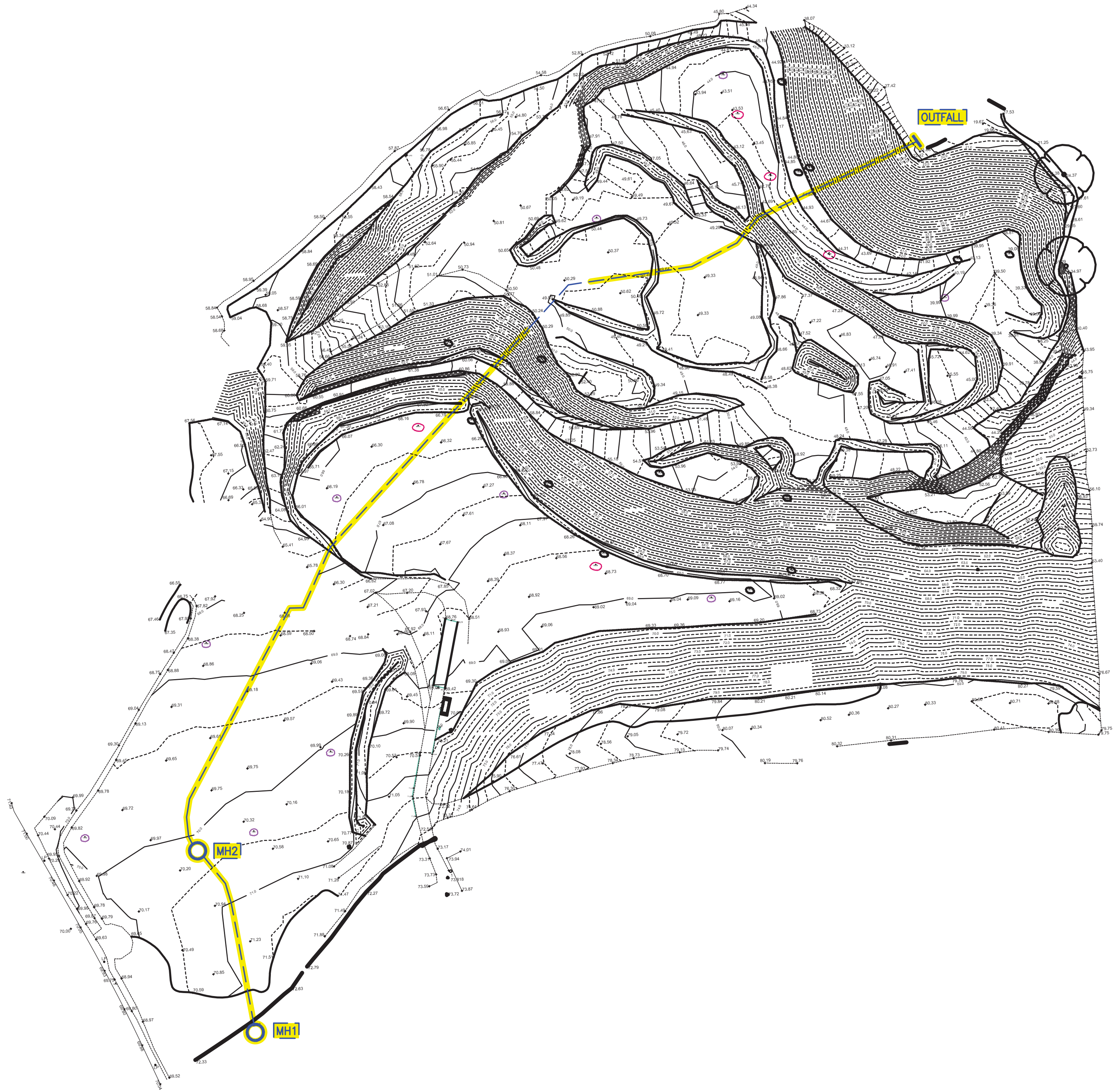


FOR INFORMATION

GENERAL NOTES

CCTV:

1. This Drawing is intended as a schematic representation of the sewer layout to aid in the understanding of the CCTV Survey Report ONLY.
2. This Drawing does not contain full details required for construction and must be read in conjunction with the relevant system specification.
3. Public Sewers indicated on this drawing are taken from a combination of Existing Public Utility Records and on-site verification during the Survey Works.
4. All Drainage Routes, Connections, and Invert Levels have been obtained by the lifting of Manhole Covers / Inspection Chambers. Where it has not been possible to lift a cover, or in the event that the Chamber or Pipe Run was blocked, then the assumed route is clearly annotated based on "Best Endeavors". Where radiodetection methods have been used to establish the Route of a Pipe Run, then the actual Route may differ from that indicated.
5. Although due care has been taken, Exjet does not accept responsibility for any errors and omissions which may have been caused by any detail being obscured or not accessible at the time of the site survey.
6. Position of all apparatus should be verified prior to any works being carried out.
7. Any discrepancies should be reported back to the controlling engineer immediately.
8. Exjet does Not accept liability for failure to adhere to this disclaimer.

Do NOT Scale off this Drawing.

GPS:

1. All measurements and positions are collated utilising Leica Viva GPS equipment and should be read in conjunction with the supplied spreadsheet detailing error margins.
2. Positions of all apparatus should be checked on site prior to works commencing. Any discrepancies in the data should be reported back to the controlling engineer immediately.
3. All measurements are related to OS Datum Newlyn.

KEY	KEY Cont'd ...	
Foul	Manhole	- MH
Surface	Inspection Chamber	- IC
Combined	Rainwater Downpipe	- RWP
Highways	Gully	- Gy
Trade Effluent	Road Gully	- RGy
Site Boundary	Soil Vent Pipe	- SVP
Surveyed	Air Admittance Valve	- AAV
Dye Traced	Back Inlet Gully	- BIG
	Stack Pipe	- SP
	Rodding Eye	- Re
	Survey Abandoned	- SA
	Concealed Chamber	- CC
	Unable to Locate	- UTL
	Unable to Raise	- UTR
	Unable to Gain Access	- UTGA
	Unknown	- Uk

Ref:	Revision / Issue	Date
1	FOR INFORMATION	13.07.17

DRAIN AND PIPE CLEANING
CCTV SURVEYS
REPAIR SERVICE
PIPE LINING
INDUSTRIAL
DOMESTIC

Exjet House, 30 Woodview Road,
Torbay Business Park, Paignton, Devon TQ4 7HP
Telephone 01803 557000
E-mail:Info@exjet.co.uk

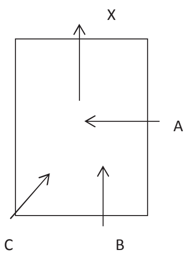
Client: Geo Consulting Engineering Ltd

Project Details: Eales Farm, Saltash, Cornwall

Drawing Title: Drainage Layout CCTV Survey

Project Ref: EXJ_36142_17	
Date: 13.07.2017	Scale: N.T.S. @ A1
Drawn By: JD	Checked By: L.D.
Drawing Nº: 001	Revision: 1

MANHOLE DATA SHEET	Sheet No: 1
SITE: Eales Farm	DATE:

MH REF	DEPTH	DIAGRAM	PIPE REF	PIPE DIM/ CONSTRUCTION	FROM/TO	DIMENSION/ CONSTRUCTION	COMMENTS
MH1	7.18		A	225		900 X 900 CONCRETE BLOCKS	
			B	150			
			C	150			
			D				
			E				
			F				
			G				
			X	900	MH2		
MH2			A				CONCEALED
			B				
			C				
			D				
			E				
			F				
			G				
			X				
			A				
			B				
			C				
			D				
			E				
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			B				
			C				
			D				
			E				
			F				
			G				
			X				
			A				
			B				
			C				
			D				
			E				
			F				
			G				
			X				

Appendix E Surface Water Runoff Calculations

Eales Farm phasing - Treatment Pond retention volumes **Mar-21**

Assuming ponds are constructed at approx EGL noted as shown on drawings and
only land above that restoration contour will drain back.

Phase	area (m²)	to N pond	to E Pond	to S Pond	to W pond
2		11601	13790		
3				1362	7234

Retention Pond volume based on CIRIA C753 for 1 in 30 year rainfall and 60 minute storm

N Pond Phase 2

Contributing area	11601	m²				
Soil	0.3					
PIMP - restored landfill	0.8		9281			
r	0.27					
Rainfall depth 1 year	18.3	mm				
Z1	1.0					
Z2 - 1:30 year 60 minute	1.53					
Av rainfall intensity M30:60	28.0	mm/hr				
Treatment Volume	260	m³		Pond to be minimum voulme of	520	m³
				with retained water volume of	260	m³

E Pond Phase 2

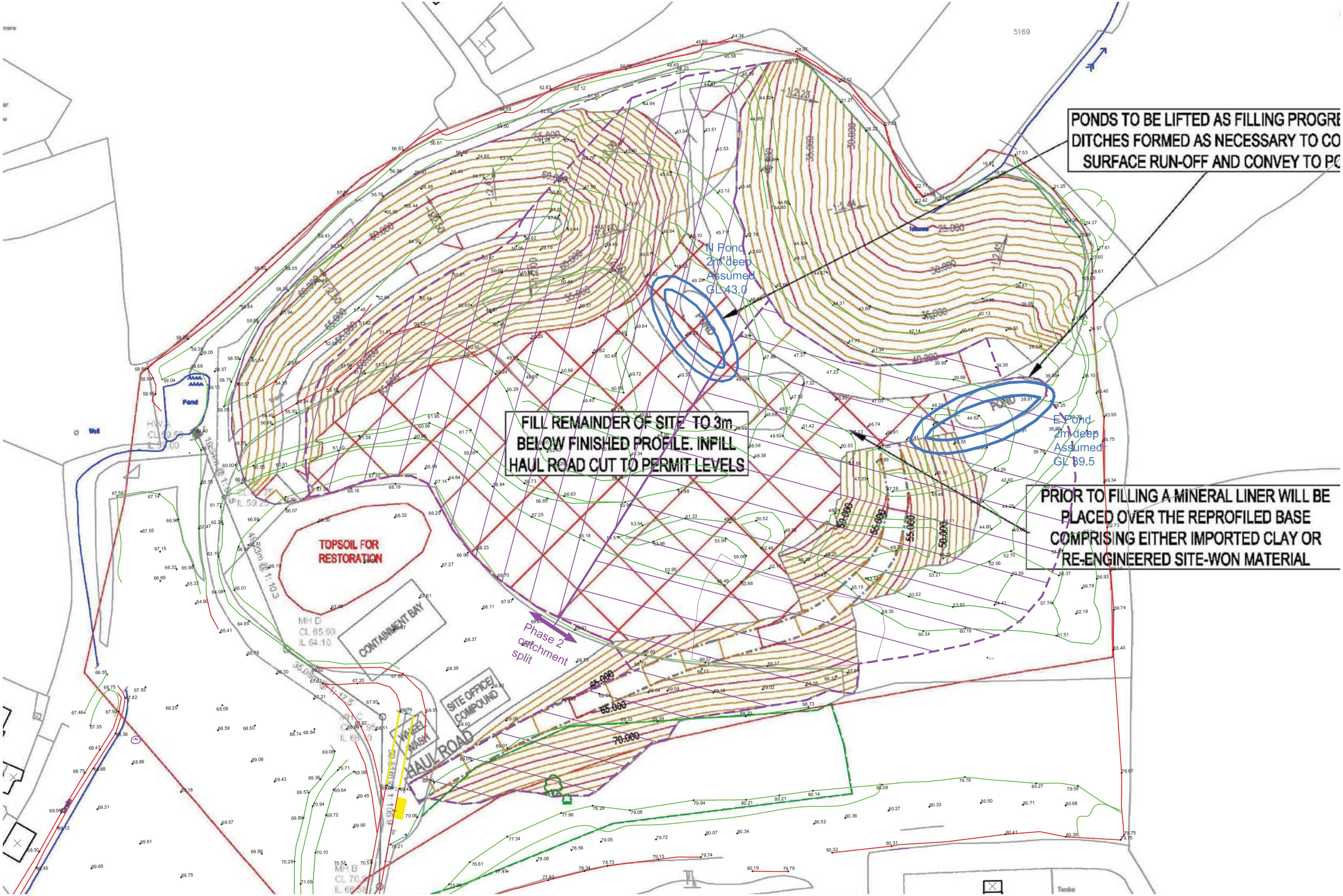
Contributing area	13790	m²				
Soil	0.3					
PIMP - restored landfill	0.8		11032			
r	0.27					
Rainfall depth 1 year	18.3	mm				
Z1	1.0					
Z2 - 1:30 year 60 minute	1.53					
Av rainfall intensity M30:60	28.0	mm/hr				
Treatment Volume	309	m³		Pond to be minimum voulme of	618	m³
				with retained water volume of	309	m³

S Pond Phase 3

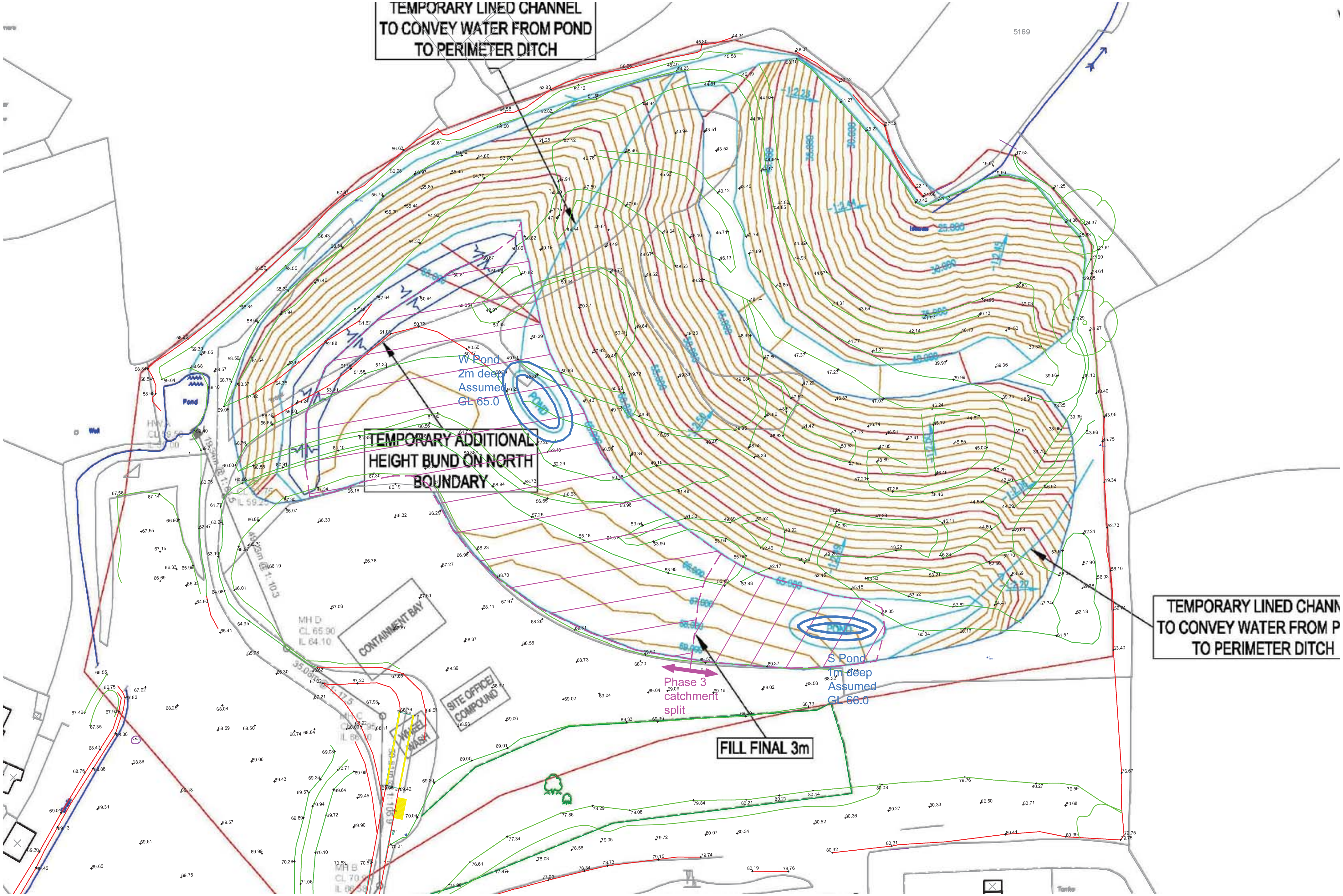
Contributing area	1362	m²				
Soil	0.3					
PIMP - restored landfill	0.8		1090			
r	0.27					
Rainfall depth 1 year	18.3	mm				
Z1	1.0					
Z2 - 1:30 year 60 minute	1.53					
Av rainfall intensity M30:60	28.0	mm/hr				
Treatment Volume	31	m³		Pond to be minimum voulme of	61	m³
				with retained water volume of	31	m³

W Pond Phase 3

Contributing area	7234	m²				
Soil	0.3					
PIMP - restored landfill	0.8		5787			
r	0.27					
Rainfall depth 1 year	18.3	mm				
Z1	1.0					
Z2 - 1:30 year 60 minute	1.53					
Av rainfall intensity M30:60	28.0	mm/hr				
Treatment Volume	162	m³		Pond to be minimum voulme of	324	m³
				with retained water volume of	162	m³

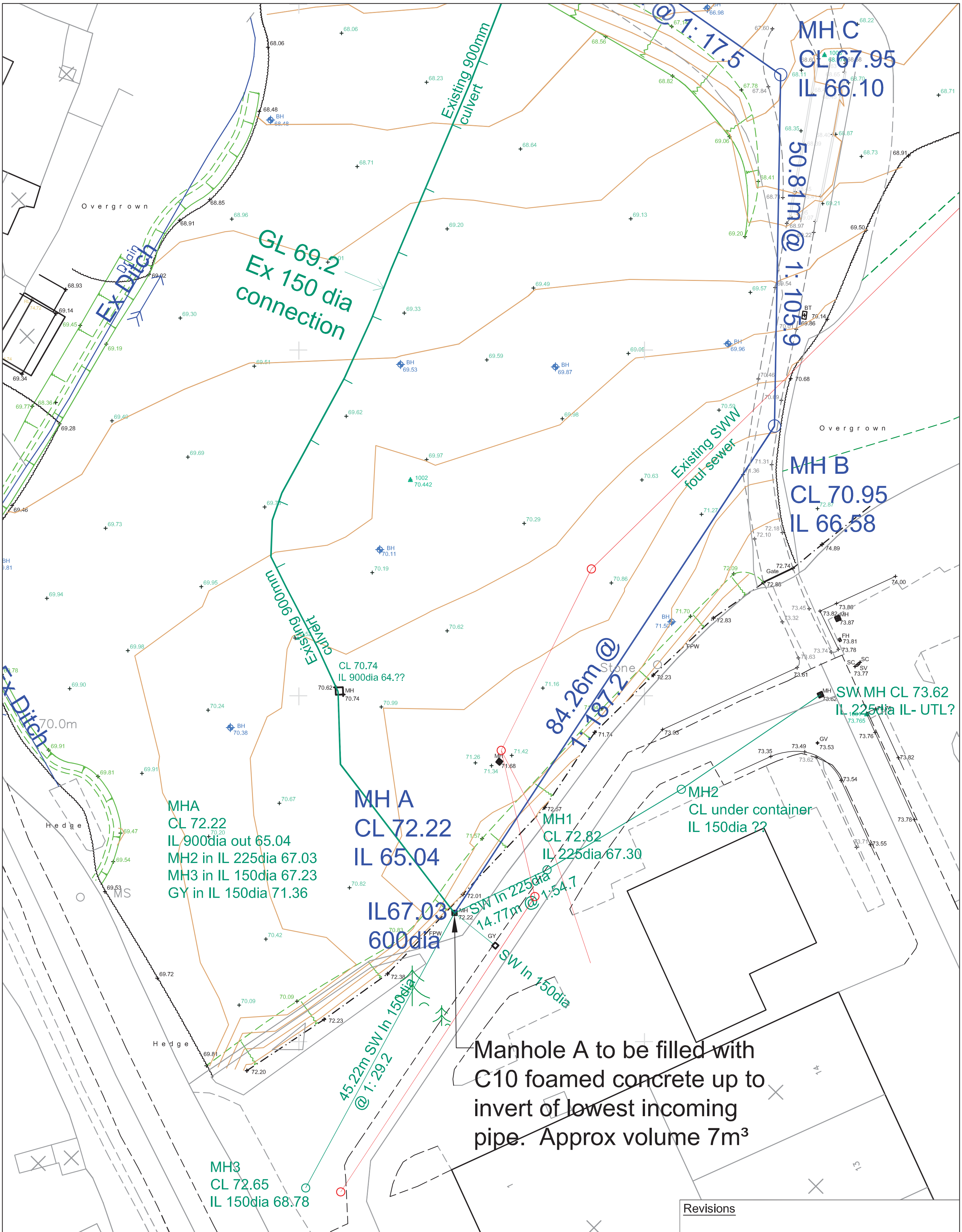


PONDS TO BE LIFTED AS FILLING PROGRE
DITCHES FORMED AS NECESSARY TO CO
SURFACE RUN-OFF AND CONVEY TO PO
PRIOR TO FILLING A MINERAL LINER WILL BE PLACED OVER THE REPROFILED BASE COMPRISING EITHER IMPORTED CLAY OR RE-ENGINEERED SITE-WON MATERIAL
FILL REMAINDER OF SITE TO 3m BELOW FINISHED PROFILE. INFILL HAUL ROAD CUT TO PERMIT LEVELS
N Pond 2m deep Assumed GL 43.0
E Pond 2m deep Assumed GL 39.5
POND
Phase 2 catchment split
TOPSOIL FOR RESTORATION
CONTAINMENT BAY
SITE OFFICE/ COMPOUND
WHEEL WASH
HAUL ROAD
Pond
Well
MH D CL 65.90 IL 64.10
5169



TEMPORARY LINED CHANNEL TO CONVEY WATER FROM POND TO PERIMETER DITCH
TEMPORARY ADDITIONAL HEIGHT BUND ON NORTH BOUNDARY
W Pond 2m deep Assumed GL 65.0
POND
S Pond 1m deep Assumed GL 66.0
Phase 3 catchment split
FILL FINAL 3m
CONTAINMENT BAY
SITE OFFICE/ COMPOUND
WHEEL WASH
MH D CL 65.90 IL 64.10
Pond
Wel
5169
Tanks

Appendix F New Culvert Drawings

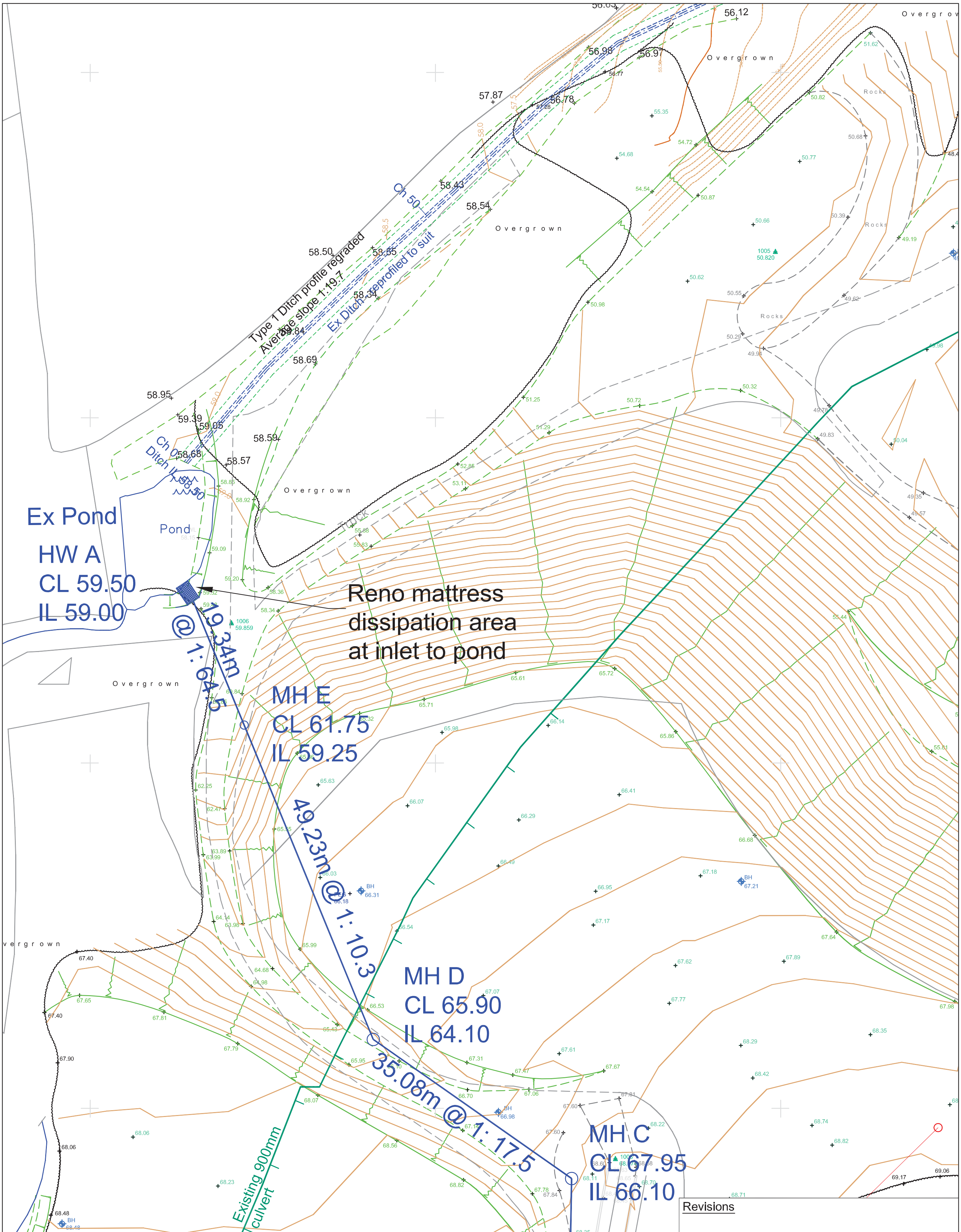


Key
MH Type 1 or 2
Carrier Drain / Culvert
Ditch - lined Types 1 - 3
Cascade location(s)
Existing 900mm pipe
and connections

Revisions

TEIGNCONSULT
9 Higher Kingsdown Road
Teignmouth
Devon
TQ14 9AT

Project: Eales Farm, Saltash		Client: Geo Consulting Engineering Ltd, Woodbury, Exeter	
Subject: Replacement culvert and surface water drainage system - Plan sheet 1 of 3		Date: May 19	Scale: 1:500 @ A3
		Drawn: NAS	Checked: NAS
Project No: 477	Drawing No: DR1		Rev.: -



Key

MH Type 1 or 2

Carrier Drain / Culvert

Ditch - lined Types 1 - 3

Cascade location(s)

Existing 900mm pipe and connections

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Teignmouth
Devon
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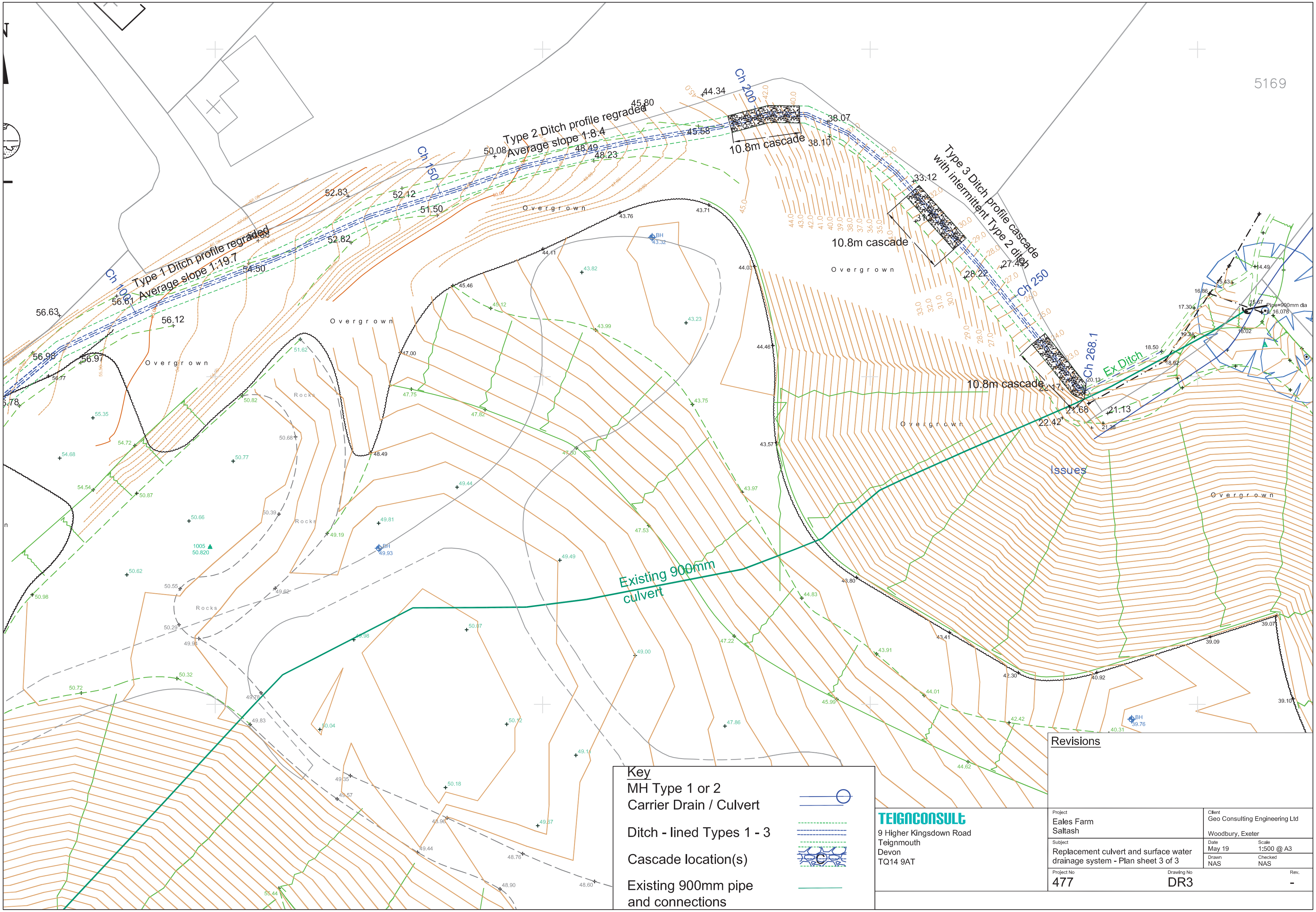
Project: Eales Farm Saltash		Client: Geo Consulting Engineering Ltd Woodbury, Exeter	
Subject: Replacement culvert and surface water drainage system - Plan sheet 2 of 3		Date: May 19	Scale: 1:500 @ A3
		Drawn: NAS	Checked: NAS
Project No: 477	Drawing No: DR2		Rev.: -



Key

MH Type 1 or 2

Carrier Drain / Culvert

Ditch - lined Types 1 - 3

Cascade location(s)

Existing 900mm pipe
and connections

Revisions

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Devon
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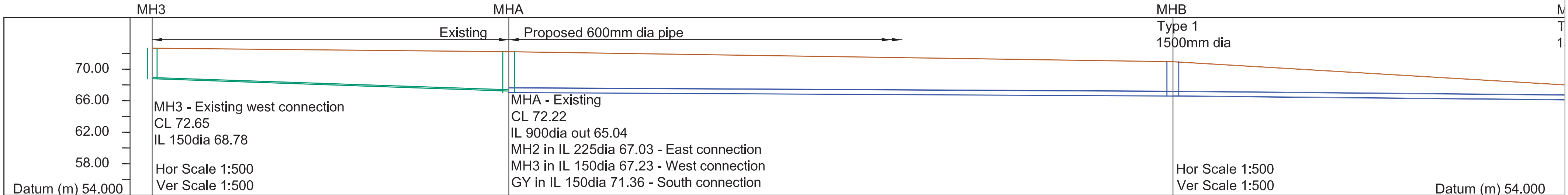
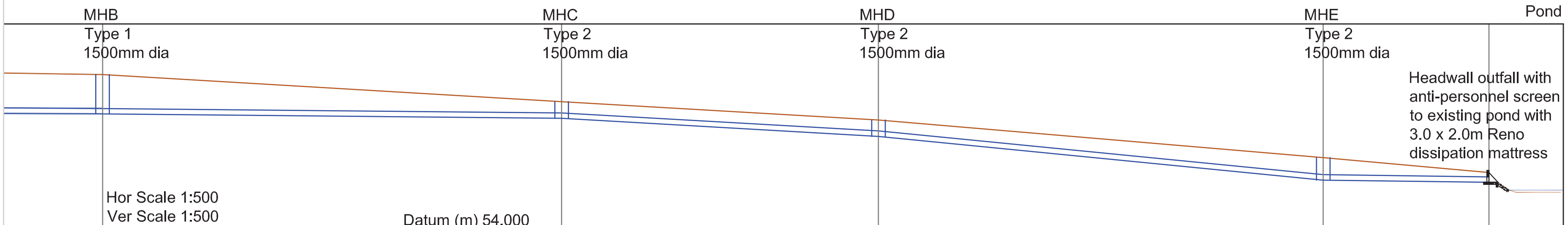
Project: Eales Farm, Saltash		Client: Geo Consulting Engineering Ltd, Woodbury, Exeter	
Subject: Replacement culvert and surface water drainage system - Plan sheet 3 of 3		Date: May 19	Scale: 1:500 @ A3
		Drawn: NAS	Checked: NAS
Project No: 477	Drawing No: DR3		Rev.: -



	MH3		MHA		MHB	
Pipe No		1.000 Existing		1.001 New		1.002 New
Dia (mm)		150		600		600
Slope (1:X)		29.2		187.2		105.9
Cover Level (m)	72.650		72.220		70.950	
Invert Level (m)	68.780		67.230 / 67.030		66.580 / 66.580	
Length (m)		45.220		84.257		50.810



	MHB		MHC		MHD		MHE		Pond
Pipe No		1.002 New		1.003		1.004		1.005	Pond
Dia (mm)		600		600		600		600	
Slope (1:X)		105.9		17.5		10.1		73.3	
Cover Level (m)	70.950		67.950		65.900		61.750		60.000
Invert Level (m)	66.580 / 66.580		66.100 / 66.100		64.100 / 64.100		59.250 / 59.250		59.000
Length (m)		50.810		35.080		49.227		18.335	

Revisions

TEIGNCONSULT
9 Higher Kingsdown Road
Teignmouth
Devon
TQ14 9AT

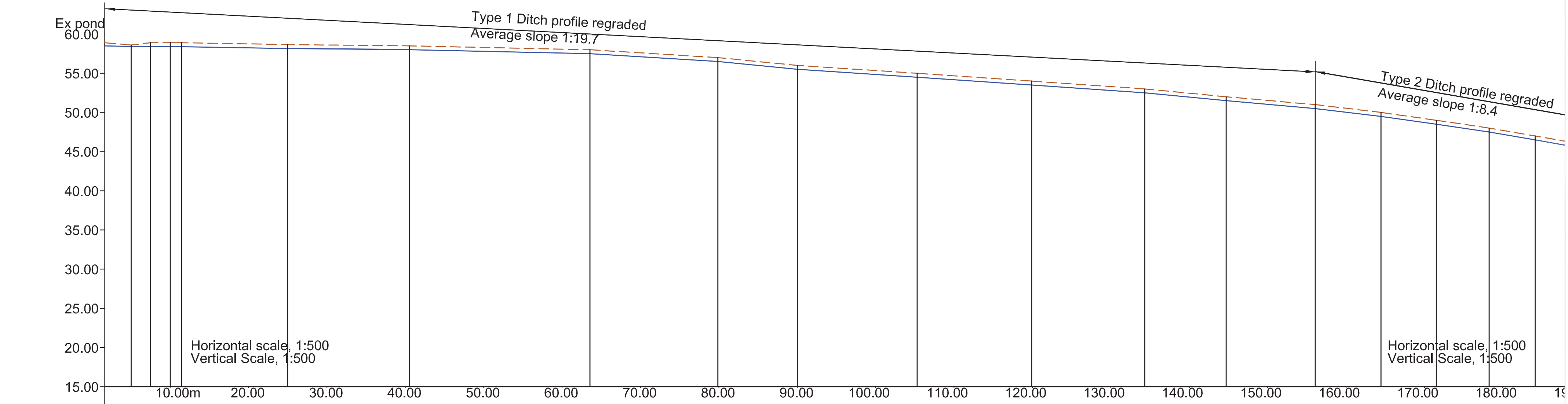
Project: Eales Farm, Saltash
Replacement culvert & ditch outfall

Client: Geo Consulting Engineering Ltd
Woodbury, Exeter

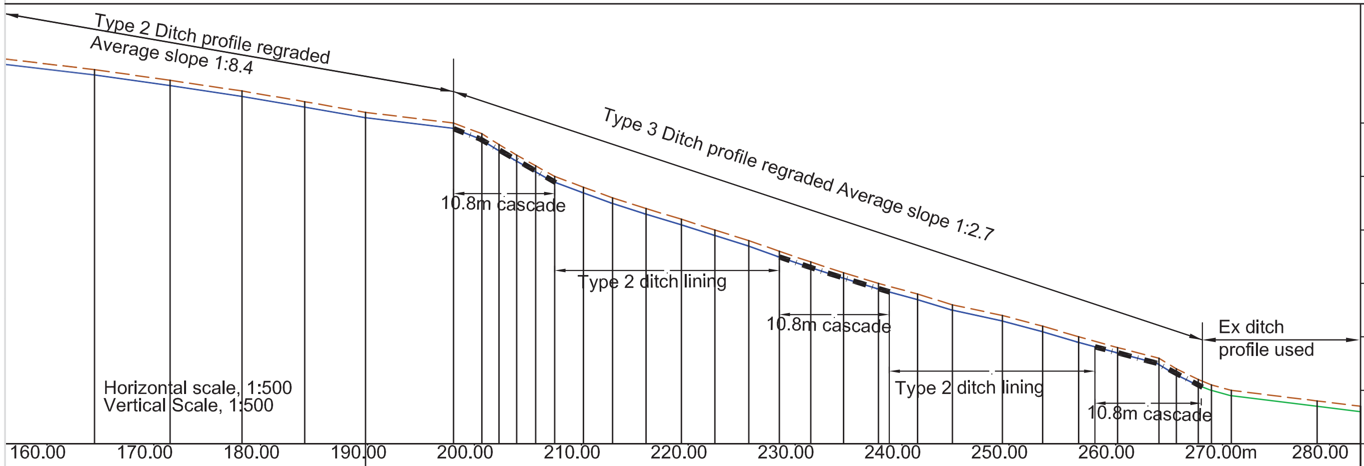
Subject: Surface water drainage - culvert
Long sections sheet 1 of 2

Date: May 19 | Scale: 1:500 @ A3
Drawn: NAS | Checked: NAS

Project No: 477 | Drawing No: DR4 LS1 | Rev: -



Chainage	Ex Elev
0.00	58.60
3.35	58.60
5.84	58.90
8.36	58.90
9.82	58.90
23.31	58.66
38.83	58.50
61.89	58.00
78.20	57.00
88.33	56.00
103.62	55.00
118.23	54.00
132.67	53.00
143.04	52.00
154.40	51.00
162.79	50.00
169.85	49.00
176.59	48.00
182.44	47.00



Chainage	Ex Elev
162.79	50.00
169.85	49.00
176.59	48.00
182.44	47.00
188.13	46.00
196.38	45.00
199.01	44.00
200.62	43.00
202.28	42.00
204.06	41.00
205.84	40.00
208.52	39.00
211.25	38.00
214.39	37.00
217.68	36.00
220.82	35.00
224.00	34.00
226.85	33.00
229.79	32.00
232.86	31.00
236.12	30.00
239.78	29.00
243.04	28.00
247.72	27.00
251.48	26.00
254.85	25.00
258.50	24.00
262.36	23.00
264.00	22.00
266.05	21.00
267.28	20.50
269.14	20.00
277.17	19.00
281.22	18.50

Ditch Type 1 - Typical velocity 2.5 - 3.0m/s lined with Fortrac3D, topsoil and grass seeded

Ditch Type 2 - Typcal velocity 3.0 - 4.0m/s lined with basal liner - Huesker Canal³ 8208 and Fortrac3D.

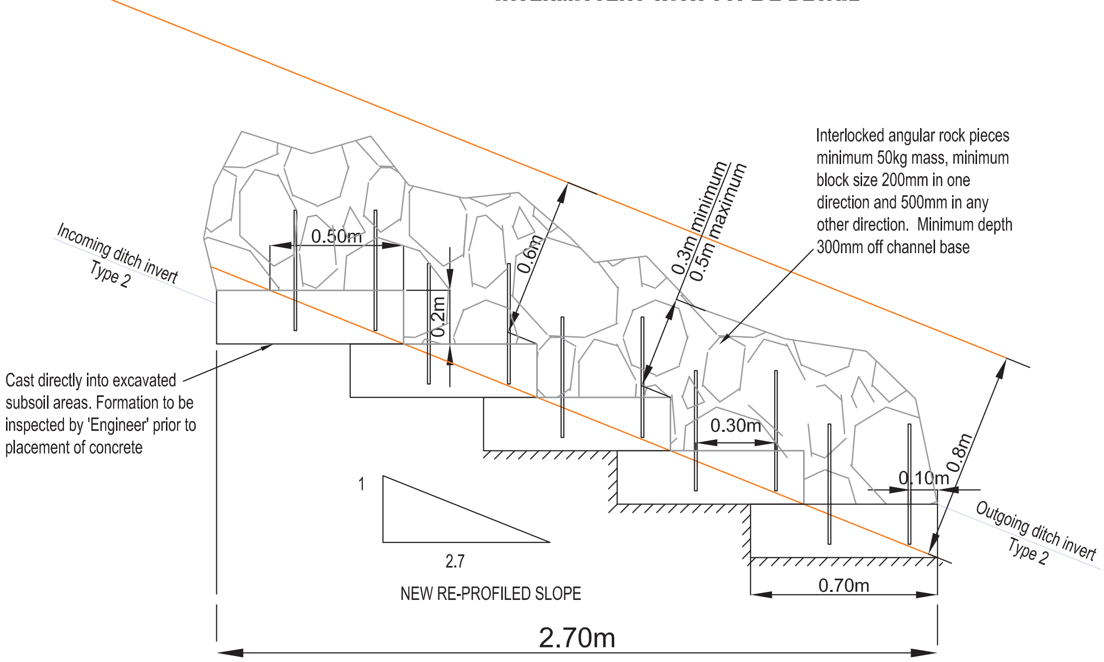
Ditch Type 3 - Typical velocity 5.0 - 8.0m/s cascade required

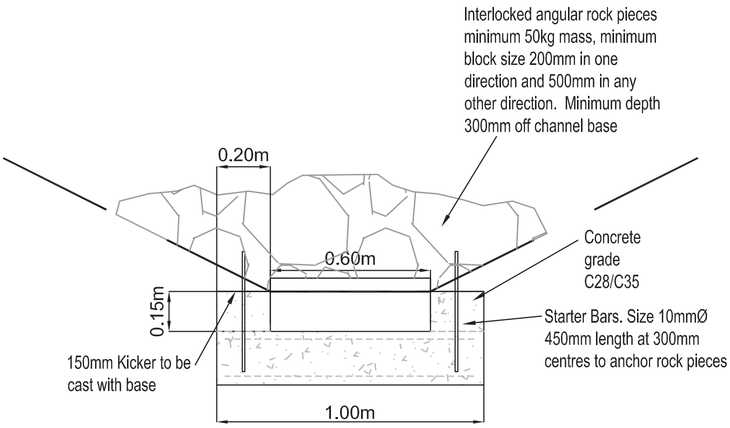
Revisions

TEIGNCONSULT
9 Higher Kingsdown Road
Teignmouth
Devon
TQ14 9AT

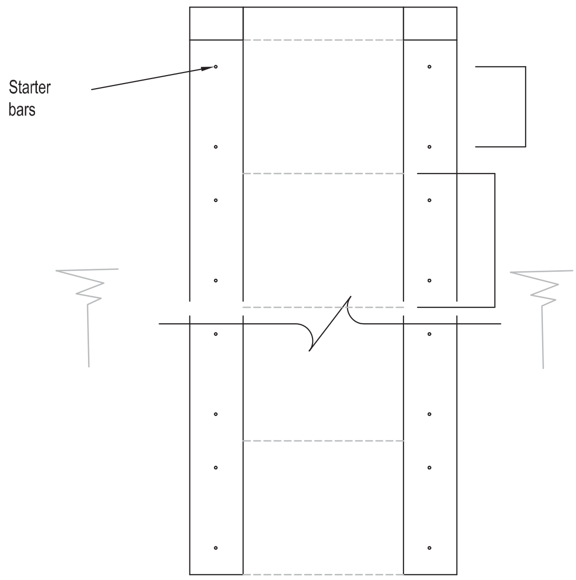
Project: Eales Farm, Saltash Replacement culvert & ditch outfall	Client: Geo Consulting Engineering Ltd Woodbury, Exeter	
Subject: Surface water drainage - ditch outfall Long sections sheet 2 of 2	Date: May 19; Drawn: NAS	Scale: 1:500 @ A3; Checked: NAS
Project No: 477	Drawing No: DR5 LS2	Rev: -

CASCADE DETAIL IN TYPE 3 DITCH AREA
INTERMITTENT WITH TYPE 2 DETAIL





STEPPED CASCADE CHANNEL
200mm Risers
500mm Going
Capacity of 1100l/s



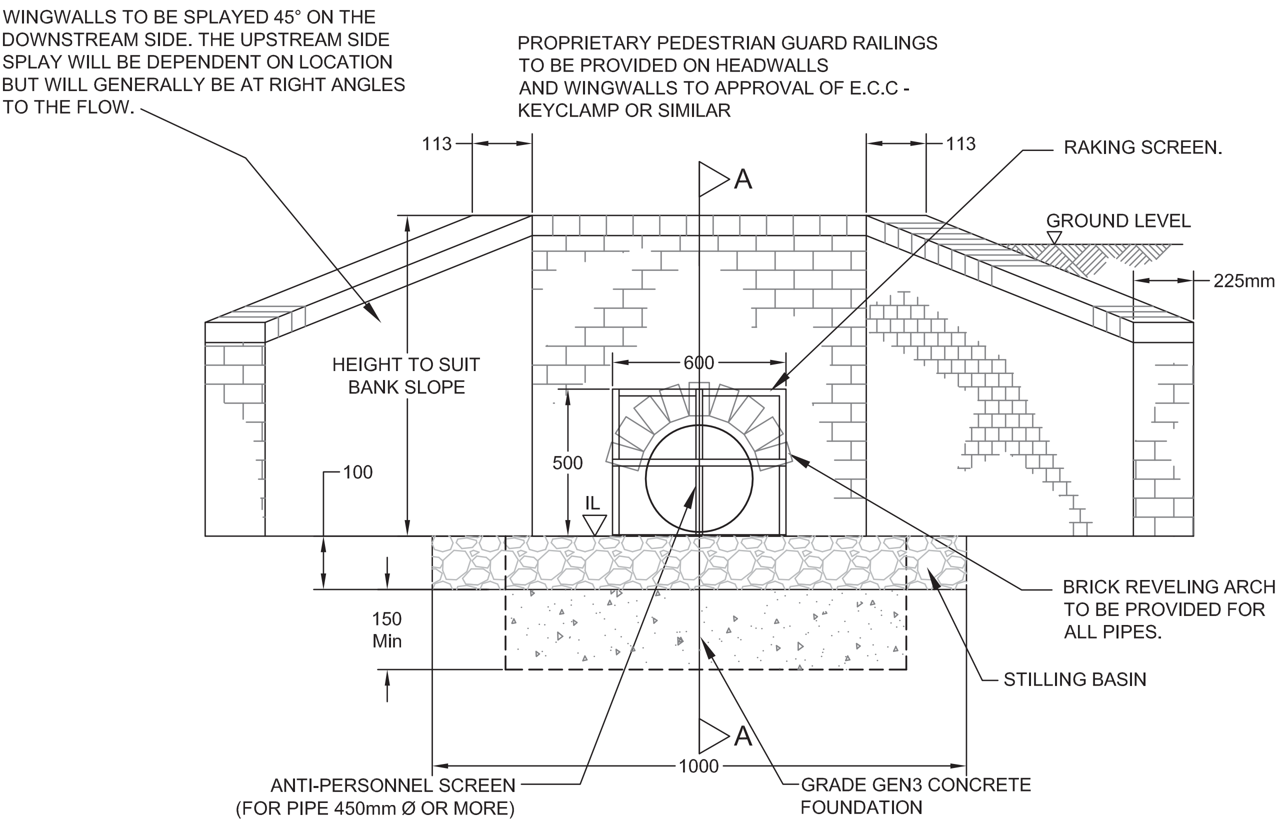
PLAN

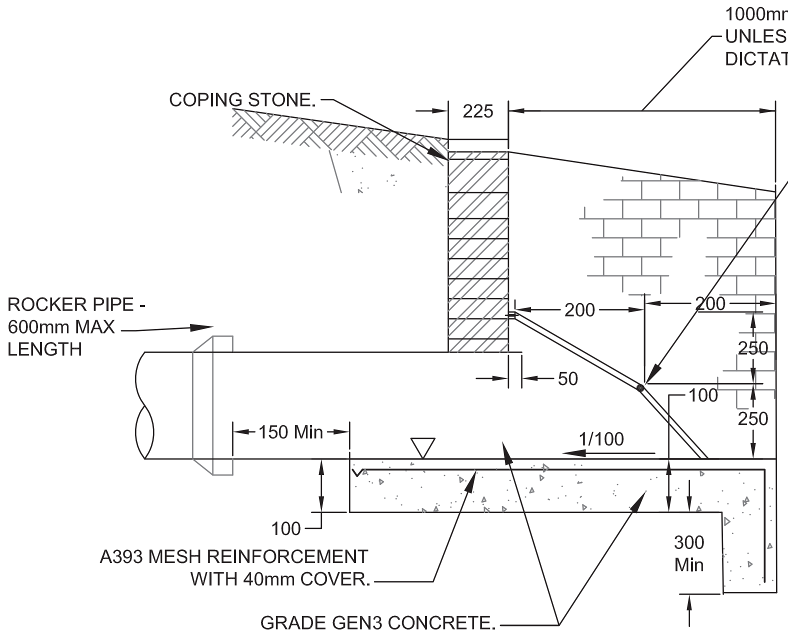
TEIGNCONSULT
9 Higher Kingsdown Road
Teignmouth
Devon
TQ14 9AT

Project: Eales Farm, Saltash		Client:	
Subject: Standard Construction Details Drainage works		Date: May 19	Scale: NTS
		Drawn: NAS	Checked: NAS
Project No: 477	Drawing No: SD-DR6		Rev.: -

DETAIL OF HEADWALL OUTFALL TO POND

NTS





NOTES:

1. ALL DIMENSIONS IN mm UNLESS OTHERWISE STATED.
2. HEADWALL FINISH TO BE AGREED .
3. BACKFILL AROUND HEADWALL SHALL BE SUITABLE SITE WON MATERIAL.
4. SCHEDULED DIMENSIONS TO BE ADJUSTED AS DIRECTED BY THE ENGINEER ON SITE.
5. BRICK WALLS TO BE FINISHED WITH BRICK ON EDGE COPING.
6. TRENCHES CARRYING THE OUTFALL PIPES TO BE BACKFILLED AND COMPACTED IN ACCORDANCE WITH THE SPECIFICATION FOR HIGHWAY WORKS.

Section A–A

TEIGNCONSULT
9 Higher Kingsdown Road
Teignmouth
Devon
TQ14 9AT

Project Eales Farm Saltash	Client	
Subject Standard Construction Details Drainage works	Date May 19 Drawn NAS	Scale NTS Checked NAS
Project No 477	Drawing No SD-DR5	Rev. -

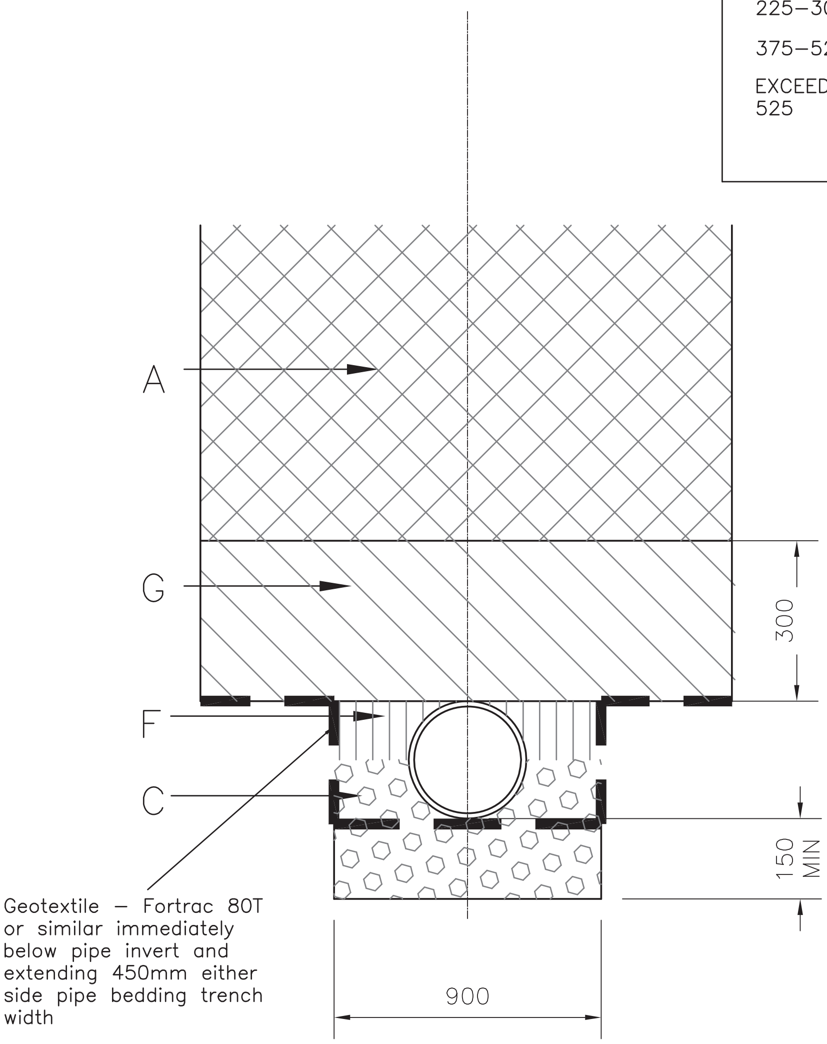
PIPE BEDDING AND TRENCH REINFORCEMENT

BEDDING & BACKFILL NOTES

1. ALL DIMENSIONS IN MILLIMETERES.
2. DIMENSION X IS THE EXTERNAL DIAMETER OF THE PIPE.
3. THE MINIMUM OR MAXIMUM WIDTH OF THE TRENCH APPLIES ON AND BELOW A LINE 300mm ABOVE THE OUTSIDE TOP OF THE PIPE BARREL. ABOVE THE 300mm LINE THE TRENCH BACK FILL SHALL BE AS DESCRIBED BELOW.
4. GRANULAR BEDDING COMPLYING WITH THE REQUIREMENTS OF TABLE 1
5. SELECTED FILL MATERIAL SHALL BE TYPE 1 FOR UNDER CARRIAGEWAYS OR FUTURE CARRIAGEWAYS, COMPACTED IN LAYERS NOT EXCEEDING 100mm AND SHALL BE HAND TAMPED. CARE BEING TAKEN NOT TO DISPLACE THE PIPE FROM IT'S CORRECT LINE AND LEVEL.
6. BEDDING TO FOUL AND SURFACE WATER DRAINS TO BE TYPE B. IF REQUIRED, PIPES SHOULD BE PROTECTED USING CONCRETE SLAB PROTECTION

TABLE 1 – USE OF GRANULAR BEDDING MATERIAL

NOMINAL BORE OF PIPE (mm)	AGGREGATE SIZE (mm)	
	SINGLE SIZED	GRADED
150	10 OR 14	14 TO 5
225–300	10,14 OR 20	14 TO 5 OR 20 TO 5
375–525	14 OR 20	14 TO 5 OR 20 TO 5
EXCEEDING 525	14,20 OR 40	14 TO 5 OR 20 TO 5, 40 TO 5



CLASS B EXTRA –
PIPE WITH MORE THAN 900mm COVER
IN MADE GROUND

PIPE BEDDING DETAILS

A SELECTED EXCAVATED MATERIAL IN BACKFILL.

B TYPE A GRANULAR MATERIAL IN BED AND SURROUND TO PIPE. (CLASS S BEDDING)

C TYPE A GRANULAR MATERIAL IN BED TO PIPE. (CLASS B BEDDING)

D TYPE 1 GRANULAR SUB BASE MATERIAL IN TRENCH FILL AS SHOWN.

E GEN 3 CONCRETE IN DISCONTINUOUS BED AND SURROUND TO PIPE.

F SELECTED EXCAVATED MATERIAL SLIGHTLY COMPACTED BY HAND.

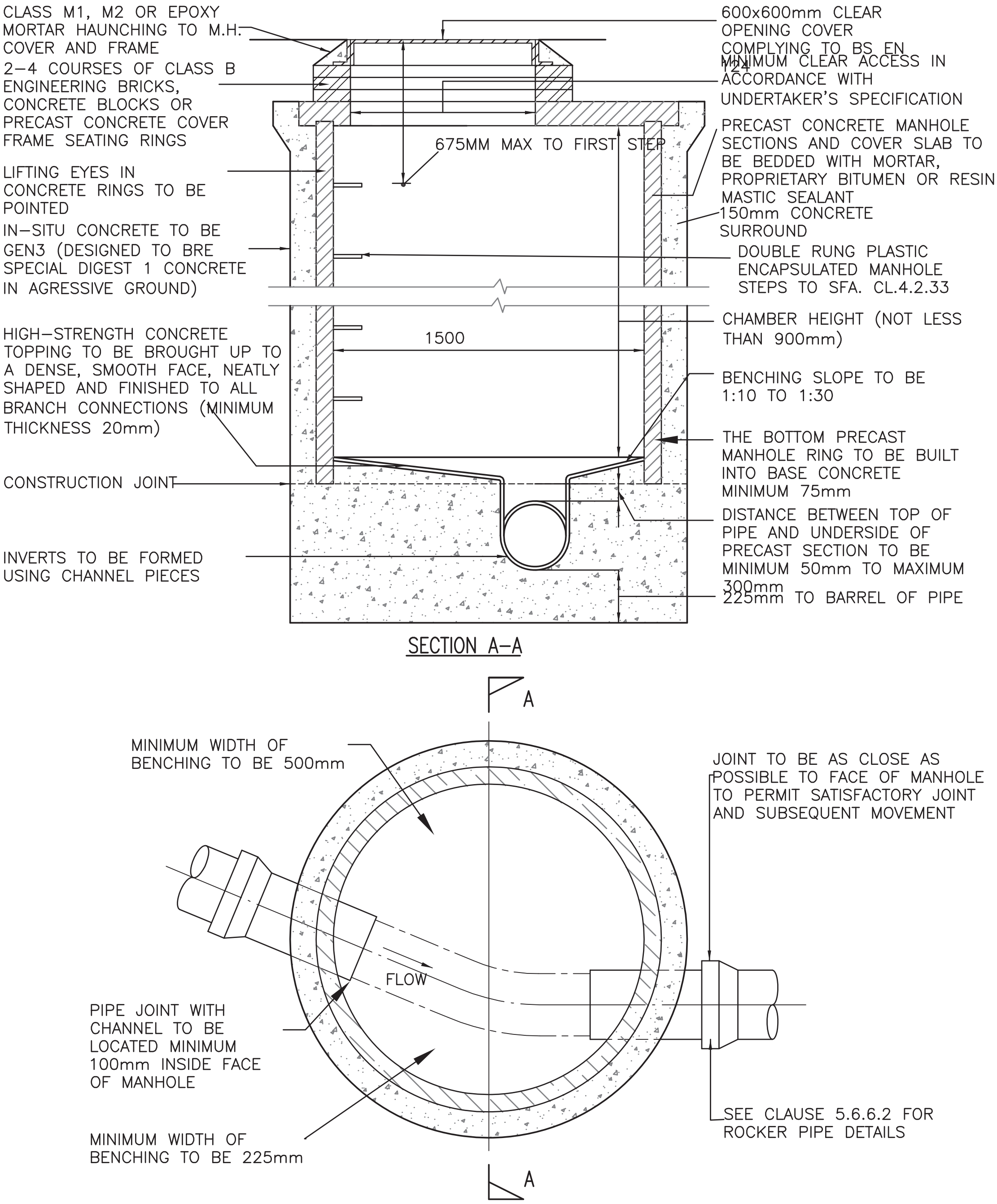
G SELECTED EXCAVATED MATERIAL WELL COMPACTED BY HAND.

TEIGNCONSULT
9 Higher Kingsdown Road
Teignmouth
Devon
TQ14 9AT

Project: Eales Farm Saltash		Client:	
Subject: Standard Construction Details Drainage works		Date: May 19	Scale: NTS
		Drawn: NAS	Checked: NAS
Project No: 477	Drawing No: SD-DR4		Rev.: -

MANHOLE TYPE 2

MAXIMUM DEPTH TO SOFFIT 3.0m

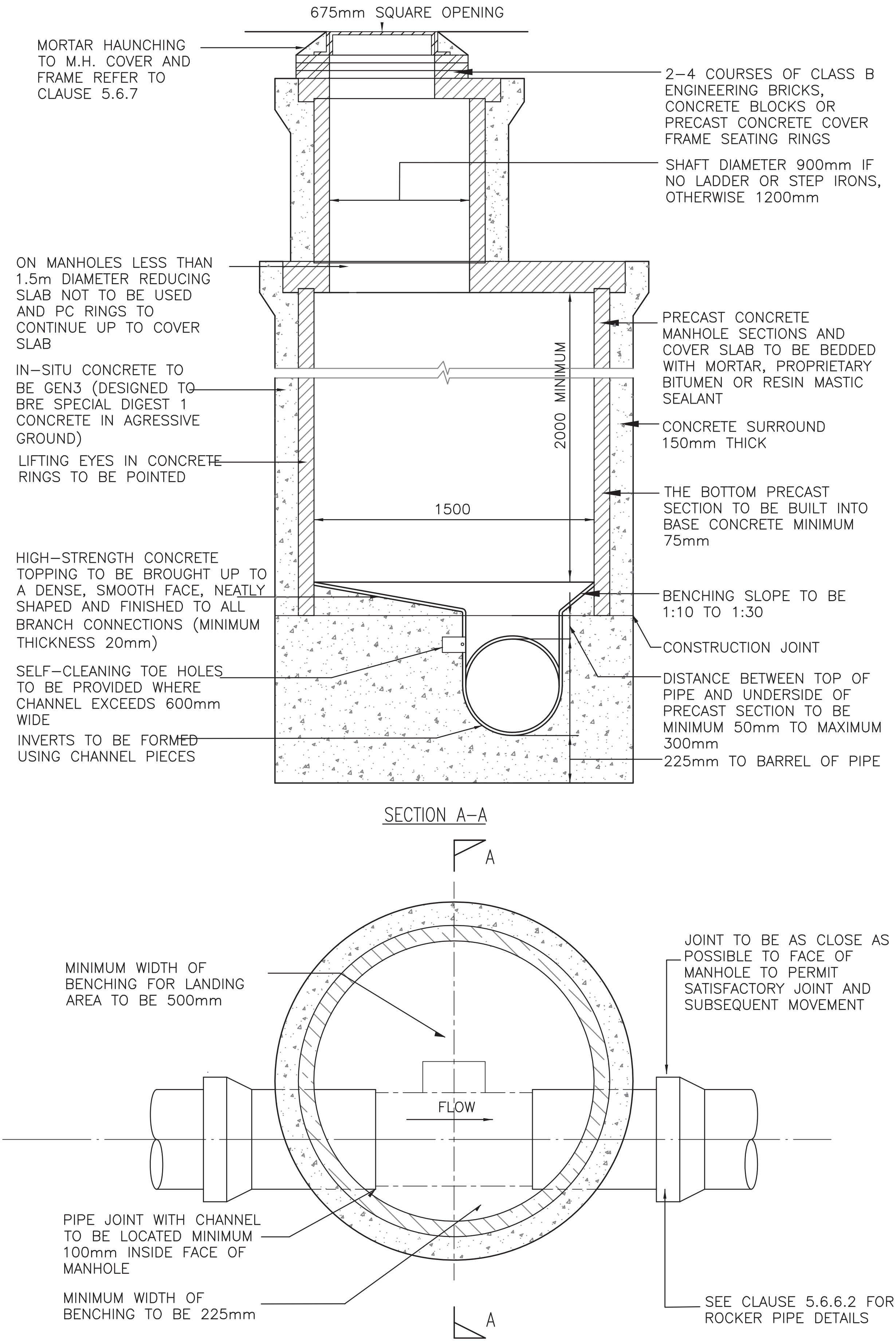


TEIGNCONSULT
9 Higher Kingsdown Road
Teignmouth
Devon
TQ14 9AT

Project: Eales Farm, Saltash		Client:	
Subject: Standard Construction Details, Drainage works		Date: May 19	Scale: NTS
		Drawn: NAS	Checked: NAS
Project No: 477	Drawing No: SD-DR3		Rev: -

MANHOLE TYPE 1

MAXIMUM DEPTH TO SOFFIT 3.0m to 6.0m

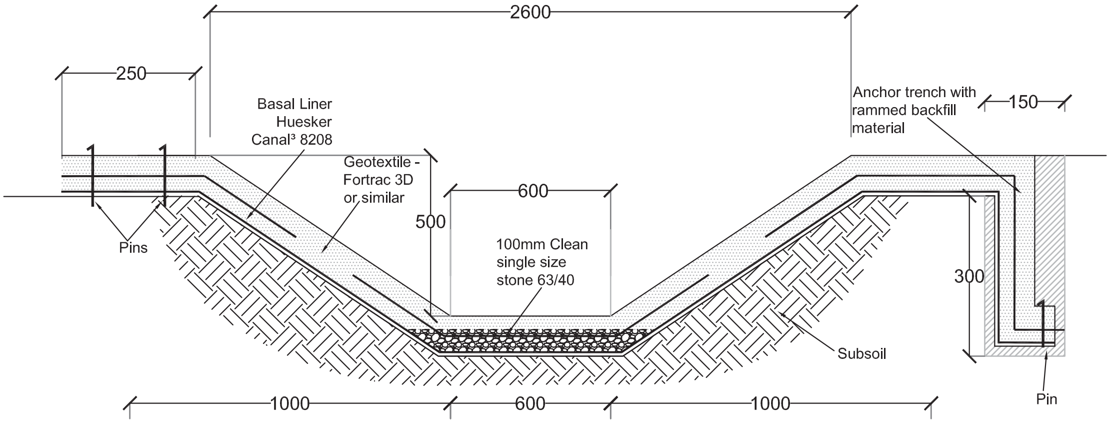


TEIGNCONSULT

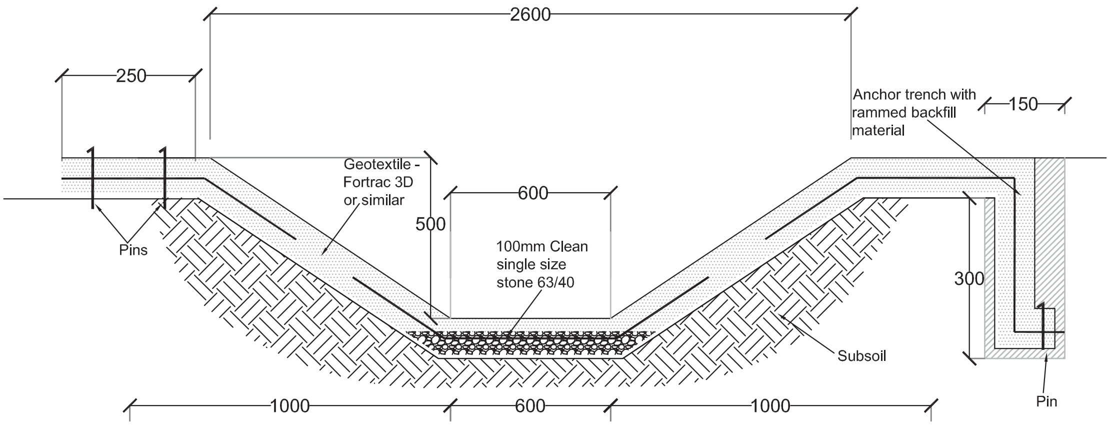
9 Higher Kingsdown Road
Teignmouth
Devon
TQ14 9AT

Project	Eales Farm Saltash
Client	
Subject	Standard Construction Details Drainage works
Date	May 19
Scale	NTS
Drawn	NAS
Checked	NAS
Project No	477
Drawing No	SD-DR2
Rev.	-

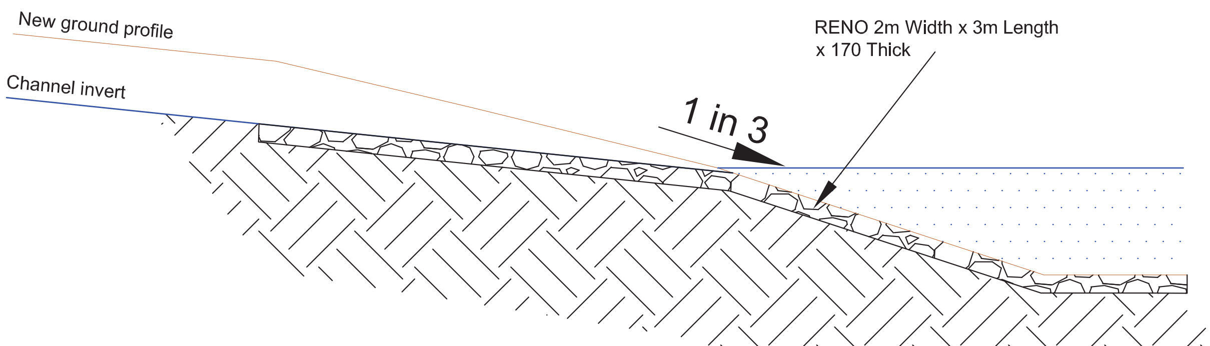
Type 2 Ditch Profile
Flow channel with basal liner - Huesker Canal³ 8208 and Fortrac3D. Fixed and pinned to manufacturers installation instructions



Type 1 Ditch Profile
Flow channel with Fortrac3D. Fixed and pinned to manufacturers installation instructions



Reno Mattress Liner at Pond Inlet



STONE FILLING FOR GABIONS AND MATTRESSES SHALL BE HARD, DURABLE QUARRIED OR ROUNDED MATERIAL SUCH AS GRANITE, BALLAST, DOLOMITIC LIMESTONE, FLINT REJECTS, COBBLES ECT, CLEAN AND FREE FROM CONTAMINATION. SAMPLES TO BE PROVIDED TO ENGINEER PRIOR TO CONSTRUCTION. SOFT FRIABLE MATERIAL, SOFT BRICKS AND CONCRETE SHALL NOT BE USED.

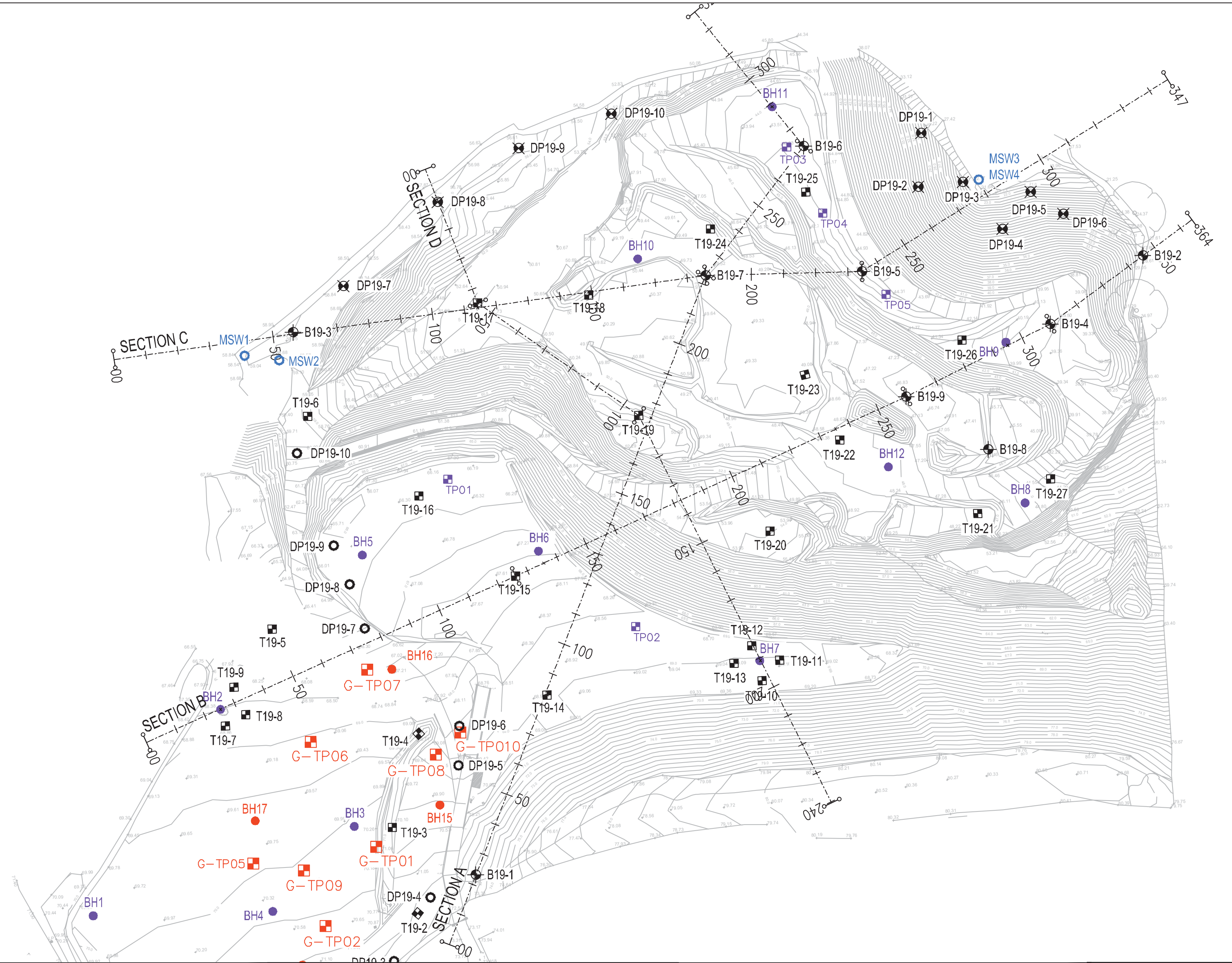
TEIGNCONSULT
9 Higher Kingsdown Road
Teignmouth
Devon
TQ14 9AT

Project: Eales Farm Saltash		Client:	
Subject: Standard Construction Details Drainage works		Date: May 19	Scale: NTS
		Drawn: NAS	Checked: NAS
Project No: 477	Drawing No: SD-DR1		Rev.: -

geo consulting engineering ltd

Appendix G Site Cross-Sections

A3



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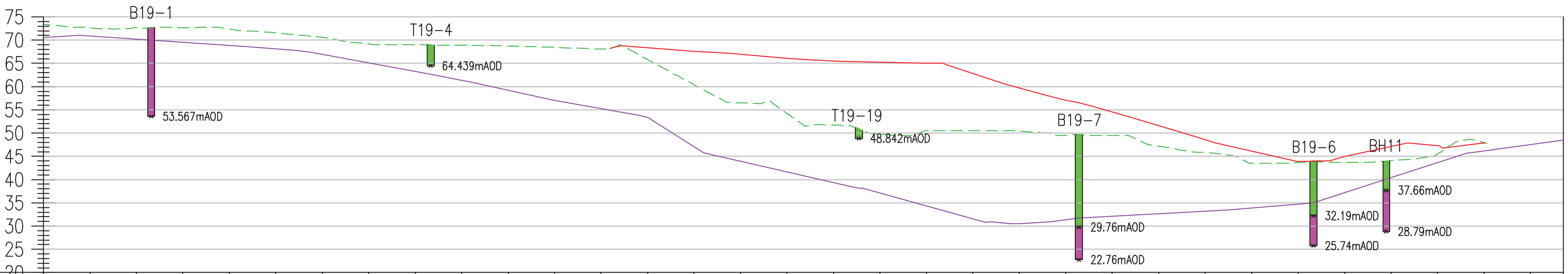
	Job Title: **Eales Farm Landfill**	Dwg Title: **Site Section Locations**	Scale 1:1250 at A3 Drawn RA Date APR 2021 Checked DLJ
			Drawing no: **GCE00692-A20-Fig1** Rev -



CHAINAGE	00.000	10.000	20.000	30.000	40.000	50.000	60.000	70.000	80.000	90.000	100.000
EXISTING LEVELS	73.334	72.651	72.665	72.660	72.373	71.537	70.554	69.161	68.986	68.902	68.728
1970 LEVELS	70.527	70.913	70.223	69.533	68.843	68.125	66.964	65.112	63.261	61.401	59.218
PROPOSED LEVELS											

CHAINAGE	110.000	120.000	130.000	140.000	150.000	160.000	170.000	180.000	190.000	200.000	210.000
EXISTING LEVELS	68.438	68.084	65.842	60.410	56.513	54.232	51.760	49.775	50.500	50.513	50.445
1970 LEVELS	57.070	55.257	53.352	47.063	43.919	41.636	39.353	37.087	34.329	31.570	30.480
PROPOSED LEVELS			68.340	67.587	66.988	66.075	65.519	65.279	65.070	62.829	59.717

CHAINAGE	220.000	230.000	240.000	250.000	260.000	270.000	280.000	290.000	300.000	310.000	320.000	327.037
EXISTING LEVELS	49.500	49.500	47.167	45.780	43.500	43.658	43.739	44.042	45.484	47.963		
1970 LEVELS	31.375	32.137	32.681	33.225	33.909	34.725	37.177	40.410	43.636	46.145	47.531	48.507
PROPOSED LEVELS	57.092	54.528	51.592	48.582	46.125	43.917	44.938	47.096	47.268	47.890		

SECTION A
SCALE: H 1:1000, V 1:1000

- FINAL PROFILE
- EXISTING PROFILE
- 1970 TOPO PROFILE
- TORPOINT FORMATION
- LANDFILL WASTE

A3

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Client: **Tamar Valley Projects Ltd**

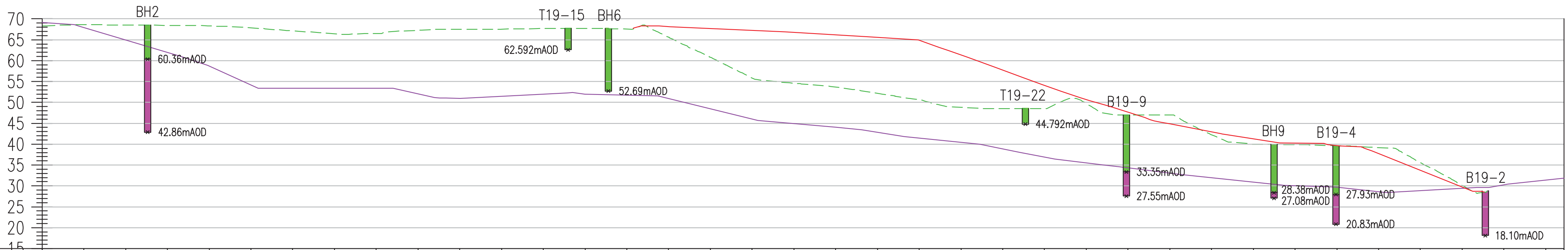
Drawing Status: **For Information**

Job Title: **Eales Farm Landfill**

Dwg Title: **Cross Section A**

Scale: 1:1000 at A3
Drawn: RA
Date: APR 2021
Checked: DLJ

Drawing no: **GCE00692-A20-Fig2**
Rev: -



CHAINAGE	EXISTING LEVELS	1970 LEVELS	PROPOSED LEVELS
00.000	68.299	69.118	
10.000	68.594	67.905	
20.000	68.529	64.919	
30.000	68.464	61.932	
40.000	68.328	58.695	
50.000	67.896	54.144	
60.000	67.136	53.340	
70.000	66.430	53.340	
80.000	66.500	53.340	
90.000	67.250	52.039	
100.000	67.500	51.000	
110.000	67.561	51.497	
120.000	67.705	52.000	
130.000	67.700	51.931	
140.000	67.560	51.716	
150.000	65.594	50.929	68.148
160.000	60.822	48.496	67.712
170.000	55.809	46.063	67.281
180.000	54.608	44.970	66.809
190.000	53.683	44.097	66.188
200.000	52.191	42.826	65.595
210.000	50.618	41.466	64.925
220.000	48.785	40.466	61.336
230.000	48.500	38.896	57.736
240.000	48.500	36.940	54.094
250.000	49.738	35.557	50.695
260.000	46.980	34.356	47.670
270.000	47.000	33.052	44.857
280.000	42.250	31.964	42.917
290.000	39.994	30.939	41.273
300.000	39.887	30.071	40.232
310.000	39.607	29.686	39.643
320.000	39.196	28.603	37.699
330.000	35.568	28.850	33.701
340.000	30.117	29.390	29.703
350.000		30.308	
360.000		31.390	
364.432		31.836	

SECTION B

SCALE: H 1:1000, V 1:1000

- FINAL PROFILE
- EXISTING PROFILE
- 1970 TOPO PROFILE
- TORPOINT FORMATION
- LANDFILL WASTE

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Client: **Tamar Valley Projects Ltd**

Job Title: **Eale Farm Landfill**

Dwg Title: **Cross Section B**

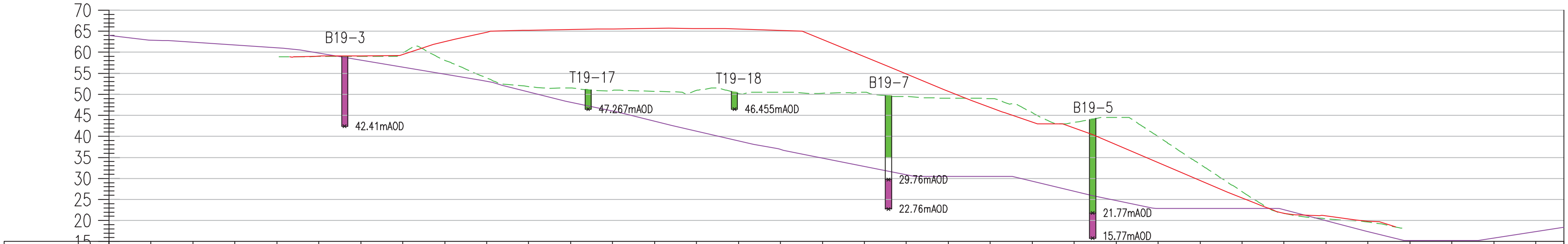
Drawing Status: **For Information**

Scale: 1:1000 at A3 | Drawn: RA

Date: APR 2021 | Checked: DLJ

Drawing no: **GCE00692-A20-Fig3** | Rev: -

A3



CHAINAGE	00.000	10.000	20.000	30.000	40.000	50.000	60.000	70.000	80.000	90.000	100.000	110.000
EXISTING LEVELS						58.992	59.000	59.843	58.075	53.889	51.847	51.510
1970 LEVELS	64.023	62.862	62.380	61.722	61.063	59.813	58.139	56.466	54.792	53.086	50.564	48.135
PROPOSED LEVELS						59.058	59.104	59.490	62.503	64.784	65.210	65.389

CHAINAGE	120.000	130.000	140.000	150.000	160.000	170.000	180.000	190.000	200.000	210.000	220.000	230.000
EXISTING LEVELS	50.933	50.706	50.925	50.221	50.492	50.259	50.500	49.500	49.099	49.008	45.613	43.301
1970 LEVELS	46.026	43.636	41.266	38.945	36.918	34.810	32.867	30.883	30.480	30.480	29.335	26.935
PROPOSED LEVELS	65.554	65.665	65.671	65.541	65.181	63.032	58.926	54.827	50.747	46.849	43.421	42.015

CHAINAGE	240.000	250.000	260.000	270.000	280.000	290.000	300.000	310.000	320.000	330.000	340.000	346.666
EXISTING LEVELS	44.500	39.940	33.339	26.857	21.674	20.431	19.645					
1970 LEVELS	24.765	22.860	22.860	22.860	22.566	19.973	17.386	15.240	15.240	15.823	17.399	18.450
PROPOSED LEVELS	38.044	33.789	29.535	25.366	21.727	21.058	19.830					

SECTION C
SCALE: H 1:1000, V 1:1000

- FINAL PROFILE
- EXISTING PROFILE
- 1970 TOPO PROFILE
- TORPOINT FORMATION
- LANDFILL WASTE

A3

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Client: **Tamar Valley Projects Ltd**

Drawing Status: **For Information**

Job Title: **Eales Farm Landfill**

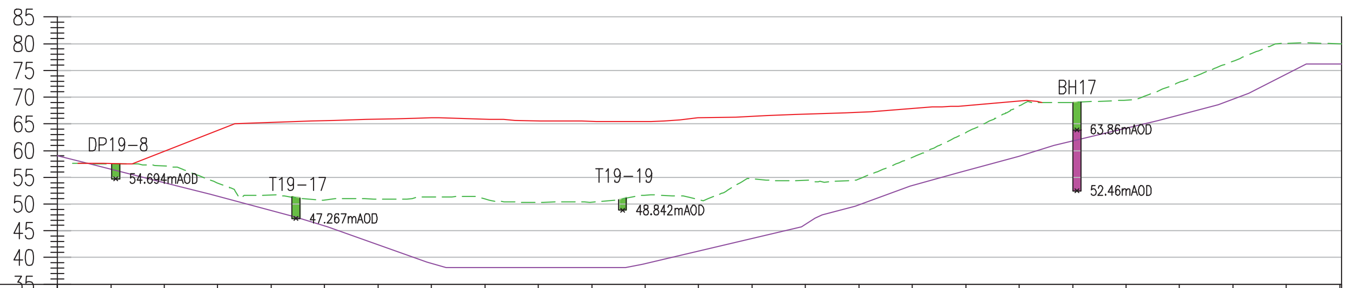
Dwg Title: **Cross Section C**

Scale: 1:1000 at A3 | Drawn: RA
Date: APR 2021 | Checked: DLJ

Drawing no: **GCE00692-A20-Fig4**

Rev: -

A3



CHAINAGE	00.000	10.000	20.000	30.000	40.000	50.000	60.000	70.000	80.000	90.000	100.000	110.000	120.000	130.000	140.000	150.000	160.000	170.000	180.000	190.000	200.000	210.000	220.000	230.000	240.000
EXISTING LEVELS		57.514	57.095	53.951	51.696	50.766	50.891	51.297	50.966	50.280	50.351	51.675	50.802	54.696	54.435	54.702	58.732	63.371	68.365	69.002	69.430	72.761	76.701	80.063	80.012
1970 LEVELS	59.046	56.513	53.984	51.439	48.780	45.903	42.387	38.892	38.100	38.100	38.100	38.854	41.197	43.541	46.180	49.886	53.463	56.207	58.951	61.805	64.215	66.698	69.635	74.310	76.200
PROPOSED LEVELS		57.569	59.856	63.743	65.247	65.601	65.911	66.103	65.898	65.577	65.490	65.457	66.147	66.420	66.802	67.145	67.834	68.437	69.283						

SECTION D PV – (214)
SCALE: H 1:1000, V 1:1000

FINAL PROFILE
EXISTING PROFILE
1970 TOPO PROFILE
TORPOINT FORMATION
LANDFILL WASTE

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Client: **Tamar Valley Projects Ltd**

Drawing Status: **For Information**

Job Title: **Eales Farm Landfill**

Dwg Title: **Cross Section D**

Scale: 1:1000 at A3 Drawn: RA
Date: APR 2021 Checked: DLJ

Drawing no: **GCE00692-A20-Fig5**
Rev: -

Appendix H Groundwater Monitoring Data

	BH1A	BH1B	BH2A	BH2B	BH3	BH4	BH5	BH6	BH7A	BH7B	BH9	BH10	BH11A	BH11B	BH12	BH13	BH15	BH16
Approximate level (AOD)	**70.35**	**70.35**	**68.86**	**68.86**	**70.26**	**70.61**	**66.69**	**67.69**	**69.46**	**69.46**	**40.38**	**50.53**	**44.06**	**44.06**	**48.13**	**70.2**	**69.99**	**67.05**
Response Zone (mbgl)	**1.8 - 2.7**	**7.3 - 10.4**	**2.6 - 6.8**	**11.0 - 26.0**	**2.7 - 9.85**	**3.0 - 7.7**	**2.6 - 13.6**	**3.0 - 14.65**	**2.6 - 4.1**	**7.3 - 16.8**	**2.6 - 10.6**	**2.6 - 14.35**	**2.6 - 5.35**	**8.5 - 15.2**	**2.6 - 9.0**	**1.0 - 6.5**	**1.9 - 4.9**	**2.4 - 14.4**
21/04/2016	2.35	2.82	6.72	10.00	Dry	Dry	13.54	Dry	Dry	13.36	10.26	Dry	Dry	9.40	Dry			
11/08/2016	2.44	2.66	6.30	10.03	Dry	Dry	Dry	Dry	Dry	12.50	Dry	Dry	Dry	10.74	Dry			
07/09/2016	1.78	2.31				Dry										Dry		
24/05/2017	1.54	1.96	6.44	9.47	Dry	Dry	Dry	Dry	Dry	13.1	Dry	13.95	Dry	9.21	Dry	3.08	Dry	12.84
16/08/2017	1.81	2.22	6.40	9.60	Dry	Dry	Dry	Dry	Dry	13.1	Dry	Dry	Dry	9.30	Dry	3.20	Dry	Dry
26/09/2017									Dry	12.8								
10/10/2017									Dry	12.8								
15/11/2017									Dry	13.1								
22/11/2017	1.23	1.33	6.37	9.47	Dry	2.82	13.41	14.42	4.02	13.1	Dry	Dry	Dry	9.06	Dry	6.39	4.49	13.42
13/12/2017	1.10		6.40	8.60	Dry		13.3	Dry	4.02	12.9	8.60	13.55	Dry	8.38	Dry	2.48	Dry	12.65
10/01/2018	1.00	1.08	6.37		9.82	7.72	Dry	14.49	Dry	11.8	9.45	13.33	Dry	7.77	Dry	2.22	Dry	12.15
26/02/2018	1.25	1.42	6.37	8.94	Dry	Dry	Dry	Dry	Dry	12.5	Dry	14.37	Dry	8.38	Dry	2.47		Dry
27/03/2018	1.37	1.36	6.39	8.51	Dry	Dry	13.29	14.48	Dry	12.0	8.60	13.36	Dry	7.41	Dry	3.02	Dry	12.77
26/04/2018	2.10	2.47	6.40	9.61	Dry	Dry	Dry	Dry	3.25	12.9	Dry	Dry	8.76	8.76	Dry	3.23	Dry	Dry
29/05/2018	2.58	2.58	6.40	9.84	Dry	Dry	Dry	Dry	3.70	13.1	Dry	Dry	Dry	9.45	Dry	4.06	Dry	Dry
26/06/2018	Dry	3.83	6.78	10.12	Dry	Dry	Dry	Dry	Dry	13.7	Dry	Dry	Dry	11.11	Dry	5.44	Dry	14.95
26/06/2018	Dry	3.83	6.78	10.12	Dry	Dry	Dry	Dry	Dry	13.7	Dry	Dry	Dry	11.11	Dry	5.44	Dry	14.95
18/07/2018	1.39	1.83	6.51	8.76	Dry	Dry	13.47	14.53	3.95	13.46	8.81	14.4	5.26	11.34	Dry	3.18	Dry	12.62
26/09/2018	1.55	1.94	6.74	9.67	Dry	Dry	13.49	14.51	4.00	13.4	Dry	14.04	Dry	11.31	Dry	3.39	Dry	14.95
25/10/2018	1.56	2.01	6.73	9.80	Dry	Dry	13.52	14.50	3.40	13.2	Dry	14.05	Dry	10.94	Dry	3.27	Dry	12.83
30/11/2018	1.02	1.18	6.44	6.67	8.74	Dry	13.19	14.52	3.38	10.8	8.44	11.05	Dry	7.63	9.04	2.35	Dry	10.44
14/12/2018	1.15	3.88	Dry	8.29	9.44	Dry	Dry	14.52	3.40	12.1	9.32	13.36	Dry	8.48	Dry	2.75	Dry	11.35
29/01/2019	1.20	2.03	6.70	8.84	9.47	Dry	13.42	14.50	3.35	12.5	8.83	13.35	Dry	7.84	Dry	2.74	Dry	11.35
28/02/2019	1.48	2.58	6.52	9.81	Dry	Dry	Dry	14.53	3.34	13.0	Dry	Dry	Dry	9.20	Dry	3.09	Dry	13.33
26/03/2019	1.42	2.35	6.44	9.68	9.86	Dry	13.42	14.49	3.32	12.7	Dry	13.83	Dry	8.72	9.03	2.92	Dry	13.35
30/04/2019	1.65	2.84	6.41	9.89	Dry	Dry	Dry	14.50	3.60	13.2	Dry	Dry	Dry	9.72	Dry	3.14	Dry	Dry
29/05/2019	1.84	3.00	6.37	9.94	Dry	Dry	Dry	Dry	3.38	13.3	Dry	Dry	Dry	10.80	Dry	3.82	Dry	Dry
25/06/2019	1.79	2.86	6.42	9.98	Dry	Dry	Dry	14.49	3.98	13.4	Dry	Dry	Dry	11.24	Dry	3.33	Dry	Dry
06/08/2019	2.30	2.79	6.75	10.26	Dry	0.10	WAB	WAB	WAB	13.9	Dry	Dry	Dry	11.87	Dry	3.96	Dry	Dry
27/11/2019	1.50	1.59	Dry	6.78	8.98	Dry	13.4	14.96	4.40	11.5	8.78	12.59	Dry	7.51	Dry	2.41	Dry	11.41
19/02/2020	1.57	1.64	6.80	7.70	10.01	6.70	13.28	14.95	4.10	10.8	8.88	11.85	Dry	7.94	WAB	2.76	WAB	12.15
18/03/2020																		

	B19-1	B19-2	B19-3	B19-4	B19-5a	B19-5b	B19-5c	B19-5d	B19-6	B19-7a	B19-7b	B19-7c	B19-7d	B19-8a	B19-8b	B19-9a	B19-9b	B19-9c	B19-d
Approximate level (AOD)	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC
Response Zone (mbgl)	13 - 18	9.2 - 15	Oct-15	16.5 - 18.6	27.5 - 28.3	13 - 14	8.6 - 9.55	3.5 - 4.6	16 - 18	26.3 - 27.3	18.7-16.7	13 - 14	2 - 3	11.2 - 13.65	3.4 - 4.5	18 - 19.1	11.6 - 12.4	9.4 - 10.4	5.4 - 6.4
21/04/2016																			
11/08/2016																			
07/09/2016																			
24/05/2017																			
16/08/2017																			
26/09/2017																			
10/10/2017																			
15/11/2017																			
22/11/2017																			
13/12/2017																			
10/01/2018																			
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26/03/2019																			
30/04/2019																			
29/05/2019																			
25/06/2019																			
06/08/2019																			
27/11/2019																			
19/02/2020																			
18/03/2020	6.82	3.59	1.17	11.97	19.61	Dry	Dry	Dry	13.12	18.62	16.92	Dry	3.32	8.21	Dry	15.83	Dry	Dry	6.6

	MBH1A	MBH1B	MBH2A	MBH2B	MBH3	MBH4	MBH5	MBH6	MBH7A	MBH7B	MBH9	MBH10	MBH11A	MBH11B	MBH12	MBH13	MBH15	MBH16
Approximate level (AOD)	**70.35**	**70.35**	**68.86**	**68.86**	**70.26**	**70.61**	**66.69**	**67.69**	**69.46**	**69.46**	**40.38**	**50.53**	**44.06**	**44.06**	**48.13**	**70.2**	**69.99**	**67.05**
Response Zone (mbgl)	**1.8 - 2.7**	**7.3 - 10.4**	**2.6 - 6.8**	**11.0 - 26.0**	**2.7 - 9.85**	**3.0 - 7.7**	**2.6 - 13.6**	**3.0 - 14.65**	**2.6 - 4.1**	**7.3 - 16.8**	**2.6 - 10.6**	**2.6 - 14.35**	**2.6 - 5.35**	**8.5 - 15.2**	**2.6 - 9.0**	**1.0 - 6.5**	**1.9 - 4.9**	**2.4 - 14.4**
21/04/2016	68.00	67.53	62.14	58.86			53.15			56.1	30.12			34.66				
11/08/2016	67.91	67.69	62.56	58.83						56.96				33.32				
07/09/2016	68.57	68.04																
24/05/2017	68.81	68.39	62.42	59.39						56.36		36.58		34.85		67.12		54.21
16/08/2017	68.54	68.13	62.46	59.26						56.32				34.76		67		
26/09/2017										56.66								
10/10/2017										56.62								
15/11/2017										56.35								
22/11/2017	69.12	69.02	62.49	59.39		67.79	53.28	53.27	65.44	56.38				35		63.81	65.5	53.63
13/12/2017	69.25	70.35	62.46	60.26		70.61	53.39		65.44	56.52	31.78	36.98		35.68		67.72		54.4
10/01/2018	69.35	69.27	62.49	68.86	60.44	62.89		53.2		57.62	30.93	37.2		36.29		67.98		54.9
26/02/2018	69.10	68.93	62.49	59.92						57		36.16		35.68		67.73	69.99	
27/03/2018	68.98	68.99	62.47	60.35			53.40	53.21		57.47	31.78	37.17		36.65		67.18		54.28
26/04/2018	68.25	67.88	62.46	59.25					66.21	56.58			35.3	35.3		66.97		
29/05/2018	67.77	67.77	62.46	59.02					65.76	56.32				34.61		66.14		
26/06/2018		66.52	62.08	58.74						55.72				32.95		64.76		52.1
26/06/2018		66.52	62.08	58.74						55.72				32.95		64.76		52.1
18/07/2018	68.96	68.52	62.35	60.10			53.22	53.16	65.51	56	31.57	36.14	38.8	32.72		67.02		54.43
26/09/2018	68.80	68.41	62.12	59.19			53.20	53.18	65.46	56.07		36.49		32.75		66.81		52.1
25/10/2018	68.79	68.34	62.13	59.06			53.17	53.19	66.06	56.245		36.48		33.12		66.93		54.22
30/11/2018	69.33	69.17	62.42	62.19	61.52		53.50	53.17	66.08	58.62	31.94	39.48		36.43	39.09	67.85		56.61
14/12/2018	69.20	66.47		60.57	60.82			53.17	66.06	57.33	31.06	37.17		35.58		67.45		55.7
29/01/2019	69.15	68.32	62.16	60.02	60.79		53.27	53.19	66.11	56.95	31.55	37.18		36.22		67.46		55.7
28/02/2019	68.87	67.77	62.34	59.05				53.16	66.12	56.5				34.86		67.11		53.72
26/03/2019	68.93	68.00	62.42	59.18	60.4		53.27	53.2	66.14	56.78		36.7		35.34	39.1	67.28		53.7
30/04/2019	68.70	67.51	62.45	58.97				53.19	65.86	56.28				34.34		67.06		
29/05/2019	68.51	67.35	62.49	58.92					66.08	56.12				33.26		66.38		
25/06/2019	68.56	67.49	62.44	58.88				53.2	65.48	56.11				32.82		66.87		
06/08/2019	68.05	67.56	62.11	58.60		70.71				55.57				32.19		66.24		
27/11/2019	68.85	68.76		62.08	61.28		53.29	52.73	65.06	57.96	31.6	37.94		36.55		67.79		55.64
19/02/2020	68.78	68.71		61.16	60.25	63.91	53.41	52.74	65.36	58.62	31.5	38.68		36.12		67.44		54.9

Appendix I Permeability Test Data

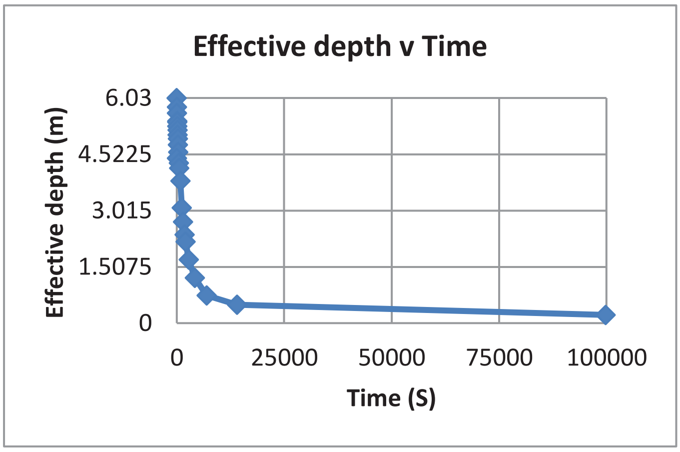
Date:	06/06/2017
Soakaway Test:	
Hole ID	BH2B
Test No.	1

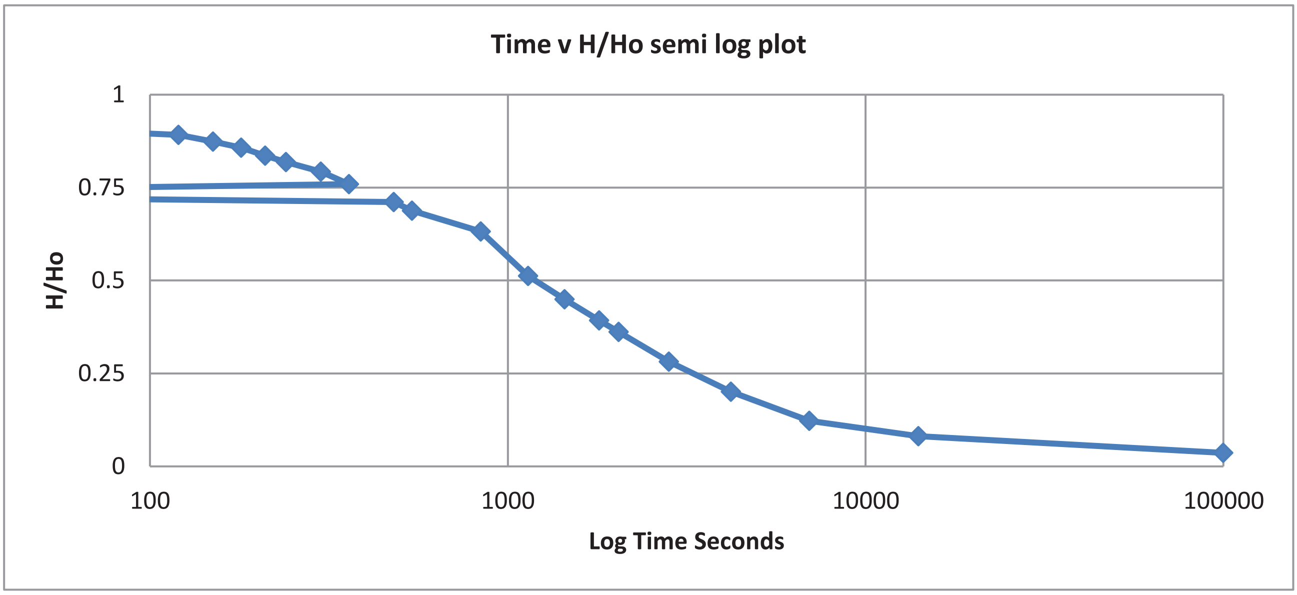
Dimensions:		
Radius	0.05	m
Depth	9.39	m
Start water depth	3.36	m
Effective Depth	6.03	m

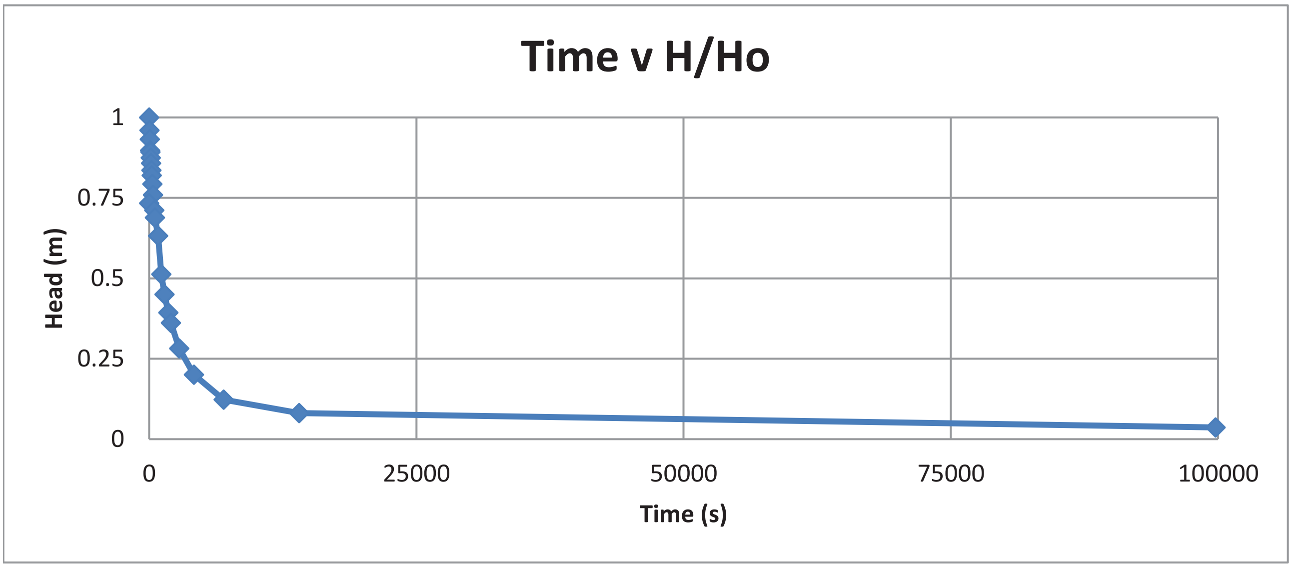
Time	Time	Seconds	Depth (m)	Effect Depth	Head	Seconds	H/Ho
06 June 2017	42892.476	0	3.36	6.03	6.03	0	1
06 June 2017	42892.477	30	3.6	5.79	5.79	30	0.960199
06 June 2017	42892.477	60	3.77	5.62	5.62	60	0.932007
06 June 2017	42892.477	90	3.98	5.41	5.41	90	0.897181
06 June 2017	42892.478	120	4.01	5.38	5.38	120	0.892206
06 June 2017	42892.478	150	4.12	5.27	5.27	150	0.873964
06 June 2017	42892.478	180	4.22	5.17	5.17	180	0.85738
06 June 2017	42892.479	210	4.35	5.04	5.04	210	0.835821
06 June 2017	42892.479	240	4.45	4.94	4.94	240	0.819237
06 June 2017	42892.480	300	4.61	4.78	4.78	300	0.792703
06 June 2017	42892.481	360	4.81	4.58	4.58	360	0.759536
06 June 2017	42892.481	4.45	4.97	4.42	4.42	4.45	0.733002
06 June 2017	42892.482	480	5.1	4.29	4.29	480	0.711443
06 June 2017	42892.483	540	5.24	4.15	4.15	540	0.688226
06 June 2017	42892.486	840	5.58	3.81	3.81	840	0.631841
06 June 2017	42892.490	1140	6.3	3.09	3.09	1140	0.512438
06 June 2017	42892.493	1440	6.68	2.71	2.71	1440	0.44942
06 June 2017	42892.497	1800	7.02	2.37	2.37	1800	0.393035
06 June 2017	42892.500	2040	7.21	2.18	2.18	2040	0.361526
06 June 2017	42892.509	2820	7.69	1.7	1.7	2820	0.281924
06 June 2017	42892.525	4200	8.18	1.21	1.21	4200	0.200663
06 June 2017	42892.557	6960	8.65	0.74	0.74	6960	0.12272
06 June 2017	42892.639	14040	8.9	0.49	0.49	14040	0.08126
07 June 2017	42893.631	99780	9.17	0.22	0.22	99780	0.036484

Effective Depth (%)	Depth (m)	Time (s)
75	4.5225	400
25	1.5075	3200
	Vp75-25	tp75-25
Total Volume	0.02367975	2800
Base Area	0.00785398	m2
Side Area	1.89438037	m

Total Area	1.90223435	m2
Infiltration Rate	**4.45E-06**	**m/s**




Time v H/Ho semi log plot
H/Ho
1
0.75
0.5
0.25
0
100
1000
10000
100000
Log Time Seconds

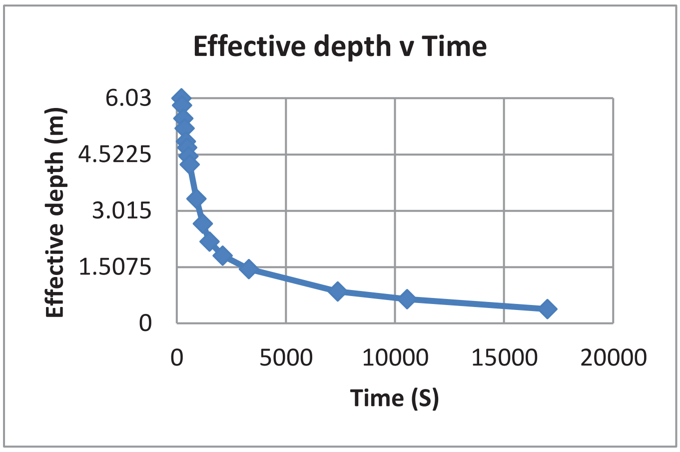

Time v H/Ho
Head (m)
1
0.75
0.5
0.25
0
0
25000
50000
75000
100000
Time (s)

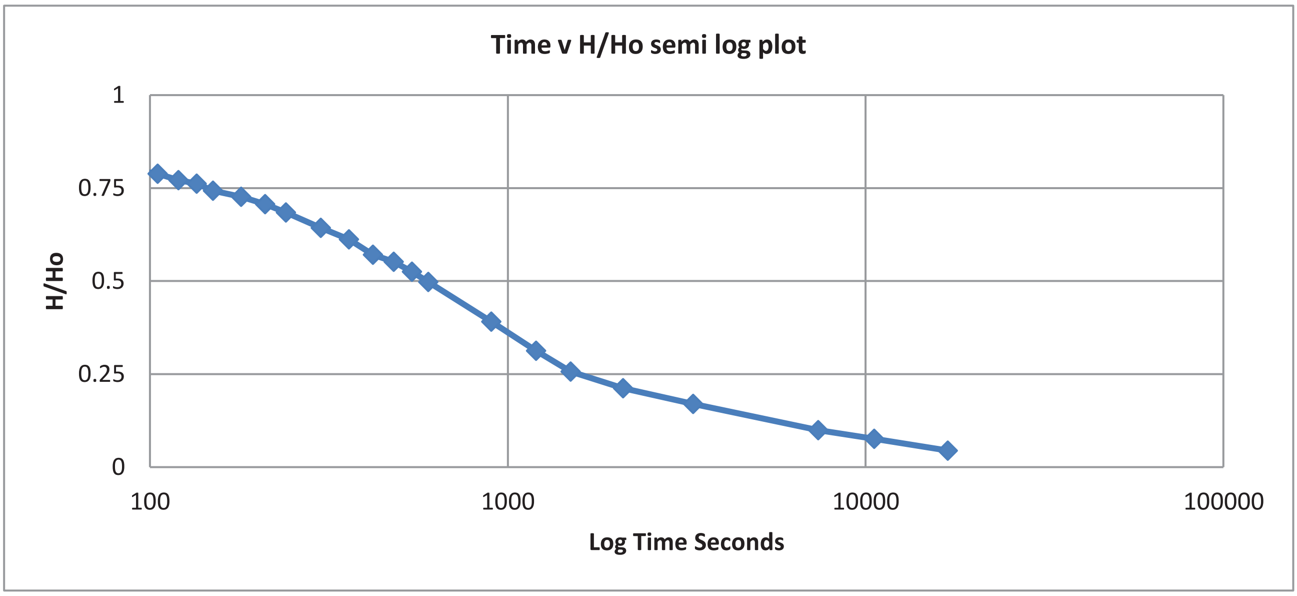
Date:	16/08/2017	
Soakaway Test:		
Hole ID	MBH11B	
Test No.	1	
Dimensions:		
Radius	0.05	m
Depth	9.78	m
Start water depth	1.25	m
Effective Depth	8.53	m

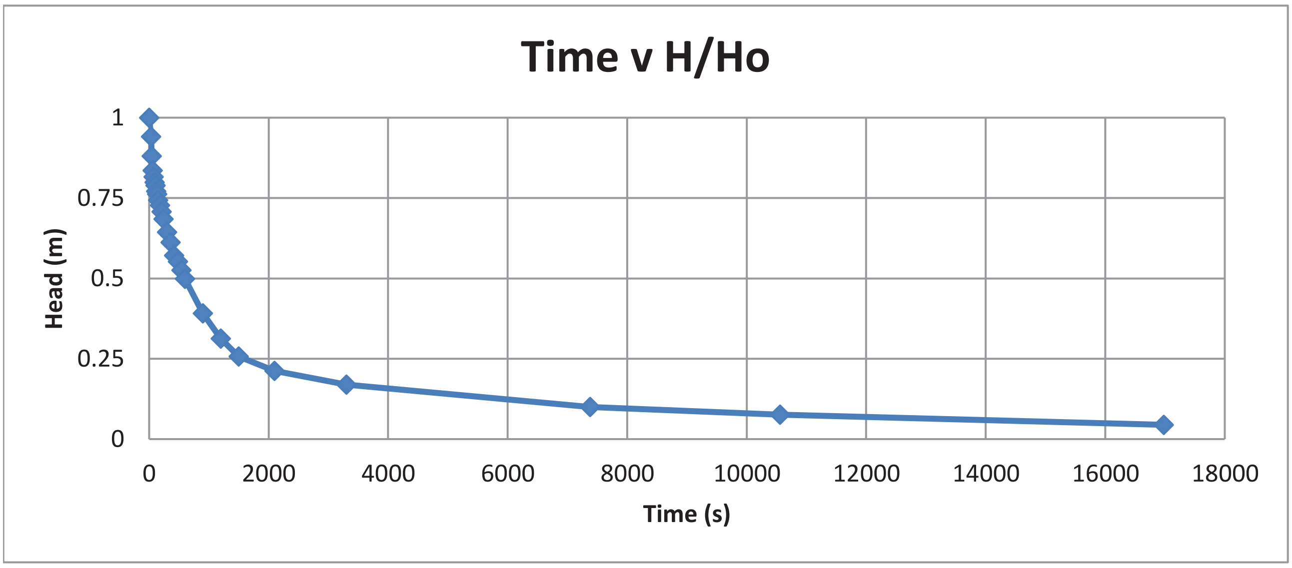
Time	Time	Seconds	Depth (m)	Effect Depth	Head	Seconds	H/Ho
00:00:15	0.00	0	1.25	8.53	8.53	0	1
00:00:30	30.00	30.00	1.75	8.03	8.03	30	0.941383
00:00:45	45.00	45.00	2.27	7.51	7.51	45	0.880422
00:01:00	60.00	60.00	2.65	7.13	7.13	60	0.835873
00:01:15	75.00	75.00	2.82	6.96	6.96	75	0.815944
00:01:30	90.00	90.00	2.97	6.81	6.81	90	0.798359
00:01:45	105.00	105.00	3.05	6.73	6.73	105	0.78898
00:02:00	120.00	120.00	3.2	6.58	6.58	120	0.771395
00:02:15	135.00	135.00	3.28	6.5	6.5	135	0.762016
00:02:30	150.00	150.00	3.44	6.34	6.34	150	0.743259
00:03:00	180.00	180.00	3.58	6.2	6.2	180	0.726846
00:03:30	210.00	210.00	3.75	6.03	6.03	210	0.706917
00:04:00	240.00	240.00	3.94	5.84	5.84	240	0.684642
00:05:00	300.00	300.00	4.29	5.49	5.49	300	0.643611
00:06:00	360.00	360.00	4.56	5.22	5.22	360	0.611958
00:07:00	420.00	420.00	4.91	4.87	4.87	420	0.570926
00:08:00	480.00	480.00	5.07	4.71	4.71	480	0.552169
00:09:00	540.00	540.00	5.3	4.48	4.48	540	0.525205
00:10:00	600.00	600.00	5.53	4.25	4.25	600	0.498242
00:15:00	900.00	900.00	6.44	3.34	3.34	900	0.391559
00:20:00	1200.00	1200.00	7.11	2.67	2.67	1200	0.313013
00:25:00	1500.00	1500.00	7.59	2.19	2.19	1500	0.256741
00:35:00	2100.00	2100.00	7.97	1.81	1.81	2100	0.212192
00:55:00	3300.00	3300.00	8.33	1.45	1.45	3300	0.169988
02:03:00	7380.00	7380.00	8.93	0.85	0.85	7380	0.099648
02:56:00	10560.00	10560.00	9.13	0.65	0.65	10560	0.076202
04:43:00	16980.00	16980.00	9.4	0.38	0.38	16980	0.044549

Effective Depth (%)	Depth (m)	Time (s)
75	6.3975	180
25	2.1325	1600
	Vp75-25	tp75-25
Total Volume	0.03349723	1420
Base Area	0.00785398	m2
Side Area	2.67977853	m

Total Area	2.68763252	m2
Infiltration Rate	**8.78E-06**	**m/s**



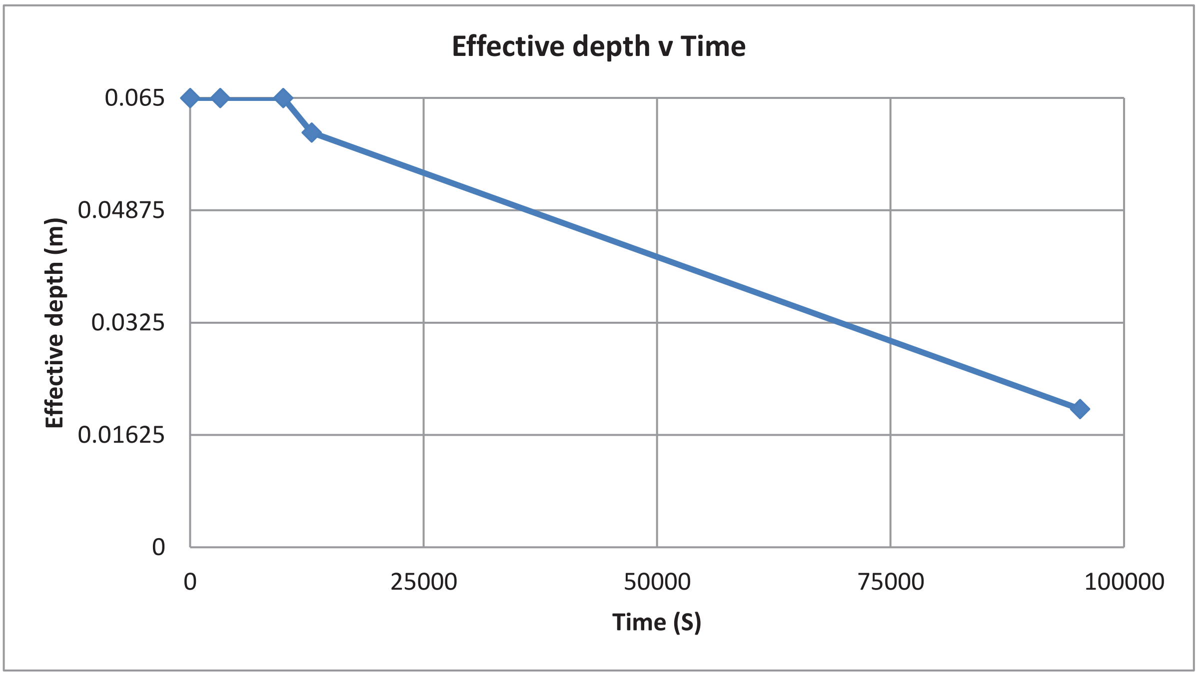


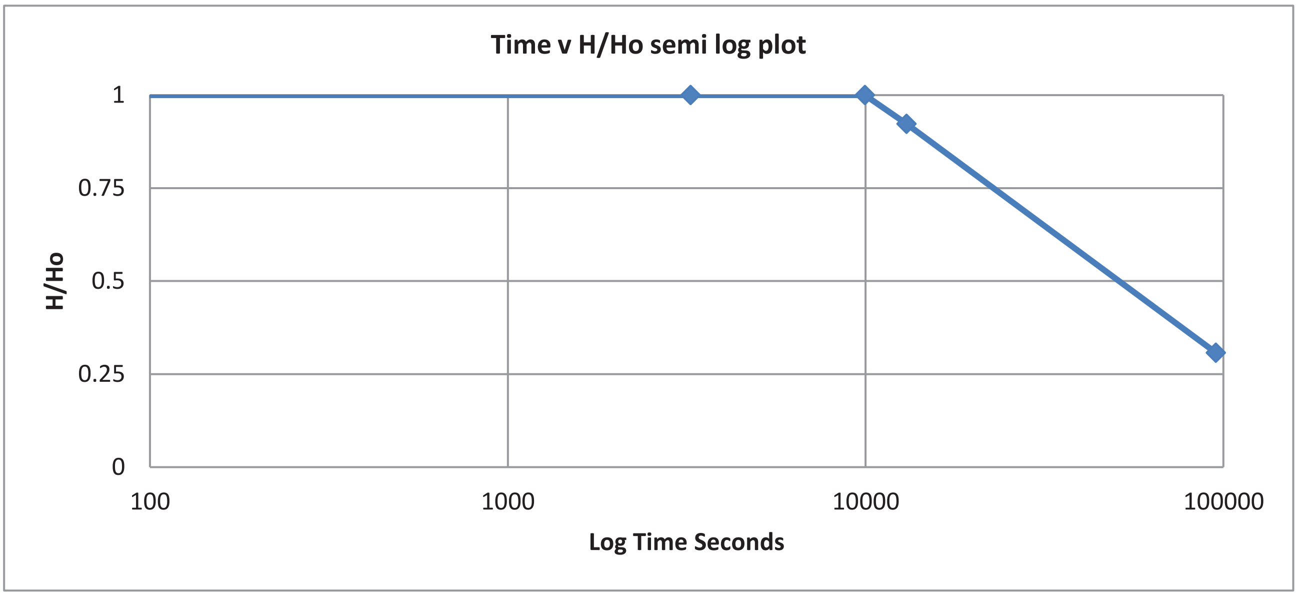


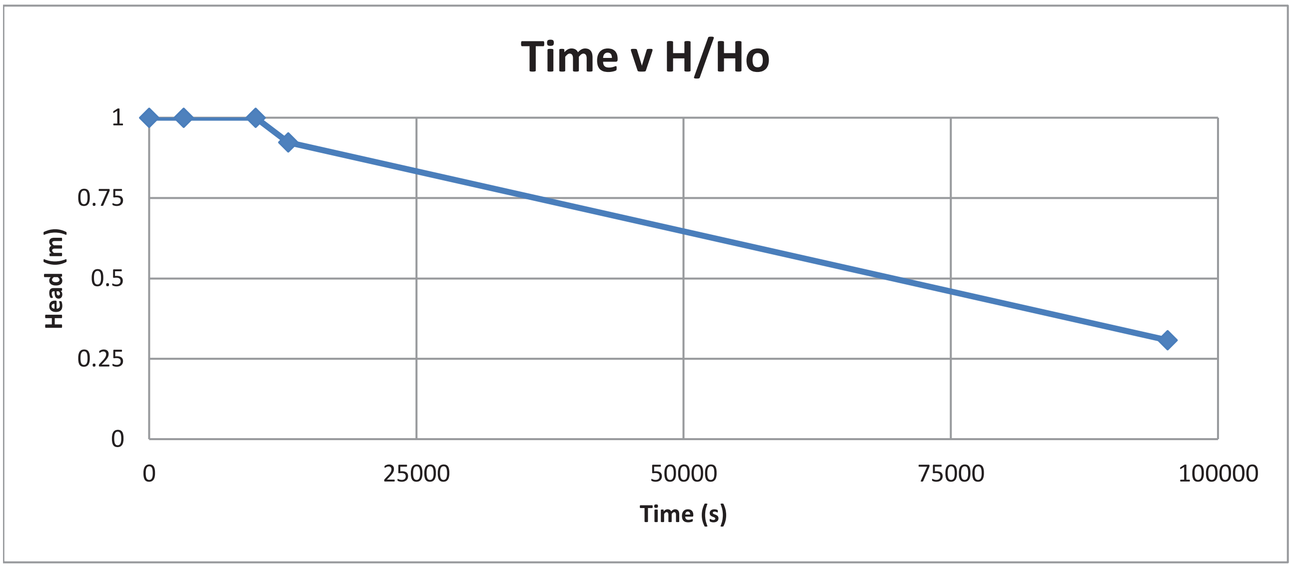
Date:	06/06/2017	
Soakaway Test:		
Hole ID	SA1	
Test No.	1	
Dimensions:		
Radius	0.1	m
Depth	0.45	m
Start water depth	0.385	m
Effective Depth	0.065	m

Time	**Time**	**Seconds**	**Depth (m)**	**Effect Depth**	**Head**	**Seconds**	**H/Ho**
06 June 2017	42892.522	0	0.385	0.065	0.065	0	1
06 June 2017	42892.559	3240	0.385	0.065	0.065	3240	1
06 June 2017	42892.637	9960	0.385	0.065	0.065	9960	1
06 June 2017	42892.672	13020	0.39	0.06	0.06	13020	0.923077
07 June 2017	42893.624	95280	0.43	0.02	0.02	95280	0.307692

Effective Depth (%)	**Depth (m)**	**Time (s)**
75	0.04875	
25	0.01625	
	Vp75-25	tp75-25
Total Volume	0.00102102	0
Base Area	0.03141593	m2
Side Area	0.0408407	m
Total Area	0.07225663	m2
Infiltration Rate		**m/s**



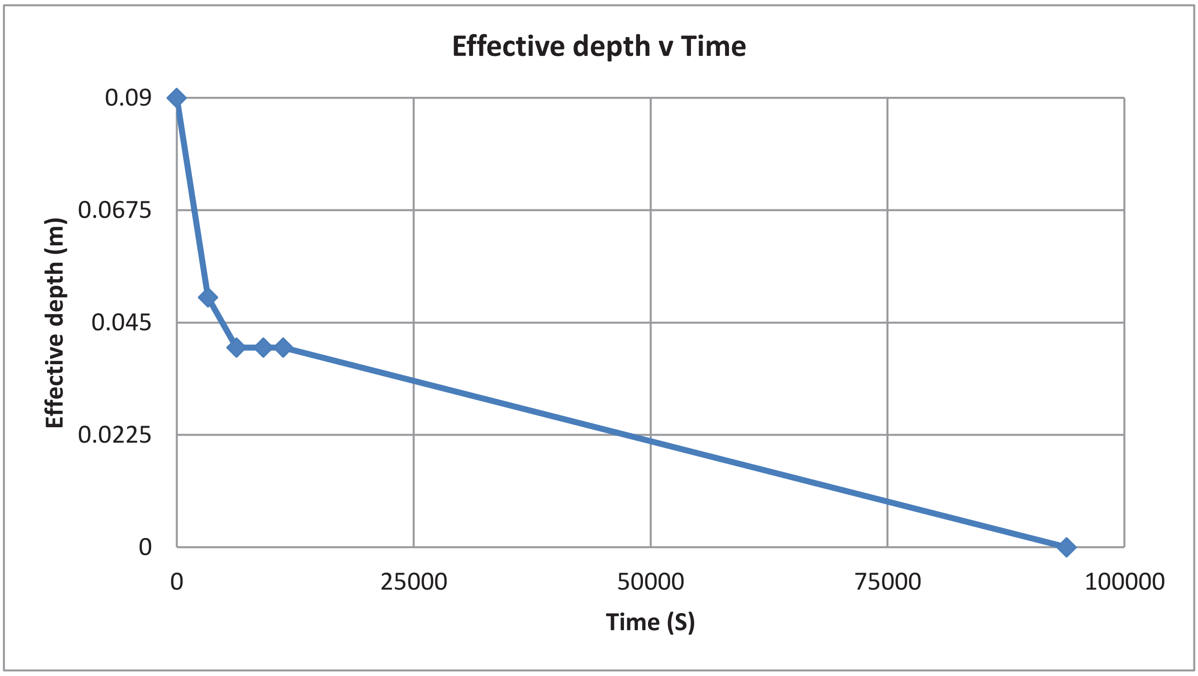

Time v H/Ho semi log plot
H/Ho
1
0.75
0.5
0.25
0
100
1000
10000
100000
Log Time Seconds

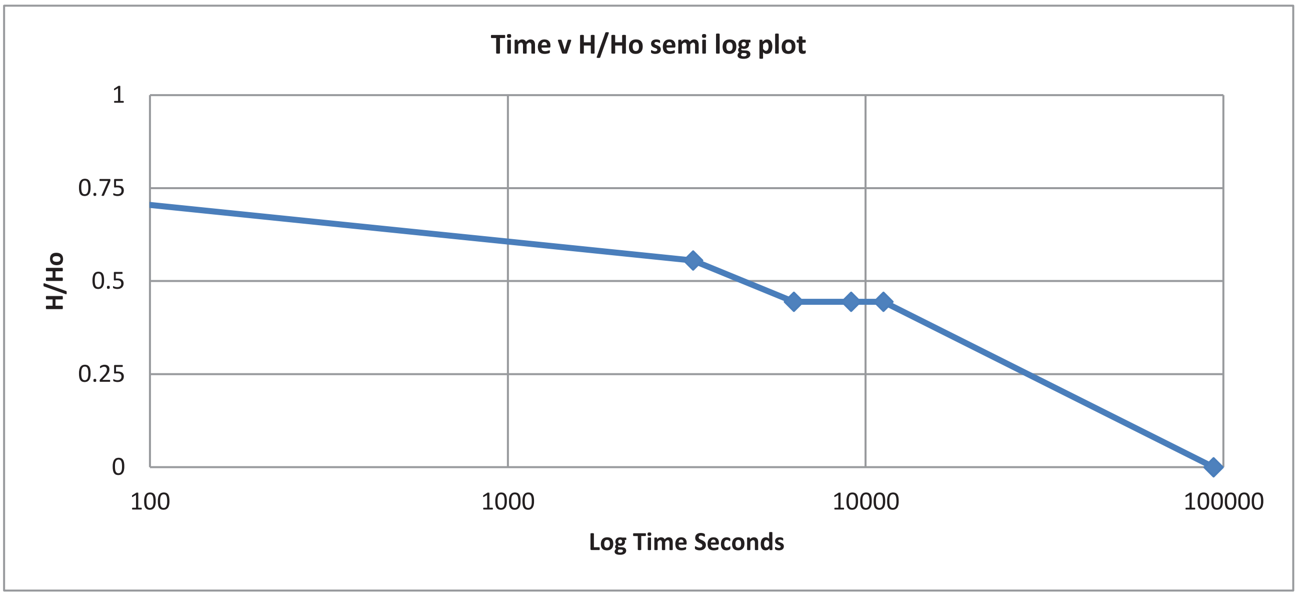

Time v H/Ho
Head (m)
1
0.75
0.5
0.25
0
0
25000
50000
75000
100000
Time (s)

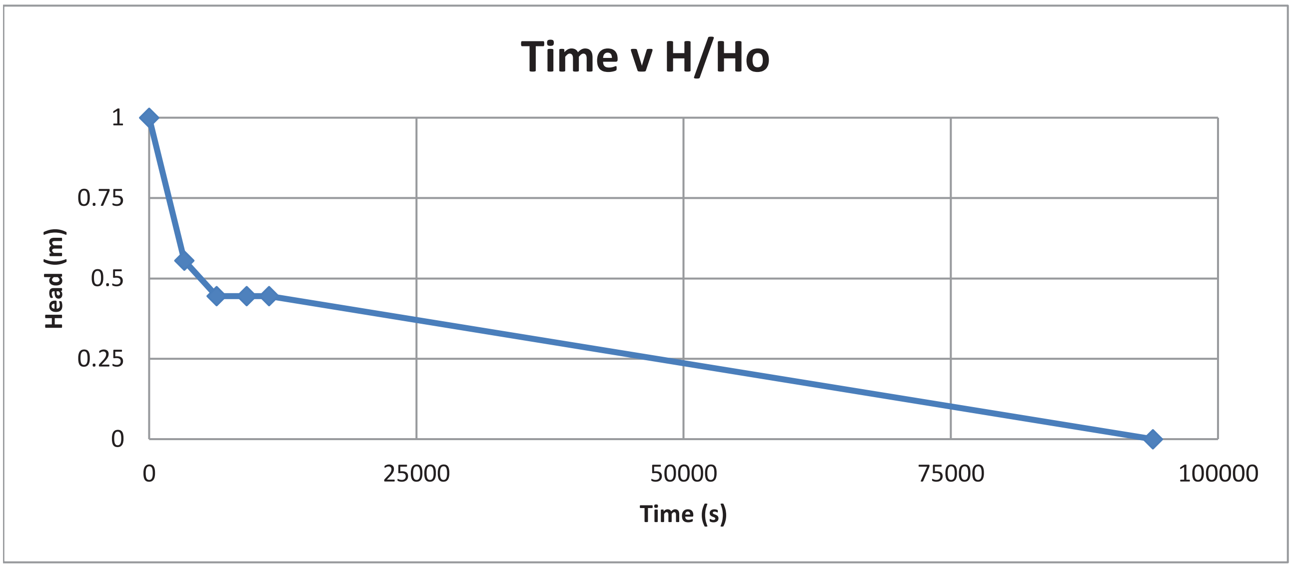
Date:	06/06/2017	
Soakaway Test:		
Hole ID	SA2	
Test No.	1	
Dimensions:		
Radius	0.1	m
Depth	0.44	m
Start water depth	0.35	m
Effective Depth	0.09	m

Time	Time	Seconds	Depth (m)	Effect Depth	Head	Seconds	H/Ho
06 June 2017	42892.540	0	0.35	0.09	0.09	0	1
06 June 2017	42892.578	3300	0.39	0.05	0.05	3300	0.555556
06 June 2017	42892.613	6300	0.4	0.04	0.04	6300	0.444444
06 June 2017	42892.646	9120	0.4	0.04	0.04	9120	0.444444
06 June 2017	42892.670	11220	0.4	0.04	0.04	11220	0.444444
07 June 2017	42893.627	93900	0.44	0	0	93900	0

Effective Depth (%)	Depth (m)	Time (s)
75	0.0675	2000
25	0.0225	48000
	Vp75-25	tp75-25
Total Volume	0.00141372	46000
Base Area	0.03141593	m2
Side Area	0.05654867	m
Total Area	0.08796459	m2
Infiltration Rate	**3.49E-07**	**m/s**



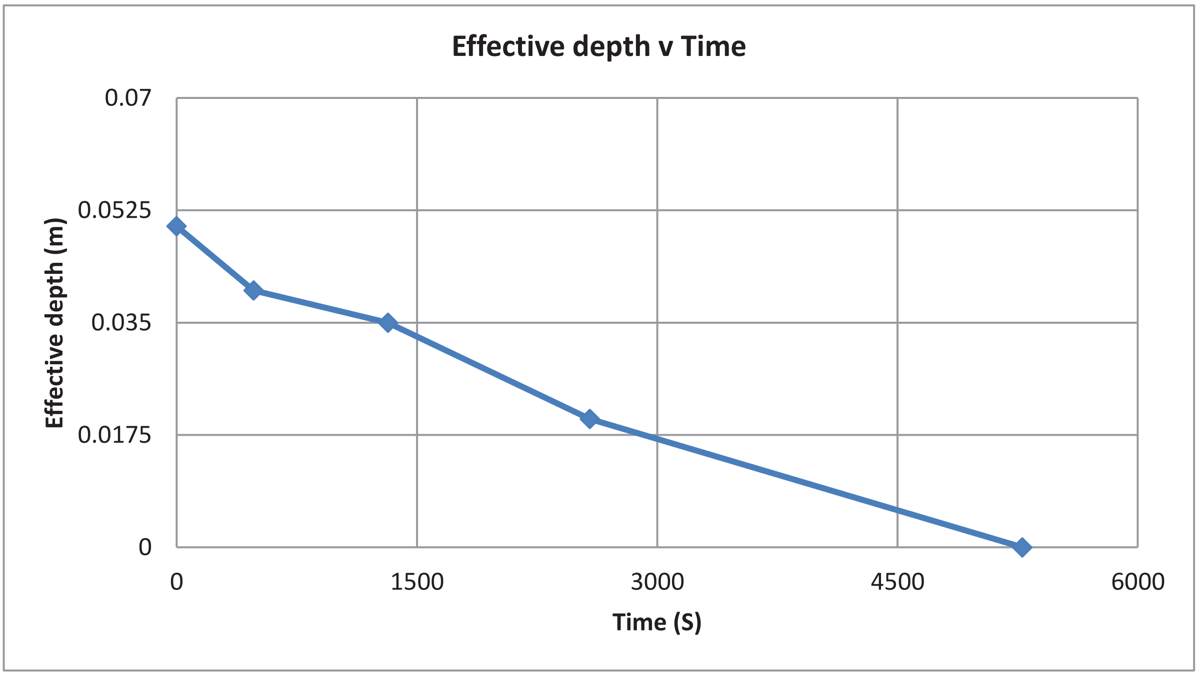

Time v H/Ho semi log plot
H/Ho
1
0.75
0.5
0.25
0
100
1000
10000
100000
Log Time Seconds

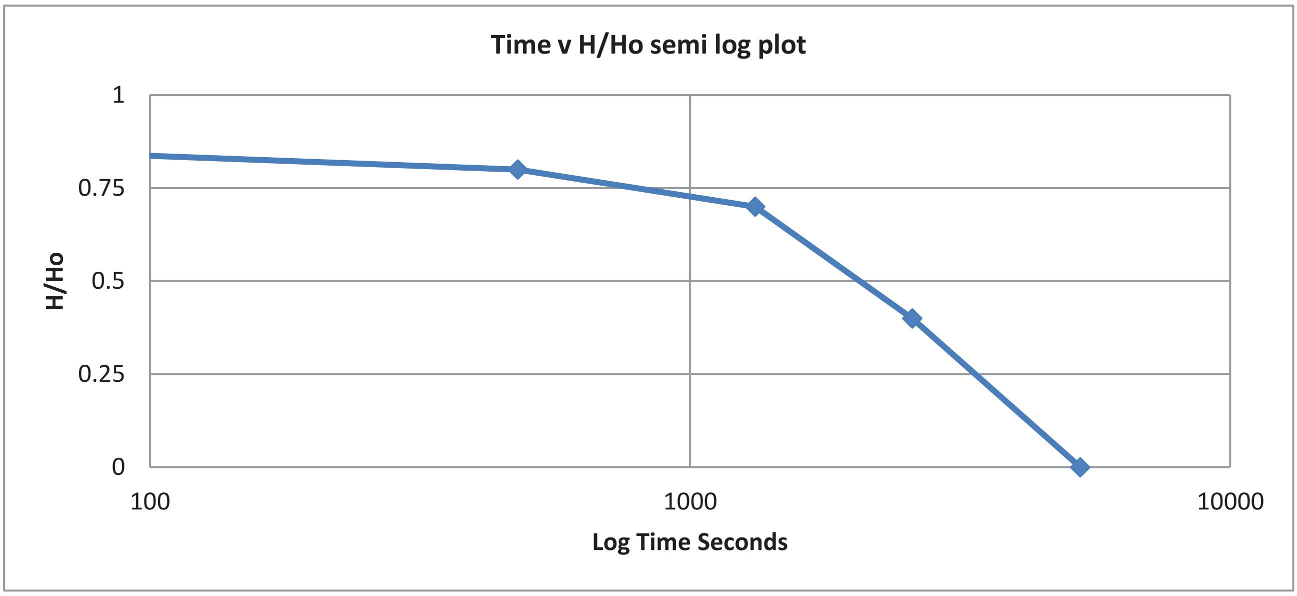

Time v H/Ho
Head (m)
1
0.75
0.5
0.25
0
0
25000
50000
75000
100000
Time (s)

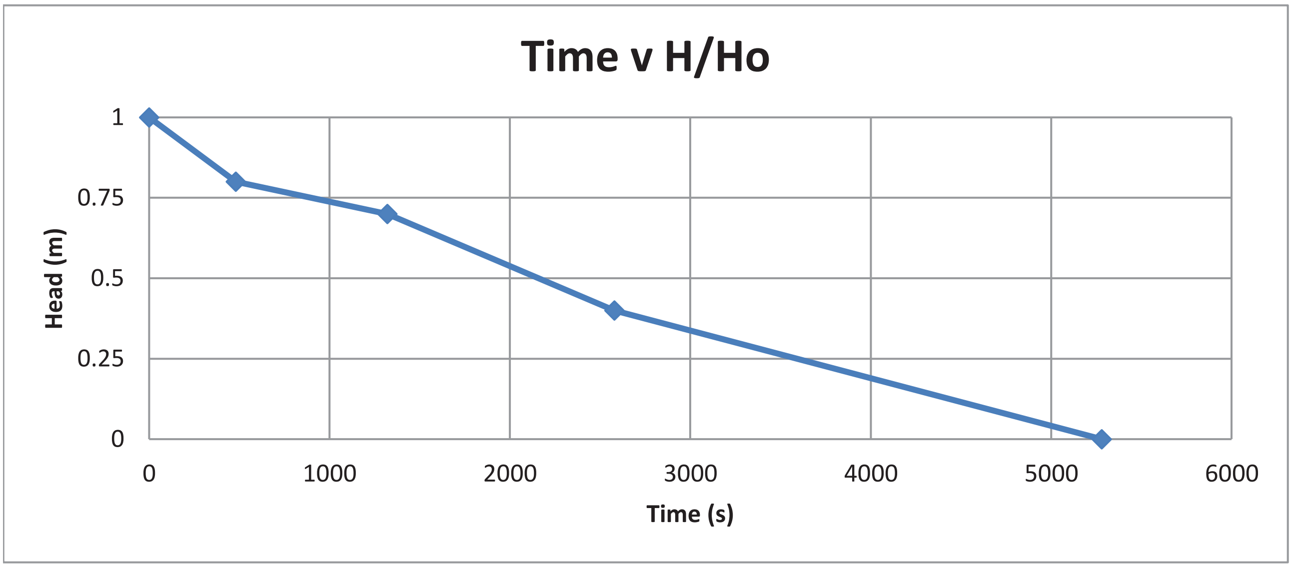
Date:	06/06/2017	
Soakaway Test:		
Hole ID	SA3	
Test No.	1	
Dimensions:		
Radius	0.1	m
Depth	0.42	m
Start water depth	0.35	m
Effective Depth	0.07	m

Time	Time	Seconds	Depth (m)	Effect Depth	Head	Seconds	H/Ho
06 June 2017	42892.549	0	0.37	0.05	0.05	0	1
06 June 2017	42892.554	480	0.38	0.04	0.04	480	0.8
06 June 2017	42892.564	1320	0.385	0.035	0.035	1320	0.7
06 June 2017	42892.578	2580	0.4	0.02	0.02	2580	0.4
06 June 2017	42892.610	5280	0.42	0	0	5280	0

Effective Depth (%)	Depth (m)	Time (s)
75	0.0525	900
25	0.0175	3600
	Vp75-25	tp75-25
Total Volume	0.00109956	2700
Base Area	0.03141593	m2
Side Area	0.0439823	m
Total Area	0.07539822	m2
Infiltration Rate	**5.40E-06**	**m/s**



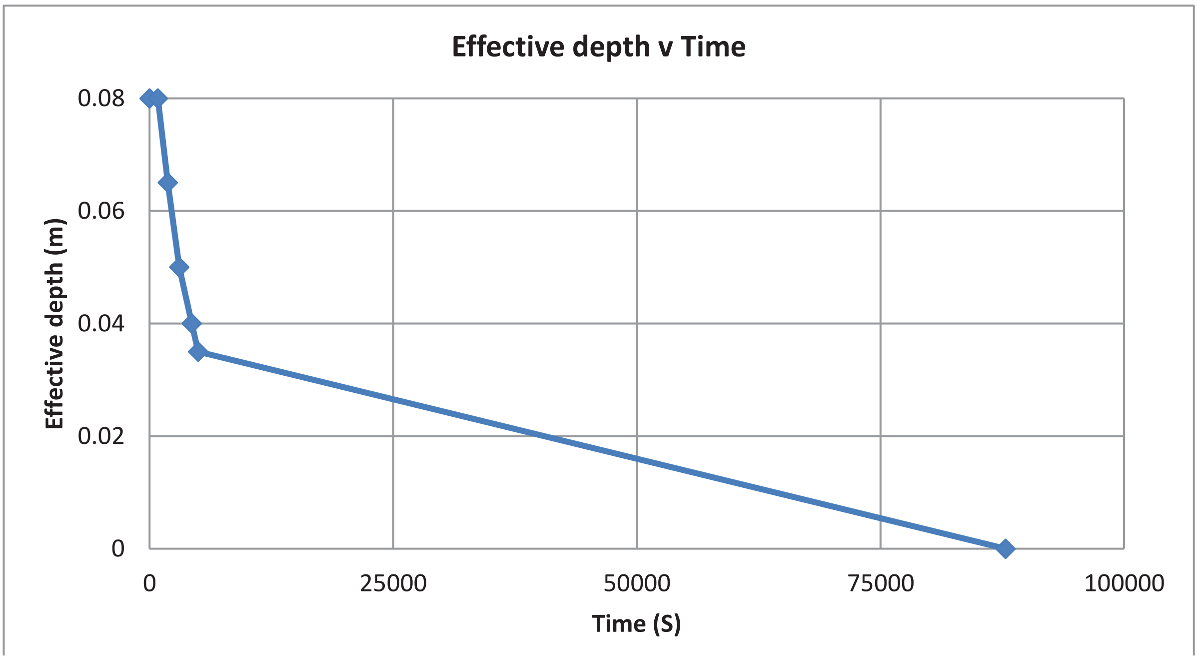

Time v H/Ho semi log plot
H/Ho
1
0.75
0.5
0.25
0
100
1000
10000
Log Time Seconds

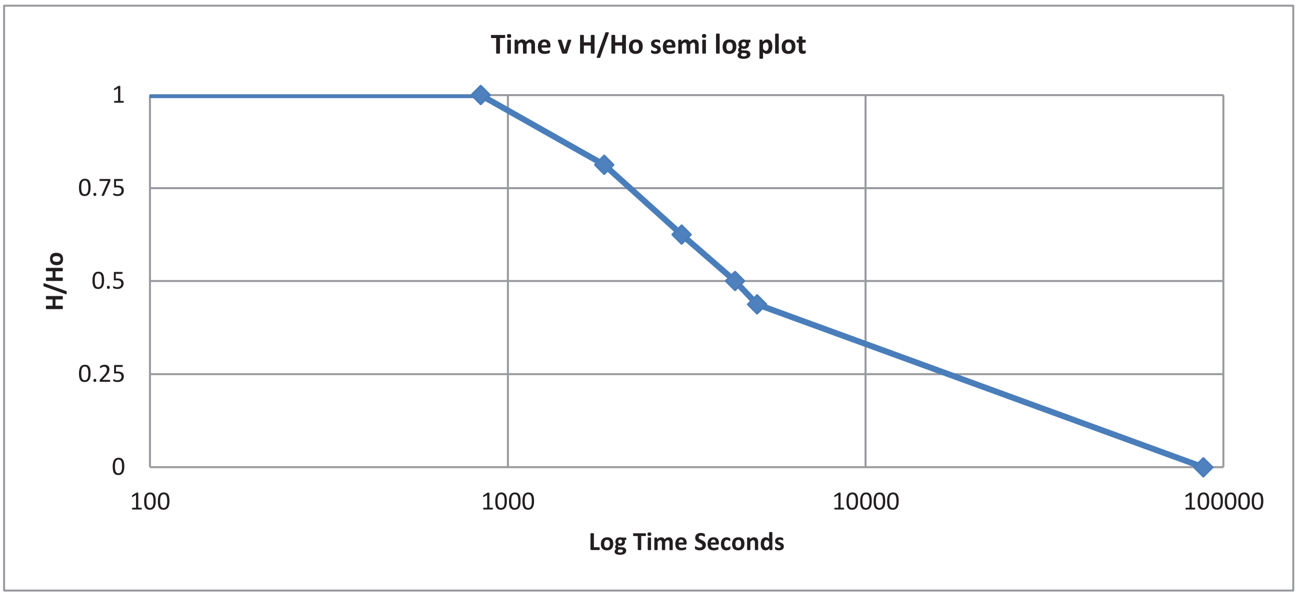

Time v H/Ho
Head (m)
1
0.75
0.5
0.25
0
0
1000
2000
3000
4000
5000
6000
Time (s)

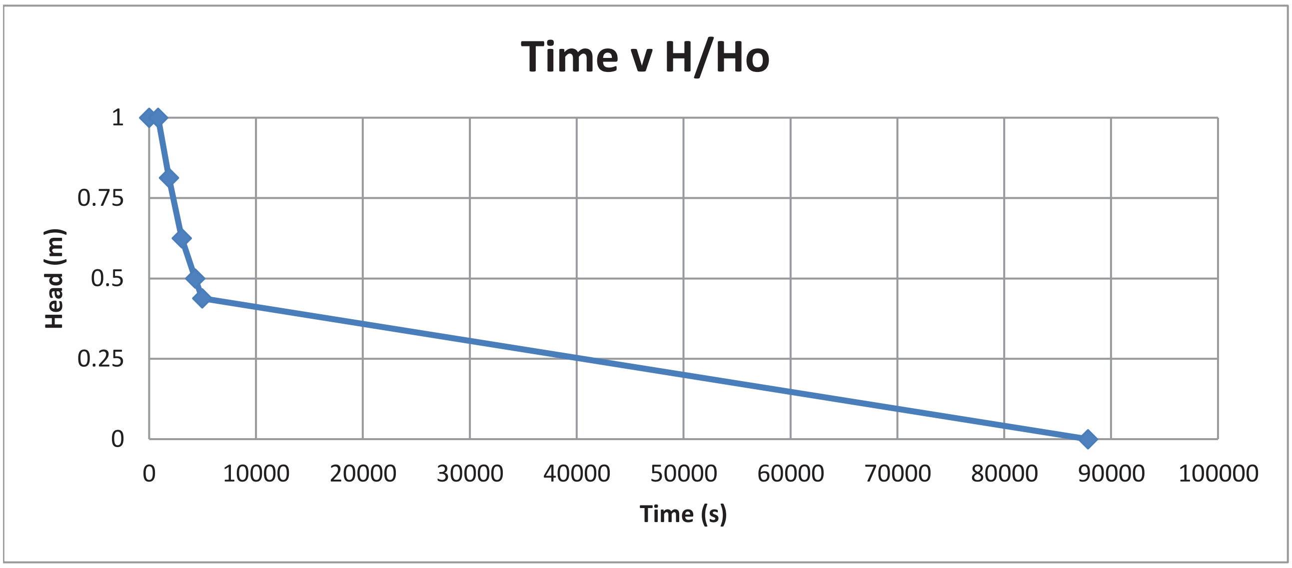
Date:	06/06/2017	
Soakaway Test:		
Hole ID	SA4	
Test No.	2	
Dimensions:		
Radius	0.1	m
Depth	0.42	m
Start water depth	0.34	m
Effective Depth	0.08	m

Time	Time	Seconds	Depth (m)	Effect Depth	Head	Seconds	H/Ho
06 June 2017	42892.612	0	0.34	0.08	0.08	0	1
06 June 2017	42892.622	840	0.34	0.08	0.08	840	1
06 June 2017	42892.633	1860	0.355	0.065	0.065	1860	0.8125
06 June 2017	42892.647	3060	0.37	0.05	0.05	3060	0.625
06 June 2017	42892.662	4320	0.38	0.04	0.04	4320	0.5
06 June 2017	42892.669	4980	0.385	0.035	0.035	4980	0.4375
07 June 2017	42893.628	87840	0.42	0	0	87840	0

Effective Depth (%)	Depth (m)	Time (s)
75	0.06	2500
25	0.02	40000
	Vp75-25	tp75-25
Total Volume	0.00125664	37500
Base Area	0.03141593	m2
Side Area	0.05026548	m
Total Area	0.08168141	m2
Infiltration Rate	**4.10E-07**	**m/s**



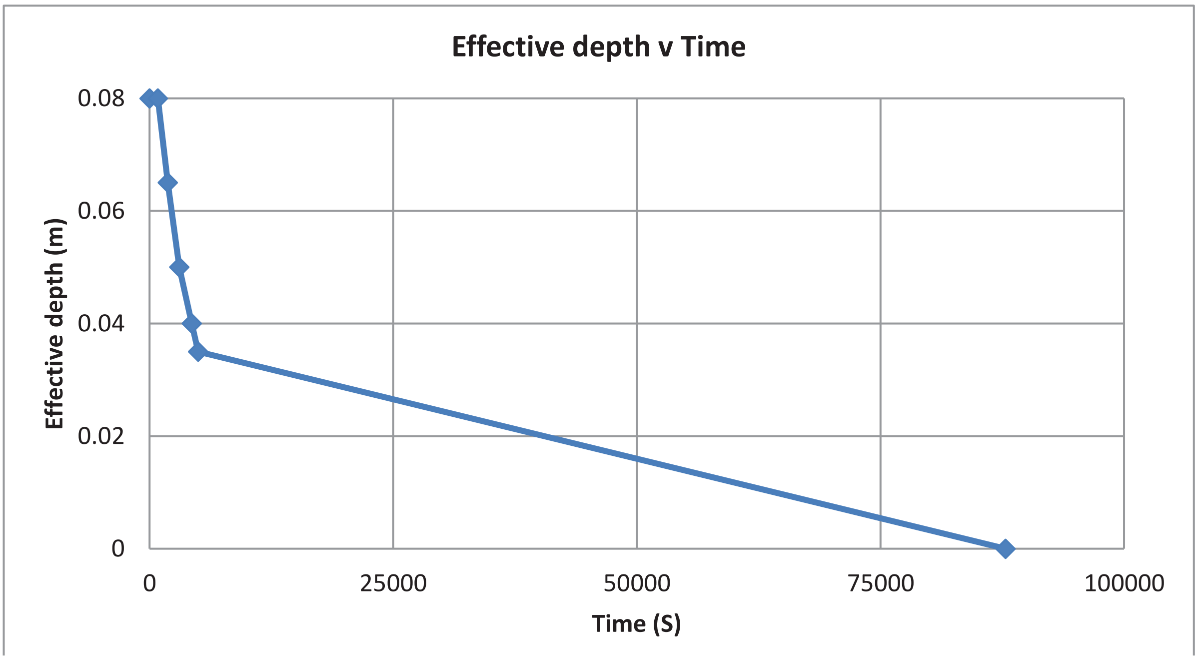

Time v H/Ho semi log plot
H/Ho
1
0.75
0.5
0.25
0
100
1000
10000
100000
Log Time Seconds

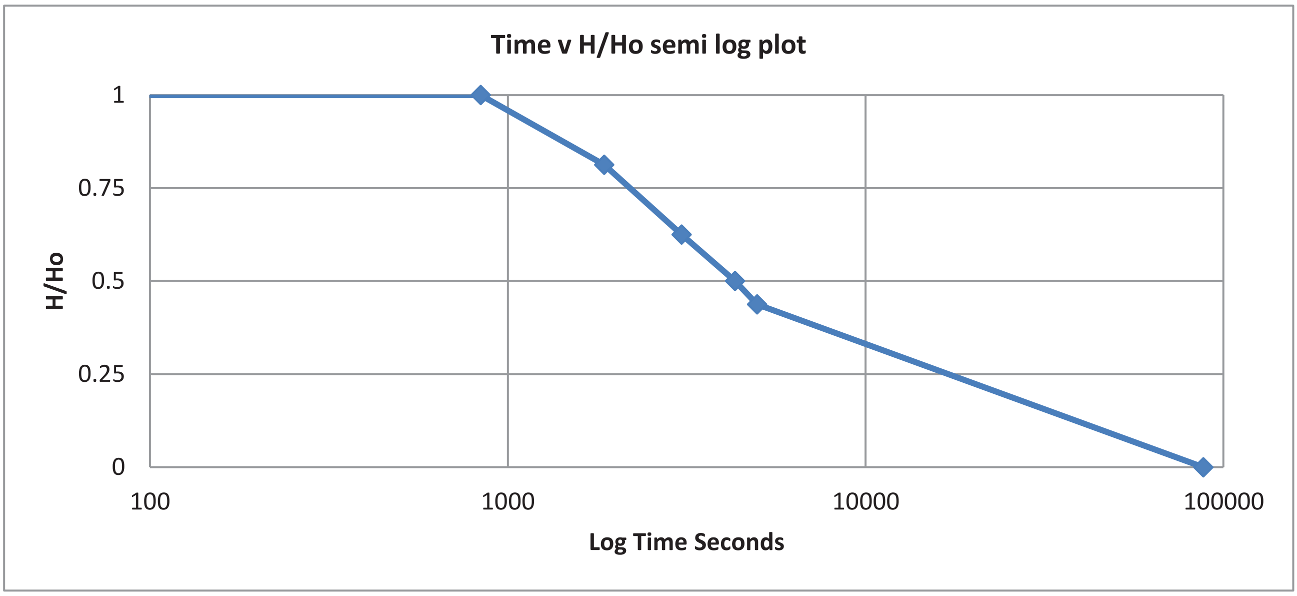

Time v H/Ho
Head (m)
1
0.75
0.5
0.25
0
0
10000
20000
30000
40000
50000
60000
70000
80000
90000
100000
Time (s)

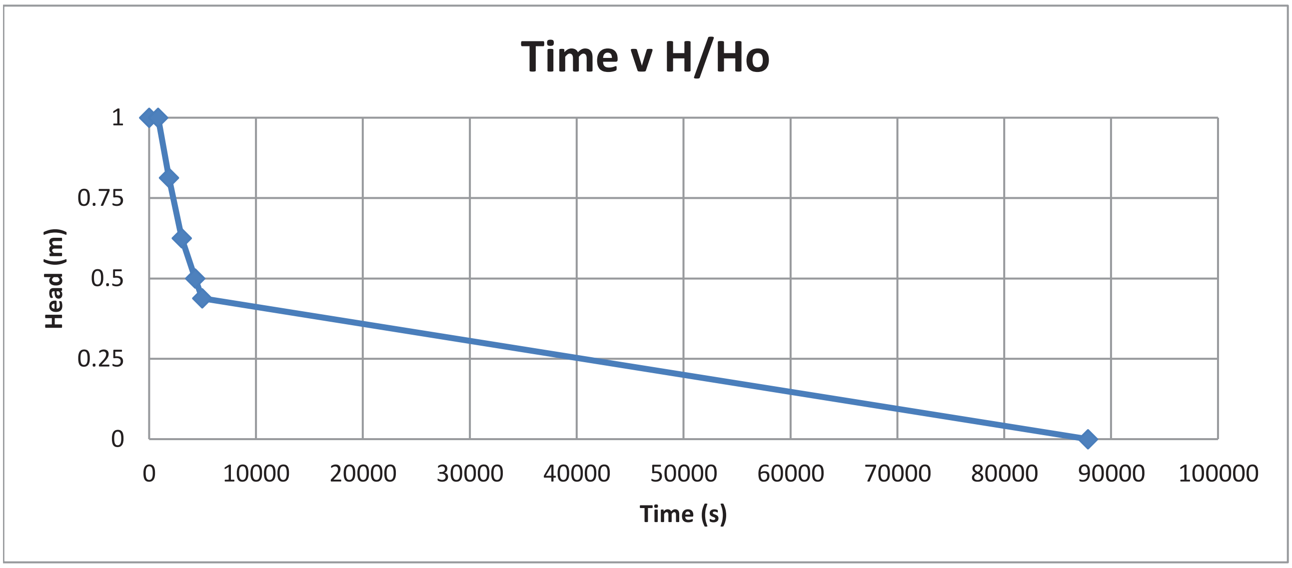
Date:	06/06/2017	
Soakaway Test:		
Hole ID	SA4	
Test No.	2	
Dimensions:		
Radius	0.1	m
Depth	0.42	m
Start water depth	0.34	m
Effective Depth	0.08	m

Time	Time	Seconds	Depth (m)	Effect Depth	Head	Seconds	H/Ho
06 June 2017	42892.612	0	0.34	0.08	0.08	0	1
06 June 2017	42892.622	840	0.34	0.08	0.08	840	1
06 June 2017	42892.633	1860	0.355	0.065	0.065	1860	0.8125
06 June 2017	42892.647	3060	0.37	0.05	0.05	3060	0.625
06 June 2017	42892.662	4320	0.38	0.04	0.04	4320	0.5
06 June 2017	42892.669	4980	0.385	0.035	0.035	4980	0.4375
07 June 2017	42893.628	87840	0.42	0	0	87840	0

Effective Depth (%)	Depth (m)	Time (s)
75	0.06	2500
25	0.02	40000
	Vp75-25	tp75-25
Total Volume	0.00125664	37500
Base Area	0.03141593	m2
Side Area	0.05026548	m
Total Area	0.08168141	m2
Infiltration Rate	**4.10E-07**	**m/s**



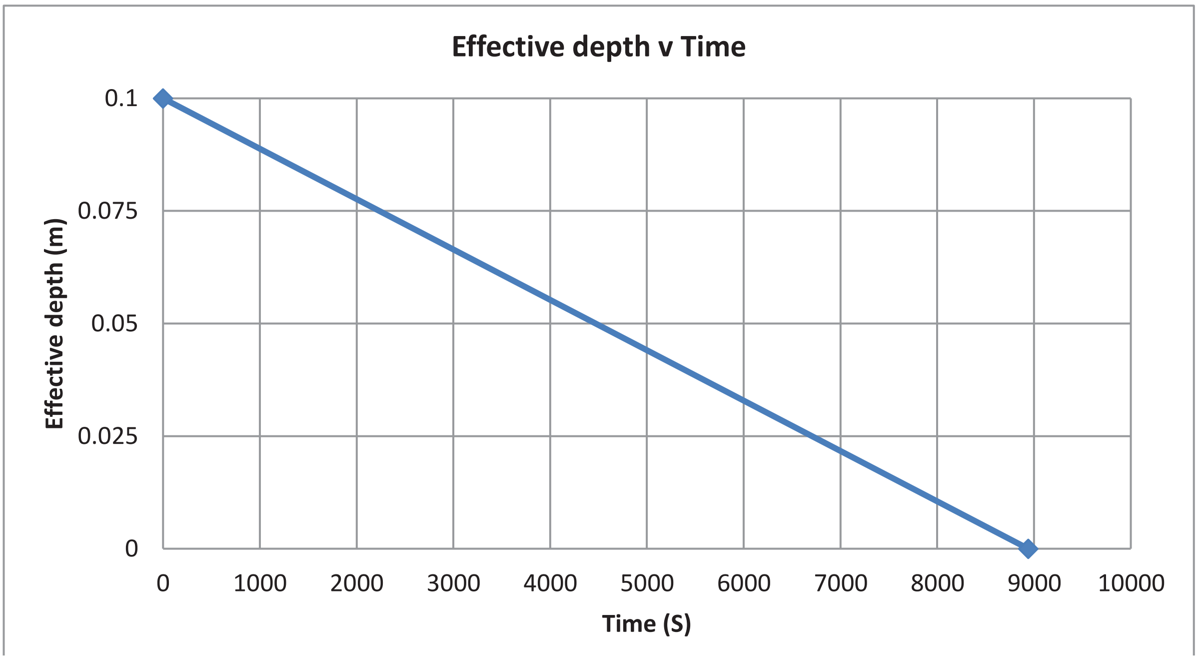

Time v H/Ho semi log plot
1
0.75
0.5
0.25
0
H/Ho
100
1000
10000
100000
Log Time Seconds

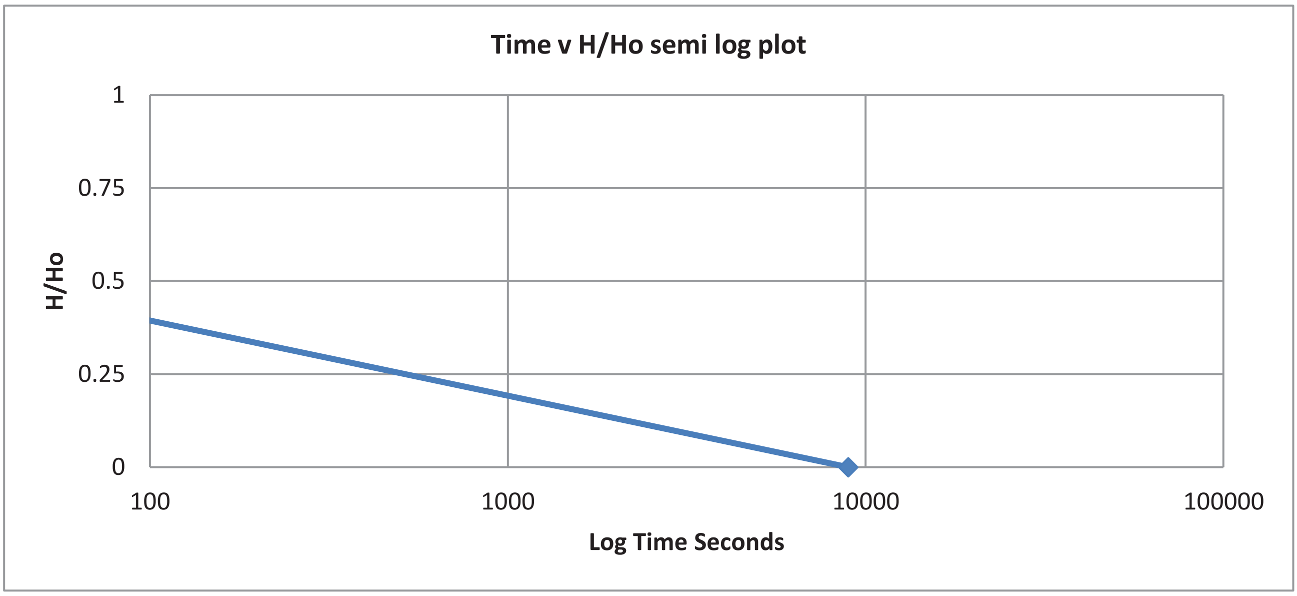

Time v H/Ho
1
0.75
0.5
0.25
0
Head (m)
0
10000
20000
30000
40000
50000
60000
70000
80000
90000
100000
Time (s)

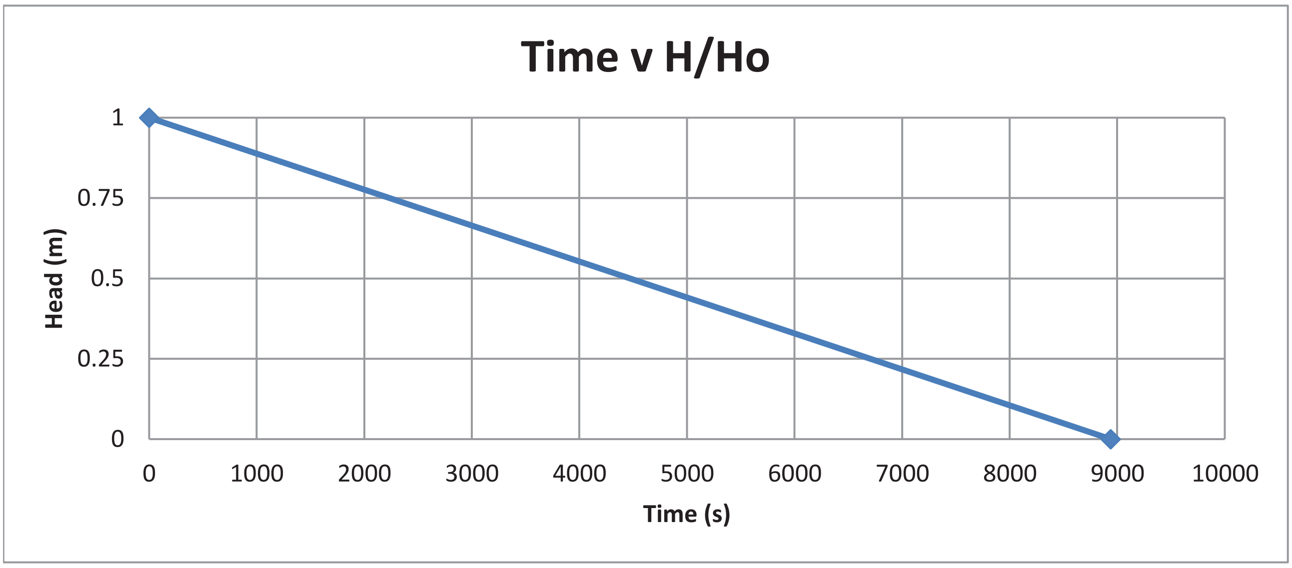
Date:	29/06/2017	
Soakaway Test:		
Hole ID	SA5	
Test No.	1	
Dimensions:		
Radius	0.1	m
Depth	0.425	m
Start water depth	0.325	m
Effective Depth	0.1	m

Time	**Time**	**Seconds**	**Depth (m)**	**Effect Depth**	**Head**	**Seconds**	**H/Ho**
29 June 2017	42915.408	0	0.325	0.1	0.1	0	1
29 June 2017	42915.511	8940	0.425	0	0	8940	0

Effective Depth (%)	**Depth (m)**	**Time (s)**
75	0.075	2200
25	0.025	6700
	Vp75-25	tp75-25
Total Volume	0.0015708	4500
Base Area	0.03141593	m2
Side Area	0.06283185	m
Total Area	0.09424778	m2
Infiltration Rate	**3.70E-06**	**m/s**




Time v H/Ho semi log plot
1
0.75
0.5
0.25
0
H/Ho
100
1000
10000
100000
Log Time Seconds

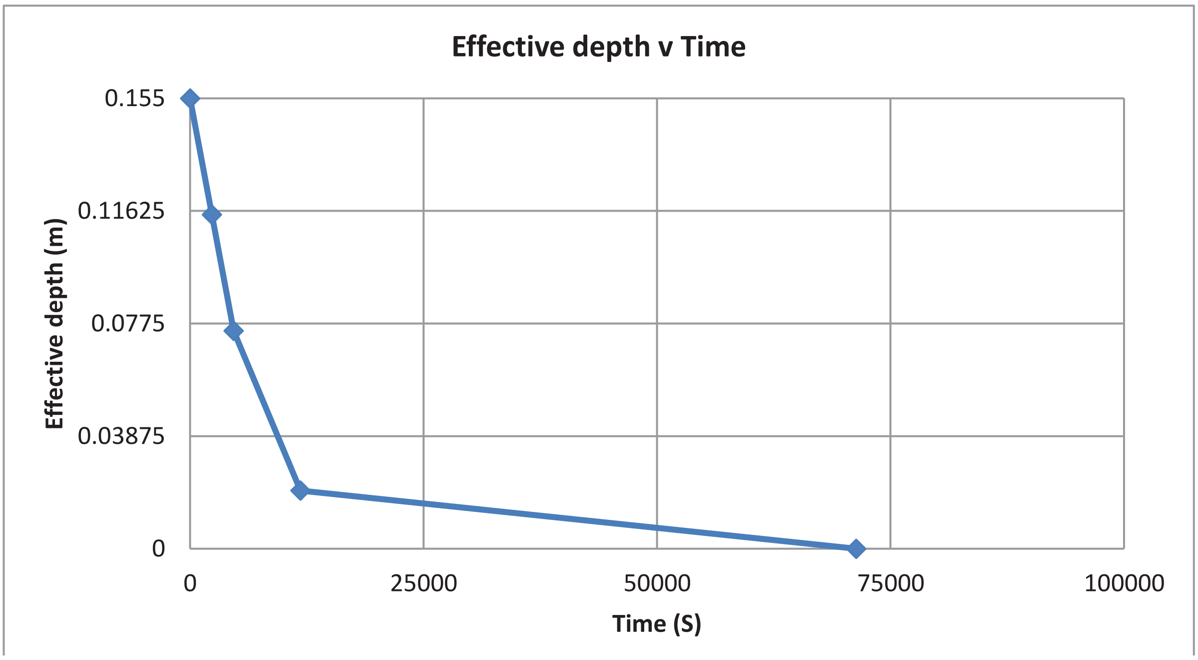

Time v H/Ho
1
0.75
0.5
0.25
0
Head (m)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
Time (s)

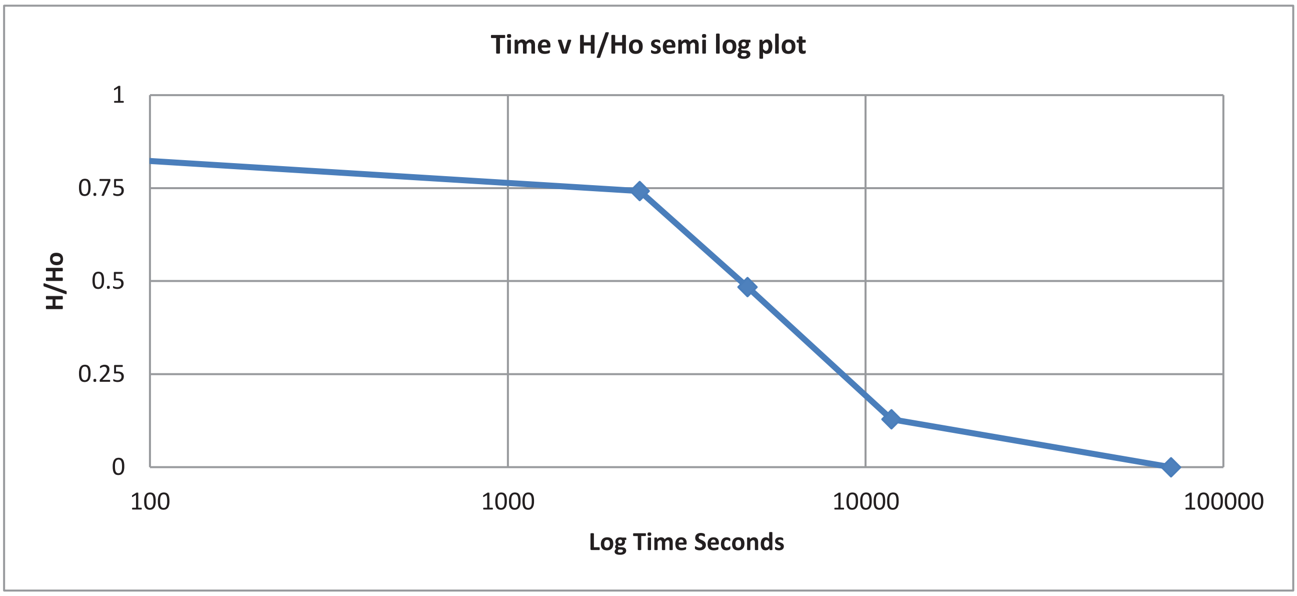
Permeability Test Location 3

Date:	29/06/2017	
Soakaway Test:		
Hole ID	SA5	
Test No.	2	
Dimensions:		
Radius	0.1	m
Depth	0.425	m
Start water depth	0.27	m
Effective Depth	0.155	m

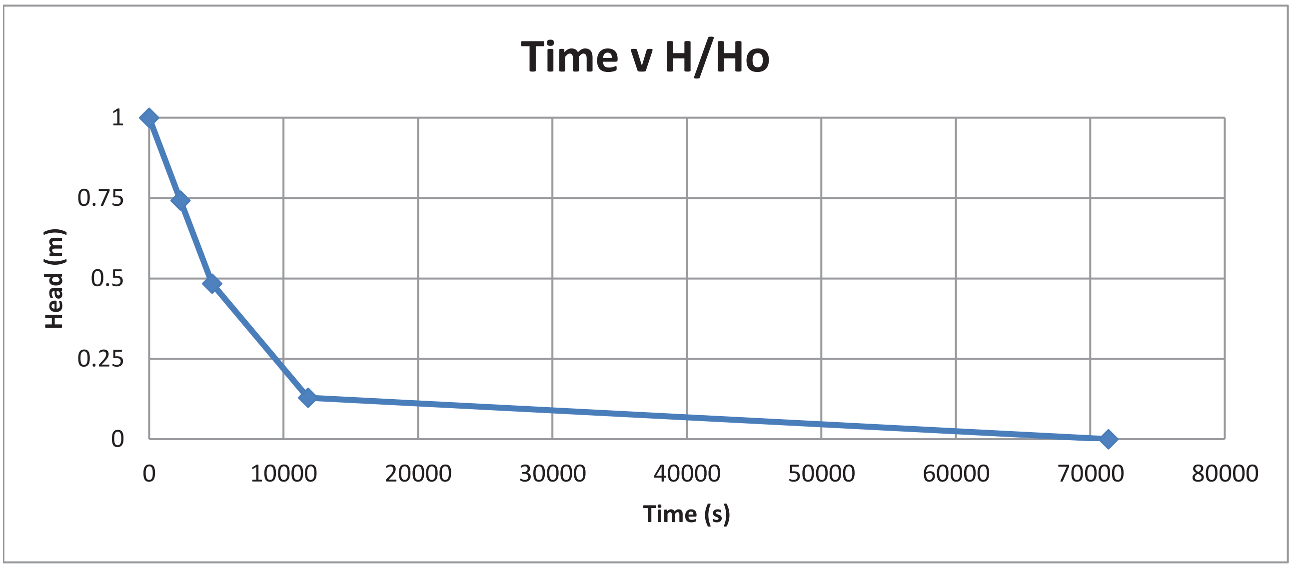
Time	Time	Seconds	Depth (m)	Effect Depth	Head	Seconds	H/Ho
29 June 2017	42915.512	0	0.27	0.155	0.155	0	1
29 June 2017	42915.539	2340	0.31	0.115	0.115	2340	0.741935
29 June 2017	42915.566	4680	0.35	0.075	0.075	4680	0.483871
29 June 2017	42915.649	11820	0.405	0.02	0.02	11820	0.129032
30 June 2017	42916.338	71340	0.425	0	0	71340	0

Effective Depth (%)	Depth (m)	Time (s)
75	0.11625	2000
25	0.03875	9000
	Vp75-25	tp75-25
Total Volume	0.00243473	7000
Base Area	0.03141593	m2
Side Area	0.09738937	m
Total Area	0.1288053	m2
Infiltration Rate	**2.70E-06**	**m/s**





Time v H/Ho semi log plot
H/Ho
1
0.75
0.5
0.25
0
100
1000
10000
100000
Log Time Seconds

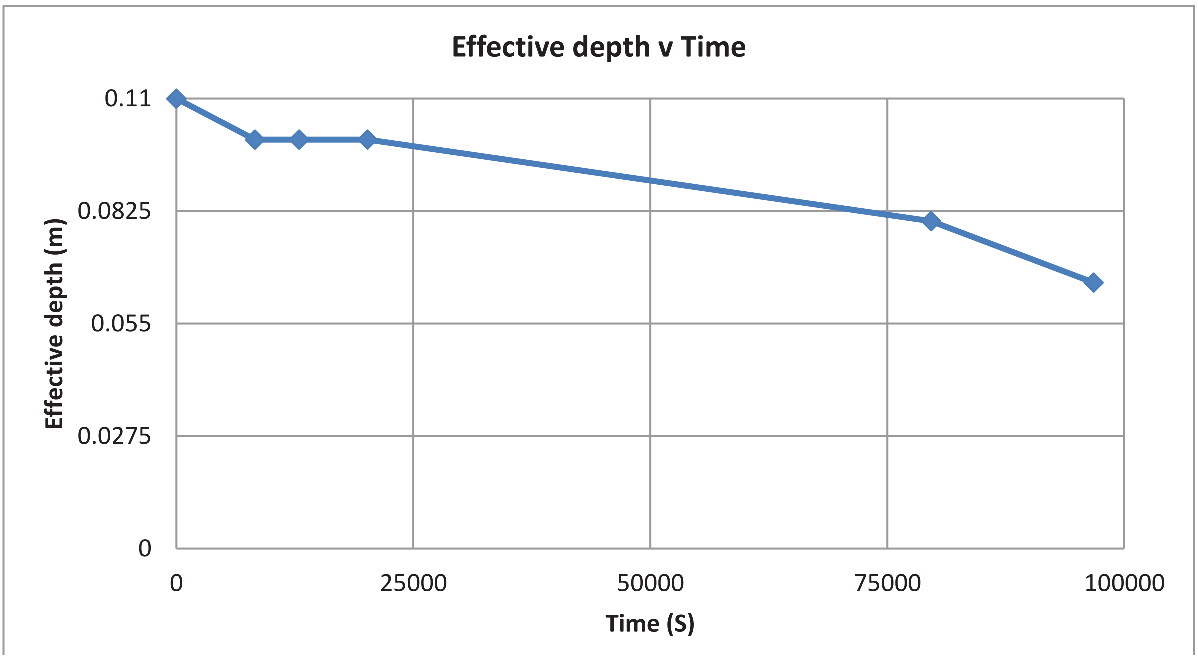


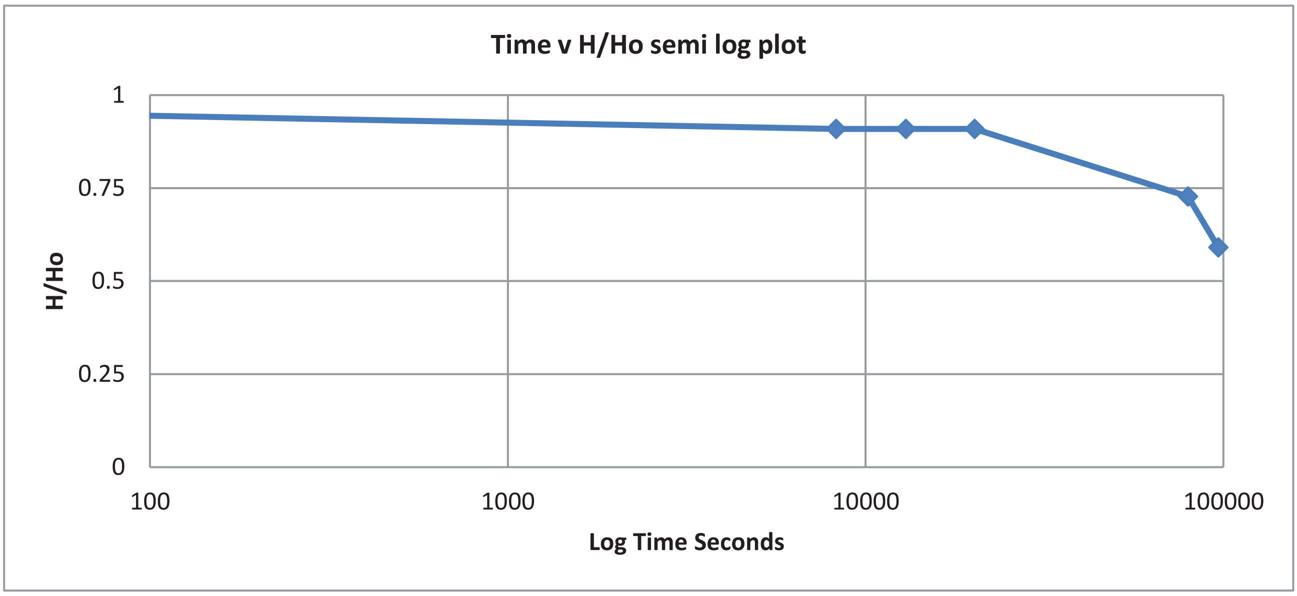
Time v H/Ho
Head (m)
1
0.75
0.5
0.25
0
0
10000
20000
30000
40000
50000
60000
70000
80000
Time (s)

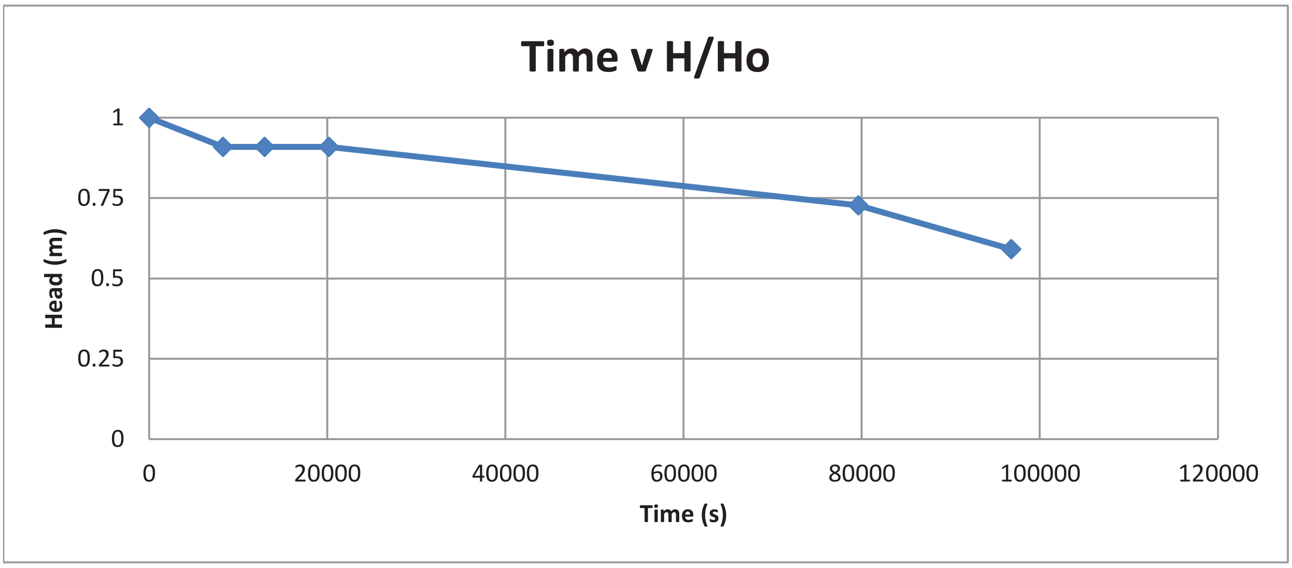
Date:	29/06/2017	
Soakaway Test:		
Hole ID	SA6	
Test No.	1	
Dimensions:		
Radius	0.1	m
Depth	0.42	m
Start water depth	0.31	m
Effective Depth	0.11	m

Time	Time	Seconds	Depth (m)	Effect Depth	Head	Seconds	H/Ho
29 June 2017	42915.417	0	0.31	0.11	0.11	0	1
29 June 2017	42915.513	8280	0.32	0.1	0.1	8280	0.909091
29 June 2017	42915.567	12960	0.32	0.1	0.1	12960	0.909091
29 June 2017	42915.650	20160	0.32	0.1	0.1	20160	0.909091
30 June 2017	42916.338	79620	0.34	0.08	0.08	79620	0.727273
30 June 2017	42916.537	96780	0.355	0.065	0.065	96780	0.590909

Effective Depth (%)	Depth (m)	Time (s)
75	0.0825	
25	0.0275	
	Vp75-25	tp75-25
Total Volume	0.00172788	0
Base Area	0.03141593	m2
Side Area	0.06911504	m
Total Area	0.10053096	m2
Infiltration Rate		**m/s**



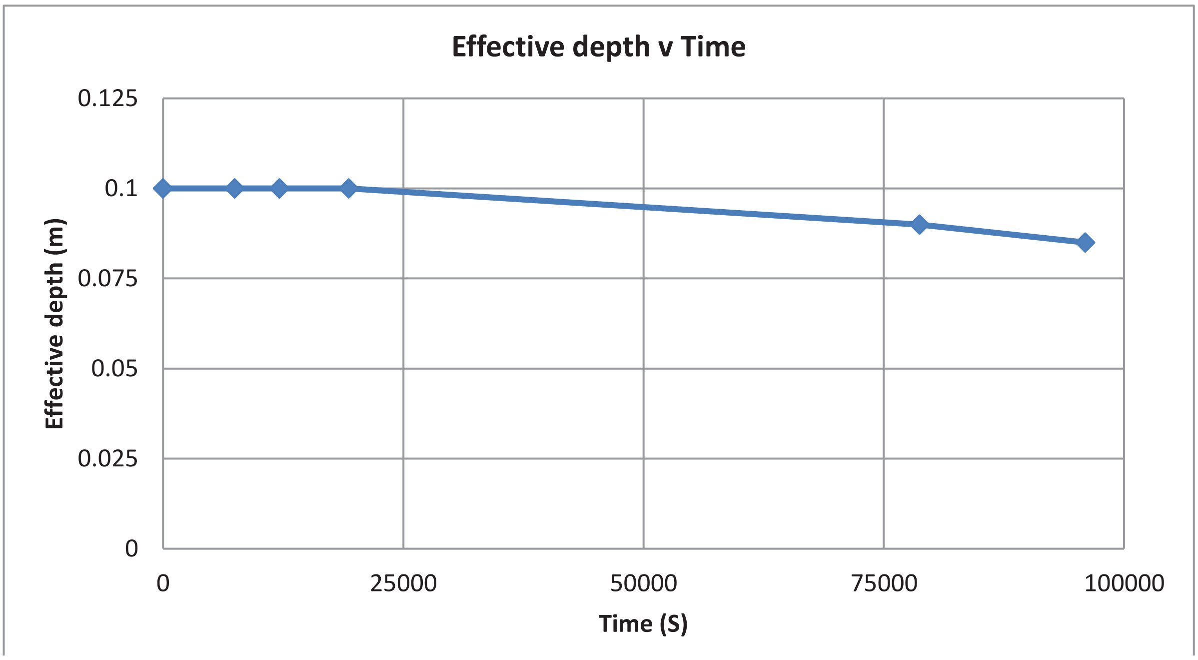

Time v H/Ho semi log plot
1
0.75
0.5
0.25
0
H/Ho
100
1000
10000
100000
Log Time Seconds

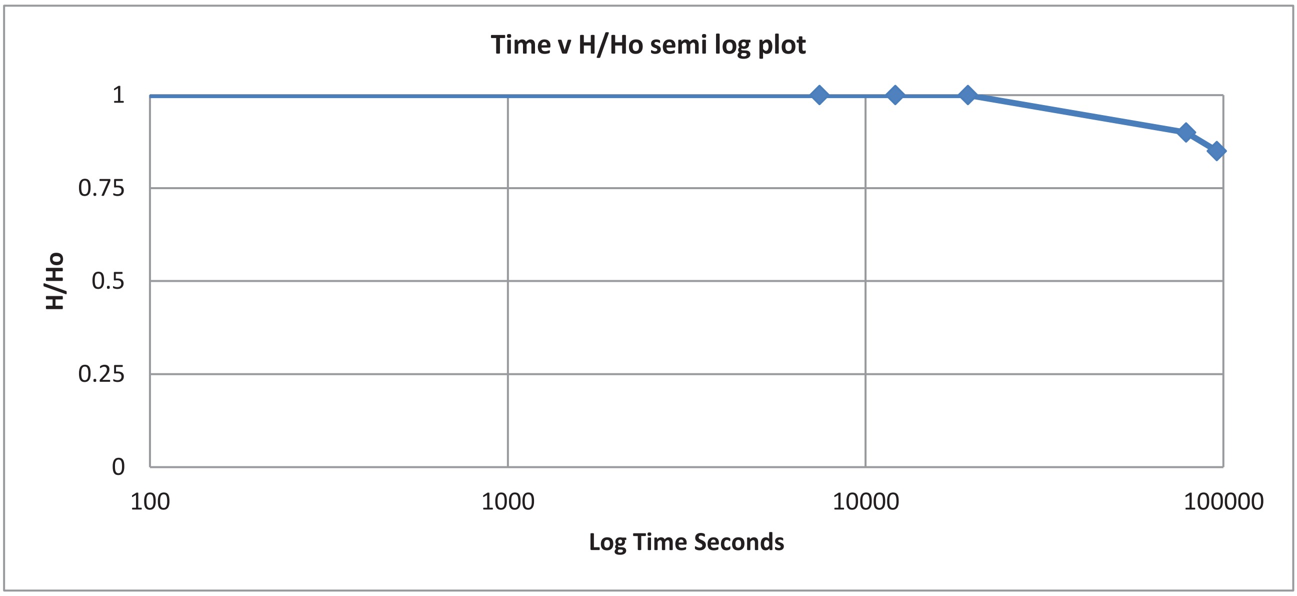

Time v H/Ho
1
0.75
0.5
0.25
0
Head (m)
0
20000
40000
60000
80000
100000
120000
Time (s)

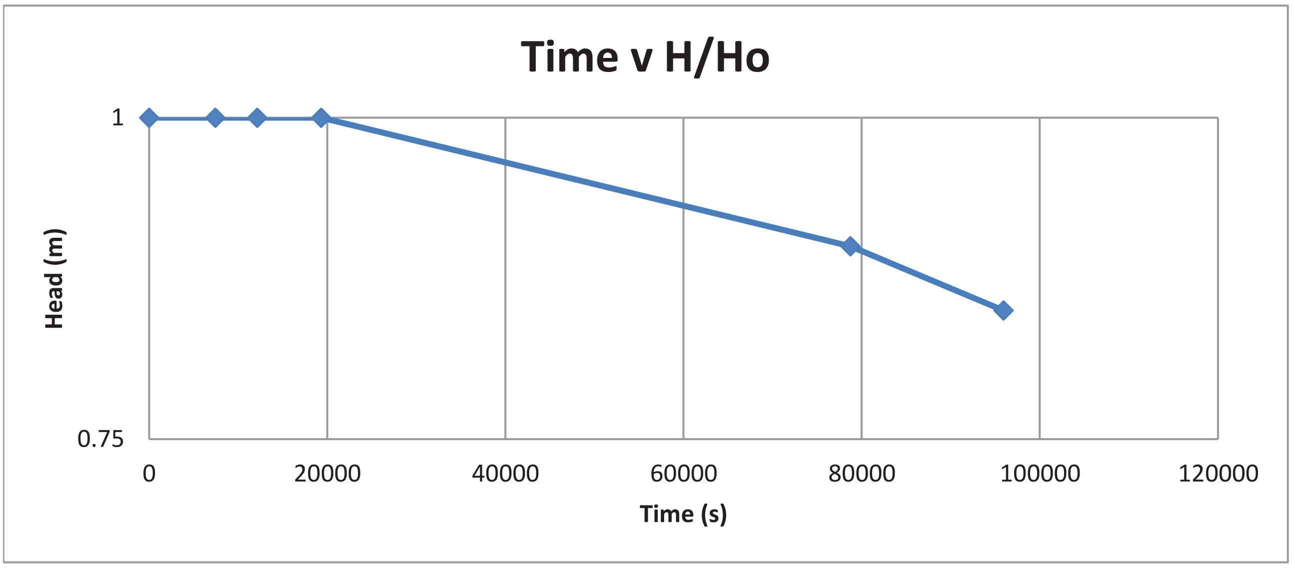
Date:	29/06/2017	
Soakaway Test:		
Hole ID	SA7	
Test No.	1	
Dimensions:		
Radius	0.1	m
Depth	0.38	m
Start water depth	0.28	m
Effective Depth	0.1	m

Time	Time	Seconds	Depth (m)	Effect Depth	Head	Seconds	H/Ho
29 June 2017	42915.427	0	0.28	0.1	0.1	0	1
29 June 2017	42915.513	7440	0.28	0.1	0.1	7440	1
29 June 2017	42915.567	12120	0.28	0.1	0.1	12120	1
29 June 2017	42915.651	19320	0.28	0.1	0.1	19320	1
30 June 2017	42916.338	78720	0.29	0.09	0.09	78720	0.9
30 June 2017	42916.538	95940	0.295	0.085	0.085	95940	0.85

Effective Depth (%)	Depth (m)	Time (s)
75	0.075	
25	0.025	
	Vp75-25	tp75-25
Total Volume	0.0015708	0
Base Area	0.03141593	m2
Side Area	0.06283185	m
Total Area	0.09424778	m2
Infiltration Rate		**m/s**



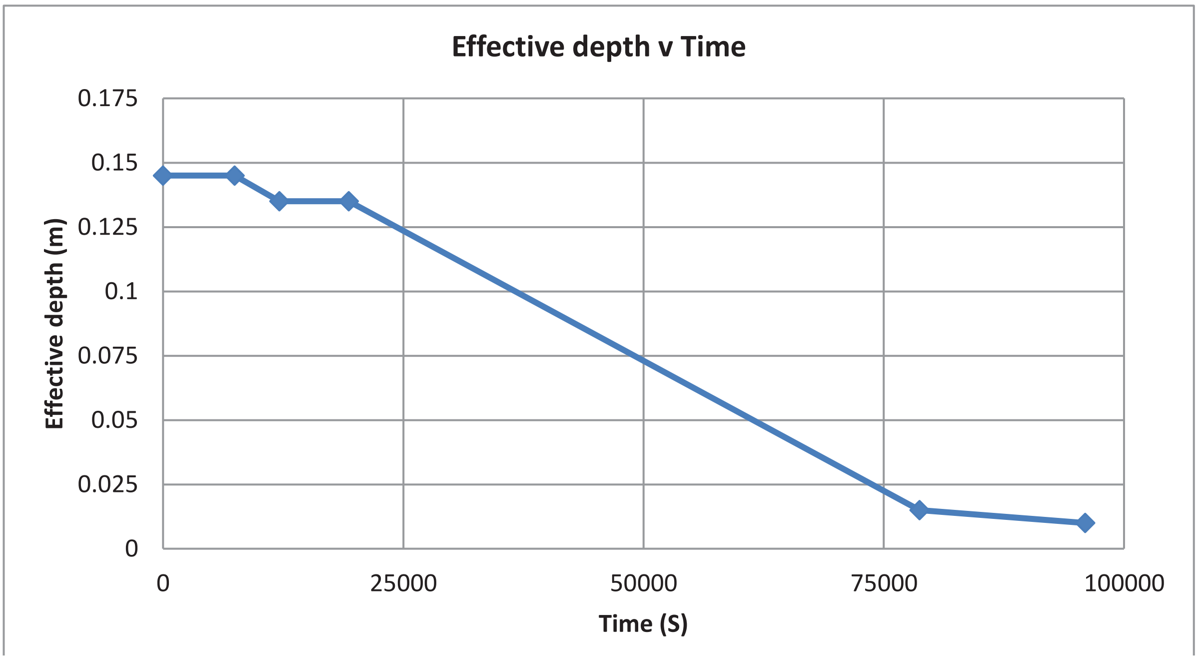

Time v H/Ho semi log plot
H/Ho
1
0.75
0.5
0.25
0
100
1000
10000
100000
Log Time Seconds

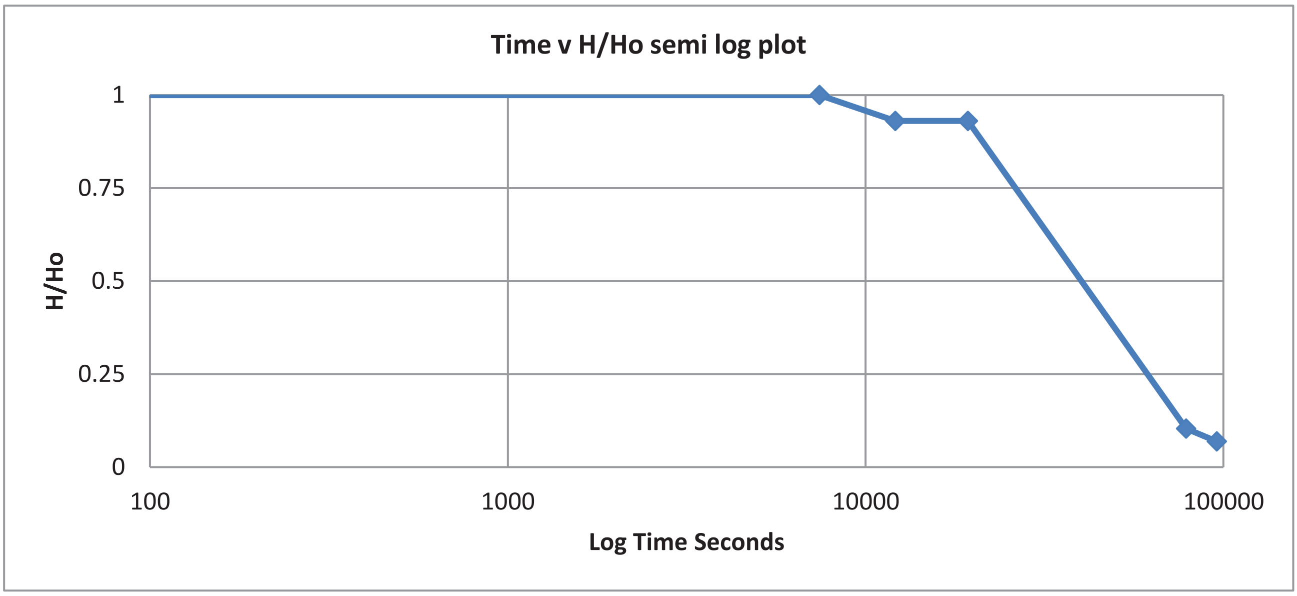

Time v H/Ho
Head (m)
1
0.75
0
20000
40000
60000
80000
100000
120000
Time (s)

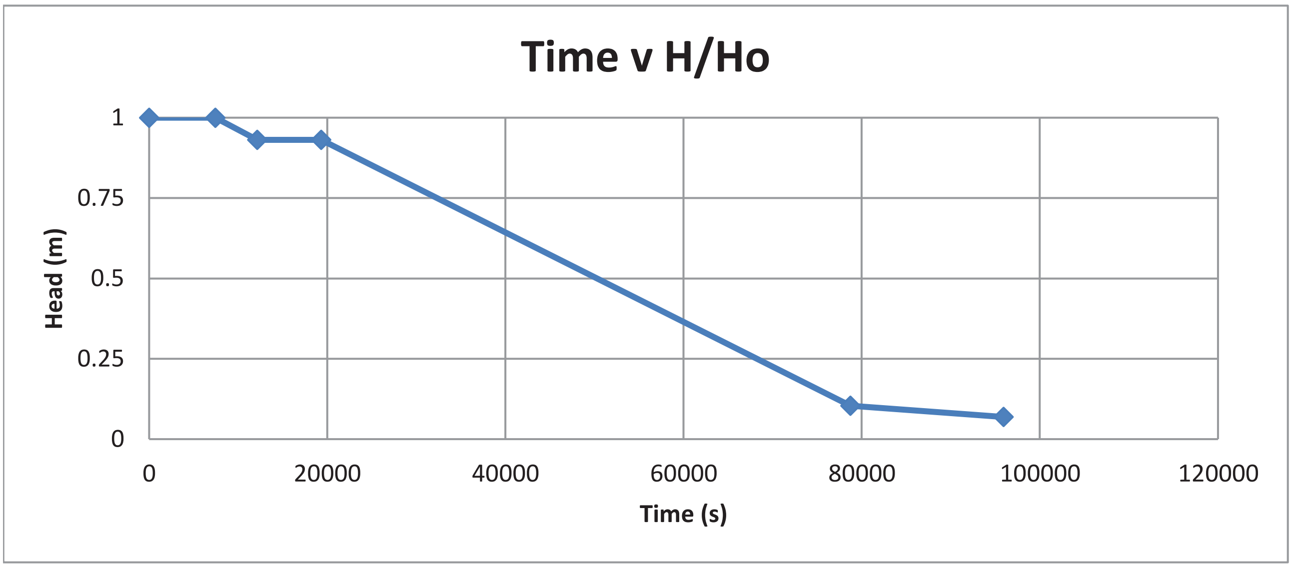
Date:	29/06/2017	
Soakaway Test:		
Hole ID	SA8	
Test No.	1	
Dimensions:		
Radius	0.1	m
Depth	0.435	m
Start water depth	0.29	m
Effective Depth	0.145	m

Time	Time	Seconds	Depth (m)	Effect Depth	Head	Seconds	H/Ho
29 June 2017	42915.427	0	0.29	0.145	0.145	0	1
29 June 2017	42915.513	7440	0.29	0.145	0.145	7440	1
29 June 2017	42915.567	12120	0.3	0.135	0.135	12120	0.931034
29 June 2017	42915.651	19320	0.3	0.135	0.135	19320	0.931034
30 June 2017	42916.338	78720	0.42	0.015	0.015	78720	0.103448
30 June 2017	42916.538	95940	0.425	0.01	0.01	95940	0.068966

Effective Depth (%)	Depth (m)	Time (s)
75	0.10875	24000
25	0.03625	60000
	Vp75-25	tp75-25
Total Volume	0.00227765	36000
Base Area	0.03141593	m2
Side Area	0.09110619	m
Total Area	0.12252211	m2
Infiltration Rate	**5.16E-07**	**m/s**




Time v H/Ho semi log plot
H/Ho
1
0.75
0.5
0.25
0
100
1000
10000
100000
Log Time Seconds

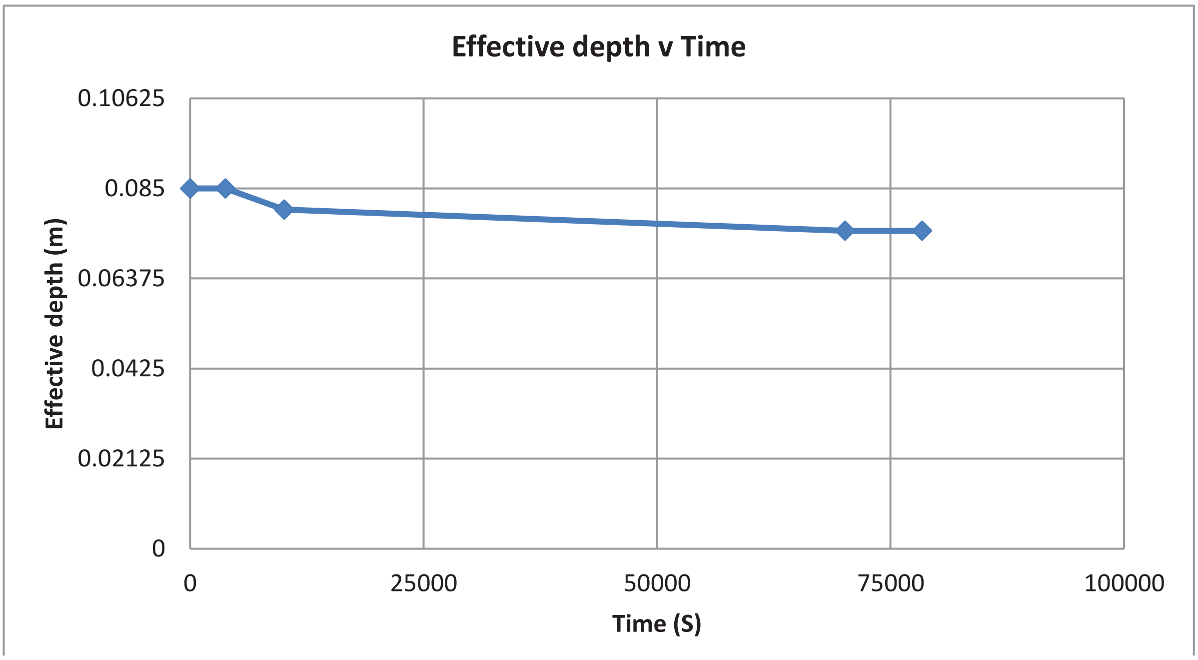

Time v H/Ho
Head (m)
1
0.75
0.5
0.25
0
0
20000
40000
60000
80000
100000
120000
Time (s)

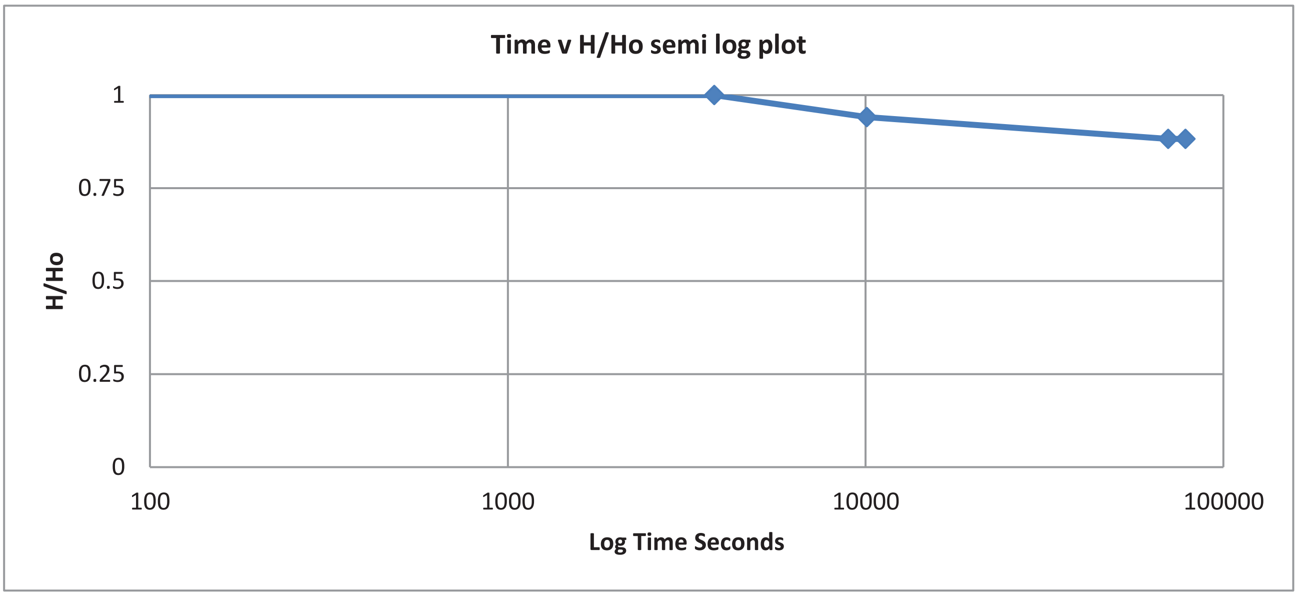
Date:	29/06/2017
Soakaway Test:	
Hole ID	SA9
Test No.	1
Dimensions:		

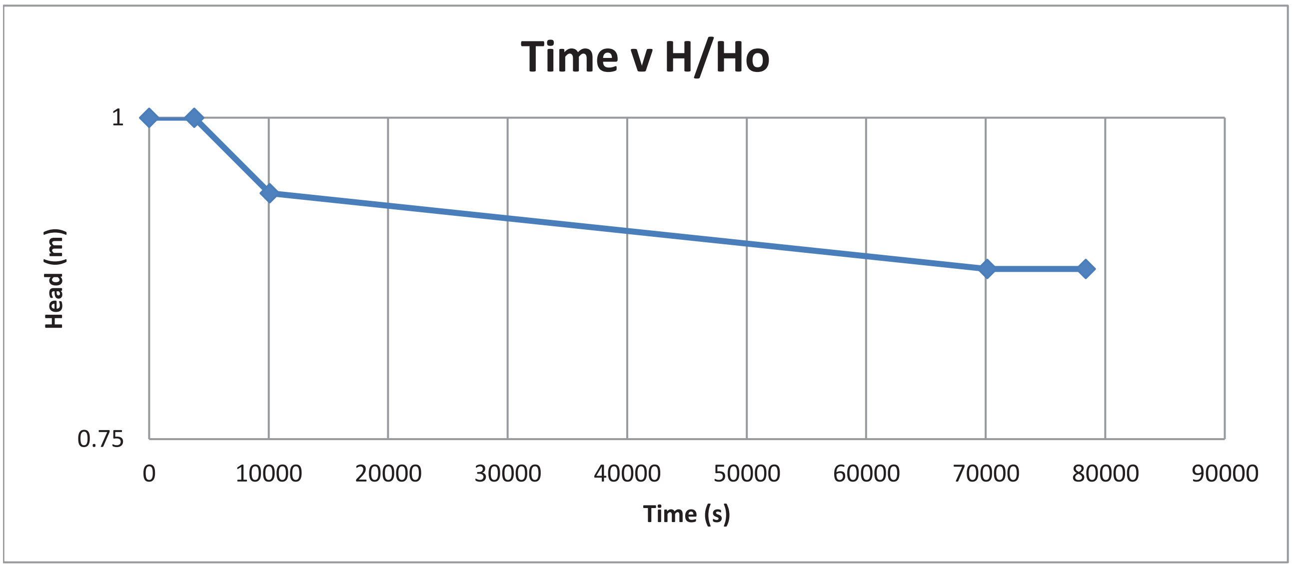
Radius	0.1	m
Depth	0.375	m
Start water depth	0.29	m
Effective Depth	0.085	m

Time	Time	Seconds	Depth (m)	Effect Depth	Head	Seconds	H/Ho
29 June 2017	42915.529	0	0.29	0.085	0.085	0	1
29 June 2017	42915.573	3780	0.29	0.085	0.085	3780	1
29 June 2017	42915.646	10080	0.295	0.08	0.08	10080	0.941176
30 June 2017	42916.341	70140	0.3	0.075	0.075	70140	0.882353
30 June 2017	42916.436	78360	0.3	0.075	0.075	78360	0.882353

Effective Depth (%)	Depth (m)	Time (s)
75	0.06375	
25	0.02125	
	Vp75-25	tp75-25
Total Volume	0.00133518	0
Base Area	0.03141593	m2
Side Area	0.05340708	m
Total Area	0.084823	m2
Infiltration Rate		**m/s**




Time v H/Ho semi log plot
H/Ho
1
0.75
0.5
0.25
0
100
1000
10000
100000
Log Time Seconds


Time v H/Ho
Head (m)
1
0.75
0
10000
20000
30000
40000
50000
60000
70000
80000
90000
Time (s)

Client	Tamar Valley Projects	**Borehole Details**	
Site	Eales Farm Landfill	**Depth of borehole (mbgl)**	18
Project No.	GCE00692	**Water level before test (mbgl)**	15.81
Operator	PF	**Diameter of borehole (m)**	0.116
Date	28/05/2020	**Depth of casing (mbgl)**	16

B19-6

Test Data

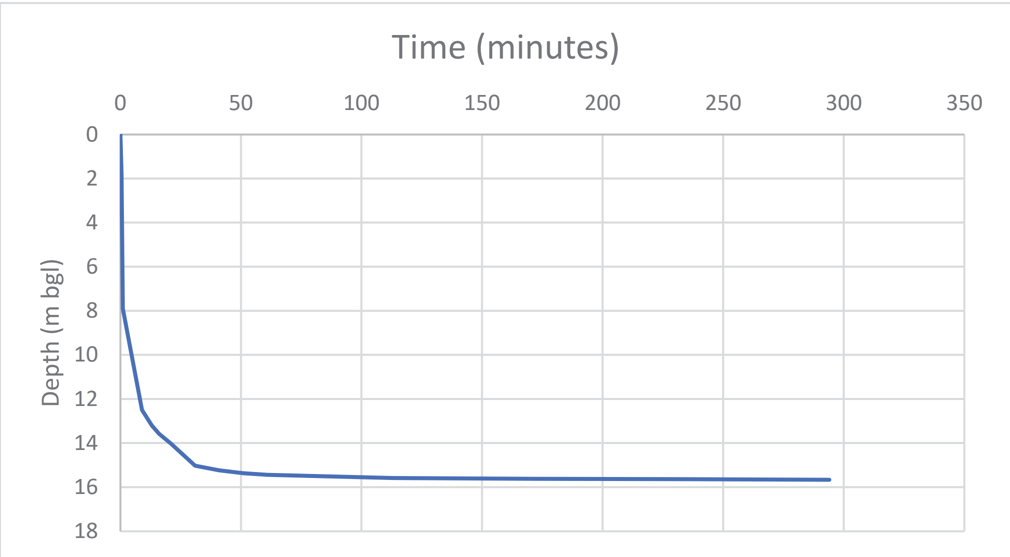
Time (mins)	Depth (mbgl)
0	0.00
0.5	1.80
1	7.90
9	12.50
13	13.20
16	13.58
21	14.03
31	15.03
41	15.24
51	15.37
61	15.44
113	15.59
173	15.62
232	15.64
294	15.66

Comments:

Formula:

k=A/(F(t2-t1))*ln(H1/H2)

Area (A)	0.010563	m^2
Time t1 selected	0.5	min
Time t2 selected	21	min
Depth at t1	1.8	m
Head at t1	14.01	m
Depth at t2	14.03	m
Head at t2	1.78	m
Intake Factor (F) from BS5930 (Method A, B, C, D, E or F)	D	
Intake Factor, F, for case D	3.546721	
Permeability (k)	**5.00E-06**	**m/s**



Client	Tamar Valley Projects	**Borehole Details**		
Site	Eales Farm Landfill	**Depth of borehole (mbgl)**	28.3	**B19-5**
Project No.	GCE00692	**Water level before test (mbgl)**	20.36	
Operator	PF	**Diameter of borehole (m)**	0.116	
Date	28/05/2020	**Depth of casing (mbgl)**	27.5	

Test Data

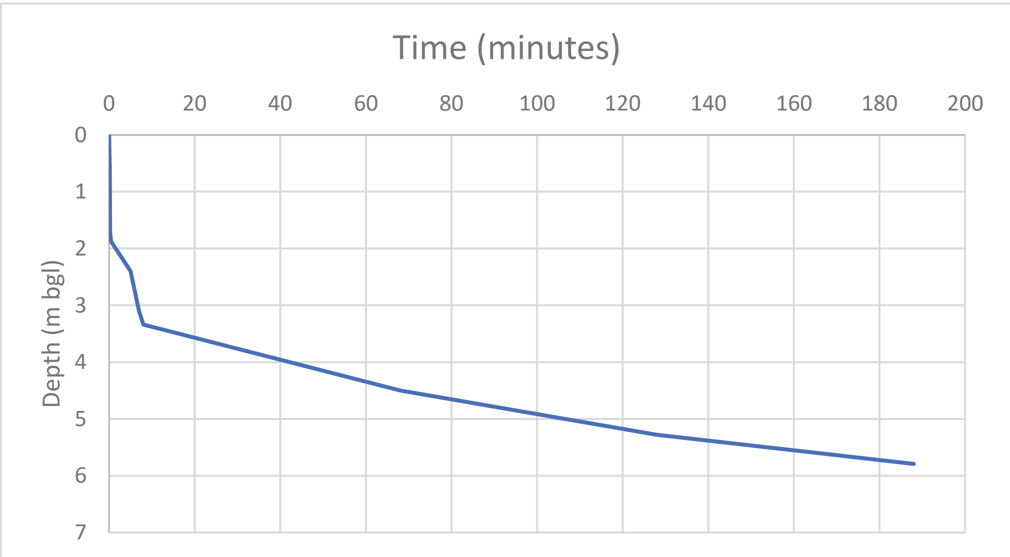
Comments:

Formula:

k=A/(F(t2-t1))*ln(H1/H2)

Time (mins)	Depth (mbgl)
0	0.00
0.16	0.57
0.25	1.72
0.5	1.88
5	2.40
7	3.10
8	3.34
68	4.50
128	5.28
188	5.79

Area (A)	0.010563	m^2
Time t1 selected	0.5	min
Time t2 selected	188	min
Depth at t1	1.88	m
Head at t1	18.48	m
Depth at t2	5.79	m
Head at t2	14.57	m
Intake Factor (F) from BS5930 (Method A, B, C, D, E or F)	D	
Intake Factor, F, for case D	1.910714	
Permeability (k)	**1.17E-07**	**m/s**



Client	Tamar Valley Projects	**Borehole Details**	
Site	Eales Farm Landfill	**Depth of borehole (mbgl)**	18.6
Project No.	GCE00692	**Water level before test (mbgl)**	15.56
Operator	PF	**Diameter of borehole (m)**	0.116
Date	28/05/2020	**Depth of casing (mbgl)**	16.6

B19-4

Test Data

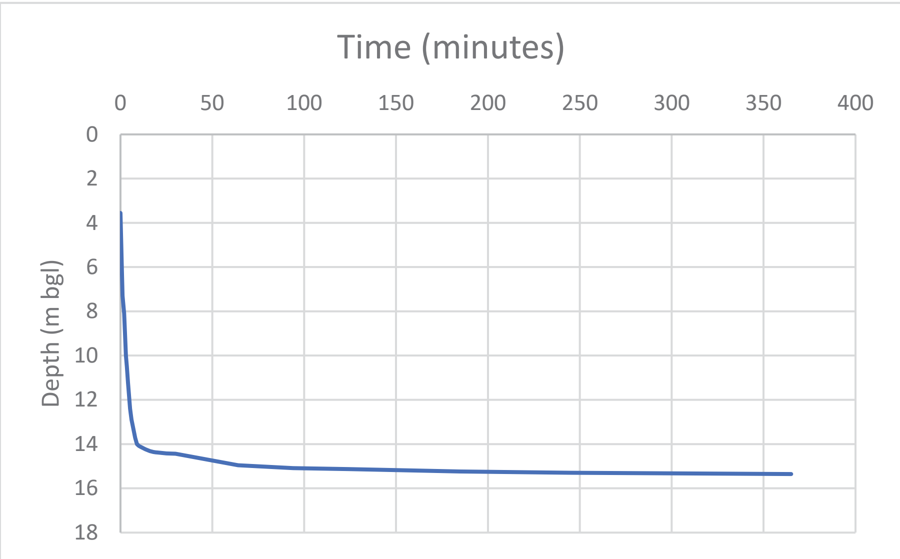
Time (mins)	Depth (mbgl)
0	3.55
0.5	5.00
0.75	5.90
1.15	7.30
2	8.10
2.5	8.95
3	10.00
3.5	10.50
4.15	11.22
5.25	12.40
6	12.90
8	13.72
9	14.00
10	14.08
11	14.13
12	14.17
13	14.21
14	14.25
15	14.29
16	14.31
17	14.34
18	14.36
20	14.38
25	14.42
30	14.44
64	14.96
94	15.09
124	15.13
185	15.24
245	15.30
304	15.33
365	15.35

Comments:

Formula:

k=A/(F(t2-t1))*ln(H1/H2)

Area (A)	0.010563	m^2
Time t1 selected	1	min
Time t2 selected	50	min
Depth at t1	1.85	m
Head at t1	13.71	m
Depth at t2	5.48	m
Head at t2	10.08	m
Intake Factor (F) from BS5930 (Method A, B, C, D, E or F)	D	
Intake Factor, F, for case D	3.546721	
Permeability (k)	**3.12E-07**	**m/s**



Appendix J Site Condition Report

geo consulting engineering ltd

Environmental Permit Variation Application

Eales Farm Landfill, Eales Farm, Saltash

Site Condition Report

Report: GCE00692/2020/SCR

March 2020

1.0 SITE DETAILS	
Name of the applicant	Tamar Valley Projects Ltd
Activity address	Eales Farm Landfill, Tamar View Industrial Estate near to Saltash, Cornwall, PL12 6PG
National grid reference	241393E 60569N

Document reference and dates for Site Condition Report at permit application and surrender	GCE00692/2020/SCR – March 2020

Document references for site plans (including location and boundaries)	GCE00692-A-Fig1 GCE00692-A-Fig2 GCE00692-2019-GI-Hole Location Plan

Note:
In Part A of the application form you must give us details of the site's location and provide us with a site plan. We need a detailed site plan (or plans) showing:

- Site location, the area covered by the site condition report, and the location and nature of the activities and/or waste facilities on the site.
- Locations of receptors, sources of emissions/releases, and monitoring points.
- Site drainage.
- Site surfacing.

If this information is not shown on the site plan required by Part A of the application form then you should submit the additional plan or plans with this site condition report.

2.0 Condition of the land at permit issue	
Environmental setting including: • geology • hydrogeology • surface waters	A ground investigation was carried out in April 2016 by John Grimes Partnership and another two by GCEL in August 2016and February 2020. Local geology is inert waste (typically clayey gravels and gravelly clays) over mudstone of Torpoint Formation. Aquifer status – Secondary A A stream flows into pond in north-west corner of site. Ditch follows from pond along the north boundary joining culvert outlet which cuts through rough centre of site.
Pollution history including: • pollution incidents that may have affected land • historical land-uses and associated contaminants • any visual/olfactory evidence of existing contamination • evidence of damage to pollution prevention measures	One Pollution Incident to Controlled Waters recorded on the site on March 1995. The incident was due to a leakage of 'Chemicals – Pesticides'. The incident was a Category 3 – Minor incident. The site was previously an inert landfill, accepting waste from 1970s to 2000's. Some variation in waste with occasional outliers of elevated arsenic and but no significant contamination sources encountered in either investigation. Ground gas monitoring carried out across the site has identified some methane and carbon dioxide concentrations in MBH7A and just west of site in MBH2A and BH13 suggesting some gas production from the historic waste on site. Little to no flow has been detected across the site. Elevated levels of ammoniacal nitrogen and manganese have been identified in groundwater samples in MBH2A (just west of site). These high levels are thought to be related to

	the septic tanks associated to the residential buildings off-site and mineralisation in the local geology respectively. See figure GCE00692-2019-GI-Hole Location Plan for borehole locations. See ESSD report (attached as part of this application) for further details.
Evidence of historic contamination, for example, historical site investigation, assessment, remediation and verification reports (where available)	See comments above.
Baseline soil and groundwater reference data	See Ground Investigation report GCE00692/R3 included as part of this permit variation application..
Supporting information	• Source information identifying environmental setting and pollution incidents • Historical Ordnance Survey plans • Site reconnaissance • Historical investigation reports • Baseline soil and groundwater reference data

3.0 Permitted activities

Permitted activities	Deposit of inert waste material
Non-permitted activities undertaken	None
Document references for: • plan showing activity layout; and • environmental risk assessment.	See attached GCE00692-A-Fig5 within report GCE00692/2020/ESSD See attached GCE00692 H1 ERA

Note:

In Part B of the application form you must tell us about the activities that you will undertake at the site. You must also give us an environmental risk assessment. This risk assessment must be based on our guidance (*Environmental Risk Assessment - EPR H1*) or use an equivalent approach.

It is essential that you identify in your environmental risk assessment all the substances used and produced that could pollute the soil or groundwater if there were an accident, or if measures to protect land fail.

These include substances that would be classified as 'dangerous' under the Control of Major Accident Hazards (COMAH) regulations and also raw materials, fuels, intermediates, products, wastes and effluents.

If your submitted environmental risk assessment does not adequately address the risks to soil and groundwater we may need to request further information from you or even refuse your permit application.

4.0 Changes to the activity		
Have there been any changes to the activity boundary?		If yes, provide a plan showing the changes to the activity boundary.
Have there been any changes to the permitted activities?		If yes, provide a description of the changes to the permitted activities
Have any ‘dangerous substances’ not identified in the Application Site Condition Report been used or produced as a result of the permitted activities?		If yes, list of them
Checklist of supporting information	• Plan showing any changes to the boundary (where relevant) • Description of the changes to the permitted activities (where relevant) • List of ‘dangerous substances’ used/produced by the permitted activities that were not identified in the Application Site Condition Report (where relevant)	

5.0 Measures taken to protect land	
Use records that you collected during the life of the permit to summarise whether pollution prevention measures worked. If you can’t, you need to collect land and/or groundwater data to assess whether the land has deteriorated.	
Checklist of supporting information	• Inspection records and summary of findings of inspections for all pollution prevention measures • Records of maintenance, repair and replacement of pollution prevention measures

6.0 Pollution incidents that may have had an impact on land, and their remediation	
Summarise any pollution incidents that may have damaged the land. Describe how you investigated and remedied each one. If you can’t, you need to collect land and /or groundwater reference data to assess whether the land has deteriorated while you’ve been there.	
Checklist of supporting information	• Records of pollution incidents that may have impacted on land • Records of their investigation and remediation

7.0 Soil gas and water quality monitoring (where undertaken)	
See report GCE00692/R3 submitted as part of this permit variation application.	
Checklist of supporting information	• Description of soil gas and/or water monitoring undertaken • Monitoring results (including graphs)

8.0 Decommissioning and removal of pollution risk	
Describe how the site was decommissioned. Demonstrate that all sources of pollution risk have been removed. Describe whether the decommissioning had any impact on the land. Outline how you investigated and remedied this.	
Checklist of supporting information	• Site closure plan • List of potential sources of pollution risk • Investigation and remediation reports (where relevant)

9.0 Reference data and remediation (where relevant)	
Say whether you had to collect land and/or groundwater data. Or say that you didn't need to because the information from sections 3, 4, 5 and 6 of the Surrender Site Condition Report shows that the land has not deteriorated. If you did collect land and/or groundwater reference data, summarise what this entailed, and what your data found. Say whether the data shows that the condition of the land has deteriorated, or whether the land at the site is in a "satisfactory state". If it isn't, summarise what you did to remedy this. Confirm that the land is now in a "satisfactory state" at surrender.	
Checklist of supporting information	• Land and/or groundwater data collected at application (if collected) • Land and/or groundwater data collected at surrender (where needed) • Assessment of satisfactory state • Remediation and verification reports (where undertaken)

10.0 Statement of site condition
Using the information from sections 3 to 7, give a statement about the condition of the land at the site. This should confirm that: • the permitted activities have stopped • decommissioning is complete, and the pollution risk has been removed • the land is in a satisfactory condition.

geo consulting engineering ltd

GCE00692/EPv3/4/21

Appendix H – Hydrogeological Risk Assessment

Transport, Environment & Design

Proposed Eales Farm Landfill Extension

Hydrogeological Risk Assessment

April 2021

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Revision Schedule

Revision	Author	Description	Date
1	Jamie Howourth	Revision includes updated figures in Appendix A.	09 July 2018
2	Alex Large	Report updated following on-Site meeting with Environment Agency (7 March 2019) to incorporate results of additional data obtained by GCE plus address Environment Agency queries.	11 June 2020
3	Alex Large	Report updated following review by GCE including removing reference to Tamar View Landfill.	13 June 2020
4	Alex Large	Revised Appendix A to include updated drawings produced by GCE.	22 March 2021

1. Introduction

1.1 Commission

1.1.1 Horizon Consulting Engineers Limited (Horizon) was commissioned by Geo Consulting Engineering Ltd (GCE) on behalf of Tamar Valley Projects Ltd (TVPL) to prepare a hydrogeological risk assessment (HRA) related to an application to vary the existing Environmental Permit at Eales Farm, Tamar View Industrial Estate, Carkeel, Saltash, Cornwall, PL12 6PG. The existing Eales Farm Landfill was originally a Category A dilute and disperse landfill facility licensed to accept non-biodegradable waste. TVPL proposes to re-open the Site and import additional waste classified as inert in accordance with current guidance[1].

1.1.2 This project was originally undertaken in accordance with Horizon's fee proposal dated 23 May 2018 with Revision 1 of the report[2], dated 09 July 2018, issued to the Environment Agency. This HRA was subsequently updated (Revision 3) in April 2020 following feedback from the Environment Agency on Revision 1 of the report[2] (in particular meeting on-Site, 7 March 2019) and to incorporate the results of additional testing by GCE following the March 2019 meeting.

1.1.3 The most recent revision of this report (Revision 4) includes revised drawings in **Appendix A** following changes to the proposed phasing of the filling works. In addition, GCE has provided Horizon with the most recent quarterly monitoring results for August 2020[3] and November 2020[4]. Given the results of the August 2020 and November 2020 monitoring events are broadly in line with previous results, the summary tables (**Appendix E**) have not been updated to include these results at this time.

1.2 Background

1.2.1 The proposed extension to the Eales Farm landfill, hereafter referred to as Eales Farm Landfill extension, is located within the boundary of the existing Eales Farm Landfill, as shown on the drawings in **Appendix A** (reproduced from GCE's May 2020 Environmental Setting and Site Design Report[5]).

1.2.2 The proposed Eales Farm Landfill extension, including import and placement of approximately 250,000 m^3 of inert waste, is intended to take place under the existing planning permission for waste deposition[6].

1.2.3 An application for a bespoke Environmental Permit was previously submitted in November 2017; the Environment Agency responded with a Schedule 5 response (dated 24 April 2018) requesting clarification and additional detail in relation to the proposed Eales Farm Landfill extension.

1.2.4 Revision 1[2] of this HRA was originally prepared in response to the April 2018 Schedule 5 response. Further feedback was provided by the Environment Agency (email dated 5 October 2018); the Environment Agency provided clarification on this feedback on-Site on 7 March 2019.

[1] Environment Agency (May 2018) Guidance on the Classification and Assessment of Waste WM3 Version 1.1
[2] Horizon (9 July 2018) Tamar View Landfill. Hydrogeological Risk Assessment. Reference: HCE0430.HRA.Rev2
[3] GCE (23 March 2021) Eales Farm Landfill – Quarterly Monitoring (August 2020). Ref: GCE00692/LR14
[4] GCE (23 March 2021) Eales Farm Landfill – Quarterly Monitoring (November 2020). Ref: GCE00692/LR15
[5] GCE (March 2021) Tamar View Landfill, Eales Farm, Saltash. Environmental Setting and Site Design Report. Reference: GCE00692/ESSD
[6] Caradon District Council (January 1975) River Fill, Second Phase. Decision Notice No.: 5/74/1136

1.2.5 Revision 1 of this report referred to the proposed additional waste as the “Tamar View Landfill”. Following the meeting on-Site and subsequent discussions between GCE and the Environment Agency it is now proposed that the Site’s existing Environmental Permit be varied (as opposed to obtaining a new Environmental Permit). On that basis, this report refers to the additional waste being accepted at the Site as the proposed Eales Farm Landfill extension as opposed to the Tamar View Landfill.

1.3 Previous Report (November 2017)

1.3.1 As part of the April 2018 Schedule 5 response, the Environment Agency provided comment and feedback on the November 2017 Hydrogeological Risk Assessment[7]. The response was separated into two Questions (Nos. 15 and 16) which are reproduced below:

1.3.2 ***Question 15. Hydrogeological Risk Assessment***

a) *Present a quantitative hydrogeological risk assessment (QHRA), based on the source-pathway-receptor principle, using the information from the April and August 2016 ground investigations and the groundwater and surface water monitoring data to date, for the status quo for the closed Eales Farm Landfill.*

b) *Present a QHRA for the additional waste scenario in which the Proposed Tamar View Landfill is constructed over the existing closed Eales Farm Landfill.*

c) *Describe and justify the modelling approach, assumptions, and parameters and their values. Your assessment should include a detailed water balance for each case.*

1.3.3 *Provide a 'Rogue Load' assessment.*

1.3.4 ***Reason**: A brief qualitative report has been presented but this is inadequate because it does not adequately establish the baseline conditions that exist prior to the proposed Tamar View Landfill being constructed over and separate from it in a 'piggyback' arrangement. It is necessary to establish the baseline conditions and how these could change with time without any further development taking place. We need to know this so that we have a handle on what to expect from the existing scenario for monitoring and compliance purposes. Not least this will be important to understand if there any significant changes to data trends and/or breaches of compliance criteria under the piggybacking scenario. Therefore we request that a quantitative assessment is presented so that the status quo impacts on groundwater and, importantly, surface water are better defined. And these can be compared with the results of the piggyback scenario, to ascertain if the piggyback scenario may lead to a worsening situation as far as impacts on surface water and groundwater are concerned, and whether that is considered acceptable or not.*

1.3.5 *The HRA should consider a rogue load risk assessment for accepting waste that is not inert (non-inert) for example, contaminated soil, or non-inert waste concealed within a load of waste that appears to be inert.*

1.3.6 ***Question 16. Hydrogeological risk assessment- Prior Investigation Table T-ESSD7 Chemical Test Results of existing waste in Eales Farm Landfill***

a) *Describe the test method and liquid to solid ratio that was used to derive the chemical composition data in Table T-ESSD7.*

b) *Present all chemical composition results from laboratory data sheets and a tabulated summary.*

c) *Explain why there are no data for Manganese in the chemical composition data, because it is present in significant concentrations in groundwater and the water in the culvert downstream.*

[7] GCE (November 2017) Tamar View Landfill, Eales Farm, Saltash. Hydrogeological Risk Assessment. Reference: GCE00692/HRA

d) *In a table present the chemical composition test data, inert WAC limits (specifying US ratio), and Environmental Quality Standards (e.g. Limit of detection, UK Drinking Water Standards, EQS) and compare data to assess whether or not they fall within inert WAC and determine the risk factors for each substance.*

e) *Describe the leachate source term for the existing waste based on your response.*

1.3.7 ***Reason**: It is important to determine whether or not the leachate source term from the existing waste meets inert WAC, and the risk factors for each substance detected. This can then be used to identify which substances may be looked at in detail for a more detailed, quantitative risk assessment, and to inform compliance criteria for surface water and groundwater. There is commentary on the arsenic and TPH but comparison with limit criteria is needed all the other substances. It is evident that for many other substances their composition greatly exceeds inert waste limit values, for example, such as Cd, Hg, Ni, Pb, and the waste is not inert waste. It is not clear whether all substances of relevance have been tested / reported. Chemical test results from ground investigation in 2016 are expressed in mglkg, but the test method and the liquid to solid ratio has not been specified. There are no data for Mn, yet it is present in significant concentrations in groundwater and the water in the culvert downstream. Why? It is not clear if Mn was analysed for in the waste samples. If not, explain why not?*

1.4 Previous Report (July 2018)

1.4.1 Feedback on Revision 1 of this HRA[2] was provided by the Environment Agency by email dated 5 October 2018. Given the nature of the feedback provided on the HRA and other reports, a follow-up meeting was held on-Site in March 2019 to review the Environment Agency's requirements.

1.4.2 During the follow up meeting it was agreed that many of the comments were not required to be addressed, however for completeness the key feedback has been reviewed in **Appendix B**.

1.5 Aims and Objectives

1.5.1 The aim of this assessment is to provide the Environment Agency with sufficient detail in relation to the potential impacts of the proposed inert landfill on the water environment. In response to Environment Agency feedback (both on the November 2017 HRA[7] and the July 2018 version[2]), this HRA considers risks to the water environment associated with the both the existing waste that has been placed (i.e. the existing Eales Farm Landfill) plus the importation and placement of further waste material (i.e. the Eales Farm Landfill extension) associated with proposed bespoke Environmental Permit.

1.5.2 To achieve the above aim, this hydrogeological assessment provides the following:

(i) *a review of existing site conceptual models (SCM) developed to date along with supporting data;*

(ii) *a controlled waters risk assessment to quantify the likely magnitude of environmental impacts from the deposition of further waste materials at the Site;*

(iii) *a description of the design, engineering and material acceptance principles that will underpin the proposed restoration scheme and how these features will help protect the water environment; and*

(iv) *recommendations for further assessment, monitoring, engineering decisions and waste acceptance procedures as appropriate.*

1.6 Data Sources

1.6.1 Horizon has been provided with selected reports, correspondence and other data by the Client for use in the preparation of this report, the information provided is considered reasonable for developing a ground model and Site Conceptual Model (SCM) for the purposes of preparing this hydrogeological risk assessment. Key reference documents include:

- GCE (May 2020) Eales Farm Landfill. Supplementary Ground Investigation. Report: GCE00692/R3[8].
- GCE (November 2017) Eales Farm Landfill, Eales Farm, Saltash. Environmental Setting and Site Design Report[9] plus drawings from the June 2020 update[5].
- GCE (November 2017) Tamar View Landfill, Eales Farm, Saltash. Hydrogeological Risk Assessment[7].
- GCE (November 2017) Tamar View Landfill, Eales Farm, Saltash. Site Condition Report[10].
- John Grimes Partnership (November 2016) Closure Report for Eales Farm Landfill, Carkeel, Cornwall[11].

1.7 Methodology

1.7.1 The approach, scope and methodology of this risk assessment have been developed and conducted in general accordance with Client requirements, UK guidance (in particular relevant guidance presented on the GOV.UK website[12, 13, 14]) and standards including documents published by the Environment Agency, DEFRA, British Standards Institute (BSI), Construction Industry Research and Information Association (CIRIA) and Contaminated Land: Applications in Real Environments (CL:AIRE).

1.7.2 In the event that significant residual uncertainties are identified, these are presented at the end of the report, along with recommendations to investigate these where appropriate.

[8] GCE (May 2020) Eales Farm Landfill. Supplementary Ground Investigation. Report: GCE00692/R3
[9] GCE (November 2017) Tamar View Landfill, Eales Farm, Saltash. Environmental Setting and Site Design Report. Reference: GCE00692/ESSD
[10] GCE (November 2017) Tamar View Landfill, Eales Farm, Saltash. Site Condition Report. Reference: GCE00692/SCR
[11] JGP (November 2016) Closure Report for Eales Farm Landfill, Carkeel, Cornwall. Ref: 12933/R6.
[12] https://www.gov.uk/guidance/risk-assessments-for-your-environmental-permit#risks-from-your-specific-activity [Accessed 21 April 2020]
[13] https://www.gov.uk/guidance/groundwater-risk-assessment-for-your-environmental-permit [Accessed 21 April 2020]
[14] https://www.gov.uk/guidance/landfill-developments-groundwater-risk-assessment-for-leachate [Accessed 21 April 2020]

2. Existing Site Condition & Proposed Works

2.1.1 The description of the Site and details relating to the Site history have been broadly drawn from documents originally submitted in support of the bespoke Environmental Permit application. For full details, reference should be made to the relevant reports, in particular the ESSD[5] and SCR[10].

2.2 Location

2.2.1 The Eales Farm Landfill (also referred to as "the Site") occupies an area of approximately 4.41 Ha and is located to the north of the Tamar View Industrial Estate, near Saltash, Cornwall. The Site location is shown on drawing a drawing reproduced from the ESSD[5] in **Appendix A**. The approximate centre of the Site is located at Ordnance Survey grid reference: 241393E, 060569N.

2.2.2 The Site is located in an area of mixed landuse. Residential properties associated with the village of Carkeel are located to the west of the Site and industrial units associated with Tamar View Industrial Estate are located to the south. To the north and east the land is predominantly used for agricultural purposes.

2.2.3 A location map is provided as **Figure 2-1** with the approximate boundary of the proposed Eales Farm Landfill extension shown in purple.

Contains Ordnance Survey data © Crown Copyright and database right 2014
Figure 2-1: Proposed Eales Farm Landfill Extension Location Plan

2.3 Eales Farm Landfill

2.3.1 The timeline associated with the existing Eales Farm Landfill is summarised as follows:

- **1889** – historical mapping shows the land to be a steep-sided valley used for agricultural purposes. A small stream is mapped flowing through the base of the valley in a south-west to north-easterly direction.
- **March 1974** – the planning permission was granted to John Garrett and Sons Ltd for waste disposal.
- **November 1990** - waste management licence issued to allow receipt of Category A (non-biodegradable wastes).
- **1991** – waste management licence transferred to Downderry Construction (Western) Ltd.
- **2004** – import of waste to the Eales Farm Landfill site is understood to have ceased.

- **March 2016** – an Enforcement Notice was issued by the Environment Agency with a series of landfill closure improvement programme requirements including submission of an updated Closure Report.
- **November 2016** - the Closure Report[11] was accepted by the Environment Agency;
- **Present Day** - the Eales Farm Landfill (permit no: EPR/MP3896HZ) is currently in the aftercare stage.

2.3.2 Waste deposition is understood to have initially commenced in the south-west corner of the existing Eales Farm Landfill site (extents as shown on the drawing in **Appendix A**) and gradually extended towards the north-east. Waste deposits now cover the majority of the Site, with the exception of the area south of the South West Water sewer (as shown on the drawing included in **Appendix A**). Further details in relation to related to the imported waste are presented in Section 3.4 of this report.

2.3.3 For description purposes, the existing Eales Farm Landfill is considered to comprise the following four areas (as summarised from the ESSD[5]):

- “Top” plateau in the south-west;
- Slope between the “Top” and “Bottom” plateaux;
- “Bottom” plateau in the north-east; and
- Area along northern boundary.

2.3.4 Within the area along the northern boundary a small pond (area roughly 250 m^2) is situated in the north-west corner of site. This pond receives water from off-site from the north and the west. An ephemeral stream flows in a ditch from the pond along the north boundary, exiting the site in the north-east corner.

2.3.5 The northern boundary is marked by a small earth mound (roughly 0.5 m high) and barbed wire fence. A small slope, roughly parallel to the north boundary and ditch, drops roughly 5 m in height from the north down to the south. Areas at the eastern end of the northern boundary are densely vegetated making it difficult to access in places.

2.3.6 The main site track, joining the “Top” and “Bottom” plateaux, heads north from the Site entrance (along the eastern boundary) bending round to the east along the base of the slope.

2.4 Existing Planning Permission

2.4.1 Planning permission was originally granted by Cornwall County Council in 1974. It is understood this planning permission is still valid and import and deposition of a further 250,000 m^3 waste would achieve the final profile as set out in the planning permission. For full details relating to the planning permission, refer to the ESSD[5].

2.4.2 The proposed Eales Farm Landfill Extension is intended to complete the waste deposition for which planning permission has been granted.

3. Geology

3.1.1 Sections 3, 4 and 5 set out the geological, hydrogeological and hydrological setting of the Eales Farm Landfill (which includes the proposed Eales Farm Landfill extension) based on review of previous reports developed for the Site, in particular the SCR[10], ESSD[5], Closure Report[11] and GCE's 2020 investigation[19] plus publicly available information. For further details reference should be made to previous reports where applicable.

3.2 Solid Geology

3.2.1 BGS mapping[15] indicates the Site is underlain by the Torpoint Formation. The Torpoint Formation is described as "*brownish purple to purplish red cleaved mudstone and fine-grained siltstone, yellowish to blue-green, fine- to coarse-grained siltstone and fine-grained sandstone. Colour mottling and transposition of colour by fluids may occur near faults. Green reduction spots are sporadically formed*."

3.2.2 The thickness of the Torpoint Formation is not known, however estimates from the BGS[16] suggest a minimum of 100 m to 200 m.

3.2.3 BGS geological mapping shows Devonian to Carboniferous unnamed microgabbro intrusions lie just south of the Site beneath the adjacent Tamar View Industrial Estate.

3.2.4 A copy of the BGS mapping from the ESSD[5] is reproduced in **Appendix A**.

3.3 Superficial Geology

3.3.1 BGS mapping indicates that superficial deposits are not present across the Site. Saltmarsh deposits (described as "*sand, silt and clay with organic debris*" are mapped along the northern boundary of the Site, associated with the unnamed water feature in this area.

3.4 Imported Waste (Eales Farm Landfill)

3.4.1 A series of boreholes and trial pits have been excavated across the footprint of the existing Eales Farm Landfill by JGP[11] and GCE[5] in 2016 and by GCE[6] in 2020. The Exploratory Hole Plan (**Appendix A**) shows the locations of the exploratory holes, with the logs reproduced in **Appendix C**.

3.4.2 The logs show a waste thickness ranging from 0.3 m (trial pit 19-02) to 22.3 m (borehole 19-5). Typically, the greatest waste thicknesses were identified in the centre of the Site, running in a south-west to north-east direction, consistent with the original profile of the valley.

3.4.3 A review of the exploratory hole logs indicates the majority of the waste mass comprises imported soil and stones. These were described as sand, clayey gravels and gravely clays in the logs. The gravel fraction predominantly comprised mudstones, with occasional sandstone, siltstone and some granite.

3.4.4 Anthropogenic inclusions mainly comprise brick fragments plus general rubble (e.g. breeze block, concrete). Rare localised inclusions such as plastic, asphalt, metal were noted, particularly in near-surface waste deposits.

[15] www.bgs.ac.uk [Accessed 27 June 2018]

[16] BGS (2018) National Geological Screening: South-West England Region. Minerals and Waste Programme Commissioned Report CR/17/095

3.5 Imported Waste (Existing Eales Farm Landfill) – Chemistry

3.5.1 **Table D1** in **Appendix D** summarises the results of the soil testing undertaken by JGP[11] and GCE[5] in 2016 and GCE[6] in 2020. In addition, **Table D2** in **Appendix D** summarises the results of the soil leachate testing undertaken by JGP[11] in 2016. The following observations are made on the basis of the soil chemical testing:

- The concentration of sum TPH was below the laboratory reporting limit (LRL) in 11 of the 79 samples tested. The concentration of sum TPH was only greater than 100 mg/kg in 11 samples as summarised in **Table 3-1** below. The TPH impacts identified were predominantly heavy end aliphatic and aromatic hydrocarbons, considered to be of low or very low overall mobility in groundwater[17]:

Location	Depth	Sum TPH Concentration (mg/kg)	Comment
MBH6	2.0	1,000	Leachate testing of the sample from this depth indicated a leached sum TPH concentration of 780 µg/l.
MBH6	10.0	340	
MBH10	6.0	3,700	The concentration of sum TPH at the deeper sample at this location (15 m bgl) was below the LRL.
MBH11	2.0	120	The concentration of sum TPH at the deeper sample at this location (6.0 m bgl) was 13 mg/kg compared with the LRL of 10 mg/kg.
B19-5	14.5	180	This sample predominantly comprised heavy end hydrocarbons (TPH >C_{21}-C_{35}).
B19-8	3.3	140	The concentration of sum TPH at the deeper sample at this location (5.6 m bgl) was 13 mg/kg compared with the LRL of 10 mg/kg.
TP08	1	140	This sample predominantly comprised heavy end hydrocarbons (TPH >C_{21}-C_{35}).
TP11	1.4	790	This sample predominantly comprised heavy end hydrocarbons (TPH >C_{21}-C_{35}). The concentration of sum TPH at the deeper sample at this location (3.0 m bgl) was 33 mg/kg.
TP15	2.5	200	This sample predominantly comprised mid to heavy end hydrocarbons (TPH >C_{16}-C_{35}). The concentration of sum TPH at the deeper sample at this location (4.2 m bgl) was 44 mg/kg.
TP23	1.00	1,800	These samples predominantly comprised heavy end hydrocarbons (TPH >C_{21}-C_{35}). The trial pit log notes a very strong odour of hydrocarbons.
TP23	2.5	600	

Table 3-1: Exploratory Holes where Sum TPH Greater Than 100 mg/kg

- Sum PAHs were detected above the LRL in 50 of the 79 samples tested. The concentration of sum PAHs was below 100 mg/kg in all samples apart four locations as summarised in **Table 3-2** below. The locations where elevated PAHs were detected correspondence with the locations where elevated petroleum hydrocarbons had been reported as shown in **Table 3-1** above.

[17] CL:AIRE (2017) Petroleum Hydrocarbons in Groundwater: Guidance on Assessing Petroleum Hydrocarbons Using Existing Hydrogeological Risk Assessment Methodologies.

Location	Depth	Sum TPH Concentration (mg/kg)
MBH10	6.0	160
MBH11	2.0	210
B19-5	14.5	200
B19-8	3.3	450

Table 3-2: Exploratory Holes where Total of 16 PAHs Greater Than 100 mg/kg

- Metals were generally detected at low concentrations. The concentration of arsenic in the sample from BH13 at 2.2 m (2,600 mg/kg) is considered to be a hotspot, given this concentration was nearly an order of magnitude greater than arsenic concentrations detected elsewhere.
- Soil samples were not tested for manganese in 2016, however as part of the 2020 investigations 23 samples were tested, with reported concentrations ranging between 1,000 mg/kg and 3,300 mg/kg.

3.5.2 Soil leachate testing was undertaken on ten samples by JGP and reported in the Closure Report[11]. The leachate testing was undertaken by Chemtest in accordance with the NRA method (i.e. soluble and suspended species leached from the sample using water with a pH of approximately 5.6 at a ratio of 1:10 over a 24 hour period). In summary:

- The majority of leached concentrations were below the adopted assessment criteria (e.g. Environmental Quality Standard (EQS) or Drinking Water Standard (DWS).
- Sum TPH was only detected above the LRL in one soil leachate sample (MBH6 at 2.0 m as per **Table 3-1** above).
- Manganese was not included in the soil leachate testing (nor is manganese included in the inert WAC leachate testing, see Section 3.7 below).

3.6 Naturally Occurring Contaminants

3.6.1 Drawings from the BGS's UK Soil Observatory showing background concentrations of arsenic, lead and manganese are presented in **Appendix E**.

3.6.2 Given that waste materials placed in the Eales Farm Landfill will have been imported from locations across the surrounding area (likely a 20 miles radius, although potentially greater based on Horizon's experience), the review of background soil chemistry has not focussed solely on the geology of the Torpoint Formation.

3.6.3 The South-West is a highly mineralised area due to the geological history of the region. Elevated concentrations of arsenic occur naturally in many soils across the South-West; with extraction and mining of arsenic undertaken at a number of locations across Devon and Cornwall. The BGS maps show significantly elevated concentrations of naturally occurring arsenic located to the north of the Site, in particular in the vicinity of Gunnislake where the English Arsenic Company historically established a substantial works.

3.6.4 Manganese is identified as occurring at elevated concentrations locally, with particularly significant concentrations found in soil to the west of the Site. Historically manganese ore was crushed using a waterwheel at Morewellham Quay[18], located upstream on the River Tamar.

3.6.5 In addition to arsenic and manganese, lead is also found at elevated concentrations locally, as shown on the plan in **Appendix E**.

[18] Association for Industrial Archaeology (1998) A Guide to the Industrial Archaeology of Devon

3.7 Imported Waste (Existing Eales Farm Landfill) – Classification

3.7.1 The Eales Farm Landfill was originally a Category A dilute and disperse facility licensed to accept non-biodegradable waste. It is not considered appropriate to describe the waste that has been placed historically as "inert" (when classified in accordance with current WM3 guidance[1]).

3.7.2 Notwithstanding this, a review of the soil chemistry, excluding asbestos, has been undertaken by Horizon to evaluate whether the placed material would be considered "hazardous" or "not-hazardous" when classified in accordance with current guidance[1] on the basis of the total concentrations of contaminants in soil. Horizon has utilised a bespoke in-house tool to undertake the hazardous properties assessment.

3.7.3 The principal aim of this task was to identify contaminants within the existing Eales Farm Landfill source with the potential to leach and therefore warrant further assessment as part of this hydrogeological risk assessment. The majority of the 79 samples were considered to be not-hazardous; notable exceptions are identified in **Table 3-3** below:

Borehole	Depth	Hazardous Properties	Comment
MBH6	2.0	HP7, HP14.	Waste contaminated with oil and PAHs.
MBH10	6.0	HP7, HP14.	Waste contaminated with oil and PAHs.
MBH11	2.0	HP14	Waste contaminated with PAHs.
MBH13	2.2	HP6, HP7, HP14	Elevated concentration of arsenic (2,600 mg/kg)

Table 3-3: Notable Samples Not Meeting Definition of Not-Hazardous

3.7.4 The additional testing in 2020 did not identify any samples which would be considered as "hazardous" from a disposal perspective, however elevated hydrocarbons (sum TPH 1,800 mg/kg) was identified in trial pit TP23 at 1.0 m. Given the sum TPH at 2.5 m depth in this trial pit had reduced to 600 mg/kg and the impacts comprised predominantly heavy end hydrocarbons, the impacts identified are not considered to warrant specific assessment.

3.7.5 The second stage of the process, evaluation of WAC data, is used to determine whether soils may be suitable for disposal as inert waste. WAC testing data is presented in the JGP report for five soil samples, four of which meet the inert WAC limits.

3.7.6 The leached concentration of arsenic in the sample from borehole MBH9 at 5.0 m (1.6 mg/kg) slightly exceeded the inert WAC limit (0.5 mg/kg). This sample was not tested for total soils chemistry, however as discussed in Section 3.6 above arsenic is routinely found to naturally occur at elevated concentrations in soils in the South-West.

3.7.7 It is noted that whilst the samples in **Table 3-3** would be classified as "hazardous" waste if disposed to landfill based on current guidance, review of the soil chemistry indicates that the majority of the contaminants present comprised heavy end hydrocarbons of low environmental mobility.

4. Hydrogeology

4.1 Regional Setting

4.1.1 A summary of the aquifers present within the vicinity of the Site is provided in **Table 4-1** below:

Geology	Designation	Description
Saltash Deposits	Secondary Undifferentiated	Assigned in cases where it has not been possible to attribute either category Secondary A or Secondary B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.
Torpoint Formation	Secondary A Aquifer	Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers;

Table 4-1: Summary of Aquifers Present Within the Vicinity of Proposed Eales Farm Landfill Extension

4.1.2 The Site is not located within a groundwater Source Protection Zone (SPZ). An outer source protection zone is located approximately 510 m east of the Site (see drawing from ESSD[5] reproduced in **Appendix A**). The source protection zone is associated with an abstraction at the China Fleet Country Club more than 1 km east of the Site.

4.1.3 The Site is not located in a nitrate vulnerable zone. Groundwater vulnerability for the Site (based on regional 1:100,000 scale mapping) is considered to be intermediate on the basis of soils of intermediate leaching potential.

4.2 Groundwater Flow

4.2.1 Subsequent to issue of the revision 1 of this report[2], a number of additional monitoring wells have been installed at the Site, including up gradient monitoring well BH19-1, cross-gradient monitoring well BH19-3 and downgradient monitoring wells BH19-2 and BH19-6. This has allowed a more detailed assessment of groundwater and leachate levels, particularly with respect to the boundary between the existing waste mass and the underlying mudstone, and an interpretation of water flow direction.

4.2.2 **Table D0** (**Appendix D**) presents the water level data for all wells with **Table 4-2** summarising key data for wells screened in the mudstone.

Well	Mudstone Elevation (m AOD)	Groundwater Elevation (m AOD)		Range in Groundwater Elevation (m)	Unsaturated Zone Thickness Beneath Waste (m)	
		Maximum Recorded	Minimum Recorded		Minimum Recorded	Maximum Recorded
B19-1	71.3	65.5	64.6	0.9	5.8	6.7
B19-2	32.7	30.0	27.9	2.2	2.6	4.8
B19-3	58.9	58.2	57.6	0.6	0.7	1.3
B19-4	27.9	27.9	25.1	2.8	0.0	2.8
B19-5a	21.8	**25.5**	**25.0**	0.5	**-3.7**	**-3.2**
B19-6	32.2	31.1	29.5	1.6	1.1	2.7
B19-7a	29.8	**32.1**	23.1	9.0	**-2.3**	6.7
B19-8a	40.8	38.5	37.4	1.1	2.4	3.4
B19-9a	33.4	31.5	29.1	2.4	1.9	4.3
MBH11B	37.7	36.7	32.2	4.5	1.0	5.5
MBH1A	69.15	**69.4**	67.8	1.6	**-0.2**	1.4
MBH1B	69.2	**62.2**	66.5	3.9	**-1.2**	2.7
MBH2B	60.4	**68.9**	58.6	10.3	**-1.8**	1.8
MBH7B	63.9	58.6	55.6	3.1	5.2	8.3

Notes:
BOLD - Denotes water level potentially within overlying waste mass.
Some uncertainties have been identified within the historic dataset. These have generally been included to be conservative, however the interpretation and ground model developed have taken these into account.

Table 4-2: Summary of Aquifers Present Within the Vicinity of Proposed Eales Farm Landfill Extension

4.2.3 In summary:

- Groundwater levels in boreholes screened within the underlying bedrock generally indicate that the upper bedrock is unsaturated. The principal exceptions here are newly installed wells BH19-5a and BH19-7a where the water level recorded in the monitoring well suggests the piezometric surface is within the waste deposits. These two wells have been drilled along the line of the historical stream (now culverted) that ran along the base of the valley floor, and the water recorded in the wells is interpreted to be due to the water flowing in the culvert backfill (i.e. the water sampled from monitoring point MSW3) as opposed to groundwater. The culvert is discussed in more detail in Section 5.2 and is due to be abandoned as part of the proposed landfill extension with a new culvert installed. The influent flow from the Tamar View Industrial Estate will be diverted into the new culvert which will be brought to a surface channel at the pond on the north boundary. Any water leaking from this culvert will cease to leak into the surrounding soils, however it is anticipated that there will still be a degree of water flow accumulating on the old valley floor and following the old culvert backfill.
- The thickness of this unsaturated zone (i.e. unsaturated mudstone beneath the waste mass) varies across the Site, with the pattern generally following the historical topography of the steep sided valley (i.e. greater thicknesses of unsaturated mudstone towards the north and south of the Site away from the base of the valley feature).
- The range in water elevations recorded was typically between 1 m and 3 m. The principal exception to this was monitoring well MBH4, with a range of 7.82 m between the maximum and minimum readings. This well is located hydraulically upgradient of the Site, towards the west and is screened in the waste mass. The variation in water levels is interpreted to be a function of the seasonal recharge in this area.

4.2.4 The conceptual model has been refined slightly to take into account the additional data, with the unsaturated zone pathway thickness reduced to a minimum of 0 m (from 1 m) and a maximum of 3 m in the Eales Farm Landfill model (see **Table D9A** in **Appendix D**). However, the overarching assumption remains that the waste mass in the existing Eales Farm landfill is generally unsaturated.

4.2.5 Review of the additional elevation data confirms the east / north-easterly flow direction originally interpreted in the ESSD[5] based on water levels in the mudstone recorded in the monitoring well network. This is consistent with regional topography.

4.2.6 A hydraulic gradient of approximately 0.12 was calculated for use in the revision 1 of this report[2], based on the groundwater contours shown in the 2018 revision of the ESSD[9]. The additional monitoring wells, including location BH19-5 located at the hydraulically downgradient end of the Site targeting the base of the historic steep-sided valley, has allowed this value to be refined and a hydraulic gradient of between 0.12 and 0.14 has been estimated between wells BH1 and BH19-5.

4.3 Groundwater Abstractions (March 2015)

4.3.1 A number of groundwater abstractions are located within a 1 km radius of the Site. A plan reproduced from the Envirocheck included in the ESSD[5] is presented in **Appendix G** showing the locations of abstractions within a 1 km radius of the Site. The majority of these are located hydraulically upgradient of the Site. The two abstractions located to the north-east of the Site (i.e. hydraulically downgradient) are summarised in **Table 4-3** below:

ID*	Distance / Direction From Site	Location	Use
38	263 North-East	241600E 060900N	General Farming & Domestic.
39	464 North-East	241900E 060900N	General Farming & Domestic.
Notes: * ID relates to abstraction as shown on plan in **Appendix G**			

Table 4-3: Surface Water Monitoring Locations

4.4 Leachate Quality

4.4.1 Water samples from wells screened within the waste mass (Eales Farm Landfill) have been obtained from two monitoring locations as shown on the exploratory hole plan (**Appendix A**) and described in **Table 4-4** below. The water samples obtained from these locations are considered to represent "leachate" from the waste mass in the vicinity of the well.

4.4.2 In total 23 wells are screened with the waste mass; the remaining wells are reported as being dry (i.e. sufficient "leachate" has not accumulated within the remaining wells to enable sampling).

ID	Location	Response Zone	Comment
MBH2A	Existing Eales Farm Landfill (to west of Proposed Eales Farm Landfill Extension).	2.6 – 6.8	Dual installation well at this monitoring location.
MBH9	Eastern boundary of Proposed Eales Farm Landfill Extension (hydraulically downgradient borehole).	2.6 – 10.6	Well sampled on one occasion only (well dry on other monitoring visits).

Table 4-4: Leachate Quality Monitoring Locations

4.4.3 The following observations are made in relation to leachate quality:

- Sum TPH and sum PAHs were not detected above the LRL in any of the samples; and
- Only manganese and iron plus ammoniacal nitrogen were consistently detected above the adopted assessment criteria.

4.5 Groundwater Quality

4.5.1 Groundwater samples from wells screened within the underlying bedrock were routinely obtained from four monitoring locations, as shown on the exploratory hole plan (**Appendix A**) and described in **Table 4-5** below. In addition, samples have been obtained on one occasion from six newly installed wells in 2020.

ID	Location	Response Zone	Comment
MBH1B	Western boundary of Existing Eales Farm Landfill. Hydraulically upgradient borehole.	7.3 – 10.4	
MBH2B	Existing Eales Farm Landfill (to west of Proposed Eales Farm Landfill Extension).	11.0 – 26.0	Dual installation well at this monitoring location.
MBH7B	Southern Boundary of Proposed Eales Farm Landfill Extension.	7.3 – 16.8	
MBH11B	North-eastern corner of Proposed Eales Farm Landfill Extension (hydraulically downgradient borehole).	8.5 – 15.2	

Table 4-5: Historic Groundwater Monitoring Locations

4.5.2 The following observations are made in relation to groundwater quality:

- Sum PAHs was only detected above the LRL (2 ug/l) in one sample (2.8 ug/l in a sample from BH2B in February 2018). Sum TPH was generally below the LRL in all samples apart from minor isolated detections as summarised in **Table 4-6** below;
- Similar to the leachate results, the principal exceedances of the adopted assessment criteria were manganese, iron and ammoniacal nitrogen. The ESSD[5] notes the presence of two septic tanks located to the west of the Site which may represent a source of ammoniacal nitrogen.
- The main manganese detections were in well BH-2B located towards the west of the existing Eales Farm Landfill Site outwith the proposed footprint of the Eales Farm Landfill Extension. The concentrations were generally lower in the groundwater sample than the overlying leachate sample. Concentrations of manganese in hydraulically downgradient locations beneath the body of the existing Eales Farm Landfill site were consistently lower than in upgradient location BH-2B.

Location	Date	Sum TPH Concentration (µg/l)
MBHB2B	6 July 2017	150
MBH7B	11 August 2016	930
MBH11B	11 August 2016	340
BH19-3	21 May 2020	150

Table 4-6: Sum TPH Detections in Groundwater

4.6 Aquifer Properties (Torpoint Formation)

4.6.1 Aquifer properties for the Torpoint Formation are variable with the BGS Minor Aquifers Manual[19] noting that "*limestone horizons within both the Saltash and Torpoint formations can provide above-average yields if solution features encountered. Sustained yields from slates and grits reported as difficult.*"

[19] BGS (2000) The Physical Properties of Minor Aquifers in England and Wales.

4.6.2 Site specific data in relation to the shallow aquifer in the immediate vicinity of the Site is reported in the ESSD[5]. Specific observations in relation to anticipated aquifer properties are as follows:

- Fracture flow is anticipated to be the predominant flow mechanism[20].
- The BGS allocates Devonian siltstone and mudstone permeability codes of moderate to low.
- Infiltration tests within the waste mass have indicated a range of permeability values between 5.4×10^{-6} m/s and 3.5×10^{-7} m/s. Laboratory based testing of waste samples reported vertical permeability between 2.75×10^{-10} m/s and 4.78×10^{-10} m/s.
- Typical values for slate tend to range between 5×10^{-6} m/s to 5×10^{-9} m/s (BGS, 2006[20]) with Site specific values for the bedrock reported in the ESSD[5] ranging from 4.45×10^{-6} m/s and 8.78×10^{-6} m/s.

[20] BGS (2006) Guide to Permeability Indices. Ref: Open Report CR/06/160N.

5. Hydrology

5.1.1 The location of surface water features in the vicinity of the Site is shown on a drawing from the ESSD[5], reproduced in **Appendix A**. In summary, these include:

- An historical stream, assumed to be spring-fed, crossing the Site in a south-west to north-easterly direction. This stream is no longer at surface following the deposition of waste associated with the existing Eales Farm Landfill, however a culvert passes beneath the Site consistent with the former alignment. This culvert was reportedly placed in sections as waste was deposited (see Section 5.2 below for additional details).
- A pond located in the south-west corner of the Eales Farm Landfill site (i.e. to the south-west of the proposed Eales Farm Landfill extension), and an open ditch, aligned along the north-western boundary of the Eales Farm Landfill site, which discharges into a second pond in the north-west corner of the proposed Eales Farm Landfill extension. A small unnamed stream flowing in a southerly direction is located to the north of the Site and also discharges into this second pond.
- An open ditch, located along the northern boundary of the Site, connecting the second pond with the culvert outlet in the north-east of the Site.
- An unnamed stream which flows from the culvert outfall (north-east corner of the Site), discharging into Hole Creek approximately 150 m north-east of the Site. Hole Creek flows into Kingsmill Lake, which forms part of the tidal River Tamar.

5.1.2 Review of the National River Flow Archive[21] did not identify any monitoring stations hydraulically downgradient of the Site.

5.1.3 Given the elevation of groundwater in boreholes to the north-east of the Site compared with the elevation of the unnamed tertiary river, the river is not considered to be consistently groundwater-fed from water in the Torpoint Formation in the immediate vicinity of the Site downgradient of the waste mass. There is likely to be a degree of recharge from the old culvert plus water infiltrating through the existing Eales Farm Landfill waste mass, with this water accumulating on the old valley floor and following the culvert backfill.

5.2 Old Culvert

5.2.1 The Closure Report[11] states that a CCTV survey confirmed the 900 mm diameter culvert only carried surface water drainage from the Tamar View Industrial Estate to the south. The Closure Report[11] concluded that "*the original watercourse flows within the granular fill upon which the culvert was constructed*" noting that flows had been observed from "*both within and beneath the culvert where it discharges into the watercourse at the north-east corner of the Site.*"

5.2.2 Following discussions with the Environment Agency, this old culvert is to be abandoned with a new shallow culvert installed around the southern perimeter of the Eales Farm Landfill, crossing to the west of the area where additional material is to be placed and discharging into the pond to the north of the Site. Plans showing the new culvert are included in **Appendix F** (reproduced from the ESSD). For the remainder of this report the existing culvert is referred to as the old culvert (works to install the new shallow culvert are planned for 2020).

5.2.3 The old culvert is not to be decommissioned and is assumed to continue to act as a preferential pathway or conduit for any water migrating vertically down through the waste deposits.

[21] https://nrfa.ceh.ac.uk/ [Accessed 28 June 2018]

5.3 Flood Risk

5.3.1 The Environment Agency Flood Map for Planning[22] shows that the proposed Eales Farm Landfill extension is situated in Flood Zone 1 and the flood risk to the proposed development is considered to be low.

5.3.2 A review of Environment Agency mapping suggests the Site may form a pathway for overland flow to watercourses, with surface water flow from the Site discharging to the unnamed water feature to the north-east of the Site. This pathway would change following the import of waste materials associated with the proposed Eales Farm Landfill extension. Long term surface water management following restoration of the proposed Eales Farm Landfill extension is set out in the ESSD[5] with drawings reproduced in **Appendix A**. It is envisaged that Site topography will be used to direct water into the ditch along the northern boundary of the Site.

5.3.3 The Site is not located in a Critical Drainage Area. A Critical Drainage Area associated with the catchment area that drains to the Latchbrook Leat is located to the south of the Site and includes part of the Tamar View Industrial Estate[23].

5.4 Surface Water Quality

5.4.1 Surface water samples have been routinely obtained from five monitoring locations, as shown on the drawing in **Appendix A**) and described in **Table 5-1** below. In addition, two new monitoring locations (MSW6 and MSW7) were added in 2019.

ID	Location
MSW1	Sample obtained from unnamed stream flowing in a southerly direction to the north of the Site prior to discharging into pond located in north-west corner of the proposed Eales Farm Landfill extension. Considered to represent water quality "upstream" of Site.
MSW2	Sample obtained from pond located in north-west corner of proposed Eales Farm Landfill extension.
MSW3	Sample obtained from water flowing beneath old culvert where it discharges into the watercourse at the north-east corner of the Site.
MSW4	Sample obtained from old culvert outfall in north-east corner of Site. Considered to represent water quality "downstream" of Site within old culvert.
MSW5	Sample obtained from manhole accessing old culvert located in south-west corner of Eales Farm Landfill site. Considered to represent water quality "upstream" of Site within old culvert (i.e. principally surface water drainage from the Tamar View Industrial Estate).
MSW6	Seepage issuing to the north-west (right hand side looking upstream) of the culvert.
MSW7	Sample obtained from stream approximately 10 m downstream of the culvert outfall.
Notes: Locations MSW6 and MSW7 monitored on a temporary basis following March 2019 meeting.	

Table 5-1: Surface Water Monitoring Locations

5.4.2 The results of the surface water quality sampling undertaken by JGP and GCE are presented in **Table D4** of **Appendix D**.

5.4.3 It is noted that in the JGP report[11], the labelling for the sample locations MSW3 and MSW4 is contradictory, with the figure showing MSW3 as the old culvert outfall whilst the table in the report text shows MSW4 as the report outfall. Horizon has reviewed the data for these locations and based on the results reported and looking at the overall results for each population, Horizon has inferred that the data from the August 2016, May 2017 and July 2017 sampling events were incorrectly labelled. The data presented in Horizon's table in **Appendix D** has been updated accordingly.

[22] https://flood-map-for-planning.service.gov.uk/ [Accessed 4 June 2018]
[23] https://www.cornwall.gov.uk/media/16936479/saltash-cda-2015.pdf [Accessed 27 June 2018]

5.4.4 The tables highlight minor exceedances of the adopted assessment criteria (typically the Environmental Quality Standard (EQS) or Drinking Water Standard (DWS), albeit these exceedances are typically associated with concentrations close to or at the LRL.

5.4.5 The following observations are made in relation to the current dataset:

- The water quality in location MSW1, considered to represent water quality upgradient of the Site and in location MSW2 (pond in the north-west corner of Site, partially fed by the water from location MSW1) is generally relatively similar. Horizon has calculated the relative percentage difference (RPD) between the two samples for each contaminant on each sampling occasion, the results are presented in **Table D5a** of **Appendix D**. The results show a strong degree of correlation between the two samples with the percentage difference between the upstream and downstream samples generally below 100%. Where minor deviations are noted, these typically relate to low concentrations close to the assumed LRL.
- Comparison of water quality in locations MSW1 and MSW2 indicates that the majority of detections above the LRL were below the applicable assessment criteria. A spike in manganese was reported in the most recent sampling event from off-site location MSW1.
- The percentage difference between the upstream (MSW5) and downstream (MSW4) culvert samples was not calculated in revision 1 of this report[2] given only one upstream sample had been obtained at that time. Subsequently, a number of additional samples have been obtained allowing a useful comparison between upstream and downstream concentrations (**Table D5b** in **Appendix D**).

5.4.6 Elevated concentrations of manganese were detected in the downstream surface water samples, compared with the upstream sample. This is not reflected in the data from sample location MSW3 (water flowing beneath the culvert) and the reason for this increase in manganese has not been identified at this time.

- The water in location MSW3 is anticipated to represent a mixture of landfill leachate, surface water associated with historical stream (potentially discharging from spring upgradient of Site) and water from the old culvert escaping through the cracks noted in the CCTV survey. The water quality in location MSW3 was significantly better than that reported in locations MSW4 and MSW5.
- Location MSW7 has only been sampled once, and it is not considered appropriate to draw conclusions regarding the data at this time. Based on the sample collected contaminant concentrations were generally low, reflecting the diluted water in the sample including water from the old culvert, water flowing beneath the old culvert and water from the existing perimeter ditch.

5.5 Amenity Resources / Conservation Interests

5.5.1 A Site of Special Scientific Interest (SSSI) and Special Area of Conservation (SAC) are located to the east of the Site, associated with the Tamar-Tavy Estuary as shown on plans reproduced from Magic Maps in **Appendix H**.

5.5.2 Whilst the SSSI and SAC are associated with the water environment, given the relatively low flows in the unnamed tertiary river which flows in a north-easterly direction from the north-east corner of the Site, these are not considered water dependent conservation interests for the purposes of this hydrogeological risk assessment.

6. Proposed Eales Farm Landfill Extension

6.1 Imported Material

6.1.1 The ESSD[5] envisages a range of materials meeting the following waste codes will be disposed of at the proposed Eales Farm Landfill extension as set out in **Table 6-1** below. Any waste accepted at the Site is to meet the definition of inert waste, classified with reference to current technical guidance on the classification of wastes[1].

Waste Code	Description
01 01 01	Wastes from mineral metalliferous excavation
01 01 02	Wastes from mineral non-metalliferous excavation
01 04 08	Waste gravels and crushed rocks other than those mentioned in 01 04 07
01 04 09	Waste sand and clays
17 01 01	Concrete
17 01 02	Bricks
17 01 03	Tiles and ceramics
17 01 07	Mixtures of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06
17 05 04	Soil and stones other than those mentioned in 17 05 03
17 05 06	Dredging spoil other than those mentioned in 17 05 05
19 12 09	Minerals (for example sand, stones)
20 02 02	Soil and stones

Table 6-1: Proposed Waste Codes (From ESSD)

6.1.2 Some materials are reasonably predictable in their chemical signature, but others such as waste soils from contaminated sites have the potential to contain a wide range of chemicals. Under the proposed works, material acceptance will follow a clearly defined procedure to provide stakeholders with confidence in the imported and placed material.

6.1.3 For the purposes of this hydrogeological assessment it is assumed that the fill material would meet the definition of inert waste, classified with reference to current technical guidance on the classification of wastes[1].

6.1.4 By definition, inert waste deposited at the proposed Eales Farm Landfill extension should be stable and non-reactive. There should be no reactive or hazardous substances in any leachate generated. However, given the types of waste accepted there is potential for inclusion of trace quantities of some substances that may be leachable in infiltrating rainwater (e.g. chloride, sulphate).

6.1.5 On that basis **Table D7** of **Appendix D**, sets out the priority contaminants and assumed source concentrations (based on the inert WAC limits) modelled in the hydrogeological risk assessment. For all contaminants where the inert WAC limit is based on a leached concentration, the hydrogeological assessment assumes these contaminants are uniformly distributed throughout the imported fill at a concentration ranging from the Laboratory Reporting Limit (LRL) to the inert WAC limit. All contaminant concentrations are entered in mg/l.

6.1.6 For contaminants where the inert WAC limit is based on a total soils concentration (i.e. in mg/kg) these contaminants are also assumed to be uniformly distributed throughout the imported fill at a concentration ranging from the LRL to the inert WAC limit. An indicator Contaminant of Potential Concern (COPC) has then been adopted to facilitate modelling of groups of contaminants as presented in **Table D7** of **Appendix D** and summarised in **Table 6-2** below. The indicator COPC has been selected on the basis of being a compound that is more readily soluble and mobile in the water environment, thereby representing a conservative assessment of potential contaminant migration in the subsurface.

6.1.7 The use of a range of concentrations is considered to be appropriate given processes such as degradation and retardation in the unsaturated zone has not been included in the model (see Section 8 for further details) and organic contaminants will, in fact, routinely degrade in the subsurface. In addition, based on Horizon's experience classifying soils from development projects for disposal as inert waste, most Sites, in particular on greenfield developments, do not report hydrocarbons above the LRL. This approach is considered to reflect the source term in the existing Eales Farm Landfill with the expectation that material placed in the proposed Eales Farm Landfill extension is likely to be derived from a similar range of development projects in the local area.

Determinand	Indicator COPC
Sum of BTEX (Benzene)	Not included in model. BTEX compounds not identified in any soil samples from across Eales Farm Landfill waste mass which is anticipated to be similar to material to be imported to the Proposed Eales Farm Landfill Extension.
PAH Sum of 17 (Benzo(a)pyrene)	Modelled as benzo(a)pyrene
PAH Sum of 17 (Naphthalene)	Modelled as naphthalene.
Mineral Oil (TPH Aliphatic C5-C6)	Modelled as TPH Aliphatic C5-C6.

Table 6-2: Indicator COPCs

6.2 Engineering Design Principles

6.2.1 Detailed engineering design for the proposed Eales Farm Landfill Extension is set out in the ESSD[5]. The summary below outlines Horizon's understanding of the anticipated site design and construction:

- Enabling works are planned prior to waste import to include site establishment, construction/improvement of surface water ditches and containment ponds plus improving access and security measures.
- As part of the enabling works the surface water containment ponds are to be lined with clean imported clays (permeability no greater than 1×10^{-9} m/s).
- Placement of waste is to take place as shown on the phasing drawings in **Appendix A**. Prior to placement of waste, a low permeability clay layer is to be placed over the existing waste comprising either imported clay or re-engineered existing clay.

6.3 Water Management

6.3.1 It is intended to restrict the wastes imported to materials that meet the definition of inert (classified in accordance with WM3[1]) based on rigorous Site-specific pre-acceptance and on-Site inspection procedures. Whilst the hydrogeological risk assessment has assumed that leaching of contaminants will occur, this is a conservative assumption for modelling purposes, given the benign nature of the material proposed to be imported.

6.3.2 Leachate generation is not anticipated to occur to a significant degree and neither active nor passive leachate management measures are planned.

7. Ground Model Interpretation

7.1.1 The ground model and SCM developed here is based on the available information relating to the Site, as discussed in Sections 3 to 6 above, and is considered to be adequate for the purposes of this hydrogeological assessment.

7.1.2 An indicative cross-section developed in the ESSD[5] is considered to provide a useful, albeit simplified, understanding of the geological setting and is reproduced in **Appendix A** for reference.

7.1.3 The existing Eales Farm Landfill is a former unlined dilute and disperse landfill and covers an area of approximately 7.62 Ha, with waste thickness ranging from around 0.3 m to a maximum recorded thickness of 22.3 m. The majority of the waste deposited comprises soil plus construction and demolition rubble, with some minor anthropogenic inclusions such as plastic and metal noted. The intention is for additional waste (known as the Proposed Eales Farm Landfill Extension) to be placed on top of the majority of the existing Eales Farm Landfill waste.

7.1.4 A low permeability clay layer is to be placed over the majority of the waste currently in-situ prior to placement of waste as part of the Proposed Eales Farm Landfill Extension which will reduce effective rainfall and therefore the potential for leaching of residual contaminants within the existing waste mass.

7.1.5 Chemical testing of the waste deposited historically (i.e. the existing Eales Farm Landfill) indicates that the majority of the waste would meet the current definition of “inert” waste (noting that this is a current standard and was not applicable at the time the waste was deposited). A few isolated hotspots have been identified with elevated concentrations of TPH and PAHs.

7.1.6 The Site is located in an area of the UK where contaminants including arsenic, lead and manganese are found to occur naturally at elevated concentrations. Soil testing has identified elevated arsenic concentrations, including one significant hotspot plus WAC testing has identified one sample with elevated arsenic compared with the inert WAC limit. Elevated concentrations of manganese have been detected in surface water (both upgradient and downgradient of the Site) and groundwater testing.

7.1.7 The existing Eales Farm Landfill waste mass is considered to be unsaturated, with groundwater in the underlying bedrock typically between 1 m and 7 m below the base of the waste. Water flowing in and around the old culvert is likely to be locally influencing water levels recorded in monitoring wells placed towards the base of the historic valley towards the north-east of the Site.

7.1.8 The underlying bedrock is of relatively low permeability with flow predominantly through fractures although localised limestone horizons may provide above-average yields.

7.1.9 Water flowing through the culvert beneath the Site is considered to represent surface water drainage from the Tamar View Industrial Estate and given the poor condition of the culvert water flowing in the pipe backfill is likely to include an element of recharge from the culvert as opposed to purely representing leachate from the landfill. Both the culvert and the backfill water, plus the drainage ditch along the northern boundary of the Site discharge into the unnamed tertiary river located in the north-east corner of the Site.

7.1.10 At this time, the reason for the elevated concentrations of manganese in the discharge from the old culvert, compared with concentrations in the upstream sample and water flowing beneath the culvert, has not been identified. Works are planned to abandon the old culvert following which further monitoring of the manganese should be undertaken.

7.1.11 Given the elevation of groundwater in boreholes to the north-east of the Site compared with the elevation of the unnamed tertiary river, the river is not considered to be groundwater-fed in the immediate vicinity of the Site. There is likely to be a degree of recharge from the old culvert plus water infiltrating through the existing Eales Farm Landfill waste mass, with this water accumulating on the old valley floor and following the culvert backfill.

7.1.12 The materials that will be deposited at the Site as part of the proposed Eales Farm Landfill extension will comprise imported inert materials (classified in accordance with WM3[1]), to be imported, placed and compacted under strict waste acceptance procedures and CQA procedures.

8. Hydrogeological Risk Assessment

8.1 Risks to Controlled Waters

8.1.1 Development and refinement of a Site Conceptual Model (SCM) underpins the process through which risks associated with contaminated sites are evaluated in the UK irrespective of the context (e.g. whether the site is being developed under planning, assessed under Part 2A of the Environmental Protection Act 1990, or being evaluated under the environmental permitting regime). The SCM identifies the possible relationships between contaminants, pathways and receptors and is used to identify relevant contaminant linkages that may warrant further assessment and/or remedial actions.

8.1.2 Consistent with DEFRA guidance[24]:

- *"A "contaminant" is a substance which is in, on or under the land and which has the potential to cause significant harm to a relevant receptor, or to cause significant pollution of controlled waters;*
- *A "receptor" is something that could be adversely affected by a contaminant, for example a person, an organism, an ecosystem, property, or controlled waters; and*
- *A "pathway" is a route by which a receptor is or might be affected by a contaminant."*

8.1.3 This report presents a site-specific evaluation of individual contaminant linkages to further evaluate potential risks to controlled waters receptors from material imported and placed on-Site during the restoration works.

8.2 Contaminant Linkages

8.2.1 The SCM has been developed by Horizon on the basis of available information relating to the Site setting and the proposed restoration works. A source-pathway-receptor linkage is required to exist in order for a risk to be present. This means that there has to be a contaminant present, a receptor that could be harmed by this contaminant, and a pathway linking the two.

8.2.2 This hydrogeological assessment is primarily associated with risks to controlled waters and associated users as opposed to the broader range of receptors typically considered under the planning regime (e.g. humans, controlled waters, ecological habitats and buildings). **Table 8-1** shows the receptors which have been identified as being at potential risk from contamination at the Site.

[24] DEFRA (2012) Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance

Receptor	On-Site	Off-Site	Rationale
Humans	No	Yes	It is proposed to restore the Site to agricultural use following placement of waste deposits. On-Site users are anticipated to be transient in nature (e.g. farm workers) and have therefore not been considered further as part of this hydrogeological assessment. Should this change it is assumed that a separate risk assessment report will be prepared to evaluate risks to human health at a later date. Off-site human receptors might include occasional users of the Hole Creek and users of water abstractions. On the basis that the majority of the groundwater abstractions within a 2 km radius of the Site are upgradient of the Site, risks to downgradient receptors have not been considered separately rather taken into account when considering risks to controlled waters.
Property (e.g. crops/livestock)	No	Yes	Whilst the Site is to be restored for agricultural land use given the depth to water this is not to be a receptor for groundwater at the Site. Should this change it is assumed that a separate risk assessment report will be prepared to evaluate risks to human health at a later date. The Site is located in an area of mixed land use, with agricultural land to the north and east. Abstractions local to the site are used for a variety of purposes including general farming. Risks to off-site receptors have not been considered separately rather taken into account when considering risks to controlled waters.
Ecological systems	No	Yes	The SSSI and SAC associated with the Tamar and Tavy Estuary are statutory designated sites of a type listed in Table 1 of DEFRA guidance[25]. Risks to Ecological Systems are not considered separately rather taken into account when considering risks to controlled waters (surface water).
Controlled waters (groundwater)	Yes	Yes	The Site is not considered to be located within a sensitive water environment, however the Torpoint Formation is considered to be a Secondary A Aquifer. The Site is located in an agricultural area with wells and boreholes identified within a 2 km radius of the Site potentially used for irrigation purposes (i.e. potential risks to crops/livestock). For the purposes of this assessment this receptor is not considered separately rather is taken into account when considering risks to controlled waters (groundwater).
Controlled waters (surface water)	Yes	Yes	An unnamed tertiary river is located to the immediate north-east of the Site. Leachate is anticipated to discharge along the old culvert backfill to this watercourse.

Table 8-1: Rationale for Including Potential Receptors in SCM

8.2.3 The development and refinement of the SCM is an ongoing process throughout a project as additional data becomes available. The SCM (presented in **Table 8-2** below) is based on Horizon's current understanding of the Site.

[25] DEFRA (2012) Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance

Primary Source	Secondary Source	Hazard	Pathway	Receptor	Discussion
Historically Deposited Waste [Existing Eales Farm Landfill]	Contaminated soils [Impacts within soils placed historically].	Degradation of water quality	Vertical / horizontal migration off-Site through more permeable fissures and voids.	Controlled waters (groundwater)	The risks associated with this potential contaminant linkage have been evaluated further in the model.
		Degradation of water quality	Migration via groundwater.	Controlled waters (Unnamed surface watercourse, tributary of Hole Creek)	
Proposed Waste to be Imported [Eales Farm Landfill Extension]	Contaminated soils [Impacts within imported soils including both low levels of contaminants that meet the Site specific acceptance criteria plus unacceptable material that bypasses the checking process].	Degradation of water quality	Vertical / horizontal migration off-Site through fracture flow .	Controlled waters (groundwater)	The risks associated with this potential contaminant linkage have been evaluated further in the model.
		Degradation of water quality	Migration via groundwater.	Controlled waters (Unnamed surface watercourse, tributary of Hole Creek)	

Notes:
Scope of hydrogeological risk assessment limited to evaluating risks to water environment.

Table 8-2: Site Conceptual Model (SCM)

8.3 Model Selection

8.3.1 Two separate models have been developed for this hydrogeological risk assessment, referred to as "Existing Eales Farm Landfill Model" and "Proposed Eales Farm Landfill Extension Model" as follows:

- "Existing **Eales Farm Landfill Model**" – this model is based on the waste that has already been deposited at the Site, using information from the 2016 and 2020 ground investigations and the groundwater and surface water monitoring data to date to evaluate the status quo for the closed Eales Farm Landfill. This model has been subdivided into two separate models, namely the overall waste mass and a smaller model used to investigate a hydrocarbon hotspot. These models have been used to estimate future "background" *water* quality.
- "Proposed Eales Farm **Landfill Extension**" – this model is based on the placement of additional inert waste at the Site over the existing Eales Farm Landfill. This model takes into account future "background" water quality as estimated using the Existing Eales Farm Landfill Model.

8.3.2 The computer program ConSim v2.5 has been used to consider potential impacts to the water environment and estimate "background" water quality resulting from the existing Eales Farm Landfill. ConSim is a probabilistic model based on the Environment Agency's 1999 R&D P20 methodology (predecessor to the current Remedial Targets Methodology[26]). ConSim uses the Monte Carlo method to select values randomly from each parameter range for use in fate and transport calculations so as to account for parameter uncertainty. Iterating the calculations many times gives a range of output values, the distribution of which reflects the uncertainty inherent in the input values. This enables determination of the likelihood of the output values being realised.

8.3.3 ConSim was developed by Golder Associates on behalf of the Environment Agency and was designed to "*provide those concerned with the management of contaminated land with a means of assessing the risk that is posed to groundwater by leaching contaminants."* An alternative software programme, LandSim, was also developed by Golder Associates on behalf of the Environment Agency to *"track leachate production, chemistry, migration and leakage through engineered and non-engineered structures, followed by leachate migration through the unsaturated zone to assess the ultimate impact on the aquifer".* The models are broadly similar, predicting the fate and transport of contaminants from source concentrations, through the unsaturated zone and within the aquifer/groundwater system.

8.3.4 Both models are identified in Environment Agency guidance on undertaking groundwater risk assessment for your environmental permit[27] as an appropriate tool for undertaking probabilistic calculations. In addition, both models enable some of the uncertainty associated with hydrogeological regime and source term to be taken into account.

8.3.5 In developing the Existing Eales Farm Landfill model, ConSim was preferred given the availability of soil data to characterise the waste mass, with the large dataset on soil quality input directly to the model. Given the age of this landfill many of the features associated with a landfill (e.g. engineered containment system etc) are not present and conceptually the waste mass was considered to better represent a contaminated site, as opposed to a landfill. For consistency it was elected to use ConSim for the placement of additional material as part of the proposed Eales Farm Landfill Extension.

8.4 Existing Eales Farm Landfill Model Domain

8.4.1 **Figures 1** and **2** of **Appendix I** show the theoretical model that has been developed for modelling purposes. In summary the model consists of:

[26] Environment Agency (20016) Remedial Targets Methodology. Hydrogeological Risk Assessment for Land Contamination.
[27] www.gov.uk/guidance/groundwater-risk-assessment-for-your-environmental-permit [Accessed 20 April 2020]

- **Sources** – Two source areas have been modelled, extents as shown on **Figure 2** of **Appendix I**. The first source is based on the majority of the contaminants of concern with a second, separate source area modelled to evaluate risks from the isolated hydrocarbon detections identified.
- Each soil source is assumed to be unsaturated (i.e. above the water table), 7m thick (main source area) and varying between 1 m and 6 m thick (hydrocarbon hotspot) comprising a well compacted cohesive soil. **Table D6** of **Appendix D** sets out the contaminants modelled, selected on the basis of review of the available soil chemistry data plus the assumed source concentrations. The effective rainfall has been reduced to take into account the planned low permeability clay layer proposed to be placed over the majority of the Eales Farm Landfill.
- **Pathway** (Unsaturated Zone) – The depth to groundwater beneath the existing waste mass is assumed to range between 0 m (towards the west of the Site) and 7 m (towards the east of the Site). The minimum value of 0 m is a conservative assumption, incorporated into the model to take into account water in the backfill around the old culvert.
- **Pathway** (Aquifer) – The model assumes the mudstone and siltstone aquifer is of low to moderate permeability. For modelling purposes the aquifer thickness is conservatively assumed to be 30 m (i.e. approximately the elevation of the base of the waste mass above sea level).
- **Receptor** – The principal receptors for landfill leachate are considered to be groundwater directly beneath the Site plus the unnamed tertiary river immediately north-east of the Site. A theoretical compliance point has been used for evaluating the degree of potential impact to groundwater immediately downgradient of the Site, see Section 8.6 below.

8.4.2 A snapshot from **Figure 1** of **Appendix I** showing the indicative model is presented as **Figure 8-1** below:

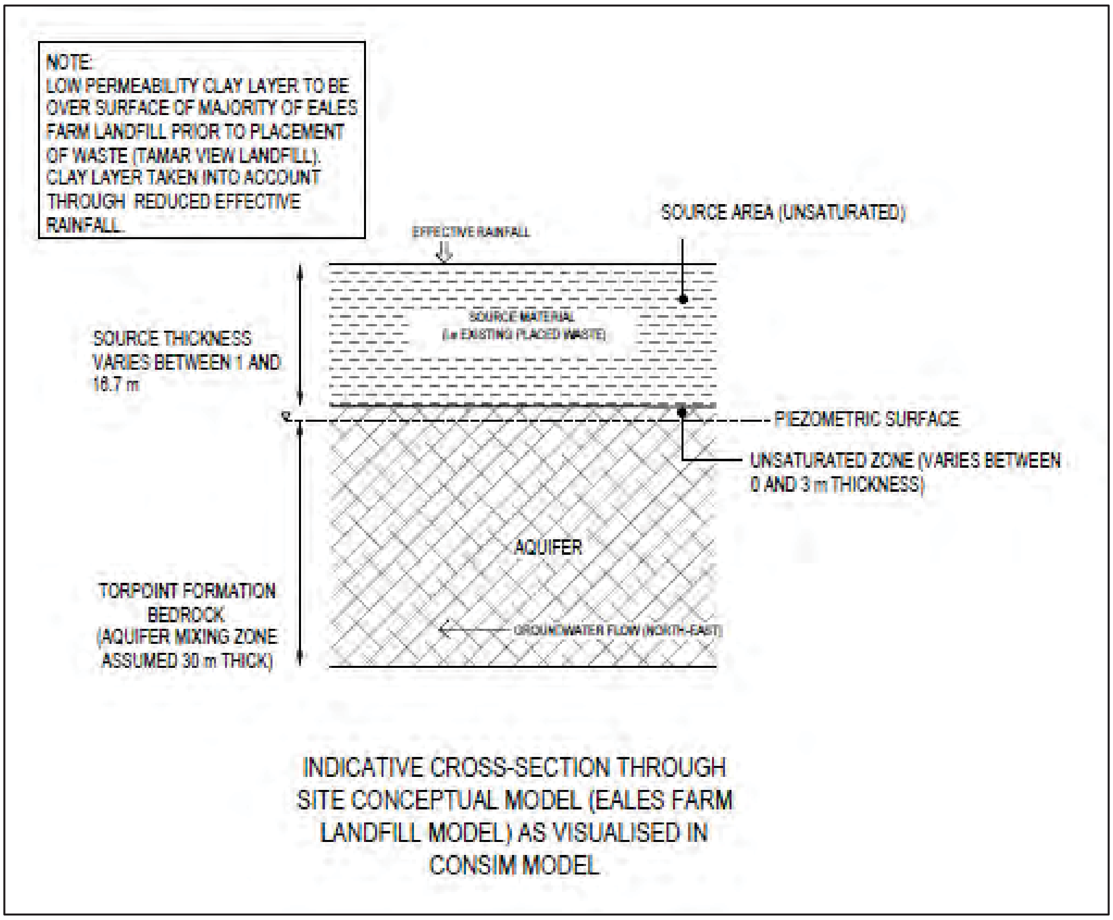


Figure 8-1: Snapshot from Figure 1 (Appendix I) Showing Theoretical Model (Eales Farm Landfill)

8.5 Proposed Eales Farm Landfill Extension Model Domain

8.5.1 **Figures 2** and 3 of **Appendix I** show the theoretical models that has been developed for modelling purposes. In summary the model consists of:

- **Sources** – A single source area has been modelled, extents as shown on **Figure 2** of **Appendix I**. The soil source is assumed to be unsaturated (i.e. above the water table), an average of 4.7 m thick and comprises a well compacted cohesive soil. The thickness of waste has been calculated based on the area of the proposed landfill and the volume remaining to be imported, then reduced by 1 m to take into account the presence of the Artificially Enhanced Geological Barrier (AEGB).
- As set out in Section 7 and **Table D7** of **Appendix D**, where the inert WAC limit is based on a leached concentration, the leached concentration (in mg/l) has been directly entered as a source concentration. Where the inert WAC limit is based on a total soils concentration, the concentration (in mg/kg) has been entered as the source concentration, with the model used to calculate the predicted leachate concentration.
- **Pathway** (Unsaturated Zone) - Underlying the imported deposition a 1.0 m clay layer is assumed to be placed. This is intended to be consistent with the low permeability clay layer (i.e. AEGB) to be placed on top of the existing Eales Farm Landfill waste material. Conservatively the model does not take into account the presence of the waste deposited historically (i.e. the Existing Eales Farm Landfill), nor unsaturated underlying bedrock which would act to further attenuate contaminant migration.
- **Pathway** (Aquifer) – Consistent with the Eales Farm Landfill Model, however the output from the Existing Eales Farm Landfill Model have been entered as background concentrations.
- **Receptor** – Consistent with the Eales Farm Landfill Model.

8.5.2 A snapshot from **Figure 3** of **Appendix I** showing the indicative model is presented in **Figure 8-2** below:

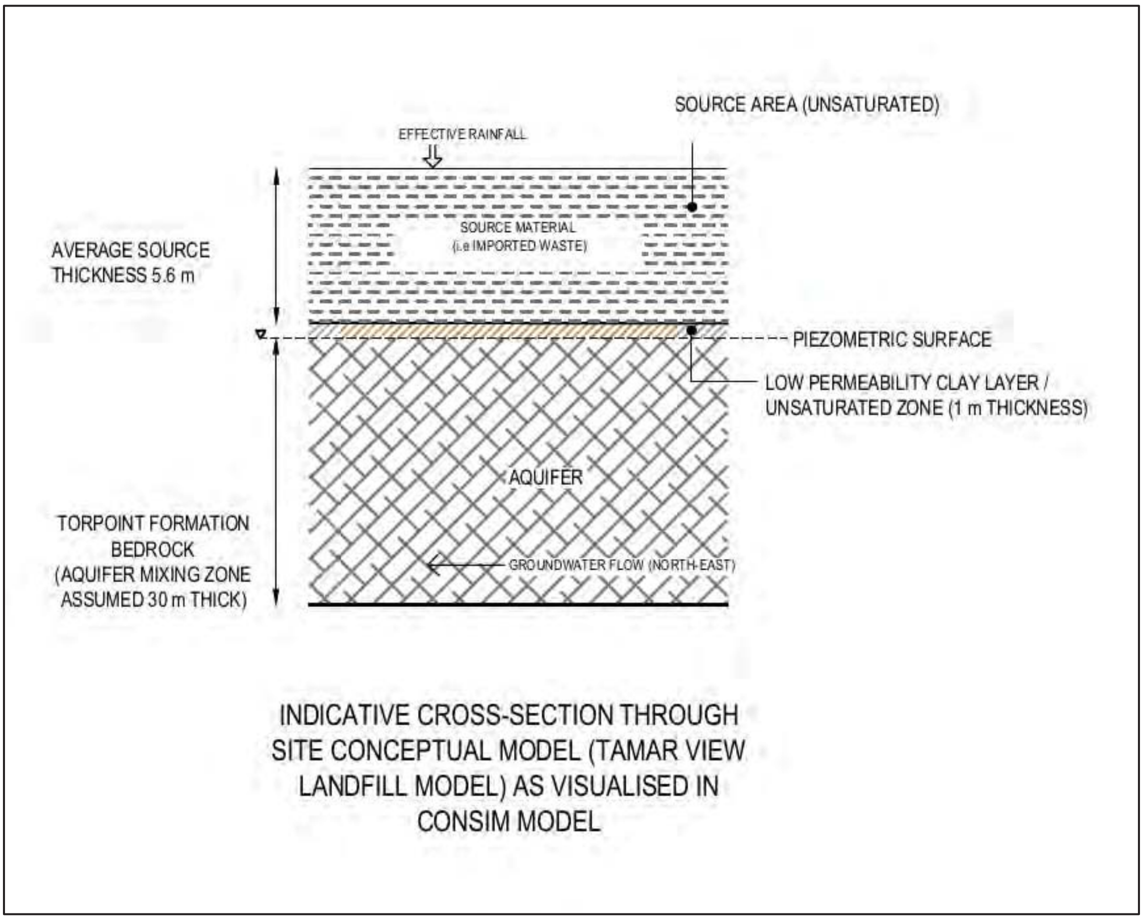


Figure 8-2: Snapshot from Figure 3 (Appendix I) Showing Theoretical Model (Proposed Eales Farm Landfill Extension)

8.6 Compliance Point

8.6.1 For modelling purposes a theoretical compliance point along the groundwater flow pathway has been used in the hydrogeological assessment for the purposes of assessing risks to the water environment. The following compliance point has been utilised, with reference to UK guidance[28] and is shown visually on the drawings in **Appendix I**.

8.6.2 The compliance point proposed is a virtual point for the purpose of undertaking the modelling exercise as opposed to physical monitoring points (e.g. monitoring well or spring). The same compliance point has been used in both models.

Name	Location	Rationale
Culvert Outfall	North-Eastern boundary of Proposed Eales Farm Landfill Extension.	This compliance point is based on the receptor for contaminants in groundwater being the water environment at the boundary of the Proposed Eales Farm Landfill Extension.

Table 8-3: Proposed Compliance Point

[28] https://www.gov.uk/guidance/land-contamination-groundwater-compliance-points-quantitative-risk-assessments [Accessed 1 June 2020]

8.7 Proposed Water Quality Standards

8.7.1 The proposed COPC together with the proposed source term concentrations are presented in **Tables D6** (Existing Eales Farm Landfill Model) and **D7** (Proposed Eales Farm Landfill Extension Model) of **Appendix D**. **Table D7** of **Appendix D** also sets out the adopted Environmental Assessment Levels (EALs). These are based on EQS, where available, otherwise the LRL has been adopted to provide a conservative screening measure.

8.7.2 Given the location of the theoretical compliance point is based on water quality at the unnamed tertiary river which discharges into Hole Creek, EQS, as opposed to drinking water standards, are considered to be a more appropriate criteria for assessing risks to the water environment.

8.8 Input Parameters

8.8.1 For the purposes of the hydrogeological assessment the most appropriate value or range has been adopted with reference to available information to take into account uncertainty associated with input parameters. Statistical distributions or probability density functions (PDFs) are therefore used to select model input parameters in ConSim. Each time a calculation is carried out, one value from the defined input distributions is selected with a concentration at the compliance point calculated. Repeating the calculation many times provides an output distribution for the concentration at the compliance point.

8.8.2 The models have been set to perform with 1,001 iterations thus enabling a 95th percentile result to be calculated. The 95th percentile (95%ile) value indicates that there is a 95% probability that the actual concentration which will ultimately reach the receptor will be below the predicted 95%ile result. Use of the 9th percentile concentration is consistent with Environment Agency guidance[12] and is considered to be sufficiently precautionary taking into account the Site setting.

8.8.3 **Tables D6** to **D11** inclusive of **Appendix D** summarise the key model input parameters and associated rationale for each of the models, as summarised below:

Table	Model	Table Title	Discussion
D6	EEFLM	Source Term For Purposes of Hydrogeological Assessment	Contaminants of potential concern and input concentrations.
D7	PEFLEM	Source Term For Purposes of Hydrogeological Assessment	Contaminants of potential concern and input concentrations.
D8a	EEFLM	Source Term Chemistry	Physico-chemical parameters adopted in model.
D8b	EEFLM – HC Hotspot	Source Term Chemistry	Physico-chemical parameters adopted in model.
D8c	PEFLEM	Source Term Chemistry	Physico-chemical parameters adopted in model.
D9a	EEFLM	Hydrogeological Processes	Parameters used to describe the ground conditions including waste mass, unsaturated zone and aquifer.
D9b	EEFLM – HC Hotspot	Hydrogeological Processes	Parameters used to describe the ground conditions including waste mass, unsaturated zone and aquifer.
D10	PEFLEM	Hydrogeological Processes	Parameters used to describe the ground conditions including waste mass, unsaturated zone and aquifer.
D11	PEFLEM	Future Background Aquifer Concentrations (Derived From EEFLM)	Assumed background concentrations in aquifer.
Notes: EEFLM – Existing Eales Farm Landfill Model HC – Hydrocarbon PEFLEM – Proposed Eales Farm Landfill Extension Model			

Table 8-4: Model Input Parameters (Tables in Appendix D)

8.8.4 Horizon has followed Environment Agency Guidance in Assigning Value to Uncertain Parameters in Subsurface Contaminant Fate and Transport Modelling[29]. In general, the following principles have been adopted:

- A normal distribution has been adopted where data is available to describe the dataset and there is the potential, albeit low for extreme values. ConSim constrains the normal distribution between zero and infinity to prevent negative values being used. Examples where the normal distribution has been adopted include:
  - Where a comprehensive dataset is available (e.g. concentration of contaminants in soil for the Existing Eales Farm Landfill model). In this instance, given the heterogeneous nature of the waste deposited there is the potential, albeit low, for greater concentrations to be detected in areas not tested.
  - If only a single value is available (e.g. effective rainfall) this has typically been used as a normal distribution with a mean of the value and standard deviation typically of 10% of the value. As noted by the Environment Agency, "*the normal distribution is the best distribution for very many observations in nature*."[29]
- A triangular distribution, regarded as a simple approximation of the normal distribution, has been adopted where it is not considered credible for a maximum or minimum value to be exceeded. Examples where the triangular distribution has been adopted include:

[29] Environment Agency (June 2001) Guidance on Assigning Values to Uncertain Parameters in Subsurface Contaminant Fate and Transport Modelling. Reference: NC/99/38/3

- contaminant concentrations in the Existing Eales Farm landfill localised hydrocarbon hotspot model;
- where literature values proposed are reasonably consistent (e.g. soil water partition coefficient for arsenic) and its considered that the potential for an extreme value is less likely.

- A uniform distribution defines probability equally between two extreme values. Uniform probability distributions have been applied where insufficient data is considered to exist to identify normal or triangular distributions or to adopt a more conservative distribution than normal / triangular. Examples where the uniform distribution has been adopted include:
  - Concentrations of contaminants in the Proposed Eales Farm Landfill Extension model. Adopting a uniform distribution in this instance is considered conservative because the distribution assumes there is an equal chance of concentrations near the inert WAC limit as opposed to a grouping around a theoretical mean at lower concentration.
- In a few instances a log normal distribution has been adopted, where values "*span more than one order of magnitude and which appear to be skewed*" as recommended by the Environment Agency[29]. Examples include:
  - where literature values suggest a range in values with the mode appearing to be low compared with upper values reported (e.g. soil water partition coefficient for cadmium).

8.8.5 The source of literature values adopted is presented in **Tables D8** and **D9** of **Appendix D**. Where available, values have been primarily sourced from ConSim. In the absence of appropriate data in ConSim, reference has been made to other sources including technical guidance published by CL:AIRE[17],

8.8.6 The ConSim model may be run with the process of biodegradation turned on or off depending upon whether there is sufficient evidence to justify its inclusion. Both degradation nor retardation have been included in both the unsaturated zone and within the aquifer. CIRIA 2017[17] notes that "*there are numerous studies …. that demonstrate that degradation of petroleum hydrocarbons occurs under most subsurface conditions at a rate that means that dissolved phase plumes reach a steady-state (i.e. the plume stops expanding) within a relatively short distance from the source.*" In addition hydrocarbon contaminants have not been routinely detected in leachate, groundwater and surface water sampling. To take into account the lack of site specific evidence, Horizon has utilised a uniform distribution of degradation rates for each contaminant (where applicable), albeit these are generally limited to lower end (i.e. longer assumed half-life) literature values (e.g. anaerobic as opposed to aerobic biotic half life adopted for benzene).

8.9 Key Assumptions / Model Limitations

8.9.1 Due to the limitations of the ConSim program in comparison to the complexity of the Site-specific conditions a number of assumptions have been made / limitations identified including:

- The ConSim model assumes a single unidirectional groundwater flow and does not account of any dilution within the aquifer or within surface water;
- The model assumes instantaneous placement of all waste in the Proposed Eales Farm Landfill Extension;
- The model has been run assuming a random centre within each source for each model iteration;
- The following correlations have been included in the model:
- Latitudinal and longitudinal dispersivity (aquifer) +0.7;
- Aquifer hydraulic gradient and hydraulic conductivity -1.0; and

- Aquifer hydraulic gradient and effective porosity -1.0.

8.10 Findings and Risk Evaluation

8.10.1 The ConSim model was utilised to derive a range of concentrations at the compliance point for each COPC. Each model simulation was capped at 1,000 years given Remedial Targets Methodology suggests that it is acceptable for no remedial action to be required where the remedial target has been exceeded at the receptor but the impact of the contamination is localised around the source and travel times exceed 1,000 years.

8.10.2 The various ConSim model run outputs are all included in **Appendix J** (Existing Eales Farm Landfill Models) and **Appendix K** (Proposed Eales Farm Landfill Extension Model). The table below sets out the ConSim model files:

Model	**Filename**
Existing Eales Farm Landfill Model	HCE0430 EEFLM Main Source Area June 2020
Existing Eales Farm Landfill Mode Hydrocarbon Hotspot	HCE0430 EEFLM Main Source Area – HC Hotspot June 2020
Proposed Eales Farm Landfill Extension Model	HCE0430 PEFLEM Main Source Area June 2020

Table 8-5: ConSim Model Files

8.10.3 **Table D11** (**Appendix D**) presents the principal output from the Existing Eales Farm Landfill models, with the predicted concentrations at the compliance point compared with existing measures in nearby well BH11B. It is considered that the predicted concentrations correlate reasonably well with measured concentrations, with the modelled concentrations generally considered to represent a conservative value for the purposes of estimating background aquifer quality as shown by the RPD calculations. The principal exception is manganese which has been detected at elevated concentrations in both groundwater and surface water.

8.10.4 Given the low TPH concentrations recorded, these have not been included within the proposed Eales Farm Landfill Extension model which has focussed on more mobile hydrocarbons.

8.10.5 The output from the Existing Eales Farm Landfill models has been used to estimate future background concentrations of contaminants in the aquifer. It is noted that this model includes a slightly reduced effective rainfall, to take into account the planned low permeability clay layer, which is not currently in place. Where contaminants have not been detected at elevated concentrations in existing sampling (e.g. soil, water) a background concentration has not been calculated.

8.10.6 For the Proposed Eales Farm Landfill Extension Model, the concentrations of all contaminants apart from the contaminants listed in **Table 8-6** either did not breakthrough or were below the adopted EAL. On that basis, these contaminants have not been considered further as part of the assessment.

8.10.7 The results for each of the model runs where exceedance of the adopted EAL was predicted are summarised in **Table 8-6** below. Both the worst case (taken as the 95%ile) and most likely case (taken as the 50%ile) concentrations have been included.

Contaminant	EAL	Proposed Eales Farm Landfill Extension Model Compliance Point (Immediately Adjacent to Site)	
		1,000 Years	
		Peak 95%ile Conc.	Peak 50%ile Conc.
Ammonium	0.6	1.52E+00	6.98E-01
Arsenic	0.05	1.93E-01	6.80E-02
Barium	0.003	2.91E-02	7.52E-03
Benzo(a)pyrene	0.00005	4.13E-04	2.14E-04
Chromium	0.0047	2.57E-01	1.19E-01
Manganese	0.03	1.52E-02	5.55E-03
Naphthalene	0.0024	5.00E-01	2.23E-01
Nickel	0.02	8.78E+01	3.62E+01
Zinc	0.02	5.92E-01	2.19E-01
Notes: All concentrations in mg/l			

Table 8-6: Summary of Model Outputs (Proposed Eales Farm Landfill Extension Model)

8.10.8 In relation to barium, the adopted EAL is the LRL in absence of an applicable EQS and the substance is not listed on the UK's list of hazardous substances required to be prevented from entering groundwater[30]. The predicted concentrations are relatively low and are based on a source term concentration up to the inert WAC leachate limit throughout the waste mass. On that basis, the risks to the water environment from barium is considered to be low.

8.10.9 Benzo(a)pyrene and naphthalene have been used as indicator COPC to assess the potential risks from import of materials with elevated concentrations of PAHs. Benzo(a)pyrene and naphthalene are amongst the most mobile PAH contaminants and have been adopted as indicator COPC for sum PAHs. In reality, the concentration of these contaminants in the waste material is likely to be significantly lower than the source concentrations adopted in the model (*note: this is likely to be the case for all contaminants of concern*). By way of example, the model was based on a maximum theoretical naphthalene concentration of 50 mg/kg throughout the Proposed Eales Farm Landfill Extension waste mass, whereas the mean concentration in the Existing Eales Farm Landfill waste mass is 0.2 mg/kg.

8.10.10 In general, the overall mobility of benzo(a)pyrene and naphthalene in the water environment are considered to be *very low*[17] and *moderate*[17]. To date no PAHs have been detected above the LRL in routine groundwater and surface water sampling. Given the conservative nature of the model and lack of resource value of groundwater in the immediate vicinity of the Site, a significant risk from PAHs is not considered to exist.

8.10.11 Taking the above into account it is considered that a significant risk from potential contaminants, apart from manganese, within the Proposed Eales Farm Landfill Extension waste mass is unlikely to be present on the basis that:

- The model is an extremely conservative assessment of the source area.

[30] http://wfduk.org/ [Accessed 10 June 2018]

- For modelling purposes, relatively mobile contaminants such as naphthalene with associated lower EQS have been used to assess the potential risk to the water environment. The model assumes a range of input concentrations for those contaminants, up to a worst-case scenario of that contaminant being present throughout the restoration material at the inert WAC limit. In reality this is an unrealistic scenario with the concentrations of contaminants in the Proposed Eales Farm Landfill Extension waste mass likely to reflect those with the Existing Eales Farm Landfill waste, with robust acceptance procedures to minimise the potential for a rogue load.
- The model has taken into account some of the restoration design features (e.g. presence of a clay layer at base of the Proposed Eales Farm Landfill Extension. The presence of a clay layer on top of the majority of the Existing Eales Farm Landfill will reduce the rate of rainwater ingress and therefore leaching of any contamination within the existing waste mass.
- The model assumes a constant and non-depleting source term acting as an ongoing source for contamination in the dissolved phase.
- The theoretical compliance points are located to immediately north-east of the most north-eastern point of each of the source zones. In reality the unnamed tertiary river, located immediately north-east of the Site, is unlikely to be groundwater-fed in the vicinity of the Site. “Leachate” has only been recorded intermittently in a few of the wells screened within the waste mass and whilst this has the potential to enter the unnamed watercourse via a preferential pathway (e.g. backfill around the old culvert beneath Site) other factors not taken into account (e.g. dilution as a result of the leaking culvert) will further mitigate risks to the unnamed tertiary river.

8.10.12 Although the existing Eales Farm Landfill model doesn’t predict the concentrations of manganese as closely as other contaminants, the source of the manganese at the Site is most likely to be naturally occurring. As shown in Section 3.6 and discussed in GCE’s 2020 investigation[8] the concentrations of manganese reported in the soil samples obtained from the landfill reflect the naturally occurring concentrations estimated by the BGS in proximity to the landfill. GCE’s report also discusses the potential influence of two cess pits in proximity to well BH-2A (screened in the waste mass) where the greatest concentrations have been consistently reported in leachate samples. Further monitoring is planned, in particular following the installation of the new culvert, as set out in the ESSD[5].

8.11 Sensitivity Analysis

8.11.1 ConSim includes an integrated sensitivity analysis to allow assessment of the most sensitive parameters. For the purposes of this report, the sensitivity analysis has focussed primarily on those contaminants listed in **Table 8-6** above.

8.11.2 The most sensitive parameter is considered to be the source concentration for which conservative assumptions have been made in order to develop a reasonable worst-case assessment.

8.11.3 Other sensitive parameters are consistently aquifer hydraulic gradient, aquifer hydraulic conductivity and aquifer effective porosity. Site specific data is available on these parameters which have been amended as appropriate based on regional topography and to reflect wider geological / hydrogeological properties.

8.11.4 For a few parameters (e.g. water filled porosity in the unsaturated zone), Horizon has adopted values based on professional experience on earthwork projects. Sensitivity analysis of these parameters indicates that the parameters are not sensitive, with doubling the parameter and associated distribution typically resulting in little change in the predicted concentrations.

8.12 Accidental Releases

8.12.1 Technical precautions are included in the engineering design to minimise the impact of accidents (for the purposes of this risk assessment assumed to comprise placement of material that does not comply with the Site-specific assessment criteria) on the water environment. Given the intended stringent testing and visual inspection regime to be adopted any unacceptable material will be limited in volume. Combined with the construction of the low permeability basal layer beneath the placed material, the potential risk of accidents or impact of a rogue load is considered to be low.

9. Engineering Design

9.1.1 This section of the report outlines the proposed essential and technical precautions to be adopted during the works such that the assumptions in this hydrogeological assessment are met.

9.2 Material Suitability and Acceptance Procedures

9.2.1 Strict acceptance procedures are to be prepared and agreed with stakeholders to safeguard against taking material that does not meet Site's acceptance limits. These procedures will identify the actions and procedure to be taken including:

- All waste deliveries will be pre-arranged and will come from known sources on licensed hauliers;
- Initial source checking of the waste characterisation data provided by the waste producer will be undertaken by a responsible person. Data to be reviewed to include details of source site history, locations of any samples, description of material and results of any laboratory testing;
- During waste delivery confirming that the waste materials are as described, within agreed quantities and are permitted within the Environmental Permit; and,
- If waste not permitted by the Environmental Permit is delivered to the Site it will be turned away from the Site immediately or retained in a defined quarantine area awaiting collection.

9.3 Site Engineering

9.3.1 Benching of material against the slopes of the waste mass are set out in the ESSD[5].

9.3.2 The low permeability layer to be placed on top of the majority of the existing Eales Farm Landfill is to be placed to an engineering specification in accordance with CQA.

9.3.3 The final design is to be confirmed but it is anticipated this will comprise the placement of at least 1.0 m of clay at a maximum hydraulic conductivity of $1x10^{-9}$ m/s.

9.4 Requisite Monitoring and Surveillance

9.4.1 The proposed scope and nature of monitoring and surveillance, to be agreed with the Environment Agency, is set out in the ESSD[5].

9.4.2 Of importance, ongoing monitoring of manganese detected in groundwater and surface water is planned, in particular following the planned culvert works.

9.4.3 A periodic review of this hydrogeological risk assessment and the Site-specific assessment criteria is proposed to provide an assessment of trends in groundwater quality and a comparison of groundwater quality against updated trigger levels based on updated technical understanding of risks from the COPC.

9.5 Leachate Management

9.5.1 No long-term leachate management measures are planned as part of the restoration works.

10. Discussion and Conclusions

10.1.1 This hydrogeological risk assessment has been prepared to assess impacts on the water environment associated with the proposed import of inert waste at the Proposed Eales Farm Landfill Extension. This report has been prepared in support of a bespoke Environmental Permit application.

10.2 Water Quality

10.2.1 The hydrogeological risk assessment has utilised a range of input parameters based primarily on Site-specific data, literature data plus modelling predicted future background contaminant concentrations in the aquifer in order to estimate most likely (50^{th} percentile) and reasonable worst case (95^{th} percentile) concentrations at a compliance point located immediately adjacent (north-east) of the proposed Eales Farm Landfill Extension. The source area is based on a series of conservative input assumptions (i.e. assume levels of contamination ranging up to the anticipated maximum allowable levels).

10.2.2 Placement of the additional material including the AEGB as part of the proposed Eales Farm Landfill Extension will reduce infiltration and leaching of contaminants within the existing waste mass with an overall betterment in conditions.

10.2.3 The majority of the contaminants of potential concern were not detected at the theoretical compliance point (nominally immediately downgradient of the Site) at concentrations above the adopted assessment criteria.

10.2.4 The model predicts slightly elevated concentrations of a few contaminants at the compliance point.

10.2.5 Where slightly elevated concentrations are predicted, these are considered to be an extremely conservative estimate of the potential contaminant concentration at the compliance point. Given the conservative assumptions within the model and low resource value of groundwater within the vicinity of the Site, a significant risk to the water environment is not considered to exist. Residual risks are to be managed through the restoration design features.

10.2.6 It is considered that some soils within the region contain naturally elevated background concentrations of arsenic, manganese and lead which is likely to contribute to the elevated concentrations of these contaminants observed in surface water and groundwater monitoring of the Site. Notwithstanding this, further monitoring is planned as part of the ESSD[5] including the manganese concentrations detected in surface water, and to a lesser extent groundwater to date.

10.2.7 Given the use of site-specific data, such as groundwater concentrations within the model, it is typically expected that elevated concentrations of these contaminants are reflected within the model output.

10.3 Restoration Design Features

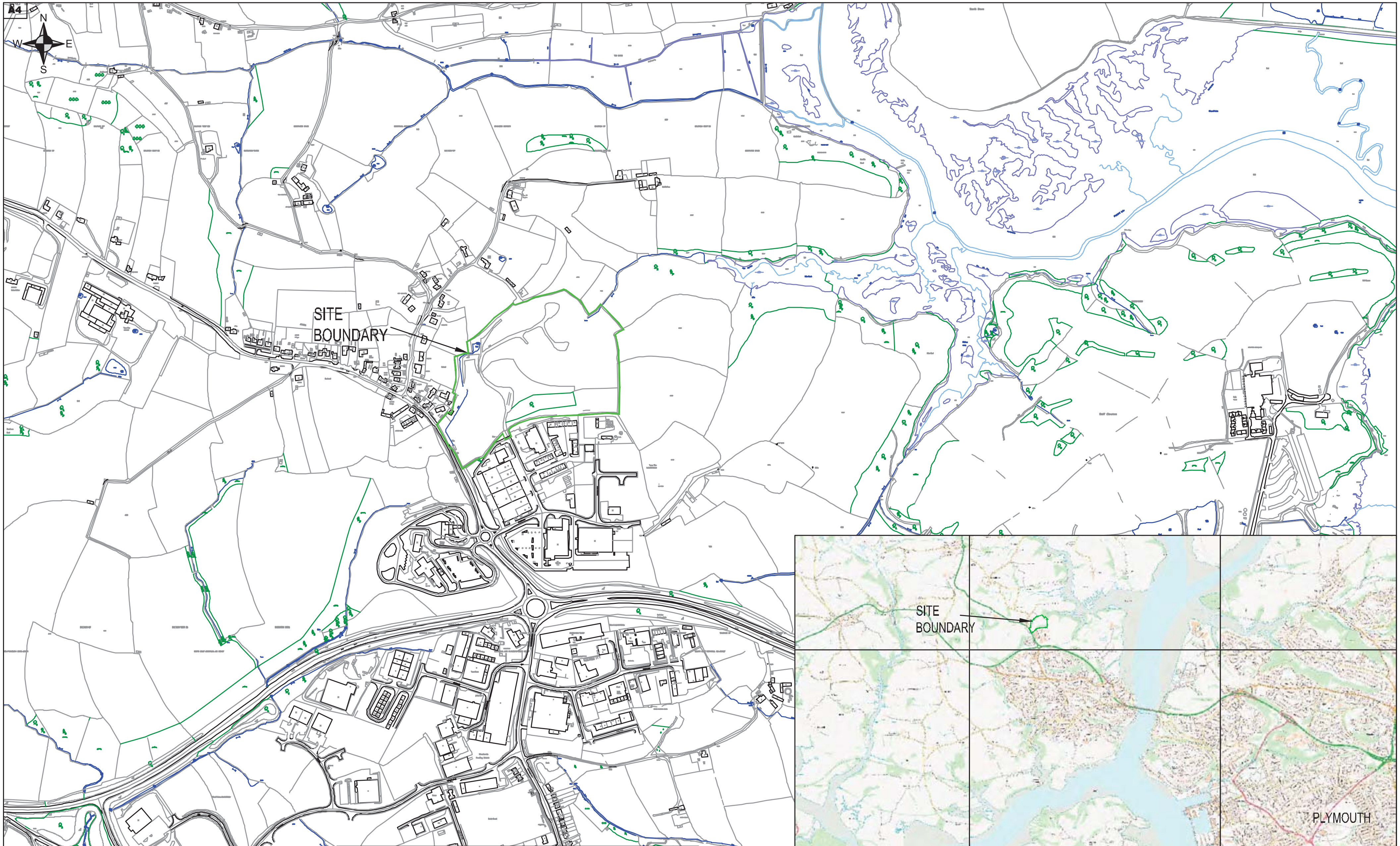
10.3.1 It is acknowledged that due to the nature of the works a bespoke Environmental Permit will be required.

10.3.2 From a practical perspective, this report has set out a series of anticipated engineering design features (see Section 9 for further details). These are intended to be adopted during the restoration works such that the assumptions in this hydrogeological assessment are met and include:

- Material Acceptance Procedures - *strict acceptance procedures are to be met to safeguard against taking material that does not meet the Site's acceptance limits.*
- Specific Engineering Measures (e.g. placement of material against the steep slopes of the existing waste mass).

- Engineering Specification – *design and installation of low permeability layer around the placed material in accordance with CQA.*
- Requisite Monitoring and Surveillance - *the proposed scope of the compliance monitoring is set out in the ESSD*[5]*.*

Appendix A GCE Drawings



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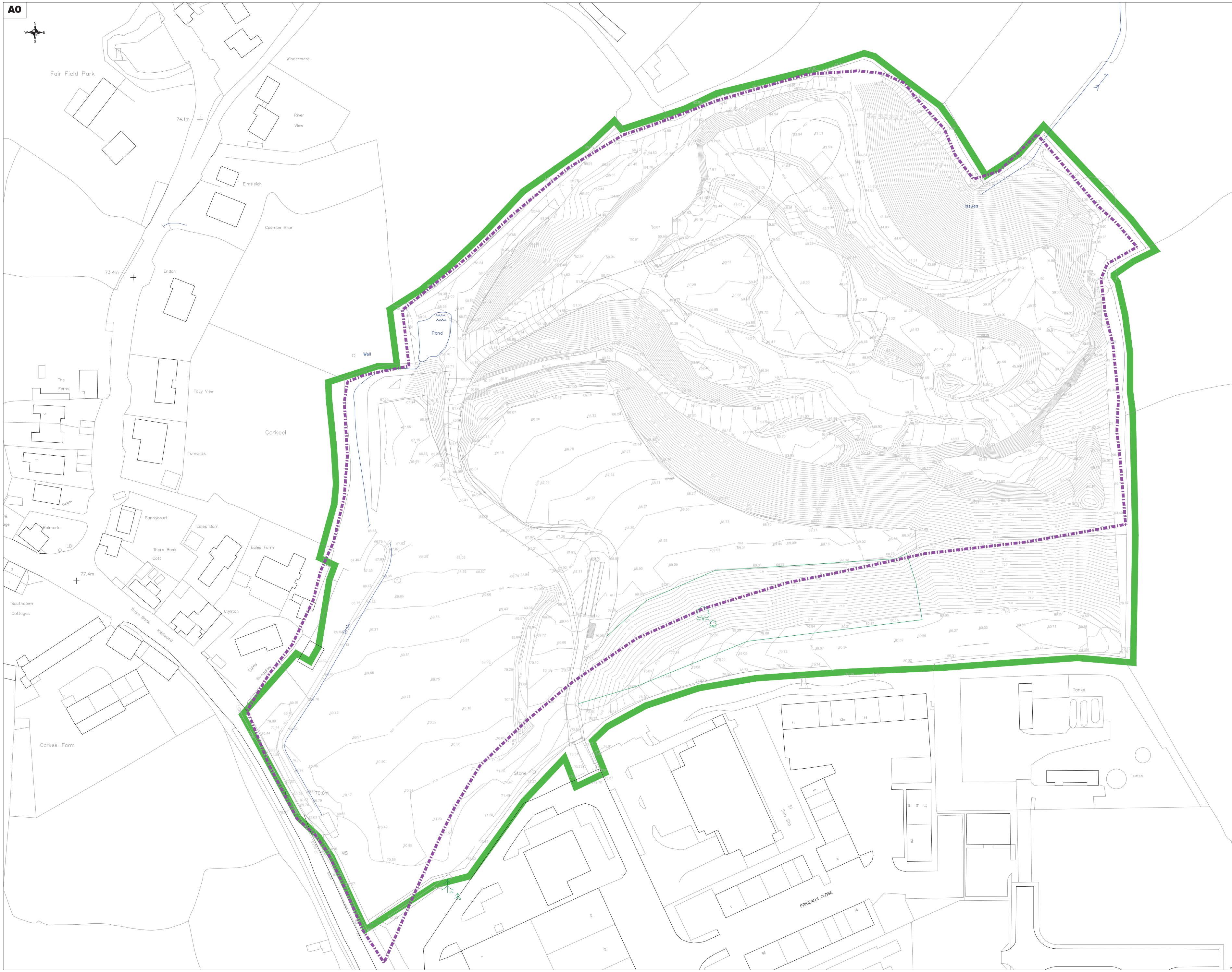
Client:	Tamar Valley Projects Ltd
Drawing Status	**For Information**
Job Title:	**Eales Farm Landfill**
Dwg Title:	**Site Location**
Scale	1:10000 @ A4
Drawn	RA
Date	Apr 2020
Checked	DLJ
Drawing no:	**GCE00692/A/Fig1**
Rev	



This drawing is not to be scaled: work to figured dimensions only.

Any discrepancy on this drawing to be reported immediately to Geo Consulting Engineering Ltd. for clarification.

KEY

- EALES FARM LANDFILL
- PLANNING PERMISSION FILL AREA

Rev	Date	Revision

Drawing Status: **For Information**

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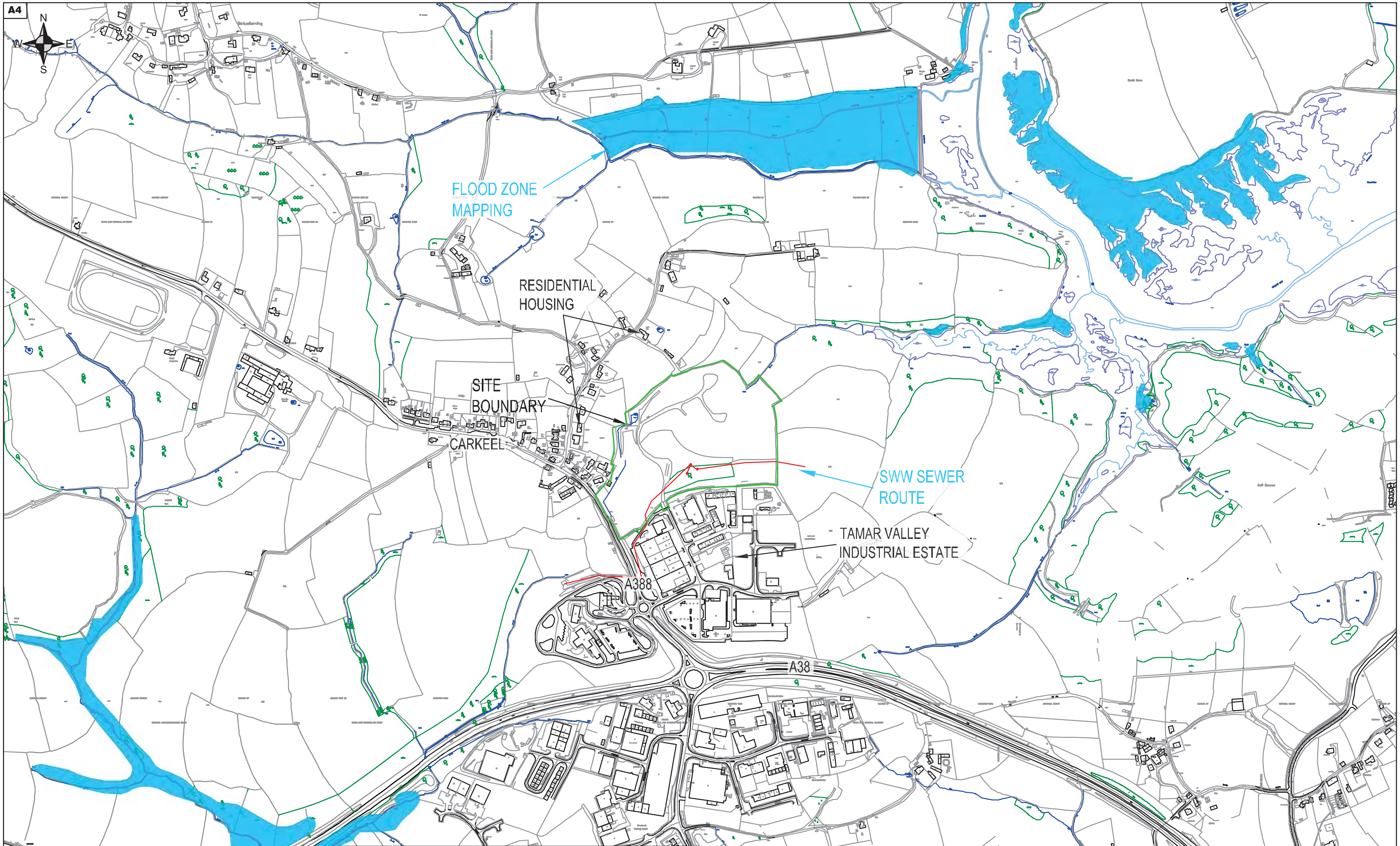
Job Title: **Eales Farm Landfill**

Dwg Title: **Permit Boundary and Site Layout**

Client: **Tamar Valley Projects Ltd**

Scale: 1:500 @ A0 | Drawn: RA
Date: Apr 2020 | Checked: DLJ

Drawing no: **GCE00692/A/Fig2** | Rev: -



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Client: **Tamar Valley Projects Ltd**

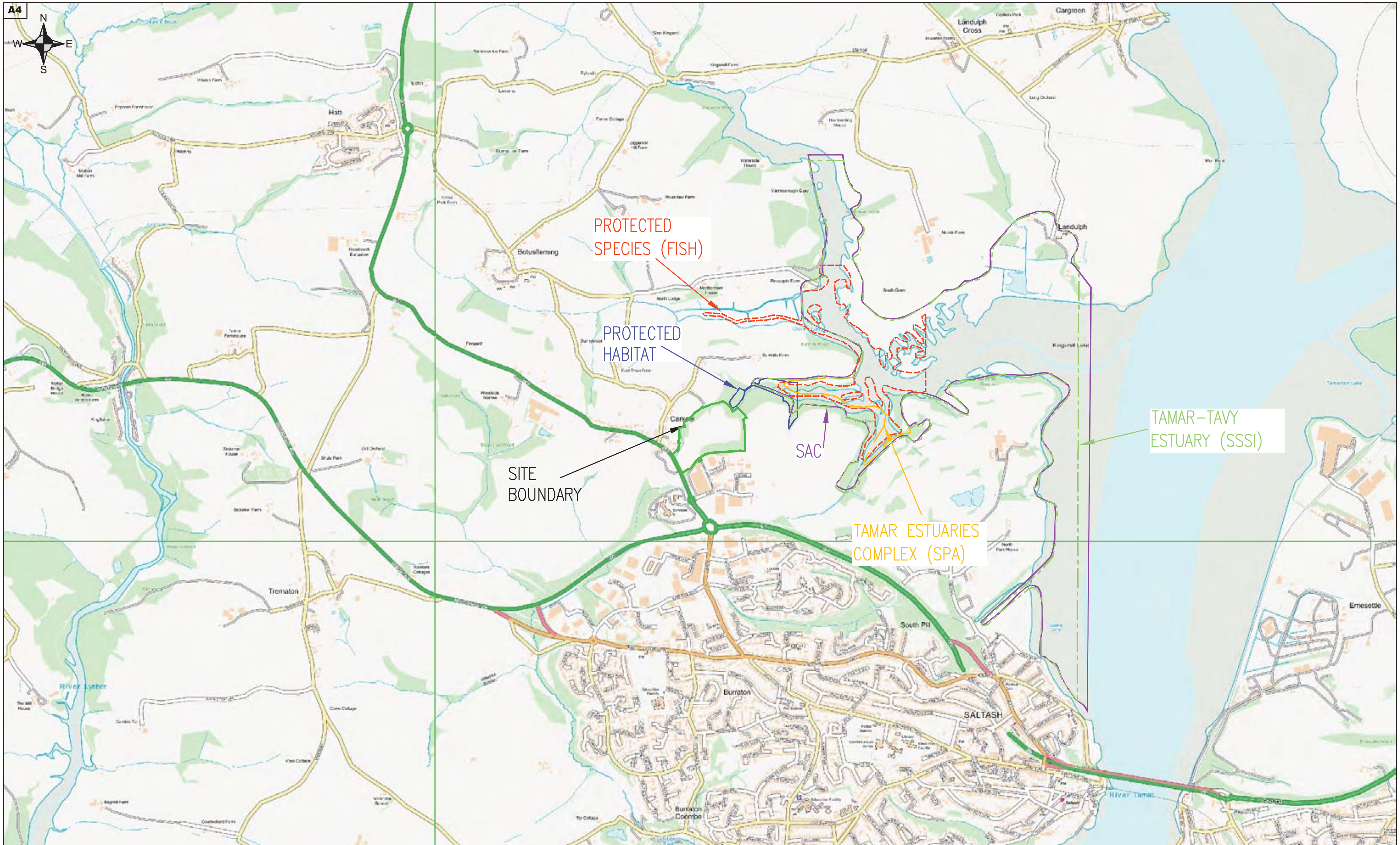
Drawing Status: **For Information**

Job Title: **Eales Farm Landfill**

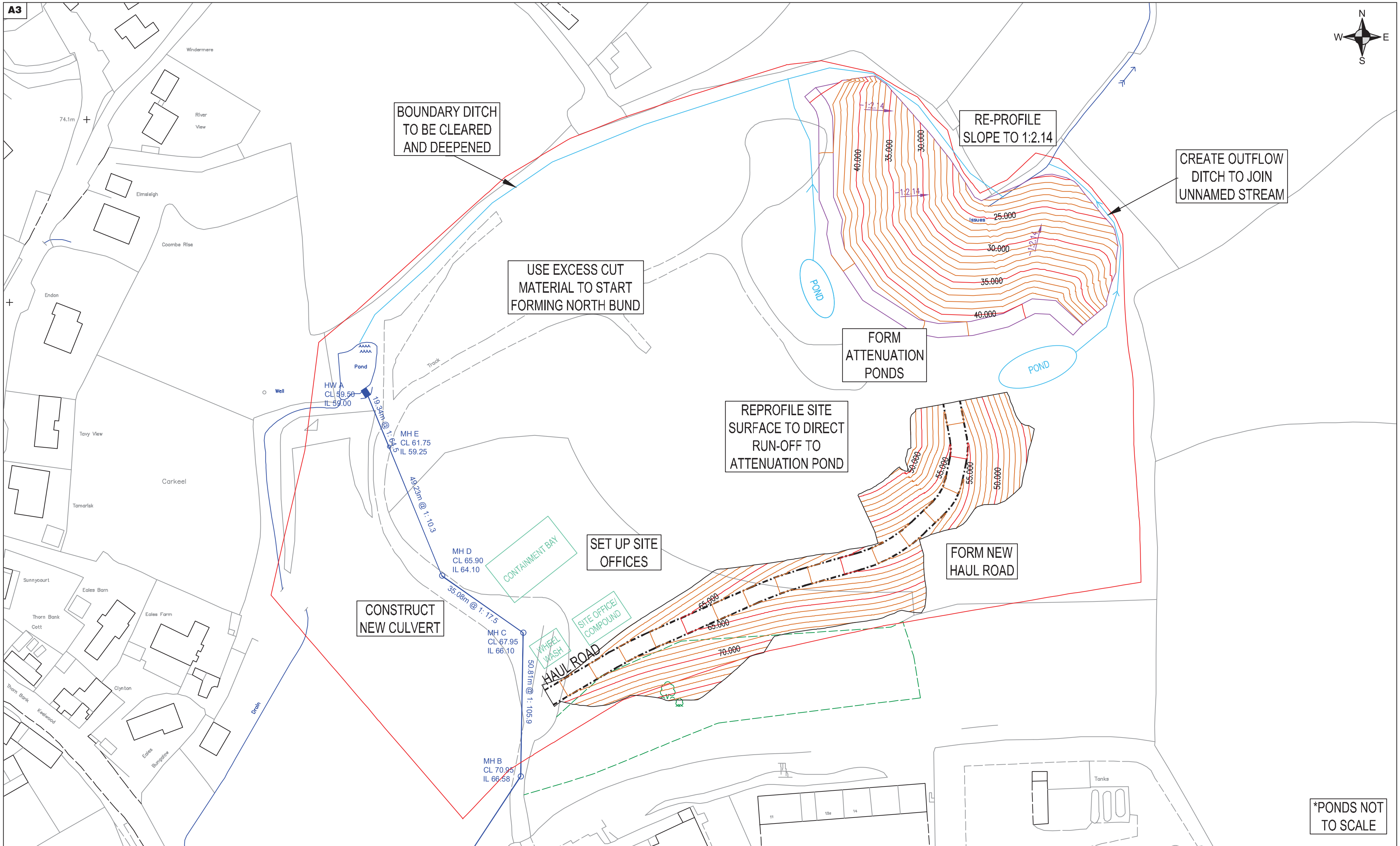
Dwg Title: **Environmental Site Setting**

Scale: 1:10000 @ A4
Drawn: RA
Date: Apr 2020
Checked: DLJ

Drawing no: **GCE00692/A/Fig3**
Rev



geoconsulting engineering ltd	Geo Consulting Engineering Ltd The Studio, Woodmanton Barns, Woodbury, Exeter, EX5 1HQ T: 01395 239977 E: mail@geoconsultingeng.co.uk W: www.geoconsultingeng.co.uk	Client: **Tamar Valley Projects Ltd**	Drawing Status **For Information**
	Job Title: **Eales Farm Landfill**	Dwg Title: **Cultural and Natural Heritage**	Scale 1:25000 @ A4 Drawn RA Date Apr 2020 Checked DLJ Drawing no: **GCE00692/A/Fig4** Rev



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Client: **Tamar Valley Projects Ltd**

Drawing Status: **For Information**

Job Title: **Eales Farm Landfill**

Dwg Title: **Enabling Works**

Scale: 1:1250 at A3
Drawn: RA
Date: Feb 2021
Checked: DLJ

Drawing no: **GCE00692-A-Fig5**

Rev: -