Rec'd ComDev 06-07-19

Appendix F
Draft Environmental Impact Report

Preliminary Drainage Report
Arcata Community Health Center

Open Door Community Health Centers
670 - 9th Street, Suite 203
Arcata, California

Prepared for:

Open Door Community Health Centers

May 2019
018011

Rec'd ComDev 06-07-19

Eureka, CA | Arcata, CA | Redding, CA | Willits, CA | Coos Bay, OR | Klamath Falls, OR

www.shn-engr.com

812 W. Wabash Ave., Eureka, CA 95501-2138 707-441-8855

Civil Engineering, Environmental Services, Geosciences, Planning & Permitting, Surveying

Reference: 018011

May 20, 2019

Ms. Laura Kadlecik, Project Manager
Open Door Community Health Centers
670 9th Street, Suite 203
Arcata, CA 95521

Subject: Preliminary Drainage Report for the Proposed Arcata Community Health Center, Located on APN 505-121-031 in Arcata, California

Dear Laura Kadlecik:

SHN has prepared this preliminary drainage report for the proposed new Arcata Community Health Center based on the conceptual site plan prepared by Pressey & Associates on May 10, 2019. This preliminary drainage report presents our initial evaluation of the project's ability to comply with the City of Arcata's MS4 Permit requirements. Because this project will create greater than 1 acre of impervious surface, it will be classified as a Hydromodification Project in accordance with the Humboldt Low Impact Development Stormwater Manual v2.0.

The conclusions and recommendations provided in this report are preliminary and will need to be adjusted as the site layout develops in the following stages of the project.

Please contact me at 441-8855 or jobarr@shn-engr.com with any questions or comments regarding the content of this report.

Respectfully submitted,

SHN

Jared O'Barr, PE
Senior Civil Engineer

JXO:ame

Enclosure: Report

Rec'd ComDev 06-07-19

Reference: 018011

Preliminary Drainage Report
Arcata Community Health Center

Open Door Community Health Centers
670 - 9th Street, Suite 203
Arcata, California

Prepared for:

Open Door Community Health Centers

Prepared by:

SHN

812 W. Wabash Ave.
Eureka, CA 95501-2138
707-441-8855

May 2019

QA/QC:PEG___

Table of Contents

List of Illustrations

Abbreviations and Acronyms

CF	cubic feet
cfs	cubic feet per second
in/hr.	inches per hour
SF	square feet
A	area
C	runoff coefficient
City	City of Arcata
DI	drain inlet
DMA	drainage management area
I	rainfall intensity
LID	low impact development
Q	flow
SCP	stormwater control plan

1.0 Introduction

SHN has prepared this preliminary drainage report to present an initial evaluation of the conceptual design for the Arcata Community Health Center, located on the west side of the Foster Avenue/Sunset Avenue roundabout in the City of Arcata (City), Assessor's parcel number 505-121-031. The project is located on an approximately 1.8-acre site.

This report is only a preliminary analysis and must be updated as the project progresses to address the changes in the design.

This initial analysis has been prepared in accordance with the Humboldt Low Impact Development (LID) Stormwater Manual v2.0, which provides the guidance necessary to comply with the City of Arcata's MS4 Permit. Because this project will create greater than one acre of impervious surface, it will be classified as a Hydromodification Project. As stated in the Humboldt LID Stormwater Manual, a hydromodification project must also meet the requirements of a regulated project. Therefore, the primary stormwater mitigation requirements for this project include the following:

- Runoff generated by the 85th percentile, 24-hour storm event must be retained onsite.
- Post-project runoff shall not exceed the estimated pre-project runoff for the 2-year, 24-hour storm.

The objectives of this report are to:

- Analyze the pre-development and post-development conditions to determine existing and proposed stormwater runoff rates and volumes.
- Determine the approximate stormwater retention and detention volumes necessary in order to meet the stormwater mitigation requirements stated above.
- Evaluate the preliminary site development plan to confirm that the stormwater mitigation objectives can be achieved under the current concept.

2.0 Site Characterization

2.1 Existing Conditions

This project is located on the west side of the Foster Avenue/Sunset Avenue roundabout in the City of Arcata. Sunset Avenue runs along the northern border of the site and Foster Avenue runs along the southern border of the site. A recently developed apartment complex is located to the west of the project site.

The project site is the location of a previous lumber mill, but it is currently undeveloped. The eastern portion of the site currently consists of an informal gravel parking area and low-lying vegetation. The western portion of the site currently consists of temporary soil stockpiles and a vegetated area that was recently cleared. A topographic survey of the existing site was prepared by Points West Surveying Co. (Appendix 1).

2.2 Proposed Conditions

The conceptual site plan prepared by Pressey & Associates is provided in Appendix 2. The proposed project consists of a 34,000 square-foot, two-story health center, and parking areas that will accommodate 78 parking stalls.

The conceptual site plan was divided into seven drainage management areas (DMAs) based on how the final site is expected to be graded. These DMAs, and their respective bioretention facilities, are shown in Figure 1.

2.3 Topography and Drainage

Elevations at the site range from approximately 47 feet to 61 feet above mean sea level. The eastern portion of the site gently slopes to the south at a relatively uniform slope of approximately 2% to 3%. The western portion of site slopes to the southwest in a less uniform and more dramatic manner. There is a relatively significant depression in the southwest corner of the site. The City installed a drain inlet (DI) in the bottom of this depression during the construction of Foster Avenue. In general, the western two-thirds (approximate) of the site drains to the DI in the southwest corner of the site; the eastern one-third (approximate) of the site drains south to the gutter on the northern side of Foster Avenue and then flows eastward to a drain inlet near the roundabout.

The proposed project is not expected to significantly alter the general drainage patterns on the site.

2.4 Soils

The soils report prepared by SHN in August 2009 identified approximately 2 feet to 10 feet of non-engineered fill, underlain by 5 feet to 7 feet of silty sand (Appendix 3). Based on the information provided in the soil borings, the native soils are expected to be predominantly hydrologic soil class C.

A Phase I report prepared by LACO in 2008 stated that historical use of the site (upper terrace) was for lumber storage. The LACO Phase I report referenced findings from a previous 1995 SHN Phase II report which identified low levels of petroleum hydrocarbons and the metals Chromium, Nickel, Zinc, and Lead in shallow soils in several locations associated with historic dumping of crank case oil. Additional samples were collected in 2008 and analyzed for the same constituents. Analytical results indicate localized impacts by petroleum hydrocarbons limited to the shallow soils. Concentrations decrease with depth. Several soil samples were collected at 5 feet below grade, and petroleum hydrocarbons were not detected. The metals concentrations are fairly consistent (same order of magnitude) throughout the site and may be more representative of background soil conditions.

3.0 Hydrologic Analysis

In accordance with the Humboldt LID Stormwater Manual, a preliminary hydrologic analysis was conducted to evaluate the project’s ability to retain runoff generated by the 85th percentile, 24-hour storm event, and also to evaluate the project’s ability to ensure that post-project runoff does not exceed the estimated pre-project runoff for the 2-year, 24-hour storm.

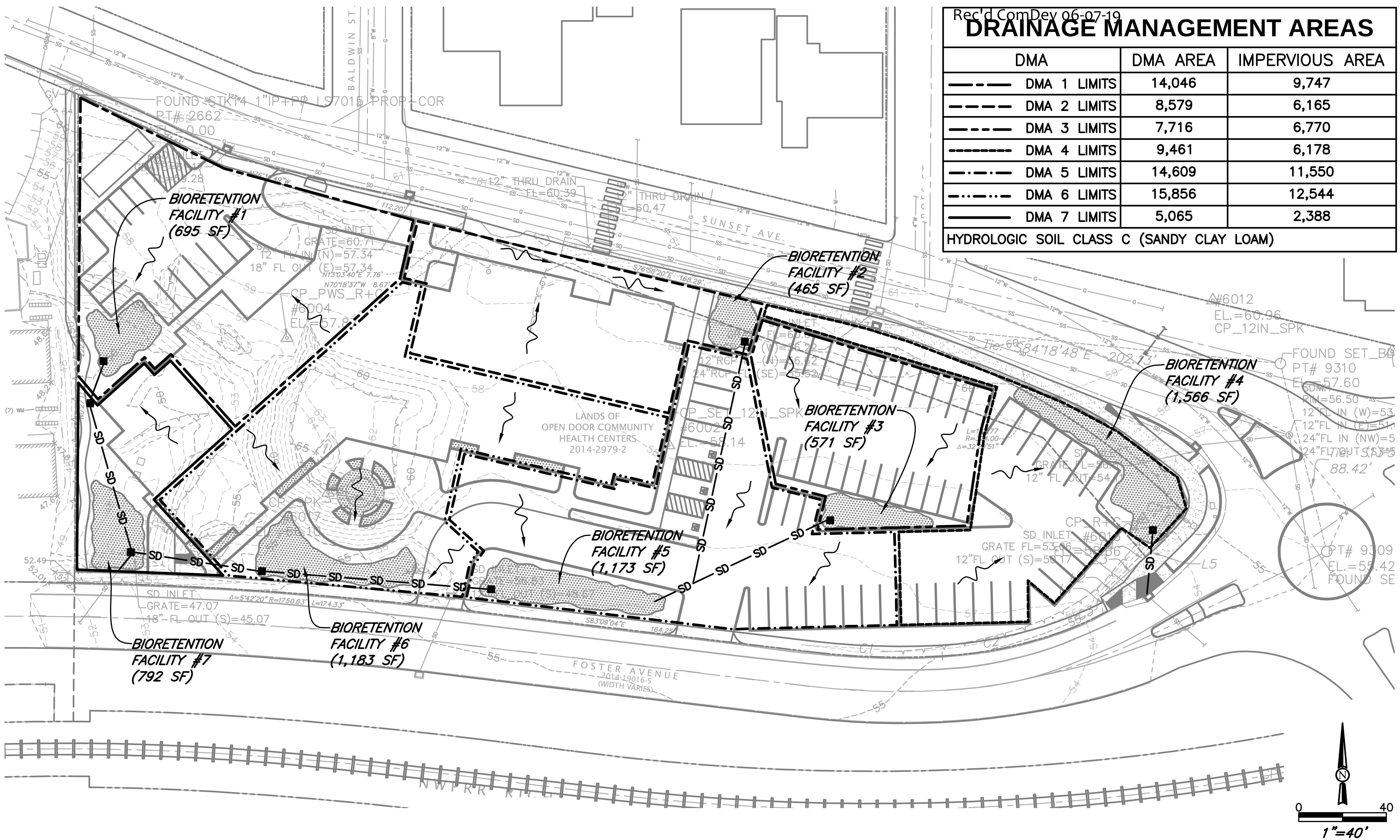
The preliminary stormwater control plan (SCP) for the project is provided in Appendix 4.

Rec'd ComDev 06-07-19

DRAINAGE MANAGEMENT AREAS

DMA	DMA AREA	IMPERVIOUS AREA
DMA 1 LIMITS	14,046	9,747
DMA 2 LIMITS	8,579	6,165
DMA 3 LIMITS	7,716	6,770
DMA 4 LIMITS	9,461	6,178
DMA 5 LIMITS	14,609	11,550
DMA 6 LIMITS	15,856	12,544
DMA 7 LIMITS	5,065	2,388

HYDROLOGIC SOIL CLASS C (SANDY CLAY LOAM)



Open Door Community Health Centers Arcata Community Health Center APN 505-121-031, Arcata, California	Preliminary Drainage Layout SHN 018011
May 2019 | 018011-PRELIM-DRNG-LAYOUT	Figure 1

\\Eureka\Projects\2018\018011-ODCHC-Arcata\Dwgs, SAVED: 5/15/2019 3:51 PM CNEWELL, PLOTTED: 5/15/2019 3:51 PM, CHRIS D. NEWELL

3.1 Stormwater Retention

Although the final site will include various LID features (such as, trees, impervious area disconnection, and soil quality improvement), this preliminary analysis did not take these features into account. This analysis provides a conservative evaluation of the site's ability to meet the stormwater retention requirements entirely through the use of bioretention facilities.

Table 1 provides an overall evaluation of the project's ability to fully retain and treat the 85th Percentile, 24-hour storm event. The total volume of water to be retained in each DMA is determined by multiplying 0.65 inches times the square footage of impervious surface. This information is also provided in the Regulated Projects Worksheets for each DMA, which are included in the Preliminary SCP (Appendix 4).

The bioretention volume provided in Table 1 is based on the following assumptions:

- Soil Media Layer
    - Thickness: 18 inches
    - Porosity (for storage of stormwater runoff): 15%
- Gravel Layer
    - Thickness: 18 inches
    - Porosity (for storage of stormwater runoff): 35%
- No ponding

Table 1. Stormwater Retention By DMA
Arcata Community Health Center, Arcata, CA

DMA[1]	Impervious Area (SF)[2]	Stormwater Runoff Volume (CF)[3]	Bioretention Facility Area (SF)	Bioretention Volume (CF)	Net Bioretention Capacity (CF)
1	9,747	526	695	521	-5
2	6,165	333	465	349	16
3	6,770	365	571	428	63
4	6,178	335	1,566	1,175	840
5	11,550	624	1,173	880	256
6	12,544	677	1,183	887	210
7	2,388	129	792	594	465
				Total Net Bioretention Facility Capacity:	**1,845**

1. DMA: drainage management area
2. SF: square feet
3. CF: cubic feet

The information provided in Table 1 confirms that even without assuming credit for the various LID features that will ultimately be incorporated into the final project, the project can easily achieve the stormwater retention requirements for the site with the use of adequately sized bioretention facilities.

3.2 Peak Flow Mitigation

As mentioned above, the western two-thirds (approximate) of the existing site drains to a DI in the southwest corner of the site, and the eastern one-third (approximate) of the existing site drains to a DI near the roundabout.

Based on some assumptions about how the site may ultimately be graded, after the project is constructed, a larger portion of the site is expected to drain to the DI in the southwest corner of the site. As a result, a smaller portion of the site is expected to drain to the DI near the roundabout. The rational method was used to evaluate the peak flow conditions at the site. Because the site is relatively small, the actual time of concentration values under both pre-construction and post-construction conditions are expected to be less than 5 minutes. However, for this analysis, a minimum time of concentration of 5 minutes was used. Detailed calculations regarding the peak flows for the pre-development and post-development conditions are provided in Appendix 5. Tables 2 and 3 summarize the results of the peak flow analysis for pre- and post-development conditions, respectively.

Table 2. Pre-Development Condition
Arcata Community Health Center

Western Drainage Area	Eastern Drainage Area
C[1] = 0.45	C = 0.48
I[2] = 1.98 in/hr.[3]	I = 1.98 in/hr.
A[4] = 1.105 acres	A = 0.647 acres
Q[5] = 0.98 cfs[6]	Q = 0.62 cfs
1. C: runoff coefficient 2. I: rainfall intensity 3. in/hr.: inches per hour	4. A: area 5. Q: flow 6. cfs: cubic feet per second

Table 3. Post-Development Condition
Arcata Community Health Center

Western Drainage Area	Eastern Drainage Area
C[1] = 0.76	C = 0.64
I[2] = 1.98 in/hr.[3]	I = 1.98 in/hr.
A[4] = 1.512 acres	A = 0.240 acres
Q[5] = 2.28 cfs[6]	Q = 0.30 cfs
1. C: runoff coefficient 2. I: rainfall intensity 3. in/hr.: inches per hour	4. A: area 5. Q: flow 6. cfs: cubic feet per second

By comparing the peak runoff values in Tables 2 and 3, the proposed project will increase the peak flow that drains to the southwest DI, and it will decrease the peak flow that drains to the DI near the roundabout. Therefore, a stormwater detention facility will be required in the western drainage area, but a stormwater detention facility will not be required in the eastern drainage area.

In order to determine the approximate detention volume that will be required to mitigate for the increased peak runoff rate associated with the 2-year storm in the western drainage area, the "Skupe" method was applied. The “Skupe” method was developed by Joe Skupien, PE, and provides a simple approach to estimate the detention basin storage volume that will be required to detain any peak runoff beyond the specified storm event for existing conditions. Appendix 6 presents a description of the “Skupe” method.

Appendix 7 presents the calculations used to estimate the required detention volume using the “Skupe” method. Based on this method of estimation, a detention basin with the capacity to hold approximately 702 to 878 cubic feet of stormwater runoff will be required in the western drainage area. The ideal location for this will likely be in the southwest corner of the site where there is already a DI, which could be converted into an outflow control structure. The proposed bioretention facility in this area (Bioretention Facility #7) can also serve as a detention basin. According to the conceptual site plan, Bioretention Facility #7 will have a footprint of approximately 792 square feet. In order to store a volume of 702 to 878 cubic feet, a ponding depth of approximately 1 foot will have to be accommodated.

4.0 Conclusions

The conceptual site plan for the Arcata Community Health Center provides adequate stormwater mitigation features to satisfy the requirements of a Hydromodification Project in accordance with the Humboldt LID Stormwater Manual v2.0. A more thorough and detailed analysis will be required during the final stages of design for the site.

Rec'd ComDev 06-07-19

Topographic Survey 1

Rec'd ComDev 06-07-19

SURVERY NOTES:

1. The purpose of this survey is to determine boundaries and topography data of the Lands of Open Door Clinic as described in Document No. 201-2979-2, Humboldt County Records.
2. Underground utilities are based on data provided by the City of Arcata and visible physical evidence. Joint Trench/ Gas line on west line of property based on found utility markings (flags). See Underground Utility Note below.
3. Bearings and distances are California Coordinate System of 1983 (CCS83) Zone 1 (Epoch 2010.0) in US Survey Feet. Control from the survey recorded in Book 72 of Surveys, pages 56-60 was utilized. The mapping angle per said survey and this project is 1 degree 23 minutes 04 seconds- rotate bearings counterclockwise by this angle to obtain "True" or Geodetic bearings. Grid distances shown should be divided by the Combined Scale factor of 0.99989669 to obtain ground distances. Elevations are NAVD88 Datum based on survey work performed for the City of Arcata Foster Ave. Extension Project.
4. Boundaries and easements are shown based on the Preliminary Title Report by Fidelity National Title Co. Order No. FFHO-FTO180146H-PG dated 2/2/2018. The resultant boundaries shown hereon are based on the data in this report. The creation deed for this property was surveyed by me in the Record of Survey for the Franke/Hibler Lot Line Adjustment recorded in Book 70 of Surveys at pages 150-153. A subsequent fee conveyance of the south portion of that property was made to the City of Arcata for Foster Ave. per Document No. 2014-19016-5. Bearings and distances from the survey recorded in Book 70 of Surveys at pages 150-153 were rotated and scaled to CCS83 per note #3 on the survey recorded in Book 72 of Surveys, pages 56-60.
5. The southwest corner of this site was covered in dense vegetation; April 2019 update surveyed this area. Trees 12 inch and bigger were located in this area along with pink wooden stakes set by others presumably delineating wetlands.

LEGEND

- FOUND SURVEY MONUMENT
- SURVEY CONTROL POINT
- SUBJECT PROPERTY LINES
- ADJACENT PROPERTY LINES
- RIGHT OF WAY CENTERLINE
- EASEMENT SIDELINES
- CONCRETE PAVING
- EDGES OF ASPHALT PAVEMENT
- EXISTING GROUND CONTOURS
- TOP OF SLOPE
- TOE OF SLOPE / GRADE BREAK
- DRAINAGE FLOW LINE
- FENCE LINE
- GAS LINE
- UNDERGROUND ELECTRIC LINE
- OVERHEAD ELECTRIC LINE
- OVERHEAD TELECOMMUNICATION LINES
- OVERHEAD ELECTRIC & TELEPHONE LINES
- SANITARY SEWER LINE
- STORM DRAIN CULVERT
- WATER LINE
- UTILITY POLE WITH GUY ANCHOR
- JOINT UTILITY POLE
- STREET LAMP
- FIRE HYDRANT
- WATER METER
- WATER VALVE
- SANITARY SEWER CLEANOUT
- SANITARY SEWER MANHOLE
- STORM DRAIN MANHOLE

UNDERGROUND UTILITY NOTE

Underground utilities are shown based on a combination of visible physical evidence and records made available to the surveyor by the City of Arcata. The surveyor makes no guarantees that the underground utilities shown comprise all such utilities in the area, either in service or abandoned. The surveyor further does not warrant that the underground utilities are in the exact locations indicated. The surveyor has not physically located the underground utilities.
Call Underground Service Alert (USA) 1-800-642-2444
a minimum of 48 hours prior to any excavations.

GRAPHIC SCALE

-20' 0 10' 20'

1 inch = 20 ft.
17"x11" PRINTS ARE 1/2 SCALE

LINE TABLE

Line #	Bearing	Distance
L1	N25°45'02"W	6.92
L2	N56°30'39"E	12.37
L3	N38°23'25"E	11.62
L4	S48°47'11"W	3.87
L5	S48°47'11"W	5.98

CURVE TABLE

Curve #	Length	Radius	Delta
C1	59.29	334.37	10°09'36"
C2	56.12	194.37	16°32'34"
C3	22.69	144.37	9°00'19"
C4	17.86	134.00	7°38'07"
C5	3.10	14.00	12°41'18"

CONTROL POINTS

Point #	Northing	Easting	Elevation	Description
6002	2210664.03	5984962.92	58.14	CP_SET_12IN_SPK
6004	2210713.04	5984788.77	57.87	CP_PWS_R+C
6103	2210701.35	5985242.14	60.26	CITYMON3
9309	2210615.50	5985263.33	55.42	SET_BD_7015

BOUNDARY & TOPOGRAPHIC SURVEY

for

OPEN DOOR HEALTH CENTERS

SECTION 29, T6N, R1E,
HUMBOLDT MERIDIAN

IN THE CITY OF ARCATA,
HUMBOLDT COUNTY, STATE OF CALIFORNIA
DATE: APRIL 2018, UPDATED APRIL 2019

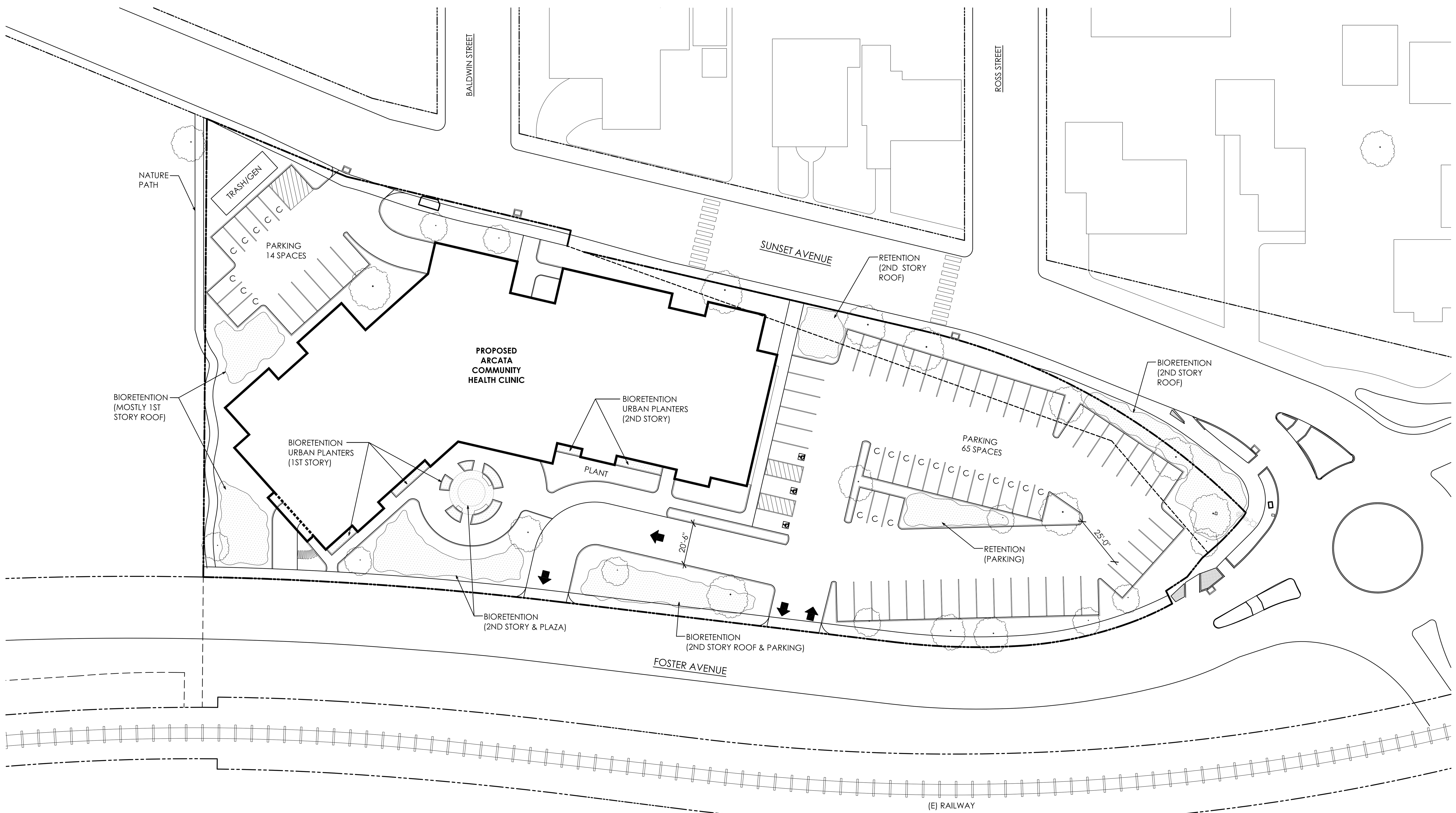
SCALE: 1" = 20' SHEET 1 OF 1

POINTS WEST SURVEYING CO.
5201 Carlson Park Dr., Suite 3 - Arcata, CA 95521
707 · 840 · 9510 · Phone 707 · 840 · 9542 · Fax

Rec'd ComDev 06-07-19

Conceptual Site Plan 2

Rec'd ComDev 06-0



1 SITE PLAN
SCALE: 1"=30'

PRESSEY & ASSOCIATES
AN ARCHITECTURAL CORPORATION

2015 H ST. THIRD FLOOR
SACRAMENTO, CA 95811
TEL 916-346-4280

REVISION HISTORY

LICENSED ARCHITECT
KEVIN W. PRESSEY
No. C25741
REN. 01/31/21
STATE OF CALIFORNIA

ARCATA CONCEPTUAL DESIGN & FEASIBILITY

FOSTER AVENUE
ARCATA CA 95521

SITE PLAN

PROJECT NO.	17091
SCALE	
DATE	----
DRAWN	---

AS-1.0

- OF -

Geologic Hazard and Geotechnical Investigation Report

3

Geologic Hazard and Geotechnical Investigation Report

Arcata Volunteer Fire Department
Proposed Sunset Avenue Fire Station
Arcata, California

Prepared for:

Arcata Volunteer Fire Department
631 9th Street
Arcata, California

SHN Consulting Engineers & Geologists, Inc.

812 W. Wabash Ave.
Eureka, CA 95501
707-441-8855

August 2009
009077

Rec'd ComDev 06-07-19

SHN CONSULTING ENGINEERS & GEOLOGISTS, INC.
812 W. Wabash • Eureka, CA 95501-2138 • 707-441-8855 • FAX: 707-441-8877 •shninfo@shn-engr.com

Reference: 009077

August 10, 2009

Mr. Dave White
Fire Chief
Arcata Volunteer Fire Department
631 9th Street
Arcata, CA 95521

Subject: Geologic Hazard and Geotechnical Investigation Report, Proposed Sunset Avenue Fire Station, Arcata, California

Dear Mr. White:

The enclosed report documents the results of our investigation for the proposed fire station on Sunset Avenue in Arcata, California. In the report we discuss geologic and geotechnical site characteristics and risks, and provide specific recommendations for site preparation, and design and construction of foundation and floor slab systems for the proposed structures.

Thank you for the opportunity to assist you with this project. If you have any questions, please feel free to contact us at 707-441-8855.

Sincerely,

SHN Consulting Engineers & Geologists

Richard W. Hanford, P.E., G.E.
Senior Geotechnical Engineer

RWH/JPB:scw

Enclosure

Rec'd ComDev 06-07-19

Reference: 009077

Geologic Hazard and Geotechnical Investigation Report

Arcata Volunteer Fire Department
Proposed Sunset Avenue Fire Station
Arcata, California

Prepared for:

Arcata Volunteer Fire Department
Arcata, CA

REGISTERED PROFESSIONAL ENGINEER
RICHARD W. HANFORD
GE000374
EXP. 3/31/__
GEOTECHNICAL
STATE OF CALIFORNIA

Prepared by:

SHN

Consulting Engineers & Geologists, Inc.
812 W. Wabash Ave.
Eureka, CA 95501-2138
707-441-8855

August 2009

QA/QC:____

\\Eureka\Projects\2009\009077-ArcataVolunteerFireDepartment\PUBS\rpts\20000810-GeotechInvest.doc

Table of Contents

Appendices

Table of Contents (continued)

Acronyms

km	kilometer
pcf	pounds per cubic foot
pci	pounds per cubic inch
psf	pounds per square foot

ASTM	American Society of Testing and Materials
BH-#	Geotechnical Bore Hole-number
CBC	California Building Code
CDMG	California Division of Mines and Geology
CME	Central Mining Equipment
CPT	Cone Penetration Test
CRR	Cyclic Resistance Ratio
CSR	Cyclic Stress Ratio
MRfz	Mad River fault zone
PMB	Processed Miscellaneous Base
SE	Sand Equivalent
SHN	SHN Consulting Engineers & Geologists, Inc.
SPT	Standard Penetration Test
TP-#	Test Pit-number
USGS	United States Geological Survey

1.0 Introduction

This report documents the results of the geotechnical investigations conducted by SHN Consulting Engineers and Geologists, Inc. (SHN) during June and July 2009 for the proposed new fire station on Sunset Avenue in Arcata, California. The site location is shown in Figure 1.

We understand that the proposed development includes two structures, the fire station with living quarters, offices and the apparatus bays, and a community building with a kitchen. Our investigation and this report are based on the proposed configuration as depicted on Sheet B of Preliminary Studies plans labeled Option 1C and dated May 15, 2009, by RRM Design Group (Figure 2). We anticipate that the building structures will have moderately loaded perimeter footings and possibly isolated column loads, and have slab-on-grade floors. A grading plan was not available at the time this report was prepared, and we have assumed that fill placement within the project area will be limited to 2 feet or less in thickness based on the existing relatively level conditions within the project site.

This report is intended to provide the owner with findings, conclusions, and recommendations related to geotechnical aspects of project design and construction. Conclusions regarding the risk of adverse effects from geologic hazards are also discussed. The conclusions and recommendations contained in this report are subject to the limitations presented herein. Attention is directed to the Additional Services and Limitations sections of this report.

Work was performed in general accordance with our service agreement with the Arcata Volunteer Fire Department.

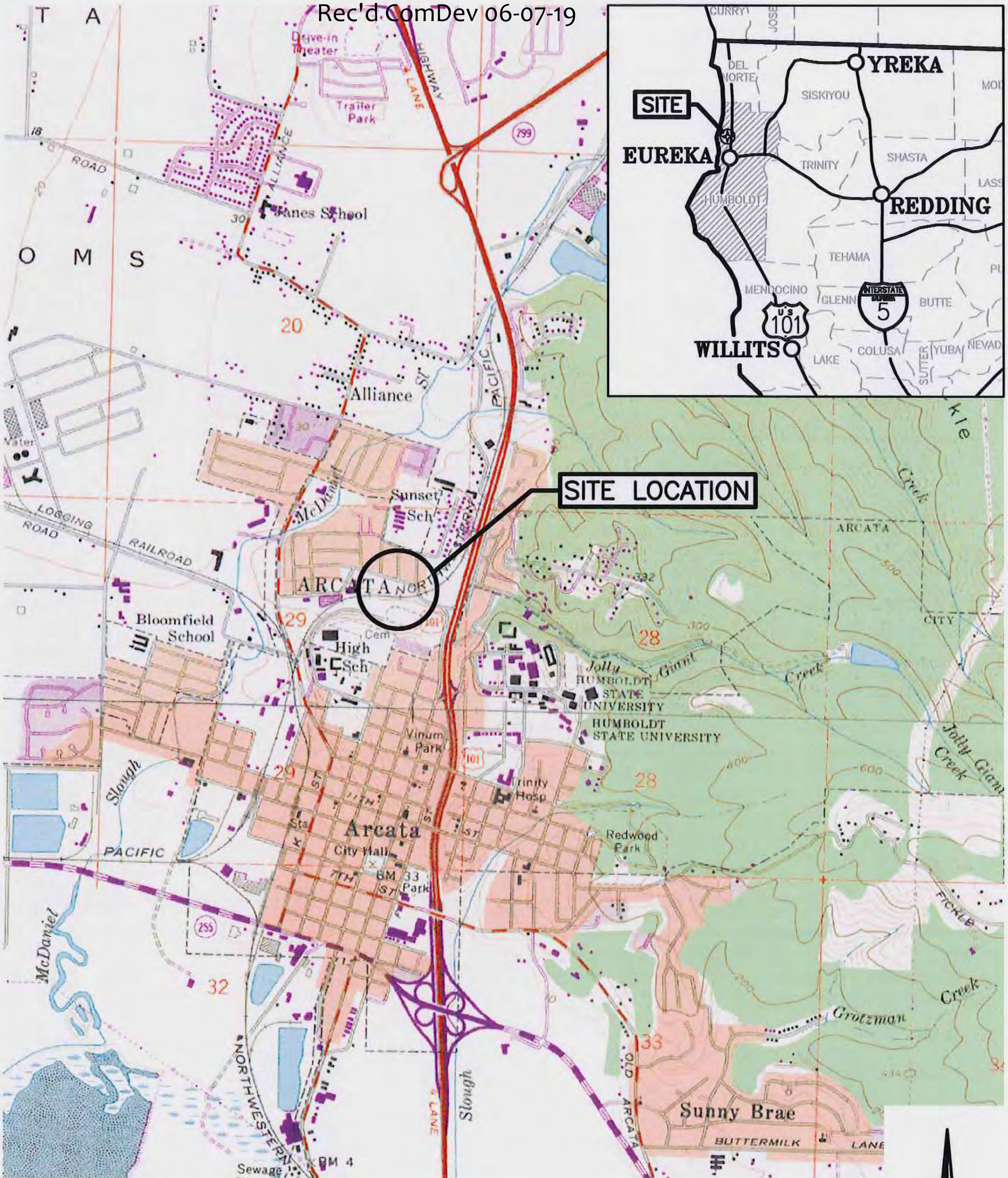
2.0 Geologic Setting

2.1 Regional Geology

Basement rock in the region is composed of late Jurassic to late Cretaceous age mélange of the Franciscan Complex (McLaughlin et al., 2000; Clarke, 1992). The mélange is part of the Central Belt subunit of the Franciscan Complex, and typically consists of blocks of conglomerate, graywacke sandstone, radiolarian chert, blueschist facies metamorphic rock, greenstone, and ophiolitic plutonic rock in an intensely sheared argillite matrix. Depth to Franciscan bedrock beneath the site is not known as it was not encountered in our subsurface investigation. The nearest surface exposures of Franciscan rocks are on the Humboldt State University campus to the east. In the Arcata area, Franciscan basement rock is unconformably overlain by early to middle Pleistocene age marine and continental deposits of the Falor formation (Carver et. al., 1985).

In coastal central Humboldt County, Franciscan basement rock and Falor formation deposits are overlain by a series of late Pleistocene marine terraces. These terraces typically consist of an abrasion platform cut across bedrock, and terrace cover sediments typically consisting of near-shore marine deposits and terrestrial alluvial, colluvial, and eolian deposits. No datable material has been recovered from the marine terraces, so age assignments have been based on elevation distributions and comparisons with global sea level chronologies, as well as comparisons of relative amounts of pedogenic soil development. Based on these analyses, the Arcata marine terrace is correlated to the Isotope Stage 7a interglacial period, about 176,000 years ago (Carver and Burke, 1992).

Rec'd ComDev 06-07-19



SOURCE: ARCATA NORTH & SOUTH USGS 7.5 MINUTE QUADRANGLES

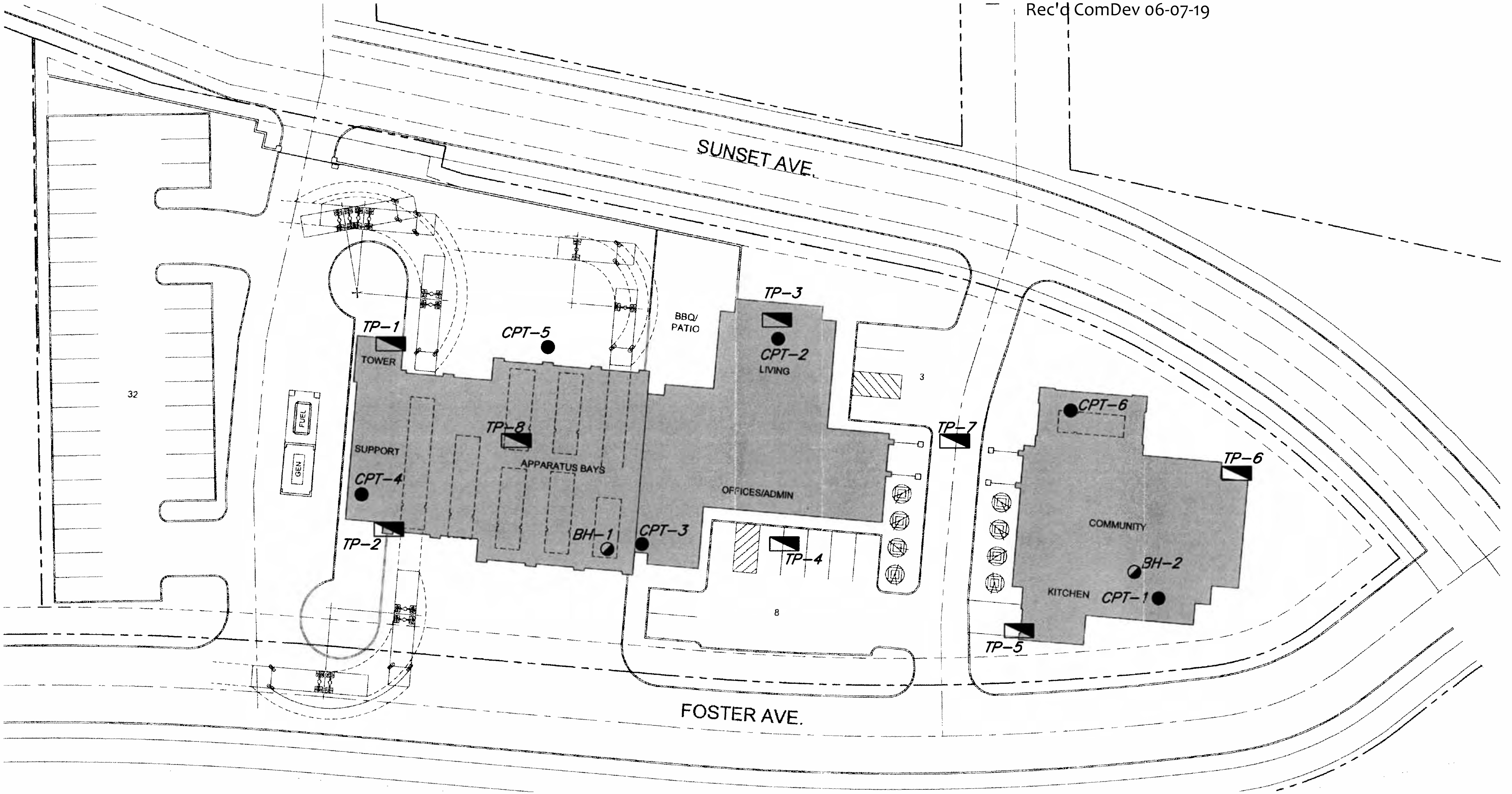
N

1"=2000'±

SHN Consulting Engineers & Geologists, Inc.	Arcata Volunteer Fire Department Arcata, California	Site Location Map SHN 009077
	July 2009	009077-SITE-LCTN
		Figure 1

\\Eureka\Projects\2009\009077-ArcataVolunteerFireDepartment\Dwgs , SAVED: 7/29/2009 5:14 PM CNEWELL, PLOTTED: 7/30/2009 9:51 AM, CHRIS D. NEWELL

Rec'd ComDev 06-07-19



EXPLANATION

TP-2 — *TEST PIT LOCATION AND DESIGNATION*

CPT-1 — *CONE PENETRATION TEST LOCATION AND DESIGNATION*

BH-1 — *SOIL BORING LOCATION AND DESIGNATION*

NOTE: *ORIGINAL BASE MAP DONE BY: rrmdesigngroup*

SHN Consulting Engineers & Geologists, Inc.	Arcata Volunteer Fire Department Arcata, California	Site Plan SHN 009077
	July 2009 / 009077-SITE-PLAN	Figure 2

\\Eureka\Projects\2009\009077-ArcataVolunteerFireDepartment\Dwgs , SAVED: 7/30/2009 9:53 AM CNEWELL, PLOTTED: 7/30/2009 9:53 AM, CHRIS D. NEWELL

2.2 Seismic Setting

Northwestern California is located in a complex tectonic region dominated by northeast-southwest compression associated with collision of the Gorda and North American tectonic plates (Figure 3). The Gorda plate is being actively subducted beneath North America north of Cape Mendocino, along the southern part of what is commonly referred to as the Cascadia subduction zone. This plate convergence has resulted in a broad fold and thrust belt along the western edge of the accretionary margin of the North American plate. In the Humboldt Bay region, this fold and thrust belt is manifested as a series of northwest-trending, northeast-dipping thrust faults, including the Little Salmon fault and faults that comprise the Mad River fault zone (MRfz). These faults are active and are capable of generating large-magnitude earthquakes.

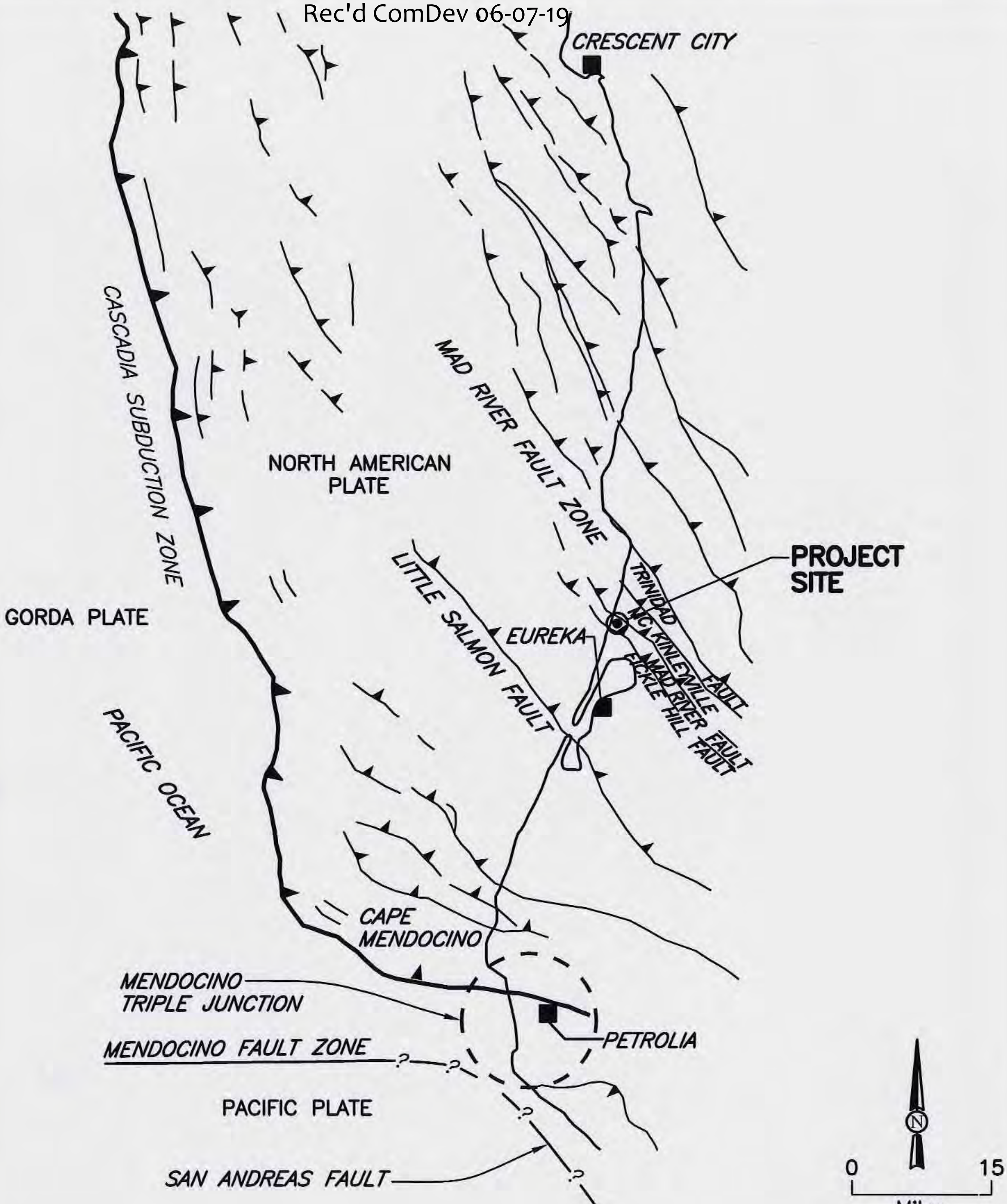
The project site is located within the MRfz. This zone consists of several major northwest-trending thrust faults and numerous minor, secondary synthetic and antithetic faults. Major faults within the MRfz include from north to south, the Trinidad, McKinleyville, Mad River, and Fickle Hill faults. The project site is located approximately 1200 feet northeast of the Alquist-Priolo Earthquake Fault Zone (APEFZ) for the Fickle Hill fault. Individual faults within the MRfz commonly exhibit variable strikes, which is common along thrust faults, and shallow to moderate dips ranging from as little as 10° to 55°. At least 3 miles of middle and late Pleistocene displacement has occurred across the MRfz since deposition of the Falor formation (Carver, 1987). In the Arcata area, the Fickle Hill fault crosses, and displaces, the marine terraces described above. The faults are typically well expressed across the terraces as west- and southwest-facing scarps separating the displaced, relatively flat terrace surfaces. Antithetic faults within the MRfz are typically associated with lesser amounts of cumulative displacement, and form subtle northeast-facing scarps. Only one moderate historic earthquake may have been generated within the MRfz, but all the faults within the zone are considered active based on deformation of Holocene-age soils overlying the faults. The principal faults within the MRfz are considered active by the State, and are included within APEFZ.

2.3 Regional Faults

Northwestern California is the most seismically active region in the continental United States. Over 60 earthquakes have produced discernable damage in the region since the mid-1800s (Dengler et al., 1992). Historic seismicity and paleoseismic studies in the area suggest there are six distinct sources of damaging earthquakes in the Humboldt Bay region:

1) **The Gorda Plate.** Gorda plate earthquakes account for the majority of historic seismicity. These earthquakes occur primarily offshore along left-lateral faults, and are generated by the internal deformation within the plate as it moves toward the subduction zone. Significant historic Gorda plate earthquakes have ranged in magnitude from M5 to M7.5. The November 8, 1980 earthquake (M7.2) was generated on a left-lateral fault within the Gorda plate.

2) **The Mendocino Fault.** The Mendocino fault is the second most frequent source of earthquakes in the region. The fault represents the plate boundary between the Gorda and Pacific plates, and typically generates right lateral strike-slip displacement. Historic Mendocino fault events have ranged in magnitude from M5 to M7.5. The September 1, 1994 M7.2 event west of Petrolia was generated along the Mendocino fault.



SHN Consulting Engineers & Geologists, Inc.	Arcata Volunteer Fire Department Arcata, California	Tectonic Setting SHN 009077
July 2009	009077-GEO-FAULT-MAP	Figure 3

\\Eureka\Projects\2009\009077-ArcataVolunteerFireDepartment\Dwgs , SAVED: 7/29/2009 5:04 PM CNEWELL, PLOTTED: 8/7/2009 3:00 PM, CHRIS D. NEWELL

3) **The Mendocino Triple Junction.** The Mendocino triple junction was identified as a separate seismic source only after the August 17, 1991 (M6.0) earthquake. Events associated with the triple junction are shallow onshore earthquakes that appear to range in magnitude from about M5 to M6. Raised Holocene terraces near Cape Mendocino suggest larger events are possible in this region.

4) **The northern end of the San Andreas Fault.** Northern San Andreas fault events are rare, but can be very large. The northern San Andreas fault is a right lateral strike-slip fault that represents the plate boundary between the Pacific and North American plates. The fault extends through the Point Delgada region and terminating at the Mendocino triple junction. The 1906 San Francisco earthquake (M8.3) caused the most significant damage in the north coast region, with the possible exception of the 1992 Petrolia earthquake.

5) **Faults within the North American Plate**. Earthquakes within the North American plate can be anticipated from a number of intraplate sources, including the MRfz. There have been no large magnitude earthquakes associated with faults within the North American plate, although the December 21, 1954, M6.5 event may have occurred in the MRfz. Expected magnitudes for North American plate earthquakes are in the M6.5 to M8 range.

6) **The Cascadia Subduction Zone.** The Cascadia subduction zone represents the most significant potential seismic source in the north coast region. A great subduction event may rupture along 200 kilometers (km) or more of the coast from Cape Mendocino to British Columbia, may be up to M9.5, and could be associated with extensive tsunami inundation in low-lying coastal areas. The April 25, 1992, Petrolia earthquake (M7.1) appears to be the only documented historic earthquake involving slip along the subduction zone, but this event was confined to the southernmost portion of the fault. Paleoseismic studies along the subduction zone suggest that great earthquakes are generated along the zone every 300 to 500 years. The last large subduction earthquake occurred in 1700. A great subduction earthquake would generate long duration, very strong ground shaking throughout the Pacific Northwest.

Table 1 presents fault location and information data collected from the United States Quaternary Faults and Fold Database (U.S. Geological Survey, 2006).

Table 1 Summary of Nearby Active Faults		
Fault Name	**Approximate Distance to Surface Trace (kilometers)**	**Maximum Earthquake Magnitude (Mw)**
Little Salmon	19	7.0
Mad River	4	7.1
Fickle Hill	<1	6.9
McKinleyville	4	7.0
Table Bluff	26	7.0
Trinidad	16	7.3
Big Lagoon/Bald Mtn. Fault Zone	22	7.3
Cascadia Subduction Zone	64	8.3
Garberville/Briceland	82	6.9
Mendocino Fault Zone	4	7.4
San Andreas	90	7.6

2.4 Historical Seismicity

A search of historical earthquake records was performed using the USGS (United States Geological Survey) Preliminary Determinations of Epicenters Catalog on the web site http://neic.usgs.gov/neis/epic/epic_circ.html. Our historical search included years from 1865 to 2008.

A total of 66 earthquake records were identified with a magnitude greater than M5.0 within a 100-km radius around the site. The largest magnitude earthquakes within 100 km of the site were estimated M7.2 events that occurred in 1923 (78 km southwest of the project site), 1980 (29 km west of the project site) and 1992 (60 km southwest of the project site).

A map showing regional historical seismicity from Dengler et al. (1992) is included as Figure 4. Listings of earthquakes identified in the historical earthquake search are included in Appendix A.

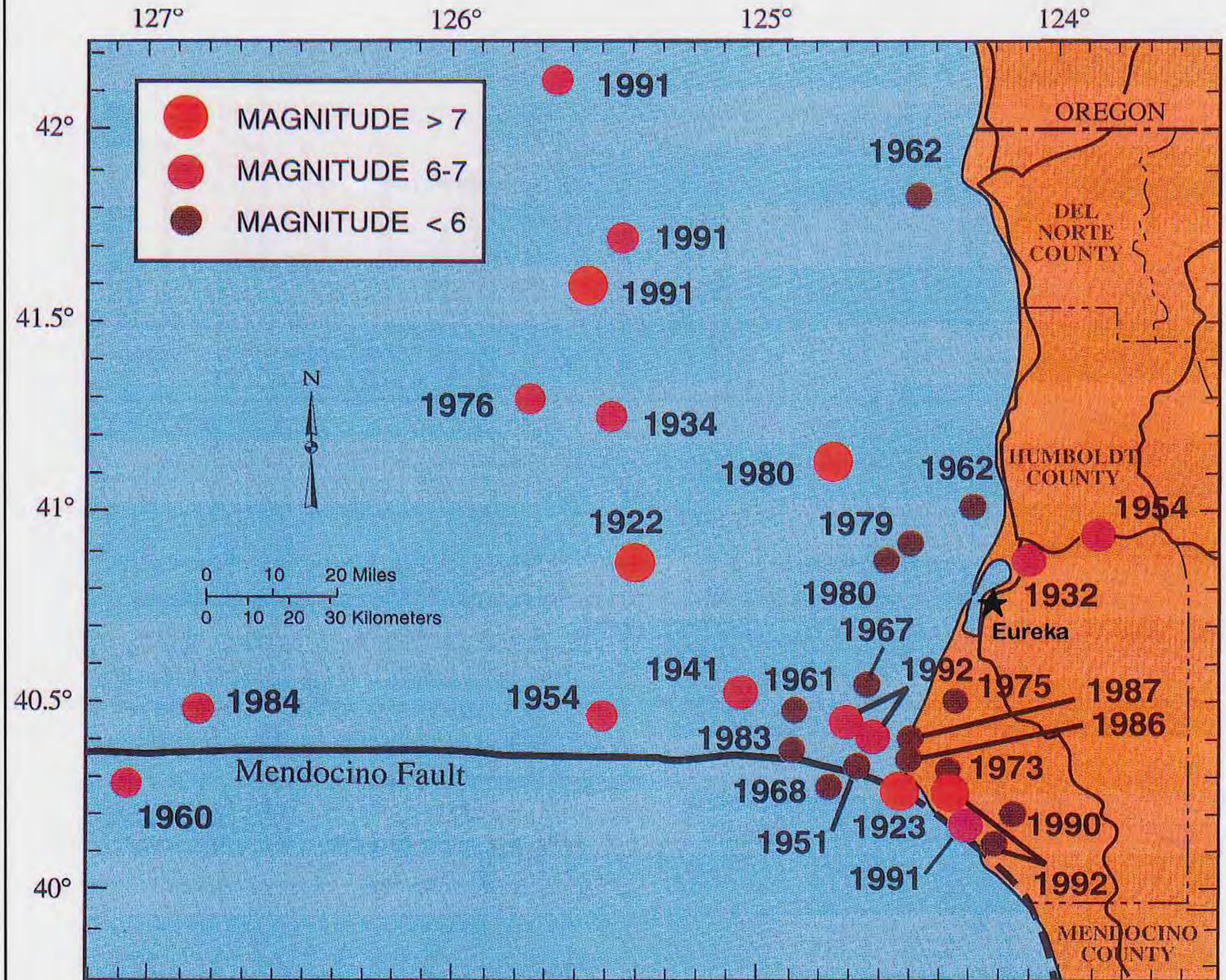
3.0 Field Investigation and Laboratory Testing

SHN conducted field investigations at the project site on June 23, 29, and July 15, 2009. Our subsurface exploration program was designed to evaluate soil and groundwater conditions underlying the proposed developments and included Cone Penetration Test (CPT)borings, geotechnical borings, and backhoe test pits. Specific components of these tasks are discussed below.

3.1 Cone Penetration Test Borings

On June 23, 2009 we observed and directed the advancement of six CPT borings (CPT-1 through CPT-6; Figure 2). Our CPT borings were distributed throughout the site to obtain a representative cross section of the site soils. CPT borings were advanced to depths ranging from 20 to 38 feet

Rec'd ComDev 06-07-19



Epicenters and dates of best located north coast historic earthquakes of magnitude greater than or equal to 5.5 and/or intensity greater than or equal to VI.

SHN Consulting Engineers & Geologists, Inc.	Arcata Volunteer Fire Department Sunset Avenue Arcata, California	Regional Seismicity Map (Dengler et al., 1992) SHN 009077
	JULY 2009 \\Zing\projects\2009\009077-Arcata Volunteer Fire Department\Figs\009077-Figure 4.cdr	Figure 4

below existing grade. Information obtained during the CPT phase of the field investigation was used to target our in-situ testing and sampling program for the machine-drilled geotechnical borings. A generalized explanation of the methods and data associated with a CPT investigation as well as the logs of the CPT borings for this project are provided in Appendix B.

3.2 Geotechnical Borings

SHN geologists observed and directed the excavation of two machine-drilled geotechnical borings (BH-1 and BH-2; Figure 2) using a Central Mining Equipment (CME) 75 truck-mounted drill rig outfitted with 6-inch hollow stem augers. Machine-drilled borings were located to assess soil and groundwater conditions underlying the proposed structures. The borings were advanced to depths ranging from 40.5 to 41.5 feet below grade and were logged in general accordance with the USCS.

Penetration resistance testing was conducted at targeted intervals as the borings were advanced. Samplers were driven by a 140-pound, 30-inch drop, automatic trip hammer. Two split spoon samplers were used; a modified California split spoon, with a nominal inside diameter of 2.5 inches, with liners, and a 2-inch outside diameter Standard Penetration Test (SPT) split spoon sampler, without liners. Soil profiles, sampler types and associated blow counts are noted on the subsurface exploration logs (Appendix C).

3.3 Backhoe Test Pits

Eight backhoe test pits (TP-1 through TP–8; Figure 2) were excavated on July 15, 2009. The objectives of the test pits were to characterize the near surface soil conditions and to assess the thickness, distribution and character of fills within the area of the proposed development. Both disturbed and undisturbed samples were collected from the test pits and soils observed in the pits were logged in general accordance with the USCS. Soil profiles, sampling locations and laboratory test results are noted on subsurface exploration logs (Appendix C).

3.4 Laboratory Testing

Selected samples of the native subsoil were collected from the borings and backhoe test pits, and laboratory tests were conducted. Laboratory testing included moisture and density measurements, percent fines (silt and clay) content, Atterberg limits, consolidation tests, and direct shear tests. Soil testing was performed in our Eureka laboratory. Index tests are summarized on the borehole logs in Appendix C. Results of the laboratory testing are included in Appendix D.

4.0 Site Conditions

4.1 Surface Conditions

The proposed development is planned for construction on a vacant parcel that is currently unimproved. The site has been graded relatively flat in the past by filling. We understand that the site was used in the past as a log deck and loading area in support of an adjacent mill facility. The proposed structures are situated within the central portions of the parcel (Figure 2). Vegetation consists mainly of grasses, with trees along the west boundary. Original topography (pre-fill) consisted of a gentle south-facing slope that made up the northern flank of a broad, low gradient swale within the Jolly Giant Creek drainage. A 20 to 30 percent slope is present along, and roughly paralleling the southern property line. The slope is heavily vegetated with brush and small trees. An abandoned railroad line on a 20- to 30-foot wide graded bench parallels the southern property line just below the slope. We note that the City of Arcata is currently considering a proposal to create an extension of Foster Avenue (connecting to Sunset Avenue), which would follow the approximate alignment of the abandoned rail line (see location of "Foster Avenue" on Figure 2).

4.2 Subsurface Soil

The subsurface materials consist of alluvial deposits with stratified layers of fine-grained (silts and clays) and coarse-grained (sands and fine gravels) materials. The near surface soils consist of imported fill materials (discussed below). The upper native soil profile, as observed in our backhoe pits, consists of a thin organic-rich silt (ML; native topsoil) that grades into a medium dense silty sand (SM) to the total depths explored with the backhoe (up to 10 feet). Soils at depth, as observed in our geotechnical boreholes and as indicated on CPT logs, consist primarily of soft to very stiff silt (ML) and clay (CL) with isolated intervals of loose to very dense silty sand (SM) and sand with silt (SP/SW). Below a depth of 30 to 35 feet, we encountered dense to very dense sand with gravel to the total depths explored in our boreholes (41.5 feet below grade).

CPT logs are included within Appendix B. Specific descriptions of the soils encountered within the boreholes and test pits are described on the logs in Appendix C.

4.3 Fills

Historic grading at the project site includes the placement of fill across most of the property. The original topography of the property was a gentle slope to the south. The site, as it exists today, is relatively flat, and as such the fill prism forms a wedge that thickens toward the south. Thickness varies from less than 2 feet along the southern edge of Sunset Avenue to as much as 10 feet, or more along the southern edge of the property. As observed in our backhoe test pits, fill materials consist of a mixture of sands, silts, clays and gravels. In most of our sampling points, well-graded river run gravels and cobbles were observed within the upper 2 to 4 feet of the fill. In places, we observed concentrated layers of woody debris and organics. The presence of this material is consistent with the previous uses of the site as a log deck and truck loading area. The fill materials were placed on the original grade with little or no site preparation (removal of topsoil, benching). Native topsoil remains in place in most areas explored. The variability of the fill, and particularly the presence of soft compressible soils and layers of organic material make the fill soils unsuitable for bearing structural loads. Foundation recommendations are provided below to mitigate the presence of the fill.

4.4 Groundwater

Groundwater was encountered within BH-1 and BH-2 at approximately 26 feet and 18 feet below grade, respectively. Perched groundwater was also encountered in TP-5 at approximately 9 feet below grade. Based on the variability of soil moisture in our boreholes and the interbedded fine and coarse grained soils, we expect that groundwater is locally perched on strata of lower permeability. We estimate the seasonal fluctuation of groundwater to vary from 5 to 30 feet below grade. We are not aware of any available records of historical groundwater levels at the project site. Groundwater conditions can be expected to fluctuate in response to seasons, storm events, and other factors. Note that the free face along the south margin of the site should allow groundwater "escape"; therefore we do not anticipate prolonged periods of very shallow groundwater.

5.0 Evaluation of Potential Geologic Hazards

5.1 Surface Fault Rupture

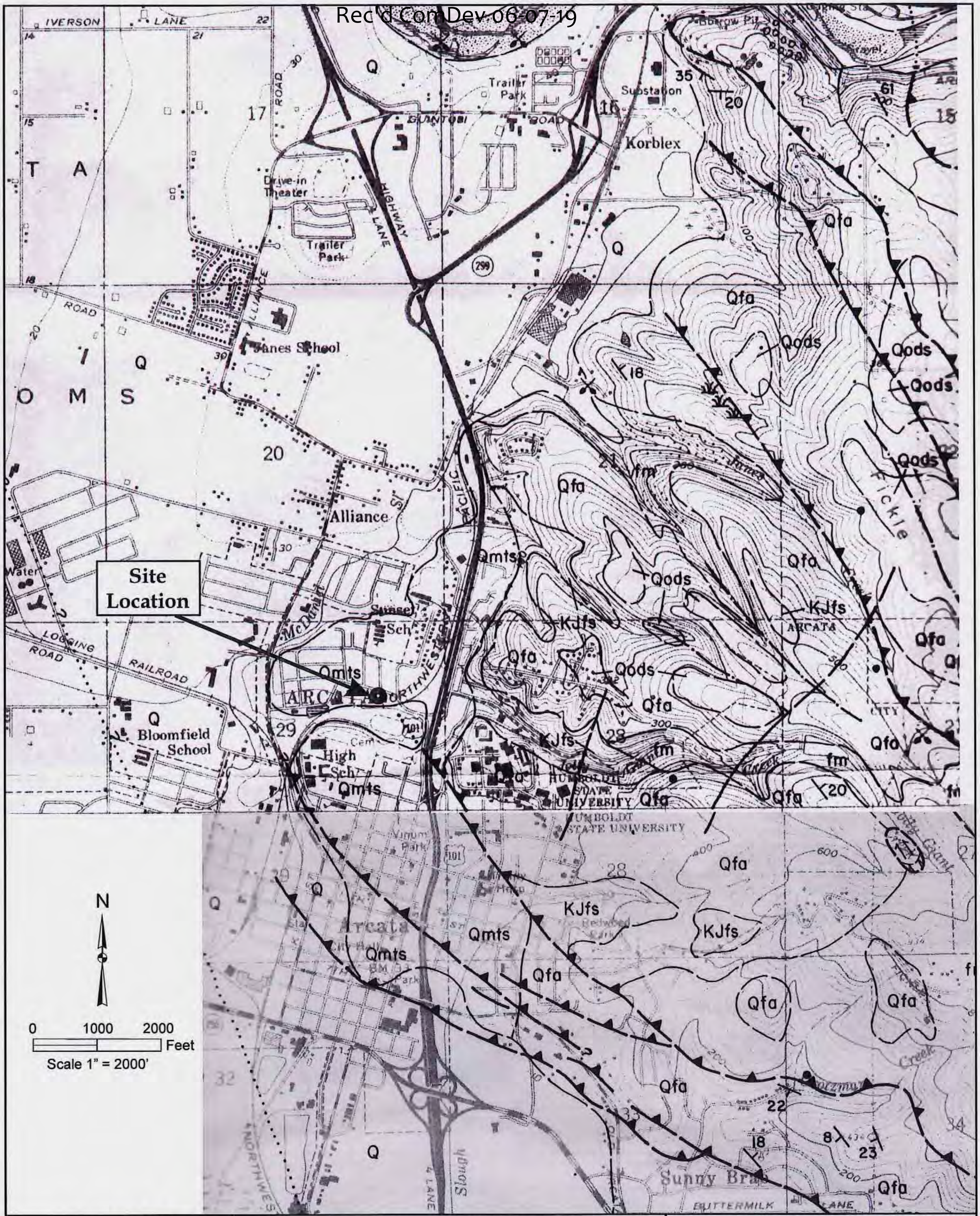
A series of three northwest trending, northeast dipping sub-parallel thrust faults have been mapped through downtown Arcata (Carver, et. al., 1985; Kelley, 1984; Figure 5). These fault traces were mapped based on geomorphic features (scarps, topographic lineaments) and limited and/or undocumented exposures in road cuts. All three of these mapped traces terminate and/or become queried within the northwest portions of Arcata. Carver, et. al., maps the northernmost fault trace south of the site, extending into and terminating within the Jolly Giant Creek drainage, coming to within approximately 400 feet of the site. Kelley shows the same fault trace striking toward the subject property and terminating approximately 1000 feet southeast of the property. Both Carver and Kelley have not mapped any structures across the marine terrace surface on which the site is located. Additionally, this particular trace has not been determined to be sufficiently active and well-defined to warrant zoning under the provisions of the Alquist-Priolo Earthquake Fault Zoning Act (1972). The closest recognized active fault is an approximately 1.5 mile segment of the Fickle Hill fault (central trace), located south of the subject property, which comes to within approximately 1800 feet of the subject property on its northwest end (Figure 6).

A thorough investigation into the surface fault rupture hazard of the northern trace of the Fickle Hill fault zone was conducted by Geomatrix (2008) at Humboldt State University's site of a Student Housing Facility (under construction at the time of this writing). Their report presented the results of approximately 300 feet of exploratory trench and a geophysical survey which focused on the mapped location of the northern trace of the Fickle Hill fault zone where it crossed the site. Gently folded sediments of Late Pleistocene aged deposits and a step in Franciscan bedrock (at depth) were documented, though no evidence of Holocene surface fault rupture was observed. Geomatrix concluded that at this location, "the potential for surface fault rupture associated with the northern trace of the Fickle Hill fault zone beneath the site is extremely low."

We found no evidence in our investigation that a previously unrecognized active fault may be present. Marine terraces, in general, are low relief topographic surfaces that would be anticipated to clearly express fault morphology, if active faults were present. The age of the undeformed marine terrace surface on which the site is located, as described above, is sufficient to preclude Holocene fault activity. The risk of surface fault rupture at the project site is considered remote.

5.2 Seismic Ground Shaking

As discussed in Sections 2.2 and 2.3 above, the project site is located within a seismically active area, with numerous sources of damaging earthquakes within the region. The 2007 California Building Code (CBC) requires specific information for seismic design. Based on our knowledge of subsurface and geologic conditions, we estimate a Site Class D for the project. Based on the site class and the latitude and longitude, we calculated the design spectral response acceleration



SHN
Consulting Engineers & Geologists, Inc.

Arcata Volunteer Fire Department
Sunset Avenue
Arcata, California

Geologic and Geomorphic Map
(CDMG 1984 Arcata North Quadrangle)
SHN 009077

July 2009

\\Eureka\projects\2009\009077 Arcata Volunteer Fire Department\figs\009077-Figure5.cdr

Figure 5

Rec'd ComDev 06-07-19

GEOLOGY AND GEOMORPHIC FEATURES RELATED TO LANDSLIDING ARCATA NORTH 7.5' QUADRANGLE, HUMBOLDT COUNTY, CALIFORNIA

Compiled by
Frederic R. Kelley, Geologist
California Department of Conservation
Division of Mines and Geology
1984

EXPLANATION

TRANSLATIONAL/ROTATIONAL SLIDE: relatively cohesive slide mass with a failure plane that is deep-seated in comparison to that of a debris slide of similar areal extent; sense of motion along slide plane is linear in a translational slide and arcuate or "rotational" in a rotational slide; complex versions with rotational heads and translational movement or earthflows downslope are common; translational movement along a planar joint or bedding discontinuity may be referred to as a block glide; ↖ indicates scarp, ⟸ indicates direction of movement; dashed where dormant, queried where uncertain.

DEBRIS SLIDE: unconsolidated rock, colluvium, and soil that has moved slowly to rapidly downslope along a relatively steep (generally greater than 65 percent), shallow translational failure plane; forms steep, unvegetated scars in the head region and irregular hummocky deposits (when present) in the toe region; scars likely to ravel and remain unvegetated for many years; revegetated scars recognized by steep, even-faceted slope and light-bulb shape; includes scarp and slide deposits; solid where active, dashed where dormant.

DEBRIS SLIDE SLOPE: geomorphic feature characterized by steep (generally greater than 65 percent), usually well vegetated slopes that have been sculpted by numerous debris slide events; vegetated soils and colluvium above shallow soil/bedrock interface may be disrupted by active debris slides or bedrock exposed by former debris sliding; slopes near angle of repose may be relatively stable except where weak bedding planes and extensive bedrock joints and fractures parallel slope.

• ACTIVE SLIDE: too small to delineate at this scale.

DISRUPTED GROUND: irregular ground surface caused by complex landsliding processes resulting in features that are indistinguishable or too small to delineate individually at this scale; also may include areas affected by downslope creep, expansive soils, and/or gully erosion; boundaries usually are indistinct.

Qbs BEACH AND DUNE SAND (Holocene): unconsolidated fine- to coarse-grained sand with smaller amounts of shell fragments and pebbles.

Qsc STREAM CHANNEL DEPOSITS (Holocene): unconsolidated silt, sand, and pebble- to cobble-sized gravel in active river channel and flood-stage, gravel-bar areas.

Q ALLUVIUM (Holocene): unconsolidated, coarse- to fine-grained sand and silt on coastal plain, in valley bottoms, and along modern river flood plains; gravel in channel areas; may include some marine terrace deposits along Mad River flood plain.

Qrt RIVER TERRACE DEPOSITS (Holocene-Pleistocene): dominantly sand and gravel with minor amounts of silt and clay deposited during higher stands of major streams.

Qods OLDER DUNE SANDS (Late Pleistocene): unconsolidated deposits of fine- to coarse-grained sand; generally well vegetated.

Qmts MARINE TERRACE DEPOSITS (Quaternary): poorly to moderately consolidated deposits of marine silts, sands, and gravels forming flat benches on wave-cut surfaces adjacent to the Mad River flood plain.

Qfo FALOR FORMATION (Early to Middle Pleistocene): fluvial and shallow-water marine sediments; includes pebbly conglomerate, sandstone, and silt; in some places, contains abundant animal and plant remains.

KJfs CENTRAL BELT FRANCISCAN SEDIMENTARY ROCKS (Cretaceous-Jurassic): well consolidated sandstone, siltstone, and shale with minor amounts of conglomerate; structurally deformed and usually highly sheared; includes areas mapped as Franciscan Broken Formation by Carver and others (1984).

fm FRANCISCAN MELANGE (Cretaceous-Jurassic): individual blocks of graywacke, sandstone, mudstone, conglomerate, greenstone, chert, and serpentinite in a sheared argillaceous matrix.

LITHOLOGIC CONTACT: dashed where approximately located.

FAULT: dashed where approximately located, dotted where projected or inferred, queried where uncertain.

THRUST FAULT: dashed where approximately located, dotted where projected or inferred, queried where uncertain; barbs on upper plate.

LINEAMENT: linear feature of unknown origin observed on aerial photographs.

16 STRIKE AND DIP OF BEDDING: approximate; may vary over short distances.

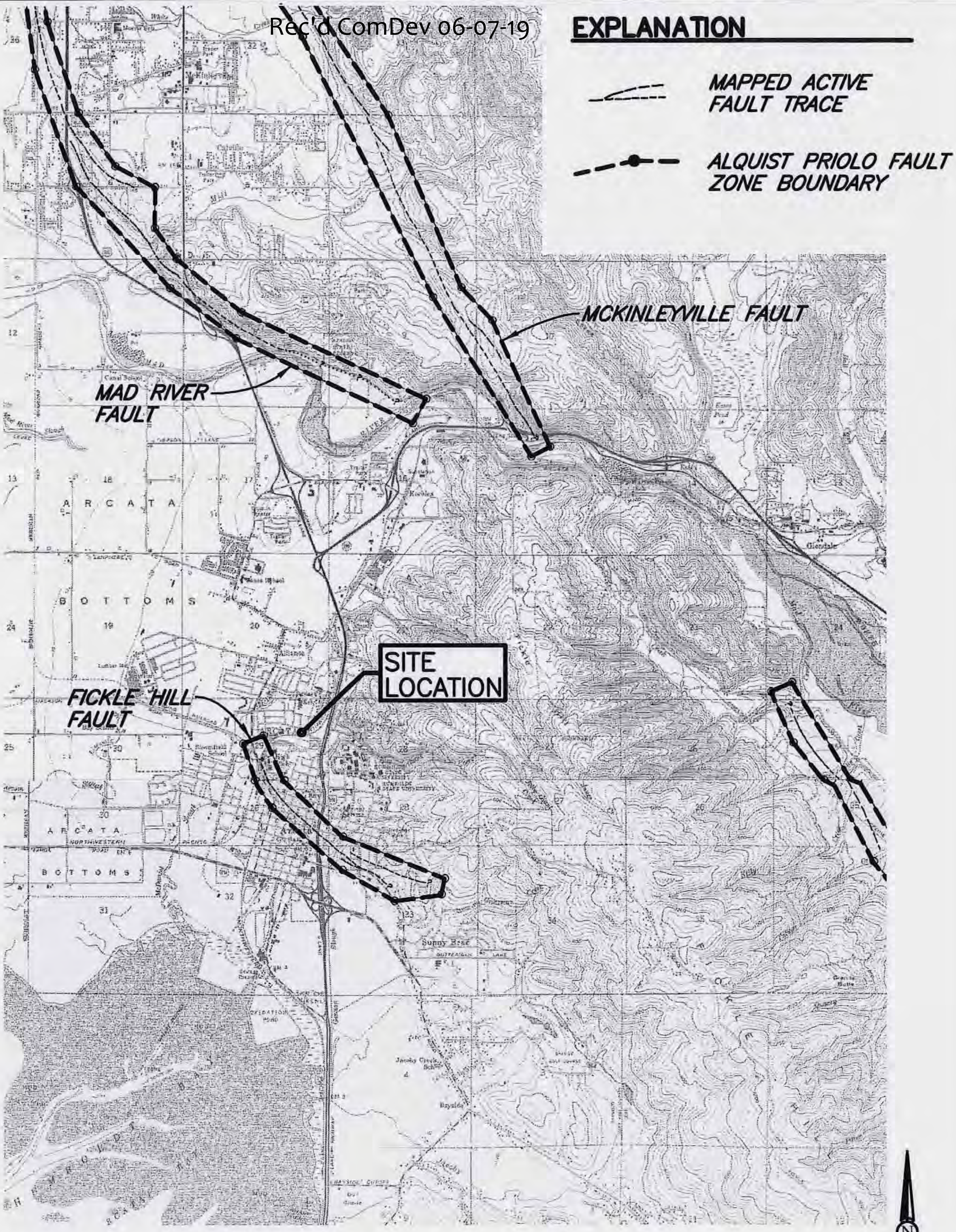
✕ QUARRY OR GRAVEL PIT

SPRING

MARSH

SHN Consulting Engineers & Geologists, Inc.	Arcata Volunteer Fire Department	Explanation Geologic and Geomorphic Map SHN 009077
July 2009	\\Eureka\projects\2009\009077-Arcata Volunteer Fire Department\Figs\009077-Figure 5a.doc	Figure 5a

Rec'd ComDev 06-07-19



SOURCE: ARCATA NORTH, ALQUIST PRIOLO MAP (CDMG, 1983)

1"=5000'±

SHN Consulting Engineers & Geologists, Inc.	Arcata Volunteer Fire Department Arcata, California		Alquist Priolo Fault Map SHN 009077
	July 2009	009077-FAULT-LCTN	Figure 6

parameters S_S, S_1, F_a, F_v, S_{MS}, S_{M1}, S_{DS}, and S_{D1} using the United States Geological Survey (USGS) seismic calculator software, "Seismic Hazard Curves, Response Parameters, Design Parameters: Seismic Hazard Curves, and Uniform Hazard Response Spectra," v. 5.0.9, dated October 6, 2008. Calculated values are presented in Table 2.

Table 2 Seismic Design Criteria Sunset Avenue, Arcata, CA	
Latitude	40.880°
Longitude	-124.086°
Site Class	D
S_S	2.597
S_1	0.928
F_a	1.00
F_v	1.50
S_{MS}	2.597
S_{M1}	1.393
S_{DS}	1.731
S_{D1}	0.928
Occupancy Category	IV
Seismic Design Category	F

5.3 Liquefaction

Liquefaction is described as the sudden loss of soil shear strength due to a rapid increase of soil pore water pressures caused by cyclic loading from a seismic event. In simple terms, it means that a liquefied soil acts more like a fluid than a solid when shaken during an earthquake. In order for liquefaction to occur, the following are needed:

- granular soils (sand, silty sand, sandy silt, and some gravels);
- a high groundwater table; and
- a low density of the granular soils (usually associated with young geologic age).

The adverse effects of liquefaction include local and regional ground settlement, ground cracking and expulsion of water and sand, the partial or complete loss of bearing and confining forces used to support loads, amplification of seismic shaking, and lateral spreading. Lateral spreading is defined as lateral earth movement of liquefied soils, or competent strata riding on a liquefied soil layer, downslope toward an unsupported slope face, such as a creek bank, or an inclined slope face.

Liquefaction has been documented on numerous occasions in the greater Humboldt Bay area following historic moderate to large magnitude earthquakes. Specific accounts of historic ground failures are presented in a compilation prepared by Youd and Hoose (1978). Careful interpretation of the historic accounts, however, indicates that liquefaction events in the area are entirely confined to recent alluvial sediments in the Eel River Valley and late Holocene age bay margin sediments surrounding Humboldt Bay. There are no historic accounts of liquefaction on the Arcata marine terraces, on which the proposed development is situated.

Geologic materials most susceptible to liquefaction are geologically recent (i.e., late Holocene age) sand- and silt-rich deposits, located adjacent to streams, rivers, bays, or ocean shorelines. It should be noted that these 'most susceptible' conditions do not exist at the subject site. Susceptibility to liquefaction decreases with increasing geologic age, according to Youd and Perkins (1978). For example, Table 2 in Youd and Perkins' paper presents estimated liquefaction susceptibility of Holocene marine terraces as low, and Pleistocene marine terraces as very low. The subject site is a late Pleistocene age marine terrace.

On City of Arcata hazard mapping (City of Arcata, 1998), the low-lying swale south of the site has been mapped within a moderate liquefaction hazard zone due to the likely presence of young unconsolidated sediments associated with Jolly Giant Creek. The proposed structures are located outside the influence of these sediments. The Planning Scenario for a great earthquake on the Cascadia Subduction Zone (CDMG, 1995) shows the site to be outside any areas of liquefaction potential. At the subject site we encountered some isolated and discontinuous soils in our geotechnical borings that meet the textural criteria for potentially liquefiable soils, although their age does not. Site-specific liquefaction potential and the associated risk to the proposed development are discussed below in Section 6.2.

5.4 Slope Stability

As described above, the project area has been historically graded flat. A 10 to 15 foot fill slope is aligned along the southern edge of the property. The slope has a moderate gradient and is heavily vegetated with brush and young trees. The proposed structures are located more than 30 feet from the slope break. The proposed alignment of Foster Avenue, as indicated on Figure 2, parallels the southern property boundary and straddles portions of the slope along the alignment. No site survey or proposed grading plan was available at the time of this writing. Additional review of site conditions may be necessary during the development of the grading plan. We provide general site preparation and grading recommendations below. Provided our recommendations are adhered to, there appears to be a negligible hazard associated with the risk of slope instability related to the proposed improvements.

5.5 Flooding

The site is located at an elevation of approximately 40 feet above mean sea level. According to the FEMA panel 0600610004E (Arcata South), revised by FEMA November 5, 1997 the subject property is not located within an identified flood hazard area. Additionally, the site is not located in the area of potential inundation resulting from a catastrophic failure of Matthews Dam.

5.6 Tsunami Hazard

The site is outside the Tsunami Run-up Zone on both City of Arcata hazard mapping (City of Arcata, 1998), and in the Planning Scenario for a great earthquake on the Cascadia Subduction Zone (CDMG, 1995). It is mapped as a No Hazard zone on other tsunami risk mapping (Patton and Dengler, 2004).

6.0 Geotechnical Conditions

6.1 Foundation Bearing Soils

Within our backhoe pits we observed up to 8 feet of fill within the locations of the proposed structures. As discussed above, the fill materials contain variable amounts of soft compressible soils and layers of organic material. The fill soils are therefore not considered suitable for bearing structural loads. The native olive brown to yellowish brown sandy silt ([ML] and silty sand[SM]) beneath the fill materials and the original native topsoil is considered suitably firm/dense to support structural loads. We make recommendations for foundation design and construction below in Section 8.2.

6.2 Liquefaction, Co-Seismic Settlement, Lateral Spreading

The liquefaction potential was evaluated quantitatively based on sampler penetration resistance (SPT N-values) in the machine drilled borings. Penetration resistance indicates the existing relative density of the underlying sand deposits, which is related to liquefaction potential. The quantitative liquefaction analysis was conducted using the software program LiqIT, version 4.7.6.1, by GeoLogismiki, Inc. The calculation method used is in accordance with the procedures that were developed by consensus of participants of the recent National Center for Earthquake Engineering Research workshops (NCEER, 1997; Youd et al, 2001). The potential for liquefaction is estimated by calculation of the estimated Cyclic Stress Ratio (CSR) induced by the upper-bound earthquake, compared with the capacity of the soil to resist liquefaction, expressed in terms of the Cyclic Resistance Ratio (CRR). The risk of liquefaction is considered significant where the ratio of CRR to CSR, or factor of safety, approaches a value of about 1.2 or less.

The factor of safety for liquefaction was calculated at less than 1.0 for the 3', 18', 23' and 36' test locations within BH-1 and all test locations within the upper 26 feet of BH-2 (Appendix E). It should be noted that the percent fines (silt and clay) in the soil profile are used by the software to adjust penetration values, but the software does not make a determination as to its potential for liquefaction based on the grain size distribution. This additional screening is required by the investigator, as the variability of factors and site conditions can not be effectively modeled for use in the software. Of the soils within the anticipated depths of seasonal saturation (below 10 feet) all but the deepest (below 22 feet in BH-1 and below 26 feet in BH-2) are considered too cohesive to be liquefiable. Laboratory testing of representative samples from this interval indicate these soils have between 80 and 100% fines. The sandy soils encountered below the cohesive soils are suitably dense that the potential for liquefaction in these deposits is considered low.

Co-seismic settlement may occur within loose, cohesionless soil deposits due to soil densification from dynamic loading. In other words, shaking or vibration can densify loose to moderately consolidated granular soils, resulting in settlement of the ground surface. The magnitude of potential co-seismic settlement was evaluated in both of the borehole locations using the software program LiqIT. The total estimated co-seismic settlement is calculated at approximately 1 and 2 inches for the borehole locations BH-1 and BH-2, respectively.

Liquefaction, co-seismic settlement and lateral spreading are considered negligible risks for earthquakes of small to moderate magnitude. In relatively rare, great earthquakes, for example those with a moment magnitude of 7.5 or greater, there may be risk of liquefaction, co-seismic settlement, and lateral spreading. Risk of damage to the proposed structures from these soil behaviors, should they occur, is considered likely to be within building code criteria for upper bound (rare, great) earthquakes.

6.3 Settlement under Static Conditions

The project site is underlain by up to 10 feet, or more, of undocumented fill. Within the footprints of the proposed structures we observed up to 8 feet of fill. The fill materials contain variable amounts of soft, unconsolidated soils and layers of concentrated organics that have the potential to compress under loaded conditions associated with additional fill placement and structural foundations. We provide site preparation and foundation design recommendations that are intended to mitigate the settlement potential.

In our opinion, under normal static conditions, the risk of significant post-construction foundation settlement will be mitigated to a low level if the recommended site preparation is completed, and if the structures are supported on foundations designed and constructed as recommended below. Due to the variability of soils deposits and the inherent limitations of current engineering and construction practices, some post-construction vertical settlement may occur. We estimate that with the project constructed in accordance with the following recommendations, and less than two feet of fill to raise site grade, total post construction settlement is not likely to exceed ¾ inch, and post-construction differential settlement is not likely to exceed ½ inch.

6.4 Expansive Soils

No high plasticity, potentially expansive soils were observed or are anticipated. Laboratory test results did not indicate significant potential for expansive soils behavior. No high plasticity clayey soils were encountered, or are generally anticipated in the geologic formation comprising the site. Risk of adverse consequences to the structures from expansive soils is considered low. Recommendations are provided for geotechnical engineering review of the foundation excavations prior to pouring the foundations, and at this time the anticipated absence of high-plasticity, potentially expansive soils can be confirmed.

7.0 Conclusions and Discussion

Based on the results of our field and laboratory investigations, it is our opinion that the project site can be developed as proposed, provided that our recommendations are followed, and that noted conditions and risks are acknowledged.

The primary geotechnical site consideration for the proposed project is the presence of undocumented fills and the potential for settlement of structures founded on these or other unsuitable soils. Consequently, recommendations presented below include provisions for foundation elements to penetrate through the fills to bear on suitably dense native soils that can provide adequate structural support. The risk of adverse affects to the proposed structure due to liquefaction is low for earthquake events such as those that have occurred within the last 150 years.

In our opinion, the risk of significant post-construction static consolidation settlement is low, provided that the recommendations for site preparation and foundation support are followed. Due to the variability of soils deposits and the inherent limitations of current engineering and construction practices, some post-construction vertical consolidation settlement is likely to occur. We estimate that with the project constructed in accordance with the following recommendations, total post construction settlement is not likely to exceed ¾-inch, and post-construction differential settlement is not likely to exceed ½-inch within a distance of 30 feet under static conditions.

The site is subject to strong ground motion from seismic sources. The minimum standard for construction of the building structures should be in accordance with the latest edition of the CBC. Recent building codes have been based on the criteria that structures should be able to:

1) Resist a minor level of earthquake motion without damage,
2) resist a moderate level of earthquake ground motions without structural damage, but possibly experience some nonstructural damage, and
3) resist a major level of earthquake ground motion having an intensity equal to the strongest either experienced or forecast for the building site, without collapse, but possibly with some structural as well as nonstructural damage. (Kramer, 1996).

The 2007 California Building Standards Administrative Code, Chapter 4, Section 4-201, states,

> Essential services buildings constructed pursuant to these rules and regulations shall be designed and constructed to ...(text omitted)... resist, insofar as practical, the forces generated by winds and major earthquakes of the intensity and severity of the strongest anticipated at the building site without catastrophic collapse, but may experience some repairable architectural or structural damage. An essential services building as designed and constructed shall be capable of providing essential service to the public after a disaster.

In our opinion, the proposed development should meet these criteria, and this report assumes that the owner understands and accepts this level of risk for the proposed construction as described by these criteria. The foundation and slab-on-grade recommendations presented below assume the acceptance of some degree of risk of adverse effects resulting from relatively rare, very strong, upper bound seismic events, as discussed above.

8.0 Recommendations

8.1 Site Preparation and Grading

The portion of the site that includes the proposed structures is vacant and covered with at least 18 inches of gravel and cobble fill. Organic topsoil and, in most of the explorations, unsuitable fill underlies the cobble fill. Unsuitable fill thickness generally increases to the south. Regardless of final site grades, all portions of the site where proposed structures are to be located will require site preparation and removal of existing fill. All grading and earthwork should be performed in accordance with the local grading ordinance.

We understand that final building pad grades have not been established. However, given the existing surface grades with respect to Sunset Avenue to the north, less that two feet of additional fill are anticipated. If structural fill to support structures are to be more than 2.5 feet above existing grade, the grading plan should be reviewed by the Geotechnical Engineer in advance for conditions that could alter the types of foundations to be implemented.

In general, the upper gravel and cobble fill is suitable for reuse as structural fill. Underlying topsoil and organic rich silt and clay containing debris is not suitable for structural fill and should be removed from the site or stockpiled for use in non-structural areas. This will require importing replacement structural fill within building pad areas.

The following sections provide recommendations for fill placement and compaction requirements as necessary to achieve design grades.

Identification of Existing Utilities: As appropriate, notify Underground Service Alert (1-800-642-2444) prior to commencing site work, and use this location service and other methods to avoid injury or risk to life from underground and overhead utilities, and to avoid damaging them. We encountered no utilities in planning our investigation.

Gravel and Cobble Fill Stripping: We encountered 1 ½ to 2 feet of fill over the entire site. This material may be stripped and stockpiled for incorporation into structural fill or as a subgrade surface for paved parking and fire truck traffic. Except in isolated areas, this fill is covered with limited vegetative cover, which need not be stripped or separated from the fill.

Stripping Fill, Organic Material and Topsoil: In nearly all exploratory borings and test pits, unsuitable fill and topsoil were encountered below the gravel and cobble fill. Organically rich (dark brown to black) topsoil, typical of the marine terrace deposits in the Arcata area, should be stripped to expose firm and unyielding native soil. Most explorations also indicated varying thicknesses of soft silt and clay fill containing debris that is unsuitable for support of structures. The fill was absent in the northern explorations but increased in thickness to the south. The depth of removal will likely extend to a depth of at least 8 feet below existing grade in the southern limits of the site. The lateral extent of removal of unsuitable fill should be at least five feet outside of the building footprint, measured at the bottom of the excavation. In all cases, native soils should be exposed, generally identified by the characteristic yellow-brown color and firm and unyielding surface. Topsoil and organic soil may be stockpiled for reuse in landscape areas. Unsuitable fill may be used in non-structural areas where there is no traffic loading.

Observation of Exposed Subgrade Surfaces: Exposed surfaces resulting from stripping and over-excavation should be observed by the Geotechnical Engineer to determine appropriate action. Due to the variation in depth to expose suitable native soil, this evaluation is essential. The geotechnical engineer may recommend that remaining unsuitable soils, such as overly weak, compressible, or disturbed soils, be additionally stripped. This evaluation may include in-place soil density testing, as well as proofrolling.

Structural Fill: Structural fill should be placed to design grades and compacted to a minimum of 90 percent of the maximum relative dry density as determined by the current ASTM D1557 test method. Beneath the building slab and foundations, structural fill should consist of imported granular soil (a durable, sand and gravel mixture, containing little or no clay and silt, no organic material or debris, and no individual particles over three inches across) such as river-run gravel or base rock). This granular soil should be relatively easy to moisture condition and compact. Outside the building slab area, structural fill material may consist of relatively non-plastic (Liquid Limit less than 40, Plasticity Index less than 15) soils with no individual particles over six inches across. Structural fill should extend horizontally beyond the exterior footing perimeters a distance of five feet, measured at the bottom of the excavation, and to a height above the footing base at least equal to the minimum embedment depth recommended in the current applicable Building Code.

8.2 Foundations

Existing site conditions are not favorable for conventional spread footings to support the proposed structures. Due to the presence and variable thickness of unsuitable fill, once this material is over-excavated and replaced with structural fill, conventional footings are appropriate. Alternately, foundations could be deepened to bear on native soils but the depths are uncertain across the site. Similarly, shallow drilled piers founded on native soils are an option. However, it may be more economical to remove the unsuitable material, and our recommendations are based on that option. We assume continuous strip footings will be designed to support perimeter walls and that isolated footings will be spaced within the interior of the structure.

Due to the presence of unsuitable and organic topsoil and fill, these materials are to be over-excavated in accordance with the Site Preparation recommendations above. Gravel and cobble fill may be stockpiled for reuse as structural fill. Based on site conditions, all foundations will be established on structural fill. The guidelines for the fill are as follows:

1. All existing fill should be excavated and either removed from the site or stockpiled.
2. The lateral limits of the excavation within a building footprint should be at least five feet beyond the outer foundation edges or equal to the depth of excavation, whichever is greater. Lateral limits should be measured at the bottom of the excavation.
3. Native soils that are exposed at the bottom of the excavation should be observed and tested by the Geotechnical Engineer.
4. Structural fill is to be placed up a height above the footing base at least equal to the minimum embedment depth in the current applicable Building Code.

Foundations should be sized, embedded, and reinforced to at least the minimums presented in the current edition of the CBC and in accordance with the following:

- Foundations supported on structural fill and at a minimum embedment depth of 1.5 feet below the lowest adjacent grade may be designed for an allowable bearing capacity of 3,000 pounds per square foot (psf).
- The minimum embedment depth of foundations is 18 inches below the lowest adjacent grade.
- The minimum footing width is 1.5 feet for perimeter footings and 2 feet for isolated column footings.

The allowable bearing capacities may be increased by one-third to accommodate the short-term effects of wind and/or seismic loading.

Settlement of conventional footings that are designed in accordance with the above is estimated at ¾-inch. Since the supporting structural fill will be granular, compression is expected to occur during construction or shortly after completion. Differential settlement between two adjacent columns should not exceed one-half of the total estimated settlement.

Horizontal loads acting on shallow foundation loads may be resisted by friction along the base of the concrete foundations. For foundations supported on structural fill, a friction coefficient of 0.40 is appropriate. Additional lateral support may be developed for short term loadings, such as lateral wind or earthquake loadings using allowable passive earth pressure. Passive soil resistance may be represented by an equivalent fluid weighing 350 pounds per cubic foot (pcf). The equivalent fluid pressure acts normal to the foundation face in contact with structural fill.

The ground surface around the structure perimeter should be sloped away, or other design measures implemented to provide positive surface water drainage away from perimeter foundation areas.

Foundation excavations should be observed by the Geotechnical Engineer prior to reinforcing steel and concrete placement. This is to assess that the foundation soils are capable of supporting the design loads and are consistent with this Report. Soft or loose soils that are exposed in foundation excavations may require over-excavation and replacement with structural fill as recommended by the Geotechnical Engineer.

8.3 Slabs-on-Grade

Concrete slabs-on-grade may be supported directly on at least eight inches of crushed rock over structural fill that is placed in accordance with this Report. We assume that concrete slabs will be designed for fire vehicles that impart heavier than normal loads and that slabs will be at least six inches thick.

Concrete slabs supported on at least eight inches of crushed rock may be designed using a subgrade modulus of 225 pounds per cubic inch (pci). The subgrade modulus is the value that would be obtained in a standard, *in situ*, one-foot square plate test where one inch of deflection is recorded.

The crushed rock should serve as a capillary break to limit upward migration of moisture through the slab. The upper four inches should consist of gravel having a gradation of No. 4 U.S. Sieve (0.187 inch) minimum to 1 inch maximum. Alternately, for additional protection, a moisture vapor retarding impermeable polyethylene membrane at least 6 mils-thick may be incorporated into the design. This membrane may overlie an alternate capillary break consisting of a 4-inch layer of Class 1 Type A permeable material in accordance with Caltrans Standard Specifications 68-1.025. A thin layer (less than 2 inches) of clean sand may be placed over the membrane to protect it during concrete placement.

8.4 Vehicle Pavements

The existing gravel and cobble fill within at least the upper 1 ½ to 2 feet as encountered in the borings and test pits appear to have adequate density and strength to support anticipated fire truck loading for either flexible or rigid pavement systems. Therefore, if site grade is to be raised in pavement areas, we recommend not over-excavating the gravel and cobble fill. However, the underlying organic topsoil and fill do not have this support capacity. If site grade is to be lowered, for all pavement areas, we recommend a subgrade thickness that consists of at least two feet of structural fill. Regardless of site grade, there may be some risk of long-term degradation of the ground surface, especially where flexible pavements are located. This risk can be reduced by providing at least two feet of structural fill (including the gravel and cobble fill) within all pavement areas. For the purpose of analysis, we assumed at least eight trucks per day with each truck imparting an Equivalent Single Axle Load (ESAL) of 1.0.

We recommend that a flexible or rigid pavement system that consists of Asphaltic Concrete or concrete, respectively, and crushed aggregate base be underlain by at least 24 inches of structural fill. The upper 12 inches of subgrade should be granular, have a minimum R-value of 50, and be compacted to at least 95 percent of the maximum dry density in accordance with ASTM D-1557. Based on our observations within the test pits, it is our opinion that the existing gravel and cobble fill satisfies these requirements.

Due to the presence of unsuitable and organic fill beneath the gravel and cobble fill across the site, and because site grades have not been established, the Geotechnical Engineer should observe the condition and consistency of the exposed subgrade surface. A firm and unyielding surface is required and will provide a stable base upon which to place and compact structural fill.

We recommend design pavement sections consisting of:

- For Flexible Pavement Parking Areas
  - A. C. Pavement Thickness: 0.20-foot minimum
  - Class 2 Aggregate Base Thickness: 0.50-foot minimum
- For Rigid Pavement Fire Truck Traffic Lanes
  - Concrete Pavement Thickness: 0.50-foot minimum
  - Class 2 Aggregate Base Thickness: 0.67-foot minimum

Materials, specifications, and procedures should be in accordance with Caltrans current Standard Specifications. The exception is that 95 percent relative compaction (ASTM D-1557-91) should be obtained in the aggregate base, and in the upper 12 inches of soil subgrade.

The ground surface around vehicle pavements should be sloped away, the pavements should be sloped to drain, and other design measures implemented to provide positive surface water drainage away from vehicle pavement areas.

8.5 Utility Trenches

All temporary excavations must comply with applicable local, state, and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards. Construction site safety generally is the responsibility of the contractor, who should be solely responsible for the means, methods, and sequencing of construction operations so that a safe working environment is maintained.

Heavy construction equipment, building materials, excavated soil, and vehicular traffic should not be allowed within a 1:1 (horizontal to vertical) projection from the toe of open excavations to the ground surface. Support systems such as shoring or bracing should be used to provide structural stability and to protect personnel working within the excavation in accordance with good construction practices and all applicable safety regulations. Cohesionless materials or unsuitable fill as encountered on site are subject to caving and should be anticipated within trenches at the site.

Groundwater is not expected within the depths of typical trench excavations. The contractor should install measures to divert or channel runoff to flow towards collection points to be removed from the trench and disposed of at an approved area. If locally perched groundwater is encountered, we anticipate a relatively high seepage inflow rate due to the coarse grained sand materials below a depth of about 8 feet.

Pipe zone backfill (i.e., material placed from the trench bottom to a minimum of 6 inches over the pipeline crown) should consist of imported soil having a Sand Equivalent (SE) of no less than 30 and having a particle size no greater than ½-inch in maximum dimension. On-site soils may not meet this recommendation. Trench zone backfill (i.e., material placed between the pipe zone backfill and finished subgrade) may consist of on-site soil that meets the material requirements previously provided for structural fill with 100 percent passing the ¾-inch sieve.

If imported material is used for pipe or trench zone backfill, we recommend it consist of fine-grained sand. In general, use of coarse-grained sand and/or gravel is not recommended due to the potential for soil migration into and water seepage along trenches backfilled with this type of material.

Recommendations provided above for pipe zone backfill are minimum requirements only. More stringent material specifications may be required to fulfill local codes and/or bedding requirements for specific types of pipe. We recommend the project Civil Engineer develop these material specifications based on planned pipe types, bedding conditions, and other factors beyond the scope of this investigation.

Backfill in temporary excavations, including utility trench backfill, should be placed and compacted in accordance with recommendations previously provided for structural fill. Mechanical compaction is recommended; jetting should not be allowed unless specifically reviewed and approved by the Geotechnical Engineer prior to construction. Special care should be given to ensuring that adequate compaction is made beneath the haunches of utility pipes (that area from the pipe springline to the pipe invert) and that no voids remain in this space.

Soft and yielding subgrade could be encountered along the bottom of excavations that expose the organic clay fill that was encountered across the site. It is recommended that the bottom of excavations be stabilized prior to placement of the pipeline bedding or structural fill so that, in the judgment of the geotechnical engineer, the subgrade is firm and unyielding. The Contractor should have the sole responsibility for design and implementation of subgrade stabilization techniques. Some methods that have been successfully used to stabilize excavation subgrades include the following:

- Use of 1–inch to 2-inch floatrock worked into the excavation bottom and covered with a woven or nonwoven geotextile;
- Placement of a geotextile on the excavation bottom and covered with at least one foot of compacted Processed Miscellaneous Base (PMB) conforming to the requirements of Section 200-2.5 of the Greenbook, latest edition; and
- Overexcavation of subgrade and placement of two-sack sand-cement slurry.

If floatrock is used, typically sand with an SE of 50 or more should be used to fill the voids in the rock prior to placement of pipe bedding materials.

8.6 Site Drainage

The site development should incorporate adequate drainage of surface waters and, thereby, minimize infiltration into the subsurface soils. Grading around the structures should be performed so that the ground drains away from the structures for a minimum of 10 feet at a minimum gradient of 5 percent, or a minimum of 2 percent if covered with relatively impervious pavement or concrete. Flows from rain gutter downspouts should be extended within non-perforated piping to discharge water away from and down-gradient of the buildings.

9.0 Additional Services

Prior to bidding, prospective contractors for the project often contact us regarding the information contained in our report. These informal contacts could result in incomplete or misinterpreted information being provided to the contractor. Consequently, we recommend a pre-bid meeting to answer such questions prior to bid submittal. Alternatively, such questions should be addressed to the Owner or designated representative, who, after consulting with SHN, can appropriately respond to all prospective contractors with clarifications or additional information.

During the design phase, we recommend that communications between the design team and SHN be maintained to optimize compatibility between the design and soil and groundwater conditions.

We have assumed, in preparing our recommendations, that we will be retained to review those portions of the plans and specifications that pertain to earthwork and foundations. The purpose of this review is to confirm that our earthwork and foundation recommendations have been properly interpreted and implemented during design. If we are not provided this opportunity for review of the plans and specifications, we will assume no responsibility for misinterpretation of our recommendations.

In order to assess construction conformance with the intent of our recommendations, we recommend that a representative of our firm:

- monitor adequate subgrade preparation;
- monitor placement of structural fill;
- observe foundation excavations.

This work allows SHN the opportunity to verify anticipated site conditions, and recommend appropriate changes in design or construction procedures if site conditions encountered during construction vary significantly from those described in this report.

10.0 Limitations

This report has been prepared for the specific application to the design and construction of the proposed fire station as discussed herein. SHN prepared the findings, conclusions, and recommendations presented herein in accordance with generally accepted geotechnical engineering practices at the time and location that this report was prepared. No other warranty, express or implied, is made.

Soil and rock materials are typically not homogeneous in type, strength, and other geotechnical properties, and can vary between points of observation and exploration. In addition, groundwater and soil moisture conditions can vary seasonally and for other reasons. SHN does not and cannot have a complete knowledge of the subsurface conditions underlying a site. The conclusions and recommendations presented in this report are based upon the findings at the points of exploration, interpolation and extrapolation of information between and beyond the points of observation, and are subject to confirmation of the conditions revealed by construction. The recommendations provided in this report are based on the assumption that an adequate program of tests and observations will be conducted by our firm during the construction phase in order to evaluate compliance with our recommendations.

Findings of this report are valid as of the date of issuance; however, changes in condition of a property can and will occur with the passage of time. Furthermore, changes in applicable or appropriate standards occur whether they result from legislation or advancement in technology. Accordingly, findings of this report may be invalidated wholly or partially by changes outside of SHN's control. This report is subject to SHN's review and remains valid for a period of two years, unless SHN issues a written opinion of its continued applicability thereafter. If the scope of the proposed construction, including the proposed loads, grades, or structural locations, changes from that described in this report, our recommendations should also be reviewed.

The scope of SHN's geotechnical services did not include any assessment for the presence or absence of any hazardous/toxic substances in the soil, ground water, surface water, or atmosphere, or the presence of any environmentally sensitive habitats or culturally significant areas.

11.0 References

California Division of Mines and Geology (1995). "Planning Scenario in Humboldt and Del Norte Counties, California, for a Great Earthquake on the Cascadia Subduction Zone", California Division of Mines and Geology, Special Publication 115, Sacramento, California.

City of Arcata (1998). Figure PS-a, Arcata General Plan 2020, Hazards Map. City of Arcata, California.

Carver, G.A. (1987). Late Cenozoic Tectonics of The Eel River Basin Region, Coastal Northern California, in Schymiczek, H. and Suchsland, R. (Eds): Tectonics, Sedimentation and Evolution of the Eel River and Associated Coastal Basins of Northern California. pp. 61-72. Bakersfield: San Joaquin Geological Society.

Carver, B. A., and R. M. Burke. (1992). Late Cenozoic deformation on the Cascadia Subduction Zone in the region of the Mendocino Triple Junction. Prepared by Humboldt State University, Department of Geology, Arcata, California.

Carver, G.A., Stephens, T.A., and Young, J.C. (1985). "Quaternary Geology of a portion of the Arcata South 7.5' Quadrangle," California Division of Mines and Geology open file report.

Clarke, S.H., Jr. (1992). Geology of the Eel River Basin and Adjacent Region: Implications for Late Cenozoic Tectonics of the Southern Cascadia Subduction Zone and Mendocino Triple Junction: AAPG Bulletin, v. 76, no. 2, p. 199-224.

Dengler, L., R. McPherson, and G.A. Carver. (1992). "Historic Seismicity and Potential Source Areas of Large Earthquakes in North Coast California," *1992 Friends of the Pleistocene Guidebook, Pacific Cell*, p. 112-118. NR: Friends of the Pleistocene.

Geomatrix (2008). "Assessment of the Potential for Surface Fault Rupture, Proposed Sutdent Housing Facility, Humboldt State University, Arcata, California," an unpublished consultant report for Humboldt State University, dated February 2008.

Kelley, F.R. (1984). "Geology and Geomorphic Features Related to Landsliding, Arcata North 7.5" Quadrangle, Humboldt County, California." NR: CDMG Open File Report 84-39 SF.

Kramer, S. L. (1996) Geotechnical Earthquake Engineering, Prentice-Hall international series in civil engineering and engineering mechanics, Prentice Hall, Upper Saddle River, N.J.

McLaughlin, R.J., et al. (2000). "Geology of the Cape Mendocino, Eureka, Garberville, and Southwestern Part of the Hayfork 30 x 60 Minute Quadrangles and Adjacent Offshore Area, Northern California," *U.S. Geological Survey Miscellaneous Field Studies MF-2336*. NR: USGS.

NCEER, December, 1997. *Proceeding of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils,* Edited by Youd, T.L. and Idriss, I.M., National Center for Earthquake Engineering Research, Buffalo, NY

Patton, J. R. , Dengler, L. (2004). Tsunami Safety Map. Humboldt Earthquake Education Center, Humboldt State University, Arcata, California (Later Versions Marked Draft, Not for Distribution or Planning).

U.S. Geological Survey and California Geological Society, 2006, Quaternary fault and fold database for the United States, accessed July 15, 2009, from USGS web site: http//earthquakes.usgs.gov/regional/qfaults/

Youd, T.L., and Perkins (1978). "Mapping Liquefaction-Induced Ground Failure Potential", American Society of Civil Engineers, Journal of the Geotechnical Engineering Division, Volume 104, No. GT4, April, 1978

Youd, T.L., and S.N. Hoose. (1978). *Geological Survey Professional Paper Number 993: Historic Ground Failures in Northern California Triggered by Earthquakes*. Washington, D.C.: United States Government Printing Office.

Youd, T.L. and Idriss, I.M., Andrus, R.D., Arango, I., Castro, G., Christian, J.T., Dobry, R., Finn, W.D., Harder, L.F. Jr., Hynes, M.E., Ishihara, K., Koester, J.P., Liao, S.S.C., Marcuson, W.F. III, Martin, G.R., Mitchell, J.K., Moriwaki, Y., Power, M.S., Robertson, P.K., Seed, R.B., Stokoe, K.H. II (2001), Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils, Journal of Geotechnical and Geoenvironmental Engineering, Vol. 127, No. 10, October 2001.

Appendix A

Historical Earthquake List

Rec'd ComDev 06-07-19

NEIC: Earthquake Search Results

U. S. G E O L O G I C A L S U R V E Y

E A R T H Q U A K E D A T A B A S E

FILE CREATED: Tue Jul 28 21:33:42 2009
Circle Search Earthquakes= 37
Circle Center Point Latitude: 40.880N Longitude: 124.085W
Radius: 100.000 km
Catalog Used: CDMG
Magnitude Range: 5.0 - 9.9
Data Selection: California (CDMG)

CAT	YEAR	MO	DA	ORIG TIME	LAT	LONG	DEP	MAGNITUDE	IEM NFO TF	DTSVNWG	DIST km
CDMG	1865	10	01	1715	40.80	-124.10		5.4 UKCDMG	7..	....	8
CDMG	1871	03	02	2105	40.40	-124.20		5.9 UKCDMG	8..	....	54
CDMG	1875	09	30	1230	40.70	-124.00		5.5 UKCDMG	7..	....	21
CDMG	1878	05	09	0425	40.10	-124.00		5.8 UKCDMG	8..	....	86
CDMG	1884	01	28	0730	41.10	-123.60		5.7 UKCDMG	5..	....	47
CDMG	1890	07	26	0940	40.50	-124.20		6.0 UKCDMG	7..	....	43
CDMG	1894	09	30	1736	40.30	-123.70		5.8 UKCDMG	7..	....	72
CDMG	1899	04	16	1340	41.00	-124.40		5.7 UKCDMG	6..	....	29
CDMG	1908	08	18	1059	40.80	-124.00		5.0 UKTO	7..	....	11
CDMG	1909	10	29	0645	40.50	-124.20		6.0 UKRI	8..	....	43
CDMG	1918	07	15	0023	41.00	-125.00		6.5 MLGR	6..	....	78
CDMG	1923	01	22	090418	40.50	-124.50		7.2 MLGR	8..	....	54
CDMG	1923	04	29	023129	41.00	-125.00		5.0 MLBRK	...	....	78
CDMG	1927	08	20	200544	41.00	-124.60		5.0 UKTO	8..	....	45
CDMG	1930	09	23	0258	40.83	-124.17		5.0 UKTO	7..	....	9
CDMG	1930	12	11	09	40.08	-124.50		5.0 UKTO	6..	....	95
CDMG	1931	09	09	134030	40.80	-125.00		5.8 MLGR	6..	....	77
CDMG	1932	06	06	084422	40.75	-124.50		6.4 MLBRK	8C.	....	37
CDMG	1935	06	03	1708	41.00	-124.00		5.0 MLBRK	...	....	15
CDMG	1936	10	10	0125	41.00	-125.00		5.0 MLBRK	...	....	78
CDMG	1938	07	01	1813	41.00	-124.00		5.0 MLBRK	...	....	15
CDMG	1938	09	12	0610	40.00	-124.00		5.5 MLBRK	6..	....	97
CDMG	1940	12	20	234042	40.00	-124.00		5.5 MLBRK	6..	....	97
CDMG	1941	10	03	161308	40.40	-124.80		6.4 MLBRK	7..	....	80
CDMG	1941	10	06	0659	40.40	-125.00		5.0 MLBRK	...	....	93
CDMG	1944	01	12	150240	40.30	-124.90		5.1 MLBRK	5..	....	94
CDMG	1945	05	02	194754	41.20	-123.50		5.0 MLBRK	6..	....	60
CDMG	1947	05	27	2059	40.40	-124.70		5.2 MLBRK	6..	....	74
CDMG	1948	08	18	191157	40.50	-124.70		5.0 MLBRK	5..	....	66
CDMG	1951	10	08	041035	40.28	-124.80		5.8 MLBRK	7..	....	89
CDMG	1952	09	22	114125	40.20	-124.42		5.2 MLBRK	7..	....	80

Rec'd ComDev 06-07-19

USGS
science for a changing world

NEIC: Earthquake Search Results

U. S. GEOLOGICAL SURVEY

EARTHQUAKE DATA BASE

FILE CREATED: Tue Jul 28 21:32:02 2009
Circle Search Earthquakes= 29
Circle Center Point Latitude: 40.880N Longitude: 124.085W
Radius: 100.000 km
Catalog Used: PDE
Magnitude Range: 5.0 - 9.9
Data Selection: Historical & Preliminary Data

CAT	YEAR	MO	DA	ORIG TIME	LAT	LONG	DEP	MAGNITUDE	IEM NFO TF	DTSVNWG	DIST km
PDE	1975	06	07	084622.40	40.57	-124.14	21	5.2 MLBRK	8D.	....	34
PDE	1975	09	09	024342.50	40.92	-124.40	27	5.0 MLBRK	4F.	....	26
PDE	1979	02	03	095816.10	40.89	-124.41	28	5.2 MLBRK	7D.	....	27
PDE	1980	03	03	141704.60	40.60	-125.03	5	5.1 MLBRK	4F.	....	85
PDE	1980	11	08	102734	41.12	-124.25	19	7.2 Mw01023	7C.	....	29
PDE	1980	11	08	224752.30	40.57	-125.07	15	5.0 MLBRK	...	....	89
PDE	1983	08	24	133630.90	40.31	-124.77	30	5.5 MLBRK	5FM	....	86
PDE	1983	12	20	104109.50	40.41	-124.90	5	5.6 MLBRK	5FM	....	86
PDE	1986	11	21	233301.70	40.37	-124.44	15	5.1 MLBRK	6D.	....	63
PDE	1986	11	21	233418	40.37	-124.45	15	5.1 MLBRK	.F.	....	64
PDE	1987	07	31	235658	40.42	-124.41	16	5.5 MLBRK	6DM	....	58
PDE	1990	01	16	200822	40.23	-124.14	2	5.3 MLBRK	7DM	....	72
PDE	1991	08	17	192940	40.24	-124.35	12	6.3 MwGS	7DM	......S	74
PDE	1992	03	08	034304.40	40.23	-124.29	13	5.5 MwHRV	6DM	....	74
PDE	1992	04	25	180604.21	40.37	-124.32	15	7.2 MwHRV	8CM	.T....S	60
PDE	1992	04	26	074139.73	40.42	-124.60	20	6.5 Mw01039	.DM	....	67
PDE	1992	04	26	111825.79	40.38	-124.57	22	6.7 Mw01039	.DM	....	69
PDE	1992	06	05	214641.90	40.27	-124.55	21	5.2 MwHRV	5FM	....	78
PDE	1994	12	26	141029.12	40.74	-124.31	23	5.5 MwHRV	7DM	....	24
PDE	1997	01	22	071716.69	40.27	-124.39	23	5.7 MwHRV	.DM	....	72
PDE	1997	01	26	062319.38	40.28	-124.40	22	5.2 MwBRK	...	....	71
PDE	1997	10	26	104408.08	41.00	-125.17	4	5.4 MwHRV	.FM	....	92
PDE	2002	06	17	165507.44	40.83	-124.60	22	5.3 MwHRV	5FM	....	44
PDE	2006	07	19	114143.53	40.28	-124.43	20	5.0 MwBRK	5FM	....	72
PDE	2007	02	26	121954.48	40.64	-124.87	0	5.4 MwGCMT	4FM	....	70
PDE	2007	05	09	075003.83	40.38	-125.02	0	5.4 MwGCMT	5FM	....	96
PDE	2007	06	25	023224.62	41.12	-124.82	3	5.0 MwGCMT	5FM	....	67
PDE	2008	04	30	030306.90	40.84	-123.50	29	5.4 MwGCMT	6FM	....	49
PDE	2008	10	26	092722.34	40.34	-124.63	21	5.0 MwGCMT	5FM	....	75

Rec'd ComDev 06-07-19

CDMG	1954	12	21	195629	40.78	-123.87	6.5	MLBRK	7D.	21
CDMG	1960	06	06	011748	40.82	-124.88	5.7	MLBRK	6..	67
CDMG	1961	04	06	040445	40.18	-124.75	5.1	MLBRK	6..	95
CDMG	1967	12	10	120652.20	40.50	-124.70	5.6	MLBRK	6..	66
CDMG	1968	06	26	014220.80	40.23	-124.27	5.9	MLBRK	7..	73
CDMG	1971	02	27	003137.70	40.27	-124.83	5.2	MLBRK	5..	92

Appendix B

Cone Penetration Test Logs

Rec'd ComDev 06-07-19

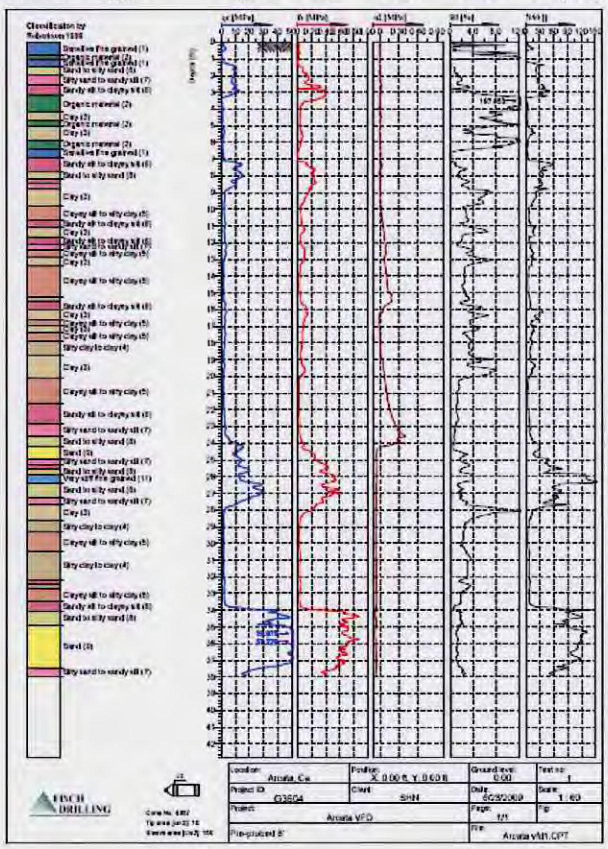
Cone Penetration Test Explanation

The **cone penetration test** (CPT) is an in situ testing method used to determine the geotechnical engineering properties of soils and delineating soil stratigraphy. The test method consists of pushing an instrumented cone tip into the ground at a controlled rate (usually 2 centimeters/second).

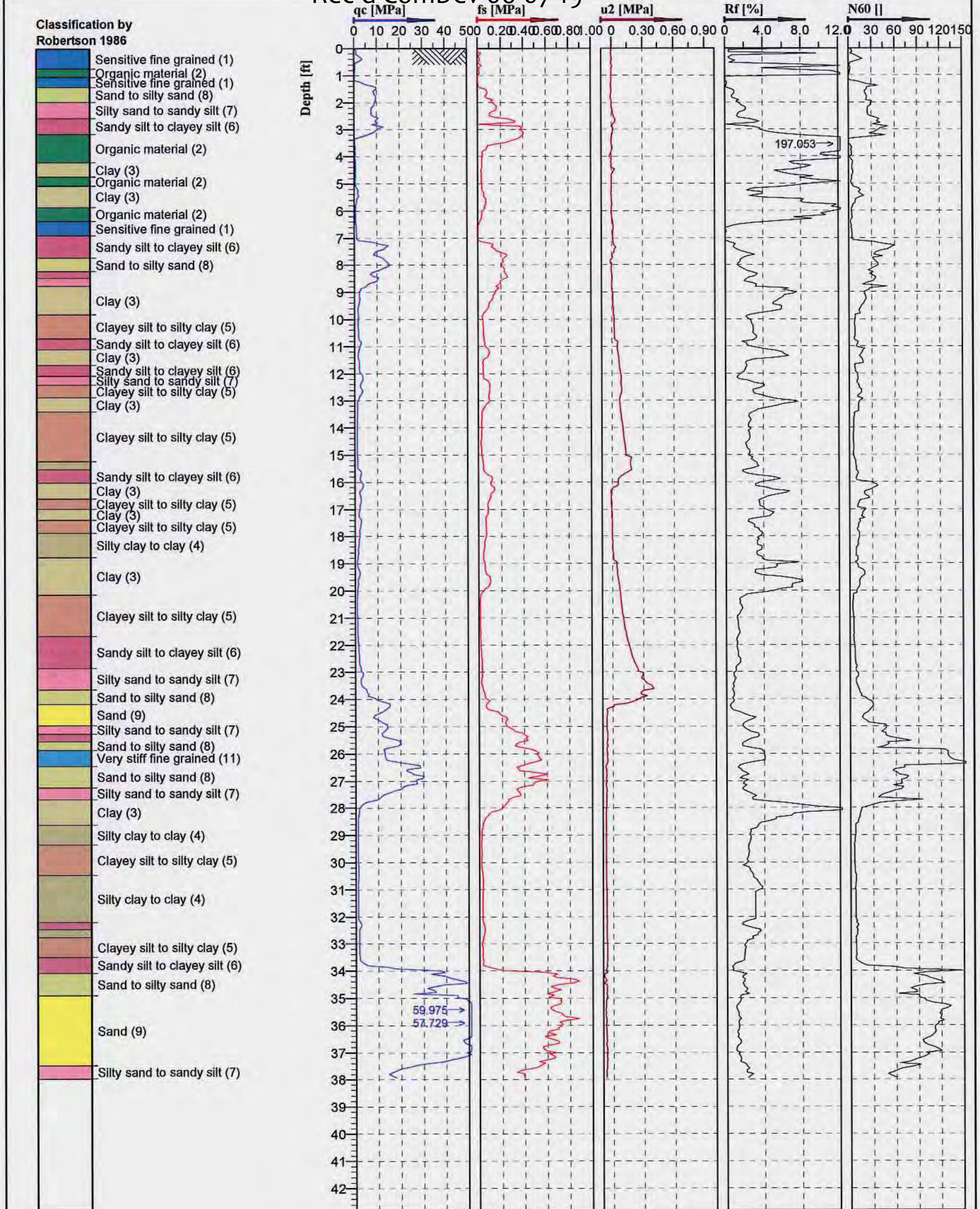
The CPT cone records a continuous measurement of tip resistance (**qc**), sleeve friction (**fs**), and pore pressure (**u2**). These parameters form the first three data columns on the logs. The friction ration (**Rf**), the fourth column on log, is the ratio of sleeve friction to tip resistance (**fs/qc**) and is used to correlate to a "soil behavior type". It should be noted that the soil behavior type (soil profile column on left side of log) is not directly indicative of the actual soil type, as would be described in a hand sample, but rather an indication of soil strength properties, and how the soil "behaves." The SPT energy ratio (**N_{60}**), the fifth column provides a derived estimate of equivalent SPT N-values.

The CPT probes are useful because they produce a continuous, repeatable profile of in-situ soil strength characteristics.

Soil Behavior Type **qs** **fs** **u2** **Rf** **N(60)**



Rec'd ComDev 06-07-19



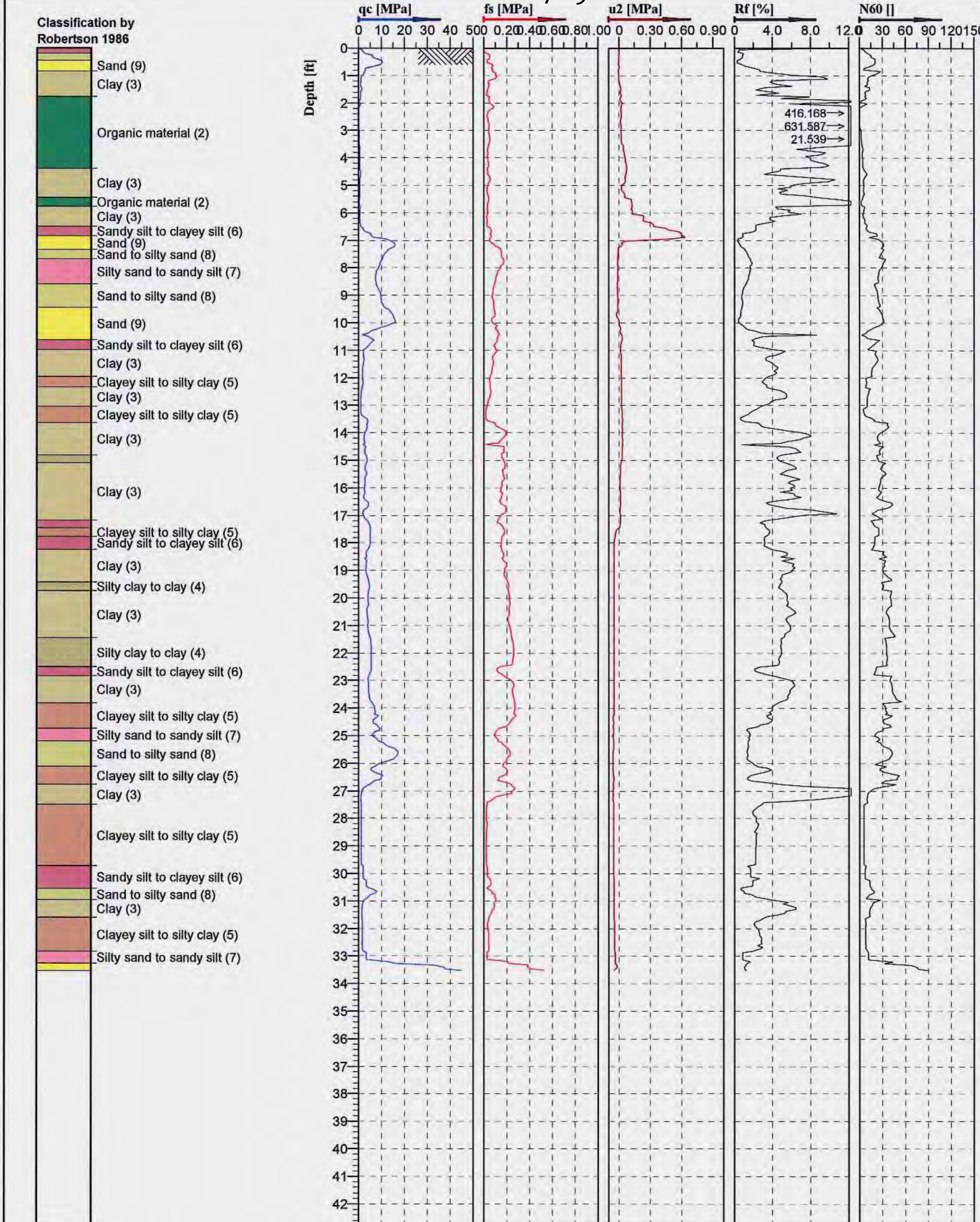
Location: Arcata, Ca	Position: X: 0.00 ft, Y: 0.00 ft	Ground level: 0.00	Test no: 1
Project ID: G3604	Client: SHN	Date: 6/23/2009	Scale: 1 : 60
Project: Arcata VFD		Page: 1/1	Fig:
Pre-probed 8'		File: Arcata vfd1.CPT	

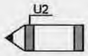
FISCH DRILLING

U2

Cone No: 4057
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Rec'd ComDev 06-07-19



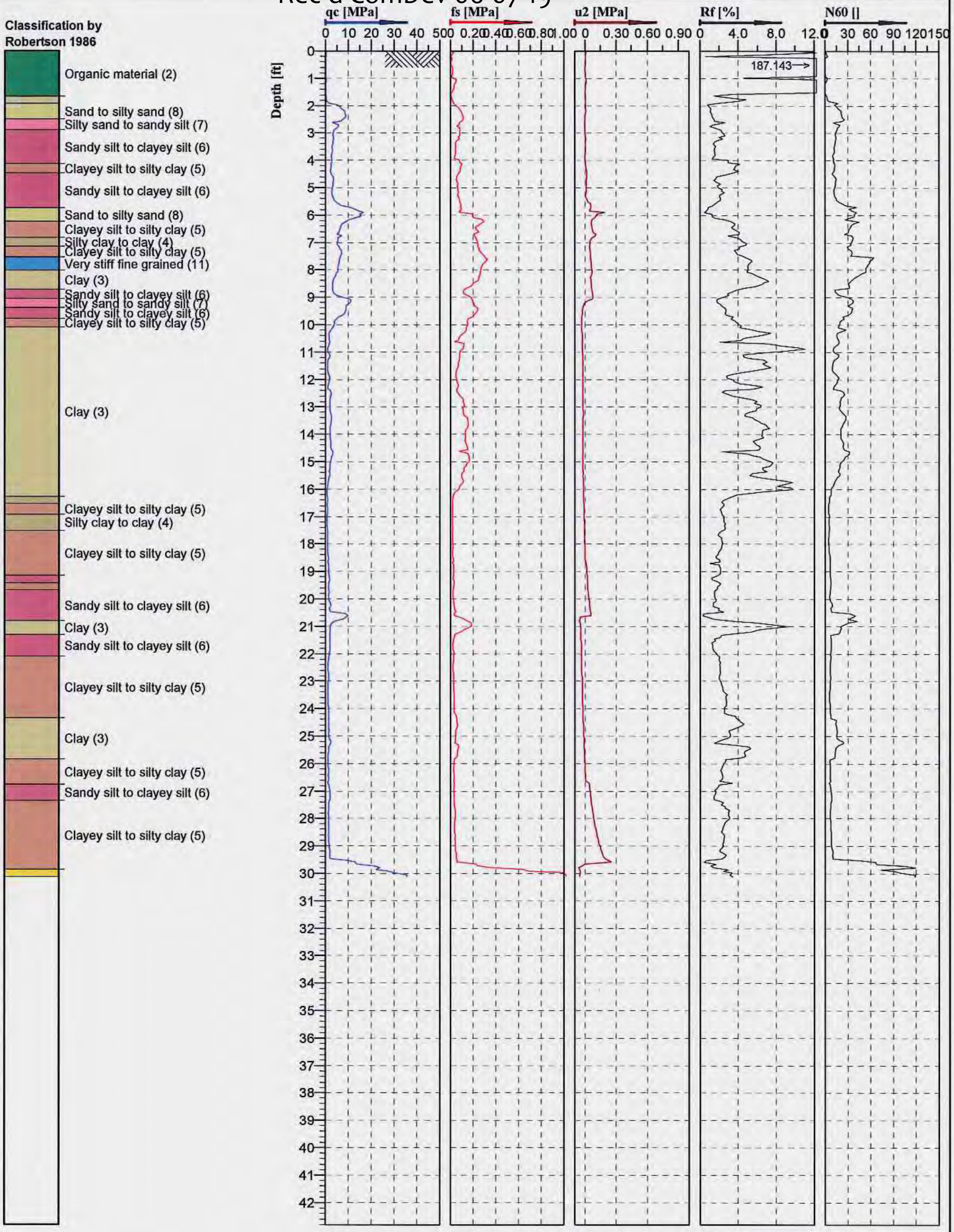


FISCH DRILLING

Cone No: 4057
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Arcata, Ca	Position: X: 0.00 ft, Y: 0.00 ft	Ground level: 0.00	Test no: 2
Project ID: G3604	Client: SHN	Date: 6/23/2009	Scale: 1 : 60
Project: Arcata VFD		Page: 1/1	Fig:
		File: Arcata vfd2.CPT	

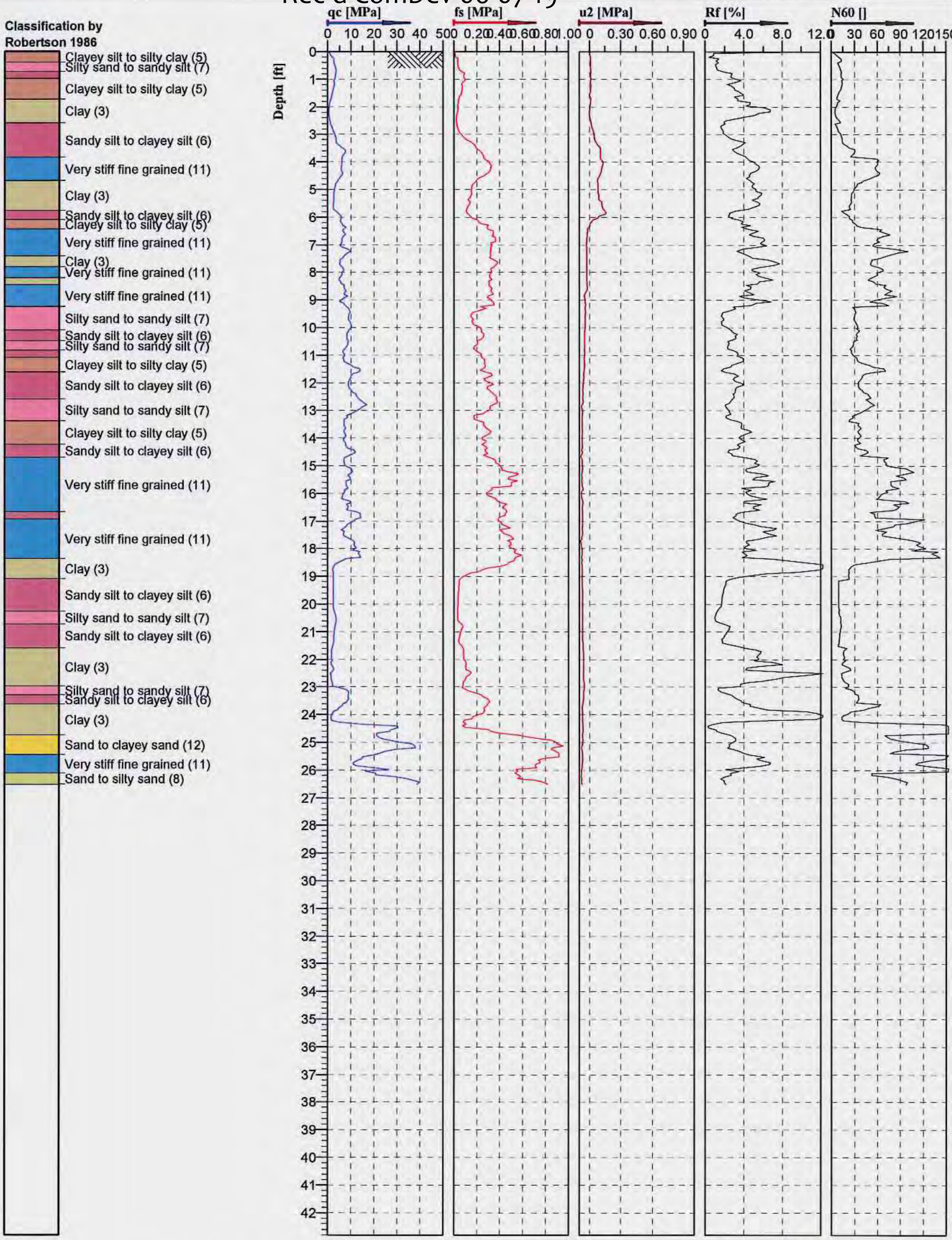
Rec'd ComDev 06-07-19



FISCH DRILLING

Cone No: 4057
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Arcata, Ca	Position: X: 0.00 ft, Y: 0.00 ft	Ground level: 0.00	Test no: 3
Project ID: G3604	Client: SHN	Date: 6/23/2009	Scale: 1 : 60
Project: Arcata VFD		Page: 1/1	Fig:
		File: Arcata vfd3.CPT	



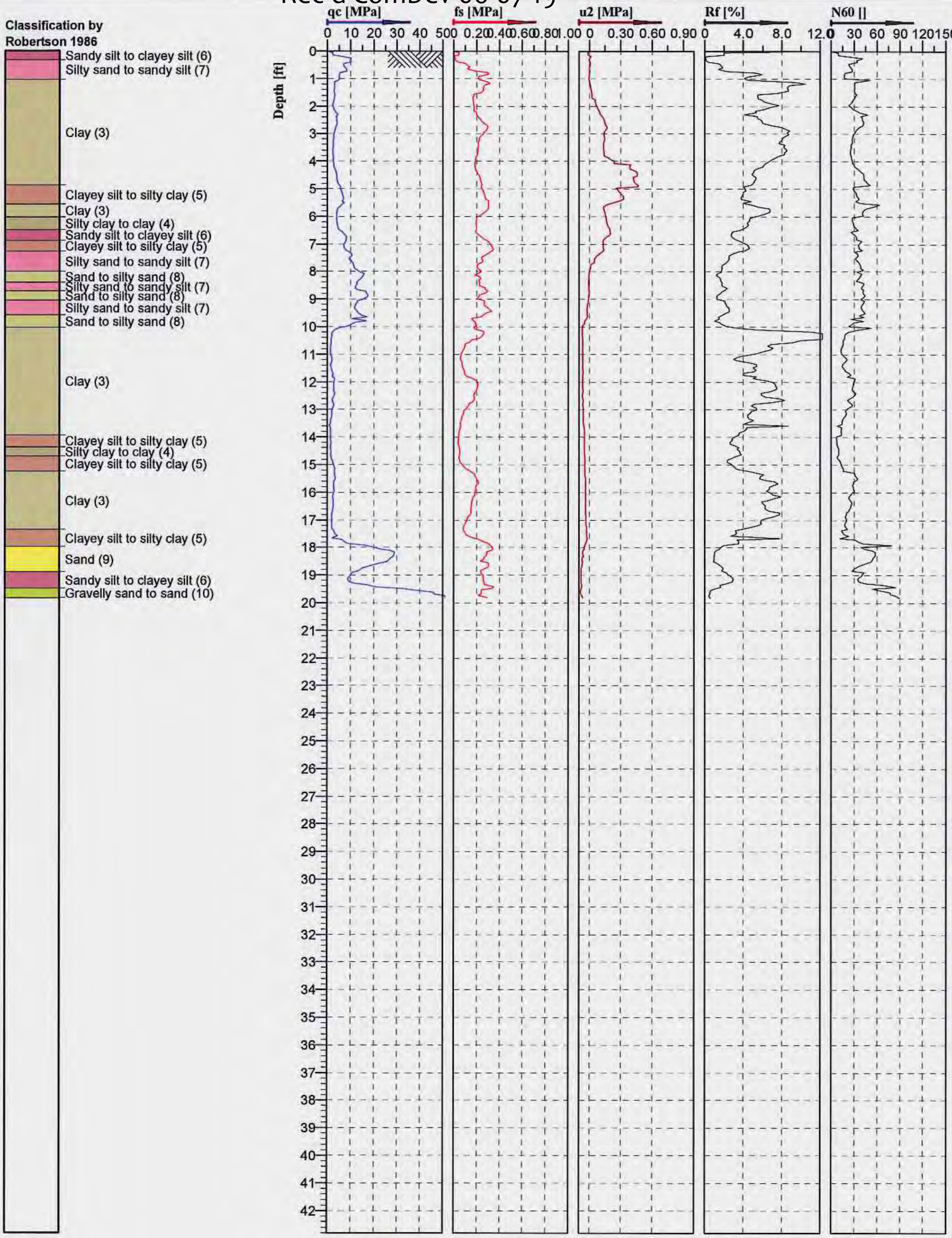
FISCH DRILLING

U2

Cone No: 4057
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Aracta, Ca	Position: X: 0.00 ft, Y: 0.00 ft	Ground level: 0.00	Test no: 4
Project ID: G3604	Client: SHN	Date: 6/23/2009	Scale: 1 : 60
Project: Arcata VFD		Page: 1/1	Fig:
		File: Arcata vfd4.CPT	

Rec'd ComDev 06-07-19



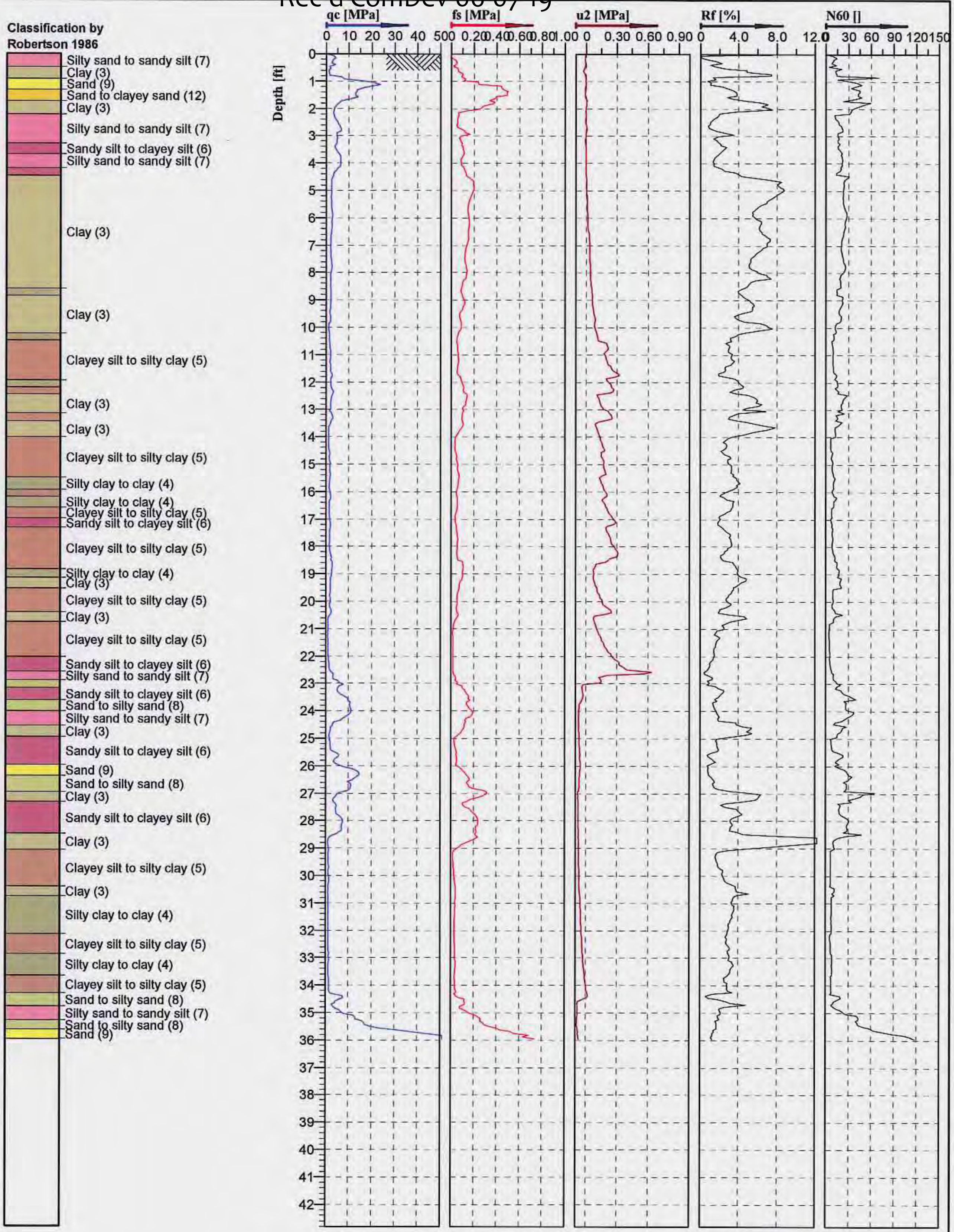
FISCH DRILLING

U2

Cone No: 4057
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Arcata, Ca	Position: X: 0.00 ft, Y: 0.00 ft	Ground level: 0.00	Test no: 5
Project ID: G3604	Client: SHN	Date: 6/23/2009	Scale: 1 : 60
Project: Arcata VFD		Page: 1/1	Fig:
		File: Arcata vfd5.CPT	

Rec'd ComDev 06-07-19



FISCH DRILLING

U2

Cone No: 4057
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Arcata, Ca	Position: X: 0.00 ft, Y: 0.00 ft	Ground level: 0.00	Test no: 6
Project ID: G3604	Client: SHN	Date: 6/23/2009	Scale: 1 : 60
Project: Arcata VFD		Page: 1/1	Fig:
		File: Arcata vfd6.CPT	

Rec'd ComDev 06-07-19

Appendix C

Geotechnical Boring and Test Pit Logs

CONSULTING ENGINEERS
& GEOLOGISTS

Rec'd ComDev 06-07-19

METHOD OF SOIL CLASSIFICATION

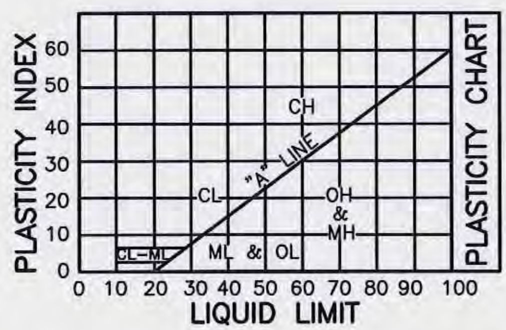
CLASSIFICATION CHART

MAJOR DIVISIONS		SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS (MORE THAN 1/2 OF SOIL >NO. 200 SIEVE SIZE)	GRAVELS (MORE THAN 1/2 OF COARSE FRACTION > NO.4 SIEVE SIZE)	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	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
FINE GRAINED SOILS (MORE THAN 1/2 OF SOIL <NO. 200 SIEVE SIZE)	SILTS & CLAYS LIQUID LIMIT LESS THAN 50	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
	SILTS & CLAYS LIQUID LIMIT GREATER THAN 50	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

GRAIN SIZE CHART

CLASSIFICATION	U.S. STANDARD SIEVE SIZE
BOULDERS	ABOVE 12"
COBBLES	12" TO 3"
GRAVEL	3" TO NO. 4
COARSE	3" TO 3/4"
FINE	3/4" TO NO. 4
SAND	NO. 4 TO NO. 200
COARSE	NO. 4 TO NO. 10
MEDIUM	NO. 10 TO NO. 40
FINE	NO. 40 TO NO. 200
SILT & CLAY	BELOW NO. 200

PLASTICITY CHART



CONSISTENCY OF FINE GRAINED SOILS		DENSITY OF COARSE GRAINED SOILS	
CLASSIFICATION	COHESION (PSF)	CLASSIFICATION	STANDARD PENETRATION (BLOW COUNT)
VERY SOFT	0-250	VERY LOOSE	0-4
SOFT	250-500	LOOSE	4-10
MEDIUM STIFF	500-1000	MEDIUM	10-30
STIFF	1000-2000	DENSE	30-50
VERY STIFF	2000-4000	VERY DENSE	50+
HARD	4000+		

MOISTURE CLASSIFICATIONS
DRY
DAMP
MOIST
WET

BASED ON UNIFIED SOILS CLASSIFICATION SYSTEM

BORING LOG KEY

SAMPLE TYPES

- DISTURBED SAMPLE (BULK)
- HAND DRIVEN TUBE SAMPLE
- 1.4" I.D. STANDARD PENETRATION TEST SAMPLE (SPT)
- 2.5" I.D. MODIFIED CALIFORNIA SAMPLE (SOLID WHERE RETAINED)
- CORE BARREL SAMPLE (NOT RETAINED)
- CORE BARREL SAMPLE (RETAINED)

SYMBOLS

- INITIAL WATER LEVEL
- STABILIZED WATER LEVEL
- - - - - - GRADATIONAL CONTACT
- WELL DEFINED CONTACT
- SS SPLIT SPOON

SHN Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Arcata Volunteer Fire Department
LOCATION: 1138 Sunset Ave, Arcata
GROUND SURFACE ELEVATION: --
EXCAVATION METHOD: 6" Hollow Stem Auger
LOGGED BY: AC

JOB NUMBER: 009077
DATE DRILLED: 06/29/09
TOTAL DEPTH OF BORING: 40.5 Feet
SAMPLER TYPE: CA, SPT, Shelby Bulk

BORING NUMBER BH-1

DEPTH (FT)	BULK SAMPLES	SHELBY TUBE	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
0.0				GW		FILL:WELL GRADED GRAVEL, with sand, dense, damp, gray.							
-1.8				ML		FILL: SILT, with sand, fine, medium stiff, damp, dark gray, mixed browns.							
-2.5 to -4.0			10, 11, 11							61			
-5.0 to -6.5			1, 18, 21										
-5.7				SM		SILTY SAND, fine, medium dense, damp, mottled yellowish-brown and light gray.	15	116					
-10.0			Push	SM		SILTY SAND, fine, loose, moist, brownish-gray.	33	93		77			Direct Shear
-13.0				ML		SILT, with sand, fine, soft, moist, brown.							
-15.0													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

FIELD LOG

PROJECT: Arcata Volunteer Fire Department

LOCATION: 1138 Sunset Ave, Arcata

GROUND SURFACE ELEVATION: --

EXCAVATION METHOD: 6" Hollow Stem Auger

LOGGED BY: AC

JOB NUMBER: 009077

DATE DRILLED: 06/29/09

TOTAL DEPTH OF BORING: 40.5 Feet

SAMPLER TYPE: CA, SPT, Shelby
Bulk

BORING NUMBER BH-1

DEPTH (FT)	BULK SAMPLES	SHELBY TUBE	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-15.0				ML		SILT, with sand, fine, soft, moist, brown.							
-16.0													
-17.0			3	CH		CLAY, soft, plastic, damp, bluish-gray.	25	99					
			4										
-18.0			5										
-19.0													
-20.0													
-21.0													
-22.0			3										
			4								27	10	
-23.0			7										
-24.0													
-25.0													
-26.0				SW-SM		WELL GRADED SAND, with silt and gravel, dense, wet, bluish-gray.							
-27.0			22										
			31							10			
-28.0			32										
-29.0													
-30.0			26	SW									

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

FIELD LOG

SHN Consulting Engineers & Geologists, Inc.
812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Arcata Volunteer Fire Department
LOCATION: 1138 Sunset Ave, Arcata
GROUND SURFACE ELEVATION: --
EXCAVATION METHOD: 6" Hollow Stem Auger
LOGGED BY: AC

JOB NUMBER: 009077
DATE DRILLED: 06/29/09
TOTAL DEPTH OF BORING: 40.5 Feet
SAMPLER TYPE: CA, SPT, Shelby
Bulk

BORING NUMBER BH-1

DEPTH (FT)	BULK SAMPLES	SHELBY TUBE	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-30.0			50/ 5"	SM		WELL GRADED SAND, with silt and gravel, dense, wet, bluish-gray.							
-31.0													
-32.0													
-33.0													
-34.0													
-35.0			6										
			17										
-36.0			13										
-37.0													
-38.0													
-39.0			26										
			29										
-40.0			33										
-41.0						Bottom of boring at 40.5 feet. Groundwater encountered at 26 feet. Boring backfilled with grout.							
-42.0													
-43.0													
-44.0													
-45.0													

FIELD LOG

SHN Consulting Engineers & Geologists, Inc.
812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

Rec'd ComDev 06-07-19

PROJECT: Arcata Volunteer Fire Department
LOCATION: 1138 Sunset Ave, Arcata
GROUND SURFACE ELEVATION: --
EXCAVATION METHOD: 6" Hollow Stem Auger
LOGGED BY: AC

JOB NUMBER: 009077
DATE DRILLED: 06/29/09
TOTAL DEPTH OF BORING: 40.5 Feet
SAMPLER TYPE: CA, SPT, Shelby Bulk

BORING NUMBER BH-2

DEPTH (FT)	BULK SAMPLES	SHELBY TUBE	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
0.0				GW		FILL:WELL GRADED GRAVEL, with sand, dense, damp, gray.							
-1.0													
-2.0				SP/SM		FILL: POORLY GRADED SAND, with silt and gravel, medium dense, damp, dark gray.							
			13										
-3.0			8										
			8										
-4.0			5										
			4			Woody Debris							
-5.0			7				19	105					
				SM		SILTY SAND, fine, with gravel, medium dense, damp, greenish-gray.							
-6.0			8										
			10							19			
-7.0			10				15	113					
-8.0													
-9.0													
-10.0			5	ML		SILT, medium stiff, damp, mottled yellowish-brown and gray.							
			7							88			
-11.0			9										
-12.0													
-13.0			Push	ML		SILT, medium stiff, moist, gray.	28	99		97			Direct Shear
-14.0													
-15.0													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

FIELD LOG

SHN Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Arcata Volunteer Fire Department

LOCATION: 1138 Sunset Ave, Arcata

GROUND SURFACE ELEVATION: --

EXCAVATION METHOD: 6" Hollow Stem Auger

LOGGED BY: AC

JOB NUMBER: 009077

DATE DRILLED: 06/29/09

TOTAL DEPTH OF BORING: 40.5 Feet

SAMPLER TYPE: CA, SPT, Shelby Bulk

BORING NUMBER BH-2

DEPTH (FT)	BULK SAMPLES	SHELBY TUBE	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-15.0				ML		SILT, medium stiff, moist, gray.							
-17.0			4	ML		SILT, soft, wet, gray.	27						
			4								24	4	
-18.0 (▽)			4										
-21.0			Push				19	113.2					
-22.0				SP/SM		POORLY GRADED SAND, with silt, medium dense, moist, gray.							
-25.0			6	SM		WELL GRADED SAND, with silt and gravel, dense, moist, bluish-gray.	15						
			11										
			18										
-30.0			Push	ML			24	104					

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

FIELD LOG

Rec'd Com Dev 05-07-19

SHN Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Arcata Volunteer Fire Department
LOCATION: 1138 Sunset Ave, Arcata
GROUND SURFACE ELEVATION: --
EXCAVATION METHOD: 6" Hollow Stem Auger
LOGGED BY: AC

JOB NUMBER: 009077
DATE DRILLED: 06/29/09
TOTAL DEPTH OF BORING: 40.5 Feet
SAMPLER TYPE: CA, SPT, Shelby Bulk

BORING NUMBER BH-2

DEPTH (FT)	BULK SAMPLES	SHELBY TUBE	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-30.0 to -35.0		Shelby tube (-30.0 to -32.0)				SILT, with gravel, soft, wet, gray.							
-35.0 to -41.5	Sample (-35.0 to -36.5); Sample (-40.0 to -41.5)		35, 41, 50/5"; 43, 50, 50/5"	SW		WELL GRADED SAND, with gravel, dense, wet, bluish-gray.							
-41.5						Bottom of boring at 41.5 feet. Groundwater encountered at 18 feet. Boring backfilled with grout.							

Depth scale: -30.0, -31.0, -32.0, -33.0, -34.0, -35.0, -36.0, -37.0, -38.0, -39.0, -40.0, -41.0, -42.0, -43.0, -44.0, -45.0

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

FIELD LOG

SHN Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Arcata Volunteer Fire Department
LOCATION: 1138 Sunset Ave., Arcata
GROUND SURFACE ELEVATION: --
EXCAVATION METHOD: Backhoe
LOGGED BY: AC

JOB NUMBER: 009077
DATE EXCAVATED: 07/15/09
TOTAL DEPTH OF TEST PIT: 9.0 Feet
SAMPLER TYPE: Bulk, 2.5" I.D Shelby hand hammer drive

TEST PIT NUMBER TP-1

DEPTH (FT)	BULK SAMPLES	SHELBY TUBE	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
0.0 – -1.3				GW		FILL: SANDY GRAVEL, dense, dry, gray.							
-1.3 – -2.4				ML		FILL: SANDY SILT, medium stiff, dry, mixed brown and gray, organics.							
-2.4 – -3.5	X (-3.0 – -3.5)	■ (-2.5 – -3.0)		ML		SILT WITH SAND, fine, medium stiff, damp, dark brown, original native topsoil.	20	102					Shelby tube sample recovered from test pit wall at an angle
-3.5 – -4.4				ML		SILT, medium stiff, damp, olive brown.							
-4.4 – -9.0				SM		SILTY SAND, fine, medium dense, damp, mottled yellowish-brown and reddish-brown. Slightly less sandy intervals interfingered with thin discontinuous lenses of medium sand with silt.							
-9.0						Bottom of test pit at 9.0 feet. No free groundwater observed.							

Depth scale: 0.0, -1.0, -2.0, -3.0, -4.0, -5.0, -6.0, -7.0, -8.0, -9.0, -10.0, -11.0, -12.0, -13.0, -14.0, -15.0

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

FIELD LOG

Rec'd Com Dev 06-07-19

SHN Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Arcata Volunteer Fire Department

LOCATION: 1138 Sunset Ave., Arcata

GROUND SURFACE ELEVATION: --

EXCAVATION METHOD: Backhoe

LOGGED BY: AC

JOB NUMBER: 009077

DATE EXCAVATED: 07/15/09

TOTAL DEPTH OF TEST PIT: 8.5 Feet

SAMPLER TYPE: Bulk, 2.5" I.D Shelby hand hammer drive

TEST PIT NUMBER TP-2

DEPTH (FT)	BULK SAMPLES	SHELBY TUBE	BLOWS PER 0.5'	USCS	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
0.0				GW	FILL: SANDY GRAVEL, dense, dry, gray.							
-1.0				SW	FILL: GRAVELY SAND, with silt, medium dense, damp, mixed browns.							
-2.0				GW	FILL: SANDY GRAVEL, dense, damp, gray.							
-3.0	X			ML	FILL: SILT, medium stiff, damp, dark brown, prominent large woody debris.							Increasing woody content to 3.5 feet
-4.0		■		ML	SILT, medium stiff, damp, dark brown, common fine roots along preexisting fractures, original native topsoil.	23	102			27	8	Shelby tube sample recovered from test pit wall at an angle
-5.0				ML	SILT WITH SAND, fine, medium stiff, damp, mottled yellowish-brown and reddish-brown.							
-6.0 to -8.5				SM	SILTY SAND, medium dense, damp, mottled yellowish-brown and gray.							
-9.0					Bottom of test pit at 8.5 feet. No free groundwater observed.							

Depth scale: 0.0, -1.0, -2.0, -3.0, -4.0, -5.0, -6.0, -7.0, -8.0, -9.0, -10.0, -11.0, -12.0, -13.0, -14.0, -15.0

FIELD LOG

Rec'd ComDev 08-07-19

SHN Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Arcata Volunteer Fire Department

LOCATION: 1138 Sunset Ave., Arcata

GROUND SURFACE ELEVATION: --

EXCAVATION METHOD: Backhoe

LOGGED BY: AC

JOB NUMBER: 009077

DATE EXCAVATED: 07/15/09

TOTAL DEPTH OF TEST PIT: 9.0 Feet

SAMPLER TYPE: Bulk, 2.5" I.D Shelby hand hammer drive

TEST PIT NUMBER TP-3

DEPTH (FT)	BULK SAMPLES	SHELBY TUBE	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
0.0				GW		FILL: SANDY GRAVEL, dense, dry, gray.							
-2.0	X			ML		SANDY SILT, medium stiff, damp, olive gray.							
-3.0		■		ML		SANDY SILT, medium stiff, damp, dark brown, original native topsoil.	17	107.9		32			Shelby tube sample recovered from test pit wall at an angle
				SM		SILTY SAND, medium dense, damp, mottled yellowish-brown and gray.							
-9.0						Bottom of test pit at 9.0 feet. No free groundwater observed.							

Depth scale: 0.0, -1.0, -2.0, -3.0, -4.0, -5.0, -6.0, -7.0, -8.0, -9.0, -10.0, -11.0, -12.0, -13.0, -14.0, -15.0

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

FIELD LOG

SHN Consulting Engineers & Geologists, Inc.
812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Arcata Volunteer Fire Department
LOCATION: 1138 Sunset Ave., Arcata
GROUND SURFACE ELEVATION: --
EXCAVATION METHOD: Backhoe
LOGGED BY: AC

JOB NUMBER: 009077
DATE EXCAVATED: 07/15/09
TOTAL DEPTH OF TEST PIT: 8.5 Feet
SAMPLER TYPE: Bulk, 2.5" I.D Shelby hand hammer drive

TEST PIT NUMBER TP-4

DEPTH (FT)	BULK SAMPLES	SHELBY TUBE	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
0.0 – -1.8				GW		FILL: SANDY GRAVEL, medium dense, dry, gray.							
-1.8 – -4.9	X (-4.3 – -4.8)			ML		FILL: SANDY SILT, with occasional fine gravel, organics, medium stiff, damp, mixed browns, large woody debris.							Zones of yellowish-brown silty sand
-4.9 – -5.7		X (-5.0 – -5.5)		ML		SANDY SILT, soft-medium stiff, damp, brown, charcoal, original native topsoil.	17	114					Shelby tube sample recovered from test pit wall at an angle
-5.7 – -8.5				SM		SILTY SAND, medium dense, damp, olive brown to greenish-gray.							
-8.5						Bottom of test pit at 8.5 feet. No free groundwater observed.							

Depth scale: 0.0, -1.0, -2.0, -3.0, -4.0, -5.0, -6.0, -7.0, -8.0, -9.0, -10.0, -11.0, -12.0, -13.0, -14.0, -15.0

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

FIELD LOG

Rec'd ComDev 06-07-19

SHN Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Arcata Volunteer Fire Department

LOCATION: 1138 Sunset Ave., Arcata

GROUND SURFACE ELEVATION: --

EXCAVATION METHOD: Backhoe

LOGGED BY: AC

JOB NUMBER: 009077

DATE EXCAVATED: 07/15/09

TOTAL DEPTH OF TEST PIT: 10.5 Feet

SAMPLER TYPE: Bulk, 2.5" I.D Shelby hand hammer drive

TEST PIT NUMBER TP-5

DEPTH (FT)	BULK SAMPLES	SHELBY TUBE	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
0.0				GW		FILL: SANDY GRAVEL, medium dense, dry, gray.							
-1.0 to -8.0				ML		FILL: SANDY SILT, with occasional fine gravel, medium stiff, damp, mixed browns, large woody debris, organics.							Zones of yellowish-brown silty sand
-8.0				ML		SANDY SILT, soft, moist, dark brown, original native topsoil.							
-9.0 (▽)	X			SM		SILTY SAND, medium dense, wet, mottled olive brown and reddish-brown.				65			
-10.0						Bottom of test pit at 10.0 feet. Groundwater encountered at 9.0 feet.							

Depth scale: 0.0, -1.0, -2.0, -3.0, -4.0, -5.0, -6.0, -7.0, -8.0, -9.0, -10.0, -11.0, -12.0, -13.0, -14.0, -15.0

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

FIELD LOG

SHN Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Arcata Volunteer Fire Department

LOCATION: 1138 Sunset Ave., Arcata

GROUND SURFACE ELEVATION: --

EXCAVATION METHOD: Backhoe

LOGGED BY: AC

JOB NUMBER: 009077

DATE EXCAVATED: 07/15/09

TOTAL DEPTH OF TEST PIT: 7.5 Feet

SAMPLER TYPE: Bulk, 2.5" I.D Shelby hand hammer drive

TEST PIT NUMBER TP-6

DEPTH (FT)	BULK SAMPLES	SHELBY TUBE	BLOWS PER 0.5'	USCS	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
0.0				GW	FILL: SANDY GRAVEL, medium dense, dry, gray.							
-1.7				ML	FILL: SILT, with sand and occasional gravel, medium stiff, damp, dark brown, organics.							
-2.5		X		ML	SILT, with sand, soft, damp, dark brown, charcoal, original native topsoil.					29	7	Shelby tube sample recovered from test pit wall at an angle
-3.0	X											
-3.4				SM	SILTY SAND, medium dense, damp, olive brown.							
-5.5					Becomes mottled olive brown and reddish-brown.							
-7.5					Bottom of test pit at 7.5 feet. No free groundwater observed.							

Depth scale: 0.0, -1.0, -2.0, -3.0, -4.0, -5.0, -6.0, -7.0, -8.0, -9.0, -10.0, -11.0, -12.0, -13.0, -14.0, -15.0

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

FIELD LOG

Rec'd ComDev 05-07-19

SHN Consulting Engineers & Geologists, Inc.
812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Arcata Volunteer Fire Department
LOCATION: 1138 Sunset Ave., Arcata
GROUND SURFACE ELEVATION: --
EXCAVATION METHOD: Backhoe
LOGGED BY: AC

JOB NUMBER: 009077
DATE EXCAVATED: 07/15/09
TOTAL DEPTH OF TEST PIT: 5.5 Feet
SAMPLER TYPE: N/A

TEST PIT NUMBER TP-7

DEPTH (FT)	BULK SAMPLES	SHELBY TUBE	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
0.0				GW		FILL: SANDY GRAVEL, medium dense, dry, gray.							
-1.0				ML		FILL: SANDY SILT, medium stiff, damp, mixed browns.							Scrap metal, zones of yellowish-brown silty sand
-2.0													
-3.0				SM		FILL: SILTY SAND, medium dense, damp, yellowish-brown.							
				ML		SILT, soft, damp, dark brown, original native topsoil.							
-4.0				SM/ML		SILTY SAND to SANDY SILT, medium dense, damp, mottled yellowish-brown and reddish-brown.							
-5.0													
-6.0						Bottom of test pit at 5.5 feet. No free groundwater observed.							
-7.0													
-8.0													
-9.0													
-10.0													
-11.0													
-12.0													
-13.0													
-14.0													
-15.0													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

FIELD LOG

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Arcata Volunteer Fire Department
JOB NUMBER: 009077
LOCATION: 1138 Sunset Ave., Arcata
DATE EXCAVATED: 07/15/09
GROUND SURFACE ELEVATION: --
TOTAL DEPTH OF TEST PIT: 4.5 Feet
EXCAVATION METHOD: Backhoe
SAMPLER TYPE: N/A
LOGGED BY: AC

TEST PIT NUMBER TP-8

DEPTH (FT)	BULK SAMPLES	SHELBY TUBE	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
0.0 – 2.5				GW		FILL: SANDY GRAVEL, medium dense, dry, gray.							Scrap metal, zones of yellowish-brown silty sand
2.5 – 4.5				ML		SANDY SILT, medium stiff, damp, mottled yellowish-brown, reddish-brown and light grayish-brown, original native topsoil.							
4.5						Bottom of test pit at 4.5 feet. No free groundwater observed.							

Depth scale: 0.0, -1.0, -2.0, -3.0, -4.0, -5.0, -6.0, -7.0, -8.0, -9.0, -10.0, -11.0, -12.0, -13.0, -14.0, -15.0

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

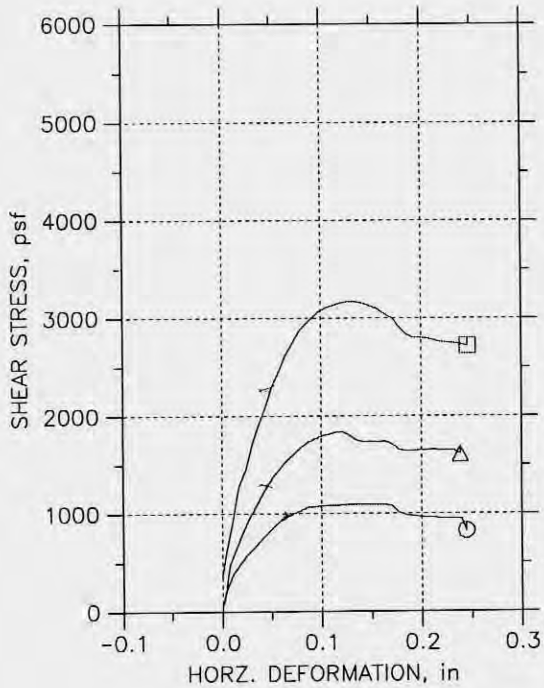
FIELD LOG

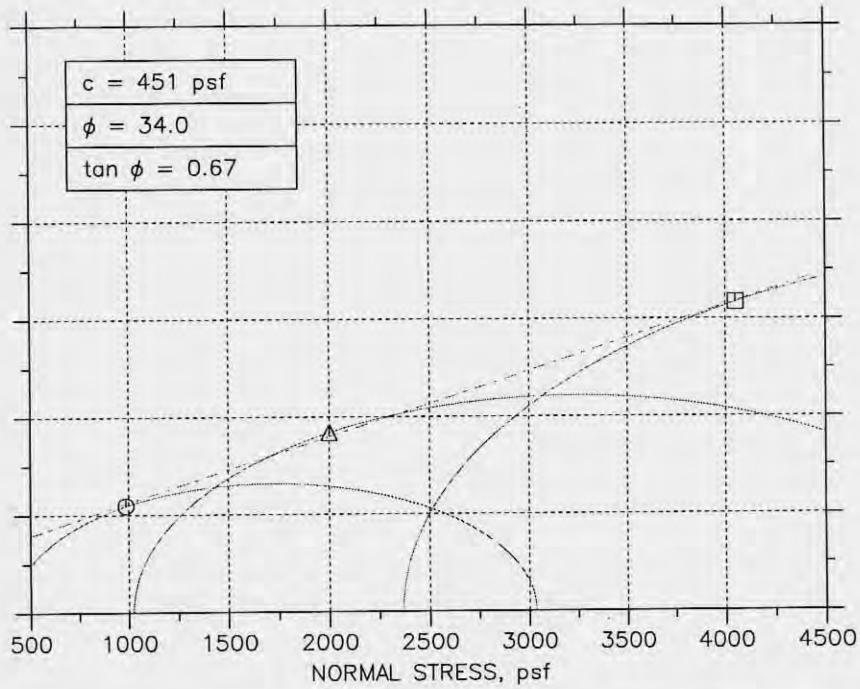
Appendix D

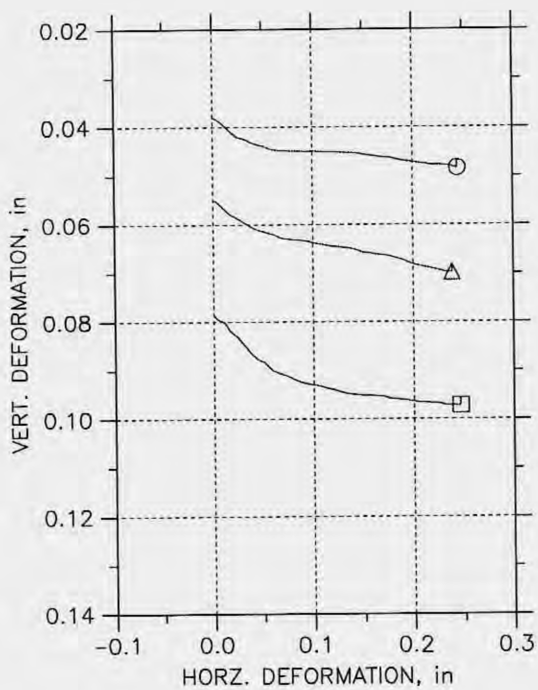
Laboratory Test Results

Rec'd ComDev 06-07-19

DIRECT SHEAR TEST REPORT







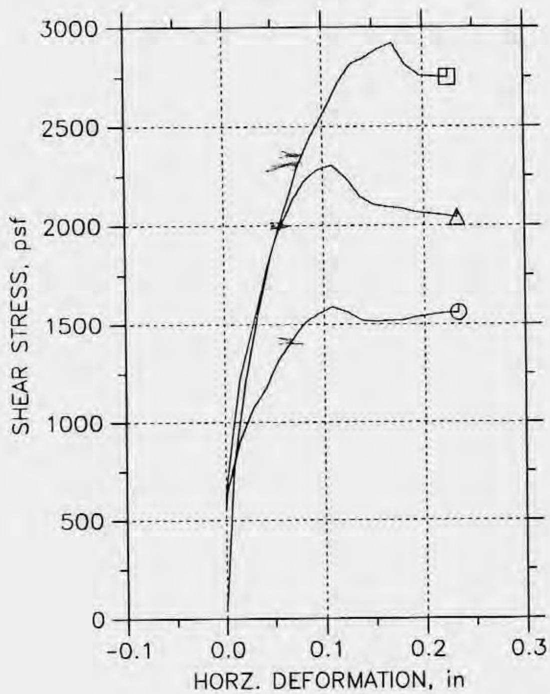
Symbol		⊙	△	⊡	
Test No.		9-981	9-981	9-981	
Sample No.		9-981A	9-981B	9-981C	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2.415	2.415	2.415	
Initial	Area, in^2	4.5806	4.5806	4.5806	
Initial	Height, in	1	1	1	
Initial	Water Content, %	32.76	33.03	33.01	
Initial	Dry Density, pcf	92.65	91.9	93.23	
Initial	Saturation, %	110.52	109.40	112.94	
Initial	Void Ratio	0.78561	0.80015	0.77446	
Consol. Height, in		0.96211	0.94497	0.92155	
Consol. Void Ratio		0.71795	0.7011	0.63525	
Final	Water Content, %	28.28	26.79	27.30	
Final	Dry Density, pcf	97.36	98.8	103.3	
Final	Saturation, %	107.18	105.25	120.17	
Final	Void Ratio	0.69916	0.67448	0.60196	
Normal Stress, psf		987.04	2001.8	4053.5	
Max. Shear Stress, psf		1089.8	1837.7	3168	
Ult. Shear Stress, psf		823	1608.4	2717	
Time to Failure, min		9.5002	9.5038	10.003	
Disp. Rate, in/min		0.002	0.002	0.002	
Estimated Specific Gravity		2.65	2.65	2.65	
Liquid Limit		0	0	0	
Plastic Limit		0	0	0	
Plasticity Index		0	0	0	

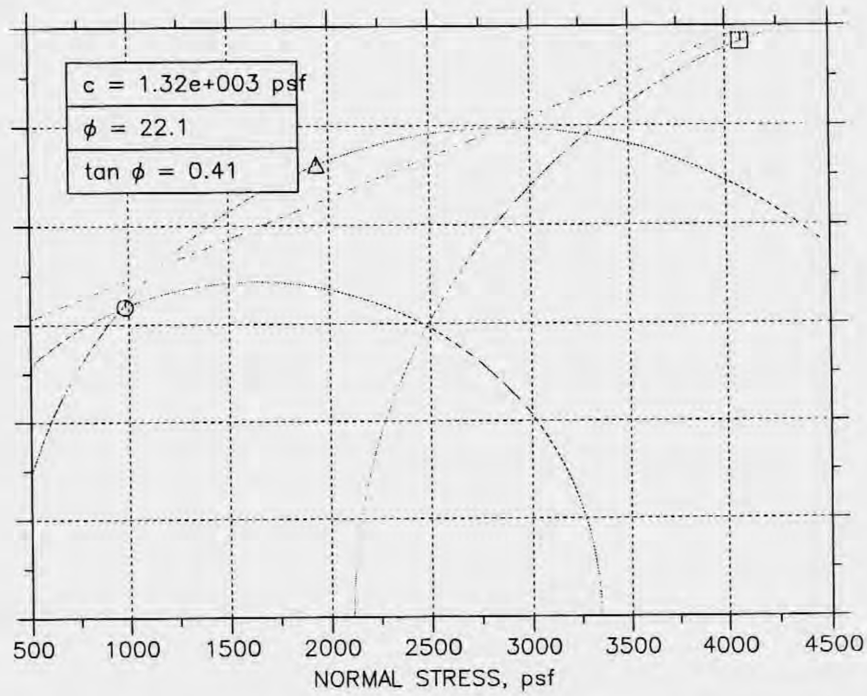
Project: Arcate Volunteer Fire Dep
Location: Arcata
Project No.: 009077
Boring No.: BH1 10-11.5
Sample Type: 3" Shelby
Description: olive grey silty CLAY
Remarks:

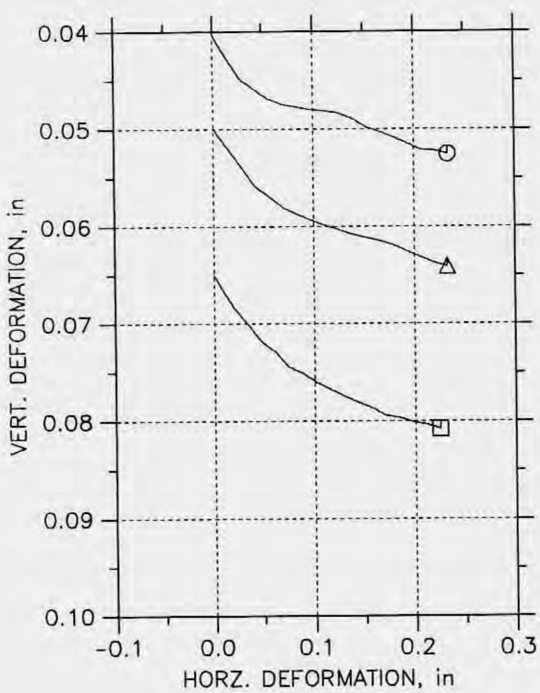
Tue, 07-JUL-2009 17:22:56

Rec'd ComDev 06-07-19

DIRECT SHEAR TEST REPORT







	Symbol	○	△	□	
	Test No.	9-992	9-992	9-992	
	Sample No.	9-992A	9-992B	9-992B	
	Shape	Circular	Circular	Circular	
Initial	Dimension, in	2.415	2.415	2.415	
Initial	Area, in^2	4.5806	4.5806	4.5806	
Initial	Height, in	1	1	1	
Initial	Water Content, %	27.26	27.47	28.80	
Initial	Dry Density, pcf	99.47	97.81	100.2	
Initial	Saturation, %	108.92	105.26	117.26	
Initial	Void Ratio	0.66318	0.69147	0.65076	
	Consol. Height, in	0.95989	0.95023	0.93502	
	Consol. Void Ratio	0.59647	0.60729	0.54349	
Final	Water Content, %	23.91	23.38	21.41	
Final	Dry Density, pcf	105.	104.5	109.	
Final	Saturation, %	110.06	106.29	109.67	
Final	Void Ratio	0.57575	0.58304	0.51738	
	Normal Stress, psf	981.49	1940.8	4075.7	
	Max. Shear Stress, psf	1589.6	2303.6	2919.9	
	Ult. Shear Stress, psf	1559.6	2040.6	2747.1	
	Time to Failure, min	4.5016	4.5003	6.5	
	Disp. Rate, in/min	0.002	0.002	0.002	
	Estimated Specific Gravity	2.65	2.65	2.65	
	Liquid Limit	0	0	0	
	Plastic Limit	0	0	0	
	Plasticity Index	0	0	0	

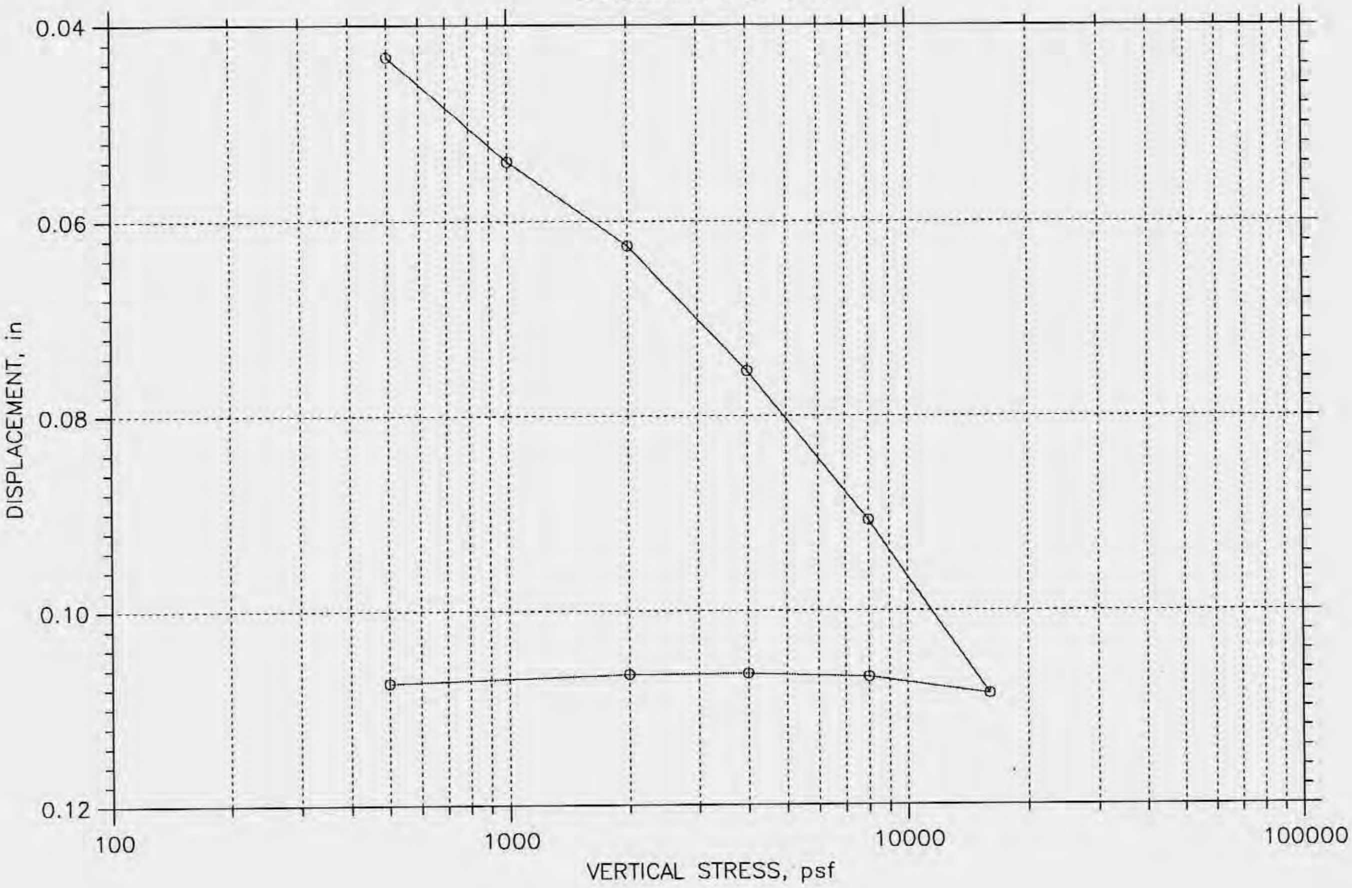
Project: AVFD
Location: arcata
Project No.: 009077
Boring No.: BH2 13-15'
Sample Type: 3" shelby
Description: grey silty CLAY
Remarks:

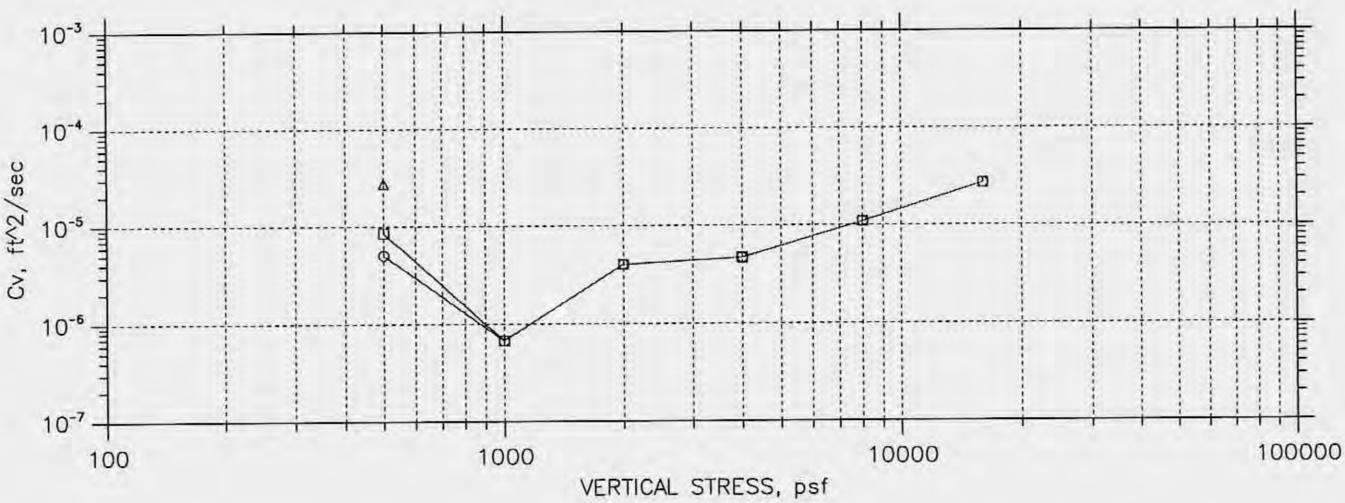
Tue, 07-JUL-2009 15:38:00

Rec'd ComDev 06-07-19

CONSOLIDATION TEST DATA

SUMMARY REPORT





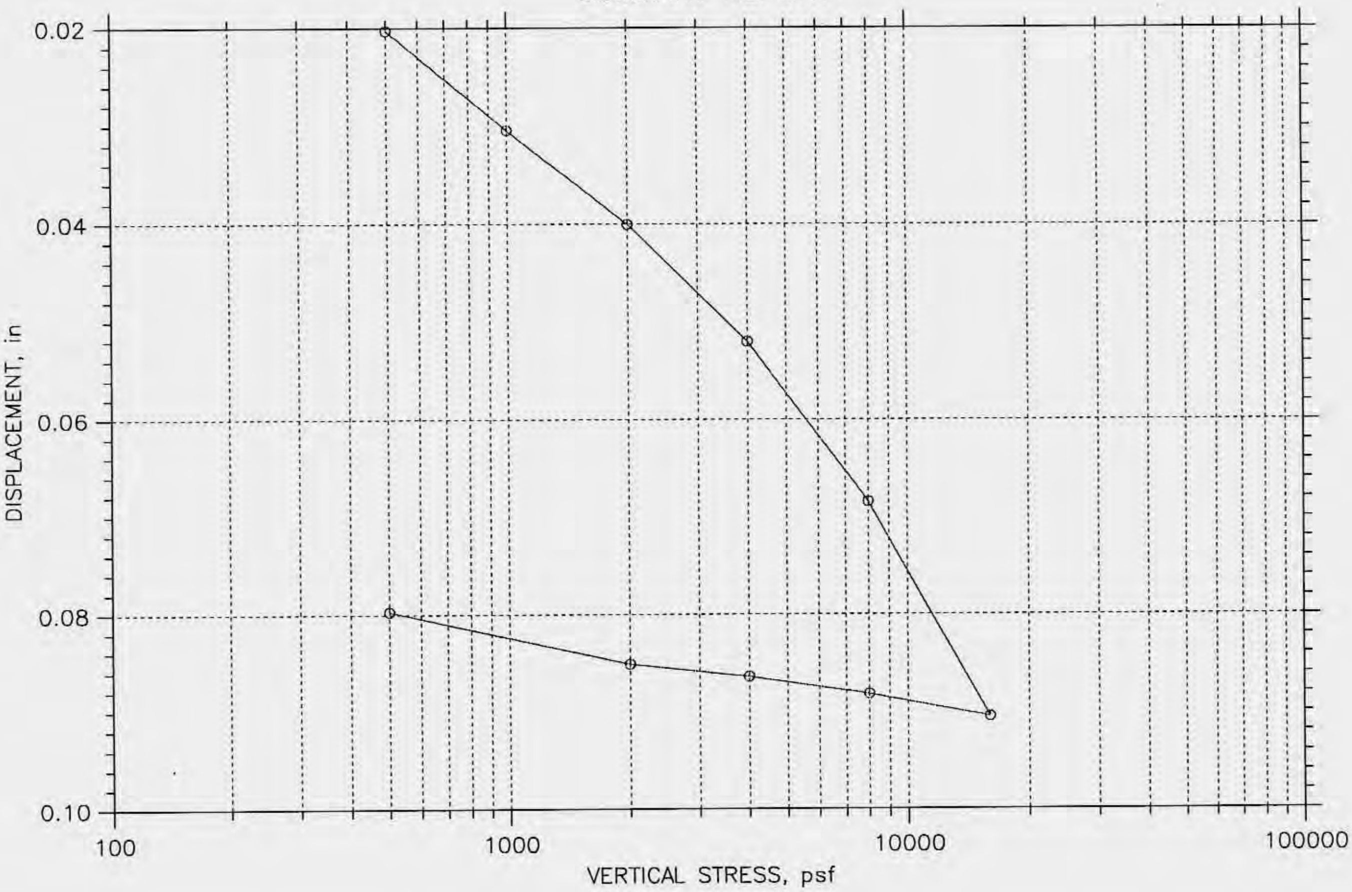
Project: Arcata Volunteer Fire Dep	Location: Arcata	Project No.: 009077
Boring No.: BH 2	Tested By: LA	Checked By:
Sample No.: 9-983	Test Date: 7/1/09	Depth: 4.5-5'
Test No.: 9-983	Sample Type: cal brl	Elevation:
Description: dark greyish brown clayey SILT		
Remarks:		

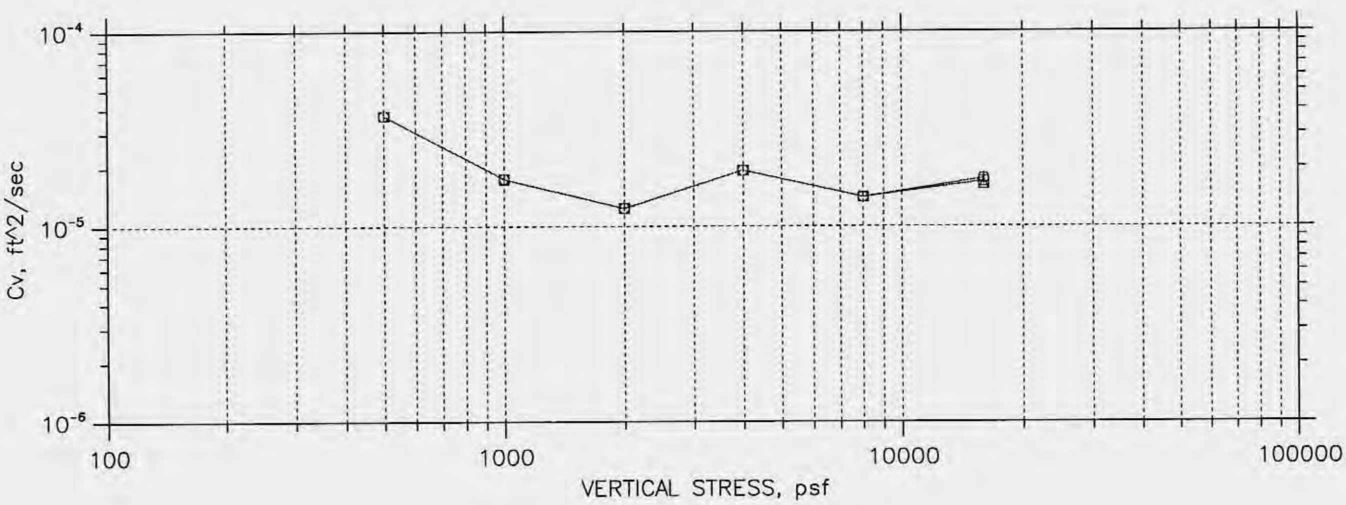
Mon, 06-JUL-2009 09:29:29

Rec'd ComDev 06-07-19

CONSOLIDATION TEST DATA

SUMMARY REPORT





Project: Arcata Volunteer Fire Dep	Location: Arcata	Project No.: 009077
Boring No.: BH 2	Tested By: LA	Checked By: JB
Sample No.: 9-987	Test Date: 7/1/09	Depth: 10-10.5
Test No.: 9-987	Sample Type: cal brl	Elevation:
Description: strong brown clayey SILT		
Remarks:		

Tue, 07-JUL-2009 15:26:48

Appendix E

Liquefaction Analysis Results

SHN
ENGINEERS & GEOLOGISTS

SHN Consulting Engineers and Geologists, Inc.
812 W. Wabash Ave
Eureka, California 95501
www.shn-engr.com

Rec'd ComDev 06-07-19

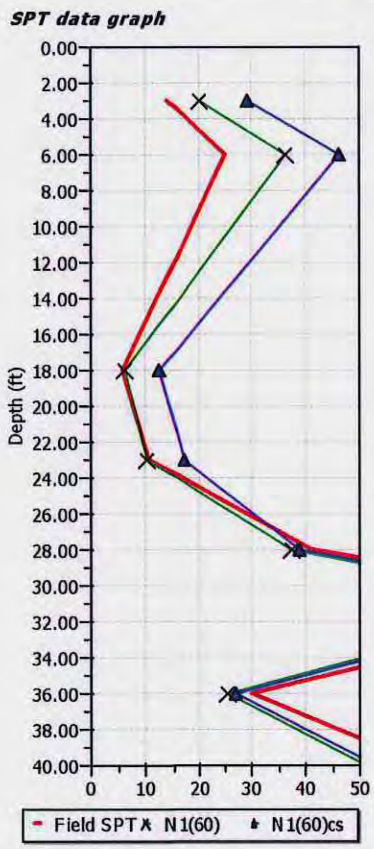
LIQUEFACTION ANALYSIS REPORT

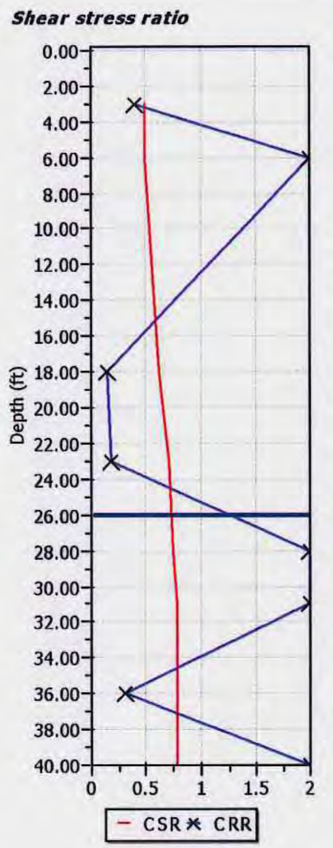
Project title : Arcata Volunteer Fire Department

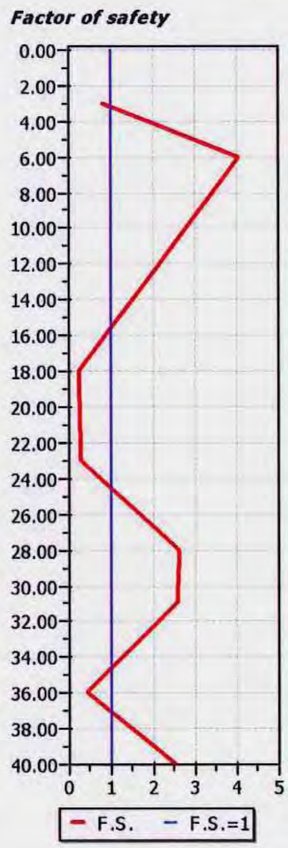
Project subtitle : BH-1

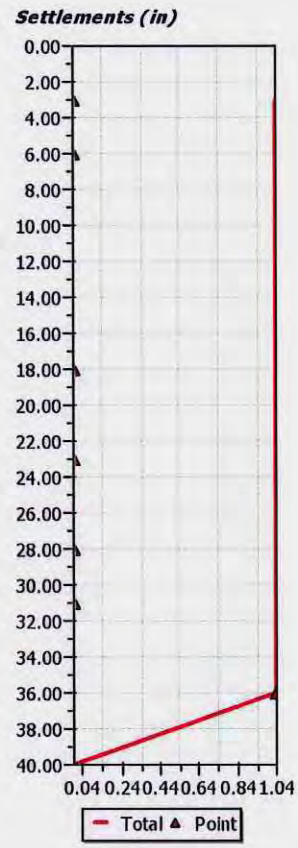
Input parameters and analysis data

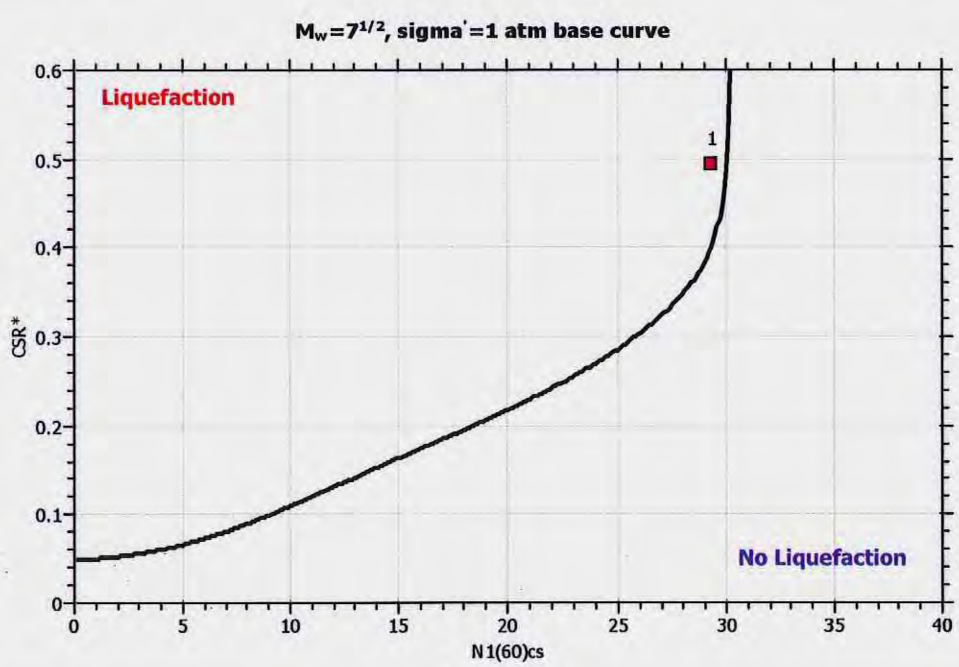
In-situ data type:	Standard Penetration Test	Depth to water table:	26.00 ft
Analysis type:	Deterministic	Earthquake magnitude M_w:	7.50
Analysis method:	NCEER 1998	Peak ground accelaration:	0.64 g
Fines correction method:	Idriss & Seed	User defined F.S.:	1.20











Rec'd ComDev 06-07-19

:: Field input data ::

Point ID	Depth (ft)	Field N_{SPT} (blows/feet)	Unit weight (pcf)	Fines content (%)
1	3.00	14.00	120.94	61.00
2	6.00	25.00	120.94	30.00
3	18.00	6.00	120.94	90.00
4	23.00	11.00	120.94	90.00
5	28.00	41.00	120.94	10.00
6	31.00	100.00	120.94	10.00
7	36.00	30.00	120.94	10.00
8	40.00	62.00	120.94	10.00

Depth : Depth from free surface, at which SPT was performed (ft)
Field SPT : SPT blows measured at field (blows/feet)
Unit weight : Bulk unit weight of soil at test depth (pcf)
Fines content : Percentage of fines in soil (%)

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Point ID	Depth (ft)	Sigma (tsf)	u (tsf)	Sigma' (tsf)	r_d	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*
1	3.00	0.18	0.00	0.18	0.99	0.41	1.00	0.41	1.00	0.41
2	6.00	0.36	0.00	0.36	0.99	0.41	1.00	0.41	1.00	0.41
3	18.00	1.09	0.25	0.84	0.96	0.52	1.00	0.52	0.99	0.52
4	23.00	1.39	0.41	0.99	0.95	0.56	1.00	0.56	0.94	0.59
5	28.00	1.69	0.56	1.13	0.93	0.58	1.00	0.58	0.91	0.64
6	31.00	1.87	0.66	1.22	0.92	0.59	1.00	0.59	0.91	0.65
7	36.00	2.18	0.81	1.37	0.88	0.59	1.00	0.59	0.89	0.66
8	40.00	2.42	0.94	1.48	0.85	0.58	1.00	0.58	0.88	0.66

Depth : Depth from free surface, at which SPT was performed (ft)
Sigma : Total overburden pressure at test point, during earthquake (tsf)
u : Water pressure at test point, during earthquake (tsf)
Sigma' : Effective overburden pressure, during earthquake (tsf)
r_d : Nonlinear shear mass factor
CSR : Cyclic Stress Ratio
MSF : Magnitude Scaling Factor
$CSR_{eq,M=7.5}$ CSR adjusted for M=7.5
K_{sigma} Effective overburden stress factor
CSR^* CSR fully adjusted

:: Cyclic Resistance Ratio calculation $CRR_{7.5}$ ::

Point ID	Field SPT	C_n	C_e	C_b	C_r	C_s	$N_{1(60)}$	DeltaN	$N_{1(60)cs}$	$CRR_{7.5}$
1	14.00	1.70	0.90	1.05	0.75	1.20	20.24	9.05	29.29	0.40
2	25.00	1.70	0.90	1.05	0.75	1.20	36.07	10.27	46.34	2.00
3	6.00	0.98	0.90	1.05	0.95	1.20	6.33	6.27	12.60	0.14
4	11.00	0.87	0.90	1.05	0.95	1.20	10.27	7.05	17.32	0.19
5	41.00	0.80	0.90	1.05	1.00	1.20	37.20	1.67	38.88	2.00
6	100.00	0.78	0.90	1.05	1.00	1.20	88.40	2.78	91.18	2.00
7	30.00	0.75	0.90	1.05	1.00	1.20	25.46	1.42	26.88	0.32
8	62.00	0.73	0.90	1.05	1.00	1.20	51.04	1.97	53.01	2.00

C_n : Overburden corretion factor
C_e : Energy correction factor
C_b : Borehole diameter correction factor
C_r : Rod length correction factor
C_s : Liner correction factor
$N_{1(60)}$: Corrected N_{SPT}
DeltaN : Addition to corrected N_{SPT} value due to the presence of fines
$N_{1(60)cs}$: Corected $N_{1(60)}$ value for fines
$CRR_{7.5)}$: Cyclic resistance ratio for M=7.5

:: Settlements calculation for saturated sands ::

Point ID	$N_{1(60)}$	N_1	FS_L	e_v (%)	Settle. (in)
1	29.29	24.41	0.80	1.74	0.00
2	46.34	38.62	4.06	0.00	0.00
3	12.60	10.50	0.22	3.41	0.00
4	17.32	14.43	0.27	2.75	0.00
5	38.88	32.40	2.62	0.00	0.00
6	91.18	75.98	2.55	0.00	0.00
7	26.88	22.40	0.41	1.93	1.04
8	53.01	44.17	2.54	0.00	0.00

Total settlement : 1.04

$N_{1,(60)}$:	Stress normalized and corrected SPT blow count
N_1:	Japanese equivalent corrected value
FS_L:	Calculated factor of safety
e_v:	Post-liquefaction volumentric strain (%)
Settle.:	Calculated settlement (in)

:: Liquefaction potential according to Iwasaki ::

Point ID	F	w_z	I_L
1	0.20	9.54	1.71
2	0.00	9.09	0.00
3	0.78	7.26	20.71
4	0.73	6.49	7.26
5	0.00	5.73	0.00
6	0.00	5.28	0.00
7	0.59	4.51	4.08
8	0.00	3.90	0.00

Overall potential I_L : 33.77

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

SHN ENGINEERS & GEOLOGISTS

SHN Consulting Engineers and Geologists, Inc.
812 W. Wabash Ave
Eureka, California 95501
www.shn-engr.com

Rec'd ComDev 06-07-19

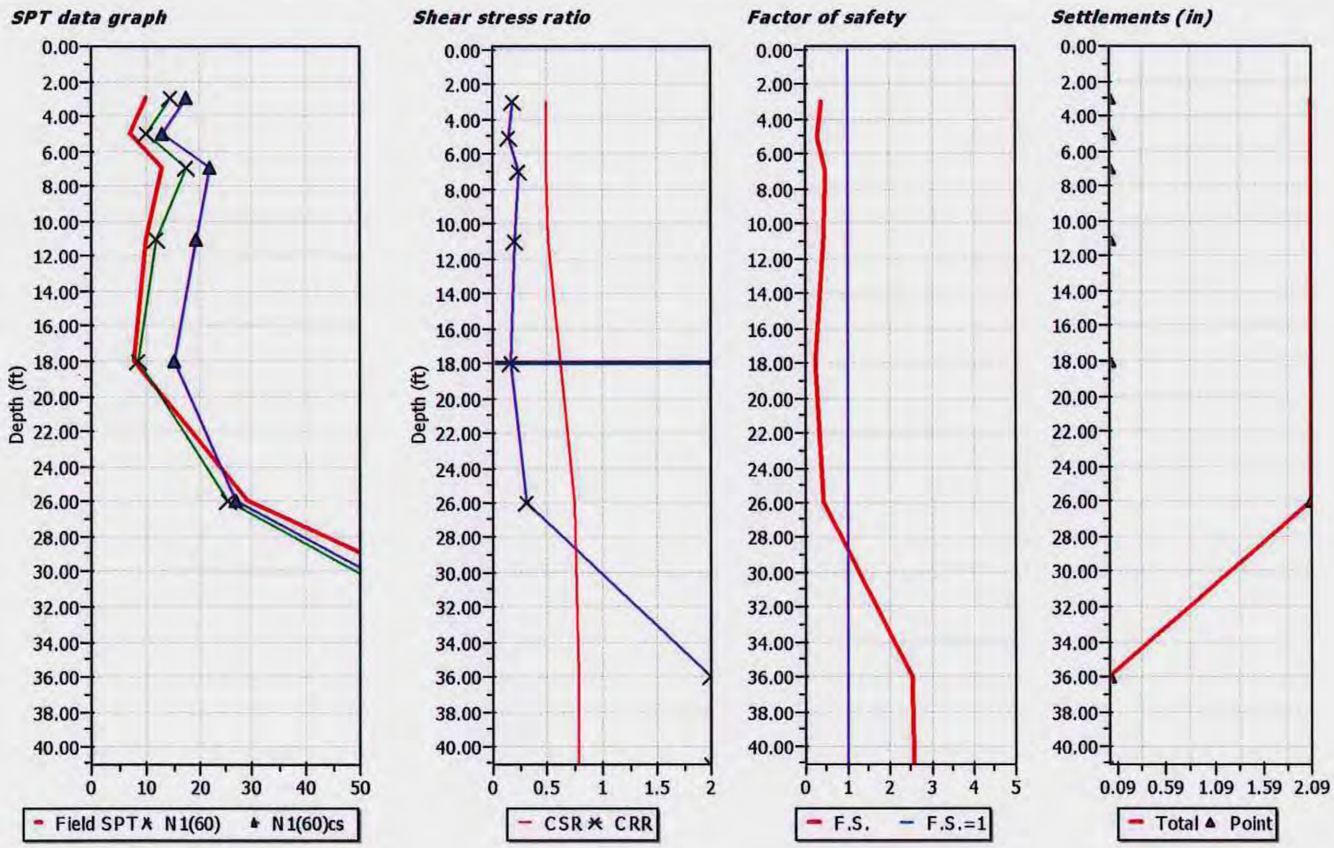
LIQUEFACTION ANALYSIS REPORT

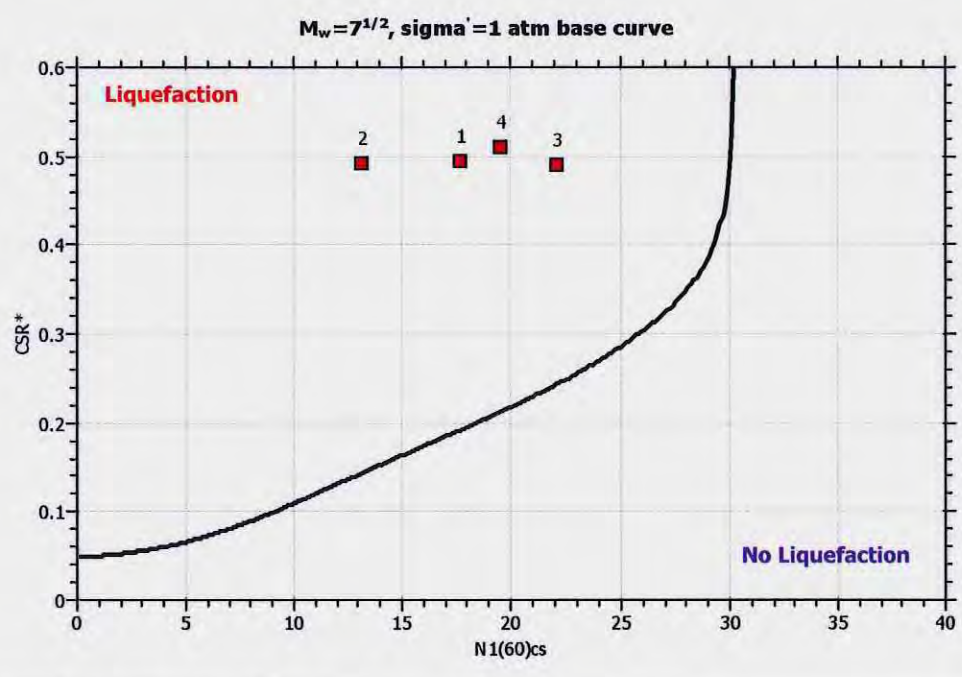
Project title : Arcata Volunteer Fire Department

Project subtitle : BH-2

Input parameters and analysis data

In-situ data type:	Standard Penetration Test	Depth to water table:	18.00 ft
Analysis type:	Deterministic	Earthquake magnitude M_w:	7.50
Analysis method:	NCEER 1998	Peak ground accelaration:	0.64 g
Fines correction method:	Idriss & Seed	User defined F.S.:	1.20





:: Field input data ::

Point ID	Depth (ft)	Field N_{SPT} (blows/feet)	Unit weight (pcf)	Fines content (%)
1	3.00	10.00	120.94	15.00
2	5.00	7.00	120.94	15.00
3	7.00	13.00	120.94	19.00
4	11.00	10.00	120.94	88.00
5	18.00	8.00	120.94	97.00
6	26.00	29.00	120.94	10.00
7	36.00	100.00	120.94	10.00
8	41.00	100.00	120.94	10.00

Depth : Depth from free surface, at which SPT was performed (ft)
Field SPT : SPT blows measured at field (blows/feet)
Unit weight : Bulk unit weight of soil at test depth (pcf)
Fines content : Percentage of fines in soil (%)

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Point ID	Depth (ft)	Sigma (tsf)	u (tsf)	Sigma' (tsf)	r_d	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*
1	3.00	0.18	0.00	0.18	0.99	0.41	1.00	0.41	1.00	0.41
2	5.00	0.30	0.00	0.30	0.99	0.41	1.00	0.41	1.00	0.41
3	7.00	0.42	0.00	0.42	0.98	0.41	1.00	0.41	1.00	0.41
4	11.00	0.67	0.03	0.63	0.97	0.43	1.00	0.43	1.00	0.43
5	18.00	1.09	0.25	0.84	0.96	0.52	1.00	0.52	0.99	0.52
6	26.00	1.57	0.50	1.07	0.94	0.57	1.00	0.57	0.92	0.62
7	36.00	2.18	0.81	1.37	0.88	0.59	1.00	0.59	0.89	0.66
8	41.00	2.48	0.97	1.51	0.84	0.57	1.00	0.57	0.88	0.65

Depth : Depth from free surface, at which SPT was performed (ft)
Sigma : Total overburden pressure at test point, during earthquake (tsf)
u : Water pressure at test point, during earthquake (tsf)
Sigma' : Effective overburden pressure, during earthquake (tsf)
r_d : Nonlinear shear mass factor
CSR : Cyclic Stress Ratio
MSF : Magnitude Scaling Factor
$CSR_{eq,M=7.5}$ CSR adjusted for M=7.5
K_{sigma} Effective overburden stress factor
CSR^* CSR fully adjusted

:: Cyclic Resistance Ratio calculation $CRR_{7.5}$ ::

Point ID	Field SPT	C_n	C_e	C_b	C_r	C_s	$N_{1(60)}$	DeltaN	$N_{1(60)cs}$	$CRR_{7.5}$
1	10.00	1.70	0.90	1.05	0.75	1.20	14.46	3.19	17.65	0.19
2	7.00	1.70	0.90	1.05	0.75	1.20	10.12	2.98	13.11	0.14
3	13.00	1.57	0.90	1.05	0.75	1.20	17.37	4.70	22.06	0.24
4	10.00	1.25	0.90	1.05	0.85	1.20	12.08	7.42	19.49	0.21
5	8.00	0.98	0.90	1.05	0.95	1.20	8.44	6.69	15.13	0.16
6	29.00	0.81	0.90	1.05	0.95	1.20	25.46	1.42	26.88	0.32
7	100.00	0.75	0.90	1.05	1.00	1.20	84.86	2.70	87.56	2.00
8	100.00	0.72	0.90	1.05	1.00	1.20	81.71	2.64	84.35	2.00

C_n : Overburden corretion factor
C_e : Energy correction factor
C_b : Borehole diameter correction factor
C_r : Rod length correction factor
C_s : Liner correction factor
$N_{1(60)}$: Corrected N_{SPT}
DeltaN : Addition to corrected N_{SPT} value due to the presence of fines
$N_{1(60)cs}$: Corected $N_{1(60)}$ value for fines
$CRR_{7.5)}$: Cyclic resistance ratio for M=7.5

:: Settlements calculation for saturated sands ::

Rec'd ComDev 06-07-19

Point ID	$N_{1(60)}$	N_1	FS_L	e_v (%)	Settle. (in)
1	17.65	14.71	0.39	2.72	0.00
2	13.11	10.92	0.29	3.34	0.00
3	22.06	18.39	0.49	2.32	0.00
4	19.49	16.24	0.42	2.56	0.00
5	15.13	12.61	0.26	3.04	0.00
6	26.88	22.40	0.43	1.93	2.09
7	87.56	72.97	2.54	0.00	0.00
8	84.35	70.29	2.55	0.00	0.00

Total settlement : 2.09

$N_{1,(60)}$: Stress normalized and corrected SPT blow count
N_1: Japanese equivalent corrected value
FS_L: Calculated factor of safety
e_v: Post-liquefaction volumentric strain (%)
Settle.: Calculated settlement (in)

:: Liquefaction potential according to Iwasaki ::

Point ID	F	w_z	I_L
1	0.61	9.54	5.35
2	0.71	9.24	4.00
3	0.51	8.93	2.76
4	0.58	8.32	5.94
5	0.74	7.26	11.41
6	0.57	6.04	8.40
7	0.00	4.51	0.00
8	0.00	3.75	0.00

Overall potential I_L : 37.85

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

Preliminary Stormwater Control Plan 4

Rec'd ComDev 06-07-19

Preliminary Stormwater Control Plan (CDP, CUP, and SP ≥ 5000 sf)

For Office Use Only
Application No.____________________
Received By: ____________________

Instructions

The following worksheet is used to demonstrate that for each and every lot, the intended use can be achieved with a design which disperses runoff from the roofs, driveways, sidewalks, streets and other impervious areas to self-retaining pervious areas. It is also used to demonstrate that drainage to treatment and/or flow control facilities is feasible and that the project is in overall compliance with the MS4 permit. Use this form to assist you in designing your project to comply with the design standards for Multi-Parcel Regulated projects. The completed, signed Preliminary SCP for Subdivision Projects, a site map, plus any additional applicable information, must be submitted with your application to the Planning Department.

Project Name: ARCATA COMMUNITY HEALTH CENTER

Physical Site Address: APN 505-121-031

Project Applicant: OPEN DOOR COMMUNITY HEALTH CENTERS

Mailing Address: 670 9th STREET, SUITE 203, ARCATA, CA 95521

Phone: 707-826-8633

Consultant's Information

Name: JARED O'BARR, PE

Firm: SHN

Address: 812 W. WABASH, EUREKA, CA 95501

Email: jobarr@shn-engr.com

Phone: 707-441-8855

A. Project Information

1a. Does Project create or replace 1-acre or more of impervious surface?	☒ **Yes** (see question below)	☐ **No** (skip question 1b.)
b. If 'Yes' to the above question than does project increase impervious surface from pre-project conditions?	☒ **Yes** (hydromodification requirements must be met)	☐ **No** (regulated project requirements must be met)
Total pre-project Impervious Surface (sf):	Ø	
Total new or replaced Impervious Surface Area (square feet) [Sum of impervious area that will be constructed as part of the project]	55,342	

Rec'd ComDev 06-07-19

Preliminary Stormwater Control Plan (CDP, CUP, and SP ≥ 5000 sf)

C. Preliminary Site Plan Checklist –items that must be include on the site plan

- [x] Topographic lines (2 ft. contours)
- [x] On-site waterways/drainages, vegetation and areas to be left undisturbed all shown with appropriate buffers
- [x] DMAs clearly delineated and labeled with name and area (square feet)
- [x] Location of site design measures used in worksheet 2
- [x] Location, size, and name of Bioretention/Treatment Facility
- [x] Flow direction that clearly demonstrates the ability of self-retaining areas, infiltration site design measure, and treatment facilities to capture runoff from impervious surfaces
- [x] Hydrologic soil class

D. Operation and Maintenance Plan Requirements

Each Bioretention facility or equivalent will be required to have an operation and maintenance plan attached to the final SCP and shall include all details found in Appendix 3, 4, and 5 of the LID Manual.

E. Additional Requirements

A detailed final Stormwater Control Plan with narrative sections will need to be submitted prior to issuance of a grading/building permit (see, Appendix 1. However, by completing the Preliminary SCP a more efficient and timely review of the final SCP is enabled.

F. Signature and Certification

I, the below signed, confirm that I have accurately described my project to the best of my ability, and that I have not purposely omitted any detail affecting my project's classification for storm water regulation. I hereby certify that the site design measures and storm water flow treatment measures identified herein as being incorporated into my project have been designed in accordance with the approved BMP Fact Sheet or equivalent, and is included in the final site plans. I also hereby certify that my project meets the storm water runoff reduction criteria identified in Worksheet 2, or as determined through other approved means.

[signature] 15 MAY 2019

Signature Date

JARED O'BARR, PE

Print Name

I am the:

- [ ] Property Owner
- [ ] Applicant
- [x] ~~Contractor~~ CONSULTANT

Rec'd ComDev 06-07-19

Preliminary Stormwater Control Plan (CDP, CUP, and SP ≥ 5000 sf)

B. Summary Table of Pervious to Impervious Surface

The following table will be used by staff to ensure that adequate measures have been utilized within the project design to capture retain and/or infiltrate the design storm.
Each DMA shown in the table shall be designated with the same name on the site plan. All site design measures used to meet the runoff reduction goals and all treatment facilities utilized to capture remaining runoff volumes must be shown on the site plan at an appropriate scale. Please use the Flow Chart as a reference of the process.

1. **Utilize Worksheet 1 to Calculate Impervious to Pervious Ratio to determine if further runoff reduction is needed**
2. **Utilize the Runoff Reduction Calculator (Worksheet 2*) to increase reduction**
3. **Utilize Bioretention or equivalent if reduction cannot be achieved using site design measures**

DMA Name	Does pervious to impervious ratio Achieve 3.5:1 or better, Worksheet 1(Yes or No)	Does runoff reduction with site design measures equal 100% or greater, Box DD (Worksheet 2)	Value from Box BB (worksheet 2) Impervious surface amount that must be treated using additional methods	Bioretention facility name and size (sf) (Use a sizing factor of 0.04 to calculate bioretention facility size or equivalent sizing technique if different treatment/baseline hydromodification facility is proposed)
(A)	**(B)**	**(C)**	**(D)**	
Example A	*Yes*	*Yes*	-----------	-------------
Example B	*No*	*Yes*	------------	--------------
Example C	*No*	*No*	*1350 sf*	*C : (1350 X .04)=54 sf*
1	NO	NO	9747	#1 – 695
2	NO	NO	6165	#2 – 465
3	NO	NO	6770	#3 – 571
4	NO	NO	6178	#4 – 1,566
5	NO	NO	11,550	#5 – 1,173
6	NO	NO	12,544	#6 – 1,183
7	NO	NO	2,398	#7 – 792

*Worksheet 1 and 2 showing calculations for each DMA must be included with the Preliminary SCP
Attach additional sheets as needed for the table above

Rec'd ComDev 06-07-19

Regulated Projects Worksheet 1 - Humboldt Low Impact Development Stormwater Manual

DMA Name	Total Post Project Impervious Surface Area (square feet)	Pervious Self-Retaining Area[1] (square feet)	Ratio of Impervious Surface Area to Self-Retaining Pervious Surface Area	Does Ratio Achieve 3.5 : 1 ratio or better of Impervious Surface Area to Self-Retaining Pervious Surface Area (Yes or No)[2]
Example A	500	150	3.3 : 1	YES
Example B	500	100	5.0 : 1	NO
DMA 1	9747	1	9747.0 : 1	NO
DMA 2	6165	1	6165.0 : 1	NO
DMA 3	6770	1	6770.0 : 1	NO
DMA 4	6178	1	6178.0 : 1	NO
DMA 5	11550	1	11550.0 : 1	NO
DMA 6	12544	1	12544.0 : 1	NO
DMA 7	2388	1	2388.0 : 1	NO
			:	
			:	
			:	
			:	
			:	
			:	
			:	
			:	
			:	

1: Self-Retaining Areas where impervious surface runoff is directed to the Pervious Self-Retaining Area in accordance with Humboldt LID Manual - Part C, Section 6.0

2: If "Yes", Ratio of Impervious Surface Area to Self-Retaining Pervious Surface Area is equal to 3.5:1 or better (1.3:1 or better in the Shelter Cove MS4 area), then compliance with runoff reduction measures have been met for DMA.

If "No", Ratio of Impervious Surface Area to Self-Retaining Pervious Surface Area does not achieve 3.5:1 or better (1.3:1 in Shelter Cove), then compliance with runoff reduction measures have not been met for DMA (Complete Worksheet 2).

Rec'd ComDev 06-07-19

Regulated Projects Worksheet 2
Humboldt Low Impact Development Stormwater Manual

Project Information						*Formulas/Notes*
DMA Name: **DMA 1**						
Total Post-Project Impervious Surface Area (square feet)			A	9747	square feet	
24 hour - 85th Percentile Design Storm			B	0.65	inch	B = Select Design Storm Value (0.65-inch Humboldt Bay Area, 1.3-inch Shelter Cove)
Impervious Surface Runoff Value (Potential Stormwater Runoff due to impervious surface area and design storm value)			C	3933	Gallons per 24 hours	C = A x B x 0.083 x 7.48
Pervious Self-Retaining Area (SRA) Credit (if applicable, if none enter 0)						
Self-Retaining Area (square feet)	0	3.5	SRA Credit	0	square feet	SRA Credit = Self-Retaining Area x Multiplier; Select Multiplier (3.5 Humboldt Bay Area, 1.3 Shelter Cove)
Site Design Measure Credits						
Tree Planting and Preservation						
New Trees		# of trees				
100 square feet per deciduous tree	D	0	E	0	square feet	E = D x 100
200 square feet per evergreen tree	F	0	G	0	square feet	G = F x 200
Existing Trees (Credit for 50% of existing canopy area)		Canopy diameter (feet)				
Tree #1	H_1	0	J_1	0	square feet	$J_1 = 3.14 \times (H_1/2)^2 \times 0.50$
Tree #2	H_2	0	J_2	0	square feet	$J_2 = 3.14 \times (H_2/2)^2 \times 0.50$
Tree #3	H_3	0	J_3	0	square feet	$J_3 = 3.14 \times (H_3/2)^2 \times 0.50$
Rain Barrel or Cisterns (55 gallon minimum)						
Square foot credit per gallon based on 24-hour, 85th Percentile Design Storm	K	2.48				K = Select square foot credit per gallon (2.48 Humboldt Bay Area, 1.24 Shelter Cove)
		Gallons				
Rain Barrels	L	0	M	0	square feet	M = L x K
Cisterns	N	0	O	0	square feet	O = N x K
Infiltration Trench/Basin (55 gallon minimum ~ 21 ft^{3**})		cubic feet				
volume(ft^3) = length x width x depth	P	0	Q	0	square feet	Q = P x R x K x 7.48
porosity (approximate %)	R	35%				
Subsurface Infiltrators (55 gallon minimum)						
Proprietary units vary, insert estimated storage in ft^3	S	0	T	0	square feet	T = S x 7.48
Impervious Area Disconnection						
Credit per square foot of pervious receiving area			U	0	square feet	U = Enter square foot value
Soil Quality Improvement						
Credit per square foot of soil quality improvement			V	0	square feet	V = Enter square foot value
Green Roof						
Credit per square foot of green roof installation			W	0	square feet	W = Enter square foot value
PPPP (Alternative engineered hardscaping surfaces)						
Credit per square foot of PPPP			X	0	square feet	X = Enter square foot value
Vegetated Swales						
Credit per square foot of vegetated swale			Y	0	square feet	Y = Enter square foot value
Stream Setbacks and Buffers						
Credit per square foot of stream setback and buffer#			Z	0	square feet	Z = Enter square foot value
Credits Total			AA	0	square feet	AA = SRA Credit + E + G + J_1 + J_2 + J_3 + M + O + Q + T + U + V + W + X + Y + Z
Post-Project Impervious Surface Area minus Site Design Measure Credits			BB	9747	square feet	BB = A - AA
NEW Impervious Surface Runoff Value (Potential Stormwater Runoff due to impervious surface area and design storm after implementation of Site Design Measures)			CC	3933	Gallons per 24 hours	CC = BB x B x 0.083 x 7.48
Percent reduction in Impervious Surface Runoff Value*			DD	0.0	%	DD = ((C - CC) / C) x 100%

***If value for DD is not greater than or equal to %100 then bioretention is required for treating remaining runoff from impervious area indicated by value BB. Design and implement bioretention facility in accordance with Humboldt LID Stormwater Manual - Part C.**

****Infiltration Trench/Basin calculations are based on porosity (35%). Increased trench dimensions (volume) are required to meet 55 gallon minimum capacity.**

Green	**Fill In [Enter Value]**	Conversions Used:
Red	**Calculated Value**	1 inch = 0.083 feet
Black	**Fixed Value/Selectable Value**	1 cubic foot = 7.48 gallons

check with agency with project area jurisdiction for requirements

Rec'd ComDev 06-07-19

Regulated Projects Worksheet 2
Humboldt Low Impact Development Stormwater Manual

					Formulas/Notes
Project Information					
DMA Name: DMA 2					
Total Post-Project Impervious Surface Area (square feet)	A	6165		square feet	
24 hour - 85th Percentile Design Storm	B	0.65		inch	B = Select Design Storm Value (0.65-inch Humboldt Bay Area, 1.3-inch Shelter Cove)
Impervious Surface Runoff Value (Potential Stormwater Runoff due to impervious surface area and design storm value)	C	2488		Gallons per 24 hours	C = A x B x 0.083 x 7.48
Pervious Self-Retaining Area (SRA) Credit (if applicable, if none enter 0)					
Self-Retaining Area (square feet): 0	3.5	SRA Credit	0	square feet	SRA Credit = Self-Retaining Area x Multiplier. Select Multiplier (3.5 Humboldt Bay Area, 1.3 Shelter Cove)
Site Design Measure Credits					
Tree Planting and Preservation					
New Trees		# of trees			
100 square feet per deciduous tree	D	0	E 0	square feet	E = D x 100
200 square feet per evergreen tree	F	0	G 0	square feet	G = F x 200
Existing Trees (Credit for 50% of existing canopy area)		Canopy diameter (feet)			
Tree #1	H_1	0	J_1 0	square feet	$J_1 = 3.14 \times (H_1/2)^2 \times 0.50$
Tree #2	H_2	0	J_2 0	square feet	$J_2 = 3.14 \times (H_2/2)^2 \times 0.50$
Tree #3	H_3	0	J_3 0	square feet	$J_3 = 3.14 \times (H_3/2)^2 \times 0.50$
Rain Barrel or Cisterns (55 gallon minimum)					
Square foot credit per gallon based on 24-hour, 85th Percentile Design Storm	K	2.48			K = Select square foot credit per gallon (2.48 Humboldt Bay Area, 1.24 Shelter Cove)
		Gallons			
Rain Barrels	L	0	M 0	square feet	M = L x K
Cisterns	N	0	O 0	square feet	O = N x K
Infiltration Trench/Basin (55 gallon minimum ~ 21 ft^3)**		cubic feet			
volume(ft^3) = length x width x depth	P	0	Q 0	square feet	Q = P x R x K x 7.48
porosity (approximate %)	R	35%			
Subsurface Infiltrators (55 gallon minimum)					
Proprietary units vary, insert estimated storage in ft^3	S	0	T 0	square feet	T = S x 7.48
Impervious Area Disconnection					
Credit per square foot of pervious receiving area			U 0	square feet	U = Enter square foot value
Soil Quality Improvement					
Credit per square foot of soil quality improvement			V 0	square feet	V = Enter square foot value
Green Roof					
Credit per square foot of green roof installation			W 0	square feet	W = Enter square foot value
PPPP (Alternative engineered hardscaping surfaces)					
Credit per square foot of PPPP			X 0	square feet	X = Enter square foot value
Vegetated Swales					
Credit per square foot of vegetated swale			Y 0	square feet	Y = Enter square foot value
Stream Setbacks and Buffers					
Credit per square foot of stream setback and buffer#			Z 0	square feet	Z = Enter square foot value
Credits Total			AA 0	square feet	AA = SRA Credit + E + G + J_1 + J_2 + J_3 + M + O + Q + T + U + V + W + X + Y + Z
Post-Project Impervious Surface Area minus Site Design Measure Credits			BB 6165	square feet	BB = A - AA
NEW Impervious Surface Runoff Value (Potential Stormwater Runoff due to impervious surface area and design storm after implementation of Site Design Measures)			CC 2488	Gallons per 24 hours	CC = BB x B x 0.083 x 7.48
Percent reduction in Impervious Surface Runoff Value*			DD 0.0	%	DD = ((C - CC) / C) x 100%

***If value for DD is not greater than or equal to %100 then bioretention is required for treating remaining runoff from impervious area indicated by value BB. Design and implement bioretention facility in accordance with Humboldt LID Stormwater Manual - Part C.**

****Infiltration Trench/Basin calculations are based on porosity (35%). Increased trench dimensions (volume) are required to meet 55 gallon minimum capacity.**

Green	**Fill In [Enter Value]**	Conversions Used:
Red	**Calculated Value**	1 inch = 0.083 feet
Black	**Fixed Value/Selectable Value**	1 cubic foot = 7.48 gallons

check with agency with project area jurisdiction for requirements

Rec'd ComDev 06-07-19

Regulated Projects Worksheet 2
Humboldt Low Impact Development Stormwater Manual

Project Information						*Formulas/Notes*
DMA Name: DMA 3						
Total Post-Project Impervious Surface Area (square feet)			A	6770	square feet	
24 hour - 85th Percentile Design Storm			B	0.65	inch	B = Select Design Storm Value (0.65-inch Humboldt Bay Area, 1.3-inch Shelter Cove)
Impervious Surface Runoff Value (Potential Stormwater Runoff due to Impervious surface area and design storm value)			C	2732	Gallons per 24 hours	C = A x B x 0.083 x 7.48
Pervious Self-Retaining Area (SRA) Credit (If applicable, if none enter 0)						
Self-Retaining Area (square feet)	0	3.5	SRA Credit	0	square feet	SRA Credit = Self-Retaining Area x Multiplier. Select Multiplier (3.5 Humboldt Bay Area, 1.3 Shelter Cove)
Site Design Measure Credits						
Tree Planting and Preservation						
New Trees		# of trees				
100 square feet per deciduous tree	D	0	E	0	square feet	E = D x 100
200 square feet per evergreen tree	F	0	G	0	square feet	G = F x 200
Existing Trees (Credit for 50% of existing canopy area)		Canopy diameter (feet)				
Tree #1	H_1	0	J_1	0	square feet	$J_1 = 3.14 \times (H_1/2)^2 \times 0.50$
Tree #2	H_2	0	J_2	0	square feet	$J_2 = 3.14 \times (H_2/2)^2 \times 0.50$
Tree #3	H_3	0	J_3	0	square feet	$J_3 = 3.14 \times (H_3/2)^2 \times 0.50$
Rain Barrel or Cisterns (55 gallon minimum)						
Square foot credit per gallon based on 24-hour, 85th Percentile Design Storm	K	2.48				K = Select square foot credit per gallon (2.48 Humboldt Bay Area, 1.24 Shelter Cove)
		Gallons				
Rain Barrels	L	0	M	0	square feet	M = L x K
Cisterns	N	0	O	0	square feet	O = N x K
Infiltration Trench/Basin (55 gallon minimum ~ 21 ft^3)**		cubic feet				
volume(ft^3) = length x width x depth	P	0	Q	0	square feet	Q = P x R x K x 7.48
porosity (approximate %)	R	35%				
Subsurface Infiltrators (55 gallon minimum)						
Proprietary units vary, insert estimated storage in ft^3	S	0	T	0	square feet	T = S x 7.48
Impervious Area Disconnection						
Credit per square foot of pervious receiving area			U	0	square feet	U = Enter square foot value
Soil Quality Improvement						
Credit per square foot of soil quality improvement			V	0	square feet	V = Enter square foot value
Green Roof						
Credit per square foot of green roof installation			W	0	square feet	W = Enter square foot value
PPPP (Alternative engineered hardscaping surfaces)						
Credit per square foot of PPPP			X	0	square feet	X = Enter square foot value
Vegetated Swales						
Credit per square foot of vegetated swale			Y	0	square feet	Y = Enter square foot value
Stream Setbacks and Buffers						
Credit per square foot of stream setback and buffer#			Z	0	square feet	Z = Enter square foot value
Credits Total			AA	0	square feet	AA = SRA Credit + E + G + J_1 + J_2 + J_3 + M + O + Q + T + U + V + W + X + Y + Z
Post-Project Impervious Surface Area minus Site Design Measure Credits			BB	6770	square feet	BB = A - AA
NEW Impervious Surface Runoff Value (Potential Stormwater Runoff due to impervious surface area and design storm after implementation of Site Design Measures)			CC	2732	Gallons per 24 hours	CC = BB x B x 0.083 x 7.48
Percent reduction in Impervious Surface Runoff Value*			DD	0.0	%	DD = ((C - CC) / C) x 100%

***If value for DD is not greater than or equal to %100 then bioretention is required for treating remaining runoff from impervious area indicated by value BB. Design and implement bioretention facility in accordance with Humboldt LID Stormwater Manual - Part C.**

****Infiltration Trench/Basin calculations are based on porosity (35%). Increased trench dimensions (volume) are required to meet 55 gallon minimum capacity.**

Green	**Fill In [Enter Value]**	Conversions Used:
Red	**Calculated Value**	1 inch = 0.083 feet
Black	**Fixed Value/Selectable Value**	1 cubic foot = 7.48 gallons

Regulated Projects Worksheet 2, Version 2.0 - June 29, 2016

\# check with agency with project area jurisdiction for requirements

Rec'd ComDev 06-07-19

Regulated Projects Worksheet 2
Humboldt Low Impact Development Stormwater Manual

					Formulas/Notes
Project Information					
DMA Name: DMA 4					
Total Post-Project Impervious Surface Area (square feet)		A	6178	square feet	
24 hour - 85th Percentile Design Storm		B	0.65	inch	B = Select Design Storm Value (0.65-inch Humboldt Bay Area, 1.3-inch Shelter Cove)
Impervious Surface Runoff Value (Potential Stormwater Runoff due to impervious surface area and design storm value)		C	2493	Gallons per 24 hours	C = A x B x 0.083 x 7.48
Pervious Self-Retaining Area (SRA) Credit (if applicable, if none enter 0)					
Self-Retaining Area (square feet): 0	3.5	SRA Credit	0	square feet	SRA Credit = Self-Retaining Area x Multiplier Select Multiplier (3.5 Humboldt Bay Area, 1.3 Shelter Cove)
Site Design Measure Credits					
Tree Planting and Preservation					
New Trees	# of trees				
100 square feet per deciduous tree	D: 0	E	0	square feet	E = D x 100
200 square feet per evergreen tree	F: 0	G	0	square feet	G = F x 200
Existing Trees (Credit for 50% of existing canopy area)	Canopy diameter (feet)				
Tree #1	H_1: 0	J_1	0	square feet	$J_1 = 3.14 \times (H_1/2)^2 \times 0.50$
Tree #2	H_2: 0	J_2	0	square feet	$J_2 = 3.14 \times (H_2/2)^2 \times 0.50$
Tree #3	H_3: 0	J_3	0	square feet	$J_3 = 3.14 \times (H_3/2)^2 \times 0.50$
Rain Barrel or Cisterns (55 gallon minimum)					
Square foot credit per gallon based on 24-hour, 85th Percentile Design Storm	K: 2.48				K = Select square foot credit per gallon (2.48 Humboldt Bay Area, 1.24 Shelter Cove)
	Gallons				
Rain Barrels	L: 0	M	0	square feet	M = L x K
Cisterns	N: 0	O	0	square feet	O = N x K
Infiltration Trench/Basin (55 gallon minimum ~ 21 ft^{3**})	cubic feet				
volume(ft^3) = length x width x depth	P: 0	Q	0	square feet	Q = P x R x K x 7.48
porosity (approximate %)	R: 35%				
Subsurface Infiltrators (55 gallon minimum)					
Proprietary units vary, insert estimated storage in ft^3	S: 0	T	0	square feet	T = S x 7.48
Impervious Area Disconnection					
Credit per square foot of pervious receiving area		U	0	square feet	U = Enter square foot value
Soil Quality Improvement					
Credit per square foot of soil quality improvement		V	0	square feet	V = Enter square foot value
Green Roof					
Credit per square foot of green roof installation		W	0	square feet	W = Enter square foot value
PPPP (Alternative engineered hardscaping surfaces)					
Credit per square foot of PPPP		X	0	square feet	X = Enter square foot value
Vegetated Swales					
Credit per square foot of vegetated swale		Y	0	square feet	Y = Enter square foot value
Stream Setbacks and Buffers					
Credit per square foot of stream setback and buffer#		Z	0	square feet	Z = Enter square foot value
Credits Total		AA	0	square feet	AA = SRA Credit + E + G + J_1 + J_2 + J_3 + M + O + Q + T + U + V + W + X + Y + Z
Post-Project Impervious Surface Area minus Site Design Measure Credits		BB	6178	square feet	BB = A - AA
NEW Impervious Surface Runoff Value (Potential Stormwater Runoff due to impervious surface area and design storm after implementation of Site Design Measures)		CC	2493	Gallons per 24 hours	CC = BB x B x 0.083 x 7.48
Percent reduction in Impervious Surface Runoff Value*		DD	0.0	%	DD = ((C - CC) / C) x 100%

***If value for DD is not greater than or equal to %100 then bioretention is required for treating remaining runoff from impervious area indicated by value BB. Design and implement bioretention facility in accordance with Humboldt LID Stormwater Manual - Part C.**

****Infiltration Trench/Basin calculations are based on porosity (35%). Increased trench dimensions (volume) are required to meet 55 gallon minimum capacity.**

Legend		Conversions Used:
Green	Fill In [Enter Value]	1 inch = 0.083 feet
Red	Calculated Value	1 cubic foot = 7.48 gallons
Black	Fixed Value/Selectable Value	# check with agency with project area jurisdiction for requirements

Rec'd ComDev 06-07-19

Regulated Projects Worksheet 2
Humboldt Low Impact Development Stormwater Manual

Project Information					Formulas/Notes
DMA Name: DMA 5					
Total Post-Project Impervious Surface Area (square feet)	A	11550		square feet	
24 hour - 85th Percentile Design Storm	B	0.65		inch	B = Select Design Storm Value (0.65-inch Humboldt Bay Area, 1.3-inch Shelter Cove)
Impervious Surface Runoff Value (Potential Stormwater Runoff due to impervious surface area and design storm value)	C	4661		Gallons per 24 hours	C = A x B x 0.083 x 7.48
Pervious Self-Retaining Area (SRA) Credit (if applicable, if none enter 0)					
Self-Retaining Area (square feet): 0	3.5	SRA Credit	0	square feet	SRA Credit = Self-Retaining Area x Multiplier. Select Multiplier (3.5 Humboldt Bay Area, 1.3 Shelter Cove)
Site Design Measure Credits					
Tree Planting and Preservation					
New Trees		# of trees			
100 square feet per deciduous tree	D	0	E 0	square feet	E = D x 100
200 square feet per evergreen tree	F	0	G 0	square feet	G = F x 200
Existing Trees (Credit for 50% of existing canopy area)		Canopy diameter (feet)			
Tree #1	H_1	0	J_1 0	square feet	$J_1 = 3.14 \times (H_1/2)^2 \times 0.50$
Tree #2	H_2	0	J_2 0	square feet	$J_2 = 3.14 \times (H_2/2)^2 \times 0.50$
Tree #3	H_3	0	J_3 0	square feet	$J_3 = 3.14 \times (H_3/2)^2 \times 0.50$
Rain Barrel or Cisterns (55 gallon minimum)					
Square foot credit per gallon based on 24-hour, 85th Percentile Design Storm	K	2.48			K = Select square foot credit per gallon (2.48 Humboldt Bay Area, 1.24 Shelter Cove)
		Gallons			
Rain Barrels	L	0	M 0	square feet	M = L x K
Cisterns	N	0	O 0	square feet	O = N x K
Infiltration Trench/Basin (55 gallon minimum ~ 21 ft^3)**		cubic feet			
volume(ft^3) = length x width x depth	P	0	Q 0	square feet	Q = P x R x K x 7.48
porosity (approximate %)	R	35%			
Subsurface Infiltrators (55 gallon minimum)					
Proprietary units vary, insert estimated storage in ft^3	S	0	T 0	square feet	T = S x 7.48
Impervious Area Disconnection					
Credit per square foot of pervious receiving area			U 0	square feet	U = Enter square foot value
Soil Quality Improvement					
Credit per square foot of soil quality improvement			V 0	square feet	V = Enter square foot value
Green Roof					
Credit per square foot of green roof installation			W 0	square feet	W = Enter square foot value
PPPP (Alternative engineered hardscaping surfaces)					
Credit per square foot of PPPP			X 0	square feet	X = Enter square foot value
Vegetated Swales					
Credit per square foot of vegetated swale			Y 0	square feet	Y = Enter square foot value
Stream Setbacks and Buffers					
Credit per square foot of stream setback and buffer#			Z 0	square feet	Z = Enter square foot value
Credits Total			AA 0	square feet	AA = SRA Credit + E + G + J_1 + J_2 + J_3 + M + O + Q + T + U + V + W + X + Y + Z
Post-Project Impervious Surface Area minus Site Design Measure Credits			BB 11550	square feet	BB = A - AA
NEW Impervious Surface Runoff Value (Potential Stormwater Runoff due to impervious surface area and design storm after implementation of Site Design Measures)			CC 4661	Gallons per 24 hours	CC = BB x B x 0.083 x 7.48
Percent reduction in Impervious Surface Runoff Value*			DD 0.0	%	DD = ((C - CC) / C) x 100%

***If value for DD is not greater than or equal to %100 then bioretention is required for treating remaining runoff from impervious area indicated by value BB. Design and implement bioretention facility in accordance with Humboldt LID Stormwater Manual - Part C.**

****Infiltration Trench/Basin calculations are based on porosity (35%). Increased trench dimensions (volume) are required to meet 55 gallon minimum capacity.**

Green	Fill In [Enter Value]	Conversions Used:
Red	Calculated Value	1 inch = 0.083 feet
Black	Fixed Value/Selectable Value	1 cubic foot = 7.48 gallons

Regulated Projects Worksheet 2, Version 2.0 - June 29, 2016

\# check with agency with project area jurisdiction for requirements

Rec'd ComDev 06-07-19

Regulated Projects Worksheet 2
Humboldt Low Impact Development Stormwater Manual

Project Information						*Formulas/Notes*
DMA Name: DMA 6						
Total Post-Project Impervious Surface Area (square feet)			A	12544	square feet	
24 hour - 85th Percentile Design Storm			B	0.65	inch	B = Select Design Storm Value (0.65-inch Humboldt Bay Area, 1.3-inch Shelter Cove)
Impervious Surface Runoff Value (Potential Stormwater Runoff due to Impervious surface area and design storm value)			C	5062	Gallons per 24 hours	C = A x B x 0.083 x 7.48
Pervious Self-Retaining Area (SRA) Credit (if applicable, if none enter 0)						
Self-Retaining Area (square feet)	0	3.5	SRA Credit	0	square feet	SRA Credit = Self-Retaining Area x Multiplier. Select Multiplier (3.5 Humboldt Bay Area, 1.3 Shelter Cove)
Site Design Measure Credits						
Tree Planting and Preservation						
New Trees		# of trees				
100 square feet per deciduous tree	D	0	E	0	square feet	E = D x 100
200 square feet per evergreen tree	F	0	G	0	square feet	G = F x 200
Existing Trees (Credit for 50% of existing canopy area)		Canopy diameter (feet)				
Tree #1	H_1	0	J_1	0	square feet	$J_1 = 3.14 \times (H_1/2)^2 \times 0.50$
Tree #2	H_2	0	J_2	0	square feet	$J_2 = 3.14 \times (H_2/2)^2 \times 0.50$
Tree #3	H_3	0	J_3	0	square feet	$J_3 = 3.14 \times (H_3/2)^2 \times 0.50$
Rain Barrel or Cisterns (55 gallon minimum)						
Square foot credit per gallon based on 24-hour, 85th Percentile Design Storm	K	2.48				K = Select square foot credit per gallon (2.48 Humboldt Bay Area, 1.24 Shelter Cove)
		Gallons				
Rain Barrels	L	0	M	0	square feet	M = L x K
Cisterns	N	0	O	0	square feet	O = N x K
Infiltration Trench/Basin (55 gallon minimum ~ 21 ft^3)**		cubic feet				
volume(ft^3) = length x width x depth	P	0	Q	0	square feet	Q = P x R x K x 7.48
porosity (approximate %)	R	35%				
Subsurface Infiltrators (55 gallon minimum)						
Proprietary units vary, insert estimated storage in ft^3	S	0	T	0	square feet	T = S x 7.48
Impervious Area Disconnection						
Credit per square foot of pervious receiving area			U	0	square feet	U = Enter square foot value
Soil Quality Improvement						
Credit per square foot of soil quality improvement			V	0	square feet	V = Enter square foot value
Green Roof						
Credit per square foot of green roof installation			W	0	square feet	W = Enter square foot value
PPPP (Alternative engineered hardscaping surfaces)						
Credit per square foot of PPPP			X	0	square feet	X = Enter square foot value
Vegetated Swales						
Credit per square foot of vegetated swale			Y	0	square feet	Y = Enter square foot value
Stream Setbacks and Buffers						
Credit per square foot of stream setback and buffer#			Z	0	square feet	Z = Enter square foot value
Credits Total			AA	0	square feet	AA = SRA Credit + E + G + J_1 + J_2 + J_3 + M + O + Q + T + U + V + W + X + Y + Z
Post-Project Impervious Surface Area minus Site Design Measure Credits			BB	12544	square feet	BB = A - AA
NEW Impervious Surface Runoff Value (Potential Stormwater Runoff due to impervious surface area and design storm after implementation of Site Design Measures)			CC	5062	Gallons per 24 hours	CC = BB x B x 0.083 x 7.48
Percent reduction in Impervious Surface Runoff Value*			DD	0.0	%	DD = ((C - CC) / C) x 100%

***If value for DD is not greater than or equal to %100 then bioretention is required for treating remaining runoff from impervious area indicated by value BB. Design and implement bioretention facility in accordance with Humboldt LID Stormwater Manual - Part C.**

****Infiltration Trench/Basin calculations are based on porosity (35%). Increased trench dimensions (volume) are required to meet 55 gallon minimum capacity.**

Green	Fill In [Enter Value]	Conversions Used:
Red	Calculated Value	1 inch = 0.083 feet
Black	Fixed Value/Selectable Value	1 cubic foot = 7.48 gallons

Regulated Projects Worksheet 2, Version 2.0 - June 29, 2016

\# check with agency with project area jurisdiction for requirements

Rec'd ComDev 06-07-19

Regulated Projects Worksheet 2
Humboldt Low Impact Development Stormwater Manual

Project Information						*Formulas/Notes*
DMA Name: **DMA 7**						
Total Post-Project Impervious Surface Area (square feet)			A	2388	square feet	
24 hour - 85th Percentile Design Storm			B	0.65	inch	B = Select Design Storm Value (0.65-inch Humboldt Bay Area, 1.3-inch Shelter Cove)
Impervious Surface Runoff Value (Potential Stormwater Runoff due to impervious surface area and design storm value)			C	964	Gallons per 24 hours	C = A x B x 0.083 x 7.48
Pervious Self-Retaining Area (SRA) Credit (if applicable, if none enter 0)						
Self-Retaining Area (square feet)	0	3.5	SRA Credit	0	square feet	SRA Credit = Self-Retaining Area x Multiplier; Select Multiplier (3.5 Humboldt Bay Area, 1.3 Shelter Cove)
Site Design Measure Credits						
Tree Planting and Preservation						
New Trees		# of trees				
100 square feet per deciduous tree	D	0	E	0	square feet	E = D x 100
200 square feet per evergreen tree	F	0	G	0	square feet	G = F x 200
Existing Trees (Credit for 50% of existing canopy area)		Canopy diameter (feet)				
Tree #1	H_1	0	J_1	0	square feet	$J_1 = 3.14 \times (H_1/2)^2 \times 0.50$
Tree #2	H_2	0	J_2	0	square feet	$J_2 = 3.14 \times (H_2/2)^2 \times 0.50$
Tree #3	H_3	0	J_3	0	square feet	$J_3 = 3.14 \times (H_3/2)^2 \times 0.50$
Rain Barrel or Cisterns (55 gallon minimum)						
Square foot credit per gallon based on 24-hour, 85th Percentile Design Storm	K	2.48				K = Select square foot credit per gallon (2.48 Humboldt Bay Area, 1.24 Shelter Cove)
		Gallons				
Rain Barrels	L	0	M	0	square feet	M = L x K
Cisterns	N	0	O	0	square feet	O = N x K
Infiltration Trench/Basin (55 gallon minimum ~ 21 ft^3)**		cubic feet				
volume(ft^3) = length x width x depth	P	0	Q	0	square feet	Q = P x R x K x 7.48
porosity (approximate %)	R	35%				
Subsurface Infiltrators (55 gallon minimum)						
Proprietary units vary, insert estimated storage in ft^3	S	0	T	0	square feet	T = S x 7.48
Impervious Area Disconnection						
Credit per square foot of pervious receiving area			U	0	square feet	U = Enter square foot value
Soil Quality Improvement						
Credit per square foot of soil quality improvement			V	0	square feet	V = Enter square foot value
Green Roof						
Credit per square foot of green roof installation			W	0	square feet	W = Enter square foot value
PPPP (Alternative engineered hardscaping surfaces)						
Credit per square foot of PPPP			X	0	square feet	X = Enter square foot value
Vegetated Swales						
Credit per square foot of vegetated swale			Y	0	square feet	Y = Enter square foot value
Stream Setbacks and Buffers						
Credit per square foot of stream setback and buffer#			Z	0	square feet	Z = Enter square foot value
Credits Total			AA	0	square feet	AA = SRA Credit + E + G + J_1 + J_2 + J_3 + M + O + Q + T + U + V + W + X + Y + Z
Post-Project Impervious Surface Area minus Site Design Measure Credits			BB	2388	square feet	BB = A - AA
NEW Impervious Surface Runoff Value (Potential Stormwater Runoff due to impervious surface area and design storm after implementation of Site Design Measures)			CC	964	Gallons per 24 hours	CC = BB x B x 0.083 x 7.48
Percent reduction in Impervious Surface Runoff Value*			DD	0.0	%	DD = ((C - CC) / C) x 100%

***If value for DD is not greater than or equal to %100 then bioretention is required for treating remaining runoff from impervious area indicated by value BB. Design and implement bioretention facility in accordance with Humboldt LID Stormwater Manual - Part C.**

****Infiltration Trench/Basin calculations are based on porosity (35%). Increased trench dimensions (volume) are required to meet 55 gallon minimum capacity.**

Green	Fill In [Enter Value]	Conversions Used:
Red	Calculated Value	1 inch = 0.083 feet
Black	Fixed Value/Selectable Value	1 cubic foot = 7.48 gallons

Regulated Projects Worksheet 2, Version 2.0 - June 29, 2016

\# check with agency with project area jurisdiction for requirements

Preliminary Peak Flow Evaluation 5

Rec'd ComDev 06-07-19

Preliminary Peak Flow Evaluation: Rational Method

Project: Arcata Open Door | By: JOB | Date: 5/16/2019
Location: Arcata CA | Checked: PEG | Date: 5/17/2019

Pre-Development Condition			
Western Drainage Area		**Eastern Drainage Area**	
C = 0.2+0.12+0.07+0.06 Per Caltrans HDM Chapter 810	0.45	C = 0.14+0.12+0.12+0.1 Per Caltrans HDM Chapter 810	0.48
I for 2-yr storm (in/hr): Tc min = 5 min	1.98	I for 2-yr storm (in/hr): Tc min = 5 min	1.98
A (acre):	1.105	A (acre):	0.647
Q (cfs):	**0.98**	Q (cfs):	**0.61**

Post-Development Condition			
Western Drainage Area		**Eastern Drainage Area**	
C = [(0.95)(49,164)+(0.2)(16,707)/65,871	0.76	C = [(0.95)(6,178)+(0.2)(4,283)/10,461	0.64
I for 2-yr storm (in/hr): Tc min = 5 min	1.98	I for 2-yr storm (in/hr): Tc min = 5 min	1.98
A (acre):	1.512	A (acre):	0.24
Q (cfs):	**2.27**	Q (cfs):	0.31

Post-Development Runoff > Pre-Development Runoff => Detention is required in Western Drainage Area	**Post-Development Runoff < Pre-Development Runoff => Detention is not required in Eastern Drainage Area**

Rec'd ComDev 06-07-19

Description of "Skupe" Method

6

Rec'd ComDev 06-07-19

by **Al Pagan, P.E., L.S.**

Detention basin sizing — quick & dirty

Many civil engineers who design and/or review detention basins have their own quick and dirty method for coming up with a fast answer — a curbstone opinion — when asked the question: "Approximately how large a detention basin will be needed to achieve zero increase in the flow rate leaving a site, after development, for a 100-year storm?"

In my own practice I know of about half a dozen "methodologies" which answer the question, some of which I devised myself. But recently I ran across a method that an engineer friend of mine uses which, based on my own review of it, works very well.

My colleague, Joe Skupien, P.E., practices primarily in New Jersey and uses the methodology outlined below. "Skupe" (as many of us in the state know him) apparently developed this method on his own, but it is certainly possible that other engineers in a parallel universe may be using a similar approach to getting a fast answer to an often asked question.

Skupe cautioned me that this is definitely an approximate method. For more accurate results and a detailed design, an inflow hydrograph should be developed and the storage indication (or other) routing procedure utilized. However, it has been my experience that Skupe's procedure works very well and I recommend it (used with caution) to anyone who needs a fast, approximate answer.

Probably the simplest solution to the quick and dirty detention basin problem is to provide a site-specific depth of runoff, spread throughout the area to be paved, or otherwise made impervious. In New Jersey, which is a relatively humid state, through experience and countless detailed detention basin designs, I have found that two inches of depth over the total proposed newly-paved area is almost always sufficient to assure zero increase in the runoff rate leaving a site (for the 100-year storm). Here is how it works:

Assume you have a 10-acre site and that 100,000 square feet, or slightly more than two acres, of it will be newly-paved after you construct a small subdivision on it. A two-inch depth (one-sixth of a foot) over 100,000 square feet equals a volume of 16,667 cubic feet.

My experience in New Jersey (it must be emphasized that the two-inch value is geographically specific) confirms that providing 16,667 cubic feet of storage will prove to be adequate to assure zero increase in runoff.

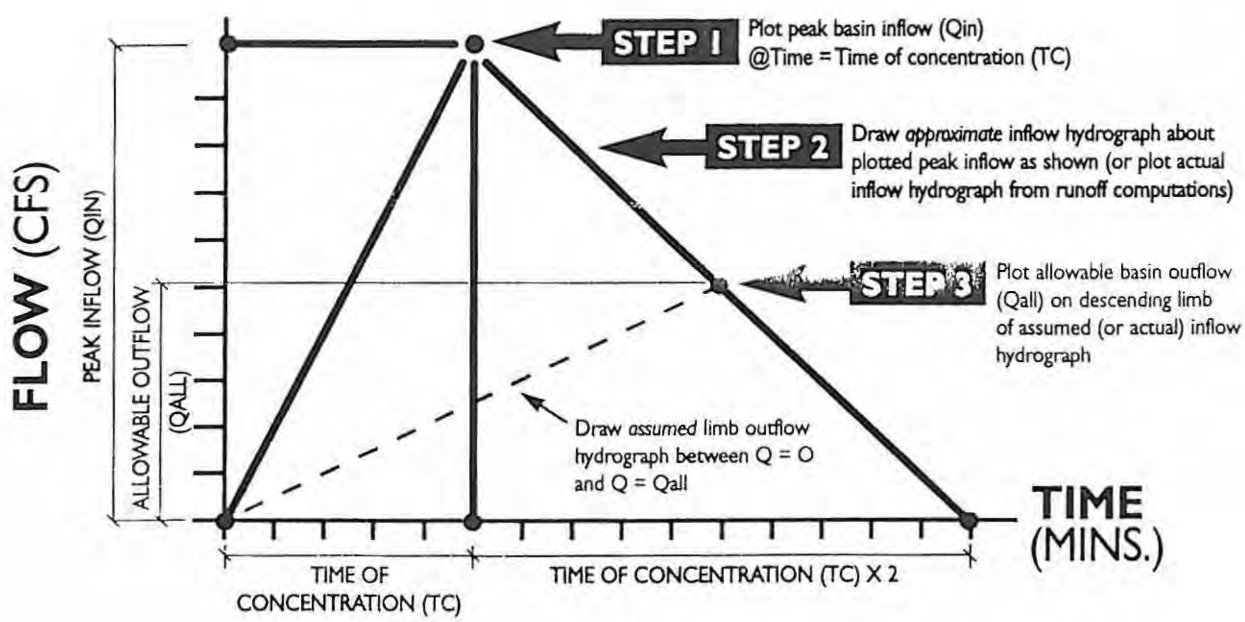
However, one should be cautioned that in some places (heavy rainfall areas such as the southeastern United States come to mind), it is likely that a depth greater than two inches would be needed.

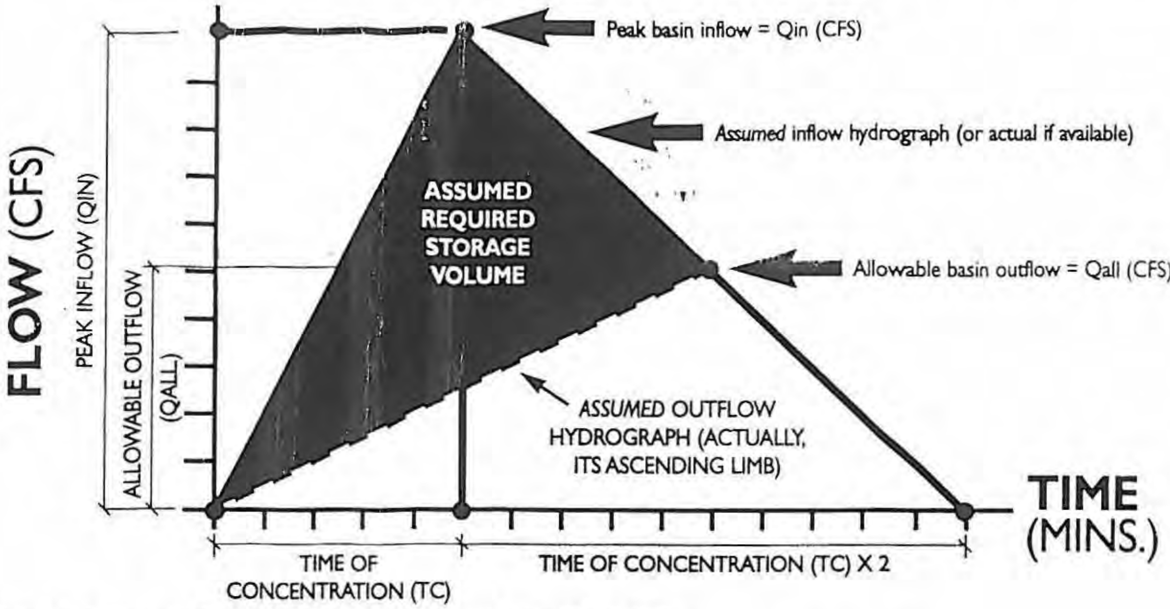
Similarly, in semi-arid climates, such as the southwest, almost certainly less than two inches of depth would be required.

I intend to write a follow-up on this subject, so if anyone has his, or her, own way of solving the quick-answer problem relating to detention basins (or any other engineering subject) please let me know. ■

***Al Pagan** is a consulting engineer in Westwood, N.J. He can be reached at (201) 666-8767. E-mail* **pagan@cenews.com.**

Estimating Required Detention Basin Storage Volume





From theory and geometry: Required storage volume = Difference in area of two triangles
From theory and experience: Approximate required storage volume = (Qin-Qall)(3)(TC)(0.5)(60sec/min)(K)
Where: Qin = Peak basin inflow (in CFS)
Qall = Allowable peak outflow (in CFS)
TC = Time of concentration (in mins.)
K = Factor to account for nonlinearity of actual hydrographs; Normal range = 1.2 to 1.5 w/o stormwater quality, 1.5 to 2.0 w/stormwater quality
Note: Do not use for SCS methodology flows where Qall < 0.2 Qin

Rec'd ComDev 06-07-19

Preliminary Detention Pond Sizing

7

Rec'd ComDev 06-07-19

Job Number:	018011	Calculated By:	JOB
Job Name:	ODCHC - Arcata	Date:	5/16/2019
		Checked By:	PEG
		Date:	5/17/2019

Preliminary Detention Pond Sizing

"Skupe" Method:
Estimates approximate required detention storage volume:

Formula:

$$V = (Q_{in} - Q_{all})(3)(TC)(0.5)\left(60\ \frac{sec}{min}\right)(K)$$

Where:

V =	Approximate required storage volume (ft^3)		
Q_{in} =	Peak Basin Inflow (cfs) =	**2.28**	cfs for post developed 2-year
Q_{all} =	Allowable Peak Outflow (cfs) =	**0.98**	cfs for pre developed 2-year
TC =	Time of concentration (mins) =	**5**	mins for post developed 2-year
K =	1.2 to 1.5 without stormwater quality		

Solution:

For K = 1.2

V= (4.93 - 2.65)(3)(33)(0.5)(60)(1.2)= 702 ft^3

For K = 1.5

V= (4.93 - 2.65)(3)(33)(0.5)(60)(1.5)= 877.5 ft^3

V = approximately 8,000 ft^3 to 10,000 ft^3