Briefing Note

Project Name: Deeside Airfields Praxis Gravity Sewer	Author: Karen Fitzsimons
Project Reference: 65201402	Date: 7/06/2021
Project Manager: Johnathan Burns	Document Reference: Transfer Abstraction Licence Supporting Information Revision:

Rev.	Date	Reason for issue	Prepared		Reviewed		Approved	
[1]	7 June 2021	Supporting information for licence application	K Fitzsimons	7 June 2021	H Carlyle	7 June 2021	J Burns	7 June 2021

Transfer Abstraction Licence Supporting Information

Construction dewatering requirements at Deeside Airfields for Praxis Gravity Sewer.

1 Introduction

1.1 Introduction

Sweco is assisting Welsh Water Developer Services with a sewer replacement scheme at Deeside Industrial Park, Flintshire. The overall scheme involves the modification of the existing Deeside Industrial Park Sewage Pumping Station and associated twin rising mains that will accommodate additional flows from the Deeside Airfield Development along with the existing flows from Deeside Industrial Park. The Scheme involves construction of 1 km of new below ground sewerage, associated manholes and existing highway new kiosk and culvert crossing.

Construction works include excavation of a 250m long trench along Parkway Road over a period of approximately 2 months. Previous site investigations (Geotechnics, 2016) including monitoring boreholes along Parkway Road, indicate the presence of shallow groundwater in the area. Further to this, anecdotal information from previous dewatering works carried out in the area by Dewatering Services indicates typical excavation inflows of between 1,296 and 2,592m^3/day (with a maximum available pumping rate of 3456m^3/day). Therefore, dewatering is anticipated to be required during trench excavation.

The overall purpose of this technical note is to provide hydrogeological information to support a transfer groundwater dewatering licence application for dewatering.

Document references are provided at the back of the report.

1.2 Dewatering Regulations

NRW online guidance (https://naturalresources.wales/permits-and-permissions/water-abstraction-and-impoundment/find-out-if-you-need-a-water-abstraction-or-impoundment-licence/?lang=en) indicates the type of abstraction licence considered suitable for the dewatering works is a transfer licence as it meets the following criteria set out in the guidance:

- Abstraction of >20m3/day.
- Taking water from one source of supply to another source of supply without intervening use, over a period of 28 days or more.

1.3 Assessment Methodology

Sichardt and Dupuit Thiem analytical equations have been used within excel spreadsheets to estimate inflow and radius of influence for given site specific hydrogeological conditions. These are in accordance with CIRIA guidance (CIRIA, 2016). The likely zone of influence has been estimated to determine potential impacts on groundwater and surface water receptors in the area (if any).

1.4 Proposed Dewatering Works

The location of the 250m trench section along Parkway road as shown on Figure 1-1. Dewatering will be via abstraction from 1m spaced well points installed on both sides of the trench. It is proposed that two No. 40m sections will be open at any one time. This will enable dewatering of one section, while the sewer is laid in the other section after groundwater levels have been drawn down to below the base of the trench. Dewatering will be required for a period of approximately 2 months, and abstracted groundwater will be discharged to a surface water with no intervening use, therefore a transfer dewatering licence is considered appropriate.

The abstracted flows will be settled and discharged to surface water sewers within the industrial park, which ultimately discharge to Shotwick Brook to the north of the park.

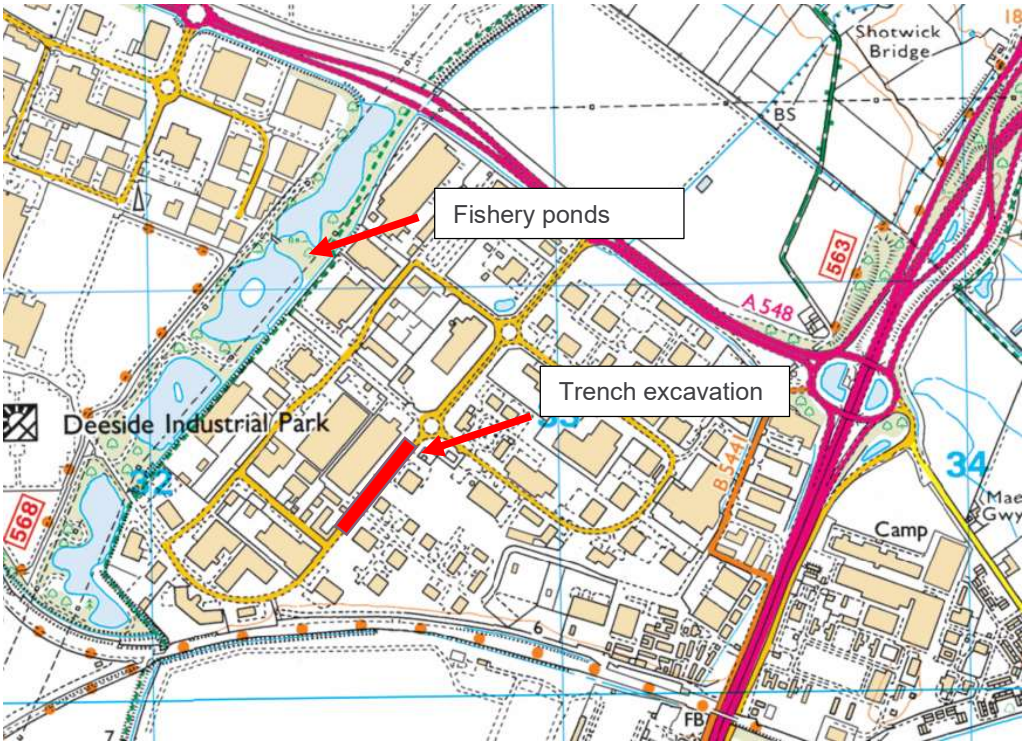

Figure 1-1 1:25,00 OS map of Deeside with trench excavation shown in red (Bing Maps, 2021)

2 Baseline Geology and Hydrogeology

2.1.1 Geology

The British Geological Survey (BGS) Geoindex online 1:50,000 geological mapping (British Geological Survey, 2021) indicates the area is underlain by tidal flat deposits comprising clay, silt and sand. This is underlain by three bedrock types, from north to south comprising: Kinnerton Sandstone Formation, Pennine Middle Coal Measures and Pennine Lower Coal Measures. The Kinnerton Sandstone Formation rests unconformably on the Coal Measures strata (Sweco, 2016).

Site investigations, reported in the GIR were carried out in 2016 and included installation of groundwater monitoring boreholes, up to 15.45m in depth. All relevant ground condition and groundwater condition information was reviewed for this technical note and logs are presented in Appendix A.

The site-specific geology underlying the area comprises topsoil and made ground that was encountered at sporadic locations in limited thickness, up to 1.5mbgl. Made ground is described as light brown slightly gravelly fine sand with fragments of metal, brick and plastic.

Natural Tidal Flat Deposits were encountered below, to a proven depth of 15.45mbgl and consist of slightly gravelly sand with rare shell and coal fragments.

Depth to bedrock was not proven during the site investigations. Historic BGS borehole logs, provided in Appendix B, indicate depths to underlying sandstone bedrock (part of the regional Kinnerton Sandstone Formation) of between 51.2mbgl (SJ36NW4) and 185mbgl (SJ37SW38). Borehole logs also record glacial Boulder Clay, underlying the Tidal Flat Deposits and overlying bedrock, beneath the surrounding area.

The interpolated geology is represented on schematic cross-sections in Figures 2-2 and 2-3.

2.1.2 Hydrogeology

The Kinnerton Sandstone Formation underlying the area is classified by Natural Resources Wales (NRW) as a Principal aquifer. The Pennine Middle and Lower Coal Measures are classified by NRW as Secondary A aquifers (DEFRA, 2021).

Overlying superficial deposits are classified by NRW as Secondary undifferentiated aquifers. Groundwater flow within superficial and bedrock aquifers is expected to be in a south westerly direction towards the River Dee.

No springs or issues are noted on 1:25,000 Ordnance Survey (OS) mapping within the area but due to the flat topography and proximity to the River Dee, it is concluded that there are likely baseflow interactions with the river although these will be affected by generally low permeability estuarine alluvium / tidal flat deposits.

The presence of low permeability clay overlying the Principal bedrock aquifer, is likely to limit hydraulic connectivity beneath the superficial and bedrock aquifers.

2.1.3 Permeability

No permeability testing was carried out during the site investigations. A range of site specific and literature permeability values has been applied in the assessment. Site specific particle size distribution (PSD) results from geotechnical testing (GIR, 2016) were applied within Hazen's rule of approximation (Hazen, 1892) to estimate permeability ranges. Results indicate a range of between 3.6E-07m/s and 4.9E-05m/s for fine-medium sand. For comparison, and sensitivity analysis, a textbook value of permeability for silty sands was also applied (4.9E-04) to give a likely worst-case scenario (Freeze and Cherry, 1979).

2.2 Water Levels

Water level monitoring in GI boreholes including along the Parkway Road was undertaken between 9 June 2016 and 21 July 2016 by means of a manual dip programme. Table 2-1 provides a summary of relevant groundwater monitoring installations and data collected during this period.

Exploratory hole	Water strike depth mbgl	Response zone	Response zone lithology	Groundwater levels range	
				mbgl	
		mbgl		Max	Min
BH04	N/A	6.00 to 8.45	Sand	3.00	2.85
BH05 P1 (19mm)	DRY	10.00 to 12.45	Sand	2.30	2.12
BH05 P2 (50mm)	DRY	1.50 to 4.00	Sand	2.25	2.14
BH06	N/A	5.00 to 10.00	Sand	2.00	2.03

Table 2-1 Summary of groundwater monitoring installations along Parkway Road and groundwater levels (9 June 2016 to 21 July 2016)

It can be seen that no groundwater was encountered at these locations during drilling. The boreholes have response zones within granular superficial deposits at varying depths.

Water level hydrographs are shown in Figure 2-1, while water strike information and water level ranges are shown on the conceptual hydrogeological model in Figures 2-2 and 2-3. The hydrographs indicate connectivity within the granular deposits with depth with a difference in levels noted at BH04, likely due to the presence of less granular materials.

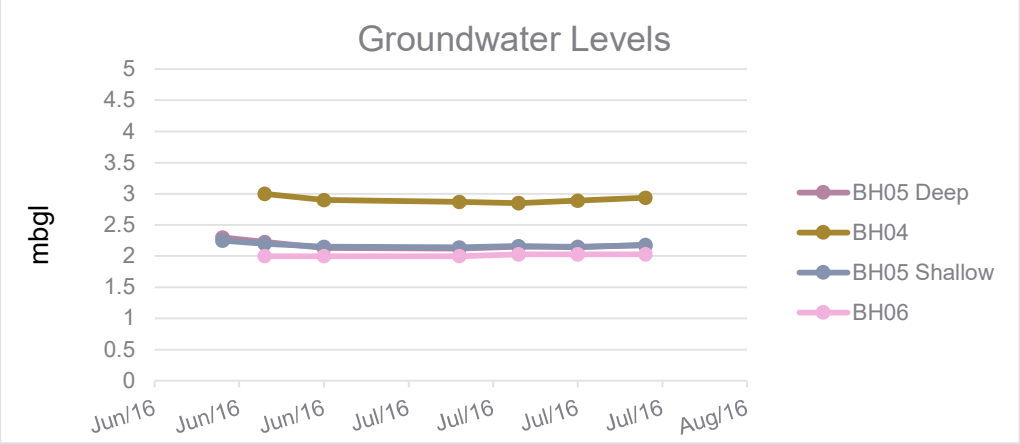

Figure 2-1 Water level hydrograph

2.3 Receptors

Dewatering activities have the potential to impact on nearby groundwater and surface water receptors. The following information on potential receptors was obtained through desk-based assessment.

Publicly held information was sought from NRW in February 2021 and Flintshire County Council in March 2021, relating to licenced and unlicenced abstractions within 1km of the trench. NRW's response confirmed no licenced abstractions (surface and groundwater) within the area of interest and Flintshire County Council responded to confirm no known private water supplies within the area of interest.

Four fishery ponds are located approximately 460m to the west northwest of the trench (as indicated on Figure 1-1), associated with the Lagoons Fishery and Shotwick Brook runs along the southern boundary of the fishery ponds. The River Lee is located approximately 1.8km to the south southwest.

BGS borehole records indicate there is a domestic water supply borehole associated with the Deeside Fishery (SJ37SW480) with an abstraction rate of greater than 50 litres/minute (0.8l/s) indicated although no more information was available at the time of this note.

An unnamed land drain is noted approximately 260m south of the southern extent of the trench and not considered to be a sensitive receptor.

2.4 Conceptual Hydrogeological Model

Hydrogeological conditions are conceptualised on schematic cross-sections in Figures 2-2 and 2-3 below, located along the approximate line of the trench and perpendicular to the trench, respectively, using both historical and site investigation information.

The cross section in Figure 2-2 illustrates the area is underlain by tidal flat deposits to depths of approximately 15mbgl, underlain by a thickness of Boulder Clay (confirmed via historic borehole records) which overlies sandstone bedrock. A second conceptual

hydrogeological section is shown in Figure 2-3, running perpendicular to Figure 2-2 and shows the relationship between the excavation and fishery pond borehole (SJ37SW480).

It is expected that the excavation for pipework installation will be to a maximum depth of 4mbgl. This will entirely fall within made ground and silty sand deposits that extend to a maximum depth of 15mbgl.

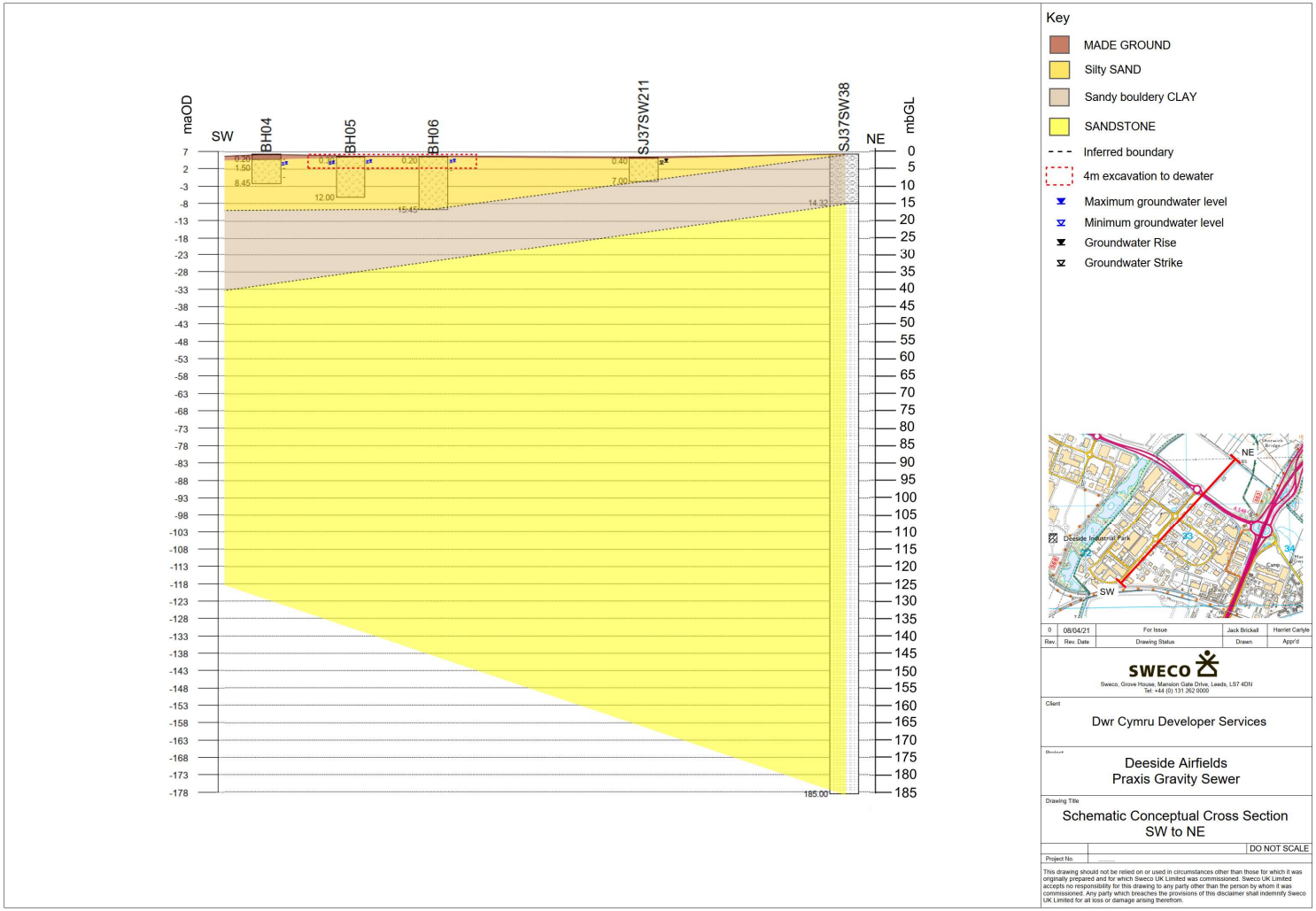

Figure 2 2 Schematic conceptual hydrogeological section (SW to NE) of trench excavation

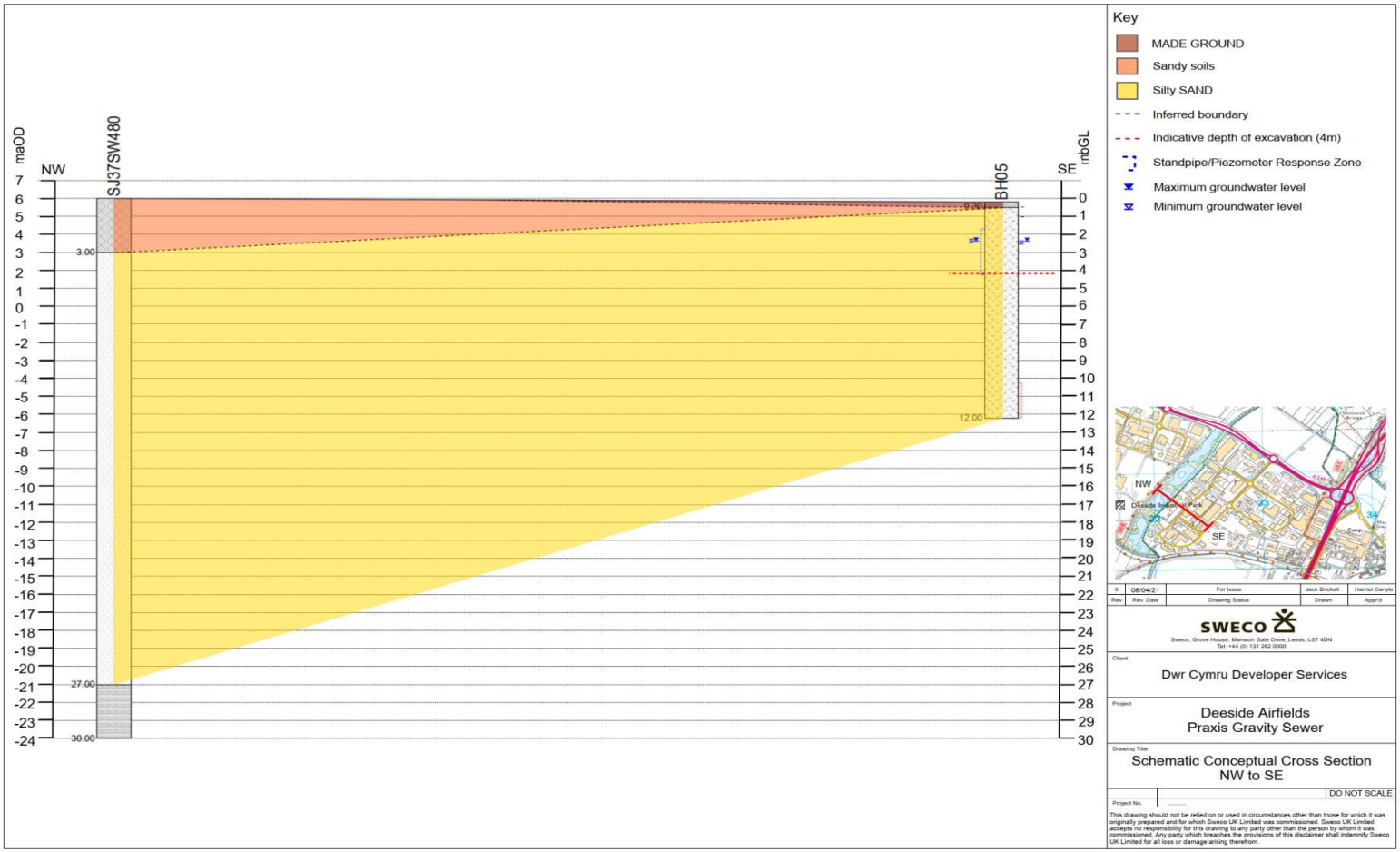

Figure 2 3 Schematic conceptual hydrogeological section (NW to SE) of fishery ponds and excavation

3 Dewatering assessment

Inflow rates and radius of influence have been assessed using quantitative means to determine the transfer licence requirements and confirm no impact to identified receptors.

It is intended that two 40m sections of the 250m trench will be open at any one time, with dewatering progressing in one section while the sewer is being laid in the other section once groundwater levels have been drawn down to below the base of the trench. This is to minimise dewatering requirements as far as possible. The trench will be entirely within tidal flat deposits that comprise silty sand.

Abstraction will be from well points on both sides of the trench, spaced at 1m intervals. The abstracted flows will be settled and discharged to surface water sewers within the industrial park, which ultimately discharge to Shotwick Brook, to the north of the park.

3.1.1 Assumptions

The following is assumed within the calculations:

- Groundwater levels are 2-3m below ground level and therefore above the estimated base of the trench excavation depth of 4mbgl.
- The dimensions of the excavation are width of 2m and length of 2x40m sections, 80m in total.
- Groundwater levels will be required to be lowered by at least 0.5m below the trench base to ensure that the excavation is dry during sewer construction. Therefore, a drawdown of between 1.5 and 2.5m is assumed based on available groundwater level information.
- Aquifer thickness is 15m based on the hydrogeological conceptual model.
- Groundwater abstraction is from one point source.

3.1.2 Results

Inflow calculation sheets for two No. 40m open sections of trench are presented in Appendix B and carried out for drawdown scenarios of 1.5 and 2.5m, respectively. Results are summarised in the tables below. Calculations have been carried out using the Sichardt and Thiem equations in accordance with CIRIA guidance (CIRIA, 2016).

The effective radius, in the tables below, converts a rectangular shape trench to a circular one to better represent conditions.

Table 3-1 Estimated inflows to 2x40m open section of the trench excavation – 1.5m drawdown

Hydraulic conductivity (m/s)	Drawdown (m)	Estimated radius of influence (m)	Effective radius of 2x40m section of trench (m)	Calculated inflow (m^3/d)
3.6E-07	1.5	2	3.6	-3
8.10E-06	1.5	9	3.6	553
4.90E-05	1.5	21	3.6	555
4.90E-04	1.5	66	3.6	2684

Table 3-2 Estimated inflows to 2x40m open section of the trench excavation – 2.5m drawdown

Hydraulic conductivity (m/s)	Drawdown (m)	Estimated radius of influence (m)	Effective radius of 2x40m section of trench (m)	Calculated inflow (m^3/d)
3.6E-07	2.5	3	3.6	-8
8.10E-06	2.5	14	3.6	241
4.90E-05	2.5	35	3.6	629
4.90E-04	2.5	111	3.6	3645

The estimated average daily abstraction rate from the two trenches is between 1,296 and 2,592m^3/day (15-30l/s) based on similar dewatering works in the area with a maximum potential rate of 3456m^3/day (40l/s) (a negative flow indicates no inflow). When these estimated average abstraction rates are compared with calculated inflows in the tables above, this indicates a potential zone of influence in the order of 10-100m for the drawdown range of 1.5 to 2.5m. Further to this, Table 3-2 indicates that the calculated drawdown required for a peak estimated flow of 3456m^3/day for the lowest permeability value, will be less than 2.5m with an estimated zone of influence of less than 111m.

Based on these calculations and sensitivity analysis, and the distance to water receptors of at least 450m, no significant impact on these receptors is predicted.

The maximum abstraction rate of 3456m^3/day, with an estimated abstraction period of 2 months.

4 References

CIRIA 750 (2016) Groundwater control: design and practice, second edition.

Freeze, A., and Cherry, J. (1979) Groundwater. Pearson Publishing.

Geotechnics (2016) Deeside Airfield Sewer Acquisition Factual Report. For Sweco Limited. Project number: PN163498

Hazen, A. (1892) Some physical properties of sands and gravels: Mass. State Board of Health, Ann. Rept. pp. 539-556.

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Bing Maps (2021) Bing maps: ordnance survey 1:25,000 mapping. Available online at: https://www.bing.com/maps, Accessed 23 March 2021.

British Geological Survey. (2021) British Geological Survey 1:50,000 and 1:625,000 superficial and bedrock geological map. Available online at Geoindex onshore: http://mapapps2.bgs.ac.uk/geoindex/home.html, accessed March 2021

Robins, N. S. & Davies, J. (2016) Hydrogeology of Wales. *British Geological Survey*.

DEFRA. (2021) DEFRA's 'Magic' interactive map. Available at http://www.magic.gov.uk/MagicMap.aspx, accessed March 2021

Appendix A – Borehole and Trial Pit Logs

BOREHOLE RECORD - Cable Percussion

Project DEESIDE AIRFIELD SEWER ACQUISITION | Engineer SWECO | Borehole / Project No BH02 / PN163498

Client SWECO | National Grid Coordinates 332026.2 E, 370028.0 N | Ground Level 4.74 m OD

Scale 1:50

Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT N	Description	Depth	Legend	Level m OD
							G.L.		4.74
0.00- 0.25	B					Grass over brown sandy TOPSOIL with some rootlets.			
0.20	ES								
0.25- 0.50	B			11			0.40		4.34
0.50- 1.00	B			11		Brown slightly silty to silty fine to medium SAND with occasional coal and bivalve shell fragments.			
0.40			PID=0.4						
0.50	ES								
0.50			PID=0.5						
1.00- 1.20	ES								
1.00			PID=0.1			Below 1.20m, loose.			
1.20- 0.65	B								
1.20- 1.65		(DRY)			S5				
1.65- 2.00	D								
2.00- 2.45	B			28		Below 2.00m, medium dense.			
2.00- 2.45	D	2.00 (1.50)			S25				
2.00			PID=0.0						
2.50- 3.00	D								
3.00- 3.45	B								
3.00- 3.45	D	3.00 (1.80)			S14				
3.00			PID=0.0						
3.50- 4.00	D								
4.00- 4.45	B								
4.00- 4.45	D	4.00 (2.70)			S14				
4.00			PID=0.0						
4.50- 5.00	D								
5.00- 5.45	B								
5.00- 5.45	D	5.00 (3.40)			S26				
5.00			PID=0.0						
5.50- 6.00	B								
6.00- 6.45	B								
6.00- 6.45	D	6.00 (3.40)			S26				
6.00			PID=0.0						
6.50- 7.00	D								
7.00- 7.45	B								
7.00- 7.45	D	7.00 (3.10)			S21				
7.00			PID=0.0						
8.00- 8.45	B					At 8.00m, slightly gravelly. Gravel is subangular fine to medium including siltstone, igneous lithologies and bivalve shell fragments. Between 8.40-8.80m, occasional pockets of soft dark grey clay.			
8.00- 8.45	D	8.00 (3.50)			S15				
8.00			PID=0.0						
8.80- 9.00	D					Below 8.80m, occasional fine to medium gravel including white bivalve shell fragments. Between 9.00m and 9.45m, dense.			
9.00- 9.45	B								
9.00- 9.45	D	9.00 (3.10)			S38				
9.50-10.00	D								
10.00-10.45	B								

Boring

Depth	Hole Dia	Technique	Crew
1.20	0.40	Inspection Pit	DG/KB
8.30	0.20	Cable Percussion	DG/KB
12.45	0.15	Cable Percussion	DG/KB

Progress

Depth of Hole	Depth Cased	Depth to Water	Date	Time
G.L.			02/06/16	08:00
8.50	8.00	3.50	02/06/16	18:00
8.50	8.00		03/06/16	08:00
12.45	12.00	1.70	03/06/16	18:00

Groundwater

Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
1.90	1.90	1.70	20		Slow inflow.

Remarks

NOTES

Inspection pit hand excavated to 1.20m depth.
ES Sample = 1 x 60ml VOC vials and 2 x 250ml amber jars
PID = Photo-ionisation detector reading measuring Total Volatile Organic Compounds concentration in ppm.
Water was added to assist boring between 1.20m and 12.00m.
A 50mm standpipe was installed to 6.00m with a geowrapped slotted section from 2.00m to 6.00m with flush lockable protective cover. Backfill details from base of hole: bentonite seal up to 6.00m, gravel filter up to 2.00m, bentonite seal up to 0.20m, concrete up to

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:1999 + A2:2010

Logged by DS

Figure 1 of 2

20/07/2016

geotechnics

BOREHOLE RECORD - Cable Percussion

Project DEESIDE AIRFIELD SEWER ACQUISITION | Engineer SWECO | Borehole / Project No BH02 / PN163498

Client SWECO | National Grid Coordinates 332026.2 E, 370028.0 N | Ground Level 4.74 m OD

Scale 1:50

Sampling			Properties			Strata			
Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT N	Description	Depth	Legend	Level m OD
10.00-10.45	D	10.00 (3.80)			S27				
10.00			PID=0.0						
10.50-11.00	D								
11.00-11.45	B								
11.00-11.45		11.00 (3.70)			S24				
11.00			PID=0.0						
11.50-12.00	D								
12.00-12.45	D	12.00 (3.70)			S13				
12.00			PID=0.0						
						End of Borehole	12.45		-7.71

Boring				Progress					Groundwater					
Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks NR ground level.

Logged by DS

Figure 2 of 2 20/07/2016

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:1999 + A2:2010

geotechnics

BOREHOLE RECORD - Cable Percussion

Project: DEESIDE AIRFIELD SEWER ACQUISITION | Engineer: SWECO | Borehole: BH03 | Project No: PN163498

Client: SWECO | National Grid Coordinates: 332312.5 E, 370121.3 N | Ground Level: 4.37 m OD

Scale: 1:50

Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT N	Description	Depth	Legend	Level m OD
							G.L.		4.37
0.00- 0.25	B					Grass over brown sandy TOPSOIL with rootlets.	0.05		4.32
0.25	ES								
0.20			PID=0.6			MADE GROUND: Greyish brown sandy angular medium to coarse gravel of limestone.	0.38		3.99
0.50	B								
0.50	ES								
0.50			PID=0.5			Medium dense brown slightly silty slightly gravelly fine SAND. Gravel is subangular to subrounded fine to medium of various lithologies and bivalve shell fragments.			
1.00- 1.20	B			23		Between 1.00m and 1.20m, silty.			
1.00	ES								
1.00			PID=0.3						
1.20- 1.65	B								
1.20- 1.65	D	(DRY)			S11				
1.30	W						1.60	▽	2.77
1.65- 2.00	D					Medium dense dark grey slightly silty to silty fine to medium SAND with occasional coal and bivalve shell fragments.			
2.00- 2.45	B			22					
2.00- 2.45	D	2.00 (1.60)			S6	Between 2.00m and 2.45m, loose and silty.			
2.00			PID=0.3						
2.50- 3.00	D								
3.00- 3.45	B			26					
3.00- 3.45	D	3.00 (1.60)			S19				
3.00			PID=0.3						
3.50- 4.00	D								
4.00- 4.45	B					Below 4.00m, brownish grey.			
4.00- 4.45	D	4.00 (1.60)			S24				
4.00			PID=0.4						
4.50- 5.00	D								
5.00- 5.45	B								
5.00- 5.45	D	5.00 (1.60)			S19				
5.00			PID=0.2						
5.50- 6.00	D								
6.00- 6.45	B								
6.00- 6.45	D	6.00 (2.00)			S18				
6.00			PID=0.2						
6.50- 7.00	D								
7.00- 7.45	B								
7.00- 7.45	D	7.00 (2.80)			S18				
7.00			PID=0.0						
7.50- 8.00	D								
8.00- 8.45	B								
8.00- 8.45	D	8.00 (2.80)			S28				
8.00			PID=0.0						
8.50- 9.00	D								
9.00- 9.45	B					Below 9.00m, dense, occasionally medium dense.			
9.00- 9.45	D	9.00 (3.10)			S32				
9.00			PID=0.0						
9.50-10.00	D								
10.00-10.45	B								

Boring

Depth	Hole Dia	Technique	Crew
1.20	0.40	Inspection Pit	DG/KB
6.00	0.20	Cable Percussion	DG/KB
12.45	0.15	Cable Percussion	DG/KB

Progress

Depth of Hole	Depth Cased	Depth to Water	Date	Time
G.L.			06/06/16	08:00
12.45	12.00	2.80	06/06/16	18:00

Groundwater

Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
1.60	1.60				No rise.

Remarks

NB Inspection pit hand excavated to 1.20m depth.
ES Sample = 1 x 60ml VOC vials and 2 x 250ml amber jars
PID = Photo-ionisation detector reading measuring Total Volatile Organic Compounds concentration in ppm.
Water was added to assist boring between 10.00 and 12.00m.
A 50mm gas monitoring pipe was installed to 3.50m with a geowrapped slotted section from 1.50m to 3.50m with flush lockable protective cover. Backfill details from base of hole: bentonite seal up to 3.50m, gravel filter up to 1.50m, bentonite seal up to 0.20m, concrete

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:1999 + A2:2010

Logged by: DS

Figure: 1 of 2, 20/07/2016

geotechnics

BOREHOLE RECORD - Cable Percussion

Project DEESIDE AIRFIELD SEWER ACQUISITION | Engineer SWECO | Borehole / Project No BH03 / PN163498

Client SWECO | National Grid Coordinates 332312.5 E, 370121.3 N | Ground Level 4.37 m OD

Scale 1:50

Sampling			Properties			Strata			
Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT N	Description	Depth	Legend	Level m OD
10.00-10.45	D	10.00 (3.80)			S42				
10.00			PID=0.0						
10.50-11.00	D								
11.00-11.45	B								
11.00-11.45	D	11.00 (4.00)			S28				
11.00			PID=0.0						
11.50-12.00	D								
12.00-12.45	D	12.00 (3.70)			S33				
12.00			PID=0.0			End of Borehole	12.00		-7.63

Boring				Progress					Groundwater					
Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks NR up to ground level.

Logged by DS

Figure 2 of 2 20/07/2016

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:1999 + A2:2010

geotechnics

BOREHOLE RECORD - Cable Percussion

Project: DEESIDE AIRFIELD SEWER ACQUISITION | Engineer: SWECO | Borehole: BH04 | Project No: PN163498

Client: SWECO | National Grid Coordinates: 332322.4 E, 370250.1 N | Ground Level: 6.28 m OD

Scale: 1:50

Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT N	Description	Depth	Legend	Level m OD
							G.L.		6.28
0.00- 0.10	B					Grass over TOPSOIL: Soft brown sandy clay with some rootlets.	0.20		6.08
0.10	ES								
0.10			PID=0.5						
0.20	ES					MADE GROUND: Light brown slightly gravelly fine sand. Gravel is angular to subangular fine to medium including sandstone and igneous lithologies. At 0.30m, metal fragment. At 1.00m, 2 No. bricks and 20mm diameter grey cable. Between 1.00m and 1.20m, silty. At 1.20m, medium dense.			
0.20			PID=0.4						
0.25	B								
0.50	B								
0.50	ES								
0.50			PID=0.5						
1.00- 1.20	B								
1.00	ES								
1.00			PID=0.4				1.50		4.78
1.20- 1.65	B			26		Medium dense light brown slightly silty fine SAND with occasional white bivalve shells and shelly fragments. Between 2.00m and 2.45m, dense.			
1.20- 1.65	D	(DRY)			S14				
1.65- 2.00	D								
2.00- 2.45	B								
2.00- 2.45	D	2.00 (1.50)			S41				
2.00			PID=0.4						
2.45- 3.00	D								
3.00- 3.45	B								
3.00- 3.45	D	3.00 (2.80)			S23				
3.00			PID=0.4						
3.50- 4.00	D								
4.00- 4.45	B								
4.00- 4.45	D	4.00 (3.20)			S28				
4.00			PID=0.3						
4.50- 5.00	D								
5.00- 5.45	B								
5.00- 5.45	D	5.00 (2.90)			S16				
5.00			PID=0.4						
5.50- 6.00	D								
6.00- 6.45	B								
6.00- 6.45	D	6.00 (4.00)			S10				
6.00			PID=0.2						
6.50- 7.00	D								
7.00- 7.45	B								
7.00- 7.45	D	7.00 (4.90)			S14				
7.00			PID=0.3						
7.50- 8.00	D								
8.00- 8.45	#	8.00 (5.40)			S30				
8.00			PID=0.4						
						End of Borehole	8.45		-2.17

Boring

Depth	Hole Dia	Technique	Crew
1.20	0.40	Inspection Pit	DG/KB
8.45	0.15	Cable Percussion	DG/KB

Progress

Depth of Hole	Depth Cased	Depth to Water	Date	Time
G.L.			13/06/16	08:00
8.45	8.00	4.40	13/06/16	18:00

Groundwater

Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
					Masked by the addition of water to the borehole.

Remarks

NBS

Inspection pit hand excavated to 1.20m depth.
ES Sample = 1 x 60ml VOC vial and 2 x 258ml amber jars.
PID = Photo-ionisation detector reading measuring Total Volatile Organic Compounds concentration in ppm.
Water was added to assist boring between 2.00m and 8.00m.
A 50mm standpipe was installed to 7.60m with a geowrapped slotted section from 6.00m to 7.60m with flush lockable protective cover. Backfill details from base of hole: gravel filter up to 6.00m, bentonite seal up to 0.20m, concrete up to ground level.

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:1999 + A2:2010

Logged by: DS

Figure: 1 of 1 20/07/2016

geotechnics

BOREHOLE RECORD - Cable Percussion

Project: DEESIDE AIRFIELD SEWER ACQUISITION | Engineer: SWECO | Borehole / Project No: BH05 / PN163498

Client: SWECO | National Grid Coordinates: 332481.8 E, 370437.9 N | Ground Level: 5.79 m OD

Scale 1:50

Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT N	Description	Depth	Legend	Level m OD
							G.L.		5.79
0.00- 0.20	B					MADE GROUND: Grass over sandy topsoil with occasional angular fine to coarse gravel of concrete.			
0.20	ES						0.30		5.49
0.20			PID=0.3			At 0.20m, concrete slab in southeast side of the pit.			
0.50	B								
0.50	ES								
0.50			PID=0.5						
1.00- 1.20	B					Medium dense light brown slightly silty to silty fine SAND with occasional coal and white bivalve shell fragments.			
1.00	ES								
1.00			PID=0.2			Between 1.20m and 1.65m, slightly gravelly.			
1.20- 1.65	B			19					
1.20- 1.65	D	(DRY)			S12				
2.00- 2.45	B								
2.00- 2.45	D	2.00			S11				
2.00	ES	(0.70)							
2.00			PID=0.1						
2.50- 3.00	D								
3.00- 3.45	B			26					
3.00- 3.45	D	3.00			S18				
3.00		(2.40)	PID=0.0						
3.50- 4.00	D								
4.00- 4.45	B			24					
4.00- 4.45	D	4.00			S18				
4.00		(3.20)	PID=0.0						
4.50- 5.00	D								
5.00- 5.45	B								
5.00- 5.45	D	5.00			S17				
5.00		(3.10)	PID=0.0						
5.50- 6.00	D								
6.00- 6.45	B					Below 6.00m, fine to medium.			
6.00- 6.45	D	6.00			S23				
6.00		(3.00)	PID=0.2						
6.50- 7.00	D								
7.00- 7.45	B								
7.00- 7.45	D	7.00			S30				
7.00		(1.00)	PID=0.1						
7.50- 8.00	D								
8.00- 8.45	B					Below 8.00m, mottled dark grey.			
8.00- 8.45	D	8.00			S45				
8.00		(1.00)	PID=0.1						
8.50- 9.00	D								
9.00- 9.45	B								
9.00- 9.45	D	9.00			S29				
9.00		(1.00)	PID=0.0						
9.50-10.00	D								
10.00-10.45	B								

Boring

Depth	Hole Dia	Technique	Crew
1.20	0.40	Inspection Pit	DG/KB
3.00	0.20	Cable Percussion	DG/KB
12.45	0.15	Cable Percussion	DG/KB

Progress

Depth of Hole	Depth Cased	Depth to Water	Date	Time
G.L.			07/06/16	08:00
6.00	6.00	3.70	07/06/16	18:00
5.40	6.00	2.30	08/06/16	08:00
12.00	12.00	1.00	08/06/16	18:00

Groundwater

Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
					Masked by the addition of water to the borehole.

Remarks

NOTES

Inspection pit hand excavated to 1.20m depth.
ES Sample = 1 x 60ml VOC vials and 2 x 250ml amber jars
PID = Photo-ionisation detector reading measuring Total Volatile Organic Compounds concentration in ppm.
Water was added to assist boring between 5.00 and 12.00m.
A 19mm standpipe piezometer was installed to 11.50m with flush lockable protective cover and a 50mm gas monitoring pipe was installed to 4.00m with a geowrapped slotted section from 1.50m to 4.00m with flush lockable protective cover. Backfill details from base of hole:

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:1999 + A2:2010

Logged by DS

Figure 1 of 2 20/07/2016

geotechnics

BOREHOLE RECORD - Cable Percussion

Project DEESIDE AIRFIELD SEWER ACQUISITION | Engineer SWECO | Borehole BH05 | Project No PN163498

Client SWECO | National Grid Coordinates 332481.8 E 370437.9 N | Ground Level 5.79 m OD | Scale 1:50

Sampling			Properties			Strata			
Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT N	Description	Depth	Legend	Level m OD
10.00-10.45	D	10.00 (1.00)			S21				
10.00			PID=0.0						
10.50-11.00	D								
11.00-11.45	B								
11.00-11.45	D	11.00 (1.00)			S32				
11.00			PID=0.0						
11.50-12.00	D								
12.00-12.45	D	12.00 (1.00)			S17	End of Borehole	12.00		-6.21
12.00			PID=0.0						

Boring				Progress				Groundwater					
Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks NB gravel filter up to 10.00m, bentonite seal up to 4.00m, gravel filter up to 1.50m, bentonite seal up to 0.30m, concrete up to ground level.

Logged by DS

Figure 2 of 2 20/07/2016

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:1999 + A2:2010

geotechnics

BOREHOLE RECORD - Cable Percussion

Project	DEESIDE AIRFIELD SEWER ACQUISITION	Engineer	SWECO
Borehole	BH06	Project No	PN163498
Client	SWECO	National Grid Coordinates	332655.6 E 370603.2 N
Ground Level	5.73 m OD	Scale	1:50

Sampling: Depth	Sample Type	Depth Cased & (to Water)	Properties: Strength kPa	w %	SPT N	Strata: Description	Depth	Level m OD
							G.L.	5.73
0.00- 0.20	B					Grass over TOPSOIL: Soft brown slightly gravelly sandy clay with some rootlets. Gravel is subangular fine to coarse including sandstone and igneous lithologies.		
0.20	ES						0.20	5.53
0.20			PID=0.2					
0.50	B							
0.50	ES							
0.50			PID=0.1			Medium dense light brown slightly silty fine SAND.		
1.00- 1.20	B							
1.00	ES					Below 1.20m, occasional coal and bivalve shell fragments.		
1.00			PID=0.2					
1.20- 1.65	B							
1.20- 1.65	D	(DRY)			S23			
1.65- 2.00	D							
2.00- 2.45	B			24		Below 2.00m, greyish brown, silty, fine to medium sand.		
2.00- 2.45	D	2.00			S14			
2.00	ES	(1.40)						
2.00			PID=0.1					
2.50- 3.00	D							
3.00- 3.45	B			22				
3.00- 3.45	D	3.00 (1.80)			S20			
3.00			PID=0.1					
3.50- 4.00	D							
4.00- 4.45	B							
4.00- 4.45	D	4.00 (1.80)			S15			
4.00			PID=0.1					
4.50- 5.00	D							
5.00- 5.45	B			24				
5.00- 5.45	D	5.00 (2.90)			S14			
5.00			PID=0.1					
5.50- 6.00	D							
6.00- 6.45	B			21				
6.00- 6.45	D	6.00 (3.50)			S16			
6.00			PID=0.1					
6.50- 7.00	D							
7.00- 7.45	#	7.00			S14			
7.00- 7.45	B	(4.00)		6.7				
7.00			PID=0.0					
7.50- 8.00	D							
8.00- 8.45	#	8.00			S13	Below 8.00m, occasional whole bivalve shells.		
8.00- 8.45	B	(4.50)						
8.00			PID=0.0					
8.50- 9.00	D							
9.00- 9.45	#	9.00 (2.70)			S40	Between 9.00m and 11.00m, dense.		
9.00			PID=0.0					
9.50-10.00	D							
10.00-10.45	B							

Boring: Depth	Hole Dia	Technique	Crew	Progress: Depth of Hole	Depth Cased	Depth to Water	Date	Time	Groundwater: Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
1.20	0.40	Inspection Pit	DG/KB	G.L.			09/06/16	08:00						Masked by the addition of water to the borehole.
4.50	0.20	Cable Percussion	DG/KB	9.00	9.00	2.20	09/06/16	18:00						
15.45	0.15	Cable Percussion	DG/KB	8.40	9.00	2.40	10/06/16	08:00						
				15.45	15.00	3.70	10/06/16	18:00						

Remarks

Inspection pit hand excavated to 1.20m depth.
ES Sample = 1 60ml VOC vial and 2 x 258ml amber jars
PID = Photo-ionisation detector reading measuring Total Volatile Organic Compounds concentration in ppm.
Water was added to assist boring between 2.00 and 9.00m.
A 50mm standpipe was installed to 10.00m with a geowrapped slotted section from 5.00m to 10.00m with flush lockable protective cover. Backfill details from base of hole: bentonite seal up to 10.00m, gravel filter up to 5.00m, bentonite seal up to 0.20m, concrete up to

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:1999 + A2:2010

Logged by DS

Figure 1 of 2

20/07/2016

geotechnics

BOREHOLE RECORD - Cable Percussion

Project DEESIDE AIRFIELD SEWER ACQUISITION | Engineer SWECO | Borehole / Project No BH06 / PN163498

Client SWECO | National Grid Coordinates 332655.6 E, 370603.2 N | Ground Level 5.73 m OD

Scale 1:50

Sampling Depth	Sample Type	Depth Cased & (to Water)	Properties Strength kPa	w %	SPT N	Strata Description	Depth	Legend	Level m OD
10.00-10.45	D	10.00 (3.90)			S31				
10.00			PID=0.0						
10.50-11.00	D								
11.00-11.45	#	11.00			S26				
11.00-11.45	B	(3.70)							
11.00			PID=0.0						
11.50-12.00	D								
12.00-12.45	B								
12.00-12.45	D	12.00 (3.70)			S15				
12.00			PID=0.0						
12.45-13.00	D								
13.00-13.45	#	13.00			S23				
13.00-13.45	B	(3.70)							
13.00			PID=0.0						
13.50-14.00	D								
14.00-14.45	B								
14.00-14.45	D	14.00 (3.70)			S19	Below 14.00m, occasional subrounded fine to medium gravel including igneous lithologies.			
14.00			PID=0.0						
14.50-15.00	D								
15.00-15.42	D	15.00 (3.70)			S50/ 265				
15.00			PID=0.0						
						End of Borehole	15.45		-9.72

Boring Depth	Hole Dia	Technique	Crew	Progress Depth of Hole	Depth Cased	Depth to Water	Date	Time	Groundwater Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks NOTE ground level.

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:1999 + A2:2010

Logged by DS

Figure 2 of 2 20/07/2016

geotechnics

TRIAL PIT RECORD — Trial Pit

Project: DEESIDE AIRFIELD SEWER ACQUISITION | Engineer: SWECO | Trial Pit: TP01 | Project No: PN163498

Client: SWECO | National Grid Coordinates: 332053.9 E, 370038.4 N | Ground Level: 4.50 m OD

Samples and Tests | Strata | Scale 1:50

Depth	Type	Stratum No	Results	Description	Depth	Legend	Level m OD
					G.L.		4.50
0.10	D			Grass over TOPSOIL: Brown silty fine to medium sand with some rootlets.			
0.20- 0.40	B				0.40		4.10
0.20- 0.40	D			Light brown mottled orangish brown slightly silty fine to medium SAND with occasional pockets of silt.			
0.20	ES						
0.20			PID=0.1				
0.50- 1.00	B		mc=14%				
0.50- 1.00	D						
0.50	ES						
0.50			PID=0.0				
1.00	ES						
1.00			PID=0.0				
1.50- 1.80	B						
1.50- 1.80	D						
1.80- 2.00	B		mc=33%		1.80		2.70
1.80- 2.00	D			Dark grey silty fine SAND / sandy SILT.			
2.00	ES				2.10		2.40
2.00			PID=0.0	End of Excavation			

Excavation

Plant: 5 tonne tracked excavator
Date: 01/06/2016
Shoring: None.
Stability: Unstable below 2.10m.
Width (B): 0.75
Length (C): 2.70
Date Backfilled: 01/06/2016

Groundwater

Depth Observed	Depth of Pit	Details
1.50	1.50	Seepage.
2.00	2.10	Slow inflow.

Remarks: The Trial Pit was terminated at a depth of 2.10m due to instability of the pits sides.
ES Sample = 1 x 60ml VOC vial and 2 x 258ml amber jars.
PID = Photo-ionisation detector reading measuring Total Volatile Organic Compounds concentration in ppm.
Backfill details from base of hole: arisings up to ground level.

Logged by: DSm
Figure: 1 of 1
20/07/2016

Symbols and abbreviations are explained on the accompanying key sheet.
All dimensions are in metres.
Logged in accordance with BS5930:1999 + A2:2010

geotechnics

TRIAL PIT RECORD — Trial Pit

Project: DEESIDE AIRFIELD SEWER ACQUISITION | Engineer: SWECO | Trial Pit: TP02 | Project No: PN163498

Client: SWECO | National Grid Coordinates: 332122.0 E, 370064.5 N | Ground Level: 4.66 m OD

Scale 1:50

Samples and Tests

Depth	Type	Stratum No	Results
0.10	D		
0.10	ES		
0.10			PID=0.2
0.20- 0.70	B		mc=15%
0.20- 0.70	D		
0.50	ES		
0.50			PID=0.1
0.80- 1.30	B		
0.80- 1.30	B		mc=23%
0.80- 1.30	D		
1.00	ES		
1.00			PID=0.1
1.40- 1.90	B		
1.40- 1.90	D		
2.00- 2.50	B		
2.00- 2.50	D		

Strata

Description	Depth	Legend	Level m OD
	G.L.		4.66
Grass over TOPSOIL: Brown slightly silty fine to medium sand with some rootlets.	0.20		4.46
Light brown mottled orangish brown slightly silty fine SAND.			
Below 0.90m, occasional pockets of sandy silt.			
Brown silty fine SAND / sandy SILT.	1.40		3.26
End of Excavation	3.00		1.66

Excavation

Plant: 5 tonne tracked excavator.
Date: 01/06/2016
Shoring: None.
Stability: Ustable below 3.00m.
Width (B): 0.80
Length (C): 2.80
Date Backfilled: 01/06/2016

Groundwater

Depth Observed	Depth of Pit	Details
1.00	1.00	Seepage.
1.80	1.50	Seepage.

Remarks

The Trial Pit was terminated at a depth of 3.00m due to instability of the pits sides.
ES Sample = 1 x 60ml VOC vial and 2 x 258ml amber jars.
PID = Photo-ionisation detector reading measuring Total Volatile Organic Compounds concentration in ppm.
Backfill details from base of hole: arisings up to ground level.

Logged by: DSm
Figure: 1 of 1
20/07/2016

Symbols and abbreviations are explained on the accompanying key sheet.
All dimensions are in metres.
Logged in accordance with BS5930:1999 + A2:2010

geotechnics

TRIAL PIT RECORD — Trial Pit

Project: DEESIDE AIRFIELD SEWER ACQUISITION | Engineer: SWECO | Trial Pit / Project No: TP03 / PN163498

Client: SWECO | National Grid Coordinates: 332216.1 E, 370094.3 N | Ground Level: 4.71 m OD

Samples and Tests | Strata | Scale 1:50

Depth	Type	Stratum No	Results	Description	Depth	Legend	Level m OD
					G.L.		4.71
0.10	D			Grass over TOPSOIL: Brown slightly silty fine to medium sand with some rootlets.			
0.20	ES				0.30		4.41
0.20			PID=0.1	Light brown mottled orangish brown sightly silty fine to medium SAND with occasional pockets of silt. Occasional white shell fragments.			
0.40- 0.90	B						
0.40- 0.90	D						
0.50	ES						
0.50			PID=0.1				
1.00- 1.50	B		mc=24%				
1.00- 1.50	D						
1.00	ES						
1.00			PID=0.0				
1.50- 2.00	B		mc=33%				
1.50- 2.00	D			Below 1.70m, grading to fine sandy silt.			
				End of Excavation	2.20		2.51

Excavation

Plant: 5 tonne tracked excavator
Date: 01/06/2016
Shoring: None.
Stability: Ustable at 2.20m.
Width (B): 0.75
Length (C): 2.80
Date Backfilled: 01/06/2016

Groundwater

Depth Observed	Depth of Pit	Details
1.60		Seepage
2.20		Slow inflow

Remarks: The Trial Pit was terminated at a depth of 2.20m due to instability of the pits sides.
ES Sample = 1 x 60ml VOC vial and 2 x 258ml amber jars.
PID = Photo-ionisation detector reading measuring Total Volatile Organic Compounds concentration in ppm.
Backfill details from base of hole: arisings up to ground level.

Logged by: DSm
Figure: 1 of 1 20/07/2016

Symbols and abbreviations are explained on the accompanying key sheet.
All dimensions are in metres.
Logged in accordance with BS5930:1999 + A2:2010

geotechnics

TRIAL PIT RECORD — Trial Pit

Project: DEESIDE AIRFIELD SEWER ACQUISITION | Engineer: SWECO | Trial Pit: TP04 | Project No: PN163498

Client: SWECO | National Grid Coordinates: 332285.3 E, 370113.5 N | Ground Level: 4.63 m OD

Samples and Tests | Strata | Scale 1:50

Depth	Type	Stratum No	Results	Description	Depth	Legend	Level m OD
					G.L.		4.63
0.10	D			Grass over TOPSOIL with some rootlets.	0.15		4.48
0.10	ES						
0.10			PID=0.0	Light brown slightly silty fine to medium SAND.			
0.30- 0.80	B						
0.30- 0.80	D						
0.50	ES						
0.50			PID=0.0				
1.00- 1.50	B						
1.00- 1.50	D			Below 1.00m, pockets of silt			
1.00	ES						
1.00			PID=0.0				
					1.90		2.73
1.90- 2.40	B			Dark grey silty fine SAND / sandy SILT.			
1.90- 2.40	D						
					2.60		2.03
				End of Excavation			

Excavation

Plant: 5 tonne tracked excavator
Date: 01/06/2016
Shoring: None.
Stability: Unstable at 2.60m.
Width (B): 0.75
Length (C): 2.80
Date Backfilled: 01/06/2016

Groundwater

Depth Observed	Depth of Pit	Details
1.00	1.00	Seepage.
1.90	1.90	Slow inflow.

Remarks

The Trial Pit was terminated at a depth of 2.60m due to instability of the pits sides.
ES Sample = 1 x 60ml VOC vial and 2 x 258ml amber jars.
PID = Photo-ionisation detector reading measuring Total Volatile Organic Compounds concentration in ppm.
Backfill details from base of hole: arisings up to ground level.

Symbols and abbreviations are explained on the accompanying key sheet.
All dimensions are in metres.

Logged in accordance with BS5930:1999 + A2:2010

Logged by: DSm
Figure: 1 of 1
20/07/2016

geotechnics

5186 6973

RECORD OF WELL (SHAFT OR BORE)

SJ 36 NW 4

N.S. 408
O.S. –
Grid Ref. 10SE 4.

At Sealand Exploration Company No 2 Bore

Town or Village Shotton County Flint Six-inch quarter sheet 10SE

Exact site At an angle of the seabank 700 yds. N.W. of Sealand Bank Farm (Griffith's on 6" series map). (640.08m.) (A rough sketch-map or a tracing from a map is very desirable)

Level of ground surface above sea-level (O.D.) c. 20 ft. (6.10m. 179.98m.) If well starts below ground surface, state how far ft.

Shaft ft., diameter ft. Bore 590½ ft. Diameter of bore: at top ins.; at bottom ins.

Details of permanent lining tubes (internal diameters preferred) (mineral Bore).

Water struck at depths of (feet)

Rest-level of water below / above top of well feet. Suction at feet. Yield on hours' / days' test

gallons per (with pump of capacity g.p.h.); depressing water level to feet

below top. Time of recovery hrs. Amount normally pumped daily g.p.h. for hours.

Quality (attach copy of analysis if available)

Sunk by for Mr. Date of well 1891

Information from Flint Memoir 1890. Supplement. page 4.

(For Survey use only). GEOLOGICAL CLASSIFICATION.	NATURE OF STRATA (and any additional remarks).	m.	THICKNESS Feet.	THICKNESS Inches.	DEPTH Feet.	DEPTH Inches.	m.
Estuarine	Sea sand	15.24	50	-	50	-	15.24
	Sand and gravel	1.07	3	6	53	6	16.31
	Blue clay	0.30	1	-	54	6	16.61
	Boulder clay with cobbles	1.57	5	2	59	8	18.19
	Stiff brown boulder clay	11.89	39	-	98	8	30.08
	Sand	0.91	3	-	101	8	30.99
	Boulder clay with cobbles	1.07	3	6	105	2	32.04
	Red sand	1.63	5	4	110	6	33.65
Glacial	Boulder clay	6.25	20	6	131	-	39.94
	Fine red sand and gravel	2.90	9	6	140	6	42.83
	Stiff brown boulder clay, with cobbles in lower part	2.34	7	10	148	4	45.21
	Sand and gravel	3.12	10	3	158	7	48.33
	Stiff brown boulder clay	1.45	4	9	163	4	49.78
	Red sandstone	2.01	6	7	169	11	51.89
	Fireclay and shale	17.30	56	9	226	8	69.09
	Coal	0.43	1	5	228	1	69.52
	Sandstone	0.15		6	228	7	69.67
	Coal	1.37	4	6	233	1	71.04
	Shale and fireclay	1.68	5	6	238	7	72.72
	Coal	0.30	1	-	239	7	73.03
	Sandstone-band	0.05		2	239	9	73.08

? Main

	Coal	0·10		4	240
	Stone-band	0·05		2	240
	Coal	0 61	2	-	242
	Fireclay and shale	5·13	16	10	259
	Coal	0 05		2	259
	Fireclay and sandy shale	17·88	58	8	317
	Limestone (?)	0 01	2	-	319
Middle Coal Measures	Shale and fireclay	1·49	24	7	344
	Dark grey limestone (?)	0 23		9	345

(Contd...

GEOLOGICAL SURVEY AND MUSEUM,
SOUTH KENSINGTON,
LONDON, S.W.7.

For Survey use only

Date received	O.S.M. Office File No.	Site marked on 1" map (use symbol)

(*11815) W1.20051/O.369 10,000 9/39
A.& E.W.Ltd. Gp.686

SS 37 SW 211

330 90 71029

Sampling

Depth	Type	Casing Depth	Date/ Water	SPT N (Cu)
0.00-1.50	B		08/03 1993 DRY	
1.50-1.95	SD	1.50	DRY	9
1.50-2.00	B			
2.25	D			
2.50-2.95	SD	2.50	1.50	13
2.50-3.00	B			
3.25	D			
3.50-3.95	SD	3.50	1.00	21
3.50-4.00	B			
4.25	D			
4.50-4.95	SD	4.50	1.20	20
4.50-5.00	B			
5.25	D			
5.50-5.95	SD	5.50	1.80	30
5.50-6.00	B			
6.25	D			
6.50-6.95	SD	6.50	1.70	27
6.50-7.00	B			
		7.00	1.90	

Strata

Description	Depth (Thickness)	Level
	G.L.	5.50
MADE GROUND:- Dark brown slightly silty fine medium and coarse sand	(0.40)	
	0.40	5.10
Loose light brown and light grey-brown slightly clayey, silty fine and medium SAND. Occasional comminuted shell debris		
Below 2.50m:- medium dense, slightly silty		
At 5.50m:- dense		
	7.00	-1.50
End of Borehole.		

Legend

Equipment: Light Cable Percussive Boring Rig (Dando 150)

Borehole Dia (mm) 200 to 7.00m

Casing Dia (mm) 200 to 7.00m

Groundwater

No.	Struck	Behaviour	Sealed
1	2.00	Rose to 1.90m after 20 minutes	

Ground Level 5.50 m OD

Drilled by BJ
Logged by DPC
Checked by JJM

Remarks

1. Service inspection pit excavated to 1.20m (1 hour)
2. Water added below 2.00m to stabilise borehole
3. Borehole backfilled with arisings

See key sheet and appendices for explanations.

Form 1/0

Borehole Record

Exploration Associates

Project
Deeside Road Link - Stage 3B
Shotwick Road Improvement
Clwyd County Council

Contract 03025

Borehole 3 (1 of 1)

SWECO

DRILLING LOG

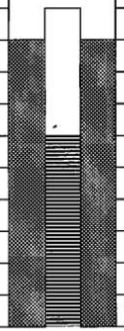
LOG NUMBER 3 274

DRAGON DRILLING (WATER & ENERGY) LIMITED
BRICKFIELD LANE
RUTHIN
LL15 2TN
TEL: 01824 707777

SITE: Deeside Fishery JOB REFERENCE: 487 SITE BH NUMBER: 2 BGS No: SN15/224 GRID REF: SJ32127084 DATE: 22/12/2015

OPERATION	SIZE (MM)	FROM DEPTH (M)	TO DEPTH (M)	TOTAL
Set up				1
Auger drilling	198	GL	3	3
Mud drilling	150	3	30	27

DEPTH (M)	DESCRIPTION	MATERIAL & DEPTH (M)
0-3	Sandy soils	
3-27	Sands	
27-30	Fine Sand and Gravel	Solid casing 113mm GL - 3
		Bentonite GL – 2
	Standing water level – 2Mbgl	
	2m Drawdown	Slotted 113mm casing 3 - 27
		6mm gravel 2 - 30



PREDICTED DEPTH (M)	ACTUAL DEPTH (M)	WATER STRIKE (MBGL)	LITRES PER MINUTE	SLOTTED (M)	PLAIN (M)	END CAP	STONE (MBGL)	BENTONITE (MBGL)
70	30	7	50+	27	3	Yes	30-2	2-GL

DRILLING FOR: Domestic water supply

NAME: MARK BATHO (LEAD DRILLER)

Appendix B – Dewatering Calculations

Drawdown of 1.5m

Linear Excavation (granular SUPERFICIAL DEPOSITS)

THIEM EQUATION (steady state conditions)

$Q=2\pi KD(H-h_w)/\ln(R_0/re)$

Empirical Formula of Sichardt

$R_0=C(h_0 - h)(K)^{0.5}$

(1.5m drawdown required with pipe invert ~200mm below GW level of 3mbGL, 0.5m gives room for sump)

Where,
Q=flow rate

K=hydraulic conductivity — Range (m/s) 4.90E-07 3.60E-04
D=aquifer thickness — 15
Ro=radius of influence — Calculated
r_e=effective radius — 7.14 Calculated
h_o=rest water level — 2.00
h_w=dynamic water level — 1.5

T = 6.35E+00 m/d
(E-05) m/s

Width of excavation (m) = 2
Length of excavation (m) = 2*40

Constant,C= 2000 (empirical calibration factor) 6.35E+01

Calculation of required flow (Thiem), Calculation of radius of influence (Sichardt)

Hydraulic Conductivity (m/d)	Hydraulic Conductivity (m/s)	Aquifer Thickness (m)	Drawdown (m) h0 - h (m)	Calculated Radius of Influence Ro (m)	Effective Radius r_e (m)	Calculated Flow Q (m^3/s)	Flow Q (m^3/d)		
4.23E-02	3.60E-07	15	1.5	2	3.6	-0.0001305	-3	Silty sand	
4.23E-01	8.10E-06	15	1.5	9	3.6	0.0011161	553	Silty sand	
4.23E+00	4.90E-05	15	1.5	21	3.6	0.0039094	555	Silty sand	Hazen range
4.23E+01	4.90E-04	15	1.5	66	3.6	0.0236969	2684	Silty sand	

Drawdown of 2.5m

Linear Excavation (granular SUPERFICIAL DEPOSITS)

THIEM EQUATION (steady state conditions)

Empirical Formula of Sichardt

$Q=2\pi KD(H-h_w)/\ln(R_0/re)$

$R_0=C(h_0 - h)(K)^{0.5}$

Water level of 2m (2.5m drawdown required with pipe invert ~200mm below GW level of 2mbGL, 0.5m gives room for sump)

Where,
Q=flow rate

K=hydraulic conductivity — Range (m/s): 4.90E-07 to 3.60E-04

D=aquifer thickness: 15

Ro=radius of influence: Calculated

r_e=effective radius: 7.14 — Calculated — T = 1.05E+01 (E-05) m/s

h_o=rest water level: 2.00

h_w=dynamic water level: 1.5

Constant,C= 2000 (empirical calibration factor): 6.35E+01

Width of excavation (m): 2

Length of excavation (m): 2*40

m/d

Calculation of required flow (Thiem), Calculation of radius of influence (Sichardt)

Hydraulic Conductivity (m/d)	Hydraulic Conductivity (m/s)	Aquifer Thickness (m)	Drawdown (m) h0 - h (m)	Calculated Radius of Influence Ro (m)	Effective Radius r_e (m)	Calculated Flow Q (m^3/s)	Flow Q (m^3/d)		
3.11E-02	3.60E-07	15	2.5	3	3.6	-0.0004876	-8	Silty sand	
7.00E-01	8.10E-06	15	2.5	14	3.6	0.0013802	241	Silty sand	Hazen
4.23E+00	4.90E-05	15	2.5	35	3.6	0.0050576	629	Silty sand	range
4.23E+01	4.90E-04	15	3.5	111	3.6	0.0428677	3645	Silty sand	