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September 12, 2018

Allan Smith
Southwest Design Group, LLC
12223 Highland Avenue, Suite 106-201
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SUBJECT: **REPORT OF INFILTRATION TESTING**
Proposed Arbor Carwash
9744 Arrow Route
Rancho Cucamonga, California
Project No. 1702-01

Mr. Smith:

In accordance with your authorization, we have conducted infiltration testing for low impact development (LID) design associated with the proposed site improvements. Our test procedures and content of this report conform to the San Bernardino County Technical Guidance Document for Water Quality Management Plans and Low Impact Development Best Management Practices.

Our findings, conclusions, and recommendations related to site infiltration are presented herein. We greatly appreciate this opportunity to be of service. Should you have any questions, or require additional services, please call our office.

Respectfully submitted,
RGS Engineering Geology

Christopher Krall, P.G. 5717, E.G. 1816
Engineering Geologist

INTRODUCTION

Accompanying Map, Illustrations, And Appendices

Figure 1 - Site Location Map
Figure 2 - Infiltration Test Location Plan

Appendix A - References
Appendix B - Exploratory Trench Logs
Appendix C - Infiltration Test Data

Scope of Work

For the purpose of this study RGS conducted the following scope or work in accordance with written authorization:

- Review related geologic and soils information available in our files.
- Excavate, log, and backfill two deep exploratory trenches on-site to evaluate the underlying soil condition to a maximum depth of 15 feet.
- Excavate a total of two shallow test pits to a depth near the bottom of the proposed basin for infiltration testing.
- Prepare each test pit for infiltration testing.
- Conduct two field infiltration tests to determine the representative rate to be used for storm water mitigation design. Testing utilized the Riverside County percolation test method in conformance with the San Bernardino County Technical Guidance Documents for Water Quality Management.
- Preparation of this report presenting our findings, conclusions, and geologic recommendations for storm water basin design.

Purpose and Objective

The purpose and objective of testing is to determine the rate of storm water infiltration for native sediments exposed along the bottom of proposed retention basins associated with site improvements at the proposed Arbor Carwash Express in Rancho Cuca Monga, California. Best management practices utilize drawdown time based on infiltration rate combined with the interaction of chemical, physical, and biological processes between soil, organic matter, and water to filter out sediments and constituents from surface run-off and storm water. Accordingly, best management practices require a maximum

drawdown time to provide proper filtration and avoid nuisance issues. Since drawdown time is contingent on the infiltration rate of the underlying soil, tests are used to help establish the vertical infiltration rate of the soil below a proposed infiltration facility. The test methods attempt to simulate the physical processes and seasonal variance that will occur when the facility is in operation.

The established infiltration rate combined with calculated storm water flow is then used by the project engineer to design the low impact development best management practice for water quality suited to the particular project.

Site Conditions and Location

The site is located along the north side of Arrow Route just east of Archibald Avenue in the city of Rancho Cucamonga, California. The geographical relationship of the site and surrounding area is shown on our Site Location Map, Figure 1.

Most of the site is currently vacant with a small residence located near the center of the property. Access for infiltration testing was limited due to the existence of the home. However, the soil conditions in the area tested are considered representative of the infiltration basin and the site as a whole based on the local geology.

Topography in the area of the proposed improvements is generally flat with a gradient of less than 2 percent toward the south-southwest. The area is void of shrubs or trees with only a sparse growth of seasonal weeds and grasses observed.

Proposed Development

The proposed site improvements include an express carwash with associated landscaping, hardscape, and buildings. Low impact design for storm water quality includes a water run-off retention basin near the south-central portion of the site. The proposed improvements and low impact development facilities are shown on depicted on our Infiltration Test Location Plan, Figure 2.

SITE EVALUATION AND TESTING

Subsurface Evaluation

To evaluate the subsurface conditions below the proposed retention basin and infiltration trench, two exploratory trench excavations (one at each infiltration facility) were conducted using Case 580 M rubber tired backhoe equipped with a 24 inch wide bucket to a depth of at least 10 feet below the proposed basin or trench invert. The number of exploratory excavations was dictated by Table 1 of Appendix A of the design handbook. Each excavation was carefully monitored by our state licensed Engineering Geologist, Christopher Krall, who prepared a log of the soil column, encountered and collected representative soil samples for field classification as warranted. Geologic conditions

related to infiltration such as soil texture, density, and moisture content was recorded. Soil color and mottling or staining and groundwater occurrence were also noted. A copy of the exploratory trench logs is provided in Append B of this report for review. The exploratory trenches were backfilled immediately following field recordation for safety.

Infiltration Test Method

Our field test method for infiltration was conducted in conformance with Appendix A of the Riverside County Design Handbook for Low Impact Development Best Management Practices. Our test method followed the San Bernardino County Technical Guidance Document for Water Quality Management Plans and Low Impact Development Best Management Practices.

This test measures the length of time required for a quantity of water to infiltrate into the soil and is often called a "percolation rate". It should be noted that the percolation rate is related to, but not equal to, the infiltration rate. While an infiltration rate is a measure of the speed at which water progresses downward into the soil, the percolation rate measures not only the downward progression but the lateral progression through the soil as well. This reflects the fact that the surface area for infiltration testing would include only the horizontal surface while the percolation test includes both the bottom surface area and the sidewalls of the test hole. However, there is a relationship between the values obtained by a percolation test and infiltration rate expressed by the following equation known as the Porchet Method of converting percolation rate to infiltration rate.

$$I_t = \frac{\Delta H\,(60r)}{\Delta t\,(r+2H_{avg})}$$

Where:

I_t = tested infiltration rate (inches/hour)
ΔH = change in head over the time interval, inches
Δt = time interval, minutes
r = effective radius of test hole
H_{avg} = average head over the time interval, inches

Test Preparation and Procedure

Test pits were excavated at each proposed infiltration facilities (two for the proposed basin and two for the proposed trench) to a depth of two to three feet below the exiting ground surface to replicate the bottom of the infiltration facility. The number of test pits was dictated by Table 1 of Appendix A of the design handbook. Along the bottom of each test pit a test hole was excavated to a depth of 22 to 24 inches with a diameter of approximately 8 inches. A six inch diameter perforated plastic pipe and 2 inches of gravel was placed in each test hole to prevent scouring or erosion.

A water container was inverted over each test hole and 5 gallons of clean water was allowed to soak into the soil prior to testing. Pre-soaking of the test holes was performed to emulate possible saturated conditions during seasonal storms. Where pre-soaking of the test holes was complete in a timely manner, testing was conducted immediately following the pre-soak. Where pre-soaking was slower, testing was conducted the following day. Under no circumstance was presoaking allowed to continue for more than 26 hours.

Following the presoak, test holes were filled with clear water to a height of 20 inches (5 times the test-hole radius) and the time required for the water to seep into the soil was recorded. All measurements were taken from a fixed reference point using a ruler placed within the test hole and are accurate to 0.25 inches.

When 2 consecutive measurements indicated that 6 inches of water seeps into the soil in less than 25 minutes, the strata was classified as “sandy soil” and testing continued for an additional hour with measurements taken every 10 minutes. The drop that occurs during the final 10 minutes was used to calculate the field percolation rate. In non-sandy material at least twelve measurements were recorded over a period of at least six hours at approximately 30 minutes intervals. The final reading was used to calculate the field percolation rate. The test pits were backfilled immediately following field recordation for safety. At the completion of testing, a 3 feet long surveyor’s stake (lath), flagged with highly visible banner tape was placed in the location of the test indicating date, test hole number, and the company performing the test. The approximate location of each test pit is shown on our Infiltration Test Location Plan, Figure 2.

SUMMARY OF FINDINGS AND TEST RESULTS

Earth Material

The earth material underlying the infiltration areas is summarized below. Detailed descriptions of the soil characteristics are provided on our exploratory trench logs, Appendix B.

In summary the subsurface conditions below each proposed infiltration areas are similar and expose silty sand (Unified Soil Classification – SM) that is yellow brown, fine to coarse grained, dry to damp, medium dense, non-cohesive, moderately graded, with a slight blocky soil structure. Soil stratigraphy is generally consistent to a depth of 15 feet or more.

Groundwater Occurrence

Groundwater was encountered in both of our exploratory trench excavation at a depth of approximately 15 feet below the ground surface corresponding to a depth of more than 10 feet below the proposed infiltration invert.

In general, groundwater does not occur in this area within 100 to 200 feet of the ground surface and groundwater is not expected to impact this development.

Test Results

Our field test data is presented in Appendix C for review and summarized in Table I below. The percolation rate of the earth material underlying the infiltration areas yields good percolation rates ranging from 1.12 to 1.16 minutes per inch. These values were converted to infiltration rate following the Porchet Method equation as explained in the previous section of this report.

TABLE 1
Tabulated Percolation/Infiltration Test Results

Test No.	Location	Interval Tested (inches)	Earth Materials	Perc. Rate (min/inch)	Infilt. Rate (inch/hour)
P-1	See Plan	34"-54"	Silty Sand (SM)	1.12	6.91
P-2	See Plan	37"-57"	Silty Sand (SM)	1.16	6.75

CONCLUSION AND RECOMMENDATIONS

Conclusions

- Based on our investigation, the areas of proposed infiltration are underlain by silty sand (SM) that is considered permeable with moderate to good percolation rates to a depth of 15 feet below the ground surface.

- Groundwater was not encountered in each exploratory trench at a depth of approximately 15 feet below the ground surface. Groundwater is not expected to impact the development or infiltration process.

- A field infiltration rate of 6.75 inches per hour is considered representative of the underlying native soil and should be considered the standard for design of the low impact development system.

- Considering the location and geologic setting of the site, installation of the proposed LID BMP will not create adverse effects to slope stability, soil erosion, off-site impacts.

Recommendations

- The low impact development system should be designed by the project engineer considering the geologic information and field infiltration rate contained in this report.

- All required setbacks as set forth in the design handbook should be adhered to during site planning, design, and construction.

- To account for long term performance variables of full scale working infiltration facilities due to accumulation of fine particles, post construction compaction of native soil, non-homogeneous soil strata, and site variations, a safety factor of 3 should be applied to the infiltration rate for design purposes.

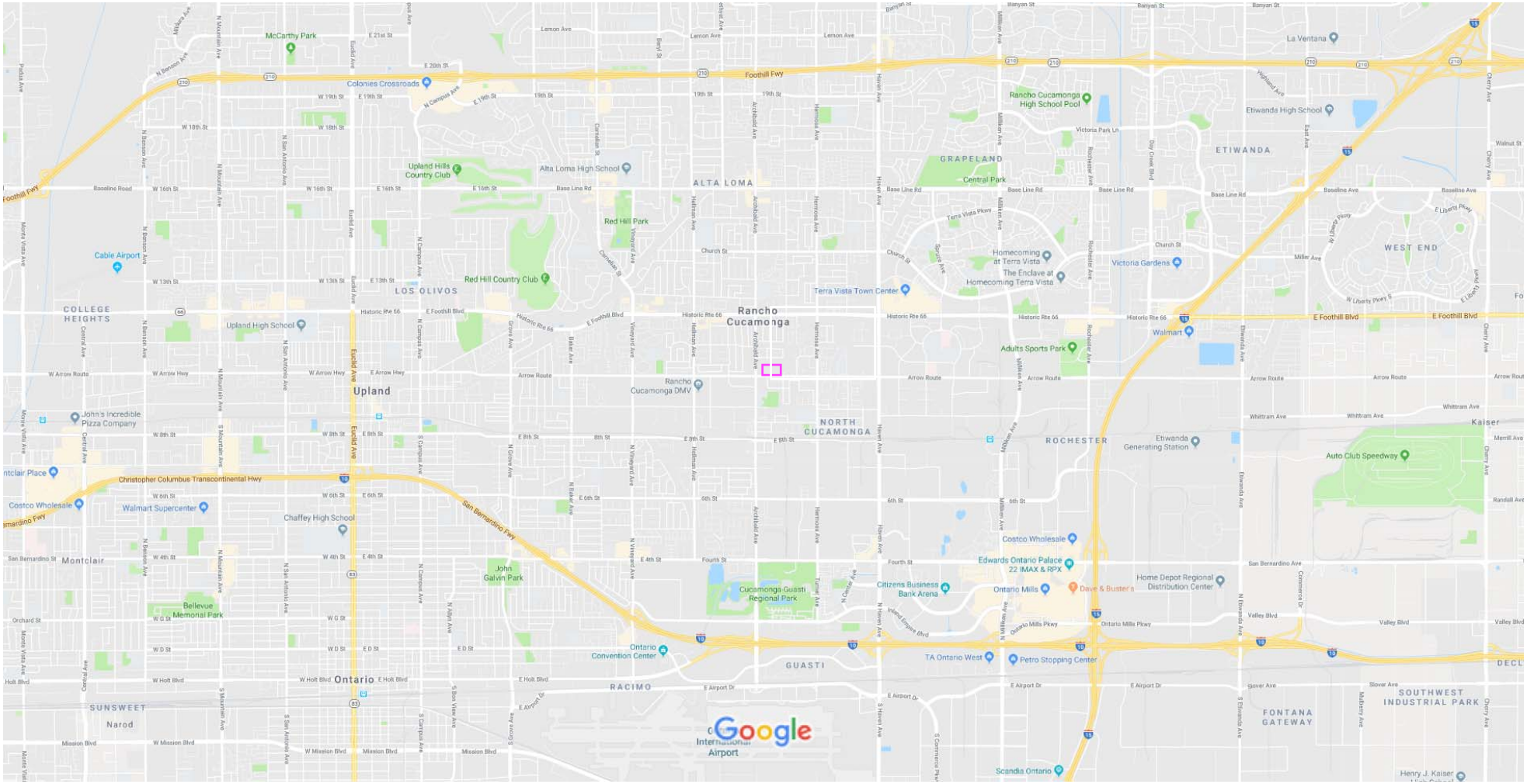
- Future building expansion or other improvements in the area of the infiltration system, including hardscape, flatwork sidewalks or paving, and water wells, should be reviewed by this firm and approved by the local governing agency.

CLOSURE

It is the owner's responsibility to insure that proper design and construction methods of the infiltration LID system are employed. Improper placement or construction of the system can cause premature failure regardless of the soil conditions.

It is also the owner's responsibility to adequately maintain this infiltration system to extend its longevity and performance. Please understand that this investigation was limited to the evaluation and feasibility of soil infiltration rates and has not included a comprehensive analysis of the stability of the proposed development from a geotechnical standpoint.

Google Maps SITE LOCATION MAP - Figure 1



Map data ©2018 Google 2000 ft

EXISTING SCHOOL

EXISTING ACCESS ROAD

EXISTING PARKING LOT

ARCHIBALD AVENUE
8477

24" BOX MULTI-TRUNK CAMPHER TREES @ 15' OC (STAGGERED)

128'

64'

EXIT

LANDSCAPE

EXIT

DRIVE

8 COVERED VACUUM STALLS

111'

5' 10' 14' 5'

TRASH/ RECYCLE

138'

LANDSCAPE

ADA ACCESS

LOADING 14' X 27'

LS

10 COVERED VACUUM STALLS

19'

28'

19'

10'

2'

34'

2'

6'

CAR WASH 5865 SQ.FT.

140'

291

T-1

DRIVE

30'

28'

16 COVERED VACUUM STALLS

ENTER ENTER ENTER

18'

7'-6"

DRIVE

EXISTING SERVICE STATION

EXISTING NOT A PART

9' 28' 19' 5' 11'-6" 11'-6" 11'-6" 5'-6" 42' 5' 19' 28'

DETAIL CENTER 1428 SQ.FT.

24'

ENTER

8'

11'

FOUNTAIN

180'

LS

DRIVE

ESCAPE

POS

T-2

POS

POS

ARBOR THEMED ENTRANCE

ACCESS

ADA

ARBOR

COMMON DRIVE

52'±

9' TYP

10

15'

LS

MONUMENT SIGN

I-1

17'-6"

LANDSCAPE

I-2

260'

NEW APPROACH PER CITY STDS

9744

REMOVE EXISTING APPROACH

REMOVE EXISTING APPROACH

9760

9786

ARROW ROUTE

N W E S

1" = 20'

SUMMARY
(9744, 9760 ARROW ROUTE)

BUILDINGS (COMBINED) FOOTPRINT	5867 SQ.FT.
LANDSCAPING (25%)	15,455 SQ.FT.
CONCRETE	40,766 SQ.FT.
SITE TOTAL (1.42 ACRES)	68,088 SQ.FT.

PARKING

VACUUMS	33 STALLS
CUSTOMER/EMPLOYEE	15 STALLS
LOADING (14' X 27')	1 STALL

I-1 - Approximate Location of Infiltration Test

T-2 - Approximate Location of Exploratory Trench

SITE PLAN

the Arbor
CAR WASH
EXPRESS

24 X 36 CLEARPRINT®

REVISIONS	BY

PETE DEJAGER
ALAN SMITH
(909) 234-9603

the Arbor
9744 ARROW ROUTE
RANCHO CUCAMONGA, CA

SOUTHWEST Design GROUP
12223 HIGHLAND AVE
SUITE # 106-201
RANCHO CUCAMONGA, CA 91739
909.234.9603

Date	
Scale	1" = 20'
Drawn	
Job	
Sheet	1
Of	Sheets

ARBOR

APPENDIX A

References

REFERENCES

Carson, Scott E. and Matti, Jonathan C., 1985, Contour Map Showing Minimum Depth to Groundwater, Upper Santa Ana River Valley, California, 1973-1979, U.S. Geological Survey, Map MF-1802

Franks, Alvin, l., 1972, “Geology for Individual Sewage Disposal Systems,” in *California Geology*, Volume 25, Number 9, September 1972, pp. 195-203

Heath, Ralph C., 1987, “Basic Groundwater Hydrology”, United States Geological Survey Water- Supply Paper 2220, Fourth Printing;

Kaplan, Benjamin O., 1988, “Septic Systems Handbook”, Lewis Publishers, Second Printing 1988, 283 pp.

Riverside County Flood Control District, 2001, Design Handbook for
Low Impact Development Best Management Practices, Revised September 2011.

San Bernardino County Technical Guidance Document for Water Quality Management Plans and Low Impact Development Best Management Practices.

APPENDIX B

Exploratory Trench Logs

EXPLORATORY TRENCH LOG

PROJECT NAME Arbor Carwash ELEVATION ___NA_____ TRENCH NO. __T-1____

PROJECT No. _1702-01_____ EQUIPMENT __CASE 580_____

DEPTH (FEET)	TYPE OF TEST*	SAMPLE DEPTH	DRY DENSITY (PCF)	MOISTURE CONTENT %	(USCS) SOIL CLASSIFICATION	EARTH MATERIAL	GEOTECHNICAL DESCRIPTION
							LOGGED BY ___CK_____ DATE 6-13-18 _____ **SAMPLED BY _____CK_____**
	NG		94.1	3.6	SM	Qal	Alluvium (Qal) SILTY SAND (SM): Yellow brown, fine to coarse grained, dry to damp,
	BULK						
	NG		105.2	4.8			Medium dense, moderately graded, non-cohesive,
5							Slight blocky structure
10							
15							
							Total depth 15 ft No Groundwater Trench Backfilled

GRAPHIC LOG Trend: Scale: 1" = 5'

*TEST SYMBOLS

B - BULK SAMPLE
R - RING SAMPLE
SC - SANDCONE
MD - MAXIMUM DENSITY
GS - GRAIN SIZE
SE - SAND EQUIVALENT
NG - NUCLEAR GAUGE
(90) - RELATIVE COMPACTION

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EXPLORATORY TRENCH LOG

PROJECT NAME Arbor Carwash ELEVATION ___NA_____ TRENCH NO. __T-2____

PROJECT No. _1702-01_____ EQUIPMENT __CASE 580_____

DEPTH (FEET)	TYPE OF TEST*	SAMPLE DEPTH	DRY DENSITY (PCF)	MOISTURE CONTENT %	(USCS) SOIL CLASSIFICATION	EARTH MATERIAL	GEOTECHNICAL DESCRIPTION
							LOGGED BY ___CK_____ DATE 6-13-18 _____ **SAMPLED BY _____CK_____**
	NG		93.8	3.9	SM	Qal	Alluvium (Qal) SILTY SAND (SM): Yellow brown, fine to coarse grained, dry to damp,
	NG		107.4	5.1			Medium dense, moderately graded, non-cohesive,
5							Slight blocky structure
10							
15							Total depth 15 ft No Groundwater Trench Backfilled

GRAPHIC LOG Trend: Scale: 1" = 5'

*TEST SYMBOLS

B - BULK SAMPLE
R - RING SAMPLE
SC - SANDCONE
MD - MAXIMUM DENSITY
GS - GRAIN SIZE
SE - SAND EQUIVALENT
NG - NUCLEAR GAUGE
(90) - RELATIVE COMPACTION

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APPENDIX C

Infiltration Test Data

PERCOLATION TEST DATA SHEET

Project:	Excel Transport	Project No:	1653-01	Date:	11/16/2016
Test Hole No:	I-1	Tested By:	Christopher Krall		
Depth of Test (D_T):	20"-32"	USCS Soil Classification:	Silty Sand (SM)		
Test Hole Radius (inches):	4	Depth of Test Hole (in.)	20		

SANDY SOIL CRITERIA TEST*

Trial No.	Start (t)	Stop (t)	Time Interval (min.)	Initial Depth to Water (in.)	Final Depth to Water (in.)	Water Level Change (in.)	Greater than or Equal to 6" (y/n)
1	6:15	6:30	15	10	2	8	Yes
2	6:30	6:45	15	10	2	8	Yes

*If two consecutive measurments demonstrate that 6 inches of water seeps into soil in less than 25 minutes, the test shall be run for an additional hour with measurements taken every 10 minutes. Otherwise, test holes were pre-soaked overnight and at least twleve measurements were recorded over a 6 hour period (approximately 30 minute intervals).

Reading No.	Start (t)	Stop (t)	(Δt) Time Interval (min.)	(D_o) Initial Depth to Water (in.)	($D_{F)}$ Final Depth to Water (in.)	(ΔH) Water Head Level Change (in.)	Percolation Rate (min./in.)	Infiltration Rate (in./hr.)
1	11:55	12:05	10	11	2	9	1.11	6.97
2	12:05	12:15	10	11	2	9	1.11	6.97
3	12:15	12:25	10	11	2.1	8.9	1.12	6.91
4	12:25	12:35	10	11	2.1	8.9	1.12	6.91
5	12:35	12:45	10	11	2.2	8.8	1.14	6.86
6	12:45	12:55	10	11	2.1	8.9	1.12	6.91
7								
8								
9								
10								
11								
12								

Comments:

PERCOLATION TEST DATA SHEET

Project:	Excel Transport	Project No:	1653-01	Date:	11/16/2016
Test Hole No:	P-2	Tested By:	Christopher Krall		
Depth of Test (D_T):	20"-32"	USCS Soil Classification:	Silty Sand (SM)		
Test Hole Radius (inches):	4	Depth of Test Hole (in.)	20		

SANDY SOIL CRITERIA TEST*

Trial No.	Start (t)	Stop (t)	Time Interval (min.)	Initial Depth to Water (in.)	Final Depth to Water (in.)	Water Level Change (in.)	Greater than or Equal to 6" (y/n)
1	7:05	7:13	8	3	9.25	6.25	Yes
2	7:14	7:23	9	3.25	9.3	6.05	Yes

*If two consecutive measurments demonstrate that 6 inches of water seeps into soil in less than 25 minutes, the test shall be run for an additional hour with measurements taken every 10 minutes. Otherwise, test holes were pre-soaked overnight and at least twleve measurements were recorded over a 6 hour period (approximately 30 minute intervals).

Reading No.	Start (t)	Stop (t)	(Δt) Time Interval (min.)	(D_o) Initial Depth to Water (in.)	($D_{F)}$ Final Depth to Water (in.)	(ΔH) Water Head Level Change (in.)	Percolation Rate (min./in.)	Infiltration Rate (in./hr.)
1	11:55	12:05	10	11	2	9	1.11	6.97
2	12:05	12:15	10	11	2.1	8.9	1.12	6.91
3	12:15	12:25	10	11	2.2	8.8	1.14	6.86
4	12:25	12:35	10	11	2.3	8.7	1.15	6.80
5	12:35	12:45	10	11	2.4	8.6	1.16	6.75
6	12:45	12:55	10	11	2.4	8.6	1.16	6.75
7								
8								
9								
10								
11								
12								

Comments: