Geotechnical Report for Deck

3730 SW Anchor Court
Lincoln City, Oregon

Prepared for:
TnT Builders

3 August 2022
Revised and updated 3 May 2023
Revised 14 July 2023
Revised 21 November 2023

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Portland, OR
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PROJECT AND SITE DESCRIPTIONS

Introduction

Rapid Soil Solutions Inc (RSS) has prepared this geotechnical report, as requested, for the proposed deck addition located at the Lincoln County tax lot currently assigned the site address of 3730 SW Anchor Ct. The subject site is an ocean front property in the greater southern end of Lincoln City. The site plan provided to RSS illustrates the new deck adjoining the western edge of the existing residence. The deck is setback at least 15-ft from the northwestern boundary line of the parcel and overlooks the sandy Lincoln Beach from the east. The purpose of this report is to assess the geotechnical suitability of the subject site and provide geotechnical recommendations based on visual observations, collected soils samples and review of available literatures.

The site is located off the terminus of SW Anchor Ct and about 365-ft north from its intersection with SW 37th Pl. It is tucked about 0.29-miles west of SE Spy Glass Ridge Dr, 0.30-miles southwest of SE 32nd St and 540-ft west of Oregon Coast Hwy (Hwy 101). Neighboring parcels to the site include 3709 SW Anchor Ave (north) and 3733 SW Anchor Ct (south). A vacant and wooded 0.19-acres tax lot borders the site to the east.

The property can be found in the southeastern segment of the northwest quarter of Section 27, Township 7-South, Range 11-West (W.M.) in Lincoln County and distinguished by the tax lot number of 07-11-27-BD-01901-00. The alternate account number of the site is R210120. The legal description of the site is 'TWNSHP 07, RNG 11, ACRES 0.18, DOC202011170'. The latitude and longitude of the site are 44.939467 and -124.023928 (44°56'22.08"N, 124°1'26.14"W). Subsequent figures include additional site location information.

SITE CONDITIONS

Surface Conditions

The subject site is located in a residential neighborhood of Taft-Nelscott Oceanfront Residential, in southern end of Lincoln City. The bulk of the Lincoln County shoreline, including the shoreline west of the property, consists of prominent coastal bluffs, formed in Tertiary sediments, and fronted by wide, gently sloping, sand beaches composed of predominantly fine-grained beach sediments. The site is perched on top of a 15-20 ft tall ocean-facing bluff.

The parcel forms an irregular boundary; at its widest the site spans approx. 99.5-ft (northern property line) and about 99-ft (eastern property line). The site is developed with a 1985 two-level dwelling home positioned on the northern majority of the parcel. The site is bordered by dwelling structures that are built year 1931 (south), 1968(north) and 2007 (southeast).

The access road SW Anchor Ct is a relatively narrow, asphalt-paved street without curbs, sidewalks or shoulders. The grade of road is generally consistent with the surrounding soils. The neighborhood contains a slight north-northwest descending slope towards the beach. Trees that are typical of coastal vegetation are scattered through the local neighborhood. The existing residence is positioned about 20-25 feet off the edge of the western bluff. The bluff is dominated by low-to-medium story vegetation with protective boulders along its base.

Historic Site Conditions

Historic aerial imagery dating back to 1982 was referenced as part of this investigation. This

imagery indicates that the north-northwest trending SW Anchor Ct that leads to the beach was developed prior to 1982. The 1982 image depict the vacant and vegetated subject site. In 1994, majority of the ocean front parcels, including the subject site, were developed containing single-family dwelling homes. Local residential developments continued slowly and intermittently through the most recent image.
Overall, review of the aerial images from 1982-present depicts no substantial changes to the subject site.

Lincoln County web maps: 2021 aerial image of the site.

General Site Conditions

A site visit and walkover inspection of the property to assess any features which may potentially influence the long-term behavior of the site was carried out by an EIT, engineer-in-training on 20 July 2022. The reconnaissance focused on the proposed deck addition on the western end of the existing residence. The dwelling structure is bordered by a handful of scattered medium-to-tall trees. Thick overgrown vegetation was observed due north and west of the proposed deck. No standing or flowing water is present on the subject site. No standing or flowing water is mapped or was historically mapped at the subject site.

The site is covered with native vegetation. The north and west sides the coverage is thick.

The current home is elevated from the seaward, with rip rap from the lot to the base of the sand/beach.

There is no drift logs or other flotsam on or within the property.

The house is perched on a nearly leveled bench built roughly 8-10 ft higher than SW Anchor Ct. The observed slopes on site accommodates a moderate southern descend of about 10-25 percent towards the property line. The vegetated slopes due north of the existing residence ascends to about 20-30 percent towards the neighboring property.

The riprap protection of the property is roughly 15-20 ft tall. The residence is positioned approx. 20-25 ft from the edge of the top of the slope to the riprap protection. On site observations indicate that the new deck is sufficiently setback from the western slope break as per the building code clearance for slope.

The ocean frontage was devoid of any drift logs or flotsam. There are stairs on the site but they do not access the beach, they access the lower level of the house from the outside. This property does not have direct access to the beach as there is public access within 150ft of the site. The beach frontage of the lot has been protected with native vegetation.

There are no headlands present with any streams within section of the Lincoln City oceanfront. There is one embayment's 0.5 miles north of the outcrop of rocks along this section of the coast, limiting the ability of rip currents to scour deep channel to the back beach area. The sands within the Lincoln littoral cell are believed to have little or no transport beyond the Cascade Head to the north and Cape Foulweather to the south.

There is rip rap installed on the ocean side of the home and the entire length of the property, including neighboring homes.

Because there are no manmade improvements, such as pathways or stairs from the house to the beach and along the beach there are no impacts that can alter or resistance wave attack. As the site has a large riprap bank that was placed at the bottom of the slope erosion from the sea is not likely.

The beach width is estimated to be 300ft to 100ft over the course of the summer to winter months. The average beach slope is 2% summer and 7% winter. **The slope from the beach up to the lot is 20%.** The average mean sea level of the beach and the property is 20ft.

Regional Geology

Current geologic literature classifies the slopes at the subject site as Quaternary marine terrace deposits. These deposits generally consist of unconsolidated to semi-consolidated sands, with some gravel and silt beds. Locally these deposits are overlain by fine grained dune deposits. Typically, the sedimentary materials comprising these terraces were emplaced in high-energy, nearshore environments. Portions of the local marine terraces contain colluvium emplaced by landslides, debris slides, mudflows, and soil creep.

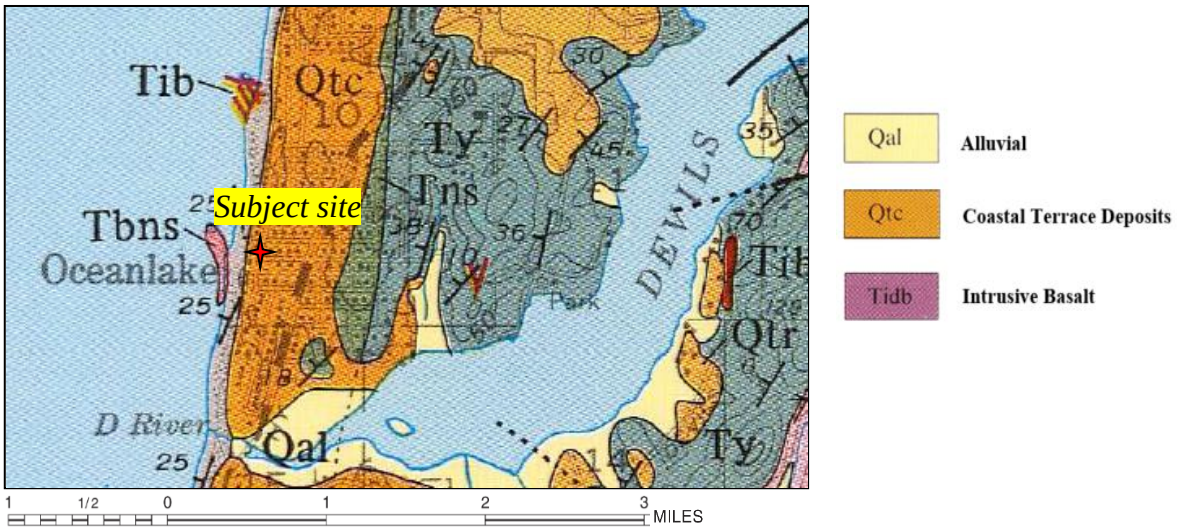
Geologic History

The site is tucked along the westernmost edge of the Oregon Coast Range, just before it plunges into the ocean. The Oregon Coast Range is an uplifted belt of land spanning roughly 200 miles and comprised of moderately high mountains (averaging 1,500' in elevation with a maximum of 4,097') that occupies a roughly 30- to 40-mile-wide swath of land along the Pacific Ocean. The mountains rising above the subject site are comprised primarily of accreted oceanic sediments and synchronously deposited igneous rocks (where the sediments overlay, underlay and are intruded by the volcanic flows). After the accretion of the Siletz Terrane to the edge of North America, a thick pile of silt, sand, and mud accumulated on the adjacent sea floor. Over tens of millions of years, sediment accumulation continued alongside tectonic impacts of the Cascadia subduction zone and sea level fluctuations. Over time the sedimentary material was scraped onto the edge of the continental plate; uplift, faulting and folding (associated with margin-parallel shortening in the Cascadia subduction zone) lifted the thick stack of sedimentary rock into the heights of the modern mountain

range.
The western flank of the Coast Range, which includes the area around the subject site, generally contain varied topography, typically dominated by rugged mountains, bold headlands and marine embayments. Steep canyons cut through the local uplands, emptying into the lowland areas along the coast. The lowland areas of the coastal range include marine embayments, coastal plains and dune areas built up along spits and beaches. The local stretch of coast falls within the lowland category, containing of a bluff-backed sandy beach with adjacent lands underlain by a marine terrace.
During periods of higher sea level elevation, typical erosional impacts along the coastline occurred at a higher elevation than their modern counterparts. The ongoing wave erosion at these higher elevations cut platforms and benches on the bedrock; as sea level changed these landforms were buried in sediment and abandoned as terraces. When sea level rose, sediments were deposited atop the benches, when sea levels subsequently lowered again, the terrace was left behind. Typical terrace deposits were laid down over wave-cut benches during interglacial stages of the Pleistocene Epoch, when sea level was relatively high. The local terrace was emplaced during the most recent interglacial stage (the Sangamon, just prior to the Wisconsin glacial stage); the local deposits represent a remnant of this terrace. The terraces along the Oregon coast are widest and longest where the local bedrock is sedimentary.

Site Geology
Along the Oregon coast, marine terrace deposits are comprised primarily of loosely cemented sand stone with occasional conglomerates and siltstone beds. Gravels are most commonly found at the base of the formation, directly above the bedrock contact. Interbedded gravels and conglomerates are less common. In some places, wood is abundant. Where the terraces abut basaltic headlands, layers of angular basalt fragments are present; these fragments represent talus deposits that were emplaced concurrent with the main body of the terrace. The subject site is near the northern end of a long terrace segment; this segment begins at Siletz Bay and extends to the northern edge of Lincoln City, nearly to Roads End Point. Sea cliffs at Lincoln City reach heights of greater than 100 feet. The sandstones are commonly capped by dune sand.
Peterson et al (1993) describes the sedimentary deposits exposed ocean-facing bluff as containing convoluted heavy-mineral layers emplaced in a planer foreshore environment. The upper sections of the outcrop include transitional backshore to eolian dune sands, typical of marine transgression.
The local terraces are underlain by the lower Eocene Nestucca Formation. The Nestucca Formation is a tertiary aged siltstone. The unit contains siltstone and sandstone horizons, and is typically thin bedded and tuffaceous. Some sandstone dikes and sills are present in the upper portion of the unit. Thick-bedded arkosic sandstone is observed in places near the base of the unit. Locally this unit appears to dip about 15-20 degrees to the west-northwest.

We estimate that the is at least 80 to 100ft of sand below the property site to layers of siltstone. During our visit site we did not observe and exposed bedrock on the beach or within the vicinity of the site. The depth of the beach sand can be 8-10 feet depending the time of year.



Geohazard Document Review and site review

Chronic coastal hazards for the Lincoln sandy shore include ocean flooding and erosion, inlet migration, land sliding, sloughing, and sand inundation. Catastrophic hazards include earthquakes and the associated ground shaking, subsidence, land sliding, liquefaction, and tsunamis. **This review indicates that the 100-year floodplain is just outside the mapped area by FEMA**

The Oregon HazVu: Statewide Geohazard Viewer was reviewed on 22 July 2022 to investigate mapped geological hazards.

The expected earthquake-shaking hazard is classified as 'very strong' across the entirety of the parcel. The earthquake liquefaction hazard is classified as 'low' The site is additionally classified as containing a 'severe' level of expected shaking during a Cascadia earthquake event. The SLIDO does not show any mapped slides at or near the site. Most of the marine terrace upon which Lincoln City is constructed, is free of the massive landslides that are pervasive along the Oregon Coast and in the Oregon Coast Range. Minor slides and slumps are extraordinarily commonly along the bluffs of bluff-backed beaches. The Oregon HazVu suggests that the bluff due west of the site consists of landslide deposits. The debris piles at the base of the bluff are the product of slope failures.

Review for Lincoln City Municipal code sections 17.47:

17.47.020.B2.f: presence of rock outcrops and sea stacks, both offshore and with the beach zone: There is an outcrop of rocks south 700 ft along this section of the shoreline. This does not affect the site deck.

17.47.020.B.a: The open file report by DOGMI O-07-01 subject area took place about 1 mile north of the project area. That the beaches in this area have gained sand from the north and the gain has been a gradual build up of sand on the primary frontal due raising its crest elevation over time. Although the shore has accreted slightly during the past decade, accretion has not led to a change in the position of the mean shoreline.

17.47.020.B3.d: see the attached calculations in the appendix. Wave runup elevation calculates to 11.5ft and the house is 34ft. **Not a problem**.

17.47.020B.4.b: The project is a replacement of existing deck.

17.47.020.B.5.d: the project is a replacement of a deck, any storm water that sheds from the deck is being collected by the existing site vegetation. It is not possible for this amount of runoff to reach the ocean.

From the O-20-11 The costal erosion exposure chart is below.

Table B-7. Coastal erosion exposure.

			(all dollar amounts in thousands)								
			High Hazard			Moderate Hazard			Low Hazard		
Community*	Total Number of Buildings	Total Estimated Building Value ($)	Number of Buildings	Building Value ($)	Percent of Building Value Exposed	Number of Buildings	Building Value ($)	Percent of Building Value Exposed	Number of Buildings	Building Value ($)	Percent of Building Value Exposed
Unincorp. County (rural)	12,637	824,038	1	9	0.0%	2	197	0.0%	9	696	0.1%
Otter Rock	634	81,971	18	3,048	3.7%	55	6,469	7.9%	152	15,479	19%
Salishan - Lincoln Beach	2,847	388,784	6	1,086	0.3%	102	26,168	6.7%	320	114,090	29%
Seal Rock - Bayshore	3,345	347,085	7	883	0.3%	155	25,329	7.3%	271	47,376	14%
Wakonda Beach	1,614	122,717	9	1,744	1.4%	44	5,629	4.6%	115	15,978	13%
Total Unincorp. County	21,077	1,764,596	41	6,770	0.4%	358	63,792	3.6%	867	193,619	11%
Depoe Bay	1,337	257,610	10	2,161	0.8%	64	12,820	5.0%	112	26,662	10%
Lincoln City	6,687	1,086,802	22	33,756	3.1%	184	60,436	5.6%	394	174,737	16%
Newport	5,602	1,243,095	75	32,111	2.6%	264	100,712	8.1%	559	196,029	16%
Waldport	1,698	161,309	0	0	0.0%	2	121	0.1%	13	1,648	1.0%
Yachats	1,050	160,911	0	0	0.0%	4	325	0.2%	12	1,716	1.1%
Total Lincoln County*	37,451	4,674,322	148	74,798	1.6%	876	238,205	5.1%	1,957	594,411	13%

*Does not include non-coastal communities (these communities do not factor into total amounts and percentages).

17.47.020.D: See the calculations that show this deck is well over the required distance for erosion or required setback for erosion.

We found no human activities affecting the shoreline erosion, as the is no development on the beach or shoreline with this lot

There are NO streams or other drainage that influence erosion on this area of the beach. There are no headlands that might long shore movement of beach sediments in front of this house.

There are rip currents or rip embayment's that can locally reduce the elevation of the front beach. There are no rock outcrops or sea stacks off shore or within the beach zone.

Erosion on the site has not been seen during the current duration of ownership. The existing bank of the property is 25ft tall and covered with trees so there has NOT had any erosion.

The proposed deck will be built on footing that are not affected by any erosion. See the below deck footing embedment depths. The new deck will not affect any of the current vegetation on the site. No erosion has been noted during the course of the homeowner's

duration at the site.

The building has a 25ft bank in front of the before the descending slope to the beach and noted covered bank with trees.

There will no additional water drainage due to the decks construction.

Beach Sediment Transport and Coastal Erosion
Erosion along the Oregon coast is complex, reflecting processes operating over both short- and long-time scales, and over large spatial scales. Beach, dune and bluff erosion are a common and chronic hazard along the regional coastline, including at the subject site. Erosion is typically gradual, but produces a substantial amount of cumulative damage. Severe weather may dramatically increase the rate and impact of erosion as it produces high surf, heavy rainfall, and/or high winds. Climactic cycles (e.g. El Niño Southern Oscillation and longer-term climate cycles associated with the Pacific Decadal Oscillation) also impact rates or erosion. Erosion of coastal duns and bluffs cause them to retreat landwards, erosion rates impact retreat rates.
The subject site is located near a mapped Active Erosion Hazard Zone (Allan & Priest, 2001: OFR O-01-03). The site is positioned adjacent to a dune-backed beach. It is noted that property erosion occurs when the total water level produced by the combined effect of extreme wave runup and tidal elevation, exceeds some critical elevation of the fronting beach, typically the elevation of the beach-dune junction. The site is not mapped within any of the three ranked erosion risk scenarios. The site is positioned roughly 350 feet beyond the upslope edge of risk scenario 3 (low-risk), this scenario is based on an extremely severe storm event (waves of 52.5' high), coupled with long-term sea level rise of 1.3 feet and a 3.3-foot vertical lowering of the coast in conjunction with a Cascadia subduction zone earthquake.

The site lies in an area mapped as undergoing critical erosion of marine terraces and sediments (Schlicker et al 1973) Priest and others (1994) have determines the average annual erosion rate for this area is as 0.27 +/- feet per year. This erosion rate was calculated by measuring the distance between existing structures to the bluff and compacted to distances measured on a 1939 or 19767 vertical aerial photograph (Priest et al 1994). During our visits in 2022 we observed no major issues with recession of the bluff. The in place vegeation and lack of direct sea wave action other than the normal course of sea erosion have not impacted the house that lies greater than 330ft from the water edges and over 70ft elevation difference from the sea’s edge.

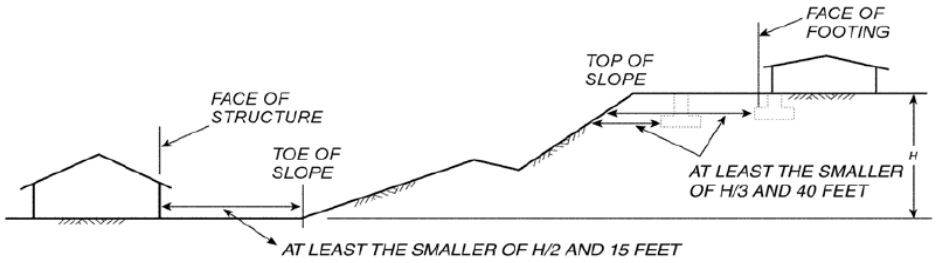
Field Exploration and subsurface conditions
The site was investigated by drilling two (2) hand-auger borings. The bore holes are shown on Figure 2 in the appendix. An EIT, engineer-in-training, observed the excavation of the borings and logged the subsurface materials. A registered professional engineer reviewed the results. Boring logs detailing materials encountered is in the appendix. The logs were created using the Unified Soil Classification and Visual Manual Procedure (ASTM-D 2488).
RSS found tan, medium to coarse grained poorly-graded SAND on site.

Moisture contents ranged from 27.7% to 47.4%. No groundwater encountered.

The average size of the beach SAND is .35mm.

Deck Foundation Design Recommendations

The new deck must be embedded into the slope following the building code. The planned setback means the deck post meet the desired slope setback. See figure below. RSS does suggest embedded the post 2ft into the ground for erosion protection.



For SI: 1 foot = 304.8 mm.

FIGURE 1808.7.1
FOUNDATION CLEARANCES FROM SLOPES

Engineering values summary

Bearing capacity SAND	2,000psf
Coefficient of friction - sand	0.35
Active pressure	40pcf
Passive pressure	300pcf

Seismic Design Criteria

The seismic design criteria for this project found herein is based on the ASCE 7-16 and from the USGS Earthquake Hazards Program. A summary of seismic design criterion below using Latitude 44.939467 Longitude of -124.023928 soil site class D. Null=see section 11.4.8

	Short Period	**1 Second**
Maximum Credible Earthquake Spectral Acceleration	Ss = 1.332 g	S1 = 0.69 g
Adjusted Spectral Acceleration	Sms = 1.598 g	Sm1 = null
Design Spectral Response Acceleration Perimeters	Sds = 1.065 g	Sd1= null

CONCLUSIONS AND RECOMMENDATIONS

Satisfactory earthwork performance depends on the quality of construction. Sufficient monitoring of the activities of the contractor is a key part of determining that the work is

completed in accordance with the construction drawings and specifications. I recommend that the geotechnical engineer or her representative should witness the installation of deck supports. Installation of deep deck foundation will ensure they will be straight and level for many years on the existing steep slope. RSS recommends continued removal of ivy and planting native plants and ground covers will assist with erosion protection as well as slope stability. As native plants and ground covers root systems grow in the slope assisting with stabilization and protection of the bluff.

The report includes information regarding the beach erosion and sea levels changes. The scope of the project is to attach a deck to the existing structure. As the existing structure is not within any setback issues from the bluff the building of a deck will not trigger the need for any additional setbacks.

Limitations

This report has been prepared for the exclusive use of the addressee, and their architects and engineers for aiding in the design and construction of the proposed development. It is the addressee's responsibility to provide this report to the appropriate design professionals, building officials, and contractors to ensure correct implementation of the recommendations. The opinions, comments and conclusions presented in this report were based upon information derived from our literature review, field investigation, and laboratory testing. Conditions between, or beyond, our exploratory borings may vary from those encountered. Unanticipated soil conditions and seasonal soil moisture variations are commonly encountered and cannot be fully determined by merely taking soil samples or soil borings. Such variations may result in changes to our recommendations and may require that additional expenditures be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

If there is more than 2years time between the submission of this report and the start of work at the site; if conditions have changed due to natural causes or construction operations at, or adjacent to, the site; or, if the basic project scheme is significantly modified from that assumed, it is recommended this report be reviewed to determine the applicability of the conclusions and recommendations.

The work has been conducted in general conformance with the standard of care in the field of geotechnical engineering currently in practice in the Pacific Northwest for projects of this nature and magnitude. No warranty, express or implied, exists on the information presented in this report. By utilizing the design recommendations within this report, the addressee acknowledges and accepts the risks and limitations of development at the site, as outlined within the report.

APPENDIX

WAVE RUNUP $R_{2\%} = .127(SH_{so}L_o)^{1/2}$

S = beach slope
H_o = deep water significant wave height
$L_o = (g/2\pi)T^2$
T = wave period

USE OPH-0-04-09
TABLE 1

$L_o = (32.2/2(\pi))(14.3)^2 = 1047.97$

$R_{2\%} = .127\left[\left(\frac{21-3}{256}\right)^{.105}(34.5 \cdot 1047.97)\right]^{1/2}$ EL NINO H_o=34 FT

$R_{2\%} = 11.48$

HOUSE ELEVATION IS 34 FT NOT A PROBLEM

USE OPH-0-04-09

FREEBOARD MODEL = $E_T + R \geq E_D$

USING SIX FOOT MEAN WITH ELEVATION TABLE z = 39.7

E_T = measured Tide

Slope = 5°

$FB = \frac{(WL - E_D) + \Delta BL}{\tan\beta}$

Lake D = 7.2
7.2 + 22.5 = 30.10

$FB = \frac{(39.7 - 30.10) + \tan 45(1)}{\tan 5°}$

FB = 109.73 FT MAXIMUM FREEBOARD POSSIBLE

HOUSE & DECK IS LOCATED @ 256 FT FROM WATER EDGE

Low Risk

REGISTERED PROFESSIONAL ENGINEER
19244PE
OREGON
JULY 15, 1997
MIA C. MAHEDY
EXPIRES: 12-31-2024

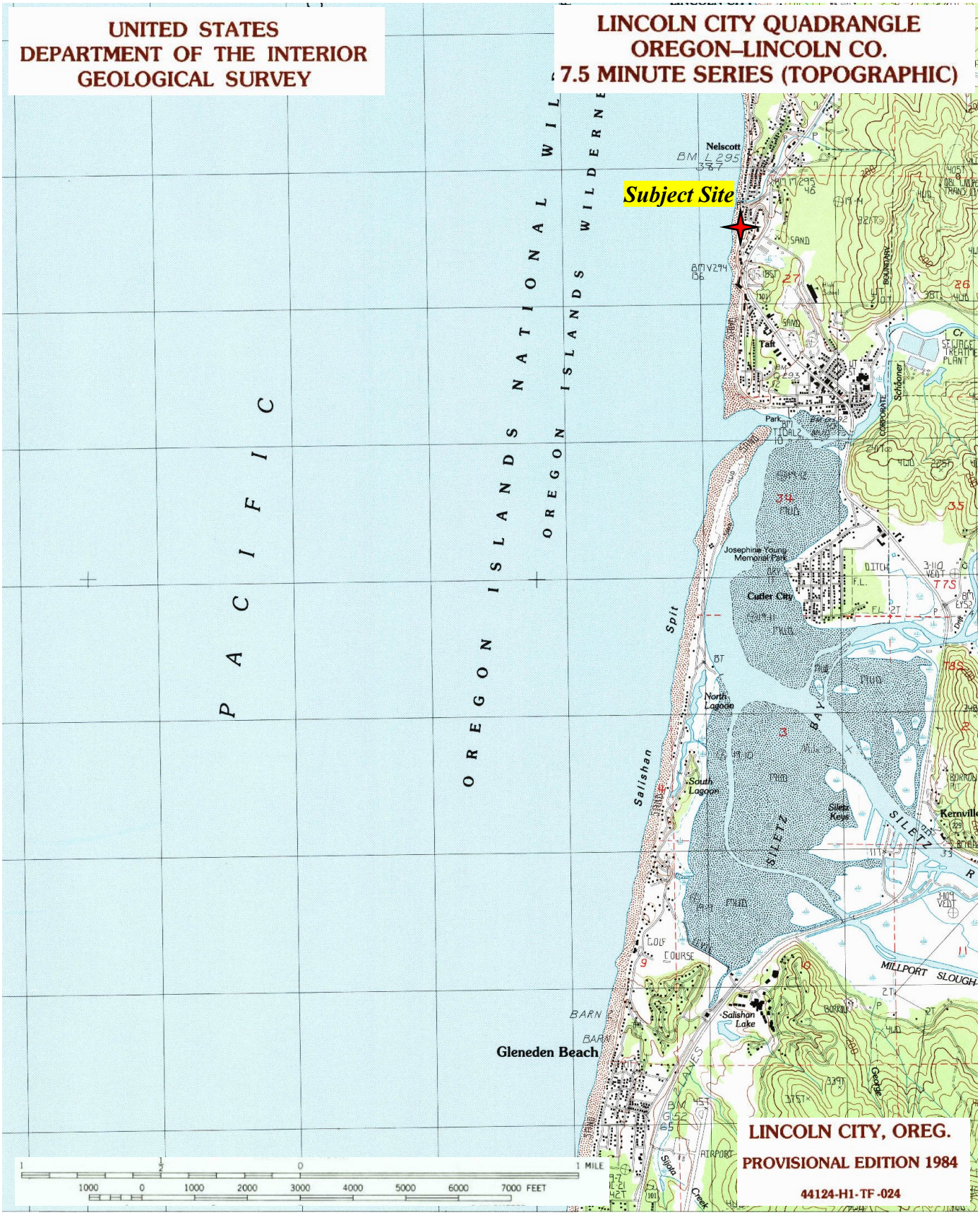


Figure 1: Subject site location on the southeast quarter of the Lincoln City Quadrangle

Figure 2: Testing Locations

Lab Results

Project Name: 3730 SW Anchor Ct Lincoln City Sample Date 7/20/2022

Moisture

	Sample number	HA-1A	HA-1B	HA-2		
1	Date and time in oven	7/21/2022 - 12:15PM	7/21/2022 - 12:15PM	7/21/2022 - 12:15PM		
2	Date and time out of oven	7/22/2022 - 10:45AM	7/22/2022 - 10:45AM	7/22/2022 - 10:45AM		
3	Depth (ft)	2	4	2		
4	Tare No.	4	5	6		
5	Tare Mass	231	234	234		
6	Tare plus sample moist	732	796	775		
7	Tare plus sample dry	571	674	602		
8	Mass of water (g)	161	122	173		
9	Mass of soil (g)	340	440	368		
10	Water Content (%)	47.4	27.7	47.0		

Grain Size Analysis: Dry Sieve Method

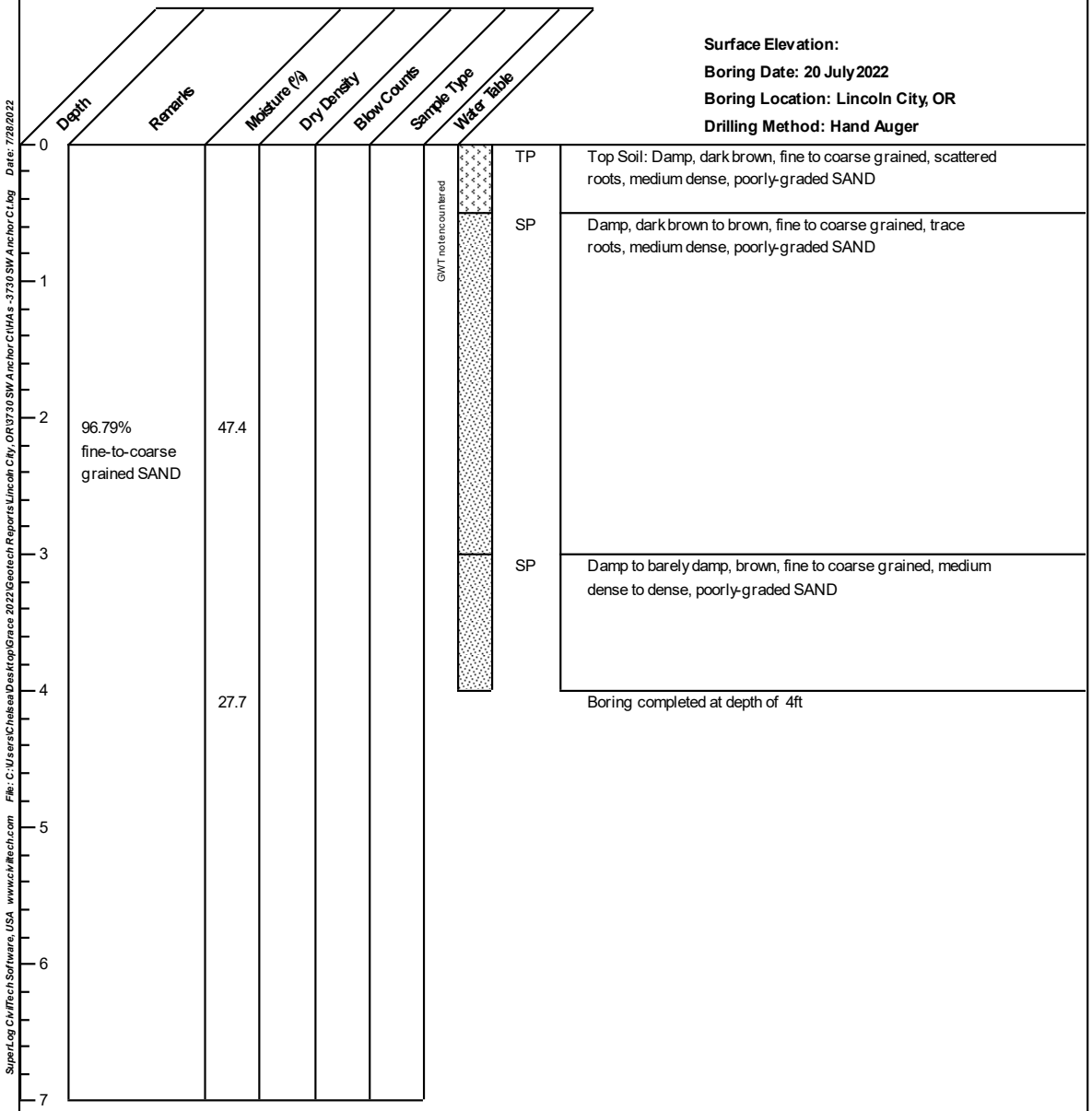
Sample Number: HA-1A

Total Sample Weight (g): 339.94

Sieve #	Weight (g)	% Retained	
>1/4"	5.49	1.61	Gravels and Larger
1/4" to #40	222.00	65.31	Medium-Coarse Sand
#40 to #200	107.00	31.48	Fine Sand
< #200	5.45	1.60	Fines (Silt & Clay)
> #200	339.94	100.00	**Classification: SP**

Rapid Soil Solutions INC

HA-1



Surface Elevation:
Boring Date: 20 July 2022
Boring Location: Lincoln City, OR
Drilling Method: Hand Auger

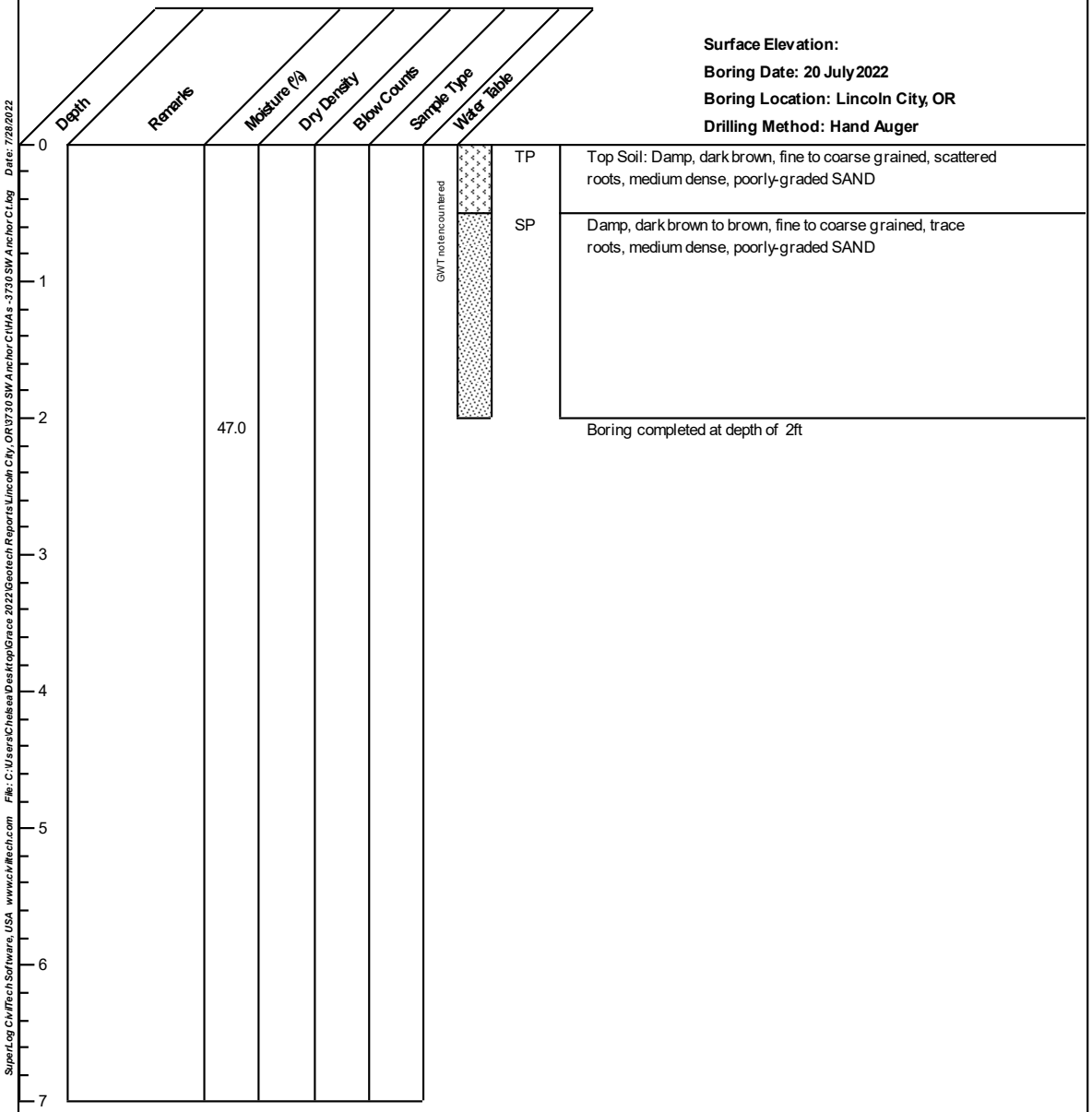
SuperLog CivilTech Software, USA www.civiltech.com File: C:\Users\Chelsea\Desktop\Grace 2022\Geotech Reports\Lincoln City, OR\3730 SW Anchor Ct\HAs - 3730 SW Anchor Ct.log Date: 7/28/2022

LOG OF BORING

Rapid Soil Solutions	**3730 SW Anchor Ct** **TNT Builders**	**Plate 1**

HA-2

Surface Elevation:
Boring Date: 20 July 2022
Boring Location: Lincoln City, OR
Drilling Method: Hand Auger



LOG OF BORING

Rapid Soil Solutions	**3730 SW Anchor Ct** **TNT Builders**	**Plate 2**