structures. In brief, based on the engineering properties and soil-type of soils at a proposed site, the site is assigned a Site Class ranging from A to F. The Site Class is then combined with Spectral Response (ground acceleration induced by earthquake) information for the location to arrive at a Seismic Design Category ranging from A to D; D being the most severe conditions. The classification of the site and related calculations must be determined by a qualified person and are site-specific. The report shall describe the Plan Area's geotechnical conditions and address potential seismic hazards, such as seismically-induced shaking. The report shall identify building techniques appropriate to minimize seismic damage. In addition, the analysis presented in the geotechnical report shall conform to the California Division of Mines and Geology recommendations presented in the *Guidelines for Evaluating Seismic Hazards in California*.[29]

All mitigation measures, design criteria, and specifications set forth in the geotechnical and any required soils reports shall be followed. Compliance with the investigation, design and engineering requirements as set forth by the Town of Truckee and the latest version of the CBC will serve to minimize the hazards presented by seismic shaking at

[29] California Division of Mines and Geology (CDMG), 1997, *Guidelines for Evaluating Seismic Hazards in California*, CDMG Special Publication 117, 74 p.

the Plan Area. Exposure to seismic hazards is a generally accepted part of living in California and therefore the mitigation measure described above reduces the potential hazards associated with seismic activity to a less-than-significant level. (LTS)

Impact GEO-2: Structures or property at the project could be adversely affected by settlement or differential settlement of project soils. (S)

Structural damage, warping, and cracking of roads and other infrastructure, and rupture of utility lines may occur if the nature of the imported fill is not considered during design and construction of improvements. This condition could significantly damage structures and utilities. In addition, non-uniformly compacted imported fill was placed previously at the site, and could experience settlements under new structural loads.

Frost heave is a phenomenon where subsurface water, either as lenses (subsurface puddles), or saturating soil expands as it freezes and can lift and weaken pavements and foundations.[30] Given a frost-susceptible soil and a sufficiently cold environment, the availability of water is the most influential factor controlling frost heave in pavement structures. In particular, the depth of the water table below the freezing front determines to a large degree the availability of new water that can be absorbed by freezing pavement layers.[31] The preliminary geotechnical investigation recommends that the base of foundations at the site be at least 24 inches below the lowest adjacent finished grade, in order to be below the depth of typical frost penetration for the area.[32]

Grading of the Plan Area in preparation for construction of buildings and utilities may result in areas of cut and fill. Areas of newer fill exist on the site related to the removal of former underground storage tanks. In addition, the demolition of current structures along with their foundations and excavation and removal of subsurface components may result in areas containing fills of irregular depths. Fills of different thickness and fills adjacent to cut areas where native soils are exposed at the surface could create the potential for differential settlement. If the settlement is not uniform, structural damage could occur. Buried utilities may also experience differential settlement along their alignments.

Mitigation Measure GEO-2: In locations underlain by non-engineered fill, the designers of building foundations and other improvements (including the sidewalks, roads, and underground utilities) shall consider these conditions. The design-level geotechnical investigation and soils investigation, to be prepared by licensed professionals and approved by the Town of Truckee Division of Building and Safety, shall include measures

[30] American Society for Testing and Materials (ASTM) D5918 - 06 Standard Test Methods for Frost Heave and Thaw Weakening Susceptibility of Soils

[31] Cold Regions Science and Technology, Volume 43, Issue 3, December 2005, Pages 128-139, Åke Hermansson and W. Spencer Guthrie

[32] Treadwell & Rollo, 2003, op cit.

to ensure potential damages related to non-uniformly compacted fill are minimized. Mitigation options may range from removal of the problematic soils and replacement, as needed, with properly conditioned and compacted fill to design and construction of improvements to withstand the forces exerted during the expected winter weather cycles and settlements. Additionally, site conditions shall be evaluated for frost heave potential and site-specific recommendations formulated to minimize impacts due to freezing and thawing cycles.

All mitigation measures, design criteria, and specifications set forth in the geotechnical and soils report shall be followed to reduce impacts associated with settlement and differential settlement to a less-than-significant level. (LTS)

Impact GEO-3: Glenshire Drive improvements of the proposed project could be adversely affected by slope stability impacts. (S)

In general, the site is relatively flat and not prone to slope stability issues; nor is it adjacent to steep slopes where failure is likely to affect improvements, with the exception of the realignment of Glenshire Drive. The hillside behind the current Glenshire Drive alignment rises from an elevation of approximately 5,840 feet NGVD at an approximately 30-percent slope before again flattening out at an elevation of about 6,000 feet NGVD. The proposed movement of the balloon track will require that Glenshire Drive is realigned in a curve around the new balloon track location. This will require that Glenshire Drive be moved into the relatively steep hillside immediately north of its current location. The necessary road cut and reshaping of the adjacent slopes could result in over-steepening of the slope above the site and potentially lead to slope stability issues, slope failure, landslide and road blockage.

Mitigation Measure GEO-3: Where slope cuts may be necessary to accommodate the realignment of local roads, the designers of road improvements shall consider slope stability conditions. The design-level geotechnical investigation and soils investigation, to be prepared by licensed professionals and approved by the Town of Truckee Division of Building and Safety and Town Engineer, shall include measures to ensure potential damages related to slope stability issues are minimized. Mitigation options may range from cutting back slopes sufficiently to achieve stable slope geometry to engineered improvements including retaining walls, hillside reinforcement with subsurface anchors, or raising the grade of the road bed to minimize the necessity for road cuts.

All mitigation measures, design criteria, and specifications set forth in the geotechnical and soils report shall be followed to reduce impacts associated with slope stability issues to a less-than-significant level. (LTS)