ROBINSON NOBLE
a terraphase company

September 15, 2023

Mr. Shane Fortney
Manager
Fortwest, LLC
Post Office Box 522
Woodinville, Washington 98072

sent via email to sfortney@live.com

Subject: Infiltration Evaluation

Dear Mr. Fortney:

This letter has been prepared on behalf of Fortwest, LLC by Robinson Noble (RN), a wholly owned subsidiary of Terraphase Engineering Inc. This letter presents our evaluation of infiltration feasibility for the proposed residential project located at 31964 East Blanche Street, Carnation, Washington (King County parcel number 3060100120). The approximate location of the project is shown on the Vicinity Map, presented as Figure 1.

The project site is approximately 0.24 acres in size and is currently developed with a single-family residence. We understand that you plan to redevelop the approximate northern 2/3 of the property with a duplex. The existing residence at the southern end of the parcel is to remain.

1 Surface and Subsurface Conditions

Surface Conditions

The surface conditions consist of grass covered lawn. A few small landscaping trees were near the existing residence to the south and along the edges of the property.

Subsurface Conditions

The geology of the area is mapped on the Washington State Department of Natural Resources Geologic Information Portal (https://geologyportal.dnr.wa.gov). The site is mapped as being underlain by alluvium (Qa). These deposits are not glacially consolidated and generally consist of sorted combinations of sand, silt, and gravel.

We explored subsurface conditions at the site on August 22, 2023 by excavating two test pits with a mini trackhoe. Both test pits were excavated to depths of approximately 4.5 feet below the ground surface (bgs). The explorations were located in the field by representatives from this firm who also examined the soils and geologic conditions encountered and maintained logs of the explorations. The approximate locations of the explorations are shown on the Site Plan in Figure 2. The soils were visually classified in

general accordance with the Unified Soil Classification System, a copy of which is presented as Figure 3. The logs of the explorations are presented in Figures 4 and 5.

The explorations generally revealed an approximate 0.5-foot-thick surficial layer of topsoil. Underlying the topsoil, we encountered medium dense, dry to moist, brown silty sand with some gravel to about 3½ feet. Underlying the silty sand in PIT-1 we observed medium dense, moist brown silty fine to medium sand to the depths explored. Below the silty sand, PIT-2 revealed medium dense, dry to moist, brown silty fine to medium sand with gravel and cobbles to the depths explored.

Groundwater was not observed during our explorations. Rust mottled and wet soils were also not observed. Review of nearby well logs indicate no groundwater was observed within at least 15 feet of the ground surface.

2 Pilot Infiltration Tests

The project site is located in Carnation and is subject to the 2014 Department of Ecology Stormwater Management Manual for Western Washington (DOE). We understand that infiltration is proposed to be sited west of the planned duplex. The DOE requires that Small Pilot Infiltration Tests (PITs) be performed at the infiltration facility location. We excavated test pits near the proposed infiltration facility to observe the subsurface soil and groundwater conditions and determine an appropriate depth for the small pilot infiltration tests (PITs). The PITs were performed in general accordance with the DOE within the location of the proposed infiltration facility as shown on the Site Plan in Figure 2.

The small-scale PIT involves excavating a test pit with a base area between 12 and 32 square feet. This test pit is then pre-soaked with 12 inches or more of water for a period of 6 hours. After the pre-soak is complete, the water depth is maintained for at least one hour to measure the steady state infiltration rate. Every 15 minutes the cumulative water volume, water depth, and flow rate are recorded. After one hour the water is shut off and the water depth is recorded every 15 minutes in order to measure the falling head infiltration rate.

The small PITs were completed at a depth of approximately 4.5 feet bgs with a base area of about 18 ft^2 for PIT-1 and 12.8 ft^2 for PIT-2. The maximum available flow from the provided hose bib into PIT-2 did not allow the entire area to be wetted or any head to be built up and maintained. Therefore, the steady state was determined using the maximum flow rate into the PIT over the observed wetted area.

2.1 Design Infiltration Rate

The measured saturated hydraulic conductivity ($K_{sat,initial}$) for each test is shown in Table 1 below. The design saturated hydraulic conductivity ($K_{sat,design}$) is determined by applying correction factors to the measured rate as prescribed in Volume III, Section 3.3.6 of the DOE. The measured rate must be reduced through appropriate correction factors for site variability (CF_v), uncertainty of test method (CF_t), and degree of influent control (CF_m) to prevent siltation and bio-buildup. It should be noted that construction traffic or other disturbance to the target infiltration area could compact the soil, which may decrease the effective infiltration rates. The correction factors and resulting design infiltration rates are

also shown in Table 1 below. We selected a site variability factor of 0.7 due to the variability of performance of the silty sand with varying amounts of gravel soils tested across the site.

Table 1: Measured and Design Infiltration Rates

Test Number	Test Depth (ft)	USCS	$K_{sat,initial}$ (in/hr)	Correction Factors			$K_{sat,design}$ (in/hr)
				CF_V	CF_T	CF_M	
PIT-1	4.5	SM	24	0.7	0.5	0.9	7.6
PIT-2	4.5	SM	37	0.7	0.5	0.9	11.6

2.2 Laboratory Testing

For groundwater protection requirements, cation exchange capacity (CEC) and organic content of samples of the soil at the infiltration testing depth of each PIT were determined by a subcontracted testing laboratory. The test results are shown in Table 2 and attached as Appendix A of this letter.

Table 2: Chemical Properties of Soil at Infiltration Test Locations

Test Number	Test Depth (ft)	USCS	CEC (meq/100g)	Organic Content
PIT-1	4.5	SM	4.7	1.0
PIT-2	4.5	SM	12.0	4.4

3 Conclusions and Recommendations

In our opinion infiltration at the site is feasible. We recommend that a design saturated hydraulic conductivity of 7.6 inches per hour be used for all facilities at the site, when designing facilities for the underlying silty sand soils. If the sand soils are not encountered during construction of the facilities at the design depth then the facility should be overexcavated until the silty sand soils are encountered.

For infiltration facilities used for water treatment purposes, DOE Section 3.3.7 Site Suitability Criteria (SSC) #4 requires measured saturated hydraulic conductivity rates to be 9 inches per hour or less. The measured rates for the silty sand layer at the site exceed this criterion, and will require the facility to be designed with an additional sand layer to reduce the infiltration rate. Additionally, SSC #6 requires the soil to have a CEC of 5 meq/100g or greater and organic content of 1.0% or greater. All of the samples met the criteria of SSC #6.

4 Closing

Terraphase is grateful for the opportunity to offer our services on this important project. If you have any questions or comments regarding this submittal, please contact Barbara Gallagher at (425) 488-0599.

Sincerely,

for Terraphase Engineering Inc.

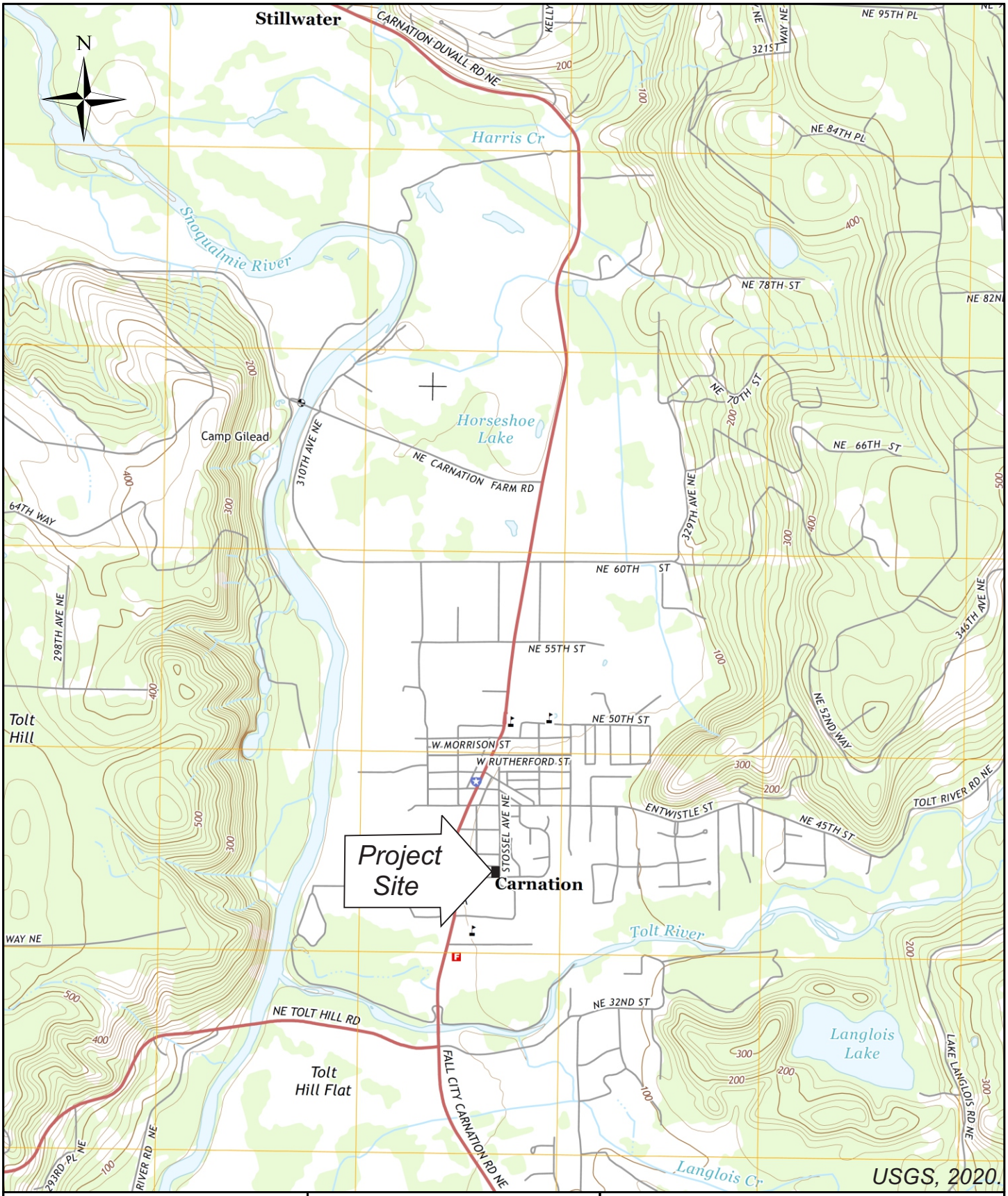
Barbara Gallagher, PE
Associate

BG:RP:am

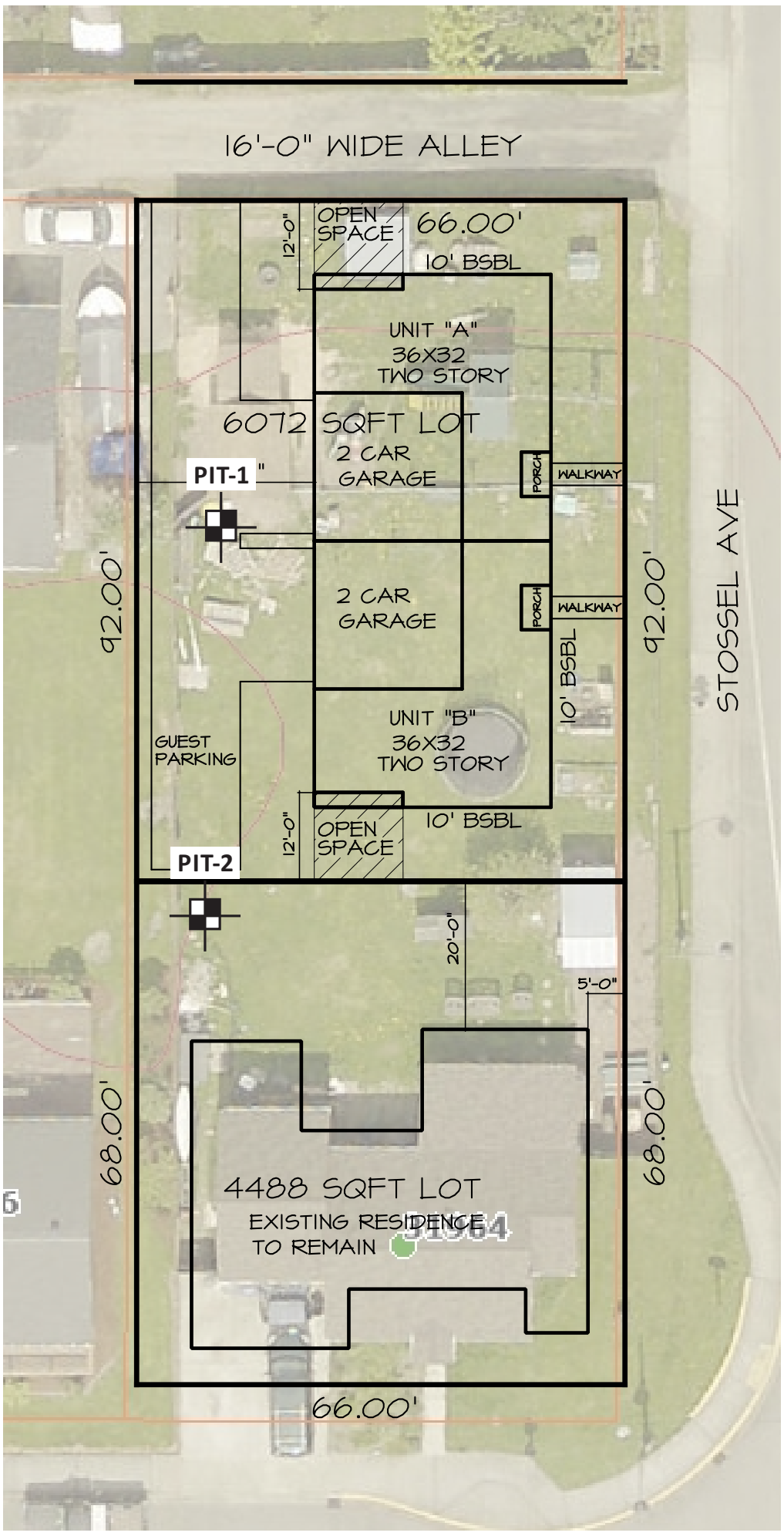
Attachments (3):

- Figure 1 - Vicinity Map
- Figure 2 – Site Plan
- Figure 3 – PIT-1
- Figure 4 – PIT-2
- Appendix A – Amtest results

Figures



SAFETY FIRST	CLIENT: Fortwest, LLC	**Vicinity Map**
ROBINSON NOBLE a terraphase company	PROJECT: East Blanche Street Carnation, WA	
	PROJECT NUMBER: W112.001.001	**FIGURE 1**



Legend

PIT-1 Approximate Infiltration Test Location

N

0 10 20 40 Feet

1 inch = 20 feet

Imagery Source: King County iMap and untitled site plan provided by client

SAFETY FIRST

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CLIENT:	Fortwest, LLC
PROJECT:	East Blanche Street Carnation, WA
PROJECT NUMBER:	W112.001.001

Site Plan

FIGURE 2

Unified Soil Classification System

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE - GRAINED SOILS MORE THAN 50% RETAINED ON number 200 SIEVE	GRAVEL MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVEL	GW	WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND MORE THAN 50% OF COARSE FRACTION PASSES NO. 4 SIEVE	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY-GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE - GRAINED SOILS MORE THAN 50% PASSES NO. 200 SIEVE	SILT AND CLAY LIQUID LIMIT LESS THAN 50%	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY LIQUID LIMIT 50% OR MORE	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

1) Field classification is based on visual examination of soil in general accordance with ASTM D 2488-83.

2) Soil classification using laboratory tests is based on ASTM D 2487-83.

3) Descriptions of soil density or consistency are based on interpretation of blowcount data, visual appearance of soils, and/or test data.

SOIL MOISTURE MODIFIERS

Dry- Absence of moisture, dusty, dry to the touch

Moist- Damp, but no visible water

Wet- Visible free water or saturated, usually soil is obtained from below water table

SAFETY FIRST	CLIENT: Fortwest, LLC	Unified Soil Classification System
ROBINSON NOBLE a terraphase company	PROJECT: East Blanche Street Carnation, WA	
	PROJECT NUMBER: W112.001.001	FIGURE 3

PIT-1

Date: 8/22/2023
Logged By: NEG

Location: East Blanche Street
Carnation, WA

Depth (ft.)	Soil Description	USC	View of PIT-1
0.0 - 0.5	Light brown silty fine sand with gravel and organics (loose, dry to moist) **(Topsoil)**	SM	
0.5 - 3.5	Brown silty sand with some gravel and trace organics (medium dense, dry to moist)	SM	
3.5 - 4.5	Brown silty fine to medium sand (medium dense, moist)	SM	

Notes

- Test pit completed at 4.5 feet
- Groundwater was not observed
- Samples collected at 4.3 feet

Tacoma
2105 South C Street
Tacoma, Washington 98402
253.475.7711

Woodinville
17625 - 130th Avenue NE, Suite 102
Woodinville, Washington 98072
425.488.0599

ROBINSON NOBLE
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East Blanche Street Infiltration Evaluation
W112.001.001
Figure 4

PIT-2

Date: 8/22/2023
Logged By: NEG

Location: East Blanche Street
Carnation, WA

Depth (ft.)	Soil Description	USC	View of PIT-2
0.0 - 0.5	Light brown silty fine sand with gravel and organics (loose, dry to moist) **(Topsoil)**	SM	
0.5 - 3.5	Brown silty sand with some gravel and trace organics (medium dense, dry to moist)	SM	
3.5 - 4.5	Brown silty fine to medium sand with gravel (medium dense, dry to moist)	GP-GM	

Notes

- Test pit completed at 4.5 feet
- Groundwater was not observed
- Samples collected at 4.5 feet

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East Blanche Street Infiltration Evaluation
W112.001.001
Figure 5

Appendix A

Am Test Inc.
13600 NE 126TH PL
Suite C
Kirkland, WA 98034
(425) 885-1664

Professional Analytical Services

Sep 14 2023
ROBINSON NOBLE
31964 BLANCHE STREET
CARNATION, WA 98014
Attention: BARBARA GALLAGHER

Dear BARBARA GALLAGHER:

Enclosed please find the analytical data for your project.

The following is a cross correlation of client and laboratory identifications for your convenience.

CLIENT ID	MATRIX	AMTEST ID	TEST
PIT 1 (BROWN SILTY SAND)	Soil	23-A014719	CONV, OM std mth
PIT 2 (BROWN SILTY SAND W/ GRAVEL/C	Soil	23-A014720	CONV, OM std mth

Your samples were received on Tuesday, August 29, 2023. At the time of receipt, the samples were logged in and properly maintained prior to the subsequent analysis.

The analytical procedures used at AmTest are well documented and are typically derived from the protocols of the EPA, USDA, FDA or the Army Corps of Engineers.

Following the analytical data you will find the Quality Control (QC) results.

Please note that the detection limits that are listed in the body of the report refer to the Practical Quantitation Limits (PQL's), as opposed to the Method Detection Limits (MDL's).

If you should have any questions pertaining to the data package, please feel free to contact me.

Sincerely,

Kathy Fugiel
President

PO Number: 253-475-7711

BACT = Bacteriological
CONV = Conventionals
MET = Metals
ORG = Organics
NUT=Nutrients
DEM=Demand
MIN=Minerals

Am Test Inc.
13600 NE 126TH PL
Suite C
Kirkland, WA 98034
(425) 885-1664
www.amtestlab.com

Professional Analytical Services

ANALYSIS REPORT

ROBINSON NOBLE
31964 BLANCHE STREET
CARNATION, WA 98014
Attention: BARBARA GALLAGHER
PO Number: 253-475-7711
All results reported on an as received basis.

Date Received: 08/29/23
Date Reported: 9/14/23

AMTEST Identification Number **23-A014719**
Client Identification **PIT 1 (BROWN SILTY SAND)**
Sampling Date **08/22/23, 10:30**

Conventionals

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cation Exchange Capacity	4.7	meq/100g		0.5	SW-846 9081	CM	09/14/23

Miscellaneous

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANLST	DATE
Organic Matter	1.0	%			SM 2540G	HV	09/14/23

AMTEST Identification Number **23-A014720**
Client Identification **PIT 2 (BROWN SILTY SAND W/ GRAVEL/C**
Sampling Date **08/22/23, 17:10**

Conventionals

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cation Exchange Capacity	12.	meq/100g		0.5	SW-846 9081	CM	09/14/23

Miscellaneous

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANLST	DATE
Organic Matter	4.4	%			SM 2540G	HV	09/14/23

Kathy Fugiel
President

Am Test Inc.
13600 NE 126th PL
Suite C
Kirkland, WA, 98034
(425) 885-1664
www.amtestlab.com

Professional Analytical Services

QC Summary for sample numbers: 23-A014719 to 23-A014720

DUPLICATES

SAMPLE #	ANALYTE	UNITS	SAMPLE VALUE	DUP VALUE	RPD
23-A014720	Cation Exchange Capacity	meq/100g	12.	10.	18.
23-A014720	Organic Matter	%	4.4	4.7	6.6

STANDARD REFERENCE MATERIALS

ANALYTE	UNITS	TRUE VALUE	MEASURED VALUE	RECOVERY
Cation Exchange Capacity	meq/100g	2.0	2.1	105. %

BLANKS

ANALYTE	UNITS	RESULT
Cation Exchange Capacity	meq/100g	< 0.5

AmTest Chain of Custody Record

AMTEST LABORATORIES
13600 NE 126th PL, Suite C, Kirkland, WA 98034
Ph (425) 885-1664 Fx (425) 820-0245
www.amtestlab.com

Chain of Custody No. [illegible]

Client Name & Address:	Invoice To:
[illegible] 31964 Blanche Street, Carnation WA	Robinson Noble a terraphase Company
Contact Person: [illegible] Barbara Gallagher	Invoice Contact: Sherrie Hanson
Phone No: [illegible] 206-227-0105	PO Number: 253-475-7711
Fax No:	Invoice Ph/Fax:
E-mail: barbara.gallagher@terraphase.com	Invoice E-mail: Sherrie.hanson@terraphase.com
Report Delivery: (Choose all that apply) Mail / Fax / (Email) / Posted Online	Data posted to online account: YES / NO Web Login ID:

Special Instructions:

Requested TAT: **(Rush must be pre-approved by lab)** (Standard) RUSH (5 Day / 3 Day / 48 HR / 24 HR)

Temperature upon Receipt: 23.9°C

Project Name:

Project Number:

AmTest ID	Client ID (35 characters max)	Date Sampled	Time Sampled	Matrix	No. of containers	Analysis Requested: Organic Content	Analysis Requested: Cation Exchange Capacity	Analysis Requested	Analysis Requested	Analysis Requested	Analysis Requested	Analysis Requested	Analysis Requested	Analysis Requested	QA/QC
14719	Pit 1 (Brown silty Sand)	08/22/23	10:30	Soil	1	X	X								
14720	Pit 2 (Brown silty sand w/gravel fragments)	08/22/23	17:10	Soil	1	X	X								

Collected/Relinquished By:	Date	Time	Received By:	Date	Time
Nancy Santos	8/29/23	12:42	KL	8/29/23	12:42
Relinquished By:	Date	Time	Received By:	Date	Time
Relinquished By:	Date	Time	Received By:	Date	Time

COMMENTS: