Attachment 4.A

LINDBERG GEOLOGIC CONSULTING
David N. Lindberg, Certified Engineering Geologist

ENGINEERING GEOLOGIC STABILITY ASSESSMENT SOILS REPORT

Existing Hoop Greenhouse Cut/Fill Pad Assessment
30705 Highway 36, near Bridgeville

Assessor's Parcel Number: APN: 208-111-029

Prepared for:
Mr. Thomas Morgan

David N. Lindberg, CEG 1895, Exp. 02/29/2020

August 13, 2018

LGC Project No. 0283.00

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1.0 INTRODUCTION

1.1 Site and Project Description

Presented in this report are the results of a site-specific, engineering-geologic soils reconnaissance conducted by Lindberg Geologic Consulting (LGC) in the Little Larabee Creek watershed near Bridgeville, California (Figure 1). Our explorations were limited to the location of an existing hoop greenhouse cut and fill pad which was graded with no permit, on Humboldt County Assessor's parcel 208-111-029 (Figure 2).

This greenhouse cut and fill pad was constructed at a formerly vacant location on the property. A Class-III ephemeral watercourse lies approximately 125 feet west of the cut/fill pad. Runoff drains downslope until it intersects the Class-III drainage and thence to Little Larabee Creek, approximately one-third mile to the south-southeast. Little Larabee Creek flows west and drains into the Van Duzen River approximately 1.2 miles from the property. Grading work performed to create the cut/fill pad disturbed approximately 0.7 acres. This pad is located in the northeastern part of parcel 208-111-029; the initial grading of the pad appears to have begun between 2010 and 2012, based on Google Earth imagery, and was completed at the time of our site reconnaissance of July 26, 2018. Our area of exploration was limited to the pad area (Figure 3). This pad is accessed by an existing driveway on the property which can be observed in satellite imagery from 1998. Runoff from this pad is discharged through a rock-lined channel toward the Class-III drainage to the west.

Parcel 208-111-029 has a GIS area of 40.73 acres, according to the Humboldt County WebGIS, and is located in southeast quarter of Section 7, T1N, and R4E. Latitude and longitude of the centroid of this parcel are 40.4733° and -123.7620°, respectively, per the Humboldt County WebGIS. This existing pad is located at approximately 40.4748° north, and 123.7603° west (Figure 3).

Elevations on the subject parcel range from approximately 900 feet in the southwestern "corner", to 1,300 feet at the highest point in the northeastern corner of the parcel. Elevation of the existing pad is estimated to be approximately 1,200 feet (Figure 1). The subject parcel is situated on the southwest-facing slopes, north of Little Larabee Creek, on a generally southeast-northwest trending slope (Figure 1), and is approximately two miles east-northeast of Bridgeville. Only minor new earthwork is anticipated on the pad at this time to lay back the cut slope and re-contour, compact and reseed the fill slope.

Included in this report are brief assessments of the site geology, subsurface soil conditions, and potential geologic hazards associated with this existing pad site. Recommendations are provided as necessary where appropriate, to mitigate potential negative effects of geologic hazards from or to this pad. Recommendations are provided for regrading, adding rock armor to the overflow channel, and erosion control for the bare soil areas at the pad. Generalized grading and erosion control recommendations are also presented later in this report.

LGC understands that the property owner requires engineering-geologic review of the existing pad for permitting purposes. The existing hoop greenhouse on this pad is used for cannabis cultivation. As mentioned, a Certified Engineering Geologist from our office examined the existing cut/fill pad site on July 26, 2018.

1.2 Scope of Work

LGC was retained to observe and characterize the apparent adequacy of the construction of this existing cut/fill hoop greenhouse pad. As part of our scope we assessed potential geologic hazards, and prepared this brief engineering geologic soils report. The specific scope of this investigation included the following:

- Review pertinent published geologic maps and reports of this area.
- Conduct a reconnaissance field exploration program of the cut/fill pad site.
- Prepare this engineering-geologic soils report to provide an assessment of stability.
- Provide earthwork and drainage recommendations for the owner and his contractors.

Excluded from our scope of work were any other proposed or existing site developments, any environmental assessment for the presence or absence of any hazardous waste, toxic, or corrosive materials. Although we assessed subsurface conditions in this investigation, we conducted no laboratory testing of any samples for the presence of hazardous material(s).

1.3 Limitations

This report has been prepared for the exclusive use of Mr. Thomas Morgan, his contractors and subcontractors, and appropriate public authorities, for specific application to the existing cut/fill pad described on parcel 208-111-029. We have endeavored to perform our services within the engineering-geologic standard of care common to the local area at the time this work was performed. LGC makes no other warranty, express or implied.

Analyses and recommendations contained in this report are based on data obtained from existing maps and reports, field observations and limited subsurface explorations. Methods indicate subsurface conditions only at locations explored, only at the time any excavations or borings were opened, and only to the depths penetrated. Soil observations and sampling cannot always be relied on to accurately reflect all stratigraphic or lithologic variations that commonly exist between sampling locations, nor do they necessarily represent conditions at any other time.

Recommendations included in this report are based, in part, on assumptions about subsurface conditions that may only be tested during earthwork. Accordingly, the validity of our recommendations is contingent upon how they are applied in the field during construction. Experienced engineers and equipment operators should be retained where necessary and appropriate to provide a complete professional service. LGC cannot assume responsibility or liability for the adequacy of our recommendations when they are applied in the field, unless we are retained to observe those phases of the construction work applicable to our recommendations (e.g., earthworks). We are available to discuss the extent that such observations may be necessary to provide assurance of the validity of our recommendations.

Do not apply any of this report's conclusions or recommendations if the nature, design, or location of the work is changed, or if other aspects of the project are modified, added or removed from the work. If changes are contemplated, LGC should be contacted and consulted to review the impact of the changes on the applicability of the recommendations in this report. Note that LGC is not responsible for any claims, damages, or liability associated with any other party's interpretation of the subsurface data or reuse of this report for other projects or at other locations without our express written authorization. There is no warranty, express or implied.

2.0 FIELD EXPLORATION AND LABORATORY TESTING

2.1 Field Exploration Program

The site and the in-situ soil conditions were assessed during a site visit on July 26, 2018. Our explorations utilized observation of existing cut slopes, and the materials in the fill slopes, to infer in-situ soil conditions. Soil stratigraphy was observed and interpreted in the field, and described in general accordance with ASTM standards.

3.0 SITE AND SUBSURFACE CONDITIONS

3.1 Topography and Site Conditions

On this subject parcel, the existing cut/fill pad is located on sloping ground with a generally southwesterly aspect. Native slope gradients were 30 to 50 percent. Steeper and gentler slopes exist in the vicinity, but are away from the existing pad. Slopes prior to grading are estimated to have been greater than 30 percent in the area of the existing pad.

The United States Geologic Survey (USGS, 1969) 7.5-minute topographic "Bridgeville, Calif." quadrangle indicates that this subject parcel is situated at elevations ranging between approximately 900 to 1,300 feet above mean sea-level (NAD83) with slopes greater than 30 percent across large portions of this parcel. Based on review of satellite imagery back to June 11, 1998, none of the "undisturbed" slopes in the immediate vicinity of this pad appear to have been altered by past grading. Thus, the topography of the ground surrounding where the pad was built, is represented reasonably by the immediately-adjacent existing topography. Native and cut/fill slopes in the immediate vicinity of the pad appeared generally-stable in their present condition.

3.2 Geologic Setting

The parcel is located in the Coast Ranges Geologic Province and is underlain by metamorphic mélange rocks of the central belt of the Franciscan Formation. McLaughlin and others (2000) designate the Yager terrane sediments as cm1, and describe them as follows:

"**Mélange of the Central belt (early Tertiary to Late Cretaceous)**-Consists of a matrix of clayey, penetratively sheared argillite and fine-grained sandstone, locally with intercalated green tuff and hard elliptical carbonate concretions armored with scaly black argillite. Includes blocks up to several kilometers across, of diverse lithologies and ages. Age range of the Central belt is based on the paleontologic and isotopic age range of rocks in the mélange and on inferred range in age of penetrative shearing, boudinage, and related deformation that occurred during mélange formation. Components of the Central belt mélange include:

Mélange (cm1)-[Consisting of] predominantly penetratively sheared, locally tuffaceous, scaly meta-argillite and less abundant blocks of metasandstone. Exhibits rounded, poorly incised, lumpy and irregular topography.

The subject parcel is located northeast of Little Larabee Creek, a tributary to Van Duzen River, east-northeast of Bridgeville. Runoff from this pad drains to a Class-III ephemeral tributary of Little Larabee Creek (Figure 1). Based on our professional experience, our on-site field review, satellite imagery, and published geologic maps (e.g., McLaughlin and others, 2000), we concur that the project site is underlain by argillite and graywacke sandstone of the central belt mélange of the Franciscan Formation.

At this existing pad site, the observable subgrade appeared to consist of medium dense to dense, intensively-fractured, siltstone and sandstone. At the pad site, native topsoil and some portion of the upper native soil profile had been stripped by site grading activities. Undisturbed native soil below the existing ground surface at this site was exposed in the cut and appeared suitable as subgrade bearing material for the existing pad and for the hoop greenhouse (Figure 3). Soil profiles, where observed, became dense and graded to fractured rock at a shallow depth.

3.3 Seismicity

The subject property is located within California's Northern Coast Ranges Geomorphic Province (CGS, 2002), a seismically active region in which large earthquakes are expected to occur during the assumed economic life span (50 years) of the site developments (Heaton and Kanamori, 1984). The Little Salmon fault, which is approximately nine miles to the west, is the nearest active fault, as defined by the State of California. The Little Salmon fault is a northwest-striking, northeast-dipping, thrust (reverse) fault. The upper-bound earthquake considered likely to occur on the Little Salmon fault has an estimated maximum moment magnitude (Mw) of 7.0 (Petersen et al., 1996).

Based on the record of historical earthquakes (approximately 150 years), faults within the North American plate boundary zone and internally-deforming, subducting Gorda and Juan de Fuca plates have produced numerous small-magnitude and several moderate to large (i.e. magnitude 6.0 or greater) earthquakes affecting the local area. The Cascadia subduction zone (CSZ) is located approximately 50 miles west of the subject parcel and is estimated to be capable of producing earthquakes of magnitude 9.0 when its entire length ruptures from Cape Mendocino to Vancouver Island in British Columbia (Satake, et al, 2003). Several active regional seismic sources in addition to the CSZ, and the Northern San Andreas fault, are proximal to the project site and have the potential to produce strong ground motions. These seismic sources include:

- Mendocino fault offshore: a high-angle, east-west trending, right-lateral strike-slip fault between the Gorda plate and Pacific plate approximately 17 miles to the southwest.
- Faults within the internally-deforming Gorda and Juan de Fuca plates consisting of high-angle, northeast-trending, left-lateral, strike-slip faults.

3.4 Subsurface Conditions and Description of the Site Soils

Subsurface data obtained during our site exploration of the subject property, indicate soils within at least the upper eight to nine feet of the soil profile to consist of silt (ML) underlain by fractured siltstone and fine sandstone. Thin native topsoil was observed in the cut faces.

Native soils below the existing ground surface appeared medium dense to dense in the soil profiles observable. Based on our observations of the soil conditions, site soils do not appear to be subject to high groundwater conditions; no soil mottling or free groundwater was encountered. This existing parcel drains to Little Larabee Creek, to the southwest. In the dry season (July), no emergent groundwater flow was observed on or near the pad site.

Native silty soils continued to a shallow depth, where they graded to fractured siltstone. At depth, soils are dense and friable. Soil structure within the upper three feet is weakly developed. Materials below three feet grade to more-dense argillite, siltstone and sandstone bedrock, with relatively-intact bedrock at some undetermined depth below the surface (bgs).

3.5 Groundwater Conditions

In the 2018 dry season, groundwater was not observable at the site during our explorations. No emergent groundwater flow was observable around the pad sites. Some seepage may potentially occur during brief periods of wet season (winter) high groundwater. Soil mottling, considered indicative of seasonally-saturated or high groundwater conditions, was likewise not observed. It is unlikely that groundwater will rise to within five feet of the ground surface except perhaps briefly in winter during periods of more-intense storm events.

4.0 GEOLOGIC AND SOIL HAZARDS

Potential geologic and soil hazards associated with the region and the proposed project at this site include seismic ground shaking, surface fault rupture, liquefaction and related phenomena, settlement, slope instability, flooding or high groundwater, and swelling or shrinking soils. Brief assessments of these potential hazards are presented below.

4.1 Seismic Ground Shaking

As noted in Section 3.3, the project site is situated within a seismically active area proximal to multiple seismic sources capable of generating moderate to strong ground motions. Given the presence of significant regional active faults within and offshore of northern California, there is high likelihood that the project site will experience strong ground shaking during the economic life span of this pad (70 years).

Table 1. Spectral Response Accelerations; APN 208-111-029		
Site Information	Latitude / Longitude*	40.4733° / -123.7620°
	Occupancy Risk Category (2016 CBC, Sect. 1604.5)	II
	Seismic Design Category (2016 CBC, Sect. 1613.3.5)	D
	Site Class (2016 CBC, Sect. 1613.3.2)	D
Spectral Acceleration	S_s	1.500
	S_1	0.739
Site Coefficients	F_a / F_v	1.0 / 1.5
Response Accelerations	S_{MS}	1.500
	S_{M1}	1.108
	S_{DS}	1.000
	S_{D1}	0.739

* Coordinates for the Parcel Centroid per Humboldt County WebGIS.

Site-specific seismic Spectral Response Accelerations are presented above in Table 1, in accordance with 2016 California Building Code (CBC 2016) requirements, and were obtained from the United States Geologic Survey (USGS 2018). The on-line USGS ground motion parameter calculator provides spectral acceleration values (S_s and S_1) based on the site specific geographic coordinates, the latest available seismic database maintained by the USGS, the site classification, site coefficients, and adjusted maximum considered earthquake values (F_a, F_v, SM_s and SM_1).

Based on the site conditions and assumptions of the soils and geologic materials within 100 feet of the ground surface, we conservatively classify the site as Site Class D consisting of a "Stiff soil" profile (Section 1613.3.2, 2016 CBC). The parameters in Table 1 are based on this classification and were determined using the 2010 ASCE Standard 7 (w/March 2013 errata), minimum design loads for buildings and other structures (USGS, 2018).

4.2 Surface Fault Rupture

The surface trace of the active Little Salmon fault is postulated to be to the southwest of this property (CDMG, 1983 and McLaughlin, and others, 2000). There are numerous ancient inactive faults in the central belt Mélange which are not zoned as "active faults" by the California Geologic Survey. The subject parcel is not located within any Alquist-Priolo earthquake fault zones where the State of California anticipates potential surface rupture. Based on the distance to the nearest active fault trace, the potential for surface fault rupture on the subject property is low.

4.3 Liquefaction

Liquefaction is a loss of soil strength that results in fluid mobility through the soil. Liquefaction typically occurs when uniformly-sized, loose, saturated sands or silts that are subjected to strong shaking in areas where the groundwater is less than 50 feet below ground surface. In addition to the necessary soil and groundwater conditions, the ground acceleration must be high enough, and the duration of the shaking must be long enough for liquefaction to occur.

According to Special Publication 115, Map S-1 (CDMG, 1995), the project site is not located within an area of recognized liquefaction potential. Based on the lack of saturated, loose, poorly-graded sand or silt in the soil profile, the potential for liquefaction to occur at this site is considered low. Site-specific quantitative evaluation of liquefaction potential was not performed.

4.4 Settlement

The shallow bearing soils at this cut/fill pad site, below the existing stripped ground surface, are siltstone and fine sandstone. Based on our observation, the existing pad has minor settlement issues. The pad fill has experienced few small fill material slope failures on its outboard slope at the time of our site observations in July 2108. Through the past several (est. four or five) winter wet seasons, this pad appears to have performed acceptably for the most part.

4.5 Landsliding

Landslide mapping published by the CDMG for the Bridgeville Quadrangle shows no landslide features near the cut fill pad. However; the same state geologic mapping shows areas of instability and an inner gorge along the lower (southern) property line at Little Larabee Creek. Landslides are also mapped on other parcels within Section 7, and on all of the neighboring parcels to the south, east and west, and north from the subject parcel. Site-specific exploration of this cut/fill pad revealed small areas of instability associated with the recent grading; some minor slumping of the cut face has occurred, as well as some minor settlement and erosion of the fill face below the hoop greenhouse. Examination of satellite imagery and field observation indicated no other areas of recent or dormant slope instabilities in the vicinity of this cut/fill pad.

4.6 Flooding and Groundwater

4.6.1 Flooding

The subject site is located on high ground above Little Larabee Creek, and there are no other watercourses of significance in the vicinity. Any potential for flooding to affect this recently-developed cut/fill pad site is minimal.

4.6.2 Groundwater

In our opinion, based on our field exploration and professional experience, seasonally high groundwater conditions have some potential to occur at this site. During our field investigation, our observation of the lack of free groundwater or soil mottling, suggested groundwater is unlikely to rise to within five feet of the ground surface during the winter wet season. Shallow groundwater conditions appear unlikely to have an adverse effect on the performance of the cut/fill pad, provided our recommendations are adhered to, and assuming this lined pad gets regraded in accordance with our recommendations which follow below. It will be important to keep the toe ditch of the cut draining unimpeded during the wet season.

4.7 Soil Swelling or Shrinkage Potential

At this pad site, bearing soils consist of silt with fine sand with some percentage of clay. The cut face of the subject cut/fill pad contained a few fragments of other lithologies. Soils were dry to the ground surface in late July 2018. Soils appeared relatively well-drained by soil fractures and tubular pores.

The presence of clay makes these soils potentially subject to shrink-swell potential associated with cyclic seasonal wetting and desiccation. Site soils do not appear likely to desiccate seasonally to a depth sufficient to affect an earthen prism for this cut/fill pad. The shrink-swell hazard to this cut/fill pad is low.

5.0 CONCLUSIONS AND DISCUSSION

1) Slope instability, a primary potential geologic hazard on the subject parcel, does not appear to be a significant hazard to the cut/fill hoop greenhouse pad in its present location.

2) This pad is underlain by stiff or medium dense soils; these materials appeared to be a suitably-firm subgrade on which to place a compacted earthen fill for a hoop greenhouse pad.

3) In the middle of the dry season, our field explorations found no free groundwater. There was some evidence to suggest that seasonally-high groundwater may seep from the cut face during the height of the wet season at this existing pad location. Perched groundwater was not observed in July. Nor was soil mottling, suggestive of temporary seasonal high groundwater conditions observed. Site soils appear relatively well drained and permeable. We anticipate the cut face of this hoop greenhouse pad will exhibit some low-volume of seepage during wet-season highest groundwater, thus a well-maintained drain ditch at the toe of the cut is important in this setting.

4) The nearest faults to the site are the Little Salmon fault, and the associated faults of the Mad River fault zone. The State of California does consider these faults active. The active Little Salmon fault is approximately nine miles from the subject property. Due to the fact that there are no recognized active faults on or near the property, the risk of fault surface rupture at the site may be characterized as low.

5) Strong seismic ground shaking, however, is likely to occur during the anticipated economic life of any developments on the subject property (50 years). Risks associated with strong ground motions are typical of the region and as such, these risks, as mitigated by prudent, code-compliant design and construction, are assumed by owners and developers in the area. Prior to construction, this pad site was not observed by our office. Nor was construction of this cut/fill

pad observed while in-progress. In our opinion, this cut/fill pad berm may resist deformation during strong seismic shaking. However, we were not involved in the design, or construction of the pad, and so can not provide a quantitative seismic stability evaluation.

6) Overflow is via a rock-lined spillway less than five feet in width and approximately one foot lower than the adjacent pad. Flow travels northwesterly along the base of the cut/fill pad and, is discharged through a rock-lined ditch. Discharge is thus directed by dispersed overland flow to the Class-III watercourse below and to the west-northwest.

7) For the native silty soil with fine sand and clay, a presumptive load-bearing value of 1,500 pounds per square foot (psf) for vertical foundation pressure would be used for design. For lateral bearing, 100 psf per foot of embedment below grade would be applicable. For lateral sliding resistance, a coefficient of friction of 0.25 psf multiplied by the dead load.

8) The undisturbed native soils at a depth of 12 inches appeared suitable to support earthen fills designed and constructed in accordance with the current building code requirements.

9) In our professional opinion and provided our recommendations are implemented, this pad is not expected to contribute to, nor be subject to, any site-specific geologic hazards.

We understand from our on-site observations that this pad was not constructed under permit. As discussed, this cut/fill pad appears to be built to an acceptable standard for supporting the loads imposed by a hoop greenhouse. It must be noted however, that we were not present to observe the site prior to construction, and we did not observe any of the designs, plans, or earthworks during construction operations. Therefore, we have no first-hand knowledge of how the earth fills were placed or compacted, or how the ground was prepared to receive the fill.

It is our opinion, based on observation, that the existing cut/fill pad is marginally acceptable in terms of its construction and its ability to support the intended (minimal) loads. The cut face, and the outboard fill face of the pad are steeper than the two horizontal to one vertical (2 to 1) slope typically recommended for such construction.

6.0 RECOMMENDATIONS

6.1 Slope Setback Considerations

We recommend a minimum hoop greenhouse construction setback of six (6) feet from cut slope toes, and fill slope crests for any future developments. At minimum, we recommend that space always be allowed to permit access by a typical "bobcat" type tractor around all four sides of the hoop greenhouse, and adjacent areas (i.e., the top of cut and the toe of fill), to provide access for repairs should such prove necessary. We recommend that this pad never be developed with anything more-substantial than the hoop greenhouse without further geotechnical investigations.

6.2 Site Preparation

Typically, to construct a new cut/fill pad such as this, one would typically remove all existing sod and topsoil, any sidecast fill, imported gravel or road base, rubble, and any other debris encountered at or below the ground surface from areas of the pad footprint, and from an area eight feet (minimum) beyond the perimeter. Any stumps left from tree removal or historic logging would also be removed. Excavated sod and topsoil would be stockpiled for later use as landscaping fill material.

Earthwork, including but not limited to, site clearing, grubbing and stripping should be conducted during dry weather conditions; generally May through September. Failure to comply with this recommendation can result in detrimental erosion or sedimentation. Erosion and sediment control recommendations are provided later in this report.

6.3 Temporary Excavations

Temporary construction slopes are not anticipated for this project. However, if any temporary construction slopes are proposed, they should be designed and excavated in strict compliance with applicable safety regulations including the OSHA Excavation and Trench Safety Standards. All construction equipment, building materials, excavated soil, vehicular traffic, and other similar loads should never be allowed near the top of any unshored or unbraced excavations. Where the stability of adjoining buildings, walls, pavements, or any other similar improvements may be endangered by excavation operations, support systems such as shoring, bracing, or underpinning may be necessary and should be provided to provide structural stability and to protect any personnel working in the excavation.

Since excavation operations are dependent on construction methods and scheduling, the owner and contractor shall be solely responsible for the design, installation, maintenance, and performance of all shoring, bracing, underpinning, and other similar systems. Under no circumstances should any comments provided herein be inferred to mean that LGC is assuming any responsibility for temporary excavations or the safety thereof. LGC assumes no responsibility for the design, installation, maintenance, and performance of any shoring, bracing, underpinning, or other similar systems.

6.4 Cut and Fill Slopes

Pad excavations for hoop greenhouses create short cut and fill slopes. Cut slopes at this location are recommended to be no steeper than 1:1 (H:V). Fill slopes of compacted soils should be no steeper than 2:1. Any new unrestrained ancillary cut and/or fill slopes with heights in excess of four feet should be no steeper than 2:1. Pad grading would typically be designed by an experienced civil engineer, and constructed per the County grading ordinance and current CBC requirements.

This cut/fill pad, although apparently not constructed to typically-rigorous standards, does not appear to have had, and is not expected to have any negative impacts on slope stability, or to impact sensitive watercourses, provided our recommendations are adhered to. We recommend placement of coarse gravel and cobbles at the outlet of the cut slope toe ditch discharge point for erosion control.

6.5 Structural Fills

Pad structural fills should be constructed as controlled and compacted engineered fills. Structural fill should be free of organic materials and may be composed of low plasticity clay, sand, or well graded gravel. Native soils below the topsoil appeared potentially-suitable for use as general engineered fill for this hoop greenhouse pad, provided they were moisture conditioned, free of organic or deleterious materials, and free of particles larger than approximately 3-inches in diameter.

Imported fill material is not anticipated to be required to achieve acceptable finished grades on this existing cut/fill pad site. Material removed from the cut slope face to decrease its steepness should be placed on the fill slope below the pad to achieve, as closely as possible, the cut and fill slopes recommended herein. If additional fills are used, there are likely native site soils which may be suitable for such use. Earthen fills should consist of select, non-expansive engineered fill. The material for select, engineered fill should be free of organic material and particles larger than approximately 3-inches in diameter, and should meet the following minimum criteria:

- Plasticity Index: 15 or less,
- Liquid Limit: 35 or less,
- Percent Passing #200 sieve: 10 to 40%,
- Maximum Particle Size: 3 inches

Avoid fill placement on sloping ground. Fills should be placed on a nominally-level, suitably prepared subgrade surfaces and keyed into the native subgrade. Fills should be compacted mechanically as described below to minimize the potential for settlement.

Structural fills should be placed on level, benched, suitably prepared subgrade surfaces and should be compacted mechanically to minimize potential settlement and slippage. Approved fill material should be placed in loose lifts no more than 8 inches thick, with a uniform moisture content at or near optimum, and then compacted mechanically.

Structural fills should be subject to compaction testing and inspection during construction. It is prudent to monitor the suitability of such fill materials as placed, and to assure compliance with the recommended compaction standards. Structural fills should be compacted as specified in the "Compaction Standard" section following below.

6.6 Compaction Standard

Fills should be compacted mechanically to 90 percent relative compaction so that no settlement will occur. Vibratory mechanical compactors should be employed to achieve the recommended compaction. If no other compaction is performed, fill materials should, at minimum, be compacted to be firm and unyielding under a loaded 10-yard dump truck.

For granular fill material such as sand and gravel, smooth-drum vibratory compactors should be used. Flooding of granular material should never be employed to consolidate backfill in trenches or other excavations.

It is recommended that structural fill and backfill material be compacted in accordance with the specifications listed in Table 2 below. A qualified person should be present to observe fill placement and assess the field density throughout each lift to verify that the specified compaction is being achieved by the contractor.

TABLE 2 – STRUCTURAL FILL PLACEMENT SPECIFICATIONS		
Fill Placement Location	Compaction Recommendation	Moisture Content (Percent Optimum)
Structural fills.	90 percent	-1 to +3 percent
Utility trenches within building and driveway/parking areas	90 percent	-1 to +3 percent
Landscape and grass areas	Compact such that no settlement will occur	-1 to +3 percent

6.7 Cut/Fill Pad Design Criteria

For the existing pad, we recommend placement of fill on the outboard side of the existing pad to bring the slope to 2:1, or as close to as feasible. The toe of the added fill should be keyed into the slope a minimum of 12-inches below the topsoil and root zone. Added fill soils may be placed, compacted and tested as described above. For cut slope enhancement, excavate to lay the slope back to a less-steep angle, as recommended above. Stockpile native mineral soil found below the topsoil and root zone for later use as fill below the pad. Regrade the outboard fill slope to accommodate the spoils from regrading the cut face and reduce the slope steepness to 2:1, or as close as feasible to a 2:1 slope.

Fill materials should be placed with a moisture content at or near optimum, and compacted mechanically to 90 percent relative compaction, with sufficient observation and testing to ensure conformance with our compactions. Continue the fill to the elevation of the existing cut/fill pad. Regrade the hoop greenhouse pad to drain by sheet flow over the fill slope. Surface the hoop greenhouse pad with at least 6 inches of compacted Class-2 aggregate base (or equivalent) for erosion control and wet-season access should winter maintenance work become necessary.

Armor the outlet point of the cut slope toe ditch with coarse gravel and cobbles to limit the potential for erosion.

All bare soil areas around the regraded hoop greenhouse pad should be treated propotly to control erosion. Generalized erosion control measures for the project site are listed in Section 6.9 below. Around the pad, we recommend that all exposed soils in the pad cut and fill slopes (and all other bare soil areas) be seeded with native grasses and covered with straw. Use straw erosion control blankets on all slopes steeper than 2:1. Anchor the straw erosion control blankets securely to the bare soil cut and fill slopes. Following the recommendations of the manufacturer, install silt fencing, securely anchored, at the toe of the pad fill slope. We recommend that fiber rolls (straw wattles), be staked down contour-parallel at the top, and at the approximate midpoint, of the pad fill slope.

6.8 Drainage

Regrading of this hoop greenhouse pad should be designed to create surface gradients adequate to provide for positive drainage by sheet flow; approximately two percent. We recommend that the pad be surfaced with a six inch thick layer of Class-2 aggregate base (or equivalent), over a suitable geotextile fabric, and compacted to provide a firm wearing surface for the personnel and equipment that may potentially operate around the periphery of the pad.

Landscaping design, grading and construction should be such that no water is ever allowed to pond onsite. Runoff from this pad site should be controlled and discharged such that no erosion, sedimentation or discharge of turbid water to perennial streams will occur. Storm water runoff should be controlled with the installation of armored outlet points. Armor the outlet points of any concentrated runoff with cobbles and coarse gravel; no erosion, sedimentation, or ponding on this cut/fill pad should be permitted to occur.

6.9 Erosion and Sediment Control Recommendations

Wet weather conditions can occur at any time at the subject property but are "a given" from mid-October through April. Storm water erosion and pollution prevention measures should be initiated concurrently with any ground disturbance, and should be completed prior to the winter rains.

Except in an emergency, we recommend avoiding wet-season earthwork and grading at this location. Humboldt County Erosion Control Standards should be incorporated into the project design and strictly adhered to during construction; a current edition may be obtainable from the Building Department. We specifically recommend the following erosion and sedimentation control measures:

- Prevent discharge of suspended sediment; control and contain sediment before discharge to any watercourse.
- Re-vegetate all disturbed soils and replace topsoil concurrently with earthwork.
- Apart from the pad area where we recommended placement of Class-2 aggregate base, seed, and mulch exposed flat soil areas with straw, at minimum, to prevent erosion.

- "Punch" straw into the soil to minimize the potential for wind to blow the straw away.
- Exposed sloping ground, especially fill slopes, will not be protected adequately with only straw mulch and should have straw mats (with seed), straw wattles at slope-top and mid-slope, and silt fencing at the base of all fill slopes.
- Seed mulched soils immediately; water as necessary through the dry season to establish new vegetation.
- Cover temporary soil stockpiles with plastic sheeting, anchored securely, to prevent wind disturbance.
- Drive no vehicles on the native site soils when they are wet; at minimum use six inches of compacted, crushed rock or road base gravel to pave driveways, parking areas, and areas associated with the cut/fill pad potentially accessed by vehicles during wet weather.
- Repair any improperly functioning erosion control measures immediately.
- Monitor site conditions before and after runoff-generating rainfall events to verify proper functioning of erosion control measures, and to repair them when/if necessary.

6.10 Additional Services

6.10.1 Review of Grading and Drainage Plans

The conclusions and recommendations provided in this report are based on the assumption that soil conditions encountered during grading will be essentially as exposed during our evaluation, and that the general nature of the grading and use of the property will be as described above. We recommend that any new grading plans be reviewed by this office prior to implementation.

6.10.2 Observation and Testing

To assure conformance with the specific recommendations contained within this report, and to assure that the assumptions made in the preparation of this report are valid, LGC should be retained to review any new design plans. Sufficient testing and observation, performed during construction would ensure that the compaction standards specified above are adhered to.

7.0 REFERENCES

CBC [California Building Code], 2016, California Code of Regulations, Title 24, Part 2, Volume 2. California Building Standards Commission.

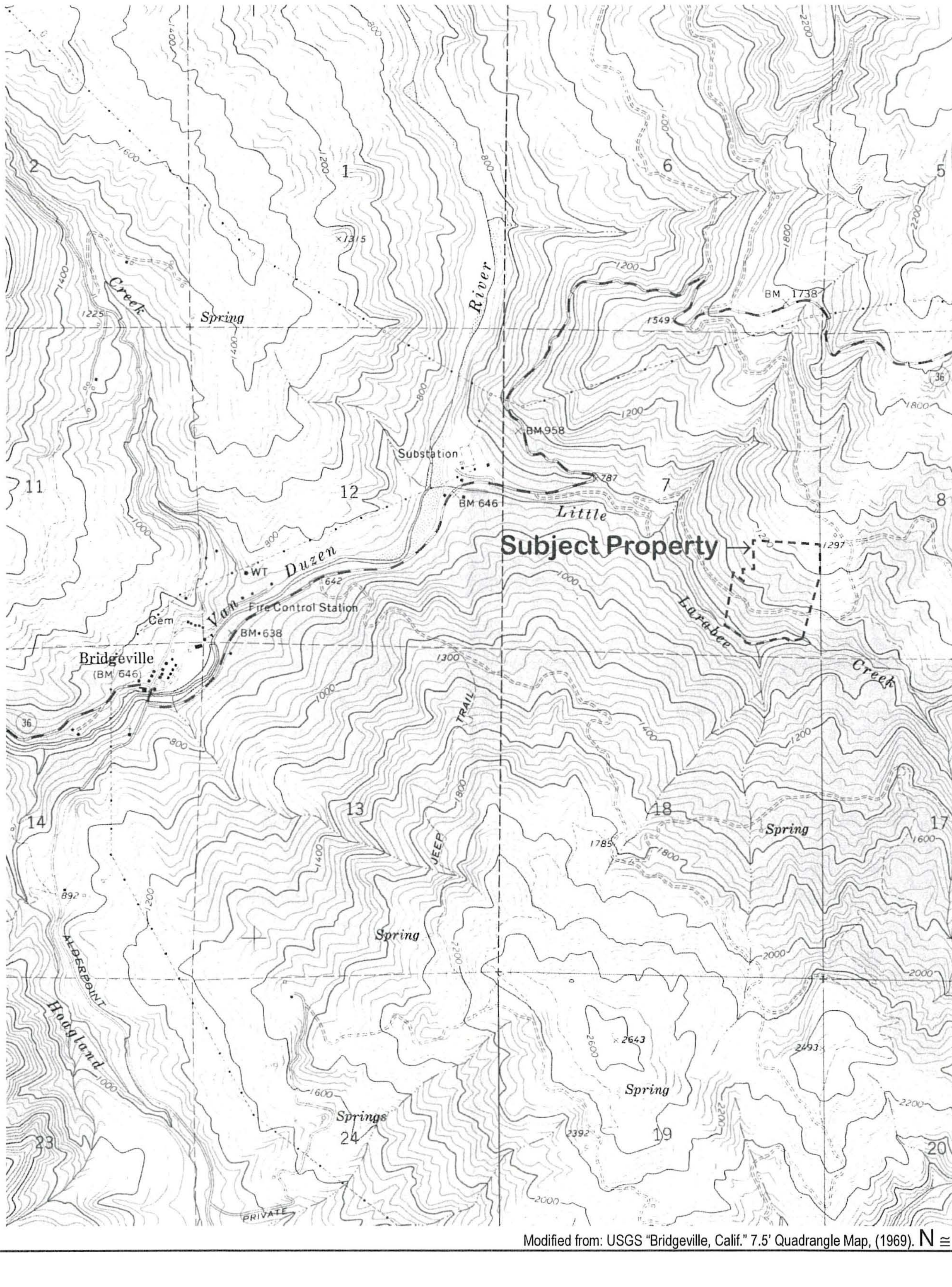
CDMG, 1995, Planning Scenario in Humboldt and Del Norte Counties, California, for a Great Earthquake on the Cascadia Subduction Zone, Special Publication 115.

CDMG, 2000, Digital Images of Official Maps of Alquist-Priolo Earthquake Fault Zones of California, Northern and Eastern Region.

CGS [California Geological Survey], 2002, Note 36; California Geomorphic Provinces.

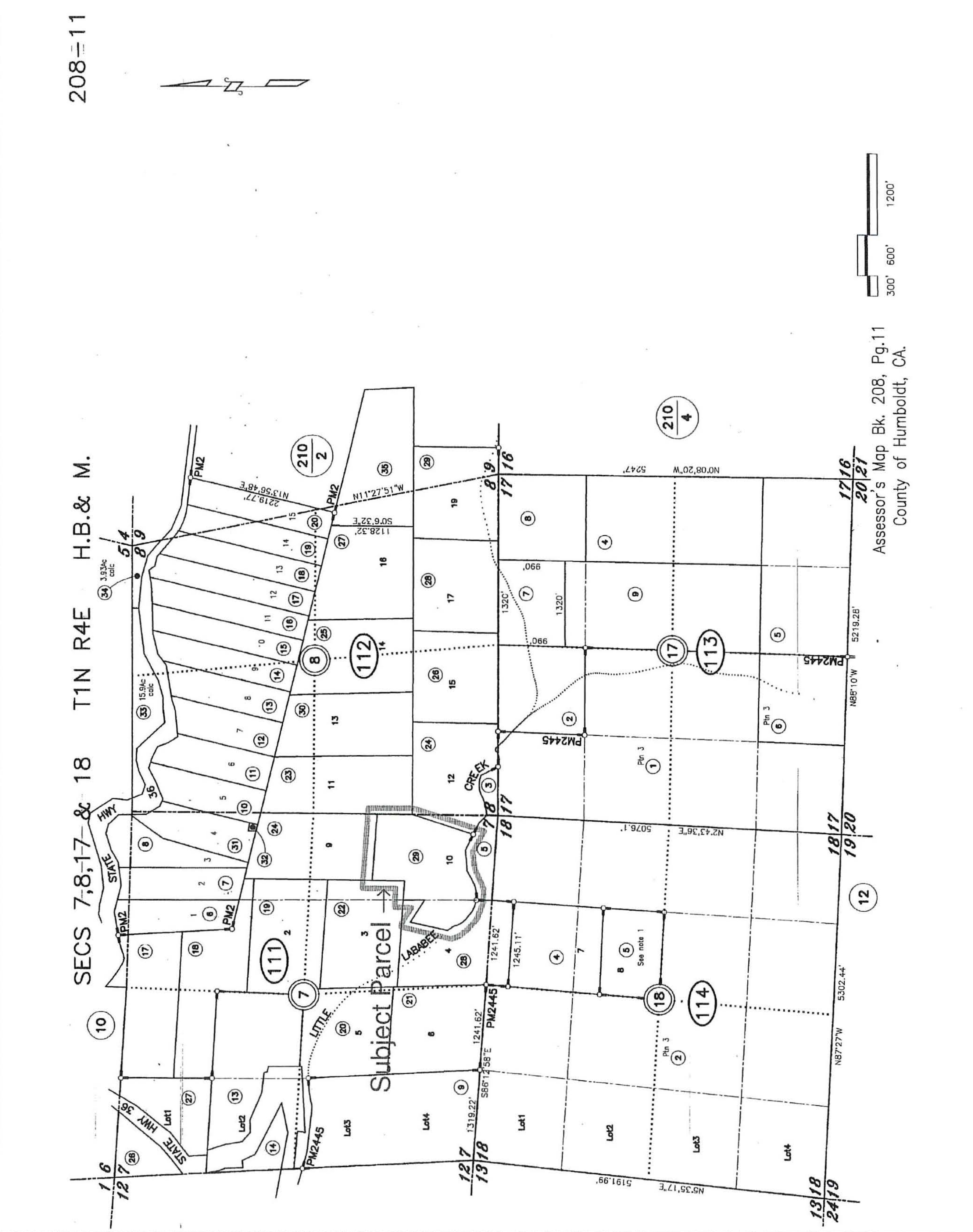
Heaton, T. H. and Kanamori, H., 1984, Seismic potential associated with subduction in the northwestern United States, Bulletin of the Seismological Society of America; June 1984; v. 74; no. 3; p. 933-941.

Lindberg Geologic Consulting	Engineering-Geologic Stability Assessment Soils Report	Figure 1
Post Office Box 306	30705 State Highway 36, Humboldt County	August 13, 2018
Cutten, CA 95534	APN 208-111-029, Mr. Thomas Morgan, Client	Project 0283.00
(707) 442-6000	Topographic Project Property Location Map (all locations approximate)	1 inch ≅ 2,300 feet

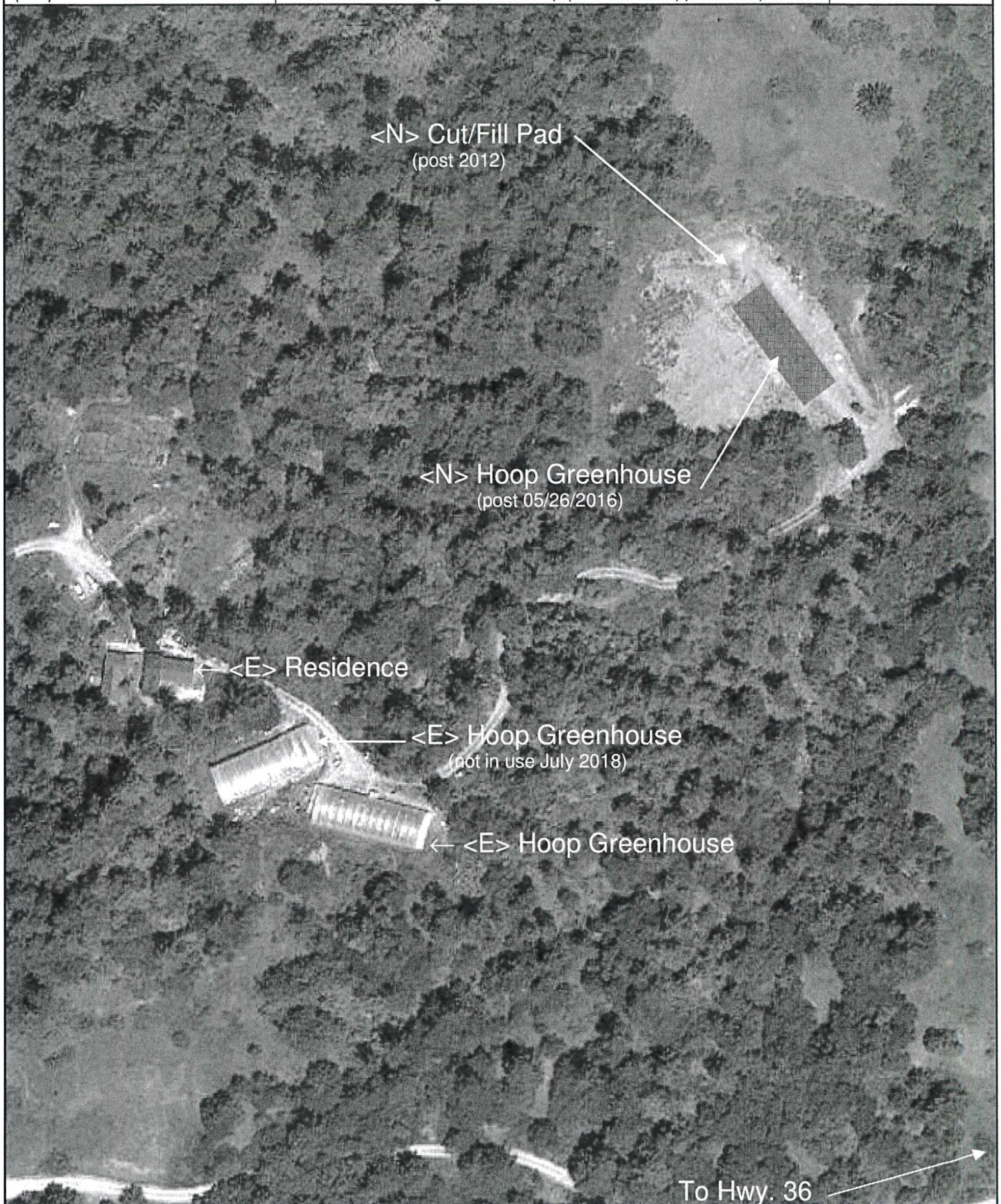


Modified from: USGS "Bridgeville, Calif." 7.5' Quadrangle Map, (1969). N ≅

Lindberg Geologic Consulting	Engineering-Geologic Stability Assessment Soils Report	Figure 2
Post Office Box 306	30705 State Highway 36, Humboldt County	August 13, 2018
Cutten, CA 95534	APN 208-111-029, Mr. Thomas Morgan, Client	Project 0283.00
(707) 442-6000	County Assessor's Parcel Map (all locations approximate)	Scale as Shown

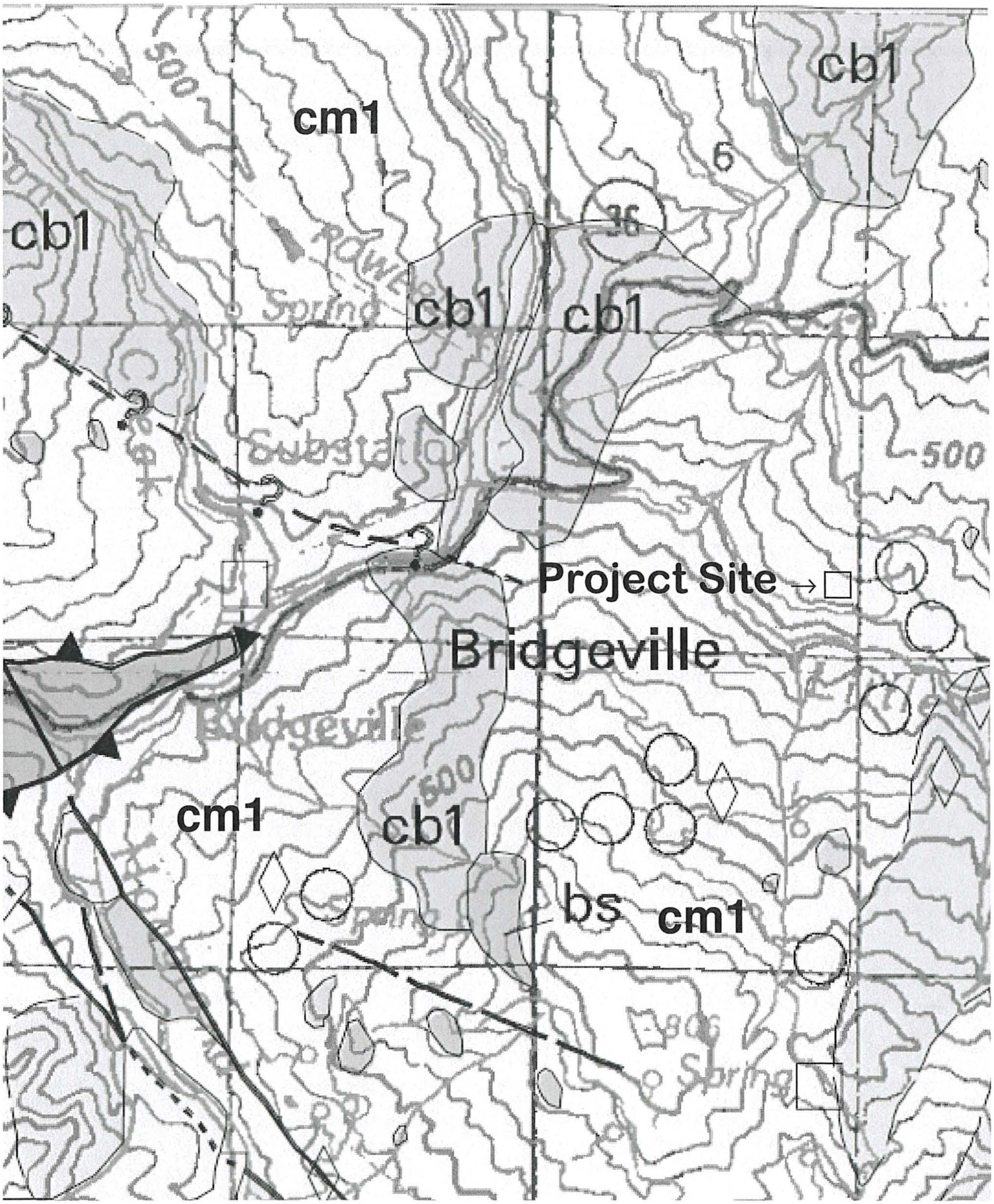


Lindberg Geologic Consulting	Engineering-Geologic Stability Assessment Soils Report	Figure 3
Post Office Box 306	30705 State Highway 36, Humboldt County	August 13, 2018
Cutten, CA 95534	APN 208-111-029, Mr. Thomas Morgan, Client	Project 0283.00
(707) 442-6000	Satellite Image Site Plan Map (all locations approximate)	1 inch ≅ 130 feet



Modified from: Google Earth Imagery of May 26, 2016. N ≅

Lindberg Geologic Consulting	Engineering-Geologic Stability Assessment Soils Report	Figure 4
Post Office Box 306	30705 State Highway 36, Humboldt County	August 13, 2018
Cutten, CA 95534	APN 208-111-029, Mr. Thomas Morgan, Client	Project 0283.00
(707) 442-6000	Local Geologic Map (all locations approximate)	1 inch ≅ 2,400 feet



Modified from: McLaughlin and Others, 2000. N ≅

Lindberg Geologic Consulting	Engineering-Geologic Stability Assessment Soils Report	Figure 4a
P. O. Box 306	30705 State Highway 36, Humboldt County	August 13, 2018
Cutten, CA 95534	APN 208-111-029, Mr. Thomas Morgan, Client	Project 0283.00
(707) 442-6000	Geologic Map Explanation	No Scale

DESCRIPTION OF MAP UNITS

QUATERNARY AND TERTIARY OVERLAP DEPOSITS

- Qal — Alluvial deposits (Holocene and late Pleistocene?)
- Qm — Undeformed marine shoreline and aolian deposits (Holocene and late Pleistocene)
- Qt — Undifferentiated nonmarine terrace deposits (Holocene and Pleistocene)
- Qls — Landslide deposits (Holocene and Pleistocene)
- QTog — Older alluvium (Pleistocene and [or] Pliocene)
- QTw — Marine and nonmarine overlap deposits (late Pleistocene to middle Miocene)
- Tf — Volcanic rocks of Fickle Hill (Oligocene)

COAST RANGES PROVINCE

FRANCISCAN COMPLEX

-- Coastal Belt --

Coastal terrane (Pliocene to Late Cretaceous)

Sedimentary, igneous, and metamorphic rocks of the Coastal terrane (Pliocene to Late Cretaceous):

- co1 — Melange
- co2 — Melange
- co3 — Broken sandstone and argillite
- co4 — Intact sandstone and argillite
- cob — Basaltic Rocks (Late Cretaceous)
- cols — Limestone (Late Cretaceous)
- m — Undivided blueschist (Jurassic?)

King Range terrane (Miocene to Late Cretaceous)

- Krp — Igneous and sedimentary rocks of Point Delgada (Late Cretaceous)
- m — Undivided blueschist blocks (Jurassic?)

Sandstone and argillite of King Peak (middle Miocene to Paleocene[?]):

- krk1 — Melange and (or) folded argillite
- krk2 — Highly folded broken formation
- krk3 — Highly folded, largely unbroken rocks
- krl — Limestone
- krc — Chert
- krb — Basalt

False Cape terrane (Miocene? to Oligocene?)

- fc — Sedimentary rocks of the False Cape terrane (Miocene? to Oligocene?)

Yager terrane (Eocene to Paleocene?)

Sedimentary rocks of the Yager terrane (Eocene to Paleocene?):

- y1 — Sheared and highly folded mudstone
- y2 — Highly folded broken mudstone, sandstone, and conglomeratic sandstone
- y3 — Highly folded, little-broken sandstone, conglomerate, and mudstone
- Ycgl — Conglomerate

-- Central belt --

Melange of the Central belt (early Tertiary to Late Cretaceous):

Unnamed Metasandstone and meta-argillite (Late Cretaceous to Late Jurassic):

- cm1 — Melange
- cm2 — Melange
- cb1 — Broken formation
- cb2 — Broken formation
- cwr — White Rock metasandstone of Jayko and others (1989) (Paleogene and [or] Late Cretaceous)
- chr — Haman Ridge graywacke of Jayko and others (1989) (Cretaceous?)
- cfs — Fort Seward metasandstone (age unknown)
- cls — Limestone (Late to Early Cretaceous)

- cc — Chert (Late Cretaceous to Early Jurassic)
- bs — Basaltic rocks (Cretaceous and Jurassic)
- m — Undivided blueschist blocks (Jurassic?)
- gs — Greenstone
- c — Metachert
- yb — Metasandstone of Yolla Bolly terrane, undivided
- b — Melange block, lithology unknown

-- Eastern Belt --

Pickett Peak terrane (Early Cretaceous or older)

Metasedimentary and metavolcanic rocks of the Pickett Peak terrane (Early Cretaceous or older):

- ppsm — South Fork Mountain Schist
- mb — Chinquapin Metabasalt Member (Irwin and others, 1974)
- ppv — Valentine Springs Formation
- mv — Metabasalt and minor metachert

Yolla Bolly terrane (Early Cretaceous to Middle Jurassic?)

Metasedimentary and metaigneous rocks of the Yolla Bolly terrane (Early Cretaceous to Middle Jurassic?):

- ybt — Taliaferro Metamorphic Complex of Suppe and Armstrong (1972) (Early Cretaceous to Middle Jurassic?)
- ybc — Chicago Rock melange of Blake and Jayko (1983) (Early Cretaceous to Middle Jurassic)
- gs — Greenstone
- c — Metachert
- ybh — Metagraywacke of Hammerhorn Ridge (Late Jurassic to Middle Jurassic)
- c — Metachert
- gs — Greenstone
- sp — Serpentinite
- ybd — Devils Hole Ridge broken formation of Blake and Jayko (1983) (Early Cretaceous to Middle Jurassic)
- c — Radiolarian chert
- ybi — Little Indian Valley argillite of McLaughlin and Ohlin (1984) (Early Cretaceous to Late Jurassic)

Yolla Bolly terrane

- yb — Rocks of the Yolla Bolly terrane, undivided

GREAT VALLEY SEQUENCE AND COAST RANGE OPHIOLITE

Elder Creek(?) terrane

- ecms — Mudstone (Early Cretaceous)

Coast Range ophiolite (Middle and Late Jurassic):

- ecg — Layered gabbro
- ecsp — Serpentinite melange

Del Puerto(?) terrane

Rocks of the Del Puerto(?) terrane:

- dpms — Mudstone (Late Jurassic)

Coast Range ophiolite (Middle and Late Jurassic):

- dpt — Tuffaceous chert (Late Jurassic)
- dpb — Basaltic flows and keratophyric tuff (Jurassic?)
- dpd — Diabase (Jurassic?)
- dpsp — Serpentinite melange (Jurassic?)
- sp — Undivided Serpentinized peridotite (Jurassic?)

KLAMATH MOUNTAINS PROVINCE

Undivided Great Valley Sequence:

- Ks — Sedimentary rocks (Lower Cretaceous)

GREAT VALLEY SEQUENCE OVERLAP ASSEMBLAGE

Hayfork terrane

Eastern Hayfork subterrane:

- eh — Melange and broken formation (early? Middle Jurassic)
- ehls — Limestone
- ehsp — Serpentinite

Western Hayfork subterrane:

- whu — Hayfork Bally Meta-andesite of Irwin (1985), undivided (Middle Jurassic)
- whwg — Wildwood (Chanchelulla Peak of Wright and Fahan, 1988) pluton (Middle Jurassic)
- whwp — Clinopyroxenite
- whji — Diorite and gabbro plutons (Middle? Jurassic)

Rattlesnake Creek terrane

- rcm — Melange (Jurassic and older)
- rcls — Limestone
- rcc — Radiolarian chert
- rcis — Volcanic Rocks (Jurassic or Triassic)
- rcic — Intrusive complex (Early Jurassic or Late Triassic)
- rcp — Plutonic rocks (Early Jurassic or Late Triassic)
- rcum — Ultramafic rocks (age uncertain)
- rcpd — Blocky peridotite

Western Klamath terrane

Smith River subterrane:

- srs — Galice? formation (Late Jurassic)
- srv — Pyroclastic andesite
- srgb — Glen Creek gabbro-ultramafic complex of Irwin and others (1974)
- srpd — Serpentinized peridotite

MAP SYMBOLS

- Contact
- Fault
- Thrust fault
- Trace of the San Andreas fault associated with 1906 earthquake rupture

Strike and dip of bedding:

- Inclined
- Vertical
- Horizontal
- Overturned
- Approximate
- Joint
- Strike and dip of cleavage

Shear foliation:

- Inclined
- Vertical

Folds:

- Synclinal or synformal axis
- Anticlinal or antiformal axis
- Overturned syncline
- Landslide

Melange Blocks:

- Serpentinite
- Chert
- Blueschist
- Greenstone
- Fossil locality and number

GEOLOGY OF THE CAPE MENDOCINO, EUREKA, GARBERVILLE, AND SOUTHWESTERN PART OF THE HAYFORK 30 X 60 MINUTE QUADRANGLES AND ADJACENT OFFSHORE AREA, NORTHERN CALIFORNIA (McLaughlin et al., 2000)