DCI ENGINEERS

memorandum

DATE:	March 6, 2017	JOB #:	16012-0017
TO:	City of Mt. Vernon – Engineering		
CC:	Darren Simpson, P.E.		
FROM:	DCI Engineers – Jarrett Grant, E.I.T.		
SUBJECT:	Storm Drainage Technical Information Report – 2400 Riverside Drive		

1. Project Overview

This project narrative describes the preliminary stormwater design considerations for the proposed project located at 2400 Riverside Drive Mt. Vernon, Washington. The proposed project is bound by Riverside Drive to the west, Pacific Place to the south, Pacific Place Senior Mobile Park to the East, and Hoag Road and the Skagit River to the north. The site area is 141,188 sq-ft (3.24 acres). The site is currently occupied by the 16,018 sq-ft retired Riverside Auto Plaza building, an existing 1,200 sq-ft tool shed and a large asphalt parking lot with minimal landscaping scattered throughout the site.

The topography of the site is flat to moderate and generally slopes from east to west and south to north. There is approximately two feet of fall as you traverse the site south to north. There is an existing retaining wall along the western property line that holds the grades along riverside drive above the site.

The project proposes to demolish the existing auto sales building and construct a new single story 15,000 square foot Harbor Freight Tools Hardware store. The project will also include the removal of a portion of the existing asphalt pavement and construction of a new parking lot and landscaping. The proposed improvements will occupy approximately 63% of the site. The remainder of the site will be segregated from the proposed development using a 6” extruded curb.

This Storm Drainage Technical Information Report was created in accordance with the 2012 Washington State Department of Ecology Stormwater Management Manual for Western Washington. This stormwater report provides stormwater requirements and design calculations for the project site.

2. Existing Conditions Summary

Currently stormwater is not managed on-site for water quality treatment or flow control. Rain water that lands in the parking lot or on the existing building sheet flows into its appropriate catch basin or roof drain and flows through the existing storm drainage west in Hoag/Stewart Road to the Stewart Road Pump Station located midway between

Riverside Drive and Market Street. Stormwater is then pumped to the northeast and discharges into the Mount Vernon Regional Detention Pond.

The parcel has approximately 89.6% impervious cover, with the remainder in landscape. Pollution generating surfaces account for 84.3% of the impervious cover, and 75.6% of the total site.

The existing land cover for the site is as follows (see basin map in Appendix B):

	Impervious (Non Polluting)	Impervious (Pollutant Generating)	Pervious	Total Site Area
Existing Conditions	19,803 SF (0.45 AC)	106,731 SF (2.45 AC)	14,654 SF (0.34 AC)	141,188 SF (3.24 AC)

The September 8, 2016 Geotechnical Engineering Report by Professional Service Industries, Inc. classifies the underlying soils as alluvial deposits consisting of very loose to medium dense sands and very soft to stiff silts within the upper 50 to 60 feet with dense sands underlying them.

There are no known wetlands on-site, but the site is in close proximity to the Skagit River. The site is approximately 400-feet south of the Skagit River.

3. Offsite Analysis

DCI staff has observed the conveyance infrastructure downstream of the site. There were no observed restrictions or problems with the downstream drain system within one quarter mile of the site. From the site stormwater is routed through 12” pipes north to the intersection of Hoag Road and Riverside Drive to intersect the 24” public main. The public main then flows west approximately 200-feet to the Stewart Street Pump Station. Stormwater is then pumped to the northeast and outfalls into the Mount Vernon Regional Detention Pond, which is located approximately 320-feet northwest of the site.

4. Permanent Stormwater Control Plan

The proposed building will be a single story Harbor Freight Tools hardware store and 67 at-grade parking spaces with access from Hoag Road and Pacific Place. The northwestern portion of the site (1.23 acres) will not be redeveloped with the proposed project. Because of this, runoff from this portion of the site will be segregated from the proposed development and will continue to drain through the existing storm drainage system on-site.

The proposed land cover for the developed conditions is as follows (see basin map in Appendix B):

	Impervious (Non-Polluting)	Impervious (Pollutant Generating)	Pervious	Total Site Area
Developed	70,786 SF	49,022 SF	21,380 SF	141,188 SF

Conditions	(1.63 AC)	(1.13 AC)	(0.48 AC)	(3.24 AC)

Flow Control

As noted in Section 2 of this report, the site is located within the Mount Vernon Regional Detention Facilities Basin. Stormwater quantity control is provided by the City of Mount Vernon. Therefore, flow control is not required.

Water Quality

Runoff treatment is required when there is 5,000 sq-ft or more of pollution generating impervious surface (PGIS). The proposed project has a total effective pollution-generating impervious surface (PGIS) that is greater than 5,000 sq-ft on-site, therefore, water quality treatment is required. According to appendix V-A the Skagit river is designated as a basic treatment receiving water.

Runoff treatment will be provided via Modular Wetlands. Storm details and additional information regarding tributary areas used for sizing is included in Appendix C.

Table 1: Water Quality Facility Summary

Tributary Area	**WQ Flowrate (On-Line)**	**WQ Flowrate (Off-Line)**	**WQ Facility Size**
2.04 Ac	0.25 cfs	0.14 cfs	8’ x 8’

Conveyance System Analysis and Design

The stormwater site plan utilizes a modular wetlands runoff treatment facility, storm drains, manholes, and catch basins to manage surface water runoff and discharge the collected surface water runoff to the City’s storm drainage system

Conveyance calculations have not been performed at this time and are not provided with this report.

5. Construction Stormwater Pollution Prevention Plan

The Fill & Grade permit plan set will include a detailed Temporary Erosion & Sedimentation Control Plan in accordance with city standards. A CSWPP narrative will be provided separately and will be maintained on site with the plan set during construction.

6. Special Reports and Studies

A copy of the geotechnical report provided by PSI dated September 8, 2016 is included in the appendix G.

7. Other Permits

No special permits are required for the proposed improvements.

8. Operations and Maintenance Manual

To be provided at a later date.

Appendices

Appendix A: Site Maps
Vicinity Map
NRCS Soils Data

Appendix B: Storm Requirements and Basin Areas
Figure 2.2 – Flow Chart for Determining Requirements for New Development
Figure 2.3 – Flow Chart for Determining Requirements for Redevelopment
Appendix V-A – Basic Treatment Receiving Waters
Map 1 – Existing Conditions Area Summary
Map 2 – Developed Conditions Area Summary

Appendix C: Water Quality Sizing and Calculations
Map 3 – Water Quality Tributary Area
Water Quality WWHM2012 Calculations
Modular Wetlands Details and Sizing Letter

Appendix D: Downstream Drainage System
Downstream System – City Map

Appendix E: Site Discharge and Conveyance Calculations
Conveyance Calculations*

Appendix F: Stormwater Site Plans
Stormwater Site Plans

Appendix G: Geotechnical Engineering Report
Geotechnical Report (Professional Service Industries, Inc. Dated September 9, 2016) – Under Separate Cover

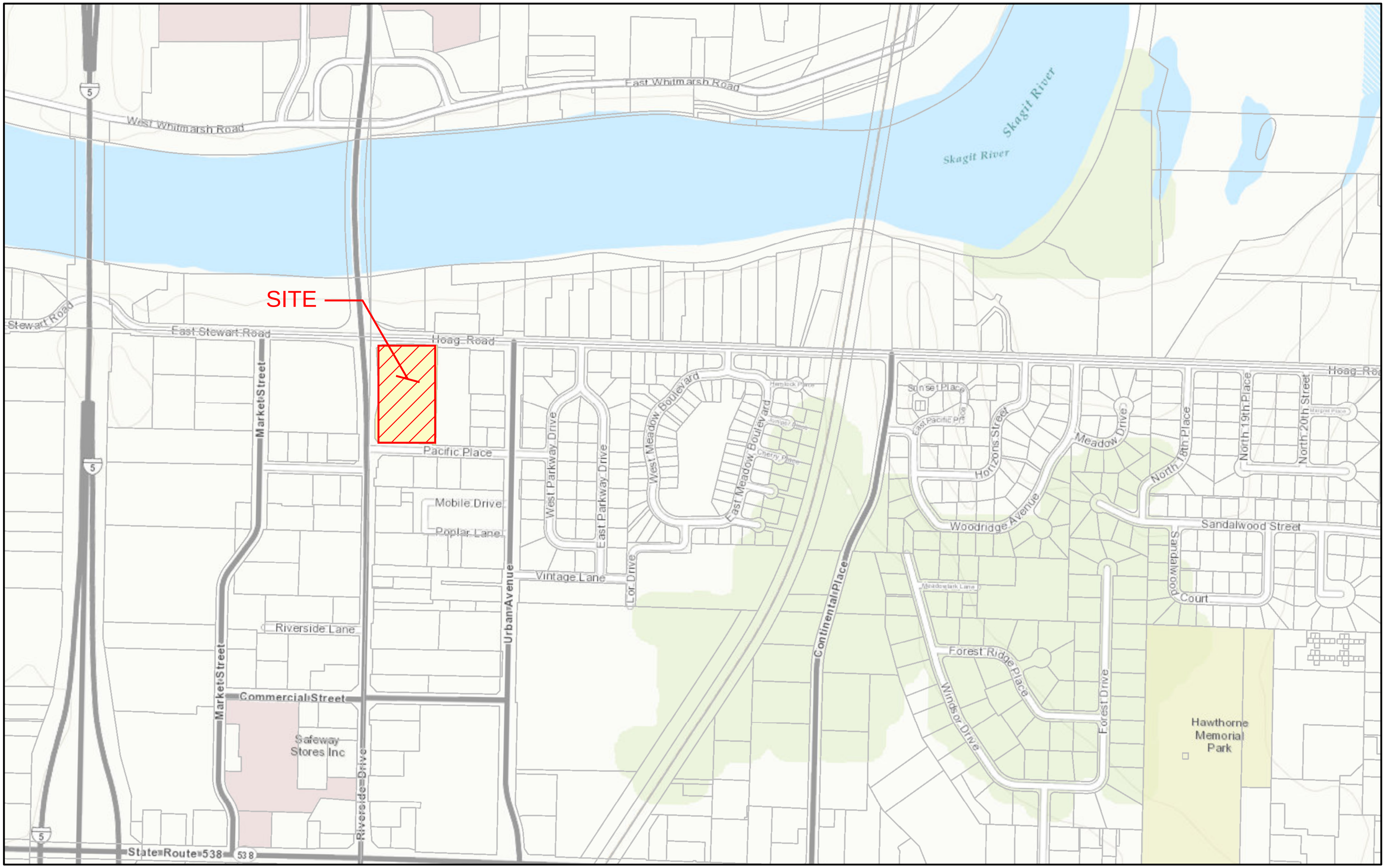
Appendix H: Operations and Maintenance Manual
Draft Operations and Maintenance Manual*

*To Be provided at a later date

Appendix A: Site Maps

Vicinity Map
NRCS Soils Map

2400 Riverside Dr. Harbor Freight Tools - Vicinity Map



October 7, 2016

1" = 700'

0 375 750 1,500 Ft

0 0.1 0.2 0.4 km

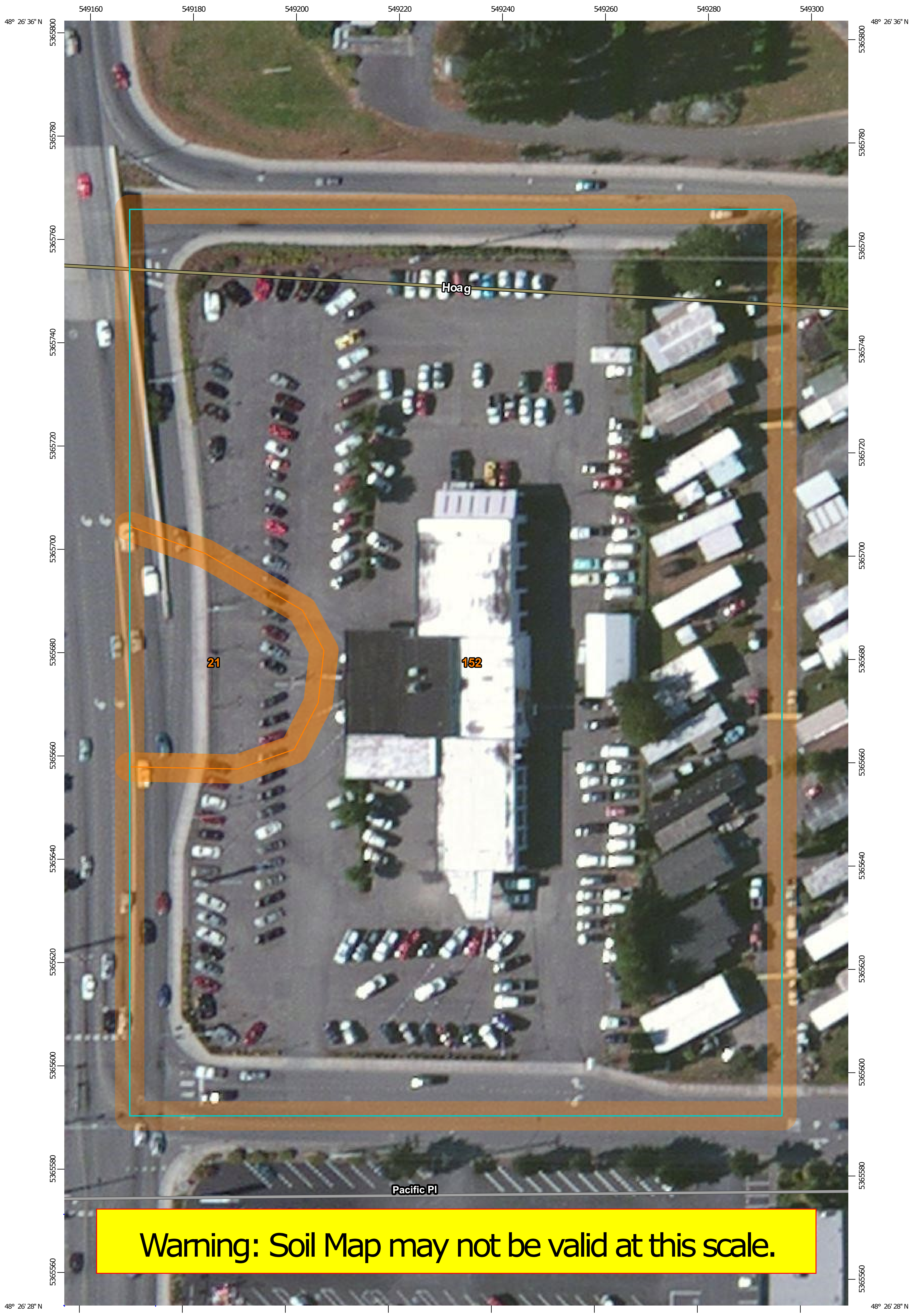
Legend

- County Boundary
- Tax Parcels
- Pre Tax Account Property

Data Accuracy Warning: All GIS data was created from available public records and existing map sources. Map features have been adjusted to achieve a best-fit registration. While great care was taken in this process, maps from different sources rarely agree as to the precise location of geographic features. Map discrepancies can be as great as 300 feet.

JCG

Soil Map—Skagit County Area, Washington
(Harbor Freight Tools - 2400 Riverside Dr.)



Map Scale: 1:696 if printed on B portrait (11" x 17") sheet.

N

Meters: 0, 10, 20, 40, 60

Feet: 0, 30, 60, 120, 180

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Skagit County Area, Washington
Survey Area Data: Version 12, Sep 15, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 9, 2010—Aug 28, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Skagit County Area, Washington (WA657)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
21	Briscot fine sandy loam	0.3	6.1%
152	Urban land-Mt. Vernon-Field complex	5.2	93.9%
Totals for Area of Interest		**5.5**	**100.0%**

Appendix B: Storm Requirements and Basin Areas

Figure 2.2 – Flow Chart for Determining Requirements for New Development
Figure 2.3 – Flow Chart for Determining Requirements for Redevelopment
Appendix V-A – Basic Treatment Receiving Waters
Map 1 – Existing Conditions Area Summary
Map 2 – Developed Conditions Area Summary

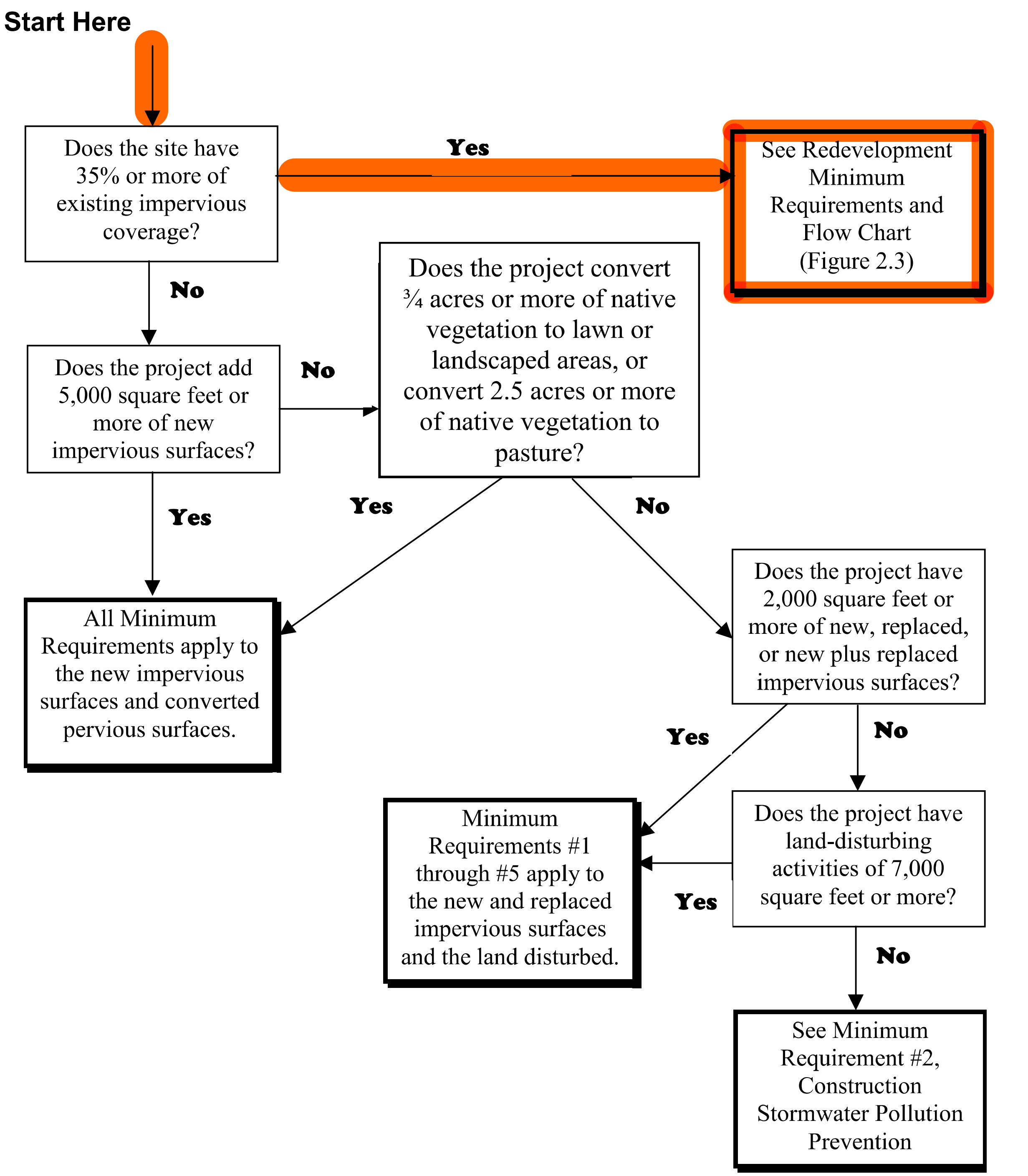


Figure 2.2 – Flow Chart for Determining Requirements for New Development

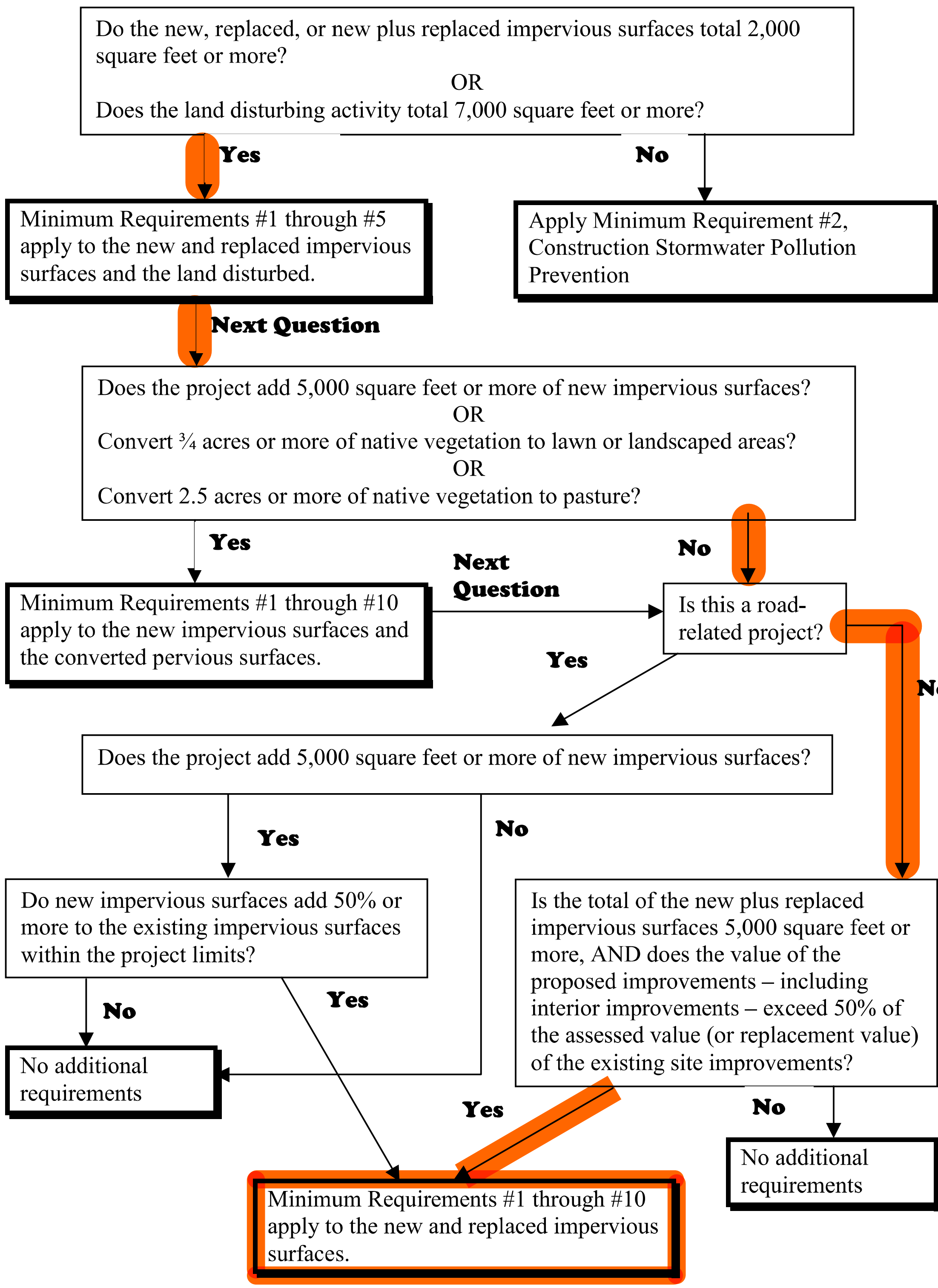


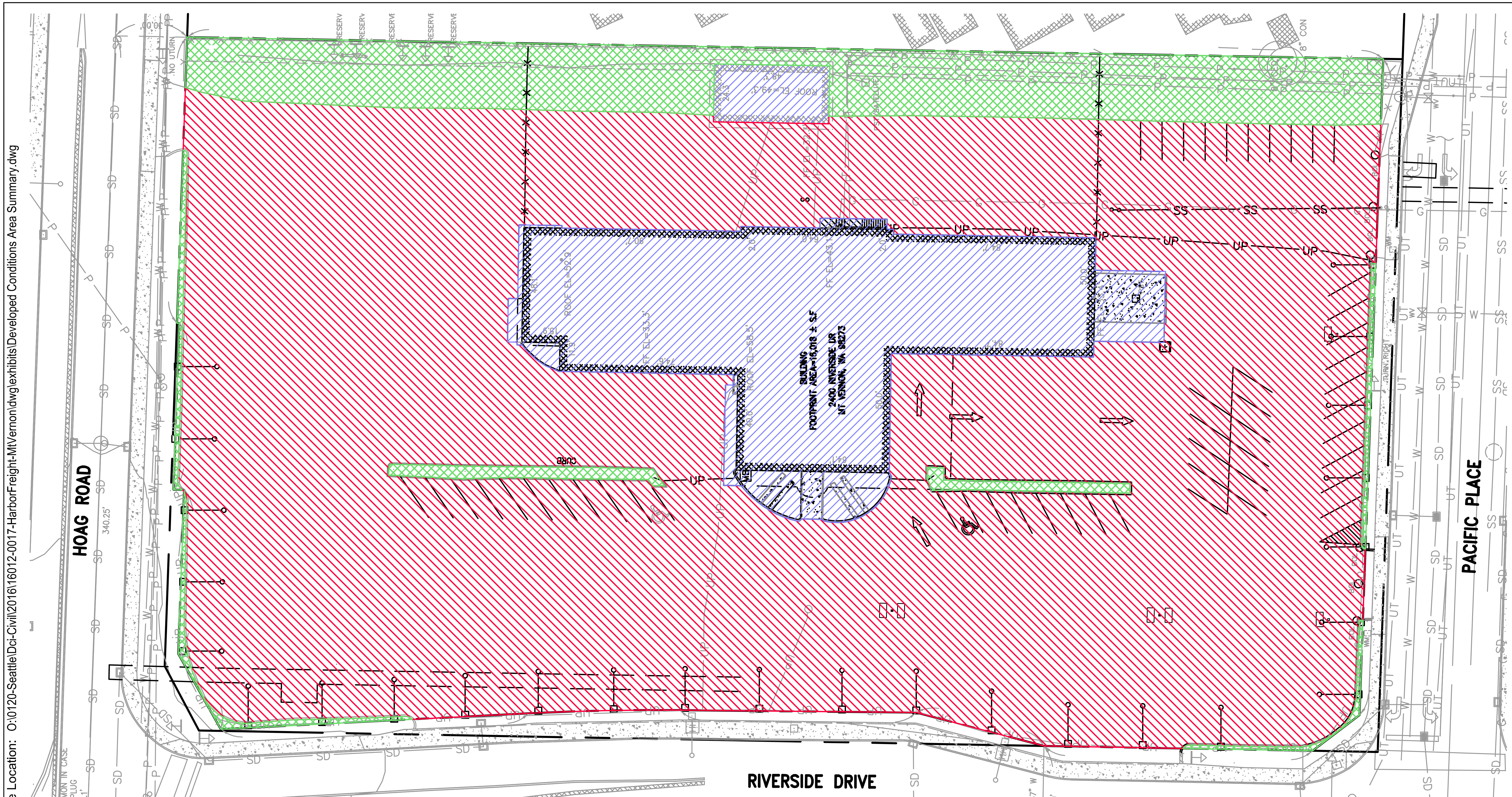
Figure 2.3 – Flow Chart for Determining Requirements for Redevelopment

Appendix V-A
Basic Treatment Receiving Waters

1. All salt waterbodies

2.

Rivers	Upstream Point for Exemption
Baker	Anderson Creek
Bogachiel	Bear Creek
Cascade	Marblemount
Chehalis	Bunker Creek
Clearwater	Town of Clearwater
Columbia	Canadian Border
Cowlitz	Skate Creek
Elwha	Lake Mills
Green	Howard Hanson Dam
Hoh	South Fork Hoh River
Humptulips	West and East Fork Confluence
Kalama	Italian Creek
Lewis	Swift Reservoir
Muddy	Clear Creek
Nisqually	Alder Lake
Nooksack	Glacier Creek
South Fork Nooksack	Hutchinson Creek
North River	Raymond
Puyallup	Carbon River
Queets	Clearwater River
Quillayute	Bogachiel River
Quinault	Lake Quinault
Sauk	Clear Creek
Satsop	Middle and East Fork Confluence
Skagit	Cascade River
Skokomish	Vance Creek
Skykomish	Beckler River
Snohomish	Snoqualmie River
Snoqualmie	Middle and North Fork Confluence
Sol Duc	Beaver Creek
Stillaguamish	North and South Fork Confluence
North Fork Stillaguamish	Boulder River
South Fork Stillaguamish	Canyon Creek
Suiattle	Darrington
Tilton	Bear Canyon Creek
Toutle	North and South Fork Confluence
North Fork Toutle	Green River
Washougal	Washougal
White	Geenwater River
Wind	Carson



LEGEND

- PGIS (106,731 SQ. FT.)
- NPGIS (19,803 SQ. FT.)
- NPGPS (14,654 SQ. FT.)

GRAPHIC SCALE

40 0 20 40

(IN FEET)
1 inch = 40 ft.

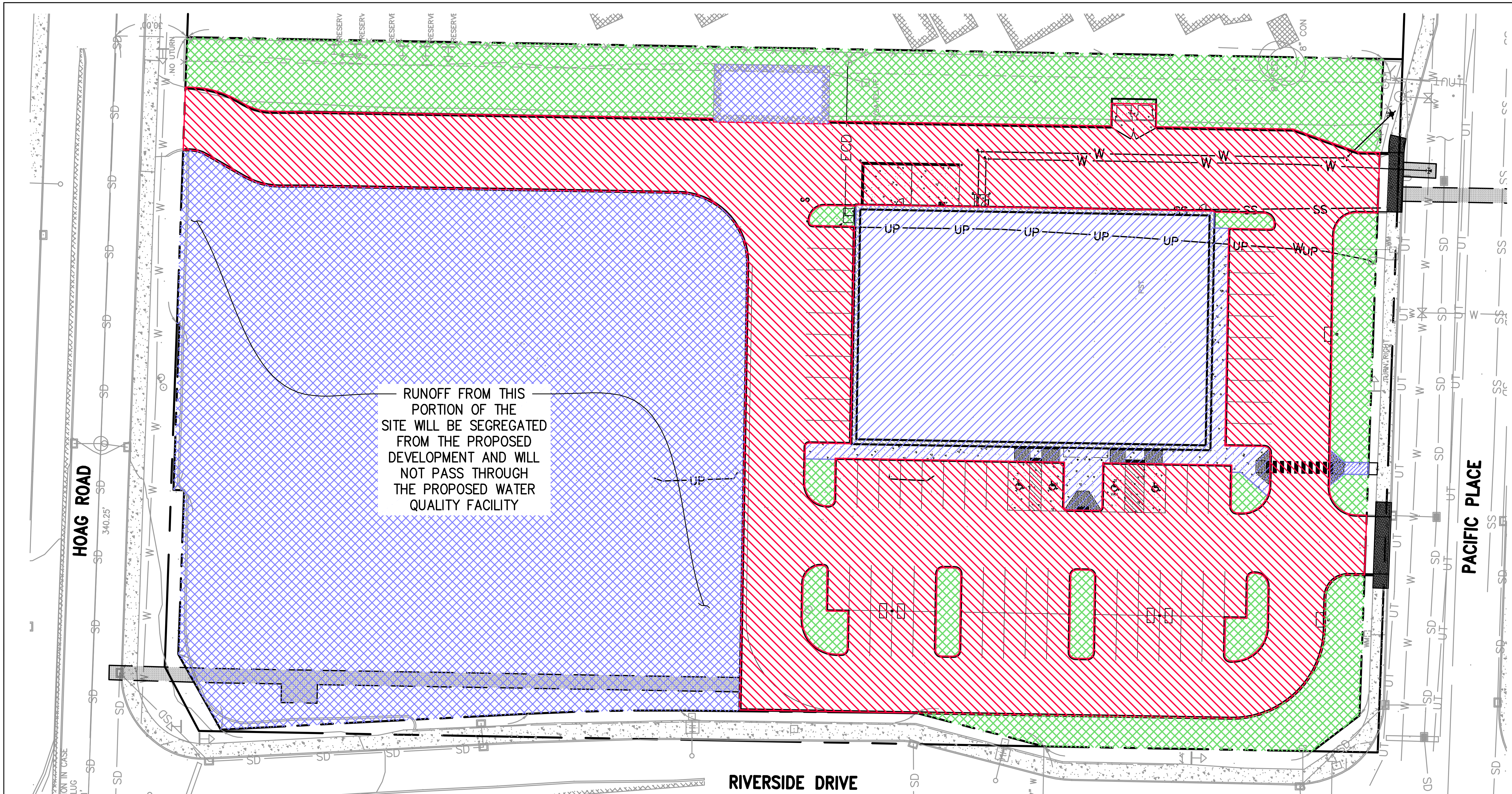
PROJECT NAME:	PROJECT NO:	BY: JCG	SHEET NO:
HARBOR FREIGHT TOOLS	16012-0017	DATE: 10/24/16	1 OF 2

818 STEWART STREET • SUITE 1000
SEATTLE, WASHINGTON 98101
PHONE: (206) 332-1900 • FAX: (206) 332-1600
WEBSITE: www.dci-engineers.com
CIVIL / STRUCTURAL
DCI ENGINEERS

TITLE:
EXISTING CONDITIONS
AREA SUMMARY
ON-SITE

Plot Date: 2017-03-06 File Location: O:\0120-Seattle\Dci-Civil\2016\16012-0017-HarborFreight-MtVernon\dwg\exhibits\Developed Conditions Area Summary.dwg

Developed Conditions Area Summary.dwg 06 Mar 2017 – 3:35 pm jgrant



LEGEND

- PGIS (49,022 SQ. FT.)
- NPGIS (17,390 SQ. FT.)
- NPGPS (21,380 SQ. FT.)
- EX NPGIS (53,396 SQ. FT.)

GRAPHIC SCALE

40 0 20 40

(IN FEET)
1 inch = 40 ft.

PROJECT NAME: HARBOR FREIGHT TOOLS	PROJECT NO: 16012-0017	BY: JCG DATE: 10/24/16	SHEET NO: 2 OF 2
818 STEWART STREET • SUITE 1000 SEATTLE, WASHINGTON 98101 PHONE: (206) 332-1900 • FAX: (206) 332-1600 WEBSITE: www.dci-engineers.com CIVIL / STRUCTURAL — DCI ENGINEERS	TITLE: DEVELOPED CONDITIONS AREA SUMMARY ON-SITE		

Developed Conditions Area Summary.dwg 06 Mar 2017 – 3:35 pm jgrant

Appendix C: Water Quality Sizing and Calculations

Map 3 – Water Quality Tributary Area
Water Quality WWHM2012 Calculations
Modular Wetlands Details and Sizing Letter

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	Water Quality Sizing
Site Name:	
Site Address:	
City:	
Report Date:	10/26/2016
Gage:	Burlington
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	1.00
Version Date:	2016/02/25
Version:	4.2.12

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year

Landuse Basin Data
Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Forest, Flat	0.22
Pervious Total	0.22
Impervious Land Use	acre
ROADS FLAT	1.82
Impervious Total	1.82
Basin Total	2.04

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Forest, Flat	0.49
Pervious Total	0.49
Impervious Land Use	acre
ROADS FLAT	1.55
Impervious Total	1.55
Basin Total	2.04

Element Flows To:

Surface	Interflow	Groundwater

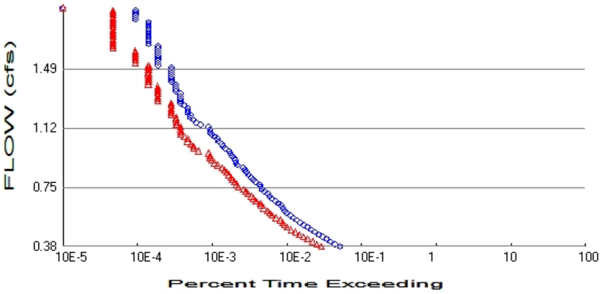
Routing Elements

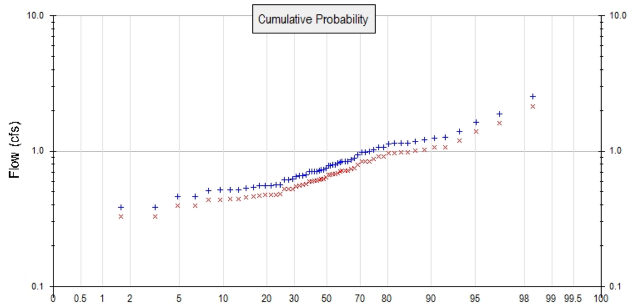
Predeveloped Routing

Mitigated Routing

Analysis Results

POC 1





\+ Predeveloped   x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 0.22
Total Impervious Area: 1.82

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.49
Total Impervious Area: 1.55

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.75757
5 year	1.065068
10 year	1.291881
25 year	1.605772
50 year	1.860038
100 year	2.132334

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.645237
5 year	0.907123
10 year	1.10029
25 year	1.367614
50 year	1.584156
100 year	1.816052

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	1.153	0.982
1950	0.567	0.483
1951	0.979	0.834
1952	1.071	0.912
1953	1.207	1.028
1954	0.558	0.475
1955	0.539	0.459
1956	0.385	0.328
1957	1.185	1.009
1958	0.513	0.437

1959	0.618	0.526
1960	0.841	0.716
1961	0.517	0.441
1962	0.881	0.751
1963	0.559	0.476
1964	0.659	0.561
1965	1.637	1.394
1966	0.672	0.572
1967	1.261	1.074
1968	0.989	0.843
1969	0.562	0.478
1970	1.253	1.067
1971	0.731	0.623
1972	0.463	0.394
1973	0.829	0.706
1974	0.612	0.522
1975	1.145	0.976
1976	1.405	1.196
1977	0.617	0.525
1978	1.141	0.972
1979	0.730	0.622
1980	0.791	0.674
1981	0.794	0.676
1982	0.748	0.637
1983	0.645	0.549
1984	0.707	0.603
1985	0.935	0.796
1986	0.515	0.439
1987	0.552	0.470
1988	1.132	0.964
1989	0.778	0.663
1990	0.708	0.603
1991	1.029	0.876
1992	0.866	0.738
1993	0.386	0.329
1994	0.534	0.455
1995	0.462	0.394
1996	0.986	0.839
1997	1.892	1.611
1998	0.780	0.664
1999	0.370	0.315
2000	1.070	0.911
2001	0.703	0.599
2002	0.521	0.443
2003	0.655	0.558
2004	2.520	2.146
2005	0.843	0.718
2006	0.809	0.689
2007	0.717	0.611
2008	0.704	0.600
2009	0.841	0.716

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	2.5203	2.1464
2	1.8918	1.6113
3	1.6371	1.3945

4	1.4047	1.1964
5	1.2611	1.0741
6	1.2527	1.0669
7	1.2066	1.0276
8	1.1846	1.0089
9	1.1534	0.9823
10	1.1450	0.9755
11	1.1407	0.9716
12	1.1318	0.9639
13	1.0714	0.9124
14	1.0699	0.9112
15	1.0290	0.8764
16	0.9893	0.8425
17	0.9857	0.8395
18	0.9793	0.8340
19	0.9347	0.7960
20	0.8814	0.7508
21	0.8660	0.7376
22	0.8426	0.7178
23	0.8411	0.7163
24	0.8410	0.7163
25	0.8292	0.7063
26	0.8094	0.6893
27	0.7940	0.6762
28	0.7914	0.6740
29	0.7797	0.6642
30	0.7783	0.6629
31	0.7482	0.6372
32	0.7311	0.6226
33	0.7304	0.6220
34	0.7170	0.6107
35	0.7081	0.6030
36	0.7074	0.6025
37	0.7041	0.5996
38	0.7030	0.5987
39	0.6718	0.5723
40	0.6586	0.5609
41	0.6552	0.5580
42	0.6446	0.5491
43	0.6175	0.5259
44	0.6165	0.5250
45	0.6124	0.5217
46	0.5667	0.4828
47	0.5616	0.4783
48	0.5588	0.4760
49	0.5576	0.4749
50	0.5522	0.4704
51	0.5385	0.4586
52	0.5342	0.4550
53	0.5207	0.4435
54	0.5174	0.4407
55	0.5152	0.4388
56	0.5126	0.4366
57	0.4629	0.3943
58	0.4621	0.3936
59	0.3861	0.3289
60	0.3847	0.3277
61	0.3703	0.3154

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.3788	1096	620	56	Pass
0.3937	949	535	56	Pass
0.4087	818	471	57	Pass
0.4237	723	403	55	Pass
0.4386	648	353	54	Pass
0.4536	571	312	54	Pass
0.4686	509	280	55	Pass
0.4835	457	244	53	Pass
0.4985	403	215	53	Pass
0.5134	356	197	55	Pass
0.5284	321	186	57	Pass
0.5434	287	175	60	Pass
0.5583	261	154	59	Pass
0.5733	234	135	57	Pass
0.5883	211	126	59	Pass
0.6032	197	117	59	Pass
0.6182	188	105	55	Pass
0.6331	177	96	54	Pass
0.6481	164	94	57	Pass
0.6631	150	82	54	Pass
0.6780	134	77	57	Pass
0.6930	125	71	56	Pass
0.7080	118	64	54	Pass
0.7229	107	60	56	Pass
0.7379	98	56	57	Pass
0.7528	94	48	51	Pass
0.7678	92	45	48	Pass
0.7828	81	42	51	Pass
0.7977	76	40	52	Pass
0.8127	71	38	53	Pass
0.8276	65	36	55	Pass
0.8426	61	33	54	Pass
0.8576	58	31	53	Pass
0.8725	55	29	52	Pass
0.8875	47	25	53	Pass
0.9025	44	23	52	Pass
0.9174	43	21	48	Pass
0.9324	42	20	47	Pass
0.9473	39	20	51	Pass
0.9623	37	19	51	Pass
0.9773	36	14	38	Pass
0.9922	32	12	37	Pass
1.0072	30	12	40	Pass
1.0222	29	11	37	Pass
1.0371	26	10	38	Pass
1.0521	25	10	40	Pass
1.0670	23	9	39	Pass
1.0820	21	8	38	Pass
1.0970	20	8	40	Pass
1.1119	20	8	40	Pass
1.1269	19	8	42	Pass
1.1419	15	7	46	Pass
1.1568	13	7	53	Pass

1.1718	12	7	58	Pass
1.1867	11	7	63	Pass
1.2017	11	6	54	Pass
1.2167	10	6	60	Pass
1.2316	10	6	60	Pass
1.2466	10	6	60	Pass
1.2616	9	6	66	Pass
1.2765	8	6	75	Pass
1.2915	8	4	50	Pass
1.3064	8	4	50	Pass
1.3214	8	4	50	Pass
1.3364	8	4	50	Pass
1.3513	7	4	57	Pass
1.3663	7	4	57	Pass
1.3812	7	4	57	Pass
1.3962	7	3	42	Pass
1.4112	6	3	50	Pass
1.4261	6	3	50	Pass
1.4411	6	3	50	Pass
1.4561	6	3	50	Pass
1.4710	6	3	50	Pass
1.4860	6	3	50	Pass
1.5009	6	3	50	Pass
1.5159	4	3	75	Pass
1.5309	4	2	50	Pass
1.5458	4	2	50	Pass
1.5608	4	2	50	Pass
1.5758	4	2	50	Pass
1.5907	4	2	50	Pass
1.6057	4	2	50	Pass
1.6206	4	1	25	Pass
1.6356	4	1	25	Pass
1.6506	3	1	33	Pass
1.6655	3	1	33	Pass
1.6805	3	1	33	Pass
1.6955	3	1	33	Pass
1.7104	3	1	33	Pass
1.7254	3	1	33	Pass
1.7403	3	1	33	Pass
1.7553	3	1	33	Pass
1.7703	3	1	33	Pass
1.7852	3	1	33	Pass
1.8002	2	1	50	Pass
1.8152	2	1	50	Pass
1.8301	2	1	50	Pass
1.8451	2	1	50	Pass
1.8600	2	1	50	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.1665 acre-feet
On-line facility target flow:	0.2499 cfs.
Adjusted for 15 min:	0.2499 cfs.
Off-line facility target flow:	0.1418 cfs.
Adjusted for 15 min:	0.1418 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

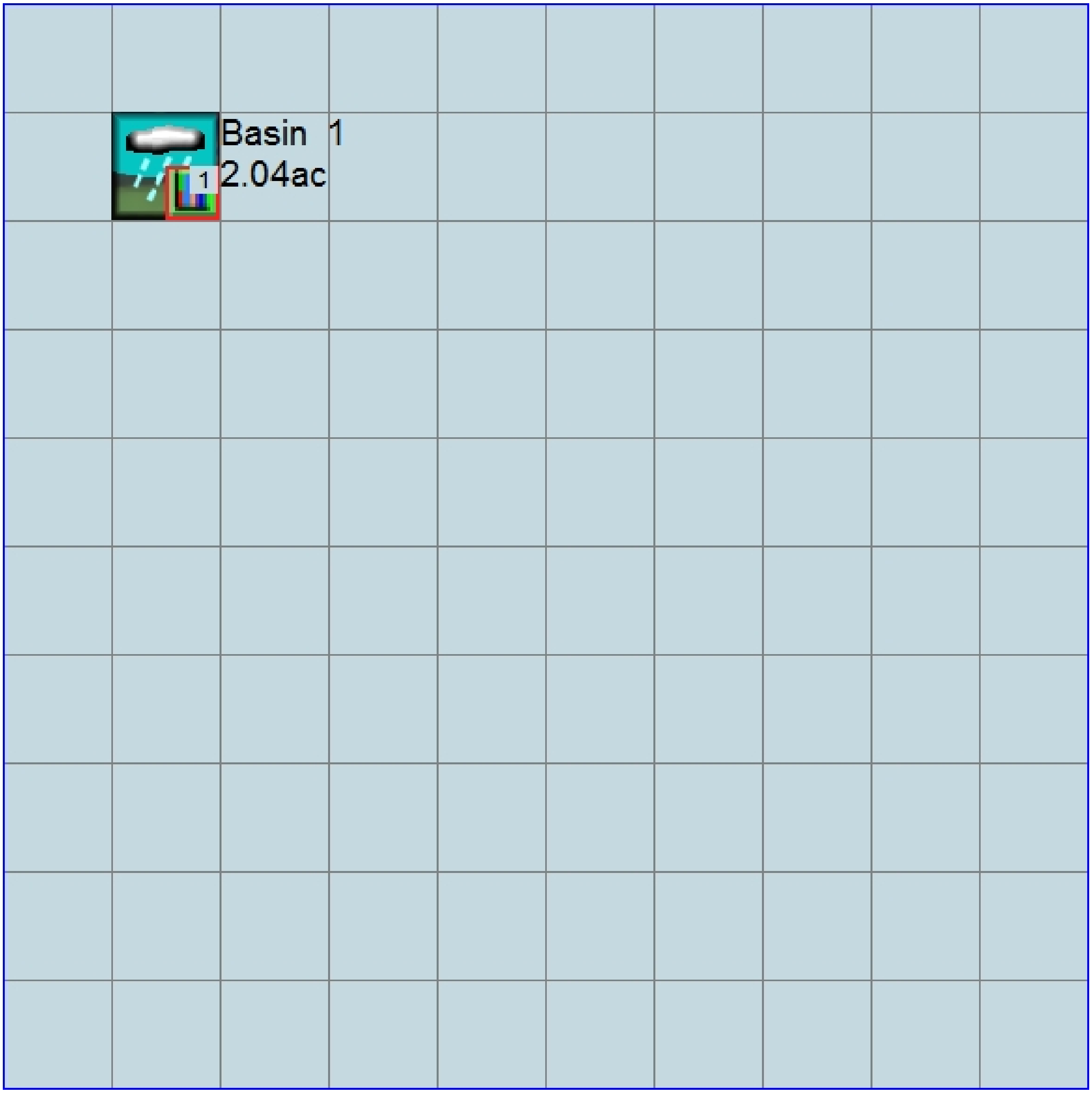
No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic

Mitigated Schematic



Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2009 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM        26   Water Quality Sizing.wdm
MESSU      25   PreWater Quality Sizing.MES
           27   PreWater Quality Sizing.L61
           28   PreWater Quality Sizing.L62
           30   POCWater Quality Sizing1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND       1
      IMPLND       1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin 1                     MAX                   1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                            User  t-series Engl Metr ***
                                            in  out           ***
    1     A/B, Forest, Flat       1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
    1         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
    1         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO
```

```
  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
    1         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
    1              0         5         2       400      0.05       0.3     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
    1              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                    ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
    1            0.2       0.5      0.35         0       0.7       0.7
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
    1              0         0         0         0         3         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                    User  t-series Engl Metr ***
                                     in  out           ***
    1     ROADS/FLAT           1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    ***
    1         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    1         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI    ***
    1         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    1            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    1              0         0
```

```
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    1             0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin 1***
PERLND   1                        0.22     COPY   501     12
PERLND   1                        0.22     COPY   501     13
IMPLND   1                        1.82     COPY   501     15

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                            in  out                          ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***    VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
```

```
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2009 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM        26   Water Quality Sizing.wdm
MESSU      25   MitWater Quality Sizing.MES
           27   MitWater Quality Sizing.L61
           28   MitWater Quality Sizing.L62
           30   POCWater Quality Sizing1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND       1
      IMPLND       1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  1                    MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
    1     A/B, Forest, Flat       1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
    1         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
    1         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO
```

```
  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
    1         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
    1              0         5         2       400      0.05       0.3     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
    1              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                 ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
    1            0.2       0.5      0.35         0       0.7       0.7
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
    1              0         0         0         0         3         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name-------> Unit-systems   Printer ***
    # -  #                    User  t-series Engl Metr ***
                                     in  out           ***
    1      ROADS/FLAT             1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    1         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    1         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    1         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    1            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    1              0         0
```

```
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    1             0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND   1                        0.49     COPY   501     12
PERLND   1                        0.49     COPY   501     13
IMPLND   1                        1.55     COPY   501     15

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                          in  out                            ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
```

```
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

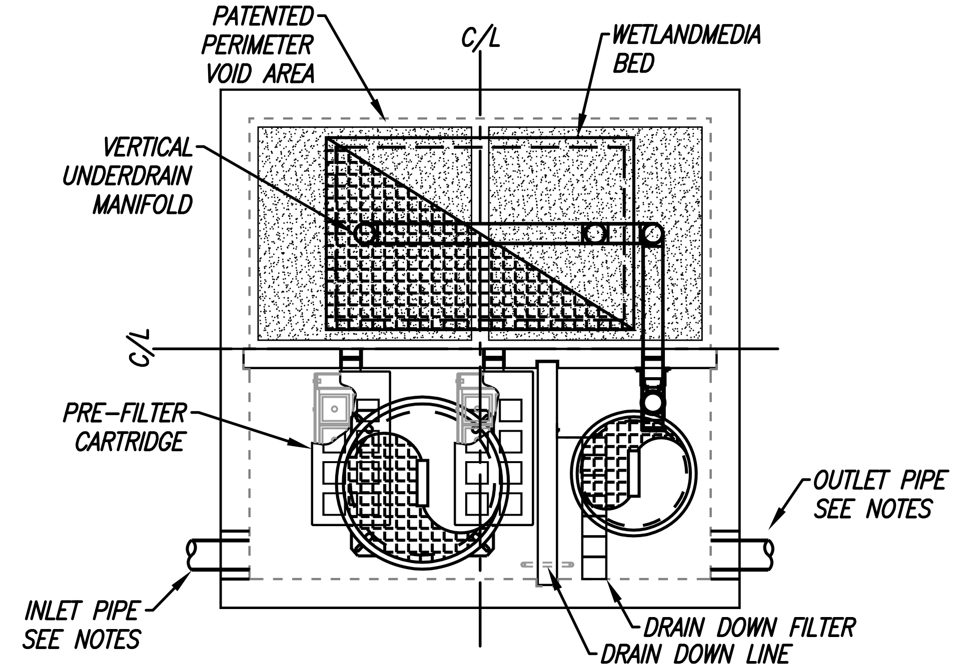
Disclaimer

Legal Notice

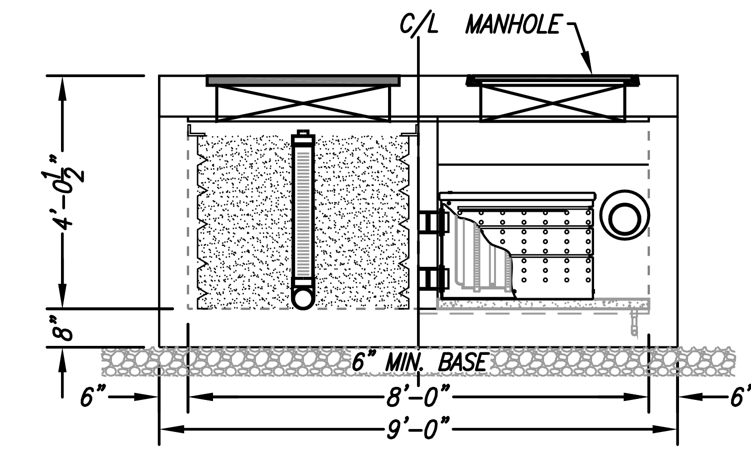
Clear Creek Solutions, Inc.
6200 Capitol Blvd. Ste F
Olympia, WA. 98501
Toll Free 1(866)943-0304
Local (360)943-0304

www.clearcreeksolutions.com

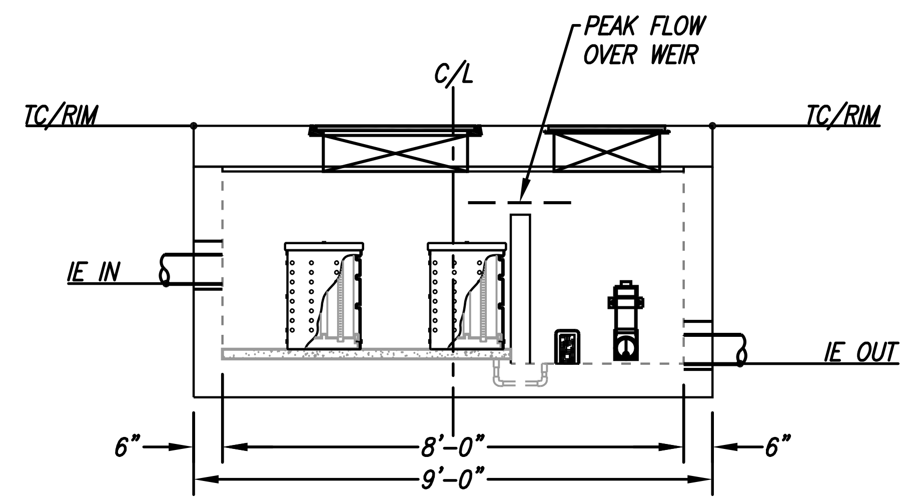
SITE SPECIFIC DATA			
PROJECT NAME		SW SUBSTATION POLE YARD	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID			
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		0.169	
TREATMENT HGL AVAILABLE (FT)			2.50
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			0.99
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	235.46	PVC	6"
INLET PIPE 2			
OUTLET PIPE	234.07	PVC	6"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	238.20		
SURFACE LOAD	H20 DIRECT	H20 DIRECT	H20 DIRECT
FRAME & COVER	ø30"	36"X60" HINGED	ø24"
WETLANDMEDIA VOLUME (CY)			TBD
WETLANDMEDIA DELIVERY METHOD			TBD
ORIFICE SIZE (DIA. INCHES)			TBD
MAXIMUM PICK WEIGHT (LBS)			TBD
NOTES:			



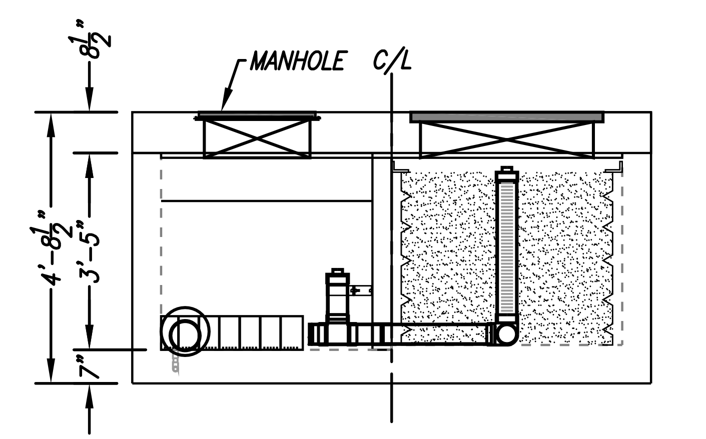
PLAN VIEW



LEFT END VIEW
BIOFILTRATION/PRETREATMENT



ELEVATION VIEW



RIGHT END VIEW
DISCHARGE/BIOFILTRATION

INSTALLATION NOTES

1. CONTRACTOR TO PROVIDE ALL LABOR, EQUIPMENT, MATERIALS AND INCIDENTALS REQUIRED TO OFFLOAD AND INSTALL THE SYSTEM AND APPURTENANCES IN ACCORDANCE WITH THIS DRAWING AND THE MANUFACTURERS SPECIFICATIONS, UNLESS OTHERWISE STATED IN MANUFACTURERS CONTRACT.
2. UNIT MUST BE INSTALLED ON LEVEL BASE. MANUFACTURER RECOMMENDS A MINIMUM 6" LEVEL ROCK BASE UNLESS SPECIFIED BY THE PROJECT ENGINEER. CONTRACTOR IS RESPONSIBLE TO VERIFY PROJECT ENGINEERS RECOMMENDED BASE SPECIFICATIONS.
3. ALL PIPES MUST BE FLUSH WITH INSIDE SURFACE OF CONCRETE. (PIPES CANNOT INTRUDE BEYOND FLUSH). INVERT OF OUTFLOW PIPE MUST BE FLUSH WITH DISCHARGE CHAMBER FLOOR. ALL GAPS AROUND PIPES SHALL BE SEALED WATER TIGHT WITH A NON-SHRINK GROUT PER MANUFACTURERS STANDARD CONNECTION DETAIL AND SHALL MEET OR EXCEED REGIONAL PIPE CONNECTION STANDARDS.
4. CONTRACTOR TO SUPPLY AND INSTALL ALL EXTERNAL CONNECTING PIPES.
5. CONTRACTOR RESPONSIBLE FOR INSTALLATION OF ALL RISERS, MANHOLES, AND HATCHES. CONTRACTOR TO GROUT ALL MANHOLES AND HATCHES TO MATCH FINISHED SURFACE UNLESS SPECIFIED OTHERWISE.
6. DRIP OR SPRAY IRRIGATION REQUIRED ON ALL UNITS WITH VEGETATION.

GENERAL NOTES

1. MANUFACTURER TO PROVIDE ALL MATERIALS UNLESS OTHERWISE NOTED.
2. ALL DIMENSIONS, ELEVATIONS, SPECIFICATIONS AND CAPACITIES ARE SUBJECT TO CHANGE. FOR PROJECT SPECIFIC DRAWINGS DETAILING EXACT DIMENSIONS, WEIGHTS AND ACCESSORIES PLEASE CONTACT MANUFACTURER.

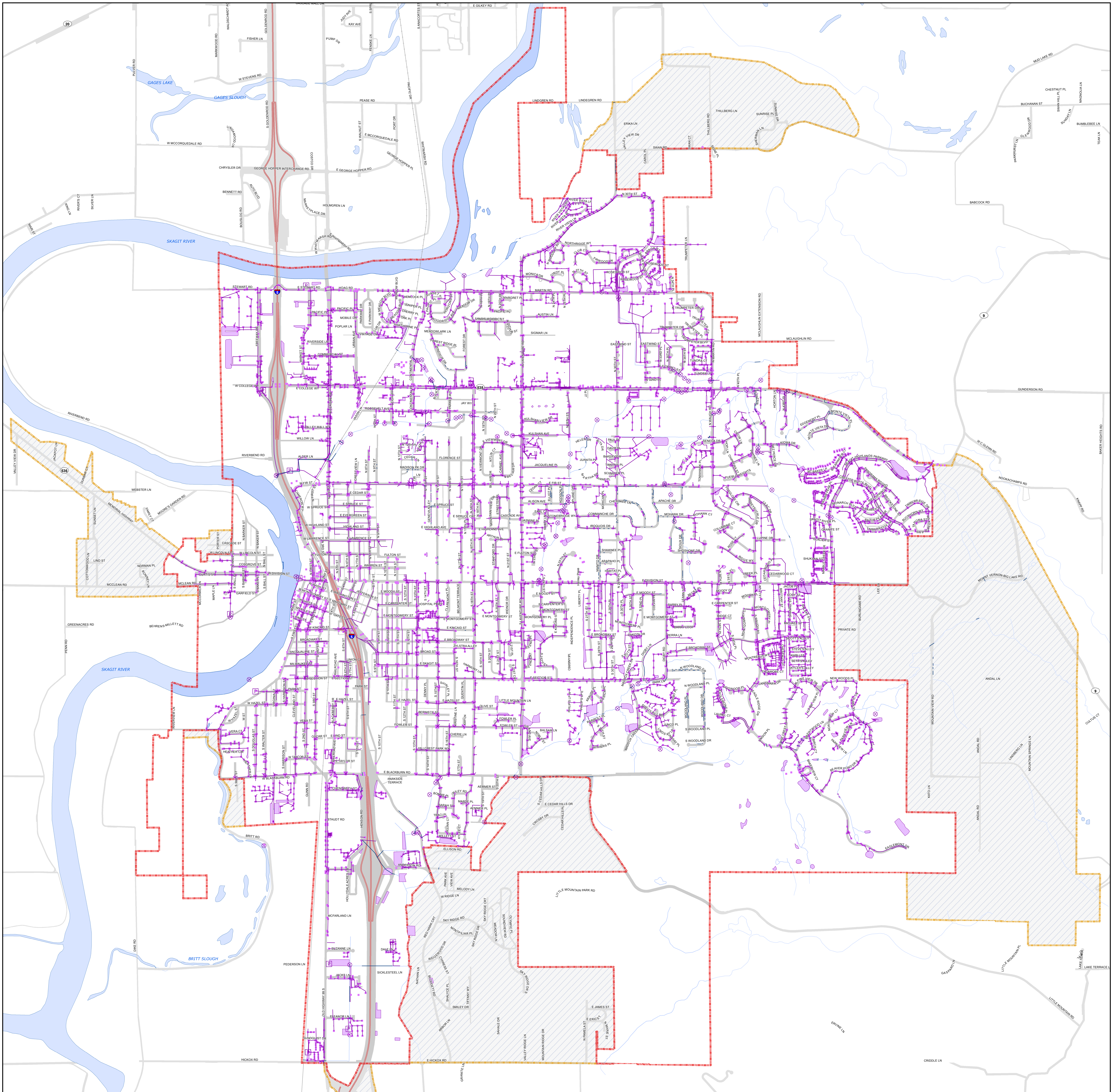
TREATMENT FLOW (CFS)	0.172
OPERATING HEAD (FT)	2.5
PRETREATMENT LOADING RATE (GPM/SF)	1.51
WETLAND MEDIA LOADING RATE (GPM/SF)	1.0

MWS-L-8-8-V-UG
STORMWATER BIOFILTRATION SYSTEM STANDARD DETAIL

6/1/15/JUSTIN

Appendix D: Downstream Drainage System

Downstream System – City Map



City of Mount Vernon Stormwater System

Map Revised: January 18, 2011

City of Mount Vernon Disclaimer: The information included on this map has been compiled by City of Mount Vernon staff from a variety of sources. The City of Mount Vernon makes no representations or warranties, expressed or implied, as to the accuracy, completeness,timeliness, or rights to the use of such information. The City of Mount Vernon shall not be liable for any general, special, indirect, incidental, or consequential damages including, but not limited to, lost revenues or lost profits resulting from the use or misuse of the information contained in this map.

City of Mount Vernon Public Works Department

- STORM LINE
- CULVERT
- Stormwater Feature
- Pump Station
- Outfall
- Detention Facility
- CITY
- UGA
- Railroad
- Right of Way
- Stream

0 0.25 0.5 1 Mile

0 0.25 0.5 1 Kilometer

N

City of Mount Vernon
910 Cleveland Avenue
Mount Vernon, WA 98273

Phone: (360)-336-6214

Appendix E: Site Discharge and Conveyance Calculations

Conveyance Calculations

Channel Report

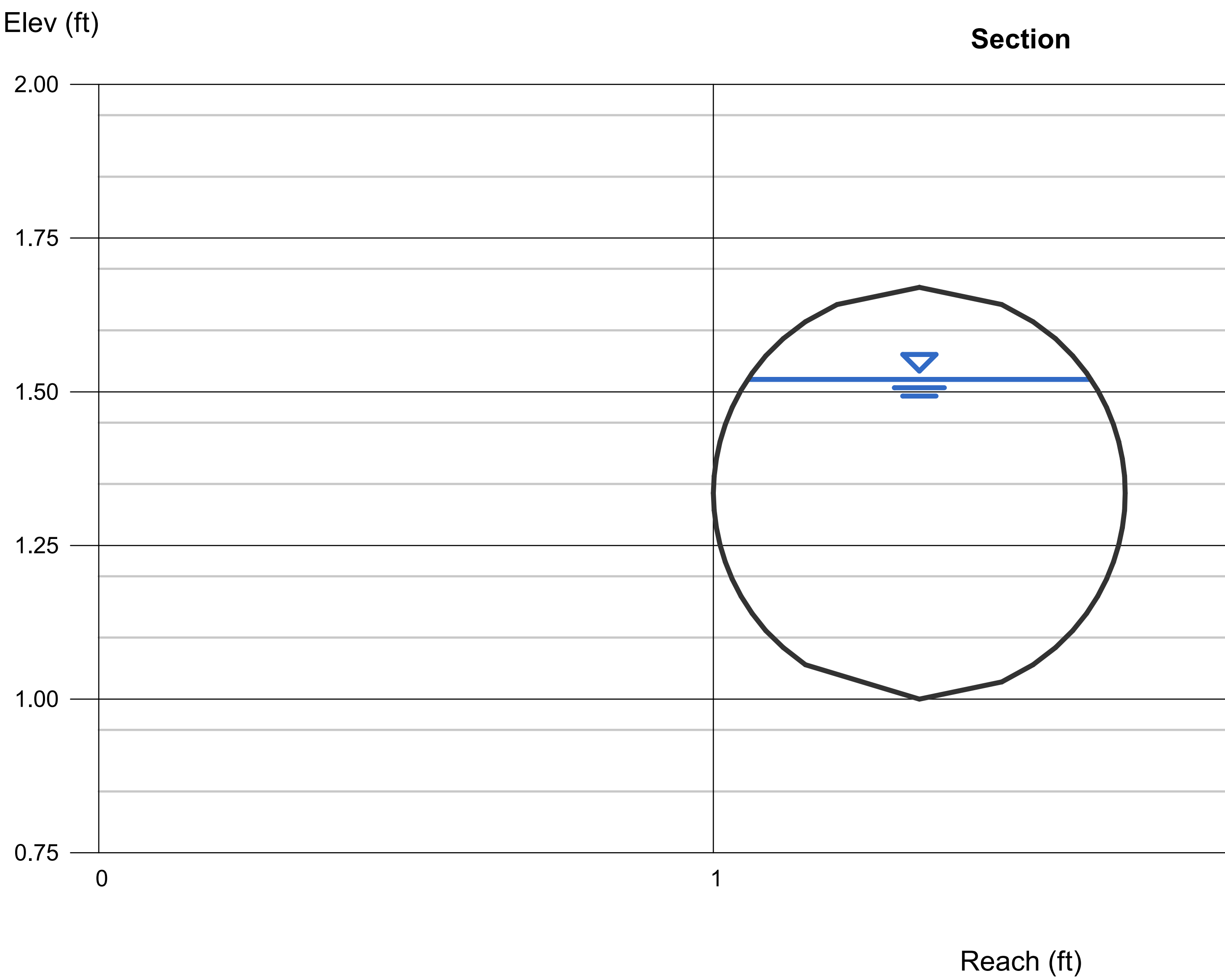
8-INCH CONVEYANCE

Circular
Diameter (ft) = 0.67

Invert Elev (ft) = 1.00
Slope (%) = 0.90
N-Value = 0.009

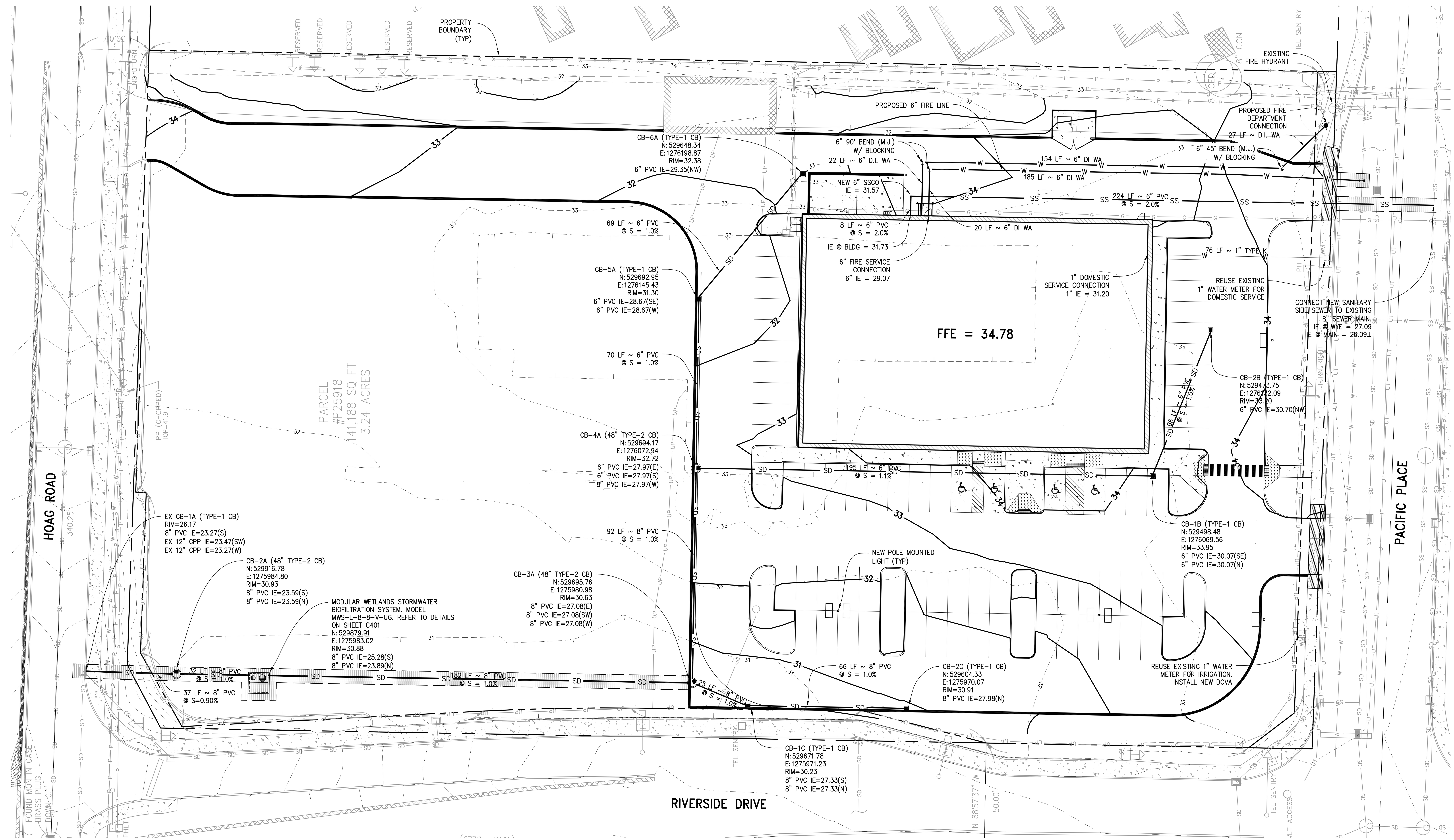
Calculations
Compute by: Known Q
Known Q (cfs) = 1.58 ← Q50

Highlighted
Depth (ft) = 0.52
Q (cfs) = 1.580
Area (sqft) = 0.29
Velocity (ft/s) = 5.37
Wetted Perim (ft) = 1.45
Crit Depth, Yc (ft) = 0.59
Top Width (ft) = 0.56
EGL (ft) = 0.97



Appendix F: Stormwater Site Plans

Stormwater Site Plans



CONTRACTOR NOTES

1. ALL EXISTING UTILITIES SHOWN ON PLANS ARE TO BE VERIFIED HORIZONTALLY AND VERTICALLY PRIOR TO ANY CONSTRUCTION. ALL EXISTING FEATURES INCLUDING BURIED UTILITIES ARE SHOWN AS INDICATED ON RECORD MAPS AND SURVEY FURNISHED BY OTHERS. WE ASSUME NO LIABILITY FOR THE ACCURACY OR COMPLETENESS OF THOSE OF EXISTING UTILITIES IN AREAS CRITICAL TO CONSTRUCTION, CONTACT THE UTILITY OWNER/ AGENCY.
2. CONTRACTOR TO SECURE SITE WITH APPROPRIATE CONSTRUCTION FENCING, PROVIDE PEDESTRIAN PROTECTION PLAN PER IBC CHAPTER 33.

GRAPHIC SCALE

20 0 10 20

(IN FEET)
1 inch = 20 ft.

CONTRACTOR NOTE

ALL EXISTING UTILITIES SHOWN ON PLANS ARE TO BE VERIFIED HORIZONTALLY AND VERTICALLY PRIOR TO ANY CONSTRUCTION. ALL EXISTING FEATURES INCLUDING BURIED UTILITIES ARE SHOWN AS INDICATED ON RECORD MAPS AND SURVEYS FURNISHED BY OTHERS. WE ASSUME NO LIABILITY FOR THE ACCURACY OF THOSE RECORDS AND SURVEYS. CONTACT THE UTILITY OWNER/AGENCY FOR THE FINAL LOCATION OF EXISTING UTILITIES IN AREAS CRITICAL TO CONSTRUCTION.

DCI ENGINEERS
818 STEWART STREET • SUITE 1000
SEATTLE, WASHINGTON 98101
PHONE: (206) 332-1900 • FAX: (206) 332-1600
WEBSITE: www.dci-engineers.com
CIVIL / STRUCTURAL

ARCHITECTS, INC.
17710 Detroit Avenue Lakewood, Ohio 44107
Phone (216) 521-5134 Fax (216) 521-4824
www.adaarchitects.cc

HARBOR FREIGHT TOOLS

2400 RIVERSIDE DRIVE

MT. VERNON, WA 98273

REVISIONS

#	DATE	TYPE
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

DATE	03/07/17
JOB NO.	16096

STORM DRAINAGE & UTILITY PLAN

SHEET NO. C-400

File Location: O:\0120-Seattle\Dci-Civil\2016\16012-0017-HarborFreight-MtVernon\dwg\16012-0017 PLN.dwg
Plot Date: 2017-03-06

Appendix G: Geotechnical Engineering Report

Geotechnical Report (Professional Service Industries, Inc. Dated September 9, 2016) – Under Separate Cover

Information To Build On
Engineering • Consulting • Testing

GEOTECHNICAL ENGINEERING REPORT

Harbor Freight
2400 Riverside Drive
Mount Vernon, WA

PSI PROJECT NO.07121398

September 8, 2016

Prepared for:

ADA Architects, Inc.
17710 Detroit Avenue
Cleveland, Ohio

Prepared by:

Professional Service Industries, Inc.
20508 - 56th Ave W, Suite A
Lynnwood, WA 98036

Information To Build On
Engineering • Consulting • Testing

September 8, 2016

ADA Architects, Inc.
17710 Detroit Avenue
Cleveland, Ohio

Attention: Brian Quinn
Phone: (216) 521-5134 x112
Email: BQuinn@adaarchitects.cc

Subject: **Geotechnical Investigation**
Harbor Freight
2400 Riverside Drive
Mount Vernon, WA
PSI Report No. 07121398

Dear Mr. Quinn

Professional Service Industries, Inc. (PSI) is pleased to submit a report based on our previous geotechnical investigation for the proposed Harbor Freight to be located at 2400 Riverside Drive in Mount Vernon, Washington. This report summarizes the work accomplished and provides our geotechnical recommendations and conclusions for support of the proposed improvements.

Based on the results of our field investigation, laboratory testing and engineering analysis, the proposed site is suitable for the construction of the proposed improvements from a geotechnical standpoint, provided the recommendations of this report are followed. Recommendations regarding the geotechnical aspects of project design and construction are presented in the attached report.

PSI appreciates the opportunity to contribute our services and looks forward to working with you during design and construction of this project. Please contact the undersigned directly if you have questions pertaining to this project.

Respectfully Submitted,

PROFESSIONAL SERVICE INDUSTRIES, INC.

MICHAEL S. PLACE
STATE OF WASHINGTON
43697
REGISTERED
PROFESSIONAL ENGINEER

9-8-16

Exp 8-17-18

Sunia Malolo, E.I.T.
Staff Engineer
sunia.mololo@psiusa.com

Michael S. Place P.E.
Principal Consultant
michael.place@psiusa.com

Information To Build On
Engineering • Consulting • Testing

Table of Contents

FIGURES

LIST OF APPENDICES

1. PROJECT DESCRIPTION

PSI was informed that due to cost associated with the renovations being so high total teardown of the old building and construction of a new 15,000 square foot building is planned. PSI understands that because of the type of remodeling work being conducted a geotechnical investigation of the site is required. PSI understand that the existing building was built prior to many of the modern building codes and structural improvement will be required to bring the building up to the 2012 International Building Code standards. Based on the structural load provided to PSI, column and wall loads will be on the order of 10 kips and 2 kips per foot, respectively. We also anticipate design floor loads of about 150 psf.

2. SITE DESCRIPTION

2.1. General

The site is located at 2400 Riverside Drive in Mount Vernon, Washington. Based on readily available aerial images and observations during our site visit, the site has an existing single story building with a large parking lot surrounding the building. The site is bound by Riverside Drive to the west, Hoag Road followed by the Skagit River to the north, a trailer park to the east, and Pacific Place to the south.

2.2. Topography

Based on available topographic information the site is relatively level and is at an approximate elevation of 30 feet above the mean sea level.

2.3. Geology

Based upon a review of Washington State Department of Natural Resources Interactive Maps (Reference 1) and the results of our field investigation the site is underlain by alluvium deposits. Alluvium in this area typically consists of fine to medium grained sands and silts deposited by moving water.

2.4. Subsurface conditions

Subsurface materials and conditions were investigated with four hand augur borings, designated HAB-1, HAB-2, HAB-3 and HAB-4; 2 Cone Penetrometer Tests (CPTu) and One Seismic Cone Penetrometer Test (SCTPu), designated CPT-1 through CPT-3, on June 7, 2016. The hand auger borings were drilled to a depth of approximately 10 feet while the CPTu's were pushed to depths ranging from 58 to 71 feet below existing ground surface (bgs). The approximate locations of the soil borings, the SCPTu and CPTu's are shown on Figure 2. In general, the soils around the proposed building areas were alluvial deposits consisting of very loose to medium dense sands and very soft to stiff silts within the upper 50 to 60 feet with dense sands underlying them. A description of our field investigation, our boring logs, along with the SCPT and CPT data, and General Notes used to describe materials encountered in the boring logs, are available in Appendix A. A description of the laboratory testing program along with sample test results are available in Appendix B.

2.5. Groundwater

Groundwater was calculated at the site at a depth of approximately 10 feet bgs at the time of our field investigation. PSI anticipates that the groundwater table fluctuates seasonally and in response the water level in the Skagit River and to significant precipitation events.

2.6. Seismic Design Values

The nearest mapped fault zone to the site is the Devils Mountain Fault Zone approximately 5.4 miles south of the site. The Devils Mountain Fault Zone is mapped as a late Quaternary age thrust fault, with a northward dip direction and a slip rate on the order of less than 0.2 millimeters per year (Reference 2).

As part of the procedure to evaluate seismic forces, the 2012 IBC requires the evaluation of the Seismic Site Class, which categorizes the site based upon the characteristics of the subsurface profile within the upper 100 feet of the ground surface. To help define the Site Class for this project PSI utilized shear wave velocities obtained from the Seismic Cone Penetrometer Tests for the upper 60 feet of the site. Based on the obtained shear wave velocities of the site the seismic site class classifies as a site class “D” soil, however since more than 10 feet of potentially liquefiable soil exists on the site the site classifies as a Site Class “F” as defined in Table 20.3-1 of ASCE 07-10. However, the exception in Section 20.3.1 of ASCE 07-10 permits the Site Class to be determined in accordance with Section 20.3 and the corresponding values of Fa and Fv determined from Tables 11.4-1 and 11.4-2. Based on this exception, Site Class E seismic design coefficients can be used and are provided. The associated USGS-NEHRP (2009) probabilistic ground acceleration values and site coefficients for the general site area were obtained from the USGS geo-hazards web page (Reference 3). The calculated seismic design Parameters for an earthquake with a risk targeted 2 percent probability of exceedance in 50 years are presented in Table 1 below:

Table 1: Ground Motion Values*

Period (sec)	Mapped MCE Spectral Response Acceleration (g)		Site Coefficients		Adjusted MCE Spectral Response Acceleration (g)		Design Spectral Response Acceleration (g)	
0.2	S_s	1.071	F_a	0.900	S_{Ms}	0.964	S_{Ds}	0.642
1.0	S_1	0.416	F_v	2.400	S_{M1}	1.0	S_{D1}	0.666

**Risk Targeted 2% Probability of exceedance in 50 years for Latitude 48.44227 and Longitude -122.33436*
MCE = Maximum Considered Earthquake

If the Site Class, as determined from the intended building use and the IBC, is interpreted to be C, D, E or F, the code requires an assessment of slope stability, liquefaction potential, and surface rupture due to faulting or lateral spreading. The following table presents a qualitative *assessment* of these issues considering the site class, the subsurface soil properties, the groundwater elevation, and probabilistic ground motions:

Table 2: Qualitative Seismic Site Assessments

Liquefaction	High	Our liquefaction analysis shows a high probability of seismic induced liquefaction occurring on this site.
Slope Stability	Low	The site is relatively flat with no observed steep slopes in close proximity to the site.
Surface Rupture	Low	No known active faults underlie the site.

2.7.2. Liquefaction Potential

In general, liquefaction is a condition where soils lose intergranular strength due to abrupt increases in pore water pressure. Pore water pressure increases typically occur during dynamic loading such as ground shaking during a seismic event. Liquefaction, should it occur on a site, can induce ground settlement and lateral spreading, which can result in damage to the structures. For liquefaction to occur, the following conditions must be present:

- The soil sediments must be in saturated or near-saturated conditions. At least 80-85 percent saturation is generally considered necessary for the liquefaction to occur.
- The soil must be predominately composed of non-plastic material such as sand or silt.
- The soil must be in a relatively loose state.
- The soil must be subjected to dynamic loading, such as an earthquake.

Based on the subsurface conditions encountered at the site, the potential for liquefaction is considered to be high at the site during a seismic event due to very shallow groundwater and loose sands with low fines content. The site is mapped as having a high liquefaction potential, based on the Washington State Department of Natural Resources Interactive Maps of the area (Reference 1). More information of liquefaction potential and settlement for the site is discussed in section 3.6 of this report.

The estimated liquefaction settlement analysis has been performed based on worst-case scenarios with conservative modeling equations and parameters. Results of our studies indicate that the soils from approximately 10 to 50 feet below ground surface would liquefy under a strong earthquake of magnitude 7.01 at a maximum considered earthquake acceleration of 0.43g, based on data obtained from the USGS 2008 interactive Deaggregations tool (Reference 4). This is illustrated in the liquefaction analysis summary in the Appendix C.

Based on our analysis of the soils encountered during our investigation, the soils encountered are susceptible to liquefaction, with a potential for liquefaction-induced settlement on the order of approximately 3½ to 5½ inches during a major seismic event with the liquefaction occurring between 10 and 50 feet bgs. Base on the data from the three CPT locations PSI anticipates differential liquefaction settlements to be on the order of approximately 2 inches over a 100-foot span.

3. CONCLUSIONS AND RECOMMENDATIONS

3.1. General

Our previous subsurface explorations for this investigation indicate the presence of approximately 50 feet of potentially liquefiable soil across the site. The groundwater table is located at a depth of at least 10 feet and the anticipated liquefaction that may occur resulting from the design earthquake is anticipated to result in 2 inches of differential settlement across a 100-foot span. We understand that the existing building appears to be supported by conventional spread footings and the expected loads for the new building will be on the order of 10 kips and 2 kips per linear foot for column and perimeter footing respectively.

3.2. Site Preparation

We anticipate that the removal of existing structures, foundations and utilities will disturb the upper 2 to 4 feet of soils across the site. Any large debris encountered below the existing site structures should be removed. Once the existing site structures are removed the site surfaces should be compacted to provide suitable access for equipment. Compacted soils should be proof rolled using a loaded tandem axle dump truck. If the surface fails the proof roll and cannot be repaired suitably to allow for heavy equipment, or if the work is to occur during the wet season, then it may be necessary for the upper 12 inches of soil to be removed and replaced with a crushed rock that has been approved by PSI.

3.3. Structural Fill

All fill placed beneath building, sidewalk, and pavement areas should be installed as compacted structural fill. The onsite soils are suitable for use as structural fill, provided they can be suitably moisture conditioned to meet the required compaction results. We recommend that imported structural fill should consist of pit-run or quarry-run rock, crushed rock, crushed gravel, or sand. It should be fairly well-graded between coarse and fine material and have less than 5 percent by weight passing the U.S. Standard No. 200 Sieve. The material should be placed in lifts with a maximum un-compacted thickness of 12 inches and compacted to not less than 95 percent of the maximum dry density as determined by ASTM D1557.

The condition of the subgrade should be evaluated by a PSI representative before fill placement or construction begins. Fill compaction should be evaluated by in-place density tests performed during fill placement so that adequacy of soil compaction efforts may be evaluated as earthwork progresses.

3.4. Utility Trench Excavations and Backfill

Excavations should be made in accordance with applicable Federal and State Occupational Safety and Health Administration regulations. Utility trenches in the near surface sand soils at the site will need to be sloped or shored from the ground surface due to the potential for caving. Actual inclinations will ultimately depend on the soil conditions encountered during earthwork. While we may provide certain approaches for trench excavations, the contractor should be responsible for selecting the excavation technique, monitoring the trench excavations for safety, and providing shoring as required, to protect personnel and adjacent improvements. The information provided below is for use by the owner and engineer and should not be interpreted to mean that PSI is assuming responsibility for the contractor's actions or site safety. The soils PSI encountered near the site surface should be classified as Type C soil according to the most recent OSHA regulations. In our opinion, excavations should be safely sloped or shored. The contractor should be aware that excavation and shoring should conform to the requirements specified in the applicable local, state, and federal safety regulations, such as OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations. We understand that such regulations are being strictly enforced, and if not followed, the contractor may be liable for substantial penalties.

Excavation and construction operations may expose the on-site soils to inclement weather conditions. The stability of exposed soils may deteriorate due to a change in moisture content or the action of heavy or repeated construction traffic. Accordingly, foundation and pavement area excavations should be protected from the elements and from the action of repetitive or heavy construction loadings.

Utility trenches within the building, pavement, and sidewalk areas should be backfilled with granular structural fill such as the onsite soil that can be properly compacted, or imported sand, sand and gravel, fragmental rock, or recycled concrete of up to 2 inches' maximum particle size with less than 5 percent passing the No. 200 sieve (washed analysis). Granular backfill should be placed in lifts and compacted to not less than 95 percent of the maximum dry density as determined by ASTM D 1557.

3.5. Foundations

The site is anticipated to experience up to 5½ inches of total settlement and up to 2 inches of differential settlement as a result of liquefaction during the maximum conceived design event. Several foundation options are presented below to mitigate the sites seismic and subsurface soil conditions. In each foundation option PSI recommends that exterior footings extend at least 18 inches below existing site grades to protect against frost heave.

3.5.1. Shallow Spread footing

If the liquefaction induced settlement is determined to be within acceptable limits any new foundation elements can be founded on at least 24 inches of suitably compacted structural fill. This may include an over-excavation of two feet of soil immediately below the proposed footings and compaction of either suitable onsite soils or approved imported materials as structural fill in accordance with section 3.3 of this report. A bearing pressure of 1,500 psf can be used for these footings. This value applies to the total of dead load and/or frequently applied live load and can be increased by one-third for the total of all loads; dead, live and wind or seismic. Static settlement with this option have been calculated to yield less than 1 inch of total settlement with an anticipated differential settlement of less than ½ inch over a 40 foot span.

3.5.2. Mat Foundation

Mat foundations can be used to support the proposed building. Mat foundations do not resist total settlement, but can be effective at limiting differential settlement since they can be designed to bridge over the estimated static and seismically-induced settlements. The material removed from the demolition would need to be removed prior to any additional work taking place. If the methods described in this section are performed PSI anticipates that differential settlements on this site will be on the order of less than ½ inch over a 40 foot span.

PSI recommends that a minimum 12 inches of soil immediately below the mat foundation be structural fill compacted to at least 95% of modified proctor (ASTM D1557), or native soil compacted to a firm and unyielding state and observed by a representative of the geotechnical engineer. If soft or loose soils are encountered at the subgrade, over-excavation for one additional foot may be required. The over-excavation and re-compacted areas should extend at least 5 feet beyond the maximum lateral extent of the footing elements.

Allowable Bearing Pressure

The mats should be founded a minimum 1½ feet below the lowest exterior site grade. The bearing capacity of large mats is not the governing criteria for design. The settlement of the mat usually governs the allowable load on the mats. We evaluated the proposed mat foundation for limiting the static settlement to less than 1/2-inch based on an allowable bearing pressure of 1,000 psf. The allowable load can be increased if the structure can tolerate higher settlements. Seismically-induced settlements should be added to the static settlement in the mat foundation design. Maximum differential settlements are expected to be less than half of the total settlement.

Coefficient of Subgrade Reaction

The coefficient of subgrade reaction (Ks) is the unit pressure required to produce a unit settlement in soils. The Ks is generally used for the structural design of the mat foundation. Factors such as size of foundation and shape affect the value of Ks. A general equation to include the effect of size for square footings on granular soils is given by:

$$K_s = K_1 \left[\frac{B+1}{2B} \right]^2 \text{(Reference : Bowles,1988)}$$

where, B = width of footing in feet
K_1 = Coefficient of subgrade reaction for a one-foot square footing.

For mat foundation over compacted fill, K1 may be taken as 200 pounds per cubic inches (pci), provided subgrade soil are prepared in the manner discussed in this report.

Resistance to Lateral Loads

Resistance to lateral loads can be provided by passive earth pressure against the side of mat foundations and by friction at the base.

Passive earth pressure may be used for the sides of mats poured against properly compacted fill or competent site soils. An equivalent fluid pressure of 250 psf can be used for ultimate passive resistance, not to exceed 3,500 psf. These values do not include a safety factor. Top one foot of passive resistance should be neglected unless the soil is confined by pavement or slab.

An ultimate friction coefficient of 0.4 can be used between the contact of concrete mat and compacted sandy soils. Friction should be applied to net dead normal load only. A minimum factor of safety of 1.5

and 1.1 should be used for sliding resistance for static and seismic cases, respectively. If passive pressure and friction are combined when evaluating the lateral resistance of a mat foundation, a factor of safety of 1.5 should be used to reduce the contribution from passive pressure.

3.5.3. Grade Beams

Grade beams may be used to interconnect footing element of the building and restrict the differential settlement of structure. Grade Beams can be designed with an allowable bearing pressure of 1,500 psf. This value applies to the total of dead load and/or frequently applied live load and can be increased by one-third for the total of all loads; dead, live and wind or seismic. Beams should bear on at least 12 inches of suitably compacted structural fill or firm and unyielding native soil. This subgrade should be observed by the geotechnical engineer prior to grade beam installation. Beams should be installed separate from the slab on grade floors to limit the amount of cracking resulting from differential settlements which may occur between them. Recommendations for resistance to lateral loading of grade beams are the same as for the mat foundation, see section 3.2.1. If the methods described in this section are performed PSI anticipates that differential settlements on this site will be on the order of less than ½ inch over a 40 foot span

3.6. Floor Support

We recommend that floor subgrades be proof rolled to verify subgrade suitability and/or observed by the Geotechnical Engineer or their representative prior to additional fill placement. PSI recommends the installation of an 8-inch thick granular base course beneath the floor slab to provide uniform support and a capillary break between the slab and the subgrade soil, the capillary. The base course should consist of crushed rock of up to 1 inch size and having less than about 2% passing the No. 200 sieve (washed analysis). Crushed rock ¾- to ¼ -inch gradation is often used for this purpose. The base course material should be installed in a single lift and compacted to at least 95% of the maximum density as determined by AS1M D 1557. In our opinion, it is appropriate to assume a coefficient of subgrade reaction, k, of 200 pci for the design of floor slabs constructed as recommended above. It may also be appropriate to install a vapor-retarding membrane beneath slabs that will receive floor coverings or will be used to store moisture-sensitive materials. The membrane should be installed in accordance with manufacturer's recommendations. Unless the mat foundation option is selected, PSI recommends that slab on grade floors be placed independent of footings to limit any damage that may result from differential settlement between the floors and the footings.

3.7. Drainage

We recommend footing drains be placed around the exterior of the building foundation to reduce the potential for lateral migration of moisture into the building envelope. We recommend that all roof drains be connected to a tight-line pipe leading to storm drain facilities. Pavement surfaces and open space areas should be sloped such that surface water runoff is collected and routed to suitable discharge points. We also recommend that ground surfaces adjacent to buildings be sloped to facilitate positive drainage away from the buildings.

PSI recommends that any infiltration system used on this site be placed at least 4 feet above the groundwater table, which will limit the depth the infiltration system to no more than 6 feet below existing site grades.

3.8. Pavement

For automobile parking areas, we recommend a pavement section consisting of 3 inches of asphaltic concrete (AC) over 6 inches of crushed rock base (CRB). For truck traffic areas, the pavement section should consist of 4 inches of AC over 8 inches of CRB. These preliminary pavement sections are based on a pavement design using the site sand subgrade, a desired pavement life of 20 years, and a terminal serviceability index of 2.0. The pavement section described above are based on ESAL's of 2,600 and 42,000 for automotive parking areas and truck traffic areas respectively. If concrete pavements are to be used in truck traffic areas or near site dumpsters, the section should consist at least a 5 inch section of concrete with at least 4 inches of CRB below it. Concrete used should have a 28 day break strength of at least 4,000 psi. These estimates and recommendations should be revised if design traffic information is shown to be different that described above.

Exposed soil subgrades should be compacted to a firm and unyielding state and proof-rolling should be used to evaluate pavement subgrade. Any soft areas disclosed by proof-rolling will likely require over-excavation and replacement with structural fill. Some contingency should be provided for the repair of any soft areas.

Permanent, properly installed drainage is also an essential aspect of pavement design and construction. All paved areas should have positive drainage to prevent ponding of surface water and saturation of the base course. This is particularly important in cut sections or at low points within the paved areas, such as in sunken loading dock areas or around stormwater catch basins. Effective means to prevent saturation of the base course including installing subdrain systems below sunken loading docks and weep holes in the sidewalls to catch basins.

4. DESIGN REVIEW AND CONSTRUCTION MONITORING

We welcome the opportunity to review and discuss construction plans and specifications as they are being developed. We are of the opinion that to observe compliance with the design concepts, specifications, and recommendations, construction operations dealing with earthwork and foundations should be observed by a qualified geotechnical engineer. We would be pleased to provide these services to you.

5. REPORT LIMITATIONS

The recommendations submitted in this report are based on the subsurface information obtained by PSI and design details furnished by representatives of the client, ADA Architects Inc, for the proposed improvements at 2400 Riverside Drive in Mount Vernon, Washington. If there are any revisions to the plans for this project, or if deviations from the subsurface conditions noted in this report are encountered during construction, PSI should be notified immediately to determine if changes in the foundation and/or pavement recommendations are required. If PSI is not retained to review these changes, PSI will not be responsible for the impact of those conditions on the project.

The geotechnical engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

After the plans and specifications are more complete, PSI should be retained and provided the opportunity to review the final design plans and specifications to verify that our engineering recommendations have been properly incorporated into the design.

REFERENCES

Reference 1: Washington Department of Natural Recourses Interactive Geologic Map: http://www.dnr.wa.gov/researchscience/topics/geosciencesdata/pages/geology_portal.aspx

Reference 2: U.S. Geological Survey, 2010, Quaternary fault and fold database for the United States, accessed November 10, 2010, from USGS web site: http://earthquake.usgs.gov/hazards/qfaults/

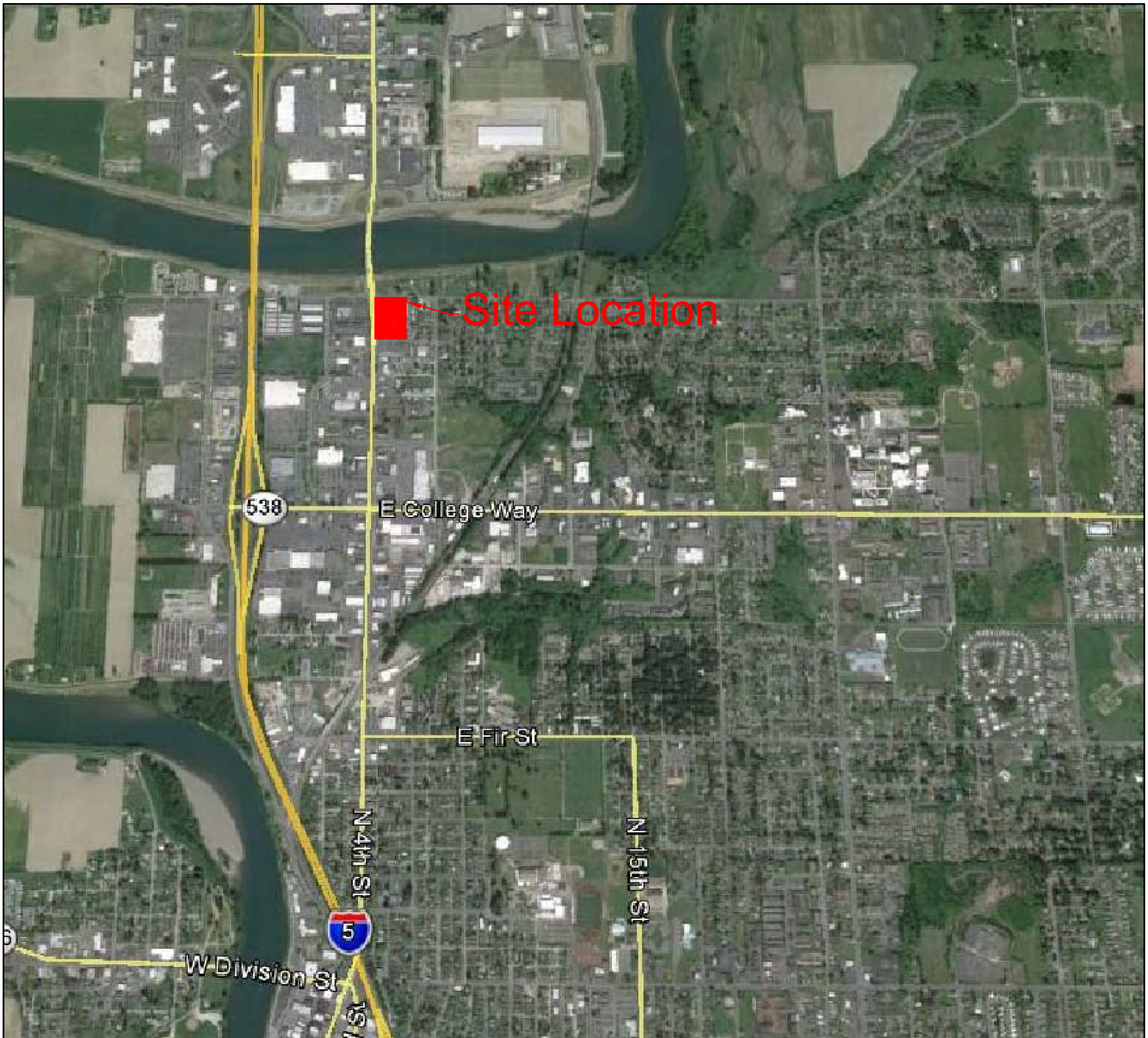
Reference 3: USGS Seismic Design Maps. http://earthquake.usgs.gov/designmaps/us/application.php

Reference 4: USGS 2008 Interactive Deaggregations: http://geohazards.usgs.gov/deaggint/2008/

FIGURES

VICINITY MAP

SITE EXPLORATION LOCATION MAP



LEGEND:

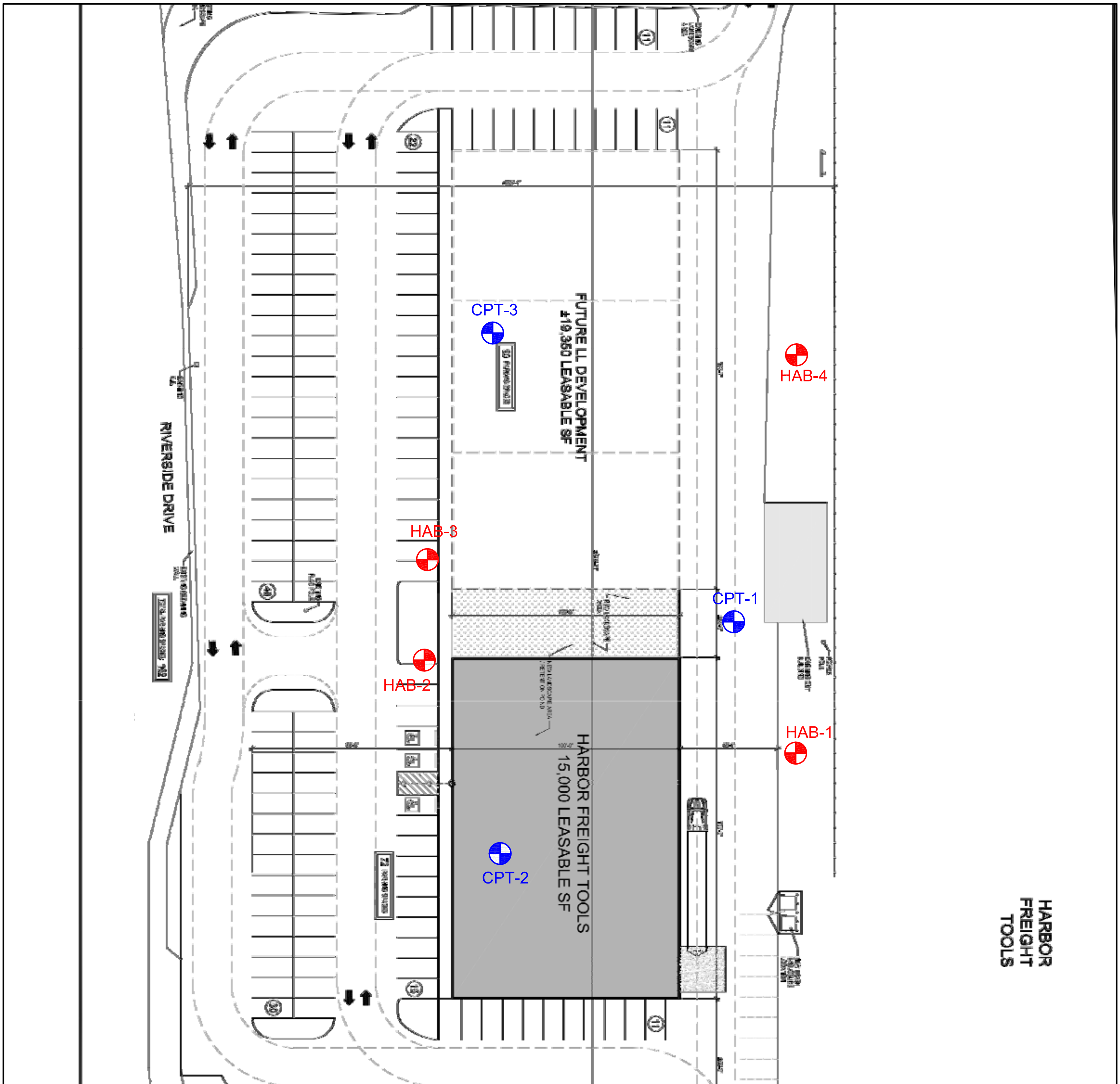
= Site Location

NOTES

SIte underlay provided by Google Earth

N
W E
S

psi Information To Build On Engineering • Consulting • Testing	PROJECT NAME: Harbor Freight 2400 Riverside Drive Mt Vernon, Washington	DRAWN BY: MSP	DATE: September, 2016	FIGURE: 1
20508 56th Ave W Suite A **Lynwood, WA 98036** **(425)409-2504**	DESCRIPTION: Vicinity Map	APPROVED BY: MSP	PSI PROJECT NUMBER: 07121398	

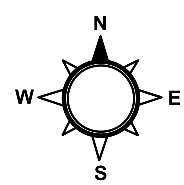


LEGEND:

- Hand Auger Boring Location
- CPT Location

NOTES

Site underlay provided by ADA Architects Inc.



psi Information To Build On Engineering • Consulting • Testing	PROJECT NAME: Harbor Freight 2400 Riverside Drive Mt Vernon, Washington	DRAWN BY: MSP	DATE: September, 2016	FIGURE: 2
20508 56th Ave W Suite A **Lynwood, WA 98036** **(425) 409-2504**	DESCRIPTION: Site Exploration Map	APPROVED BY: MSP	PSI PROJECT NUMBER: 07121398	

APPENDIX A

FIELD EXPLORATION PROGRAM

GENERAL NOTES

SOIL CLASSIFICATION CHART

BORING LOGS

FIELD EXPLORATION PROGRAM

General

We explored the site by drilling four hand auger soil borings (HAB1-HAB4) to depths ranged from approximately 6½ feet to 10 feet bgs and 3 CPT to depths ranging 58 to 71 feet bgs using a truck mounted CPT rig, on June 7, 2016. Prior to performing all hand auger borings, PSI performed Dynamic Cone penetrometers (DCP) tests which are used to determine blow counts of the soil and thereby provide relative density/relative constancy of the subsurface soils. DCP test involves taking a one-inch diameter probe and a 35-pound slide hammer that is manually lifted 15 inches and dropped vertically onto the top of the probe. DCP blow counts are recorded every 10 centimeters to provide blow counts, to determine the relative density/relative consistency of a material. The locations of the borings are shown on Figure 2. A representative of PSI's geotechnical staff was present during the explorations to record soil and groundwater conditions encountered in the exploration and to obtain soil and rock samples for laboratory testing.

Sampling Procedures

Throughout the drilling operation, soil samples were obtained from the hand auger borings using a 5-inch hand auger. The soils were observed continuously throughout the drilling process and samples were collected when changes in material were observed.

The DCP's and hand auger borings were conducted to observe the stratigraphy, density, and variability of subsurface soil conditions.

No samples can be collected form CPT's. Logs form CPT's are shown in this Appendix A.

Field Classification

Soil samples were initially classified visually in the field. Consistency, color, relative moisture, degree of plasticity, peculiar odors and other distinguishing characteristics of the soil samples were noted. The terminology used in the soil and rock classifications and other modifiers are defined in the General Notes in this Appendix A.

Exploration Logs

Summary boring log follows in this appendix. The left-hand portion of the boring log gives our interpretation of the soil encountered in the soil boring, sample locations and depths, and groundwater information. The right-hand portion of the log shows the results of the sample water contents, and other laboratory information.

The soil profile shown on the boring logs represent the conditions only at actual exploration location. Variations may occur and should be expected. The stratifications represent the approximate boundary between subsurface materials; the actual transition may be gradual.

GENERAL NOTES

SAMPLE IDENTIFICATION

The Unified Soil Classification System (USCS), AASHTO 1988 and ASTM designations D2487 and D-2488 are used to identify the encountered materials unless otherwise noted. Coarse-grained soils are defined as having more than 50% of their dry weight retained on a #200 sieve (0.075mm); they are described as: boulders, cobbles, gravel or sand. Fine-grained soils have less than 50% of their dry weight retained on a #200 sieve; they are defined as silts or clay depending on their Atterberg Limit attributes. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size.

DRILLING AND SAMPLING SYMBOLS

- SFA: Solid Flight Auger - typically 4" diameter flights, except where noted.
- HSA: Hollow Stem Auger - typically 3¼" or 4¼ I.D. openings, except where noted.
- M.R.: Mud Rotary - Uses a rotary head with Bentonite or Polymer Slurry
- R.C.: Diamond Bit Core Sampler
- H.A.: Hand Auger
- P.A.: Power Auger - Handheld motorized auger
- SS: Split-Spoon - 1 3/8" I.D., 2" O.D., except where noted.
- ST: Shelby Tube - 3" O.D., except where noted.
- BS: Bulk Sample
- PM: Pressuremeter
- CPT-U: Cone Penetrometer Testing with Pore-Pressure Readings

SOIL PROPERTY SYMBOLS

- N: Standard "N" penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2-inch O.D. Split-Spoon.
- N_{60}: A "N" penetration value corrected to an equivalent 60% hammer energy transfer efficiency (ETR)
- Q_u: Unconfined compressive strength, TSF
- Q_p: Pocket penetrometer value, unconfined compressive strength, TSF
- w%: Moisture/water content, %
- LL: Liquid Limit, %
- PL: Plastic Limit, %
- PI: Plasticity Index = (LL-PL),%
- DD: Dry unit weight, pcf
- ▼, ▽, ▼: Apparent groundwater level at time noted

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Relative Density	N - Blows/foot
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	50 - 80
Extremely Dense	80+

ANGULARITY OF COARSE-GRAINED PARTICLES

Description	Criteria
Angular:	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular:	Particles are similar to angular description, but have rounded edges
Subrounded:	Particles have nearly plane sides, but have well-rounded corners and edges
Rounded:	Particles have smoothly curved sides and no edges

GRAIN-SIZE TERMINOLOGY

Component	Size Range
Boulders:	Over 300 mm (>12 in.)
Cobbles:	75 mm to 300 mm (3 in. to 12 in.)
Coarse-Grained Gravel:	19 mm to 75 mm (¾ in. to 3 in.)
Fine-Grained Gravel:	4.75 mm to 19 mm (No.4 to ¾ in.)
Coarse-Grained Sand:	2 mm to 4.75 mm (No.10 to No.4)
Medium-Grained Sand:	0.42 mm to 2 mm (No.40 to No.10)
Fine-Grained Sand:	0.075 mm to 0.42 mm (No. 200 to No.40)
Silt:	0.005 mm to 0.075 mm
Clay:	<0.005 mm

PARTICLE SHAPE

Description	Criteria
Flat:	Particles with width/thickness ratio > 3
Elongated:	Particles with length/width ratio > 3
Flat & Elongated:	Particles meet criteria for both flat and elongated

RELATIVE PROPORTIONS OF FINES

Descriptive Term	% Dry Weight
Trace:	< 5%
With:	5% to 12%
Modifier:	>12%

GENERAL NOTES

(Continued)

CONSISTENCY OF FINE-GRAINED SOILS

Q_U - TSF	N - Blows/foot	Consistency
0 - 0.25	0 - 2	Very Soft
0.25 - 0.50	2 - 4	Soft
0.50 - 1.00	4 - 8	Medium Stiff
1.00 - 2.00	8 - 15	Stiff
2.00 - 4.00	15 - 30	Very Stiff
4.00 - 8.00	30 - 50	Hard
8.00+	50+	Very Hard

MOISTURE CONDITION DESCRIPTION

Description	Criteria
Dry:	Absence of moisture, dusty, dry to the touch
Moist:	Damp but no visible water
Wet:	Visible free water, usually soil is below water table

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term	% Dry Weight
Trace:	< 15%
With:	15% to 30%
Modifier:	>30%

STRUCTURE DESCRIPTION

Description	Criteria
Stratified:	Alternating layers of varying material or color with layers at least ¼-inch (6 mm) thick
Laminated:	Alternating layers of varying material or color with layers less than ¼-inch (6 mm) thick
Fissured:	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided:	Fracture planes appear polished or glossy, sometimes striated

Description	Criteria
Blocky:	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed:	Inclusion of small pockets of different soils
Layer:	Inclusion greater than 3 inches thick (75 mm)
Seam:	Inclusion 1/8-inch to 3 inches (3 to 75 mm) thick extending through the sample
Parting:	Inclusion less than 1/8-inch (3 mm) thick

SCALE OF RELATIVE ROCK HARDNESS

Q_U - TSF	Consistency
2.5 - 10	Extremely Soft
10 - 50	Very Soft
50 - 250	Soft
250 - 525	Medium Hard
525 - 1,050	Moderately Hard
1,050 - 2,600	Hard
>2,600	Very Hard

ROCK BEDDING THICKNESSES

Description	Criteria
Very Thick Bedded	Greater than 3-foot (>1.0 m)
Thick Bedded	1-foot to 3-foot (0.3 m to 1.0 m)
Medium Bedded	4-inch to 1-foot (0.1 m to 0.3 m)
Thin Bedded	1¼-inch to 4-inch (30 mm to 100 mm)
Very Thin Bedded	½-inch to 1¼-inch (10 mm to 30 mm)
Thickly Laminated	1/8-inch to ½-inch (3 mm to 10 mm)
Thinly Laminated	1/8-inch or less "paper thin" (<3 mm)

ROCK VOIDS

Voids	Void Diameter
Pit	<6 mm (<0.25 in)
Vug	6 mm to 50 mm (0.25 in to 2 in)
Cavity	50 mm to 600 mm (2 in to 24 in)
Cave	>600 mm (>24 in)

GRAIN-SIZED TERMINOLOGY

(Typically Sedimentary Rock)

Component	Size Range
Very Coarse Grained	>4.76 mm
Coarse Grained	2.0 mm - 4.76 mm
Medium Grained	0.42 mm - 2.0 mm
Fine Grained	0.075 mm - 0.42 mm
Very Fine Grained	<0.075 mm

ROCK QUALITY DESCRIPTION

Rock Mass Description	RQD Value
Excellent	90 -100
Good	75 - 90
Fair	50 - 75
Poor	25 -50
Very Poor	Less than 25

DEGREE OF WEATHERING

Slightly Weathered:	Rock generally fresh, joints stained and discoloration extends into rock up to 25 mm (1 in), open joints may contain clay, core rings under hammer impact.
Weathered:	Rock mass is decomposed 50% or less, significant portions of the rock show discoloration and weathering effects, cores cannot be broken by hand or scraped by knife.
Highly Weathered:	Rock mass is more than 50% decomposed, complete discoloration of rock fabric, core may be extremely broken and gives clunk sound when struck by hammer, may be shaved with a knife.

SOIL CLASSIFICATION CHART

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND 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 AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

psi

Professional Service Industries, Inc.
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Lynnwood, WA 98036
Telephone: (425) 409-2504
Fax: (425) 582-8193

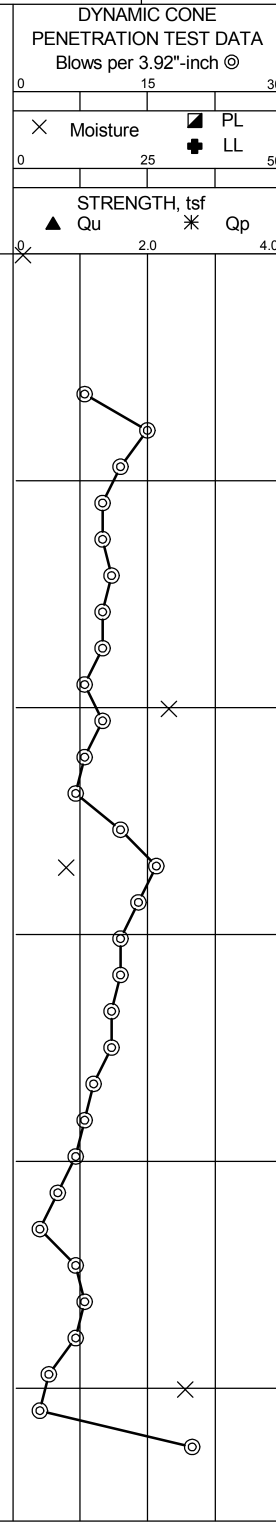
LOG OF HAB-1

PSI Job No.: 07121398
Project: Harbor Freight
Location: 2400 Riverside Drive
Mount Vernon, WA

Excavation Method: Hand Auger
Sampling Method: Continous
DCP Type: Wild Cat
Boring Location:

WATER LEVELS

Depth, (feet)	MATERIAL DESCRIPTION	USCS Classification	Dynamic Cone (DCP) Blows per 3.92"-inch	Moisture, %
0	**Poorly graded GRAVEL with silt & sand:** with organics (Topsoil)			2
0.5	**Silty SAND:** brown, moist, loose to medium dense, fine to medium sand [Alluvium]	SM	8, 15, 12, 10, 10, 11, 10, 10, 8, 10, 8, 7, 12	29 (at 4 ft)
5.4	**SILT with Sand:** light brown, moist, medium stiff to stiff. [Alluvium]	ML	16, 14, 12, 12, 11, 11, 9, 8, 7, 5, 3, 7, 8, 7, 4	10 (at 5.4 ft)
10	**Poorly graded SAND:** grayish brown, moist, medium dense, fine sand, trace fines [Alluvium]	SP	3, 20	32 (at 10 ft)
	Bottom of boring at 10 feet 2 inches, DCP to 9 feet 10 inches. No groundwater observed.			



Additional Remarks

Completion Depth: 10.0 ft
Date Boring Started: 6/7/16
Date Boring Completed: 6/7/16
Logged By: SM
Excavation Contractor: PSI, Inc.

Sample Types:
Shelby Tube
Dynamic Cone (DCP)
Grab Sample

Latitude: 48.4422°
Longitude: -122.33388°
Excavation Equipment:
Remarks:

The stratification lines represent approximate boundaries. The transition may be gradual.

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LOG OF HAB-2

Sheet 1 of 1

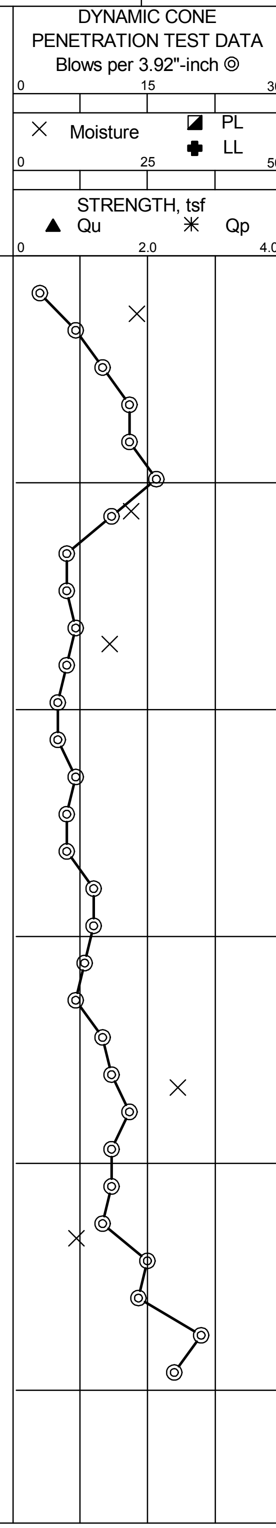
PSI Job No.:	07121398
Project:	Harbor Freight
Location:	2400 Riverside Drive Mount Vernon, WA
Excavation Method:	Hand Auger
Sampling Method:	Continous
DCP Type:	Wild Cat
Boring Location:	

WATER LEVELS

Depth, (feet)	MATERIAL DESCRIPTION	USCS Classification
0 – 0.5	**TOPSOIL:** dark brown, moist, loose, silty SAND with organics.	SM
0.5 – 7.3	**Silty SAND:** brown, moist, loose to medium dense, fine to medium sand [Alluvium]	SM
7.3 – 8.7	**SILT with Sand:** light brown, moist, medium stiff to stiff. [Alluvium]	ML
8.7 – 10.6	**Poorly graded SAND:** grayish brown, moist, medium dense, fine sand, trace fines [Alluvium]	SP
	Bottom of boring at 10 feet 2 inches, DCP to 9 feet 10 inches. No groundwater observed.	

Dynamic Cone (DCP) Blows per 3.92"-inch: 3, 7, 10, 13, 13, 16, 11, 6, 6, 7, 6, 5, 5, 7, 6, 6, 9, 9, 8, 7, 10, 11, 13, 11, 11, 10, 15, 14, 21, 18

Moisture, %: 23, 22, 18, 31, 12



Additional Remarks

Completion Depth:	10.6 ft
Date Boring Started:	6/7/16
Date Boring Completed:	6/7/16
Logged By:	SM
Excavation Contractor:	PSI, Inc.

Sample Types:
- Shelby Tube
- Dynamic Cone (DCP)
- Grab Sample

Latitude: 48.44219°
Longitude: -122.33457°
Excavation Equipment:
Remarks:

The stratification lines represent approximate boundaries. The transition may be gradual.

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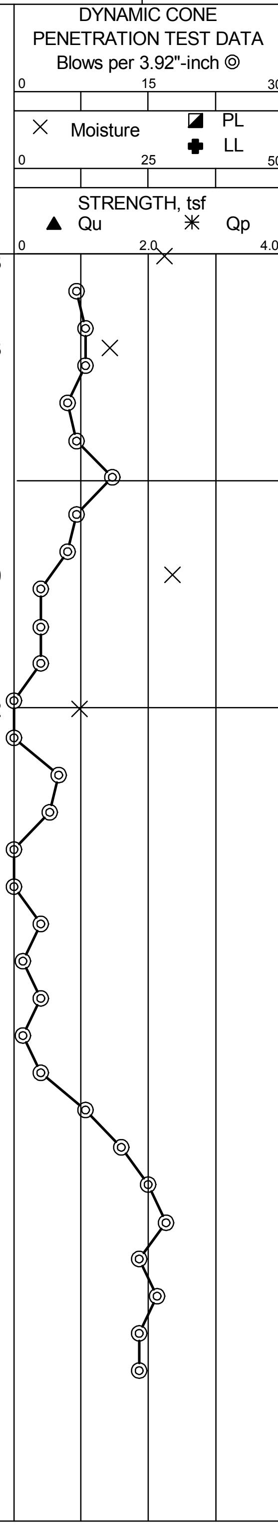
LOG OF HAB-3

PSI Job No.:	07121398	Excavation Method:	Hand Auger
Project:	Harbor Freight	Sampling Method:	Continous
Location:	2400 Riverside Drive	DCP Type:	Wild Cat
	Mount Vernon, WA	Boring Location:	

WATER LEVELS

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	Dynamic Cone (DCP) Blows per 3.92"-inch	Moisture, %	Additional Remarks
	0					**TOPSOIL:** dark brown, moist, loose, silty SAND with organics.		7, 8	28	
	1–3					**Silty SAND:** brown, moist, very loose to medium dense, fine to medium sand [Alluvium]	SM	8, 6, 7, 11, 7, 6, 3, 3	18, 30	
	4–5					**SILT with Sand:** light brown with orange mottling, moist, very soft to soft. [Alluvium]	ML	3, 0, 0, 5, 4, 0	12	
						Poorly graded SAND: grayish brown, moist, medium dense, fine sand, trace fines [Alluvium]	SP	0		
						Bottom of boring and refusal at 5 feet 10 inches, DCP to 9 feet 10 inches. No groundwater observed.		3, 1, 3, 1, 3, 8, 12, 15, 17, 14, 16, 14, 14		

DYNAMIC CONE PENETRATION TEST DATA



Completion Depth:	5.8 ft	Sample Types:	Latitude: 48.44238°
Date Boring Started:	6/7/16	Shelby Tube	Longitude: -122.33457°
Date Boring Completed:	6/7/16	Dynamic Cone (DCP)	Excavation Equipment:
Logged By:	SM	Grab Sample	Remarks:
Excavation Contractor:	PSI, Inc.		

The stratification lines represent approximate boundaries. The transition may be gradual.

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LOG OF HAB-4

Sheet 1 of 1

PSI Job No.:	07121398	Excavation Method:	Hand Auger
Project:	Harbor Freight	Sampling Method:	Continous
Location:	2400 Riverside Drive, Mount Vernon, WA	DCP Type:	Wild Cat
		Boring Location:	

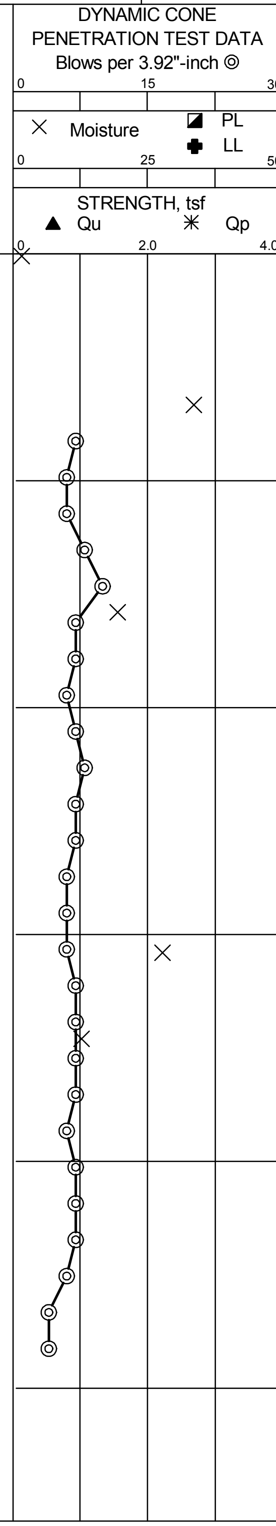
WATER LEVELS

Depth, (feet)	MATERIAL DESCRIPTION	USCS Classification
0–1	**Crushed Rock Surfaceing:**	
1–6.2	**Silty SAND:** brown, moist, loose, fine to medium sand [Alluvium]	SM
6.2–6.9	**SILT with Sand:** light brown, moist, medium stiff. [Alluvium]	ML
6.9–10	**Poorly graded SAND:** grayish brown, moist, loose to very loose, fine sand, trace fines [Alluvium]	SP
10–10.2	**SILT with Sand:** grayish brown, moist, soft. [Alluvium]	ML

Bottom of boring at 10 feet 2 inches, DCP to 8 feet 4 inches . No groundwater observed.

Dynamic Cone (DCP) Blows per 3.92"-inch: 7, 6, 6, 8, 10, 7, 7, 6, 7, 8, 7, 7, 6, 6, 6, 7, 7, 7, 7, 6, 7, 7, 7, 6, 4, 4

Moisture, %: 2, 34, 20, 28, 13



Additional Remarks

Completion Depth:	10.2 ft
Date Boring Started:	6/7/16
Date Boring Completed:	6/7/16
Logged By:	SM
Excavation Contractor:	PSI, Inc.

Sample Types:
- Shelby Tube
- Dynamic Cone (DCP)
- Grab Sample

Latitude: 48.44257°
Longitude: -122.3339°
Excavation Equipment:
Remarks:

The stratification lines represent approximate boundaries. The transition may be gradual.

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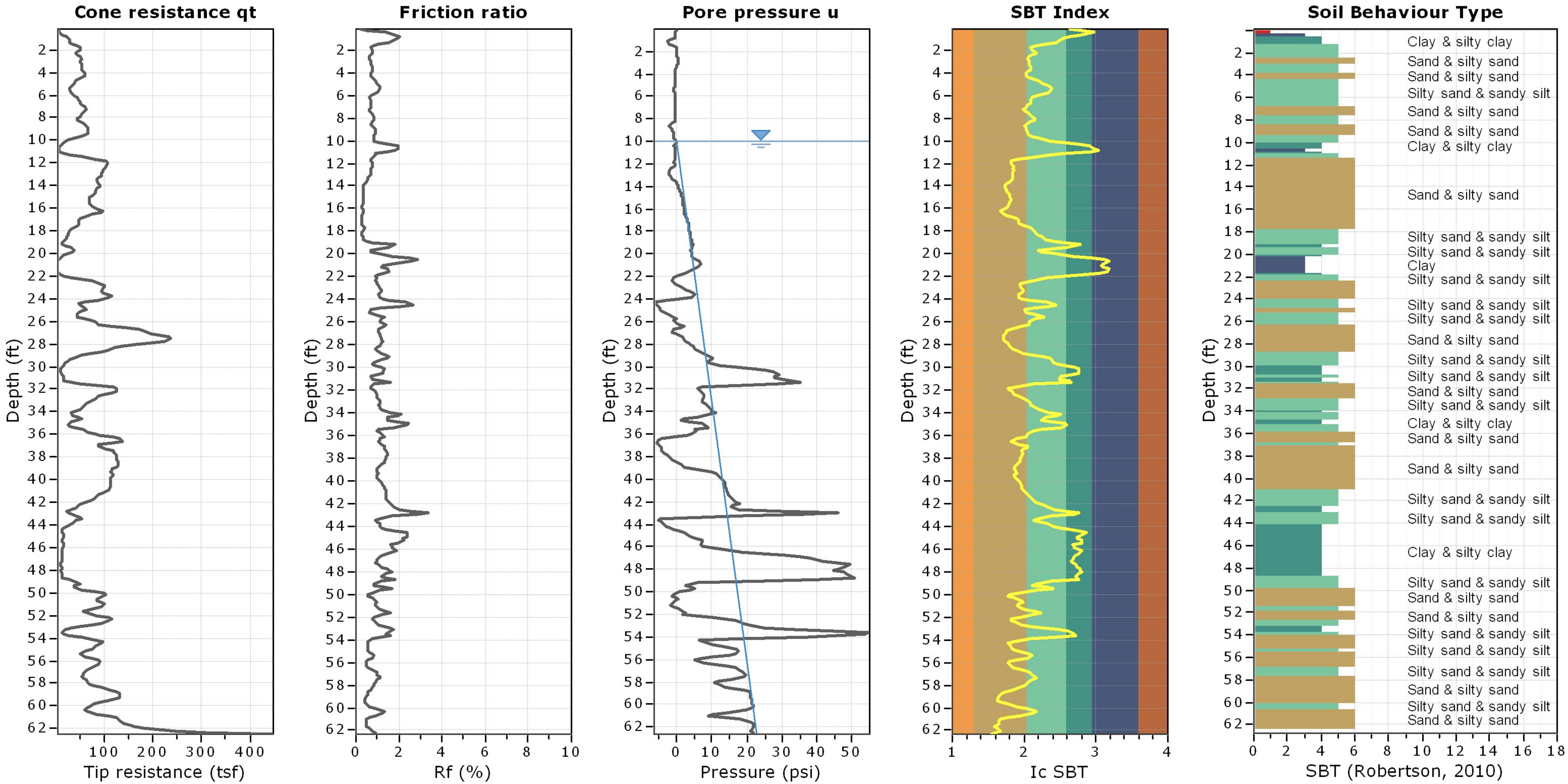
CPT: CPT-01

Project:

Location:

Total depth: 62.50 ft, Date: 6/10/2016
Surface Elevation: 0.00 ft



SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

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Phone: 425-409-2504

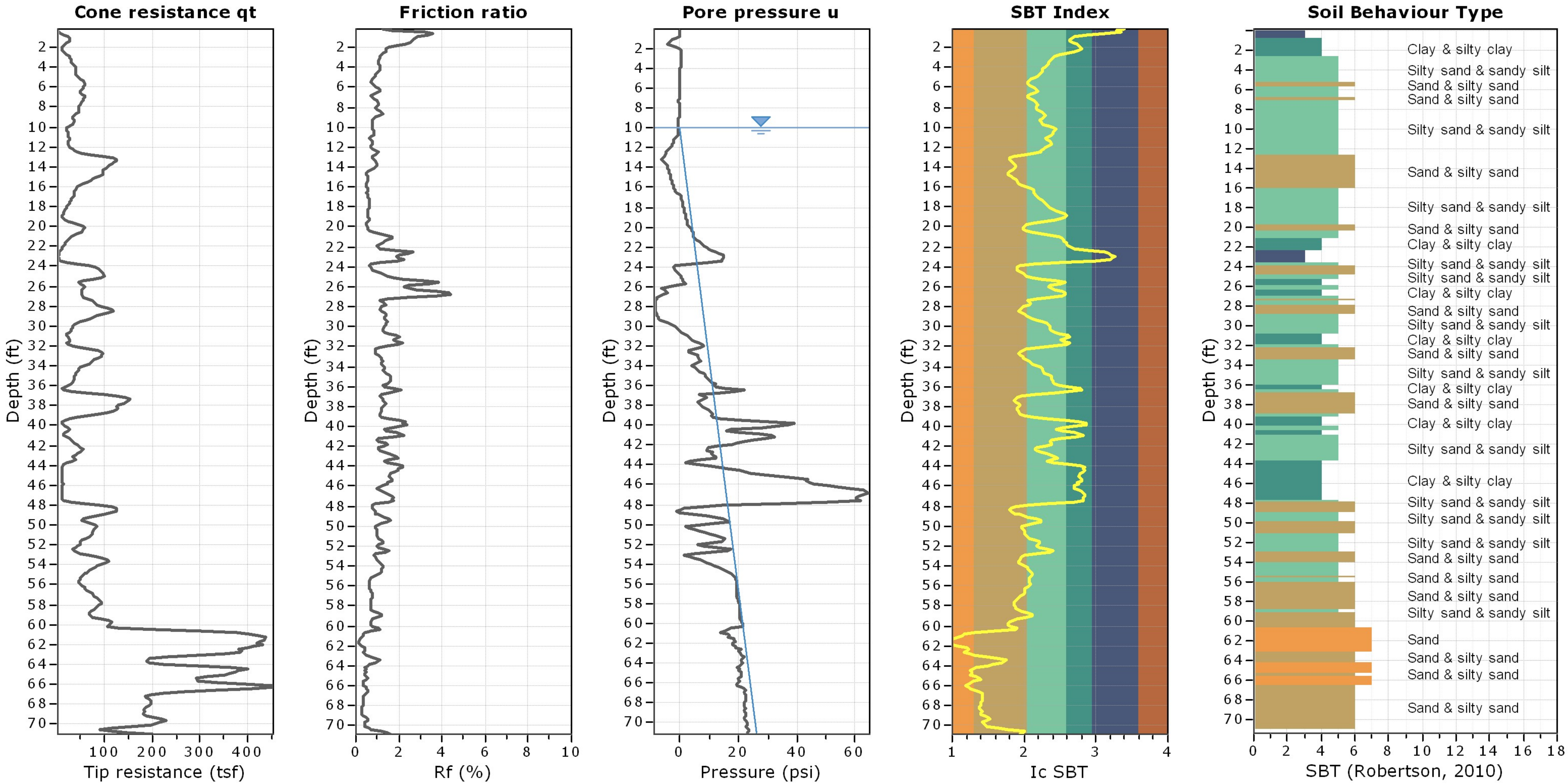
CPT: CPT-02

Project:

Total depth: 71.03 ft, Date: 6/10/2016

Location:

Surface Elevation: 0.00 ft



SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

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Phone: 425-409-2504

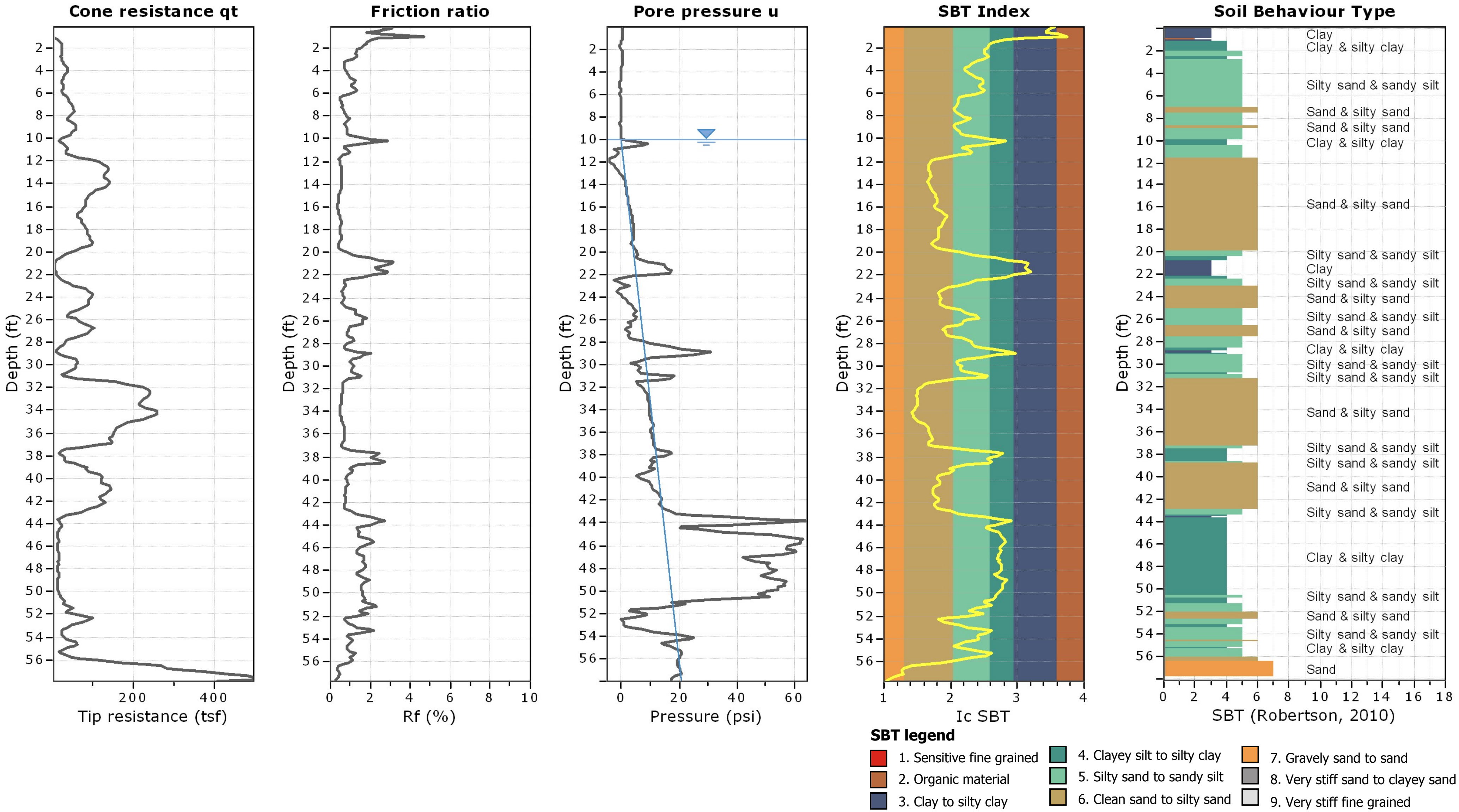
CPT: CPT-03

Total depth: 57.91 ft, Date: 6/10/2016

Surface Elevation: 0.00 ft

Project:

Location:



APPENDIX B

LABORATORY TEST RESULTS

Laboratory Testing Program and Procedures

General

Soil samples obtained during the field explorations were examined in our laboratory. The physical characteristics of the samples were noted and the field classifications were modified where necessary in accordance with terminology presented the General Notes included in this appendix.

Representative samples were selected during the course of the examination for further testing. The testing procedures and results of the tests are summarized below. The phrase "In general accordance with guidelines presented in…" means that certain local and common descriptive practices and methodologies have been followed.

Visual-Manual Classification

The soil samples were classified in general accordance with guidelines presented in ASTM D2488, *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*. Certain terminology incorporating current local engineering practice, as provided in the Soil Classification Chart included with or in lieu of ASTM terminology. The term which best described the major portion of the sample was used in determining the soil type (that is, gravel, sand, silt or clay).

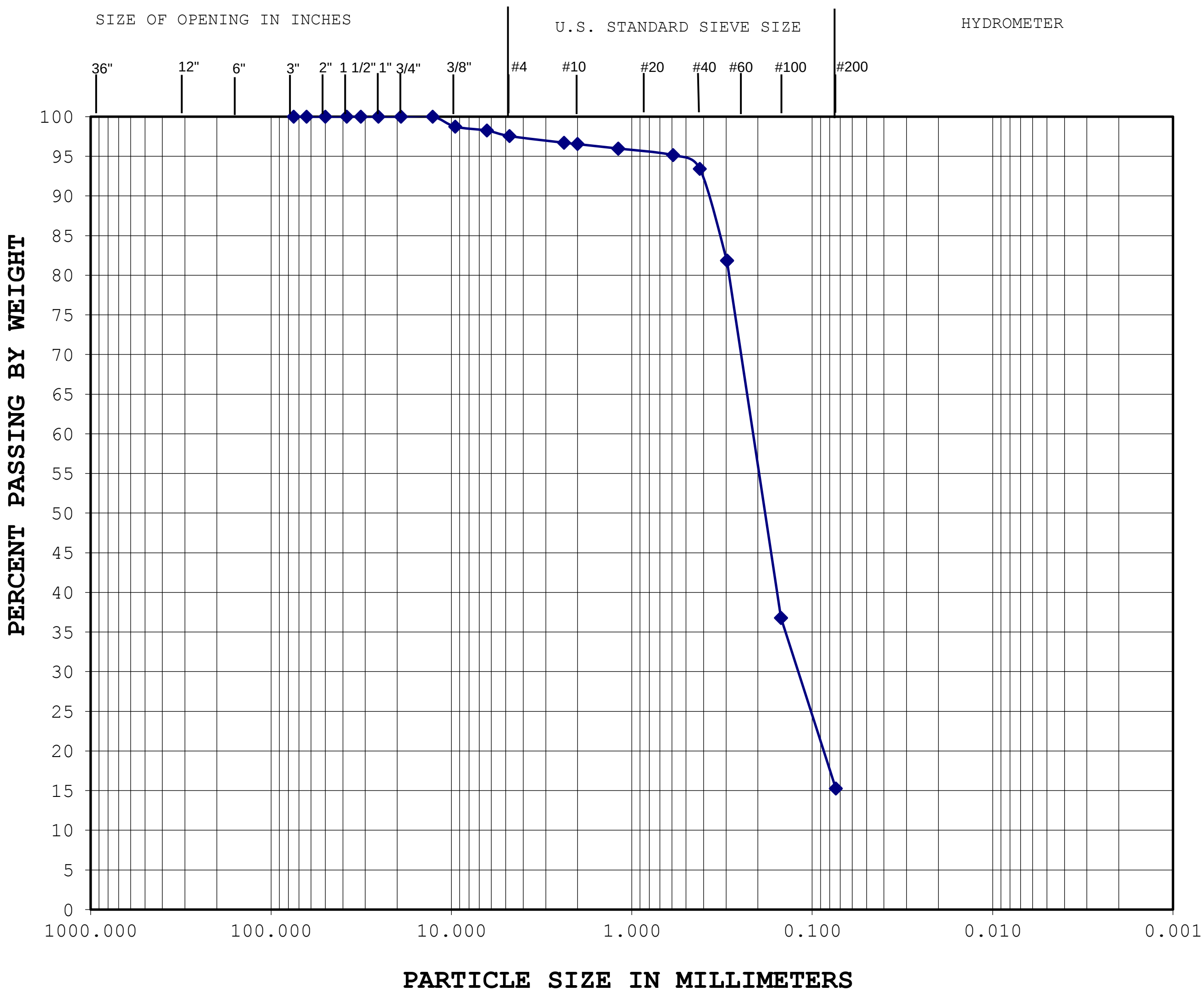
Moisture Content

Natural moisture content determinations were made on all samples. The natural moisture content is defined as the ratio of the weight of water to dry weight of soil, expressed as a percentage. The results of the moisture content determinations are presented on the boring logs in this appendix.

Grain Size Analysis

Select samples from the borings were analyzed for grain size in general conformance with ASTM C 136 and ASTM C117. In general, samples were oven dried, weighed then washed over a #200 sieve to remove silt and clay sized particles and then dried again. The samples were separated through a series of sieves of progressively smaller openings for determination of particle size distribution. The material passing and/or retained on each sieve was recorded as a percent of the total sample weight. The results of the sieve analysis are depicted in this appendix.

PARTICLE SIZE ANALYSIS - ASTM C136/C117



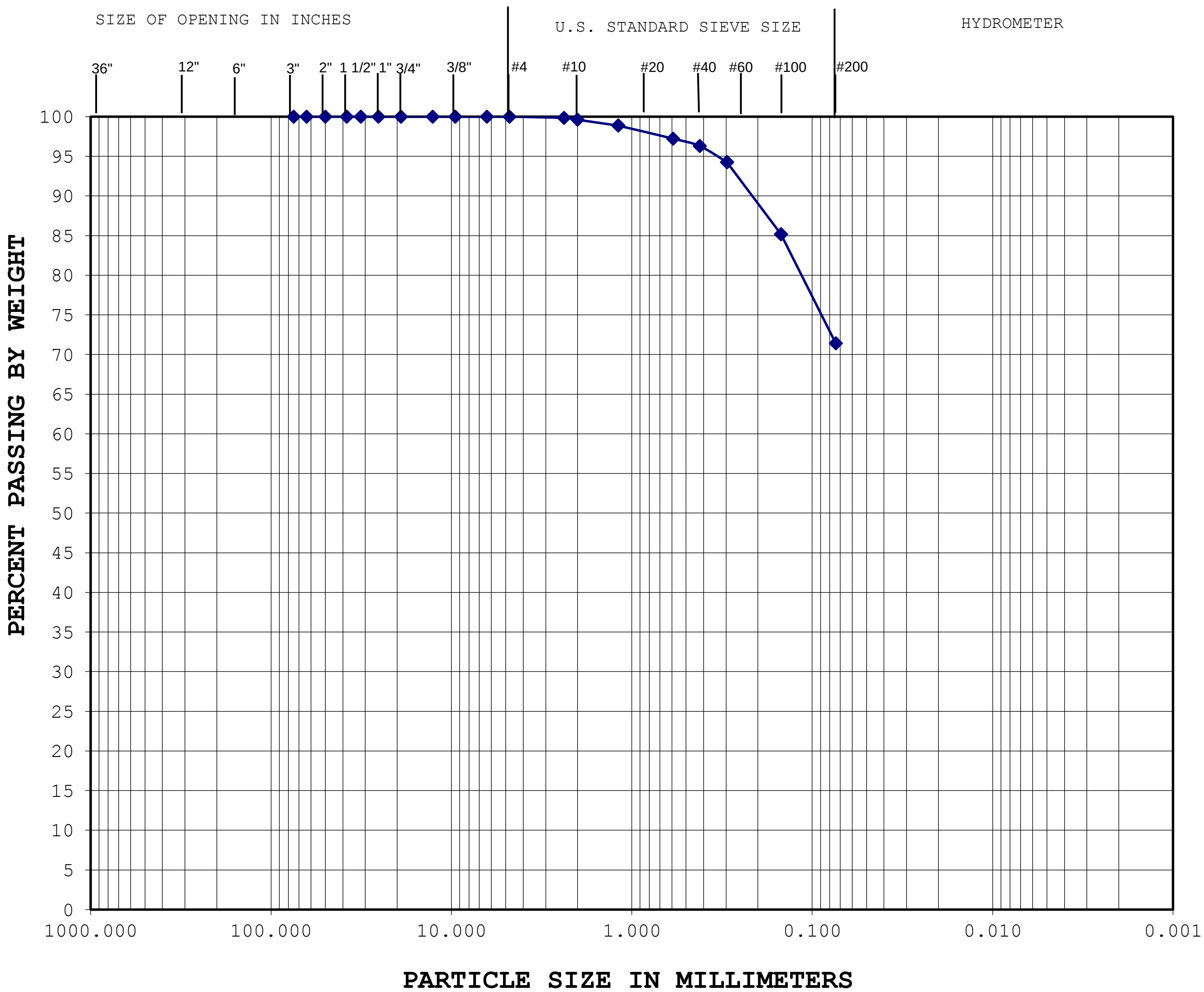
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

% Gravel	% Sand	% Fines	
2.4%	82.3%	15.3%	PL = -
			LL = -
Soil Classification Silty SAND			PI = -

Exploration	Sample	Depth (feet)	Moisture	Reviewed	USCS Symbol
HAB-1		1/2 foot	10.3	MSP	SM

psi Information To Build On — Engineering • Consulting • Testing	PROJECT NO:	PROJECT NAME:
	7121398	Harbor Freight, Riverside DR., Mount Vernon

PARTICLE SIZE ANALYSIS - ASTM C136/C117



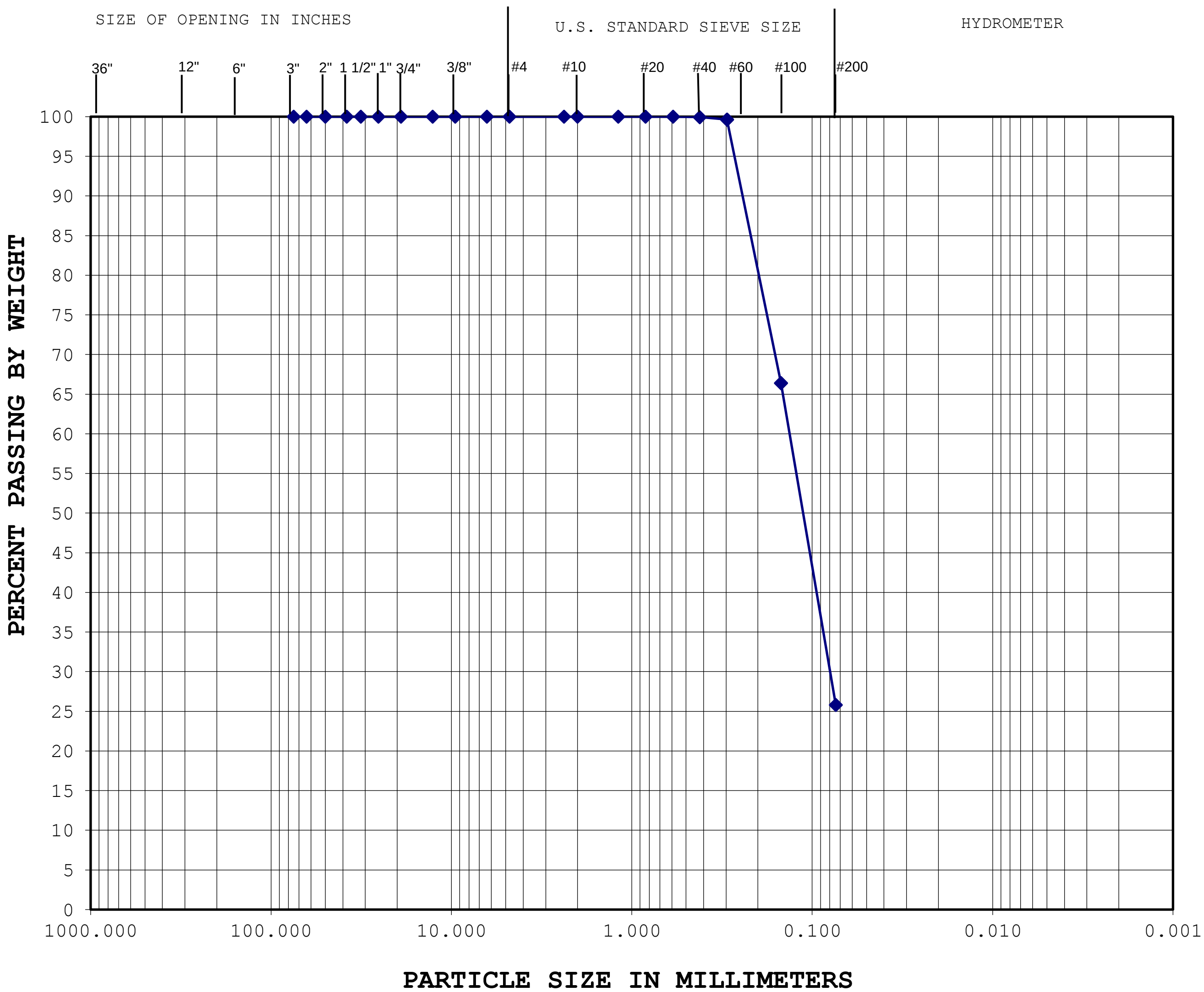
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

% Gravel	% Sand	% Fines	
0.0%	28.6%	71.4%	PL = -
			LL = -
Soil Classification SILT with Sand			PI = -

Exploration	Sample	Depth(feet)	Moisture	Reviewed	USCS Symbol
HAB-2		8 feet 3 inches	30.6	MSP	ML

psi Information To Build On Engineering • Consulting • Testing	PROJECT NO: 7121398	PROJECT NAME: Harbor Freight, Riverside DR., Mount Vernon

PARTICLE SIZE ANALYSIS - ASTM C136/C117



BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

% Gravel	% Sand	% Fines	
0.0%	74.2%	25.8%	PL = -
			LL = -
Soil Classification Silty SAND			PI = -

Exploration	Sample	Depth(feet)	Moisture	Reviewed	USCS Symbol
HAB-4		10 feet	31.4	MSP	SM

psi Information To Build On — Engineering • Consulting • Testing	PROJECT NO:	PROJECT NAME:
	7121398	Harbor Freight, Riverside DR., Mount Vernon

APPENDIX C

LIQUEFACTION ANALYSIS

TABLE OF CONTENTS

Professional Service Industries, Inc.
20508 56th Avenue W, Suite A
Lynnwood, WA 98036
Phone: 425-409-2504

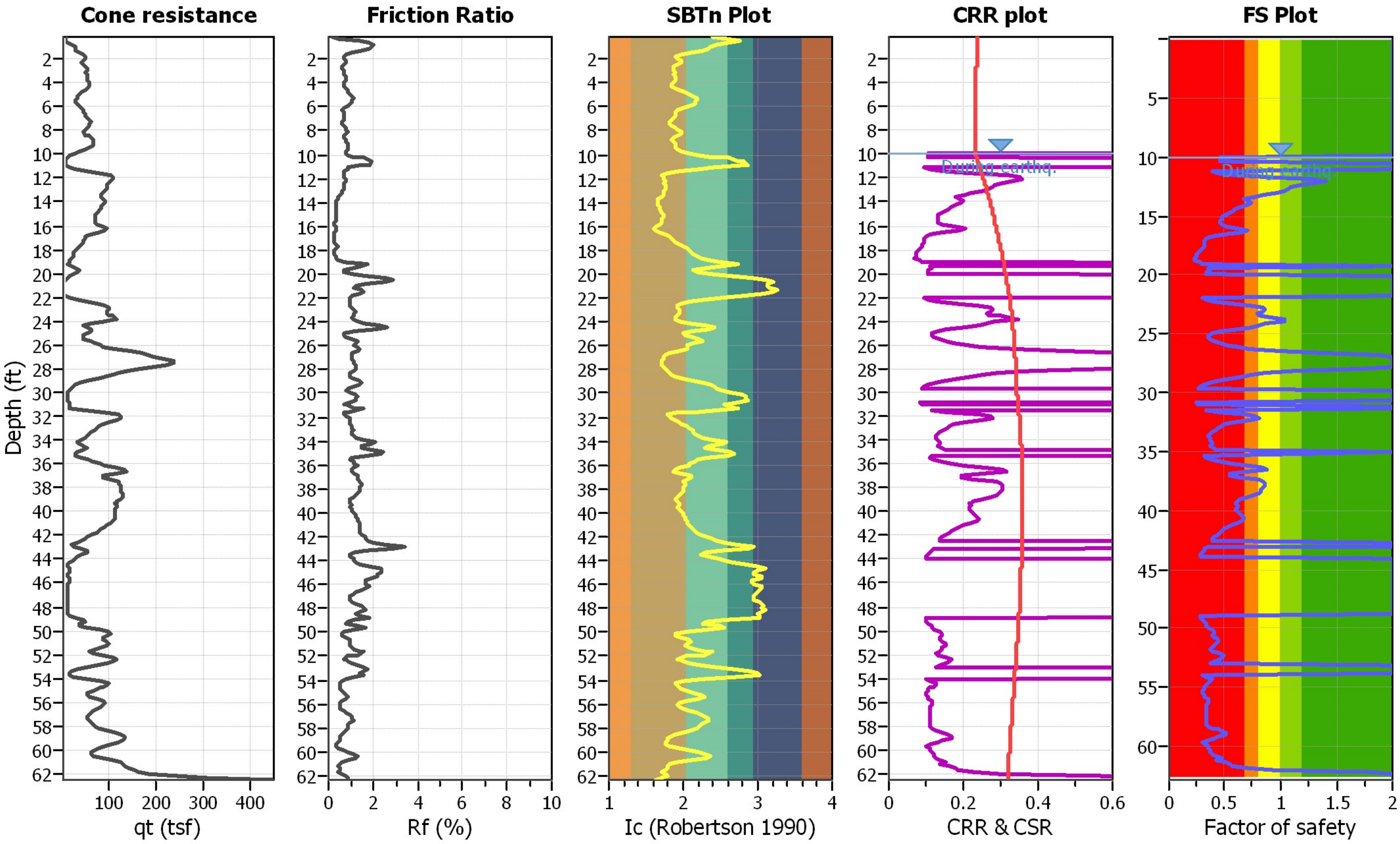
LIQUEFACTION ANALYSIS REPORT

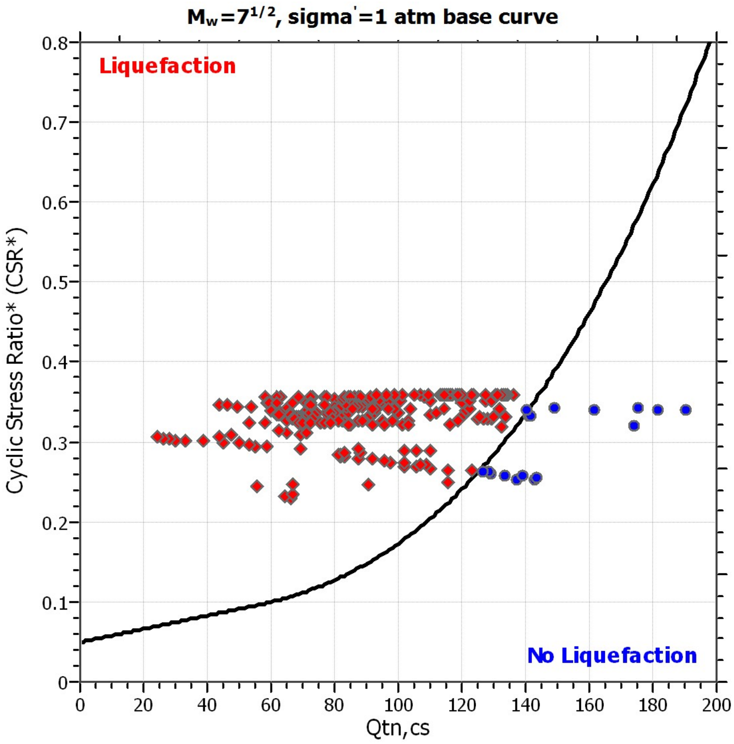
Project title : **Location :**

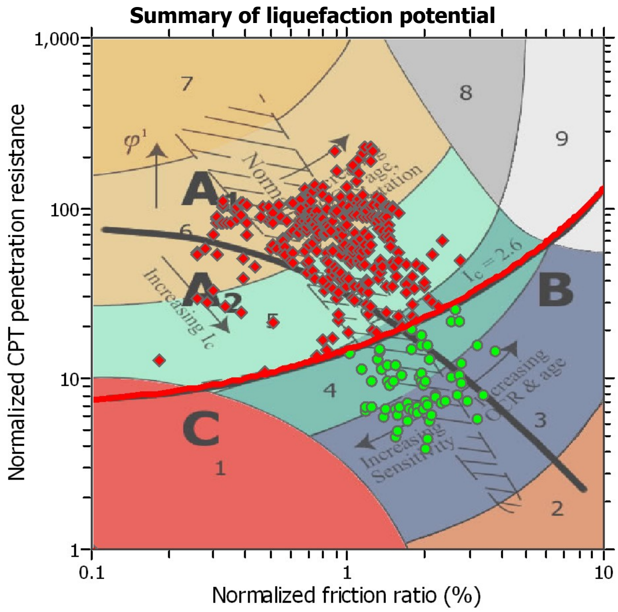
CPT file : CPT-01

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	10.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	10.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.01	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.43	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

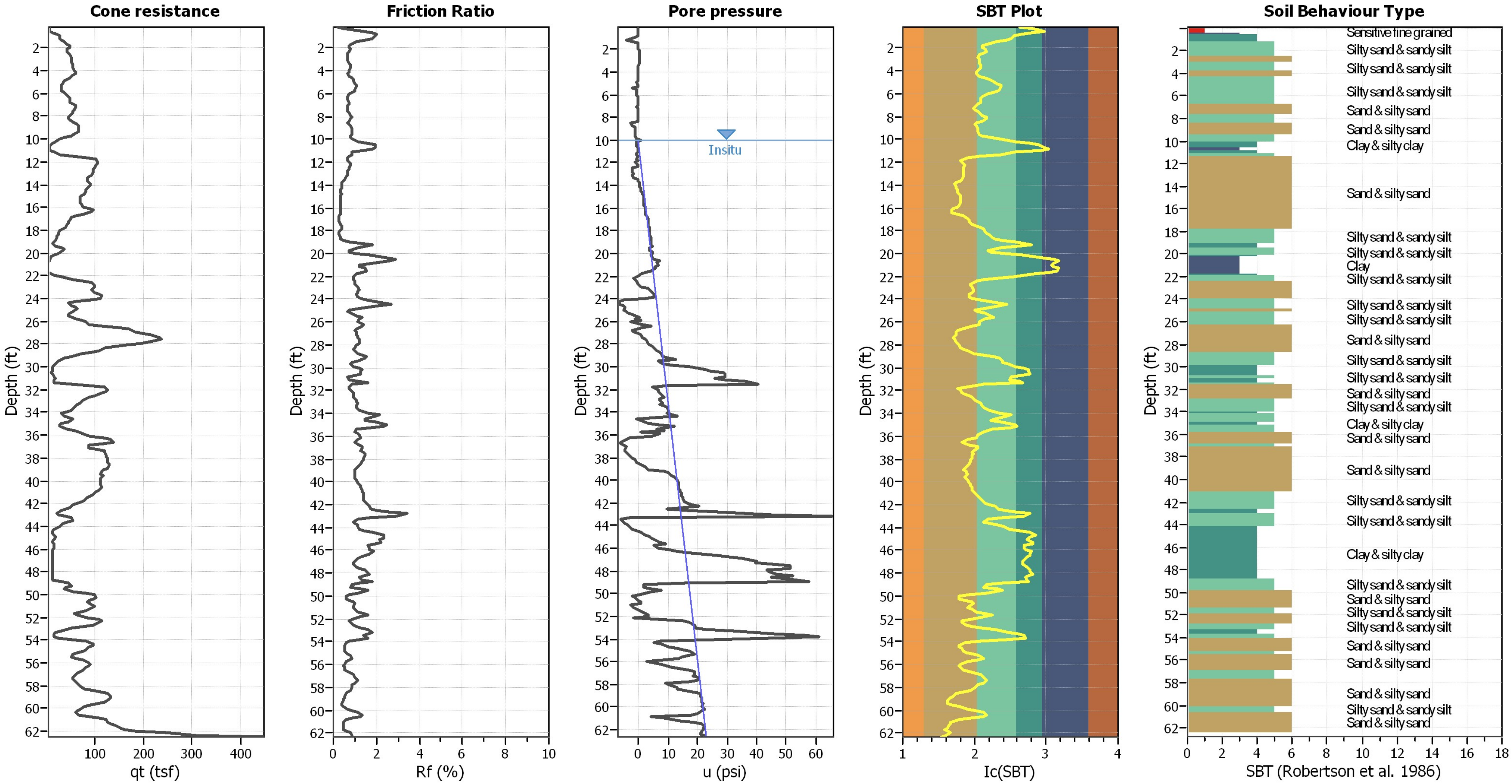






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



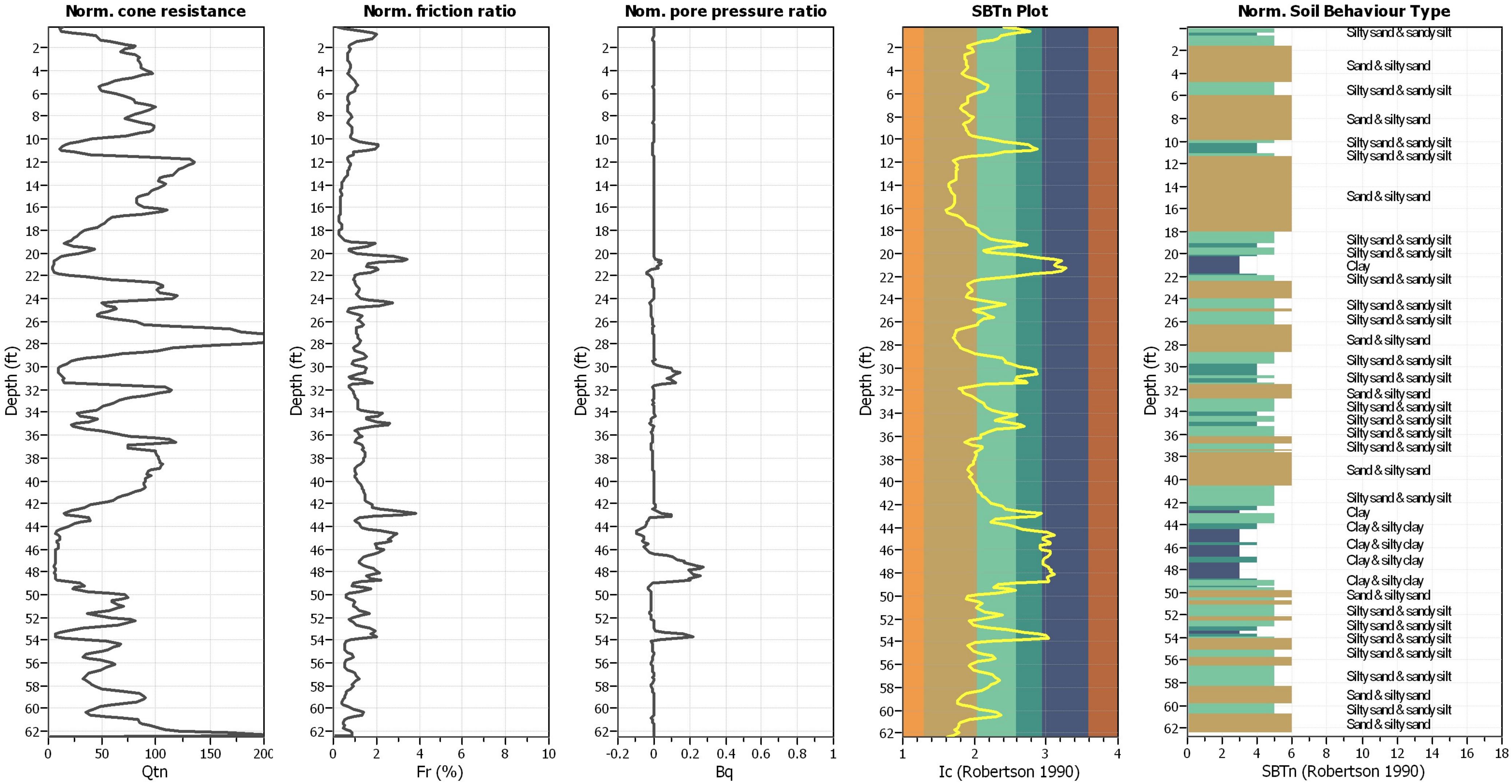
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	10.00 ft	Fill weight:	N/A		
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No		
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes		
Earthquake magnitude M_w:	7.01	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only		
Peak ground acceleration:	0.43	Use fill:	No	Limit depth applied:	No		
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A		

SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

CPT basic interpretation plots (normalized)



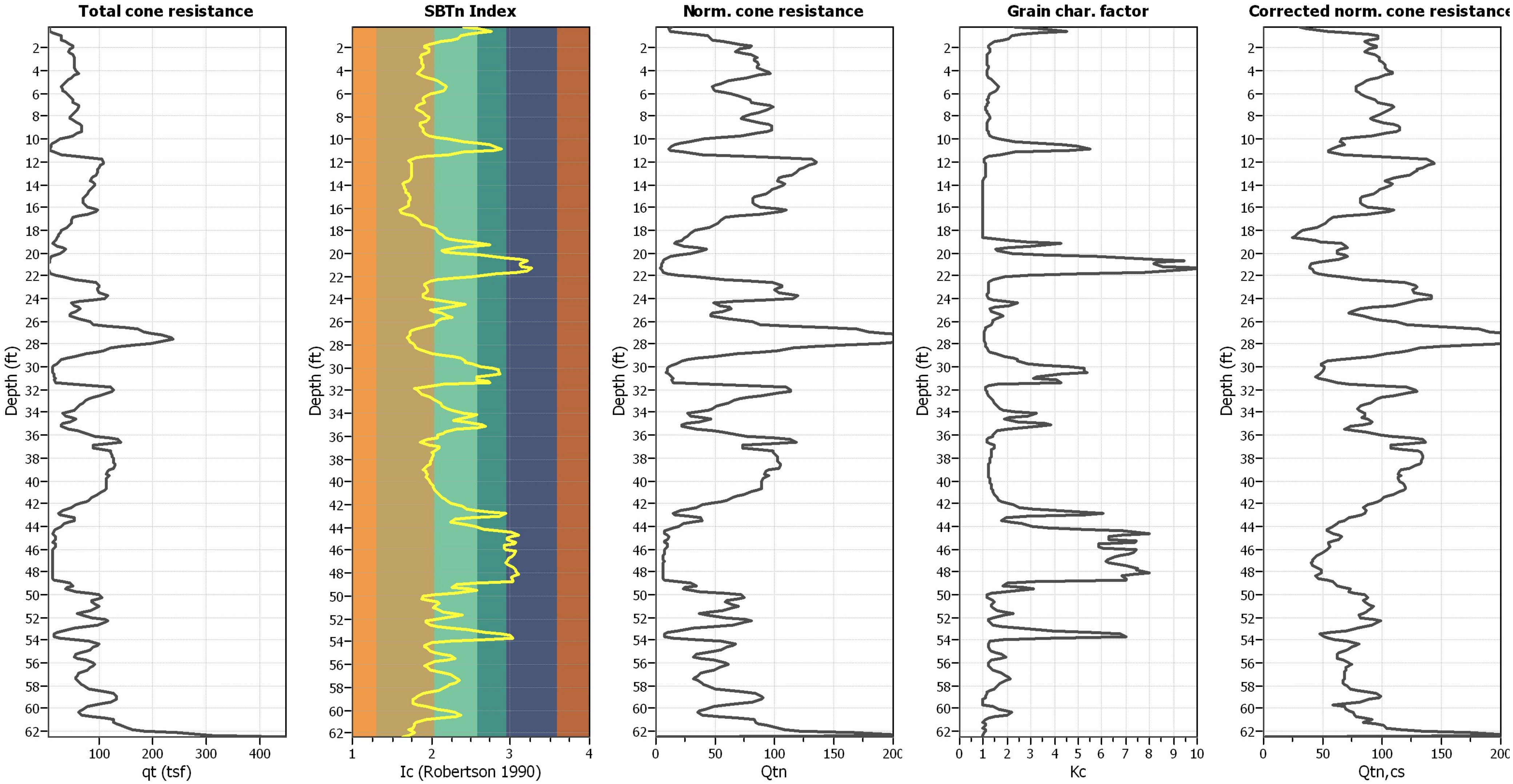
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	10.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.01	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.43	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

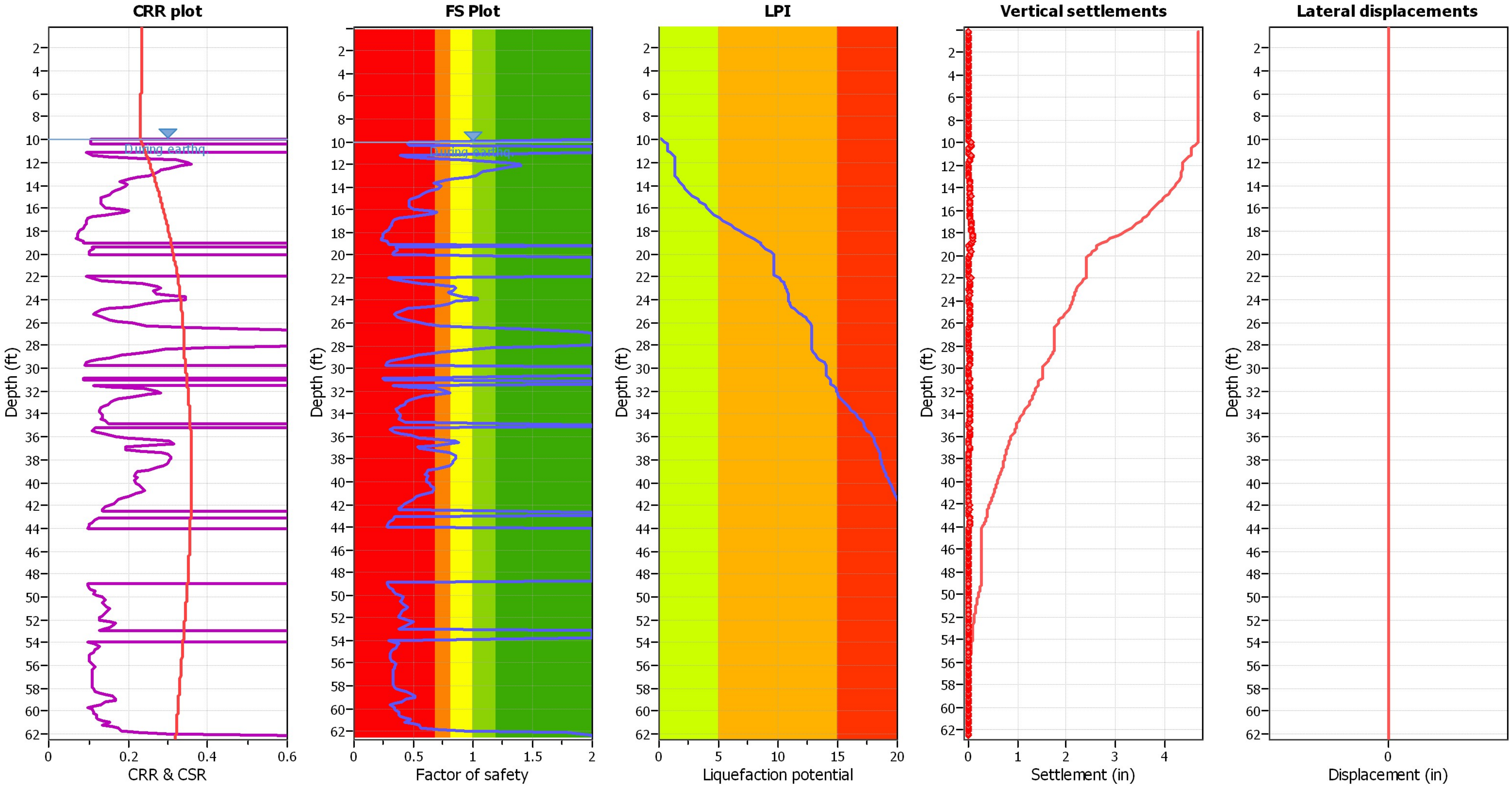
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	10.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.01	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.43	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	10.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.01	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.43	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

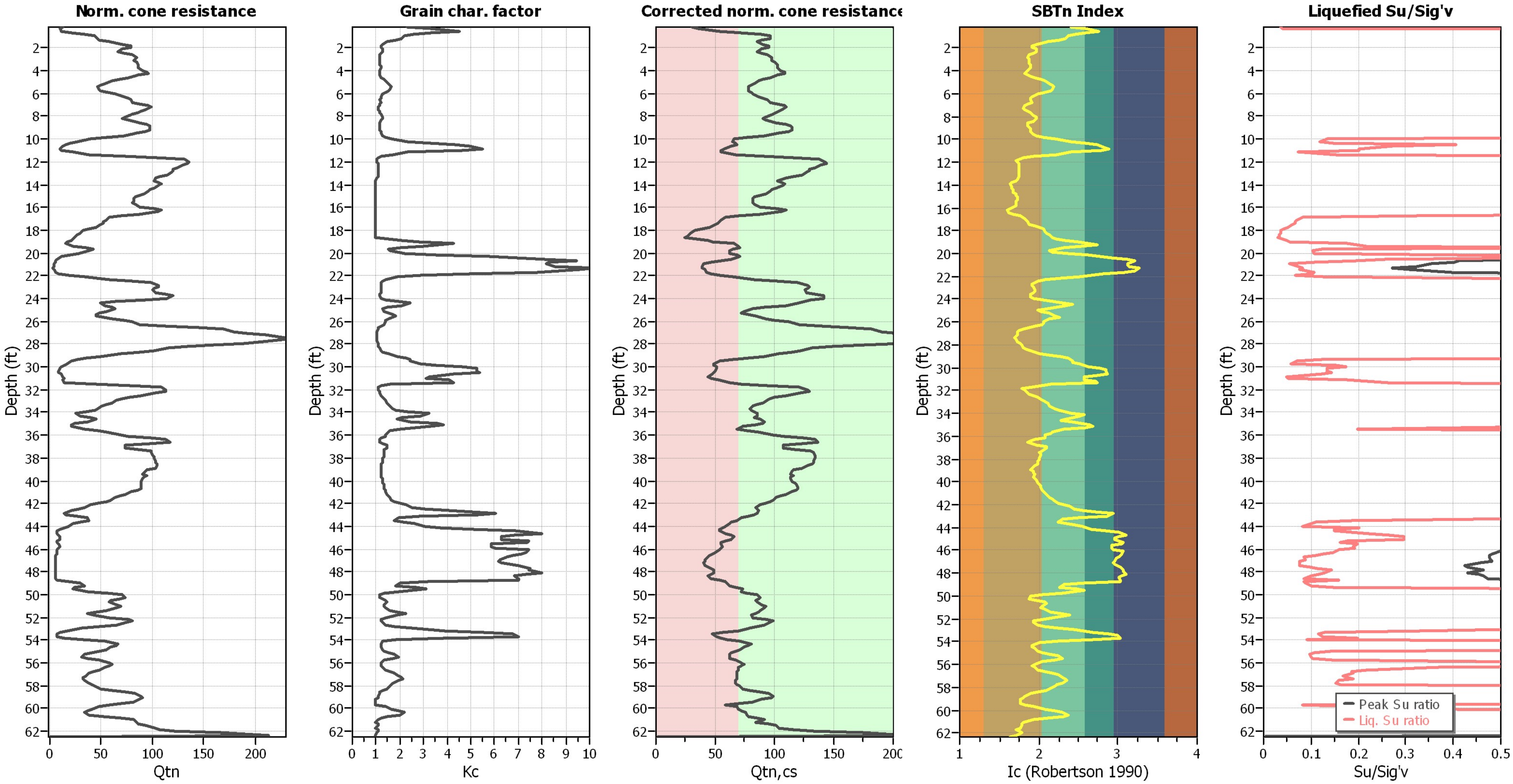
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	10.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.01	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.43	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

Professional Service Industries, Inc.
20508 56th Avenue W, Suite A
Lynnwood, WA 98036
Phone: 425-409-2504

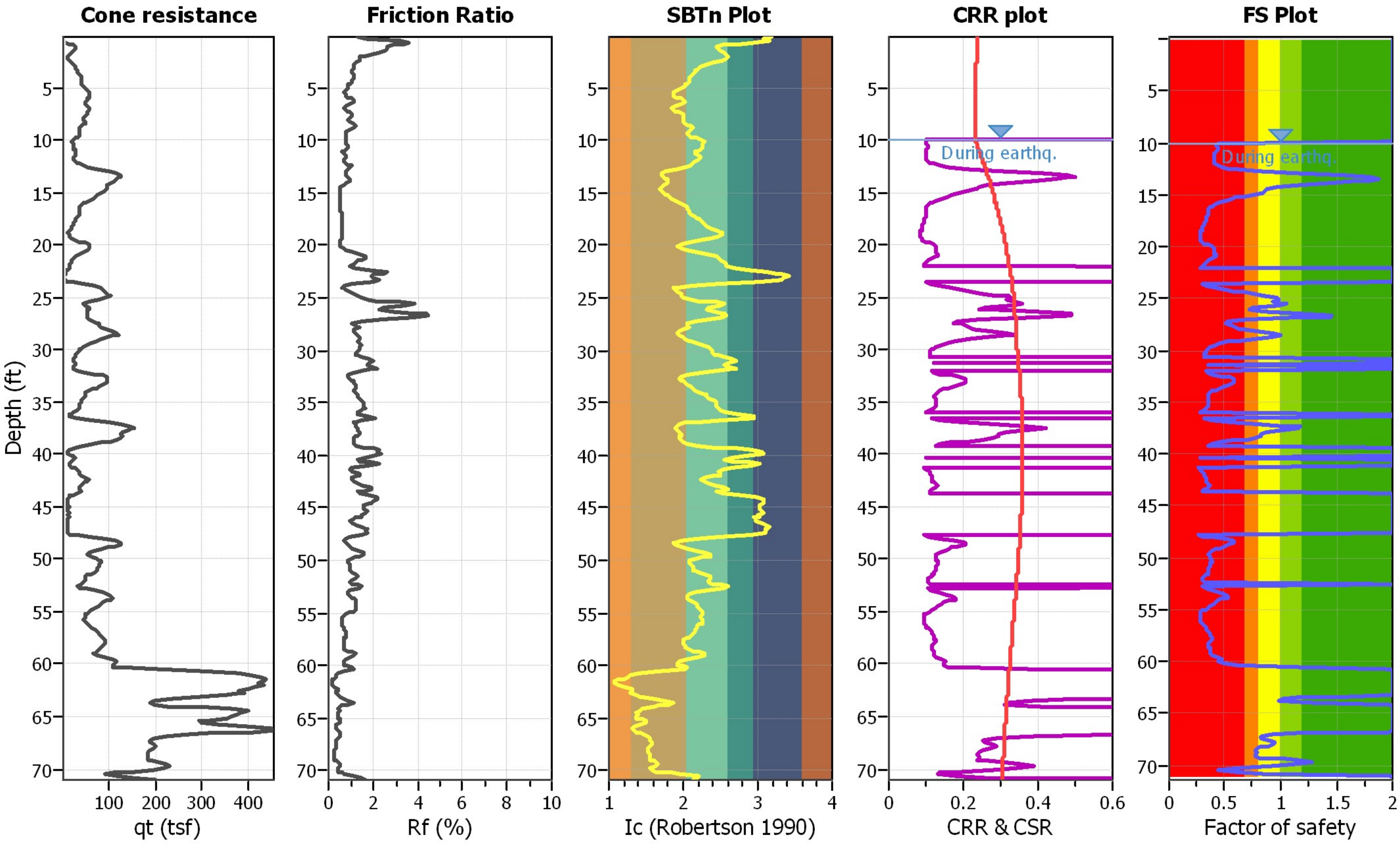
LIQUEFACTION ANALYSIS REPORT

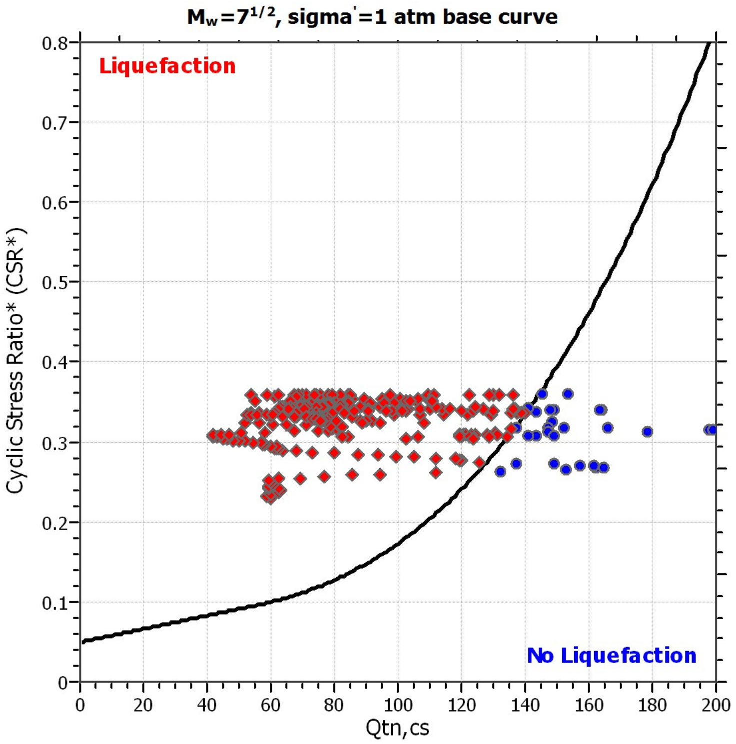
Project title : **Location :**

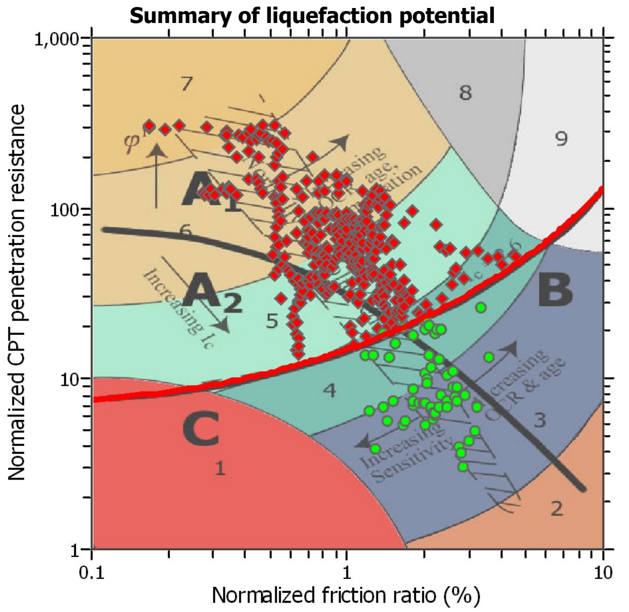
CPT file : CPT-02

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	10.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	10.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.01	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.43	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

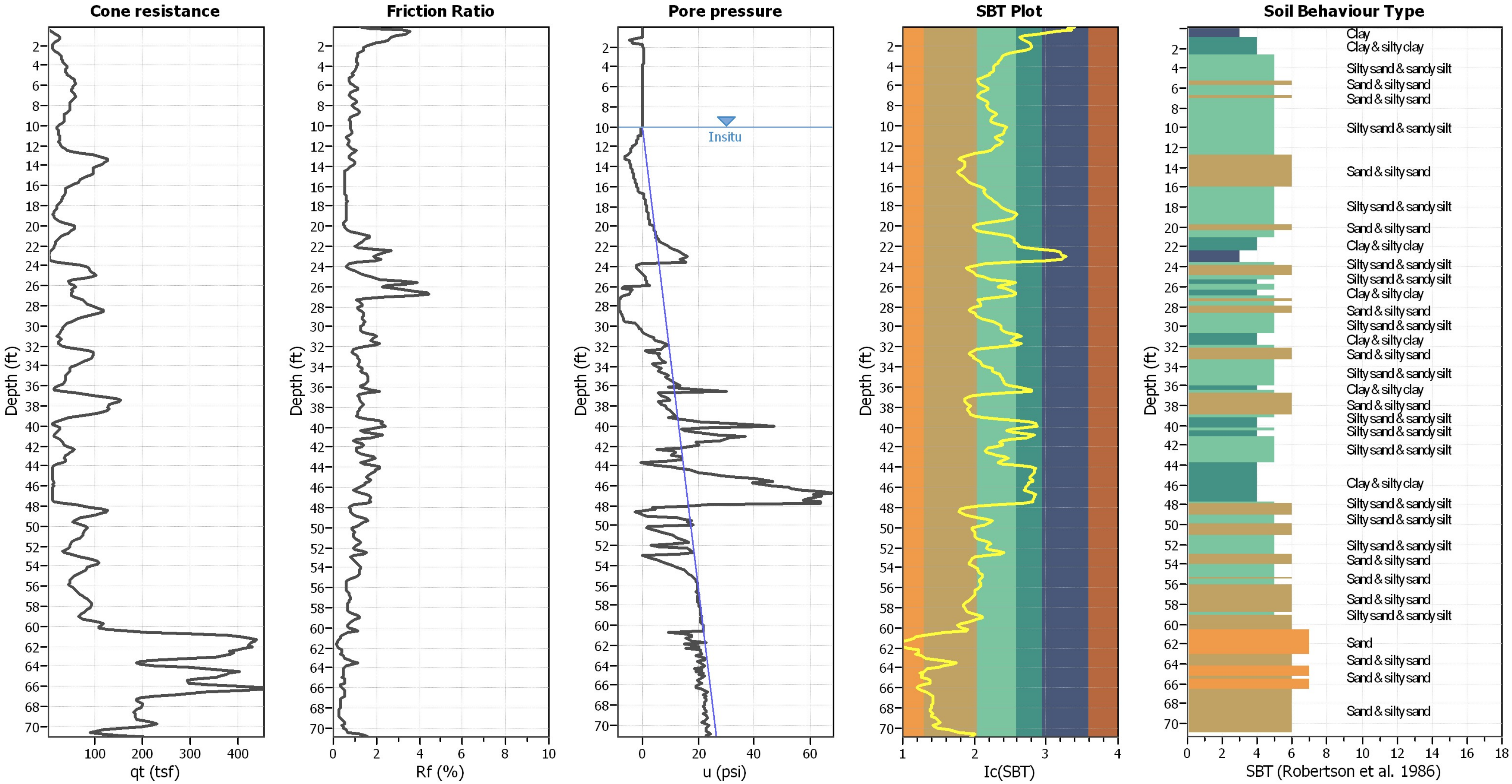






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



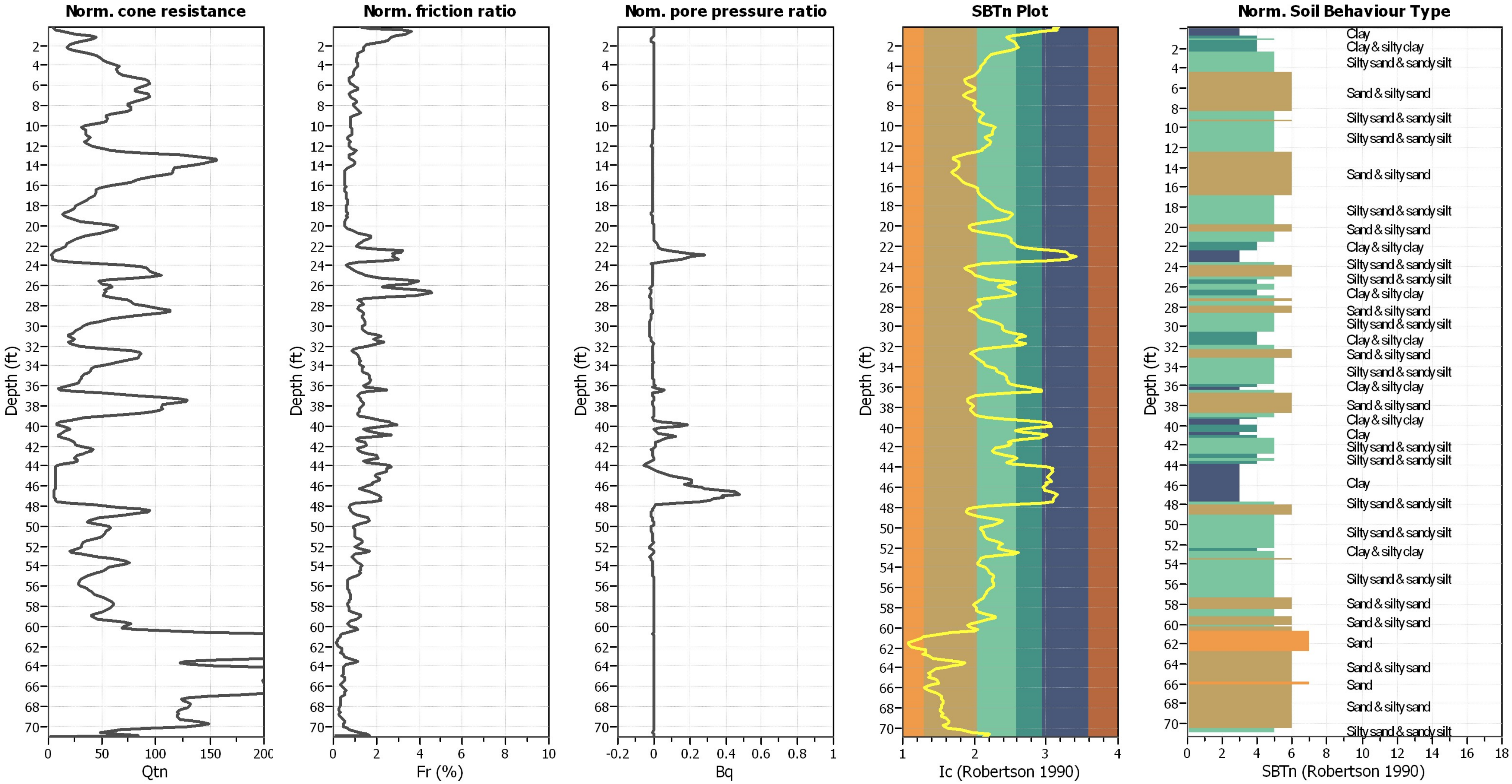
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	10.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.01	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.43	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normalized)



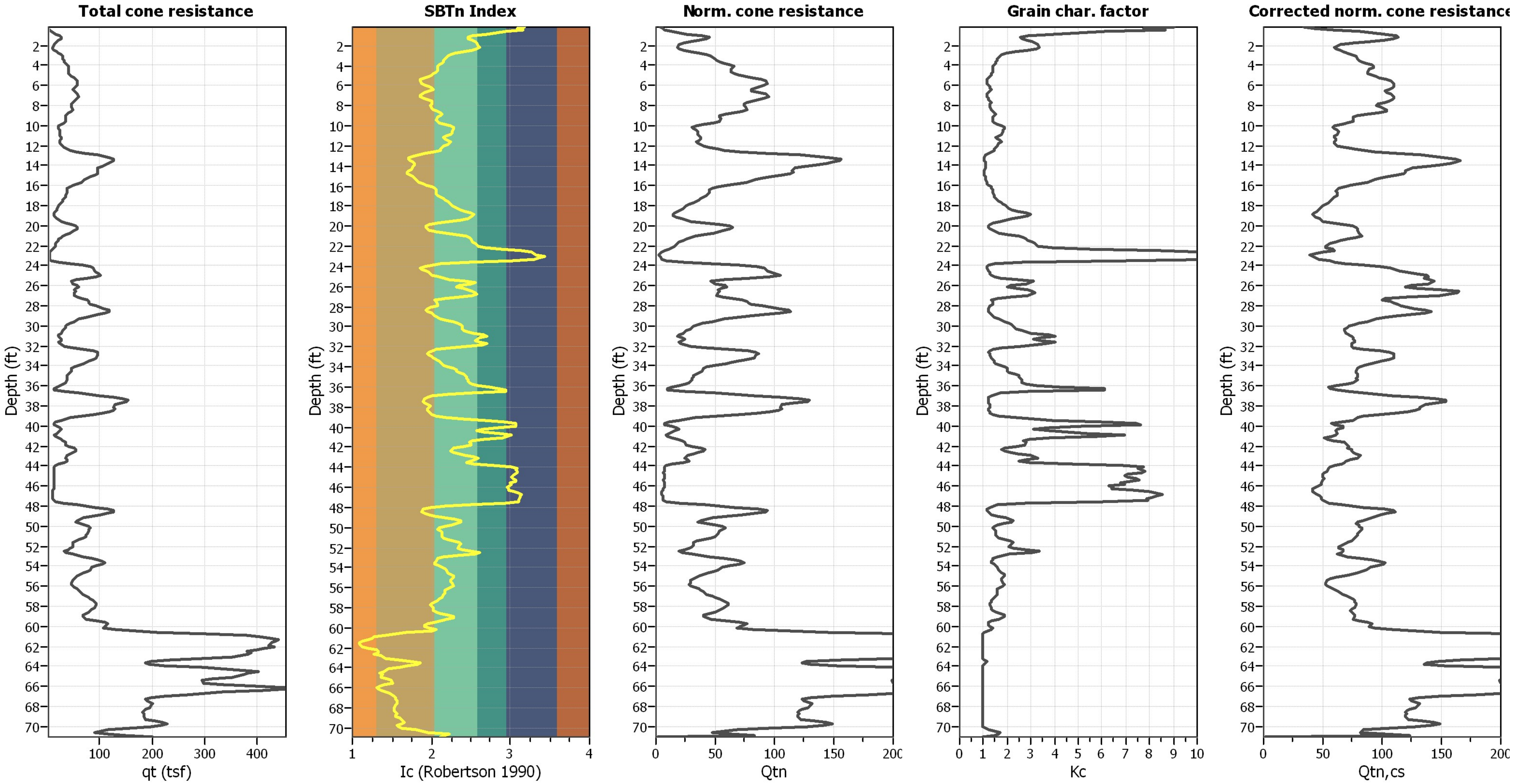
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	10.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.01	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.43	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

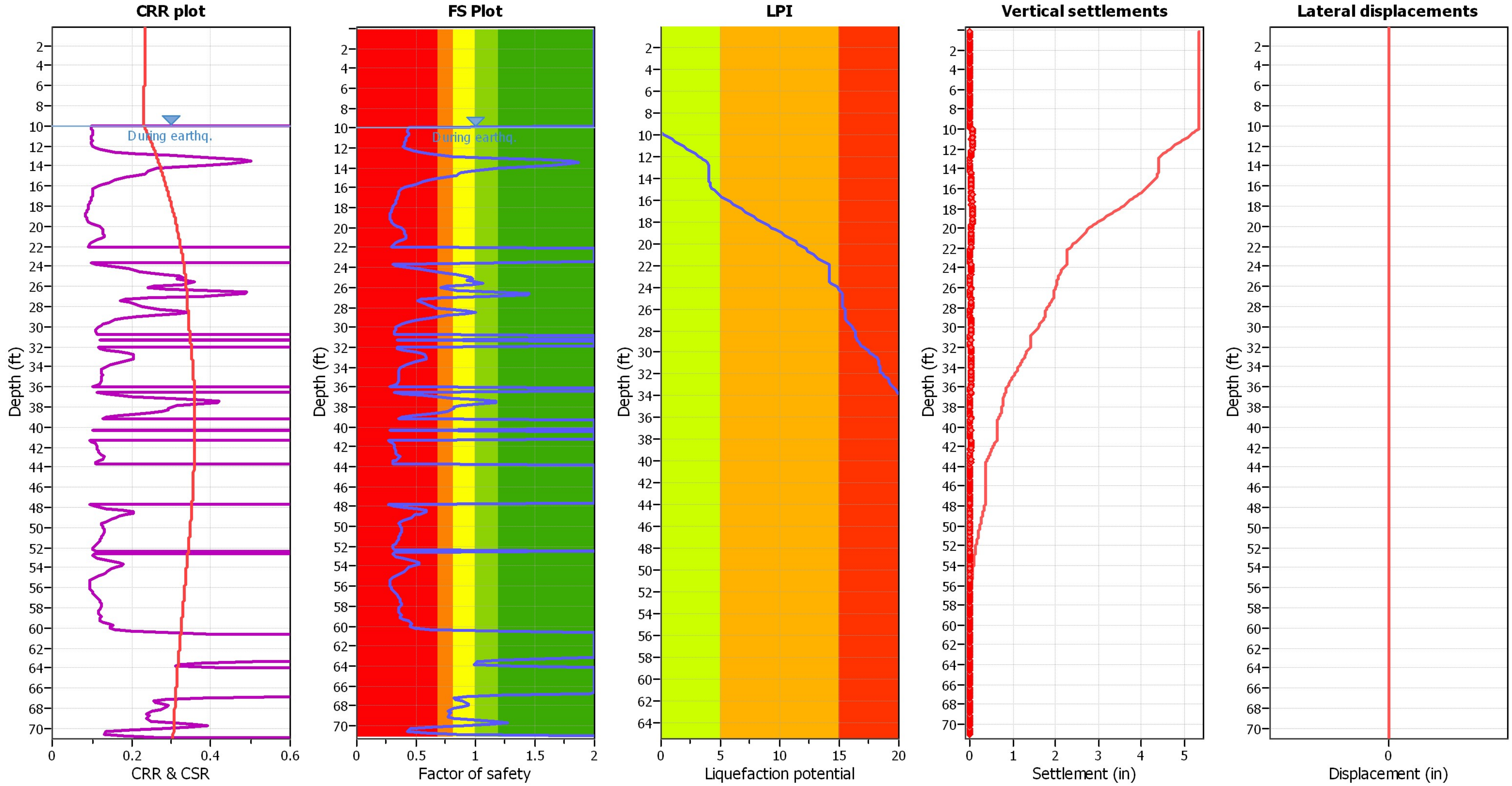
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	10.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.01	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.43	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	10.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.01	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.43	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

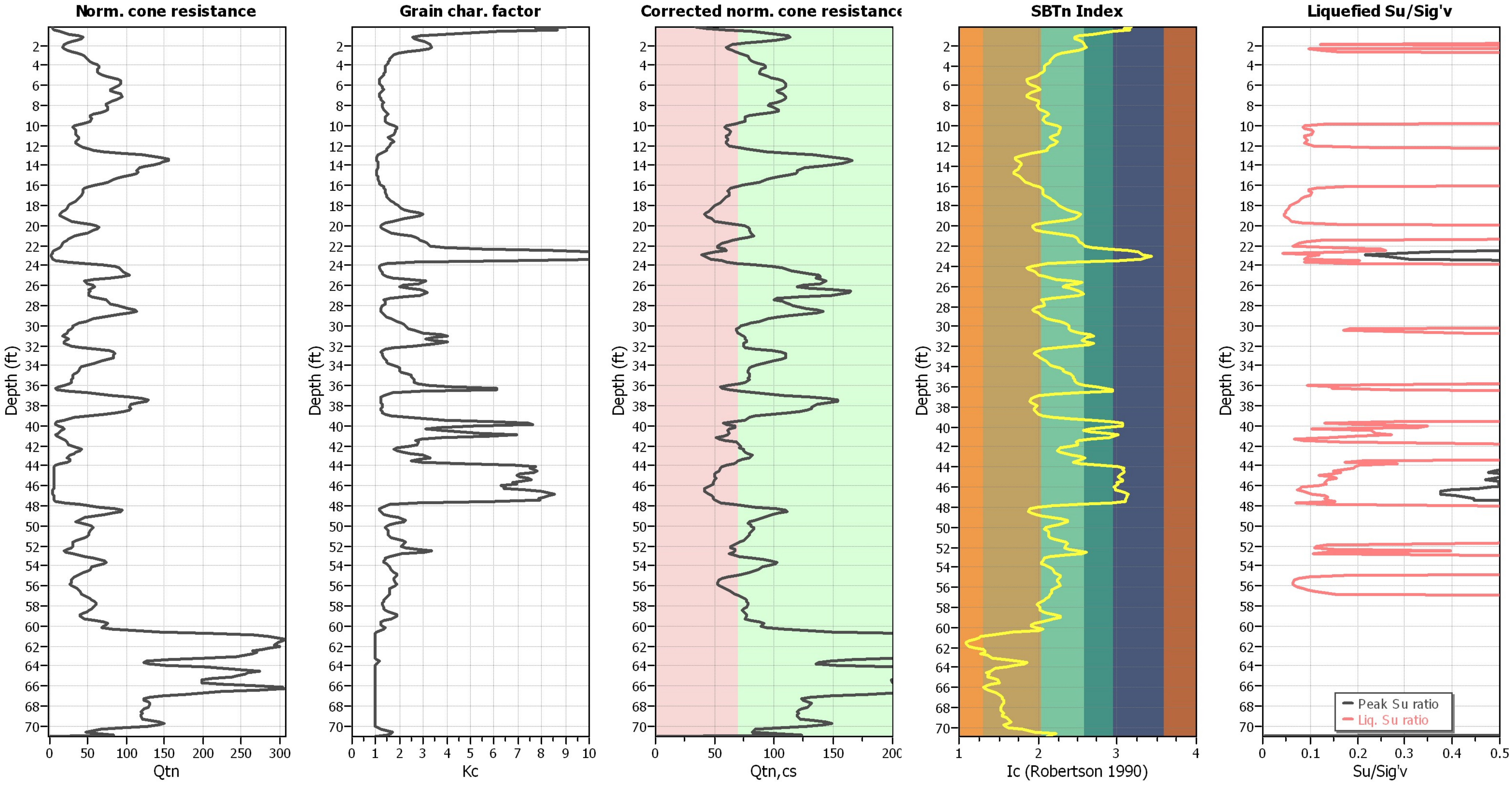
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	10.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	7.01	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.43	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

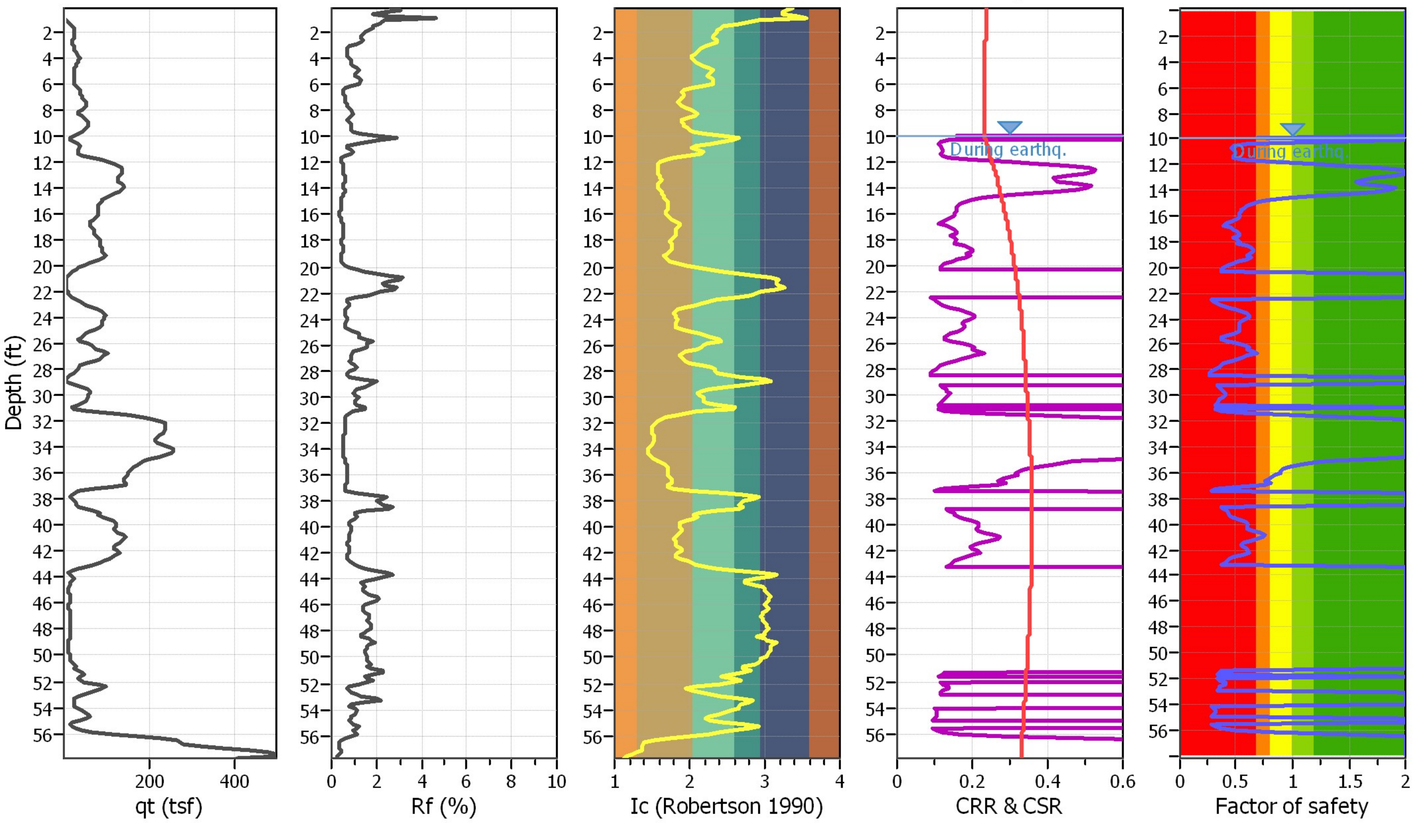
LIQUEFACTION ANALYSIS REPORT

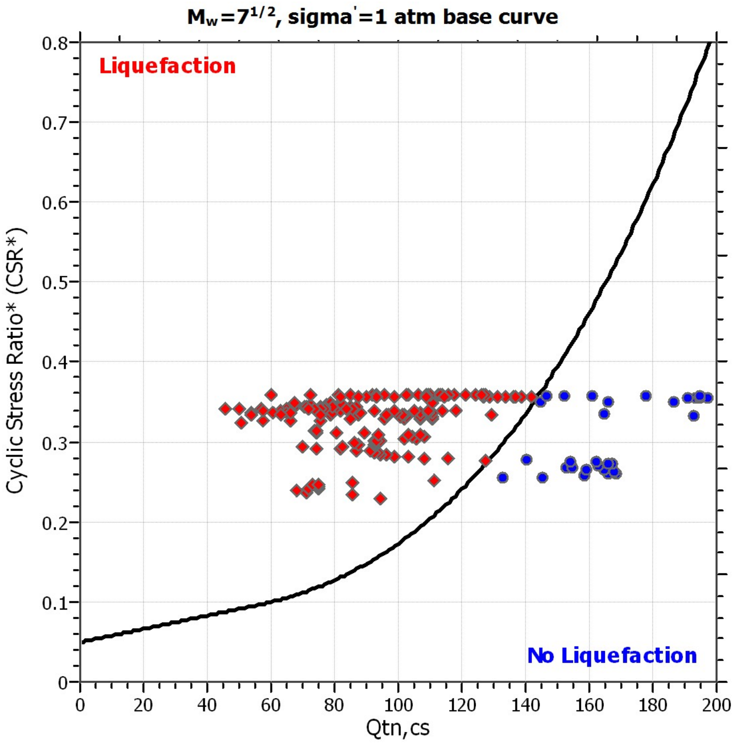
Project title : **Location :**

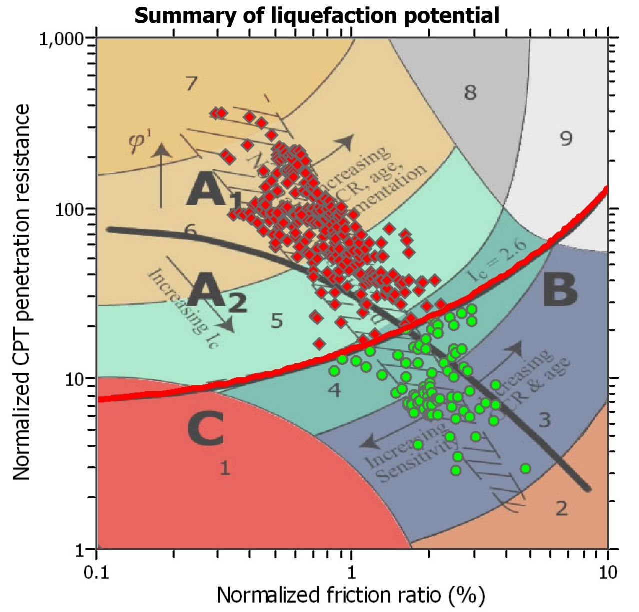
CPT file : CPT-03

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	10.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	10.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.01	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.43	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

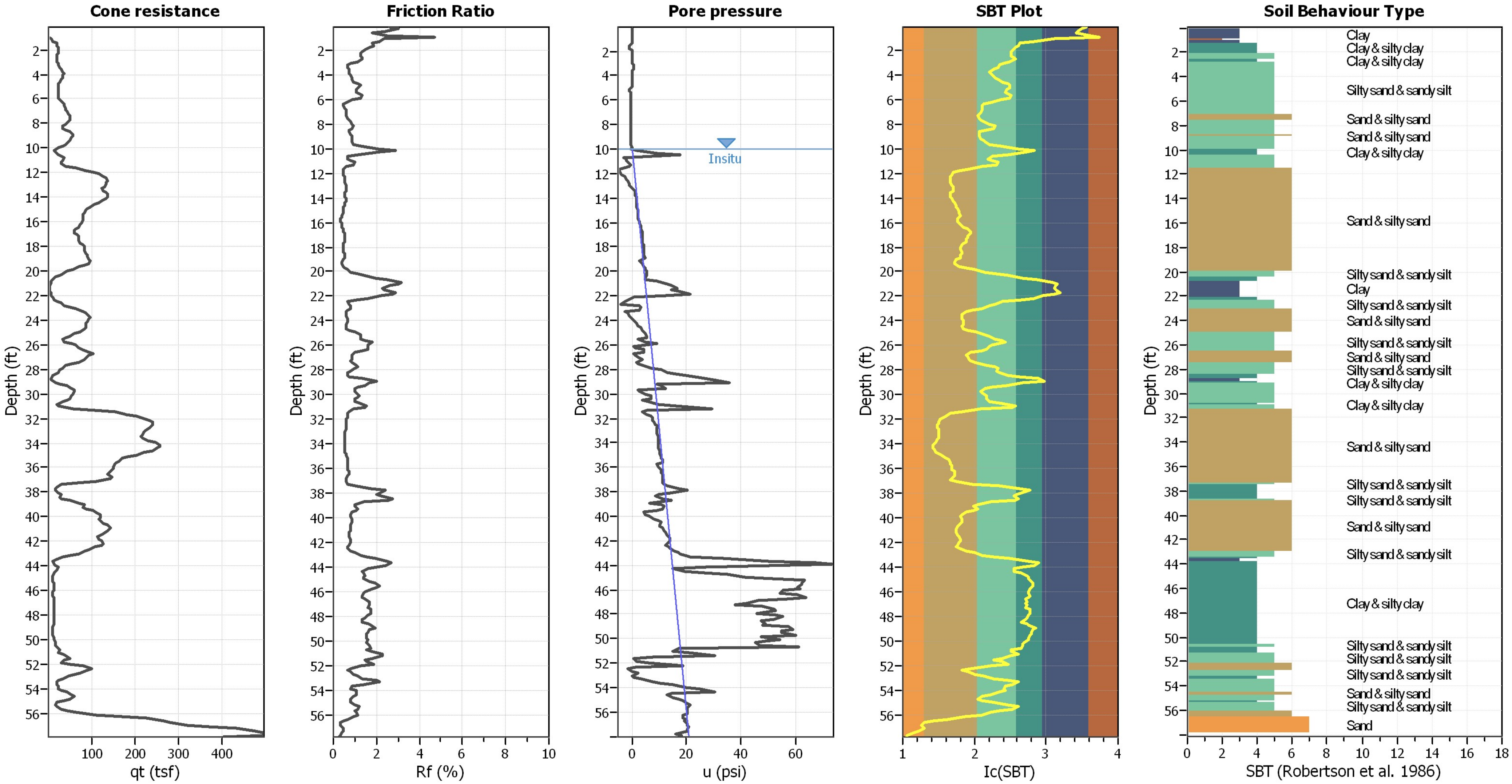






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



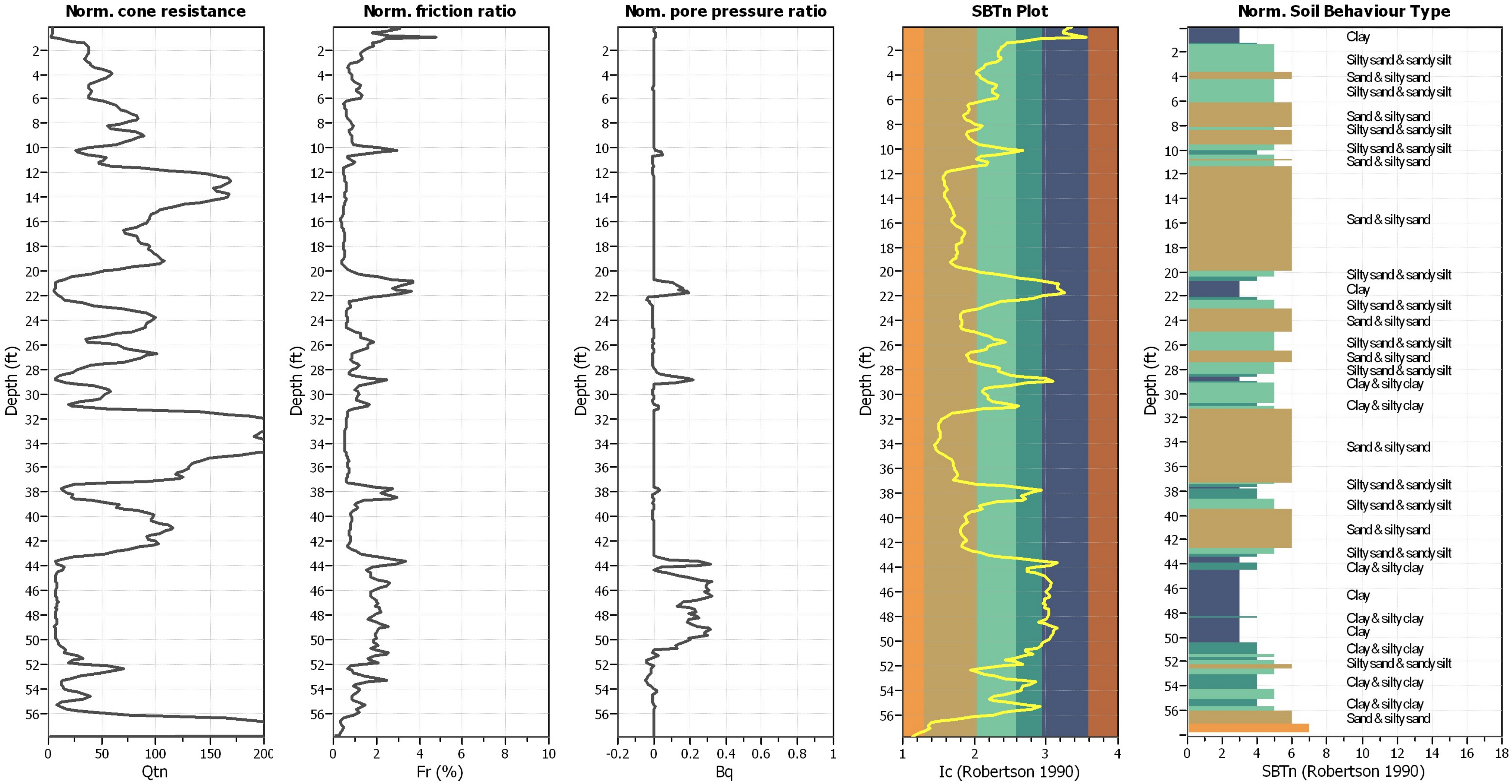
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	10.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.01	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.43	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normalized)



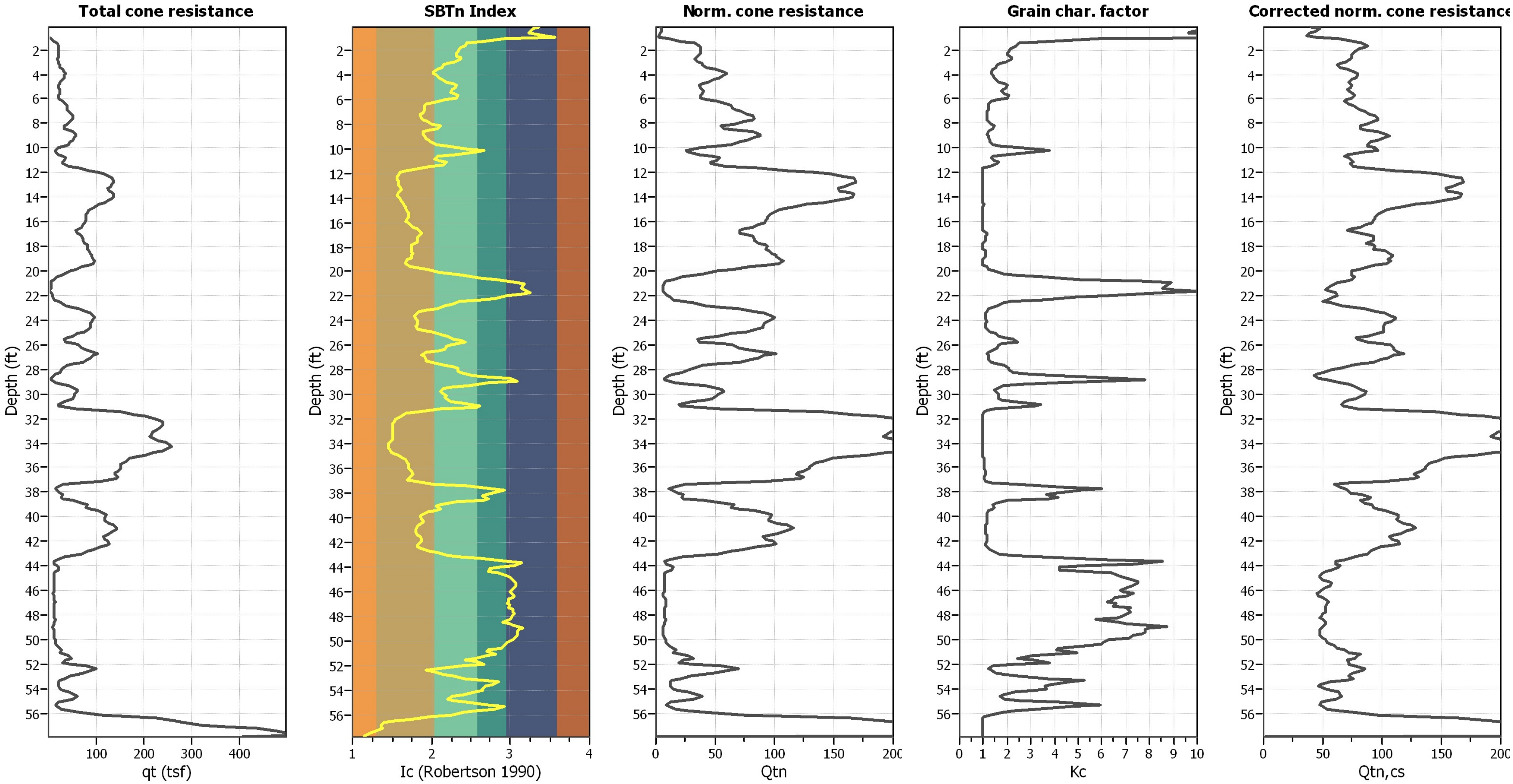
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	10.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.01	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.43	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

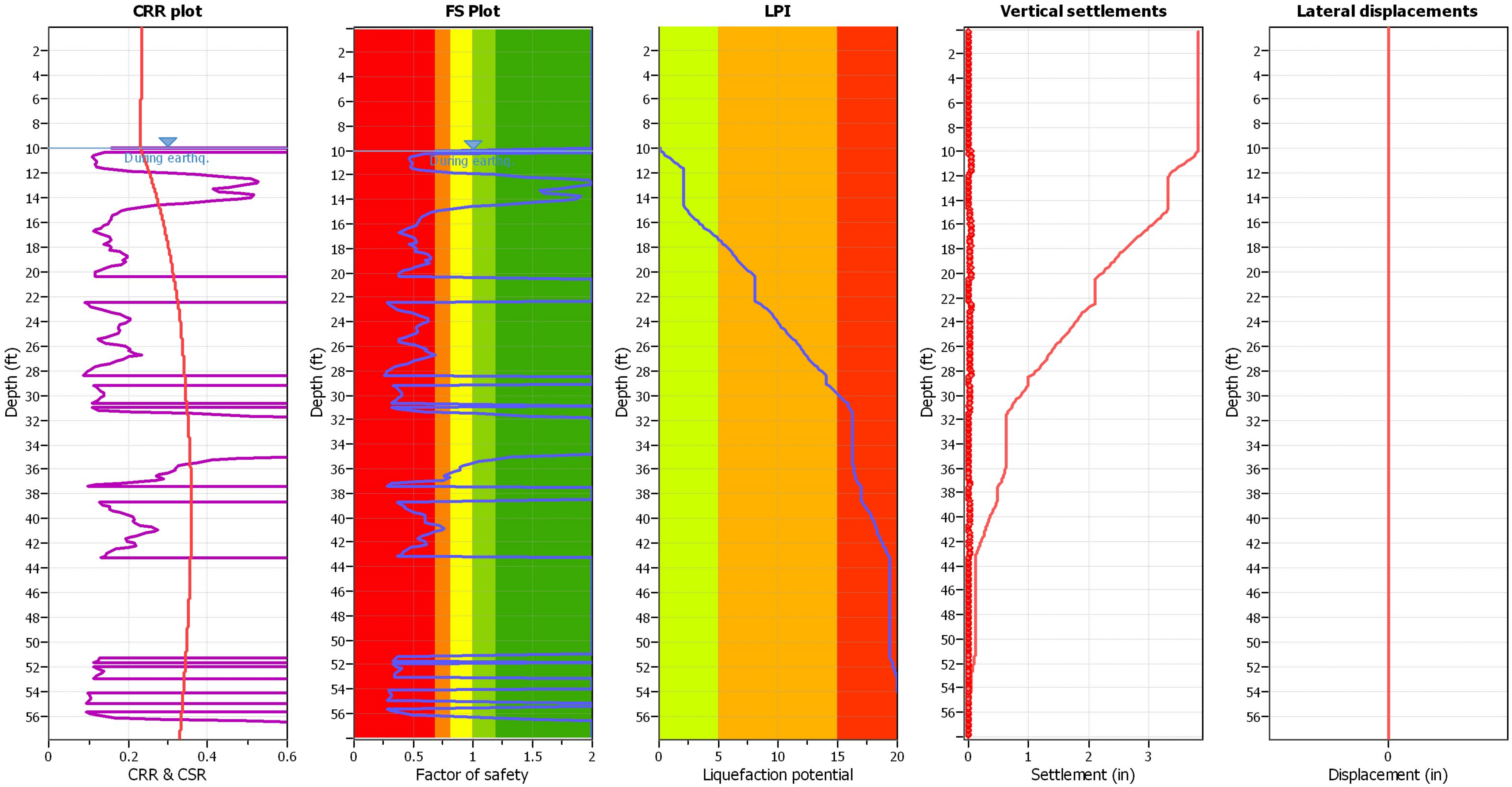
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	10.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.01	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.43	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	10.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.01	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.43	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

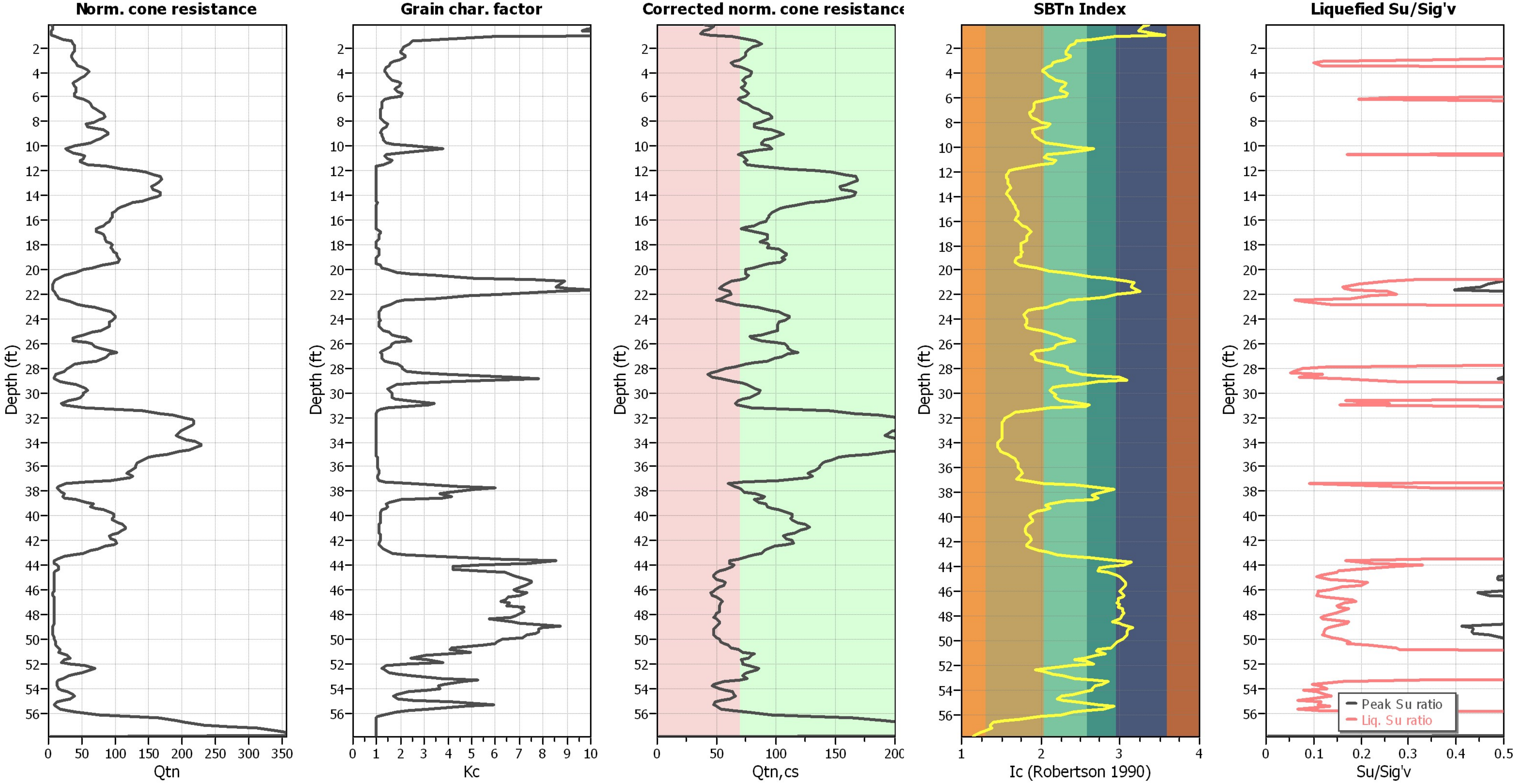
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))

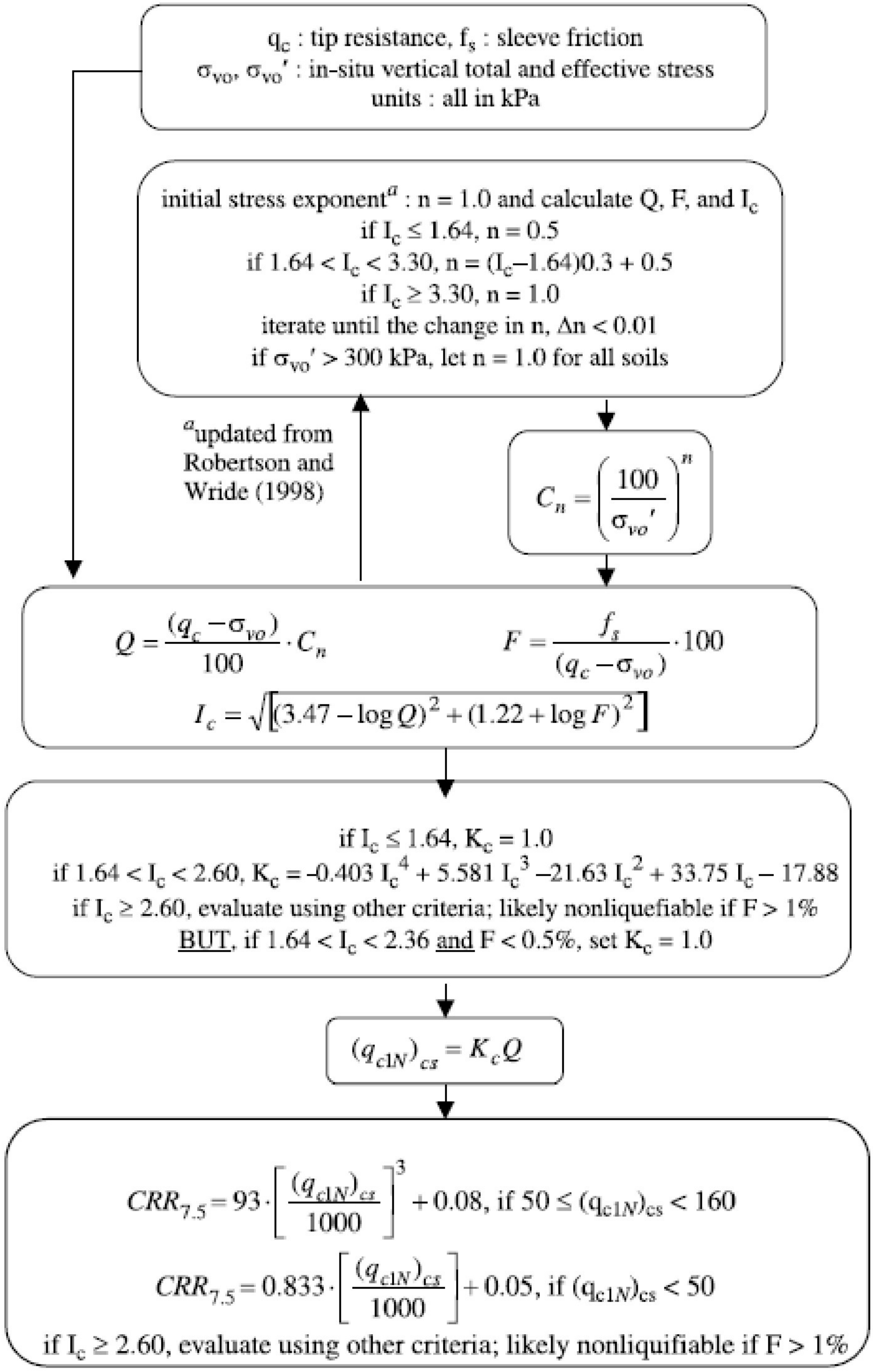


Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	10.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.01	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.43	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

Procedure for the evaluation of soil liquefaction resistance, NCEER (1998)

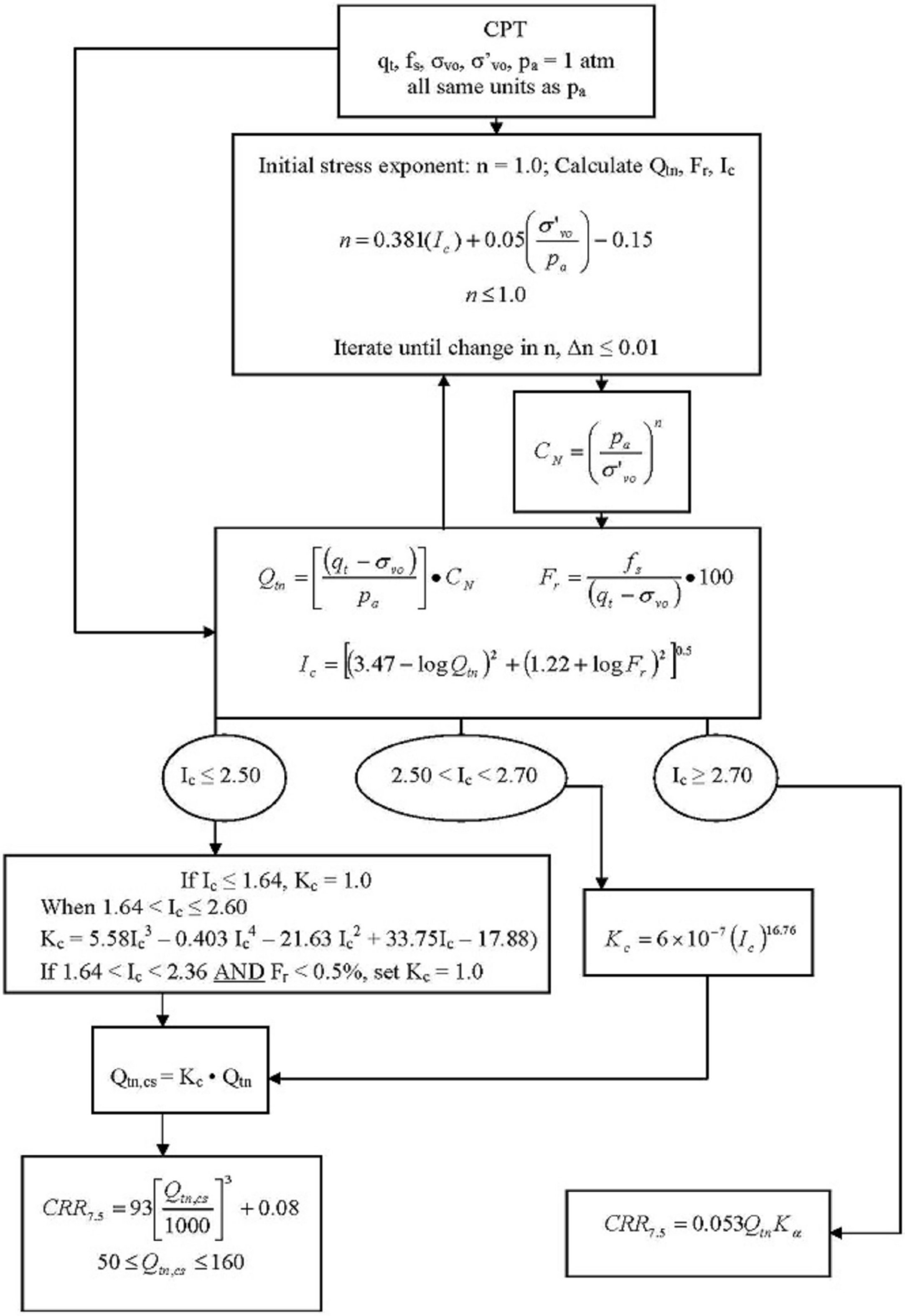
Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. The procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils). The revised procedure is presented below in the form of a flowchart[1]:



[1] "Estimating liquefaction-induced ground settlements from CPT for level ground", G. Zhang, P.K. Robertson, and R.W.I. Brachman

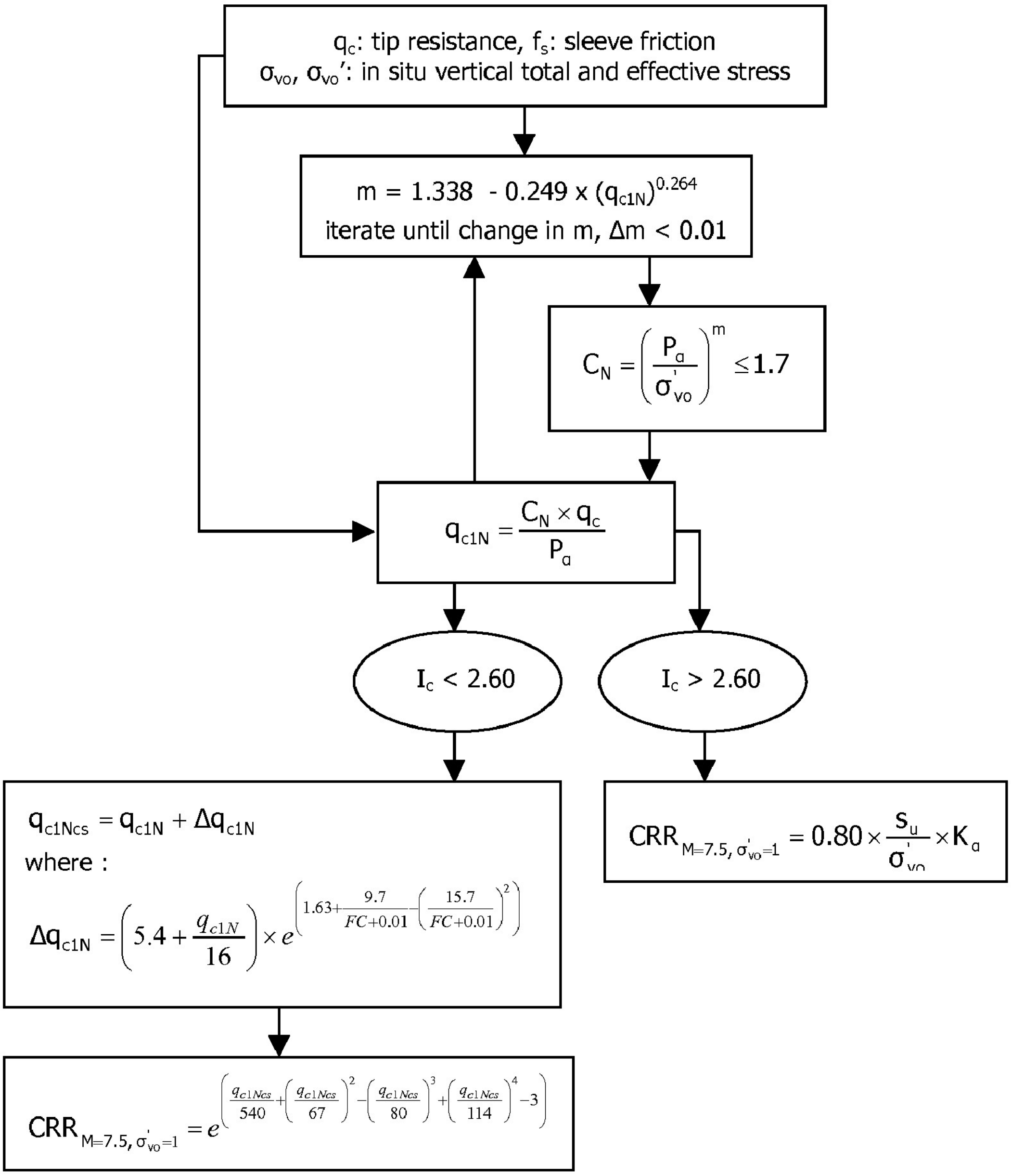
Procedure for the evaluation of soil liquefaction resistance (all soils), Robertson (2010)

Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. This procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils). The revised procedure is presented below in the form of a flowchart[1]:

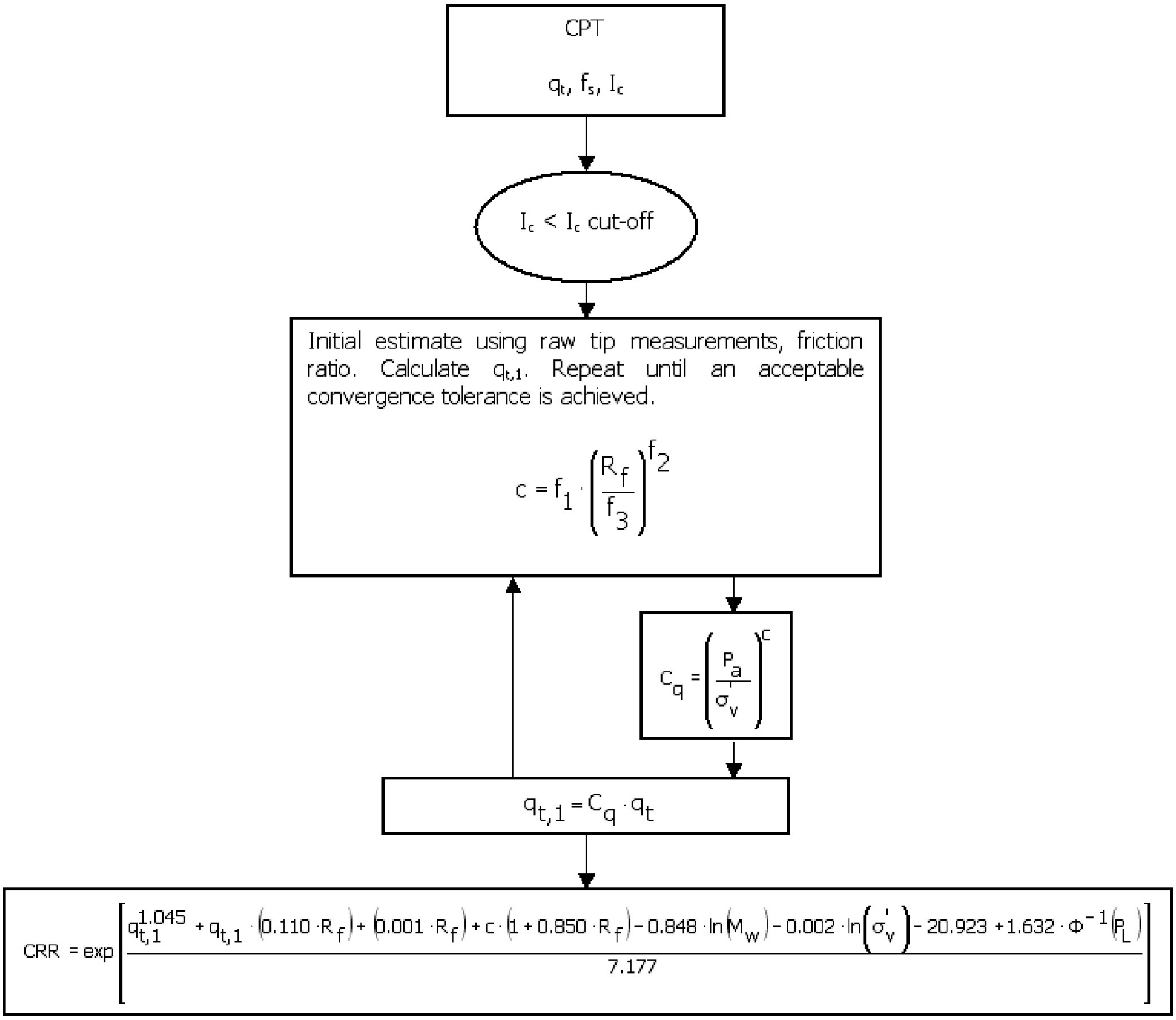


[1] P.K. Robertson, 2009. "Performance based earthquake design using the CPT", Keynote Lecture, International Conference on Performance-based Design in Earthquake Geotechnical Engineering – from case history to practice, IS-Tokyo, June 2009

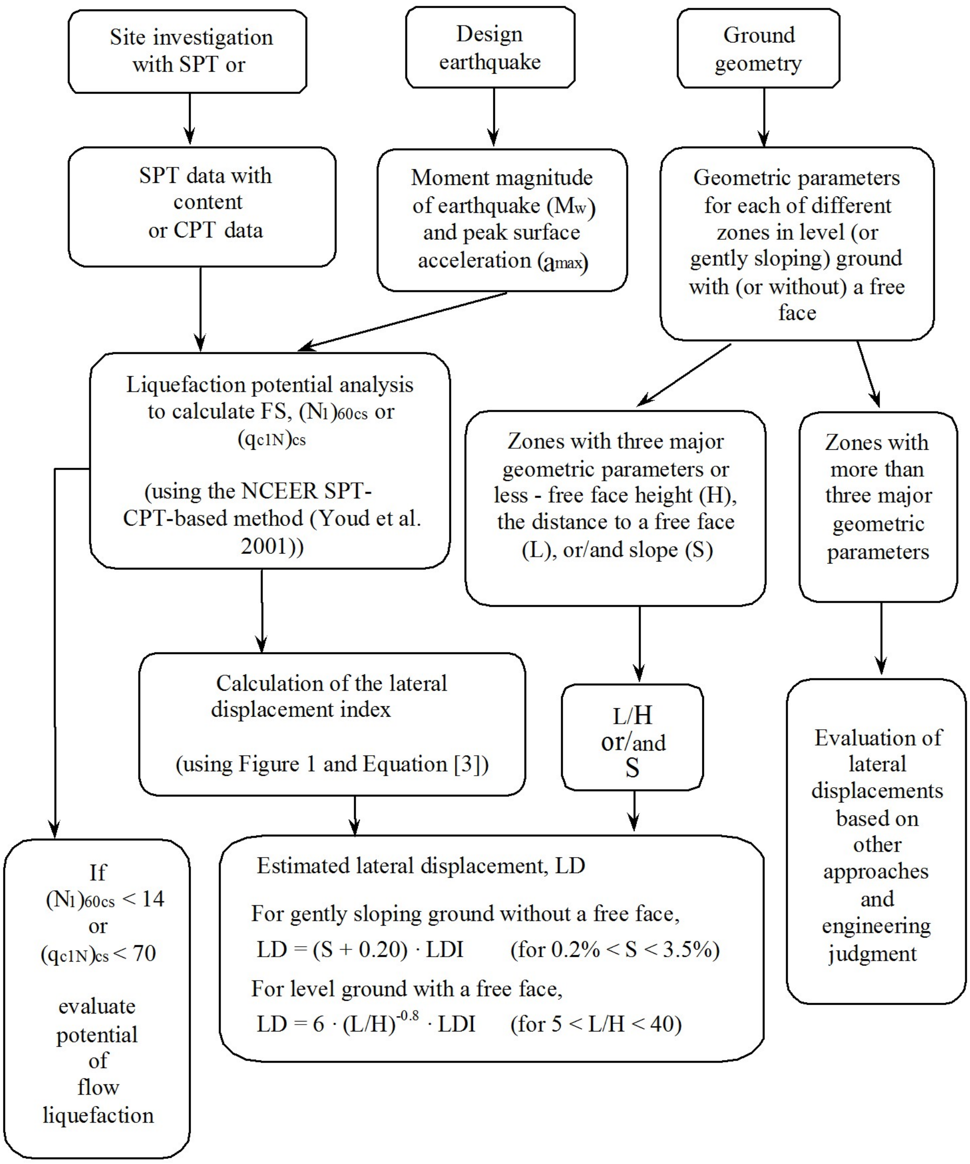
Procedure for the evaluation of soil liquefaction resistance, Idriss & Boulanger (2008)



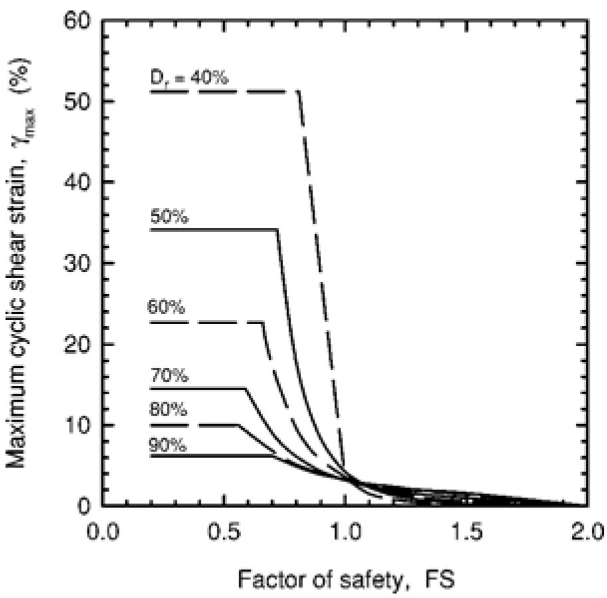
Procedure for the evaluation of soil liquefaction resistance (sandy soils), Moss et al. (2006)



Procedure for the evaluation of liquefaction-induced lateral spreading displacements



[1] Flow chart illustrating major steps in estimating liquefaction-induced lateral spreading displacements using the proposed approach



[1] **Figure 1**

$$LDI = \int_0^{Z_{max}} \gamma_{max} dz$$

[1] **Equation [3]**

[1] "Estimating liquefaction-induced ground settlements from CPT for level ground", G. Zhang, P.K. Robertson, and R.W.I. Brachman

Procedure for the estimation of seismic induced settlements in dry sands

Average shear stress, τ_{av}

$$\tau_{av} = CSR^{*} \cdot \sigma_{v0}' = 0.65 \cdot \frac{a_{max}}{g} \cdot \sigma_{v0} \cdot \tau_{a}$$

↓

Estimate small shear strain modulus, G_0

$$G_0 = 0.0188 \cdot \left[10^{(0.55 I_c - 1.68)}\right] \cdot (q_t - \sigma_v)$$

↓

Estimate shear strain amplitude, γ (based on Pradel (1998))

$$\gamma = \left[\frac{1 + \alpha \cdot e^{bR}}{1 + \alpha}\right] \cdot R \cdot 100\ (\%)$$

$$R = \frac{\tau_{av}}{G_0}\ (\text{Note } \tau_{av} \text{ and } G_0 \text{ same units})$$

$$\alpha = 0.0389 \cdot \left(\frac{\sigma_v}{p_a}\right) + 0.124$$

$$b = 6400 \cdot \left(\frac{\sigma_v}{p_a}\right)$$

↓

Estimate volumetric strain in 15 cycles

$$\varepsilon_{vol(15)} = \gamma \cdot \left[\frac{(N_1)_{60,cs}}{20}\right]^{-1.20}$$

$$(N_1)_{60,cs} = \frac{Q_{tn,cs}}{8.5 \cdot \left[1 - \frac{I_c}{4.6}\right]}$$

↓

Volumetric strain in design earthquake

$$\Sigma_{vol} = \varepsilon_{vol(15)} \cdot \left[\frac{N_c}{15}\right]^{0.45}$$

$$N_c = (M - 4)^{2.17}$$

↓

Seismic settlement, s

$$s = 2 \cdot \int_{0}^{GWT} \Sigma_{vol} \cdot dz$$

Robertson, P.K. and Lisheng, S., 2010, "Estimation of seismic compression in dry soils using the CPT" FIFTH INTERNATIONAL CONFERENCE ON RECENT ADVANCES IN GEOTECHNICAL EARTHQUAKE ENGINEERING AND SOIL DYNAMICS, Symposium in honor of professor I. M. Idriss, San Diego, CA

Liquefaction Potential Index (LPI) calculation procedure

Calculation of the Liquefaction Potential Index (LPI) is used to interpret the liquefaction assessment calculations in terms of severity over depth. The calculation procedure is based on the methology developed by Iwasaki (1982) and is adopted by AFPS.

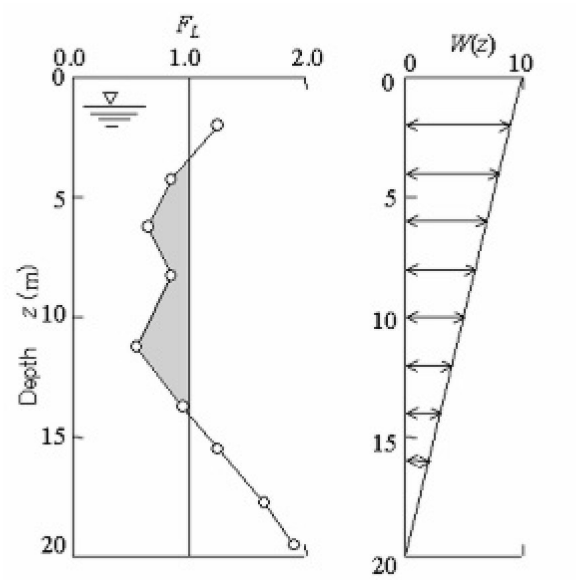
To estimate the severity of liquefaction extent at a given site, LPI is calculated based on the following equation:

$$\textbf{LPI} = \int_0^{20} (10 - 0{,}5_z) \times F_l \times d_z$$

where:
F_L = 1 - F.S. when F.S. less than 1
F_L = 0 when F.S. greater than 1
z depth of measurment in meters

Values of LPI range between zero (0) when no test point is characterized as liquefiable and 100 when all points are characterized as susceptible to liquefaction. Iwasaki proposed four (4) discrete categories based on the numeric value of LPI:

- LPI = 0 : Liquefaction risk is very low
- 0 < LPI <= 5 : Liquefaction risk is low
- 5 < LPI <= 15 : Liquefaction risk is high
- LPI > 15 : Liquefaction risk is very high



Graphical presentation of the LPI calculation procedure

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Appendix H: Operations and Maintenance Manual

Draft Operations and Maintenance Manual*