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Subject: Engineering Geologic and Geotechnical Investigation, Proposed Development of Hardin Road, Montgomery Creek Rancheria, Pit River Tribe, Shasta County, California

Mr. Quinn:

Introduction

This report provides the results of SHN's engineering geologic and geotechnical investigation for the proposed development of Hardin Road on the Montgomery Creek Rancheria in Shasta County, California. The purpose of this investigation is to define subsurface (soils) conditions along the proposed road alignment, to provide appropriate geotechnical recommendations to inform the preparation of engineering plans, and to define the appropriate testing and inspection requirements for the construction phase of the project.

The Rancheria is located directly south of the community of Montgomery Creek, in eastern Shasta County. We understand the proposed road alignment extends from the end of the existing road within the Rancheria, Windy Point Road, to the west to a proposed intersection with Highway 299 (Figure 1). The total length of the proposed road is about 3,900 feet. The majority of the proposed alignment follows an existing dirt road that has a variable thickness of aggregate surfacing (a few inches of aggregate to as much as 2 feet in rare instances). The western end of the proposed road is new road construction, where little if any previous grading has occurred. In general, the road alignment descends from higher elevations in the eastern part of the Rancheria toward Highway 299. There is a single watercourse crossing along the western reach of the proposed alignment.

We visited the site on May 21st, 2018 and completed engineering geologic reconnaissance of the site and vicinity. We observed the excavation of three shallow test pits to document and sample soils along the proposed alignment. Samples from the test pits were tested for R-value and plasticity index. The test pits were excavated with a backhoe provided by the Pit River tribe; a cultural monitor was present during the subsurface excavation work.

Geologic Setting

Published geologic maps of the site indicate the area is near the mapped contact between Pliocene age volcanic rocks (basalt) and Eocene age "nonmarine" sediments (Lydon and others, 1960). The Eocene sediments are locally referred to as the "Montgomery Creek Formation" (Higinbotham, 1987), and consist of a variety of fluvial sediments, including conglomerate, sandstone, siltstone, and shale (locally carbonaceous).

Results of the Field Investigation

We completed an engineering geologic reconnaissance along the entire proposed road alignment. We also reviewed road cuts along Windy Point Road, just to the north, which has been recently improved and paved. Our reconnaissance indicates the area is primarily underlain by sediments of the Montgomery Creek Formation, with a surface veneer of large, randomly distributed basaltic cobbles and boulders. Near the eastern end of the proposed road alignment, where it joins Windy Point Road, we observed deeply weathered sandstone. To the west, the ground surface is covered with pebble conglomerate, consisting of tightly cemented rounded, siliceous pebbles in a sandy matrix. This pebble conglomerate persists at the ground surface for the remainder of the alignment to the west; it was observed all the way to Highway 299. Large, rounded basalt boulders are scattered randomly across the ground surface and in the shallow subsurface throughout the area, but these do not appear to represent a continuous basalt flow. Rather, they appear as remnants of a flow that has largely been eroded away.

We observed the excavation of three test pits; locations are shown on the attached Figure 1. Discussion of the exposures in the three test pits are as follows:

Test Pit #1:

Test pit #1 was excavated at the western end of the existing road, at the point where new road construction will begin. The pit exposed less than one foot of dark brown, silty topsoil, overlying about two feet of dark reddish brown pebbly conglomerate. The conglomerate contains about 20% rounded pebbles in a clayey sand matrix. The lower few inches of the test pit exposed gray, slightly plastic clay with a few random pebbles. We encountered several large rounded basalt boulders throughout the profile, and we noted it was difficult digging at this site.

A sample collected between a depth of two and three feet in this test pit resulted in an R-value of 33 (see attached lab results).

Test Pit #2:

Test pit #2 was excavated near the middle of the proposed Hardin Road alignment, along a segment of the existing dirt road that slopes westward at a gradient of about 12%. The pit was excavated on a turn-out adjacent to the south side of the road; the existing dirt road in this area is associated with a two to three foot deep through-cut. This pit exposed just less than one foot of loose, silty topsoil, overlying a one foot thick layer of reddish sandy clay with about 20% rounded pebbles. This material was described as sticky and plastic, suggesting high plasticity clays. The base of the pit exposed gray gravelly clay. This material contained up to 50% rounded cobbles and pebbles, and the matrix material was also described as sticky and plastic. Very hard digging conditions were noted at the base of the pit, due to the presence of cobbles and boulders.

A sample collected from the fine grained soils in the lower part of this test pit resulted in an R-value of <5 (see attached lab results).

Test Pit #3:

Test pit #3 was excavated along the eastern part of the proposed alignment, along a low gradient reach of the existing road. The pit was excavated on the north side of the existing road, near an area where a low topographic knob exists on the south side of the road; the knob appears to be associated with an outcrop of basalt, as there is a concentration of large basalt boulders (the ground surface is notably redder than surrounding areas on aerial photographs). There are numerous basalt boulders along the margins of the existing road, suggesting an abundance of boulders were encountered during initial road construction in this area. Subsurface conditions in this pit were similar to those in test pit #2, with the lower part consisting of stiff gravelly clay. 20% rounded pebbles and cobbles were encountered; the matrix material was mixed gray and red clay described as sticky and plastic. Hard digging was noted at this site. The test pit became wet at its base within about 20 minutes of opening the hole.

A sample from the fine grained soils in the lower part of test pit #3 resulted in an R-value of <5. A plasticity index test indicates a plasticity index of 45 (with a liquid limit of 74), indicating the material is high plasticity clay.

Engineering Geologic Design Considerations

The primary design considerations relative to the geologic site conditions are the clayey nature of the subgrade materials (high plasticity clays with very low R-values) and the presence of large basaltic boulders in the shallow subgrade. These conditions will result in difficult grading and construction conditions. Excavation conditions were noted as “difficult” in the field, and the presence of large cobbles and boulders will make controlled excavation challenging. We expect it will be difficult to develop a smooth working surface, and native soils will be difficult to successfully moisture condition where compaction standards must be achieved.

Additional design considerations include a series of seeps and wet areas along the proposed alignment, overall road drainage, and the creek crossing near the western end. The wet areas encountered at the time of our field investigation are shown on the attached map. These were primarily seeps that resulted in localized wet areas at the time of our investigation (late May), but we expect they may be more substantial during or immediately following the winter season. Adjacent to Highway 299, a substantial wet area occurs in a low gradient area that appears subject to poor drainage conditions. In general, we expect site soils to be associated with low permeability and poor infiltration capacity.

Road drainage is currently an issue along much of the western part of the existing road, where the road bed occupies a shallow through-cut on slopes with gradients on the order of 10% to 12%. In these areas, long sections of the road are associated with inboard ditches with no apparent drainage relief (that is, there are no cross drains, water bars/rolling dips, or other means to divert run-off from the road bed). Gully erosion is occurring in these areas (it has remained relatively minor, due to the erosion resistant nature of the substrate). Road design will need to accommodate the road grade, abundance of through-cuts along the existing road, and the need to manage seasonally high levels of run-off.

The Hardin Road alignment crosses a narrow, shallow ephemeral watercourse near the western end (near the intersection with Highway 299). The flow appears confined to the subject channel, but the presence of large cobbles and boulders in the channel suggests it may experience seasonally high flows.

Geotechnical Recommendations

Earthwork

The subsections that follow present SHN's recommendations for earthwork for design and construction of the proposed road improvements. In the ensuing discussion, we assume that the road grade will be raised and that areas of significant cutting are not necessary to achieve project goals.

Site Preparation

Prior to grading and subgrade preparation, the existing ground surface should be prepared as described in this section in areas to receive fill and improvements. Site preparation includes stripping of vegetation and removal of debris, organic topsoil and other unsuitable material. Site preparation operations should extend at least 5 feet beyond the limits of new fill or improvements, where possible. The Geotechnical Engineer should approve the limits of site preparation during construction.

The surface soil should be stripped of vegetation and organic topsoil with more than 2 percent organic material by dry weight. Root balls and roots greater than 2 inches in diameter should be removed. Debris, pavements, utilities to be abandoned, and other underground facilities should be removed. The exposed ends of removed pipes should be capped. Stripped organic soil and vegetative material may be stockpiled for later use in landscape areas if approved by the architect or owner. The Geotechnical Engineer should approve prepared surfaces prior to excavation and/or covering them.

Fill placed in swales and drainage channels should be benched into firm soils along the bottom and sides to provide a firm level surface on which to place new engineered fill. If zones of weak or saturated soils are encountered during site preparation, they should be removed by further excavation to expose firm natural soil. This overexcavation should be observed and approved in the field by the Geotechnical Engineer.

Subgrade Preparation

After approval by the Geotechnical Engineer, the soil subgrade beneath improvements and fill, except for subgrades beneath vehicular pavement, should be scarified to a depth of 8 inches, moisture conditioned to near optimum moisture content (as necessary to help facilitate compaction), cobbles larger than 4" should be removed and the subgrade should be compacted to at least 90 percent relative compaction[1]. Subgrades beneath vehicular pavements should be compacted to at least 95 percent relative compaction. Subgrade preparation should extend at least 3 feet beyond the limits of new fill and improvements where possible. The Geotechnical Engineer should approve the limits of subgrade preparation during construction.

Subgrades that become dry and/or disturbed should be scarified, moisture conditioned, and recompacted. The Geotechnical Engineer should approve soil subgrade before the contractor covers them.

[1] Relative compaction refers to the in-place dry density of a soil expressed as a percentage of the maximum dry density of the same soil, as determined by the ASTM D1557 compaction test procedure. Optimum moisture is the water content (percentage by dry weight) corresponding to the maximum dry density.

Excavations

The Contractor is responsible for the stability of temporary excavations and their excavation work should comply with applicable Cal/OSHA regulations (California Construction Safety Orders).

Although cuts are not expected, SHN recommends that permanent cutslopes exposing rock up to 15 feet in height be planned to be as steep as 1.5H:1V (horizontal to vertical). The top portions of cutslopes exposing soil should be inclined 2H:1V or flatter. We conclude that steeper cutslopes may be stable at some areas pending further evaluation by the geotechnical engineer during construction. The Geotechnical Engineer should check cutslopes visually during construction to evaluate their stability and to develop supplemental recommendations for increasing stability, as necessary. Recommended measures to improve stability will likely consist of flattening cutslope inclinations.

Overexcavation

SHN recommends overexcavating the existing ground below new fill placed on existing slopes steeper than 5H:1V. Key excavations below the toe of fills on slopes should have a minimum width of 8 feet, and should be founded about 2 feet below existing grade (downslope side) into the firm underlying soil. The bottom of the key excavation should be relatively level in the upslope/downslope direction. Above the keyway, overexcavations for benches should be made. The Geotechnical Engineer should approve the key and bench excavations prior to covering them with engineered fill.

Fill Slopes

In general, fill slopes should be no steeper than 2H:1V. The area at both the top and toe of fill slopes should be graded, or provided with a lined berm or V-ditch, to provide good surface drainage away from the slope to protect against erosion. All slope surfaces should be planted with fast-growing erosion-resistant vegetation immediately after grading. Should erosion channels develop, they should be repaired immediately to prevent progressive undermining or sloughing of the slope surface.

Subdrains

The contractor should place subdrains beneath fill placed over slopes, as recommended by the Geotechnical Engineer during construction (if the geotechnical engineer observes indications of potential for significant subsurface seepage during subgrade preparation).

Subdrains should consist of 4- to 6-inch diameter perforated pipes surrounded by drainage aggregate that connects to solid discharge pipes. The pipes should be SDR-35, Schedule 30, or stronger. The drainage aggregate should be Class 2 Permeable Materials (Caltrans Specification) or open-graded rock with less than 2 percent fines by dry weight. If open-graded rock is used, then the contractor should wrap it in filter fabric (Mirafi 140N or equal). Subdrain pipes should lie over at least 3 inches of drainage aggregate, and perforations should face downward. Aggregate width should be at least 12 inches. The Geotechnical Engineer should specify the thickness of drainage aggregate over the pipe.

Pipes should be graded at least 2 percent to daylight or to a storm drain. Where they daylight, erosion control measures should be added to the ground surface below the discharge, and rodent screens should be placed over the pipe. The contractor should add cleanouts to upstream ends of subdrains. Junction angles in

pipes should be no sharper than 45 degrees, and the angles should sweep from the upstream to downstream direction to allow for access of cleanout equipment to the entire pipe system from the cleanouts.

Engineered Fill

Engineered fill should have less than 2 percent by dry weight of vegetation and deleterious material and should meet the gradation requirements presented in Table 1.

Table 1. Fill Gradation Criteria

Sieve Designation	Percent Passing by Dry Weight
3-inch (50 mm)[1]	100
1½-inch (37.5 mm)	90 minimum
¾-inch (19 mm)	70 minimum
No. 4 (4.75 mm)	60 minimum
No. 200 (75 µm) [2]	5 minimum, 30 maximum
1. mm: millimeters 2. µm: micrometers	

Fine-grained soil with a liquid limit greater than 40 and a plasticity index greater than 15 should not be used as engineered fill. If the clayey soils at the site do not meet the plasticity requirements, mixing with sandier soils may be required. Crushing and/or removal of rock particles greater than 3 inches in size will be required.

Engineered fill should be moisture conditioned or aerated to facilitate compaction, as necessary and compacted to at least 90 percent relative compaction. Engineered fill should be placed in horizontal lifts that are less than 8 inches in uncompacted thickness, and each lift should be compacted to the requirements prior to placing subsequent lifts.

A qualified field technician should be present to observe fill placement and perform field density tests in accordance with ASTM D 6938 test method at random locations thoughout each lift to verify the specified compaction is being obtained.

Utility Trenches

Below-grade utilities should be bedded and backfilled according to the requirements of Shasta County. Where there are no requirements, SHN recommends placing free-draining sand bedding with a sand equivalent of at least 30 or ⅜-inch crushed rock from 3 inches below to 12 inches above the conduit or pipe. Bedding and backfill should not be jetted or ponded to compact it. It should be mechanically compacted. Backfill should be placed and compacted according to our recommendations for engineered fill.

Surface Drainage and Erosion Control

Surface drainage should be provided to prevent ponding and to drain surface water away from the edges of pavements and the tops of fill slopes. Surface runoff should be directed toward suitable collection or discharge facilities and should be designed by the project civil engineer. We recommend using a surface

gradient of at least 2 percent. Pavements should be designed with gradients of about 2 percent in their principal direction of drainage, unless drainage reaches are less than about 10 feet. The designer should consider whether flow velocities can cause water to flow upgradient and over fill slopes, and design curbs or berms along edges of the roadway over fill slopes, accordingly.

Concentrated water should not be discharged onto bare ground or slopes, but should be carried in pipes or lined channels to suitable disposal points. We recommend that approved temporary and permanent erosion control measures be implemented to limit erosion and comply with applicable Shasta County regulations and California construction storm water requirements. Designers should note the poor infiltration capacity of the native soils. Soil on graded slopes should be fertilized, mulched and planted as soon as possible after grading with erosion-resistant vegetation. These plants should be watered lightly at appropriate intervals until growth is established. Drainage ditches, catch basins, and storm drains should be cleaned out periodically as part of the site's maintenance program.

Pavements

Soil subgrades beneath pavements should be prepared and maintained moist and undisturbed until covered. The Geotechnical Engineer should approve subgrades before they are covered.

Based on the results of the R-value laboratory tests, we recommend using an R-value of 5 for design and project planning in the eastern part of the alignment, and an R-value of 33 from TP-1 to the west to the intersection with Highway 299. SHN should evaluate the actual design R-value and our pavement design recommendations during construction after pavement subgrades are prepared. The R-value of imported material should be at least as high as the design value.

Class 2 aggregate base (AB) beneath pavements should comply with the minimum requirements specified in Caltrans Standard Specifications, Section 39 for 19 mm (¾-inch) Type B aggregate and should be compacted to 95 percent compaction (based on ASTM Test Method D-1557 or Cal 216). AB that becomes disturbed after compaction should be re-compacted and re-tested prior to paving. The geotechnical engineer should approve AB surfaces prior to paving.

Paved areas should be sloped and adequately drained to prevent surface water or subsurface seepage from saturating the pavement subgrade soil. Where adjacent landscape, vacant areas, or cutslopes slope down to pavement, provisions should be made to reduce seepage of subsurface water beneath pavements. Curbs that extend at least 6 inches below the soil subgrade could be used to reduce seepage. For better performance, especially where swales descend down towards pavement edges, we recommend that adequate surface drainage be provided and that subdrains (edge drains) be considered. Where AB is exposed along pavement shoulders, placing a subdrain or a horizontal seepage cutoff should be considered to reduce seepage of water beneath pavement from saturation of the exposed AB.

Vehicular Asphalt Concrete (AC) Pavement

We based our AC pavement design on the Caltrans Flexible Pavement Design Method as presented in Chapter 600 of the California Department of Transportation Highway Manual. The designs include a 0.2 factor added to the required gravel equivalent (GE) of the AC layer. Based on a traffic index (TI) of 6.6 provided by the project civil engineer and design R-Value of 5 (see laboratory test results in Appendix B),

SHN recommends a preliminary design of 0.3 feet of asphalt concrete over 1.25 feet of Class 2 Aggregate Base (minimum R-Value of 78). The AC should comply with the Caltrans material property requirements.

For the widening of Highway 299, at the entrance to the newly constructed portion of Hardin Road, we recommend using an R-Value of 33 (based on laboratory test results from TP-1), and a TI of 10.0 from the project civil engineer. Based on these values, SHN recommends a preliminary design of 0.5 feet of asphalt concrete over 1.25 feet of Class 2 Aggregate Base.

Construction Considerations

SHN anticipates that standard backhoes and excavators will be adequate for excavations. We anticipate processing by segregation and crushing may be required to process the excavated material into engineered fill.

The contractor should review this report, evaluate site conditions, and develop excavation and material processing procedures based on their evaluation and experience.

Additional Services

SHN should review project designs to check that our recommendations apply and that the design team incorporates the intent of our recommendations in the design.

Because subsurface conditions at this site vary and our site investigation was limited to evaluating surface and subsurface conditions at widely spaced locations, it is not possible to include all construction details related to the geotechnical engineering aspects of the project in design documents. Geotechnical engineering recommendations depend on the possible need for adjustment in the field during construction. The adjustments depend on actual conditions revealed during construction that we could only assume from our site and subsurface investigation. These inspections would allow SHN to verify conformance of the work to project guidelines, determine that soil conditions are as anticipated, and to modify our recommendations, if necessary. Therefore, SHN or another qualified representative should perform geotechnical engineering observations and testing during construction of earthwork and pavements to check that the intent of our recommendations are followed during construction, and that the geotechnical engineering aspects of the work are performed in general accordance with the approved design documents. In addition, we should check for any subsurface conditions that vary from the conditions encountered during our site and subsurface investigation and develop supplemental geotechnical engineering recommendations, as necessary.

Limitations

The geotechnical conclusions and recommendations presented in this report are for planning and design of the proposed improvements as described in the Introduction. These conclusions and recommendations may not apply if:

- This report is used for a different site or project.
- The recommendations presented in this report are not followed.
- Any other change is made that materially alters the proposed project.

SHN based the conclusions and recommendations presented in this report on data obtained from observation of surface conditions and limited subsurface data, as described in this report. Subsurface conditions are expected to vary. If anyone discovers varied conditions during construction, additional investigation, testing, analysis and development of supplemental recommendations may be required. Any person associated with this project who observes conditions or features of the site or its surrounding areas that are different from those described in this report should report them immediately to SHN for our evaluation.

Implementation of our recommendations requires an adequate testing and observation program during construction. If SHN does not perform this testing and observation, then the Geotechnical Engineer who is responsible for observation and testing should thoroughly review this report and agree with its conclusions and recommendations or, otherwise, provide alternative recommendations.

This report was prepared in accordance with the generally accepted standards of geotechnical engineering practice that exist in Shasta County at the time we prepare this report. No other warranty, express or implied, is made. It is the owner's responsibility to see that all parties to the project, including the designers, contractors and subcontractors, are made aware of this report in its entirety.

Changes in the standards of practice in the field of geotechnical engineering, changes in site conditions such as new excavations or fills, new agency regulations, or modifications to the proposed project warrant professional review of this report. Because of this, there is a practical limit to the usefulness of this report without critical professional review. It is suggested that 2 years be considered a reasonable time for the validity of this report.

We trust that this report provides the information that you need at this time. If you require additional information, or clarification of the information herein, please do not hesitate to contact our office.

Respectfully,

SHN Engineers & Geologists

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