



Reference: 021094

July 7, 2021

County of Humboldt
Department of Public Works–Environmental Services
Attn: Hank Seemann
1106 Second Street
Eureka, CA 95501

**Subject: Bay Mud and Marsh Sampling Along the Margin of Humboldt Bay,
Brainard to Bracut, for the “Humboldt Bay Living Shoreline Project”**

Hank Seemann:

This report presents a description of the methods and results of sampling and hand augering at a series of representative sites along the margin of Humboldt Bay as part of the “Natural Shoreline Infrastructure in Humboldt Bay for Intertidal Coastal Marsh Restoration and Transportation Corridor Protection Project.” The subject sampling was coordinated through Jeremy Svelha of GHD, Inc., the project engineer. The work scope described herein was developed based on a Sediment Sampling Map and discussion provided by GHD.

The study area is located along the bay shoreline between the Brainard and Bracut industrial (former mill) sites and is shown on the attached figure.

The work consisted of two phases:




1. Collection of bay mud samples from three locations on the mud flat for flume testing
2. Hand augering at five locations on marsh remnants along the bay shoreline. Soil stratigraphy in these 2- to 6-foot-deep auger borings was logged, and a sample was collected from the upper 1-foot of soil and laboratory tested for organic content and salinity.

Bay Mud Sampling

The three bay mud sampling sites are shown on the attached sample location map. The sites are all located on the mud flat between 600 (sites A, C) and 1,500 feet (site B) from the bay shoreline. The locations were identified in the field with a tape measure and accessed by foot at low tide, using special “mudders.” (see Photo 1, Appendix 1). Sampling was intended to provide samples for “flume testing” to evaluate erodibility of the mud flat surface, and therefore required following specific methods and criteria. We were provided with sampling equipment (a slide hammer) and plastic liners by Sam McWilliams of Integral Consulting Inc., who are completing the “SEDflume” analysis of the samples. The plastic liners are equivalent to the dimensions of a standard Shelby tube sampler, measuring 3 inches wide by 24 inches long and fit inside the sampling head of the slide hammer.



Legend

-  Project Shoreline
-  Marsh Sediment Sampling Locations
-  Mudflat Sediment Erosion Measurement Locations (SEDFlume)



Hank Seemann

Bay Mud and Marsh Sampling for Humboldt Bay Living Shoreline Project

July 7, 2021

Page 2

The sampling method allows for collection of relatively undisturbed samples by using the slide hammer with the plastic liner/sleeve. The sampler was pushed into the bay mud, which offered little resistance (Photo 2, Appendix 1). Even at low tide, the bay muds are soft and wet (Photo 3, Appendix 1). As is typical in soft, wet muds, retention of samples in the sampler is the biggest challenge in subsurface investigations, and this was true during this effort. Despite using a variety of methods, we experienced consistent challenges in retention of a full sample (Photo 4, Appendix 1). Other than inversion of the sample to remove it from the sampler in the field, the samples were maintained in a vertical (upright) position until they were shipped to Integral for flume testing.

Sampling was completed on June 1, 2021. The samples were securely wrapped and shipped on June 3, 2021 and received at Integral on June 8, 2021.

Marsh Borings

Hand auger borings were completed at five locations along the study area shoreline, on apparent marsh remnants, to evaluate soil stratigraphy. The sample locations are shown on the attached sample location map and are numbered sequentially from north to south (B-1 through B-5). The individual sites were pre-flagged in the field by Jeremy Svelha (GHD) and all the flagging was apparent at the time of our field work. The five sample sites are shown on photographs 5 through 9, in Appendix 1. The target depth of the borings was six feet. The hand borings were logged and described by a California Professional Geologist (PG), following the Manual-Visual Classification Method (ASTM International D2488).

Due to the soft, wet condition of the marsh soils, we were only able to retain samples in the auger to full (6') depth in two of the borings (B-1 and B-3). Notably, these two borings were logged as containing distinct organic horizons (noted as concentrations of plant fragments). In the absence of significant plant fragments, it appears the muds were too soft to be retrievable from deeper than about 2 to 4 feet. In two cases, the hand auger could literally be pushed to the full 6-foot depth under body weight, which is indicative of very soft, saturated muds. Boring logs are attached in Appendix 2.

The two borings that reached the 6-foot target depth (B-1, B-3) both encountered distinct horizons characterized by concentrations of buried roots and organics. We infer that these horizons represent formerly exposed marsh surfaces that have been subsequently buried.

Based on the long, linear morphology of the northwest-trending "peninsula" at site B-2 (extending nearly 1000' into the bay), we infer this feature is a remnant of a historic man-made structure that is composed of fill soils. We note that the massive silty fill soils at the site were too soft and contained insufficient organics to be retained in the auger.

Soils in borings B4 and B-5 were also too soft to retrieve from deeper than 4 and 2 feet, respectively. Logs for these borings note an absence of buried root/organic horizons, which appears to have contributed to their "soupy" texture. The absence of buried organic strata at these sites may suggest these are younger marsh soils, due to either natural or man-induced infilling.



Hank Seemann

Bay Mud and Marsh Sampling for Humboldt Bay Living Shoreline Project

July 7, 2021

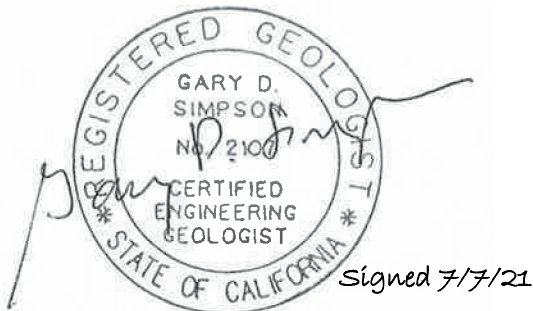
Page 3

Each auger site was vegetated with marsh plants and we encountered several inches of near-surface decayed organics and roots. The upper one foot of the marsh soils were collected for laboratory testing of organic content and salinity. The five samples were submitted to A&L Western Agricultural Laboratories in Modesto for testing. Results of the soil testing are included in Appendix 3. We note similarities in the lab results in the two borings with intact buried stratigraphy (B-1 and B-3), relative to those without apparent stratigraphy (B-2, B-4, and B-5). Soils from the borings absent of buried root horizons had higher organic contents and anomalously high levels of sodium content.

We trust this report provides the documentation required to describe the subject sampling. If you have any questions, please do not hesitate to contact us at 707-441-8855.

Respectfully,

SHN



Gary D. Simpson, CEG
Geosciences Director

GDS:lam

- Appendices:
1. Photographs
 2. Boring Logs
 3. Laboratory Test Results



Photographs

1



Photo 1. Low tide field access, measurement to Sample Site "A"





Photo 2. Sampling on the Humboldt Bay mud flat



Photo 3. Mudflat surface, Site B



Photo 4. Sample liners with bay mud samples



Photo 5. Marsh auger site #1





Photo 6. Marsh auger site #2



Photo 7. Marsh auger site #3





Photo 8. Marsh auger site #4



Photo 9. Marsh auger site #5



Boring Logs **2**



CLIENT <u>GHD</u>	PROJECT NAME <u>Bay Mud Geo - Living Shoreline</u>
PROJECT NUMBER <u>021094</u>	PROJECT LOCATION <u>Humboldt Bay Margin</u>
DATE STARTED <u>6/8/21</u> COMPLETED <u>6/8/21</u>	GROUND ELEVATION <u>3 ft 3</u> HOLE SIZE <u>3.5"</u>
DRILLING CONTRACTOR _____	GROUNDWATER DEPTH
DRILLING METHOD <u>Hand Auger</u>	AT TIME OF DRILLING <u>3.25 ft / Elev -0.25 ft</u>
LOGGED BY <u>A. Call</u> CHECKED BY _____	AT END OF DRILLING <u>---</u>
NOTES _____	AFTER DRILLING <u>---</u>

GENERAL BH / TP / WELL - CTTEST_TEMPLATE_PROJECT_CREATION.GDT - 6/8/21 19:42 - \\NEUREKAGE\GROUPO\PI\GINTL\LIBRARY\BENTLEY\GINTCL\PROJECTS\PROJECT_FILES\2021021094-GHD-BAYMUD-GEO.GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0					
	GB B-1				0.1 Plants, Roots, Pickleweed 2.9 (ML) SILT; soft, light brownish gray, wet, crude lamination at 6 inches bgs with decayed organics and plant fragments, less than 1/4 inch thick, common fine roots, few medium roots. Becomes mottled brown and gray. Grades to very fine sandy.
2.5		At 2.5 fet BGS, becomes saturated.	ML		2.5 (ML) SANDY SILT; soft, gray, saturated, very fine sand, common organics. 0.5 At 3.0 feet BGS, becomes very dark gray, organic rich with plant fibers decomposed to "peat like" consistency with individual fibers encased in sandy silt. At 3.5 feet BGS, becomes brownish gray, less sand, less organic rich.
		Sulfur smell	ML		4.3 Grades to: -1.3 (ML) SILT; soft, gray, saturated, few plant fragments, massive (no bedding). At 4.75 to 5.75 feet BGS, increased partially decomposed plant fragments.
5.0			ML		
6.0					-3.0

Bottom of borehole at 6.0 feet.



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PROJECT NUMBER <u>021094</u>	PROJECT LOCATION <u>Humboldt Bay Margin</u>
DATE STARTED <u>6/8/21</u> COMPLETED <u>6/8/21</u>	GROUND ELEVATION <u>2.5 ft 3</u> HOLE SIZE <u>3.5"</u>
DRILLING CONTRACTOR _____	GROUNDWATER DEPTH
DRILLING METHOD <u>Hand Auger</u>	AT TIME OF DRILLING <u>1.00 ft / Elev 1.50 ft</u>
LOGGED BY <u>A. Call</u> CHECKED BY _____	AT END OF DRILLING <u>---</u>
NOTES _____	AFTER DRILLING <u>---</u>


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DEPTH (ft)	SAMPLE TYPE NUMBER	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0					
	GB B-2				0.1 Scrub Grass, Pickleweed. 2.4 (ML) SILT; soft, brownish gray, wet, abundant fine roots forming a loose mat in silt matrix.
		Sulfur smell	ML		At 1.0 feet BGS, becomes saturated, with fewer roots. ▽
2.5					2.0 Extremely soft soils not recovered in hand auger at 2.0 feet BGS. Able to advance (push) auger through soils from 2.0 feet BGS to target depth of 6.0 feet BGS with body weight. Poor recovery when auger was extracted. Refusal on saturated soils. 0.5 Bottom of borehole at 2.5 feet.



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DRILLING CONTRACTOR _____	GROUNDWATER DEPTH
DRILLING METHOD <u>Hand Auger</u>	AT TIME OF DRILLING <u>5.00 ft / Elev -1.50 ft</u>
LOGGED BY <u>A. Call</u> CHECKED BY _____	AT END OF DRILLING <u>---</u>
NOTES _____	AFTER DRILLING <u>---</u>

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DEPTH (ft)	SAMPLE TYPE NUMBER	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0					
	GB B-3				0.1 Pickleweed, Roots. (CL-ML) SILT/ CLAY; soft, wet, gray, common fine roots, organics. 3.4
2.5			CL-ML		Becomes medium stiff, moist, abundant black, carbonized plant fragments in gray matrix.
5.0		Sulphur smell.			At 3 feet BGS, loss of carbonized plant fragments, massive (no bedding), soft to medium stiff, gray, wet. Becomes with occasional (brown) plant fragments, clamshell. Becomes abundant partially decomposed plant fragments. ∇ Becomes saturated.
6.0					Bottom of borehole at 6.0 feet. -2.5



CLIENT GHD

PROJECT NAME Bay Mud Geo - Living Shoreline

PROJECT NUMBER 021094

PROJECT LOCATION Humboldt Bay Margin

DATE STARTED 6/8/21 COMPLETED 6/8/21

GROUND ELEVATION 2 ft 3 HOLE SIZE 3.5"

DRILLING CONTRACTOR _____

GROUNDWATER DEPTH _____

DRILLING METHOD Hand Auger

AT TIME OF DRILLING 1.50 ft / Elev 0.50 ft

LOGGED BY A. Call CHECKED BY _____

AT END OF DRILLING ---

NOTES _____

AFTER DRILLING ---

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DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0				
	GB B-4			Pickleweed, Roots. (ML) SILT; soft, gray, saturated, abundant fine roots and partially decomposed plant fibers (brown).
		ML		Becomes less roots, very soft.
2.5				Grades to: dark gray, soft.
4.0				

No recovery in bucket.
 Unable to push auger past 4.0 feet BGS with body weight.
 Refusal on saturated soils.
 Bottom of borehole at 4.0 feet.



CLIENT GHD
 PROJECT NUMBER 021094
 DATE STARTED 6/8/21 COMPLETED 6/8/21
 DRILLING CONTRACTOR _____
 DRILLING METHOD Hand Auger
 LOGGED BY A. Call CHECKED BY _____
 NOTES _____

PROJECT NAME Bay Mud Geo - Living Shoreline
 PROJECT LOCATION Humboldt Bay Margin
 GROUND ELEVATION 2.5 ft 3 HOLE SIZE 3.5"
 GROUNDWATER DEPTH
 AT TIME OF DRILLING 0.50 ft / Elev 2.00 ft
 AT END OF DRILLING ---
 AFTER DRILLING ---

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DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0				
0.1	GB B-5	ML		Pickleweed, Roots. (ML) SILT; soft, gray, saturated, common fine roots.
2.0				Becomes few roots.
0.5				

Extremely soft soils not recovered in hand auger at 2.0 feet BGS. Able to advance (push) auger through soils from 2.0 feet BGS to target depth of 6.0 feet BGS with body weight.
 Poor recovery when auger was extracted.
 Refusal on saturated soils.
 Bottom of borehole at 2.0 feet.

Laboratory Test Results



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REPORT NUMBER: 21-161-083

CLIENT NO: 2946

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GROWER: 021094-GHD-BAY MUD GEO

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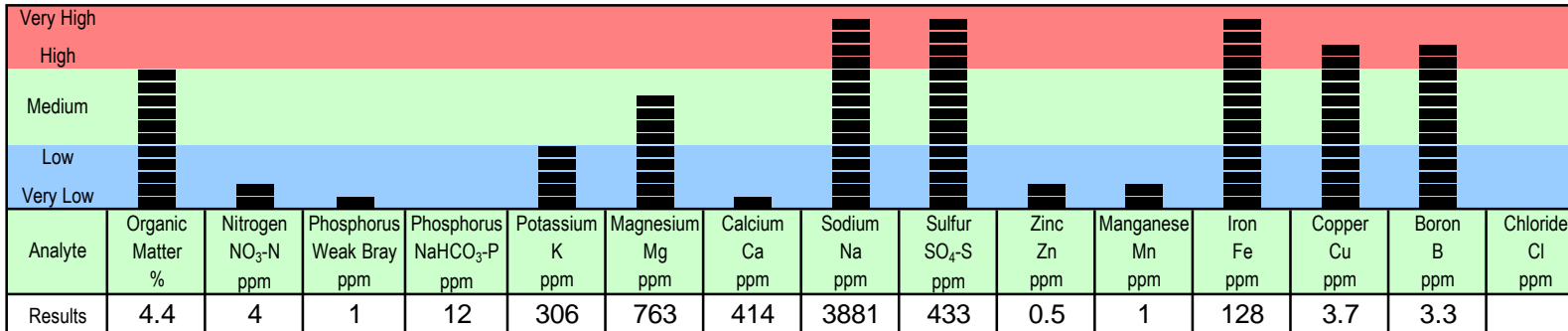
Graphical Soil Analysis Report

DATE OF REPORT: 06/15/21

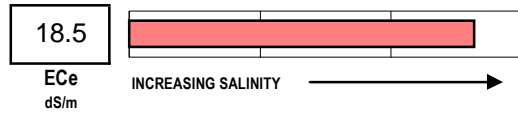
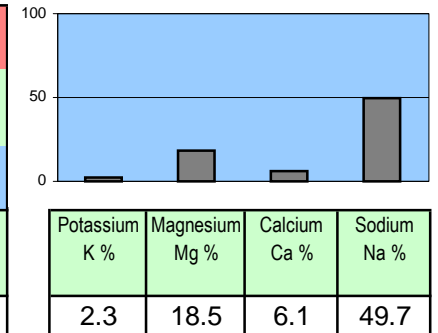
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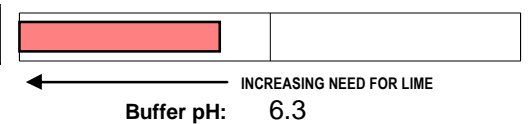
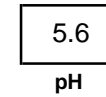
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Percent Cation Saturation (computed)



L
Ex. Lime



NaHCO₃-P unreliable at this soil pH

Soil Fertility Guidelines

CROP:

RATE:

NOTES:

Dolomite (70 score)	Lime (70 score)	Gypsum	Elemental Sulfur	Nitrogen N	Phosphate P ₂ O ₅	Potash K ₂ O	Magnesium Mg	Sulfur SO ₄ -S	Zinc Zn	Manganese Mn	Iron Fe	Copper Cu	Boron B

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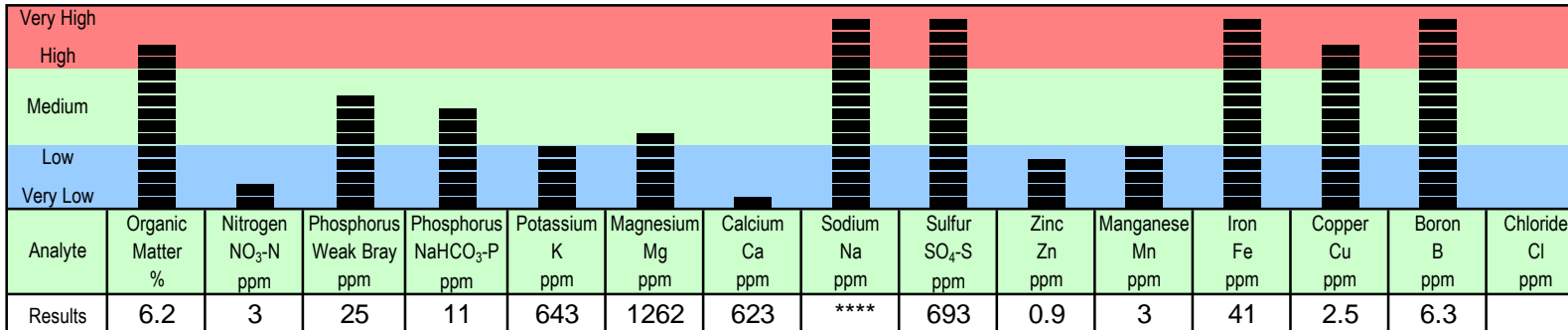
Graphical Soil Analysis Report

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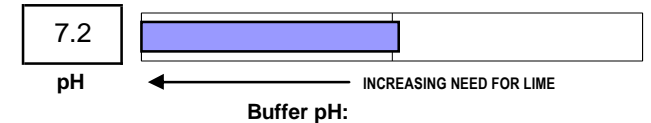
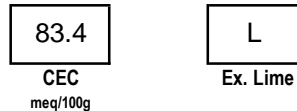
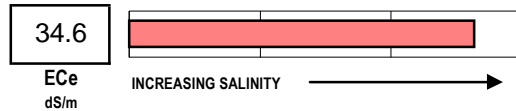
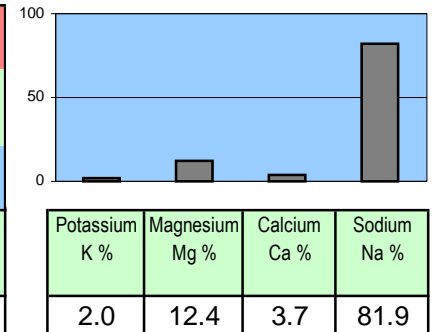
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SAMPLE ID: B-2

PAGE: 2



Percent Cation Saturation (computed)



Soil Fertility Guidelines

CROP:

RATE:

NOTES:

Dolomite (70 score)	Lime (70 score)	Gypsum	Elemental Sulfur	Nitrogen N	Phosphate P ₂ O ₅	Potash K ₂ O	Magnesium Mg	Sulfur SO ₄ -S	Zinc Zn	Manganese Mn	Iron Fe	Copper Cu	Boron B

C
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**** Na 15700 ppm

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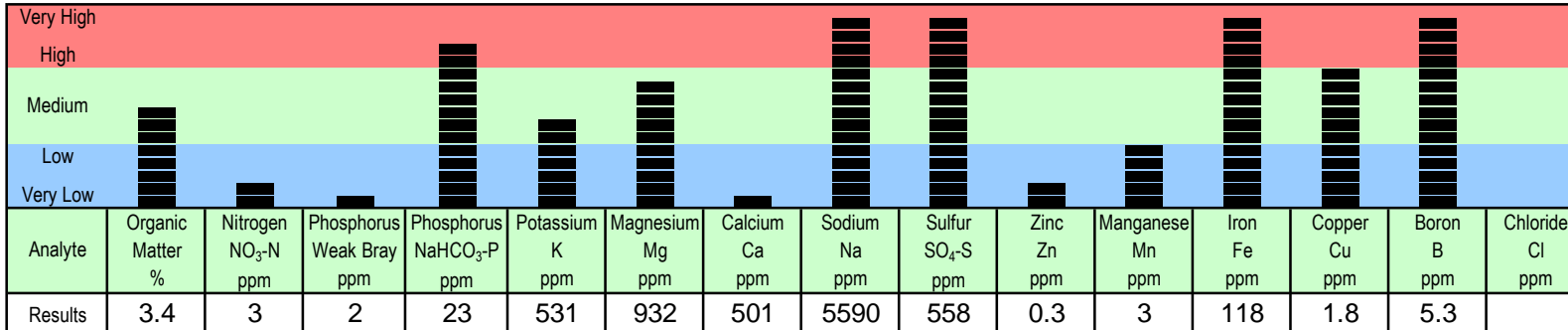
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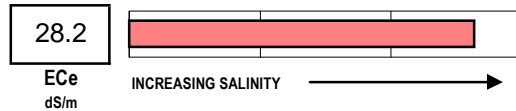
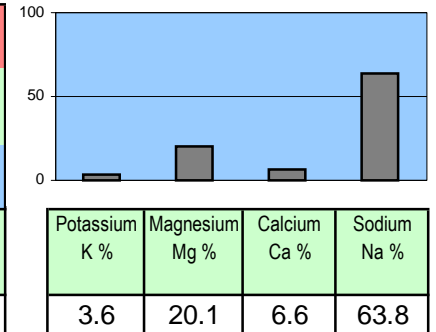
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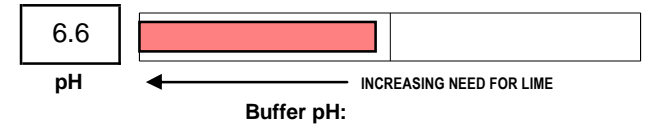
PAGE: 3



Percent Cation Saturation (computed)



L
Ex. Lime



Soil Fertility Guidelines

CROP:

RATE:

NOTES:

Dolomite (70 score)	Lime (70 score)	Gypsum	Elemental Sulfur	Nitrogen N	Phosphate P ₂ O ₅	Potash K ₂ O	Magnesium Mg	Sulfur SO ₄ -S	Zinc Zn	Manganese Mn	Iron Fe	Copper Cu	Boron B

C
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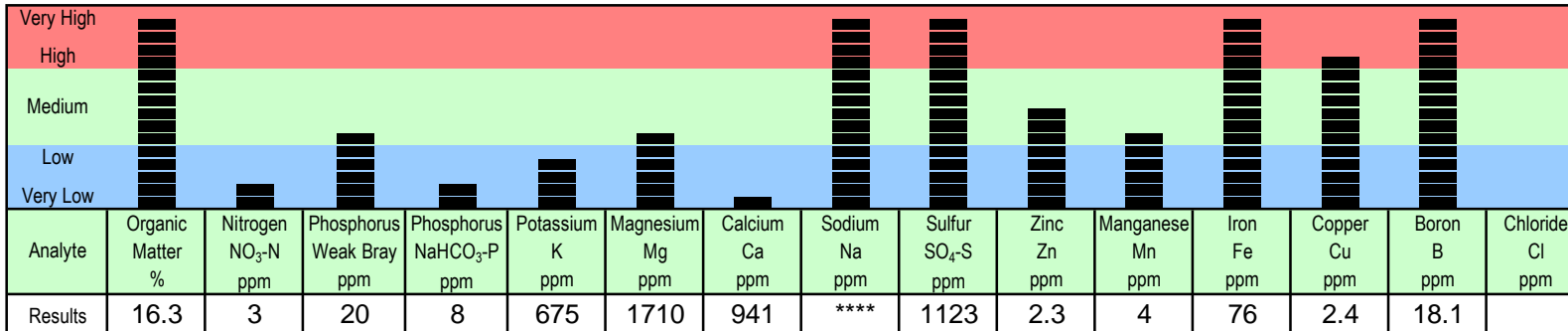
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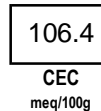
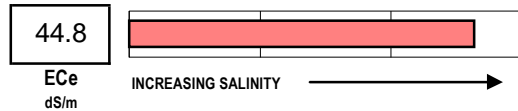
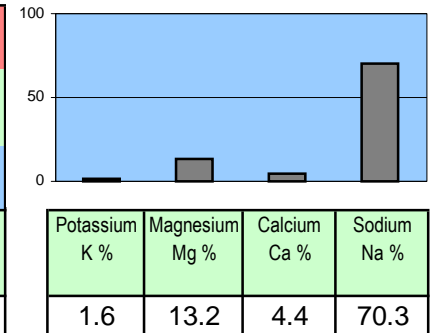
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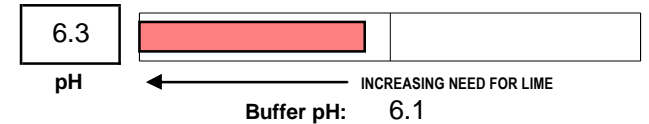
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Percent Cation Saturation (computed)



L
Ex. Lime



Soil Fertility Guidelines

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RATE:

NOTES:

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C
O
M
M
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S

**** Na 17200 ppm

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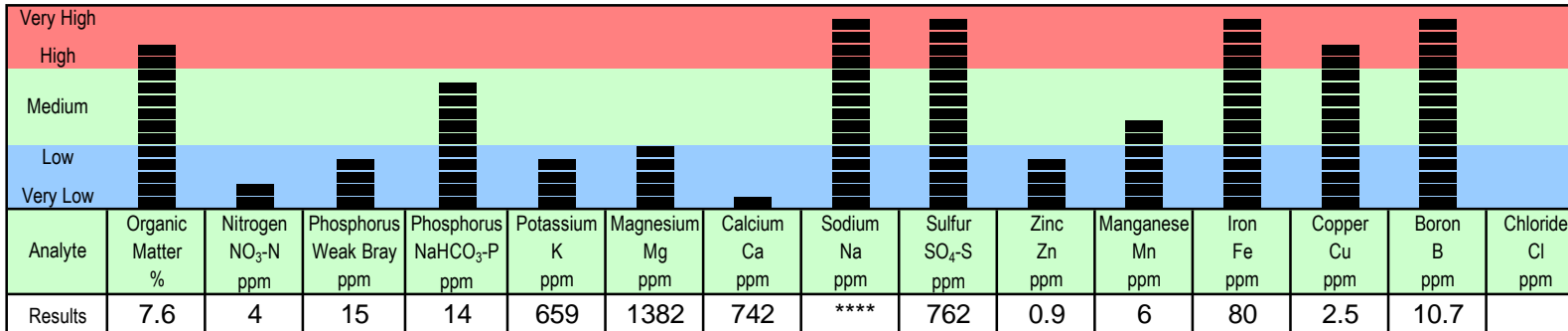
Graphical Soil Analysis Report

DATE OF REPORT: 06/15/21

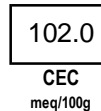
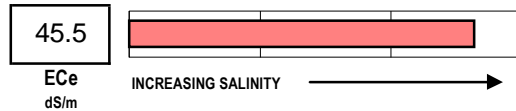
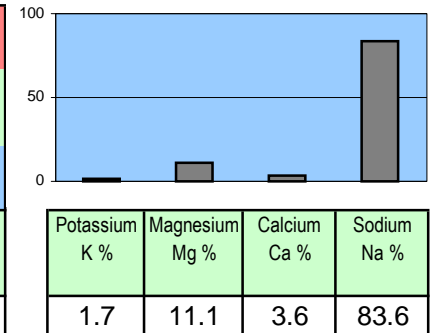
LAB NO: 55412

SAMPLE ID: B-5

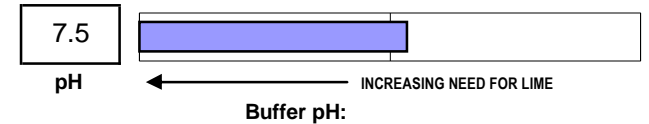
PAGE: 5



Percent Cation Saturation (computed)



L
Ex. Lime



Soil Fertility Guidelines

CROP:

RATE:

NOTES:

Dolomite (70 score)	Lime (70 score)	Gypsum	Elemental Sulfur	Nitrogen N	Phosphate P ₂ O ₅	Potash K ₂ O	Magnesium Mg	Sulfur SO ₄ -S	Zinc Zn	Manganese Mn	Iron Fe	Copper Cu	Boron B

C
O
M
M
E
N
T
S

**** Na 19600 ppm

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REPORT NUMBER: 21-161-083

CLIENT: 2946

SUBMITTED BY: ANSON CALL

SEND TO: SHN CONSULTING ENGINEERS
812 W. WABASH
EUREKA, CA 95501-

GROWER: 021094-GHD-BAY MUD GEO

DATE OF REPORT: 06/17/21

SOIL SALINITY ANALYSIS REPORT

PAGE: 1

Sample ID	Lab Number	SAR	ESP	Na meq/L	Ca meq/L	Mg meq/L	pH	CO ₃ meq/L	HCO ₃ meq/L	E.C. dS/m	Cl meq/L	B ppm	Saturation %
B-1	55408	30.1	30.1	106.6	5.1	20.0	5.6	0.0	1.0	18.5	212.5	1.5	103.3
B-2	55409	36.5	34.5	168.0	8.7	33.6	7.2	0.0	1.4	34.6	343.7	1.4	116.5
B-3	55410	35.8	34.0	150.2	7.1	28.0	6.6	0.0	1.3	28.2	343.7	2.2	88.3
B-4	55411	42.4	38.0	247.2	14.1	54.0	6.3	0.0	1.8	44.8	636.2	4.4	134.7
B-5	55412	47.0	40.5	262.9	12.8	49.8	7.5	0.0	2.9	45.5	727.9	1.8	106.0

NOTES:

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