APPENDIX C-1

Hydrogeology

MECP Water Well Records

Water Well Records

Friday, June 15, 2018

12:20:03 PM

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
MILTON TOWN (TRAFALG	17 602793 4818411 W	7523	6.25	FR 0053	7/29/18/1:	DO	0049 6	7238740 (Z184258) A166779	BLCK LOAM 0002 BRWN LOAM SAND 0019 RED SHLE SOFT 0038 BRWN SAND GRVL 0053 RED SHLE 0055
MILTON TOWN (TRAFALG	17 602470 4818538 W	2013/11 7472	2.04	0008		MO	0010 5	7212335 (Z182827) A158938	BRWN SILT CLAY PCKD 0008 BRWN FSND MSND PCKD 0015
MILTON TOWN (TRAFALG DS N 02 009	17 602929 4818570 W	2017/07 7407	30 36			DO		7293973 (Z247288) A	
OAKVILLE TOWN	17 602784 4818268 W	2005/07 6809	2 2				0015 5	2810340 (Z33982) A023181	BLCK LOAM 0001 BRWN TILL 0010 RED SHLE 0020
OAKVILLE TOWN	17 603080 4816959 W	2013/10 7360						7218875 (C23027) A150486 P	
OAKVILLE TOWN 02 008	17 602861 4818591 W	2008/11 4005	5.98	0064	29//1/1:	DO		7115131 (Z79458) A070724	BRWN CLAY 0010 GREY CLAY 0025 RED SHLE 0070
OAKVILLE TOWN 02 012	17 602094 4817483 W	2006/10 3349						2810672 (Z71495) A	
OAKVILLE TOWN DS N 01 010	17 602619 4818048 W	1963/06 1308	30	FR 0018	10/20/2/1:0	DO		2802104 ()	BRWN CLAY 0005 RED CLAY BLDR 0011 RED SHLE 0021
OAKVILLE TOWN DS N 01 010	17 603396 4817359 L	2004/03 1660				NU		2809937 (Z00787) A000697 A	
OAKVILLE TOWN DS N 01 010	17 603396 4817359 L	2004/03 1660				NU		2809936 (Z00786) A000696 A	
OAKVILLE TOWN DS N 01 012	17 602401 4817024 W	2009/11 7140			9///:	NU		7135929 (Z01648) A	0024 GRVL 0025 0026
OAKVILLE TOWN DS N 02 009	17 602862 4818466 W	1962/05 4823	4	FR 0048	10/20/10/6:0	ST DO	0050 4	2802195 ()	PRDG 0018 MSND 0030 MSND GRVL 0054
OAKVILLE TOWN DS N 02 010	17 602671 4818291 W	1964/02 1308	30	FR 0013	13/22/2/1:0	ST DO		2802199 ()	BRWN CLAY MSND 0006 BRWN MSND 0016 RED CLAY 0024 SHLE 0025
OAKVILLE TOWN DS N 02 010	17 602535 4818183 W	1970/12 3637	30	FR 0011 FR 0032	10//1/:	ST		2803520 ()	BRWN CLAY STNS 0003 BRWN MSND 0010 GREY GRVL 0011 GREY CLAY MSND 0017 BRWN CLAY 0021 RED SHLE 0038
OAKVILLE TOWN DS N 02 010	17 602479 4817999 W	1963/11 1308	30	SA 0022 SA 0051	18/52/1/1:0	ST DO		2802197 ()	RED CLAY MSND BLDR 0019 RED SHLE 0053

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
OAKVILLE TOWN DS N 02 010	17 602569 4818250 W	1964/02 1308	24					2802198 () A	BRWN CLAY MSND 0009 RED CLAY 0012 RED SHLE 0057
OAKVILLE TOWN DS N 02 010	17 602515 4818203 W	1970/11 4813	7	FR 0035	10/75/1/5:0	NU		2803477 () A	BRWN CLAY 0010 GRVL 0016 RED CLAY 0025 RED SHLE 0078
OAKVILLE TOWN DS N 02 010	17 602575 4818133 W	1970/11 4813	7	FR 0034	10/63/1/5:0	NU		2803478 () A	BRWN CLAY 0008 RED MSND CLAY 0025 RED SHLE 0063
OAKVILLE TOWN DS N 02 012	17 602134 4817519 W	1955/05 1642	6	FR 0025	5/24/1/:			2802203 () A	MSND CLAY 0025 RED SHLE 0080
OAKVILLE TOWN DS N 02 012	17 602144 4817529 W	1955/05 1642	6	SA 0090	8//1/:	NU		2802202 () A	MSND CLAY 0025 RED SHLE 0091
OAKVILLE TOWN DS N 02 012	17 602198 4817597 W	1955/05 1642	6 6	FR 0025	5/24/1/:	PS		2802204 ()	CLAY MSND 0025 RED SHLE 0080
OAKVILLE TOWN DS N 02 012	17 602094 4817438 W	1962/08 4602	6 6	MN 0026	6/56/1/2:0	PS		2802205 ()	MSND CLAY 0021 RED SHLE 0056
OAKVILLE TOWN DS N 02 012	17 602103 4817473 W	1971/04 3637	30	FR 0020 FR 0028	7/30//4:0	DO		2803735 ()	BRWN LOAM 0001 BRWN MSND CLAY 0007 BRWN CLAY 0020 RED SHLE 0030

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION

Notes:
UTM: UTM in Zone, Easting, Northing and Datum is NAD83; L: UTM estimated from Centroid of Lot; W: UTM not from Lot Centroid
DATE CNTR: Date Work Completedand Well Contractor Licence Number
CASING DIA: .Casing diameter in inches
WATER: Unit of Depth in Fee. See Table 4 for Meaning of Code

PUMP TEST: Static Water Level in Feet / Water Level After Pumping in Feet / Pump Test Rate in GPM / Pump Test Duration in Hour : Minutes
WELL USE: See Table 3 for Meaning of Code
SCREEN: Screen Depth and Length in feet
WELL: WEL (AUDIT #) Well Tag . A: Abandonment; P: Partial Data Entry Only
FORMATION: See Table 1 and 2 for Meaning of Code

1. Core Material and Descriptive terms

Code	Description	Code	Description	Code	Description	Code	Description	Code	Description
BLDR	BOULDERS	FCRD	FRACTURED	IRFM	IRON FORMATION	PORS	POROUS	SOFT	SOFT
BSLT	BASALT	FGRD	FINE-GRAINED	LIMY	LIMY	PRDG	PREVIOUSLY DUG	SPST	SOAPSTONE
CGRD	COARSE-GRAINED	FGVL	FINE GRAVEL	LMSN	LIMESTONE	PRDR	PREV. DRILLED	STKY	STICKY
CGVL	COARSE GRAVEL	FILL	FILL	LOAM	TOPSOIL	QRTZ	QUARTZITE	STNS	STONES
CHRT	CHERT	FLDS	FELDSPAR	LOOS	LOOSE	QSND	QUICKSAND	STNY	STONEY
CLAY	CLAY	FLNT	FLINT	LTCL	LIGHT-COLOURED	QTZ	QUARTZ	THIK	THICK
CLN	CLEAN	FOSS	FOSILIFEROUS	LYRD	LAYERED	ROCK	ROCK	THIN	THIN
CLYY	CLAYEY	FSND	FINE SAND	MARL	MARL	SAND	SAND	TILL	TILL
CMTD	CEMENTED	GNIS	GNEISS	MGRD	MEDIUM-GRAINED	SHLE	SHALE	UNKN	UNKNOWN TYPE
CONG	CONGLOMERATE	GRNT	GRANITE	MGVL	MEDIUM GRAVEL	SHLY	SHALY	VERY	VERY
CRYS	CRYSTALLINE	GRSN	GREENSTONE	MRBL	MARBLE	SHRP	SHARP	WBRG	WATER-BEARING
CSND	COARSE SAND	GRVL	GRAVEL	MSND	MEDIUM SAND	SHST	SCHIST	WDFR	WOOD FRAGMENTS
DKCL	DARK-COLOURED	GRWK	GREYWACKE	MUCK	MUCK	SILT	SILT	WTHD	WEATHERED
DLMT	DOLOMITE	GVLY	GRAVELLY	OBDN	OVERBURDEN	SLTE	SLATE		
DNSE	DENSE	GYPS	GYPSUM	PCKD	PACKED	SLTY	SILTY		
DRTY	DIRTY	HARD	HARD	PEAT	PEAT	SNDS	SANDSTONE		
DRY	DRY	HPAN	HARDPAN	PGVL	PEA GRAVEL	SNDY	SANDYOAPSTONE		

2. Core Color

Code	Description
WHIT	WHITE
GREY	GREY
BLUE	BLUE
GREN	GREEN
YLLW	YELLOW
BRWN	BROWN
RED	RED
BLCK	BLACK
BLGY	BLUE-GREY

3. Well Use

Code	Description	Code	Description
DO	Domestic	OT	Other
ST	Livestock	TH	Test Hole
IR	Irrigation	DE	Dewatering
IN	Industrial	MO	Monitoring
CO	Commercial	MT	Monitoring TestHole
MN	Municipal		
PS	Public		
AC	Cooling And A/C		
NU	Not Used		

4. Water Detail

Code	Description	Code	Description
FR	Fresh	GS	Gas
SA	Salty	IR	Iron
SU	Sulphur		
MN	Mineral		
UK	Unknown		

APPENDIX C-2

Hydrogeology

Borehole and Monitoring Well Logs

LOG OF DRILLING OPERATIONS

RJB1

BURNSIDE

R.J. Burnside & Associates Limited
292 Speedvale Avenue West, Guelph, Ontario N1H 1C4
telephone (519) 823-4995 fax (519) 836-5477

Client: **Jennifer Lawrence and Associates**	Project Name: **1086 Burnhamthorpe Rd. E.**	Logged by: **C.D.**
Project No.: **300040463**	Location: **Oakville, ON**	Ground (m amsl): **180.20**
Drilling Co.: **Lantech Drilling Services Inc.**	Date Started: **6/20/2017**	Static Water Level Depth (m):
Drilling Method: **Hollow Stem Auger**	Date Completed: **6/21/2017**	Sand Pack Depth (m) : **3.35 - 5.20**

Depth Scale (ft)	Depth Scale (m)	Stratigraphic Description (Surface Elevation (m): 180.20)	Strat. Plot	Elev. Depth (m)		SAMPLE Num.	Type	Int.	N.Val.
		TOPSOIL Brown, sandy, dry, rootlets.		179.92	0.28	1a	SS		10
						1b	SS		12
		CLAYEY SILT Brown, stiff, dry, weathered rocks, iron staining, some sand, occasional rounded gravel (<1 cm diameter), low plasticity.		179.18	1.02	2	SS		11
5.0	1.0	SILTY SAND Brown, fine to medium, compact, saturated, some clay, well graded.		178.75	1.45				
	2.0	CLAYEY SILT TILL Brown, verry stiff, dry, trace sand, trace gravel (<2 cm diameter, subangular to subrounded), occasional iron staining, fragments of weathered rocks, occasional fine sand inclusions, low plasticity.				3	SS		30
10.0	3.0	At 2.51 m - 5 cm of fine silty sand At 2.61 m - 10 cm of fine silty sand		177.23	2.97	4	SS		21
	4.0	SILTY SAND to SANDY SILT Brown, dense, dry, trace clay, trace fine gravel subangular, iron staining. Becoming moist with depth.				5	SS		>50/6"
15.0	5.0					6	SS		>50/3"
		SHALE Red shale, hard (cuttings dry).		174.70	5.50				
20.0	6.0			173.50	6.70	7	SS		>50/2"

bentonite seal

silica sand pack
well screen

bentonite seal

6.70

Prepared By: **C.D.** Checked By: **D.S.** Date Prepared: **9/30/2017**

This borehole log was prepared for hydrogeological and/or environmental purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by R. J. Burnside & Associates Limited personnel before use by others.

LEGEND
- Water found @ time of drilling
- Static Water Level -

MONITORING WELL DATA
- Pipe: **51 mm dia. PVC**
- Screen: **51 mm dia. PVC**

SAMPLE TYPE
- AC Auger Cutting
- CS Continuous
- RC Rock Core
- SS Split Spoon
- AR Air Rotary
- WC Wash Cuttings

LOG OF DRILLING OPERATIONS

RJB2D

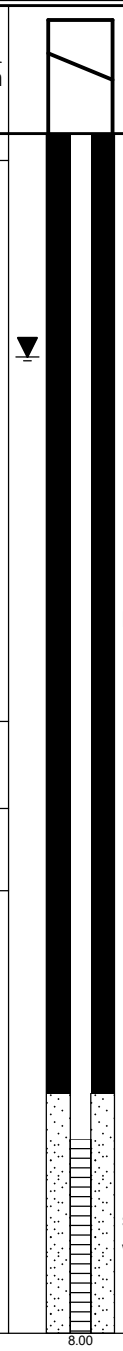
BURNSIDE

R.J. Burnside & Associates Limited
292 Speedvale Avenue West, Guelph, Ontario, N1H 1C4
telephone (905) 821-1800 fax (905) 821-1809

Client: **Jennifer Lawrence and Associates**	Project Name: **1086 Burnhamthorpe Rd. E.**	Logged by: **J.D.**
Project No.: **300040463**	Location: **Oakville, ON**	Ground (m amsl): **180.17**
Drilling Co.: **Lantech Drilling Services Inc.**	Date Started: **2/14/2018**	Static Water Level Depth (m):
Drilling Method: **Hollow Stem Auger**	Date Completed: **2/14/2018**	Sand Pack Depth (m) : **6.50 - 8.00**

Surface Elevation (m): **180.17**

Depth Scale (ft)	Depth Scale (m)	Stratigraphic Description	Strat. Plot	Elev. Depth (m)
		TOPSOIL Brown, silty, trace sand, rootlets.		179.99 0.18
		SILTY CLAY to CLAYEY SILT TILL Brown, stiff, dry, trace sand, trace gravel (<1 cm diameter, angular to subrounded), weathered shale fragments, occasional silt and sand inclusions, iron staining, low plasticity.		
5.0	1.0	From 1.5 m - gravel > 3 cm diameter, subangular to subrounded, hard.		
	2.0	At 3.5 m - turns grey, damp.		
		Harder with depth.		
10.0	3.0			
	4.0	**SILTY SAND** Grey, fine, dense, wet, uniform.		176.25 3.92
15.0		**SANDY SILT** Grey-red, very stiff, wet, trace clay, occasional fine gravel.		175.67 4.50
	5.0	**SHALE** Red, green, weathered, dry.		175.12 5.05
20.0	6.0			
	7.0			
25.0	8.0			172.17 8.00



SAMPLE Num.	Type	Int.	N.Val.	Depth Scale (ft)	Depth Scale (m)
1a	SS		6		
1b	SS		13		
2	SS		24		1.0
3	SS		36	5.0	2.0
4	SS		35		
5	SS		74	10.0	3.0
6	SS		55		4.0
7	SS		38	15.0	5.0
8	SS		>50/5"		
9	SS		>50/2"	20.0	6.0
10	AUGER				7.0
				25.0	8.0

Prepared By: **C.D.** Checked By: **D.S.** Date Prepared: **9/30/2017**

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LEGEND
▼ Water found @ time of drilling
▽ Static Water Level -

MONITORING WELL DATA
Pipe: **51 mm dia. PVC**
Screen: **51 mm dia. PVC #10 slot**

SAMPLE TYPE AC Auger Cutting; CS Continuous; RC Rock Core; SS Split Spoon; AR Air Rotary; WC Wash Cuttings

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LOG OF DRILLING OPERATIONS

RJB2S

BURNSIDE

R.J. Burnside & Associates Limited
292 Speedvale Avenue West, Guelph, Ontario, N1H 1C4
telephone (905) 821-1800 fax (905) 821-1809

Client: **Jennifer Lawrence and Associates**	Project Name: **1086 Burnhamthorpe Rd. E.**	Logged by: **C.D.**
Project No.: **300040463**	Location: **Oakville, ON**	Ground (m amsl): **180.21**
Drilling Co.: **Lantech Drilling Services Inc.**	Date Started: **6/20/2017**	Static Water Level Depth (m):
Drilling Method: **Hollow Stem Auger**	Date Completed: **6/20/2017**	Sand Pack Depth (m) : **3.66 - 4.90**

Depth Scale (ft)	Depth Scale (m)	Stratigraphic Description (Surface Elevation (m): **180.21**)	Strat. Plot	Elev. Depth (m)		SAMPLE Num.	Type	Int.	N.Val.
		TOPSOIL Brown, silty, trace sand, rootlets.		180.03 0.18		1a	SS		6
		SILTY CLAY to CLAYEY SILT TILL Brown, stiff, dry, trace sand, trace gravel (<1 cm diameter, angular to subrounded), weathered shale fragments, occasional silt and sand inclusions, iron staining, low plasticity.				1b	SS		13
	1.0	From 1.5 m - gravel > 3 cm diameter, subangular to subrounded, hard.				2	SS		24
5.0		At 3.5 m - turns grey, damp.			bentonite seal	3	SS		36
	2.0	Harder with depth.				4	SS		35
10.0	3.0					5	SS		74
	4.0	SILTY SAND Grey, fine, dense, wet, uniform.		176.29 3.92	silica sand pack well screen	6	SS		55
15.0		SANDY SILT Grey-red, very stiff, wet, trace clay, occasional fine gravel.		175.71 4.50		7	SS		38
	5.0	SHALE Red, green, weathered, dry.		175.16 5.05	bentonite seal	8	SS		>50/3"
				174.27 5.94	5.94				

Prepared By: **C.D.** Checked By: **D.S.** Date Prepared: **9/30/2017**

This borehole log was prepared for hydrogeological and/or environmental purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by R. J. Burnside & Associates Limited personnel before use by others.

LEGEND
- Water found @ time of drilling
- Static Water Level -

MONITORING WELL DATA
- Pipe: **51 mm dia. PVC**
- Screen: **51 mm dia. PVC**

SAMPLE TYPE
- AC Auger Cutting
- CS Continuous
- RC Rock Core
- SS Split Spoon
- AR Air Rotary
- WC Wash Cuttings

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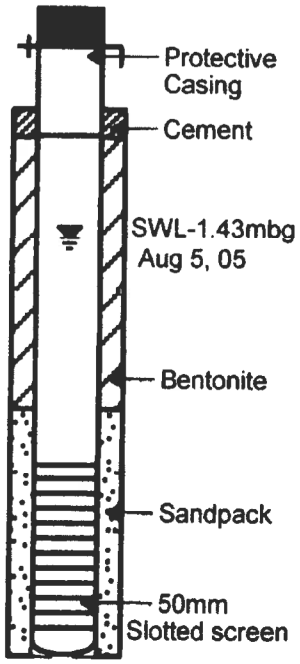
BEATTY & ASSOCIATES

Borehole Log: DL1 (Dryland)

Project No: 431-051
Client: Mattamy Homes
Location: Oakville
Static Water Level: 178.07 masl

Estimated Ground Elevation: 179.5masl
Top of Casing: 180.65 masl
Logged By: CD
Drill Date: Aug 3, 2005

SUBSURFACE PROFILE				SAMPLE			
Depth (m)	Symbol	Description	Elevation (masl)	Number	Type	N-Value (1ft; 1ft)	Well Completion Details
-1.00							
0.00		Ground Surface	179.50				
		Top Soil: Sandy, brown, soft, dry, some rootlets, trace clay, trace silt, trace fine pebbles.	179.20	1	SS	15	
1.00		***Sandy Silt Till:*** Brown, dry, firm, friable, trace pockets of fine sand, trace iron staining, trace fine pebbles, high plasticity.					
2.00				2	SS	23; 50-3"	
3.00			176.30				
		Clayey Silt Till: Redish, stiff, damp, friable, trace pebbles, trace sand, trace fragments of cobbles.		3	SS	21; 50-4"	
4.00							
5.00			174.32	4	SS	60-3"	
		Shale: Red shale (from cuttings).	173.40				
6.00		End of Log		5	SS	50-2"	
7.00							
8.00							
9.00							
10.00							



Drill Method: Hollow Stem Auger

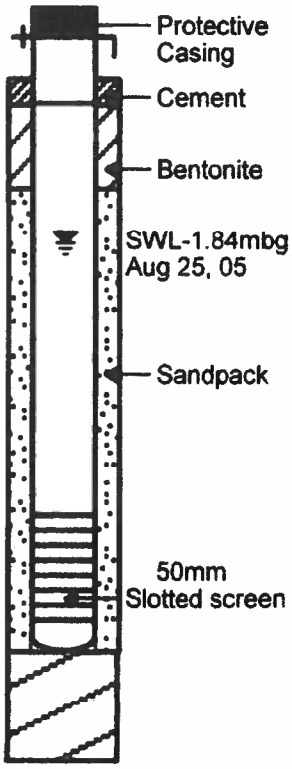
BEATTY & ASSOCIATES

Borehole Log: DL3 (Dryland)

Project No: 431-051
Client: Mattamy Homes
Location: Oakville
Static Water Level: 176.85masl

Estimated Ground Elevation: 178.7masl
Top of Casing: 179.51 masl
Logged By: CD
Drill Date: July 29, 2005

Depth (m)	Description	Elevation (masl)	Number	Type	N-Value (1ft; 1ft)
0.00	Ground Surface	178.70			
	Top Soil: Clayey, brown, soft, dry, some rootlets, trace silt, trace pebbles. At 0.35m, 5cm mixture of clayey silt till and top soill.	178.30	1	SS	3; 14
1.00					
2.00	***Clayey Silt Till:*** Brown-grey, stiff, damp, high plasticity, trace sandy silt like fine bands (<1mm), trace small pockets of sand, trace iron staining.		2	SS	41; 45
3.00		175.70	3	SS	38; 50
4.00	***Sandy Silt Till:*** Brown-grey, stiff, moist, trace fine to large gravel, trace pockets of coarse sand.	174.44			
5.00	***Redish Silt Till:*** Redish, hard, dry to damp, some pebbles, some shale fragments, trace sand, some clay, high plasticity.	173.20	4	SS	60-4"
6.00	***Shale:*** Fragments of red shale, friable, bedding plannes.		5	SS	50-1"
7.00		171.08			
8.00	End of Log		6	SS	50--2"
9.00					
10.00					
11.00					



Drill Method: Hollow Stem Auger

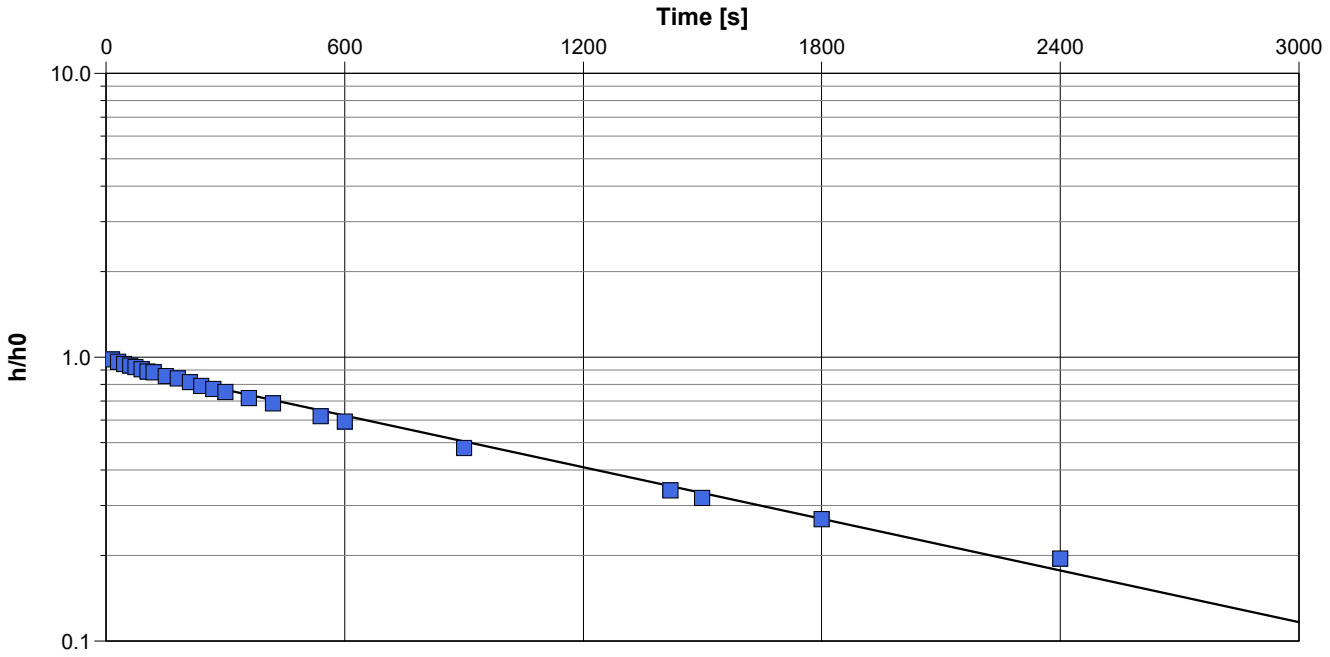
APPENDIX C-3

Hydrogeology

Hydraulic Conductivity Tests

BURNSIDE	**Slug Test Analysis Report**
	Project: 1086 Burnhamthorpe Road East
	Number: 300040463
	Client:

Location: Oakville, ON	Slug Test: Recovery Test	Test Well: RJB1
Test Conducted by: J.D.		Test Date: 6/14/2018
Analysis Performed by: J.D.	Screened in Silty Sand	Analysis Date: 6/15/2018
Aquifer Thickness: 2.53 m		

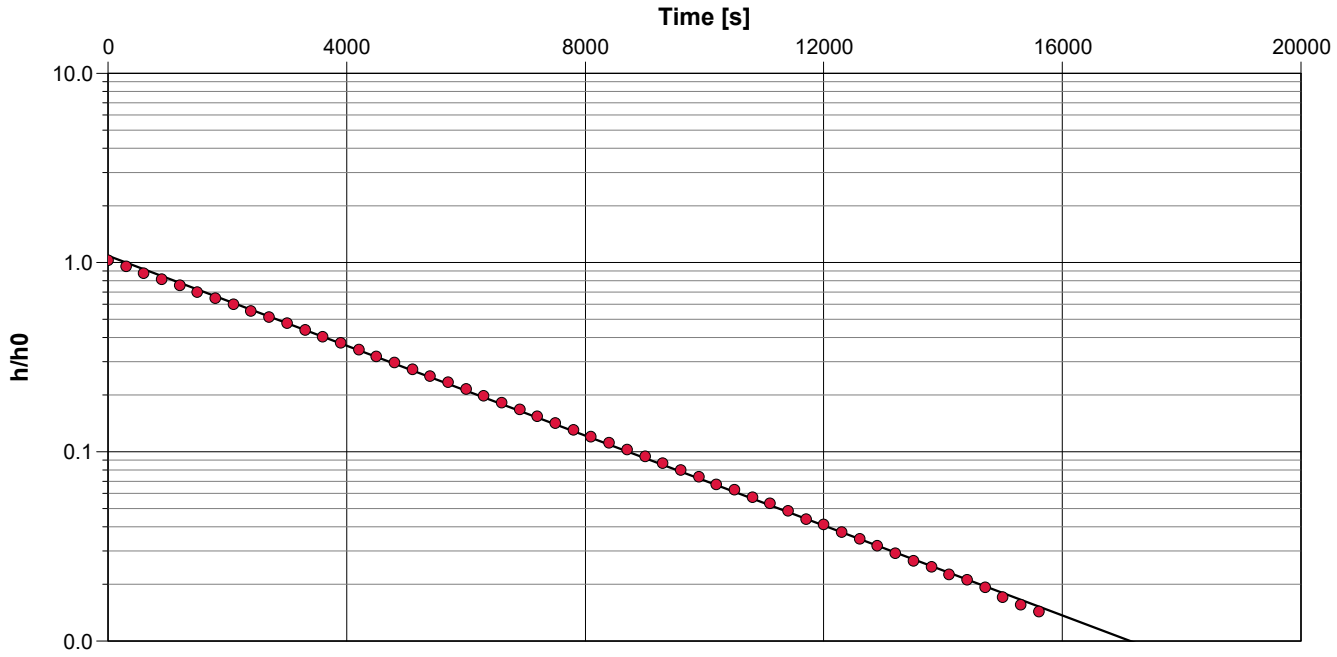


Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [cm/s]	
RJB1	4.64×10^{-5}	

BURNSIDE	**Slug Test Analysis Report**
	Project: 1086 Burnhamthorpe Road East
	Number: 300040463
	Client:

Location: Oakville, ON	Slug Test: Recovery Test	Test Well: RJB2s
Test Conducted by: J.D.		Test Date: 6/14/2018
Analysis Performed by: J.D.	Screened in Silty Sand	Analysis Date: 6/15/2018
Aquifer Thickness: 1.13 m		

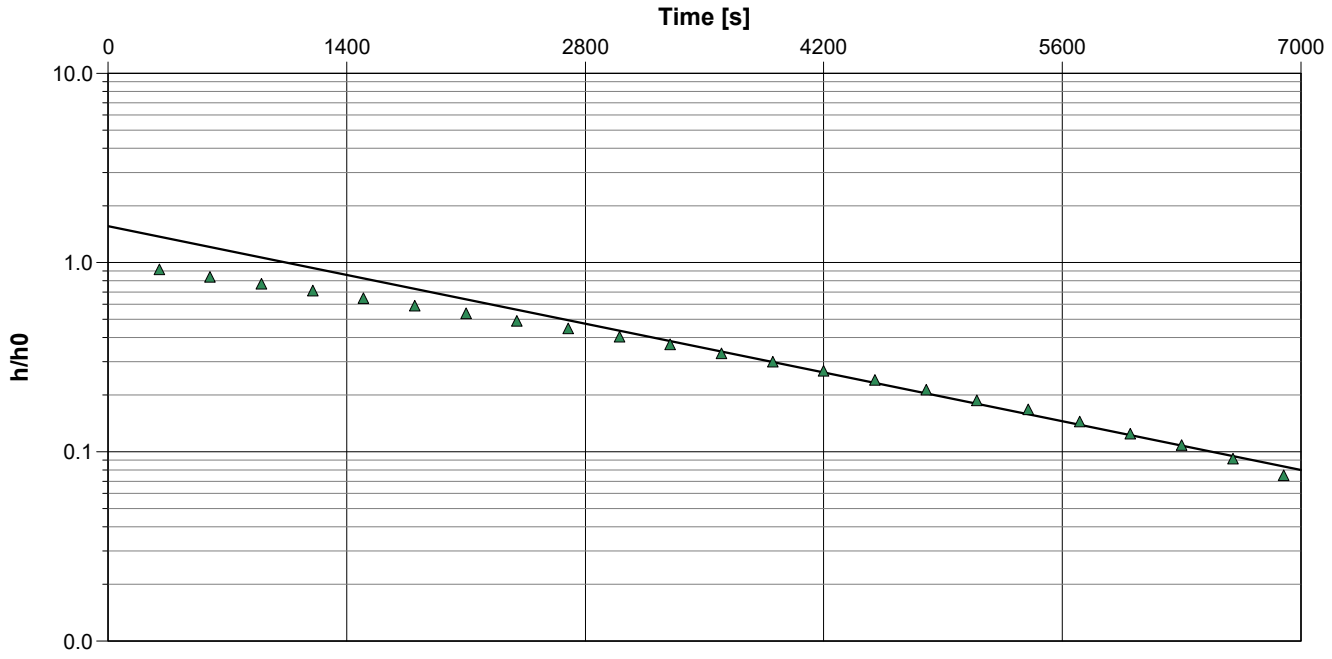


Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [cm/s]	
RJB2s	2.49×10^{-5}	

BURNSIDE	**Slug Test Analysis Report**
	Project: 1086 Burnhamthorpe Road East
	Number: 300040463
	Client:

Location: Oakville, ON	Slug Test: Recovery Test	Test Well: RJB2d
Test Conducted by: J.D.		Test Date: 6/14/2018
Analysis Performed by: J.D.	Screened in Shale	Analysis Date: 6/15/2018
Aquifer Thickness: 2.60 m		



Calculation using Bouwer & Rice

Observation Well	Hydraulic Conductivity [cm/s]	
RJB2d	2.86×10^{-5}	

APPENDIX C-4

Hydrogeology

Groundwater Monitoring

Table C-4
Groundwater Elevations

	Well Depth (mbgs)	Ground Surface Elevation (masl)	May 17, 2017 (Completion of Piezometers)		June 20, 2017 (Completion of Monitoring Wells)		July 28, 2017		August 29, 2017		September 27, 2017	
			Level (mbgs)	Elevation (masl)	Level (mbgs)	Elevation (masl)	Level (mbgs)	Elevation (masl)	Level (mbgs)	Elevation (masl)	Level (mbgs)	Elevation (masl)
RJB1	5.20	180.20	na	na	dry	dry	1.85	178.35	2.20	178.00	2.55	177.65
RJB2s	4.90	180.21	na	na	0.27	179.94	0.85	179.36	1.27	178.94	1.77	178.44
RJB2d	8.00	180.17	na	na	na	na	na	na	na	na	na	na
DL1	6.10	179.67	na	na	na	na	na	na	na	na	na	na
DL3	4.69	178.67	na	na	na	na	1.02	177.66	na	na	na	na
PZ1s	0.99	176.42	dry	dry	na	na	0.47	175.95	0.59	175.83	0.94	175.48
PZ1d	1.03	176.46	dry	dry	na	na	0.76	175.70	0.45	176.01	0.71	175.75
PZ2s	1.12	179.67	dry	dry	0.05	179.62	0.72	178.95	0.65	179.02	0.88	178.79
PZ2d	1.75	179.67	dry	dry	0.33	179.35	0.56	179.12	0.54	179.14	0.64	179.04

Notes
mbgs - meters below ground surface
masl - metres above sea level
*Surveyed - J.H. Gelbloom Surveying Ltd. 07/18
"na" - data not available due to not being monitored

Table C-4
Groundwater Elevations

	Well Depth (mbgs)	Ground Surface Elevation (masl)	November 14, 2017		December 19, 2017		January 25, 2018		February 6, 2018		March 12, 2018	
			Level (mbgs)	Elevation (masl)	Level (mbgs)	Elevation (masl)	Level (mbgs)	Elevation (masl)	Level (mbgs)	Elevation (masl)	Level (mbgs)	Elevation (masl)
RJB1	5.20	180.20	3.02	177.18	3.11	177.09	1.97	178.23	1.51	178.69	0.76	179.44
RJB2s	4.90	180.21	2.13	178.08	2.16	178.05	0.93	179.28	0.88	179.33	0.14	180.07
RJB2d	8.00	180.17	na	na	na	na	na	na	na	na	1.04	179.13
DL1	6.10	179.67	2.25	177.43	2.19	177.49	0.99	178.69	na	na	0.93	178.75
DL3	4.69	178.67	2.03	176.65	1.88	176.80	0.67	178.01	na	na	0.53	178.15
PZ1s	0.99	176.42	0.69	175.73	0.49	175.93	0.33	176.09	0.29	176.13	0.18	176.24
PZ1d	1.03	176.46	0.29	176.17	0.26	176.20	frozen	frozen	0.23	176.23	0.18	176.28
PZ2s	1.12	179.67	dry	dry	dry	dry	0.91	178.76	0.82	178.85	0.63	179.04
PZ2d	1.75	179.67	0.91	178.77	0.97	178.71	0.91	178.77	0.88	178.80	0.77	178.91

Notes
mbgs - meters below ground surface
masl - metres above sea level
*Surveyed - J.H. Gelbloom Surveying Ltd. 07/18
"na" - data not available due to not being monitored

Table C-4
Groundwater Elevations

	Well Depth (mbgs)	Ground Surface Elevation (masl)	April 10, 2018		May 10, 2018		June 14, 2018		August 16, 2018		October 22, 2018	
			Level (mbgs)	Elevation (masl)	Level (mbgs)	Elevation (masl)	Level (mbgs)	Elevation (masl)	Level (mbgs)	Elevation (masl)	Level (mbgs)	Elevation (masl)
RJB1	5.20	180.20	0.65	179.55	0.65	179.55	1.19	179.01	2.13	178.07	2.52	177.68
RJB2s	4.90	180.21	-0.15	180.36	-0.09	180.30	0.56	179.65	0.88	179.33	1.20	179.01
RJB2d	8.00	180.17	1.13	179.04	0.80	179.37	0.97	179.20	1.27	178.90	1.50	178.67
DL1	6.10	179.67	0.79	178.89	0.52	179.16	0.85	178.83	1.16	178.52	1.59	178.09
DL3	4.69	178.67	0.44	178.24	0.46	178.22	0.91	177.77	0.92	177.76	0.77	177.91
PZ1s	0.99	176.42	0.05	176.37	0.03	176.39	0.12	176.30	0.47	175.95	0.28	176.14
PZ1d	1.03	176.46	0.13	176.33	0.13	176.33	0.53	175.93	0.44	176.02	-0.89	177.35
PZ2s	1.12	179.67	0.53	179.14	0.42	179.25	0.36	179.31	0.50	179.17	0.49	179.18
PZ2d	1.75	179.67	0.70	178.98	0.63	179.05	0.58	179.10	0.60	179.08	0.58	179.10

Notes
mbgs - meters below ground surface
masl - metres above sea level
*Surveyed - J.H. Gelbloom Surveying Ltd. 07/18
"na" - data not available due to not being monitored

Table C-4
Groundwater Elevations

	Well Depth (mbgs)	Ground Surface Elevation (masl)	January 4, 2019		February 28, 2019		May 2, 2019		July 4, 2019		August 29, 2019	
			Level (mbgs)	Elevation (masl)	Level (mbgs)	Elevation (masl)	Level (mbgs)	Elevation (masl)	Level (mbgs)	Elevation (masl)	Level (mbgs)	Elevation (masl)
RJB1	5.20	180.20	0.52	179.68	0.85	179.35	0.38	179.82	1.24	178.96	2.23	177.97
RJB2s	4.90	180.21	-0.34	180.55	Frozen	Frozen	-0.57	180.78	0.27	179.94	1.31	178.90
RJB2d	8.00	180.17	0.86	179.31	1.29	178.88	0.83	179.34	0.95	179.22	1.54	178.63
DL1	6.10	179.67	0.55	179.13	0.92	178.76	0.46	179.22	0.74	178.94	1.34	178.34
DL3	4.69	178.67	0.42	178.26	0.49	178.19	0.29	178.39	0.88	177.80	1.39	177.29
PZ1s	0.99	176.42	0.06	176.36	0.05	176.37	-0.07	176.49	0.02	176.40	0.57	175.85
PZ1d	1.03	176.46	-0.89	177.35	-0.89	177.35	-0.89	177.35	-0.89	177.35	-0.89	177.35
PZ2s	1.12	179.67	0.34	179.33	0.28	179.39	0.22	179.45	0.19	179.48	0.48	179.19
PZ2d	1.75	179.67	0.51	179.17	0.47	179.21	0.39	179.29	0.34	179.34	0.44	179.24

Notes
mbgs - meters below ground surface
masl - metres above sea level
*Surveyed - J.H. Gelbloom Surveying Ltd. 07/18
"na" - data not available due to not being monitored

Table C-4
Groundwater Elevations

	Well Depth (mbgs)	Ground Surface Elevation (masl)	March 17, 2020		June 26, 2020		September 16, 2020		December 8, 2020		April 19, 2021	
			Level (mbgs)	Elevation (masl)	Level (mbgs)	Elevation (masl)	Level (mbgs)	Elevation (masl)	Level (mbgs)	Elevation (masl)	Level (mbgs)	Elevation (masl)
RJB1	5.20	180.20	0.55	179.65	1.55	178.65	2.78	177.42	2.90	177.30	0.72	179.48
RJB2s	4.90	180.21	-0.22	180.43	0.39	179.82	2.00	178.21	1.78	178.43	0.17	180.04
RJB2d	8.00	180.17	1.00	179.17	1.09	179.08	2.11	178.06	2.44	177.73	1.31	178.86
DL1	6.10	179.67	0.45	179.23	0.99	178.69	2.56	177.12	2.51	177.17	0.91	178.76
DL3	4.69	178.67	0.29	178.39	1.07	177.61	2.03	176.65	1.69	176.99	0.66	178.01
PZ1s	0.99	176.42	0.01	176.41	0.15	176.27	0.82	175.60	0.56	175.86	0.48	175.94
PZ1d	1.03	176.46	0.13	176.33	-0.89	177.35	-0.89	177.35	-0.89	177.35	0.42	176.04
PZ2s	1.12	179.67	0.40	179.27	0.25	179.42	Dry	Dry	1.04	178.63	0.48	179.19
PZ2d	1.75	179.67	0.50	179.18	0.39	179.29	0.75	178.93	Dry	Dry	1.04	178.63

Notes
mbgs - meters below ground surface
masl - metres above sea level
*Surveyed - J.H. Gelbloom Surveying Ltd. 07/18
"na" - data not available due to not being monitored

Table C-4
Groundwater Elevations

	Well Depth (mbgs)	Ground Surface Elevation (masl)	June 15, 2021		September 9, 2021		December 20, 2021	
			Level (mbgs)	Elevation (masl)	Level (mbgs)	Elevation (masl)	Level (mbgs)	Elevation (masl)
RJB1	5.20	180.20	1.48	178.72	2.30	177.90	0.63	179.57
RJB2s	4.90	180.21	0.71	179.50	1.66	178.55	-0.16	180.37
RJB2d	8.00	180.17	1.44	178.73	1.71	178.46	0.80	179.37
DL1	6.10	179.67	1.12	178.55	1.62	178.05	0.80	178.87
DL3	4.69	178.67	0.85	177.82	1.47	177.20	0.41	178.26
PZ1s	0.99	176.42	-	-	0.40	176.02	0.35	176.07
PZ1d	1.03	176.46	-	-	0.45	176.01	0.40	176.06
PZ2s	1.12	179.67	0.33	179.34	0.32	179.35	0.11	179.56
PZ2d	1.75	179.67	0.87	178.80	0.63	179.04	0.32	179.35

Notes
mbgs - meters below ground surface
masl - metres above sea level
*Surveyed - J.H. Gelbloom Surveying Ltd. 07/18
"na" - data not available due to not being monitored

Groundwater Elevation - RJB1
(Well Depth: 5.2m, Screened in Silty Sand)

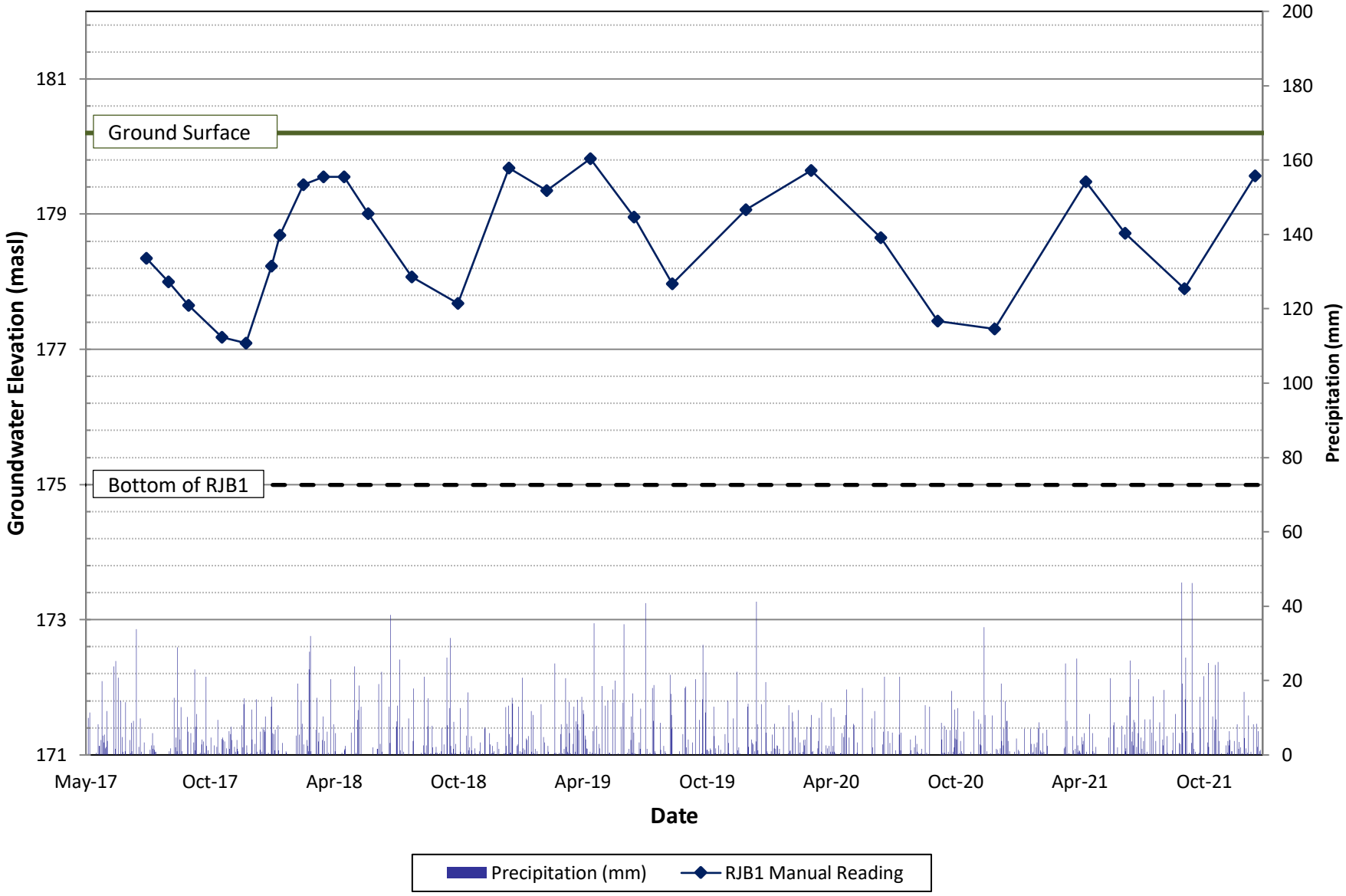


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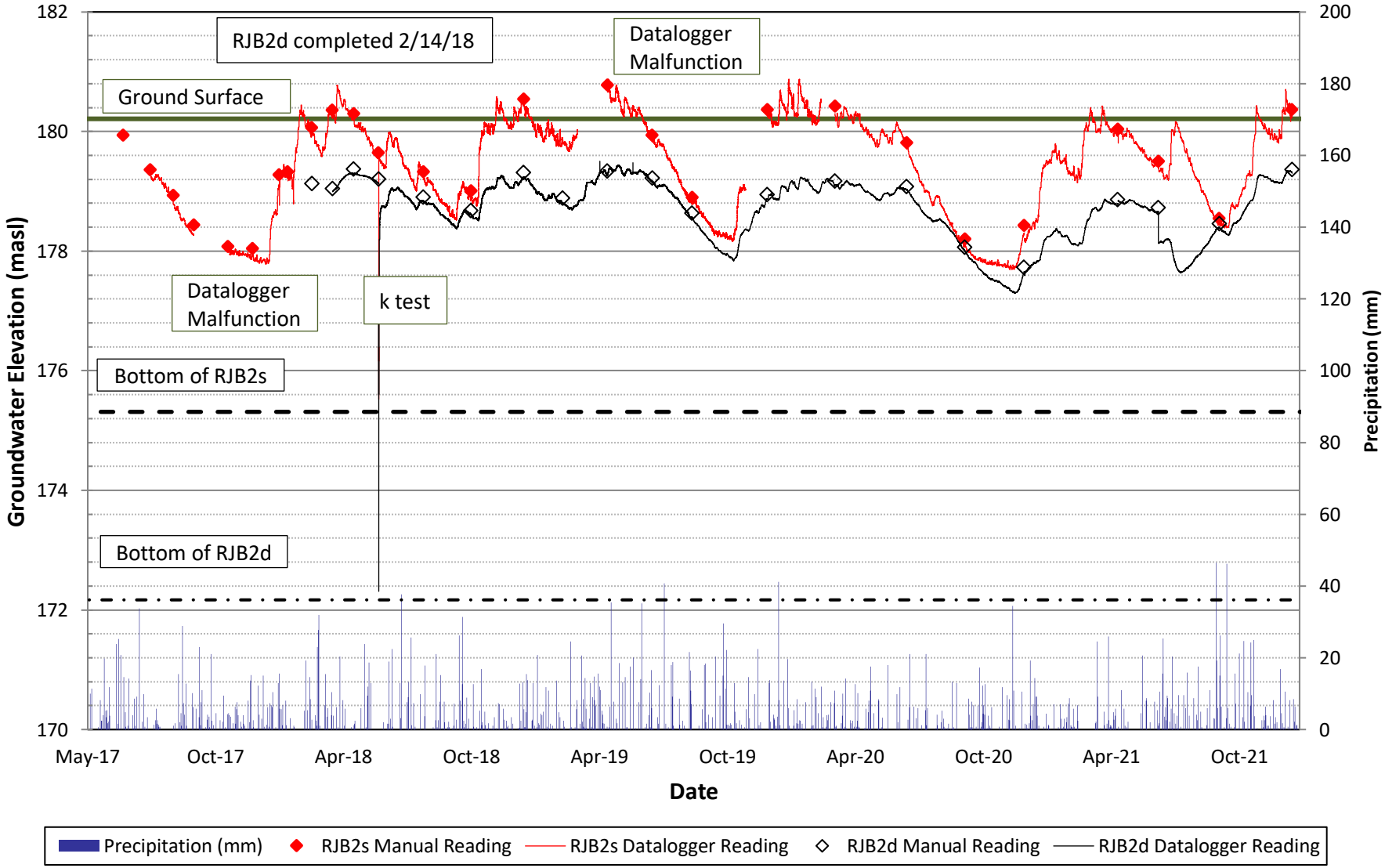
Figure C-4-1

Groundwater Elevation - RJB2s/d
(Well Depth: 4.9m, Screened in Silty Sand)
(Well Depth: 8.0m, Screened in Shale)



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300040463

Figure C-4-2

Groundwater Elevation - DL1
(Well Depth: 4.6m, Screened in Clayey Silt and Shale)

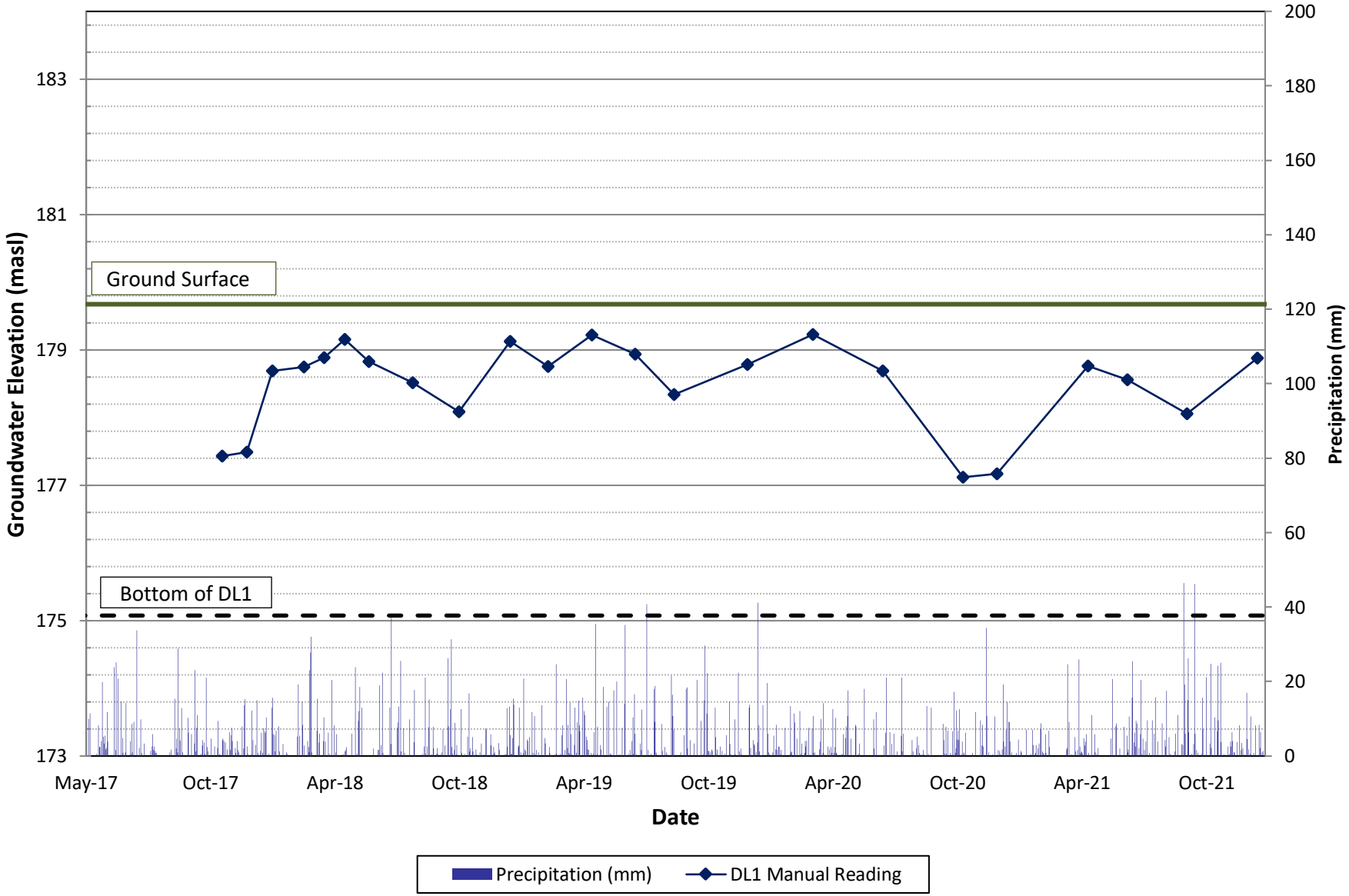

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Figure C-4-3

Groundwater Elevation - DL3
(Well Depth: 4.7m, Screened in Silt and Shale)

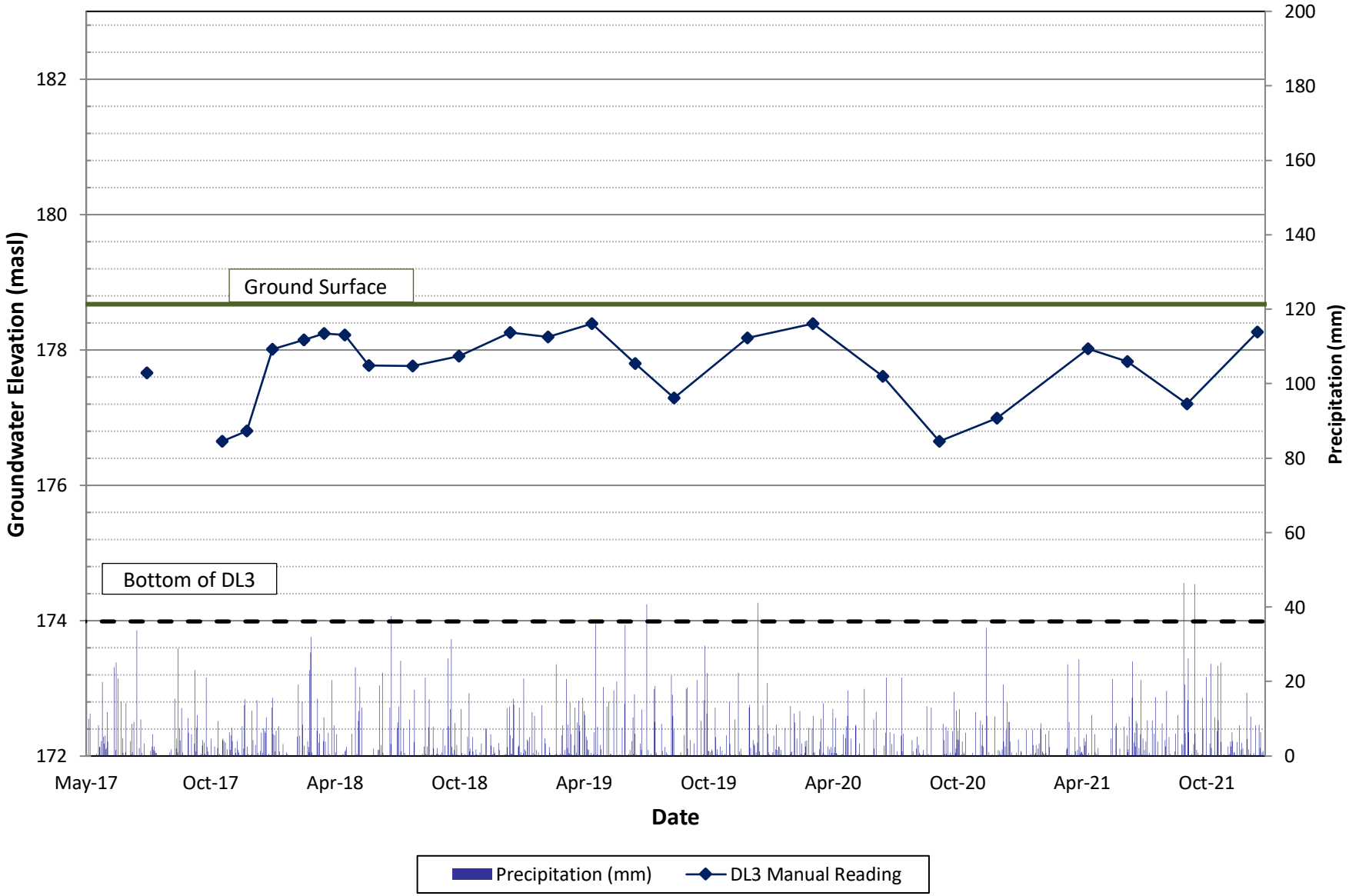

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Figure C-4-4

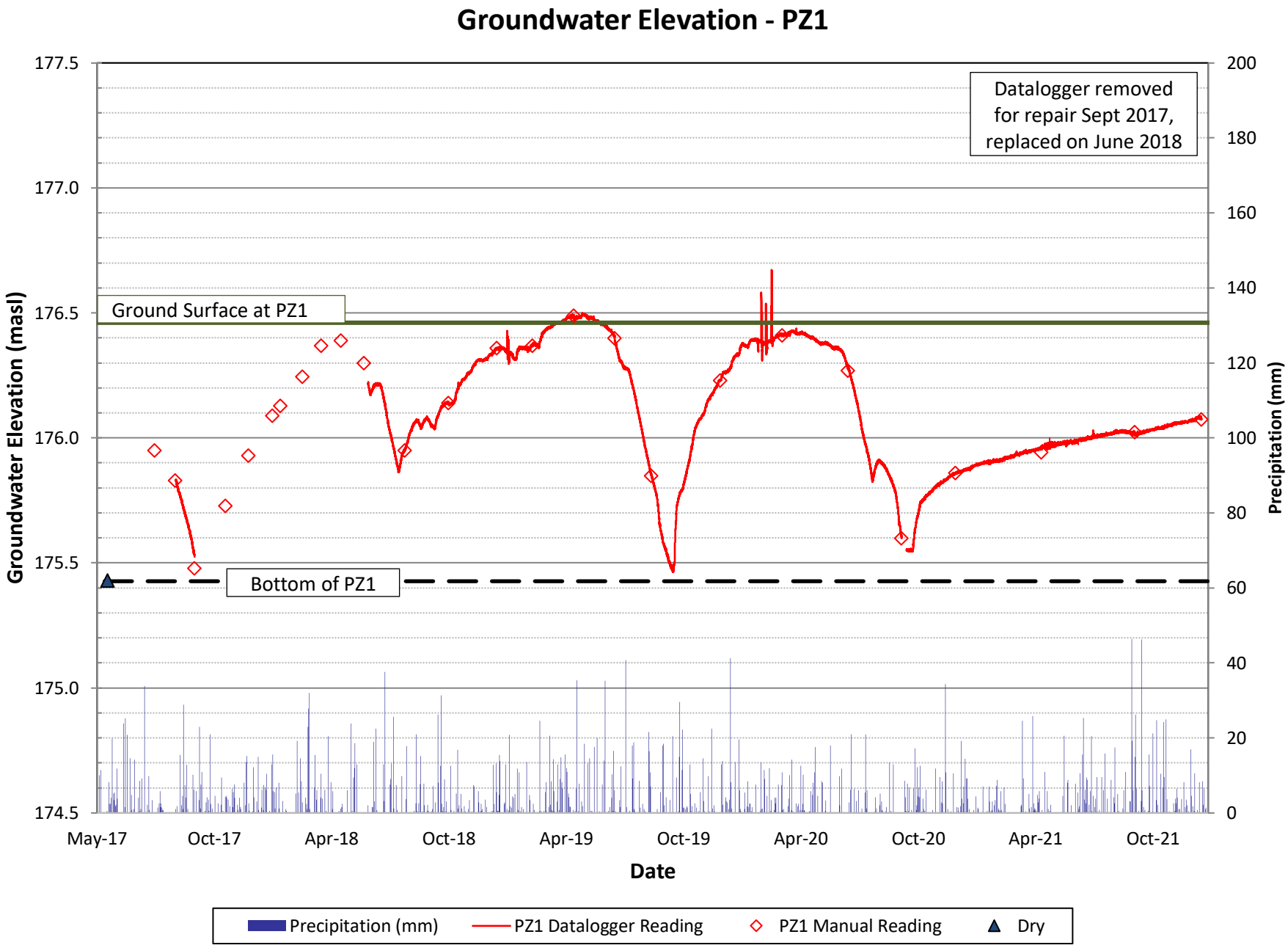

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Figure C-4-5

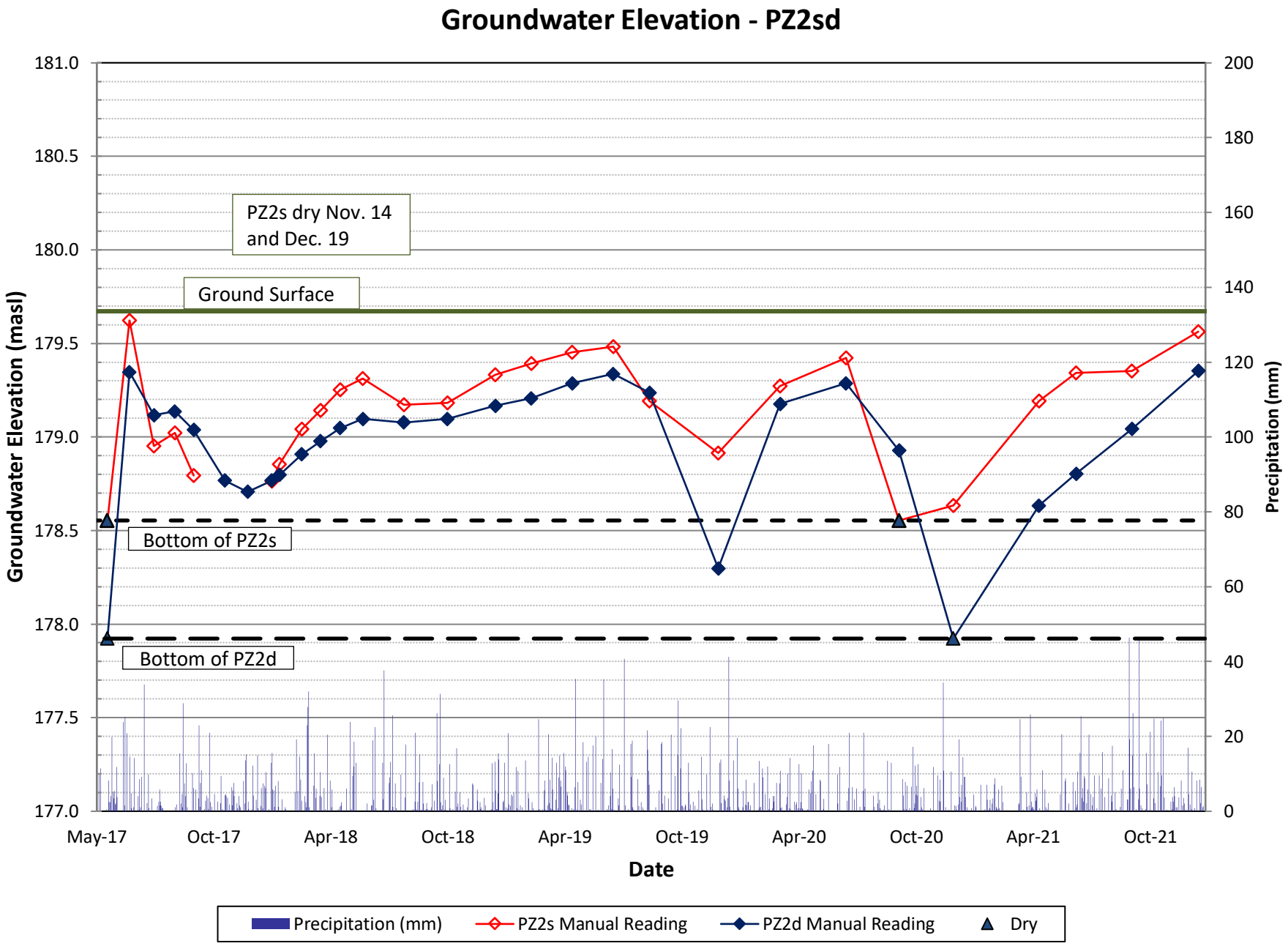

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Figure C-4-6

APPENDIX C-5

Hydrogeology

Surface Water Monitoring

Table C-5-1
Surface Water Elevations

Date	Days since precipitation	Flow Rate (L/s)
		SS1
28-Jul-17	1	Dry
17-Aug-17	0	Dry
27-Sep-17	13	Dry
14-Nov-17	1	Standing Water
19-Dec-17	1	<0.5
25-Jan-18	2	Frozen
6-Feb-18	10	Frozen
12-Mar-18	5	2.9
10-Apr-18	4	4.1
10-May-18	4	1.7
14-Jun-18	1	Dry
16-Aug-18	7	Dry
22-Oct-18	2	<0.5
4-Jan-19	1	2.1
28-Feb-19	1	Frozen
2-May-19	1	183
4-Jul-19	2	Dry
29-Aug-19	2	Dry
13-Dec-19	3	Frozen
17-Mar-20	3	Frozen
26-Jun-20	2	Dry
16-Sep-20	3	Dry
8-Dec-20	23	3.0
19-Apr-21	0	2.0
15-Jun-21	1	Dry
9-Sep-21	0	Standing Water
20-Dec-21	1	Standing Water

"<0.5" - estimated (flow too little to measure)

Table C-5-2
Surface Water Elevations

Location	SG1	
Ground Elevation (masl)	176.0	
Date	Water Level (mags)	Water Elevation (masl)
28-Jul-17	Dry	Dry
17-Aug-17	Dry	Dry
27-Sep-17	Dry	Dry
14-Nov-17	0.02	175.98
19-Dec-17	0.04	176.00
25-Jan-18	Frozen	Frozen
6-Feb-18	Frozen	Frozen
12-Mar-18	0.14	176.10
10-Apr-18	0.20	176.16
10-May-18	0.16	176.12
14-Jun-18	Dry	Dry
16-Aug-18	Dry	Dry
22-Oct-18	0.06	176.02
4-Jan-19	0.25	176.21
28-Feb-19	Frozen	Frozen
2-May-19	0.45	176.41
4-Jul-19	Dry	Dry
29-Aug-19	Dry	Dry
13-Dec-19	Frozen	Frozen
17-Mar-20	0.20	176.16
26-Jun-20	Dry	Dry
16-Sep-20	Dry	Dry
8-Dec-20	0.10	176.06
19-Apr-20	0.20	176.16
15-Jun-21	Dry	Dry
9-Sep-21	0.23	176.19
20-Dec-21	0.23	176.19

Notes:
mags - metres above ground surface
masl - metres above sea level
underlined - estimated elevation

APPENDIX C-6

Hydrogeology

Water Quality

Table C-6-1
Groundwater Quality Results

			Monitoring Well	RJB1	RJB2s
			Date Sampled	14-Jun-18	14-Jun-18
Parameter	**Unit**	**RDL**	**ODWQS**		
Electrical Conductivity	umho/cm	2		1230	909
pH	pH Units	NA	(6.5-8.5)	7.86	7.84
Saturation pH				6.47	6.74
Langelier Index				1.39	1.10
Total Hardness (as CaCO3)	mg/L	0.5	(80-100)	**602**	**274**
Total Dissolved Solids	mg/L	20	500	**810**	500
Alkalinity (as CaCO3)	mg/L	5	(30-500)	451	477
Bicarbonate (as CaCO3)	mg/L	5		451	477
Carbonate (as CaCO3)	mg/L	5		<5	<5
Chloride	mg/L	0.50	250	9.17	4.6
Nitrate as N	mg/L	0.25	10.0	2.14	<0.25
Nitrite as N	mg/L	0.25	1.0	<0.25	<0.25
Sulphate	mg/L	0.50	500	346	70.1
Ortho Phosphate as P	mg/L	0.50		<0.50	<0.50
Ammonia as N	mg/L	0.02		0.06	0.14
Total Phosphorus	mg/L	0.10		8.80	0.02
Total Organic Carbon	mg/L	1.0		3.00	7.40
Calcium	mg/L	0.10, 0.05		109	59
Magnesium	mg/L	0.10, 0.05		80.00	30.70
Sodium	mg/L	0.10, 0.05	20 (200)	38.30	106.00
Potassium	mg/L	0.10, 0.05		7.73	5.67
Aluminum	mg/L	0.004	0.1	0.008	0.006
Antimony	mg/L	0.003	0.006	<0.003	<0.003
Arsenic	mg/L	0.003	0.025	<0.003	<0.003
Barium	mg/L	0.002	1	0.043	0.065
Beryllium	mg/L	0.001		<0.001	<0.001
Boron	mg/L	0.010	5	0.1520	0.0920
Cadmium	mg/L	0.001	0.005	<0.001	<0.001
Chromium	mg/L	0.003	0.05	<0.003	<0.003
Cobalt	mg/L	0.001		<0.001	<0.001
Copper	mg/L	0.003	1	<0.003	<0.003
Iron	mg/L	0.010	0.3	<0.010	<0.010
Lead	mg/L	0.001	0.01	<0.001	<0.001
Manganese	mg/L	0.002	0.05	0.029	0.038
Molybdenum	mg/L	0.002		0.0070	0.0510
Nickel	mg/L	0.003		<0.003	<0.003
Selenium	mg/L	0.004	0.01	<0.004	<0.004
Silver	mg/L	0.002		<0.002	<0.002
Strontium	mg/L	0.005		4.320	0.825
Thallium	mg/L	0.006		<0.006	<0.006
Titanium	mg/L	0.002		0.005	<0.002
Uranium	mg/L	0.002	0.02	0.012	**0.030**
Vanadium	mg/L	0.002		<0.002	0.002
Zinc	mg/L	0.005	5	<0.005	<0.005

ODWQS - Ontario Drinking Water Quality Standards
RDL - Reported detection limits
Bold indicates an exceedence of the ODWQS

Table C-6-2
Surface Water Quality Results

Sample Location				**SS1**
Date Sampled				**19-Dec-17**
Parameter	**Unit**	**RDL**	**PWQO**	
Electrical Conductivity	umho/cm	2		2650
pH	pH Units	NA	(6.5-8.5)	8.4
Saturation pH				6.91
Langelier Index				1.49
Total Hardness (as CaCO3)	mg/L	0.5		466
Total Dissolved Solids	mg/L	20		1490
Alkalinity (as CaCO3)	mg/L	5		209
Bicarbonate (as CaCO3)	mg/L	5		198
Carbonate (as CaCO3)	mg/L	5		10
Chloride	mg/L	2.0		679
Nitrate as N	mg/L	1.0		<1.0
Nitrite as N	mg/L	1.0		<1.0
Sulphate	mg/L	2.0		134
Ortho Phosphate as P	mg/L	2.0		<2.0
Ammonia as N	mg/L	0.02		0.08
Total Phosphorus	mg/L	0.01	0.03	0.07
Total Organic Carbon	mg/L	0.5		7.3
Turbidity	NTU	0.5		5.4
Calcium	mg/L	0.25		137
Magnesium	mg/L	0.25		30.2
Sodium	mg/L	0.25		337
Potassium	mg/L	0.25		3.31
Aluminum	mg/L	0.004	0.075	0.005
Antimony	mg/L	0.003	0.020	<0.003
Arsenic	mg/L	0.003	0.1	<0.003
Barium	mg/L	0.002		0.085
Beryllium	mg/L	0.001	0.011	<0.001
Boron	mg/L	0.010	0.20	0.025
Cadmium	mg/L	0.0001	0.0002	<0.0001
Chromium	mg/L	0.003		0.003
Cobalt	mg/L	0.0005	0.0009	0.0005
Copper	mg/L	0.001	0.005	0.002
Iron	mg/L	0.01	0.3	0.11
Lead	mg/L	0.001	0.005	<0.001
Manganese	mg/L	0.002		0.322
Molybdenum	mg/L	0.002	0.04	<0.002
Nickel	mg/L	0.003	0.025	<0.003
Selenium	mg/L	0.004	0.1	<0.004
Silver	mg/L	0.0001	0.0001	<0.0001
Strontium	mg/L	0.005		0.815
Thallium	mg/L	0.0003	0.0003	<0.0003
Titanium	mg/L	0.002		0.008
Uranium	mg/L	0.002	0.005	<0.002
Vanadium	mg/L	0.002	0.006	<0.002
Zinc	mg/L	0.005	0.02	0.007

PWQS - Provincial Water Quality Standards
RDL - Reported Detection Limit

Table C-6-3
Surface Water Field Chemistry at SS1

Surface Water Station	Surface Water Station Condition	Salinity (ppt)	Temperature (^{o}C)	pH	Conductivity (uS/cm)	TDS (g/L)
28-Jul-17	Dry					
29-Aug-17	Dry					
27-Sep-17	Dry					
14-Nov-17	Standing Water					
19-Dec-17	Flowing	1.5	1.5	8.6	2790	1.970
25-Jan-18	Frozen					
6-Feb-18	Frozen					
12-Mar-18	Flowing	-	-	-	-	-
10-Apr-18	Flowing	1.4	4.5	8.4	1917	1.428
10-May-18	Flowing	1.2	20.2	8.1	1650	1.236
14-Jun-18	Dry					
16-Aug-18	Dry					
22-Oct-18	Too little flow					
4-Jan-19	Flowing	0.5	0.3	8.2	839	0.673
28-Feb-19	Frozen					
2-May-19	Flowing	0.3	9.2	8.4	732	0.515
4-Jul-19	Dry					
29-Aug-19	Dry					
13-Dec-19	Frozen					
17-Mar-20	Flowing	1.2	5.4	8.2	2230	1.580
19-Apr-21	Flowing	0.2	17.9	7.9	3290	2.100
15-Jun-21	Dry					
9-Sep-21	Standing Water					
20-Dec-21	Standing Water					

"-" data not available

APPENDIX C-7

Hydrogeology

Groundwater Balance

R.J. Burnside & Associates Limited 292 Speedvale Avenue West Unit 20 Guelph ON N1H 1C4 CANADA
telephone (519) 823-4995 **fax** (519) 941-8120 **web** www.rjburnside.com

BURNSIDE
[THE DIFFERENCE IS OUR PEOPLE]

July 21, 2022

Via: Email

Mr. Jesse Orser
Project Engineer
David Schaeffer Engineering Limited
600 Alden Road, Suite 700
Markham ON L3R 0E7

Dear Jesse:

Re: Joshua's Creek Coscorp Water Balance and LID Second Update
Project No.: 300040463.0000

R.J. Burnside & Associates Limited (Burnside) has undertaken a review and update of the groundwater-based site wide water balance for the Coscorp Lands within the Joshua's Creek JC-9A and JC-17 subcatchments. The update was undertaken to respond to comments from Halton Region and incorporates the proposed LIDs strategies into the water balance. The discussion below should be used to provide details of the updated calculations performed by Burnside. The pre-development and post-development recharge values without LIDs and with LIDs are presented in the attached tables. The review has been undertaken using the latest draft plan concept that excludes land at the northern extremity of the property. In order to be consistent for the areas considered in pre- and post-development, the pre-development scenario has been updated to consider only the draft plan area and the post-development scenario has also been restricted to lands within the draft plan.

Proposed LID Measures

It is our understanding that low impact development (LID) measures are proposed to be included in the design of the development to reduce the loss of recharge. The LID measures to be implemented include increased topsoil depths in landscaped areas, roof leader disconnection and discharge to pervious area with increased topsoil in residential areas and tree pits on all streets in accordance with Town standards.

Mitigation Impact Analysis

The following discussion is provided as part of an analysis to demonstrate the impact of LID measures (roof leader disconnection and tree pits) in reducing the deficit. It should be noted that the quantification of the impact of LID measures is challenging as there are no widely accepted methods or standards, however the following discussion is provided as part of an analysis to illustrate the impact of LID measures (roof leader disconnection and tree pits) in reducing the deficit. The impact of increased topsoil has not been assessed as there are no widely accepted methodologies for analysis of this impact.

Roof Leader Disconnection

The Toronto and Region Conservation Authority (TRCA) and Credit Valley Conservation (CVC) in their Low Impact Development Stormwater Management Planning and Design Guide allow for a 25% runoff reduction (contribution to recharge) from roof leader disconnection and discharge to pervious areas. This credit can be applied in the land use areas where roof leader disconnection is proposed.

This 25% credit is a conservative estimate and corresponds to the hydrologic soil group C soils being present at the site. Based on the previous calculations and geological and soil information from previous studies it was confirmed that hydrologic soil group C is present across the Coscorp lands. Use of the 25% estimate also requires the following requirements are met:

- A minimum 5 m length flow path from the downspout across a pervious area;
- The flow path is grading is between 1% and 5%;
- The receiving soils are tilled to a depth of 300 mm and have organic content between 8 and 15% by weight (30 to 40% by volume); and
- The area of roof drainage contributing to individual downspouts should not be greater than 100 m^2.

The estimated recharge volumes are provided in Table 1. The 25% runoff reduction was applied to the volume of direct runoff calculated for housing areas with no LIDs (see Table C-7-14 and C-7-15).

Table 1: Recharge Due to Roof Leader Disconnection

	Approximate Land Area (m^2)		Direct Runoff without Roof Leader Disconnection (m^3/year)	Potential Recharge Increase (m^3/year)
	Single Homes	**Townhouses**		
JC-9A	28,476	10,964	19,713	4,930
JC-17	18,902	-	9,451	2,239

The total estimated recharge from directing roofs to backyards is approximately 7,169 m^3/year.

Tree Pits

Burnside further understands that tree pits will also be utilized as a runoff reduction measure within the development area. Based on discussion with the design engineers we are aware that tree pits are proposed on all streets as per the Town standards. We understand that the typical tree pit will be 1 m in radius and typically 0.75 m deep. The storage capacity for tree pits is therefore approximately 0.72 m^3 based on a porosity value of 30% for the mainly clayey silt soils. If we assume that the drainage area for the tree pit is the area of the tree pit itself, then the storage capacity is sufficient to capture 100% of rain events in a year. Using climate normal data from the Hamilton RGB climate station, the total rainfall for a year is 780 mm. This number was used to estimate the annual volume being infiltrated by the tree pits.

It is understood that there will be approximately one tree pit per lot. A review of the current plan indicates there will be 129 single lots and 52 townhouse lots, with approximately 131 lots within the JC-9A subcatchment and 50 lots within the JC-17 subcatchment. Each tree pit has the capacity to infiltrate 0.78 m^3/year, and therefore the volume available for recharge per year from tree pits is approximately 101 m^3/year for JC-9A and 39 m^3/year for JC-17.

Post-Development Recharge with LID Measures

The water balance and post-development recharge is summarized in Table 2 below.

Table 2: Summary of Post-Development Recharge after LID

	Post-Development Deficit (m^3/year)	Downspout Disconnection (m^3/year)	Tree Pit (m^3/year)	Recharge Due to LID (m^3/year)
JC-9A	2,447	4,930	101	5,031
JC-17	1,824	2,239	39	2,278
Total	4,271	7,169	140	7,309

The above calculations indicate that the post-development recharge can be increased by approximately 7,309 m^3/year with the use of downspout disconnection. Based on the assumptions required for these calculations and the uncertainty and known range of fluctuations in soils, the calculations demonstrate that downspout disconnections have a significant impact on the post-development recharge conditions. Assuming the conditions for tree pit recharge outlined above, tree pits have the potential to produce additional post-development recharge. Based on these considerations it can be concluded that the calculations performed demonstrate the benefit of the proposed LID measures in providing additional recharge and a best efforts approach to maintaining pre-development recharge conditions.

Yours truly,

R.J. Burnside & Associates Limited

Josh Donkersgoed, P.Eng.
Project Engineer
DS/JD:cl

Dwight Smikle, M.Sc., P.Geo.
Senior Hydrogeologist

Enclosure(s) Water Balance Tables

inaccuracies or errors in the instruments of service provided to the client, arising from deficiencies in the aforementioned third party materials and documents.

R.J. Burnside & Associates Limited makes no warranties, either express or implied, of merchantability and fitness of the documents and other instruments of service for any purpose other than that specified by the contract.

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TABLE C-7-1

Water Balance Components
Based on Thornthwaite's Soil Moisture Balance Approach
with a Soil Moisture Retention of 100 mm (selected for Short-Rooted Vegetation on Clay Soils)

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Average Temperature (Degree C) from RBG Hamilton	-4.7	-3.9	0.5	7.1	13.3	18.9	22	20.9	16.3	10	4.1	-1.4	**8.6**
Heat index: $i = (t/5)^{1.514}$	0.00	0.00	0.03	1.70	4.40	7.49	9.42	8.72	5.98	2.86	0.74	0.00	**41.3**
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	1.42	29.73	61.02	91.26	108.61	102.41	77.03	44.01	15.85	0.00	**531**
Adjusting Factor for U (Latitude 43^{o} 16.8'N)	0.81	0.82	1.02	1.12	1.26	1.28	1.29	1.2	1.04	0.95	0.81	0.77	
Adjusted Potential Evapotranspiration PET (mm)	0	0	1	33	77	117	140	123	80	42	13	0	**626**
PRE-DEVELOPMENT WATER BALANCE COMPONENTS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Precipitation (P) from RBG Hamilton 1981-2010	56.8	57.2	63.7	73.3	85.5	72.7	82.7	89.7	80.9	71.6	91.3	71.9	**897**
Potential Evapotranspiration (PET)	0	0	1	33	77	117	140	123	80	42	13	0	**626**
P - PET	57	57	62	40	9	-44	-57	-33	1	30	78	72	**271**
Change in Soil Moisture Storage	0	0	0	0	0	-44	-56	0	1	30	69	0	**0**
Soil Moisture Storage (max 100 mm)	100	100	100	100	100	56	0	0	1	31	100	100	
Actual Evapotranspiration (AET)	0	0	1	33	77	117	139	90	80	42	13	0	**591**
Soil Moisture Deficit (max 100 mm)	0	0	0	0	0	44	100	100	99	69	0	0	
Water Surplus - available for infiltration or runoff	57	57	62	40	9	0	0	0	0	0	9	72	**306**
Potential Infiltration (based on MOECC metholodogy*; independent of temperature)	20	20	22	14	3	0	0	0	0	0	3	25	**107**
Potential Direct Surface Water Runoff (independent of temperature)	37	37	40	26	6	0	0	0	0	0	6	47	**199**
Recharge (deep infiltration - assume 50% of I)	10	10	11	7	2	0	0	0	0	0	2	13	**54**
Interflow (indirect runoff - assume 50% of I)	10	10	11	7	2	0	0	0	0	0	2	13	**54**
Total Runoff (direct and indirect components)	47	47	51	33	7	0	0	0	0	0	7	59	**252**
IMPERVIOUS AREA WATER SURPLUS													
Annual Precipitation (P)	897	mm/year											
Potential Evaporation (PE) from impervious areas (assume loss of up to 20%)	179	mm/year											
P-PE (surplus available for runoff from impervious areas)	718	mm/year											

Assume January storage is 100% of Soil Moisture Storage
Soil Moisture Storage for short-rooted vegetation 100 mm

*MECP SWM infiltration calculations (from 2003 Planning & Design Manual)

topography - rolling land	0.15
soils - relatively tight silty clay till materials	0.1
cover - predominantly cultivated land	0.1
Infiltration factor	**0.35**

TABLE C-7-2

Water Balance Components

Based on Thornthwaite's Soil Moisture Balance Approach
with a Soil Moisture Retention of 200 mm (selected for Deeper-Rooted Vegetation on Clay Soils)

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Average Temperature (Degree C) from RBG Hamilton	-4.7	-3.9	0.5	7.1	13.3	18.9	22	20.9	16.3	10	4.1	-1.4	**8.6**
Heat index: $i = (t/5)^{1.514}$	0.00	0.00	0.03	1.70	4.40	7.49	9.42	8.72	5.98	2.86	0.74	0.00	**41.3**
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	1.42	29.73	61.02	91.26	108.61	102.41	77.03	44.01	15.85	0.00	**531**
Adjusting Factor for U (Latitude 43^{o} 16.8'N)	0.81	0.82	1.02	1.12	1.26	1.28	1.29	1.2	1.04	0.95	0.81	0.77	
Adjusted Potential Evapotranspiration PET (mm)	0	0	1	33	77	117	140	123	80	42	13	0	**626**
PRE-DEVELOPMENT WATER BALANCE COMPONENTS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Precipitation (P) from RBG Hamilton 1981-2010	56.8	57.2	63.7	73.3	85.5	72.7	82.7	89.7	80.9	71.6	91.3	71.9	**897**
Potential Evapotranspiration (PET)	0	0	1	33	77	117	140	123	80	42	13	0	**626**
P - PET	57	57	62	40	9	-44	-57	-33	1	30	78	72	**271**
Change in Soil Moisture Storage	0	0	0	0	0	-44	-57	-33	1	30	78	26	**0**
Soil Moisture Storage (max 200 mm)	200	200	200	200	200	156	98	65	66	96	174	200	
Actual Evapotranspiration (AET)	0	0	1	33	77	117	140	123	80	42	13	0	**626**
Soil Moisture Deficit (max 200 mm)	0	0	0	0	0	44	102	135	134	104	26	0	
Water Surplus - available for infiltration or runoff	57	57	62	40	9	0	0	0	0	0	0	46	**271**
Potential Infiltration (based on MOECC metholodogy*; independent of temperature)	26	26	28	18	4	0	0	0	0	0	0	21	**122**
Potential Direct Surface Water Runoff (independent of temperature)	31	31	34	22	5	0	0	0	0	0	0	25	**149**
Recharge (deep infiltration - assume 50% of I)	13	13	14	9	2	0	0	0	0	0	0	10	**61**
Interflow (indirect runoff - assume 50% of I)	13	13	14	9	2	0	0	0	0	0	0	10	**61**
Total Runoff (direct and indirect components)	44	44	48	31	7	0	0	0	0	0	0	36	**210**
IMPERVIOUS AREA WATER SURPLUS													
Annual Precipitation (P)	897	mm/year											
Potential Evaporation (PE) from impervious areas (assume loss of up to 20%)	179	mm/year											
P-PE (surplus available for runoff from impervious areas)	718	mm/year											

Assume January storage is 100% of Soil Moisture Storage
Soil Moisture Storage (for deeper-rooted vegetation) 200 mm

*MECP SWM infiltration calculations

topography - rolling to hilly land	0.15
soils - relatively tight silty clay till materials	0.1
cover - woodland	0.2
Infiltration factor	**0.45**

TABLE C-7-14

Pre- and Post-Development Water Balance Calculations for JC-9A Subcatchment Area (Coscorp Lands) With No Use of LID Strategies

Land Use Description	Approx. Land Area (m^2)	Estimated Impervious Coefficient for Land Use	Estimated Impervious Area (m^2)	Runoff from Impervious Area* (m/a)	Direct Runoff Volume from Impervious Area (m^3/a)	Estimated Pervious Area (m^2)	Total Runoff (Direct and Indirect) from Pervious Area* (m/a)	Runoff Volume from Pervious Area (m^3/a)	Recharge in Pervious Area* (m/a)	Recharge Volume in Pervious Area (m^3/a)	Total Runoff (Direct and Indirect) Volume (m^3/a)	Total Recharge Volume (m^3/a)
Existing Conditions												
Agricultural/Rural Residential/Open Space	90,874	0.00	0	0.718	0	90,874	0.252	22,900	0.054	4,907	22,900	4,907
TOTAL PRE-DEVELOPMENT	**90,874**		**0**		**0**	**90,874**		**22,900**		**4,907**	**22,900**	**4,907**
Potential Post-Development Conditions with no LID												
Residential Lots (Singles)	28,476	0.66	18,794	0.718	13,494	9,682	0.252	2,440	0.054	523	15,934	523
Residential Lots (Townhouses)	10,964	0.79	8,661	0.718	6,219	2,302	0.252	580	0.054	124	6,799	124
Open Space (NHS)	28,892	0.00	0	0.718	0	28,892	0.252	7,281	0.054	1,560	7,281	1,560
Parks (Village Square)	704	0.25	176	0.718	126	528	0.252	133	0.054	29	260	29
Roads	21,838	0.81	17,689	0.718	12,700	4,149	0.252	1,046	0.054	224	13,746	224
TOTAL POST-DEVELOPMENT	**90,874**		**45,320**		**32,540**	**45,554**		**11,480**		**2,460**	**44,020**	**2,460**
									% Change from Pre to Post		192	50
									Potential Change		1.9 times increase in runoff	50% reduction of recharge

* figures from Table C-7-1 and Table C-7-2 of *Joshua's Creek EIR/FSS*

Agricultural and rural residential lands are allocated recharge characteristics of short-rooted vegetation.

Difference between pre and post recharge volumes (m3/a) **2,447**

TABLE C-7-14.1

Pre- and Post-Development Water Balance Calculations for JC-9A Subcatchment Area (Coscorp Lands) With LID Strategies

Land Use Description	Approx. Land Area (m^2)	Estimated Impervious Coefficient for Land Use	Estimated Impervious Area (m^2)	Runoff from Impervious Area* (m/a)	Direct Runoff Volume from Impervious Area (m^3/a)	Estimated Pervious Area (m^2)	Total Runoff (Direct and Indirect) from Pervious Area* (m/a)	Runoff Volume from Pervious Area (m^3/a)	Recharge in Pervious Area* (m/a)	Recharge Volume in Pervious Area (m^3/a)	Total Runoff (Direct and Indirect) Volume (m^3/a)	Total Recharge Volume (m^3/a)
Existing Conditions												
Agricultural/Rural Residential/Open Space	90,874	0.00	0	0.718	0	90,874	0.252	22,900	0.054	4,907	22,900	4,907
TOTAL PRE-DEVELOPMENT	**90,874**		**0**		**0**	**90,874**		**22,900**		**4,907**	**22,900**	**4,907**
Potential Post-Development Conditions with LID												
Residential Lots (Singles)	28,476	0.66	18,794	0.718	13,494	9,682	0.252	2,440	0.054	523	12,561	523
Roof Leader Disconnection in Singles												3,374
Residential Lots (Townhouses)	10,964	0.79	8,661	0.718	6,219	2,302	0.252	580	0.054	124	5,244	124
Roof Leader Disconnection in Townhouses												1,555
Open Space (NHS)	28,892	0.00	0	0.718	0	28,892	0.252	7,281	0.054	1,560	7,281	1,560
Parks (Village Square)	704	0.25	176	0.718	126	528	0.252	133	0.054	29	260	29
Roads	21,838	0.81	17,689	0.718	12,700	4,149	0.252	1,046	0.054	224	13,746	224
TOTAL POST-DEVELOPMENT	**90,874**		**45,320**		**32,540**	**45,554**		**11,480**		**2,460**	**39,091**	**7,388**
									% Change from Pre to Post		171	-51
									Potential Change		1.7 times increase in runoff	51 % reduction of recharge

* figures from Table C-7-1 and Table C-7-2 of *Joshua's Creek EIR/FSS*

Agricultural and rural residential lands are allocated recharge characteristics of short-rooted vegetation.

Difference between pre and post recharge volumes (m3/a) **-2,481**

TABLE C-7-15

Pre- and Post-Development Water Balance Calculations for JC-17 Subcatchment Area (Coscorp Lands) With No Use of LID Strategies

Land Use Description	Approx. Land Area (m^2)	Estimated Impervious Coefficient for Land Use	Estimated Impervious Area (m^2)	Runoff from Impervious Area* (m/a)	Direct Runoff Volume from Impervious Area (m^3/a)	Estimated Pervious Area (m^2)	Total Runoff (Direct and Indirect) from Pervious Area* (m/a)	Runoff Volume from Pervious Area (m^3/a)	Recharge in Pervious Area* (m/a)	Recharge Volume in Pervious Area (m^3/a)	Total Runoff (Direct and Indirect) Volume (m^3/a)	Total Recharge Volume (m^3/a)
Existing Conditions												
Agricultural/Open Space	42,600	0.00	0	0.718	0	42,600	0.252	10,735	0.054	2,300	10,735	2,300
Wooded Areas (NHS)	20,200	0.00	0	0.718	0	20,200	0.210	4,242	0.061	1,232	4,242	1,232
TOTAL PRE-DEVELOPMENT	**62,800**		**0**		**0**	**62,800**		**14,977**		**3,533**	**14,977**	**3,533**
Potential Post-Development Conditions with no LID												
Residential Lots (Singles)	18,902	0.66	12,476	0.718	8,957	6,427	0.252	1,620	0.054	347	10,577	347
Roads	8,159	0.81	6,609	0.718	4,745	1,550	0.252	391	0.054	84	5,136	84
Parks (Village Sqaure)	1,139	0.25	285	0.718	204	854	0.252	215	0.054	46	420	46
Wooded Area (NHS)	20,200	0.00	0	0.718	0	20,200	0.210	4,242	0.061	1,232	4,242	1,232
Open Space (NHS)	14,400	0.00	0	0.718	0	14,400	0.252	3,629	0.054	778	3,629	778
TOTAL POST-DEVELOPMENT	**62,800**		**19,369**		**13,907**	**29,031**		**6,467**		**1,709**	**20,374**	**1,709**
									% Change from Pre to Post		136	52
									Potential Change		1.4 times increase in runoff	52% reduction in infiltration

* figures from Table C-7-1 and Table C-7-2 of *Joshua's Creek EIR/FSS*

Agricultural and rural residential lands are allocated recharge characteristics of short-rooted vegetation.

Difference between pre and post recharge volumes (m3/a) **1,824**

TABLE C-7-15.1

Pre- and Post-Development Water Balance Calculations for JC-17 Subcatchment Area (Coscorp Lands) With LID Strategies

Land Use Description	Approx. Land Area (m^2)	Estimated Impervious Coefficient for Land Use	Estimated Impervious Area (m^2)	Runoff from Impervious Area* (m/a)	Direct Runoff Volume from Impervious Area (m^3/a)	Estimated Pervious Area (m^2)	Total Runoff (Direct and Indirect) from Pervious Area* (m/a)	Runoff Volume from Pervious Area (m^3/a)	Recharge in Pervious Area* (m/a)	Recharge Volume in Pervious Area (m^3/a)	Total Runoff (Direct and Indirect) Volume (m^3/a)	Total Recharge Volume (m^3/a)
Existing Conditions												
Agricultural/Open Space	42,600	0.00	0	0.718	0	42,600	0.252	10,735	0.054	2,300	10,735	2,300
Wooded Areas (NHS)	20,200	0.00	0	0.718	0	20,200	0.210	4,242	0.061	1,232	4,242	1,232
TOTAL PRE-DEVELOPMENT	**62,800**		**0**		**0**	**62,800**		**14,977**		**3,533**	**14,977**	**3,533**
Potential Post-Development Conditions with LID												
Residential (Singles)	18,902	0.66	12,476	0.718	8,957	6,427	0.252	1,620	0.054	347	10,577	347
Roof Leader Disconnection in Singles												2,239
Roads	8,159	0.81	6,609	0.718	4,745	1,550	0.252	391	0.054	84	5,136	84
Parks (Village Sqaure)	1,139	0.25	285	0.718	204	854	0.252	215	0.054	46	420	46
Wooded Area (NHS)	20,200	0.00	0	0.718	0	20,200	0.210	4,242	0.054	1,091	4,242	1,091
Open Space (NHS)	14,400	0.00	0	0.718	0	14,400	0.252	3,629	0.061	878	3,629	878
TOTAL POST-DEVELOPMENT	**62,800**		**19,369**		**13,907**	**43,431**		**10,096**		**2,446**	**24,003**	**4,685**
										% Change from Pre to Post	160	-33
										Potential Change	1.6 times increase in runoff	33% increase in infiltration

* figures from Table C-7-1 and Table C-7-2 of *Joshua's Creek EIR/FSS*

Agricultural and rural residential lands are allocated recharge characteristics of short-rooted vegetation.

Difference between pre and post recharge volumes (m3/a) **-1,153**