Subsurface Drainage Conditions – Cleath Harris Geologists, Inc.

At the Coastal Commission hearing on March 11, 2010 members of the public expressed concern that the proposed trail could impact subsurface drainage in areas adjacent to the historic tarplant area D. Coastal Commission staff asked the City to prepare a geologic report to analyze the subsurface drainage in the vicinity of the proposed trial. Cleath-Harris Geologists, Inc. conducted a site visit on May 19, 2010 and conducted seven borings in the center line of the proposed multi use path and adjacent to the historic tarplant area D. The boring locations are mapped on the RRM Preliminary Trail Alignment Study mapping found in Appendix 29.

The results of the geologic report conclude that the subsurface conditions that exist on site, combined with the design and construction of the trail would not impact the subsurface drainage flows to the historic tarplant area D.

The report is attached to this summary.

Cleath-Harris Geologists, Inc.
11545 Los Osos Valley Road, Suite C-3
San Luis Obispo, California 93405
(805) 543-1413

June 15, 2010

Michael Sherrod
RRM Design Group
3765 South Higuera Street
San Luis Obispo, California 93401

SUBJECT: Subsurface drainage conditions in the vicinity of the Proposed Arana Gulch Trail Site, Santa Cruz, California

Dear Mr. Sherrod:

Cleath-Harris Geologists (CHG) has investigated subsurface drainage in the vicinity of the proposed Arana Gulch multi-use trail in the City of Santa Cruz, California. The purpose of the investigation is to evaluate whether a proposed trail with a mechanically compacted base and pavement would interfere with subsurface water flow that is being tapped or could be tapped by the Santa Cruz tarplant. To determine the characteristics of the subsurface and the depth to groundwater, CHG advanced seven hand-augured borings to depths ranging from five to fifteen feet depth along the proposed trail alignment on May 19, 2010. Prior to drilling, the boring locations and ground surface elevations were surveyed by a licensed surveyor with RRM Design Group. Boring coordinates and ground surface elevations are recorded on the attached boring logs and in the table below.

Table 1

Boring	Survey Point	Northing	Easting	Surface Elevation (feet)	Total Depth (feet)
HA-1	6001	1,816,966	6,123,805	35	5.3
HA-2	6002	1,817,031	6,123,798	40	15
HA-3	6003	1,817,085	6,123,799	45	8.5
HA-4	6004	1,817,145	6,123,806	50	8
HA-5	6005	1,817,208	6,123,813	55	8
HA-6	6006	1,817,321	6,123,809	60	8
HA-7	6000	1,816,903	6,123,814	30	5

Survey based on California State Plane coordinate system

Materials from the borings were described using the Unified Soil Classification System. The color description of logged materials is based on Munsell Soil Color Charts, GretagMacbeth, 2000.

The seven borings were drilled on an undisturbed, southeasterly sloping surface underlain by pedogenic soil and partially eroded marine terrace deposits. The marine terrace is represented by a mix of terrestrially deposited sand, silt, clay and minor amounts of gravel, and by marine deposited clean sand. Material logged near the surface consisted of dark brown silty sand and sandy silt forming a loose and soft organic soil, bioturbated by burrowing animals and roots. Underlying the organic soil are predominantly silty and clayey sands and sandy clays with thin lenses of lower permeability clay. Thin lenses of clean, uniformly fine-grained sand were logged in borings HA-5 and HA-6, and a deeper unit of clean, dense, fine-grained sand was observed in borings HA-2 and HA-7.

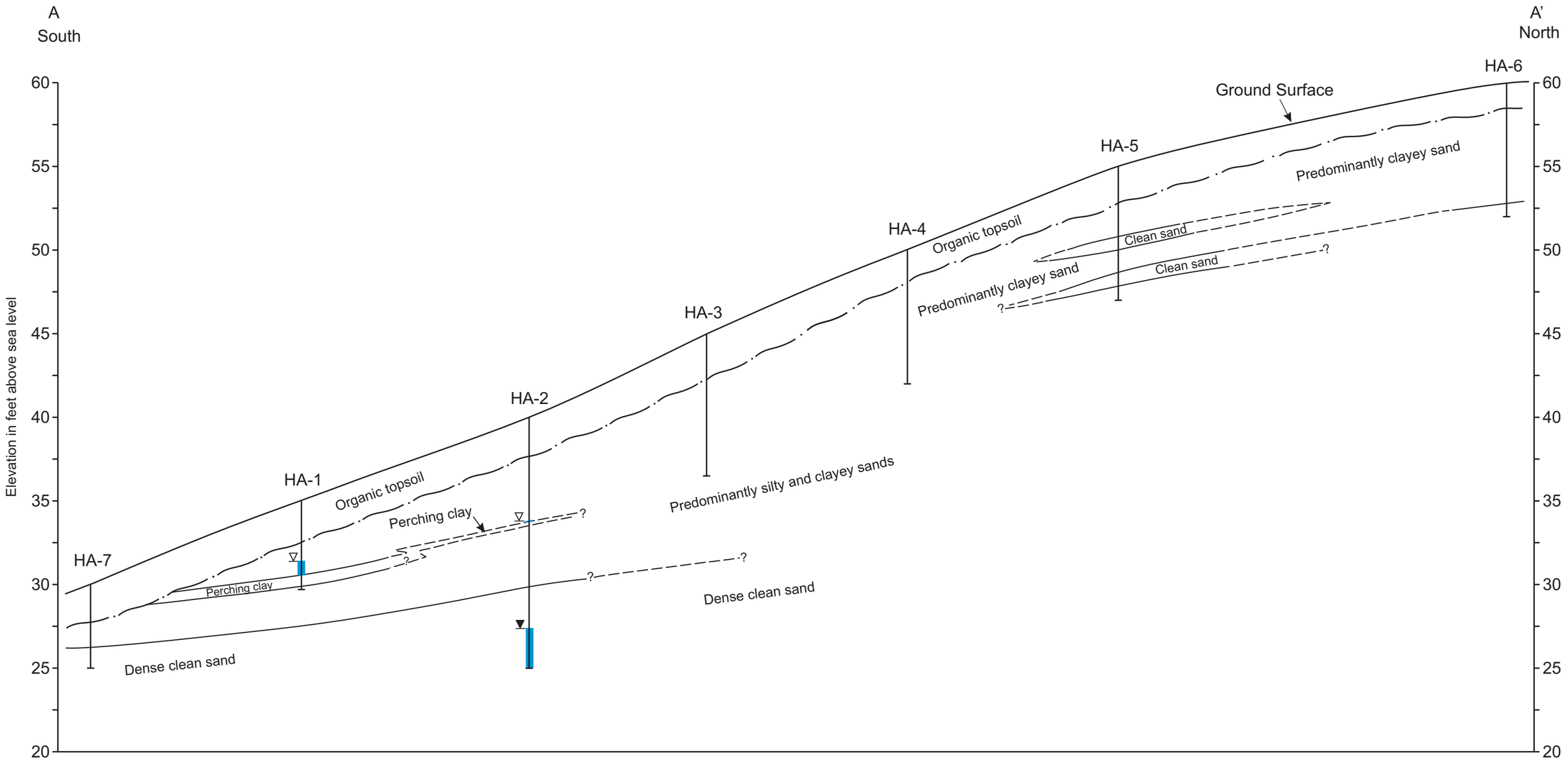
Moisture content ranged from damp to moist in the approximately two-feet thick organic soils. Shallow, saturated conditions were found above perching, low-permeable clay in borings HA-1 and HA-2, at approximately three and one half feet depth and six feet depth respectively. Groundwater moving through silty sand observed at boring HA-2 appeared as seeps from preferential flow paths of relative high permeability controlled by thin perching clay layers and possibly bioturbated materials. A deeper groundwater zone was observed in boring HA-2 at 12.5 feet depth within the clean, dense sand unit. The lateral extent of this deeper saturated zone is not known. Groundwater was not observed in borings HA-3 through HA-7. Groundwater was not observed in the lowest elevation boring, HA-7, although perched groundwater was observed in the nearby upgradient boring HA-1, suggesting that flow is impeded by the lower permeability organic soil layer. Geologic cross sections are shown in Figures 1 and 2.

The perched groundwater observed in borings HA-1 and HA-2 flows within preferential flow paths controlled by variable permeabilities, and the lateral extent of the deeper groundwater zone is undocumented. It does not appear that perched groundwater observed at borings HA-1 and HA-2 reaches documented tarplant sites as the flow is toward Arana Gulch and away from the tarplant sites. Site grading and soil compaction along the trail alignment in the vicinity of borings HA-1 and HA-2 could collapse existing or filled animal burrows and locally disturb other preferred groundwater flow paths in the vicinity. Groundwater beneath the proposed trail alignment north of boring HA-3 is considered to be at a sufficient depth not to be impacted by proposed grading and soil compaction.

The trail design by RRM Design Group will limit disturbance to the upper 10 inches of the subsurface, and will involve no compaction. The trail as designed and its location relative to historic tarplant populations will not adversely impact subsurface groundwater flow to mapped tarplant areas. If you have any questions concerning the boring logs, conclusions, or recommendations, please contact CHG.

Sincerely,
CLEATH-HARRIS GEOLOGISTS, INC.

David R. Williams
Associate Geologist



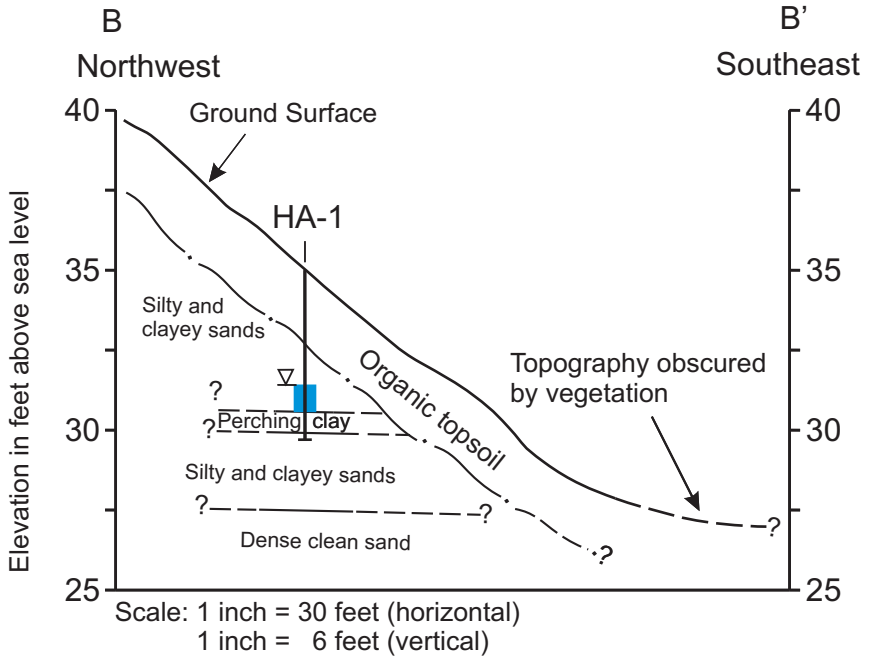
Scale: 1 inch = 30 feet (horizontal)
1 inch = 6 feet (vertical)

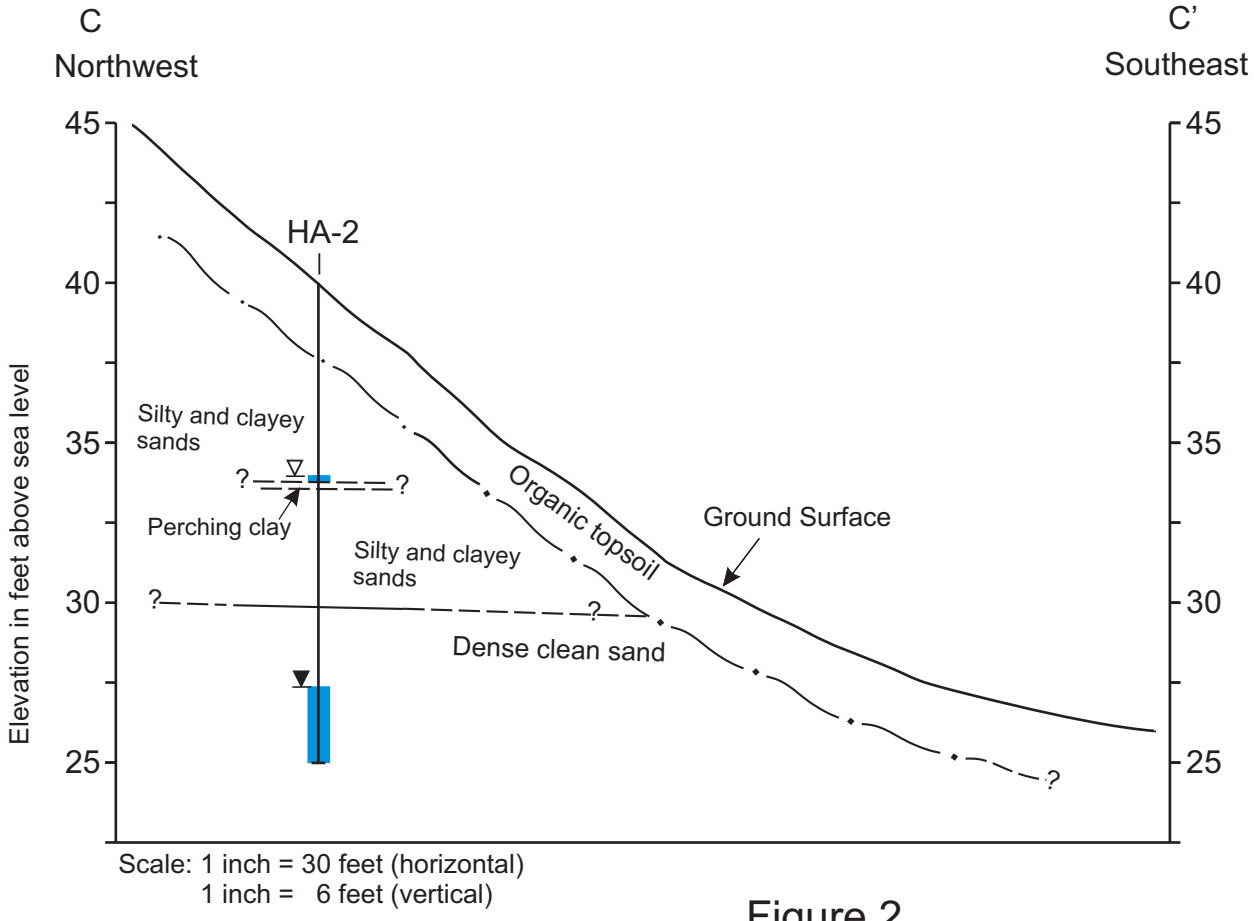
Explanation

HA-7	Hand auger boring designation
?	Geologic contact, queried and dashed where inferred
	Perched groundwater (inferred saturated lense in blue)
	Deeper groundwater zone (lateral extent unknown)

Figure 1
Geologic Cross Section A-A'
Arana Gulch Trail Site
City of Santa Cruz

Cleath-Harris Geologists, Inc.





Explanation

HA-2	Hand auger boring designation
?---?	Geologic contact, queried and dashed where inferred
▽	Perched groundwater (lateral extent of lens unknown)
▼	Deeper groundwater zone (lateral extent unknown)

Figure 2
Geologic Cross Sections B-B' and C-C'
Arana Gulch Trail Site
City of Santa Cruz

Cleath-Harris Geologists, Inc.

Attachment A

Boring Logs

Boring Logs
Arana Gulch Trail Site, Santa Cruz, California

Date: May 19, 2010
Geologists: Harris/Williams, Cleath-Harris Geologists
Drilling Method: hand auger

Boring HA-1
Elevation: 35 ft above sea level (RRM survey)
Total depth: 5.3 feet
Depth to top and bottom in feet

Top	Bottom	Thickness	Description
0	2.5	2.5	**Silty Sand (SM)**; dark brown (10YR 3/3); fine grained sand; organic; moist. Silt content increased to 40% and moisture increased from 1' to 2.5' depth.
2.5	4.5	2	**Silty Sand (SM)**; dark brown (10YR 3/3); weak dark red mottling (2.5YR 3/6); fine sand; common iron oxide nodules to ½" diameter; moist. Becomes saturated at 3.5 feet depth.
4.5	5	0.5	**Clay (CH);** dark yellowish brown (10YR 4/4) soft, moderately plastic; saturated.
5	5.3	0.3	**Silty Sand (SM);** dark brown (10YR 3/3); strong brown mottling (7.5YR 5/6); mostly fine sand with lesser medium to coarse sand; common iron oxide nodules to ¾" diameter; moist.

Total depth at 5.3 feet. Saturated at 3.5 feet depth.

Boring HA-2
Elevation: 40 ft above sea level (RRM survey)
Total depth: 15 feet
Depth to top and bottom in feet

Top	Bottom	Thickness	Description
0	3	3	**Silty Sand (SM);** dark brown (10YR 3/3); fine sand, angular to subangular; organic; moist. Silt content increased to 30% from 1.5' to 3'; common iron oxide nodules from 2' to 3' depth; moist.
3	3.5	0.5	**Silty Sand (SM);** trace gravel; dark yellowish brown (10YR 4/4), weakly mottled yellowish brown (10YR 5/4); fine sand; subrounded gravel to ¾"; wet.
3.5	5	1.5	**Sandy Clay (CL);** dark yellowish brown (10YR 4/4), weakly mottled yellowish brown (10YR 5/8); soft; mostly fine sand, trace medium; few iron oxide nodules; becoming slightly micaceous from 4' to 5'; moist, with increasing moisture from 4' to 5' depth.

Boring Logs
Arana Gulch Trail Site, Santa Cruz, California

HA-2 (continued)

Top	Bottom	Thickness	Description
5	8.5	3.5	**Silty Sand (SM);** dark yellowish brown (10YR 4/6); mostly fine sand, lesser medium; wet; thin saturated zone (seeps) at 6' depth approximately 3" thick on thin low-permeable perching layer with unsaturated zone underlying seeps.
8.5	10	1.5	**Sand with Silt (SP-SM);** yellowish brown (10YR 5/6), strongly mottled 10YR 5/8); fine sand, with trace medium sand; micaceous; moist, becoming wet at 9' depth.
10	15	5	**Sand (SP);** yellowish brown (10YR 5/6), strongly mottled 10YR 5/8; angular to subangular, quartzose; wet. Becomes saturated at 12.5' depth.

Total depth at 15 feet. Saturated at 6 feet depth.

Boring HA-3
Elevation: 45 ft above sea level (RRM survey)
Total depth: 8.5 feet
Depth to top and bottom in feet

Top	Bottom	Thickness	Description
0	3.5	3.5	**Silty Sand (SM);** dark brown (10YR 3/3); mostly fine sand, trace medium to coarse; organic; moist. Silt content increased to 30% from 2' to 3.5' depth. Becomes dark yellowish brown (10YR 4/4) with weak yellowish brown (10YR 5/6 mottling from 2.5' to 3.5' depth; trace inferred clast at 3' depth.
3.5	5.5	2	**Sandy Silt (ML);** yellowish brown (10YR 5/6); soft silt; fine to medium sand; slightly micaceous; moist.
5.5	6.5	1	**Silty Sand (SM);** dark yellowish brown (10YR 4/6), strongly mottled yellowish brown (10YR 5/8); mostly fine sand, lesser medium, angular to subangular; micaceous; few iron oxide nodules to ¼" diameter; 35 to 40% soft fines; moist, becoming wet at 6' depth.
6.5	8	1.5	**Sandy Clay (CL);** dark yellowish brown (10YR 4/6); strongly mottled yellowish brown (10YR 5/8); soft clay; fine sand; few iron oxide nodules to 1/8" diameter; wet.
8	8.5	0.5	**Clayey Sand (SC);** dark yellowish brown (10YR 4/6); strongly mottled yellowish brown (10YR 5/8); fine sand; wet.

Total depth at 8.5 feet. No observed groundwater.

Boring Logs
Arana Gulch Trail Site, Santa Cruz, California

Boring HA-4
Elevation: 50 ft above sea level (RRM survey)
Total depth: 8 feet
Depth to top and bottom in feet

Top	Bottom	Thickness	Description
0	1.5	1.5	**Silty Sand (SM);** dark brown (10YR 3/3); trace gravel; fine sand; moist.
1.5	2	0.5	**Silty Sand (SM);** trace gravel; dark yellowish brown (10YR 4/4), strongly mottled yellowish brown (10YR 5/8); mostly fine sand, lesser medium to coarse; gravel to ½", granitic clasts; moist.
2	3	1	**Sandy Clay (CL);** dark yellowish brown (10YR 4/6), strongly mottled yellowish brown (10YR 5/8) and dark yellowish brown (10YR 3/4); soft clay; fine to medium sand, angular to subangular; few iron oxide nodules; moist.
3	3.5	0.5	**Clay with Sand (CL);** dark yellowish brown (10YR 4/6), weakly mottled yellowish brown (10YR 5/8); soft clay; fine sand; moist.
3.5	5	1.5	**Sandy Clay (CL);** dark yellowish brown (10YR 4/6), weakly mottled yellowish brown (10YR 5/8); soft clay; fine sand; moist. Becoming strongly mottled with friable iron oxide nodules to ¼" from 4' to 5' depth.
5	5.5	0.5	**Clay with Sand (CL);** dark yellowish brown (10YR 4/6); weakly mottled yellowish brown (10YR 5/8); soft clay; fine sand; moist.
5.5	8	2.5	**Clayey Sand (SC);** dark yellowish brown (10YR 4/6), strongly mottled yellowish brown (10YR 5/8); fine sand, angular to subangular, mostly quartz; moist. Becomes weakly mottled and more uniformly yellowish brown; wet from 7' to 8' total depth.

Total depth at 8 feet. No observed groundwater.

Boring HA-5
Elevation: 55 ft above sea level (RRM survey)
Total depth: 8 feet
Depth to top and bottom in feet

Top	Bottom	Thickness	Description
0	2	2	**Silty Sand (SM);** dark brown (10YR 3/3); roots, organic; fine to medium sand; moist.
2	3.5	1.5	**Clay with Sand (CL);** dark yellowish brown (10YR 4/4); soft clay; slightly plastic; fine sand; moist. Slightly increasing fine sand content from 2.5' to 3.5' depth.

Boring Logs
Arana Gulch Trail Site, Santa Cruz, California

HA-5 (continued)

Top	Bottom	Thickness	Description
3.5	4	0.5	**Silty Sand with Gravel (SM);** yellowish brown (10YR 5/4), weakly mottled dark yellowish brown (10YR 3/4); fine sand; gravel to ½", subrounded; moist.
4	5	1	**Sand with Silt (SP-SM);** yellowish brown (10YR 5/6); fine sand, well sorted, quartzose; wet. Becomes very micaceous from 4.5' to 5' depth.
5	6	1	**Sandy Clay (CL);** yellowish brown (10YR 5/6); soft clay; fine sand; wet.
6	7	1	**Sand with Silt (SP-SM);** yellowish brown (10YR 5/6); fine sand, well sorted, quartzose; micaceous; wet.
7	8	1	**Silty Sand (SM);** yellowish brown (10YR 5/6), weakly mottled 10YR 5/8); fine sand; wet.

Total depth at 8 feet. No observed groundwater.

Boring HA-6
Elevation: 60 ft above sea level (RRM survey)
Total depth: 8 feet
Depth to top and bottom in feet

Top	Bottom	Thickness	Description
0	1.5	1.5	**Silty Sand (SM);** dark brown (10YR 3/3); roots, organic; sand, mostly fine grained, lesser medium; slightly micaceous; damp.
1.5	3	1.5	**Silty Sand (SM);** dark yellowish brown (10YR 3/6), strongly mottled red (2.5YR 4/8); sand, mostly fine, lesser medium to coarse; moist.
3	4	1	**Clay (CH);** pale brown (10YR 6/3); soft, plastic; moist. Becomes strongly mottled yellowish brown (10YR 5/8) from 3.5' to 4' depth.
4	5	1	**Clayey Sand with Gravel (SC);** yellowish brown (10YR 5/4), strongly mottled 10YR 5/8); mostly fine to medium sand, lesser coarse; weakly indurated iron oxide cemented sand to ½" diameter, highly weathered granitic clasts; moist.
5	5.5	0.5	**Clayey Sand (SC);** yellowish brown (10YR 5/4), weakly mottled 10YR 5/8); fine sand; moist to wet.
5.5	6.5	1	**Sandy Clay (CL);** yellowish brown (10YR 5/4), strongly mottled 10YR 5/8); soft clay; fine sand; slightly micaceous; wet.

Boring Logs
Arana Gulch Trail Site, Santa Cruz, California

HA-6 (continued)

Top	Bottom	Thickness	Description
6.5	7	0.5	**Clayey Sand (SC);** trace gravel; yellowish brown (10YR 5/6), strongly mottled red (2.5YR 4/6); sand, mostly fine to medium, lesser coarse; highly weathered gravel to ¾" with abundant decomposed material; wet.
7	8	1	**Sand (SP);** yellowish brown (10YR 5/6); fine sand, well sorted, quartzose; micaceous; wet. With 3" thick lens of silty sand with gravel, yellowish brown (10YR 5/4), strongly mottled 10YR 5/8; fine to coarse sand; moderately to highly weathered gravel to ½".

Total depth at 8 feet. No observed groundwater.

Boring HA-7
Elevation: 30 ft above sea level (RRM survey)
Total depth: 5 feet
Depth to top and bottom in feet

Top	Bottom	Thickness	Description
0	0.5	0.5	**Sandy Silt (ML);** dark brown (10YR 3/3); soft silt; roots, organic; fine sand; moist.
0.5	1.5	1.5	**Silty Sand (SM);** dark brown (10YR 3/3); organic; fine sand; slightly micaceous; moist.
1.5	2	0.5	**Sandy Clay (CL);** dark brown (10YR 3/3); soft clay; fine sand; moist.
2	3.5	1.5	**Sandy Clay (CL);** trace gravel; dark yellowish brown (10YR 4/6), strongly mottled red (2.5YR 4/6); mostly fine sand, lesser medium to coarse; gravel to ½"; moist. Becomes wet at 2.5' depth.
3.5	5	1.5	**Sand (SP);** yellowish brown (10YR 5/4); fine to medium, lesser medium, angular to subangular, quartzose; weakly indurated with iron oxide cement; moist.

Total depth at 5 feet. No observed groundwater.