



Project No. 5279.02  
June 11, 2020 (Revised September 11, 2020)

Rise Grass Valley, Inc.  
333 Crown Point Circle, Suite 215  
Grass Valley, CA 95945

Attention: Ben Mossman, President

**Reference: Idaho-Maryland Mine Project**

**Subject: Geotechnical Assessment of Near Surface Mine Features**

Dear Mr. Mossman,

NV5 prepared this letter to summarize our assessment of geotechnical engineering conditions related to specific historical near-surface mine features associated with the Idaho-Maryland Mine (IMM) Project.

## **1 INTRODUCTION**

### **1.1 PURPOSE**

The purpose of the assessment was to provide an analysis of the potential for surface impacts at the location of known near-surface mine features resulting from dewatering of the underground mine workings as part of proposed IMM underground mining operations. The potential impacts evaluated herein include the potential for near-surface instability resulting from drawdown of the water level in the mine workings.

### **1.2 SCOPE**

The assessment included review of surface conditions and existing improvements at the feature locations, review of as-built documentation of the underground workings, the Project Description of the Idaho-Maryland Mine Project, and discussion of the proposed future mining operations with a representative of Rise Grass Valley, Inc. (Rise). This letter presents NV5's opinion regarding the identified features and provides preliminary recommendations for mitigation of potential geotechnical impacts.

### **1.3 BACKGROUND**

The features addressed as part of this assessment are depicted on the attached Sheet A207, *Mine Workings, Near Surface, Showing Location and Geometry* (Rise Grass Valley, Inc., August 15, 2019). The plan and cross sections are based on a digital LiDAR derived surface model and a digital model of the as-built mine workings.

Rise's acquisition of the Idaho-Maryland Mine Property included a significant collection of historic records of the Idaho-Maryland Mine such as reports, production records and data, financial statements, development reports, survey data, exploration drill results, maps showing mine workings, geological information, and assay results. The historical records have been compiled by Rise, reviewed by Amec Foster Wheeler (Amec, 2017) and were used by Rise to locate near surface mine workings.

The Idaho-Maryland Mine was first located as the Eureka claim in 1851, targeting a gently easterly-raking ore shoot located on the eastern side of Grass Valley. In 1915, the Eureka, Idaho and Maryland claims were assembled under Errol MacBoyle and reopened. MacBoyle consolidated the Brunswick and Morehouse mines into the Idaho Maryland group in 1926. The mine was forced to close at the onset of World War II but reopened after the war and continued operations until final closure in 1957.

Subsequent land use in the area shifted toward urban development and land holdings were subdivided and rezoned for commercial, light industrial and residential use. Over this period, some near-surface mining excavations were closed, filled, or obscured by earthwork grading and development. NV5 performed record searches and located as-built documentation or records of closure for some of the near-surface features. Other features were historically closed without engineering design or agency oversight.

The current water elevation in the mine is approximately 2,500 feet above mean sea level (amsl) and currently drains by gravity from the East Eureka Shaft (referenced as Feature 4 on the attached Table 1). In order to recommence mining, the underground mine must be dewatered, and groundwater entering the mine must be continuously pumped during the mining operation. Approximately 2,500 acre-feet (approximately 815 million gallons) of water are expected to be pumped from the underground workings during the initial 6-month dewatering period (EMKO, 2020), lowering the water level in the mine approximately 3,200 feet from the current water elevation in the mine of 2,497 feet amsl. When the water level in the mine workings is located near the ground surface, the drawdown of groundwater within the mine workings may increase the potential for settlement or collapse of shallow workings that were not formally closed. Near surface workings that are already in a dewatered state would generally not be significantly impacted by dewatering the mine.

In addition, near-surface mine openings that are not sealed have the potential to serve as a conduit for air between the underground mine workings and the ground surface. This natural ventilation can be of concern when structures are built over or adjacent to such mine features. This has been identified as a potential concern for the East Eureka Shaft (Table 1, Feature 4). Rise has entered into a cooperation agreement to assist the subject property owner in physical closure of this feature to mitigate the potential for air transfer.

This assessment focuses on specific near-surface mine features because they are generally more susceptible to subsidence and collapse than are deeper mine workings. The near-surface features may be located in weaker materials (soil and weathered rock); whereas the deeper mine workings are commonly located in competent bedrock. In addition, the underground mine workings focused on removal of quartz vein materials that are generally narrow, so the collapse of a deep (e.g., 100 feet bgs) mine feature is not likely to be expressed at the ground surface.

Rise does not plan to mine above 500 feet bgs and so the only subsidence risks requiring evaluation are the existing historic workings.

## **2 FINDINGS**

Assessment findings are presented below by mine feature. Feature locations are depicted on the attached Sheet A207 (Rise, 2019). Feature characteristics and preliminary recommendations are summarized in the attached Table 1. A list of references is presented in Section 4.

### **2.1 EUREKA SHAFT**

The Eureka Shaft is located at 125 Spring Hill Drive and is likely beneath a commercial building with slab-on-grade floor. The building is currently occupied by Eagle Lift Automotive and other businesses. According to Rise this feature is associated with mine workings that have been idle since the 1920s.

A geotechnical engineering report for Wolf Creek Industrial Park by Lowry and Associates (1985) identified the Eureka shaft and provided general design recommendations for excavation and physical closure using wood timbers, steel beams and concrete. Lowry recommended that all shaft treatment work be observed and evaluated by their engineering geologist.

A geotechnical investigation was also performed by others at 125 Springhill Drive by Earthtec Ltd. (1989) prior to site development. The investigation report did not identify the subject feature or any historical mining excavation.

The original shaft construction likely included a concrete collar. The specific method of physical closure is not known, and no specific closure documentation is available beyond the Lowry 1985 report. No structure distress is known, although the interior of the building has not been observed. As depicted in Section A, the shaft is nearly vertical. Based on the water level in the mine workings determined by EMKO (2020) and ground surface elevations from LIDAR data (Aero Geomatics Ltd., May 2018) the water level in the mine workings is anticipated at approximately 35 feet bgs and is likely in bedrock.

### **2.2 EUREKA VERTICAL SHAFT**

The Eureka Vertical Shaft is located in the vicinity of the westbound lane/sidewalk of Spring Hill Drive near its intersection with Idaho Maryland Road. The feature appears to be covered by pavement, sidewalk or landscaping area associated with the road. According to Rise this feature is associated with mine workings that have been idle since the 1920s.

A geotechnical engineering report for Wolf Creek Industrial Park by Lowry and Associates (1985) did not specifically identify this shaft. However, Lowry identified the adjacent Eureka Shaft which they provided general design recommendations for excavation and physical closure using wood timbers, steel beams and concrete. Lowry recommended that all shaft treatment work be observed and evaluated by their engineering geologist. Lowry performed visual surveys, geophysical surveys, and test boring in the area as part of the investigation for the Wolf Creek Industrial Park.

The specific method of physical closure is not known, and no specific closure documentation is available. No settlement of the ground surface is apparent. As depicted in Section B, the shaft is nearly vertical. Based on the water level in the mine workings determined by EMKO (2020) and ground surface elevations from LIDAR data (Aero Geomatics Ltd., May 2018), the water level in the mine workings is anticipated at approximately 17 feet bgs.

### **2.3 EUREKA DRAIN**

The Eureka Drain is a black corrugated plastic culvert which comes from the hillside below 109 and 125 Spring Hill Drive on the north side of Idaho-Maryland Road. It is located approximately 100 feet west of the Idaho Maryland Road/Spring Hill Drive intersection and enters a culvert that passes under Idaho Maryland Road and discharges to Wolf Creek. The water quality parameters at the Eureka Drain are similar to those of the Eureka Shaft (EMKO, 2020), suggesting that the two are hydraulically connected. This modern drain would likely have been installed during development of 109 and 125 and Spring Hill Drive. A geotechnical engineering report for Wolf Creek Industrial Park by Lowry and Associates (1985) identified the a spring at the Eureka Shaft and provided general design recommendations for a full sub drainage piping and recommended specific subdrain recommendations upon review of the final grading plans and filed conditions encountered during grading. This drain may be part of the drainage plan implemented.

### **2.4 EAST EUREKA SHAFT**

The East Eureka Shaft is located at 815 Idaho Maryland Road beneath a commercial office building occupied by Navo and Sons, as shown approximately on Section E. Access to the feature is limited by the existing building. Below the building, the feature is suspected to be open and supported with a concrete collar. A small steel pipe passes through the east side of the building from a sump adjacent to the feature (EMKO, 2020). Further investigation and physical closure are recommended. Rise and the property owner have entered into a cooperation agreement to allow Rise to assist the property owner to close this feature before or at the commencement of dewatering.

### **2.5 EAST EUREKA DRAIN**

The East Eureka Drain includes an approximately 24-inch diameter culvert that extends approximately 70 feet to the southwest from the East Eureka Shaft through a gravel parking lot. The drain discharges to Wolf Creek. Further investigation and physical closure are recommended. Rise and the property owner have entered into a cooperation agreement to allow Rise to assist the property owner to close this feature before or at the commencement of dewatering.

### **2.6 IDAHO DRAIN TUNNEL**

The Idaho Drain Tunnel (Idaho Drain Drift, depicted in Section F) is located at 865 Idaho Maryland Road, and appears to be a horizontal excavation that was covered by previous earthwork grading.

Minor seepage was observed emanating from bottom of the fill into Wolf Creek in February 2020. Water level in the mine workings is likely present near the elevation of the drain portal, which is lower than the current ground surface elevation as a result of the fill placed over the area. Based on information provided by a neighboring property owner, the boulders and fill were placed in the tunnel portal approximately 15 years ago. No closure documentation available.

## **2.7 IDAHO PUMP SHAFT**

The Idaho Pump Shaft (depicted in Section F) is located in an industrial yard at 865 Idaho Maryland Road. Previous earthwork grading to construct the industrial yard resulted in the placement of fill over the Idaho Pump Shaft.

The property owner indicated that the settlement at the ground surface was observed approximately 5 years ago at a location approximately 100 feet south of the mapped location of the Idaho Pump Shaft. The settlement was subsequently backfilled. No closure documentation is available for the Idaho Pump Shaft or the nearby settlement feature.

Water level in the mine workings is expected at approximately 27 feet below the current ground surface.

Further investigation and physical closure are recommended. Rise and the property owner have entered into a cooperation agreement to allow Rise to assist the property owner to close this feature before or at the commencement of dewatering.

## **2.8 IDAHO SHAFT**

The Idaho Shaft (depicted in Section G) is a larger diameter incline shaft extending from the ground surface to the 2,000-level of the mine. The shaft is located immediately south of a large concrete ore bin that remains from the historical mining operations. The ore bin was observed to be tilting to the south, presumably as a result of settlement around the Idaho Shaft collar, which is reportedly covered by a concrete cap and soil/rock fill. Further investigation and physical closure are recommended. Rise and the property owner have entered into a cooperation agreement to allow Rise to assist the property owner to close this feature before or at the commencement of dewatering.

The property owner indicated that approximately two years ago settlement of the ground surface was observed near the shaft location and was backfilled with boulders and soil. No documentation available. Additional settlement at the shaft location, measuring approximately four feet by five feet wide and 18 inches deep, was observed in February 2020. Further investigation and physical closure are recommended. Rise and the property owner have entered into a cooperation agreement to effect this closure before of at the commencement of dewatering.

## **2.9 OLD AIR RAISE**

The Old Air Raise (see Section J) is located in the vicinity of the westbound lane/center of Whispering Pines Lane between Idaho Maryland Road and Clydesdale Court. The feature appears to be covered by fill and pavement or landscaping.

Geotechnical engineering reports for Whispering Pines by Lowry and Associates (1983, 1986) did not specifically identify the feature. However, Lowry recognized the presence of numerous historic mine features in its report to support the development of the Whispering Pines Industrial Park, provided recommendations for closure of historic mine features, and required all shaft treatment work to be observed and evaluated by an engineering geologist from their firm. Its mapped location appears to be at a location where the road fill is approximately nine feet deep.

The method of physical closure is not known, and no closure documentation is available. No settlement of the ground surface is apparent. As depicted in Section J, the shaft is nearly vertical. Based on the water level in the mine workings determined by EMKO (2020) and ground surface elevations from LIDAR data (Aero Geomatics Ltd., May 2018), the water level in the mine workings is anticipated at approximately 75 feet bgs.

### **2.10 ROUNDHOLE SHAFT (IDAHO #2)**

The Roundhole Shaft is located approximately 200 feet west of Brunswick Road between Idaho Maryland Road and Whispering Pines Lane. The feature includes a five-foot diameter vertical shaft bored to the 1000-level of the mine. The shaft was used for ventilation and transportation of supplies to the upper mine levels. Boring logs indicate that the upper 44 feet of the shaft were mined by hand and square set. Bedrock (gabbro) was encountered from 44 to 180 feet bgs and was underlain by serpentinite. The shaft is likely supported by a concrete collar near the ground surface and was observed to be covered with a concrete slab. The water level in the Roundhole Shaft is located in the underlying bedrock, below the weaker near-surface materials. The shaft is nearly vertical and water level in the mine workings is anticipated at approximately 165 feet bgs.

### **2.11 OLD BRUNSWICK INCLINE SHAFT**

The Old Brunswick Incline Shaft is located at 12305 Bet Road. The feature extends from the ground surface at an incline of approximately 45 to 50 degrees to the 1,250-level of the mine. A Non-engineered soil/rock backfill collapsed in 1998 at the existing residence location. The collapse was likely associated with a vertical excavation to the ground surface from the incline shaft. The collapsed portal was closed by engineered design and the foundation residence was underpinned (Carlton Engineering, Structural Engineer Thomas Burkhart, S.E. 4378) in 2000 and 2001. Design and permitting documents are on file with Nevada County Building Department (Permit # 72094). The permit status is listed as final and closed. Based on the water level in the mine workings determined by EMKO (2020) and ground surface elevations from LIDAR data (Aero Geomatics Ltd., May 2018), the water level in this feature is expected to be at depth in bedrock.

### **2.12 OLD BRUNSWICK RAISE (SHAFT #2)**

The Old Brunswick Raise (Section N) is mapped in a forested area at 12448 Old Mine Road and may be located beneath waste rock. According to Rise, this relatively shallow working is associated with the original mining exploration in the area. The feature is likely located above the water level in the mine workings elevation. Based on information provided by Rise, the

water level in this feature is expected to be at depth in bedrock. This feature is already dewatered and therefore the planned dewatering will have no effect on this feature. The Old Brunswick mine features were described during the parcel map creation in a geotechnical report by Anderson (1986) who conducted test boring and delineated areas inappropriate for residential construction over the Old Brunswick mine features which were incorporated into the final map for Bet Acres.

### **2.13 OLD BRUNSWICK 70-LEVEL STOPE**

The Old Brunswick 70-level stope includes a relatively shallow mine excavation in the vicinity of 12477 and 12401 Old Mine Road and 12305 Bet Road. The stope extends from tunnel level upward towards the ground surface. As shown on Section M, the stope extends upwards to an elevation of approximately 88 feet bgs.

This feature is already dewatered and therefore the planned dewatering will have no effect on this feature. The Old Brunswick mine features were described during the parcel map creation in a geotechnical report by Anderson (1986) who conducted test boring and delineated areas inappropriate for residential construction over the Old Brunswick mine features which were incorporated into the final map for Bet Acres.

Shallow workings, referred to as the “70-foot level tunnel” (approximately 50-54 vertical feet below shaft surface), extend a few hundred feet in a general east-southeasterly direction from the Old Brunswick Incline Shaft.

The feature is located beneath forested property and in the vicinity of residential driveways. Water level in the mine workings is relatively deep at this location. Based on information provided by Rise, the water level in this feature is expected to be at depth in bedrock.

This feature is already dewatered and therefore the planned dewatering will have no effect on this feature. The Old Brunswick mine features were described during the parcel map creation in a geotechnical report by Anderson (1986) who conducted test boring and delineated areas inappropriate for residential construction over the Old Brunswick mine features which were incorporated into the final map for Bet Acres.

### **2.14 OLD BRUNSWICK DRAIN TUNNEL**

The Old Brunswick Drain Tunnel is a lateral excavation that is mapped on a hillside where it meets the ground surface. The portal was not observed and may have been covered over or collapsed. Based on the water level in the mine workings determined by EMKO (2020) and ground surface elevations from LIDAR data (Aero Geomatics Ltd., May 2018), the water level in this feature is expected to be at depth in bedrock.

This feature is already dewatered and therefore the planned dewatering will have no effect on this feature. The Old Brunswick mine features were described during the parcel map creation in a geotechnical report by Anderson (1986) who conducted test boring and delineated areas inappropriate for residential construction over the Old Brunswick mine features which were incorporated into the final map for Bet Acres.

## 2.15 NEW BRUNSWICK SHAFT

The New Brunswick Shaft is a deep, large-rectangular vertical shaft that extends from the ground surface to below the 3280-level of the IMM. The portal is covered by a steel plate. The prominent cylindrical ore bin adjacent to the portal is still intact. The shaft is to be used as part of the proposed mining project.

## 3 CONCLUSIONS AND PRELIMINARY RECOMMENDATIONS

NV5 presents the following conclusions and preliminary recommendations based on the assessment findings presented above. Mine dewatering is not likely to have a significant effect on the historical, near-surface mine features analyzed herein. Mitigation (physical closure) is recommended at the East Eureka Shaft, East Eureka Drain, Idaho Drain Tunnel, Idaho Pump Shaft and Idaho Shaft, which are currently open or partially-closed. The proposed mitigation measures are readily-implemented, and cooperation agreements are in place to allow Rise to assist the property owners with closure. The assessment did not include subsurface investigation to confirm the actual subsurface conditions; therefore, these recommendations are considered preliminary and may need to be updated based on conditions encountered during physical closure work or future investigation(s). Specific recommendations for each feature are listed in Table 1.

1. Investigate and Close: For locations where water level in the mine workings is present at or near the ground surface and no records of physical closure are known, NV5 recommends further investigation and development of physical closure design. This includes near-surface features associated with the East Eureka Shaft, East Eureka Drain, Idaho Drain Tunnel, Idaho Pump Shaft and Idaho Shaft. The approximate location of these features is depicted on Figure 1.

The likely course of action will be to overexcavate surface soil in the areas of these features to determine where competent, native soil/rock is located and attempt to identify the trend of any subsurface mining-related structures (i.e. tunnel, shaft, drift, etc.). Once the alignment and limits of the feature are established, NV5 will provide recommendations for physical closure of the feature, including a narrative and a cross section, stamped by a licensed geotechnical engineer. We anticipate that the recommended closure methods will include the use of a cast-in-place concrete cap or plug supported by temporary false work and covered to the ground surface with engineered fill. Typical equipment utilized for repairs of this nature may include a large excavator (Cat 320 or equivalent), mid-size backhoe or loader, haul truck, concrete trucks and concrete pump. Typical duration for such mitigation activities take approximately a week to complete; however, the site accessibility, weather, contractor scheduling, and scale of mitigation effort will govern scheduling of such work. Site specific conditions and repair details should be verified in the field by NV5 during investigation and be implemented into the repair design. A representative of NV5 should be present during all field explorations of the features and construction of the closure. Following closure work, we will prepare a letter report summarizing the works performed including as-built drawing stamped by a licensed geotechnical engineer detailing the closure work performed.

2. **Survey and Monitor:** For paved locations where water level in the mine workings is present at depths less than 100 feet and no records of physical closure are known, impact to near-surface features is not considered likely as a result of the proposed dewatering. However, NV5 recommends documentation of baseline conditions (current ground surface elevations) and periodic monitoring during future dewatering/mining operations. The ground surface at these locations should be surveyed prior to dewatering so that the locations can be monitored for possible future settlement. Surveying should include ground surface elevation relative to mean sea level to an accuracy of 0.01 foot, and horizontal coordinates (latitude and longitude) in decimal degrees using methods that satisfy state regulations. Surveying should be performed by a California Registered Professional Land Surveyor.
3. **Notify and Document:** NV5 recommends photographic documentation of surface conditions before, during and after dewatering for the following cases, where impact to near-surface features is not considered likely as a result of the proposed dewatering.
  - a. Developed locations where the water level in the mine workings is present at depths less than 100 feet, and although the features were previously closed, no formal record of physical closure was identified.
  - b. Undeveloped locations where water level in the mine workings is present at depths less than 10 feet and no records of physical closure are known. The currently undeveloped locations should not be developed without investigation and engineered physical closure.
4. **No Action:** For locations where the water level in the mine workings is relatively deep (i.e., greater than 100 feet bgs) and/or the mining feature has previously been physically closed, the chance of near-surface impact associated with dewatering is considered remote. This evaluation does not eliminate the possibility of future settlement at these historical excavation locations, but finds that the possibility of impact resulting from the proposed dewatering is remote.

## 4 LIST OF REFERENCES

AMEC Foster Wheeler, June 1, 2017. Technical Report on the Idaho-Maryland Project, Grass Valley, California.

Anderson Geotechnical Consultants, Inc. May 12, 1986. Geotechnical Investigation, East Bennett Street Property, East Bennett Street and Brunswick Road, Nevada County, California. File no. 1818-1.

Bigley, Doug. February 5, 2020. NV5 Interview with property owner at 865 Idaho-Maryland Road, Grass Valley, California.

Carlton Engineering Inc. June 12, 2000. Lawler House Underpinning, 12305 Bet Road, Grass Valley, California. Sheets G1-G4

Earthtec Ltd, February 8, 1989. General Geotechnical Study, Hilltop Warehouse Phase I, Springhill Drive near Idaho-Maryland Road, Grass Valley, California. Job no. 88-295.

EMKO Environmental, Inc., March 2020. Groundwater Hydrology and Water Quality Analysis Report for the Idaho-Maryland Mine Project.

Environmental Science Associates, Inc. October 2008. DRAFT Environmental Impact Report, Idaho-Maryland Mine Project, Grass Valley, California. SCH N

Holdrege & Kull Consulting Engineers and Geologists. October 25, 2004. Preliminary Geotechnical Engineering Report, Idaho-Maryland Mining Corporation Property, Nevada County, California. H&K Project no. 2416.03.

Lawler, David. NV5 Interview with property owner at 12305 Bet Road, Grass Valley, California.

Lowry & Associates, July 31, 1978. Preliminary Gseologic Investigation, Spring Hill Mines Property, Idaho-Maryland Road and Dorsey Drive, Grass Valley, California. L & A job no. 78-420.

Lowry & Associates, April 21, 1983. Engineering Geologic Report, Whispering Pines Park, Idaho-Maryland Road at Brunswick Road, Grass Valley, California. L & A job no. 83-118.

Lowry & Associates, December 19, 1985. Foundation Engineering Report, Wolf Creek Industrial Park, Idaho-Maryland Road, Grass Valley, California. L & A job no. 85-510.

Lowry & Associates, February 27, 1986. Geotechnical Report, Whispering Pines Assessment District Improvements, Idaho-Maryland Road at Brunswick Road, Grass Valley, California. L & A job no. 86-73.

Navo, Chris. February 5, 2020. NV5 Interview with property owner at 815 Idaho-Maryland Road, Grass Valley, California.

Nevada, County of. August 10, 2001. Nevada County Residential Building Inspection Record, 12305 Bet Road, Grass Valley, California. Permit #00-72094

Newsom, J.B., September 1936. Shaft Boring Found Inexpensive and Safe, *Engineering and Mining Journal*.

Newsom, J.B. and Jackson, G.F., October 1936. Shaft Sinking with a Shot Drill, Idaho Maryland Mine, Grass Valley, Calif. *Information Circular Department of the Interior – Bureau of Mines*.

Waterman, Glenn C., September 30, 1997. Geological Paper - The Idaho Maryland Mine

## 5 LIMITATIONS

NV5's assessment was limited to the specific features identified in this letter. Other features may be present that were not addressed herein.

NV5's scope was limited to the review of surface conditions and historical as-built documentation. No subsurface investigation was performed. Therefore, this assessment did not completely characterize subsurface conditions, and conditions may exist that require modification of our preliminary recommendations and proposed mitigation measures.

NV5's professional services were performed consistent with the generally accepted geotechnical engineering principles and practices employed in northern California. No warranty, expressed or implied, is made or intended in connection with our work.

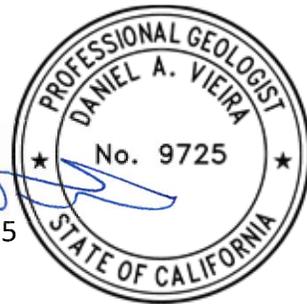
These services were performed consistent with NV5's agreement with our client. We are not responsible for the impacts of any changes in standards, practices, or regulations subsequent to performance of our services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this report. This report is solely for the use of our client. Any reliance on this report by a third party is at the party's sole risk.

The findings of this report are valid as of the present date. Changes in the conditions of the property can occur with the passage of time. The changes may be due to natural processes or to the works of man, on the subject site or adjacent properties. If changes are made to the nature or design of the project as described in this report, then the conclusions and recommendations presented in this report should be considered invalid by all parties. Only our firm can determine the validity of the conclusions and recommendations presented in this report. Therefore, we should be allowed to review all project changes and prepare written responses with regards to their impacts on our conclusions and recommendations. The recommendations presented in this report should not be relied upon after a period of two years from the issue date without our review.

Please contact us if you have any questions regarding our findings or the conclusions and recommendations presented in this letter.

Sincerely,

**NV5**



Daniel A. Vieira, P.G. 9725  
Project Geologist

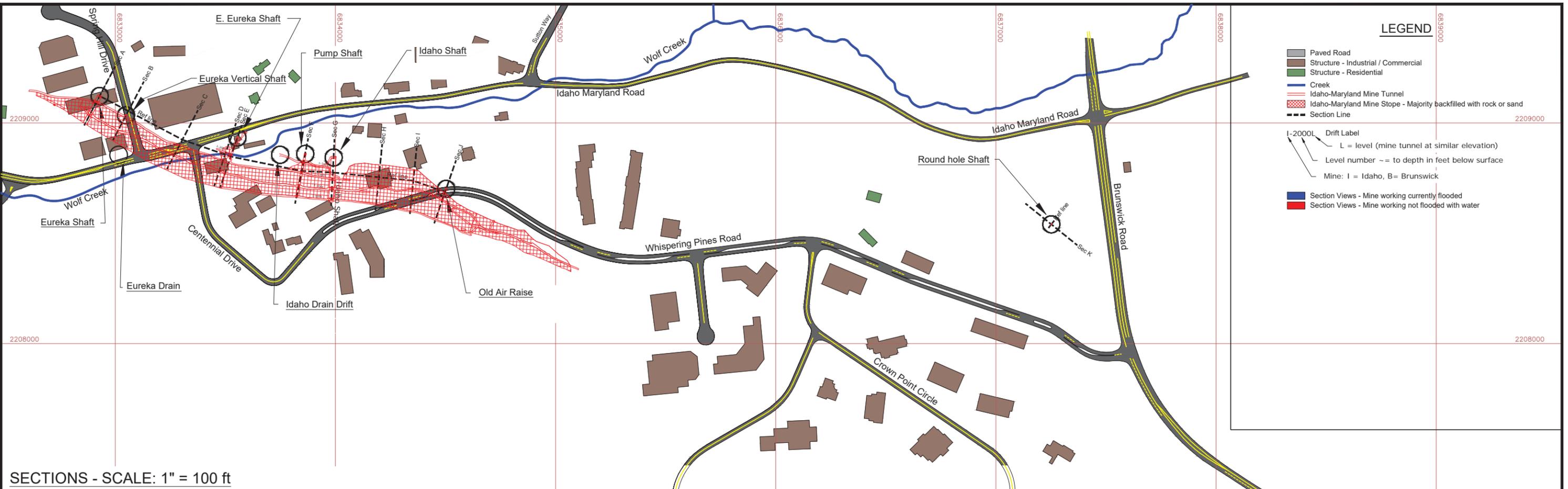


Chuck Kull, G.E. 2359  
Principal Engineer

Attachments: Sheet A207, Mine Workings, Near Surface, Showing Location and Geometry (Rise, 2019)  
Table 1, Summary of Geotechnical Assessment  
Figure 1, Surface Features to Investigate and Close  
Additional References

Copies: PDF to Rise Grass Valley Inc. /Attn: Ben Mossman, [ceo@risegoldcorp.com](mailto:ceo@risegoldcorp.com)

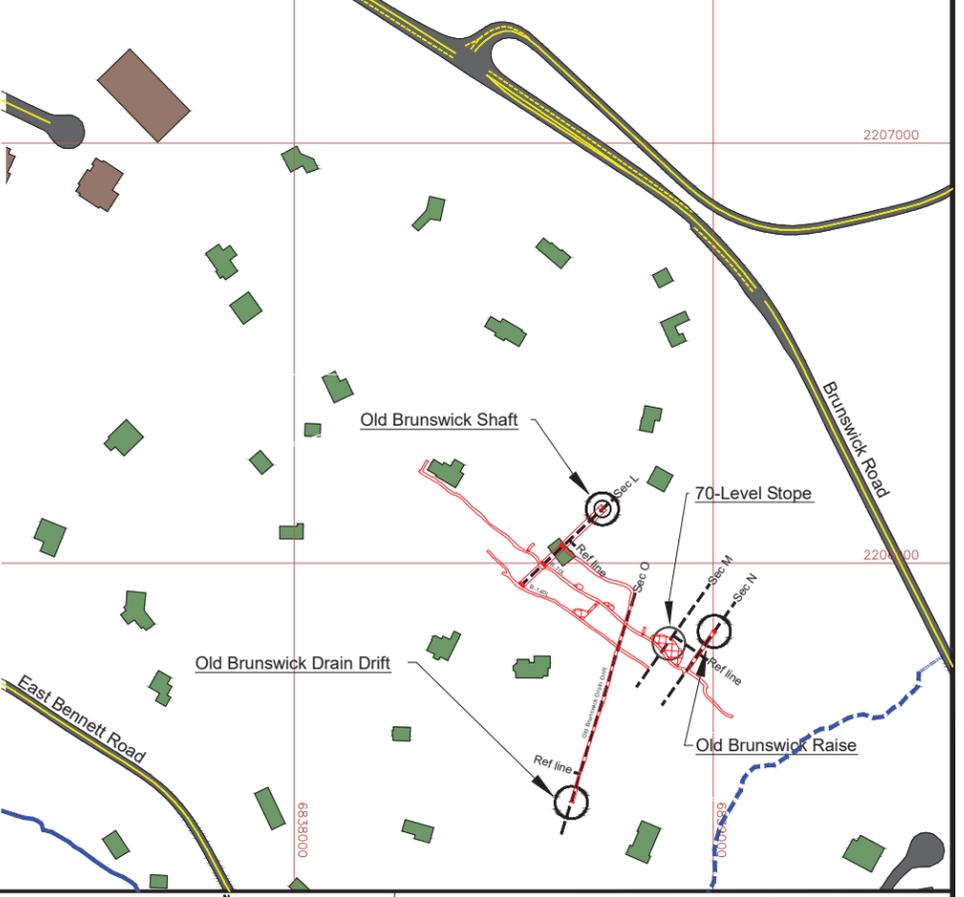
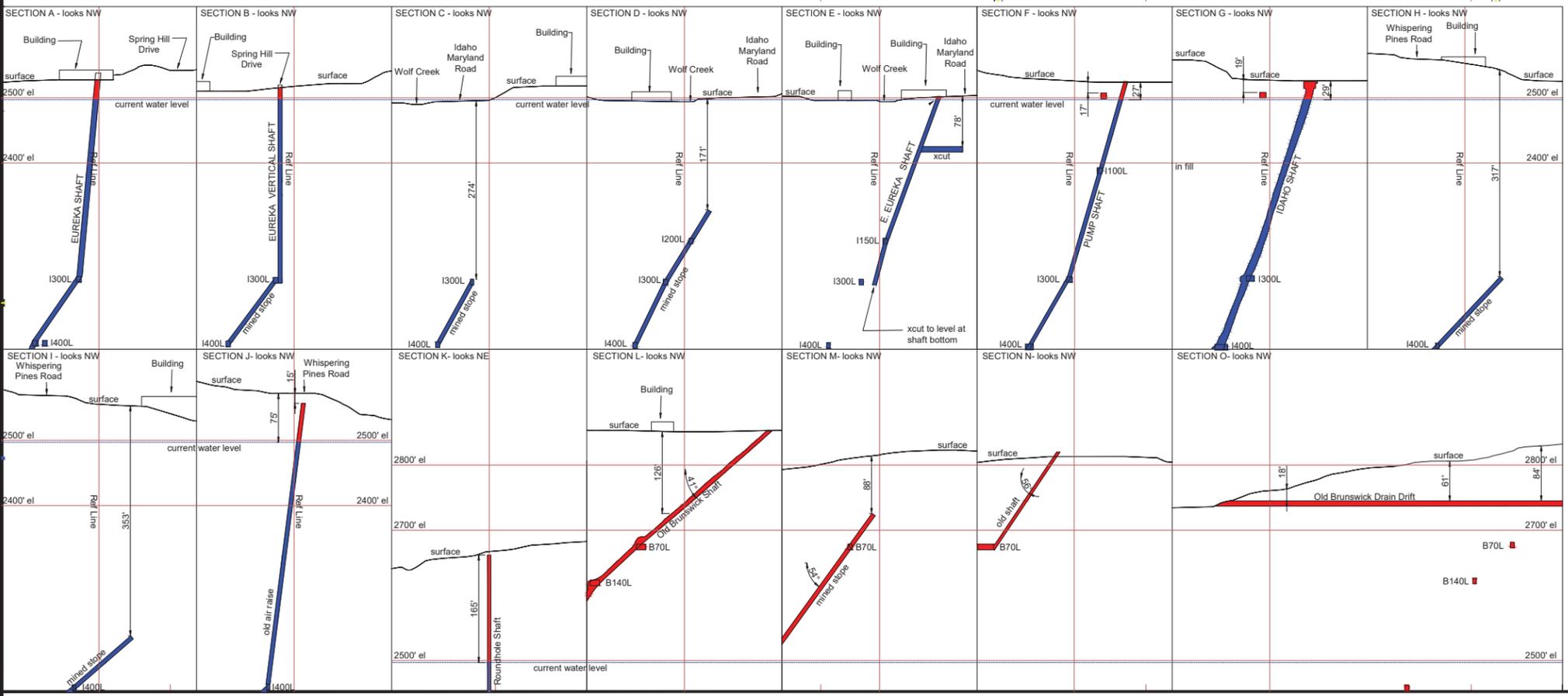
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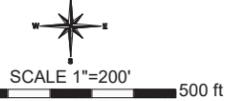
**LEGEND**

- Paved Road
- Structure - Industrial / Commercial
- Structure - Residential
- Creek
- Idaho-Maryland Mine Tunnel
- Idaho-Maryland Mine Stope - Majority backfilled with rock or sand
- Section Line
- Drift Label
- L = level (mine tunnel at similar elevation)
- Level number ~ = to depth in feet below surface
- Mine: I = Idaho, B = Brunswick
- Section Views - Mine working currently flooded
- Section Views - Mine working not flooded with water

**SECTIONS - SCALE: 1" = 100 ft**



**R** Idaho-Maryland Gold Project  
 Rise Grass Valley Inc.  
 PO Box 271  
 Grass Valley, California, USA 95945



**A207 Mine Workings Near Surface**  
 Showing location and geometry

Drawn by : Rise Grass Valley - Aug 15 / 19    Scale : 1" = 200 feet  
 Approval : TBA

Lidar & Airphotos by Aero Geometrics with survey control by Nevada City Engineering May 7th 2018; Grass Valley, CA. Horizontal Datum: NAD83 (2011). Vertical Datum: GEOID 128. NAVD 83 Projection: California State Plane Zone 2. Combined Scale Factor: 0.9979891

**Table 1 – Summary of Geotechnical Assessment of Near-Surface Mine Features and Preliminary Recommendations**

Idaho Maryland Mine Project  
Nevada County, California

ID No.	Feature	Grass Valley Street Address and APN	Approximate Latitude and Longitude (degrees)	Existing Surface Conditions	Known Water Discharge	Approximate Ground Surface Elevation (ft amsl)	Estimated Depth to Static Groundwater* (ft bgs)	Preliminary Recommendation (see Section 3)
1	Eureka Shaft	125 Spring Hill Drive (009-201-022)	39.2243, -121.0424	commercial building, slab-on-grade	No	2532	35	Notify and Document
2	Eureka Vertical Shaft	Westbound lane/sidewalk of Spring Hill Drive (no APN)	39.2240, -121.0420	street pavement, sidewalk, planter, utility vaults	No	2514	17	Survey and Monitor
3	Eureka Drain	Vicinity of Eureka Shaft (009-720-001 and 009-550-041)	39.2239, -121.0402	street pavement	Yes	2502	5	Notify and Document
4	East Eureka Shaft	815 Idaho Maryland Road (009-550-041)	39.2237, -121.0403	commercial building, framed floor	Yes	2501	4	Investigate and Close
5	East Eureka Drain	815 Idaho Maryland Road (009-550-041)	39.2235, -121.0404	gravel surface parking lot	Yes	2497	0	Investigate and Close
6	Idaho Drain Tunnel	865 Idaho Maryland Road (009-680-021)	39.2235, -121.0396	industrial yard, soil/rock fill	No	2516	19	Investigate and Close
7	Idaho Pump Shaft	865 Idaho Maryland Road (009-680-021)	39.2235, -121.0392	industrial yard, soil/rock fill, settlement nearby	No	2524	27	Investigate and Close
8	Idaho Shaft	865 Idaho Maryland Road (009-680-021)	39.2235, -121.0387	concrete cap, soil/rock fill, settlement	No	2526	29	Investigate and Close
9	Old Air Raise	Westbound lane/center of Whispering Pines Lane	39.2231, -121.0369	street pavement, median planter	No	2572	75	Survey and Monitor
10	Roundhole Shaft	200 feet west of Brunswick Rd between Idaho Maryland Rd and Whispering Pines	39.2225, -121.0272	concrete slab	No	2670	173	No Action
11	Old Brunswick Incline Shaft	12305 Bet Road (009-581-019)	39.2158, -121.0221	residence, engineered closure under building permit	No	2854	357	No Action
12	Old Brunswick Raise (Shaft)	12448 Old Mine Road (009-581-053)	39.2150, -121.0211	earth fill, waste rock	No	2816	319	No Action
13	70-Level Stope	12477 & 12401 Old Mine Road and 12305 Bet Road (009-581-016, 017, 019)	39.2150, -121.0215	vacant wooded area, residential driveway	No	2830	330	No Action
14	Old Brunswick drain tunnel	12448 Old Mine Road (009-581-053)	39.2139, -121.0223	vacant wooded area, residential driveway	No	2742	245	No Action
15	New Brunswick Shaft	12301 Millsite Road (009-630-039)	39.2111, -121.0180	mine site, steel plate	No	2756	259	Not applicable: to be used as part of the proposed mining

Notes:

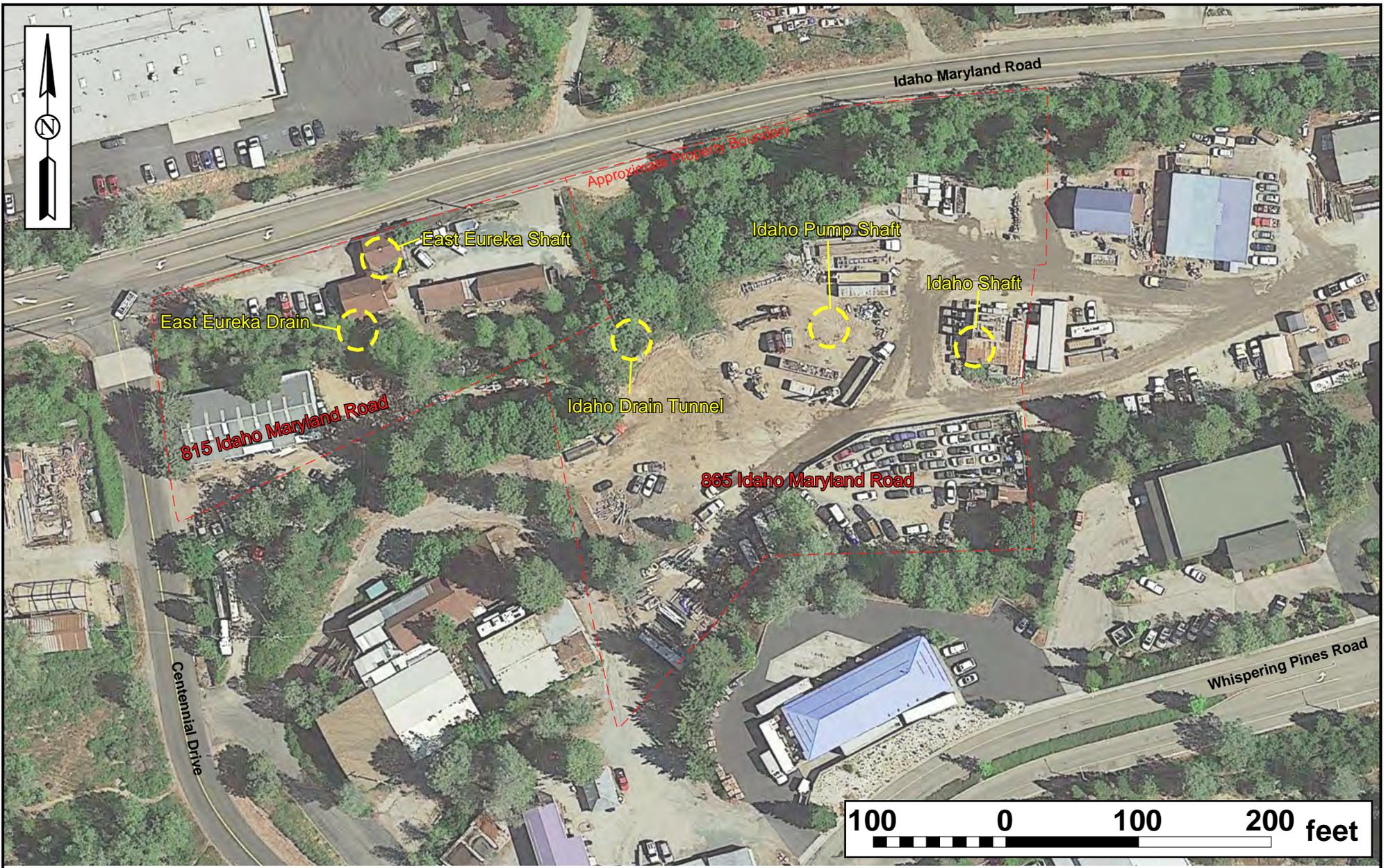
\*The depth to groundwater was estimated based on the difference between the estimated ground surface elevation at the feature location and the estimated static groundwater elevation within the mine workings (2,497 ft amsl).

All coordinates and elevations are estimated and were not determined by survey. Therefore, the locations and elevations should not be relied upon as being exact.

amsl = above mean sea level

APN = Nevada County assessor parcel number

ft = feet



Reference: Google Earth Imagery, Image Date 5/17/2018, Accessed 9/8/2020

Scale: 1" = 100'



792 Searls Avenue, Nevada City, California, 95959  
 PHONE: 530-478-1305, FAX: 530-478-1019

## SURFACE MINE FEATURES TO INVESTIGATE AND CLOSE

Project Name: IDAHO-MARYLAND MINE PROJECT  
 Location: GRASS VALLEY, CALIFORNIA  
 Project No.: 5279.02

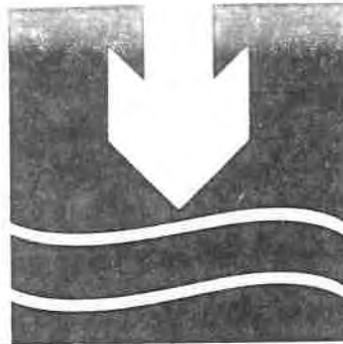
Date: AUGUST 2020  
 Drawn By: D. VIEIRA  
 Checked By: J. MUIR

FIGURE

1

File No. 1818-1

12 May 1986



file copy  
ANDERSON  
GEOTECHNICAL  
CONSULTANTS, INC.

Erickson, Bouma, and Toms  
c/o Erica Erickson  
353 Clay Street  
Nevada City, California 95959

Subject: East Bennett Street Property  
East Bennett Street and Brunswick Road  
Nevada County, California  
GEOTECHNICAL INVESTIGATION

RECEIVED  
MAY 13 1986  
NEVADA COUNTY  
PLANNING DEPARTMENT

Gentlepersons:

An additional geotechnical investigation of 5 proposed residential lots on the north side of East Bennett Street near Brunswick Road has been completed. The purpose of our investigation was to locate any possible geologic hazards due to past mining activity at the old Brunswick Mine. This investigation was performed in conjunction with our previous Geotechnical Reconnaissance (dated 26 February 1986) in which we recommended that additional studies take place to locate buried shafts, tunnels, and adits and find buildable areas on each residential lot. No additional work was performed on lots 6, 7, and 8. These lots are to have geotechnical investigations performed on an individual basis at a later date.

To complete our additional investigation, six test borings were excavated, at least one per lot, and a review of previous underground surveys was performed. The underground survey map was provided to us by Al Beeson, who obtained it from the

12 May 1986

property owners. The underground map was produced by plotting underground data on a topographic base map produced in 1920 when the Brunswick Mine was still active. Using this map we were able to determine where the old mine structures (headworks, mills, pipelines, tailings piles) were located in relation to the site. The 1920 base map also shows the locations of old ditches, prospects, adits, and shafts. We were also able to determine the depth beneath the ground surface of the shafts and tunnels in the area. An extensive surface reconnaissance and a review of old (1962) aerial photos was also completed.

The locations of the test borings is shown on Figure 1. In the test borings, we found no evidence of near surface tunnels or voids within the depths drilled (20 to 35 feet). In choosing the locations of the test borings, we utilized spots that were unlikely to be the location of any tunnels (according to the 1920 map). Logs of the six test borings are shown on Figures 2 through 7. The locations of the borings on Figure 1 is only approximate as they were located by referencing from topographic features.

#### RESULTS AND CONCLUSIONS

The results of our study indicate that single family residences can be built on select areas on each of the five lots. On Figure 1, we have plotted appropriate building envelopes on each lot. These building areas have been selected to minimize the risk of experiencing problems from past mining activities at the site.

We recommend that residential construction be avoided on the tailings piles on lots 2 and 4. Although most of the tailings have been removed (reused for aggregate and/or fill off the site), constructing on the remaining tailings could prove difficult. Home sites on the tailings are also considered undesirable. Lots

File No. 1818-1

12 May 1986

2 and 4 have enough area that is not on the tailings to provide sufficient building areas.

The fault that was addressed in our initial Geotechnical Reconnaissance (dated 26 February 1986) as crossing near lot 2 appears to be present on the northern most part of the lot. The age of this fault is on the order of 100 million years and any potential risk of movement is so slight that it should not effect single family residential construction. We recommend that any construction be set back at least 200 feet from the fault (the approximate location of the fault is shown in our previous work, Geotechnical Reconnaissance).

Soil conditions at the site, other than the tailings piles, are suitable for conventional residential foundation systems if footings are properly designed and constructed.

Sincerely,

ANDERSON GEOTECHNICAL CONSULTANTS, INC.

Eric C. Schwarz

A handwritten signature in black ink, appearing to read "Gery F. Anderson". The signature is fluid and cursive, with a long horizontal stroke extending to the right.

Gery F. Anderson

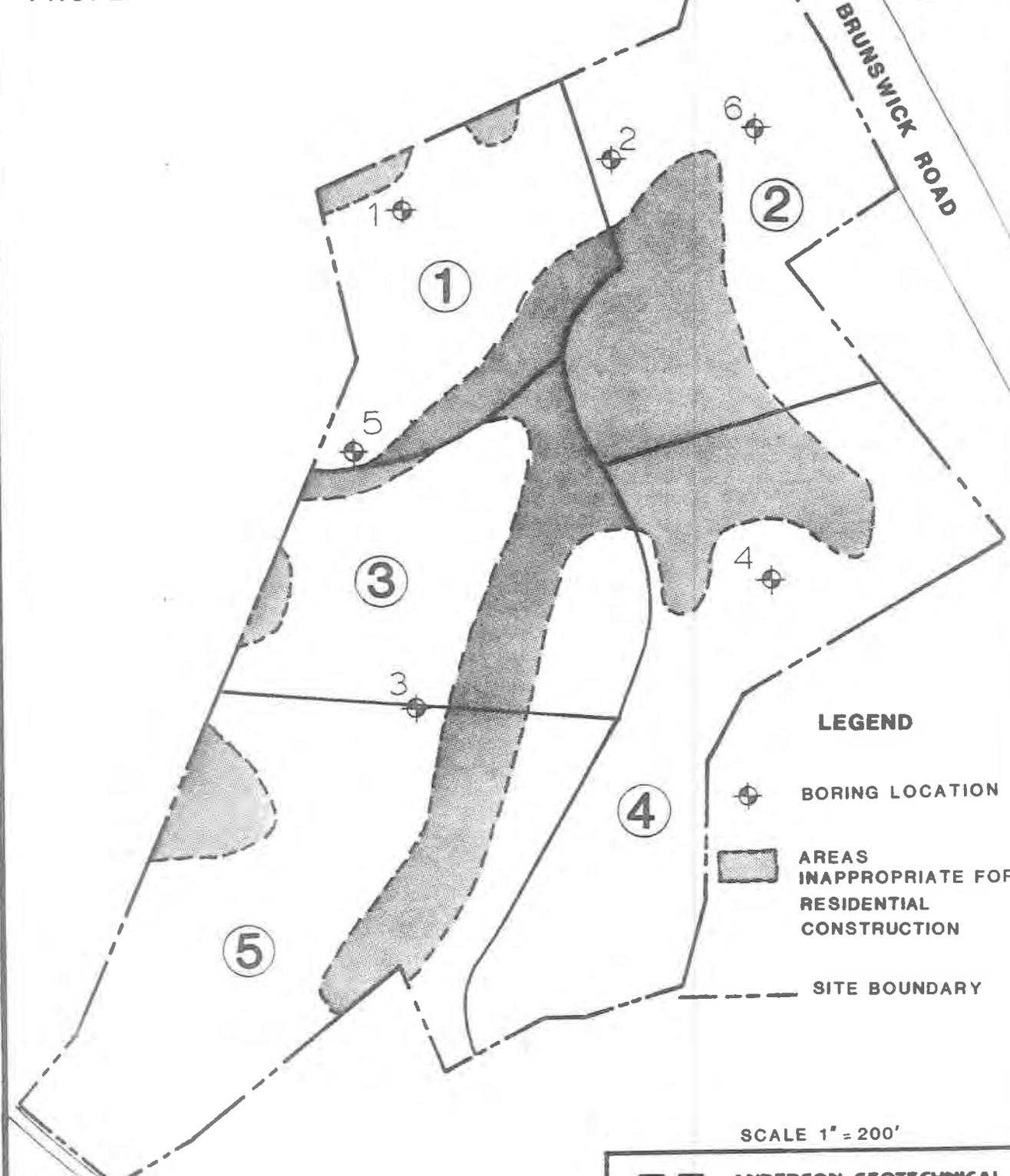
C. E. 25387

E. G. 163

copies: 2 to Al Beeson

**ANDERSON GEOTECHNICAL CONSULTANTS, INC.**

# SITE PLAN FOR EAST BENNETT STREET PROPERTY LOTS 1-5



SCALE 1" = 200'

EAST BENNETT STREET



**ANDERSON GEOTECHNICAL  
CONSULTANTS, INC.**  
Roseville (916) 786-8883  
Grass Valley (916) 273-SOIL

Fig. 1



## FIELD EXPLORATION AND LABORATORY TESTING

Six test borings were drilled at the project site under the supervision of an engineer to determine the type, location, and uniformity of the underlying soil and to locate any possible underground workings in the area. Relatively undisturbed soil samples were obtained as the borings were advanced, the purpose of the exploration being to determine if the locations drilled would be suitable for residential construction. Logs of the six test borings, graphically depicting the materials encountered, are shown as Figures 3 through 8. The maximum depth penetrated by the borings was 35 feet.

The borings were drilled with a Mobile B-34 truck-mounted drill rig, using 4-inch diameter continuous flight augers. Undisturbed soil sampling was accomplished with a 2-inch O.D. sampler. The sampling tool was driven into the ground by the force of a 140 pound hammer dropping 30 inches. Undisturbed samples were examined in the field to determine the type of material encountered.

No laboratory tests were performed on soil samples taken from the test borings. The results of penetration tests aided in the determination of soil and rock strata encountered.

File No 1818-1

LOG OF BORING NO. 1

Date Drilled: 4/25/86

Surface Elevation: Unknown

DEPTH IN FEET	SAMPLE NO.	LOG & LOCATION OF SAMPLE	BLOWS/FT.	WATER LEVEL	DESCRIPTION	UNIFIED SOIL CLASSIFICATION	DRY DENSITY P.C.F.	MOISTURE CONTENT, %
5	1-1		13		Brown, tan, moist, very loose clayey SILT  Some rocks up to 3 inches  FILL	ML		
					Red slightly moist, moderately dense SILT	ML		
10	1-2		30		Completely weathered metavolcanic rock has some rock texture; breaks into fine SILT tan/orange  Fairly easy drilling			
15					Highly weathered metavolcanic rock More tan, less orange  A little harder drilling from 15 feet on down continuing to 30 feet			
30					Boring terminated at 30 feet			

File No. 1818-1

LOG OF BORING NO. 2

Date Drilled: 4/25/86

Surface Elevation: Unknown

DEPTH IN FEET	SAMPLE NO.	LOG & LOCATION OF SAMPLE	BLOWS/FT	WATER LEVEL	DESCRIPTION	UNIFIED SOIL CLASSIFICATION	DRY DENSITY p.c.f.	MOISTURE CONTENT, %
					Red brown orange, very moist, fine SILT	SML		
2-1			11		Tan orange, completely weathered metavolcanic rock			
2-2			63		Isolated hard rock at 4 feet			
5					More tan, less orange, highly weathered metavolcanic rock			
					Has some rock texture, consistency of SILT when broken			
10					Highly to moderately weathered metavolcanic rock			
					Slow but steady drilling to 25 feet			
15								
20								
25								
					Boring terminated at 25 feet			

File No. 1818-1

LOG OF BORING NO. 3

Date Drilled: 4/25/86

Surface Elevation: Unknown

DEPTH IN FEET	SAMPLE NO.	LOG & LOCATION OF SAMPLE	BLOWS/FT	WATER LEVEL	DESCRIPTION	UNIFIED SOIL CLASSIFICATION	DRY DENSITY p.c.f.	MOISTURE CONTENT %
					Red brown, moist, loose SILT	ML		
0	3-1		8		Orange tan, completely weathered metavolcanic rock, has some rock texture-silty consistency when broken			
5					More tan in color Soft, easy drilling			
10	3-2		30		Very easy drilling More moisture More clayey SILT in cuttings			
15								
20								
25								
30					Break in log			
35					Boring terminated at 35 feet			

File No 1818-1

LOG OF BORING NO. 4

Date Drilled: 4/25/86

Surface Elevation: Unknown

DEPTH IN FEET	SAMPLE NO	LOG & LOCATION OF SAMPLE	BLOWS/FT	WATER LEVEL	DESCRIPTION	UNIFIED SOIL CLASSIFICATION	DRY DENSITY p.c.f.	MOISTURE CONTENT %
					Some gravel on roadway	GM		
					Red brown, moist, loose SILT, little SAND	ML		
5	4-1		20		Completely weathered metavolcanic rock has some rock texture, breaks into fine SILT with little clay  Easy drilling straight to 30 feet			
30					Boring terminated at 30 feet in steady drilling			

File No 1818-1

LOG OF BORING NO. 5

Date Drilled: 4/25/86

Surface Elevation: Unknown

DEPTH IN FEET	SAMPLE NO.	LOG & LOCATION OF SAMPLE	BLOWS/FT.	WATER LEVEL	DESCRIPTION	UNIFIED SOIL CLASSIFICATION	DRY DENSITY P.C.F.	MOISTURE CONTENT, %
					Rock and gravel tailings	Rocks		
					Red brown, moist, loose SILT little Sand	ML		
5					Orange tan, completely weathered metavolcanic rock has SILTY with some clay texture when broken			
10								
15								
17					Harder slightly weathered metavolcanic rock at 17 approximately 17 feet			
20					Harder drilling			
					Boring terminated at 20 feet			

File No. 1818-1

LOG OF BORING NO. 6

Date Drilled: 4/25/86

Surface Elevation: Unknown

DEPTH IN FEET	SAMPLE NO.	LOG & LOCATION OF SAMPLE	BLOWS/FT.	WATER LEVEL	DESCRIPTION	UNIFIED SOIL CLASSIFICATION	DRY DENSITY Pct.	MOISTURE CONTENT %
					Grey, dense, trailings Rock up to 4 inches Mainly rock and gravel, little sand	GP		
5					Red orange brown, moist, loose SILT	ML		
10					Orange tan completely weathered rock Fairly easy drilling			
15					Somewhat harder drilling to 30 feet			
20								
25								
30					Boring terminated at 30 feet			

SURVEYOR'S CERTIFICATE:

This Final Map for BET ACRES represents a survey which is true and complete as shown, made by me or under my direction in conformance with the requirements of the Subdivision Map Act and local ordinances in January 1987, and the monuments are of a character and occupy the positions as shown and are sufficient to enable the survey to be retraced.

A.W. Beeson  
A.W. BEESON L.S. 3224

COUNTY SURVEYOR'S CERTIFICATE:

This Final Map has been examined by me, and the subdivision shown is substantially the same as it appeared on the Tentative Map and any approved alterations thereof and provisions of the Subdivision Map Act and local ordinances applicable at the time of the approval of the Tentative Map have been complied with and I am satisfied that this Final Map is technically correct this 25 day of FEB. 1987

Wesley W. Zachary  
WESLEY W. ZACHARY R.C.E. 19284

COUNTY RECORDER'S CERTIFICATE:

I Bruce C. Bolinger, hereby certify that Inter-County Title certificate no. 82246 was filed with this office, and that this plat map was accepted for record, and recorded in BOOK 7 of Subdivisions at Page 75 Document NO 87-04782 at 3:00 p.m. on this 24<sup>th</sup> day of February 1987

Doc # 87 04782  
FEE: \$ 12.00 pd  
Bruce C. Bolinger  
BRUCE C. BOLINGER  
By: Frances Durr  
DEPUTY

TAX COLLECTOR'S CERTIFICATE:

I, E. Christina Dabis, the official computing redemptions for the County of Nevada, State of California, do hereby certify that according to the records of my office, there are no liens for unpaid taxes or special assessments collected as taxes against the lands subdivided hereon, except taxes or assessments not yet due and payable, but constituting a lien is paid.

E. Christina Dabis  
E. CHRISTINA DABIS  
NEVADA COUNTY TAX COLLECTOR

BOARD OF SUPERVISOR'S CERTIFICATE:

This is to certify that the Board of Supervisors of the County of Nevada, State of California, by a motion adopted at a meeting held on the 23rd day of FEBRUARY 1987, did approve for filing this map of the BET ACRES property consisting of 4 sheets, and accepted for public use item 1 offered for dedication above. All provisions of the Subdivision Map Act and local ordinances have been complied with regarding deposits this 23rd day of FEBRUARY 1987

Steve James CHAIRMAN OF THE BOARD  
Lady Thompson CLERK OF THE BOARD

OWNER'S CERTIFICATE:

The undersigned, being the only persons representing any record title interest in the herein subdivided lands, do hereby consent to the preparation and recording of this Final Map and offer for dedication and do hereby dedicate to the County of Nevada the following:

ITEM 1: For any and all Public road and Utility purposes, those areas shown as East Bennett rd. Areas A, B and C, excepting therefrom minerals below 150' with the right to mine without disturbing the surface.

Mary Bouma  
MARY BOUMA  
Erica Erickson  
ERICA ERICKSON  
William Toms  
WILLIAM TOMS

STATE OF CALIFORNIA } SS.  
COUNTY OF \_\_\_\_\_ }

On this 5<sup>th</sup> day of February 1987 Before me, the undersigned, a Notary Public, State of California, duly commissioned and sworn, personally appeared Mary Bouma, Erica Erickson and William Toms. Known to me to be the persons whose names are subscribed to the within instrument and acknowledged to me that they executed the same.

In Witness Whereof I have hereunto set my hand and affixed my official seal the day and year in this certificate first above written

A Notary  
NOTARY PUBLIC IN AND FOR SAID COUNTY & STATE  
MY COMMISSION EXPIRES July 5, 1990

EASEMENTS OF RECORD OF WHICH EXACT LOCATION CAN NOT BE DETERMINED

- 1. Idaho Maryland Mines to Normile, (now Walker) Pipeline Esmt. 224 OR 286
- 2. Matteson to Central Calif. Electric Co. overhead wires, 100 DEEDS 418 & 96 DEEDS 470

REFERENCE DEEDS:

- D1 Bulgrin, 85-14691
- D2 Bohemia Inc., 504 OR 129
- D3 Bouma, Erickson & Toms 83-20536
- D4 "The Cedars" 1074 OR 647
- D5 Bohemia (Brunswick Timber) 986 OR 341 & 780 OR 284, 288.

REFERENCE MAPS:

- R1 3 Sub. 13, "Cordell Estates" Ingram, R.C.E. 9927 1968

FINAL MAP  
# 85-7

for  
BET ACRES

Being portions of the S.E. 1/4 of Sec. 25, the N.E. 1/4 of Sec. 36 T.16N., R.8E., and the N.W. 1/4 of Sec. 31. T.16N. R.9E., M.D.B. & M.

In the unincorporated territory of  
THE COUNTY OF NEVADA

January 1987 Scale 1"=100'  
A.W. Beeson & Assoc. Inc.

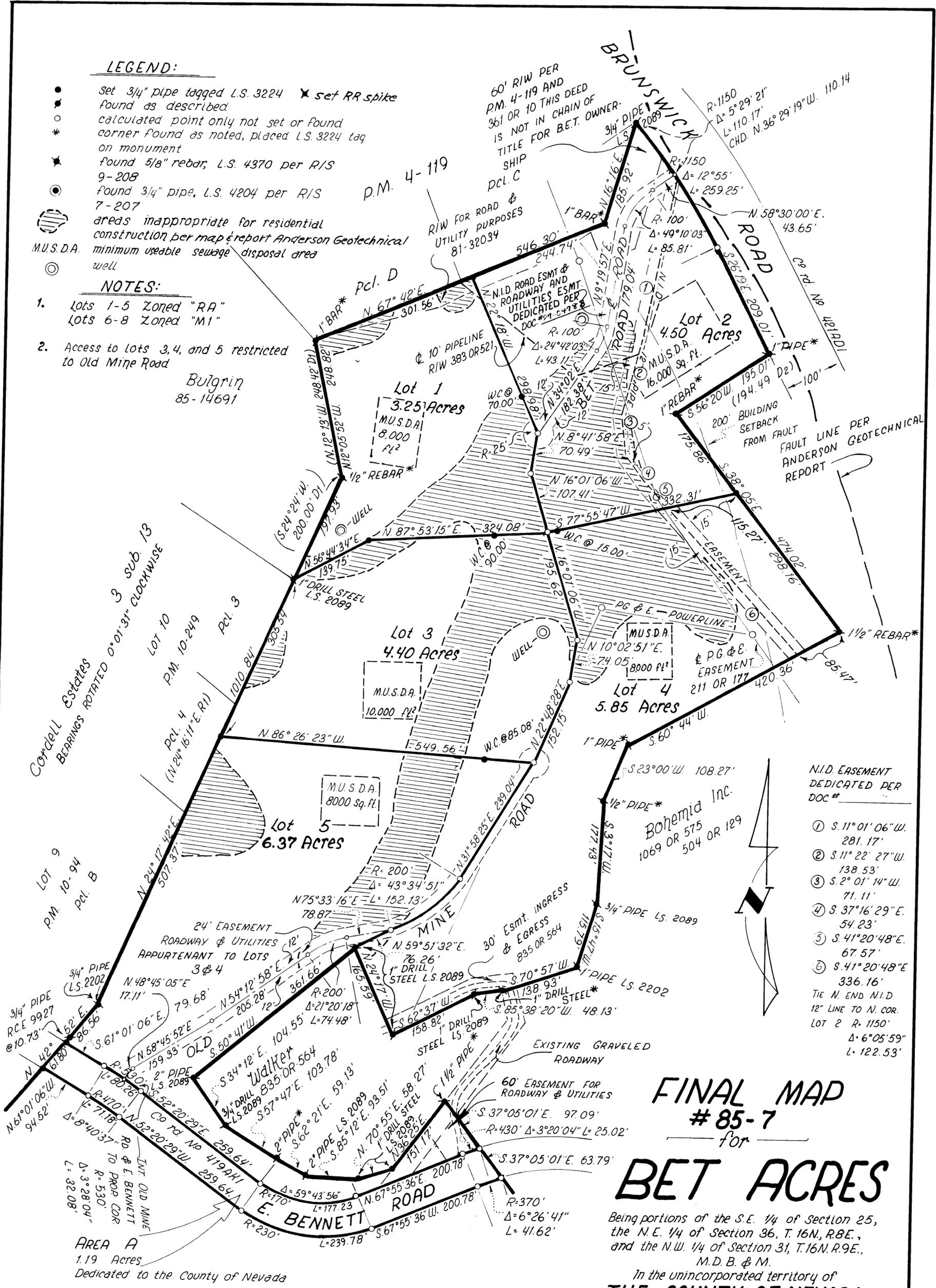
**LEGEND:**

- Set 3/4" pipe tagged L.S. 3224 ✖ set RR spike
- found as described
- calculated point only not set or found
- \* corner found as noted, placed L.S. 3224 tag on monument
- ✖ found 5/8" rebar, L.S. 4370 per R/S 9-208
- found 3/4" pipe, L.S. 4204 per R/S 7-207
- ⊕ areas inappropriate for residential construction per map & report Anderson Geotechnical
- M.U.S.D.A. minimum useable sewage disposal area well

**NOTES:**

1. Lots 1-5 Zoned "RA"  
Lots 6-8 Zoned "M1"
2. Access to lots 3, 4, and 5 restricted to Old Mine Road

Bulgrin  
85-14691



- N.I.D. EASEMENT DEDICATED PER DOC #
- ① S. 11° 01' 06" W. 281.17'
  - ② S. 11° 22' 27" W. 138.53'
  - ③ S. 2° 01' 14" W. 71.11'
  - ④ S. 37° 16' 29" E. 54.23'
  - ⑤ S. 41° 20' 48" E. 67.57'
  - ⑥ S. 41° 20' 48" E. 336.16'
- TIE N. END N.I.D. 12" LINE TO N. COR. LOT 2 R. 1150' Δ= 6° 05' 59" L= 122.53'

**FINAL MAP  
# 85-7  
for**

**BET ACRES**

Being portions of the S.E. 1/4 of Section 25, the N.E. 1/4 of Section 36, T. 16N, R. 9E., and the N.W. 1/4 of Section 31, T. 16N, R. 9E., M.D.B. & M.

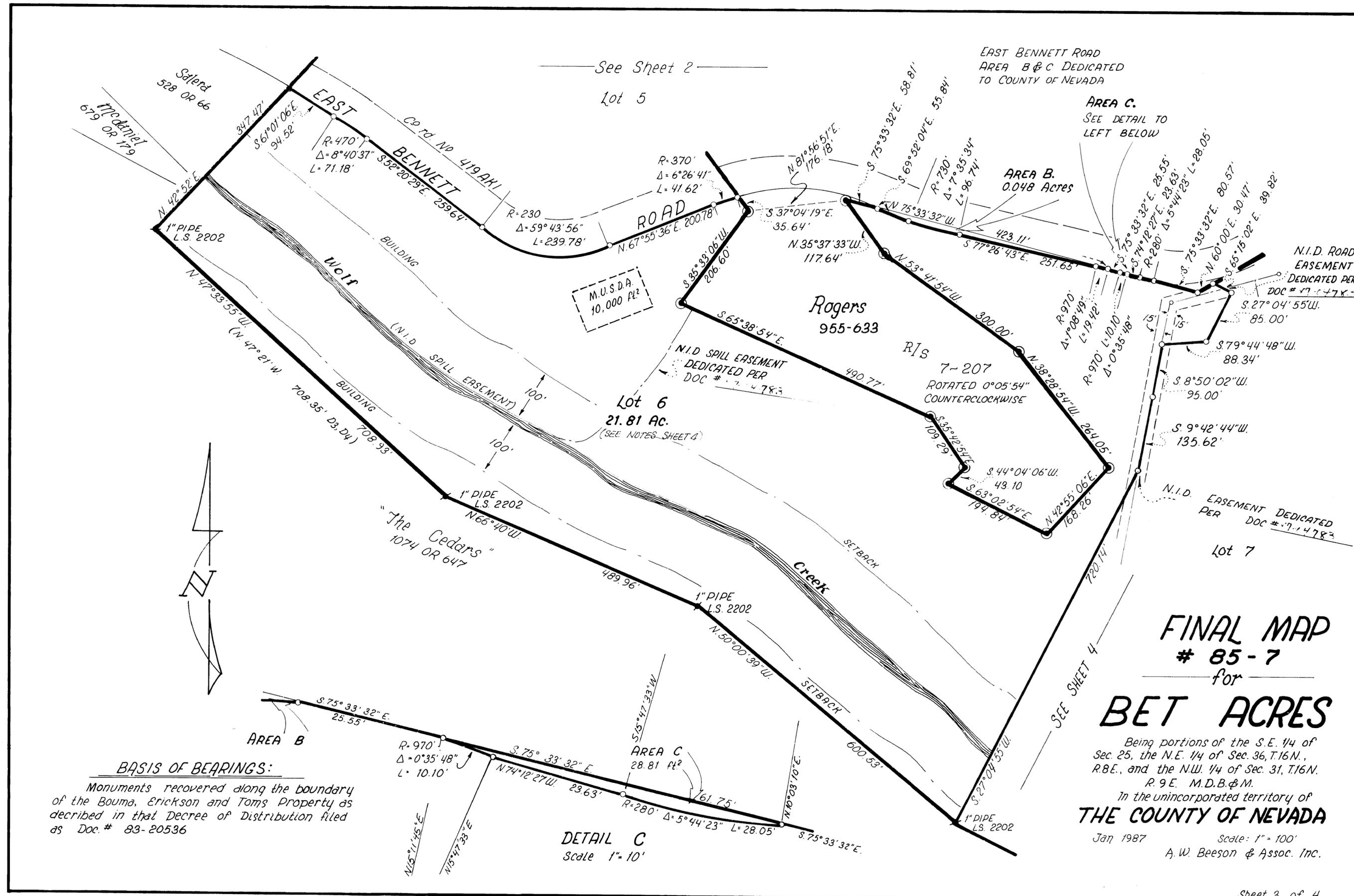
In the unincorporated territory of **THE COUNTY OF NEVADA**

January 1987 Scale: 1"=100'  
A.W. Beeson & Assoc. Inc.

**AREA A**  
1.19 Acres  
Dedicated to the County of Nevada

SEE SHEET 3  
lot 6

Sub 7 25 3-4



See Sheet 2

EAST BENNETT ROAD  
AREA B & C DEDICATED  
TO COUNTY OF NEVADA

AREA C.  
SEE DETAIL TO  
LEFT BELOW

AREA B.  
0.048 Acres

N.I.D. ROAD  
EASEMENT  
DEDICATED PER  
DOC # 83-20536

M.U.S.D.A.  
10,000 Ft<sup>2</sup>

Lot 6  
21.81 AC.  
(SEE NOTES SHEET 4)

Rogers  
955-633

R/S  
7-207  
ROTATED 0°05'54"  
COUNTERCLOCKWISE

N.I.D. EASEMENT DEDICATED  
PER DOC # 83-20536

FINAL MAP  
# 85-7  
for

BET ACRES

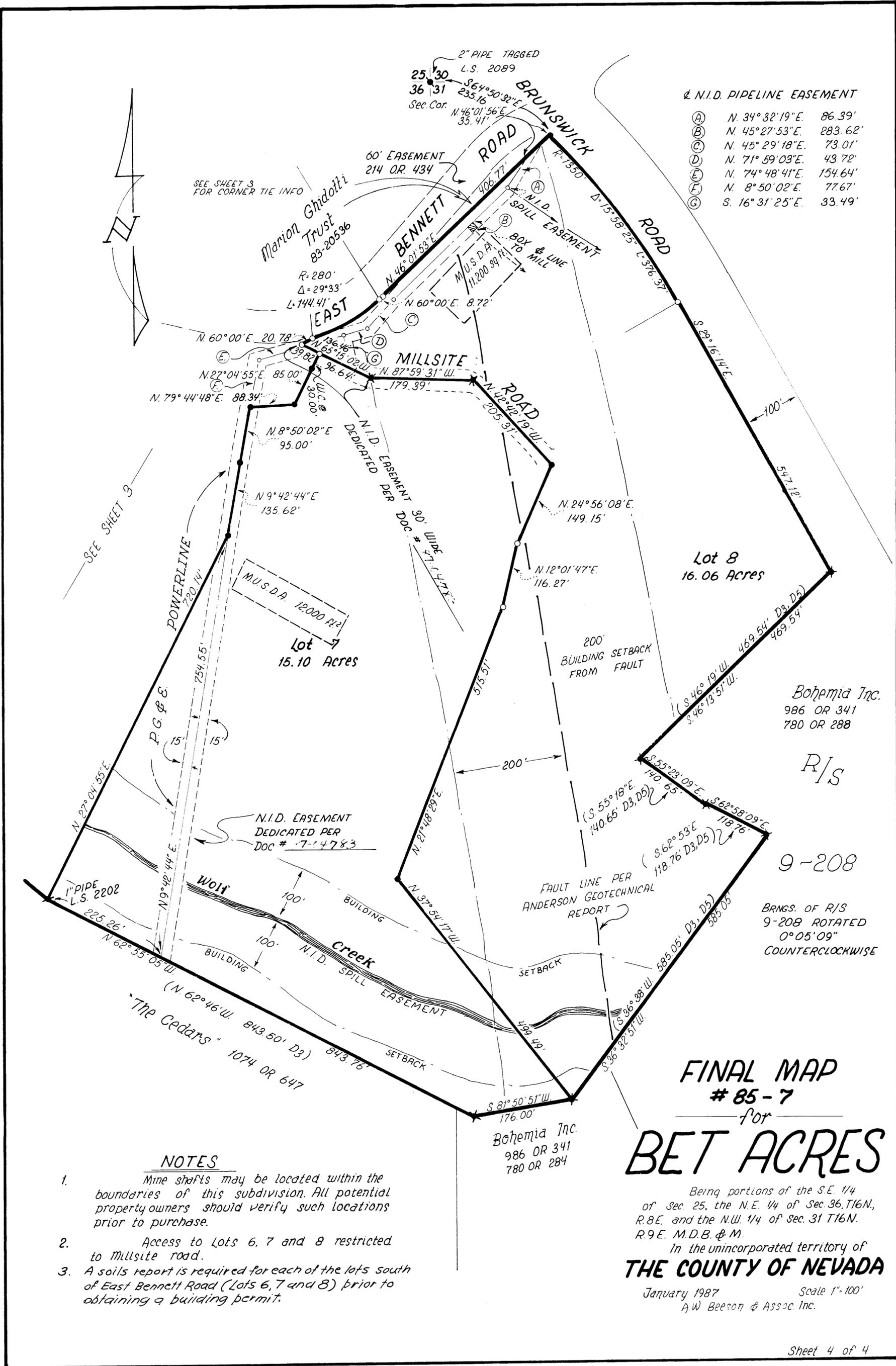
Being portions of the S.E. 1/4 of  
Sec 25, the N.E. 1/4 of Sec. 36, T.16N.,  
R.8E., and the N.W. 1/4 of Sec. 31, T.16N.,  
R. 9 E. M.D.B.&M.  
In the unincorporated territory of  
**THE COUNTY OF NEVADA**

Jan 1987 Scale: 1" = 100'  
A.W. Beeson & Assoc. Inc.

DETAIL C  
Scale 1" = 10'

**BASIS OF BEARINGS:**

Monuments recovered along the boundary  
of the Bouma, Erickson and Toms Property as  
described in that Decree of Distribution filed  
as Doc. # 83-20536



# LAWLER HOUSE UNDERPINNING

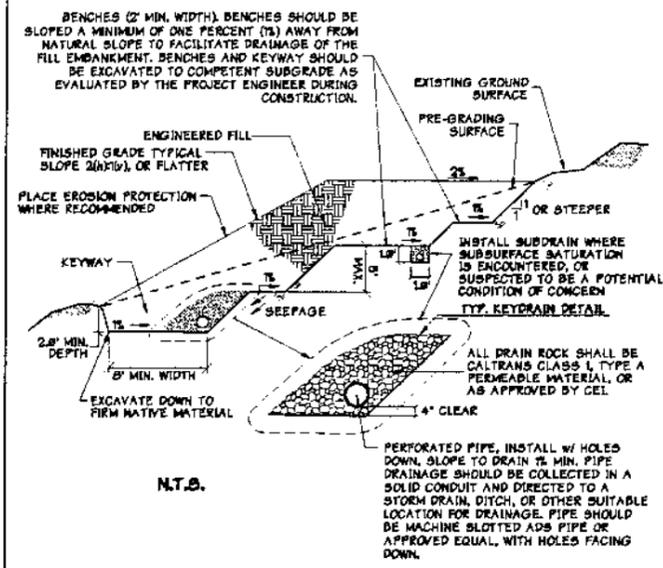
12305 Bett Road  
Nevada County, California

## Geotechnical Plans

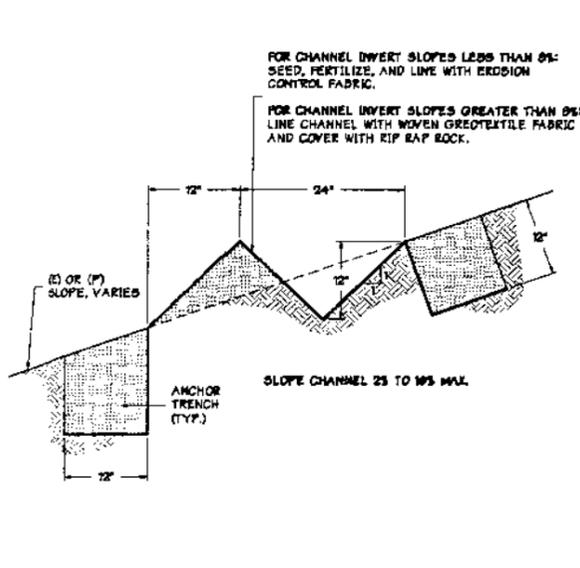


### General Notes

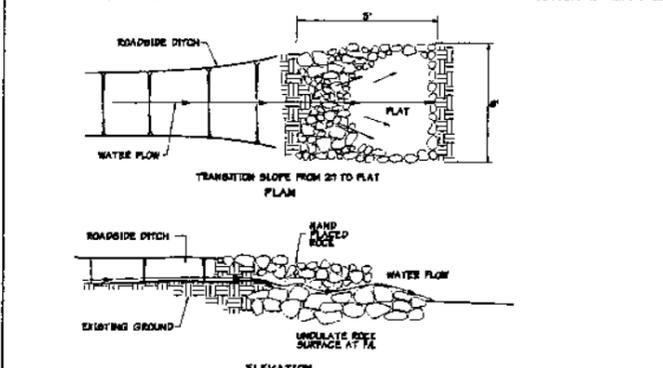
1. ALL REFERENCES TO "STANDARD SPECIFICATIONS" SHALL MEAN THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION (CALTRANS) STANDARD SPECIFICATIONS, JULY, 1992. CONSTRUCTION NOT SPECIFIED ON THESE PLANS OR SPECIFIC NEVADA COUNTY ORDINANCES SHALL CONFORM TO THE REQUIREMENTS OF THE STANDARD SPECIFICATIONS. THE CONTRACTOR IS OBLIGATED TO FAMILIARIZE HIMSELF WITH APPLICABLE SPECIFICATIONS NOT DISCUSSED IN THE GENERAL NOTES.
2. CLEARING AND GRUBBING SHALL CONFORM TO THE PROVISIONS OF SECTION 16 OF THE STANDARD SPECIFICATIONS.
3. ALL EXCAVATION, EMBANKMENT, AND BACKFILL SHALL CONFORM TO THE PROVISIONS IN SECTION 16, "EARTHWORK," OR THE STANDARD SPECIFICATIONS.
4. ALL GRADING SHALL CONFORM TO THE NEVADA COUNTY GRADING, EROSION AND SEDIMENT CONTROL ORDINANCE.
5. ALL WORK SHALL BE ACCOMPLISHED IN ACCORDANCE WITH THE NEVADA COUNTY DESIGN AND IMPROVEMENTS STANDARDS MANUAL AND TO THE SATISFACTION OF THE DIRECTOR OF THE DEPARTMENT OF TRANSPORTATION.
6. COMPACTION TESTS SHALL BE TAKEN AT A MAXIMUM OF TWO (2) FOOT LIFTS AND IN CONFORMANCE WITH THE NEVADA COUNTY GRADING ORDINANCE. TESTS SHALL BE AT THE DISCRETION OF THE DEPARTMENT OF TRANSPORTATION INSPECTOR. COSTS FOR TESTING SHALL BE THE RESPONSIBILITY OF THE DEVELOPER.
7. FILLS SHALL BE MOISTURE CONDITIONED TO A UNIFORM MOISTURE CONDITION AT LEAST 2 PERCENT ABOVE OPTIMUM MOISTURE CONTENT AND COMPACTED TO A MINIMUM OF 90% OF THE MAXIMUM DRY DENSITY AS DETERMINED BY THE ASTM D97-91 TEST PROCEDURE.
8. THE TOP EIGHT INCHES OF SUBGRADE BENEATH PAVEMENT AREAS SHALL BE MOISTURE CONDITIONED TO A UNIFORM MOISTURE CONDITION AT LEAST 2 PERCENT ABOVE OPTIMUM MOISTURE CONTENT AND COMPACTED TO A MINIMUM OF 95% OF THE MAXIMUM DRY DENSITY AS DETERMINED BY THE ASTM D97-91 TEST PROCEDURE.
9. VEGETATION SHALL BE ESTABLISHED ON ALL AREAS INCLUDING CUTS AND FILL IMMEDIATELY AFTER IMPROVEMENT CONSTRUCTION TO CONTROL EROSION. REVEGETATION SHALL BE 6 LBS/ACRE TORO ANNUAL RESCUE, 9 LBS/ACRE ROBE CLOVER, 10-20-00 FERTILIZER AT 500 LBS/ACRE AND STRAW MULCH (TUCKED) AT 4000 LBS/ACRE STRAW MULCH TO BE APPLIED TO A UNIFORM DEPTH OF 2-3 INCHES SO THAT 50%-100% OF THE SURFACE IS COVERED, OR EQUIVALENT AS APPROVED BY THE RESOURCE CONSERVATION DISTRICT.
10. THE CONTRACTOR SHALL BE RESPONSIBLE FOR IMPLEMENTING ALL TEMPORARY EROSION CONTROL MEASURES WHICH HAVE BEEN INCORPORATED INTO THIS GRADING PLAN. ALL SUCH MEASURES SHALL CONFORM TO THE NEVADA COUNTY GRADING, EROSION AND SEDIMENT CONTROL ORDINANCE TO ENSURE THAT SEDIMENT LADEN RUNOFF DOES NOT LEAVE THE PROJECT SITE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE MAINTENANCE AND PERFORMANCE OF THE TEMPORARY EROSION CONTROL MEASURES THROUGH THE DURATION OF THE PROJECT. IF GRADING ACTIVITIES ARE NOT COMPLETED BY OCTOBER 15, THE DEVELOPER SHALL IMPLEMENT THE TEMPORARY EROSION CONTROL MEASURES.
11. PERIODIC INSPECTION AND REPAIR WILL BE REQUIRED BY THE OWNER TO KEEP DRAINAGE IMPROVEMENTS OPERABLE. REMOVAL OF SEDIMENT DEPOSITS AND VEGETATIVE MATERIALS IN PIPES, INLET STRUCTURES AND DRAINAGE INVERTS SHALL BE PERFORMED AT A REGULAR MAINTENANCE INTERVAL TO PREVENT ACCUMULATION AND OBSTRUCTION OF DRAINAGE IMPROVEMENT OPERATION.
12. THE EXISTENCE AND LOCATION OF ANY UNDERGROUND UTILITIES, PIPES AND/OR STRUCTURES SHOWN ON THIS PLAN WERE OBTAINED BY A SEARCH OF AVAILABLE RECORDS. THE CONTRACTOR SHALL ASCERTAIN THE TRUE LOCATION OF ANY UNDERGROUND UTILITIES AND SHALL BE RESPONSIBLE FOR ANY AND ALL DAMAGE TO ANY AND ALL PUBLIC OR PRIVATE UTILITIES, SHOWN OR NOT SHOWN HEREON.



Keyway Detail NTS 1



Drainage Ditch Detail NTS 3

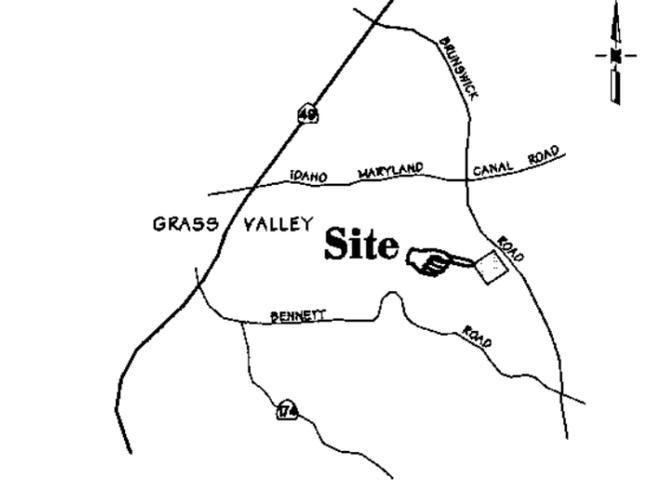


Outlet Protection Detail NTS 2

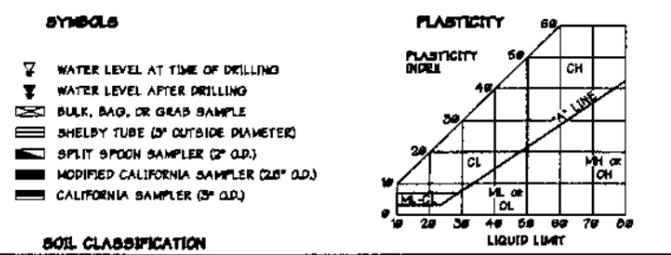
### Sheet Index

- G1 GEOTECHNICAL NOTES & DETAILS
- G2 EXPLORATORY BORING PLAN & PROFILE
- G3 EXPLORATORY BORING LOGS
- G4 EXPLORATORY BORING LOGS

### Vicinity Map



### Borelog Explanation



SOIL CLASSIFICATION		SYMBOL	DESCRIPTION
COARSE GRAINED SOILS < 50% FINE FRACTION #4 SIEVE	GRAVELS LITTLE OR NO FINES	GW	WELL GRADED GRAVEL, GRAVEL/SAND MIXES
		GP	POORLY GRADED GRAVEL, GRAVEL/SAND MIXES
	GRAVELS > 12% FINES	GM	SILTY GRAVEL, POORLY GRADED GRAVEL/SAND/SILT MIXES
		GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL/SAND/CLAY MIXES
	SANDS LITTLE OR NO FINES	SW	WELL GRADED SAND, GRAVELLY SAND
		SP	POORLY GRADED SAND, GRAVELLY SAND
SANDS > 12% FINES	SM	SILTY SAND, POORLY GRADED SAND, SAND/GRAVEL/SILT MIXES	
	SC	CLAYEY SAND, POORLY GRADED SAND/GRAVEL/CLAY MIXES	
FINE GRAINED SOILS > 50% FINE FRACTION #200 SIEVE	SILTS & CLAYS LIQUID LIMIT < 50	ML	MORGANIC SILTS AND VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, CLAYEY SILTS WITH SLIGHT PLASTICITY
		CL	MORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
	SILTS & CLAYS LIQUID LIMIT > 50	OL	ORGANIC CLAYS AND SILTS OF LOW PLASTICITY
		MH	MORGANIC SILTS, MORGANIC OR DIATOMACEOUS FINE SAND OR SILT
	HIGHLY ORGANIC SOILS	CH	MORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
		EH	ORGANIC SILTS AND CLAYS OF MEDIUM TO HIGH PLASTICITY
	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENT	

Plans  
Not To Scale

DATE	
DESCRIPTION	

LAWLER HOUSE UNDERPINNING  
GEOTECHNICAL NOTES AND DETAILS

Project Location:  
Lawler House Underpinning  
12305 Bett Road  
Nevada County, CA

Ownership Information:  
David Lawler  
485 Kentucky Ave.  
Berkeley, CA 94707

DESIGNED	DD	06/22/2009
DRAWN	ML	N/A
CHECKED	ML	N/A
DATE PLOTTED	08/28/09	1:00
SHEET	01	OF 02





**Schematic**  
NOT FOR CONSTRUCTION

Revisions	DATE	BY

**LAWLER HOUSE UNDERPINNING  
EXPLORATORY BORING PLAN  
AND PROFILE**

**Project Location:**  
Lawler House Underpinning  
12305 Bett Road  
Nevada County, CA

**Ownership Information:**  
David Lawler  
483 Kentucky Ave.  
Berkeley, CA 94707

DESIGNED BY	DATE
DO	06/12/2008
DRAWN BY	REV. SCALE
LS	T=30'
CHECKED BY	REV. SCALE
2008-M.D.	T=30'
SHEET	081003-1/10



PROPERTY BOUNDARY PER "FINAL MAP #85-7 FOR BET ACRES", THE COUNTY OF NEVADA, JANUARY 1997.

LOT 1, BET ACRES  
3.25 ACRES

APPROXIMATE LOCATION OF (E) MINE  
CONCRETE STRUCTURES/FOOTINGS

APPROXIMATE CENTERLINE OF OBSERVED ABOVE-GROUND  
(E) MINE CONCRETE STRUCTURES/FOOTINGS

(P) DITCH OUTLET PROTECTION LOCATION  
IS APPROXIMATE (FIELD VERIFY)

(P) DRAINAGE DITCH LOCATION IS  
APPROXIMATE (FIELD VERIFY)

VISIBLE PORTION OF (E) LEACH LINE

APPROXIMATE HORIZONTAL  
EXTENTS OF VOID

EXISTING HOUSE (22005 BET ROAD)  
APPROXIMATE LOCATION

PROPERTY CORNER USED  
TO APPROXIMATELY  
LOCATE HOUSE

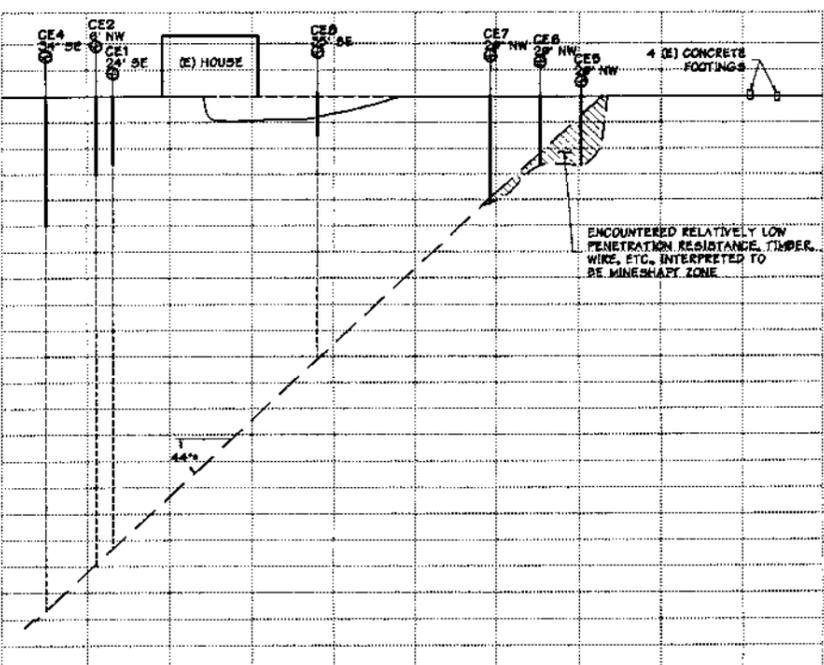
PROPERTY CORNER USED TO  
APPROXIMATELY LOCATE HOUSE

**Site Plan**

SCALE: Hor: T=30'

ALL SURFACE FEATURES DEPICTED WERE ESTIMATED BY FIELD MAPPING BY CARLTON ENGINEERING, INC. USING APPROXIMATE METHODS, ON 4/18/2008, 6/12/2008, AND 6/17/2008. NO GUARANTEE OF THEIR ACCURACY IS GIVEN NOR SHOULD BE INFERRED. INFORMATION DEPICTED HERE SHOULD BE CONSIDERED APPROXIMATE.

ESTIMATED ELEVATIONS



**Section A**

SCALE: Hor: T=30' Vert: T=30'

DEPICTED SOIL PROFILE IS INFERRED BASED ON THE BORING LOGS  
BORING CE3 OMITTED FOR CLARITY.

**Sheet Notes**



"AREAS INAPPROPRIATE FOR RESIDENTIAL CONSTRUCTION" PER "FINAL MAP #85-7 FOR BET ACRES, THE COUNTY OF NEVADA, JANUARY 1997" HATCH BOUNDARIES HAVE BEEN TRANSFERRED TO THIS DRAWING BY APPROXIMATE METHODS AND NO GUARANTEE OF THEIR ACCURACY IS GIVEN NOR SHOULD BE INFERRED.

Plans  
Not To Scale



CE6		HE	CME-75e	6/7/2000	2560' (Estimated)	
ELEV. (FT)	DEPTH (FT)	MATERIALS DESCRIPTION		GEOTECHNICAL		
		SAMPLE No.	Field No.	SPT Blows/ft	DRY DENSITY (pcf)	MOISTURE (%)
0	0	Brown Silty SAND (SM) w/ Gravel & Wood. Dam. --FILL--				
1	1	Same Material Between 5'-11"				
2	2	Gray SILT (ML) & SAND (SM), Damp, Soft		CE6-1		
3	3	Drills Easily to 28"		CE6-2	8	
4	4	Drills Very Easily				
5	5	Gray Clayey SILT (ML), Damp, Soft				
6	6	No Formation Resistance, Sampled by Pushing Sampler		CE6-3		
7	7	Boring Terminated @ 28", No Groundwater, Backfilled w/ Cuttings		CE6-4		

CE7		HE	CME-75e	6/7/2000	2560' (Estimated)	
ELEV. (FT)	DEPTH (FT)	MATERIALS DESCRIPTION		GEOTECHNICAL		
		SAMPLE No.	Field No.	SPT Blows/ft	DRY DENSITY (pcf)	MOISTURE (%)
0	0	Brown Silty SAND (SM) w/ Gravel & Wood, Damp				
1	1	Gray Brown Clayey Sandy SILT (ML), Damp, Soft				
2	2	Drills Easily				
3	3	Drills Easily				
4	4	Drills Easily				
5	5	Drills Easily				
6	6	Drills Easily				
7	7	Drills Easily				
8	8	Drills Easily				
9	9	Drills Easily				
10	10	Drills Easily				
11	11	Drills Easily				
12	12	Drills Easily				
13	13	Drills Easily				
14	14	Drills Easily				
15	15	Drills Easily				
16	16	Drills Easily				
17	17	Drills Easily				
18	18	Drills Easily				
19	19	Drills Easily				
20	20	Light Brown CLAY (CL) Damp, Soft, Drills Easily				
21	21	Drills Easily				
22	22	Drills Easily				
23	23	Drills Easily				
24	24	Drills Easily				
25	25	Gray Brown SILT (ML) w/ Black & Red Fracture Filling, Damp, Medium, Stiff		CE7-1		
26	26	Drills Very Easily		CE7-2		
27	27	Drills Very Easily				
28	28	Drills Very Easily				
29	29	Drills Very Easily				
30	30	Drills Very Easily				
31	31	Drills Very Easily				
32	32	Drills Very Easily				
33	33	Drills Very Easily				
34	34	Drills Very Easily				
35	35	Drills Very Easily				
36	36	Gray Yellow SILT (ML), Damp, Medium Stiff		CE7-3		
37	37	Drills easily		CE7-4	8	
38	38	Drills easily				
39	39	Drills easily				
40	40	Wood (Lumber) in Tip of Sampler				
41	41	Gray Yellow SILT (ML), Damp, Soft		CE7-5		
42	42	Drills Very Easily		CE7-6	4	
43	43	Boring Terminated @ 41", No Groundwater, Backfilled w/ Cuttings				

CE8		HE	CME-75e	6/7/2000	2560' (Estimated)	
ELEV. (FT)	DEPTH (FT)	MATERIALS DESCRIPTION		GEOTECHNICAL		
		SAMPLE No.	Field No.	SPT Blows/ft	DRY DENSITY (pcf)	MOISTURE (%)
0	0	Top 5' Gravel & Rocks Mixed w/ Silty SAND (SM)				
1	1	Orange-Red SILT (ML) and SAND (SM), Damp, Stiff		CE8-1		
2	2	Drills Easily		CE8-2	10	
3	3	Drills Easily				
4	4	Drills Easily				
5	5	Drills Easily				
6	6	Drills Easily				
7	7	Drills Easily				
8	8	Drills Easily				
9	9	Drills Easily				
10	10	Orange SILT (ML) w/ Black Filling, Trace of Parent Rock Fabric, Damp, Stiff		CE8-3		
11	11	Drills Easily		CE8-4	10	66.6
12	12	Drills Easily				43.8
13	13	Drills Easily				
14	14	Drills Easily				
15	15	Drills Easily				
16	16	Orange SILT (ML), Damp, Stiff		CE8-5		
17	17	Boring Terminated @ 16", No Groundwater, Backfilled w/ Cuttings		CE8-6	10	



DATE	
DESCRIPTION	

**LAWLER HOUSE UNDERPINNING  
EXPLORATORY BORING LOGS**

**Project Location:**  
Lawler House Underpinning  
12305 Bett Road  
Nevada County, CA

**Ownership Information:**  
David Lawler  
483 Kenuckey Ave.  
Berkeley, CA 94707

DATE: 06/20/2000  
SCALE: N/A  
SHEET: 2000-H-8



Plans  
Not To Scale

Site #		Equipment		Date		Location	
CE1		CME-750		8/8/2008		2008' (Estimated)	
ELEV (FT)	DEPTH (FT)	MATERIALS DESCRIPTION		GEOTECHNICAL			
		SAMPLE No.	Field (lb/ft <sup>3</sup> )	SPT (blows/ft)	DRY DENSITY (lb/ft <sup>3</sup> )	MOISTURE CONTENT (%)	
2245	0						
2245	1						
2245	2						
2245	3						
2245	4						
2245	5						
2245	6						
2245	7						
2245	8						
2245	9						
2245	10						
2245	11						
2245	12						
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2245	98						
2245	99						
2245	100						

Site #		Equipment		Date		Location	
CE2		CME-750		8/8/2008		2008' (Estimated)	
ELEV (FT)	DEPTH (FT)	MATERIALS DESCRIPTION		GEOTECHNICAL			
		SAMPLE No.	Field (lb/ft <sup>3</sup> )	SPT (blows/ft)	DRY DENSITY (lb/ft <sup>3</sup> )	MOISTURE CONTENT (%)	
2245	0						
2245	1						
2245	2						
2245	3						
2245	4						
2245	5						
2245	6						
2245	7						
2245	8						
2245	9						
2245	10						
2245	11						
2245	12						
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2245	96						
2245	97						
2245	98						
2245	99						
2245	100						

Site #		Equipment		Date		Location	
CE3		CME-750		8/8/2008		2008' (Estimated)	
ELEV (FT)	DEPTH (FT)	MATERIALS DESCRIPTION		GEOTECHNICAL			
		SAMPLE No.	Field (lb/ft <sup>3</sup> )	SPT (blows/ft)	DRY DENSITY (lb/ft <sup>3</sup> )	MOISTURE CONTENT (%)	
2245	0						
2245	1						
2245	2						
2245	3						
2245	4						
2245	5						
2245	6						
2245							

tectonics, volcanic activity within the southern Cascade Range and from regional tectonic activity within the Basin Range province to the east could constitute future sources of seismic activity.

#### **Earthquake-Induced Ground Failure**

Violent ground shaking can lead to various types of ground failure that liquefaction can initiate. Liquefaction is a phenomenon whereby unconsolidated and/or near saturated soils lose cohesion and are converted to a fluid state as a result of severe vibratory motion. As discussed above, the project area could experience ground shaking during an earthquake but because the intensity of the ground shaking in this region would be low to moderate, the potential for liquefaction and seismically-induced landslides is low. The threat of damage by liquefaction is not a concern for the 101-acre Idaho-Maryland site because subsurface materials beneath the property are mostly lacking in the combination of soil types and groundwater conditions needed for this type of failure. Some localized, shallow slope failures (e.g., contained debris flows or slumps) may occur during an earthquake but there is a low potential for these incidents to cause injury or damage.

#### **Mining-Induced Subsidence or Collapse**

Subsidence and sudden collapse of the ground surface can be caused by natural geologic phenomenon (gradual subsidence from groundwater and oil removal, decomposition of organic material, roof failures in underground limestone caves) and by the failure of subsurface manmade features, such as tunnels, water lines, and mine shafts. Mining and construction operations over mine workings (i.e., tunnels and portals) can compromise the structural integrity of a shallow mine tunnel resulting in a cave-in. Caving in a shallow mine tunnel or portal can be expressed at the surface as rapid or gradual ground surface subsidence. Shallow mine workings are more susceptible to caving because the geologic materials between the shaft and the surface are less competent than the bedrock at depth. For example, a portion of the Old Brunswick shaft of the Idaho-Maryland mine collapsed during a storm in 1998 causing a sinkhole that structurally damaged the foundation of a private home. The shaft collapse occurred because a contractor inadvertently built a house over an abandoned 45-degree inclined shaft years after it was backfilled with uncompacted material. The surface subsidence occurred when the loose uncompacted material covering the shaft became saturated with surface water and washed down the shaft.

At the Idaho Maryland Mine, most of the mine workings are deep and the potential is low for a collapsed mine tunnel to affect the ground surface. However, there are areas where shallow mine workings could cave-in resulting in ground surface subsidence.

#### **Slope Stability**

Unstable soils can result from vegetation removal associated with wildfires, timber harvesting, mining, and grading as part of road and building and site development. Significant precipitation can exacerbate unstable conditions, resulting in landslides and mudslides. Slope failures include falls; topples; slides (rotational or translational); lateral spreads; flows (in bedrock or soils); or a complex combination of two or more of the five types of movement. Relative stability is

liquefaction, landslides, substantial soil erosion or the loss of topsoil due to construction activities, and expansive soils would be less than significant. These potential hazards were discussed above in the setting section but are not further analyzed in this EIR. Please note that soil erosion impacts associated with sustained increases in flow due to dewatering activities and discharge into the Wolf Creek Watershed are analyzed in Section 4.7, *Hydrology and Water Quality*.

## Impacts and Mitigation Measures

### ***Reclamation Plan Impacts (Class IV-No Impact)***

The proposed Reclamation Plan includes several actions necessary to restore the project site and prepare it for the proposed subsequent use. The proposed subsequent use could consist of commercial/industrial development. Those reclamation plan actions with geotechnical and seismic considerations include backfilling drill holes and water wells, concrete capping of underground accesses, backfilling shafts and portals, clearing the site of foundations, drawing down stockpiles, demolishing access roads, revegetation and re-soiling. From a geotechnical standpoint, the actions under the Reclamation Plan actions can be considered site improvements that would reduce future geologic impacts on the project areas. For example, revegetation, re-soiling, and removal of foundations would reduce erosion and loss of topsoil and would stabilize near-surface soils. Compaction, slope contouring, and backfilling would comply with the local and State building code requirements. Reclamation Plan actions would not reduce the potential for earthquakes but the removal of structures and other equipment would decrease the potential impacts associated with structural failure or collapse during a seismic event.

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**Impact 4.5-1: Proposed dewatering and mining activity could cause shallow mine workings to cave-in resulting in subsidence at the ground surface at some locations. Subsidence due to collapsed shallow tunnels and mine portals could injure mine workers and the public or result in property loss both at the project site and on adjacent parcels. *Less than Significant with Mitigation (Class II)*.**

Some areas on or nearby the project site would be susceptible to surface subsidence in the event of a mine tunnel or portal cave-in.<sup>7</sup> The applicant has identified the proposed decline portal and the concrete collar of the New Brunswick Shaft as project areas susceptible to a cave-in and surface subsidence. All other areas proposed for mining would be sufficiently deep and an unanticipated collapse of these deep workings would not cause surface subsidence. The 1995 EIR

---

<sup>7</sup> In a mine tunnel, the degree of caving from above into the tunnel is dependent on the size of the tunnel; at some point, the cave-in stops because the tunnel fills up with material and the cave-in is essentially "choked-off". The existing tunnels at the Idaho-Maryland Mine are relatively small (e.g. only 6 feet high and narrow) compared to tunnels built today. Considering the size of the existing tunnels, this analysis conservatively considers that 70 vertical feet of caving would occur before the cave-in stops. The actual extent of upward caving would likely be less. However, the 70-foot estimate provides a means to identify and categorize shallow mine workings; this analysis assumes that if the mine tunnel is less than 70 feet deep, there is a potential for surface subsidence to occur if that tunnel collapses.

identified other locations where there is a potential for subsidence to occur.<sup>8</sup> The first location is on the order of a couple hundred feet of tunnel trending in a generalized south-southwesterly direction from the collar of the “Old Brunswick Incline Mine Shaft”, which reportedly was an old drainage tunnel that is no longer in use (GeoSolutions, 2008). The second location of potential subsidence is a few hundred feet of tunnel trending in a generalized east-southeasterly direction from the “Old Brunswick Incline Mine Shaft”; this tunnel section was previously interpreted as the 70-foot level of the Old Brunswick Mine (70 foot level tunnel).<sup>9</sup> The 1995 Draft EIR also mentions subsidence potential in the area of assessor parcel numbers 09-581-12, 09-581-13 and 09-581-17. These parcels are privately owned but are considered in the analysis because they are proximate to and could be affected by subsidence of the “70-foot level tunnel.” Based on the available information, the analysis of subsidence for this EIR considered the structural integrity of the proposed decline portal, the concrete collar of the New Brunswick Shaft, and the areas identified during the 1995 EIR, as discussed below.

Although the proposed decline portal would be shallow for a certain distance, it would be constructed with internal structural features consisting of a combination of wire mesh reinforced concrete and/or steel supports. The applicant proposes to place concrete and steel supports in the decline portal and tunnel for an adequate distance until the decline reaches a depth where it is surrounded by fresh, unweathered, competent bedrock. Given the proposed construction techniques and current state of the art in mining engineering and construction, the decline portal would not be susceptible to subsidence after completion and throughout the life of the project.

The concrete collar of the New Brunswick shaft is a concern for the proposed project because the concrete may be too old and structurally weak to support the weight of structures needed to support the dewatering pumps and other mining-related construction. Failure of the concrete collar is considered an adverse impact because if the concrete were to fail, it could cause localized cave-in, subsidence, and structural collapse, which could injure workers, cause property damage, and result in construction delays. It should be noted that the public would not be able to access the Brunswick Shaft area; restricting access would therefore eliminate the public’s exposure to potential subsidence hazards at that location.

The former drainage tunnel and “70-foot level tunnel” still represents a potential subsidence hazard because these two tunnels were identified as shallow mine workings. Although the proposed project would likely not affect these two sites, a cave-in of one of the tunnels could cause injury or property damage if surface subsidence were to occur. Because these locations are proximate to the project and subsidence could affect project operations, this EIR considers subsidence in these locations a potential adverse impact of the project.

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<sup>8</sup> It should be noted that the 1995 EIR identified the areas discussed herein as potential areas of subsidence but did not prescribe mitigation because the applicant’s project would not affect these areas.

<sup>9</sup> It should be noted that although this tunnel is named the “70 foot level tunnel”, its vertical distance from the ground surface is not 70 feet. Lateral tunnels connected to this shaft are labeled by their slope distance down centerline of the declined shaft instead of their vertical distance from ground surface. Because the shaft slopes at an angle of about 50 degrees to the horizontal in a southeast direction, the maximum vertical distance between top of tunnel to the ground surface is likely to be about 54 feet in the area adjacent to the portal of the shaft.

### **Reclamation Plan**

Actions required under the Reclamation Plan would reduce the potential for future cave-ins and surface subsidence. The Idaho-Maryland site portal, Idaho-Maryland shaft, Round Hole shaft, and the New Brunswick site shaft would be capped with concrete thereby reducing the potential for cave-in or collapse of these near-surface mining structures. Reclamation of underground shafts and headings would be completed by the use of paste backfill. Rock backfill could also be used depending on the suitability and availability of material. Capping and backfilling subsurface accesses and shafts would reduce the future risk of collapse and subsidence and therefore, the Reclamation Plan would ensure that impacts remain less than significant.

### **Conclusion**

Based on the geologic characteristics found in the area and intentions of the applicant to mine only at deeper levels of the mine, there would be a very low risk of subsidence at the surface as a result of the proposed underground mining activities. However, the areas identified above, in addition to unidentified locations, could, at some point during the life of the project, experience cave-in with associated surface subsidence. This is especially the case for the concrete collar around the Brunswick Shaft; failure of the concrete to support down-shaft equipment would adversely affect the project. Mitigation Measure 4.5-1 addresses the potential for cave-in and subsequent surface subsidence in mine workings at the site and the uncertainty surrounding the competency of the concrete collar and tunnels. Mitigation Measure 4.5-1 provides a mechanism that requires the applicant, through a third party review, to identify and correct potential subsidence hazards and requires that corrective action take place prior to construction. Engineered remedies to reduce or eliminate potential subsidence (i.e., shoring, tie-backs, steel supports, concrete mesh, rock bolting, steel reinforced concrete) are standard mining tunnel construction methods used successfully throughout the industry and thus, secondary impacts associated with corrective measures are not expected.

**Mitigation Measure 4.5-1:** The applicant shall identify current mine workings that are less than 70 feet deep (considered shallow), regardless of whether they are utilized during the proposed project or would remain unaffected. The applicant shall retain a licensed geotechnical engineer (per approval by the City of Grass Valley) to perform a detailed, third-party evaluation of the existing, shallow mine workings. The applicant shall complete the evaluation prior to the start of project construction. Through this evaluation, the mining engineer, with assistance from the applicant, shall establish sufficient data to determine whether the particular shallow mine working is susceptible to failure. Information required by this evaluation includes, but is not necessarily limited to, tunnel depth, underlying geology, relative rock strengths, size of the mine working, and groundwater conditions. Using generally accepted mine engineering practice, including American Society of Testing and Materials (ASTM) standards for rock strength testing, the third party review shall demonstrate that shallow mine workings would not fail under static and earthquake conditions and that the concrete collar at the Brunswick Shaft is competent to support the weight of the proposed equipment. If the third-party review determines a potential subsidence hazard exists, the applicant and the third party licensed engineer shall 1) develop feasible corrective measures to be included as part of the project, 2) have the measures approved by the City of Grass Valley, and 3) ensure that all corrective actions are completed before project construction begins. The corrective measures recommended by

the third party engineer shall effectively reduce or eliminate the risk of subsidence in the event that the underlying mine working collapsed. Measures could include but are not limited to shoring, tie-backs, steel supports, concrete mesh, rock bolting, steel reinforced concrete. The applicant shall submit to the City of Grass Valley, the completed report prepared by the third-party mining engineer and a detailed schedule outlining the process and schedule necessary to rectify identified subsidence hazards.

**Significance after Mitigation: Less than Significant.**

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**Impact 4.5-2: Areas of the project sites contain fill material that is unsuitable to support structural improvements. Soils with low bearing strength or fills that are compressible or can collapse could cause proposed buildings and other structural improvements to settle differentially leading to structural damage, injury to workers, and potential property loss. Less than Significant (Class III).**

Following their preliminary geotechnical investigation in October 2004, Holdrege and Kull stated that their primary concern is the presence of fill in portions of the previously graded areas of the Idaho-Maryland site and New Brunswick site. Much of the fill encountered during a previous subsurface investigation at the Idaho-Maryland site reportedly contained organic material that would not be suitable to support structural improvements.

Holdrege and Kull anticipate that the relatively shallow fill across much of the southern area of the Idaho-Maryland site would be able to be removed or, if deemed suitable for the purpose, used for compacted fill. However, deeper fill previously encountered in the southeastern area would likely require extensive excavation and would not likely be reused due the reported abundance of organic materials. The disturbed material and waste rock identified in the northwestern part of the Idaho-Maryland site and at the New Brunswick site may not be suitable to support structural improvements. Additionally, waste rock piles cover portions of the Idaho-Maryland, New Brunswick, and Round Hole sites. In general, these piles are not suitable to support structural improvements, and the waste rock piles in the area of the proposed ceramic plant would likely require removal prior to construction.

The October 2004 Holdrege and Kull geotechnical study was intended as a preliminary assessment of the geotechnical conditions on the three proposed project sites and did not constitute a detailed geotechnical investigation (sometimes referred to as the "design-level geotechnical investigation"). Typically, the design-level geotechnical investigation is conducted following completion of the CEQA process when project details can be more fully developed and finalized. Design-level investigations usually consist of subsurface soil sampling, detailed identification of underlying geologic material, and soil and rock strength testing. While the October 2004 study did conclude that development of the proposed project was feasible, it did identify unsuitable soils. These unsuitable soil conditions would be further investigated during the design-level investigation using accepted, standard geotechnical methods and testing protocols. For example, field drilling and/or test pits would help determine the depth and distribution of the previously identified unsuitable soils and engineers would submit samples to the soils laboratory

**PRELIMINARY GEOTECHNICAL  
ENGINEERING REPORT**  
for  
**IDAHO-MARYLAND MINING  
CORPORATION PROPERTY**  
*Nevada County, California*

**Prepared for:**  
**Idaho-Maryland Mining Corp.**  
**179 Clydesdale Court**  
**Grass Valley, California 95945**

**Prepared by:**  
**Holdrege & Kull**  
**792 Searls Avenue**  
**Nevada City, California 95959**

**Project No. 2416-03**  
**October 25, 2004**



Project No. 2416-03  
October 25, 2004

Idaho-Maryland Mining Corp.  
179 Clydesdale Court  
Grass Valley, California 95945

Attention: Ross Guenther

**Reference: Idaho-Maryland Mining Corporation Property**

Idaho-Maryland Mine, New Brunswick, and Roundhole Easement Sites  
Nevada County, California

**Subject: Preliminary Geotechnical Engineering Report**

Dear Mr. Guenther:

This report presents the results of our preliminary geotechnical engineering investigation for three sites on Idaho-Maryland Mining Corporation property. The Idaho-Maryland site encompasses 101 acres and is located south of Whispering Pines Lane and north of East Bennett Road near Grass Valley, California. The 37-acre New Brunswick site is located southwest of the intersection of Brunswick Road and East Bennett Road. The one-acre Roundhole Easement site is located north of Whispering Pines Lane near its intersection with Brunswick Road. We understand that, as currently proposed, the project will include the construction of industrial facilities associated with proposed mining on the Idaho-Maryland Site.

The preliminary findings presented in this report are based on a cursory surface reconnaissance at the site; review of selected geologic, soil survey and historical references; review of previous reports for the property; and our experience with subsurface conditions in the area. Based on our preliminary findings, the project as currently proposed appears to be feasible from a geotechnical engineering standpoint. We should be allowed to perform a subsurface investigation to confirm our preliminary recommendations as part of a design-level geotechnical engineering report. Furthermore, we should be allowed to perform testing and observation services during grading to confirm our design-level recommendations.

Please contact us if you have any questions regarding our observations or the preliminary recommendations presented in this report.

Sincerely,

**HOLDREGE & KULL**

Prepared by:

Reviewed by:

Zack Washburn  
Staff Geologist

Jason W. Muir  
C.E. 60167

copies: 6 to Idaho-Maryland Mining Corp. (one unbound)

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SHEETS

Sheet 1                      Approximate Site Map

APPENDIX

Important Information About Your Geotechnical Engineering Report (included with permission of ASFE, Copyright 2004)

## **1 INTRODUCTION**

At the request of Idaho-Maryland Mining Corporation (IMMC), Holdrege & Kull (H&K) performed a preliminary geotechnical engineering investigation of Idaho-Maryland Mining Corporation property in Nevada County, California. For your review, the Appendix contains a document prepared by ASFE entitled *Important Information About Your Geotechnical Engineering Report*, which summarizes the general limitations, responsibilities, and use of geotechnical reports.

### **1.1 SITE DESCRIPTION**

The project includes three sites on IMMC property. The Idaho-Maryland site encompasses 101 acres and is located south of Whispering Pines Lane and north of East Bennett Road near Grass Valley, California. The 37-acre New Brunswick site is located southwest of the intersection of Brunswick Road and East Bennett Road. The one-acre Roundhole Easement site is located north of Whispering Pines Lane near its intersection with Brunswick Road. The sites are currently in an unincorporated portion of Nevada County adjacent to the city limits of Grass Valley, California. Site boundaries are shown on the attached Sheet 1.

### **1.2 PROPOSED IMPROVEMENTS**

Our understanding of the project as currently proposed is based on our conversation with Mr. Ross Guenther and our review of a conceptual site plans prepared by IMMC dated May 2004. We understand that, as currently proposed, the project will include the construction of industrial facilities associated with proposed mining on the Idaho-Maryland site. A grading plan for the project was not available for our review.

### **1.3 PURPOSE**

The purpose of our preliminary geotechnical investigation was to review pertinent geologic, soil survey and historical information; to review a report previously prepared by H&K; and to observe the site to assess the feasibility of development from a geotechnical engineering standpoint.

## **1.4 SCOPE OF SERVICES**

To prepare this report, we performed the following scope of services:

- We performed a cursory reconnaissance of the site.
- We reviewed selected geologic and soil survey literature.
- We reviewed selected historical maps and literature pertinent to historic mining activity in the vicinity of the site.
- We reviewed our *Preliminary Geotechnical Engineering Report for Milco and Platner Property*, dated April 22, 2003, that pertains to a portion of the subject property.
- Based on observations made during our site reconnaissance, the results of our literature review and our experience with soil conditions in the area, we prepared this report, which provides preliminary geotechnical engineering recommendations for the proposed improvements.

## **2 SITE INVESTIGATION**

The following sections summarize our literature review and field reconnaissance.

### **2.1 GEOLOGIC SETTING**

We reviewed the Geologic Map of the Grass Valley - Colfax Area (A. Tuminas, 1983). According to this map, the Idaho-Maryland site is underlain by early Mesozoic rock associated with the Lake Combie complex. The geology of the western portion of the site is characterized by serpentized rock. The central portion of the site is underlain by gabbro and diorite and the eastern portion is characterized by massive diabase. The Mesozoic era occurred between approximately 245 and 65 million years before present (MYBP).

The central portion of the New Brunswick site lies on Quaternary alluvium (i.e., water lain sediments deposited in the past 2 million years); the flanks of the site are underlain by massive diabase of the Lake Combie complex.

The northern portion of the Roundhole Easement site is underlain by massive diabase, and the southern portion is characterized by serpentized rock.

## **2.2 SITE SOIL CONDITIONS**

### **2.2.1 Idaho-Maryland Site**

We reviewed the *Soil Survey of the Nevada County Area, California* (USDA Soil Conservation Service, reissued August 1993). The soil survey indicates that the undisturbed portions of the southwestern part of the Idaho-Maryland site are located in an area typified by Secca-Rock outcrop complex. The soil survey describes the Secca soil type as moderately well drained soil underlain by metabasic or basic rock. Permeability is slow, and partly weathered basic rock is typically encountered at a depth of approximately 45 inches below the ground surface (bgs). Rock outcrop typically comprises 10 to 40 percent of the surface area typified by this complex. The undisturbed portions of the eastern side of the site are located in an area typified by Sites loam. The soil survey describes the Sites soil type as well drained soil underlain by tilted metasedimentary and metabasic rock. Weathered metasedimentary and basic rock is typically encountered at a depth of approximately 78 inches bgs. Permeability is moderately slow. The southern central portion of the site is classified by the soil survey as cut and fill land, which has been altered by methods other than mining. The survey states that deep accumulations of bark may be present at locations previously used as logging deck yards or lumber stack yards. The northwestern portion of the site is underlain by Placer diggings, according to the survey. This soil type occurs along drainage ways that have been placer mined and is typically comprised of gravel with little fines.

### **2.2.2 New Brunswick Site**

The southwestern part of the New Brunswick is underlain by Aiken Loam according to the soil survey. The soil survey describes the Aiken Loam as a well-drained soil that forms on the sides of andesitic flows. According to the survey, permeability of the Aiken Loam soil type is moderately slow and weathered andesite is commonly encountered at about 64 inches bgs. The central portion of the site is characterized by Placer diggings while the northeastern portion is classified as clayey Alluvial Land. The soil survey describes clayey Alluvial Land as a

miscellaneous land type consisting of narrow areas of alluvial deposits. These soils are moderately well drained to poorly drained and permeability is moderately slow to very slow.

### **2.2.3 Roundhole Easement Site**

The Roundhole Easement site lies entirely on Secca-Rock outcrop complex according to the soil survey. The properties of this soil type are described above.

## **2.3 HISTORICAL RESEARCH**

We reviewed portions of the following documents pertaining to historic mining activities in the immediate vicinity of the subject property.

### **2.3.1 Geologic Map of the Grass Valley Quadrangle and Adjacent Area, Nevada County, California**

#### **2.3.1.1 Idaho-Maryland Site**

The Geologic Map of the Grass Valley Quadrangle and Adjacent Area, Nevada County, California (1939) contained in *The Gold Quartz Veins of Grass Valley, California* (W.D. Johnston, Jr., Geological Survey Professional Paper 194, U.S. Department of the Interior, 1940) depicted the Maryland Mine north of the subject property on the Eureka-Idaho-Maryland vein. The vein strikes west-northwest and dips 50 to 70 degrees to the south-southwest. An underground inclined shaft extended south and southeast from the Maryland Mine. This shaft lies north of the northern boundary of the site, according to the map.

The Geologic Map of the Grass Valley Quadrangle and Adjacent Area, Nevada County, California (1939) shows the South Idaho vein striking west-northwest across the central portion of the site. The vein dips 60 degrees to the south. The South Idaho shaft is shown in the alignment of the vein. A horizontal or inclined tunnel is shown striking east along the vein within the southeast portion of the site.

According to *The Gold Quartz Veins of Grass Valley, California* (W.D. Johnston, Jr., Geological Survey Professional Paper 194, U.S. Department of the Interior, 1940), the Idaho-Maryland shaft inclined to the 1000-foot level at an angle of 70

degrees. The Canyon (or Cañon) shaft, an inclined winze raking to the east from the 1000-foot level, was advanced as far as the 1900-foot level to a depth greater than 2,500 feet bgs. The Eureka-Idaho-Maryland vein strikes north 77 degrees west and has an average dip of 70 degrees southwest, ranging between 50 and 80 degrees. The hanging wall is composed of diabase and gabbro and the footwall is composed of serpentine.

### **2.3.1.2 New Brunswick Site**

The Geologic Map of the Grass Valley Quadrangle and Adjacent Area, Nevada County, California (1939) shows Union Hill Mine in the western part of the site on the Union Hill vein. The vein strikes northwest and dips between 50 and 90 degrees to the southwest. An underground inclined shaft extended south-southwest from the Union Hill Mine beneath the site. The Union Hill shaft was advanced to about 1050 feet bgs, according to the researched documents.

The Lucky and Cambridge shafts lie a few hundred feet west of the site. These shafts are vertical and intersect the Lucky Cambridge vein, which parallels the Union Hill vein. The Lucky shaft was apparently advanced to the 300-foot level, but the depth of the Cambridge shaft is not stated in the *The Gold Quartz Veins of Grass Valley, California* report. The New Brunswick (shown as Brunswick on the map) vertical shaft was included on the 1939 map, but no description of the shaft dimensions was included in the report.

### **2.3.1.3 Roundhole Easement Site**

No information on the Roundhole shaft is provided in the *The Gold Quartz Veins of Grass Valley, California* or shown on the Geologic Map of the Grass Valley Quadrangle and Adjacent Area, Nevada County, California (1939). The approximate location of the Roundhole shaft, as shown on Sheet 1, was provided by IMMC.

### **2.3.2 Mines and Mineral Resources of Nevada County**

We reviewed the *Mines and Mineral Resources of Nevada County* (Errol MacBoyle, California State Mining Bureau, December 1918). This publication contained information regarding the Eureka-Idaho-Maryland vein that was

discussed above, and contained additional information regarding the South Idaho Mine. The South Idaho vein is located approximately 1500 feet south of and parallel to the Eureka-Idaho-Maryland vein. The vein is located in diabase and gabbro, strikes north 85 degrees west, and dips 70 degrees to the south. The lode was developed by inclined shaft only to a depth of 155 feet at the time of the 1918 publication. A crosscut was driven south for a distance of 12 feet at a depth of 60 feet, and drifting was performed at the 100-foot level for a distance of 25 feet to the south. A tunnel was driven a distance of 800 feet on the vein east of the shaft location.

This publication also contained information regarding the Union Hill vein and shaft that was discussed above, but did not provide any information on the New Brunswick, Lucky, or Cambridge shafts.

### **2.3.3 Map of the Grass Valley Quadrangle included in the Nevada City Special Folio, California**

The Map of the Grass Valley Quadrangle included Nevada City Special Folio, California (United States Geologic Survey, 1896) depicted the features described above that were shown on the 1939 Geologic Map of the Grass Valley Quadrangle and Adjacent Area, Nevada County, California.

### **2.3.4 Map Showing Mining Properties of the Grass Valley Mining District, Nevada County, California**

#### **2.3.4.1 Idaho-Maryland Site**

The Map Showing Mining Properties of the Grass Valley Mining District, Nevada County, California (Division of Mines, 1930) showed the Idaho-Maryland site as being located within the Idaho-Maryland Mining Company claim. The map also depicted the Idaho-Maryland vein and shaft, as well as the South Idaho vein and shaft, as discussed above for the 1939 Geologic Map of the Grass Valley Quadrangle and Adjacent Area, Nevada County, California.

### **2.3.4.2 New Brunswick Site**

The Map Showing Mining Properties of the Grass Valley Mining District, Nevada County, California (Division of Mines, 1930) showed the New Brunswick site as being located within the Idaho-Maryland Mining Company claim. The map also depicted the Union Hill vein and shaft, as well as the New Brunswick shaft, as discussed above for the 1939 Geologic Map of the Grass Valley Quadrangle and Adjacent Area, Nevada County, California.

### **2.3.4.3 Roundhole Easement site**

The Map Showing Mining Properties of the Grass Valley Mining District, Nevada County, California (Division of Mines, 1930) did not show the Roundhole shaft, but did depict the area of the Roundhole shaft as being within the Idaho-Maryland Mining Company claim.

## **2.4 REVIEW OF OTHER REPORTS**

In our 2003 *Preliminary Geotechnical Engineering Report for Milco and Platner Property*, we reviewed a report prepared by Neil O. Anderson and Associates, Inc. entitled *Preliminary Geotechnical Investigation, Grass Valley Business and Professional Park Between Idaho Maryland and East Bennett Rd, Grass Valley, California* (August 15, 1991). The 1991 investigation included the excavation of 22 exploratory trenches on portions of the Idaho-Maryland site. The trenches ranged from 2.5 to 13.5 feet deep.

The Anderson and Associates report described two previously graded areas on the Idaho-Maryland site that have loose, organic fill. One previously graded area lies in southeastern part of the site at the base of a cut slope. Fill up to 3.5 feet deep was encountered in the exploratory trenches excavated on the northern portion of this previously graded area. The fill was generally described as sand and gravel with organic material and occasional larger rock. Fill deeper than 13.5 feet was encountered in the exploratory trenches excavated on the southern end of this area. The fill was generally described as clay with abundant wood debris, as well as sand and gravel. There are no proposed structures shown on the site plan in the vicinity of the eastern previously graded area.

The other previously graded area lies in the southern part of the Idaho-Maryland site beneath the proposed employee parking area. Fill up to 4 feet deep was encountered in the exploratory trenches excavated on the perimeter of this area. The fill was generally described as sawdust, wood chips, clay, sand and gravel.

Atterberg Limits testing was performed using five bulk samples of clay soil obtained from depths ranging from 2.5 to 5.5 feet bgs in the exploratory trenches. Plasticity Indices ranged from 13 to 32, and Liquid Limits ranged from 37 to 57.

The Anderson and Associates report concluded that the relatively loose, organic fill onsite would not be suitable to support structural improvements.

We did not review any reports that pertain to the New Brunswick or Roundhole Easement sites.

## **2.5 FIELD INVESTIGATION**

We performed a surface reconnaissance of the project sites on October 15 and 18, 2004 to observe near surface soil conditions and visible evidence of potential geologic hazards that may be present.

### **2.5.1 Surface Conditions**

#### **2.5.1.1 Idaho-Maryland Site**

We have subdivided the Idaho-Maryland site into three sections to clarify discussion of the surface conditions at this site. We define the main area, southern area, and the southeastern area based on proposed use and topography.

The main area occupies the largest portion of the site and will include the ceramics plant and the majority of the other proposed improvements. The main area is located in the northwest part of the Idaho-Maryland site and had topography that slopes gently to the northwest. The slopes ranged from less than 5 percent along the perimeter of the main area to about 25 percent beneath the ceramics plant. The gently sloping areas (<5%) appeared to have been previously graded and much of their surfaces were covered with waste rock, presumably associated with past hard rock mining. The steeper slope in the vicinity of the proposed ceramics

plant was covered with piles of waste rock up to 10-feet in height. A ditch also crossed this slope in the vicinity of the proposed ceramics plant. The western part of the central area was relatively flat lying and had patchy areas of sandy material on the surface. Two approximately 40-foot high reinforced concrete towers were seen in the northwestern portion of the main area. Site elevations ranged from approximately 2490 feet above mean sea level (MSL) near the concrete towers to 2560 feet above MSL in the northeastern part of the main area.

Topography of the southern area was dominated by the western end of a small, west-trending ridge and the land that sloped away from the ridge to the north, south and west. The native soil had been cut from the ridge top and deposited along the edges of the resulting flat-lying area. A short, timber crib wall retained less than 5 feet of fill on the southern edge of the previously graded area, immediately north of a dirt access road. The remainder of the property appeared to consist primarily of undisturbed native soil. Elevations ranged from approximately 2620 feet above MSL on the ridge near the eastern property boundary to approximately 2530 feet above MSL near the southwest property corner. Slope gradients ranged from approximately 2 to 8 percent on the previously graded ridge top and from approximately 2:1, horizontal to vertical (H:V) on the land sloping away from the ridge.

The southeastern area contains the previously graded area, cut slopes, and a steep natural slope along the eastern boundary. The southeastern area was relatively flat-lying and characterized by extensive cut and fill associated with past lumber milling activities. Several relic foundations, apparently associated with the past lumber mill, as well as a concrete slab-on-grade and a pile of large concrete fragments, were observed within the previously graded area. Cut slopes on the east side of the graded area were up to 30 feet in height, and slope gradients ranged from approximately 1:1, horizontal to vertical (H:V), to near vertical. Significant residual rock structure was observed in the soil exposed in the cut slope faces. Elevations in this area ranged from approximately 2590 feet above MSL on the graded area at the toe of the cut slope to approximately 2730 feet above MSL near the eastern site boundary. Slope gradients were generally less than 10 percent, excluding the natural slope, the cut slope, and a relatively steep fill slope located on the southern end of the historic mill area.

### **2.5.1.2 New Brunswick Site**

The New Brunswick site sits in a valley created by the South Fork of Wolf Creek. The site is bounded by Bennett Road to the north, a pond and associated dam to the east, and a steep slope (60%) to the south. Elevations across the site ranged from 2540 feet above MSL at the western site boundary to roughly 2750 feet above MSL around the New Brunswick Mine area. The site consisted of the generally flat lying surfaces around the New Brunswick Mine, gently sloping open fields and tree covered areas extending downstream of the dam, and steep slopes along the southern part of the site.

Deep fill was apparent in the vicinity of the New Brunswick Mine workings. We also observed the mine silo, concrete slabs-on-grade, and the covered New Brunswick shaft in this area.

The gently sloping surfaces along the valley floor were covered with thick vegetation and we could not evaluate the nature of the material in this area.

We observed concrete walls and waste rock piles associated with the Union Hill shaft in the northwestern part of the site. We also observed numerous waste rock piles on the northeast facing slopes across from the Union Hill shaft. These piles were up to 10 feet in height and were likely associated with mining from the Cambridge shaft and nearby exploration.

### **2.5.1.3 Roundhole Easement Site**

The Roundhole Easement site lies on the slope immediately north of Whispering Pines Lane. The proposed site consists of a 300-foot long access road and 300-foot diameter circular area according the site plan. We observed a north facing 25 percent slope along the access road and a shallower northeast facing 15 percent slope in the circular area. Elevations across the site ranged from 2705 feet above MSL at the top of the access road to 2640 feet above MSL at the lowest part of the site. We observed the remains of a concrete structure and waste rocks piles in the northern part of the site. These features were likely associated with the Roundhole shaft.

### **2.5.2 Surface and Groundwater Conditions**

We did not observe standing water at either the Idaho-Maryland site or the Roundhole Easement site. However, the ground surface of the flat lying portions of both sites were saturated from recent rain.

The South Fork of Wolf Creek trends northwest through the center of the New Brunswick site. The low-lying areas downstream of the dam were covered with marsh vegetation, but we did not observe standing water in these areas at the time of our site visit, which was performed at the end of the dry season. However, we observed flowing water in the South Fork of Wolf Creek.

## **3 LABORATORY TESTING**

Laboratory testing was not included in the scope of our preliminary geotechnical engineering investigation. Laboratory testing would be required as part of a design-level geotechnical engineering investigation for the project.

## **4 CONCLUSIONS**

The following conclusions are based on our field observations and our experience in the area.

- Based on the results of our preliminary geotechnical investigation, our opinion is that the project is feasible from a geotechnical standpoint. The recommendations contained in this report are preliminary in nature and should not be used for construction.
- Based on our review of geologic maps pertaining to the subject sites, we do not anticipate that naturally occurring asbestiform minerals will be encountered in the native soil/rock encountered in the majority of the three sites. However, the western edge of the Idaho-Maryland site was mapped as serpentine and may contain natural asbestiform minerals. In addition, material that may have been imported to the sites may contain asbestiform minerals, although we did not encounter evidence of asbestiform minerals during our site reconnaissance. The State of California Environmental Protection Agency and Air Resources Board have recognized asbestos as

a carcinogen. Grading in areas of fibrous serpentinite rock typically requires an asbestos dust mitigation plan. The plan would address engineering controls, air monitoring, laboratory testing, special handling and input from local regulatory agencies.

- Our primary concern, from a geotechnical standpoint, is the presence of relic mine features at the three sites and the presence of fill in portions of the previously graded areas of the Idaho-Maryland site and New Brunswick site. We observed and performed field density testing during fill placement in the area of the New Brunswick shaft, as summarized in our letter dated February 5, 1997. Much of the fill encountered during a previous subsurface investigation performed by others at the Idaho-Maryland site reportedly contained organic material that would not be suitable to support structural improvements. We anticipate that the relatively shallow fill across much of the southern area would be able to be removed or, if deemed suitable for the purpose, used for compacted fill. However, the deeper fill encountered by others in the southeastern area would likely require extensive excavation and would not likely be able to be reused due the reported abundance of organic materials.
- The disturbed material and waste rock identified in the northwestern part of the Idaho-Maryland site and at the New Brunswick site may not be suitable to support structural improvements.
- Waste rock piles cover portions of the Idaho-Maryland, New Brunswick, and Roundhole Easement sites. In general, these piles are not suitable to support structural improvements. The waste rock piles in the area of the proposed ceramic plant would likely have to be removed prior to construction.
- The most notable historic mining features documented on the site were the New Brunswick shaft; the Roundhole shaft; the South Idaho shaft; and a horizontal tunnel that extends east along the South Idaho vein in the southeastern part of the site. If improvements are planned in the immediate recorded mining features, the features should be identified, if possible, and closed per the recommendations of H&K or another qualified

engineer. We would be able to provide closure recommendations as part of a design-level geotechnical engineering report.

- Based on our experience in the area, relatively shallow, resistant rock may be encountered in portions of the site during grading or excavation for utilities. Preliminary recommendations for resistant rock are presented in the following section. Subsurface soil and existing fill may also contain significant oversized rock and other large material that would require specific recommendations for use as fill. General recommendations for placement of oversized rock are also presented in the following section.
- Based on our experience in the area and our review of laboratory test results prepared by others, we anticipate that potentially expansive clay soil may be encountered in some portions of the site above relatively shallow, weathered rock. Expansive clay soil is typically encountered in this area in thin layers that require relatively modest design modification. General recommendations pertaining to expansive soil are presented in the following section.
- If the proposed improvements are to be located immediately above or below the relatively high cut slopes on the southeastern area of the Idaho-Maryland site, we anticipate that the slopes would require further evaluation.
- Other mine features may be present on or extending beneath the subject properties which were not identified during this preliminary investigation.

## **5 PRELIMINARY RECOMMENDATIONS**

The following preliminary geotechnical engineering recommendations are based on our understanding of the project as currently proposed, our field observations, and our experience in the area. The recommendations are preliminary and should be verified by a design-level geotechnical engineering investigation.

## **5.1 GRADING**

### **5.1.1 Clearing and Grubbing**

Subgrade for fill placement, paved areas, and building pads should be cleared and grubbed of vegetation and other deleterious materials as described below.

1. Strip and remove organic surface soil (typically 0 to 2 inches in undisturbed areas) containing shallow vegetation and any other deleterious materials. Topsoil can be stockpiled onsite and used in landscape areas, but is not suitable for use as fill. The actual depth of stripping may vary across the site. We anticipate that deeper fill with organics will be encountered in portions of the previously graded areas.
2. Overexcavate loose fill, debris and/or other onsite excavations to underlying, competent material. Possible excavations include exploratory trenches excavated by others, mantles or soil test pits, mining features, and tree stump holes.
3. Remove all rocks greater than 8 inches in greatest dimension (oversized rock) from the top 12 inches of soil. Oversized rock should be placed in deep fill per the recommendations of the project geotechnical engineer, stockpiled for later use in landscape areas or stacked rock walls, or removed from the site.
4. Vegetation, tree stumps and exposed root systems, any other deleterious materials and oversized rocks not used in landscape areas should be removed from the site.

### **5.1.2 Preparation for Fill Placement**

Upon completion of site clearing, grubbing and overexcavation, the exposed native soil should be observed by a representative of our firm prior to placement of fill at the project site. Fill placed on slopes steeper than 5:1, horizontal:vertical (H:V), should be benched into the existing slope to allow placement of fill in horizontal lifts.

### **5.1.3 Fill Placement**

Fill should be placed according to the following guidelines:

1. Material used for fill construction should consist of uncontaminated, predominantly granular, non-expansive native soil or approved import soil. Rock used in fill should be no larger than 8 inches in diameter. Rocks larger than 8 inches are considered oversized material and should be placed in deep fill per the recommendations of the project geotechnical engineer, stockpiled for use in landscape areas or rock walls, or removed from the site.
2. Oversized material may be windrowed in deeper fill under the observation of a representative of the project geotechnical engineer. The windrows should be separated by at least one equipment width. Compacted fill should be worked into the sides of each windrow, and remaining voids should be filled with smaller rock. If the oversized material is to be incorporated into a rock fill that does not permit density testing by nuclear methods, the contractor should prepare a test fill during initial fill placement for observation and testing. The means and methods of subsequent fill placement will be evaluated for conformance with the approved test fill. Subsurface seepage should be addressed in areas of oversized rock placement and rock fill to reduce the chance of soil migration in the fill associated with groundwater seepage through the oversized material or rock fill.
3. Imported fill material should be predominantly granular, non-expansive and free of deleterious or organic material. If imported material is required to grade the site, it should be submitted to H&K for approval and laboratory analysis at least 72 hours prior to use as fill.
4. Clay soil, if encountered, may be used as fill if mixed with granular soil at a ratio determined by the project geotechnical engineer. A typical mixing ratio for granular soil to clay soil is four to one.
5. Fill should be uniformly moisture conditioned and placed in maximum 8-inch thick loose lifts (layers) prior to compacting.

6. All fill should be compacted to at least 90 percent of the maximum dry density per ASTM D1557. The upper 8 inches of fill in building footprints and paved areas should be compacted to a minimum of 95 percent of the maximum dry density per ASTM D1557.
7. The moisture content, density and relative compaction of all fill should be evaluated by our firm during construction.

#### **5.1.4 Differential Fill Depth**

To reduce the magnitude of differential settlement associated with variable fill depth beneath structures, we recommend that differential fill depths beneath structures should not exceed 5 feet. For example, if the maximum fill depth is 8 feet across a building pad, the minimum fill depth beneath that pad should not be less than 3 feet. If a cut-fill building pad is used in this example, the cut portion would need to be overexcavated 3 feet and replaced with compacted fill. As part of a design-level geotechnical investigation, we would be able to provide additional recommendations to reduce differential settlement for structures, such as the proposed ceramics plant, which are to be located in moderately sloping portions of the site.

#### **5.1.5 Cut/Fill Slope Grading**

1. Cut and fill slopes should generally be no steeper than 2:1, H:V. Based on our experience in the area, 1½:1, H:V, or steeper cut slope gradients may be possible in some areas that have significant rock structure. Allowable slope gradients must be verified based on the results of laboratory testing performed as part of a design-level geotechnical investigation.
2. Fill slopes should be constructed by overbuilding the slope face and then cutting it back to the design slope gradient. Fill slopes should not be constructed or extended horizontally by placing soil on an existing slope face and/or compacted by track walking.
3. Benching during placement of fill on an existing slope must extend through loose surface soil into firm material, and be performed at intervals such that

no loose soil is left beneath the fill. An equipment width bench should be made at least every 5 vertical feet.

4. Our observation of rock outcrop and our experience in the area has shown that isolated areas of moderately or slightly weathered rock that is difficult to trench with conventional trenching equipment may be encountered in some portions of the site during grading or trenching. Pre-ripping, blasting, or splitting may be required in these isolated areas.

#### **5.1.6 Erosion Control**

Graded portions of the site should be seeded as soon as possible following grading to allow vegetation to become established prior to the rainy season. The following erosion control measures should be implemented for cut and fill slopes to reduce erosion.

1. Slopes should be hydroseeded or hand seeded/strawed with an appropriate seed mixture compatible with the soil and climate conditions of the site as recommended by the local Resource Conservation District office.
2. Following seeding, jute netting should be placed and secured over the slopes to keep seeds and straw from being washed or blown away. Tackifiers or binding agents may be used in lieu of jute netting. Surface water drainage ditches should be established at the top of all graded slopes to intercept and redirect surface water away from the slope face.
3. Under no circumstances should surface water be allowed to run over slope faces. The intercepted water should be discharged into natural drainage courses or into the on site storm water drainage system.

#### **5.1.7 Subsurface Drainage**

If grading is performed during or immediately following the rainy season, seepage may be encountered, particularly in the low-lying portions of the New Brunswick and Idaho-Maryland sites. If groundwater or saturated soil conditions are encountered during grading, we anticipate that dewatering may be possible by gravity or by installation of sump pumps in the excavation. Control of subsurface

seepage at the base of fill areas can typically be accomplished by placement of an area drain or a strip drain. Underlying, saturated soil is typically removed and replaced with free draining, granular drain rock enveloped in geotextile fabric. Fill soil can be placed after placing the granular rock to an elevation that is higher than the encountered groundwater. Rock drains typically consist of open graded rock enveloped in a non-woven geotextile filter fabric such as Amoco 4546™ or equivalent. Drains should have a minimum 4-inch diameter, perforated, schedule 40, PVC pipe placed at the low point of the drain, inside the drainrock, with the perforations placed down. The PVC pipe should be sloped so that water is directed away from the fill placement area by gravity. Site specific subsurface drainage recommendations can be provided as part of a design-level geotechnical report.

#### **5.1.8 Surface Water Drainage**

Proper surface water drainage is important to the successful development of the project. We recommend the following measures to help mitigate surface water drainage problems:

1. Slope final grade in structural areas so that surface water drains away from buildings at a minimum 2 percent slope for a minimum distance of 10 feet.
2. Compact and slope all soil placed adjacent to building foundations such that water is not allowed to pond or infiltrate. Backfill should be free of deleterious material.
3. Direct downspouts to a closed collector pipe which discharges flow to positive drainage.

#### **5.1.9 Construction Monitoring**

Construction monitoring includes review of plans and specifications and observation of onsite activities during construction as described below.

1. We should be allowed to review the final grading plans prior to construction to determine whether recommendations presented in the design-level

geotechnical report have been implemented, and if necessary, to provide additional and/or modified recommendations.

2. We should be allowed to perform construction monitoring of earthwork grading performed by the contractor to determine whether our recommendations have been implemented, and if necessary, provide additional and/or modified recommendations.

## **5.2 FOUNDATION SYSTEMS**

Our preliminary opinion is that shallow spread footings are suitable for support of structures across much of the subject site. Footings should be founded on native, undisturbed soil/rock or compacted, tested fill. Foundation design criteria and construction recommendations are typically provided as part of a design-level geotechnical engineering report.

If adverse subsurface conditions such as loose fill or expansive soil are encountered, such as the deeper fill documented in the eastern side of the Idaho-Maryland site, a deep foundation or removal and replacement of the fill may be required. Based on the larger material encountered by others in the deep fill, we do not anticipate that drilled piers would be appropriate at that particular location. We understand that improvement of this area is not currently proposed.

Footings should be deepened through expansive clay soil, if encountered at the base of the footing excavations. Expansive clay soil is occasionally encountered in relatively thin layers above the weathered rock in this area.

## **6 LIMITATIONS**

The following limitations apply to the findings, conclusions and recommendations presented in this report:

1. Our professional services were performed consistent with the generally accepted geotechnical engineering principles and practices employed in northern California. This warranty is in lieu of all other warranties, either expressed or implied.

2. These services were performed consistent with our agreement with our client. We are not responsible for the impacts of any changes in environmental standards, practices or regulations subsequent to performance of our services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this report. This report is solely for the use of our client. Any reliance on this report by a third party is at the risk of that party.
3. If changes are made to the nature or design of the project as described in this report, then the conclusions and recommendations presented in this report should be considered invalid by all parties. Only our firm can determine the validity of the conclusions and recommendations presented in this report. Therefore, we should be allowed to review all project changes and prepare written responses with regards to their impacts on our conclusions and recommendations. Subsurface investigation and laboratory testing will be required to develop design-level recommendations.
4. The analyses, conclusions and recommendations presented in this report are preliminary, based on site conditions as they existed at the time we performed our surface observations. The subsurface conditions should be confirmed by a design-level geotechnical investigation prior to construction.
5. Our scope of services did not include evaluating the project site for the presence of hazardous materials. Waste rock associated with historic mining has the potential to contain elevated metals concentrations which may pose a hazard to human health and water quality. Although we did not identify hazardous materials at the time of our field investigation, we understand that petroleum products have been released at the subject site. Project personnel should be careful and take the necessary precautions should hazardous materials be encountered during construction.
6. The findings of this report are valid as of the present date. Changes in the conditions of the property can occur with the passage of time. The changes may be due to natural processes or to the works of man, on the project site or adjacent properties. In addition, changes in applicable or appropriate standards can occur, whether they result from legislation or the broadening of knowledge. Therefore, the recommendations presented in this report should not be relied upon after a period of two years from the issue date without our review.

***SHEETS***

**Sheet 1    Approximate Site Map**

***APPENDIX***

***IMPORTANT INFORMATION ABOUT YOUR  
GEOTECHNICAL ENGINEERING REPORT***

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Prepared

April 21, 1983

ENGINEERING GEOLOGIC REPORT  
WHISPERING PINES PARK  
Idaho-Maryland Road at  
Brunswick Road  
Grass Valley, California  
L & a No. 83-118

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**LOWRY & ASSOCIATES**  
**GEOTECHNICAL ENGINEERS**

ENGINEERING GEOLOGIC REPORT  
WHISPERING PINES PARK  
Idaho-Maryland Road at Brunswick Road  
Grass Valley, California  
L & a No. 83-118  
April 21, 1983

INTRODUCTION

PURPOSE

An engineering geologic study has been completed for Whispering Pines Park, located at the southwest corner of Brunswick and Idaho-Maryland Roads, just east of Grass Valley, California. The purposes of this investigation have been to define general geologic conditions and to assess the influence of these conditions upon potential development of the property for residential and/or industrial use.

SCOPE

The scope of this study has included geologic reconnaissance and mapping of the property; stereoscopic interpretation of aerial photographs; geologic research and historical investigation; limited laboratory testing; and the preparation of this report.

This report presents the results of our study, including findings with regard to site, soil, geologic and hydrologic conditions; evidence of previous mining activity; conclusions pertaining to erosion susceptibility, slope stability, springs, rock hardness and generalized support conditions for roadways and buildings; an opinion concerning site development feasibility; and tentative recommendations for erosion mitigation during construction as well as methods for the treatment of preexisting mine shafts.

A preliminary geologic map is displayed on Plate No. 1, together with an explanation of the symbols and coding used to delineate the disposition and orientation of the various geologic formations over the property. The appendix contains general information, references consulted during the course of this investigation and laboratory test results.

#### PROPERTY DESCRIPTION

##### General

As presently constituted, Whispering Pines Park now encompasses approximately 154 acres, including a 15-acre parcel which originally was part of the 430-acre Loma Rica

Ranch for which our firm completed an engineering geologic study in 1981 (L & a No. 81-378); and the original 91-acre Whispering Pines Industrial Park Site, for which we also conducted an engineering geologic study in 1981 (L & a No. 81-246). Except for a very small part of its western extremity, the property lies entirely within Section 25, T16N, R8E, MDB&M.

The property is bounded on the north by Idaho-Maryland Road and on the east by Brunswick Road. High tension electrical transmission lines borne on steel towers extend along one of the westerly property limits. To the south, there are private residences and undeveloped wooded hill slopes.

#### Northeast Sector

The northeast sector of the property comprises about 37 acres encompassed by Whispering Pines Lane, Brunswick Road, Idaho-Maryland Road and the electrical transmission lines. This area generally slopes from a high point, near elevation +2710 feet (U.S.G.S. datum) at Whispering Pines Lane to about elevation +2555 feet, at Idaho-Maryland Road. Most of the area is heavily-wooded and the terrain is rugged, with maximum slopes exceeding 2 horizontal to 1 vertical at the

extreme northwesterly corner. Generally, however, the slopes in this area do not exceed an inclination of 3 horizontal to 1 vertical. Two houses, a barn and a church were observed northerly of Whispering Pines Lane. Three terraces up to 100 feet wide and 400 feet long have been constructed on the slope within the northwesterly portion of this area, by means of cuts and fills up to 15 feet deep. Power lines and telephone cables supported on wooden poles cut diagonally across the sector. There are several unimproved roadways or trails that lead off Whispering Pines Drive, near its intersection with Brunswick Road, and another extends south, off Idaho-Maryland Road. This area is densely populated with black and ponderosa pines, oaks and heavy underbrush, together with isolated clumps of berry vines.

Idaho-Maryland Ditch, following the approximately elevation +2645-foot contour, enters the sector from the west and continues to Brunswick Road. Extensive mounds of mine tailings and rock rubble are present within the southeast quarter. A cylindrical excavation approximately 5 feet in diameter is visible near the northerly edge of the tailings dump; rock cores extracted to advance the shaft are piled near its entrance. In addition, the remnants of at least 3 mine buildings exist nearby: stepped concrete foundations and slabs-on-grade attest to the former presence of these

buildings, which probably included a stamp mill and a hoist house. Other indications of previous mining activity include two shallow prospects located on either side of the access road projecting from Whispering Pines Drive.

#### Southeast Sector

This part of the property encompasses approximately 91 acres of heavily-wooded, moderately rugged terrain situated on the southwest corner of Whispering Pines Lane and Brunswick Road. Vegetation here chiefly consists of ponderosa pine, toyon, manzanita, cascara and scattered buckeye with a low volunteer rye grass cover in open areas. The sector is crisscrossed with numerous old bulldozer trails, probably blazed for firefighting purposes in the past. Many of these trails are inaccessible except on foot, having been overgrown with brush and obstructed by fallen trees. A cleared loop road extending off Whispering Pines Lane affords the principal access to the center of the sector.

Ground surface generally slopes from about elevation +2850 feet at the summit of a knoll near the extreme southerly property corner, to approximate elevation +2640 feet, at the far northwesterly corner. Natural hill slopes stand as steep

as 3 horizontal to 1 vertical, but are flatter at most locations. All of the trees and brush appear to be standing upright, suggesting that little, if any, soil creep has taken place; however, there are signs of ground deterioration due to erosion on old bulldozer trails over which only sparse vegetative growth has been reestablished.

An old pipeline consisting of 18-inch diameter or 18-inch square, cast iron rivetted conduit joined by bolted compression rings is exposed at 3 points not far from Whispering Pines Drive. This pipeline apparently conducts water from a source east of Brunswick Road (likely the Idaho-Maryland Ditch) to a reservoir west of Whispering Pines Park. From the apparent age of the pipeline, it is probable that it once serviced off-site mine workings.

Several old prospects were discovered, the most conspicuous of which is a 6-foot diameter, cylindrical hand-dug shaft about 15 feet deep. In addition, a few trenches were noted over the easterly half of the sector; the purpose of these excavations is unknown to us.

Northwest Sector

This part of the property encompasses about 26 acres west of the power transmission lines and is presently owned by Robinson Timber Company. Remaining vegetation consists of mixed ponderosa pine and deodar cedar with an understory of toyon and manzanita.

Ground surface slopes from about elevation +2780 feet at the power lines to a nearly-level area at about elevation +2520 feet, at the northwesterly property corner. The surface has been disturbed by previous mining and logging activities. An extensive area of mine tailings forms a lobe stretching nearly 1000 feet along the north property line. Numerous roads traverse the sector and the lower portions have been levelled, apparently for log storage and parking areas.

Several structures exist near the northwest property corner. Concrete foundation remnants also were observed in this area and probably are associated with a stamp mill and hoisting works for the immediately-adjointing (now defunct) Idaho-Maryland Mine. Just west of the power transmission lines, three large terraces have been graded into the slope, by means of cuts and fills up to 20 feet deep. Lowell

Robinson of Robinson Timber Company has indicated that the terraces were graded 2 to 3 years ago with the intention of constructing shops and parking areas on the completed pads. He has indicated that a Caterpillar D8 bulldozer was used for ripping and that the removed materials were pushed downslope to form the fill embankments without any attempt at benching, keying or other standard fill construction procedures. The project was later abandoned.

Idaho-Maryland Ditch originates at a small reservoir just south of the sector and conducts seasonal flow eastward along the approximate elevation +2645-foot contour.

## FINDINGS

### GEOLOGY

#### Regional Setting

The Nevada City-Grass Valley area lies in the western part of the Central Sierra Nevada. It is dominated by steeply-dipping, faulted and folded metamorphic rocks that have been intruded by several types of igneous rocks. Overlying the bedrock in many places are mantles of river gravel and volcanic debris.

The ascent from the Central Valley is gentle, and the average slope through a west-to-east transect is about 5 percent. In general, the trend of the ridges and rock formations is northwest-to-southeast. Drainage generally is toward the southwest: the drainage channels have incised geologic formations and followed the westward tilting of the Sierra Nevada fault block. The headward parts of the major streams and rivers are more deeply-incised by river canyons and drainageways than are the rolling foothills, where river dissection is less. Typically, the folded and faulted areas are rounded and smooth and have a domelike appearance, while the volcanic areas resemble plateaus or mesas.

#### Local Geology

##### Rock

Four distinct geologic units are identified on the property:

- 1) metasiltstone, quartzite, talcose conglomerate and metashale (phyllite) identified as a part of the Calaveras Formation of Permian age (225-280 my B.P.);

- 2) amphibolite schistose basalt and melaphyre with subordinate gneissic dikes and quartz veins, all assigned to the Copper Hill Volcanics Group of Early Cretaceous age (134-136 my B.P);
- 3) ultrabasic rocks, predominantly serpentinite and lherzolite of Middle Cretaceous age (95-120 my B.P); and
- 4) basic intrusive rocks, including gabbro diorite and pyroxenite, also of Middle Cretaceous age.

Each of the four formations listed above is discussed in ascending geochronologic order.

Calaveras Formation rocks (map symbol: Pms) are exposed at a single location, just south of Whispering Pines Drive. At this point, sheared, talcose conglomerate and slaty metasediments form a crescent-shaped island bordered by younger Cretaceous rocks to the north and south. Generally, Calaveras Formation rocks show a dusty orange-gray cast when highly weathered, but are light blue-gray when fresh. Shearing and crumpling of individual beds has obliterated the original lithologic structure, and some beds may even be overturned.

The Copper Hill Volcanics Group (map symbol: Kmv) is extensively exposed and underlies almost the entire property. Of the outcrops observed, the bedding or foliation attitudes range from  $68^{\circ}$  to  $80^{\circ}$  W dip on a N  $10-20^{\circ}$  W strike conforming to the regional texture. The amphibolite and melaphyre display a characteristic dull blue-gray to blue-green cast while the schistose basalt is usually gray-green. The bedding or foliation planes are rather widely-spaced, resulting in a blocky appearance with the rock fragments tending to break off in slabs, some up to 2 or 3 feet thick. Hydrothermally-emplaced quartz veins, some of which are gold-bearing, occur along some of the bedding planes and were the object of exploitation by previous mining enterprises. Four such veins -- three of considerable length and one a truncated segment -- were mapped on the site. Each measured more than 18 inches wide and were found to pass through prospects situated in the southeast sector of the property.

Ultrabasic rocks (map symbol: Kub) composed of serpentinite and lherzolite are exposed over most of the northeast and northwest sectors. These rocks are essentially structureless because of the haphazard arrangement of joints and fractures. Serpentinite is an almost glassy (sometimes porcelainous) rock which has a characteristic black-gray to

yellow-green appearance. The lherzolite is a very dark green to black more massive rock from which the serpentinite has been derived by hydrothermal processes. Both rock types have a blocky texture, with individual fragments attaining dimensions of 1 foot or more on a side. The contacts formed between ultrabasic rocks and others frequently are sites of secondary mineralization by chromium compounds, gold, silver and other valuable metals. Two splays of quartz were individually identified in the field, one of which is the renowned Gold Point Vein on which several major mine shafts were sunk.

Basic intrusive rocks (map symbol: Kbi) composed of gabbro diorite and pyroxenite are exposed as thin sliver in contact with the Copper Hill Volcanics group near Brunswick Road. The strike and dip of the foliation appear to conform to those of the metamorphic sequence. The gabbro member is a very dark, equigranular rock which has been slightly altered by metamorphism while the pyroxenite member forms dark gray-green to black streaks or stains within the main gabbro intrusive body. Two prominent sets of joints were observed in the field: the primary set is strongly oriented at N 22-42° W, with a dip of 83° to 89° N, while the secondary

set is less consistently oriented, with strikes ranging from N 5° E to N 73° E and dip attitudes ranging from 83° N to vertical. Cleavage is preferential along the primary joints with the rock tending to spall off in slabs. Unlike the Copper Hill Volcanics Group, secondary mineralization is indistinct to nonexistent.

### Soils

Three major groups or categories of soils are distinguished on the basis of composition, texture and relative age:

- 1) alluvium, restricted to stream deposits;
- 2) colluvium, derived by in-place weathering of the underlying parent bedrock; and,
- 3) artificial deposits, including mine tailings and manmade fills.

Of the foregoing, only the artificial deposits are shown separately on the Plate No. 1; mine tailings are designated by map symbol Qt, and fills, by map symbol Qf.

Alluvial soils which have been transported by Wolf Creek and, to a lesser extent by its tributaries, are indicated to consist of saturated silts and sands containing various

amounts of rock fragments. They are likely not thicker than 2 or 3 feet within the confines of Wolf Creek itself and, even there, are not continuously exposed.

Colluvial soils are divided into two genetic categories. The uppermost soil horizon, consisting of inert mineral particles derived by chemical and/or mechanical disintegration of the parent bedrock and which are less than 1-inch in diameter, is designated the "A" horizon. Below the "A" horizon are soils containing a considerable amount of broken rock, the proportion of which increases rapidly with depth and as the underlying bedrock surface is approached. This zone is the "B" horizon, or regolith. Both "A" and "B" horizon soils are not necessarily present everywhere throughout the property; their development depends upon the relative age and weathering susceptibility of the parent formation as well as the inclination of the slopes upon which they repose.

In general, our study shows that soils produced by in-place weathering of metavolcanic bedrock are more cohesive than those developed from the other types. For the former situation, "A" horizon soils are indicated to vary in thickness between 6 and 18 inches; Atterberg limits tests conducted on a selected sample of "A" horizon soils developed

over metavolcanic bedrock indicate that these materials are silty clays (Unified Soil Classification: CL) with a reddish-brown cast and containing approximately 15 percent root fibers, decomposed vegetation and the like. The "B" horizon soils are indicated to vary in thickness from 12 to 36 inches; laboratory tests indicate that "B" horizon soils are "fat" (i.e., very plastic) clays conforming to the Unified Soil Classification CH. Soils developed over basic intrusive, metasedimentary or ultrabasic bedrock show a definite "A" horizon but the "B" horizon is indistinct to absent. The thickness of soil cover generally does not exceed 12 inches; the results of Atterberg limits tests conducted on these materials show that they conform to Unified Soil Classifications ML or MH.

The USDA Soil Conservation Service has classified the more cohesive soils as species of the Aiken group -- either loam or stony clay loam -- and the remainder as Boomer loam.

The artificial deposits mapped over the property consist of fills constructed in berms along the Idaho-Maryland Ditch, embankments for building pads and debris from previous mining activity. Mine waste is indicated to consist of rock fragments (sometimes mixed with native soils) ranging from gravel to boulder-sized and typically composed of quartz,

amphibolite schist, serpentinite and lherzolite. The cores near the entrance to the air shaft previously described are predominantly serpentinite. The fills and embankments all appear to have been constructed of native soils and excavated rock in the immediate vicinity of the respective improvements.

## HYDROLOGY

### GROUND WATER

#### Perennial Springs

Three perennial springs were discovered on the property; their approximate locations are depicted on Plate No. 1. These springs are expected to seep year-round, with the greatest flow occurring during or shortly following seasonal rainfall or snowmelt. Typically, perennial springs occur at or near the geologic contacts where dissimilarities in rock jointing patterns and/or local shear zones pervade the rock fabric; or where topographic lows coincide with the strike of major bedding planes or fractures.

### Ephemeral Springs

Areas of apparent seasonal spring activity also were observed on the northerly part of the property; two such locations are shown on Plate No. 1. Seasonal springs also are suspected on other parts of the site. Based on our site observations, we expect that cut slopes -- especially those with exposed faces oriented in the east-west direction -- may intercept limited seepage through bedrock foliation planes, at least seasonally.

Ephemeral springs occur under the same circumstances as perennial springs but discharge is restricted because the permeability through interconnecting bedrock joints and topographic position are less favorable.

### SURFACE WATER

#### Wolf Creek

Wolf Creek is naturally recharged by spring fields originating near the Lava Cap Reservoir and is artificially recharged by diversion of flow in the Cascade Canal and the D-S Canal, both of which are diverted from Deer Creek above and below (respectively) Scotts Flat Reservoir. Most of the channel is very deep (40-50 feet) and rockbound from the

source near elevation +3270 feet, to approximate elevation +2720 feet, but is much shallower (10-15 feet) and alluviated farther downstream. In the upper reaches, the cross-section of the channel is V-shaped, but in alluviated portions is roughly trapezoidal.

Discussions with Nevada Irrigation District personnel indicate that Wolf Creek conveys peak flows on the order of 60 to 65 cubic feet per second , usually between May 15 and September 15, for ranch land and crop irrigation purposes. Minor recharge of Wolf Creek occurs through leakage from neighboring canals, surface runoff during the wet season and bank seepage in areas of active springs. Without artificial recharging, Wolf Creek would be practically dry during the summer months. The average gradient above elevation +2720 feet is nearly 10 percent, but below, reduces to about 2 percent. Wolf Creek is the only stream artery serving Grass Valley.

#### Idaho-Maryland Ditch

This water course is about 5 feet deep and once served the Idaho-Maryland Mine workings but has since been abandoned. Its long disuse is confirmed by encroachment of native

vegetation and heavy underbrush, even at the center of the channel. The only recharge appears to be from seasonal runoff and (perhaps) from a few ephemeral springs.

#### PREVIOUS MINING

##### Idaho-Maryland Mine

The main shaft of the Idaho-Maryland Mine lies immediately west of the property, near the extreme northwest property corner. The prospect was originally named the Idaho Quartz Mine and was patented in 1864. By 1882, the inclined main shaft had reached a depth of 2200 feet (1600 feet vertically). The uppermost seven levels -- i.e., to a vertical depth of 700 feet -- extend to the west along the ore shoot, which dips to the south at about 65° and is about 2-1/2 feet wide. The foot wall is composed of basic intrusive rocks, while the hanging wall is serpentinite. At the contact between these rocks, the vein consists of hydrothermal quartz shot with finely-disseminated native gold and gold alloys.

Below a vertical depth of 700 feet, all of the horizontal workings follow the course of the vein to the east. In 1886, the depth of the incline had been increased to 2696 feet (1790 feet vertically). The average width of the vein at

that time was reported at 3 feet, and 1200 lineal feet of horizontal workings extending to the west had been completed. By 1890, the main shaft had been sunk another 200 feet, and the length of the horizontal workings was increased to 3100 feet to the east. A raise, the Maslin Shaft, was driven to the surface to provide ventilation and to decrease the ore haulage route. In 1894, the Maryland Mine (to the southwest) was acquired and connected to the Idaho Mine at the 1300- and 1500-foot levels. By 1896, an underground incline (shown on Plate No. 1) had been driven from the 700-foot level to the south, thence east and southeast, in an attempt to explore for new ore shoots extralaterally, but this venture was abandoned due to unmanageably high inflows of ground water.

The New Brunswick Shaft (south of the property) was sunk from the 1400-foot level to a point near the 3300-foot level and, at the end of 1940, sinking operations were being continued, although no development of importance had been undertaken below the 1600-foot level. The 2000-foot level of the Idaho-Maryland Mine was connected with the 2300-foot level of the New Brunswick Shaft and the entire property was being operated as one mine. From 1929 to 1940, 228,901 lineal feet of new headings were driven, all below the 2000-foot level.

### Idaho No. 2 Calyx

In 1934, the Idaho No. 2 Calyx was driven to a point below the 1000-foot (vertical) level. The shaft was advanced by a 5-foot diameter diamond core drill which was developed on the property. As previously mentioned, rock cores discarded from this operation are still visible on site.

### Other Shafts

A 15-foot deep cylindrical hand-dug shaft was observed on the southerly portion of the site. There is also a shaft adjacent to the south shoulder of Idaho-Maryland Road that is braced with square sets, and is of undetermined depth; it may have served as a ventilation winze for the Idaho-Maryland workings.

### Prospects

Several prospects were discovered within the study area. Most of these consist of shallow pits less than 5 feet deep. In addition, troughs and depressions over 10 feet deep were observed northerly of Whispering Pines Lane and westerly of

the existing house and church. These may be the result of a shallow and partially-collapsed shaft. All of the prospects appear to be the result of individual efforts and are of limited extent.

## CONCLUSIONS

### EROSION SUSCEPTIBILITY

#### Rock

Ultrabasic, basic intrusive and metavolcanic rocks are indicated to be very resistant to erosion because of the relatively wide spacing of the joints and/or dense texture.

Calaveras Formation metasediments are indicated to be at least moderately susceptible to erosion where unprotected by vegetation or other means, because of the close spacing of bedding planes, especially as are characteristic of the metasilstone and metashale members.

### Soils

According to United States Army Corps of Engineers criteria, the soils on the Whispering Pines Park property are at least moderately susceptible to erosion on slopes which are either unprotected by vegetation or exceed very flat inclinations. The threshold velocity -- defined as that velocity at which soil particles will just begin to move -- ranges from about 0.6 to 1.5 feet per second.

The extent of potential erosion is, of course, related to slope inclination, exposed area, time to concentration of rainfall and mechanical reinforcement offered by vegetation. We have concluded that temporary erosion control measures during construction as well as permanent erosion control systems should be implemented on this property.

### SLOPE STABILITY

#### Rock

Ultrabasic and basic intrusive rocks were noted to be grossly stable, even at inclinations as steep as 2 vertical to 1 horizontal. We have concluded that rock slope inclinations

steeper than Uniform Building Code standards ordinarily permit likely are possible, but this must be confirmed or denied by further geotechnical studies.

### Soils

Natural hill slopes appear to be stable in most areas; however, on the northerly edge of the site, near the existing power lines where slopes exceed an inclination of 2 horizontal to 1 vertical, slight rotation of trees downslope indicates that minor soil creep has occurred. The area involved is indicated to be of relatively limited extent, and we anticipate that it can be stabilized with special grading procedures during development or taken into consideration in land use planning. Existing fill slopes, spoil piles, ground overlain by mine tailings and soils disturbed by previous bulldozing operations, may be unstable, but this condition is expected to be alleviated during the ordinary course of grading for site development.

Although a detailed analysis of slope stability is beyond the scope of this present investigation, our geologic observation suggests that cut and fill slopes in soil, constructed in accordance with prudent engineering practice per Uniform

Building Code requirements, should remain stable, provided that fill slopes are properly benched and keyed and that both excavation and embankment slopes are protected from concentrated surface runoff.

#### SPRINGS

Deep cut slopes -- especially those with exposed faces oriented in the northeast-southwest direction -- may intercept seepage through foliation planes or joints in metavolcanic, ultrabasic or basic intrusive bedrock, especially near lithologic contacts. The quantity of such seepage is dependent upon the spacing and openness of these discontinuities. Seepage could be expected during or shortly following a period of prolonged intense rainfall, especially where the soil mantle is of more than nominal thickness.

We have concluded that subdrainage of certain areas may be necessary depending upon proposed site usage, grading and construction requirements.

EXCAVATION

Rock

An intensive study of rock excavation characteristics is beyond the scope of this study, but could be undertaken by a combination of test borings and a geophysical survey program. Our observations suggest, however, that at least the uppermost 10 feet of weathered metavolcanic or basic intrusive bedrock should be amenable to excavation using heavy grading equipment comparable to a D9 Caterpillar tractor equipped with a single ripper. At least the uppermost 15 feet of weathered ultrabasic or metasedimentary rock probably can be excavated with similar equipment. Increasingly laborious effort is likely to be required below this depth.

Rock exposures and cut slopes up to 25 feet high along Brunswick and Idaho-Maryland Roads indicate that existing highway grades were successfully achieved without resorting to blasting. As previously indicated, this is also the case for the terraces graded within the Robinson Timber Company property. It is further indicated that ripping of metavolcanic or basic intrusive bedrock will require less effort in the direction parallel to the strike of foliation or jointing (i.e., northwest-to-southeast) than across the strike, because these types of bedrock are weaker in this direction.

### Soils

It is indicated that all on-site "A" and "B" horizon soils can be excavated using conventional earthmoving equipment. This implies that cuts up to 6 feet deep can be so accomplished.

### SUBSIDENCE

Our research indicates that all of the horizontal mine workings which pass beneath the property are deep enough to preclude the possibility of subsidence due to relaxation and consequent collapse that could be reflected at the ground surface. The shafts themselves, however, must be treated to promote an acceptable level of safety.

### STRUCTURAL SUPPORT

#### Buildings

Adequate structural support should be available for industrial and residential buildings generating foundation loads of light to intermediate intensity, where foundations will bear in undisturbed or recompacted natural soils, newly-constructed engineered fills, or a combination of those

materials. Direct support of heavy concentrated loads is available for foundations achieving nominal penetration into bedrock. Existing fills such as those observed on the Robinson Timber Company parcel are of questionable quality and are probably unacceptable for support of construction in their present state.

Frostline penetration depths are unlikely to exceed 12 inches for the soil types that exist on the property. Specific recommendations for allowable soil or rock foundation pressures as well foundation system alternatives can be provided by further geotechnical studies.

#### Roadways

Selected samples of each soil type within the confines of the study area were subjected to Resistance value tests to give an indication of pavement subgrade qualities. We have calculated sample pavement sections based on the Resistance value series, the Caltrans "Design Method for Flexible Pavements" and various traffic indices which are indications of anticipated wheel load repetitions and intensities. These sample pavement sections should not be considered definitive, but may be used as a guide in planning for future roadway sections.

Design Traffic Index	Corresponding Pavement Usage	R-Value	Sample Sections - inches	
			Asphalt Concrete (Type B)	Aggregate Base (Class 2)
4.5	Light	30	2	6
		40	2	5
		50	2-1/2	4
		60	2	4
5.5	Medium	30	3	7
		40	3	5
		50	2	6
		60	2	4
6.5	Heavy	30	4	8
		40	4	6
		50	3	6
		60	3	5
7.5	Very Heavy	30	4-1/2	10
		40	4-1/2	8
		50	4	6
		80	3-1/2	-

The least favorable subgrade soils for pavement sections are those associated with metavolcanic rock ( $R=+ 30$ ) and the most favorable are those associated with basic intrusive rock ( $R=+ 60$ ). The pavement materials classification and quality shown above refer to the Caltrans "Standard Specifications" (1983 edition), and it is assumed that the pavement sections will be constructed upon properly compacted subgrade soils consisting of materials comparable to the soils tested. Minimum thicknesses could be used in areas where the subgrade consists of bedrock; in such cases, however, the wearing course thickness for any traffic index would not be expected to be less than listed above.

OPINION

DEVELOPMENT FEASIBILITY

Based upon the results of this study, it is our opinion that the subject property is acceptable for development as a light commercial or industrial park, residential tract or both, considering the prevailing geotechnical aspects. Specific recommendations for site grading should be developed on the basis of further geotechnical studies, including test borings and supplemental geophysical work.

It is anticipated that engineered fills must be benched and keyed into the natural hill slopes. Removal of unwanted trees, brush and associated root systems is an important consideration. Erosion control measures should be implemented during construction and -- depending upon the magnitude and extent of proposed grading -- on a permanent basis thereafter. Subdrainage elements may be required in areas of existing perennial springs or where subsurface water is intercepted in deep cuts.

Other than the foregoing, we observed no exceptional or overriding soil or geologic conditions which would render the property unsuitable for the intended development.

## RECOMMENDATIONS

### EROSION MITIGATION

The following discussions apply to temporary erosion control during construction. These recommendations conform to those published in "Erosion and Sediment Control Handbook" (1982), published by the State of California Department of Conservation. Additional recommendations for permanent erosion control can be developed upon completion of further studies.

#### Slopes

Seeding with Italian rye grass (Lolium multiflorum) or Wimmera rye grass (Lolium wimmera) is considered the most effective (though not the only) method of temporary erosion control on cut or fill slopes. The Italian variety provides better ground cover due to the greater number of seeds. An alternative that might be considered is Lana woolypod vetch (Vilia dasycarbia). Lana vetch provides erosion control although it has unfavorable aspects because it is an excellent feed for wild animals and its vines may create fire hazards.

On temporary construction slopes exceeding 2-1/2 horizontal to 1 vertical, consideration should be given to energy dissipation devices such as would be created by a break to a flatter slope. This can be accomplished by construction of temporary berms covered with or retaining rocks. Level spreaders are suggested at the berm outlets, but must be constructed in undisturbed soil and lead to discharge onto areas stabilized with vegetation. An advantage to the hydraulic jump-level spreader system is that the structure occupies a relatively small area. A disadvantage is that, unless continually maintained, sediment deposits in the structure will decrease the effectiveness of the hydraulic jump. In addition, a formal design is required.

#### Roadways

An effective measure to prevent deterioration of roadway subgrades is the installation of polyethylene sheeting. If this method is attempted, however, energy dissipation devices such as rock-covered berms are necessary at points of maximum sheet runoff onto unprotected areas. Seeding is not recommended, since considerable regrading to remove established root systems may be required after the wet season.

Mulching of roadway surfaces utilizing timber waste in an asphaltic emulsion often proves to be an effective alternative. Medium to high effectiveness and immediate erosion control protection can result from implementation of this method, but wood and bark chips must be graded and leaves or small twigs must be excluded from the mulch. Type SS asphaltic emulsion usually is satisfactory. Chemical mulches provide similar immediate effectiveness in erosion protection; although the chemical film increases cohesion, it reduces soil porosity. Chemical mulches are organic or plastic and are sprayed on the soils, thereby forming a crust. The crusts formed are quite effective, but may be damaged by rodents, deer or frost heave.

#### MINE SHAFTS

Small shafts, less than 6 feet in diameter, should be cleaned out to a depth of at least 8 feet and at that point bridged over with overlapping, horizontal timber stulls or (preferably) H-beam spiling. Seating of the bridgework is an important consideration; timber stulls may be driven into place with enough force to engage at least 50 percent of the ultimate axial compressive strength of each member, and steel spiling should be cradled in properly affixed beam seats.

The bridgework should then be floored over with timber stringers or lightweight metal decking, and a concrete seal at least 3 feet thick placed over the flooring. After the concrete has cured, the shaft should be backfilled with selective granular materials that can be readily vibrated or mechanically compacted to finished grade.

Major excavations -- including the Idaho No. 2 Calyx and Maslin Shaft -- should be treated as described above, but should also be bridged over with a reinforced concrete slab at least 4 inches thick and extending at least 5 feet beyond the excavation perimeter. Reinforcement should consist of deformed steel bars (at least No. 4 gauge) spaced on centers not more than 18 inches apart in each direction.

All shaft treatment work should be observed and evaluated by an engineering geologist from our firm.

LIMITATIONS

The information contained in this report is based upon our geologic reconnaissance, historical research and limited laboratory testing, as well as professional judgement. The scope of this investigation is preliminary only and should not be construed to imply final conclusions or recommendations for use in design or construction at Whispering Pines Park. Further geotechnical studies should be undertaken to resolve specific questions with regard to site grading, proposed structures and roadway sections.

If, during the course of other investigations, soil or geologic conditions different from those described above are discovered, then the contents of this report shall be considered invalid, unless the information is modified by written amendment.

Page 36  
April 21, 1983  
L & a No. 83-118

We emphasize that this report is applicable only to  
Whispering Pines Park and should not be used for the  
assessment of soil or geologic conditions on any other site.

LOWRY & associates

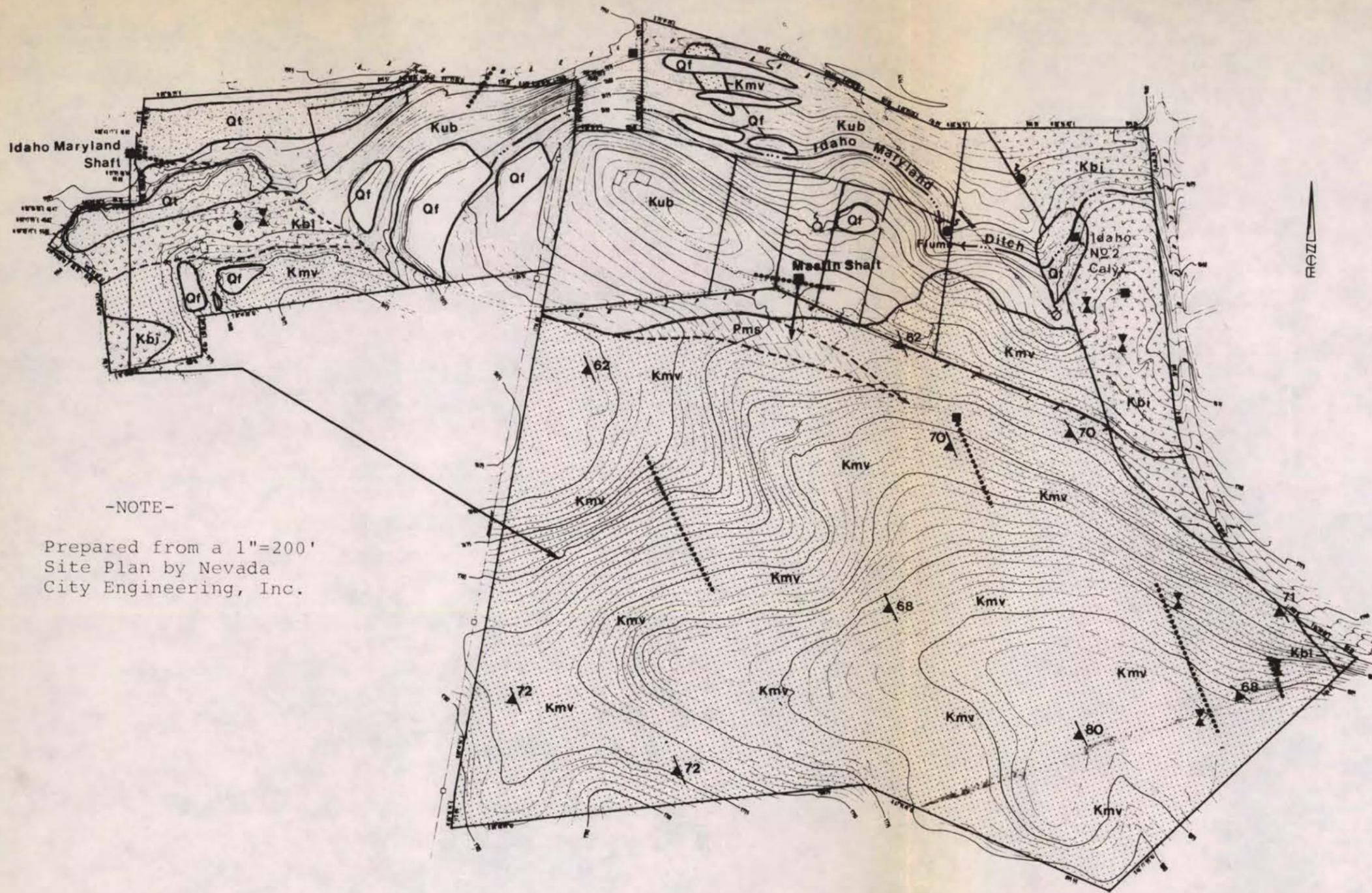
*Paul C. Weidig*  
PAUL C. WEIDIG

Registered C. E. No. 25,128

Certified Engineering Geologist No. 932

PCW:jm

xc: (25)



- |            |  |   |
|------------|--|---|
| Recent     |  | Fill embankments                            |
|            |  | Mine tailings                               |
| Cretaceous |  | Basic intrusive rocks                       |
|            |  | Ultrabasic rocks                            |
|            |  | Copper Hill Group metavolcanic rocks        |
| Permian    |  | Calaveras Formation metasedimentary rocks   |
|            |  | Ore shoot or vein                           |
|            |  | Geologic contact - dashed where inferred    |
|            |  | Strike and dip of foliation                 |
|            |  | Shaft                                       |
|            |  | Prospect                                    |
|            |  | Underground incline - terminus at arrowhead |
|            |  | Springs - solid denotes perennial flow      |

-NOTE-

Prepared from a 1"=200'  
Site Plan by Nevada  
City Engineering, Inc.

**GEOLOGIC  
MAP**

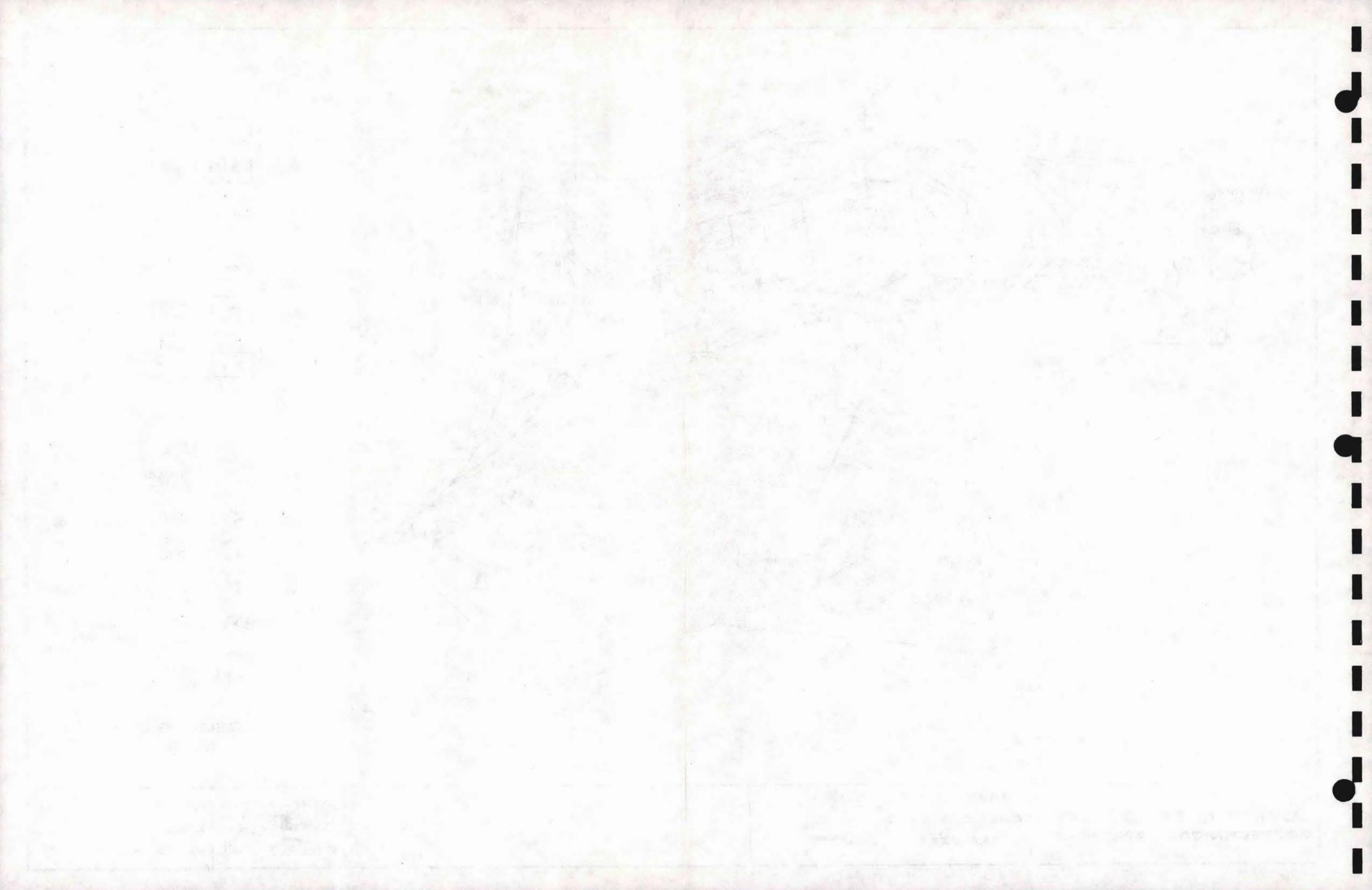
**LOWRY & ASSOCIATES**  
GEOTECHNICAL ENGINEERS

**DRAWN BY:** G. C. Barmby  
**CHECKED BY:** P. C. Weidig  
**SCALE: FEET**

WHISPERING PINES PARK  
Idaho-Maryland Road at Brunswick Road  
Grass Valley, California



**PROJECT NO:** 83-118  
**DATE:** 4/83  
**PLATE NO:** 1



APPENDIX

APPENDIX  
GENERAL INFORMATION

An investigation of soil and geologic conditions at Whispering Pines Park was authorized by Brenda Gillarde of WPM Inc., on March 28, 1983. This study was conducted in accordance with the terms and conditions stated in LOWRY & associates' contract and proposal letter for geotechnical services, dated January 26, 1983.

The general civil engineering consultant for this project is Nevada City Engineering, Inc., 424 Broad Street, Nevada City, California 95945.

The base map from which the Geologic Map, Plate No. 1, was prepared, is referenced to a site plan (scale: 1"=200') drawn by Nevada City Engineering, Inc.

Site cultural features and conditions are those existing at the time of our geologic reconnaissance, March 30, 1983, and are not necessarily representative of such features or conditions at other places and times.

FIELD EXPLORATION

The nature, distribution and characteristics of the geologic formations underlying the property were evaluated by geologic reconnaissance and mapping on a scale of 1"=200'. The map was then reduced to a scale of 1"=400' for presentation in the report and the finished map appears on Plate No. 1, together with a legend explaining the geologic symbols.

Field exploration also included an evaluation of potential springs or other high ground water conditions, the locations of previous mine workings and the recovery of selected bulk samples of the native soils for laboratory classification and testing.

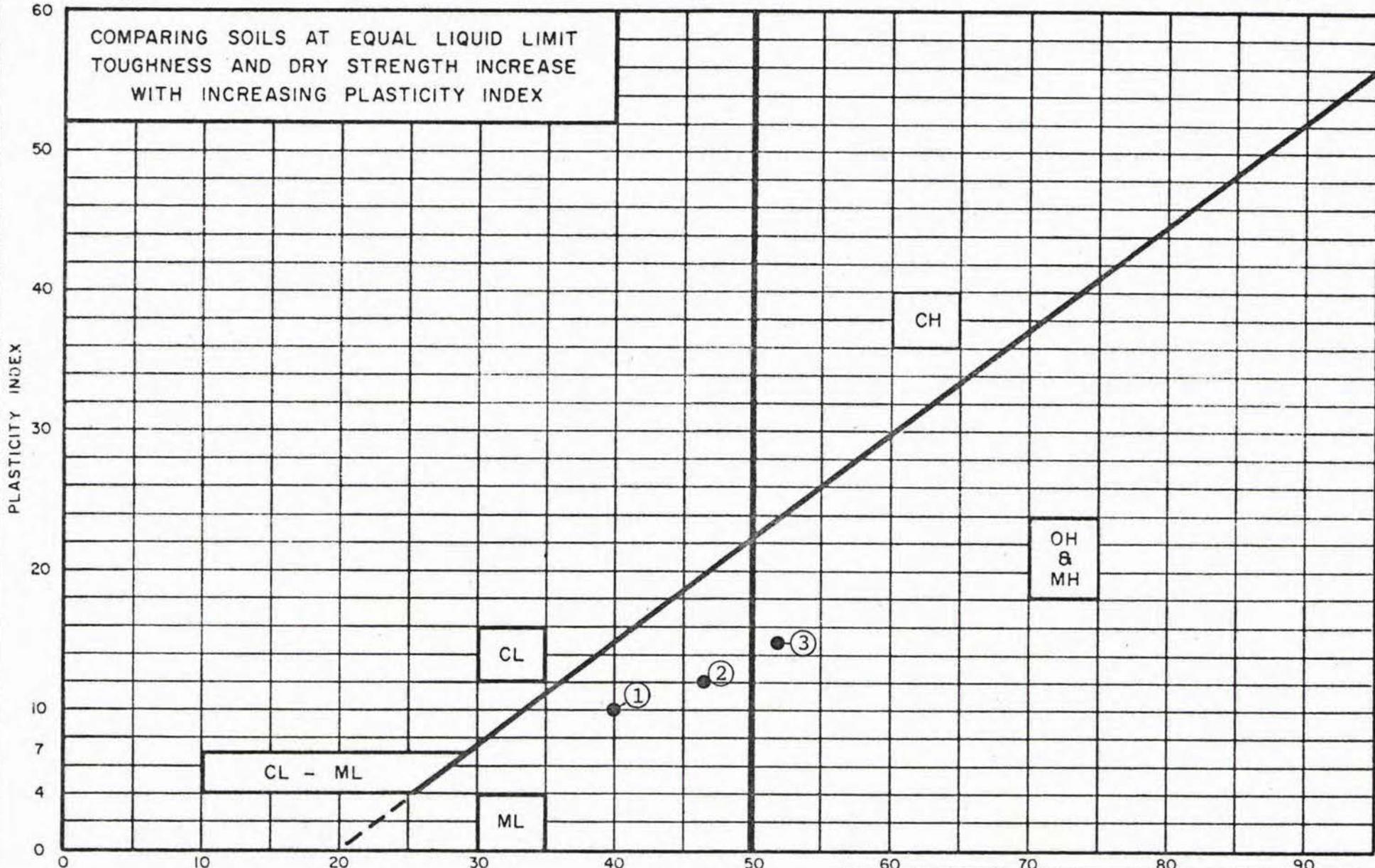
LABORATORY TESTING

Samples of the surface ("A" horizon) and subsurface ("B" horizon) soils were subjected to Atterberg limits tests (ASTM D423 and 424) to determine the plasticity characteristics of the materials. The results of these tests are displayed on Plates No. A1 and A2.

Page 3A

Resistance value tests (CTM-301G) were conducted on selected samples of the anticipated pavement subgrade soils. These tests results, which were used in our pavement section analyses, are presented on Plates No. A3 and A4.

LOWRY & associates



- ① Material: Red-brown slightly clayey silt (ML)  
Origin: "B" horizon; gabbro
- ② Material: Red-orange clayey silt (ML)  
Origin: "A" horizon; metasiltstone
- ③ Material: Rust brown silt (MH)  
Origin: "A" horizon; serpentinite

WHISPERING PINES PARK  
Grass Valley, California

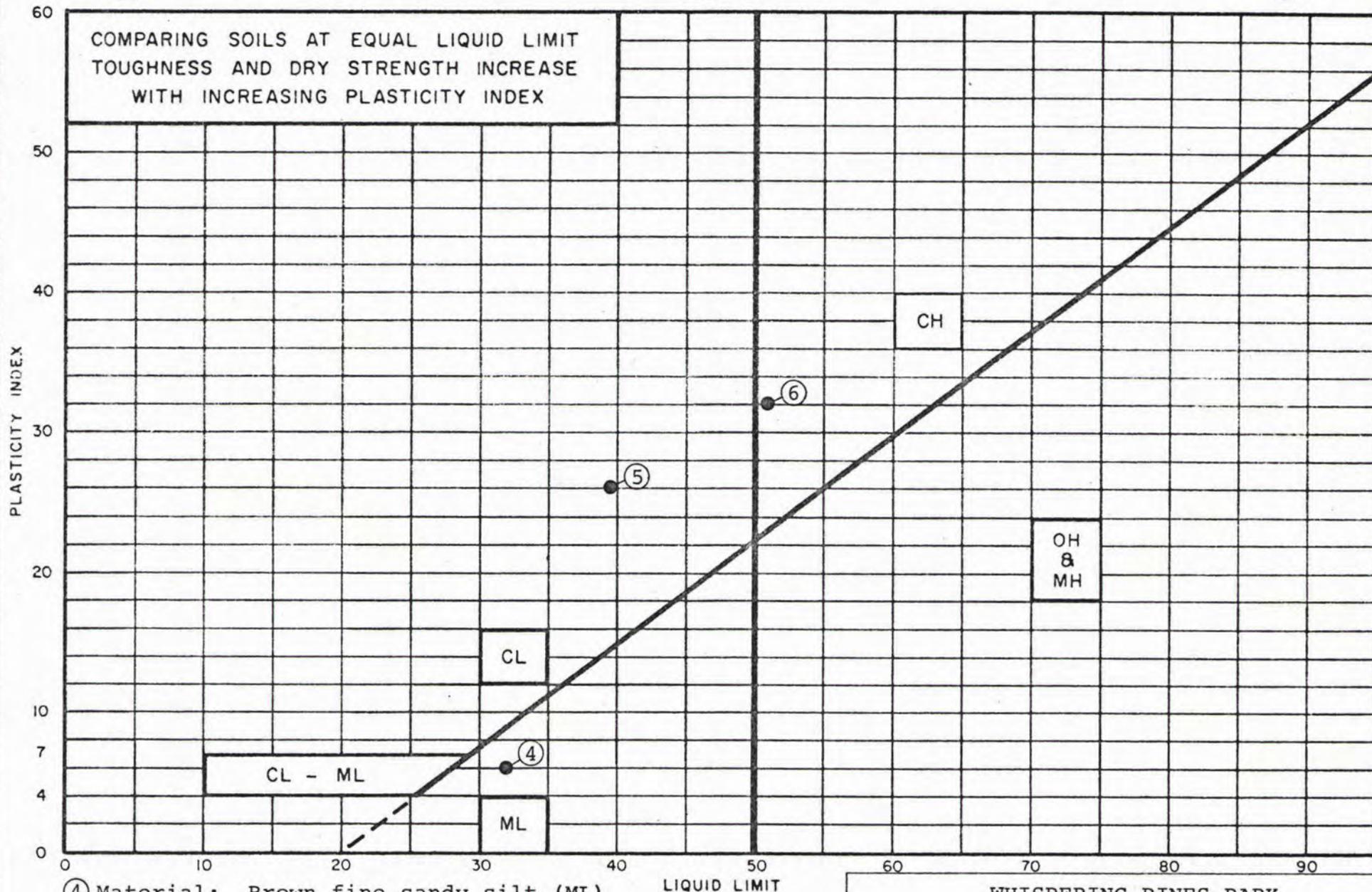


**Plasticity Chart**  
**LOWRY & ASSOCIATES**  
**GEOTECHNICAL ENGINEERS**

DATE: 4/83

PROJECT No. 83-118

COMPARING SOILS AT EQUAL LIQUID LIMIT TOUGHNESS AND DRY STRENGTH INCREASE WITH INCREASING PLASTICITY INDEX



- ④ Material: Brown fine sandy silt (ML)  
Origin: "A" horizon; gabbro
- ⑤ Material: Red-brown silty fine sandy clay (CL)  
Origin: "A" horizon; amphibolite schist
- ⑥ Material: Yellow-orange "fat" clay (CH)  
Origin: "B" horizon; amphibolite schist

WHISPERING PINES PARK  
Grass Valley, California



**Plasticity Chart**  
**LOWRY & ASSOCIATES**  
**GEOTECHNICAL ENGINEERS**

DATE: 4/83

PROJECT No: 83-118

WHISPERING PINES PARK  
Brunswick Road at Idaho-Maryland Road  
Grass Valley, California  
L & a No. 83-118

RESISTANCE VALUE TEST  
California Test Method No. 301-G

Material Description: Red-brown silty clay

Origin: Amphibolite schist

Depth: 0-12"

Specimen No.	Dry Unit Weight (pcf)	Compaction Moisture (%)	Exudation Pressure (psi)	<u>Expansion Pressure</u> (dial reading) & (psf)		Resistance (R) Value
1	97	16.1	172	22	95	40
2	98	14.9	268	42	182	70
3	99	13.7	384	87	377	75

R Value at 300 psi Exudation pressure = 74

Material Description: Brown fine sandy silt (ML)

Origin: Gabbro

Depth: 0-8"

Specimen No.	Dry Unit Weight (pcf)	Compaction Moisture (%)	Exudation Pressure (psi)	<u>Expansion Pressure</u> (dial reading) & (psf)		Resistance (R) Value
1	114	16.6	128	0	0	18
2	117	15.6	248	15	65	49
3	118	14.6	352	40	173	74

R Value at 300 psi Exudation pressure = 60

WHISPERING PINES PARK  
 Brunswick Road at Idaho-Maryland Road  
 Grass Valley, California  
 L & a No. 83-118

RESISTANCE VALUE TEST  
California Test Method No. 301-G

Material Description: Red-orange clayey fine sandy silt (ML)

Origin: Metasiltstone

Depth: 0-12"

<u>Specimen No.</u>	<u>Dry Unit Weight (pcf)</u>	<u>Compaction Moisture (%)</u>	<u>Exudation Pressure (psi)</u>	<u>Expansion Pressure (dial reading) &amp; (psf)</u>	<u>Resistance (R) Value</u>
1	96	26.7	128	3      13	17
2	98	25.1	288	28      121	39
3	99	23.5	408	100      433	69

R Value at 300 psi Exudation pressure = 40

Material Description: Yellow-orange clayey silt (MH)

Origin: Serpentinite

Depth: 72 - 96"

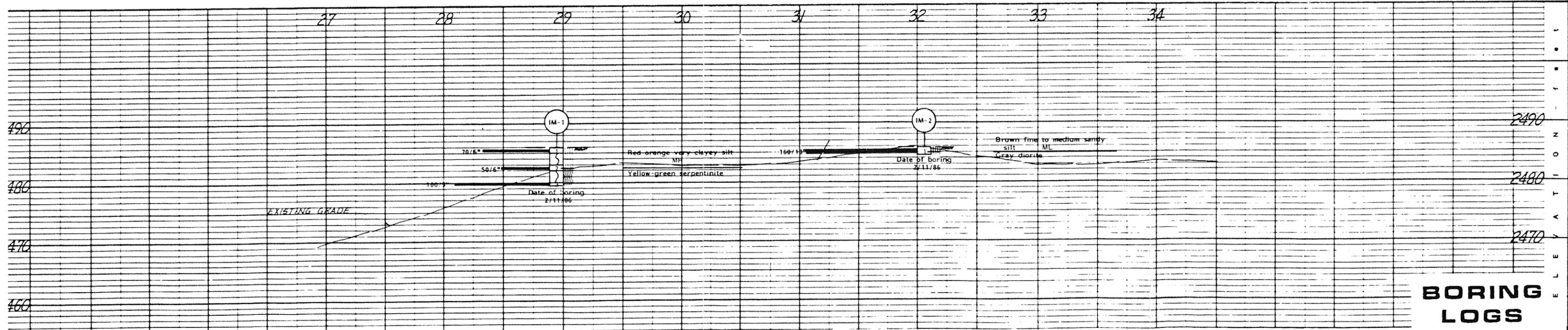
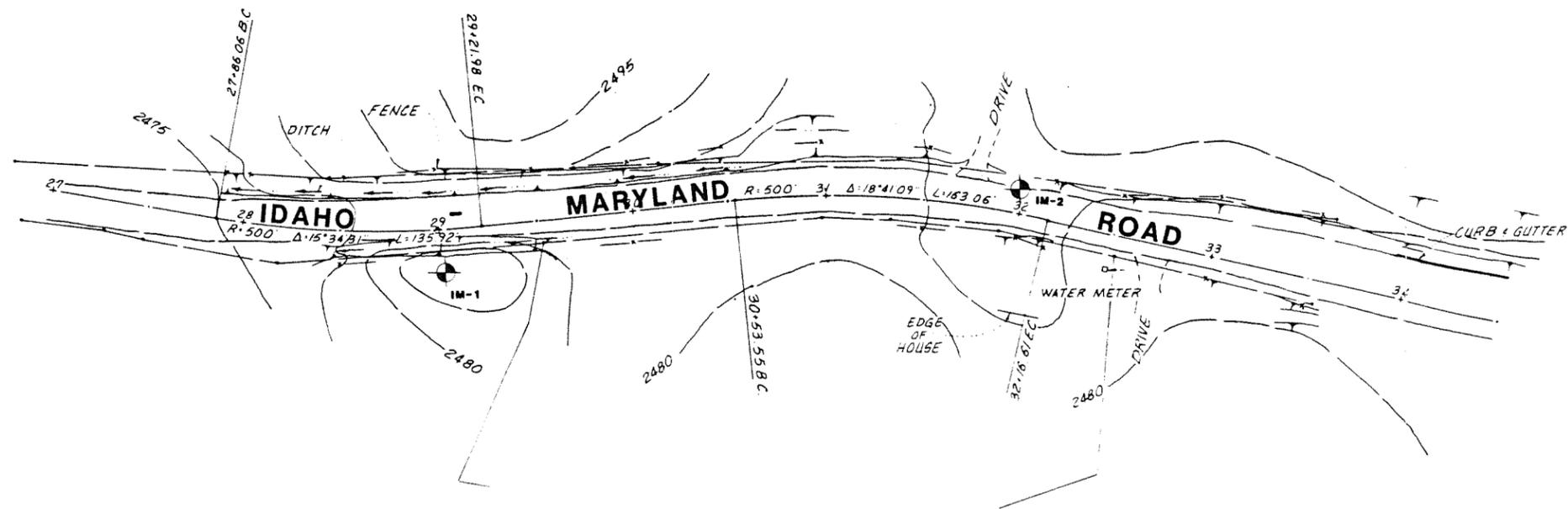
<u>Specimen No.</u>	<u>Dry Unit Weight (pcf)</u>	<u>Compaction Moisture (%)</u>	<u>Exudation Pressure (psi)</u>	<u>Expansion Pressure (dial reading) &amp; (psf)</u>	<u>Resistance (R) Value</u>
1	86	32.2	168	37      160	49
2	87	33.3	344	102      442	63
3	88	35.5	544	183      792	67

R Value at 300 psi Exudation pressure = 60

## REFERENCES

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12. "Engineering Geologic Report - Whispering Pines Park", LOWRY & associates, 1981.
13. "Engineering Geologic Report - Loma Rica Ranch", LOWRY & associates, 1981.

- NOTES-
1. This plate modified from a plan/profile sheet prepared by Nevada City Engineering, Inc.
  2. Explanation of symbols and classification system used on boring logs are presented on Plate No. 15.
  3. No free ground water observed in borings.
  4. The boring logs show subsurface conditions at the locations and on the date indicated. It is not warranted that they are representative of such conditions at other locations and times.
  5. Boring locations are approximate only.



**BORING LOGS**

**LOWRY & ASSOCIATES**  
**GEOTECHNICAL ENGINEERS**

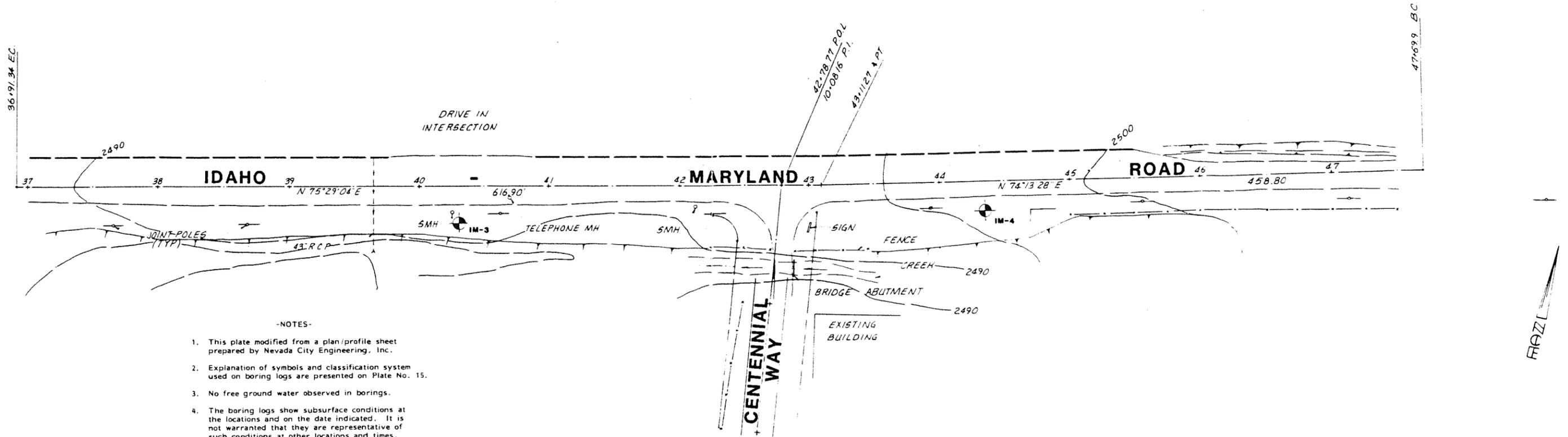
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**CHECKED BY:** P. C. Weidig  
**SCALE: FEET**

0 40 80 **HORIZ.**  
 0 8 16 **VERT.**

WHISPERING PINES ASSESSMENT DISTRICT IMPROVEMENTS  
 Idaho-Maryland Road, Sta. 27 - 34  
 Grass Valley, California

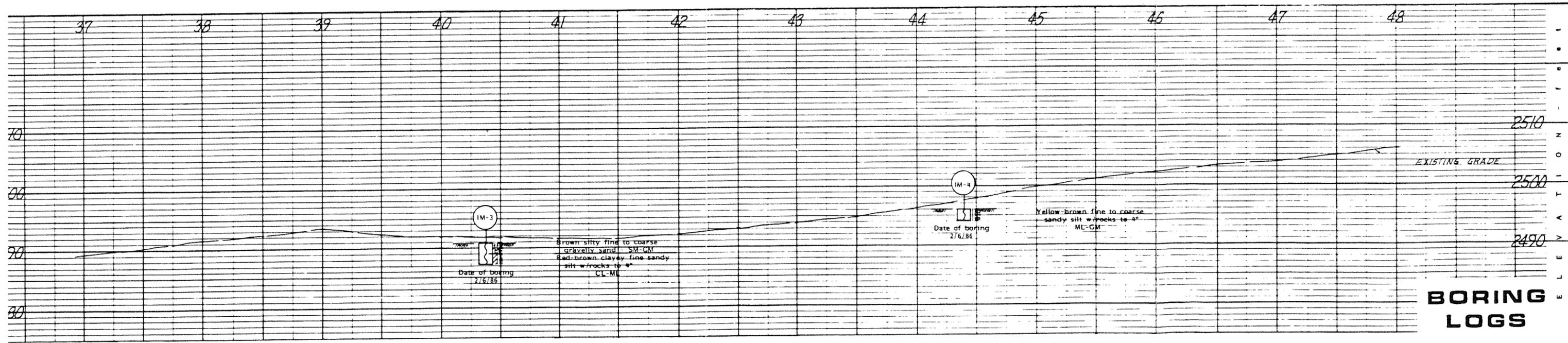


**PROJECT NO:** 86-73  
**DATE:** 2/86  
**PLATE NO:** 1



**-NOTES-**

1. This plate modified from a plan/profile sheet prepared by Nevada City Engineering, Inc.
2. Explanation of symbols and classification system used on boring logs are presented on Plate No. 15.
3. No free ground water observed in borings.
4. The boring logs show subsurface conditions at the locations and on the date indicated. It is not warranted that they are representative of such conditions at other locations and times.
5. Boring locations are approximate only.



**BORING LOGS**

**LOWRY & ASSOCIATES**  
GEOTECHNICAL ENGINEERS

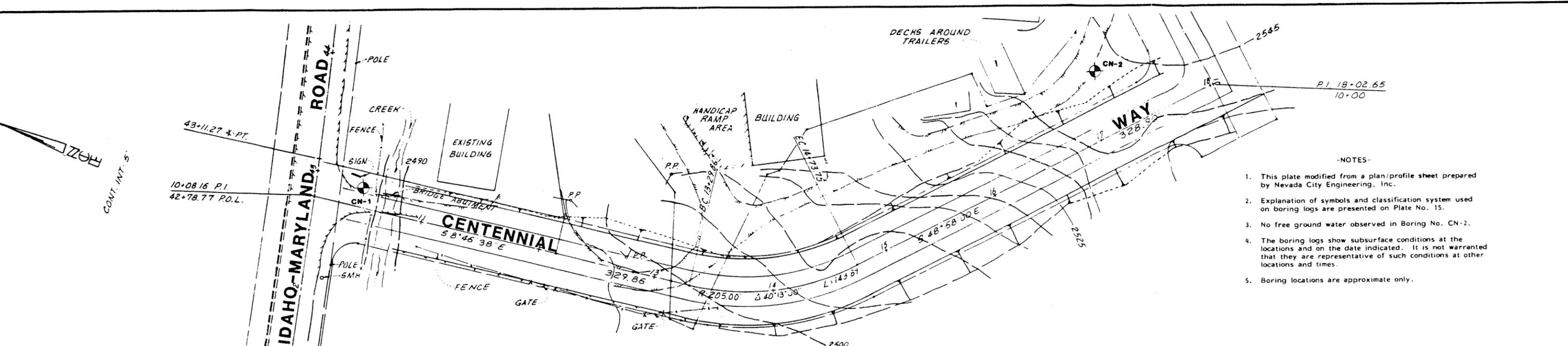
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**CHECKED BY:** P. C. Weidig  
**SCALE: FEET**

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0 8 16 **VERT.**

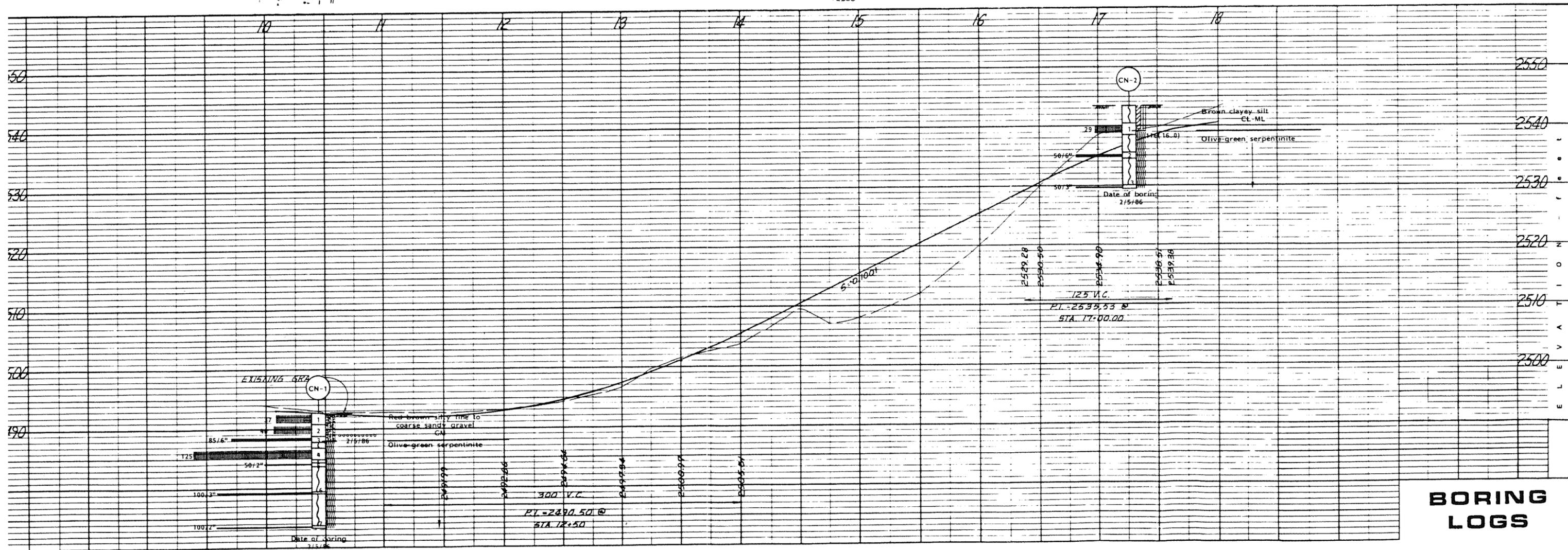
WHISPERING PINES ASSESSMENT DISTRICT IMPROVEMENTS  
Idaho-Maryland Road, Sta. 37 - 48  
Grass Valley, California



**PROJECT NO:** 86-73  
**DATE:** 2/86  
**PLATE NO:** 2



- NOTES-
1. This plate modified from a plan/profile sheet prepared by Nevada City Engineering, Inc.
  2. Explanation of symbols and classification system used on boring logs are presented on Plate No. 15.
  3. No free ground water observed in Boring No. CN-2.
  4. The boring logs show subsurface conditions at the locations and on the date indicated. It is not warranted that they are representative of such conditions at other locations and times.
  5. Boring locations are approximate only.



**BORING LOGS**

**LOWRY & ASSOCIATES**  
**GEOTECHNICAL ENGINEERS**

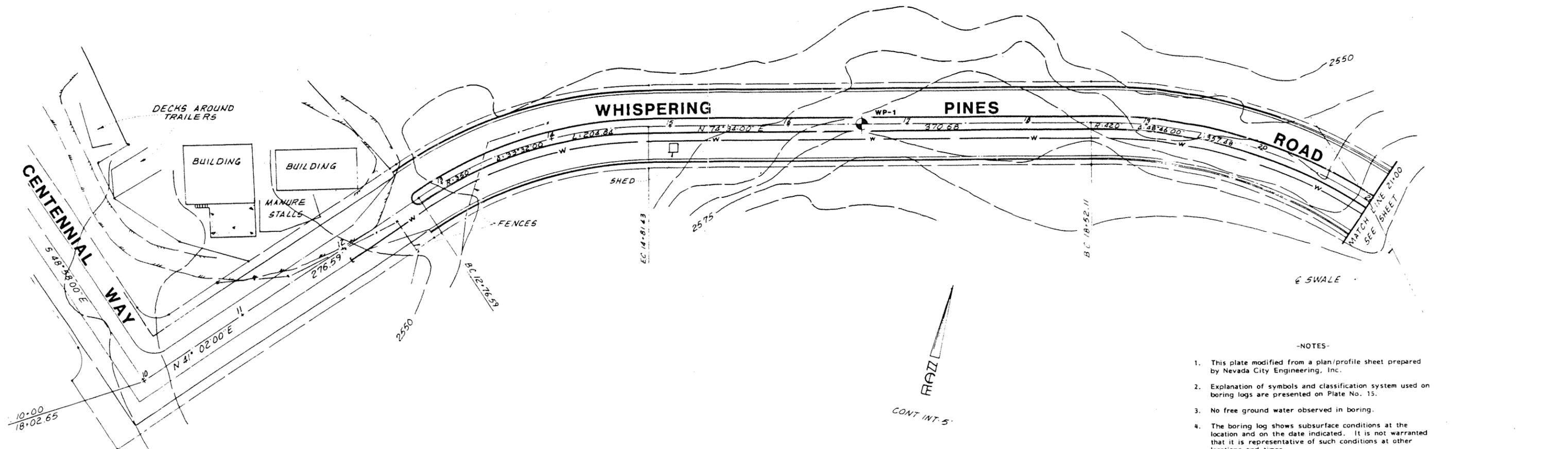
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**CHECKED BY:** P. C. Weidig  
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 0 8 16 VERT.

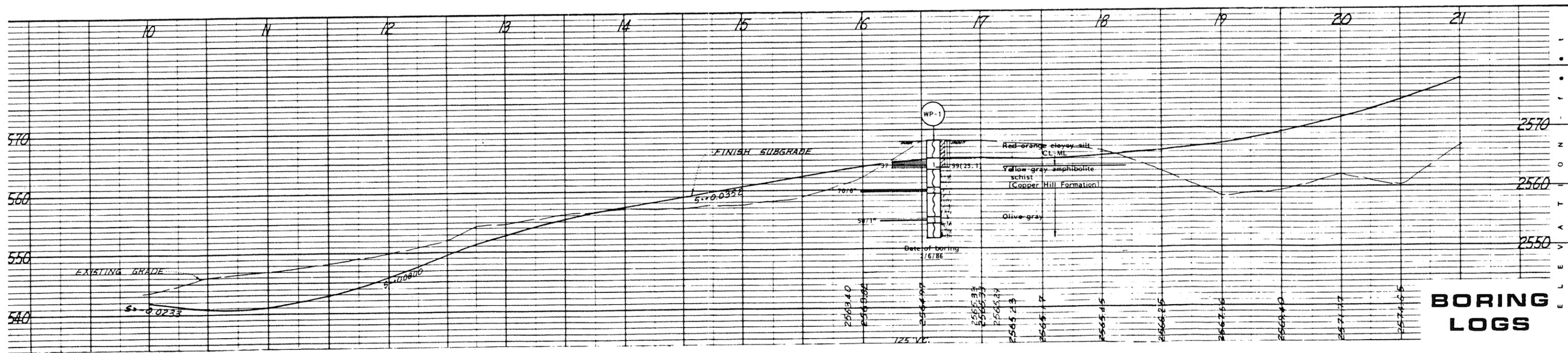
WHISPERING PINES ASSESSMENT DISTRICT IMPROVEMENTS  
 Centennial Way, Sta. 10 - 18  
 Grass Valley, California



**PROJECT NO:** 86-73  
**DATE:** 2/86  
**PLATE NO:** 3



- NOTES-
1. This plate modified from a plan/profile sheet prepared by Nevada City Engineering, Inc.
  2. Explanation of symbols and classification system used on boring logs are presented on Plate No. 15.
  3. No free ground water observed in boring.
  4. The boring log shows subsurface conditions at the location and on the date indicated. It is not warranted that it is representative of such conditions at other locations and times.
  5. Boring location is approximate only.



**LOWRY & ASSOCIATES**  
**GEOTECHNICAL ENGINEERS**

**DRAWN BY:** G. C. Barmby  
**CHECKED BY:** P. C. Weidig  
**SCALE: FEET**

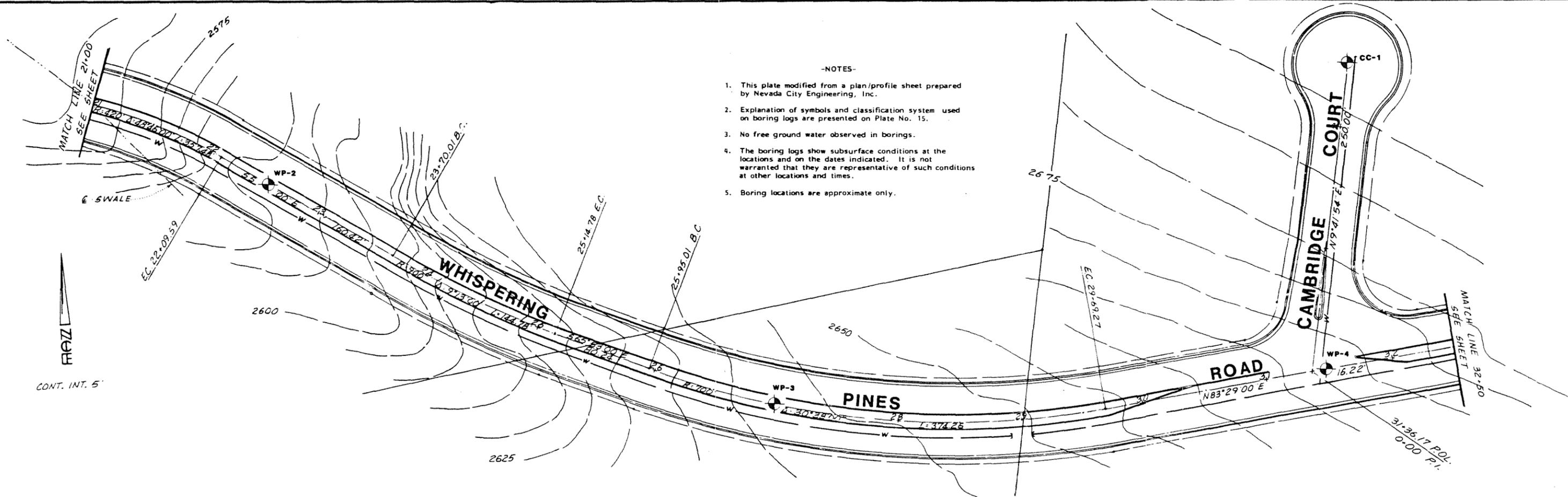
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WHISPERING PINES ASSESSMENT DISTRICT IMPROVEMENTS  
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 Grass Valley, California



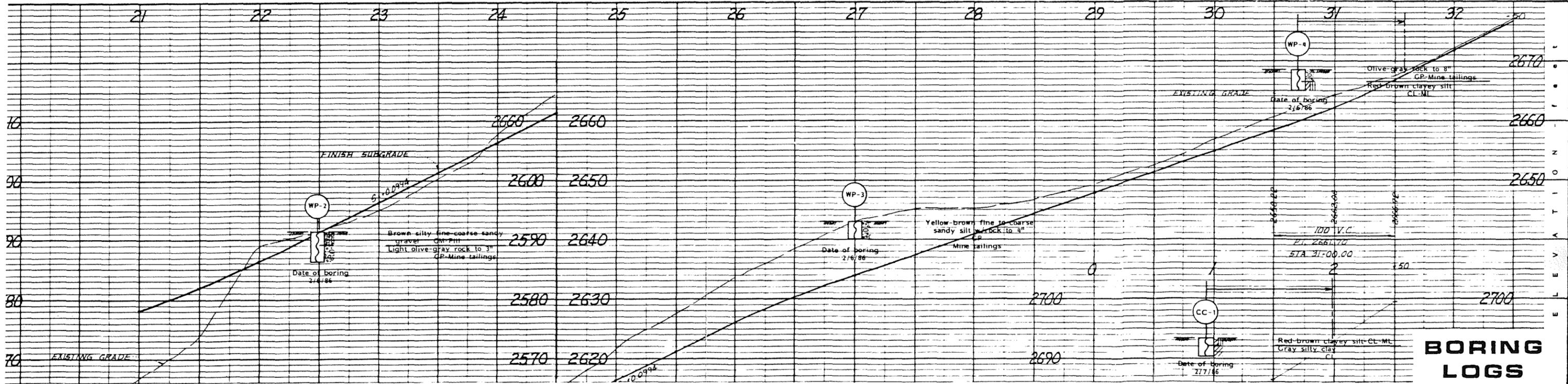
**PROJECT NO:** 86-73  
**DATE:** 2/86  
**PLATE NO:** 4

CONT. INT. 5'



-NOTES-

1. This plate modified from a plan/profile sheet prepared by Nevada City Engineering, Inc.
2. Explanation of symbols and classification system used on boring logs are presented on Plate No. 15.
3. No free ground water observed in borings.
4. The boring logs show subsurface conditions at the locations and on the dates indicated. It is not warranted that they are representative of such conditions at other locations and times.
5. Boring locations are approximate only.



**BORING LOGS**

**LOWRY & ASSOCIATES**  
GEOTECHNICAL ENGINEERS

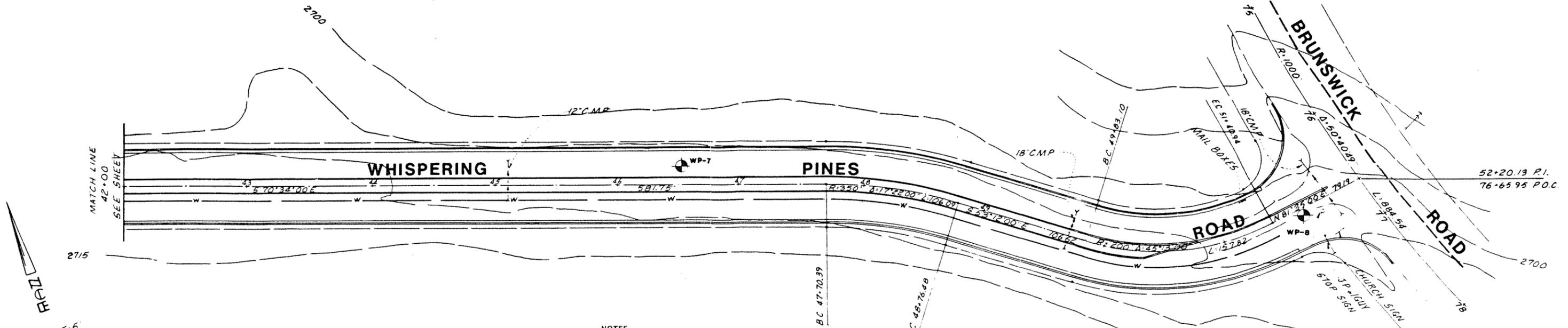
**DRAWN BY:** G. C. Barmby  
**CHECKED BY:** P. C. Weidig  
**SCALE: FEET**  
0 40 80 HORIZ.  
0 8 16 VERT.

WHISPERING PINES ASSESSMENT DISTRICT IMPROVEMENTS  
Whispering Pines Road, Sta. 21 - 32  
Cambridge Court, Sta. 0 - 2+50  
Grass Valley, California



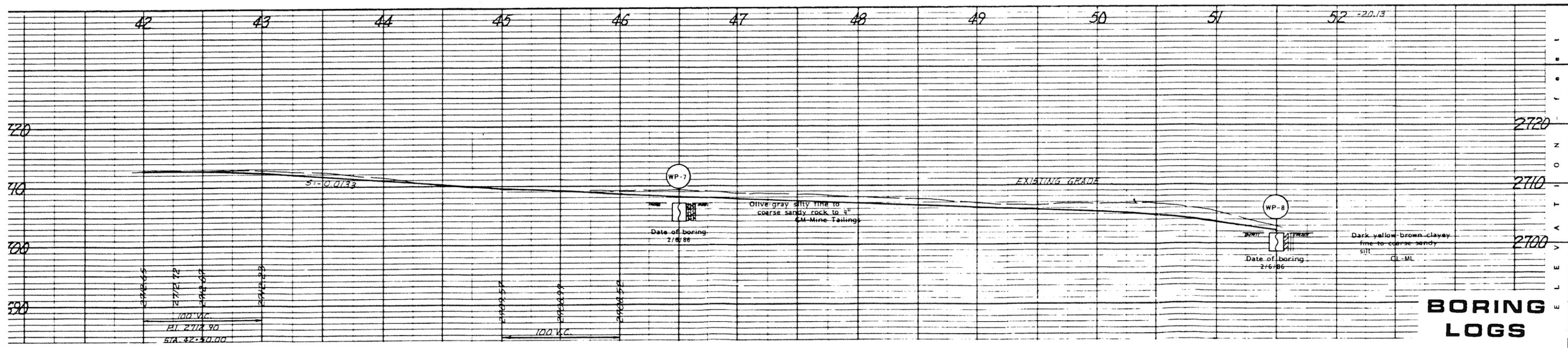
**PROJECT NO:** 86-73  
**DATE:** 2/86  
**PLATE NO:** 5





**-NOTES-**

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**BORING LOGS**

**LOWRY & ASSOCIATES**  
**GEOTECHNICAL ENGINEERS**

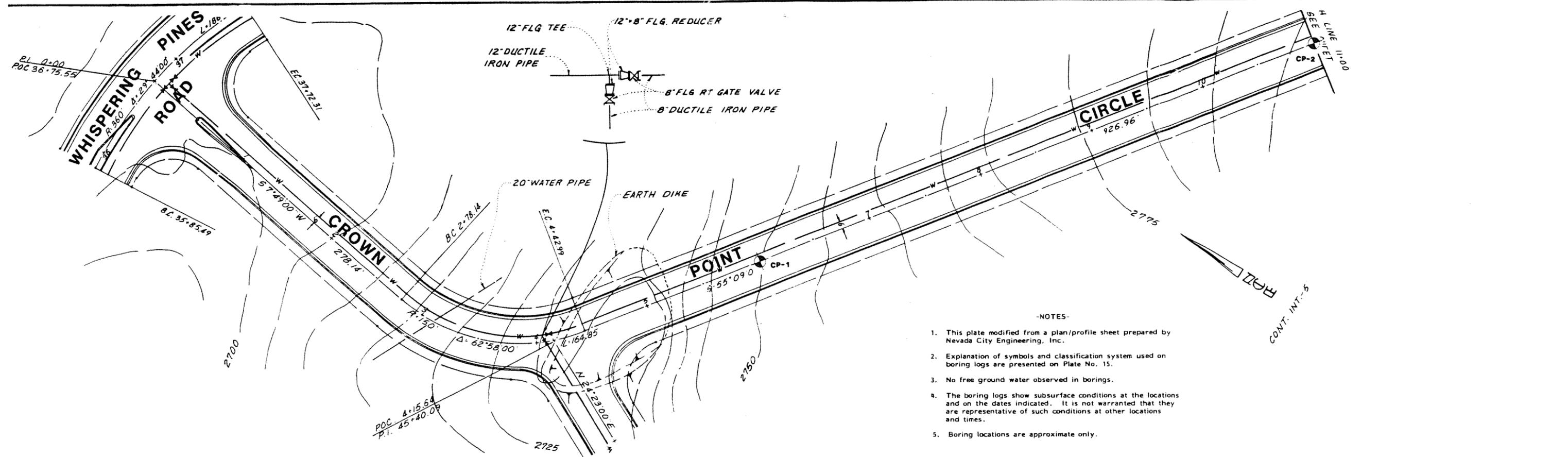
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**CHECKED BY:** P. C. Weidig  
**SCALE: FEET**

0 40 80 **HORIZ.**  
 0 8 16 **VERT.**

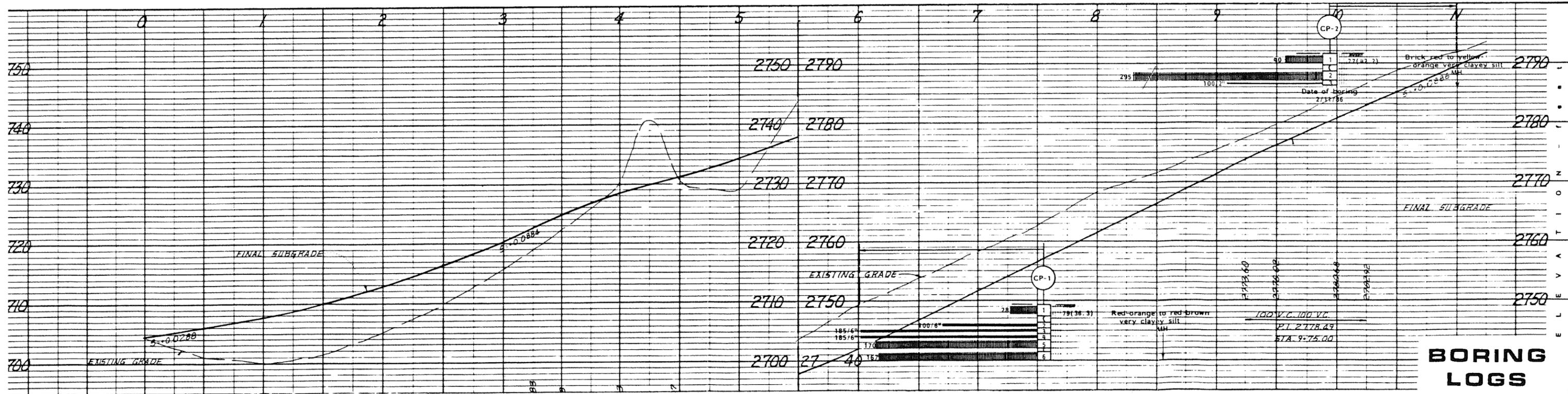
WHISPERING PINES ASSESSMENT DISTRICT IMPROVEMENTS  
 Whispering Pines Road, Sta. 42 - 52  
 Grass Valley, California



**PROJECT NO:** 86-73  
**DATE:** 2/86  
**PLATE NO:** 7



- NOTES-
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**BORING LOGS**

**LOWRY & ASSOCIATES**  
GEOTECHNICAL ENGINEERS

**DRAWN BY:** G. C. Barnby  
**CHECKED BY:** P. C. Weidig  
**SCALE: FEET**

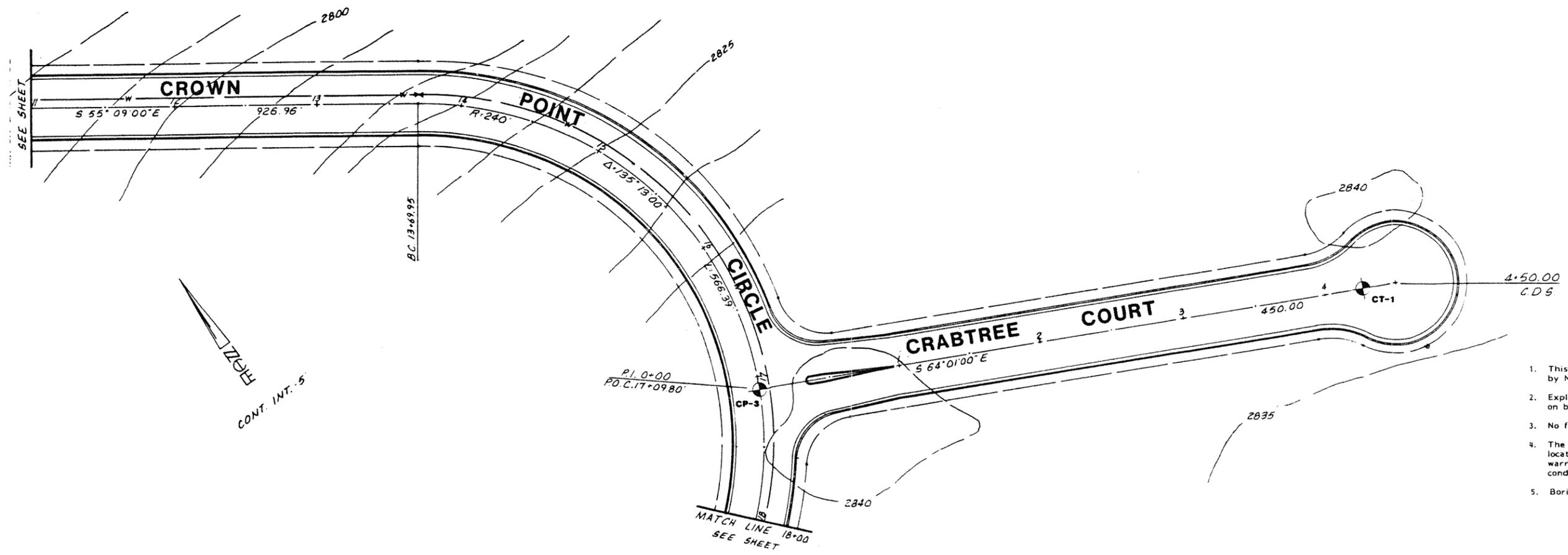
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VERT.

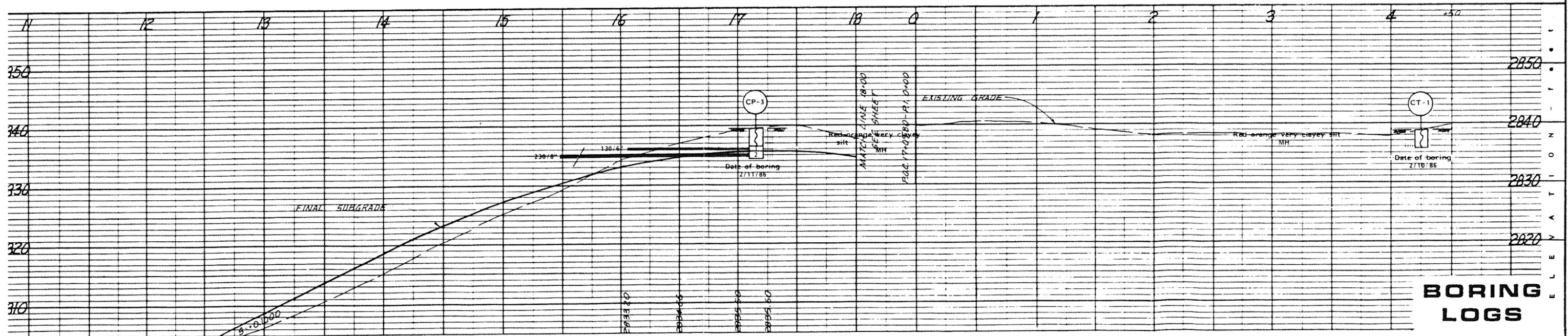
WHISPERING PINES ASSESSMENT DISTRICT IMPROVEMENTS  
Crown Point Circle, Sta. 0 - 11  
Grass Valley, California



**PROJECT NO:** 86-73  
**DATE:** 2/86  
**PLATE NO:** 8



- NOTES-
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**BORING LOGS**

**LOWRY & ASSOCIATES**  
**GEOTECHNICAL ENGINEERS**

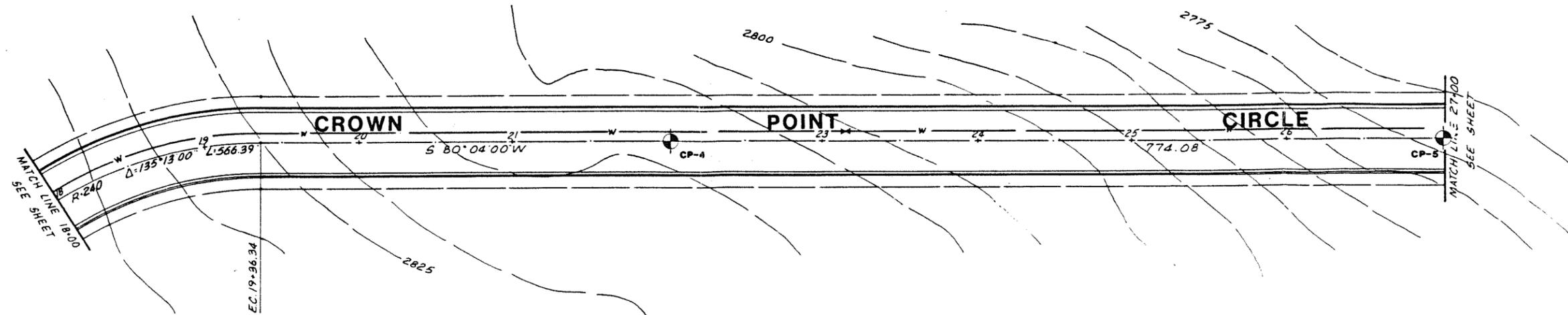
**DRAWN BY:** G. C. Barnby  
**CHECKED BY:** P. C. Weidig  
**SCALE: FEET**

0 40 80 HORIZ.  
 0 8 16 VERT.

WHISPERING PINES ASSESSMENT DISTRICT IMPROVEMENTS  
 Crown Point Circle, Sta. 11 - 18  
 Crabtree Court, Sta. 0 - 4+50  
 Grass Valley, California

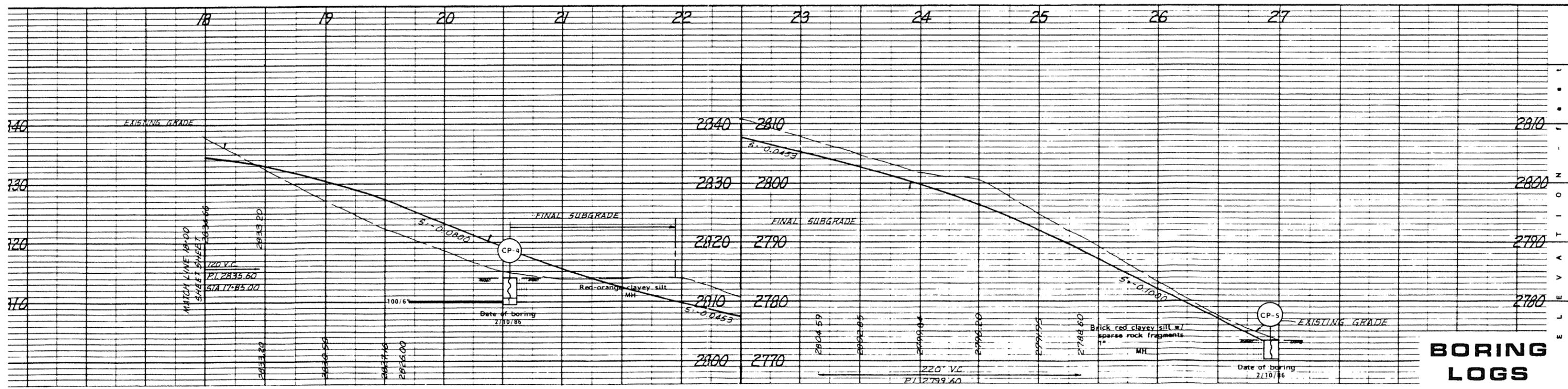


**PROJECT NO:** 86-73  
**DATE:** 2/86  
**PLATE NO:** 9



-NOTES-

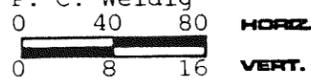
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**BORING LOGS**

**LOWRY & ASSOCIATES**  
**GEOTECHNICAL ENGINEERS**

**DRAWN BY:** G. C. Barmby  
**CHECKED BY:** P. C. Weidig  
**SCALE: FEET**

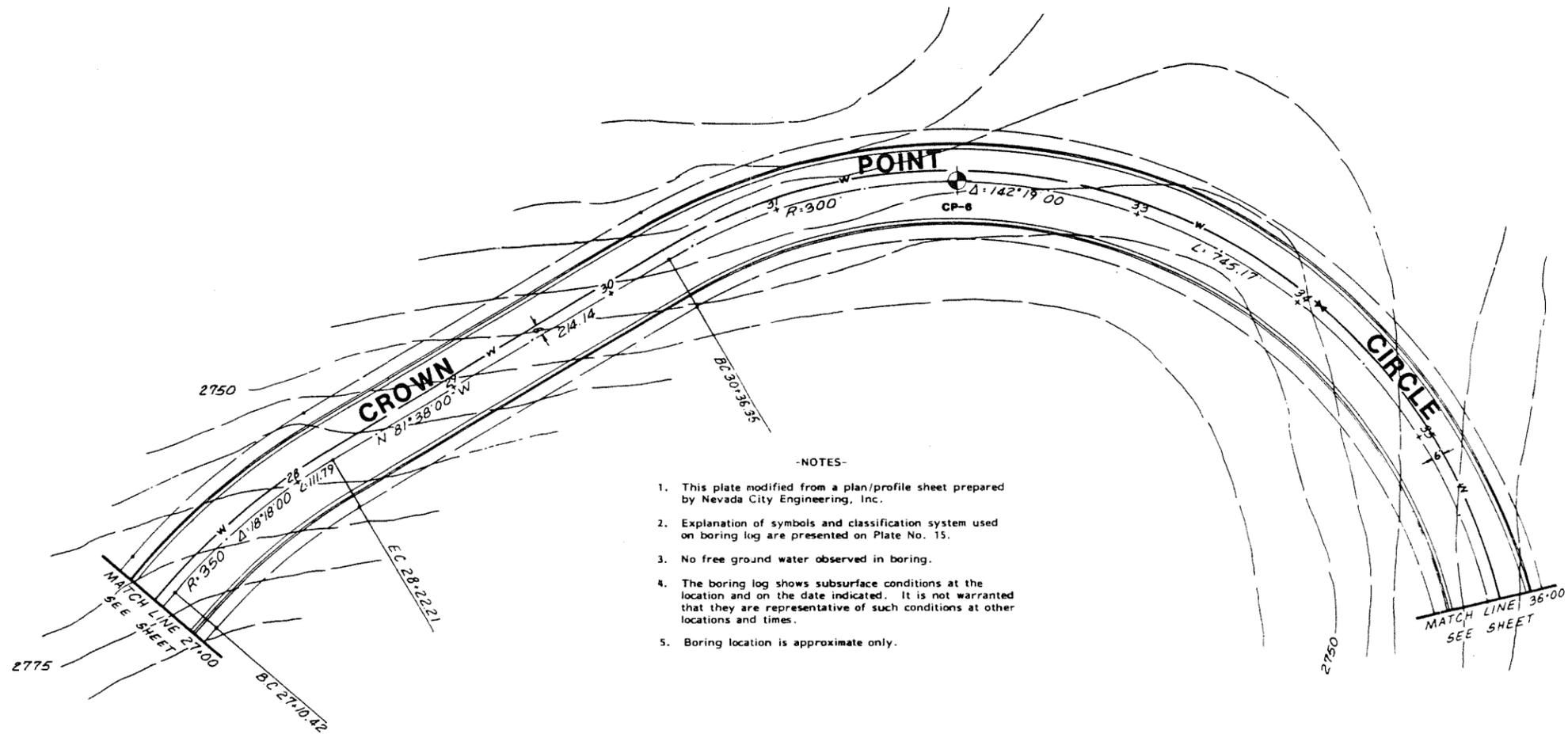


WHISPERING PINES ASSESSMENT DISTRICT IMPROVEMENTS  
 Crown Point Circle, Sta. 18 - 27  
 Grass Valley, California

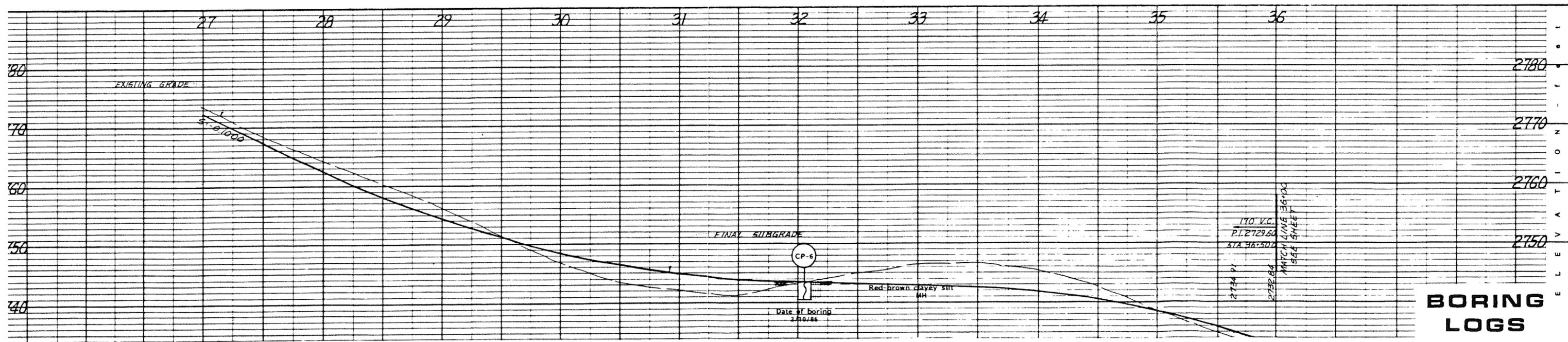


**PROJECT NO:** 86-73  
**DATE:** 2/86  
**PLATE NO:** 10

CONT. INT. - 5'  
HORIZ



- NOTES-
1. This plate modified from a plan/profile sheet prepared by Nevada City Engineering, Inc.
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**BORING LOGS**

**LOWRY & ASSOCIATES**  
GEOTECHNICAL ENGINEERS

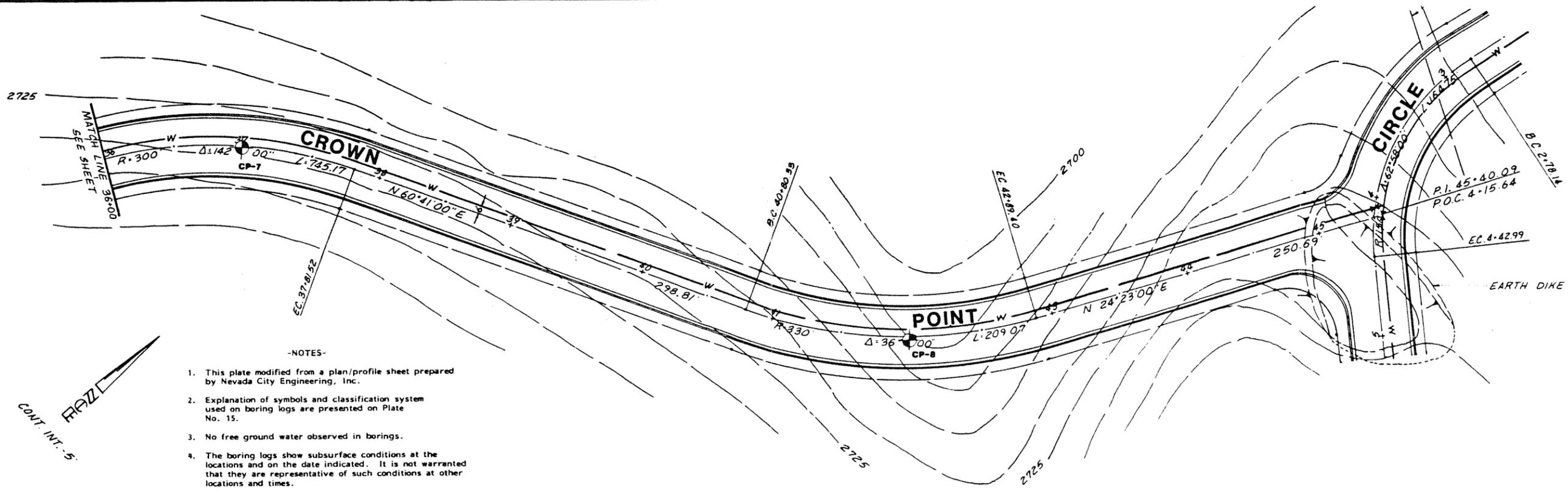
**DRAWN BY:** G. C. Barmby  
**CHECKED BY:** P. C. Weidig  
**SCALE: FEET**

0 40 80 HORIZ  
0 8 16 VERT.

WHISPERING PINES ASSESSMENT DISTRICT IMPROVEMENTS  
Crown Point Circle, Sta. 27 - 36  
Grass Valley, California

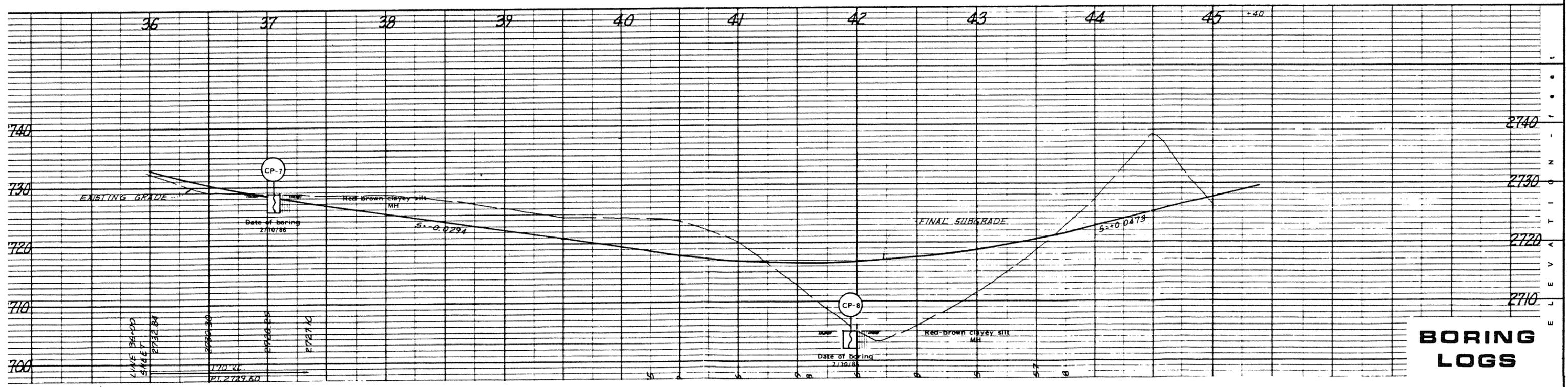


**PROJECT NO:** 86-73  
**DATE:** 2/86  
**PLATE NO:** 11



- NOTES-
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CONT. INT. 5  
RAZI



**BORING LOGS**

**LOWRY & ASSOCIATES**  
GEOTECHNICAL ENGINEERS

**DRAWN BY:** G. C. Barnby  
**CHECKED BY:** P. C. Weidig  
**SCALE: FEET**

0 40 80 HORIZ.  
0 8 16 VERT.

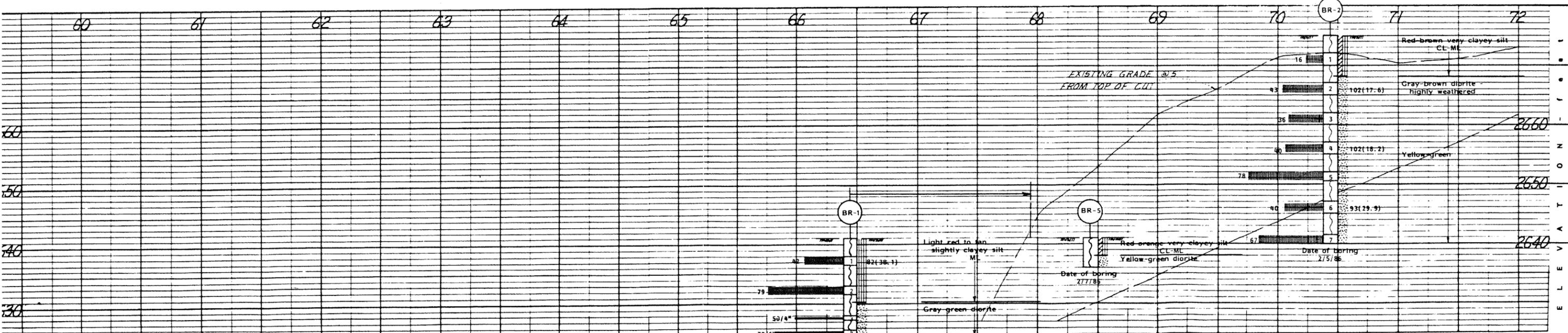
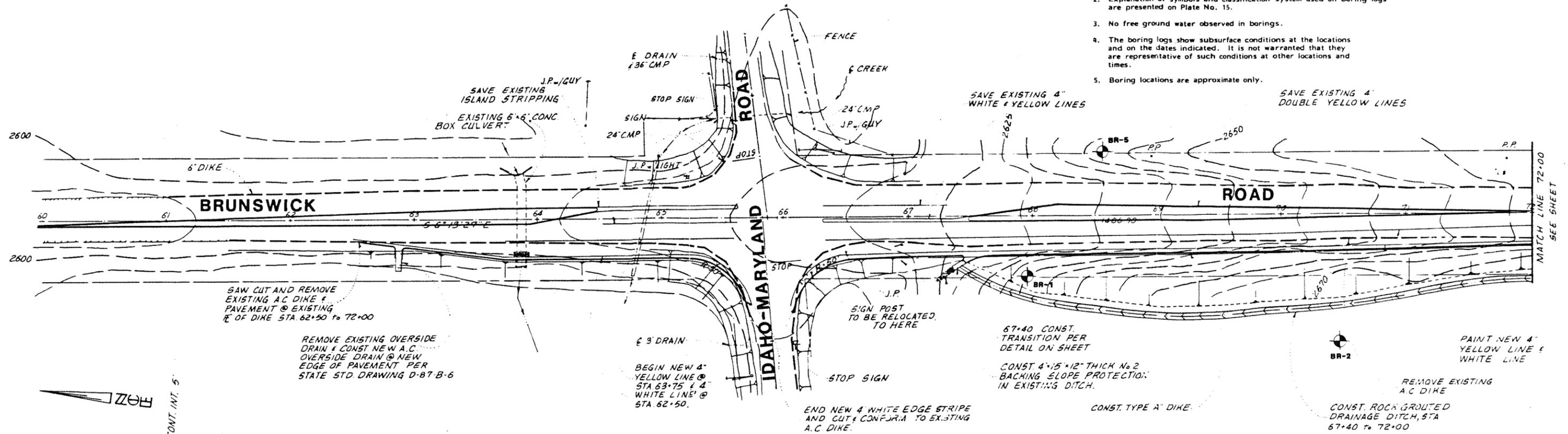
WHISPERING PINES ASSESSMENT DISTRICT IMPROVEMENTS  
Crown Point Circle, Sta. 36 - 45  
Grass Valley, California



**PROJECT NO:** 86-73  
**DATE:** 2/86  
**PLATE NO:** 12

**-NOTES-**

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**LOWRY & ASSOCIATES**  
**GEOTECHNICAL ENGINEERS**

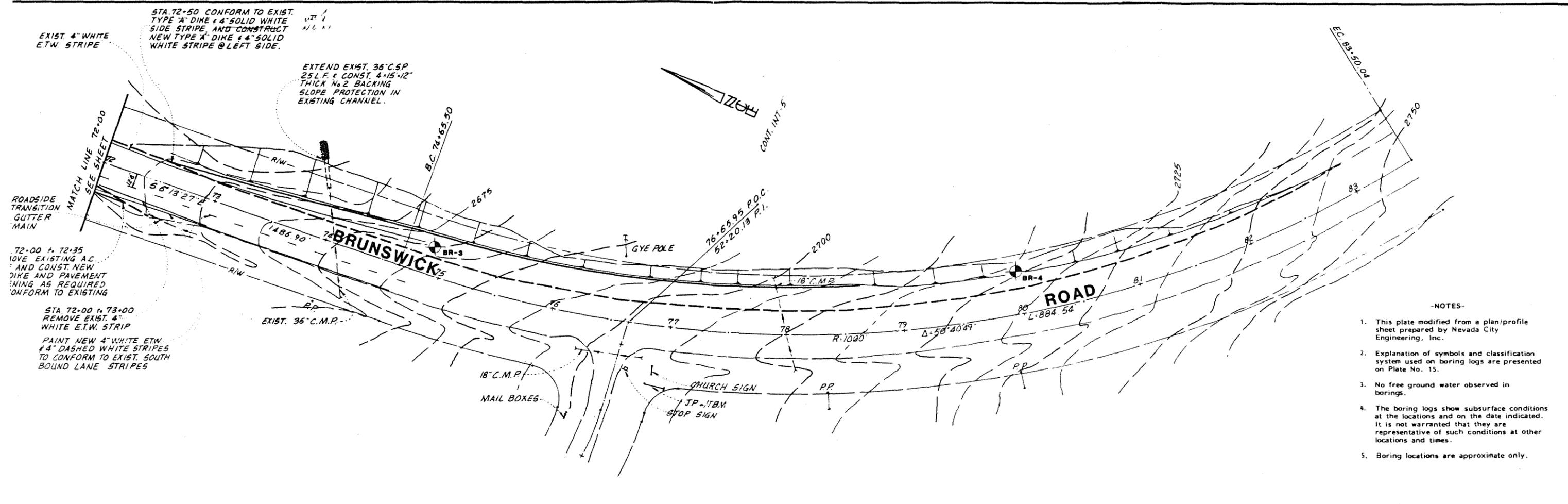
**DRAWN BY:** G. C. Barnby  
**CHECKED BY:** P. C. Weidig  
**SCALE: FEET**

HORIZ. SCALE: 0, 40, 80  
 VERT. SCALE: 0, 8, 16

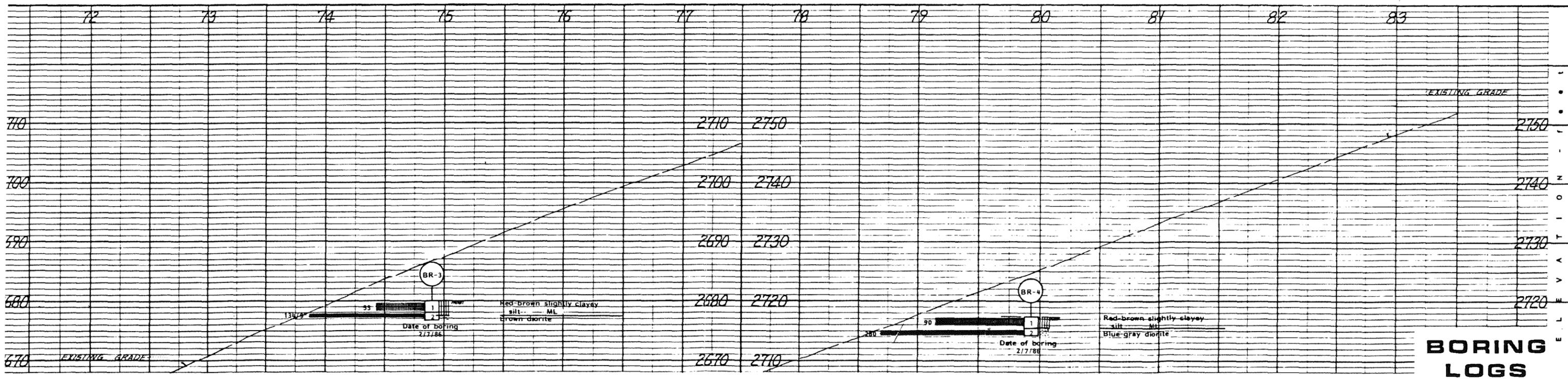
WHISPERING PINES ASSESSMENT DISTRICT IMPROVEMENTS  
 Brunswick Road, Sta. 60 - 72  
 Grass Valley, California



**PROJECT NO:** 86-73  
**DATE:** 2/86  
**PLATE NO:** 13



- NOTES-**
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**BORING LOGS**

**LOWRY & ASSOCIATES**  
**GEOTECHNICAL ENGINEERS**

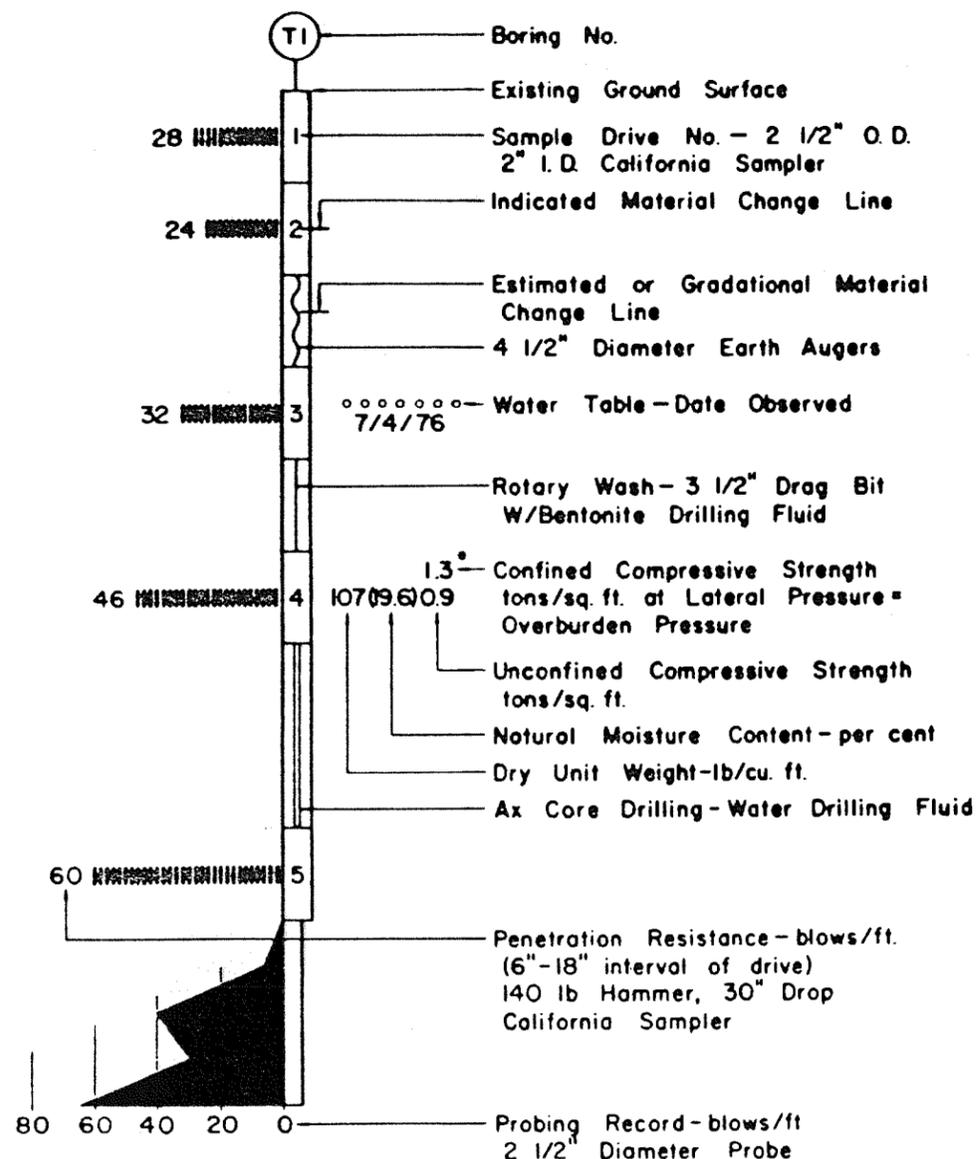
**DRAWN BY:** G. C. Barmby  
**CHECKED BY:** P. C. Weidig  
**SCALE: FEET**

0 40 80 **HORIZ.**  
 0 8 16 **VERT.**

WHISPERING PINES ASSESSMENT DISTRICT IMPROVEMENTS  
 Brunswick Road, Sta. 72 - 83  
 Grass Valley, California



**PROJECT NO:** 86-73  
**DATE:** 2/86  
**PLATE NO:** 14



MAJOR DIVISIONS	SYMBOLS	CODE	TYPICAL NAMES
COARSE GRAINED SOILS (More than 1/2 of soil > no. 200 sieve size)	<b>GRAVELS</b>		
	GW		Well graded gravels or gravel-sand mixtures, little or no fines
	GP		Poorly graded gravels or gravel-sand mixtures, little or no fines
	GM		Silty gravels, gravel-sand-silt mixtures
	GC		Clayey gravels, gravel-sand-clay mixtures
	SANDS (More than 1/2 of coarse fraction < no. 4 sieve size)	SW	
SP			Poorly graded sands or gravelly sands, little or no fines
SM			Silty sands, sand-silt mixtures
SC			Clayey sands, sand-clay mixtures
FINE GRAINED SOILS (More than 1/2 of soil < no. 200 sieve size)		<b>SILTS &amp; CLAYS</b>	
	ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
	CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	OL		Organic silts and organic silty clays of low plasticity
	MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	CH		Inorganic clays of high plasticity, fat clays
<b>SILTS &amp; CLAYS</b>	OH		Organic clays of medium to high plasticity, organic silty clays, organic silts
	<b>HIGHLY ORGANIC SOILS</b>		
Pt		Peat and other highly organic soils	

**UNIFIED SOIL CLASSIFICATION SYSTEM**

COHESIVE SOILS		GRANULAR SOILS	
Description	Blows/ft.	Description	Blows/ft.
Very Soft	< 3	Very Loose	< 5
Soft	3 - 5	Loose	5 - 15
Medium (firm)	6 - 10	Medium Dense	16 - 40
Stiff	11 - 20	Dense	41 - 65
Very Stiff	21 - 40	Very Dense	> 65
Hard	> 40		

**CONSISTENCY CLASSIFICATION**

CLASSIFICATION	RANGE OF GRAIN SIZES	
	U.S. Standard Sieve Size	Grain Size in Millimeters
BOULDERS	Above 12"	Above 305
COBBLES	12" to 3"	305 to 76.2
GRAVEL	coarse (c)	3" to No. 4
	medium (m)	3" to 3/4"
	fine (f)	3/4" to No. 4
SAND	coarse (c)	No. 4 to No. 200
	medium (m)	No. 4 to No. 10
	fine (f)	No. 10 to No. 40
		No. 40 to No. 200
SILT & CLAY	Below No. 200	Below 0.074

**GRAIN SIZE CLASSIFICATION**

**LOWRY & ASSOCIATES**  
GEOTECHNICAL ENGINEERS

DRAWN BY: G. C. Barnby  
CHECKED BY: P. C. Weidig

WHISPERING PINES ASSESSMENT DISTRICT IMPROVEMENTS  
Idaho-Maryland Road at Brunswick Road  
Grass Valley, California



PROJECT NO: 86-73  
DATE: 2/86  
PLATE NO: 15

SPRING HILL MINES PROPERTY  
Idaho-Maryland Road and Dorsey Drive  
Grass Valley, California  
L & a No. 78-420

*for PM 78-11 , 13 PM39*

Prepared  
July, 1978



**LOWRY & ASSOCIATES**  
**GEOTECHNICAL ENGINEERS**

July 31, 1978

J. Kenneth Little  
P.O. Box 3087  
El Macero, CA 95618

SPRING HILL MINES PROPERTY  
Idaho-Maryland Road and Dorsey Drive  
Grass Valley, California  
L & a No. 78-420

In accordance with your authorization of July 27, 1978, we have completed a preliminary geologic investigation of the subject 31.25-acre parcel. The purposes of this work have been to provide a preliminary geologic evaluation of the property and to identify any areas which may require special study or treatment prior to construction of the proposed improvements.

Scope

This report presents the results of our investigation, including findings pertaining to previous mining operations on the site; conclusions regarding site, geologic and groundwater conditions; and opinions pertaining to potential geologic hazards and land suitability. It is our understanding that only the extreme north-easterly 6.5-acre split of the entire property is contemplated for development at this time; this report, however, addresses all 31.25 acres.

Summary of Findings

- There are no visible active or inactive faults, nor is there any evidence of fault-related surface features on or in the near vicinity of the subject site.
- The property is considered suitable for the intended use from the standpoint of geologic and seismologic characteristics. Existing mine shafts on Parcel B should be more thoroughly investigated prior to siting of permanent structures thereon.
- Planning should reflect the probability for ground shaking intensities per Zone 3 (Uniform Building Code, 1978 edition) within the lifetime of the contemplated construction.

■ A subsurface exploration program designed to provide information on pertinent geotechnical aspects of the property not specifically a part of this report should be undertaken following development of preliminary construction plans.

#### Site Description

The subject parcels are located on the northerly side of Idaho-Maryland Road, to the east of Lake Olympia Road and to the south of Dorsey Drive in Sections 23, 25 and 26 of Township 16 North, Range 8 East, Grass Valley. A segment of Stone-Griffith Ditch extends along and just inside the southerly property line. The ditch conducts water from Spring Hill Reservoir in an easterly to westerly direction, but was dry at the time of our field reconnaissance. A narrow ravine trends from north to south through the extreme westerly portion of the property and discharges seasonal flow into the ditch.

Native vegetation consists primarily of ponderosa pine with manzanita, toyon and buckeye understory. The surface of the site is characterized by moderately rugged topography and generally slopes from about elevation +2700 feet (U. S. G. S. datum) at the far northerly property corner to about elevation +2530 feet at the northerly margin of Idaho-Maryland Road. Natural slope inclinations range from as shallow as 4.5 horizontal to 1 vertical over the easterly half of the property to as steep as 2.5 horizontal to 1 vertical adjacent to the ravine.

Numerous mounds or ridges of mine tailings (discussed below) were observed throughout the area, but the major concentrations are confined to the central portion of the site. Several rough-graded access roads and trails extend through the property in a sinuous pattern. Natural rock outcrops are abundant; additional rock exposures have been created by previous grading to form cut pads. A concrete revetment about 10 feet high is situated about 550 feet S 28° W from a monument (located off the property) marking the corner common to Sections 23, 24, 25 and 26 of Township 16 North, Range 8 East. Another concrete wall is located nearby and to the northwest. What appears to be an excavation or prospect was noted near the revetment and another was observed nearly 250 feet away and due west of the revetment.

The present southeasterly terminus of Dorsey Drive, a paved roadway extending across Highway 49 from East Main Street, provides

access for residents of a mobile home park to the north of the site. This roadway is indicated to have been graded in slight cut, but with fill up to 6 feet deep.

Other than as described above, there were no indications of surface or subsurface structures throughout the site; however, the possible presence of such features cannot be precluded.

#### Previous Land Use

Reference to mining records filed in 1942 and prepared by Edward C. Uren, Mining Engineer, shows that the property has been actively mined for precious metals, primarily gold; mining operations apparently were restricted to subsurface winzes or inclined shafts. The subject site is indicated to have been mined under the following claim titles: Somerset Lode, Spring Hill Lode, Spring Hill Extension, Golden Gate West, Golden Gate East, Alpha Lode, Kentucky Lode, and Christopher Columbus Treasury Lode. Of these several claims, only the Golden Gate East, Golden Gate West and Christopher Columbus Treasury Lode splits appear to have been excavated.

No evidence of previous subsurface exploration was noted on the Christopher Columbus Treasury Lode split. On the remaining splits, however, the disturbed areas or prospects observed in the field coincide with the locations of the portals to the Golden Gate East and Golden Gate West inclines. The Golden Gate East incline is shown as 1800 feet in length and driven on a bearing of about N 28° E; the Golden Gate West incline is shown as approximately 500 feet in length and driven on a bearing approaching N 32° W. The declivity of these inclines is not indicated. The Golden Gate East portal is located near the southeasterly corner and the Golden Gate West portal, near the southwesterly corner of Parcel B.

The presence of the concrete revetment and extensive deposits of mine tailings surrounding the Golden Gate East portal suggests that a stamp mill probably operated at that location. The tailings are composed primarily of shards or fragments of metamorphic and igneous rock or quartz ranging from only a few inches to more than 4 feet in diameter. The angle of repose of the tailing slopes was observed to be as steep as 1 horizontal to 1 vertical.

#### Local Geology

The area within which the property is located is dominated by ultrabasic and basic intrusive rocks with subordinate associations

of metamorphic rocks. Although the interrelationship of the rock types is complex, the general texture or preferred direction of alignment (foliation) is about N 10°-20° W, consistent with the regional geologic structure. Attitudes on foliation planes typically are extremely steep to vertical.

The principal rock types are gabbro, diabase, serpentine, peridotite, lherzolite and amphibolite. The age of these rocks is uncertain, but is estimated at pre-Cretaceous, or older than 135 million years.

The primary source of precious metals is a system of hydrothermally deposited quartz veins intimately associated with the igneous and metamorphic bedrock. The quartz veins have developed along planes of weakness in the bedrock, chiefly fractures and joints.

The overlying regolith and soil mantle (colluvium) is a sandy to clayey silt produced by in-place weathering of the underlying parent bedrock.

No expressions of faulting were observed at any point on the property, although minor shears may exist at some locations. These lineaments are considered inactive and are unlikely to pose any danger from the standpoint of seismicity.

#### Groundwater

Reconnaissance of the site disclosed no springs, marshy areas, or other phenomena indicative of high groundwater conditions. Owing to differences in rock types, however, limited seepage may be expected through interconnecting joints and fractures in the bedrock, and subsurface water may emerge at points wherever topographic influences and hydraulic gradient are favorable. Spring activity is expected to be seasonal and localized only, and the amount of seepage emanating from any single source is anticipated to be minor to inconsequential.

During the wet season, infiltrating surface runoff water may become trapped at or near the soil/bedrock interface, resulting in partial saturation of the soils, but such a condition is not expected to affect the integrity of the proposed construction.

#### Geologic Hazards

No evidence of continuing soil creep, landsliding or other forms of earth movement were detected during our study. Natural slopes

appear to be stable and would be expected to remain so, even with substantial clearance of vegetation. The deposits of mine tailings probably are marginally stable under present conditions and must be regraded to provide an acceptable degree of stability.

Soils exposed to concentrated surface runoff are considered to be at least moderately susceptible to erosion and must be protected to promote long-term stability.

Our study shows that primary geologic hazards — including shallow ground rupture and/or prolonged ground shaking of considerable strength or duration — do not warrant particular consideration, since the property is located in an area of comparative seismic quiescence. Seismic disturbances at locations and of intensities comparable to those reflected by the seismic record, may produce secondary seismic effects equivalent to Intensity VII (Modified Mercalli Intensity Scale) at this site within the lifetime of the proposed improvements, consistent with the requirements for Zone 3 of the Uniform Building Code (1978 edition).

Secondary geologic hazards also appear to be of negligible concern. Liquefactory response of the on-site soils is a virtual impossibility due to the shallow depth to bedrock and the considerable depth to the perennial groundwater table. Properly prepared original ground and engineered fill embankments are highly unlikely to experience differential compaction and/or subsidence under the influence of anticipated earthquake forces. For similar reasons, the probability for seismically-induced landsliding or lurching is practically non-existent under present conditions; engineered fill embankments and permanent excavation slopes can be designed to withstand anticipated future seismic shocks without resulting distress or failure.

Inundation of the site due to seismic forces is exceedingly improbable due to the remote position of the site from any closed bodies of water and the protection afforded by intervening topography.

Consideration must be given to the presence of subsurface mining excavations as they may influence siting of structures and use of the land for residential development or commercial enterprises. These factors can be addressed in greater detail when improvement is undertaken of those portions of the site on which such features exist.

#### Land Use

Except for the presence of the Golden Gate East and the Golden Gate West inclines, and associated deposits of mine tailings on

Parcel B of the property, there is no evidence of extraordinary soil or geologic conditions which would render this site unsuitable for the intended residential and commercial development. Specific programs of subsurface exploration must be undertaken to assess other important geotechnical aspects of the property, including: expansive soils at depth, materials suitability, available bearing capacity, slope design, grading requirements and foundation design. In addition, recommendations for subsurface drainage and erosion control may be appropriate, depending upon building layout, structural details, and/or the extent of proposed grading.

#### Limitations

The opinions presented in this report are based upon local and regional geologic conditions disclosed by field reconnaissance, review of available geologic literature and subsurface conditions obtained from mining records. If geologic conditions superseding or overriding those upon which our opinions are predicated are discovered, the conclusions in this report shall be considered invalid, unless the changes are reviewed and the conclusions modified or approved in writing.

The contents of this report are directed toward an evaluation of site suitability and construction feasibility. It is emphasized that this report is applicable only to the proposed construction and that the information presented should not be utilized to assess geologic or seismologic conditions on any other site.

Thank you for this opportunity to be of service. If we can amplify or clarify any of the foregoing findings or opinions, please do not hesitate to contact us.

LOWRY & associates

*Paul C. Weidig*

PAUL C. WEIDIG  
Registered C. E. No. 25,128  
Certified Engineering Geologist No. 932

PCW:c11

- xc: (3)  
(2) John Atkinson, Development Consultant  
(1) Sierra Western Engineering Company, Inc.



Prepared  
December 19, 1985

FOUNDATION ENGINEERING REPORT  
WOLF CREEK INDUSTRIAL PARK  
Idaho-Maryland Road  
Grass Valley, California  
L & a No. 85-510

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25 YEARS OF SERVICE 1960-1985

# LOWRY & ASSOCIATES



FOUNDATION ENGINEERING REPORT  
WOLF CREEK INDUSTRIAL PARK  
Idaho-Maryland Road  
Grass Valley, California  
L & a No. 85-510  
December 19, 1985

## INTRODUCTION

### Purpose

A foundation engineering investigation has been completed for the proposed Wolf Creek Industrial Park, adjoining the City of Grass Valley. The purposes of this investigation have been to evaluate earth materials and ground water conditions on the site; to formulate geotechnical recommendations for use in the design of specific construction elements; and to provide criteria for site grading, including the construction of engineered fill.

### Scope

The scope of this investigation has included a reconnaissance of the site by a member of our engineering staff; the drilling of six test borings to a maximum depth of 30+ feet below existing site grade; laboratory testing conducted upon selected samples recovered from the borings; completion of two, 600-foot long geoseismic refraction traverses; geologic research and historical investigation; engineering analyses and the preparation of this report.

This report includes our findings regarding site, geologic setting, past mining, earth materials and ground water conditions; conclusions pertaining to expansive soils, bearing capacity, materials suitability, slope stability, erosion potential, excavation, and foundation alternatives; and recommendations for site grading, erosion control, ground water control, foundations, floor support and pavement section alternatives.

The locations of the test borings and geophysical surveys completed on the property are depicted on Plate No. 1. The logs of the test borings and results of laboratory testing are displayed on Plates No. 2 and 3; an explanation of the symbols and classification system used on the logs appears on Plate No. 4. Geologic sections interpreted from field

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geophysical data and a key to the geologic symbols used on the sections are illustrated on Plates No. 5 and 6. Appendix A contains information of a general nature regarding project concepts, descriptions of our field exploration and laboratory testing programs, further laboratory test results, and selected references consulted during the course of our investigation. Suggested specifications for earthwork appear in Appendix B, and separate specifications for foundations are presented in Appendix C. These specifications may be used as guides to the composition of contract documents.

#### Nature of Project

It is expected that the development will consist of 1- and 2-story, light commercial and/or industrial buildings. Preliminary grading plans prepared by the civil engineering consultant indicate that extensive grading requiring up to 30 feet of cut and fill will be utilized in construction of the roadways and building pads. It is likely that most structures generating foundation loads of no more than intermediate intensity can be supported on conventional spread footings, and that heavier design loads can be carried by cast-in-place drilled piers.

#### FINDINGS

##### Site Description

Wolf Creek Industrial Park is an irregularly-shaped, 26-acre property divided into four parcels ("A" through "D") bordered to the south by Idaho-Maryland Road; to the north by the Ruppert property and State Highway 49; to the west by the open, undeveloped Cannon property; and to the east by the Richardson property. Barbed wire fences extend along at least parts of the north and east boundaries.

The surface of the subject site slopes to the south from elevation +2646 feet (U.S.G.S. datum), near the northeast property corner, to about elevation +2495 feet, along Idaho-Maryland Road. A knoll rises to elevation +2603 feet in the northwest quarter of the study area. Drainage is principally directed to the south and southwest. During our field reconnaissance, we discovered several springs, all of which are probably perennial. Stone-Griffiths ditch, which once supplied water to the City, is an excavated channel that

follows the approximate elevation +2543-foot contour, but has been abandoned and now collects only upslope sheet runoff.

Most vegetation had been cleared off Parcels "A" and "B". Remaining vegetation, generally confined to Parcels "C" and "D", consisted chiefly of indigenous pine and cedar trees, and some remaining manzanita understory.

The previously-described knoll marks the approximate location of the Mobile Mine, now defunct. The Eureka Shaft, also inactive, is located to the southeast of the knoll and below the ditch, which at this point is carried over the shaft portal by means of a hand-hewn stone aqueduct. Mine tailings from these workings have been dumped along the south edge of the knoll, through the center of Parcel "D". A large concrete block near the center of Parcel "A" appears to have supported a tramway tower which may have been a part of an ore conveyor system serving the Mobile Mine and Spring Hill Mine on the Ruppert property.

#### Geologic Setting

The site is indicated to be underlain by two distinct rock types. The older is serpentinite and serpentinite schist, created during the Upper Jurassic period (Kimmeridgian epoch) of geologic time, or about 140-155 million years ago. These serpentinitized rocks are perithermal formations composed of metamorphically altered, ultrabasic rocks. The younger geologic association is a suite of dioritic rocks, predominantly diabase and gabbro, that form dikes which intrude the serpentinitic rocks. They are estimated to have originated during the Upper Cretaceous period (Berriasian epoch), about 130-136 million years ago, and are identified as a part of the Grass Valley Pluton. The dikes typically are oriented on a westerly strike and dip almost vertically, where visible at ground surface.

Along the contacts between the serpentinitic and dioritic rocks -- and to a lesser extent along fractures pervading zones of serpentinite schist -- there are hydrothermally-deposited, gold-bearing veins, a geologic phenomenon which the early miners recognized and exploited. Most of the successful gold mines in the Grass Valley area are driven along these ore shoots.

### Mining History

The Mobile Mine, Spring Hill Mine and Eureka Shaft are shown on geologic maps published as early as 1896. The Eureka Mine was opened in 1851, on the Eureka-Idaho-Maryland vein, and the shaft was sunk to a depth of 100 feet. The vein, which averages from about 2 to 4 feet in thickness, was followed to a depth of 1200 feet until the mine closed in 1877. The Idaho-Maryland Mine, developed on the eastward extension of the Eureka-Idaho-Maryland vein, was worked to a total vertical depth of 2180 feet. Drifts follow the strike of the vein and extend across the width of the claim a lateral distance of 1550 feet.

The Eureka-Idaho-Maryland vein is confined to a contact between serpentinite and diabase. It has an average strike of N 77° W, dips about 70° to the south, and consists exclusively of solid quartz in the pay shoot, except where the adjoining country rock is impregnated with quartz stringers. A schematic representation of the vein as discovered in the Eureka Shaft, is shown on Figure No. 1. Another gold-bearing quartz vein was found about 30 feet to the south of the main vein and is separated from it by a dike of diabase. Records indicate that this southerly vein has never been worked. Records also indicate that the ore assay ranged from 0.2 to 2.5 ounces of gold per ton over an average width of 3 feet.

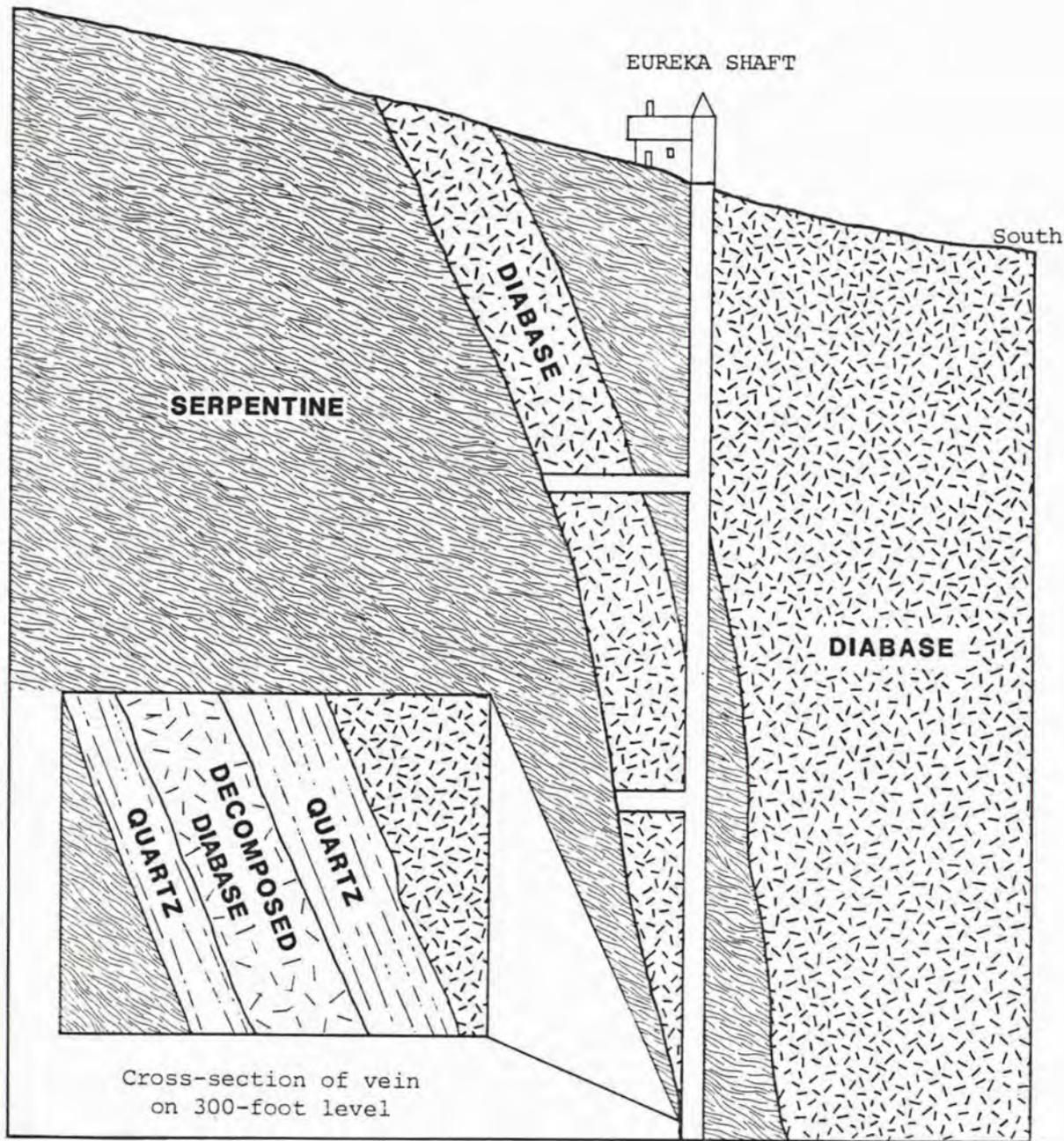
### Earth Materials

#### Soils

All but Boring No. T5 disclosed a thin veneer of surface soil immediately overlying the bedrock. This native soil cover was found to be 1-1/2 to 3-1/2 feet thick and consists of medium-dense, brown, fine to coarse sandy silty clay (Unified Soil Classification: CH), with highly-weathered serpentinite schist fragments up to 1/2 inch wide. The silts are colluvial in nature, having been derived from in-place weathering of the underlying serpentinitic bedrock.

The results of the geophysical surveys show a computed average compressive wave velocity of about 710 feet per second for the surface soils.

North



0 25 50

-SCALE: FEET-

-NOTE- After: *Gold-quartz Veins of Nevada City and Grass Valley Districts*,  
U.S. Geological Survey, 17th Annual Report, pt. 2, pp. 224-229, 1896.

Mine Waste

Boring No. T5 encountered mine tailings or fill to a depth of 15 feet. The tailings consist of medium-dense, green, weathered serpentinite schist rock fragments and reddish-brown, fine to coarse, sandy clayey silt and silty clay (MH-CH) dumped over slope from past workings at the Mobile Mine Eureka shaft.

Rock

Every boring except Boring No. T5 penetrated green-brown, highly weathered serpentinite schist or reddish-brown and white mottled talcose serpentinite to the maximum 30-foot depth of exploration below the soil mantle. Rock consistency per sampler penetration resistance data ranges from medium-dense to very dense, depending upon the degree of weathering.

The results of our geophysical survey shows a computed average compression wave velocity of about 4175 feet per second for the serpentinitic rock. Although not discovered in our test borings, the underlying dioritic rock is interpreted to have a compression wave velocity approaching 14,740 feet per second.

Ground Water

Each of the test borings was checked for ground water during and immediately following completion of drilling. No ground water was observed at any boring location.

At least four major springs, as schematically depicted on Plate No. 1, exist on the property. They are probably expressions of seepage emanating from breached or near-surface mine workings that are now flooded and function as perennial ground water conduits. The most prominent spring is situated just above the north shoulder of Idaho-Maryland Road and immediately west of the present main access to the study area. At the time of our field reconnaissance, this spring was flowing at a rate of nearly 200 gallons per minute. Less pronounced springs are marked by dense berry vine colonies and marshy areas at higher elevations. It is also possible that during the rainy season, ground water recharge through bedrock fractures will occur, resulting in additional springs not seen during this

investigation. Moreover, other areas of seepage could be uncovered during grading, especially near the mine shafts.

### CONCLUSIONS

#### Expansive Soils

The results of Atterberg limits tests conducted on a selected sample of the near-surface soils shows that this material is significantly plastic ("P.I." = 26) and could develop significant swelling pressures with variations in moisture content. Clay seams associated with the serpentinite schist bedrock are also indicated to be appreciably plastic and potentially expansive, although the rock itself is indicated to be essentially nonexpansive.

#### Bearing Capacity

The results of this investigation indicate that the native, undisturbed soils are capable of sustaining directly-applied foundation loads of intermediate intensity, as well as areal loads produced by engineered fill embankments of limited height. Intact bedrock is indicated to be capable of supporting heavy, concentrated foundation loads as well as areal surcharges of considerable magnitude.

Deposits of coarse to fine tailings or mine waste are considered unsuitable for support of either foundation or areal loads without recompaction. The equilibrium of the mine waste embankments is questionable even under present conditions.

The results of this study also indicate that new engineered fills, placed and compacted in accordance with the recommendations of this report and the appended earthwork specifications, will be competent for support of the proposed construction.

#### Materials Suitability

On-site soils, mine tailings and rock are acceptable for use in engineered fill construction provided they are processed to remove significant vegetation, rubbish and oversized rock fragments, are brought to the correct moisture content; and if the soils are blended with rock fragments of suitable size

in order to produce a mixture having reduced expansive tendencies.

#### Slope Stability

Natural hill slopes appear to be stable at their present configurations, although they are susceptible to erosion where exposed to concentrated surface flow.

Mine tailings found south of the knoll are considered only marginally stable at present and could become unstable with very little additional loading.

The results of this study indicate that cut and fill slopes constructed in accordance with the recommendations of this report should remain adequately stable, provided that fill slopes are properly benched and keyed over steep, natural ground and that both excavation and embankment slopes are protected from deterioration by erosive forces. The serpentinitic bedrock is virtually structureless and is prone to minor but persistent spalling where planes of weakness are unfavorably oriented with respect to exposed cut faces.

#### Erosion Susceptibility

Erosion of natural devegetated slopes has been minimal and is probably related to the degree of mechanical reinforcement offered by remaining roots. Slopes constructed of engineered fill will be more sensitive to erosion due to an increased angle of repose. Cut slopes in serpentinite schist or diabase probably will not pose significant erosion problems.

#### Excavation

The results of the test boring and geophysical exploration programs indicate that all of the surface soils and mine tailings can be excavated using conventional earthmoving equipment.

The depth to which it may be possible to remove the underlying bedrock is directly dependent upon the type of equipment utilized and the characteristic geoseismic velocity at the level of excavation sought. The geophysical surveys and test borings suggest that about 35 to 50 feet of soil and weathered serpentinite schist can be removed with grading equipment comparable to a D8L Caterpillar equipped with

double rippers. Excavations exceeding a depth of approximately 50 feet below existing ground surface are indicated to be unfeasible except by blasting.

#### Foundation Alternatives

Isolated spread or continuous spread footings are likely to be the most practical foundation system for buildings generating light to intermediate structural loads. Drilled piers designed to acquire end-bearing in bedrock could be used for support of more heavily-loaded structural elements.

### RECOMMENDATIONS

#### Site Grading

##### Clearance

General clearance within the proposed building and pavement areas should include the removal of all surface vegetation, underbrush, downed timber, unwanted trees and associated root systems; loose and/or saturated materials in drainage swales and the existing ditch; existing piles of rock and mine waste; the existing concrete tram tower base, floor slab and foundations; and any underground utilities that are within 2 feet of existing or final grade (whichever is lower).

After the above clearing operations have been completed, depressions extending below planned finished grade should be cleaned out to firm, undisturbed soil or bedrock (whichever is higher) and backfilled with engineered fill as described below. For earthwork purposes, building pad dimensions should be considered to extend at least 5 feet beyond exterior foundation lines.

##### Treatment of Shafts

The Mobile and Eureka shafts should be reopened to a depth of at least 10 feet below existing or finished grade (whichever is lower). All timber lagging or railwork should be stripped from the shaft walls and any potentially unstable soils or weathered rock surrounding the shaft collar broken back to a configuration not exceeding 1 horizontal to 1 vertical. The exposed earth materials should be evaluated by our engineering geologist who will issue a special procedure for

remedial work in the event that conditions conducive to future instability are identified.

The open shafts should be bridged with overlapping horizontal timbers that are pressure treated in accordance with ASTM Specification D1760-80 or (preferably) corrosion resistant H-beams. Seating of the bridgework is an important consideration. Timber should be driven into place with enough force to engage at least 50 percent of the ultimate axial compressive strength of each member. Steel should be cradled in properly-affixed beam seats. The bridgework should then be floored over with timber stringers or lightweight metal decking and a lightweight concrete seal at least 3 feet thick should be placed over the flooring. After the concrete has cured, the shaft should be backfilled with selected granular material that can be readily vibrated or mechanically compacted to finished grade.

Alternative treatments may be acceptable or desirable, depending upon conditions uncovered in the field, if comparable security can be assured. Irrespective of which approaches are adopted, all shaft treatment work should be observed and evaluated by our engineering geologist.

#### Subgrade Preparation

Soil subgrades designated to receive engineered fill should be scarified to a depth of 6 inches or to the underlying bedrock surface (whichever requires less penetration) and recompacted in place to not less than 95 percent of maximum dry density, at or above the optimum moisture content, as stipulated by ASTM Specification D1557-78.

For rock subgrades, no attempt at scarification or recompaction should be undertaken, but the grade should be cleared of all loose rock fragments greater than 4 inches in maximum size.

#### Engineered Fill

Engineered fill materials to be used within the uppermost 3 feet of embankments may consist of approved, native soils mixed with not less than 15 percent native rock fragments 4 inches wide or less, or excavated weathered bedrock processed to remove any unsuitable debris including vegetation, rubble, rubbish and rock fragments exceeding 4 inches in largest

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dimension. Salvaged mine tailings may also be used for this purpose if they are processed to conform to the above criteria. Imported fill, if required, should have a plasticity index not exceeding 12, a maximum particle size of 4 inches and an expansion index not exceeding 20. The intended borrow area should be tested and approved by our firm as a condition of use. Rocks over 60 inches in diameter and frozen soils should not be used in embankment construction.

Engineered fill materials derived by on-site excavation to produce rock fragments that are larger than 4 inches in maximum size may be used below a depth of 3 feet from finished embankment grade. Boulders greater than 36 inches in largest dimension should be placed directly on the cleared embankment subgrade and spaced at least 3 diameters apart, in staggered rows, the spacing to be governed by the larger of any two adjacent boulders. It should be recognized that fills containing substantial amounts of coarse rock fragments may pose difficulties to trenching equipment during utility installation and/or drilling equipment during pier foundation construction.

Engineered fill should be placed in horizontal lifts not exceeding 6 inches in compacted thickness. Each lift should be compacted to at least 95 percent of maximum dry density at or above the optimum moisture content in accordance with ASTM Specification D1557-78.

#### Benching - Keying

Where the slope of the original ground exceeds an inclination of 6 horizontal to 1 vertical, benches should be cut into the natural slope as the filling operations proceed. Each bench should consist of a level terrace at least 8 feet wide with the rise to the next bench not greater than 4 feet.

Where the slope of the original ground exceeds an inclination of 4 horizontal to 1 vertical, a keyway should be provided in addition to the benches. Each keyway should consist of a level trench at least 4 feet wide, cut to a depth of 3 feet into the original ground along the proposed embankment toeline, with side slopes not exceeding an inclination of 1 horizontal to 1 vertical.

### Slopes

Permanent embankment slopes constructed in engineered fill using native earth materials may be designed at an inclination not exceeding 2.0 horizontal to 1.0 vertical to a height not greater than 30 feet. Embankment slopes of greater height should be flattened to 2.25 horizontal to 1.0 vertical.

Permanent slopes excavated in bedrock may be designed at an inclination of 1.5 horizontal to 1.0 vertical to heights not greater than 35 feet. Cut slopes of greater height should be flattened to 1.75 horizontal to 1.0 vertical. The inclination of all cut slopes in soil should be reduced to 2.0 horizontal to 1.0 vertical or flatter.

### Testing

Our representative should be present during all site clearing and grading operations to test and observe earthwork construction. The foregoing recommendations and those which appear in later points in this report are predicated upon the adherence to the provisions of the appended earthwork specifications in Appendix B.

### Erosion Control

#### Planting

All engineered fill slopes should be seeded and/or planted with environmentally-compatible species as protection from concentrated surface flow. The appropriate species should be selected giving due consideration to plant hardiness, propagation, and nutritive requirements including watering demands as well as competition with indigenous plants and trees. Interim slope protection could be provided by straw punching or hydromulching. The crowns of all slopes should be rounded and compacted.

#### Drains

Interceptor drains should be installed no more than 4 feet behind the crown lines of all slopes greater than 5 feet in height. These drains should be paved with at least 3 inches of reinforced portland cement concrete or gunite and should be founded at a minimum depth of 12 inches below lowest

adjacent finished grade in undisturbed materials. The drains should have a minimum paved width of 30 inches, measured horizontally. A minimum gradient of -2 percent should be provided and the accumulated runoff directed toward other drains or lateral ditches designed to discharge the runoff at points well away from vertical faces. Where downdrains discharge onto slopes that are steeper than 10 percent, energy dissipation devices should be installed at discharge ends. These devices typically could include retained rocks, lined stilling basins, or level spreaders designed to disperse runoff gradually across a flatter slope.

Adjacent to roadways, asphalt or portland cement concrete berms should be installed along crown lines of slopes greater than 5 feet in height to prevent excessive sheet runoff. Alternatively, rolled gutters paved and at the dimensions stated above may be formed along the crown lines provided that the gradient is not less than -1.5 percent. Collected runoff from roof drains and pavement surfaces should be directed towards appropriately-sited drop inlets, scuppers or other drainage devices for disposal beyond the limits of the slope faces.

#### Terraces

For slopes greater than 20 feet in height, terracing will be necessary. Terraces should be at least 6 feet in width and should be paved with reinforced concrete or gunite not less than 3 inches in thickness, or equivalent asphalt concrete paving. Terrace drains should have a minimum depth of 12 inches at the deepest point, and a minimum paved width of 5 feet. Not less than 12 inches of pavement should extend along the finished face of slope above the flow line. Terrace drains should be inclined into the face of finished slope at a minimum gradient of -2 percent and should be sloped to drain toward either hinge point at a minimum gradient of -5 percent. A single runoff terrace drain should not be allowed to collect runoff from a tributary area exceeding 13,500 square feet (projected) without discharging into a downdrain.

#### Subdrainage

Depending upon final grades and slope configurations, a full subdrainage piping system may be required to drain the major spring just above Idaho-Maryland Road. Areas of less

prominent seepage probably can be adequately drained with herringbone galleries and/or gravel seepage blankets designed to discharge into conveniently-sited drop inlets or downdrains.

Specific subdrainage recommendations can be formulated only upon a review of the final grading plans, and upon evaluation of actual field conditions during grading.

### Foundations

#### Axial Bearing

The proposed buildings may be supported upon continuous and isolated spread foundations based in undisturbed or recompacted natural soils, newly-constructed engineered fill, or a combination of those materials; or in bedrock, but not both, due to differential settlement considerations. All foundations should extend to a minimum depth of 24 inches below lowest surrounding finished pad grade and should have a minimum width of 12 inches.

Foundations established in and underlain by at least 18 inches of undisturbed soils and/or engineered fill may be designed for maximum allowable bearing values of 1700 pounds per square foot for dead load, 2500 pounds per square foot for dead plus live load, or 3400 pounds per square foot for total load, including the effect of either seismic or wind forces. Foundations supported entirely on bedrock may be designed for 5000 pounds per square foot for dead load, 7500 pounds per square foot for dead plus live load, or 10,000 pounds per square foot for total load, including the effect of transient forces. The weight of foundation concrete extending below grade may be disregarded in sizing computations. At the minimum recommended depth, spread foundations are expected to be adequately protected against heave due to frost invasion. Continuous foundations should be reinforced with at least two, No. 4 bars -- one each, top and bottom.

To satisfy the requirement that all foundations for any individual structure be based in and underlain by similar materials, it may be necessary to overexcavate those parts of building pads in cut, where there are transitions from cut to fill across daylight lines, unless the foundations are deepened to engage bedrock throughout.

Alternatively, buildings may be supported upon drilled, cast-in-place concrete piers designed to acquire end bearing. All pier shafts should have a minimum diameter of 18 inches and should extend to firm, undisturbed rock. Such piers may be designed for the net rock contact pressures stated above.

If highly-resistant bedrock is encountered above the minimum recommended foundation depth(s), stability can be achieved by dowelling into the bedrock surface. Dowels should consist of No. 6 bars achieving at least 8 inches of bedrock penetration. Dowels should be spaced on 24-inch centers or closer for continuous foundations; isolated foundations (including piers) should be pinned to the bedrock surface with at least one dowel. Dowel holes may be advanced with percussion drilling equipment and should be about 1-1/2 inches in diameter. Dowels should be fixed with epoxy resin or a rapid-setting grout with an ultimate compressive strength of at least 2500 psi. We suggest, at least for continuous foundations, that dowels be bent at right angles at the centers and along the longitudinal axes of the foundations to enhance anchorage.

#### Setbacks

On slopes having a configuration of 10 horizontal to 1 vertical or greater, continuous foundations should be stepped to provide an effective slope no steeper than 2 horizontal to 1 vertical, or dowelled where stepping is either impractical or unattainable. Foundation lines should be set back a lateral distance of at least 6 feet from slope crown lines.

#### Lateral Bearing

Resistance to lateral foundation displacement may be computed using allowable friction factor of 0.25 acting at the foundation level.

Alternatively, lateral resistance may be calculated using a uniform passive pressure of 350 pounds per square foot combined with an equivalent fluid pressure of 150 pounds per cubic foot exerted against any appropriate vertical foundation face. For drilled piers, these pressures may be assumed to act against a virtual plane equal in width to 1.6 times the pier diameter.

### Uplift Capacity

Uplift of spread foundations will be resisted by the dead weight of footing concrete and shearing resistance developed along vertical planes extending between the outermost foundation edges and ground surface. Similarly, uplift of drilled piers will be resisted by the dead weight of pier concrete and shearing resistance developed along the pier sides.

For design purposes, the dead weight of foundation concrete may be assumed at 100 pounds per cubic foot, and shearing resistance may be assumed at 20 pounds per square foot per foot of foundation depth combined with a uniform resistance of 190 pounds per square foot.

### Construction

All excavations for footings should be free of loose soil and rock fragments immediately prior to placement of foundation concrete and reinforcing steel. Foundation concrete may be placed neat, without forming, against trimmed approved bearing materials.

Pier shafts should be thoroughly clean and dry prior to placement of concrete and reinforcing steel. For shafts greater than 5 feet deep, foundation concrete should be placed by means of an elephant trunk or similar device to avoid contamination of the concrete by soil and rock fragments dislodged from the shaft walls. Specifications for drilled pier construction are presented in Appendix C.

### Retaining Walls

#### Lateral Pressures

Yielding (cantilevered) retaining walls capable of deflecting at least 0.1 percent of the wall height could be subjected to lateral earth pressures equivalent to those exerted by a fluid weighing about 40 pounds per cubic foot.

Fully-constrained or unyielding walls incapable of such rotation could be subjected to lateral earth pressures equivalent to those exerted by a fluid weighing about 50 pounds per cubic foot.

The above lateral earth pressures are based upon the assumption that walls will be fully drained to prevent the creation of hydrostatic pressures.

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### Drainage

Impervious paving extending to top-of-wall grade will suffice to prohibit significant surface water infiltration that could result in the development of hydrostatic pressures. If such a paving system cannot be provided, however, walls should be drained by means of weep holes at least 4 inches in diameter, spaced not farther than 6 feet on centers, and positioned not more than 18 inches above the lower grade. To prevent wall backfill intrusion, each weep hole should be overlapped by two, 8-inch square swatches of spunwoven geotextile fabric affixed to the rear weep hole opening prior to placement of structural backfill.

### Backfill

Structural backfill should consist of nonplastic sand, pea gravel, or a mixture thereof. Since these materials are not available on site, imported backfill will be required for this purpose and should be approved by our firm.

Backfill should be constructed within a wedge-shaped zone defined by the rear wall surface, finished grade above and beyond the wall, and a plane extending upward and away from the heel of the wall at an inclination not exceeding 2 vertical to 1 horizontal.

The uppermost 2 feet of backfill may consist of native soils. All wall backfill should be placed in level lifts not exceeding 12 inches in compacted thickness. Each lift should be brought to at least the optimum moisture content and compacted to not less than 90 percent relative compaction as stipulated by ASTM Specification D1557-78, except that in areas to be overlain by pavements, the minimum compaction standard within the uppermost 2 feet should be increased to 95 percent.

### Floors

#### General

Potential swelling pressures due to expansion of the subgrade soils must be counteracted to reduce the possibility of distress to concrete slabs-on-grade. This objective can be achieved by several techniques, each of which offers a different level of security against slab cracking and

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displacement. These include, in order of ascending degree of protection: 1) subgrade moisture conditioning; 2) overexcavation of subgrade soils and restoration to grade with nonexpansive materials compacted as engineered fill; 3) slab reinforcement with deformed bars; and 4) a combination of all three.

#### Moisture Conditioning

For the moisture-conditioning option (the least positive), we recommend that subgrade soils be saturated to a depth of at least 12 inches below finished grade. The correct moisture content to be achieved should be determined by our representative, following completion of the building pad under consideration. Moisture-conditioning likely can be best achieved by liberal sprinkling or flooding of the grade and may be expedited by utilizing commercially-available penetrant additives if desired. Should the moisture-conditioning option be chosen, our representative should field-check the subgrade moisture content no more than 24 hours prior to placement of slab concrete.

#### Nonexpansive Subgrade

Alternatively, slab protection could be afforded by construction of a nonexpansive subgrade consisting of approved, imported granular soils as previously described. Such soils should be placed within the uppermost 12 inches of final subgrade level and should be compacted as recommended for engineered fill. Subgrade soils should be brought to at least the optimum moisture content immediately prior to placement of slab concrete as a precaution against moisture withdrawal by the subgrade soils as the concrete cures.

#### Reinforcement

Slab cracking due to subgrade swelling pressures can be reduced by the incorporation of No. 4 bars spaced no farther apart than 24 inches on centers in each direction. A minimum slab thickness of 4 inches should be provided. Bars should be chaired at slab middepth.

#### Capillary Break

Regardless of which method is chosen to treat the subgrade, each concrete slab-on-grade floor should be underlain by a 4-inch thick blanket of free-draining, granular material conforming to the following specification:

<u>Sieve Size</u>	<u>Percent Passing</u>
1-inch	100
No. 4	0

Vapor Barrier

If greater assurance against slab moisture penetration is desired, vapor barrier membranes could be placed above the gravel blankets. A 1- or 2-inch thick layer of damp, clean sand spread over each membrane is suggested as puncture protection and to encourage uniform slab concrete curing.

Exterior Flatwork

Recommendations similar to those for floor slabs would be applicable to exterior flatwork, including utility pads and concrete walkways, constructed on potentially-expansive subgrades. Minimal slab reinforcement for exterior walkways should consist of 6 x 6/W1.4 x W1.4 welded wire mesh. Thickened slab edges should be a required part of exterior flatwork construction. Thickened edges should extend to a minimum depth of 8 inches below finished slab grade for the entire slab perimeter. Similar thickening at cold joints would also be desirable.

Pavements

Design Criteria

We have calculated alternative pavement sections for the proposed parking stalls, driveways and service aprons using the the results of Resistance ("R") value tests conducted upon selected samples of the anticipated subgrade soils, the Caltrans "Design Method for Flexible Pavements", and assumed traffic indices ("T.I."s) which represent wheel load frequency and intensity. Laboratory tests show "R" = 17-59 at 300 psi exudation pressure. For the design pavement sections, we recommend "T.I." = 4.5 for ordinary automobile parking and areas subject to comparable wear, and "T.I." = 6.5 for moderate to heavy traffic, such as might be realized in driveways, access lanes and parking aisles, or in areas travelled by delivery vans, refuse collection trucks or similar vehicles. We emphasize that the selected traffic indices are based upon projected pavement usage and do not reflect wheel load repetitions derived from actual traffic counts.

Sections

Our recommended pavement section alternatives follow:

<u>Design Traffic Index</u>	<u>Recommended Pavement Sections - inches</u>	
	<u>Asphalt Concrete (Type B)</u>	<u>Aggregate Base (Class 2)</u>
4.5	3	7
6.5	4 5	12 10

Materials quality and construction requirements within the structural sections should conform to the applicable provisions of the Caltrans "Standard Specifications" (July, 1984).

The foregoing pavement section recommendations are presented with the understanding that soils exposed at final pavement subgrade level will be similar to those tested during this investigation, that subgrade preparation will be accomplished in accordance with the provisions of the attached guide specifications, that the pavement subgrades will be stable, and that the pavements themselves will be adequately drained. Where drop inlets or other surface drainage devices are to be installed, we strongly recommend that perforations, slots or other openings be provided to allow free drainage of the contiguous base course materials.

LIMITATIONS

The recommendations of this report are based upon the information provided regarding the proposed improvements as well as the subsurface conditions encountered at the test boring locations. If it is found during construction that subsurface conditions differ from those described on the boring logs, the conclusions and recommendations in this report shall be considered invalid, unless the changes are reviewed and the conclusions and recommendations modified or approved in writing.

Page 20  
December 19, 1985  
L & a No. 85-510

**LOWRY & ASSOCIATES**

We would appreciate the opportunity to review the final plans and specifications to determine if the recommendations of this report have been implemented in those documents. The review would be acknowledged in writing.

We emphasize that this report is applicable only to the proposed construction, as described herein, and should not be utilized for design and/or construction on any other site.

LOWRY & associates

*Jeff O. Short*

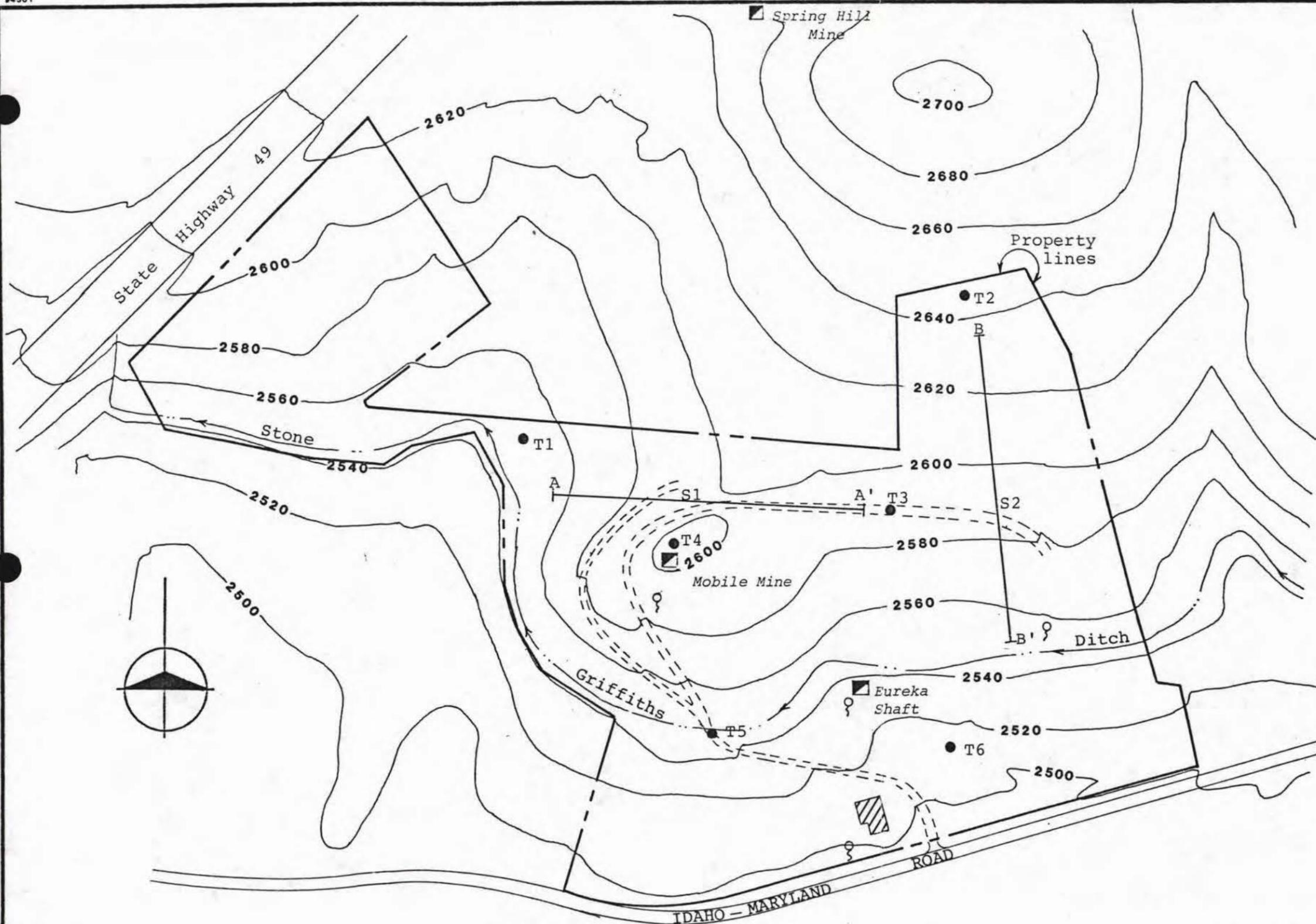
JEFF O. SHORT  
Staff Geotechnical Engineer

*Paul C. Weidig*

PAUL C. WEIDIG  
Registered C. E. No. 25,128  
Registered Geologist No. 3163

JOS:jm

xc: (6)



-NOTES-

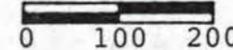
1. Prepared from: "TOPOGRAPHIC MAP" (scale: 1"=100') by O'Dell and Associates, Grass Valley, California.
2. Locations of borings are approximate only.
3. Elevation contour reference: U.S.G.S. datum.

-LEGEND-

- T1 ● Boring location
- S2 |—| Geophysical survey line
-  Existing slab
-  Spring

**LOCATION PLAN**

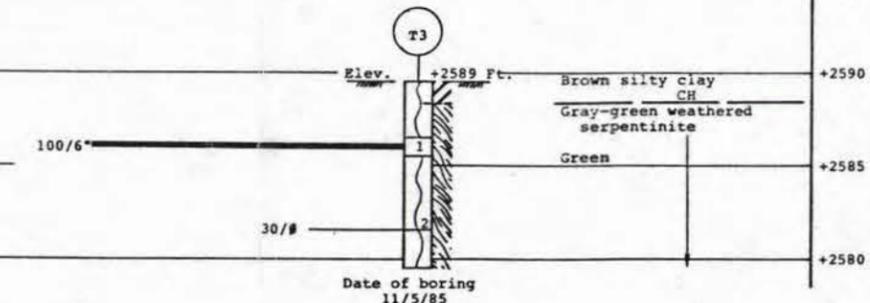
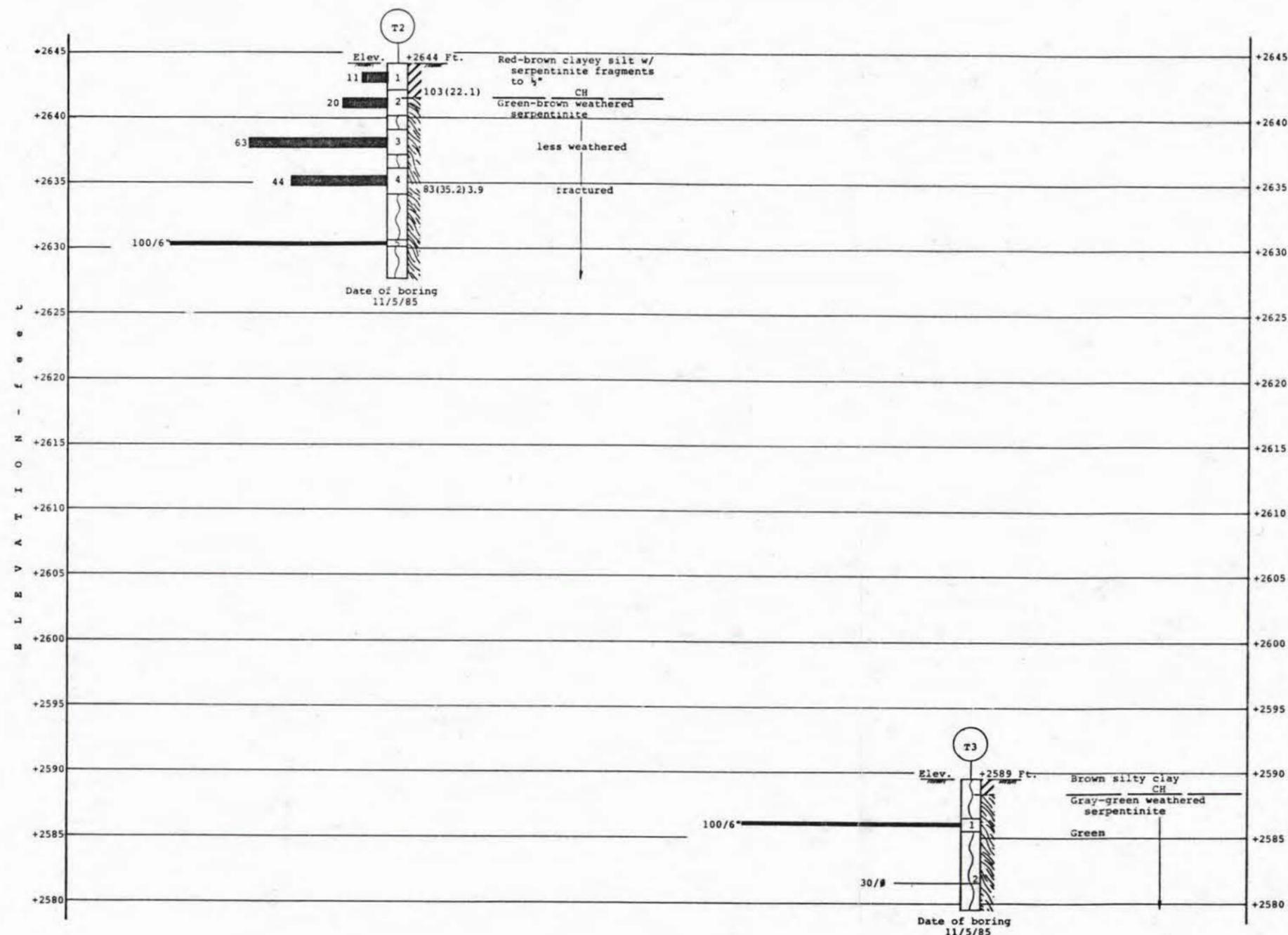
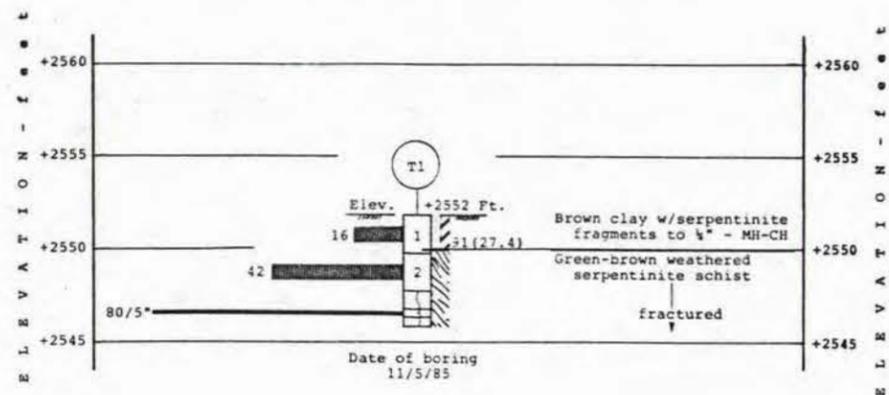
**LOWRY & ASSOCIATES**  
GEOTECHNICAL ENGINEERS

**DRAWN BY:** G. C. Barmby  
**CHECKED BY:** J. O. Short  
**SCALE: FEET** 

WOLF CREEK INDUSTRIAL PARK  
 Idaho-Maryland Road  
 Grass Valley, California



**PROJECT NO:** 85-510  
**DATE:** 12/85  
**PLATE NO:** 1



- NOTES-
1. Explanation of symbols and classification system shown on Plate No. 4.
  2. Elevation reference: County datum; elevations shown are approximate only.
  3. No free ground water observed in borings.
  4. The boring logs show subsurface conditions at the locations and on the date indicated. It is not warranted that they are representative of such conditions at other locations and times.

**BORING LOGS**

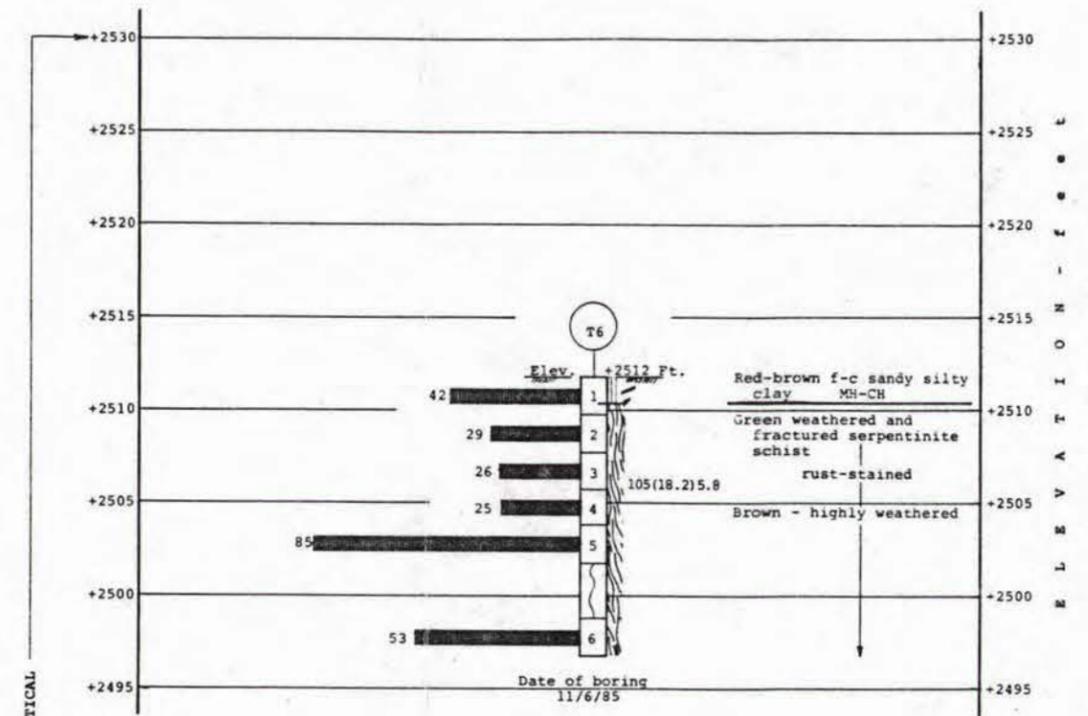
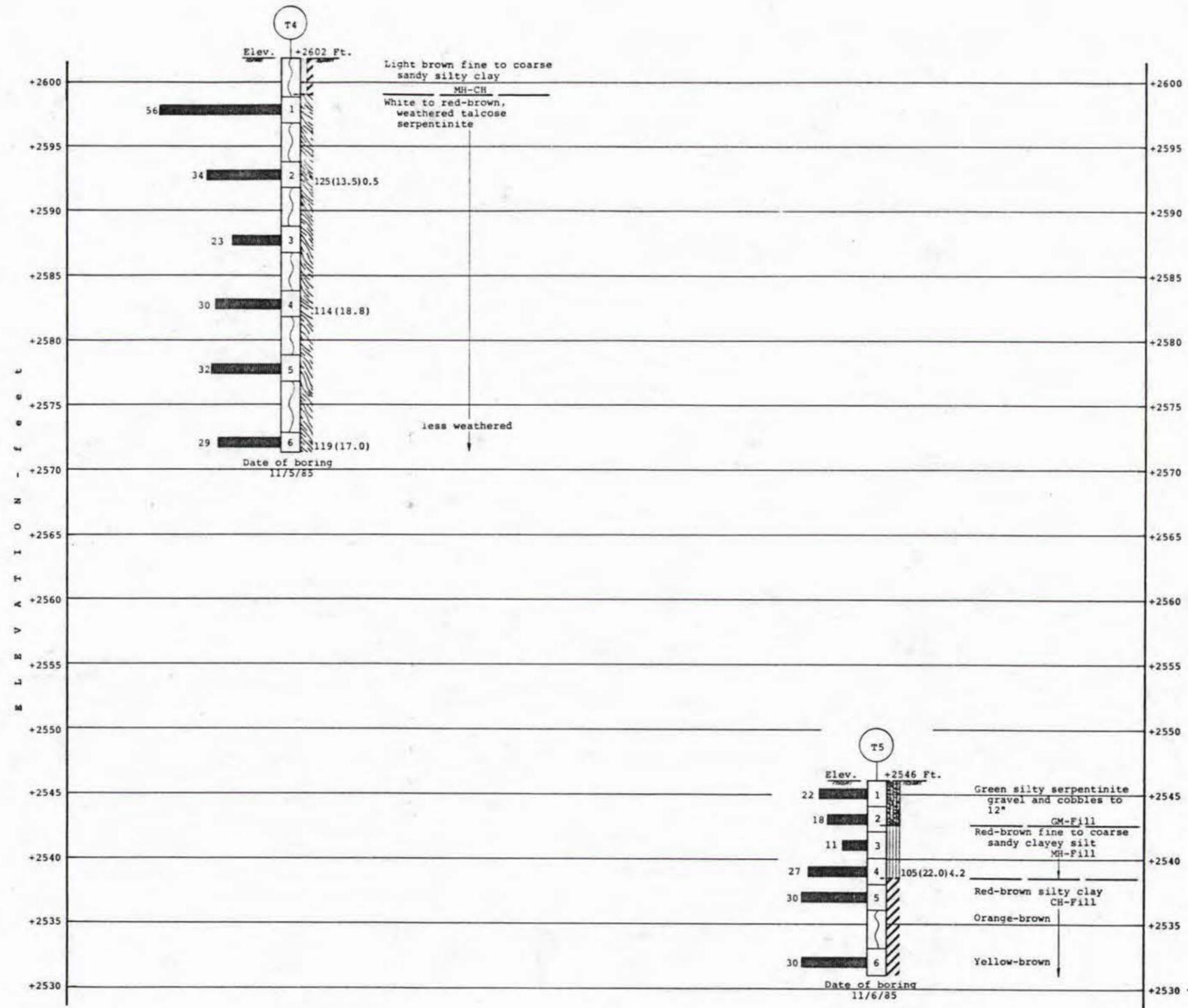
**LOWRY & ASSOCIATES**  
**GEOTECHNICAL ENGINEERS**

**DRAWN BY:** G. C. Barmby  
**CHECKED BY:** J. O. Short

WOLF CREEK INDUSTRIAL PARK  
 Idaho-Maryland Road  
 Grass Valley, California



**PROJECT NO:** 85-510  
**DATE:** 12/85  
**PLATE NO:** 2



IDENTICAL

-NOTES-

1. Explanation of symbols and classification system shown on Plate No. 4.
2. Elevation reference: County datum; elevations shown are approximate only.
3. No free ground water observed in borings.
4. The borings show subsurface conditions at the locations and on the dates indicated. It is not warranted that they are representative of such conditions at other locations and times.

**BORING LOGS**

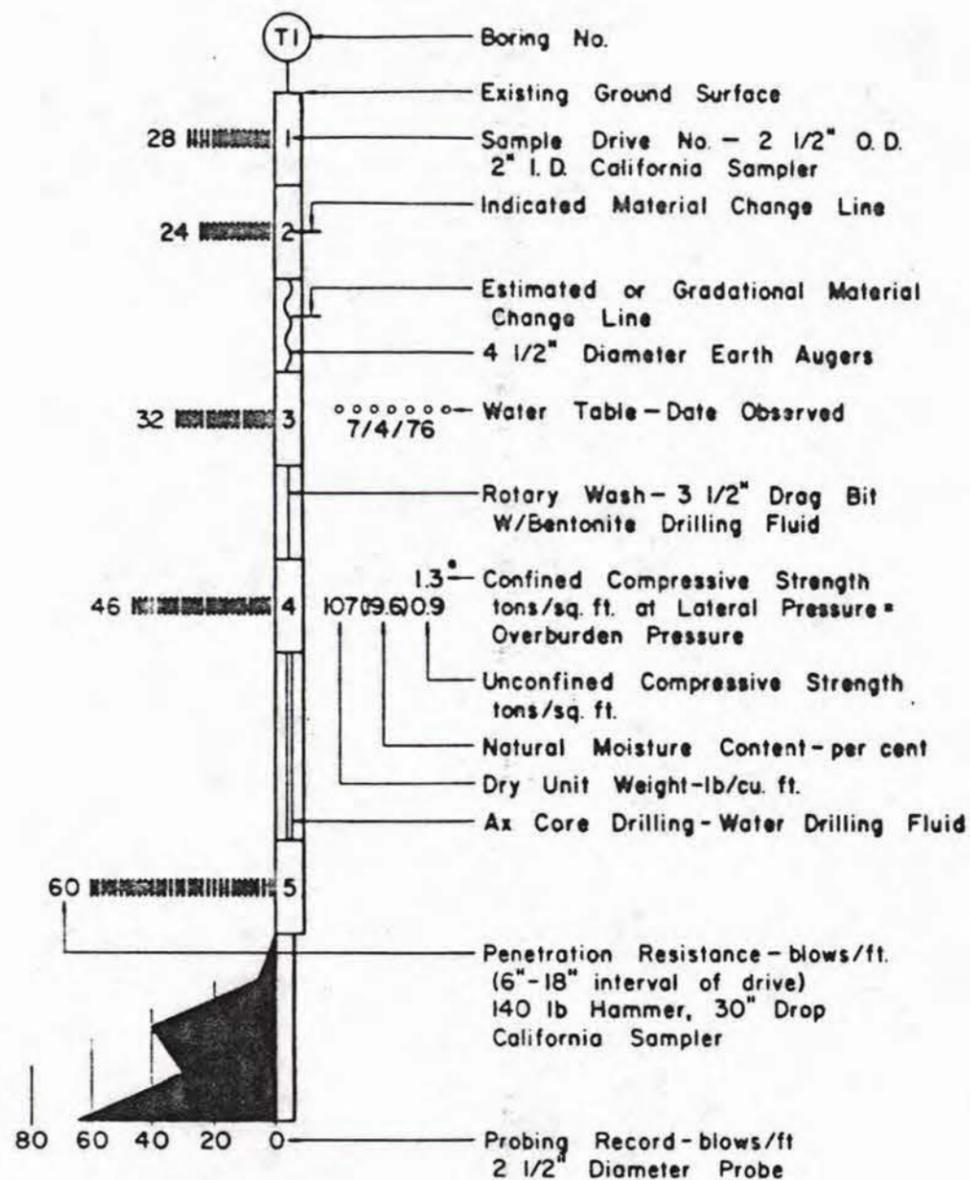
**LOWRY & ASSOCIATES**  
 GEOTECHNICAL ENGINEERS

**DRAWN BY:** G. C. Barmby  
**CHECKED BY:** J. O. Short

WOLF CREEK INDUSTRIAL PARK  
 Idaho-Maryland Road  
 Grass Valley, California



**PROJECT NO:** 85-510  
**DATE:** 12/85  
**PLATE NO:** 3



MAJOR DIVISIONS	SYMBOLS	CODE	TYPICAL NAMES
COARSE GRAINED SOILS (More than 1/2 of soil no. 200 sieve size)	<b>GRAVELS</b>		
	GW		Well graded gravels or gravel-sand mixtures, little or no fines
	GP		Poorly graded gravels or gravel-sand mixtures, little or no fines
	GM		Silty gravels, gravel-sand-silt mixtures
	GC		Clayey gravels, gravel-sand-clay mixtures
	<b>SANDS</b>		
FINE GRAINED SOILS (More than 1/2 of soil no. 200 sieve size)	<b>SILTS &amp; CLAYS</b>		
	SW		Well-graded sands or gravelly sands, little or no fines
	SP		Poorly graded sands or gravelly sands, little or no fines
	SM		Silty sands, sand-silt mixtures
	SC		Clayey sands, sand-clay mixtures
	<b>SILTS &amp; CLAYS</b>		
ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	
CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
OL		Organic silts and organic silty clays of low plasticity	
<b>SILTS &amp; CLAYS</b>			
MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	
CH		Inorganic clays of high plasticity, fat clays	
OH		Organic clays of medium to high plasticity, organic silty clays, organic silts	
HIGHLY ORGANIC SOILS	Pt		Peat and other highly organic soils

**UNIFIED SOIL CLASSIFICATION SYSTEM**

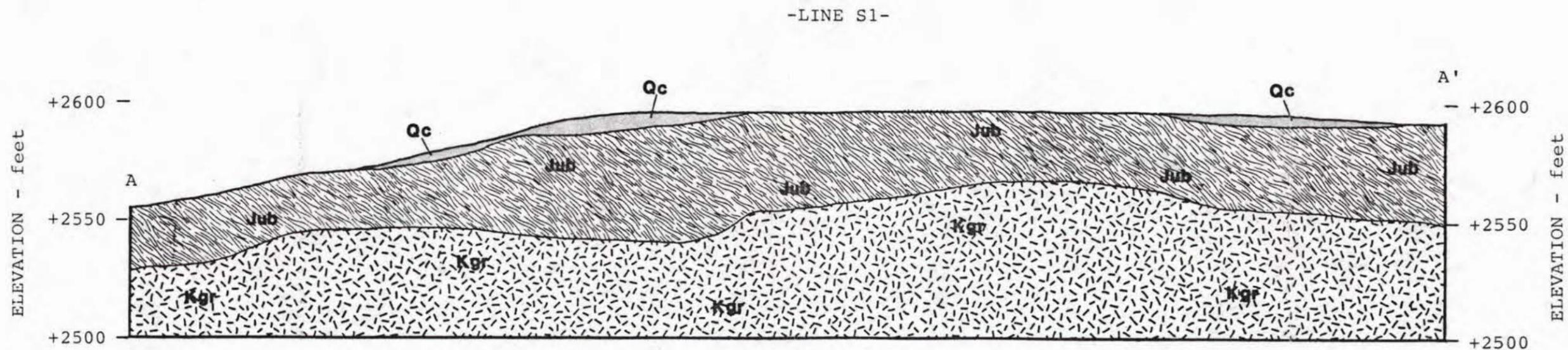
COHESIVE SOILS		GRANULAR SOILS	
Description	Blows/ft.	Description	Blows/ft.
Very Soft	< 3	Very Loose	< 5
Soft	3 - 5	Loose	5 - 15
Medium (firm)	6 - 10	Medium Dense	16 - 40
Stiff	11 - 20	Dense	41 - 65
Very Stiff	21 - 40	Very Dense	> 65
Hard	> 40		

**CONSISTENCY CLASSIFICATION**

CLASSIFICATION	RANGE OF GRAIN SIZES	
	U.S. Standard Sieve Size	Grain Size in Millimeters
BOULDERS	Above 12"	Above 305
COBBLES	12" to 3"	305 to 76.2
GRAVEL	3" to No. 4	76.2 to 4.76
	coarse (c) 3" to 3/4" fine (f) 3/4" to No. 4	76.2 to 19.1 19.1 to 4.76
SAND	No. 4 to No. 200	4.76 to 0.074
	coarse (c) No. 4 to No. 10	4.76 to 2.00
	medium (m) No. 10 to No. 40	2.00 to 0.420
fine (f) No. 40 to No. 200	0.420 to 0.074	
SILT & CLAY	Below No. 200	Below 0.074

**GRAIN SIZE CLASSIFICATION**



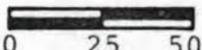


-NOTES-

1. Geologic legend shown on Plate No. 6.
2. Date of exploration: 11/6/85.
3. Elevation reference: U.S.G.S datum; elevations shown are approximate only.
4. The geologic sections depict approximate subsurface geologic conditions as inferred from the geophysical surveys only at the locations and on the date indicated.

**GEOLOGIC SECTION**

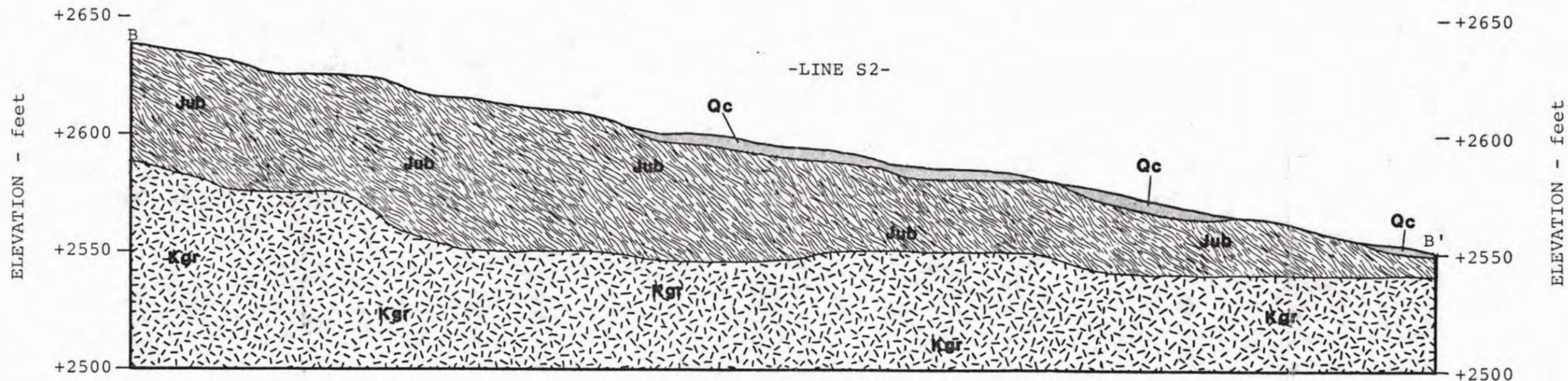
**LOWRY & ASSOCIATES**  
**GEOTECHNICAL ENGINEERS**

**DRAWN BY:** G. C. Barmby  
**CHECKED BY:** J. O. Short  
**SCALE: FEET** 

WOLF CREEK INDUSTRIAL PARK  
 Idaho-Maryland Road  
 Grass Valley, California



**PROJECT NO:** 85-510  
**DATE:** 12/85  
**PLATE NO:** 5



-LEGEND-

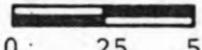
- Recent  **Qc** Colluvium. Silts and clays derived by in-site weathering.
- Cretaceous  **Jub** Basic Intrusive Rock. Gabbro and diorite.
- Jurassic  **Kgr** Ultrabasic Rocks. Serpentinite and serpentinite schist.

-NOTES-

1. Date of explanation: 11/6/85.
2. Elevation reference: U.S.G.S. datum; elevations shown are approximate only.
3. The geologic sections depict approximate subsurface geologic conditions as inferred from the geophysical surveys only at the locations and on the date indicated.

**GEOLOGIC SECTION**

**LOWRY & ASSOCIATES**  
**GEOTECHNICAL ENGINEERS**

**DRAWN BY:** G. C. Barmby  
**CHECKED BY:** J. O. Short  
**SCALE: FEET** 

WOLF CREEK INDUSTRIAL PARK  
 Idaho-Maryland Road  
 Grass Valley, California



**PROJECT NO:** 85-510  
**DATE:** 12/85  
**PLATE NO:** 6

APPENDIX A

APPENDIX A

GENERAL INFORMATION

A foundation engineering investigation at the site of the proposed Wolf Creek Industrial Center in Grass Valley was authorized by John Odell on November 5, 1985, by subscription to and execution of LOWRY & associates' proposal letter and contract for geotechnical services, dated November 1, 1985.

The civil engineering consultant for this project is O'Dell and Associates, 100 South Church Street, Grass Valley, California 95945 (1-272-2613); John O'Dell is the coordinating civil engineer.

The boundaries of the study area are referenced to a document entitled:

"BOUNDARY LINE ADJUSTMENT, PARCEL MAP NO. 84-19, BEING A PORTION OF SECTIONS 23 AND 26, T.16 N., R.8E., M.D.M. IN THE CITY OF GRASS VALLEY, STATE OF CALIFORNIA" (scale: 1"=100'; dated January, 1985), prepared by O'Dell & Associates, Grass Valley, California.

The locations of our test borings are referenced to a document entitled:

"TOPOGRAPHIC MAP" (scale: 1"=100') supplied by O'Dell and Associates, Grass Valley, California.

Boring locations shown on the Boring Location Plan are approximate only.

Boring elevations shown on the logs are approximate only and were obtained by interpolation between nearest ground surface contours shown on the above-cited document.

Preliminary grades for Parcels "B", "C" and "D" are referenced to a document entitled:

"GRADING PLAN FOR R. SEIFRIED, ET. UX., PARCEL MAP 84-19" (dated Feb. 1985; plan scale: 1"=50'; profile scales: 1"=40' horizontal, 1"=10' vertical), prepared by O'Dell & Associates, Grass Valley, California.

Site conditions and cultural features mentioned in the text are those existing at the time of our field investigation, November 5 and 6, 1985, and may not necessarily be representative of such conditions or features at other locations and times.

### FIELD EXPLORATION

#### Test Borings

Field exploration included the drilling of 6 borings at the locations shown on the Boring Location Plan, Plate No. 1, as well as the sampling of surface soils from various points on site. The borings were advanced with 4-1/2-inch diameter continuous flight helical augers powered by a CME-55 truck-mounted drill rig. At various intervals, relatively undisturbed soil and rock samples were recovered from the borings by means of a 2-1/2-inch O.D.-2-inch I.D. California-type sampler which was driven with a 140-pound hammer freely falling 30 inches. The number of blows of the hammer required to drive the 24-inch long sampler each 6-inch interval was recorded, with the sum of blows required to drive the sampler the middle foot (6-inch to 18-inch interval) of each drive denoted the penetration resistance or "blow count" for that particular drive.

The soil and rock samples were retained in 2-inch diameter by 6-inch long, thin-walled brass tubes contained within the sampler. Immediately after recovery, the samples were visually classified and the ends of the brass tubes were sealed to preserve the natural moisture content. Selected samples of the surface soils were obtained in a disturbed condition. All samples were taken to the laboratory for classification, with selected samples designated for testing.

The Boring Logs, Plates No. 2 and 3, contain descriptions of the soils and rock encountered in each boring. The soils were classified in accordance with the Unified Soil Classification System. An explanation of that system and other symbols used on the logs appears on Plate No. 4. In addition, the boring logs show a graphical representation of the previously-defined penetration resistance or "blow count" obtained during sampling.

#### Geophysical Investigation

The geophysical exploration program included the completion of two refraction seismic traverses at the locations shown on

Plate No. 1. Exploration was accomplished using a 12-channel, impact-actuated, signal enhancement seismograph and linear geophone arrays 600 feet in length. Geophone spacing was held constant at 50 feet, center-to-center. Seven impact points -- two at the ends and five at interior locations -- were used to define the velocity profiles.

The arrival time profiles were recorded on aluminized paper and the field data reduced for computer processing. Raw field data were interpreted and the respective travel times submitted to computer program FSIP1 (Fast Seismic Interpretation Program - Version 1). This program utilizes a ray-tracing method to compute the depths to respective velocity interfaces.

Geologic sections interpreted from the processed geophysical data are displayed on Plates No. 5 and 6, along with a key to the symbols which portray each geologic section.

#### LABORATORY TESTING

Selected, undisturbed samples of soil and rock were tested to determine dry unit weight, natural moisture content (ASTM D2216) and unconfined compressive strength (ASTM D2166). The results of these tests are included on the boring logs at the depth from which each sample was obtained.

A sample of the near-surface soil was subjected to Atterberg limits tests (ASTM D423 and 424) to determine the plasticity characteristics of the material. The results of these tests are displayed on Plate No. A1.

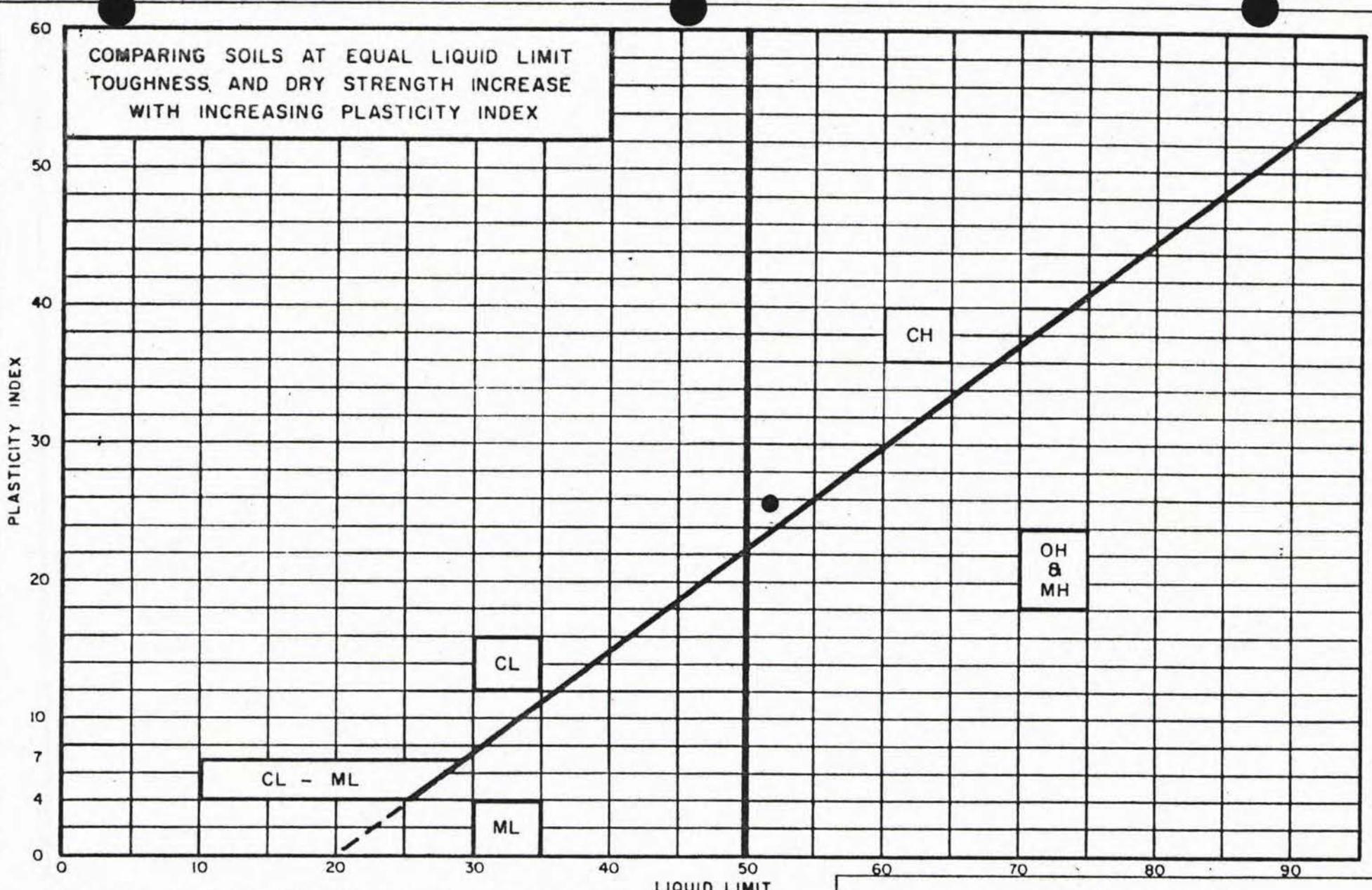
The internal strength characteristics of the earth materials were evaluated by means of triaxial compression tests (ASTM D2850) conducted at lateral or confining air pressures of 10, 20 and 30 psig. The results of this test series are illustrated on Plate No. A2.

The internal strength characteristics of the remolded earth materials were evaluated by means of triaxial compression tests (ASTM D2850) conducted at lateral or confining air pressures of 10, 20 and 30 psig. The results of this test series are illustrated on Plate No. A3.

Resistance value tests (CTM 301G) were conducted on selected samples of the anticipated pavement subgrade soils. These test results, which were used in our pavement section analyses, are presented on Plates No. A5 and A6.

A selected sample of the surface soil was subjected to a compaction test (ASTM D1557-78) to determine the dry unit weight-moisture content interrelationships of the material. The results of this test are shown in the form of a curve on Plate No. A6.

LOWRY & associates



Sample: Borings No. T2 and T2, depth 3'-6'  
 Description: Green-brown weathered serpentinite  
 Equivalent Unified Soil Classification: CH

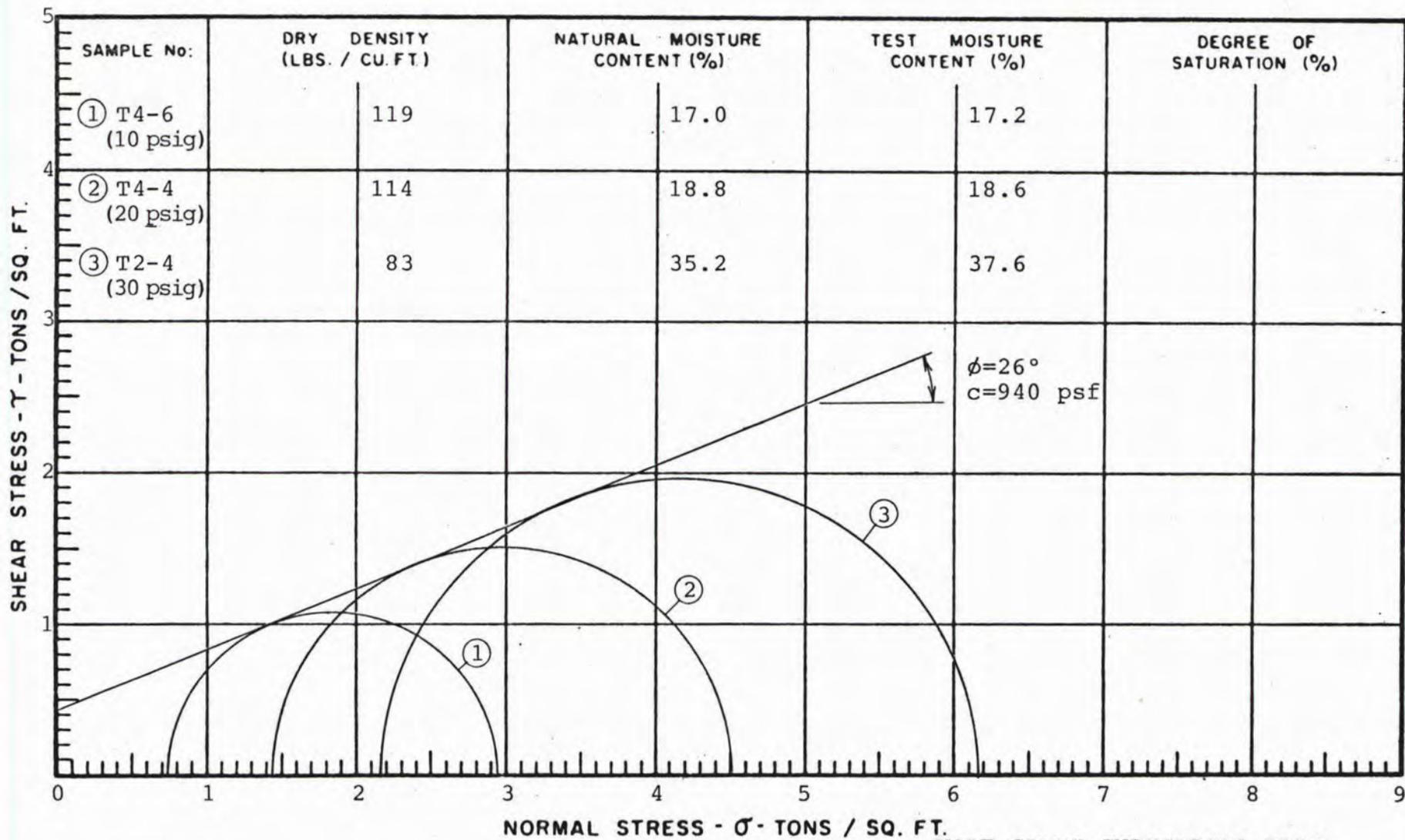
WOLF CREEK INDUSTRIAL PARK  
 Grass Valley, California



**Plasticity Chart**  
**LOWRY & ASSOCIATES**  
**GEOTECHNICAL ENGINEERS**

DATE: 12/85

PROJECT No. 85-510



**TEST DATA**

MATERIAL DESCRIPTION: Green-brown weathered  
 serpentinite  
 SAMPLE CONDITION: Undisturbed, saturated  
 TYPE OF TEST: Slow (strain rate: 0.0075 in/min)

WOLF CREEK INDUSTRIAL PARK  
 Idaho-Maryland Road  
 Grass Valley, California

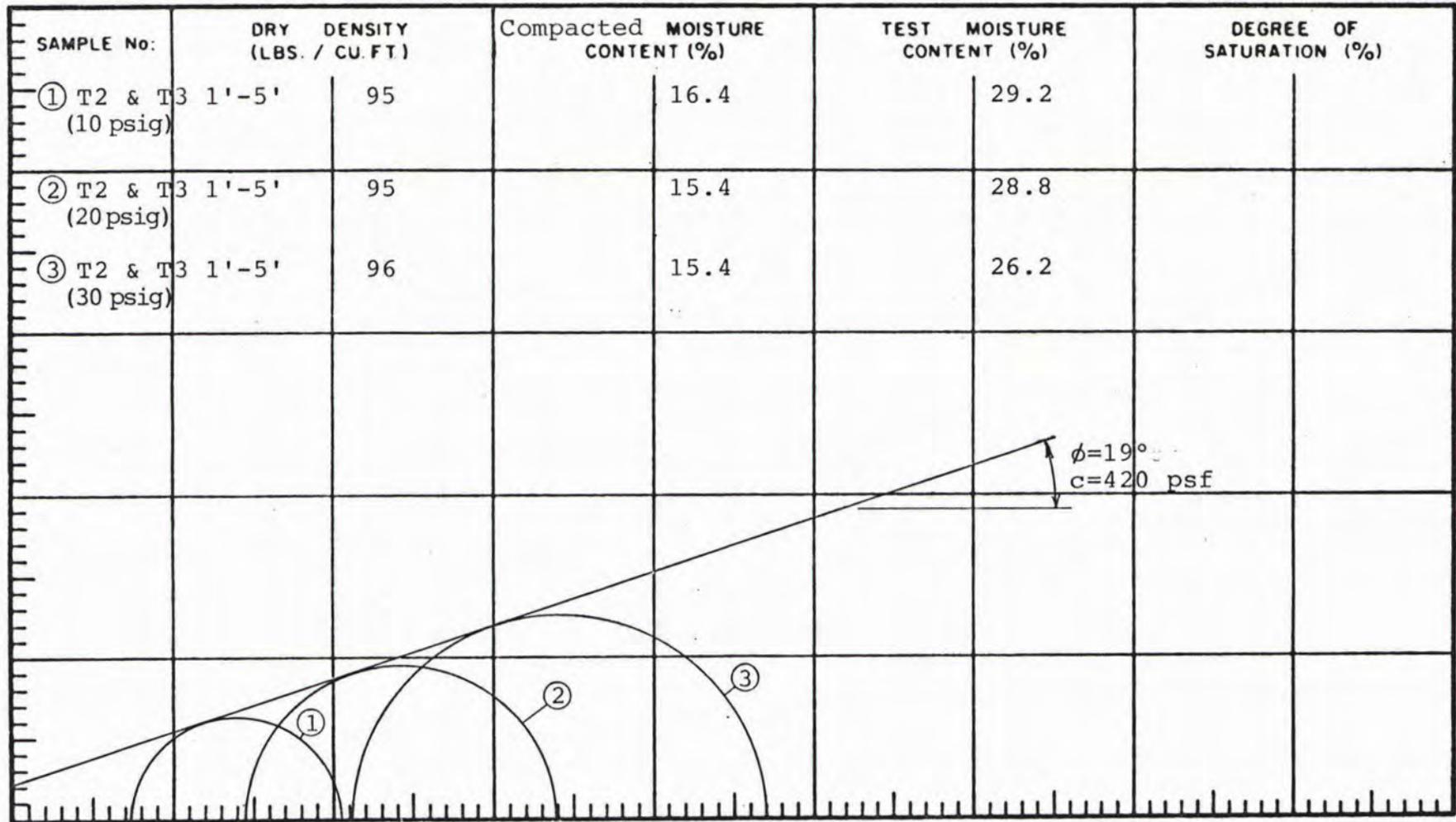
**TRIAxIAL COMPRESSION TEST**



**LOWRY & ASSOCIATES**  
**GEOTECHNICAL ENGINEERS**

DATE: 12/85

PROJECT NO85-510



SHEAR STRESS -  $\tau$  - TONS / SQ. FT.

NORMAL STRESS -  $\sigma$  - TONS / SQ. FT.

**TEST DATA**

**MATERIAL DESCRIPTION:** Green-brown weathered serpentinite  
**SAMPLE CONDITION:** Saturated, remolded  
**TYPE OF TEST:** Slow (strain rate: 0.0075 in/min)

WOLF CREEK INDUSTRIAL PARK  
 Idaho-Maryland Road  
 Grass Valley, California

**TRIAxIAL COMPRESSION TEST**



**LOWRY & ASSOCIATES**  
**GEOTECHNICAL ENGINEERS**

**DATE:** 12/85

**PROJECT NO. 85-510**

PLATE NO: A3

# LOWRY & ASSOCIATES

WOLF CREEK INDUSTRIAL PARK  
 Idaho-Maryland Road  
 Grass Valley, California  
 L & a No. 85-510

RESISTANCE VALUE TEST  
 (California Test Method No. 301-G)

Soil Description: Green-brown weathered  
 serpentinite

Sample No.: T2

Depth: 3' - 5'

<u>Specimen No.</u>	<u>Dry Unit Weight (pcf)</u>	<u>Compaction Moisture (%)</u>	<u>Exudation Pressure (psi)</u>	<u>Expansion Pressure (dial reading) &amp; (psf)</u>	<u>Resistance ("R") Value</u>
1	92	29.0	168	11      48	11
2	96	27.5	336	23      100	19
3	100	26.0	528	60      260	31

Design "T.I."

Least Equilibrium "R" Value

4.5

17

6.5

17

# LOWRY & ASSOCIATES

WOLF CREEK INDUSTRIAL PARK  
Idaho-Maryland Road  
Grass Valley, California  
L & a No. 85-510

RESISTANCE VALUE TEST  
(California Test Method No. 301-G)

Soil Description: White and red-brown mottled  
weathered serpentinite

Sample No.: T4

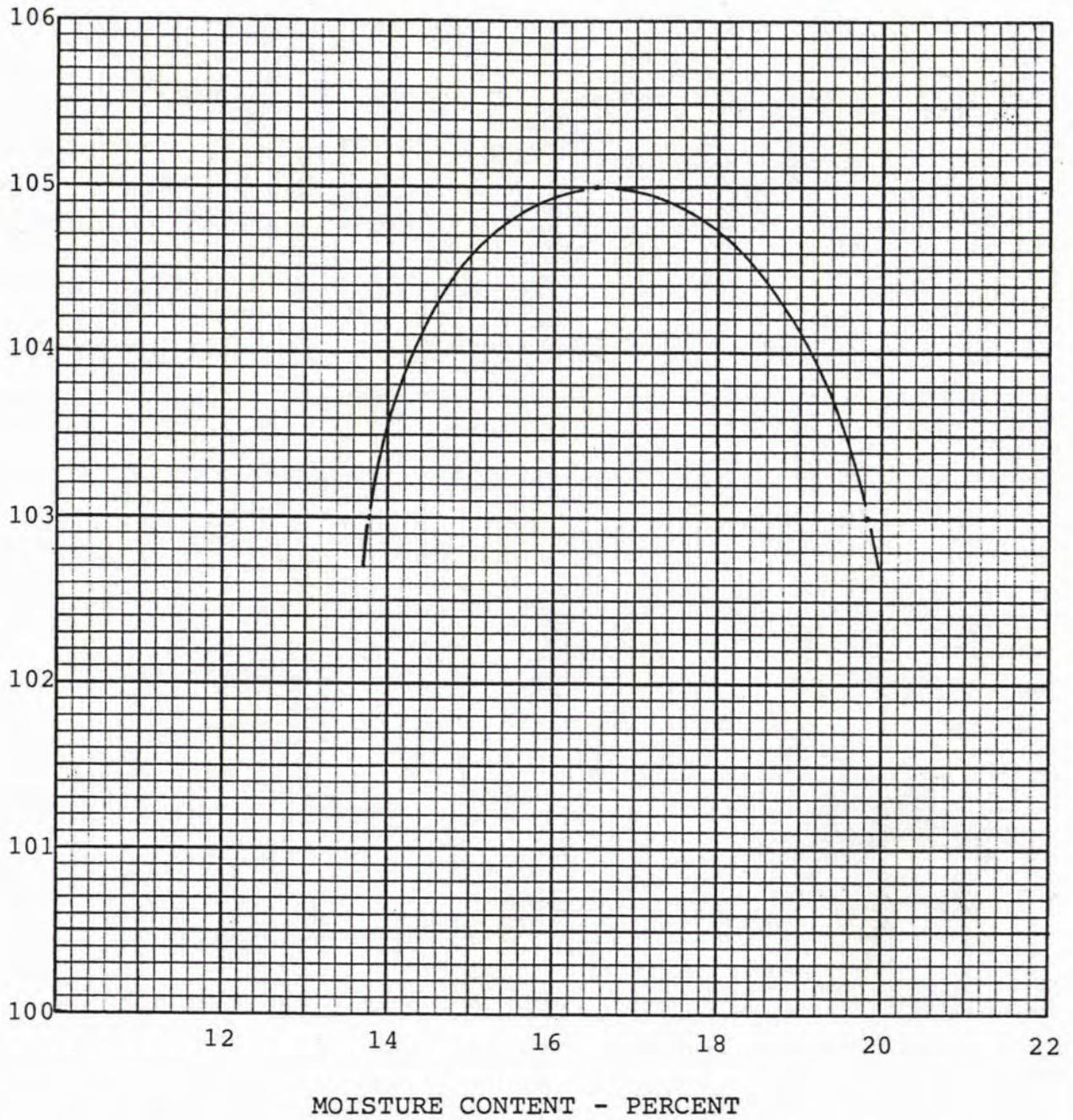
Depth: 3' - 6'

<u>Specimen No.</u>	<u>Dry Unit Weight (pcf)</u>	<u>Compaction Moisture (%)</u>	<u>Exudation Pressure (psi)</u>	<u>Expansion Pressure (dial reading) &amp; (psf)</u>	<u>Resistance ("R") Value</u>
1	112	18.1	152	50      216	51
2	113	17.1	280	65      281	58
3	115	15.2	520	110     476	64

R Value at 300 psi exudation pressure = 59

<u>Design "T.I."</u>	<u>Least Equilibrium "R" Value</u>
4.5	19
6.5	35

UNIT WEIGHT - LBS/CU. FT.



Test Data

Material: Green-brown weathered serpentinite  
Type of Test: ASTM D1557-78 "A"  
Maximum Dry Density (Lbs/Cu Ft): 105  
Optimum Moisture Content (%): 16.5

**COMPACTION TEST**

WOLF CREEK INDUSTRIAL PARK  
Idaho-Maryland Road  
Grass Valley, California



PROJECT NO: 85-510  
DATE: 12/85  
PLATE NO: A6

APPENDIX B

APPENDIX B

GUIDE SPECIFICATIONS - EARTHWORK  
WOLF CREEK INDUSTRIAL PARK  
Idaho-Maryland Road  
Grass Valley, California  
L & a No. 85-510

SECTION 2A - EARTHWORK

PART 1: GENERAL

1.1 SCOPE

a. General Description

This item shall include all clearing and grubbing, preparation of land to be filled, filling, spreading, compaction, observation and testing of the fill, and all subsidiary work necessary to complete the grading of the building and pavement areas to conform with the lines, grades and slopes as shown on the accepted Drawings.

b. Related Work Specified Elsewhere

- (1) Trenching and backfilling for sanitary sewer system: Section \_\_\_\_\_.
- (2) Trenching and backfilling for storm sewer system: Section \_\_\_\_\_.
- (3) Trenching and backfilling for underground water, telephone, natural gas, and electrical supplies: Section \_\_\_\_\_.

1.2 PROTECTION

- a. Adequate protection measures shall be provided to protect workmen and passers-by the site. Streets and adjacent property shall be fully protected throughout the operations.

- b. In accordance with generally accepted construction practices, the Contractor shall be solely and completely responsible for working conditions at the job site, including safety of all persons and property during performance of the work. This requirement shall apply continuously and not be limited to normal working hours.
- c. Any construction review of the Contractor's performance conducted by the Soil Engineer is not intended to include review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.
- d. Adjacent streets and sidewalks shall be kept free of mud, dirt or similar nuisances resulting from earthwork operations.
- e. Provide for surface drainage during the period of construction in a manner to avoid creating a nuisance to adjacent areas.
- f. Water as required to suppress dust nuisance.
- g. Carefully protect existing trees and shrubs which are to remain.

1.3 FOUNDATION REPORT

- a. A Foundation Engineering Report (L & a No. 85-510 dated December 19, 1985) has been prepared for this site by LOWRY & associates, Sacramento, California [(916) 929-9012]. A copy is available for review at the Civil Engineer's office or at LOWRY & associates' office.
- b. The information contained in this report was obtained for design purposes only. The Contractor is responsible for any conclusions he may draw from this report; should he prefer not to assume such risk, he is under obligation to employ his own experts to analyze available information and/or to make additional borings upon which to base his conclusions, all at no cost to the Owner.

1.4 EXISTING SITE CONDITIONS

The Contractor shall acquaint himself with all site conditions. If unshown active utilities are encountered

during the work, the Architect shall be promptly notified for instructions. Failure to notify will make the Contractor liable for damage to these utilities arising from Contractor's operations subsequent to his discovery of such unshown utilities.

#### 1.5 SEASONAL LIMITS

Fill material shall not be placed, spread or rolled during unfavorable weather conditions. When the work is interrupted by heavy rains or snowfall, fill operations shall not be resumed until field tests indicate that the moisture contents of the subgrade and fill materials are satisfactory.

### PART 2: PRODUCTS

#### 2.1 MATERIALS

- a. All fill shall be of approved local materials from required excavations, supplemented by imported fill, if necessary. Approved local materials are defined as local soils and crushed or broken bedrock free from rubble, rubbish and vegetation, tested and approved by the Soil Engineer prior to use. Clods, rocks or hard lumps exceeding four inches (4") in final size shall not be allowed in the uppermost three feet (3') of any fill supporting pavements and buildings. No rocks exceeding sixty inches (60") in maximum size shall be used in constructing embankments. Frozen soils shall not be used in any part of the earthwork.
- b. Imported fill materials shall meet the above requirements, shall have a plasticity index not exceeding twelve (12), shall have an expansion index not exceeding twenty (20), and shall be of four-inch (4") maximum particle size.
- c. Wall backfill materials shall consist of approved, imported, nonexpansive materials.
- d. Capillary break material under floor slabs shall be provided to the thickness shown on the Drawings. This material shall be clean gravel or crushed rock of one-inch (1") maximum size, with no material passing a Number four (#4) sieve.

PART 3: EXECUTION3.1 LAYOUT AND PREPARATION

Lay out all work, establish grades, locate existing underground utilities, set markers and stakes, set up and maintain barricades and protection of utilities; all prior to beginning actual earthwork operations.

3.2 CLEARING, GRUBBING AND PREPARING BUILDING PAD AND PAVEMENT AREAS

- a. All vegetation; rubble; rubbish; existing mine tailings and rock fragments exceeding four inches (4") in final size; loose existing fill and other loose and/or saturated materials; downed timber, brush, stumps and root systems of removed trees within two feet (2') of original or final grade (whichever is lower); underground utilities within two feet (2') of original or final grade (whichever is lower); and any existing concrete slabs and foundations shall be removed and disposed of so as to leave the areas that have been disturbed with a neat and finished appearance, free from unsightly debris. If they extend below planned finished subgrade level, excavations and depressions resulting from the removal of the foregoing items, as well as any existing excavations or loose soil deposits as determined by the Soil Engineer or his representative, shall be cleaned out to firm, undisturbed soil or weathered bedrock (whichever is higher) and backfilled with suitable materials in accordance with these specifications.
- b. All subgrades upon which fill is to be placed shall be evaluated by the Soil Engineer or his representative to determine the presence of springs, marshy areas or other high ground water conditions. If evidence of seepage is confirmed by the Engineering Geologist, he shall issue subdrainage recommendations, which shall be implemented prior to the construction of any engineered fill in the affected areas.
- c. Soil surfaces upon which fill is to be placed, as well as subgrades of the building pad and pavement areas left at existing grade, shall be plowed or scarified to a depth of six inches (6"), or to the

underlying bedrock surface (whichever is higher) until the surface is free from ruts, hummocks or other uneven features which would tend to prevent uniform compaction by the equipment to be used.

- d. After the foundation for the fill has been cleared, plowed, or scarified, it shall be disced or bladed until uniform and free from large clods. The foundation for fill shall then be brought to the proper moisture content, as specified below.
- e. When the moisture content of the subgrade is less than the optimum moisture content, water shall be added until the proper moisture content is achieved.
- f. When the moisture content of the subgrade is too high to permit the specified degree of compaction to be achieved, the subgrade shall be aerated by blading or other methods until the moisture content is satisfactory for compaction, but not less than the optimum moisture content.
- g. The foundation for fill shall be compacted while at the proper moisture content to at least ninety-five percent (95%) of the maximum dry density as determined by ASTM Specification D1557-78.
- h. Exposed rock subgrades shall be cleaned of all rock fragments over four inches (4") in largest dimension, but shall otherwise be left undisturbed.

### 3.3 PLACING, SPREADING AND COMPACTING FILL MATERIAL

- a. The selected fill material shall be placed in layers which when compacted shall not exceed six inches (6") in thickness. Each layer shall be spread evenly and shall be thoroughly mixed during the spreading to promote uniformity of material in each layer.
- b. When the moisture content of the fill material is less than three percent (3%) over the optimum moisture content, water shall be added until the proper moisture content is achieved.
- c. When the moisture content of the fill material is too high to permit the specified degree of

compaction to be achieved, the fill material shall be aerated by blading or other methods until the moisture content is satisfactory for compaction, but not less than three percent (3%) over the optimum moisture content.

- d. Rock fragments larger than four inches (4") but less than thirty-six inches (36") in maximum size shall be thoroughly blended so as to promote a uniformly graded moisture that is free of significant voids or concentrations of larger rock fragments. Boulders thirty-six inches (36") or larger in maximum dimension and which are to be used in engineered fill embankments shall be placed in staggered rows, directly on the subgrade and parallel to the embankment toe line such that the center-to-center spacing between individual boulders shall not be less than three (3) diameters as governed by the larger of any two (2) adjacent boulders. Interstitial fill shall consist of approved soils having a particle size not exceeding four inches (4").
- e. After each layer has been placed, mixed and spread evenly, it shall be thoroughly compacted to not less than ninety-five percent (95%) of maximum dry density as determined by ASTM Specification D1557-78. Compaction shall be undertaken with equipment capable of achieving the specified density and shall be accomplished while the fill material is at the required moisture content. Each layer shall be compacted over its entire area until the desired density has been obtained.
- f. Wall backfill shall be placed and compacted as fill in accordance with these specifications. The fill shall be compacted to at least ninety percent (90%), with the exception of the upper twelve inches (12") of fill which shall be compacted to at least ninety-five percent (95%).
- g. The filling operation shall be continued until the fill has been brought to the finished slopes and grades as shown on the accepted Drawings.

#### 3.4 BENCHING AND KEYING

- a. Where the slope of the natural ground exceeds an inclination of six horizontal to one vertical

(6:1), benches shall be cut into the hillside as the filling operations proceed. Each bench shall be a level terrace at least eight feet (8') wide, and the rise to the next bench shall not exceed four feet (4').

- b. Where the slope of the natural ground exceeds an inclination of four horizontal to one vertical (4:1), a keyway shall be provided in addition to the benches. The keyway shall consist of a level trench at least four feet (4') wide and at least three feet (3') deep, cut into the original ground at the toeline of the embankment. Keyway sideslopes shall not exceed one horizontal to one vertical (1:1).

### 3.5 FINAL SUBGRADE PREPARATION

- a. The upper six inches (6") of all final building pad subgrades and the upper six inches (6") of all final subgrades supporting pavement sections shall be brought to at least the optimum moisture content and shall be uniformly compacted to not less than ninety-five percent (95%) of ASTM Specification D1557-78 maximum dry density, regardless of whether final subgrade elevation is attained by filling or excavation, or is left at existing grade.
- b. Where required, building pad and exterior flatwork subgrades shall be saturated to a depth of not less than twelve inches (12"). The moisture content of the saturated zone shall be determined by the Soil Engineer or his representative, after the building pads and flatwork subgrades to be saturated have been brought to final elevation. Saturation shall be maintained until and immediately prior to placement of floor slab concrete.

### 3.5 TESTING AND OBSERVATION

- a. All grading operations shall be tested and observed by the Soil Engineer, who is serving as the representative of the Owner.
- b. Field density tests shall be made by the Soil Engineer or his representative after compaction of each layer of fill. Where compaction equipment has disturbed the surface to a depth of several

inches, density tests shall be taken in the compacted material below the disturbed surface. Additional layers of the fill shall not be spread until the field density tests indicate that the specified density has been obtained.

- c. Earthwork shall not be performed without the physical presence or approval of the Soil Engineer. The Contractor shall notify the Soil Engineer at least two (2) working days prior to commencement of any aspect of the site earthwork.
- d. If moisture conditioning of building pads and exterior flatwork is required, the subgrade moisture contents shall be field-checked by the Soil Engineer or his representative not more than twenty-four (24) hours prior to placement of slab concrete.
- e. If the Contractor should fail to meet the technical or design requirements embodied in this document and on the applicable plans, he shall make the necessary readjustments until all work is deemed satisfactory as determined by the Soil Engineer and the Architect/Engineer. No deviation from the specifications shall be made except upon written approval of the Soil Engineer or Architect/Engineer.

LOWRY & associates

APPENDIX C

# LOWRY & ASSOCIATES

## APPENDIX C

GUIDE SPECIFICATIONS - PIERS  
WOLF CREEK INDUSTRIAL PARK  
Idaho-Maryland Road  
Grass Valley, California  
L & a No. 85-510

### SECTION 2B - CAST-IN-PLACE CONCRETE PIERS

#### PART 1: GENERAL

##### 1.1 SCOPE

Furnish all plant, labor, equipment, appliances and materials, and perform all operations in connection with the installation of cast-in-place piers completed, in accordance with these specifications and the applicable Drawings, and subject to the terms and conditions of the contract.

##### 1.2 QUALIFICATIONS

All piers shall be installed by a Foundation Contractor qualified to install the type of pier to be constructed in accordance with the Drawings and Specifications, and under conditions existing at the site. The minimum requirements for qualifications shall be five (5) years experience and evidence of satisfactory completion of pier installations comparable in scope to the work specified hereunder and the subsurface conditions anticipated at this site.

##### 1.3 PROTECTION

- a. Adequate protection measures shall be provided to protect workmen and passers-by the site. Streets and adjacent property shall be fully protected throughout the operations.
- b. In accordance with generally accepted construction practices, the Contractor shall be solely and completely responsible for working conditions at the job site, including safety of all persons and property during

performance of the work. This requirement shall apply continuously and not be limited to normal working hours.

- c. Any construction review of the Contractor's performance conducted by the Soil Engineer is not intended to include review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.
- d. Adjacent streets and sidewalks shall be kept free of mud, dirt, or similar nuisances resulting from pier drilling operations.
- e. Provide for surface drainage during the period of construction in a manner to avoid creating a nuisance to adjacent areas. Keep all surface excavations free of water during the entire progress of the work, regardless of the cause, source or nature of the water.
- f. Stored materials and construction equipment shall be kept at least ten feet (10') away from the vertical axis of all open drilled pier shafts, at all times.
- g. Water as required to suppress dust nuisance.
- h. Work shall comply with all Municipal, State, and Federal regulations regarding safety, including the requirements of the Williams-Steiger Occupational Safety and Health Act of 1970.

#### 1.4 FOUNDATION REPORT

- a. A Foundation Engineering Report (L & a No. 85-510; dated December 19, 1985) of this site has been prepared by LOWRY & associates, Sacramento, California [(916) 929-9012]. A copy is available for review at the Civil Engineer's office or at LOWRY & associates' office.
- b. The information contained in this report was obtained for design purposes only. The Contractor is responsible for any conclusions he may draw from this report; should he prefer not to assume such risk, he is under obligation to employ his own experts to analyze available information and/or to make additional borings upon which to base his conclusions, all at no cost to the Owner.

### 1.5 EXISTING SITE CONDITIONS

The Contractor shall acquaint himself with all site conditions. If unshown active utilities are encountered during the work, the Architect shall be promptly notified for instructions. Failure to notify will make the Contractor liable for damage to these utilities arising from Contractor's operations subsequent to his discovery of such unshown utilities.

## PART 2: PRODUCTS

### 2.1 MATERIALS

- a. Reinforcing steel shall be as specified in Section \_\_\_\_\_. The reinforcing steel cage shall be assembled, including centering guides, as shown on the Drawings and approved by the Engineer or his representative in sufficient time prior to completion of drilling operations to permit the assembled cage to be inserted in the completed drill hole without delay.
- b. Concrete shall be as specified in Section \_\_\_\_\_. The Contractor shall make provisions for a supply of concrete that is adequate to complete placement of any given pier in one (1) continuous, uninterrupted operations, so as to form a monolithic concrete structural element.

### 2.2 EQUIPMENT, TOOLS AND LABOR

- a. The Foundation Contractor shall provide a combination of power-driven rotary type rig, bits and/or augers, belling tools and casing of a size and type to drill pier holes to the dimensions shown on the plans and in materials commonly encountered in fills and natural soils of the type existing at this site.
- b. All other materials, labor, tools and equipment necessary for the construction of any given pier in one (1) continuous operation, shall be furnished and installed by the Contractor.

PART 3: EXECUTION3.1 LAYOUT AND PREPARATION

Lay out all work, establish grades, locate existing underground utilities, set markers and stakes, set up and maintain barricades and protection of utilities; all prior to beginning actual earthwork operations.

3.2 TOLERANCES

Pier drilling equipment shall be positioned so that the center of any pier as drilled shall be not more than three inches (3") from the required location, and no pier shall be out of plumb more than two percent (2%) as measured over the total length of the shaft. Drilled shaft diameter shall be not more than one inch (1") under specified size. The top elevation of the pier stem shall be not greater than one inch (1") above, no more than three inches (3") below the elevation(s) shown on Drawings. If these tolerances are exceeded, additional construction, as required by the Engineer, shall be provided without additional cost.

3.3 DATA REPORTS

- a. Each drilled shaft shall be logged by the Contractor. The records shall contain the following information:
- 1) Identification mark
  - 2) Shaft diameter
  - 3) Ground elevation
  - 4) Top elevation of shaft
  - 5) Bottom elevation of shaft
  - 6) Number designation of shaft
  - 7) Reinforcing steel length
  - 8) Casing (if any)
  - 9) Concrete quality
- b. At the end of each day, copies of completed logs shall be submitted to the Owner's representative.

3.4 PIER DRILLING

- a. Pier drilling operations shall be prosecuted by dry drilling methods. Helical or bucket auger drilling shall be used to advance the pilot and stems of the piers.

- b. Temporary casing may be installed to facilitate drilling, subject to the approval of the Soils Engineer.
- c. Entry of pier shaft excavations by the Contractor's personnel to prepare the bearing surface is subject to the governmental safety regulations previously specified and shall not be performed in uncased or inadequately cased excavations nor in excavations that have not been tested for the presence of methane or other toxic gases.
- d. Every pier excavation shall be inspected for cleanliness and acceptability of bearing materials by the Soil Engineer or his representative. All soil bearing surfaces shall be thoroughly cleaned by mechanical devices or hand labor, if required. Suitable access and lighting for proper inspection of completed pier excavations shall be provided by the Contractor. Concrete and reinforcing steel shall not be placed in any pier excavation until the Soil Engineer or his representative has given express approval of the suitability of foundation soils exposed at the base of the pier excavations, of the degree of cleanliness of the bearing surfaces, and of the suitability of the pier excavations.
- e. No pier excavation shall be permitted to stand open for more than four (4) hours after completion.

### 3.5 REINFORCING STEEL PLACEMENT

Upon completion of drilling, the reinforcing steel cage shall be positioned in the pier shaft as shown on the Drawings and shall be suspended above the bottom of excavation before any concrete is placed in the shaft. In the event that difficulties are encountered in positioning the reinforcing steel cage, or if it cannot be freely rotated (prior to suspension) indicating caving of the excavation sides, the cage shall be removed and the hole reamed sufficiently to permit the final positioning of the cage without difficulty. The top of the cage shall be braced or supported to assure that it remains concentrically aligned in the shaft excavation during placement of concrete.

### 3.6 CONCRETE PLACEMENT

Concrete shall be deposited by use of an elephant trunk

or other approved device when the free fall is in excess of five feet (5'). Concrete shall be vibrated during placement operations so as to provide a dense, monolithic concrete section throughout the full length and diameter of the pier. During and after the vibrating operation, the top of the freshly placed concrete shall be observed to see that it remains constant and that there is no appreciable drop in elevation that would signify loss of concrete through hidden voids.

### 3.7 TESTING

If the Soil Engineer has reason to suspect that any pier may contain extraneous material or otherwise fail to meet specifications, he may order testing of the pier by coring or other methods. The Contractor shall bear the expense of the investigation and/or testing and shall also at no cost to the Owner, install proper additional construction as required by the Engineer.

### 3.8 CLEANUP

The Contractor at all times shall keep the area adjacent to pier drilling operations free of accumulations of excavated material and/or rubbish and trash caused by his employees or work. At the completion of work, he shall remove all excavated materials, trash, and rubbish from and about the area of the premises and all his tools, scaffolding, and surplus materials, and shall leave the site with a clean finished appearance.

### 3.9 CHANGES OR SUBSTITUTIONS

No changes in any material or equipment or method of installation, deviation from Drawings or Specifications, will be permitted without written approval of the Engineer or his representative.

APPENDIX A

# LOWRY & ASSOCIATES

## APPENDIX A

### GENERAL INFORMATION

A geotechnical investigation for the Whispering Pines Assessment District roadway improvements was authorized by Ken Baker of Nevada City Engineering, Inc., on February 4, 1986, by subscription to and execution of LOWRY & associates' proposal letter and contract for geotechnical services, dated January 31, 1986.

The locations of our test borings are referenced to documents entitled:

"IMPROVEMENT PLANS FOR IDAHO-MARYLAND ROAD, STA. 27+00 to 34+00; STA. 37+00 to 47+69.9 B.C." (scales: 1"=40' horiz., 1'+8' vert.; dated Jan-86);

"IMPROVEMENT PLANS FOR BRUNSWICK ROAD, STA. 60+00 to 83+50.04" (scales: 1"=40' horiz., 1"=8' vert.; dated Jan-86);

"IMPROVEMENT PLANS FOR WESTERN ACCESS ROAD, STA. 10+08.16 to 18+02.65" (scales: 1"=40; horiz., 1"=8' vert.; dated Jan-86);

"IMPROVEMENT PLANS FOR WHISPERING PINES ROAD, STA. 10+00 to 51+69.43" (scales: 1"=40' horiz., 1"=8" vert., dated Jan-86);

"IMPROVEMENT PLANS FOR CROWN POINT ROAD, STA. 0+00 to 45+40.09 & CRABTREE CT., STA. 0+00 to 4+50" (scales: 1"=40' horiz., 1"=8' vert., dated Jan-86).

Boring locations are to be considered approximate only. Boring elevations were determined by interpolation between nearest adjacent ground surface contours shown on the above-cited documents and are also to be considered approximate only.

Site conditions and cultural features described in the text of this report are those existing at the time of our field reconnaissance and exploration, February 5 through 11, 1986, and may not necessarily be representative of such conditions or features at other locations and times.

**LOWRY & ASSOCIATES**FIELD EXPLORATION

Field exploration included the drilling of 29 borings at the locations shown on the Boring Logs, Plates No. 1 through 14. The borings were advanced with 4-1/2-inch diameter continuous flight helical augers powered by a CME-55 truck-mounted drill rig. At various intervals, relatively undisturbed samples of soil and rock were recovered from the borings by means of a 2-1/2-inch O.D.-2-inch I.D. California-type sampler which was driven with a 140-pound hammer freely falling 30 inches. The number of blows of the hammer required to drive the 24-inch long sampler each 6-inch interval was recorded, with the sum of blows required to drive the sampler the middle foot (6-inch to 18-inch interval) of each drive denoted the penetration resistance or "blow count" for that particular drive.

The samples were retained in 2-inch diameter by 6-inch long, thin-walled brass tubes contained within the sampler. Immediately after recovery, the samples were visually classified and the ends of the brass tubes were sealed to preserve the natural moisture content. Selected samples of the anticipated pavement subgrade soils were obtained in a disturbed condition. All samples were taken to the laboratory for classification, with selected samples designated for testing.

The Boring Logs contain descriptions of the soils and rock encountered in each boring. The soils were classified in accordance with the Unified Soil Classification System. An explanation of that system and other symbols used on the logs appears on Plate No. 15. In addition, the boring logs show a graphical representation of the previously-defined penetration resistance or "blow count" obtained during sampling.

LABORATORY TESTING

Selected, undisturbed samples of the soils were tested to determine dry unit weight and natural moisture content (ASTM D2216). The results of these tests are posted on the boring logs at the depth from which each sample was obtained.

The internal strength characteristics of the undisturbed soils and weathered rock were evaluated by means of triaxial compression tests (ASTM D2850) conducted at lateral or confining air pressures of 10 and 30 psig. The results of these test series are illustrated on Plates No. A1 and A2.

## LOWRY & ASSOCIATES

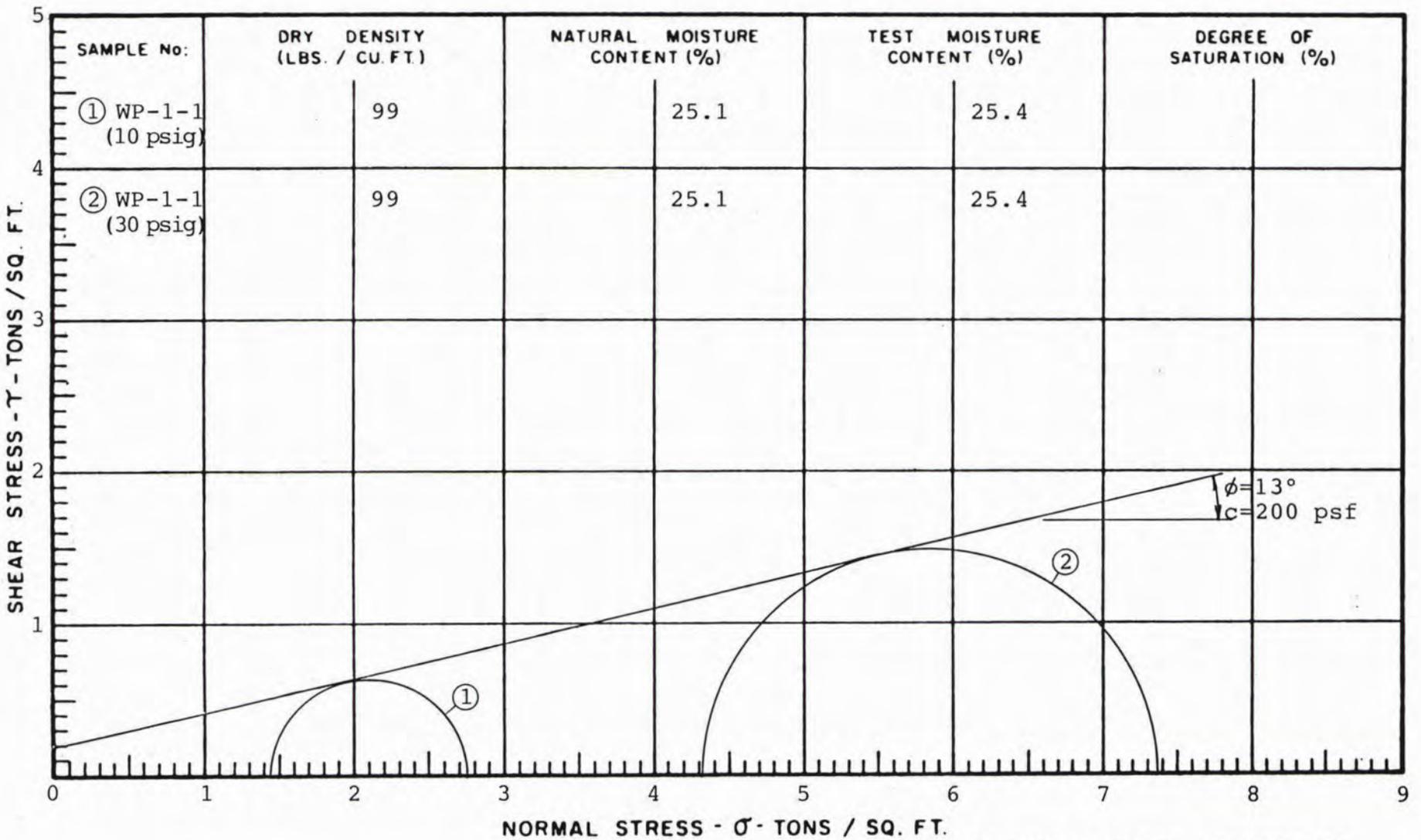
A selected sample of native soil was subjected to a compaction test (ASTM D1557-78) to determine the dry unit weight-moisture content interrelationships of the material. The results of this test are shown in the form of a curve on Plate No. A3.

A triaxial compression test series (ASTM D2850) was conducted on soil specimens remolded to 90 percent relative compaction, as determined by the laboratory compaction test. The results of these tests are depicted on Plate No. A4.

Resistance ("R") value tests (CTM 301G) were conducted on selected samples of the anticipated pavement subgrade soils and mine tailings. These test results, which were used in our pavement section analyses, are presented on Plates No. A5 through A15.

Selected bulk samples of the surface soils were subjected to pH and resistivity tests (CTM 532) to evaluate their corrosion potential. These test results, by our affiliate, Century Laboratories, Inc., are listed on Plate No. A16.

LOWRY & associates



**TEST DATA**

MATERIAL DESCRIPTION: Red-orange clayey silt (CL-ML)  
 SAMPLE CONDITION: Undisturbed, saturated  
 TYPE OF TEST: Slow, staged (strain rate = 0.007 in/min)

WHISPERING PINES ASSESSMENT  
 DISTRICT IMPROVEMENTS  
 Grass Valley, California

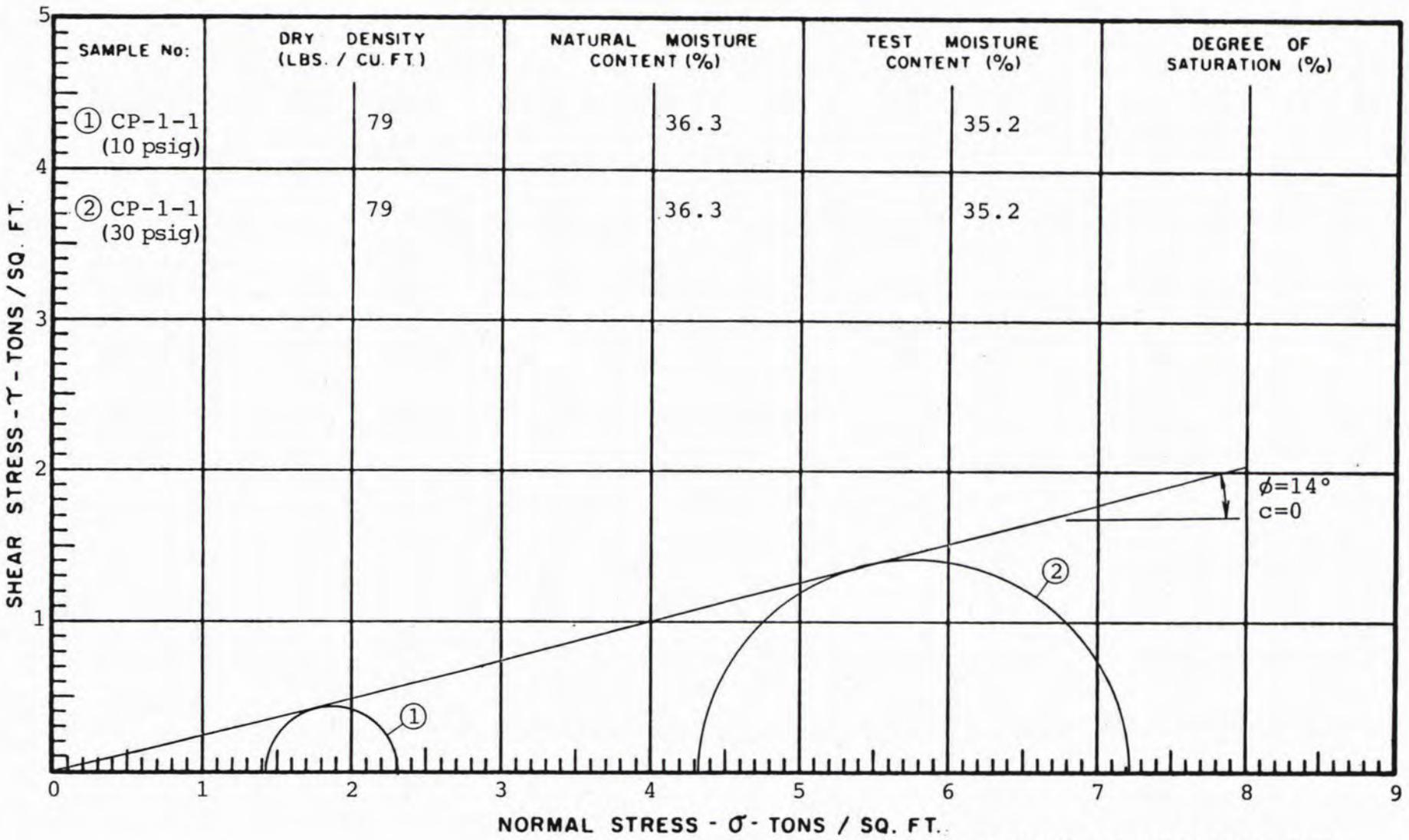
**TRIAxIAL COMPRESSION TEST**



**LOWRY & ASSOCIATES**  
**GEOTECHNICAL ENGINEERS**

DATE: 2/86

PROJECT NO. 86-73



**TEST DATA**

MATERIAL DESCRIPTION: Red-orange very clayey silt (MH)  
 SAMPLE CONDITION: Undisturbed, saturated  
 TYPE OF TEST: Slow, staged (strain rate = 0.007 in/min)

WHISPERING PINES ASSESSMENT  
 DISTRICT IMPROVEMENTS  
 Grass Valley, California

**TRIAxIAL COMPRESSION TEST**



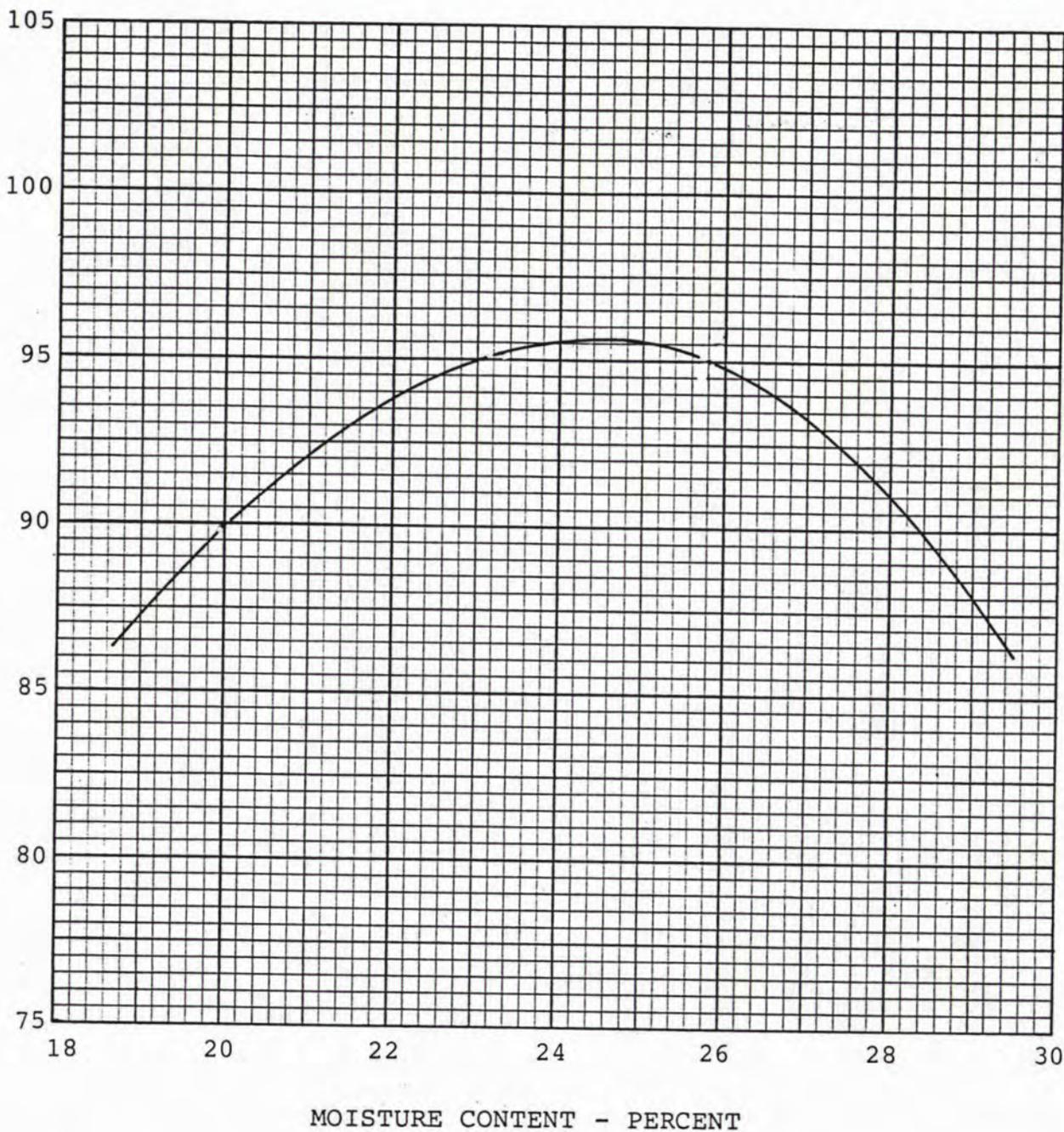
**LOWRY & ASSOCIATES**  
**GEOTECHNICAL ENGINEERS**

DATE: 2/86

PROJECT NO. 86-73

PLATE NO: A2

UNIT WEIGHT - LBS/CU. FT.



Test Data

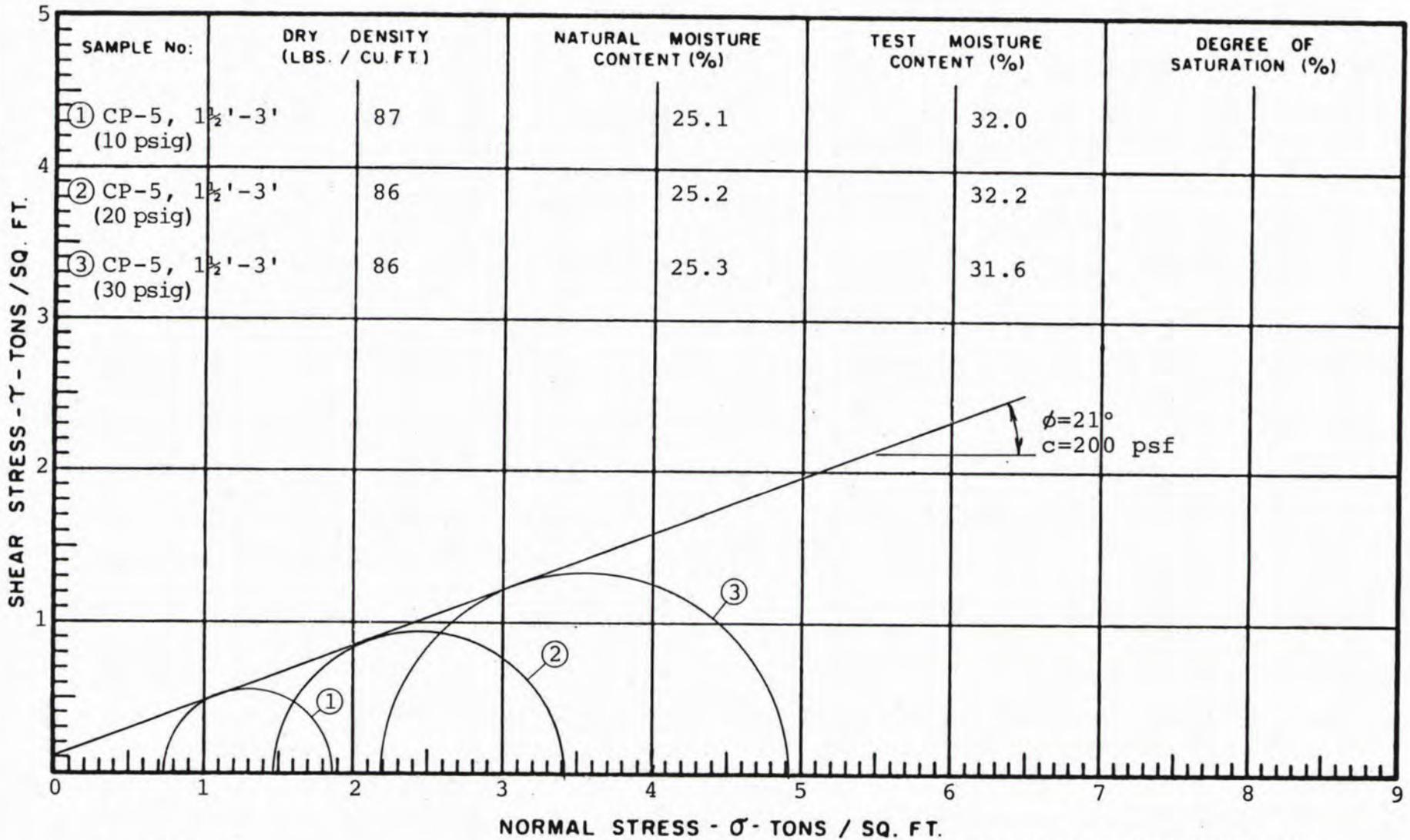
Material: Brick red clayey silt (MH)  
Type of Test: ASTM D1557-78 "A"  
Maximum Dry Density (Lbs/Cu Ft): 96  
Optimum Moisture Content (%): 24.6

**COMPACTION TEST**

WHISPERING PINES ASSESSMENT  
DISTRICT IMPROVEMENTS  
Grass Valley, California



PROJECT NO: 86-73  
DATE: 2/86  
PLATE NO: A3



**TEST DATA**

MATERIAL DESCRIPTION: Brick red clayey silt (MH)

SAMPLE CONDITION: Remolded\*, saturated

TYPE OF TEST: Slow, drained (strain rate = 0.007 in/min)

\* 90% relative compaction at optimum moisture content

WHISPERING PINES ASSESSMENT  
 DISTRICT IMPROVEMENTS  
 Grass Valley, California

**TRIAxIAL COMPRESSION TEST**



**LOWRY & ASSOCIATES**  
**GEOTECHNICAL ENGINEERS**

DATE: 2/86

PROJECT NO. 86-73

# LOWRY & ASSOCIATES

WHISPERING PINES ASSESSMENT  
 DISTRICT IMPROVEMENTS  
 Idaho-Maryland Road at Brunswick Road  
 Grass Valley, California  
 L & a No. 86-73

RESISTANCE VALUE TEST  
 (California Test Method No. 301-G)

Soil Description: Yellow-brown clayey silt  
 (weathered rock)

Boring No.: IM-1 (Idaho-Maryland Road)

Depth: 3' - 5-1/2'

Specimen No.	Dry Unit Weight (pcf)	Compaction Moisture (%)	Exudation Pressure (psi)	<u>Expansion Pressure</u> (dial reading) & (psf)		Resistance ("R") Value
1	100	23.6	152	15	65	34
2	101	22.0	256	85	368	58
3	102	20.3	520	128	554	64

"R" value at 300 psi exudation pressure = 59

<u>Design "T.I."</u>	<u>Least Equilibrium "R" Value</u>
9.5	43

**LOWRY & ASSOCIATES**

WHISPERING PINES ASSESSMENT  
 DISTRICT IMPROVEMENTS  
 Idaho-Maryland Road at Brunswick Road  
 Grass Valley, California  
 L & a No. 86-73

RESISTANCE VALUE TEST  
 (California Test Method No. 301-G)

Soil Description: Yellow-brown clayey  
 silt

Boring No.: CN-2 (Centennial Way)

Depth: 9' - 13-1/2'

<u>Specimen No.</u>	<u>Dry Unit Weight (pcf)</u>	<u>Compaction Moisture (%)</u>	<u>Exudation Pressure (psi)</u>	<u>Expansion Pressure (dial reading) &amp; (psf)</u>	<u>Resistance ("R") Value</u>
1	109	20.1	192	35 108	8
2	114	18.6	352	90 390	19
3	118	17.0	446	160 693	35

"R" value at 300 psi exudation pressure = 15

<u>Design "T.I."</u>	<u>Least Equilibrium "R" Value</u>
8.5	14

**LOWRY & ASSOCIATES**

WHISPERING PINES ASSESSMENT  
 DISTRICT IMPROVEMENTS  
 Idaho-Maryland Road at Brunswick Road  
 Grass Valley, California  
 L & a No. 86-73

RESISTANCE VALUE TEST  
 (California Test Method No. 301-G)

Soil Description: Light olive-gray silt

Boring No.: WP-1 (Whispering Pines Road)

Depth: 12' - 16-1/2'

<u>Specimen No.</u>	<u>Dry Unit Weight (pcf)</u>	<u>Compaction Moisture (%)</u>	<u>Exudation Pressure (psi)</u>	<u>Expansion Pressure (dial reading) &amp; (psf)</u>	<u>Resistance ("R") Value</u>
1	126	13.6	184	25 108	16
2	129	12.3	280	70 303	46
3	130	11.0	480	135 585	56

"R" value at 300 psi exudation pressure = 47

<u>Design "T.I."</u>	<u>Least Equilibrium "R" Value</u>
7.5	26

**LOWRY & ASSOCIATES**

WHISPERING PINES ASSESSMENT  
 DISTRICT IMPROVEMENTS  
 Idaho-Maryland Road at Brunswick Road  
 Grass Valley, California  
 L & a No. 86-73

RESISTANCE VALUE TEST  
 (California Test Method No. 301-G)

Soil Description: Yellow-brown fine to  
 coarse sandy silt

Boring No.: WP-3 ( Whispering Pines Road)

Depth: 1/2' - 3'

<u>Specimen No.</u>	<u>Dry Unit Weight (pcf)</u>	<u>Compaction Moisture (%)</u>	<u>Exudation Pressure (psi)</u>	<u>Expansion Pressure (dial reading) &amp; (psf)</u>	<u>Resistance ("R") Value</u>
1	120	13.8	176	0	20
2	122	2.5	280	15	40
3	122	10.8	576	26	71

"R" value at 300 psi exudation pressure = 43

<u>Design "T.I."</u>	<u>Least Equilibrium "R" Value</u>
7.5	43

# LOWRY & ASSOCIATES

WHISPERING PINES ASSESSMENT  
 DISTRICT IMPROVEMENTS  
 Idaho-Maryland Road at Brunswick Road  
 Grass Valley, California  
 L & a No. 86-73

RESISTANCE VALUE TEST  
 (California Test Method No. 301-G)

Soil Description: Red-brown to olive  
 clayey silt

Boring No.: WP-6 (Whispering Pines Road)

Depth: 2' - 3-1/2'

Specimen No.	Dry Unit Weight (pcf)	Compaction Moisture (%)	Exudation Pressure (psi)	Expansion Pressure (dial reading) & (psf)	Resistance ("R") Value
1	87	250	176	80      346	5
2	102	22.5	352	88      381	11
3	106	20.0	624	130      563	15

"R" value at 300 psi exudation pressure = 10

<u>Design "T.I."</u>	<u>Least Equilibrium "R" Value</u>
6.0	5

# LOWRY & ASSOCIATES

WHISPERING PINES ASSESSMENT  
 DISTRICT IMPROVEMENTS  
 Idaho-Maryland Road at Brunswick Road  
 Grass Valley, California  
 L & a No. 86-73

RESISTANCE VALUE TEST  
 (California Test Method No. 301-G)

Soil Description: Red-brown clayey fine  
 to coarse sandy silt

Boring No.: WP-8 (Whispering Pines Road)

Depth: 1-1/2' - 3'

Specimen No.	Dry Unit Weight (pcf)	Compaction Moisture (%)	Exudation Pressure (psi)	Expansion Pressure (dial reading) & (psf)	Resistance ("R") Value
1	105	20.4	192	22      95	10
2	110	18.3	344	35      152	14
3	111	17.3	640	48      207	21

"R" value at 300 psi exudation pressure = 12

Design "T.I."	Least Equilibrium "R" Value
6.0	12

**LOWRY & ASSOCIATES**

WHISPERING PINES ASSESSMENT  
 DISTRICT IMPROVEMENTS  
 Idaho-Maryland Road at Brunswick Road  
 Grass Valley, California  
 L & a No. 86-73

RESISTANCE VALUE TEST  
 (California Test Method No. 301-G)

Soil Description: Red-orange silty clay

Boring No.: CC-1 (Cambridge Court)

Depth: 1-1/2' - 3'

<u>Specimen No.</u>	<u>Dry Unit Weight (pcf)</u>	<u>Compaction Moisture (%)</u>	<u>Exudation Pressure (psi)</u>	<u>Expansion Pressure</u>		<u>Resistance ("R") Value</u>
				<u>(dial reading)</u>	<u>&amp; (psf)</u>	
1	95.5	29.8	240	180	780	21
2	97	27.0	480	200	1126	24

"R" value at 300 psi exudation pressure < 5

<u>Design "T.I."</u>	<u>Least Equilibrium "R" Value</u>
5.0	5

**LOWRY & ASSOCIATES**

WHISPERING PINES ASSESSMENT  
 DISTRICT IMPROVEMENTS  
 Idaho-Maryland Road at Brunswick Road  
 Grass Valley, California  
 L & a No. 86-73

RESISTANCE VALUE TEST  
 (California Test Method No. 301-G)

Soil Description: Red very clayey silt

Boring No.: CP-3 (Crown Point Drive)

Depth: 1-1/2' - 3'

<u>Specimen No.</u>	<u>Dry Unit Weight (pcf)</u>	<u>Compaction Moisture (%)</u>	<u>Exudation Pressure (psi)</u>	<u>Expansion Pressure (dial reading) &amp; (psf)</u>	<u>Resistance ("R") Value</u>
1	86	32.1	176	25 108	12
2	88	31.0	272	30 130	18
3	89	29.9	512	38 165	26

"R" value at 300 psi exudation pressure = 19

<u>Design "T.I."</u>	<u>Least Equilibrium "R" Value</u>
5.5	19

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WHISPERING PINES ASSESSMENT  
 DISTRICT IMPROVEMENTS  
 Idaho-Maryland Road at Brunswick Road  
 Grass Valley, California  
 L & a No. 86-73

RESISTANCE VALUE TEST  
 (California Test Method No. 301-G)

Soil Description: Red very clayey  
 silt

Boring No.: CP-6 (Crown Point Drive)

Depth: 0 - 3'

<u>Specimen No.</u>	<u>Dry Unit Weight (pcf)</u>	<u>Compaction Moisture (%)</u>	<u>Exudation Pressure (psi)</u>	<u>Expansion Pressure (dial reading) &amp; (psf)</u>	<u>Resistance ("R") Value</u>
1	85	34.4	168	0      0	6
2	88	32.1	296	0      0	10
3	91	29.7	400	0      0	15

"R" value at 300 psi exudation pressure = 10

<u>Design "T.I."</u>	<u>Least Equilibrium "R" Value</u>
5.5	10

# LOWRY & ASSOCIATES

WHISPERING PINES ASSESSMENT  
 DISTRICT IMPROVEMENTS  
 Idaho-Maryland Road at Brunswick Road  
 Grass Valley, California  
 L & a No. 86-73

RESISTANCE VALUE TEST  
 (California Test Method No. 301-G)

Soil Description: Yellow-brown clayey  
 silt - pulverized rock

Boring No.: BR-2 (Brunswick Road)

Depth: 8' - 28'

Specimen No.	Dry Unit Weight (pcf)	Compaction Moisture (%)	Exudation Pressure (psi)	Expansion Pressure (dial reading) & (psf)	Resistance ("R") Value
1	97	26.6	128	25      108	6
2	102	24.4	248	75      215	10
3	105	22.3	360	165      714	29

"R" value at 300 psi exudation pressure = 17

<u>Design "T.I."</u>	<u>Least Equilibrium "R" Value</u>
9.0	11

# LOWRY & ASSOCIATES

WHISPERING PINES ASSESSMENT  
 DISTRICT IMPROVEMENTS  
 Idaho-Maryland Road at Brunswick Road  
 Grass Valley, California  
 L & a No. 86-73

RESISTANCE VALUE TEST (REPROPORTIONED)  
 (California Test Method No. 301-G)

Soil Description: Gray-green silty fine to  
 coarse sandy rock to 8" -  
 Mine tailings

Boring No.: WP-4 and WP-6  
 (Whispering Pines Road)

Depth: 0 - 24"

Specimen No.	Dry Unit Weight (pcf)	Compaction Moisture (%)	Exudation Pressure (psi)	Expansion Pressure (dial reading) & (psf)	Resistance ("R") Value
1	133	8.8	176	2            9	70
2	136	7.6	328	6            21	74
3	143	6.3	464	14           61	76

"R" value at 300 psi exudation pressure = 73

Design "T.I."	Least Equilibrium "R" Value
≥ 5.0	73



# CENTURY LABORATORIES, INC.

CHEMISTRY • GEOCHEMISTRY • METALLURGY • MINERALOGY

2340 GOLD RIVER ROAD, SUITE H  
RANCHO CORDOVA, CALIFORNIA 95670  
Phone (916) 635-1849

Date: 24th February 1986  
Lab No: T- 1828

Lowry Associates  
P.O. Box 13340  
Sacramento, CA 95813

Your Ref: 86-73; Req # 1900  
Date Rec'd: 2/16/86  
Subject: 2 samples soil for resistivity and pH

	<u>Resistivity</u> (ohm-cm)	<u>p H</u>
24"-42" WP-4	38,461	6.35
CP 7 0-18"	5,556	7.84

Respectfully submitted,

*Nick A. HammaDES*

NICK A. HAMMADES, Director  
NAH/kle

Our reports & letters apply only to sample(s) tested and are not necessarily indicative of other apparently similar materials. Samples not used up in testing & analysis are retained for a maximum of 30 days unless specifically requested by customer otherwise,

APPENDIX B



# LOWRY & ASSOCIATES

GUIDE EARTHWORK SPECIFICATIONS  
WHISPERING PINES ASSESSMENT DISTRICT  
IMPROVEMENTS  
Idaho-Maryland Road at Brunswick Road  
Grass Valley, California  
L & a No. 86-73

## SECTION 2A - EARTHWORK

### PART 1: GENERAL

#### 1.1 SCOPE

##### a. General Description

This item shall include all clearing and grubbing, preparation of land to be filled, filling, spreading, compaction, observation and testing of the fill, and all subsidiary work necessary to complete the grading of the pavement areas to conform with the lines, grades and slopes as shown on the accepted Drawings.

##### b. Related Work Specified Elsewhere

- (1) Trenching and backfilling for sanitary sewer system: Section \_\_\_\_\_.
- (2) Trenching and backfilling for storm sewer system: Section \_\_\_\_\_.
- (3) Trenching and backfilling for underground water, telephone, natural gas, and electrical supplies: Section \_\_\_\_\_.

#### 1.2 PROTECTION

- a. Adequate protection measures shall be provided to protect workmen and passers-by the site. Streets and adjacent property shall be fully protected throughout the operations.
- b. In accordance with generally accepted construction practices, the Contractor shall be solely and completely responsible for working conditions at the

## LOWRY & ASSOCIATES

job site, including safety of all persons and property during performance of the work. This requirement shall apply continuously and not be limited to normal working hours.

- c. Any construction review of the Contractor's performance conducted by the Soil Engineer is not intended to include review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.
- d. Adjacent streets and sidewalks shall be kept free of mud, dirt or similar nuisances resulting from earthwork operations.
- e. Provide for surface drainage during the period of construction in a manner to avoid creating a nuisance to adjacent areas.
- f. Water as required to suppress dust nuisance.
- g. Carefully protect existing trees and shrubs which are to remain.

### 1.3 GEOTECHNICAL REPORT

- a. A Geotechnical Report (L & a No. 86-73; dated February 27, 1986) has been prepared for this site by LOWRY & associates, Sacramento, California [(916) 929-9012]. A copy is available for review at the Architect's office or at LOWRY & associates' office.
- b. The information contained in this report was obtained for design purposes only. The Contractor is responsible for any conclusions he may draw from this report; should he prefer not to assume such risk, he is under obligation to employ his own experts to analyze available information and/or to make additional borings upon which to base his conclusions, all at no cost to the Owner.

### 1.4 EXISTING SITE CONDITIONS

The Contractor shall acquaint himself with all site conditions. If unshown active utilities are encountered during the work, the Architect shall be promptly notified for instructions. Failure to notify will make the Contractor liable for damage to these utilities arising from Contractor's operations subsequent to his discovery of such unshown utilities.

**LOWRY & ASSOCIATES****1.5 SEASONAL LIMITS**

Fill material shall not be placed, spread or rolled during unfavorable weather conditions. When the work is interrupted by heavy rains or snowfall, fill operations shall not be resumed until field tests indicate that the moisture contents of the subgrade and fill materials are satisfactory.

**PART 2: PRODUCTS****2.1 MATERIALS**

- a. All fill shall be of approved local materials from required excavations. Approved local materials are defined as local soils and mine tailings free of rubble, rubbish, and vegetation. Soils to be placed within two feet (2') of final pavement subgrade level shall be free of rock fragments over four inches (4") in maximum size and below this level, over six inches (6") in maximum size. Local mine tailings shall be free of trash, vegetation and rock fragments over six inches (6") in maximum size. All materials for use as engineered fill shall be tested and approved by the Soil Engineer prior to use. Clods, rocks or hard lumps exceeding six inches (6") in final size shall not be allowed in the upper two feet (2') of any fill supporting pavements. Mine tailings to be used as roadway base course materials shall be graded such that not more than twenty-five percent (25%) of fine particles will pass a Number two-hundred (#200) mesh sieve. No ricks exceeding six feet (6') in maximum size shall be used in constructing embankments. Frozen soils shall not be used in any part of the earthwork.
- b. Structural backfill materials shall consist of approved nonexpansive materials having a plasticity index not exceeding twelve (12), an expansion index not exceeding twenty (20), and a two-inch (2") maximum particle size.

**LOWRY & ASSOCIATES****PART 3: EXECUTION****3.1 LAYOUT AND PREPARATION**

Lay out all work, establish grades, locate existing underground utilities, set markers and stakes, set up and maintain barricades and protection of utilities; all prior to beginning actual earthwork operations.

**3.2 CLEARING, GRUBBING AND PREPARING THE PAVEMENT AREAS**

- a. All vegetation; rubble; rubbish; rock fragments exceeding six inches (6") in final size; loose existing fills and other loose and/or saturated materials; down timber; slash; brush; stumps and root systems of removed trees within two feet (2') of original or final grade (whichever is lower); and all existing structures shall be removed and disposed of so as to leave the areas that have been disturbed with a neat and finished appearance, free from unsightly debris. If they extend below planned finished grade, excavations and depressions resulting from the removal of such items, as well as any existing prospects or loose soil deposits as determined by the Soil Engineer or his representative, shall be cleaned out to firm, undisturbed soil or rock (whichever is higher) and backfilled with suitable materials in accordance with these specifications.
- b. Mine shafts, if encountered during the course of grading, shall be inspected by the Engineering Geologist, who shall issue special recommendations for corrective treatment before any further grading is undertaken in the area of discovery.
- c. Soil surfaces upon which fill is to be placed, as well as subgrades of the building pad and pavement areas left at existing grade, shall be plowed or scarified to a depth of six inches (6") or to the underlying bedrock surface (whichever is higher), until the surface is free of ruts, hummocks or other uneven features which would tend to prevent uniform compaction by the equipment to be used.
- d. After the foundation for the fill has been cleared, plowed, or scarified, it shall be disced or bladed until uniform and free of large clods. The

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foundation for fill shall then be brought to the proper moisture content, as specified below.

- e. When the moisture content of the subgrade is below the optimum moisture content, water shall be added until the proper moisture content is achieved.
- f. When the moisture content of the subgrade is too high to permit the specified degree of compaction to be achieved, the subgrade shall be aerated by blading or other methods until the moisture content is satisfactory for compaction, but not less than the optimum moisture content.
- g. The foundation for fill to within two feet (2') of finished pavement subgrade level shall be compacted while at the proper moisture content to at least ninety percent (90%) of maximum dry density as determined by ASTM Specification D1557-78.
- h. The foundation for fill within two feet (2') of finished pavement subgrade level shall be compacted while at the proper moisture content to at least ninety-five percent (95%) of maximum dry density as determined by ASTM Specification D1557-78.

**3.3 PLACING, SPREADING AND COMPACTING FILL MATERIAL**

- a. Soil fill material shall be placed in layers which when compacted shall not exceed six inches (6") in thickness. Each layer shall be spread evenly and shall be thoroughly mixed during the spreading to promote uniformity of material in each layer.
- b. Mine tailings fill material shall be placed in layers which when compacted shall not exceed twelve inches (12") in thickness. Each layer shall be spread evenly and shall be thoroughly mixed during the spreading to promote uniformity of material in each layer.
- c. When the moisture content of the fill material is below the optimum moisture content, water shall be added until the proper moisture content is achieved.
- d. When the moisture content of the fill material is too high to permit the specified degree of

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compaction to be achieved, the fill material shall be aerated by blading or other methods until the moisture content is satisfactory for compaction, but not less than the optimum moisture content.

- e. After each layer to within two feet (2') of finished pavement subgrade level has been placed, mixed and spread evenly, it shall be thoroughly compacted to not less than ninety percent (90%) of maximum dry density as determined by ASTM Specification D1557-78. Compaction shall be undertaken with equipment capable of achieving the specified density and shall be accomplished while the fill material is at the required moisture content. Each layer shall be compacted over its entire area until the desired density has been obtained.
- f. After each layer within two feet (2') of finished pavement subgrade level has been placed, mixed and spread evenly, it shall be thoroughly compacted to not less than ninety-five percent (95%) of maximum dry density as determined by ASTM Specification D1557-78. Compaction shall be undertaken with equipment capable of achieving the specified density and shall be accomplished while the fill material is at the required moisture content. Each layer shall be compacted over its entire area until the desired density has been obtained.
- g. The filling operation shall be continued until the fill has been brought to the finished slopes and grades as shown on the accepted Drawings.

**3.4 BENCHING AND KEYING**

- a. Where the slope of the natural ground exceeds an inclination of six horizontal to one vertical (6:1), benches shall be cut into the hillside as the filling operations proceed. Each bench shall be a level terrace at least eight feet (8') wide, and the rise to the next bench shall not exceed four feet (4').
- b. Where the slope of the natural ground exceeds an inclination of four horizontal to one vertical (4:1), a keyway shall be provided in addition to

the benches. The keyway shall consist of a level trench at least four feet (4') wide and at least three feet (3') deep, cut into the original ground at the toeline of the embankment. Keyway sideslopes shall not exceed one horizontal to one vertical (1:1).

3.5 PLACING, SPREADING AND COMPACTING STRUCTURAL BACKFILL MATERIAL

- a. The selected backfill material shall be placed in layers which when compacted shall not exceed twelve inches (12") in thickness. Each layer shall be spread evenly and shall be thoroughly mixed during the spreading to promote uniformity of material in each layer.
- b. When the moisture content of the fill material is less than the optimum moisture content, water shall be added until the proper moisture content is achieved.
- c. When the moisture content of the fill material is too high to permit the specified degree of compaction to be achieved, the fill material shall be aerated by blading or other methods until the moisture content is satisfactory for compaction, but not less than the optimum moisture content.
- d. After each layer has been placed, mixed and spread evenly, it shall be thoroughly compacted to not less than ninety percent (90%) of maximum dry density as determined by ASTM Specification D1557-78, except that beneath pavement areas, the uppermost two feet (2') shall be compacted to not less than ninety-five percent (95%). Compaction shall be undertaken with equipment capable of achieving the specified density and shall be accomplished while the fill material is at the required moisture content. Each layer shall be compacted over its entire area until the desired density has been obtained.
- e. The filling operation shall be continued until the fill has been brought to the finished slopes and grades as shown on the accepted Drawings.

### 3.6 FINAL SUBGRADE PREPARATION

The upper six inches (6") of all final pavement subgrades shall be brought to at least the optimum moisture content and shall be compacted to not less than ninety-five percent (95%) of ASTM Specification D1557-78 maximum dry density, regardless of whether final subgrade elevation is attained by filling or excavation, or is left at existing grade.

### 3.7 TESTING AND OBSERVATION

- a. All grading operations shall be tested and observed by the Soil Engineer, who is serving as the representative of the Owner.
- b. Field density tests shall be made by the Soil Engineer or his representative after compaction of each layer of fill. Where compaction equipment has disturbed the surface to a depth of several inches, density tests shall be taken in the compacted material below the disturbed surface. Additional layers of the fill shall not be spread until the field density tests indicate that the specified density has been obtained.
- c. Earthwork shall not be performed without the physical presence or approval of the Soil Engineer. The Contractor shall notify the Soil Engineer at least two (2) working days prior to commencement of any aspect of the site earthwork.
- d. If the Contractor should fail to meet the technical or design requirements embodied in this document and on the applicable plans, he shall make the necessary readjustments until all work is deemed satisfactory as determined by the Soil Engineer and the Architect/Engineer. No deviation from the specifications shall be made except upon written approval of the Soil Engineer or Architect/Engineer.

Prepared  
February 27, 1986

GEOTECHNICAL REPORT  
WHISPERING PINES ASSESSMENT  
DISTRICT IMPROVEMENTS  
Grass Valley, California  
L & a No. 86-73

# LOWRY & ASSOCIATES

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GEOTECHNICAL REPORT  
WHISPERING PINES ASSESSMENT DISTRICT  
IMPROVEMENTS  
Idaho-Maryland Road at Brunswick Road  
Grass Valley, California  
L & a No. 86-73  
February 27, 1986

INTRODUCTIONPurpose

A geotechnical study has been completed for the roadway improvements to Whispering Pines Assessment District in Grass Valley. The purposes of this investigation have been to gather information on the nature, distribution and characteristics of the earth materials and pavement subgrade conditions along the proposed roadway alignments, and to prepare specific geotechnical recommendations for use in design and construction.

Scope

The scope of this study has included a reconnaissance of the project by a member of our engineering staff; the completion of 29 test borings at selected points within the proposed new roadway alignments as well as roadways scheduled for renovation; laboratory testing conducted on selected samples of the earth materials recovered from the borings; geologic interpretation and engineering analyses; and the preparation of this report.

This report includes our findings regarding site, soil, geologic and ground water conditions; conclusions pertaining to pavement subgrade quality, soil corrosivity, slope stability, potential borrow materials, excavation characteristics, and support capability for a new box culvert on one of the roadway alignments; and recommendations for roadway grading, erosion control, subdrains, pavements and box culvert as well as storm drain design.

The locations and logs of the borings are displayed on plan/profile sheets, Plates No. 1 through 14. An explanation of the soil symbols and classification system used on the logs appears on Plate No. 15. Appendix A contains information of a general nature regarding project concepts and details

pertaining to the field exploration and laboratory testing phases of our investigation. Appendix B contains suggested earthwork specifications, which may be used as a guide to the composition of contract documents.

Reference is made to our previous engineering geologic reports, both entitled: "Whispering Pines Park" (L & a No. 81-246, dated June 18, 1981; and L & a No. 83-118, dated April 21, 1983). Geologic information contained in those reports has been reviewed and incorporated by this investigation.

#### Nature of Project

As presently proposed, the improvements to the assessment district will include some 9000 lineal feet of new roadway as well as a widening and grade adjustment of existing Idaho-Maryland Road and Brunswick Road. The approximate lengths of the new roadways are as follow: Whispering Pines Road, 4169 feet; Crown Point Circle, 4540 feet; Centennial Way, 807 feet; Cambridge Court, 210 feet; and Crabtree Court, 430 feet. All of the new roadways will be constructed with a shoulder-to-shoulder width of 40 feet and a corridor width of 60 feet.

Idaho-Maryland Road will be improved between approximate Stations 28 and 33. The existing roadway is only about 24 feet wide, but it will be broadened to about 30 feet in width and the grade lowered slightly. A new box culvert is to be constructed on Centennial Way, over Wolf Creek.

Brunswick Road presently is up to 48 feet wide, shoulder-to-shoulder, but will be broadened to almost 60 feet wide between approximate Stations 63 and 81, in order to accommodate left-turn lanes at the intersection of Idaho-Maryland Road and Whispering Pines Road, as well as a right-hand acceleration lane at the intersection of Brunswick Road and Whispering Pines Road. A possible source of borrow material for the lane widenings is the cut required to expand the roadway width right of Stations 66 to 73.

We understand that the following traffic indices ("T.I."s) are to be assigned to each roadway: Idaho-Maryland Road, "T.I." = 9.5; Brunswick Road, "T.I." = 9.0; Centennial Way, "T.I." = 8.5; Whispering Pines Road, "T.I." = 7.5 west and "T.I." = 6.0 east of Crown Point Circle; Crown Point Circle,

"T.I." = 5.5; Cambridge Court and Crabtree Court, "T.I." = 5.0.

Subsidiary improvements will include storm drains, which may be of CMP design. Earthwork is expected to balance, and no fill is to be imported.

### FINDINGS

#### Description of Project Area

##### Boundaries

Whispering Pines Assessment District encompasses approximately 154 acres, bounded on the north by Idaho-Maryland Road and on the east by Brunswick Road. High-tension electrical transmission lines borne on steel towers extend along one of the westerly property limits. To the south, there are private residences and undeveloped wooded hill slopes.

##### Northeast Area

The northeast sector of the assessment district comprises about 37 acres encompassed by Whispering Pines Road, Brunswick Road, Idaho-Maryland Road and the electrical transmission lines. This area generally slopes from a high point, near elevation +2710 feet (U.S.G.S. datum) at Whispering Pines Road, to about elevation +2555 feet at Idaho-Maryland Road. Existing Whispering Pines Road is a narrow drive surfaced with a nominal thickness of asphalt concrete. It serves existing development, including two homes, a barn and a church to the north.

##### Southeast Area

The southeast sector of the property encompasses approximately 91 acres of heavily-wooded, moderately rugged terrain situated on the southwest corner of Whispering Pines Road and Brunswick Road. Crown Point Drive and Crabtree Court are to be constructed in this part of the improvement district. Vegetation presently consists of ponderosa pine, toyon, manzanita, cascara and scattered buckeye with a low volunteer rye grass cover in open areas. This part of the project is criss-crossed with numerous old bulldozer trails,

probably blazed for firefighting purposes in the past. Many of these trails are inaccessible except on foot, having been overgrown with brush and obstructed by fallen trees. Rough grading for Crown Point Drive affords the principal access to the center of the sector. Ground surface generally slopes from about elevation +2850 feet at the summit of a knoll near the extreme southerly property corner to approximate elevation +2640 feet at the far northwesterly corner, but there are several large depressions, at least one of which lies within a proposed roadway right-of-way.

Natural hill slopes stand as steep as 3 horizontal to 1 vertical, but are flatter at most locations. All of the trees and brush appear to be standing upright, suggesting that little if any soil creep has taken place; however, there are signs of ground deterioration due to erosion on both the old bulldozer trails and rough-graded alignment for Crown Point Drive. An old pipeline consisting of an 18-inch diameter or 18-inch square cast iron riveted conduit joined by bolted compression rings is exposed at three points not far from Whispering Pines Road. This pipeline apparently conducts water from a source east of Brunswick Road to a reservoir west of the assessment district. From the age of the pipeline, it is probable that it once serviced off-site mine workings. Several old prospects were discovered in the southeast part of the project; the most conspicuous is a 6-foot diameter, cylindrical hand-dug shaft about 15 feet deep. In addition, a few trenches were noted over the easterly half of this area; the purpose of these excavations is unknown to us.

#### Northwest Area

The northwest sector encompasses about 26 acres west of the power transmission lines and is presently owned by Robinson Timber Company. The extension of Whispering Pines Road and all of Centennial Way are to be constructed on this part of the project. Vegetation consists of mixed ponderosa pine and deodar cedar with an understory of toyon and manzanita. Ground surface slopes from about elevation +2780 feet at the power lines to a nearly-level area at about elevation +2520 feet, near the northwesterly property corner. The surface has been disturbed by previous mining and logging activities. An extensive area of mine tailings forms a lobe stretching nearly 1000 feet along the north property line.

## LOWRY & ASSOCIATES

Numerous roads traverse the sector and the lower portions have been levelled apparently for log storage and parking areas. Several structures exist near the northwest property corner. Concrete foundation remnants also were observed in this area and probably are associated with a stamp mill and hoisting works for the immediately-adjointing (now defunct) Idaho-Maryland Mine. Just west of the power transmission lines, three large terraces have been graded into the slope by means of cuts and fills up to 20 feet deep. We have it on report that these terraces were built around 1980, with the intention of constructing shops and parking areas on the completed pads. We understand that a Caterpillar D8L bulldozer was used for ripping and that the removed materials were pushed downslope to form the fill embankments without any attempt at benching, keying or other standard fill construction procedures. The commercial project was later abandoned.

Idaho-Maryland Ditch originates at a small reservoir impounded by a tailings dam just south of the extreme westerly part of the project and conducts seasonal flow eastward along the approximate elevation +2645-foot contour. In addition, Wolf Creek, the principal natural drainageway that flows through Grass Valley, is constricted to a narrow channel about 10 to 12 feet deep along the south shoulder of Idaho-Maryland Road and is spanned by a wood bridge leading to a gravelled drive that wraps around the Robinson Timber Company facilities to form a connection with the existing end of pavement at Whispering Pines Road.

### Earth Materials

#### Fills

Test borings for Whispering Pines Road and the upper reaches of Centennial Way revealed surface deposits consisting of silty or fine to coarse sandy rock fragments (GM) recognized as mine tailings. Within the existing right-of-way for Whispering Pines Road, these tailings function as road base and may initially have been lain down to stabilize the subgrade soils. The borings revealed that the blanket of mine tailings varies in thickness from as much as 4-1/2 feet within the Robinson Timber Company property, to an average of 2 feet along the Whispering Pines Road alignment.

### Soils

Native soils penetrated below the veneer of fill, or from ground surface elsewhere, are colluvial silts, the color, texture and composition of which are governed by the character of the underlying bedrock from which they have been derived.

In general, the borings on Idaho-Maryland Road, the Centennial Way alignment, the west reach of Whispering Pines Road, and the stretch of Brunswick Road to be improved revealed brown to red-brown, fine to coarse sandy silts (ML), while the remaining borings encountered red-orange to yellow-orange, clayey to very clayey silts (MH). Typically, the darker (ML) silts display higher in-place unit weights and lower moisture contents than the lighter-colored (MH) soils. In many of the borings, the amount of incorporated rock fragments appears to increase with depth through the natural soil sequence.

### Rock

Most of the borings penetrated rock below the veneer of colluvial soil and/or fill. On the west side of the project along Centennial Way and Idaho-Maryland Road -- the rock is identified as serpentinite, an ultrabasic formation created during the Middle Cretaceous period (Albian to Cenomanian epochs) of geologic time, or about 95-120 million years ago. Borings drilled along and in the vicinity of Brunswick Road encountered diorite, also of Middle Cretaceous age. On the other hand, bedrock revealed by the remaining borings consist primarily of amphibolite schist, identified as a part of the Copper Hill Volcanics group of Early Cretaceous (Berriasian) age, or about 134-136 million years old.

The results of our earlier engineering geologic investigations indicate that there also exist, at isolated locations, minor lenses and outliers of metasiltstone, quartzite, conglomerate and phyllite of the Calaveras Group, deposited during the Permian period, or about 225-280 million years ago.

Ground Water

Test Borings

Each test boring was checked for ground water following completion of drilling. Free water was intercepted in Boring No. CN-1 only, near the interface of the gravelly stream alluvium and underlying bedrock adjacent to Wolf Creek. It is likely that the observed ground water level reflects the creek stage.

Artificial Springs

Seepage emerging from the existing ground surface was observed at many locations along the proposed western extension of Whispering Pines Road and the upper reaches of Centennial Way. This water appears to be due primarily to leakage from the cast iron water line and/or underseepage from the tailings dam previously described. Similar seepage conditions could be expected at other locations where perforated segments of pipeline cross the proposed roadways, notably Crown Point Drive.

Natural Springs

Our earlier investigation also revealed areas of natural springs which may be either perennial or ephemeral, especially at or near the geologic contact where dissimilarities in rock joining patterns and/or local shear zones pervade the rock fabric, or where topographic lows coincide with the strike of major bedding planes or fractures.

CONCLUSIONS

Slope Stability

Existing Slopes

Natural hill slopes appear to be stable in most areas. Existing fill slopes, spoil piles, ground overlain by mine tailings and soils disturbed by previous bulldozing operations may be unstable where existing inclinations exceed a configuration of 2 horizontal to 1 vertical; however, this condition is expected to be alleviated during the ordinary course of grading.

The existing cut slopes along Idaho-Maryland Road and Brunswick Road appear to be stable, even as steep as 1.8 horizontal to 1 vertical.

#### Proposed Slopes

Triaxial compression test series conducted on undisturbed samples of soil and weathered rock show angles of internal friction on the order of 13° or 14°, with nominal cohesion values of 200 pounds per square foot or less. These values are considered quite low, but will allow stable slope inclinations as steep as those permitted by ordinary building code provisions. Remolded triaxial tests indicate similar internal strength parameters. Embankment slopes constructed of native soils also can be expected to remain adequately stable, if they are constructed in accordance with the recommendations of this report. The results of the triaxial compression test series are depicted on Plates No. A1, A2 and A4, in Appendix A.

Minimum factors of safety associated with artificial slopes may be assumed at 2.0 under static conditions and 1.5 under combined static and earthquake loading conditions. These factors of safety are predicated upon cut and fill slopes as high as 15 feet in soil. For earthquake loading conditions, a peak horizontal acceleration of 0.25 g has been used in the design analyses. The stability computations are predicated upon the assumption that all slopes will be satisfactorily protected from erosion.

#### Borrow Areas

##### Materials Suitability

Borings completed for the Brunswick Road cut and for the shoulder widening along Idaho-Maryland Road revealed that the earth materials will consist of both rock and soil, a mixture of which would be acceptable for use in engineered fill construction, provided that the materials are processed to remove rubble, rubbish, vegetation and other undesirable substances, including oversized rock fragments. Most of the excavated rock appears to be amenable to crushing in order to produce fragments of acceptable size. Extensive areas of mine tailings, including existing embankments, are considered excellent sources for roadbase to improve subgrade conditions along the proposed roadway routes, provided that these materials are similarly processed.

Native soils, free of roots and trash, are considered suitable for use in constructing at least the lowermost lifts of engineered fill embankments. A laboratory compaction test conducted on a selected sample of on-site soils is presented on Plate No. A3.

#### Grading Factor

We have calculated an approximate shrinkage factor for the soil types expected to be encountered during grading. This analysis is based upon a comparison of laboratory in-place unit weight and compaction data, and thus must be considered theoretical. In addition, the analysis does not (and cannot) account for materials losses due to subsidence over haulageways, overcompaction, attrition during transportation, or proration for unsuitable materials.

The computed shrinkage factor for all of the soils is 18 percent. Hence, 1.00 cubic yard of excavated soil can be expected to produce approximately 0.82 cubic yard of properly-compacted engineered fill.

#### Subgrade Quality

Resistance ("R") value tests were conducted on 11 individual samples of fill, soil and rock expected to be encountered at proposed pavement subgrade level; the results are tabulated on Plates No. A5-A15. One such test -- re-proportioned to account for coarse rock sizes -- was conducted on a sample of the mine tailings that exist over most of the present alignment of Whispering Pines Road, and on higher terrain over the Robinson Timber Company property. The results of this test showed "R" = 73 at 300 psi exudation pressure, indicating that, in this regard, the existing mine tailings are only slightly inferior to Caltrans Class 2 aggregate base materials ("R"  $\geq$  78).

Other subgrade quality tests conducted on the native soils show "R" = 5-12 for clayey silts (MH) and "R" = 19-26 for sandy silts (ML), when reduced for expansion. Samples of serpentinite bedrock show "R" = 43, but a sample of reconstituted diorite bedrock scheduled for use as borrow material on the Brunswick Road renovation showed only "R" = 11.

In light of the foregoing, we have concluded that the subgrade qualities of the native soils and of what

essentially constitutes soil borrow derived from excavation along Brunswick Road are poor to fair. Subgrade quality can be greatly enhanced, however, by designing the structural sections to incorporate at least 12 inches of existing mine tailings as a base course substitute.

Soil Corrosivity

Resistivity and pH tests were conducted on selected samples of fine sandy silts (ML) and clayey to very clayey silts (MH) as an aid to assessing the chemical aggressiveness of the native soils. These tests show a pH of 6.35 and an effective resistivity of about  $3.8E+04$  ohms-centimeter for the sandier silts, indicating that they are slightly acidic and mildly electroconductive. On the other hand, the tests yielding a pH of 7.84 and an effective resistivity of  $5.6E+03$  for the clayey silts (MH), suggesting that these soils are slightly alkaline and only moderately electroconductive. The following tabulation, relating pH resistivity and a qualitative assessment of soil corrosivity is presented below for your convenience.

TABLE I - CORROSION RATINGS

<u>Effective Resistivity</u> (ohms-cm)	<u>pH</u>	<u>Corrosion Rating</u>
<4.0E+02	<4.0	critical
4.0-8.0E+02	4.0-6.0	severe
9.0-15.0E+02	6.0-7.0	serious
-----		
1.5-3.5E+03	7.0-8.0	moderate
3.5-8.0E+03	8.0-9.0	slight
8.0-20.0E+03	9.0-10.0	nominal
>20.0E+03	>10.0	insignificant

The results of the pH and resistivity tests are displayed on Plate No. A16.

Excavation Conditions

The results of this investigation indicate that the planned finished roadway grades -- including superjacent rock cut

## LOWRY & ASSOCIATES

slopes -- can be accomplished using conventional grading equipment ordinarily available to contractors. None of the bedrock types appears particularly resistant to excavation, and removal of these materials is anticipated to be feasible by means of machinery equal to or larger than a Caterpillar D8L (or equivalent) tractor equipped with dual rippers.

### Ground Water Control

Deeper cut slopes -- especially those with exposed faces oriented in the northeast-southwest direction -- may intercept seepage through bedrock foliation planes or joints. The quantity of such seepage is dependent upon the spacing and openness of these discontinuities. After a period of prolonged intense rainfall, seepage also could be expected at or near the contact between the more pervious soil mantle and underlying, comparatively impervious, bedrock surface. Ground water from either of these sources, however, is expected to be limited and practically inconsequential.

Areas of persistent seepage -- such as those affected by pipeline leakage and/or perennial springs -- will require subdrainage, unless flow from these areas can be permanently shunted away from and disposed beyond the limits of the proposed roadways, particularly the western branch of Whispering Pines Road and the upper part of Centennial Way.

### Culvert Support

The results of this investigation indicate that the gravelly stream alluvium (GM) at the Centennial Way crossing of Wolf Creek has sufficient internal strength for support of the proposed box culvert, and that adequate headwall cutoff is available in the underlying serpentinite bedrock.

## RECOMMENDATIONS

### Grading

#### Clearance

General clearance of the proposed roadway improvement areas should include the removal of all unwanted trees, brush and associated root systems; downed timber; surface grasses; existing asphalt concrete paving; rubbish and rubble; and any

underground utilities that are within 2 feet of existing or final grade (whichever is lower). Ponded water should be drained away from all roadbed areas, and any encroaching seepage should be diverted by construction of dikes or training channels designed to carry it away from the construction areas toward appropriate disposal sites.

In addition to the foregoing, all loose existing fills, soft and/or saturated soils and structural remnants -- including those following demolition of the existing wood bridge over Wolf Creek -- should be removed.

In the event that small shafts (less than 4 feet in diameter and not over 10 feet deep) are encountered within the proposed rights-of-way, the sides of the shafts should be broken back to a configuration not exceeding 1 horizontal to 1 vertical. If major shafts are encountered, our engineering geologist should be contacted immediately for special corrective recommendations.

If they extend below planned finished pavement subgrade elevation, excavations and depressions resulting from the removal of the above items should be cleaned out to firm, undisturbed soil or bedrock (whichever is higher) and backfilled with engineered fill processed, placed and compacted in accordance with the following recommendations.

#### Subgrade Preparation

Soil subgrades designated to receive engineered fill should be scarified to a depth of 6 inches or to the underlying rock surface, whichever is higher. In areas where the scarified subgrade is within 2 feet of finished subgrade elevation, the soils should be brought to at least the optimum moisture content and recompactd in place to not less than 95 percent relative density, as stipulated by ASTM Specification D1557-78; otherwise, the minimum degree of compaction may be reduced to 90 percent. Bedrock subgrades, attained by excavation, should be cleared of all loose rock fragments exceeding 6 inches in largest dimension but should otherwise be left undisturbed. No subgrade preparation should be undertaken while the ground is frozen.

#### Engineered Fill

All soils placed as engineered fill required to establish final roadway subgrade elevation should be constructed in

horizontal lifts not exceeding 6 inches in compacted thickness. Such materials should consist of native soils free of trash and vegetation; soils within 2 feet of final pavement subgrade level should be free of rock fragments exceeding 4 inches in largest dimension, and below that level, 6 inches in largest dimension. All mine tailings to be used as engineered fill should be placed in level lifts not greater than 12 inches in compacted thickness. Mine tailings should be processed to remove rubbish, vegetation and rock fragments over 6 inches in largest size, and, where used within the uppermost 18 inches of final pavement subgrade level, should contain not more than 25 percent fine particles passing the No. 200 sieve.

Each lift of fill should be brought to at least the optimum moisture content and compacted to not less than 90 percent relative compaction to within 2 feet of final subgrade elevation, and to not less than 95 percent relative compaction thereabove, all in accordance with ASTM Specification D1557-78. No frozen soil should be used as engineered fill.

#### Benching - Keying

Where the slope of the original ground exceeds an inclination of 6 horizontal to 1 vertical, benches should be cut into the natural slope as the filling operations proceed. Each bench should consist of a level terrace at least 8 feet wide with the rise to the next bench not greater than 4 feet.

Where the slope of the original ground exceeds an inclination of 4 horizontal to 1 vertical, a keyway should be provided in addition to the benches. Each keyway should consist of a level trench at least 4 feet wide, cut to a depth of 3 feet into the original ground along the proposed embankment toeline, with side slopes not exceeding an inclination of 1 horizontal to 1 vertical.

#### Final Compaction

Except in rock cuts, all final subgrades should be brought to at least the optimum moisture content and recompacted in place to not less than 95 percent of maximum dry density in accordance with the preceding standard.

### Slopes

Permanent excavation slopes in soils or highly-weathered rock may be designed as steep as 1-1/2 horizontal to 1 vertical. Permanent cut slopes through intact rock -- estimated to exist at and below an average depth of 6 feet from existing grade and approved by the engineering geologist during grading -- may be inclined as steep as 1-1/4 vertical to 1 horizontal.

All finished embankment slopes should be constructed no steeper than 2 horizontal to 1 vertical.

### Testing

Our representative should be present during all site clearing and grading operations to test and observe earthwork construction. The further recommendations of this report are predicated upon compliance with the foregoing recommendations and adherence to the appended guide earthwork specifications.

### Erosion Control

#### Slope Rounding

The uppermost 3 feet, measured vertically from the crown line, of all cut slopes should be rounded and compacted to the standards previously recommended.

#### Seeding - Planting

All engineered fill slopes should be seeded and/or planted as protection from concentrated surface flow. The appropriate species should be selected giving due consideration to plant hardiness, propagation and nutritive requirements, including watering demands. Interim slope protection should be provided by straw-punching with an appropriate tackifier (including a chemical mulch, if desired) or hydromulching. Similar protection is advisable -- although not essential -- on cut slopes as a precaution against progressive deterioration.

#### Drains

Interceptor drains should be installed no more than 4 feet behind the crown lines of all cut slopes greater than 10 feet

in height. These drains should be paved with at least 3 inches of reinforced portland cement concrete or gunite and should be founded at a minimum depth of 12 inches below lowest adjacent finished grade, in undisturbed materials. The drains should have a minimum paved width of 30 inches, measured horizontally across the drain. A minimum gradient of -2 percent should be provided and the accumulated runoff directed toward other drains or lateral ditches designed to discharge the runoff at points well away from the exposed cut faces. Where downdrains discharge onto slopes that are steeper than 10 percent, energy dissipation devices should be installed at the discharge ends. These devices could include retained rocks, lined stilling basins, or level spreaders designed to disburse the runoff gradually across a flatter slope.

#### Berms

Adjacent to the roadways, asphalt or portland cement concrete berms should be installed along the crown lines of engineered fill slopes greater than 5 feet in height to prevent excessive sheet runoff. Alternatively, rolled gutters paved and of the dimensions stated above may be formed along the crown lines provided the gradient is no less than 2 percent. Collected runoff from pavement surfaces should be directed toward appropriately-sited drop inlets, scuppers or other drainage devices for disposal beyond the limits of the embankment faces.

#### Subdrains

##### Interceptor Pipes

Segments of Centennial Way between approximate Stations 8 and 10 and of Whispering Pines Road between approximate Stations 10 and 13 may be subject to a seepage nuisance arising from leaks in the nearby cast iron water main and/or seepage beneath the tailings dam to the south and west. In the event that the need for subdrains is confirmed during grading, we recommend the use of 4-inch diameter galvanized CMP (ASTM Specification A742) or Schedule 80 PVC (ASTM Specification D2979) drainage pipe.

Pipes should be placed at a 45° skew to the new centerlines and designed to cross the full width of the roadbed at spacings not farther apart than 40 feet. Drainage pipe

should be bedded in trenches at least 12 inches wide and at least 12 inches deep. Pipe invert levels should be no higher than 6 inches above the trench bottom grade, and pipes should be sloped at a minimum gradient of .5 percent toward the lower shoulder. The entire herringbone pattern should be connected to a 4-inch diameter solid collector pipe routed to discharge well away from the roadway limits.

Subdrains may be either perforated or slotted. Slots, if chosen, should be no more than 1/8 inch wide and perforations, and perforations no more than 1/4 inch in diameter. In either case, openings should be placed down.

#### Permeable Materials

Permeable materials surrounding the underdrains should conform to the grading and other criteria stated in the Caltrans "Standard Specifications" (1984). It is our experience that a volumetric mixture of 75 percent 3/8-inch diameter pea gravel and 25 percent concrete sand closely approximates the grading specifications for Caltrans Class 2 permeable materials and would be considered an acceptable substitute. Subdrains should be bedded with and surrounding by at least 6 inches of this material which should be placed and compacted to at least 90 percent relative compaction, at or above the optimum moisture content, in accordance with ASTM Specification D1557-78. Alternative permeable materials gradings could be considered, if the underdrain trenches are lined with pervious geotextile fabric.

#### Pavements

##### Design Criteria

We have computed various pavement design alternatives on the basis of the "R" value tests, "T.I." data for each roadway and the Caltrans "Design Method for Flexible Pavements". All of the designs are based upon the lowest "R" values for the subgrade soil type that appears to be most characteristic of the roadway reach under consideration.

As earlier discussed, subgrade conditions can be dramatically improved by using existing mine tailings as a roadway base substitute. Therefore, alternative recommendations for standard 2-zone structural sections, as well as a hybrid section consisting of mine tailings base course and a

**LOWRY & ASSOCIATES**

standard wearing course, are presented in the following tabulations. It appears that, where at least a 2-foot thick layer of mine tailings already exists within the proposed rights-of-way, these alternative pavement sections could be used, provided that finished subgrade level is not more than 12 inches below existing grade. This option may be particularly attractive on Whispering Pines Road, specifically between Stations 10 and 45.

It should be recognized that a smooth base course subgrade over which the asphalt concrete wearing course can be constructed may be difficult to achieve using mine tailings alone. Therefore, we suggest that a levelling course composed of Class 2 aggregate base per Caltrans standards and of nominal thickness be used for this purpose.

Structural Sections

Our recommended structural sections for each roadway are presented below:

TABLE II - PAVEMENT SECTIONS

Recommended Structural Sections - inches

<u>Roadway Reach</u>	<u>Design Values</u>		<u>Asphalt Concrete (Type B)</u>	<u>Aggregate Base (Class 2)</u>	<u>Mine Tailings ("R" &gt; 73)</u>
	<u>"T.I."</u>	<u>"R"</u>			
1) Idaho-Maryland Rd.	9.5	43	6 6	9 -	- 12
2) Centennial Way	8.5	14	7 4.5	13 -	- 18
3) Whispering Pines Rd.					
a) East	6.0	5	5 3.5 3.5	10 13 -	- - 16
b) West	7.5	26	5 3.5 3.5	10 13 -	- - 16

TABLE II - PAVEMENT SECTIONS

Recommended Structural Sections - inches

<u>Roadway Reach</u>	<u>Design Values</u>		<u>Asphalt Concrete (Type B)</u>	<u>Aggregate Base (Class 2)</u>	<u>Mine Tailings ("R"&gt;73)</u>
	<u>"T.I."</u>	<u>"R"</u>			
4) Cambridge Court	5.0	5	4 3 2	8 10 -	- - 12
5) Crown Point Circle	5.5	10	4 3 2.5	5 7 -	- - 12
6) Crabtree Court	5.0	10	3 2 2	9 11 -	- - 12
7) Brunswick Road	9.0	11	8 5.5	14 -	- 19

Materials quality and construction characteristics for asphalt concrete and aggregate base should conform to the applicable provisions of the Caltrans "Standard Specifications" (July, 1984). The foregoing pavement recommendations are predicated upon the assumptions that the soils exposed at pavement subgrade level will be similar to those tested, that all engineered fill and subgrade preparation will be undertaken in accordance with the recommendations of this report, that the pavement subgrades will be stable, and that the pavements themselves will be adequately drained.

Where drop inlets or other drainage devices are to be installed, we strongly recommend that openings be provided to encourage free drainage of the contiguous base course materials.

Box Culvert

Cutoff

Satisfactory cutoff for the box culvert headwalls is available at and below elevation +2486 feet, in serpentinite

bedrock. The gravelly alluvium in Wolf Creek, mine tailings imported from nearby sources or Class 2 aggregate base all would be considered satisfactory bedding materials for base slab support. Alternatively, structural backfill materials could consist of a sand-gravel mixture having a plasticity index not exceeding 12, an expansion index not exceeding 20, and a maximum particle size of 2 inches. Structural backfill should be placed and compacted as engineered fill in accordance with the preceding recommendations. We assume that all construction will be undertaken "in the dry".

### Lateral Pressures

Rigid box culvert walls could be subjected to at rest lateral earth pressures equivalent to those exerted by a fluid weighing about 60 pounds per cubic foot. If wing walls capable of yielding or deflecting at least 0.1 percent of their height are also contemplated, they could be subjected to active lateral earth pressures equivalent to those exerted by a fluid weighing about 35 pounds per cubic foot.

The above lateral earth pressures are predicated upon the assumption that hydrostatic pressures due to infiltrating surface runoff water will not accumulate behind the walls. If such a condition cannot be assured, then weep holes should be provided to alleviate the anticipated hydrostatic pressures. Weep holes should be at least 4 inches in diameter and should be spaced no farther apart than 3 feet. The rear opening of each weep hole should be covered with two overlapping swatches of geotextile fabric, or screened to prevent wall backfill intrusion.

### Structural Backfill

Structural backfill should consist of nonplastic sand, gravel, or a mixture thereof; or, mine tailings graded to reject rock fragments over 2 inches in largest dimension. Structural backfill should be placed in horizontal lifts not exceeding 12 inches in compacted thickness. Each lift should be brought to at least the optimum moisture content and compacted to not less than 90 percent relative density in accordance with ASTM Specification D1557-78, except that within in the uppermost 2 feet of backfill beneath Centennial Way, the minimum degree of compaction should be increased to 95 percent.

**LOWRY & ASSOCIATES**

Storm Drains

The expected service life of CMP storm drains proposed for the project may be determined from the following tabulation. Storm drains on the west side of the project include all those along that stretch of Whispering Pines Road west of Crown Point Circle, and all of Centennial Way, whereas those on the east side include all others.

TABLE III - CMP SERVICE LIFE  
(Caltrans Test Method 643-B)

<u>Culvert Specifications</u>		<u>Project Service Life - years</u>	
<u>Gauge</u>	<u>Wall Thickness</u>	<u>West Side</u>	<u>East Side</u>
	(in)		
18	0.052	33	50
16	0.064	43	66
14	0.079	52	81
12	0.109	72	111
10	0.138	92	141
8	0.168	111	171

All CMP drains should conform to ASTM Specification A444.

LIMITATIONS

The recommendations of this report are based upon the information provided regarding the proposed improvements as well as the subsurface conditions encountered at the test boring locations. If it is found during construction that subsurface conditions differ from those described on the boring logs, the conclusions and recommendations in this report shall be considered invalid, unless the changes are reviewed and the conclusions and recommendations modified or approved in writing.

We would appreciate the opportunity to review the final plans and specifications to determine if the recommendations of this report have been implemented in those documents. The review would be acknowledged in writing.

We emphasize that this report is applicable only to the

Page 21  
February 27, 1986  
L & a No. 86-73

## LOWRY & ASSOCIATES

proposed construction, as described herein, and should not be utilized for design and/or construction on any other site.

LOWRY & associates

*Paul C. Weidig*

PAUL C. WEIDIG  
Registered C. E. No. 25,128



PCW:im

xc: (6)

Seal  
Exp. 12-31-89

NEVADA COUNTY RESIDENTIAL BUILDING INSPECTION RECORD

916-606-9694

PROJECT ADDRESS 12305 Bett Road APN# 09-581-19 PERMIT# 00-72094  
 OWNER Lawler, DAVID PHONE# \_\_\_\_\_ CONTRACTOR Mark Doherty PHONE# 271144  
 DESCRIPTION Repair - shaft closure / cap w/ foundation under pinning REFERENCES: \_\_\_\_\_  
 LIVING SPACE: \_\_\_\_\_ #BDRMS: \_\_\_\_\_ GARAGE: \_\_\_\_\_ DECK: \_\_\_\_\_ STORAGE: \_\_\_\_\_ UBC: 97 ISSUE DATE 9-6-2001

TYPE APPD DATE TYPE APPD DATE TYPE APPD DATE

SETBACK / ADDRESS			FRAME			MISC INSPECTIONS		
SERVICE GROUND			ROUGH ELECTRIC			FIREPLACE THROAT		
FOOTINGS/FORMS/STEEL	<u>PJP</u>	<u>11-1-00</u>	ROUGH PLUMBING			ICE GUARD/ABV 5000 FT		
GROUND PLUMBING			ROUGH MECHANICAL			DRIVEWAY / ENCROACH		
OK TO POUR			LATH NAIL			SPECIAL INSPECTIONS		
SLAB <u>410 @ 12" o.c. c.w.</u>	<u>PJP</u>	<u>9-27-00</u>	OK TO INSULATE			GRADE <u>DM</u>	<u>PJP</u>	<u>12-7-00</u>
VAPOR BARRIER			INSULATION CERT <b>FINALED</b>			NEW STEM / FTG	<u>PJP</u>	<u>1-26-01</u>
WM FIBER STEEL			CEILING R _____			APPROVALS		DATE
OK TO POUR			WALL R _____			FIRE PLANNER INSPECT		<u>3-19-01</u>
UNDERFLOOR FRAME			OK TO SHEETROCK			ELECTRIC SERVICE <u>X</u>	<u>PJP</u>	<u>3-15-01</u>
PLUMBING MECHANICAL			SHEETROCK NAIL			TEMP POWER POLE		
INSULATION R _____			BLDG GAS	<u>PJP</u>	<u>4-16-01</u>	GAS SERVICE (METER)		
OK TO COVER			UNDER GROUND GAS	<u>PJP</u>	<u>4-5-01</u>	ENVIRO. HEALTH	<u>JK</u>	<u>7/23/01</u>
ROOF SHEATHING			BLDG SEWER			PARK & REC FEE	\$	
OK TO ROOF			UNDERGROUND CONDUIT			ROAD FEES	\$	
EXTERIOR SHEAR			WATER SERVICE			TEMP OCCUPANCY: _____		DATE
HOLD DOWNS			OK TO COVER			# DAYS		
OK TO COVER								

INSPECTOR CERTIFYING FINAL COMPLIANCE WITH ALL APPLICABLE CODES AND APPROVED PLANS FOR FINAL OCCUPANCY: Pat

DATE: 8-10-01



# NEVADA COUNTY BUILDING PERMIT - RECEIPT

**OWNER**  
 LAWLER DAVID A  
 483 KENTUCKY AVE  
 BERKELEY, CA 94707

**CONTRACTOR**

**LICENSE**                      **EXP. DATE**

**W.C. #**                              **EXP. DATE**



<b>APN</b>	<b>RECEIPT</b>	<b>ST</b>	<b>PERMIT</b>
09-581-19-000	67956	0	00072094
<b>SITUS ADDRESS</b>			
12305 BET RD			
<b>APPLICANT</b>			
AGENT: MARK HALE			
530-272-7144			
<b>DESIGN PROFESSIONAL</b>			
<b>LENDER</b>			

**PROJECT DESCRIPTION**  
 SHAFT CLOSURE/CAP/WITH FOUNDATION UNDERPINNING

<b>APPROVALS</b>	PLNG/SITE					
<b>DATE BY</b>	7/2					

<b>VALUATION</b>				<b>APPLIED</b>	08/25/00
REPAIR	0 SQ. FT. AT	\$0.00 =	\$0.00	<b>ISSUED</b>	08/25/00
Total Sqft =	0	Total Valuation =	\$0.00	<b>LAST RENEWED</b>	

### DECLARATIONS

1. **OWNER BUILDER DECLARATION**-I hereby affirm that I am exempt from the contractors license law, Business and Professions Code (Sec. 7031.5) by one of the following:
  - a) I, as the owner of the property, will do the work myself without hiring any employees, and the building or structure is not intended for sale. (Sale or offering for sale within one year after completion is presumptive evidence that the structure was undertaken for purposes of sale.)
  - b) I, as owner, am contracting with licensed contractors to construct the project. (Sec. 7044).
  - c) I, as owner, will employ workers with wages as their sole compensation. (Sec 7044)
  - d) I am exempt under Sec. \_\_\_\_\_, Reason \_\_\_\_\_
2. **CERTIFICATE OF EXEMPTION FROM WORKMEN'S COMPENSATION INSURANCE** - I certify that in the performance of the work for which this permit is issued I shall not employ any person in any manner so as to become subject to Workmen's Compensation Laws of California.  
 NOTE: If, after making this certificate you should become subject to Workmen's Comp provisions of the Labor Code, you must forthwith comply or the permits shall be deemed revoked.

I hereby certify that I have read this application and that the information is correct. I agree to comply with all applicable County Ordinance and State Laws pertaining to construction and related activities.

NO WORK HAS BEEN STARTED ON THIS PROJECT

\_\_\_\_\_  
 Signature (Owner/Builder/Auth. Agent)

DESCRIPTION	FEES/PAYMENT	FEES
122 PLAN CHECK MISC		28.00
111 INSP UNIT		135.00
150A DOCUMENT ARCHIVING		1.35
150E DOCUMENT ARCHIVING		10.35
155 PERMIT ADMIN FEE		52.40
<b>Total Fees.....</b>		<b>227.10</b>
<b>PAYMENT</b>		
MARK D HALE		08/25/00
Check Number 1089	227.10	
<b>Total Amount Paid....</b>	<b>227.10</b>	

*1 HR Perm CHECK  
7.2*

Call Mark Hale  
 265-2700  
 272-4161-work  
 Monday am

**DATE:** \_\_\_\_\_ **SIGNATURE:** \_\_\_\_\_ **OWNER CONTRACTOR AGENT** **PLAN CHECKED BY:** 7.2 **ISSUED BY:** \_\_\_\_\_

09-581-19  
72094

DAVID LAWLER  
483 KENTUCKY AVE. BERKELEY, CALIFORNIA 94707  
(510) 549-9694 FAX (510) 525-6114

9-1-00

County of Nevada  
Building Dept.  
950 Maidu Ave.  
Nevada City , CA 95959

Office phone (530-265-1444)/Fax (530-265-1272)

RE: POWER OF ATTORNEY DOCUMENT

This document hereby grants power of attorney to Mr. Mark Hale of Grass Valley, California from Mr. David A. Lawler - to conduct business matters on behalf of Mr. Lawler with Nevada County - Building Dept staff on permitting and financial issues pertaining to Mr. Lawler's 12305 Bett Rd., (AP 09-581-19)(Lot 1 Bett Acres) Grass Valley residence and property :

Sincerely,



DAVID A. LAWLER

9-6-2000  
OK to issue per  
Bob Porto + Clint Mc Kenney  
Following [unclear] = Notarized letter  
to follow.  
gah

IDAHO-MARYLAND sinks 5-ft. circular vertical opening 1,125 ft deep with novel machine that is supported and operated from within the hole. . . . Core is removed in sections up to many tons in weight

# Shaft Boring

## Found Inexpensive

## And Safe

*J. B. Newsom*

*Mining Engineer  
Grass Valley, Calif.*

**V**ERTICAL SHAFTS in the United States have heretofore been sunk by blasting and mucking. The blasting leaves uneven, shattered walls which must usually be supported. Even though the walls will stand, shaft lining is needed to furnish supports for the cage guides, pipes, and power conduits. The lining is generally timber, and as timber can be most easily framed into rectangles, rectangular shaft openings are the rule. The timber reduces the size of the cage floor. For example, if the Idaho Maryland company had put down No. 2 shaft by blasting and mucking, the cage area would have been about 30 per cent of the total shaft area. Besides a low percentage of useful area, an ordinary shaft is subject to fire hazard and to timber-maintenance charges. It is also poor for ventilation because the timber ribs cause eddies which greatly reduce the speed of the air currents.

A bored shaft does not have these disadvantages. Inasmuch as the walls are smooth, circular, and not shattered by blasting, lining is not required in most ground. Guides and columns can be fastened directly to the rock walls by stud bolts. The cage area is 79 per cent

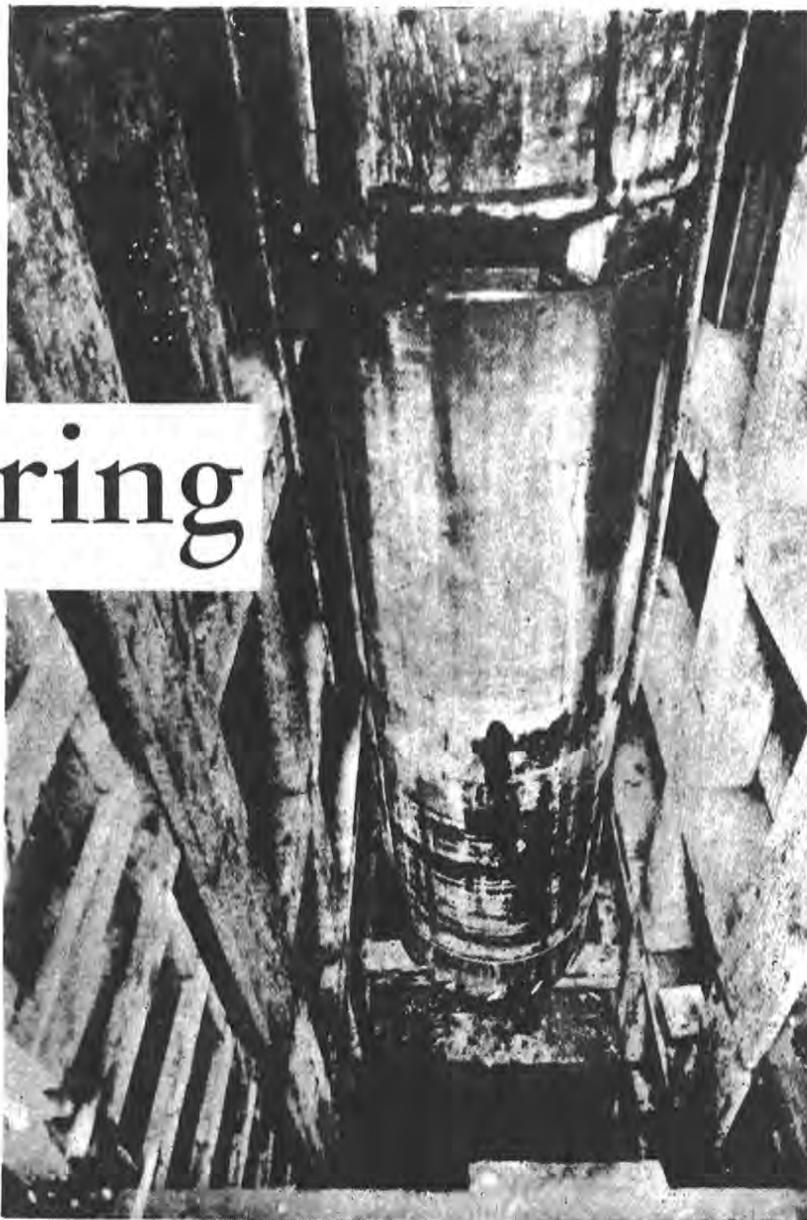
of the total shaft area. When steel cage guides are used, such a shaft has the further advantages of being fireproof and free from timber-maintenance charges. Also, being circular, with smooth sides, it is much better for ventilation. Preliminary figures indicated that a bored shaft would be less expensive and that the sinking operation would be considerably safer. Increased sinking speed was also indicated.

To prove these various points, the Idaho Maryland Mines Corporation recently bored and equipped a circular shaft 5 ft. in diameter and 1,125 ft. deep at Grass Valley, Calif. The site chosen for the work had the following advantages:

It offered many types of ground: an abrasive gabbro; swelling ground;

gouge, blocky serpentine; and firm serpentine. The site was away from the main surface plant, so experiments did not interfere with other work. The shaft passed near mine workings at the 500-ft., 750-ft., and 1,100-ft. levels. An air and timber shaft was needed at the site chosen.

I had used a large-diameter core drill, and had trouble with the drill rods whipping in the hole. Connecting and disconnecting the rods had consumed much time. Also, drill rods are expensive, a string a thousand feet long costing several thousand dollars. These various difficulties had led me to design a drill which could be lowered into the drill hole on the end of a cable, eliminating the rods. This drill consisted of a cabin containing a motor, the driving mech-



**THE CORE BARREL, 15 ft. in length, which is attached to the lower end of the vertical driving shaft. Forty-two feet of overburden was mined in the usual way and supported with timber as seen here. The rest of the shaft was bored with this machine**

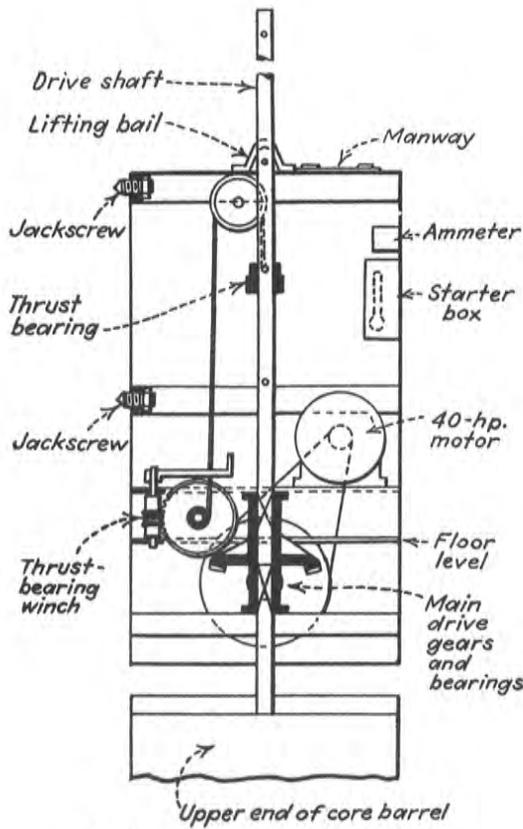
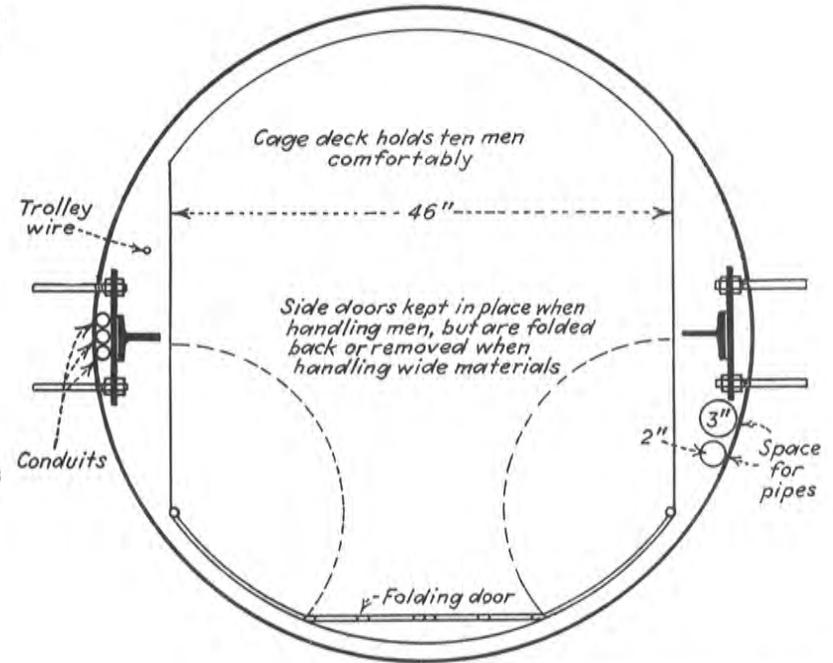


Fig. 1. . . . THE SHAFT DRILL MECHANISM in generalized cross-section. Note the Jackscrews. Six of these are provided and can be forced out against the sides of the hole to hold the cabin and its machinery securely in place

CORE FRAGMENTS taken from the 5-ft. diameter bored shaft by a specially designed combination core puller and core barrel. They are of gabbro and are about 7 ft. long, weighing approximately 11 tons each



Fig. 2. . . . COMPLETED SHAFT CROSS-SECTION. in outline. The cage deck, 46 in. wide, will hold ten men comfortably. In the space between the sides of the cage and the circular wall are the guides, pipes, and conduits supported directly by the rock



anism and controls, and a seat for the operator. The cabin was supplied with six screw jacks which could be forced out to fasten it securely in place against the sides of the drill hole. The operator stayed in the cabin all the time during the drilling operation. He was protected by a roof of  $\frac{1}{2}$ -in. steel plate.

The drive unit was a constant-speed 40-hp. motor, which transmitted power through a chain drive and conical gears to a vertical splined shaft which extended up through the center of the cabin. A movable thrust bearing was fixed on this splined shaft, and the operator had a control mechanism by which he could raise or lower this vertical bearing, controlling the weight on the cutting shoe. In addition to the vertical feed control, an ammeter in the cabin indicated how much friction the drill was developing. The motor was protected by overload and no-voltage releases.

A core barrel 15 ft. long was attached to the lower end of the splined shaft. Detachable cutting shoes were fixed to the bottom edge of this barrel. In practice, these shoes failed, and were replaced by a solid cutting ring riveted in place.

The first work done brought out the following points:

1. The machine would cut rock at the rate of about a foot an hour.

2. A crew of skilled operators was vitally necessary to successful operation. Inasmuch as this was a new development in mining, skilled operators were not available, and men had to be trained for the work. Later developments indicated that inexperience was one of the main reasons for the slow progress at the beginning of the job.

3. In hard rock the machine would not deviate from a straight line. This proved annoying, as we had thought we could turn the hole by drilling to one side, so had not taken pains to plumb the machine accurately at first. The hole was finally straightened by blasting out one side of the bottom and re-collaring the drill.

4. It was easy enough to break off cores, but not so easy to bring them to the surface in large pieces. Inasmuch as one of the main economies expected was the elimination of mucking, this seemed a serious drawback. This difficulty of bringing up large pieces was overcome later.

5. The sides of the hole would stand well without support in most ground.

6. If the men knew what they were about, the method was safe, but with unskilled men it was extremely hazardous.

7. The basic design of the machine was right, but it was under-powered and the auxiliary equipment had to be developed.

To describe the many discouraging delays encountered or the mistakes made before faith in the process seemed justified is not worth while. In the first

three and a half months of drilling three shifts per day half of the time, a shift and a half the rest of the time, only 44.6 ft. of shaft was drilled. At the end of this period better progress was made, the shaft advancing 84.8 ft. in the next two months. The operating cost being about \$1,500 a month, this was more encouraging as to cost, but still not fast enough as to sinking rate to be of real value.



**DRIVE HEAD** and core barrel hoisted above the shaft collar and suspended in the headframe. Detachable cutting shoes were originally fixed at the bottom edge of the barrel. They failed, however, and were replaced by a solid cutting ring riveted in place

By the time the second period was finished, the shaft had been deepened to the limit of the hoisting equipment, so new surface tackle and a new hoist were installed. During the next three months, the shaft was deepened 249 ft., or an average of 83 ft. a month. At this point, very heavy ground was encountered, which had to be supported with reinforced concrete. Seventy-four feet of this was drilled and cemented in two months.

By this time the shaft extended 506 ft. below the collar, and after sinking another 40 ft. to provide a sump, opera-

tions were stopped to cut the 515 level station through from other workings.

When drilling was resumed, 162 ft. were sunk in 34 days, a rate of 147.5 ft. a month. During this last drilling period we found that the hole had again deviated from the vertical in the heavy ground. This could be understood, because during that work the bottom of the hole often widened beyond the bottom of the drill shoe. To straighten it, enough of the shaft wall was moiled out so that the machine could be set vertically again. This moiling took ten days.

The succeeding months were devoted to technique and to answering important questions. This made the speed and cost records suffer, but many problems were solved.

The last time the direction of the hole was turned, mainly to see if it could be done easily, the cost of the lost time was \$9.85.

In bad ground cores would sometimes fall apart so completely that a band could not be placed around them to pull them to the surface, and they had to be mucked out. A combination core puller and core barrel which was designed to solve this problem at first caused trouble, as the pulling dogs were on springs which it took nearly a month to learn to adjust easily. However, when this was mastered the device proved satisfactory, and better than average sinking speed was made in spite of the fact that lack of hoist capacity prevented pulling long cores.

Trouble with rope spin during hoisting and lowering was also eliminated and methods were developed for handling the electric power cable and signal wire easily. During the last sinking period air conditions became troublesome. A small air hose lowered to the bottom of the shaft solved this difficulty.

The crew consisted of two men per shift, a drill runner in the hole and a helper on the surface. The helper ran the hoist. There were three shifts a day, this making six regular men. The operation was supervised by a foreman who, necessarily, was an experienced drill runner. Drill runners were paid \$5.25, helpers \$4.40 per shift, and, in addition, a dollar a foot sunk was divided among the drillers and helpers.

As a safety precaution, the shaft walls were tapped from top to bottom once a week. In addition, safety hoods of  $\frac{1}{4}$ -in. plate were mounted on the hoist lines just over the men, so they were almost never exposed to danger from falling objects. No hoisting was ever done over a man. Although the rope safety factors were high, men were not allowed to ride on heavy loads, such as the drilling machine or a core.

The drilling cycle was as follows: (1) Put the drill in the hole and line it up. (2) Drill till the core is cut to its full depth. (3) Remove the drill from the hole and set it back out of the way.

(4) Bail out the water and cuttings. (5) Break off the core. (6) Attach the core hoisting tackle. (7) Hoist and dump the core. (8) Bail out the water and cuttings which were in the drill kerf during operation (4). (9) Inspect the bottom of the hole and remove any broken pieces which would interfere with drilling the next core.

The combination core barrel and core puller not only cut the core but also lifted it out of the hole, greatly reducing the time consumed by operations (4) to (7) above.

As mentioned, swelling ground was supported with reinforced concrete. The method was to dig out the bad ground until there was a cavity four or more inches deep, to place reinforcing bars in this cavity on about 12-in. centers, sticking the ends of the bars into holes drilled in the sides of the cavity, and then to fill it with concrete. The concrete was poured behind a steel form consisting of a single rolled plate 4 ft. high and rolled to 5 ft. diameter, but with the edges overlapping and fitted with expansion bolts. The form could be contracted to a diameter of 4 ft. 6 in. or expanded to a diameter of about 5 ft. 2 in. Twenty-four hour cement, mixed three to one with river sand, was used. A leaner mix proved unsatisfactory, as it was slow setting and the sand washed out of it in a few places. The concrete was taken down the shaft in galvanized pails.

This method was simple and satisfactory. Some of the concrete has been in place over a year (June, 1936), and shaft inspections have not discovered any weaknesses in the concrete or the rock next to it. Reinforcing may not be necessary, as apparently the main thing is to seal the air away from the walls. It may be that time and reinforcing could have been saved by using gunite, but this was not tried.

In summarizing the results of the sinking operations, these points seem worthy of attention:

The method is inexpensive. When it

is considered that a single man was used underground, that almost no powder was used, and that nearly 150 ft. were sunk in a thirty-day period, the economy will be apparent.

In the hands of skilled operators, the method is safe. Inasmuch as powder is seldom used, rock is not hoisted over men, and the hoist lines are equipped with heavy safety hoods, the usual hazards of shaft sinking are greatly reduced. Our record is a single broken leg and a few minor scratches.

The method has by no means reached its ultimate speed. A little over 10 ft. was the best day's record. The best continuous record was 21 ft. in three days. It is likely that in the future 7 ft. a day will be considered slow progress.

Larger shafts seem entirely feasible. Since a ten-man cage or a 7-ton skip can be used in a 5-ft. diameter round opening, it may be better to drill several 5-ft. holes than to drill a single larger one. Several small holes would make a better operating shaft, because they would be easier to support, independent in case of accidents, fireproof, and separated for ventilation. Several holes drilled simultaneously would cost little more than a single one, as one helper could serve several drillers, and no additional supervision or equipment would be required.

With proper handling equipment, stations are unnecessary to the sinking operations. Besides the drill and accessories, little equipment is needed except a hoist and a strong headframe or a derrick.

To keep the number of men on the payroll fairly constant, the crosscuts to stations were not all started at once. The guides were installed a few at a time and were run below each station as soon as blasting was completed. They are 4x4-in. x $\frac{1}{2}$ -in. structural tees, welded together at the joints, with the joints ground smooth. The rails are welded to brackets, which in turn hang on stud bolts anchored to the sides of the shaft. The brackets are 8 ft. apart vertically, and

are set out from the walls far enough so there is room for 1 $\frac{1}{2}$ -in. diameter electrical conduits behind them.

Guides were installed from a working platform the full size of the hole, with a horizontal straight-edge above the platform to assist in orientation. Templets were cut in the floor, so if the platform could be moved up and down on the guides they were certain to be in place. Plumb bobs operated from the surface were used to orient the working platform. Guides were lowered in strings 200 ft. long, the joints being welded on the surface as they were lowered. The work went rapidly, all operations for a hundred feet of shaft taking about three shifts.

The cage floor plan is shown in an illustration. It is a single-deck cage, but is built so that two auxiliary decks can be hung below the main deck. It is equipped with safety dogs of the conventional type but with much smaller teeth than would be used for wooden rails. The safety dogs were drop-tested with the cage empty and also with a ton of weight added.

A trolley wire runs beside one of the guides, and a trolley on the cage transmits current for the bell knocker and an electric light inside of it. Thus, the cage tender need not reach outside to signal the hoist man.

A leveling contact which flashes a light when the cage floor is leveled at a station is being installed. It is hoped this will assist in spotting the cage regardless of cable stretch under varying loads. When the guide-rail installation has been completed so the extra handling tackle at the collar can be cleared away, the shaft will be protected against overwinding by power cut-out and automatic brake-setting devices.

Reinforced-concrete floors, sides, and tops are being put in at the stations. It is planned to put a 2-in. water pipe down the shaft to provide water for the drills, for drinking, and for use in case of fire.



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INFORMATION CIRCULAR

DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

SHAFT SINKING WITH A SHOT DRILL, IDAHO MARYLAND MINE,  
GRASS VALLEY, CALIF. 1/

By J. B. Newsome 2/ and C. F. Jackson 3/

INTRODUCTION

This is one of a series of circulars dealing with mining methods, practices, and costs. It describes the method of sinking a shaft 60 inches in diameter with a shot drill, as employed at the Idaho Maryland mine, Grass Valley, Calif. The operation involved a great deal of experimentation in applying the shot-drill method to large bore drilling, overcoming mechanical and other difficulties which developed during sinking, and developing operating technique. Under such circumstances, costs are obviously higher than they would be after the pioneer work has been done, but even so, these actually obtained compare favorably with costs of sinking by more conventional methods.

ACKNOWLEDGMENTS

The authors are indebted to Mr. Errol McBoyle, president of the Idaho Maryland Mining Co., not only for his cooperation and advice during the sinking of this experimental shaft, but for permission to prepare this article for publication with the inclusion of cost data.

PURPOSE OF SHAFT

A new shaft was required at the Idaho Maryland mine to serve for ventilation and supply purposes. A circular shaft is ideal for ventilation because it furnishes for a given area a minimum area of rubbing surface and hence, a minimum frictional loss. For cage purposes, where one compartment only is to be employed, a circular shaft often gives, except for handling rectangular containers, a maximum ratio of useful cage area to the total area of the shaft.

1/ The Bureau of Mines will welcome reprinting of this paper provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6923".

2/ One of the consulting engineers, U. S. Bureau of Mines.  
3/ Chief engineer, Mining Division, U. S. Bureau of Mines.

MILBY and had sunk one large-diameter hole in connection with wire-  
work. With deep holes of large diameter, considerable trouble was ex-  
perienced because of the drill rods whipping in the hole. Considerable time  
was lost connecting and disconnecting the rods, and a long string of rods is  
inconvenient. These considerations led the senior author to design a drill with  
the drive mechanism and core barrel close-connected so that they could be  
lowered into the hole together. The third purpose of this shaft, then, was  
to develop equipment and operating technique based on this design.

#### NATURE OF GROUND

At the site selected for the shaft, it was anticipated that the ground to  
be penetrated would be mostly serpentine. A log of the formations penetrated  
is as follows:

<u>Feet</u>	
0 - 44	--- Alluvium, mined by hand and square-set.
44 - 180	--- Gabbro.
180 - 182	--- Fault.
182 - 415	--- Serpentine, blocky, increasingly treacherous at greater depths - contained several diabase dykes.
415 - 470	--- Ankerite, very heavy and treacherous.
470 - 710	--- Serpentine, generally firm.
710 - 750	--- Fault material, streaked with heavy gouge seams.
750 - 1080	--- Serpentine.
1080 - 1110	--- Treacherous serpentine.
1110 - 1125	--- Serpentine.

The serpentine as encountered in the mine generally stands well except where shattered by faulting or highly altered, and it was believed that a drilled shaft would have an additional advantage in that there would be no heavy blasting to shatter the walls of the shaft, and that, therefore, the drilled shaft would probably stand for the most part without lining.

Drilling characteristics of the various materials were as follows:

Gabbro - drilled 6 to 10 inches per hour, produced cuttings which packed firmly and caused some difficulty in removing cores.

Upper fault zone - caused delay due to inexperience. The lower fault zone was drilled without difficulty.

Serpentine - drilled 12 to 20 inches per hour, produced colloidal sludge which did not hamper the other operations.

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4/ Newsom, J. B., and Bowles, Oliver, A New Adaptation of a Wire Saw: Eng. and Min. Jour., vol. 124, no. 12, December 1933, pp. 506-508.

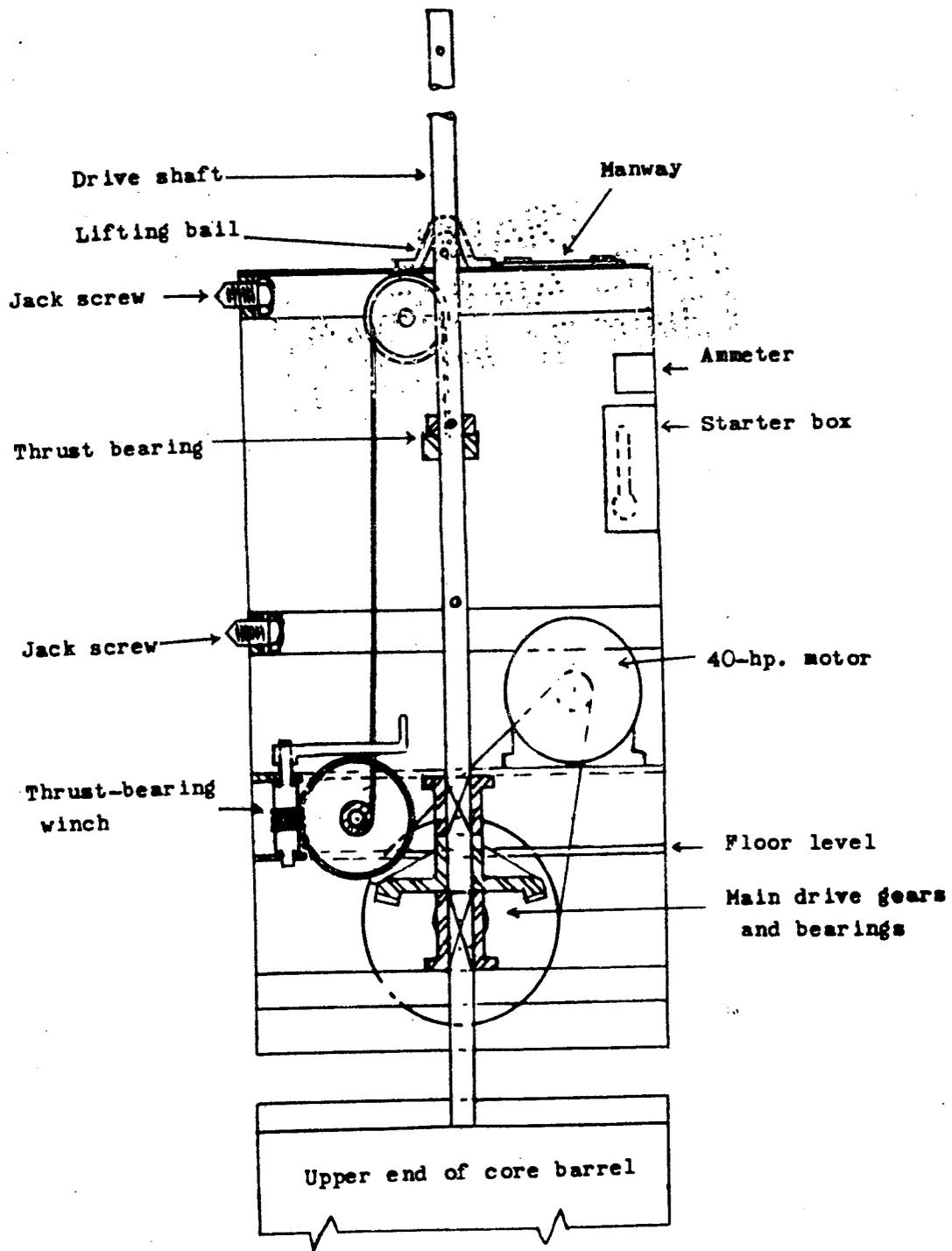


Figure 1 Generalized cross-section of shaft drill.

Ankerite and Treacherous Serpentine - drilled 8 to 15 inches per hour, pieces from the walls often slipped in against the core barrel and retarded operations.

The average length of core during most of the work was 7 feet, but in heavy ground the average core length was not over 5 feet, due to these tipping blocks.

#### DESCRIPTION OF EQUIPMENT AND MODE OF OPERATION

The job was started with an ordinary tripod, and an air hoist on the surface, and with only the drill and core barrel for the drilling operation. As the work progressed, various needs for auxiliary equipment developed and were filled. When the job was in its last stages, the equipment employed included the following major items:

##### Surface Equipment

Standard wooden headframe - consisting of 12- by 12-inch timbers; height of headframe, 83 feet.

Hoist - 150 hp., double-drum; rope speed, 600 feet per minute.

Power cable reel - A converted steel hoist with a 20-hp. motor, the flanges built up so the reel carried 1,150 feet of 3-conductor, rubber-covered power cable.

Core-handling arrangements - consisting of a drawbridge which could be lowered over the drillhole, and a wooden platform car. In operation, the cores were hoisted above the collar, the drawbridge was lowered, and the car was pushed under the core, which was then lowered onto the car and pulled to the dump.

##### Underground Equipment

The drill consisted of the two parts, the driving mechanism and the core barrel. These were assembled as a single unit which was lowered into the hole. The drive mechanism was assembled in a circular cab which contained room for the drill runner, and the cab was kept from rotating by screw jacks which could be set against the walls.

The unit was driven by a 40-hp. motor, with reduction gears to give a core-barrel speed of 60 revolutions per minute.

The core barrel was 15 feet long, with a cutting shoe  $1\frac{1}{2}$  inches thick by 12 inches high attached to the lower end. The outside diameter of the shoe was 59-9/16 inches.

The actual cutting was done by chilled shot. No attempt was made to use other cutting media, such as insert teeth, or angular abrasives.

als, as follows:

The hole deviated from vertical in the heavy ground at a depth of 450 feet. Since deviation in a vertical shaft must be avoided, it was necessary to devise a method of bringing the hole back on line. This was accomplished with a short core barrel, which was fitted with a standard-size shoe, but was enough smaller on the upper end so that the upper end could be held to one side of the drillhole, thus changing the direction. This device proved simple and satisfactory in operation.

The other special core barrel was an experimental barrel built to extract cores when the machine was hoisted to the surface directly after the drilling was completed. This special barrel was not delivered until the job was so nearly completed that experiments with it were not finished. However, enough work was done to demonstrate that such a barrel can be employed and will probably be used on future work in blocky ground.

In addition to the drilling mechanism and core barrels, there was a core puller consisting of a tapered ring and a number of fluted dogs. This was designed in such a way that it could be lowered around a core and when hoisting pressure was put on the core puller, the dogs would contract and grip the rock. After cores were removed there was always a certain amount of loose rock in the bottom of the hole. This was removed in an ordinary half-ton mucking bucket fitted with a safety hood. The hood was attached to the bucket in such a way that the bucket and hood were a unit, and the hood could not be lowered onto a man in the bucket or standing beside it. Water was handled with an ordinary clack-valve bailing bucket holding about 150 gallons of water. When the drill was in the hole, men were raised or lowered in a torpedo-shaped steel shell, 22 inches wide by 14 inches thick by 7 feet long, pointed on each end. A supply of fresh air in the bottom of the hole was required, and this was furnished by running compressed air through a half-inch hose which was lowered and raised by hand.

An ordinary bell-signal system was used, with special signals to fit the job.

#### Cycle of Operations

The drilling cycle was as follows:

1. Lower and line up the drill.
2. Drill.
3. Hoist drill from hole and move to one side.
4. Bail water and cuttings.
5. Lower core lifter, break off core, and hoist and dump core.
6. Bail water and cuttings.
7. Inspect and clean the bottom of the hole.
8. Run in 8 feet of water in preparation for next drilling cycle.

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SAFETY RECORD

Safety precautions consisted mainly of continual care in training men. For example, there was always an apprentice on the crew. Safety belts were worn whenever men were riding up and down the shaft. Safety belts were required to break the cores, was all done by electricity, with the men on the surface. No men were ever hoisted with heavy loads. The walls of the shaft were inspected and tested once each week from top to bottom for loose ground, and the general rule was never to do anything else when something could be done to increase the safety of the operation. Where loose ground was encountered, it was made safe before any operations were carried below. The result of these policies was to complete the hole with but one accident, and this only a simple leg fracture. Due to the small number of men, it was possible to supervise the entire operation closely and give thorough training to each man employed.

COSTS

Following is given the total cost of the 1,125 feet of shaft, including the plant (materials and labor of installation and erection) and the direct sinking cost, as taken from the books of the company:

Surface plant

Headframe, hoist house, and change house . . . . .	\$4,670.10
Transformers and 40-hp. motor . . . . .	576.31
2-in. and 4-in. air pipe . . . . .	660.24
150-hp. hoist (second hand) . . . . .	3,681.16
1 double-drum tigger hoist . . . . .	285.00
Tigger hoist . . . . .	152.29
Lighting and signal systems . . . . .	229.88
Total plant . . . . .	<u>\$10,254.98</u>

<u>Shaft Boring Equipment</u> . . . . .	5,333.58
Total plant and shaft boring equipment . . . . .	<u>15,588.56</u>

Shaft Boring Operation

Following is the cost of actual sinking operations:

Labor . . . . .	\$17,368.96
Supplies . . . . .	4,847.54
Power . . . . .	1,061.11
Miscellaneous . . . . .	<u>3,248.24</u>
Total operation . . . . .	26,525.85
Grand total plant, equipment, and operation . . . . .	<u>42,114.41</u>

(Depth of shaft, 1,125 feet)

Cost per foot

Labor . . . . .	\$15.44
Supplies . . . . .	4.30
Power . . . . .	.94
Miscellaneous . . . . .	2.89
Total	23.57

The above direct operating cost per foot does not include depreciation on the equipment. It does include the following items:

All direct labor and supervision, including hoistmen - also including the labor spent in supporting the walls where necessary.

Supplies - includes all direct drilling supplies, such as shot, drill shoes, small tools, oil and grease, and sand and cement for concrete.

Power - this item was taken from the company's distribution sheets. The power was not metered. The various motors in use have been mentioned above.

"Miscellaneous" consists principally of repair parts to the drilling and other equipment, and shop costs.

In considering the probable future costs, it must be remembered that the total costs covered the experimental periods, as well as the more satisfactory sinking periods. The experience gained in sinking this shaft covered so many types of ground that with holes 5 feet in diameter this experimental lost time should be greatly reduced in the future. The direct sinking costs should be further decreased by the use of heavier, better-powered equipment, and improvements in handling technique.

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Drill runners were paid \$5.20 per day, helpers \$4.40 per day, and the apprentice \$4.40 per day. The footage sunk was measured twice a month and a bonus of \$1.00 per foot was divided among the drill runners and helpers in accordance with the amounts earned. The apprentice and the foreman did not share in this bonus. At the beginning of the work, labor turnover was high, but during the last six months there were no changes in personnel.

#### COMPLETED SHAFT

##### Guide Installation, Cages, Conduits, etc.

Steel shaft guides hung on stud bolts were installed. The guides were set 1-1/2 inches from the walls, so electric conduit could be placed behind them. Since the walls are smooth, the guides were easily aligned and were fastened to stud bolts set in drill holes.

The cage was built with three detachable decks, each of which will accommodate 10 men comfortably. There was some question as to the efficiency of steel safety dogs on steel guides. However, the cage was tested empty and with a ton weight, and the dogs found to hold. The method of testing was to suspend the cage from a hemp rope, which was then sawed in half.

The cage contains an electric light, and signal knocker. Power for these is transmitted inside the cage through a trolley at a potential of 32 volts.

A 2-inch, fresh-water line extends down the shaft, and it is planned to run a 4-inch air column. The mine water is pumped at the main shaft.

The cage is circular in cross-section, with 2-inch wall clearance, and the sides are flattened to make room for the guides. The effective area is quite large, as follows:

Area of opening	19.7 sq. ft.
Cage area	15.8 " "
Percent effective	80.1 percent

#### APPLICATION OF METHOD

Future work may be expected to define the boundaries of application of the boring method and possibly to enlarge the field. However, based on present results the following limits seem indicated:

- Diameters - between 2 feet 6 inches and 6 feet.
- Depths - not less than 100 feet, not over 1,500 feet without cutting stations.

	<u>Crew-hours</u> <u>per foot</u>
Setting and moving drill	0.723
Drilling	1.150
Bailing	.509
Mucking broken ccores	1.150
Removing cores with core puller	.750
Drill maintenance and repairs	.104
Cementing walls	.265
Lost time	<u>.609</u>
Total	5.260

Those most familiar with the work feel that an average sinking rate of well over 5 feet per day should ultimately be obtained. That this expectation is not entirely unreasonable is indicated by the results for a 3-day period in good ground, as follows:

Footage, 3 days	21 feet
Direct labor, per foot	\$6.41
Other charges, per foot	<u>3.74</u>
Total per foot	10.15

#### Wall Support

It is difficult to give total costs for this part of the operation, because bad places in the walls ranged from small patches to ground so bad that a solid column of reinforced concrete had to be built, with the shaft opening inside of the column. The method used was simply to dig out the bad ground far enough back so a shell of reinforced concrete could be placed in the cavity. Then a lattice of reinforcing bars was built in the opening, an expandible form was placed, and cement was poured behind the form. 24-hour cement, quickened with 2 percent of CaCl<sub>2</sub>, was used for this work. During one period when a large proportion of the time was spent on wall support, careful records of time and materials were kept. They showed approximate costs of \$10.00 per foot of shaft for labor and \$2.50 per foot for materials, a total of \$12.50 per foot for the portion cemented.

#### Organization of Crew and Wages

The crew consisted of eight men, as follows:

- 1 foreman
- 3 drill runners (1 for each shift)
- 3 helpers (" " " " )
- 1 apprentice

## Ground Characteristics

Experience of others, and the previous experience of the senior author in drilling stratified and creviced ground and in drilling ground containing cavities, shows that such ground can be handled satisfactorily. Hard ground does not greatly delay the operation. Ground support may, of course, add to the cost, as it would in any type of sinking operation.

## Water Conditions

This is an unknown factor at present. The shaft described in the foregoing pages made about 7,000 gallons of water per day. Methods of handling heavy flows of water have been worked out on paper, but they have yet to be proved in actual operation.

## Inclined Holes

The writers have not had experience with inclined shot drill holes.

## A group of Holes

Since the helpers are idle most of the time, it would seem that a single helper could serve two or more drill runners. A foreman could easily look after two or more such holes. Thus, a group of holes, to produce in effect a two- or three-compartment shaft, apparently would not cost two or three times as much as a single hole.

Idaho-Maryland Mine  
Round Hole Head Frame  
Round hole was a 5 ft. diameter core-drilled  
vertical shaft



Photograph provided by David Watkinson



Idaho-Maryland Mine No. 2 Shaft Collar  
"Round Hole" 5 foot "Bored" circular shaft)  
Glenn Waterman & Joe Landis on left, Jim & ?  
on right. March 1943

Photograph provided by David Watkinson

Idaho-Maryland Mine 5ft. diameter  
cores from the Round Hole Shaft



Photograph provided by David Watkinson

Idaho-Maryland Mine  
Jack Clark with Round Hole Shaft head frame  
1941



Photograph provided by David Watkinson

Glenn C. Waterman  
11205 NE Wing Pt. Drive  
Bainbridge Is., WA 98110  
206-842-1352

September 3, 1997

Mr Jack Clark,  
437 French Ave.,  
Grass Valley, Calif. 95945.

Dear Jack:

A hello from the rain country. Hope all is well with you and that growing older isn't too bad after all!!

For sometime I have wanted to write a geological paper on the Idaho Maryland mine and finally got around to it. No one has ever written a story of the mine since it was re-opened in the twenties, and as far as I am aware no one has ever described the geology (including the Brunswick). The U.S.G.S. was denied permission (by MacBoyle) to study the mine during the investigations of Johnson, and very little of the geology of the mine was mentioned in his Professional Paper. Before all of we old timers are pushing daisies I thought it was about time for someone to write a story of the past.

I have contacted the editor of the quarterly publication of the Society of Economic Geologists and she is interested in my geological account. However, she wrote that I should receive permission from the owner (s) of the mine, giving me an OK to publish.

Shortly after my trip to G.U. Mark Payne seemed to scratch me off his list and he never answered my letters. Indirectly I have heard that the investigations leading to a possible re-opening of the mine have been abandoned. Thus, I am writing you and asking if you will give me the name (s) and address of the mine owners so that I can write them.

In the event the owner wants to know what I want to submit as a geological account of the mine, I am enclosing a draft of the proposed paper (without photos) which you could give to them. In any event I will write after I receive their address from you.

If you have comments on the paper I would be delighted to hear what you have to report.

Best wishes,



Glenn Waterman

Glenn C. Waterman  
11205 NE Wing Pt. Drive  
Bainbridge Is., WA 98110  
206-842-1352

September 30, 1997

Mr. Ross Guenther.  
Emperor Gold Corp.,  
P.O.Box 1836--12503 Brunswick Rd.,  
Grass Valley,  
CA 95945

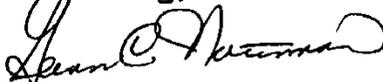
Dear Ross:

Many thanks for reviewing my Idaho Maryland paper and sending review notes by Mark Payne. I have incorporated many of his suggestions in the enclosed modified paper. I appreciate that you will give me permission to publish, pending final approval.

Also, thanks for the fine underground photographs. We took many underground photos during the period 1934-1947. They would provide a great historical geological record if someone hasn't already destroyed them!! Also, you did <sup>not</sup> include a copy of your June 1997 report prepared for the N. Calif Geological society. I would like to read it.

Also enclosed are some notes for Mark with respect to some of his comments. As you are well aware, few (if any) geologists agree with one another--only explainable by the fact that God was pretty complicated and geological study of his complexities yields diverse opinions. In my case, old age and lack of personal involvement in the final few years of IM operations left me a bit 'short'!!

Sincerely,



Glenn C. Waterman

# **The Idaho Maryland Mine (Version short)**

Glenn Waterman, SEG, P. Eng.

## **ABSTRACT**

The Idaho Maryland mine is a famous old California gold mine first located in 1851 and operated near continuously until 1914 when it was closed as ostensibly 'worked out'. The mine was reopened in 1919 and a new ore shoot, #3 vein, was discovered. It proved to be the mainstay of the mine until World War #2. Through the period 1937 to 1941 the Idaho Maryland Mine was annually the second largest gold producer in the United States, The mines were closed in 1957.

The structural controls of the veins, faults and oreshoots, the morphology and genesis of the veins, and the controls of gold distribution are of sufficient interest to warrant a geological description even at this late date.

Consideration of the overall genetic problem from source to sites of deposition poses a number of questions that need further study.

## **HISTORY**

The Eureka-Idaho-Maryland mine in the Grass Valley district, was one of the earliest California lode gold mines, located as the Eureka claim in 1851. The gently easterly-raking ore shoot was successively mined under the Eureka, the Idaho and then the Maryland claims. The mine was closed in 1914, considered as 'worked out'.

In 1915 Errol MacBoyle, a mining engineer, assembled all the Idaho group claims under one ownership, and in 1919 optioned the combined holdings to the Harry Payne Whitney syndicate. This syndicate dewatered the workings and started an exploration program. They found the highgrade #3 vein on the Idaho 1900 level but the vein was cut off above the level by a fault and they were unable to locate the faulted extension. The mine was closed in 1925, the property reverting to MacBoyle. He kept the workings clear of water and raised funds to explore for the faulted vein. Exploration in the Idaho located the #3 ore shoot under the fault above the Idaho 1900 level. This rich orebody was mined from the 1900 to the 450 level and largely sustained mine production through World War #2. In 1926 (according to information from Jack Clark) MacBoyle consolidated the Brunswick and Morehouse mines into the Idaho Maryland group.

The adjacent Brunswick mine was reopened in 1935 and later connected to the Idaho. At the onset of World War #2 the Government, by order L-208, forced closure of the mine (and other gold mines) because of the shortage of miners at base metal mines. The Idaho was reopened after the war and continued operations until 1957 when it was permanently closed because of dwindling and marginal grade ore reserves under a low price of gold relative to increasing production costs. As far as I know the US government never reimbursed the mine owners a single cent lost because of what 'we' thought were illegal mine closures. Indeed, most of the gold mines that were forced to close in 1942 were financially unable to reopen after the war years.

I was junior geologist, geologist and Chief Geologist at the mine during the period from 1934 to 1942 and then from 1945 to 1947. My senior associate and mentor during those years was Rollin Farmin who was an astute observer and developed new ideas of the genesis of gold quartz veins. I owe a debt of gratitude to 'Dusty,' a nickname bestowed by friends, for being my instructor and a good friend.

### PRODUCTION

Although production statistics are somewhat questionable historical records show the following:

EUREKA-IDAHO-MARYLAND	1866-1956	
1,961,607 tons	@ .79 oz/ton recovered	
BRUNSWICK-UNION HILL	1880-1956	
3,584,393 tons	@ .23 oz/ton recovered	
TOTAL: EUREKA-IDAHO-MARYLAND-BRUNSWICK-UNION HILL	1866-1956	
5,546,000 tons	@ .43 oz/ton recovered	?

### LOCATION and GEOLOGICAL SETTING

The combined Idaho Maryland properties are located in a fault-bounded structural block on the easterly side of the Grass Valley District. The important Empire-NorthStar-Pennsylvania properties are west of the Idaho block, more or less centered under and south of the town of Grass Valley.

The Idaho-Maryland veins occur along the contact of serpentine with diabase or porphyrite, a name given by Lindgren to cover a unit of steeply dipping volcanics with some interbedded sediments. The series of parallel Brunswick veins, in the hanging wall of the Idaho vein system, are in the porphyrite and extend into and under the Union Hill block where an increasing percentage of sediments are interbedded with the volcanics. The deepest level in the Idaho-Brunswick mine is the 3280, measured vertically.

The Empire-Star mines developed a series of rather gently dipping quartz veins most of which are hosted in granodiorite. Development and mining of these veins was continued to near the 12000 level (measured on the dip).

### DEVELOPMENT

The main inclined Idaho #1 shaft extends from the surface to the 2000 level. The Canyon winze from the 1000 level to the 2000 level generally followed under the gentle rake of the Idaho #1 vein oreshoot and developed the downward continuation of the #1 and #2 vein system to the 1900 level. The '30' winze from the 2000 level was sunk on the #2 vein to below the Idaho 2700 level. An early 2000 level Morehouse winze (old 45 winze) developed the Morehouse orezone below the 2000 level. A later three compartment winze (new 45 winze) in the hanging wall, was sunk to the Idaho 2400 level (=Brunswick 2700 level). The five foot diameter circular Idaho #2 shaft was bored from the surface to the 1000 level. It served for ventilation and supplies to the upper levels of the Idaho operation. In the fifties the 60 winze was sunk several hundred feet below the west end of the Idaho 2700 level to develop ore for stoping.

The westerly portion of the Brunswick was developed by the Old Brunswick inclined shaft which bottomed at the 1250 level (= Brunswick 900 L) The main Brunswick vertical shaft was bottomed below the 3280 mine level. The Idaho and Brunswick were connected on the Idaho 2000=Brunswick 2300 level. Two raises to the 2700 from the 3280 level also connected the Idaho and Brunswick workings. In the fifties Brunswick development was extended westerly toward and under the old Union Hill workings.

### MINE STRUCTURE

The easterly boundary of the Idaho-Brunswick block is a strong regional fault, locally called the 6-3 structure. It has a steep easterly dip, a North 10-30 West strike, and where exposed underground shows 20-30" of rubber gouge. The westerly boundary of the block is the easterly dipping Morehouse fault, which curves from near parallel to the 6-3 at the south to a more gently-dipping northwesterly strike to the north.

In my opinion all the NW by W. veins and faults within the 6-3-Morehouse structural block were formed by movements on these two important bounding structures. The displacement along these faults is not known. The steeply south-dipping veins and faults have steep up-to-the-east reverse movements. A paraffine model of the bounding structures with several internal veins, separated into segments by cutting with a heated wire, confirmed that movements on the 6-3 and Morehouse could produce the deduced and known offsets of faults and vein structures..

On and near the surface the N 70 W striking #1 Eureka-Idaho vein weakens as it continues northwesterly but a strong hanging wall branch curves westerly and then swings southerly and merges into the Morehouse structure. This relationship is clearly shown on the Idaho #1 shaft 1500 level. On the lower levels (Idaho 2700 to Brunswick 3280) as the #3 Idaho vein system approaches the Morehouse structure to the west, the veins flatten, bifurcate, become braided and pinch. The Brunswick veins on their general S 70 E strike and southerly dip terminate just under the 6-3 structure where they bend into the structure and/or split into irregular veins and stringer zones.

There is no evidence that postmineral movements of the 6-3 or the Morehouse faults cut off any significant vein mineralization although it was reported that on the Brunswick 2300 level erratic mineralization was stoped from fault material in a hanging wall branch of the 6-3 structure, and a flatter mineralized zone in the hanging wall showed faulted lenses of quartz.

Thus, the more or less simple veins and vein structures generally become complex multiple veins and stringer zones as they approach the bounding structures on the east (6-3) and west (Morehouse fault) The Morehouse orebody occurs above and below the 2000 level, sub-parallel to the fault structure. A low grade vein was explored above the 1500 level, and on the Idaho 2700 level a drill hole southwest (under) the Morehouse cut an 11.5 foot mineralized zone.

### VEINS and VEIN STRUCTURES

The major Eureka-Idaho-Maryland vein system occurs along the contact of

hanging wall porphyrite with footwall serpentine (#1 vein), or under fine-grained diabase (local name) dikes which are intrusive into serpentine (#3 vein system). Mineralization does not extend into serpentine; structures split and weaken when they enter this incompetent rock which cannot sustain continuity of structure.

The original northwesterly striking Eureka-Idaho #1 vein outcropped on the Eureka claim. The oreshoot occurs where the vein structure flattened updip to 55-60 degrees above a steepening 75 degree southerly dip. The movement on the structure was reverse with the hanging wall moving up steeply to the east. The area of relative tension-flatter dip produced a gentle down-to-the-east rake of the ore shoot.

Little is known about the updip termination of the Eureka-Idaho orebody although the original Idaho shaft (east of the Eureka) was sunk in waste several hundred feet until it cut into the gently east-plunging Eureka oreshoot.

The #1 vein orebody is worked out. Good ore was continuously mined from the surface to the Idaho 1600 level where the mineralization swung into the footwall on the gently south-easterly dipping Dorsey (#2) vein. Very little ore was discovered on the #1 vein below the Idaho 1600 level.

The easterly raking #3 vein system (in the footwall and more or less parallel to the #1 vein) was continuously mined from 1900 to above the 450 level, the high grade #3 vein extending from 1900 to above 900, the #13 vein, a westerly hanging wall branch of #3, from 1200 to 450, and 4-5 veins, easterly footwall branches of #3, from 2000 to above the 1800 level. When I resigned in 1947 an overview of mine development indicated little high grade ore remained above the 2000 level.

The #3 vein system terminates above the Idaho 450 level where the #13 vein flattens, turns into the ankeritized footwall serpentine, breaks into a high-grade stringer zone and pinches out. Similarly, high grade ore at the upward termination of the north-dipping 23 vein in the footwall at the east end of the Idaho 2000 level occurs in strongly ankeritized serpentine. The top 15-45 feet of mineralization shows high grade free gold along weak branching and curving fractures in talcose ankerite; there is little to no quartz. Thus, both the top of the southerly-dipping #3 vein system at the 450 level and the northerly dipping 23 vein at about the 1975 level pinch out up-dip where the vein structures flatten, and mineralization enters incompetent ankeritized serpentine.

The Brunswick-Union Hill mines developed a parallel series of steeply-dipping 10-30 inch quartz veins, gently-dipping braided quartz stringer zones near vein junctions, and the anomalous, curving, northerly striking #4 vein. Many of the ore shoots in the porphyrite occur where vein structures flatten updip from a steep 70-80 degree to more or less 50-60 degree southerly dip. Given the steep up-to-the-east reverse movements of the vein structures quartz deposition thus occurred in the area of relative tension, which in most cases produced a down-to-the-east rake. All the ore was deposited in the flatter areas of the structures. The top of many of the ore shoots, irrespective of elevation, occurs where the hanging wall structure steepens and the quartz mineralization turns into the footwall and pinches out as a series of narrow, sub-parallel, gently dipping high-grade quartz stringers,

In summary, both the Idaho vein system and the Brunswick-Union Hill veins show similar structural control of the ore shoots, i.e. ore in flatter sections of

the structures with the tops of many ore shoots generally as weakening stringer zones which depart into the footwall from a steepening hanging wall. It is significant that the tops of individual orebodies occur at different elevations.

### FAULTS.

In the Idaho block a series of strong to moderately strong pre and post mineral faults guide and in certain places cut the veins of the Idaho system. Thus, the #3 vein, discovered on the 1900, was displaced by the 'H' reverse fault. The I-J-K faults also show reverse post mineral movements. However, the much stronger 'L' fault, shows a different history. This fault, which forms the footwall along the upper and easterly portions of the 3-4-5 vein system, is a pre-mineral structure with post-mineral movement. In the upper levels the 50-60 degree south dipping 3 vein steepens up dip, bends into and parallels the 75 degree dipping fault, follows it up dip for a hundred or so feet and then pinches out with no evidence of fault cutoff. Likewise, the steep #5 vein pinches out against the L fault above the 1800 level. To the east on the lower levels below 2000 the L fault cuts the #5 vein.

Mac Boyle and his associates were obsessed with the idea that the L fault cut off the upper part of the #3 vein orebody. We (the geological department) were unable to convince them that up dip the #3 vein pinched out against the L fault, and the westerly branching #13 vein flattened, and pinched out about the 450 level. We drilled many diamond drill holes probing for a faulted orebody. Nothing was ever found.

It appears the L fault and the Idaho #1 and #3 vein structures have considerable movement inasmuch as they markedly displace the north-dipping serpentine block and, in the case of the #3 and #5 veins, provided a structure which guided the intrusion of pre-mineral diabase dikes. A careful study of the distribution of the serpentine mass and its offset along these structures would likely indicate the overall movement. I do not have a handle on the total offset along the Brunswick veins but it appears the movements are considerably less than the Idaho vein structures.

### MINERALIZATION

Most of the Idaho veins are 3-8 foot ribboned quartz veins but ribboning per se is no indication of gold content. For instance, the #13 vein, a westerly hanging wall branch of the #3 vein in the upper levels, is well ribboned below the 1100 level but the vein is low grade. Up-dip the ribboning persists but the gold content of the vein markedly increases. All of the veins in the Idaho and Brunswick have a common denominator: gold content increases up dip, with the highest grade quartz occurring in the area of vein and stringer termination.

Massive unribboned quartz veins in the Idaho appear to be late generation quartz and are usually low grade. These near-massive veins often contain 6-12 inch rotated and unsupported blocks of diabase and earlier ribboned quartz.

Idaho mineralization produced strong ankeritization of the serpentine, with ankerite, talc, fuchsite, and mariposite. Hanging wall diabase dikes are chloritized, bleached and carbonatized. The wall rocks of the Brunswick veins and the hanging wall of the Idaho #1 vein are narrowly bordered by bleached and somewhat pyri-

tized porphyrite; low gold values (.01 to .04 oz/ton) are often associated with the alteration.

The excellent grade Idaho #1 vein, becomes weak, the quartz narrows, and the structure steepens as it goes into porphyrite on both walls down-dip beneath the ore shoot. It appears that up-dip the structure refracted and developed a more gentle dip as it cut into less competent footwall serpentine.

The gold in the Idaho vein oreshoots generally occurs as discrete grains generally sub-uniformly distributed in the quartz. Occasionally there were spectacular pockets of high grade between areas of ribboning. This gold, usually collected by the shift bosses and geologists, averaged perhaps 500-1000 ounces per powder box! On the 1450 level in the 3 vein #3 raise a 3-4 inch band of nearly solid gold about five feet in length and ten feet up-dip provided funds for a new 750 ton Idaho flotation mill! However, the erratic and relatively minor occurrence of visible pockety high grade suggests that over-all it contributed but a relatively small percentage of the total gold contained in the Idaho veins.

Compared to veins along the serpentine-dabase or porphyrite contact, a higher percentage of the gold contained in Brunswick veins was in isolated pockets of high grade. This spectacular type gold occurred as interbraided masses with associated quartz, with the mass of high grade being perhaps 75% gold. Geologists and shift bosses (and miners!!) examined all new mine faces in drifts, raises and stopes and dug out the free gold. We used to figure \$10,000 a powder box of high grade.

Pockets of Brunswick high grade were not cut by ribboning and thus represented gold in the quartz introduced during a stage of mineralization. We were unable to detect any geological reason for the specific location of gold pockets.

### VEIN GENESIS

As previously mentioned, many of the Brunswick-Union Hill ore shoots in porphyrite occur where the hanging wall vein structures flatten up-dip from a steep 70-80 degree to more or less 50-60 degree southerly dip. The ore continues upwards until the hanging wall steepens to perhaps 75 degrees and the quartz mineralization then leaves the steepening structure and breaks into the footwall as a series of overlapping, gently-dipping frozen veins and narrow stringers which then pinch out. Where stringers of quartz finally terminate many detailed observations and thin sections conclusively demonstrated that no fractures nor joints extend beyond the end of individual stringers. Neither were there any hanging wall or footwall structures bounding the stringer zones. Careful observation of hundreds of terminations of irregular narrowing frozen veins and stringers suggests that the quartz 'solution' must have thrust its way into fractured rock, following weak fractures until they terminated. Identifiable banding in stringer walls and at an angle to narrowing stringers and frozen veins was wedged apart by the introduction of the quartz. If the quartz were removed the banding would assume its original attitude.

The above observations (and others) suggest that the silica solution was intruded into fractured wall rock, wedged apart the walls of the fracture and deposited quartz. It is likely that as the quartz was injected the pressure of the injection may have extended a fracture and concomitantly filled it.

Although prominent ribboning indicates multiple stage development of veins, there is still strong evidence of a vein-dike type genesis. In the Idaho I mapped a 45 degree dipping four-foot gabbro dike cut by the Idaho #3 vein and fragments of the gabbro were carried 'up hill' inside the vein walls. In other instances 6-18 inch fragments of ribboned quartz and hanging wall diabase and/or footwall ankerite have been engulfed, moved and rotated by the introduction of low grade quartz. These angular blocks of various sizes are truly unsupported, being completely surrounded by quartz. i.e. they are suspended within the quartz, a difficult job for a dilute solution. Arguments have been posed that the fragments may not be unsupported, that they are in contact with other fragments and wall rock behind or in front of a vein face. In several instances I dug into fractured vein quartz, uncovered an inclusion and further exposure proved that it was entirely supported by quartz on all sides. Often isolated fragments within vein walls do not represent immediate hanging or footwall rocks. Thus, these inclusions in many cases have been moved by the vein-forming 'solution'.

The positive evidence that although the Idaho and Brunswick vein systems occur in diverse hosts the mineralizing 'solution' was able to support fragments of wall rock and ribboned quartz, move them away from their points of origin and uphill within vein walls suggests a forceful injection of a concentrated silica-water solution rather than that a dilute hydrothermal solutions containing silica deposited quartz in 'open spaces'. Farmin's descriptive papers detailing some of the evidence for this vein-dike type genesis are tabulated in the bibliography.

The evidence that serpentine was ankeritized and diabase and porphyrite chloritized during the mineralization event indicates interaction between the vein forming solution and the wallrock. Careful examination of gold and sulfide minerals in frozen veins and stringers indicates one stage of mineralization; there is no evidence of multiple stages with the introduction of 'late gold'. Further, the plumbing problem of introducing 'late gold' more or less uniformly into thousands of quartz stringers is enough to negate this explanation. Gold with minor sulfides occurs erratically scattered through the quartz.

In the steeper-dipping ribboned vein areas of Idaho and Brunswick ore shoots, although there is ample evidence of multiple stages of mineralization, there is absolutely no evidence to indicate that the gold was introduced late in the mineralization event. It appears that the gold was introduced at the same time as its quartz host,

Indeed, in the Norambagua mine in the southern part of the Grass Valley District, I carefully examined several polished slabs of 4" quartz veins which showed gold settling around comb quartz at the bottom of the gently-dipping veins. Individual 1" cut samples across a vein showed a ten-fold increase of gold towards the bottom of what appeared to be a single-stage mineralization event. It appears the gold and quartz were introduced together, the gold was precipitated and then settled towards the footwall around comb quartz which had formed on the vein footwall.

The quartz veins in Brunswick ore shoots below the top stringer zones show some ribboning but usually no more than several ribbons across a 1-3 foot vein. This suggests, at most, only several structural interruptions during the period of mineral-

ization. There are no ribbons in thick footwall stringers at the top of ore shoots. On the other hand the Idaho veins beneath the near-flat upper terminating stringer zones show prominent ribboning. The only reasonable explanation for the observed ribboning is that it represents wall rock sliced during multiple movements of the vein structure. Each ribboning episode likely represents movement followed by entry of additional vein material. I was unable to discern any visible evidence that indicated the vein quartz had 'intruded' or filled a shear or foliated zone with the ribbons representing unreplaced septa of wall rock.

It is significant that although the Idaho and the Brunswick vein systems occur in different wallrock hosts the oreshoots consistently show an increase in gold content updip until they terminate as stringer zones, pinching out against L fault, or bending or splaying into the 6-3 and Morehouse structures. And it is also significant that the termination of ore shoots was above the present surface (Idaho #1 and Brunswick #1 veins), and at various deeper elevations i.e. Idaho #3 at 450 level, Brunswick 32 vein at 500 level, Brunswick 16 vein at 580 level, Idaho #5 vein at 1600 level, 23 vein at the 1975 level and other veins (I can't recall the numbers) at other elevations. The vein structure controlled the top elevation of an ore shoot and there is no evidence of mine-wide gold zoning. I was unable to deduce the geological control of the location of the changes in dip of vein structures except the Idaho #1 vein where the structure in porphyrite flattens (refracts) where it cuts into footwall serpentine.

The sulfide content in the quartz veins was pretty low, perhaps 4% in Idaho veins and 2% in Brunswick veins. Pyrite is the principal rather uniformly distributed sulfide. Chalcopyrite increases updip. It is often associated with very high grade ore near the tops of the Idaho veins. Galena and sphalerite are rare. Petzite was often noted in high grade ore.

Brunswick veins in the porphyrite contained a minor amount of scheelite. As drifts were pushed westerly into the Union Hill area, where sediments interleaved with volcanics became more prominent, the scheelite content in the veins increased. Where one or both vein walls were carbonaceous (slatey) sediments, in several instances gold was found in the walls, undoubtedly precipitated by the carbon. Old reports suggest transverse structures were in part responsible for localizing the gold.

The many sub-parallel productive veins and branch veins in the Brunswick (about 20 veins were stoped) are horizontally more or less separated by 100-200 feet. Downdip beneath raking ore shoots the gold content of the quartz vein is meagre, the vein narrows, the carbonate content increases, and finally the mineralization pinches out. The vein structures continue at depth but are not impressive. Nonetheless, careful mapping in crosscuts disclosed barren and near-barren structures with marginal alteration. Correlation of these structures to upper or deeper levels indicated areas of projected flattening which were successful targets for new ore shoots.

The genesis of these gold-quartz veins brings up difficult questions in addition to a permissive versus injection theory of vein emplacement. I believe that the primary source area of the 'solutions' was a cooling granitic body (or a cupola)

having a residual water and silica-rich center that also contained, gold, sulfur, metals etc. Inasmuch as most of the Empire-Star veins to a vertical depth of nearly a mile are in granodiorite it is likely the source of the Idaho-Brunswick veins in porphyrite and/or serpentine was granodiorite possibly 5000 feet below the deepest 3280 level.

Some writers postulate that vein material in mesothermal veins may be leached from wall rock by circulating ground water or hot magmatic water. The porphyrite wall rock of the Brunswick veins outside of the narrow band of altered rock bordering the veins is fresh, relatively unfractured and shows no evidence of pervasive leaching of anything. Inasmuch as it is difficult to believe that gold and silica were leached from the granodiorite wall rock of the Empire-Star veins and because it is likely the Idaho-Brunswick and Empire veins were genetically related to a granodioritic magma I do not believe vein wall rocks were the source of the vein material.

I wonder whether structural movements controlling vein deposition far above such a deep source would have any effect on solution travel from that source. I cannot believe that 6-3 and Morehouse fault movements would stimulate solution travel from a source 5000 feet below the areas of vein deposition. So, we pose the question, what did? And then if we pose that question for ribboned veins, would many small structural movements have any control over the movement of 'solutions' upward several thousands of feet to areas of deposition? What was controlling silica entry, where was the silica 'solution' just before the movement that produced slicing of walls (ribboning)? Was it waiting 'just below' points of precipitation or did it have to travel 100?, 1000?, 5000?, feet to 'get there'?

One supposes that dikes intruded into wall rock above a source magma continue downward to that source. Do quartz veins also continue downward to their source or are there barren sections along which 'solutions' traveled to areas of deposition thousands of feet above? Or does a conduit filled with silica, water etc., under what would have to be considerable pressure, extend upwards thousands of feet, ready for the tapping by near-surface structural movements?

I believe that whether quartz veins were 'intruded' or were deposited from dilute solutions would effect the thinking about the questions posed above. But if we are to fully understand the genesis of mesothermal gold-quartz veins we must quantify 'solution' travel from source to where the veins were deposited.

#### SAMPLING and GOLD DISTRIBUTION

At the Brunswick each drift face was routinely sampled and mapped, usually on a daily basis. The geologist and sampler also recorded the particle size, distribution and amount of visible gold, if present, and collected any high grade. A sample of the vein was cut in the quartz after any high grade had been bagged. It would have been impossible to determine an accurate overall grade of a vein by cutting a sample across a pocket of high grade. Thus, the geologists notes, tabulation of size, amount and distribution of gold, face samples, and the location of the drift face within the overall pattern of the ore shoot were integrated to determine if the vein should be stoped. To indicate the high overall value of pocket gold, in the heart of

the #16 vein oreshoot the erratic cut sample average was, as I recall, about .10-.15 oz per ton but after qualitatively factoring in the amount of high grade extracted from the vein faces the average in-place grade of the vein was calculated to be about .35-.50 oz. per ton.

Until the last several operating years of the early forties Brunswick, drifting and raising on contract, and days pay shrinkage stoping of 2-4 feet veins excavated about as much waste as quartz so that in-place vein grade was much higher than muck grade. In about 1940 a new mine superintendent changed the stoping method to resuing and/or sorting and mill grade markedly improved, of course at an increased mining cost per ton. Calculations comparing the two mining methods indicated that there was no significant improvement in cost per ounce under the sorting program compared to the earlier shrinkage stoping method.

Sampling in the Idaho was minimal. Very few veins were routinely sampled. Mining was controlled by whether a vein was ribboned or not, and by the location of the vein within the overall pattern of the oreshoot. Actually, almost all the quartz was mined.

The production statistics for Idaho ore are quite misleading. During the period when I was working at the mine it appeared to be the operating policy of management to put nearly all the mine muck through the mill and let 'it' collect the gold rather than underground sorting, resuing, or attempting to minimize waste produced from caving of the normally unstable ankeritized footwall. There were no waste chutes from 2000 to 1000 nor from the 1000 to the 450 level; all the muck from stoping plus development and crosscuts waste that couldn't easily be dumped into a nearby open stope was put in the ore chutes. Waste produced on the 1000 and 2000 levels and below 2000 were handled separately, hoisted and hauled to discard.

Thus, I would guess that all the Idaho ore sent to the mill consisted of a higher percentage of waste than quartz so that in-place vein grade, on average, was at least two to three times production grade. I suspect that the in-place grade of the 3-6 foot #5 vein above the 2000 level averaged 5-10 ounces gold per ton; the #3 vein in the upper levels probably averaged 5 ounces per ton.

After the war, when operations were largely centered in the Brunswick block it became vital that mining costs per ounce be reduced in order to program profitable operations on the moderate grade ore left in the Brunswick. Farmin developed a new mining method that markedly decreased waste mined in stoping and I developed a contract system for stoping that paid miners per square foot of vein footwall exposed by their drilling and blasting. Contract prices per square foot depended on the width of the vein; miners were only interested in drilling and blasting the quartz and thus blasting of waste was minimized. All other underground operations were also put on contract. The result was a marked lowering in operating costs and cost per ounce and, almost as significant, the miners were happy; their take-home pay had increased.

During the operating period immediately after the war it was necessary to develop a reasonably accurate evaluation of the grade of ore to be treated in the Brunswick mill at future dates in order to know what the mill would 'provide' in the short term (and pay the bills!!). A refinement of stope-sampling methods com-

bined with time of flow of ore to the mill yielded a future grade to the mill with an accuracy of about 90%. Muck samples were used at assay value and not "cut," as is common practice at many gold mines.

#### EXPLORATION POSSIBILITIES:

There are numerous exploration targets in the Idaho-Brunswick block. Although it is almost certain that because of swelling ground all of the drifts in the Idaho above the 2000 level are caved almost beyond recognition, the Brunswick development openings should be in good shape.

It is intriguing to contemplate what would be developed on levels below the 3280 as the 6-3 and Morehouse structures approach each other at depth. One suspects an increase in the fracturing of the ground with perhaps a more complex structural pattern guiding mineralization. The grade of quartz is the \$64 question.

#### SUMMARY

Geological work at the Idaho-Brunswick disclosed several important geological controls of these mesothermal gold-quartz veins. Some of these may be applicable to understanding the geology of other mesothermal veins.

1. Vein structures and faults are genetically related to movements on strong boundary faults.
2. Brunswick oreshoots commonly terminate (a) up dip where the hanging wall steepens and the quartz goes into the footwall as a stringer zone which pinches out or (b) veins curve into or break up under the easterly bounding 6-3 fault.
3. Idaho oreshoots either (a) pinch out up dip against the L fault, or break into gently dipping stringers where the vein enters incompetent serpentine, or in deeper levels flatten and split near the Morehouse and 6-3 structures.
4. The upward termination of oreshoots may be at any elevation.
5. There is an increase of gold in quartz up dip with the highest grade quartz at and near the upward termination of the quartz shoots.
6. The ore forming 'solution' was capable of lifting, transporting and then supporting inclusions within vein walls, and wedging apart and extending fractures in stringer zones.
7. It appears the ore forming 'solution' was similar to that proposed in the intrusive vein-dike theory by Spurr many years ago, i.e. liquid dissolved in silica was injected rather than a dilute solution of silica in liquid permissively filled open spaces.
8. There is no evidence of 'late gold', nor mine-wide gold zoning.
9. Pockets of 'high grade' in many Brunswick veins are an important percentage of total gold content and pose a problem in determining overall in-place vein grade. In the more ribboned Idaho veins, where I believe there were more periods of quartz introduction and the gold more widely distributed, specks of gold are quantitatively more important and routine sampling would approximate average vein

- grade.
10. Chalcopyrite is the sulfide most commonly associated with high grade ore.
  11. Scheelite increases in the veins where they cut into areas of sediments interbedded with volcanics. Gold in wallrock carbonaceous sediments appears to have been precipitated by the carbon.
  12. What controlled the movement of 'solutions' from a deep source to areas of vein deposition is a question that needs further study.
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September 30, 1997

Dear Mark:

I appreciated your review and notes re. my I.M. paper. I have made some revisions to the paper, many of which incorporated your comments and suggestions. I sent the revised version to Ross. There are several items I wish to discuss with you but, as I wrote Ross, geologists rarely agree, we only try to understand what God had in mind!

It is a fine contribution to be able to up-date my historical records to document the entire production record of a great mine operation. Thanks.

I was a bit confused with your comments following the "Rose Garden" Idaho 2000 level development. I was unaware of any drifting along the 6-3, and any mineralization, faulted or otherwise, along or contained within the structure. That the "vein" was flatter than the 6-3, dipping northerly and was faulted opens up a new chapter in the life of north and south dipping veins. The map I had only shows a southeasterly drift on 23 vein up to the 6-3. I am sanguine that the general top termination of the 23 vein just above the 2000 level and indications of diabase dikes in the hanging wall (drill holes), that downdip the vein will become 'attached' to the diabase which should provide a firm footwall or hanging wall and that the vein may then persist to depth--rake and economic viability entirely conjectural.

I think the historical records confuse the Morehouse structure and the Morehouse vein--in fact on the Idaho 2000 level I am still confused!! That mineralization was found under the Morehouse on the Idaho 2700 level (drill hole) leaves open the question of whether the mineralization was under the Morehouse vein OR the Morehouse bounding structure. If the latter, it is a pretty significant development.

In our Idaho "ore reserve" tabulations, on instructions I was directed to include all quartz veining above a \$4 (or \$5?) grade. Obviously some of this stuff wasn't ore--hence the name 'quartz reserve'. I left the mine early in 1947 and at that point in time practically all operations were centered in the Brunswick-- the Idaho workings had markedly deteriorated during the war shutdown period. So, unless there was a revival in Idaho mine exploration and development subsequent to my departure, my memory of 'what ore was left in the Idaho at 1947 should be about what remains there today.

The 201 Wz pillars from about the 1250 level elevation to the 1000 were good ore. I don't know if that ore was mined or not. There is no ore along the winze below about the 1250. The 1300 level #3 vein was waste, I don't believe any ore on 13 or 3 veins remains unstopped above the 1000 level. The 1050 #3 vein (high grade) was mined to the 1000 level. I don't believe there is any ore left below the stopes on the #13 vein--it was markedly lower grade and less significant with depth below the 1100 level.

There may be some blocks (faulted by K Fault) of #3 vein above and below the 1500 west drift on #3 vein. There may be some #3 raise pillars remaining above 1900. although some #3 vein ore was mined from under the raise. I doubt that there is anything of significance remaining on #4 vein-- as I recall it's strike length shortened

up dip and finally became a minor link between #3 and #5 veins. There is no ore remaining on #5 vein. This high grade was mined to the bitter end above the 1800 level.

In summary, your 'abundant evidence' to the contrary notwithstanding, I do not believe there is any appreciable ore left in the 3 vein and its appendages above the Idaho 2000 level. If indeed development or exploration at the Idaho above the 2000 level after 1947 found new ore then I cannot comment on that. I was involved in most of the reporting (until early 1947) at the Idaho and I cannot recall any of my records documenting or showing any enthusiasm about ore remaining and available for mining.

Regarding the #4 vein. It showed its best development length on 1900 level where it was a good link between #3 and #5 veins. You will note that strikewise it became longer and longer and less significant below 2000. As I recall it 'went to pot' a little ways above say perhaps the 1850 level and became much less obvious as a finite good vein link between the two veins. Actually, the #3 vein was considerably flatter than #5 and thus the #3 and #5 became a continuous projectable vein zone above say above the 1700 elevation although the #5 vein at that elevation had 'pinched out' and the #4 had vein merged with the #3 vein and 'disappeared as an identifiable vein. Thus, your comments about the #4 high grade ore between 1800 and 1900 level document that the best ore occurred near the top of the quartz shoot,

Regarding the 'solid gold band' in #3 raise near the 1400 level, my only knowledge of this occurrence came from a comment by Bert Crase. He didn't tell me how many ounces were contained nor whether it was 100% gold or say 50 percent. He only indicated a heluva spectacular band of gold that paid for the new mill.

Farbeit from me to disparage the work of McKinstry and Ohle. I was with Hugh on one consulting job, and in the old days Ernie and I communicated from time to time. Nonetheless, even though I was quite aware of the replacement explanation for ribboning in mesothermal gold-quartz veins my detailed factual mapping of practically all the mine workings in the Idaho (at 1"=20') strongly suggested that replacement was not a completely viable explanation for the ribboning I observed. There was NO foliation that bent into the veins and became ribboning. In fact, any structural patterns were always almost exactly parallel to the vein walls. There were practically no 'ghostly' relics of partial or interrupted replacement. In one instance a 2" quartz 'band' between two ribbons abruptly cut diagonally across the vein, and across earlier formed ribbons and vein material. I still worry about ribbons--no explanation seems completely adequate, and that they may represent earlier gougy walls (most ribbons seemed to be extremely chloritized diabase) is not correct (at the Idaho). That 'ribbons' became structurally separated and were interfilled by a dilute hydrothermal solution which deposited quartz is not adequate. That they represent successive movements along vein walls and were inflated by a silica solution under pressure seemed reasonable. I hang my hat on that line.

With regard to the gold in carbonaceous rocks. It seems reasonable to believe that the gold was largely precipitated by the carbon. That transverse faults were in part a causative control dictates they were pre-mineral. Of course, I don't know anything about these "20 set" structures.

Cheers,



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October 30, 1997

Ross Guenther, Project Manager,  
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Dear Ross and Mark:

Mark, I really appreciate your taking the time to write such an informative letter concerning the geology and exploration data on the Idaho and Brunswick. You included a great deal of information that post-dates my last personal knowledge (1947) of the mines. It is obvious that not realizing that significant work that was done from '47 to '57 a certain amount of up-dating was needed. I hope I have added comments that will suggest the exploration potential for more "ore", although the term 'ore' depends of gold price, costs, government meddling etc. Although the engineering data are minimal I do believe that the geological aspects of my paper (although perhaps debatable) are significant and a worthy contribution.

Let me respond to some of your thoughtful comments in sequence rather than entering into a dissertation on the geology.

Serpentine Melange etc.

In my early days at the Idaho I had inherited the (school) belief that serpentine was believed to be a residual product of alteration of a 'gabbroic' type intrusive. After mapping and logging thousands of feet of nearly homogenous serpentine and never finding any residual or only partially altered gabbroic rock, I began to wonder if the serpentine itself was an intrusive. How does this square with your thoughts?

At the Idaho it was our opinion that the diabase dikes intruded the serpentine along structures and were distinctly later, and that these structures were related to pre-mineral faults and later vein structures. Would you class the dikes as members of your sheeted dike complexes and related to the serpentine?

We never really thoroughly investigated the three-dimensional boundaries of serpentine bodies but it was our opinion that 'they' dipped northerly and that where vein-type structures in porphyrite cut into serpentine and refracted (flattened), that a potential of ore was a possibility--(Idaho #1 vein as an example)

"Mine Call Factor" etc.

There is no doubt that a reasonably accurate in-place value of Brunswick veins cannot be determined by cut-samples (as you suggest, muck samples would be better although they would include a lot of waste). However, geological drift-mapping notes which indicated the presence, and number and size of specks of gold plus high grade if present, were used to indicate areas of vein worth stoping. The position of the developed vein within the pattern of stoping and rake were used almost irrespective of

samples or visible gold. In most cases these indicators proved to be correct. All this says is that the distribution of gold in Brunswick veins is erratic but that visible gold was strongly indicative of (then) ore. Now, with higher gold price being offset by anticipated much higher operating costs a new measure of vein values must be developed.

The practical significance of visible gold was reasonably documented to my satisfaction when I posed the following: assume the smallest speck of gold I could see (determined by looking at assay cupels), assume a vein 18" thick and seven feet from drift back to sill, and that I could identify gold a millimeter (or perhaps less) into a vein face, I calculated (if my memory is not defunct) that one speck of gold occurring in each millimeter of vein would yield an assay of .01 oz. So, it took more than one wee speck in a face to make ore and, in the matter of whether development quartz that had to be hoisted was ore or should be discarded, we usually sent it for ore if we saw the equivalent of three or more specks of gold in a face, using mill per ton costs assuming the 'ore' was a plus to the normal mill supply plus tailings grade as a measure of cut off, and that the mill had capacity for 'extra' ore.

With respect to veins cut by drill holes (then EX) anytime the core showed any gold we considered it very significant, irrespective of assay.

I don't remember ever working with a Joseph Slouber--he must have been at the Idaho after my time. Following the comment about Slouber (which perhaps reflected sampling after I left the mine): we DID NOT try to eliminate ALL the visible gold from our cut samples--only the "high grade" which occurred in distinctive small to large interwoven blobs and seams and masses of gold cemented by quartz.

It is perhaps significant that as I remember high-grade in vein faces the 'high grade' usually occupied a three-dimensional area of perhaps 8" x 5" x 5". Rarely was 'high grade' smaller than 3x4x3". Inasmuch as all collected 'high grade' was turned into the manager for dumping into the mill (too bad) we did not have an accurate handle as to the oz of gold contained in bags of high grade.

In my career I have had experience in dealing with ore deposits where the gold is in narrow quartz stringers and in veins. I have concluded that it is usually nearly impossible to get an accurate over-all grade of a drilled or a normally sampled area when there is a non-uniform distribution of gold. A significant particle of gold may be in or out of the sample portion sent for final assaying, and reported assy grade may thus be widely variable. This, of course, relates to the distribution and size of the gold. If gold occurs in significant size then sampling and assaying may be really suspect as to overall accuracy in drill core almost irrespective of core size. I make these comments because in the Idaho-Brunswick area I believe that any drill hole that cuts a significant vein is worthy of serious attention, irrespective of the assay of the core.

One other comment. I strongly suspect that the deviation of drill holes from a projected collar orientation may be VERY significant. Long holes should be surveyed. I recall a 150 ft. 'horizontal' drill hole from the Idaho 2000 level that cut a small vein. We drove a crosscut along the hole and it departed into the back at 40 feet, We cut the vein at 70 feet (?) and turned west along it. At a distance of 20 feet we found the drill hole coming down out of the back with a bearing 30 off the collar and a dip of minus 30 degrees. That is quite a deviation within a short distance!!!!

Rose Garden etc.

I can't recall diabase dikes in the 1000 L Mitchell crosscut so I can't answer your

*see geological mapping*

question if they had structural contacts or not. I do recall the northwesterly striking rather gently dipping #10 vein. There were erratic values and irregular mineralization on the 1000 level and the subdrift above but values were not consistent nor too attractive and work was terminated. I rather suspect that down-dip the mineralization should strengthen.

I call your attention to a north dipping surface drill hole perhaps 500 feet (or more) westerly from #2 shaft (we were drilling the footwall of the L fault to locate a faulted #3 vein) To the north of the fault (perhaps 200 feet below the surface) we cut a narrow vein (several inches) that showed a lot of gold, We drilled a deviated hole and it also showed a lot of gold in the core. No one was interested in any follow-up.

#### Potential Ore above Idaho 2000

Gee, the work that was done after 1947 is indeed encouraging. Our 600 level irregular working westerly that finally reached the porphyrite contact and presumed #1 vein showed a barren structure, The later drill holes to the east are encouraging.

I recall that the hole on the west end of 1200-3D that was drilled northwesterly and finally cut mineralization at the L-#3 projection was encouraging but no one wanted to drive a crosscut that far. The west end of 1200 where we cut into the old stope deserves a drive westerly. The working did not show on any map and suggests another mineralized zone along #1 structure. Our east drive along the narrow vein in porphyrite was disappointing, but up-dip there remains an open area (increase in grade up-dip?) that might be beneath the 1 vein drilled from the 600.

I have always wondered about the mineralized and faulted area shown on old maps in a drift from a northerly footwall crosscut on the 1600 level from the Dorsey workings. Looks like an undeveloped vein.

There appears to be lots of places to investigate, both above and below 2000.

#### Controls of Brunswick High Grade.

I did not state that the intersection of steep Brunswick veins with flat (stringer) zones were frequently found to host high-grade pockets. I was rather clear to say that as the hanging wall of the 55 degree veins steepened the mineralization pinched, but often the mineralization departed into the footwall as excellent grade stringer zones. I cannot say if there were more or less high grade pockets in the narrow to 12" stringers, all I can say is that the ore grade (perhaps 50% waste) was excellent. Although I must rely on partial data from associates I never had the impression that there was more pockety high grade in the stringers

I know nothing about the "number" faults you mentioned nor do I recall that our daily mapping of almost all the workings disclosed sets of faults such as you describe. This is news to me. Certainly, in the steep Brunswick veins no one ever was able to deduce the reason, structural or otherwise, for the location of the high grade within vein walls.

I don't know anything about "the great disruption of the steep Brunswick veins". As I recall they were pretty simple structures, nearly barren beneath ore shoots and mineralization generally pinching out up-dip. A few minor slips did some damage but they were generally post mineral

### Ribboning

Of course I have seen quartz veins in many areas where residual ghostly remnants of partially replaced rock are clearly visible. Sections of The Mother Lode often shows this feature. There is little doubt that replacement was effective altho incomplete. However, in the Idaho the margins of ribbons are usually quite sharp, sometimes undulatory, but no evidence of rock in the process of being replaced, And I must repeat that never did I observe any evidence of original shearing, or mylonitic, or cataclastic structure in what is now ankeritized serpentine, nor in the compact nearly structureless hanging wall diabase and or porphyrite. Inasmuch as most ribbons appear to have been derived from the near massive hanging wall diabase the lack of angular structure seems to preclude it having been the progenitor of the ribbons.

### Additional Comments

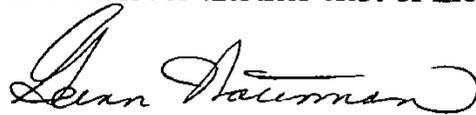
As I recall our 2700 level westerly drift off the "30" winze, what we considered as the westerly continuation of the #2 vein, began to flatten and the grade was dismal. We drove westerly until the vein curved into the #1 (?) vein structure at about the time I resigned from the mine. The newer 202 vein with ore grades was developed after I left. One interesting thing I recall was that in the raise immediately west of the winze (driven as a second outlet to the 2400 level) the vein was pretty low grade except for a narrow width (3"?) of quartz below (or above?) a narrow gougy slip that cut the center of the vein. This narrow section of quartz showed many colors.

I think I have changed or modified my manuscript to take care of the several perfectly reasonable suggestions you have made, I hope that the attached 'tome' is finally OK.

Gee, if I were a younger guy I would love to be a part of the revitalization of the Idaho-Brunswick. A part of my geologic heart is on IM mine problems and I have dreamed about them many times. What I do feel unhappy about is that I was pretty green and naive when I was at the Idaho. In retrospect we should have done a better and more thorough job in developing geological understanding. In partial defence I must say that geologists were not entirely welcome in the thirties and we were often left on the outskirts baying in the breeze when it came to exploration planning. Actually, the exploration programs were largely developed by MacBoyle and Crase and we heard about them when they started. We mapped and logged and sampled and surveyed and once in awhile were able to contribute an acceptable idea.

The Brunswick, principally under the superintendency of Jack Cowley, was an efficient and wonderful operation. The Idaho was a Cousin Jack controlled mine with one motive--follow the ore and stop 'high-grading'!!

I wish you guys well-- the old Mine deserves another shot of life!



Glenn Waterman--October 1997