



# Technical Memorandum

To: Rob Holmlund (HBHRCD)  
From: Erik Nielsen (SHN)  
Date: April 30, 2024  
Subject: **Infiltration Testing Results Summary**  
Project: Redwood Marine Multipurpose Terminal Replacement Project  
Location: Eureka, CA  
M&N Job No: 212991-03  
cc: Shane Phillips (M&N)

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**Disclaimer:** This draft technical memorandum is a work-in-progress and is intended to be an internal document for use by the Humboldt Bay Offshore Wind Heavy Lift Marine Terminal Project team as a part of the conceptual design process and the ongoing permitting process. This memorandum is meant to be read as a part of a comprehensive packet of technical analyses. It is not written to be a standalone document, and it is assumed that the reader has substantial project knowledge and context to understand the memorandum's content. All aspects of this memorandum are subject to change and may become less accurate over time. To better understand the project, please review the more comprehensive and up-to-date documents posted to the Humboldt Bay Harbor District's website at <https://humboldt-bay.org/humboldt-bay-offshore-wind-heavy-lift-marine-terminal-project-3>.

## Introduction

This memorandum provides a summary of results for test pit evaluation and double ring infiltrometer testing conducted at the Redwood Marine Multipurpose Terminal (RMMT) project site. Work was conducted in general accordance with the stormwater infiltration work scope outlined in the geotechnical investigation task item for Phase 3. Infiltration testing was completed at accessible locations on the project site according to ASTM-International Method D3385 during the period of January 12 through March 21, 2024.

## Site Conditions

The work scope initially identified eight locations for infiltration testing as shown on Figure 1 in Attachment 1 (TP/INF-1 through TP/INF-8). Two of these locations (TP/INF-2 and TP/INF-3) were identified to be on property not controlled by the Humboldt Bay Harbor, Recreation, and Conservation District (District) and were unable to be completed. As the testing was performed over the course of an above average rainy season in the Humboldt Bay region, standing water was observed in many areas of the site, including immediately surrounding TP/INF -6, TP/INF -7, and TP/INF -8. Test pit excavations at TP/INF-6 and TP/INF-8 were unsuccessful due to caving conditions and, therefore, no infiltration testing data was obtained at these locations.



## Field Program

Infiltration testing was performed at four locations on the subject property. SHN staff were accompanied by District personnel for backhoe operation and cultural monitors from Roscoe Associates. The locations of test pits and infiltration testing locations (TP/INF) completed, and the areas of saturated conditions are shown in Figure 2. Using a backhoe, test pits were excavated to a depth below groundwater and a soil profile was produced to describe subsurface conditions. The profile from each test pit was used to determine the horizon of performing the infiltration test in a second test pit that was excavated a short distance away from the original excavation (8 to 10 feet). The test pit profiles generated at each location are provided in Attachment 2.

The infiltration test was performed at a clean excavated surface by placing an inner and outer steel ring that was pressed into the surface using the backhoe bucket. The inner ring measures 11.375 inches in diameter, and the outer ring measures 24 inches in diameter. Using a backhoe bucket, the inner ring was advanced into the testing surface to a depth of 6 inches. The outer ring was advanced into the testing ground surface at a depth of 9 inches. Water was then added to both the inner and outer rings at an equal elevation (approximately 9 inches above the testing surface). The inner ring water depth was maintained at a constant head height with the volume of water measured over the testing period. The double ring infiltrometer method is designed to measure the vertical infiltration of water from the inner ring as the outer ring works to create a bulb-shaped wetting front. Water from the inner ring is constrained to vertical infiltration only. Infiltration test data sheets for each location are provided in Attachment 3.

Results for cultural monitoring provided by Roscoe & Associates indicated no significant cultural resources were encountered in any of the test pits completed. Items noted within the spoils and sidewalls of the test pits included fragments of brick, bay dredging material with shell fragments, areas of fill, and original sediment deposits.

## Testing Summary Results

The summary of results for infiltration testing conducted the RMMT project site are presented on Table 1.

Table 1. Testing Summary Results

Location	Date	Depth Tested (BGS)	Rate (feet/day)	Depth To base of fill (if present)
INF-1	1/12/2024	24 inches	86	Not present
INF-4	2/21/2024	42 inches	81	Not present
INF-5	3/21/2024	36 inches	48	8 inches
INF-7	2/21/2024	25 inches	0.12	24 inches
INF-8	2/20/2024	48 inches	(No Data)	48 inches



Infiltration testing at locations TP/INF-1 and TP/INF-4 were performed in original deposits of clean sand that resulted in rapid infiltration rates of 86 feet per day and 81 feet per day, respectively. At location TP/INF-5, testing within the fill material resulted in an infiltration rate of 48 feet per day. This rate for TP/INF-5 is relatively fast, although significantly slower than rates observed for original material at locations TP/INF-1 and TP/INF-4. The recorded rate for location TP/INF-7 is orders of magnitude slower than the other locations and was performed within compacted sandy/gravelly fill containing abundant shell material derived from dredge spoils.

## Discussion of Findings

2024 infiltration testing at the project site was limited to four locations. Results and data obtained provide an indication of rates for varying material types encountered at the site. The undisturbed in-place soils with sufficient separation from groundwater can be expected to provide high rates of infiltration. Compacted fill materials should be expected to provide limited infiltration capacity, especially if high groundwater conditions exist.

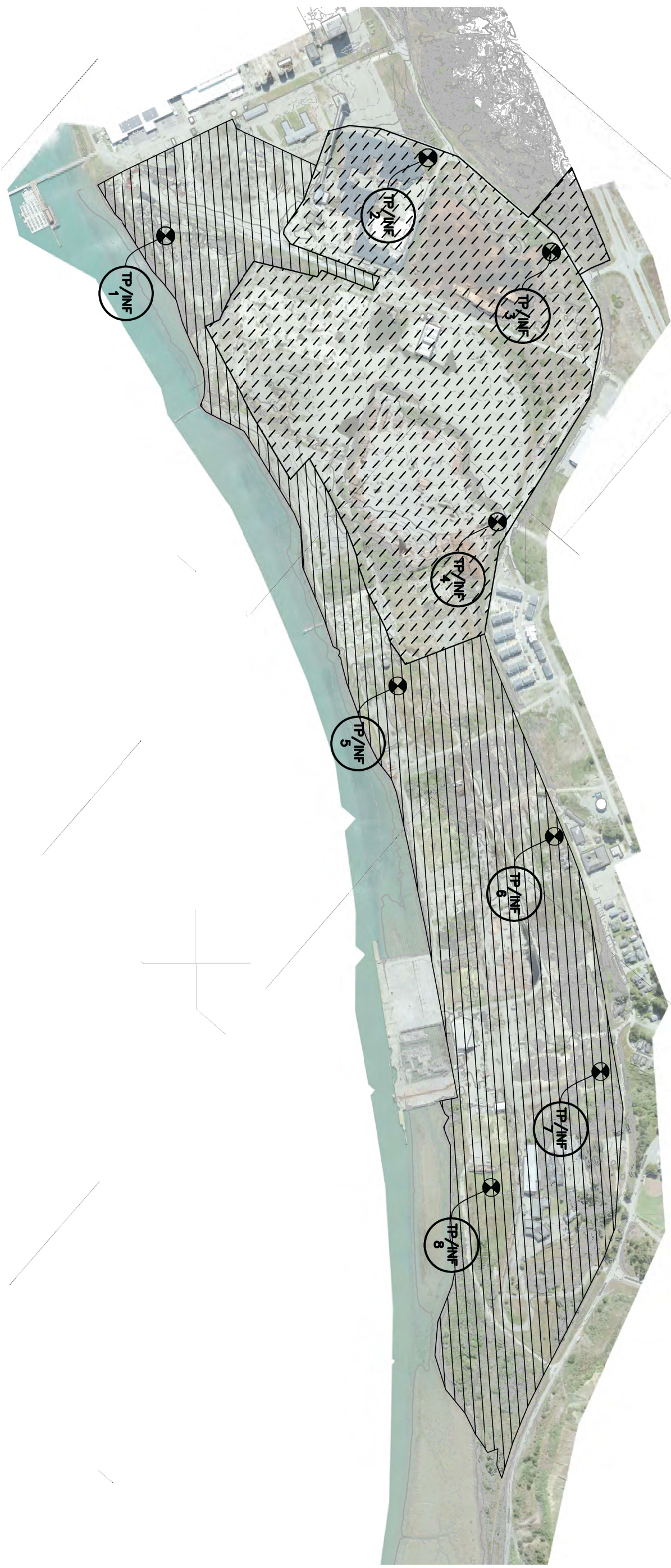
- Attachment 1. Figures
- Attachment 2. Test Pit Logs
- Attachment 3. Infiltrometer Test Data



Figures


1

Controlled by Others  
 Controlled



PLAN  
 1"=300'

PRELIMINARY

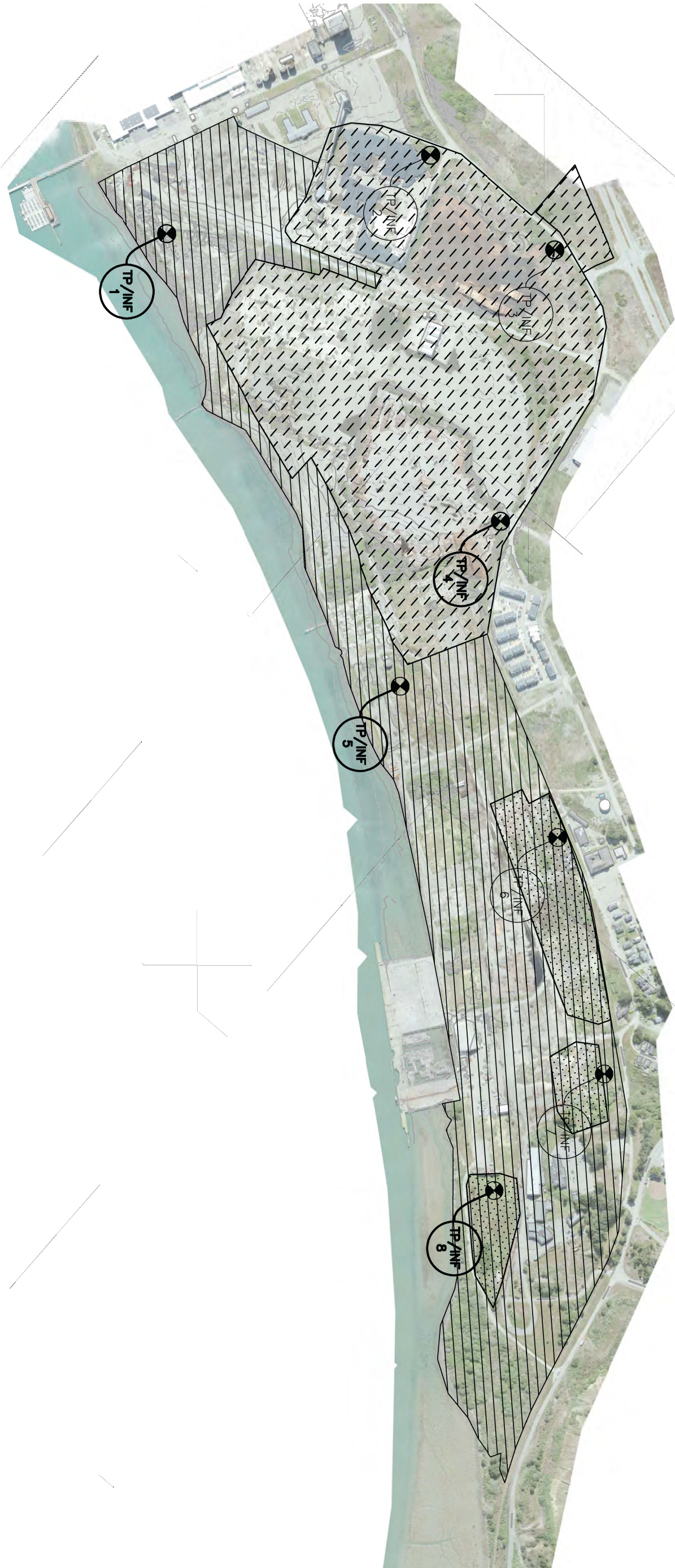
SHEET <b>FIG 1.0</b>	MOFFATT & NICHOL REDWOOD MARINE MULTIPURPOSE TERMINAL SAMOA, CALIFORNIA	DSGN	DSGN	NO.	DATE	REVISION	BY	 812 W. WABASH AVE. EUREKA, CA. 95501 WWW.SHN-ENGR.COM 707-441-8855	VERIFY SCALES BAR IS ONE INCH ON ORIGINAL DRAWING 0 ————— 1"	
		DR	CDN/JWF							CHK
DATE 09/2023	SE0	PROPOSED TESTING LOCATIONS								
PROJ. NO. 022054										

Controlled  
by Others

Controlled

Submerged

PLAN  
1"=300'



PRELIMINARY

SHEET  
FIG 2.0

DATE 09/2023  
 PROD. NO. 022054

MOFFATT & NICHOL  
 REDWOOD MARINE MULTIPURPOSE TERMINAL  
 SAMOA, CALIFORNIA

TESTING LOCATIONS

DSGN	DSGN				
DR	CDN/JWF				
CHK	JSO				
APVD		NO.	DATE	REVISION	BY

812 W. WABASH AVE.  
 EUREKA, CA. 95501  
 WWW.SHN-ENGR.COM  
 707-441-8855

VERIFY SCALES

BAR IS ONE INCH ON ORIGINAL DRAWING

0 1"

IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

Test Pit Logs

2



# TEST PIT NUMBER TP-1

CLIENT RMMT PROJECT NAME RMMT

PROJECT NUMBER 022054 PROJECT LOCATION Samoa Peninsula

DATE STARTED 1/11/24 COMPLETED 1/12/24 GROUND ELEVATION \_\_\_\_\_ TEST PIT SIZE \_\_\_\_\_

EXCAVATION CONTRACTOR HBHD GROUNDWATER DEPTH \_\_\_\_\_

EXCAVATION METHOD Backhoe  AT TIME OF EXCAVATION  AT END OF EXCAVATION  AFTER EXCAVATION

LOGGED BY AC CHECKED BY \_\_\_\_\_

NOTES \_\_\_\_\_

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0				
0.5			GRASS, ROOTS, Upper 6"	
1.0			(NATIVE) SAND, moist, loose, non sticky, non plastic, massive to weak subangular blocky, gray, clean, fine sand.	
1.5				
2.0				
2.5				
3.0				
3.5				
4.0				
4.5				
5.0				
5.5				
6.0				
6.5	GB TP-1 1667 @ 5.5 to 6'			
7.0				
7.5				
8.0				
8.5				
9.0				
9.5				
10.0				

SAND, moist, non sticky, non plastic, loose, massive to weak subangular blocky, weakly mottles gray and reddish brown, clean, fine sand, organic rich layer to 1" thick observed at 7 feet BGS.

Bottom of test pit at 10.0 feet.





# TEST PIT NUMBER TP-4

CLIENT <u>RMMT</u>	PROJECT NAME <u>RMMT</u>
PROJECT NUMBER <u>022054</u>	PROJECT LOCATION <u>Samoa Peninsula</u>
DATE STARTED <u>1/11/24</u> COMPLETED <u>1/11/24</u>	GROUND ELEVATION _____ TEST PIT SIZE _____
EXCAVATION CONTRACTOR <u>HBHD</u>	GROUNDWATER DEPTH
EXCAVATION METHOD <u>Backhoe</u>	▽ AT TIME OF EXCAVATION <u>9.50 ft</u>
LOGGED BY <u>AC</u> CHECKED BY _____	▼ AT END OF EXCAVATION <u>---</u>
NOTES _____	▼ AFTER EXCAVATION <u>---</u>

GENERAL BH / TP / WELL - GINT STD US GDT - 3/22/24 14:40 - \\EUREKA\GEOGROUP\GINT\LIBRARY\BENTLEY\GINTCL\PROJECTS\PROJECT FILES\2022022054 - RMMT.GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0				
			(FILL) GRAVELLY SAND, damp, loose, non plastic, non-sticky, brown, masive, subrounded to subangular gravels to 4" maximum, roots and organics.	
1.7			(NATIVE) SAND, loose, weak subangular blocky, non plastic, non sticky, damp, gray,	
2.5			Sidewalls caving at 3.5 feet BGS. Continued exploration to depth with hand auger.	
5.0		Encountered cable bundle in infiltration test excavation. Infiltration test performed at nearby location on 2/21/24.		
7.5				
10.0				

Bottom of test pit at 10.0 feet.



# TEST PIT NUMBER TP-5

CLIENT <u>RMMT</u>	PROJECT NAME <u>RMMT</u>
PROJECT NUMBER <u>022054</u>	PROJECT LOCATION <u>Samoa Peninsula</u>
DATE STARTED <u>3/21/24</u> COMPLETED <u>3/21/24</u>	GROUND ELEVATION _____ TEST PIT SIZE _____
EXCAVATION CONTRACTOR <u>HBHD</u>	GROUNDWATER DEPTH
EXCAVATION METHOD <u>Backhoe</u>	▼ AT TIME OF EXCAVATION <u>4.00 ft</u>
LOGGED BY <u>AC</u> CHECKED BY _____	▼ AT END OF EXCAVATION <u>---</u>
NOTES _____	▼ 2.5hrs AFTER EXCAVATION <u>3.33 ft</u>

GENERAL BH / TP / WELL - GINT STD US GDT - 3/22/24 14:52 - \NEUREKA\GEOGROUP\GINT\LIBRARY\BENTLEY\GINTCL\PROJECTS\PROJECT FILES\2022\022054\_RMMT.GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0				
0.3				(FILL) GRASS, ROOTS, upper 3".
0.7				(FILL) SAND, damp, loose to medium dense, non sticky, non plastic, weak subangular blocky, gray, common fine roots.
				(FILL) GRAVELLY SAND, moist, slightly hard, massive, non sticky, non plastic, abundant shelly debris.
				Increasing moisture with depth.
2.5	GB 20000 TP-5 @ 2.0 to 2.5			
4.5				



Bottom of test pit at 4.5 feet.



# TEST PIT NUMBER TP-6

PAGE 1 OF 1

CLIENT RMMT PROJECT NAME RMMT  
 PROJECT NUMBER 022054 PROJECT LOCATION Samoa Peninsula  
 DATE STARTED 1/11/24 COMPLETED 1/11/24 GROUND ELEVATION \_\_\_\_\_ TEST PIT SIZE \_\_\_\_\_  
 EXCAVATION CONTRACTOR \_\_\_\_\_ GROUNDWATER DEPTH \_\_\_\_\_  
 EXCAVATION METHOD Hand Auger ▽ AT TIME OF EXCAVATION 0.00 ft  
 LOGGED BY AC CHECKED BY \_\_\_\_\_ ▼ AT END OF EXCAVATION ---  
 NOTES \_\_\_\_\_ ▼ AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0		Standing water on ground surface surrounding TP-6.		▽ (FILL) GRAVELLY SAND, loose, saturated, non sticky, non plastic, grayish brown, abundant organics, roots, rounded gravel to 4 inch maximum.
				0.9 1.3 (NATIVE) SAND, lose, massive, saturated, non sticky, non plastic, gray, flowing/ caving, clean, fine sand, poorly graded.

Bottom of test pit at 1.3 feet.

GENERAL BH / TP / WELL - GINT STD US GDT - 3/22/24 15:39 - \\EUREKA\GEOGROUP\GINT\LIBRARY\BENTLEY\GINTCL\PROJECTS\PROJECT FILES\2022\022054\_RMMT.GPJ



# TEST PIT NUMBER TP-7

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CLIENT <u>RMMT</u>	PROJECT NAME <u>RMMT</u>
PROJECT NUMBER <u>022054</u>	PROJECT LOCATION <u>Samoa Peninsula</u>
DATE STARTED <u>1/11/24</u> COMPLETED <u>1/11/24</u>	GROUND ELEVATION _____ TEST PIT SIZE _____
EXCAVATION CONTRACTOR <u>HBHD</u>	GROUNDWATER DEPTH
EXCAVATION METHOD <u>Backhoe</u>	▼ AT TIME OF EXCAVATION <u>2.43 ft</u>
LOGGED BY <u>AC</u> CHECKED BY _____	▼ AT END OF EXCAVATION <u>---</u>
NOTES _____	▼ AFTER EXCAVATION <u>---</u>

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0					
					(FILL) GRAVELLY SANDY LOAM, loose to very friable, moist, slightly sticky, slightly plastic, yellowish brown, very fine sand, common large mottles, rounded gravels to 1" (typical).
					0.9
					(FILL) GRAVELLY SAND, loose to very friable, moist, non sticky, non plastic, gray, rounded gravels to 3 inches maximum (1 inch typical).
					1.7
					(NATIVE) SAND, loose, wet, non sticky, non plastic, gray, fine sand, fine, clean sand,
2.5	GB	100	Fill depth varies from 20 to 28 inches BGS.		▼ @ 29 inches BGS, becomes saturated, caving/ flowing sand observed.
					3.0

Bottom of test pit at 3.0 feet.

GENERAL BH / TP / WELL - GINT STD US GDT - 3/22/24 17:19 - \\EUREKA\GEOGROUP\GINT\LIBRARY\BENTLEY\GINTCL\PROJECTS\PROJECT FILES\2022\022054 - RMMT.GPJ





# TEST PIT NUMBER TP-8

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CLIENT <u>RMMT</u>	PROJECT NAME <u>RMMT</u>
PROJECT NUMBER <u>022054</u>	PROJECT LOCATION <u>Samoa Peninsula</u>
DATE STARTED <u>2/20/24</u> COMPLETED <u>2/20/24</u>	GROUND ELEVATION _____ TEST PIT SIZE _____
EXCAVATION CONTRACTOR <u>HBHD</u>	GROUNDWATER DEPTH
EXCAVATION METHOD <u>Backhoe</u>	▽ AT TIME OF EXCAVATION <u>3.00 ft</u>
LOGGED BY <u>AC</u> CHECKED BY _____	▽ AT END OF EXCAVATION <u>---</u>
NOTES _____	▽ 3hrs AFTER EXCAVATION <u>1.50 ft</u>

GENERAL BH / TP / WELL - GINT STD US GDT - 3/22/24 17:07 - \\EUREKA\GEOGROUP\GINT\LIBRARY\BENTLEY\GINTCL\PROJECTS\PROJECT FILES\2022022054 - RMMT.GPJ

DEPTH (ft)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0				
2.5		Base of fill varies in depth from 2 to 4.0 feet BGS.		(FILL) SANDY BOULDERS/ COBBLES, saturated, slightly sticky, friable, slightly hard, gray, subangular gravels to 18" max, chunks of brick, cable.
		Double Ring Infiltrometer test performed at top of Native material at 48" BGS.		(NATIVE) SAND, loose, non sticky, non plastic, moist, gray, fine sand with trace silt. @ 3' BGS, becomes saturated.
				Bottom of test pit at 4.0 feet.

Infiltrrometer Test  
Data

3



DOUBLE RING INFILTRMETER TEST DATA SHEET - RMMT Site

CLIENT RMMT DATE 1/12/2024  
 SHN JOB REF. 022054 TESTED BY Anson Call  
 TEST No. INF-1 PRE-SOAK 1 Hour  
 LOCATION Southeast Corner DTW >10 feet  
 DEPTH TESTED 24" BEGIN PRE-SOAK 9:30

Notes:  
 Inner ring inner diameter = 11.375 inches Inner ring set 6" into ground  
 Outer ring inner diameter = 21.625 inches Outer ring set 7" into ground  
 Infiltration surface area of inner ring: 101.625 in<sup>2</sup>  
 Depth of water during test: 9"

Reading No.	Start Time	Stop Time	Interval (Minutes)	Volume (mL)	Infiltration Rate (mL/Minute)	Infiltration Rate:			
						mL/(Minutes * Area {Sq in.})	mL/(Min* Sq Ft.)	Ft/Min	Ft/Day
1	10:30	10:45	15	18,000	1200	11.81	1700.37	0.0600	86.47
2	10:45	11:00	15	16,000	1067	10.50	1511.44	0.0534	76.86
3	11:00	11:15	15	16,000	1067	10.50	1511.44	0.0534	76.86
4	11:15	11:30	15	17,000	1133	11.15	1605.90	0.0567	81.67
5	11:30	11:45	15	18,000	1200	11.81	1700.37	0.0600	86.47
6	11:45	12:00	15	18,000	1200	11.81	1700.37	0.0600	86.47

1 mL = 1 cc = 0.061

STABILIZED INFILTRATION RATE = 86.47 Ft/Day

TEST No. INF-4 TESTED BY Anson Call  
 LOCATION Eastern Central PRE-SOAK 1 Hour  
 DEPTH TESTED 42" DTW >10 feet  
 BEGIN PRE-SOAK 8:50

Notes:  
 Inner ring inner diameter = 11.375 inches Inner ring set 6" into ground  
 Outer ring inner diameter = 21.625 inches Outer ring set 9" into ground  
 Infiltration surface area of inner ring: 101.625 in<sup>2</sup>  
 Depth of water during test: 8"

Reading No.	Start Time	Stop Time	Interval (Minutes)	Volume (mL)	Infiltration Rate (mL/Minute)	Infiltration rate:			
						mL/(Minutes * Area {Sq in.})	mL/(Min* Sq Ft.)	Ft/Min	Ft/Day
1	9:50	10:05	15	19,000	1267	12.46	1794.83	0.0634	91.27
2	10:05	10:20	15	17,000	1133	11.15	1605.90	0.0567	81.67
3	10:20	10:35	15	18,000	1200	11.81	1700.37	0.0600	86.47
4	10:35	10:50	15	17,000	1133	11.15	1605.90	0.0567	81.67
5	10:50	11:05	15	18,000	1200	11.81	1700.37	0.0600	86.47
6	11:05	11:20	15	17,000	1133	11.15	1605.90	0.0567	81.67

STABILIZED INFILTRATION RATE = 81.67 Ft/Day

TEST No. INF-5 TESTED BY Anson Call  
 LOCATION Western Central PRE-SOAK 1 Hour  
 DEPTH TESTED 36" DTW 40 inches  
 BEGIN PRE-SOAK 10:00

Notes:  
 Inner ring inner diameter = 11.375 inches Inner ring set 6" into ground  
 Outer ring inner diameter = 21.625 inches Outer ring set 8" into ground  
 Infiltration surface area of inner ring: 101.625 in<sup>2</sup>  
 Depth of water during test: 9"

Reading No.	Start Time	Stop Time	Interval (Minutes)	Volume (mL)	Infiltration Rate (mL/Minute)	Infiltration rate:			
						mL/(Minutes * Area {Sq in.})	mL/(Min* Sq Ft.)	Ft/Min	Ft/Day

1	11:00	11:15	15	10,000	667	6.56	944.65	0.0334	48.04
2	11:15	11:30	15	10,000	667	6.56	944.65	0.0334	48.04
3	11:30	11:45	15	10,000	667	6.56	944.65	0.0334	48.04
4	11:45	12:00	15	10,000	667	6.56	944.65	0.0334	48.04
5	12:00	12:15	15	9,000	600	5.90	850.18	0.0300	43.23
6	12:15	12:30	15	10,000	667	6.56	944.65	0.0334	48.04

STABILIZED INFILTRATION RATE = 48.04 Ft/Day

TEST No. INF-7  
LOCATION Western Central  
DEPTH TESTED 25"

TESTED BY Anson Call  
PRE-SOAK 1 Hour  
DTW 24.5 inches  
BEGIN PRE-SOAK 13:00

Notes:  
Inner ring inner diameter = 11.375 inches Inner ring set 6" into ground  
Outer ring inner diameter = 21.625 inches Outer ring set 8" into ground  
Infiltration surface area of inner ring: 101.625 in<sup>2</sup>  
Depth of water during test: 8"

Reading No.	Start Time	Stop Time	Interval (Minutes)	Volume (mL)	Infiltration Rate (mL/Minute)	Infiltration rate: mL/(Minutes * Area {Sq in.})	mL/(Min* Sq Ft.)	Ft/Min	Ft/Day
1	14:00	14:15	15	19	1	0.01	1.79	0.0001	0.09
2	14:15	14:30	15	28	2	0.02	2.65	0.0001	0.13
3	14:30	14:45	15	26	2	0.02	2.46	0.0001	0.12
4	14:45	15:00	15	26	2	0.02	2.46	0.0001	0.12
5	15:00	15:15	15	26	2	0.02	2.46	0.0001	0.12
6	15:15	15:30	15	26	2	0.02	2.46	0.0001	0.12

STABILIZED INFILTRATION RATE = 0.12 Ft/Day

TEST No. INF-8  
LOCATION Western Central  
DEPTH TESTED 42"

TESTED BY Anson Call  
PRE-SOAK 1 Hour  
DTW 18 inches  
BEGIN PRE-SOAK 10:15

Notes:  
Inner ring inner diameter = 11.375 inches Inner ring set 6" into ground  
Outer ring inner diameter = 21.625 inches Outer ring set 8" into ground  
Infiltration surface area of inner ring: 101.625 in<sup>2</sup>  
Depth of water during test: 9"  
After setting up test, water in inner ring began to rise, and by 11:00 overflowed in  
No infiltration data to report.

Reading No.	Start Time	Stop Time	Interval (Minutes)	Volume (mL)	Infiltration Rate (mL/Minute)	Infiltration rate: mL/(Minutes * Area {Sq in.})	mL/(Min* Sq Ft.)	Ft/Min	Ft/Day
1	14:00	14:15	15	0	0	0.00	0.00	0.0000	0.00
2	14:15	14:30	15	0	0	0.00	0.00	0.0000	0.00
3	14:30	14:45	15	0	0	0.00	0.00	0.0000	0.00
4	14:45	15:00	15	0	0	0.00	0.00	0.0000	0.00
5	15:00	15:15	15	0	0	0.00	0.00	0.0000	0.00
6	15:15	15:30	15	0	0	0.00	0.00	0.0000	0.00

STABILIZED INFILTRATION RATE = 0 Ft/Day