A30 Chiverton to Carland Cross
Environmental Statement

Volume 6 Document Ref 6.4 ES Appendix 13.3 DMRB assessments

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22/08/18

Planning Act 2008
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 (as amended)
APFP Regulation 5(2)(a)

European Union
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Development Fund

highways
england

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Notice

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13 DMRB Assessments

13.1 Overview

13.1.1 This document contains the methodologies and results of the assessments carried out as per the requirements of the Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 10: HD 45/09 Road Drainage and the Water Environment (November 2009) for the A30 Chiverton to Carland Cross Environment Statement.

13.1.2 This includes the Method A assessment of the risk from routine runoff, the Method C assessment of the risk of routine runoff to groundwaters and the Method D assessment of the risk of accidental spillage.

13.2 Method A – Assessment of Pollution Impacts from Routine Runoff on Surface Waters

Introduction

13.2.1 The assessment of routine runoff has been undertaken using the Highways Agency Water Risk Assessment Tool (HAWRAT) as prescribed in Method A of the *Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 10, HD45/09- Road Drainage and the Water Environment (DMRB HD45/09)*.

Methodology

13.2.2 HAWRAT adopts a tiered approach as follows:

- Step 1: Runoff quality. This predicts concentrations of pollutants in untreated and undiluted highway runoff prior to any treatment and dilution in a water body.
- Step 2: In-river impacts. This predicts concentrations of pollutants after mixing within the receiving water body. At this stage, the ability of the receiving watercourse to disperse sediments is considered and, if sediment is predicted to accumulate, the potential extent of sediment coverage (i.e. the deposition index, DI) is also considered. Step 2 also incorporates two 'tiers' of assessment for sediment accumulation, based on different levels of input parameters. If one or more risks are defined as unacceptable at Tier 1, i.e. ‘fail’, then a more detailed Tier 2 assessment is undertaken, requiring values for further parameters relating to the physical dimensions of the receiving watercourse.
- Step 3: In-river impacts with mitigation. Steps 1 and 2 assume that the road drainage system incorporates no mitigation measures to reduce the risk. Step 3 includes mitigation in the form of Sustainable Drainage Systems (SuDS), taking into account the risk reduction associated with any existing measures or any proposed new measures.

Cumulative assessment within HAWRAT

13.2.3 The cumulative impacts of the scheme were calculated following the DMRB guidance. The combined effect of two outfalls into the same watercourse within the same 'reach'[1] are assessed by combining the contributing impermeable areas to the affected ponds.

13.2.4 For solutes, cumulative effects have been considered where proposed outfalls are within 1km of each other (stream length) and discharge into the same watercourse. For sediment, cumulative impacts have been considered where proposed outfalls are less than 100m apart.

Environmental Quality Assessments within HAWRAT

13.2.5 A long-term impact assessment of surface water runoff from the highway has been undertaken by comparing the annual average concentrations of copper and zinc predicted in the HAWRAT results with the EQSs stated in the WFD (Standards and Classifications) Directions 2015.

Table 13-1 Environmental Quality Standards for surface waters

Standards for specific pollutants	
Substance	**Dissolved Concentration (µg/l)**
Copper	1µg/l bioavailable
Zinc	10.9 bioavailable plus Ambient Background Concentration

Input parameters

13.2.6 The main parameters used in the HAWRAT are as follows:

- two-way annual average daily traffic (AADT)[2];
- climatic conditions[3];
- Q95 flow in the receiving watercourse[4];
- road area drained[5];
- water hardness[6]; and
- physical attributes of a given watercourse[7].

13.2.7 The study area for the HAWRAT assessment encompasses all the watercourses that would receive road runoff from the proposed development (Volume 6 Document Ref 6.3 ES Figure 13.1). This includes 18 new outfalls in total; 10 new outflows from the A30, six new outflows from side roads and two new combined outfalls.

13.2.8 A two-way Annual Average Daily Traffic (AADT) of 42,766 along the A30 has been predicted for 2038. This falls within the lowest range used in the HAWRAT assessment of between 10,000 and 50,000 AADT.

[1] Reach – The distance between two outfalls into the same watercourse.
[2] Taken as 42,766 for all sites. This is based on the estimated traffic in 2038 from the Stage 3 Traffic Forecasting Report (WSP, 2017).
[3] The scheme is within the 'warm and wet' region and with a standard average annual rainfall (SAAR) of 1200mm (Bodmin).
[4] Q95 of 0.0013 m^3/s used for all watercourses following estimation using the method described in the Institute of Hydrology Report No. 108.
[5] Impermeable areas provided by the drainage design team and listed in Table 4 and Table 5.
[6] Water hardness was estimated using the Drinking Water Inspectorate Map for England and Wales. All watercourses have been deemed to have high water hardness, i.e. less than 50mg CaCO-3/l.
[7] Estimated based on photos of watercourses from the fish survey report and a site walkover on 15/16 November 2017.

13.2.9 The water hardness was taken from the DWI map and gives a hardness for the region of less than 50mg CaCO3, placing it within the Low category for HAWRAT.

13.2.10 Discharges from all basins would be to watercourses with assumed Q95 flows of 0.0013 m^3/s.

13.2.11 Due to these low flows, it is likely that discharge from the drainage system would infiltrate to groundwater, particularly during summer months. It is therefore more appropriate to assess the risk of this discharge to groundwater rather than surface watercourses. However, Method-A of HD45/09 (‘Simple Assessment’) has been used on a precautionary basis to assess the operational effects of the road surface runoff from the proposed outfalls, in the event that flows entered the watercourse directly. Method A has also been used to demonstrate that the mitigation will be sufficient to ensure that water quality is not compromised as part of the scheme. A cumulative assessment of impacts has also been undertaken following the HD 45/09 guidance at five locations where two outfalls are within the specified distance from each other.

13.2.12 Table 13-5 lists the outfalls, the receiving watercourse and impermeable road drainage areas for each outfall on the new section of A30 and side roads. The permeable area draining to all of the new outfalls has been taken as 0m^2.

13.2.13 The proposed discharge locations were screened against the location of protected areas (e.g. SSSIs, SACs). Outfall locations less than 1km upstream of a protected site required more stringent pollutant thresholds to be applied. Mainline outfalls A-C, E and H-L, along with side road outfalls 1, 4, 7 and 8 met these requirements.

13.2.14 To complete the assessment, the treatment efficiencies of SUDS features incorporated into the drainage design were considered.

13.2.15 As outlined in the Engineering Design section of the ES, the proposed mitigation measures to be incorporated uses filter drains and detention basins at all locations and wet ponds where they were required for mainline Pond F and Pond G. The features used within the treatment train are dependent on the level of mitigation required; which is indicated by the results from the HAWRAT analysis.

13.2.16 Following the observations on the site visit and calculations, low flows (Q95) have been calculated for each watercourse receiving runoff.

13.2.17 The HAWRAT assessment has been undertaken on a precautionary basis and because of the low-flows, reference is made to Method-C. Table 13-2 shows the relative infiltration rates of each attenuation pond.

Table 13-2 Attenuation Pond infiltration rates

Mainline attenuation ponds				
Chainage	Pond reference	Infiltration rate (m/s)	Level of infiltration to ground	Within 1km upstream of a protected site Y/N

0+500	A	$2.6 * 10^{-5}$	Partial	
1+400	B	$1.62 * 10^{-4}$	Dominant	
2+000	C	$2.78 * 10^{-4}$	Dominant	
4+100	D	$3.09 * 10^{-4}$	Dominant	
6+000	E	$2.11 * 10^{-3}$	Dominant	
7+100	F	Lined Pond		
8+900	G	$4 * 10^{-5}$	Partial	
10+900	H	$2.63 * 10^{-5}$	Partial	
11+900	I	$1.95 * 10^{-6}$		
13+300	J	$5.82 * 10^{-6}$		
13+500	K	$1.59*10^{-3}$	Dominant	
14+200	L	$2.02 * 10^{-5}$	Partial	
Side road attenuation ponds				
Chainage	**Pond reference**	**Infiltration rate (m/s)**	**Level of infiltration to ground**	
1+600	1	$7.93 * 10^{-5}$	Partial	
4+100	2	$3.09 * 10^{-4}$	Dominant	
4+600	3	Soak away		
6+000	4	$2.11 * 10^{-3}$	Dominant	
8+000	5	Soakaway		
9+700	6	$1.13 * 10^{-4}$	Dominant	
11+000	7			
13+200	8	$1.86 * 10^{-5}$	Partial	

13.2.18 Inputting watercourse widths to the ‘Tier 1’ assessment was originally informed through OS mapping. The site visit confirmed the estimate of stream width 1m for each site.

13.2.19 The drainage design measures treatment efficiencies (%) were taken from CIRIA C609. Following this guidance, treatment efficiencies were calculated for treatment trains by combining the additional treatment efficiency with the existing. Table 13-3 shows the treatment efficiency of Filter drains and Detention ponds; which are incorporated into the design of all ponds. Table 13-4 shows the treatment train efficiencies for designs where grassed swales or wet ponds have also been incorporated into the design.

Table 13-3 Treatment efficiencies of proposed carriageway runoff treatment trains

		Treatment efficiency (% reduction)

Treatment step	Proposed mitigation	Copper	Zinc	Sediment
Step 1	Filter Drain	65	65	67.5
Step 2	Detention Pond	65	65	77.5
Cumulative (% reduction)		88	88	93
Sources: CIRIA C609: p66, Section 3.4.2 Filter Drains and detention basins (median value used). NOTE: For cumulative efficiency the treatment stages the additional measures were combined for a total mitigation efficiency. This is based on the conservative cumulative removal efficiency recommended in CIRIA C609.				

Table 13-4 Treatment efficiencies of proposed carriageway runoff treatment trains

Treatment Step	Proposed Mitigation	Treatment Efficiency (% reduction)		
		Copper	Zinc	Sediment
Step 1	Filter Drain	65	65	67.5
Step 2	Detention Pond	65	65	77.5
Step 3	Grassed Swales (dry) / Wet Pond	85 / 65	85 / 65	80 / 82.5
Cumulative (% reduction)		98.2 / 96	98.2 / 96	98.5 / 98
Sources: CIRIA C609: p66, Section 3.4.2 Filter Drains, detention basins (median value used) and grassed swales (dry) and wet ponds (median value used). NOTE: For cumulative efficiency the treatment stages the additional measures were combined for a total mitigation efficiency. This is based on the conservative cumulative removal efficiency recommended in CIRIA C609.				

13.2.20 Table 13-5 provides details of the data used for the HAWRAT analysis. As previously stated, a Q95 of 0.0013m3/s was used based on observations from the site visit and a Base Flow Index (BFI) of 0.5 incorporates the inflow from ground water.

Table 13-5 Input data for HAWRAT assessments

Receiving watercourse from mainline attenuation ponds				
Pond reference	**Receiving watercourse**	**Q95**	**Impermeable area (ha)**	**BFI**
A	Calenick Stream	0.0013	1.90	0.5
B	Hayle Red River and Northern Streams	0.0013	2.03	0.5
C	Kenwyn	0.0013	3.86	0.5
D	Bolingey Stream	0.0013	6.46	0.5
E	Zelah Brook	0.0013	3.90	0.5
F	Zelah Brook	0.0013	6.125	0.5
G	Zelah Brook	0.0013	6.94	0.5
H	Upper River Allen (Fal)	0.0013	3.63	0.5
I	Upper River Allen (Fal)	0.0013	3.00	0.5
J	Kestel Stream	0.0013	0.72	0.5
K	Kestel Stream	0.0013	0.51	0.5
L	Ganel Porth and Menalhyl	0.0013	3.85	0.5
Receiving watercourse from side road attenuation ponds				
Pond reference	**Receiving watercourse**	**Q95**	**Impermeable area (ha)**	**BFI**
1	Hayle Red River and Northern Streams	0.0013	2.40	0.5
2	Bolingey Stream	0.0013	0.75	0.5
3	Kenwyn	0.0013	0.31	0.5
4	Zelah Brook	0.0013	0.20	0.5
5	Bolingey Stream	0.0013	0.93	0.5
6	Zelah Brook	0.0013	0.19	0.5
7	Zelah Brook / Upper River Allen (Fal)	0.0013	0.24	0.5
8	Benny Stream	0.0013	0.86	0.5

Results

13.2.21 The HAWRAT results after Tier 2 assessment and the level of mitigation required to be incorporated into the designs for mainline and side roads are provided in Table 13-6 and Table 13-7 respectively.

13.2.22 Table 13-8 and Table 13-9 show the HAWRAT Tier 3 results with mitigation being incorporated into the scheme. For each pond, the reduction in pollutant concentrations resulting from the addition of mitigation exceeds the required reduction indicated by the HAWRAT model. This is shown by all main line and side road ponds passing both the EQS assessment and the HAWRAT assessment at Tier 3.

13.2.23 Table 13-10 gives the results for the HAWRAT assessment of the cumulative assessment for ponds with outfalls into the same watercourse within the distance specified in the Methodology. As shown, with mitigation incorporated, all outfalls pass for heavy metal concentrations. All ponds pass for sediment output aside from Pond B and 1 and Pond D and 2 which fail by 0.3% and 3.3% respectively.

13.2.24 Due to the minor failure of Ponds D and 2, the guidance given in CIRIA C609 regarding the use of HAWRAT results indicates no further mitigation is required:

13.2.25 "*It is important to note that the performance of SUDS is subject to the variables previously discussed and the values should not be considered or used as absolute values. They should be used as an aid to judgement when assessing the risks of system failure and to compare the relative performance between different combinations of systems*."

13.2.26 As shown in Table 13-2, the drainage from Ponds B and D are predominantly infiltration. At this rate of infiltration, it can be assumed that the ponds will mainly infiltrate to ground. Due to the use of the HAWRAT model on a precautionary basis, no further mitigation measures have been incorporated following these HAWRAT results.

Table 13-6 Summary of individual outfall routine runoff assessments (Mainline)

Pond reference	Step 2 - Concentration no mitigation		Tier 2 HAWRAT result		
	Copper	Zinc	Copper	Zinc	Sediment
A	1.03	4.44	Fail	Fail	Fail
B	1.07	4.65	Fail	Fail	Fail
C	1.63	6.97	Fail	Fail	Fail
D	2.19	9.26	Fail	Fail	Fail
E	1.64	7.01	Fail	Fail	Fail
F	2.12	9.01	Fail	Fail	Fail
G	2.27	9.6	Fail	Fail	Fail
H	1.57	6.72	Fail	Fail	Fail
I	1.39	5.99	Fail	Fail	Fail
J	0.49	2.15	Pass	Fail	Fail
K	0.37	1.62	Pass	Fail	Fail
L	1.63	6.96	Fail	Fail	Fail

Table 13-7 Summary of individual outfall routine runoff assessments (Side-roads)

Pond Reference	Step 2 - Concentration no mitigation		Tier 2 HAWRAT result		
	Copper	Zinc	Copper	Zinc	Sediment
1	1.2	5.19	Fail	Fail	Fail
2	0.51	2.23	Pass	Fail	Fail
3	0.15	0.65	Pass	Pass	Pass
4	0.16	0.71	Pass	Pass	Pass
5	0.6	2.64	Pass	Fail	Fail
6	0.15	0.68	Pass	Pass	Pass
7	0.18	0.78	Pass	Pass	Pass
8	0.54	2.36	Pass	Fail	Fail

Table 13-8 Results for individual outfall routine runoff from mainline pond assessments

Pond reference	IA (ha)	Tier 2 – Mitigation required (%)			Proposed mitigation	Mitigation efficiency (%)			Assessment against EQS - pass/fail		HAWRAT assessment - pass/fail		
		Copper	Zinc	Sediment		Copper	Zinc	Sediment	Copper	Zinc	Copper	Zinc	Sediment
A	1.9	20	60	83	Filter Drain> Detention Basin	87.75	87.75	92.69	Pass	Pass	Pass	Pass	Pass
B	2.03	25	60	84	Filter Drain> Detention Basin	87.75	87.75	92.69	Pass	Pass	Pass	Pass	Pass
C	3.86	40	65	92	Filter Drain> Detention Basin	87.75	87.75	92.69	Pass	Pass	Pass	Pass	Pass
D	6.46	40	60	95	Filter Drain > Detention Basin > Swale	98.16	98.16	98.54	Pass	Pass	Pass	Pass	Pass
E	3.9	40	65	92	Filter Drain > Detention Basin > Swale	98.16	98.16	98.54	Pass	Pass	Pass	Pass	Pass
F	6.12	35	55	95	Filter Drain > wet pond > Detention Basin	95.71	95.71	97.64	Pass	Pass	Pass	Pass	Pass
G	6.94	40	60	96	Filter Drain > Detention Basin > Swale	98.16	98.16	98.54	Pass	Pass	Pass	Pass	Pass
H	3.627	35	65	90	Filter Drain> Detention Basin	87.75	87.75	92.69	Pass	Pass	Pass	Pass	Pass
I	3	30	65	90	Filter Drain > Detention Basin > Swale	98.16	98.16	98.54	Pass	Pass	Pass	Pass	Pass
J	0.72	0	30	55	Filter Drain > Detention Basin	87.75	87.75	92.69	Pass	Pass	N/A	Pass	Pass
K	0.51	0	20	36	Filter Drain > Detention Basin	87.75	87.75	92.69	Pass	Pass	N/A	Pass	Pass
L	3.85	40	65	92	Filter Drain > Detention Basin > Swale	98.16	98.16	98.54	Pass	Pass	Pass	Pass	Pass

Table 13-9 Results for individual outfall routine runoff from side road pond assessments

Pond reference	IA (ha)	Tier 2 – Mitigation required (%)			Proposed mitigation	Mitigation efficiency (%)			Assessment against EQS - pass/fail		HAWRAT assessment - pass/fail		
		Copper	Zinc	Sediment		Copper	Zinc	Sediment	Copper	Zinc	Copper	Zinc	Sediment
1	1.9	30	60	87	Filter Drain> Detention Basin	87.75	87.75	92.69	Pass	Pass	Pass	Pass	Pass
2	2.03	0	5	57	Filter Drain> Detention Basin	87.75	87.75	92.69	Pass	Pass	Pass	Pass	Pass
3	3.86	0	0	0	Filter Drain> Detention Basin	87.75	87.75	92.69	Pass	Pass	Pass	Pass	Pass
4	6.46	0	0	0	Filter Drain > Detention Basin > Swale	98.16	98.16	98.54	Pass	Pass	Pass	Pass	Pass
5	3.9	0	15	65	Filter Drain > Detention Basin > Swale	98.16	98.16	98.54	Pass	Pass	Pass	Pass	Pass
6	6.12	0	0	0	Filter Drain > wet pond > Detention Basin	95.71	95.71	97.64	Pass	Pass	Pass	Pass	Pass
7	6.94	0	0	0	Filter Drain > Detention Basin > Swale	98.16	98.16	98.54	Pass	Pass	Pass	Pass	Pass
8	3.627	0	30	62	Filter Drain> Detention Basin	87.75	87.75	92.69	Pass	Pass	Pass	Pass	Pass

Table 13-10 Cumulative HAWRAT results

Pond reference	Combined IA (ha)	Tier 2 - Mitigation required (%)			Proposed mitigation	% reduction with treatment			Assessment against EQS - pass/fail		HAWRAT assessment - pass/fail		
		Copper	Zinc	Sediment		Copper	Zinc	Sediment	Copper	Zinc	Copper	Zinc	Sediment
B + 1	4.43	40	70	93	Filter Drain > Detention Basin	87.75	87.75	92.69	Pass	Pass	Pass	Pass	Fail
D + 2	7.21	40	65	96	Filter Drain > Detention Basin	87.75	87.75	92.69	Pass	Pass	Pass	Pass	Fail
E + 4	4.1	40	65	92	Filter Drain > Detention Basin > Swale	87.75	87.75	92.69	Pass	Pass	Pass	Pass	Pass
H + 7	3.867	30	50	92	Filter Drain > Detention Basin	87.75	87.75	92.69	Pass	Pass	Pass	Pass	Pass
K + L	4.36	40	65	93	Filter Drain > Detention Basin > Swale	98.16	98.16	98.54	Pass	Pass	Pass	Pass	Pass

**Infiltration to ground water can be assumed from failing ponds B and D

13.3 Method C - Assessment of Pollution Impacts from Routine Runoff on Groundwater

Introduction

13.3.1 Annex I of the DMRB Environmental Assessment Techniques guidance (Volume 11, Section 3, Part 10 HD 45/09) provides a methodology (Method C) to assess the potential impact on the quality of groundwater resources from routine runoff discharges to the ground.

13.3.2 This risk assessment procedure is based on the study of the source-pathway-receptor (S-P-R) protocol. The principles of this approach have been applied to the disposal of road drainage whereby the:

- Source term comprises the road drainage water with any pollutants contained therein, as it enters any unlined ditch, watercourse or soakaway discharge system, that has the potential to transmit water through the ground to groundwater;
- Pathway term represents the processes, which may modify the pollutants during transmission through the discharge system and soil and subsoil until the actual ‘point of entry’ to groundwater (this includes the unsaturated zone);
- Receptor, which is the groundwater.

13.3.3 For there to be a risk of impact to groundwater, all elements of the S-P-R model must be present to create a pollutant linkage.

Methodology

13.3.4 The drainage solution for the A30 scheme includes 12 attenuation ponds on the mainline route and eight attenuation ponds along the side roads, all of which discharge to surface water courses (Volume 6 Document Ref 6.3 ES Figure 13.2). The ponds are situated at various points along the scheme and filter drains are used where appropriate (when cuttings have been made for construction). For the purpose of assessment, all ponds will be a single point serving varying road areas. On event of the runoff water discharging into the attenuation pond, it has been assumed that it will also act as a soakaway.

13.3.5 The method determines the risk score by incorporating the key factors affecting the level of risk posed by the source of pollutants, the persistence and movement of pollutants within the pathway to groundwater and linkages between them. In this way, the matrix provides a means of ranking specific road drainage discharge sites in terms of their potential risks to groundwater.

<u>Input parameters</u>

Source

Traffic Density (component number 1)

13.3.6 A two-way Annual Average Daily Traffic (AADT) of 42,766 along the A30 between Chiverton to Carland Cross has been predicted for 2038 within the *Stage 3 Traffic Forecasting Report*, 2017 (WSP) giving a low risk score of <50,000.

Rainfall Volume (component number 2)

13.3.7 According to the Met Office Climate data[8], the annual average rainfall between 1981-2010 was 1206.1mm in the St Austell area. This gives a high-risk rainfall volume for the A30 scheme (>1060mm).

Pathway

Soakaway Geometry (component number 3)

13.3.8 Each soakaway pond serving an area greater than 5000m^2 with run-off serving a single-entry point from the road are assigned a high risk soakaway geometry score.

Unsaturated Zone (component number 4)

13.3.9 Data taken from the nearest groundwater monitoring installations show ground water levels vary above and below 5mbgl with eight of the 12 sites recording a water table depth >5mbgl, Low risk score and the other four a depth <5mbgl., Medium risk.

Flow Type (component number 5), Effective Grain Size (component number 6), Lithology (component number 7)

13.3.10 Whilst the works cross three different formations, they are all interbedded mudstones, siltstone and sandstones with high clay content. Therefore, the infiltration rates may vary locally where the lithology changes at outcrop. It is assumed the flow type; grain size and lithology will not change across the site.

Results

13.3.11 Table 13-11 summarises the results of the Method C assessment. The risk scores of 220 and 240 are within the 150 – 250 DMRB suggested action class range, which indicates there is a medium risk of impact.

13.3.12 For the medium risk impact, mitigation measures should be considered to protect groundwater, the DMRB guidance suggests the need for and nature of the mitigation measures should be informed by additional risk assessment. However, as informed from the HAWRAT analysis, the copper and zinc concentrations are below the EQS threshold so in this case no further assessment is required.

[8] Met Office, *St Austell Climate Data,* available at: https://www.metoffice.gov.uk/public/weather/climate/gbuw75d29 last accessed 13/12/17

Table 13-11 Overall risk score for existing site conditions – Mainline attenuation ponds

<table>
<tr><th>Component number</th><th rowspan="4">SOURCE</th><th>Weighting factor</th><th>Property or parameter</th><th>Site data</th><th>Risk score</th><th colspan="2">Component score</th></tr>
<tr><td>1</td><td>15</td><td>Traffic Density</td><td><50,000</td><td>Low risk - 1</td><td colspan="2">15</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">15</td><td>Rainfall Volume (annual averages)</td><td>Average Annual Rainfall of 1200mm</td><td>High risk -3</td><td colspan="2" rowspan="2">45</td></tr>
<tr><td>Rainfall Intensity</td><td>X</td><td>X</td></tr>
<tr><td>3</td><td>PATHWAY</td><td>15</td><td>Soakaway Geometry</td><td>Single point – serving high road area (>5,000m2)</td><td>High Risk - 3</td><td colspan="2">45</td></tr>
<tr><td rowspan="2">4</td><td rowspan="5"></td><td rowspan="2">20</td><td rowspan="2">Unsaturated Zone</td><td>Water table is less than 5m below ground level based on monitoring data</td><td>Medium Risk - 2</td><td rowspan="2">40</td><td rowspan="2">60</td></tr>
<tr><td>Depth to water table between 5m to 15m below ground level based on monitoring data</td><td>High risk - 3</td></tr>
<tr><td>5</td><td>20</td><td>Flow Type</td><td>Fracture flow within metamorphic rocks.</td><td>High risk - 3</td><td colspan="2">60</td></tr>
<tr><td>6</td><td>7.5</td><td>Effective Grain Size</td><td>Fine sand and below. Whilst we go through three different formations, they are all interbedded mudstones, siltstone and sandstones.</td><td>Low risk -1</td><td colspan="2">7.5</td></tr>
<tr><td>7</td><td>7.5</td><td>Lithology</td><td>The clay contents according to particle size distribution (PSD) results are typically >15%.</td><td>Low risk -1</td><td colspan="2">7.5</td></tr>
<tr><td colspan="6">Overall Risk Score</td><td>220</td><td>240</td></tr>
</table>

13.4 Method D - Pollution impacts from accidental spillages

13.4.1 Assessment of accidental spillages of polluting substances from roads has been carried out using Method D as prescribed in *DMRB HD45/09* (Highways Agency et al., 2009) to ensure provision of appropriate drainage design measures where the risk of a serious pollution incident is more frequent than the 1% annual exceedance probability (AEP) (or more frequent than 1 in 100 year return period). For more sensitive watercourses, a higher level of protection has been afforded up to the 0.5% AEP (or more frequent than 1 in 200 years).

13.4.2 The results of the assessment are reported as 'pass' or 'fail'. The risk of an acute pollution incident due to accidental spillage or vehicle fire is considered proportionate to the risk of a heavy goods vehicle (HGV) road traffic collision.

Thus, the percentage of HGV's on a given road is the main parameter used in assessment of the risk of serious pollution accidents.

13.4.3 Other parameters considered include the type and length of road, two-way annual average daily traffic (AADT) flow and emergency services response time depending on whether a site is in an urban, rural or remote setting. If the accidental spillage is less than or equal to 1% AEP (or 0.5% AEP for sensitive watercourses), the risk is considered acceptable.

13.4.4 Vehicle numbers from the 2038 AADT flows have been used to account for future growth.

Results

13.4.5 Detailed results of the Method D assessment are given in Table 13-12 and the summary values are in Table 13-13 below. The accidental spillage risk assessment results show that, without consideration of the drainage scheme, there would be no discharge with a serious spillage risk more frequent than the 1% and 0.5% AEP (1 in 100 year and 1 in 200 year return period) thresholds.

Table 13-12 Detailed Method D results

Pacc=Probability of a spillage accident.
Ppol=Probability of serious pollution occurring, given an accident happens.
Pinc=Pacc x Ppol
factored %HGV=%HGV factor for unusually high proportions of hazardous materials x %HGV.
Individual Outfall Risks will need to be identified if the Total Annual Probability is greater than the Acceptable Risk. This involves repeating this exercise for each individual outfall.

Location	Road reference (refer to attached junction layouts)	Start chainage (m)	End chainage (m)	Table D1.1 Road category	2-way AADT	%HGV	%HGV factor for unusually high proportions of hazardous materials	Factored %HGV	Pspl (%)	Ppol (table D 1.2)	Pinc (%)
Pond A	Holly Farm Trunk Road	0	1400	0.29	39915	4.8	1	4.8	0.028	0.6	0.017
	Slip road to overbridge (north side A30)	0	800	0.83	9612	3.73	1	3.73	0.009	0.6	0.005
	Slip road to overbridge (south side A30)	0	837	0.83	22497	0.85	1	0.85	0.005	0.6	0.003
Pond B	Chiverton Cross Roundabout	1400	1500	3.09	19915	2.02	1	2.02	0.021	0.6	0.012
	Slip Road onto roundabout (south east)	0	100	0.83	10	0.301	1	0.301	0.000	0.6	0.000
	Slip Road onto roundabout (east)	0	179	0.83	560	0.71	1	0.71	0.000	0.6	0.000

Location	Road reference (refer to attached junction layouts)	Start chainage (m)	End chainage (m)	Table D1.1 Road category	2-way AADT	%HGV	%HGV factor for unusally high proportions of hazardous materials	Factored %HGV	Pspl (%)	Ppol (table D 1.2)	Pinc (%)
	Slip Road onto Roundabout (North east)	0	765	0.83	13138	2.46	1	2.46	0.007	0.6	0.004
	A30	1500	2750	0.29	53936	4	1	4	0.029	0.6	0.017
Pond C	A30	2750	4250	0.29	53936	4	1	4	0.034	0.6	0.021
	A30	4250	5250	0.29	42766	4.8	1	4.8	0.022	0.6	0.013
	North Overbridge Roundabout	4750	4800	3.09	15129	2.8	1	2.8	0.008	0.6	0.005
	North Overbridge Roundaboutm slip road West	4000	4780	0.83	2858	5.16	1	5.16	0.003	0.6	0.002
	South Overbridge Roundabout	4700	4750	3.09	21865	1	1	1	0.005	0.6	0.003
	South Overbridge Roundabout slip road West	0	111	0.83	560	0.71	1	0.71	0.000	0.6	0.000
Pond D	A30	5250	6600	0.29	42766	4.8	1	4.8	0.029	0.6	0.018

Location	Road reference (refer to attached junction layouts)	Start chainage (m)	End chainage (m)	Table D1.1 Road category	2-way AADT	%HGV	%HGV factor for unusally high proportions of hazardous materials	Factored %HGV	Pspl (%)	Ppol (table D 1.2)	Pinc (%)
	Underbridge Road	6000	6000	0.29	2193	0.33	1	0.33	0.000	0.6	0.000
Pond E	A30	6600	8300	0.29	42766	4.8	1	4.8	0.037	0.6	0.022
Pond F	A30	8300	10500	0.29	42766	4.8	1	4.8	0.048	0.6	0.029
	Underbridge Road	8600	8600	0.83	2193	0.33	1	0.33	0.000	0.6	0.000
	Underbridge Road	8900	8900	0.83	2318	2.73	1	2.73	0.000	0.6	0.000
	Underbridge Road	9700	9700	0.83	54	15	1	15	0.000	0.6	0.000
	A30	10500	11500	0.29	42766	4.8	1	4.8	0.022	0.6	0.013
Pond G	A30	11500	12750	0.29	42766	4.8	1	4.8	0.027	0.6	0.016
Pond H	A30	12750	14000	0.29	42766	4.8	1	4.8	0.027	0.6	0.016

Location	Road reference (refer to attached junction layouts)	Start chainage (m)	End chainage (m)	Table D1.1 Road category	2-way AADT	%HGV	%HGV factor for unusally high proportions of hazardous materials	Factored %HGV	Pspl (%)	Ppol (table D 1.2)	Pinc (%)
Pond I	A30	14000	14496	0.29	30498	4.03	1	4.03	0.006	0.6	0.004
	Slip from north roundabout to A30	13500	1400	0.83	8741	4.53	1	4.53	0.007	0.6	0.004
Pond J	Carland Cross North Roundabout	13250	13500	3.09	26768	4.14	1	4.14	0.020	0.6	0.012
	Link between roundabouts	13250	13250	0.83	5621	3.65	1	3.65	0.002	0.6	0.001
Pond K	Carland Cross South Roundabout	13000	13500	3.09	8012	4.8	1	4.8	0.004	0.6	0.002
	Link between roundabouts	13250	13250	0.83	5621	3.65	1	3.65	0.002	0.6	0.001
	Slip Road South to roundabout	13500	13500	0.83	6645	4.84	1	4.84	0.005	0.6	0.003
	Slip road east to roundabout	14250	13500	0.83	7013	7.91	1	7.91	0.013	0.6	0.008

Table 13-13 Method D assessment summary values

Total annual probability	Acceptable risk (normally 1%, or 1-in-100 year)	Do individual outfall risks need to be identified?	Highest individual risk	Can the highest individual risk be reduced?
0.241%	1.000%	No	0.029%	No

13.5 Assessment of potential impact of dewatering and excavation works associated with cuttings

Potential impacts on groundwater levels

13.5.1 A high-level assessment of the potential impact on local groundwater levels has been undertaken for the length of the scheme.

13.5.2 The groundwater level at cutting locations has been assessed through the groundwater monitoring data obtained as part of the Phase 1 GI carried out by Structural Soils in early 2017. Areas of cutting have been screened against the data to obtain locations where dewatering may be required (Table 13-14). The following areas of cutting have been identified as having groundwater levels that are likely to be intercepted by the scheme:

- Chiverton Junction Side Road Cuttings (Ch 0+500 to 1+000m);
- Nanteague Mainline Cutting (Ch 6+300 to 7+450m);
- Two Barrows Mainline Cutting (Ch 7+450 to 7+900m);
- Zelah Side Road Crossing (Ch 8+150);
- Pennycomequick Side Road Crossing (Ch 11+000m); and
- Penglaze Mainline Cutting (Ch 11+200 to 11+750m).

Table 13-14 Assessment of mainline cuttings on groundwater levels

Cuttings				Nearest monitoring borehole				Potential impact upon groundwater level?
Name	Chainage (m)	Maximum depth (m)	Ground level (mOD)	Name	Chainage (m)	Design level (mOD)	Design level (mbgl)	
Chiverton Cutting	0+500 to 1+000	2.6	138.2-146.99	Groundwater monitoring data for nearby BH-S-005 not available due to land access constraints. Water level recorded during the installation of the data logger at 8.7mbgl (135mOD).				No - Groundwater anticipated to be below base of cutting
Four Burrows Earthwork 1	2+500 to 3+100	3	141.696 - 135.15	BH-R-004	2+900	140.75	2.87	No - Groundwater anticipated to around 1.0m below base of cutting
Hillview Cutting	4+700 to 5+900	4.5	115.22 - 91.83	BH-S-012	4+850	111.75	6.15	No - Groundwater anticipated to be below base of cutting
				BH-R-013	5+800	92.5	6.17	
				BH-S-019	6+000	79	2.78	
Nanteague Cutting	6+300 to 7+450	5.6	98.06 - 75.58	BH-R-017	7+100	78.25	1.1	Yes
				BH-303	7+300	81.25	3.04	
Two Barrows Cutting	7+450 to 7+900	4.5	87- 99.7	BH-213	7+650	99	2.91	Yes
Tolgroggan Earthworks	8+450 to 8+750	4.7	97 - 77	BH-S-032	8+700	74.75	5.61	No - Groundwater anticipated to be below

Cuttings				Nearest monitoring borehole				Potential impact upon groundwater level?
Name	Chainage (m)	Maximum depth (m)	Ground level (mOD)	Name	Chainage (m)	Design level (mOD)	Design level (mbgl)	
								base of cutting
Zelah Earthworks 1	8+950 to 9+200	3.8	70.5 - 73.15	No groundwater monitoring installations. Trial pits within this area were all dry. Cut level approx. 3m above nearby streams; groundwater unlikely to be encountered in cut.				No - Groundwater anticipated to be below base of cutting
Zelah Earthworks 3	9+350 to 9+600	3.6	78 - 87.89					
Trevalso Crossing	9+900 to 10+500	5.1		BH-R026	10+280	6.0	107.6	Yes
Pennycomequick cut	10+700 to 10+950	2	115 - 113	BH-S-036	11+000	106.75	4.55	No - Groundwater anticipated to be below base of cutting
Penglaze Cutting	11+200 to 11+750	4.3	112.98 - 120.26	BH-R-027	11+400	117.5	2.9	Yes
				BH-309	11+500	120.5	1.99	
Quarry Retaining Wall	12+650 to 12+950	4.2	142 - 146	BH-S-042	12+900	141	5.8	No; but quarry pond (used as a private water supply) at Ch. 12+700 will be affected; supply relocation is required
Carland Cross Earthworks 3	13+850 to 14+300	2.4		BH-R-041	14+050	131.25	4.67	No; but water abstraction (council owned) and associated SPZ at Ch. 13+700 will be impacted; supply relocation is required.

Table 13-15 Assessment of side road cuttings on groundwater levels

Cuttings				Nearest monitoring borehole				Potential impact upon groundwater level?
Name	Chainage (m)	Maximum depth (m)	Ground level (mOD)	Name	Chainage (m)	Design level (mOD)	Design level (mbgl)	
Chiverton Junction Side Roads	0+500 to 1+000	4	135	BH-201	1+400	137.5	2.17	Yes
			130	BH-207	1+550	130.75	2.17	No

Cuttings				Nearest monitoring borehole				Potential impact upon groundwater level?
Name	Chainage (m)	Maximum depth (m)	Ground level (mOD)	Name	Chainage (m)	Design level (mOD)	Design level (mbgl)	
Tresawsen Side Road	6+000	2.1	88	BH-S-019	6+000	79	2.78	No
Zelah Side Road	8+150	7.5	66	Cut level potentially below nearby streams; groundwater may be encountered. depending on location of the side road in relation to the streams.				Yes
Trevalso Crossing	10+000	8.1	83.6	None				Yes
Pennycomequick Side Road	11+000	2.4	105.5	BH-S-036	11+000	106.75	4.55	Yes
Carland Cross Junction Side Roads	13+850 to 14+300	5 - 6.5	140	BH-S-049	13+350	140.5	3.27	No

Potential impacts upon known groundwater features

13.5.3 Following the assessment of potential impacts upon groundwater levels, a more detailed assessment of the potential effects on known groundwater features has been undertaken. The areas of cutting identified as potentially intersecting groundwater (Table 13-14 and Table 13-15) were considered against nearby features (e.g. private water supplies, wells, springs). These features were identified based on historic mapping, current Ordnance Survey mapping and aerial imagery.

13.5.4 A large proportion of these features are wells or springs marked on historic mapping. The continued use of many of these features is unknown and it is likely that many have been discontinued. Following the precautionary principle, these features have been retained in the assessment until their continued use can be ascertained during the detailed design of the scheme.

13.5.5 The following sections consider the groundwater-fed features surrounding each area of cutting identified in Section 0 as potentially having an effect on groundwater levels.

<u>Chiverton Junction</u>

13.5.6 Four groundwater features surrounding Chiverton Junction have been identified as potentially being impacted by the lowering of groundwater levels surrounding the Chiverton Junction Side Road cuttings. These consist of a licenced groundwater abstraction, a private water supply, a well/spring and a seepage. These are listed in Table 13-16.

Table 13-16 Groundwater features identified as potentially being impacted by cutting construction at Chiverton Junction.

Type of feature	Chainage	Distance to cutting, m	Feature elevation at GL, mOD	Scheme elevation / drawdown level, mOD	Further assessment required?

Well/spring	1+050	500NW	130	135	No
Well/spring	1+100	300W	130	135	No
Spring/headwater	1+200	265NW	122	135	No
GW abstraction licence (FID 7)	1+600	145N	125	130	No
Headwater	1+600	310S	120	130	No
GW abstraction licence (FID 6)	1+700	145E	133	130	Yes - Confirmation of well depth is needed; detailed assessment required.
Private water supply (well)	1+800	220E	132	130	Yes - Potentially the same feature. Confirmation of well depth is needed; detailed assessment required.
Well/spring	1+800	220E	132	130	
Spring	1+800	350NE	112	130	No
Seepage	1+750 - 1+950	270E	132	130	Yes - Detailed assessment required.
Well/spring	1+950	480NE	114	130	No
Private water supply (well)	1+950	480NE	114	130	No

Nanteague and Two Barrows Cuttings

13.5.7 As these cuttings are adjacent to one another the assessment was combined as both are likely to have a similar level of drawdown. Four groundwater features surrounding have been identified as potentially being impacted by the lowering of groundwater levels. These consist of a private water supply (borehole) and three wells or springs. These are listed in Table 13-17.

Table 13-17 Groundwater features identified as potentially being impacted by cutting construction at Nanteague and Two Barrows

Type of feature	Chainage	Distance to cutting, m	Feature elevation at GL, mOD	Scheme elevation / drawdown level, mOD	Further assessment required?
Seepage	6+000 - 6+250	335m SW	70-90	97	No
Headwater	6+050	430m W	75	97	No
Spring	6+200	360m SW	71	97	No
Pond	6+200	350m SW	70	97	No
Private water supply (BH)	7+150	Online	79	76	Yes – Supply point lost due to cutting. Relocation required.
GW abstraction licence (FID 25)	7+200	150m S	74	76.6	No
Pond/ headwater	7+250	130m S	73	78	No
Well/spring	7+200	35mN	80	76.6	Yes - Unclear if in use. Detailed assessment may be required.
Seepage	7+200 - 7+450	215m S	73-65	76.6 - 87.5	No
Spring	7+750	220m N	74	98	No

Spring	7+750	205m N	75	98	No
Spring	7+800	200m N	75	98.9	No
Well/spring	7+800	490m N	64	98.9	No
Headwater	7+800	410m N	67	98.9	No
GW abstraction licence (FID 25)	8+000	120m NE	91	99.7	No
Well/spring	8+050	180m NE	90	99.7	No
Well/spring	8+250	420m NE	104	99.7	Yes - Unclear if in use. Detailed assessment may be required.
Well/spring	8+275	365m E	105	99.7	Yes - Unclear if in use. Detailed assessment may be required.

Zelah Side Road Crossing

13.5.8 All fifteen of the groundwater features surrounding Zelah Side Road Crossing have been identified as at risk from the lowering of groundwater levels. These consist of two licensed groundwater abstractions, two private water supplies, two headwaters and nine wells/springs. These are listed in Table 13-18.

Table 13-18 Groundwater features identified as potentially being impacted by cutting construction at Zelah Side Road Crossing

Type of feature	Chainage	Distance to cutting, m	Feature elevation at GL, mOD	Scheme elevation / drawdown level, mOD	Further assessment required?
Spring	7+750	350m NW	74	66	Yes - Unclear if in use. Detailed assessment may be required.
Spring	7+750	345m NW	75	66	Yes - Unclear if in use. Detailed assessment may be required.
Spring	7+800	300m NW	75	66	Yes - Unclear if in use. Detailed assessment may be required.
Headwater	7+800	410m N	67	66	Yes - Detailed assessment required.
GW abstraction licence (FID 25)	8+000	40m N	91		Yes - Confirmation of well depth is needed; detailed assessment required.
Well/spring	8+050	80m N	90	66	Yes - Unclear if in use. Detailed assessment may be required.
Well/spring	8+250	260m N	104	66	Yes - Unclear if in use. Detailed assessment may be required.
Well/spring	8+275	50m S	105	66	Yes - Unclear if in use. Detailed assessment may be required.
Well/spring	8+550	165m N	80	66	Yes - Unclear if in use. Detailed assessment may be required.
Private water supply	8+550	110m N	85	66	Yes - Detailed assessment required.
Private water supply	8+700	420m NE	80	66	Yes - Detailed assessment required.

GW abstraction licence (FID 32)	8+700	450m NE	80		Yes - Confirmation of well depth is needed; detailed assessment required.
Spring	8+750	420m NE	80	66	Yes - Unclear if in use. Detailed assessment may be required.
Well/spring	8+900	80m NE	77	66	Yes - Unclear if in use. Detailed assessment may be required.
Headwater	8+850	350m E	75	66	Yes - Detailed assessment required.

Trevalso Underbridge

13.5.9 Ten groundwater features were identified as potentially being impacted by the lowering of groundwater levels surrounding the Trevalso Underbridge. These consist of two licenced groundwater abstractions, a seepage, a spring, one area of wet ground and five wells/springs. These are listed in Table 13-19.

Table 13-19 Groundwater features identified as potentially being impacted by cutting construction at Trevalso Underbridge.

Type of feature	Chainage	Distance to cutting, m	Feature elevation at GL, mOD	Scheme elevation / drawdown level, mOD	Further assessment required?
Well/spring	9+200	470m W	80	83.6	No
Well/spring	9+200	465m W	77		
Well/spring	9+300	410m W	80		
Well/spring	9+300	410m W	77		
Well/spring	9+350	370m W	80		
Well/spring	9+250	490m W	75		
Spring/headwater	9+250	460m W	75		
Seepage	9+250	455mW	75		
Well/spring	9+600	140m W	87		Yes - Unclear if in use. Detailed assessment may be required.
GW abstraction licence (FID 35)	9+600	110m W	92		Yes - Confirmation of well depth is needed; detailed assessment required.
Well/spring	9+700	250m S	88		Yes - Unclear if in use. Detailed assessment may be required.
Well/spring	9+700	online	95		Yes - Unclear if in use. Detailed assessment may be required.
Spring	9+800	370m N	88		Yes - Detailed assessment required.
Well/spring	9+900	250m NE	96		Yes - Unclear if in use. Detailed assessment may be required.
GW abstraction licence (FID 36)	9+900	250m NE	99		Yes - Confirmation of well depth is needed; detailed assessment required.
Wet disturbed ground	9+900	170m NE	96-100		Yes - Detailed assessment required.
Well/spring	9+850	140m S	82		No

Well/spring	9+800	230m S	70		
Pond	10+100	370m SE	68-70		
Seepage	10+150 - 10+250	415m S	83-87		Yes - Detailed assessment required.
Seepage	10+100 - 10+200	450m S	71-74		No
Well/spring	10+100	390m E	109		Yes - Unclear if in use. Detailed assessment may be required.

Trevalso Crossing

13.5.10 Eleven groundwater features were identified as potentially being impacted by the lowering of groundwater levels surrounding the Trevalso Crossing. These consist of a licenced groundwater abstraction, one private water supply, three ponds, two areas of wet ground and five wells/springs. These are listed in Table 13-20.

Table 13-20 Groundwater features identified as potentially being impacted by cutting construction at Trevalso Crossing.

Type of feature	Chainage	Distance to cutting, m	Feature elevation at GL, mOD	Scheme elevation / drawdown level, mOD	Further assessment required?
Well/spring	9+600	370m W	87	98.45	No
GW abstraction licence (FID 35)	9+600	345m W	92	98.45	No
Well/spring	9+700	190m W	88	98.45	No
Well/spring	9+700	120m W	95	98.45	No
Spring	9+800	470m NW	88	98.45	No
Well/spring	9+900	215m N	96	98.45	No
GW abstraction licence (FID 36)	9+900	175m N	99	98.45	Yes - Confirmation of well depth is needed; detailed assessment required.
Wet disturbed ground	9+900	130m N	96-100	98.45	Yes - Detailed assessment required.
Well/spring	9+850	165m SW	82	98.45	No
Well/spring	9+800	280m SW	70	98.45	No
Pond	10+100	190m S	68-70	104.35	No
Seepage	10+150 - 10+250	160m S	83-87	106-109	No
Seepage	10+100 - 10+200	320m S	71-74	104.35-107.29	No
Well/spring	10+100	45m N	109	104.35	Yes - Unclear if in use. Detailed assessment may be required.
Well/spring	10+250	75m N	116	109	Yes - Unclear if in use. Detailed assessment may be required.
Well/spring	10+300	120m N	116	110.3	Yes - Unclear if in use. Detailed assessment may be required.
Pond	10+350	140m N	115	111.5	Yes - Detailed assessment required.

Well/spring	10+400	340m N	115	113.02	Yes - Unclear if in use. Detailed assessment may be required.
Poorly drained	10+400 - 10+600	0m N	114-115	113.02-114.9	Yes - Detailed assessment required.
Pond; Private water supply	10+450	35m N	114	114	Yes - Detailed assessment required. Alternative supply required.
Pond/ headwater	10+500	150m N	114	114	Yes - Detailed assessment required.
Spring	10+600	415m N	115	114.9	No
Well/spring	10+900	395m NE	116	114.9	Yes - Unclear if in use. Detailed assessment may be required.

Pennycomequick Side Road Crossing

13.5.11 Eight groundwater features were identified as potentially being impacted by the lowering of groundwater levels surrounding the Pennycomequick Side Road Crossing. These consist of four ponds, a wet depression and three wells/springs. These are listed in Table 13-21.

Table 13-21 Groundwater features identified as potentially being impacted by cutting construction at Pennycomequick Side Road Crossing

Type of feature	Chainage	Distance to cutting, m	Feature elevation at GL, mOD	Scheme elevation / drawdown level, mOD	Further assessment required?
Pond; Private water supply	10+450	460m W	114	105.5	Yes - Detailed assessment required.
Pond/ headwater	10+500	430m W	114	105.5	Yes - Detailed assessment required.
Spring	10+550	500m NW	110	105.5	Yes - Detailed assessment required.
Spring	10+800	500m N	105	105.5	No
Well/spring	10+900	90m NW	116	105.5	Yes - Unclear if in use. Detailed assessment may be required.
Pond W	11+050	online/adjacent W	106.5	105.5	Yes - Detailed assessment required.
Private water supply	11+050	online	104	105.5	No
Pond E	11+100	30m E	106.5	105.5	Yes - Detailed assessment required.
Well/spring	11+100	260m NE	118	105.5	Yes - Unclear if in use. Detailed assessment may be required.
Wet depression	11+200 - 11+300	250m E	115-116	105.5	Yes - Detailed assessment required.
Private water supply; spring	11+000	130m S	103	105.5	No
Seepage	11+150 - 11+500	320m SE	90 - 80	105.5	No

Penglaze Cutting

13.5.12 Five groundwater features were identified as potentially being impacted by the lowering of groundwater levels surrounding the Penglaze Cutting. These consist of two private water supplies, a wet depression and two wells/springs. These are listed in Table 13-22.

Table 13-22 Groundwater features identified as potentially being impacted by cutting construction at Penglaze Cutting

Type of feature	Chainage	Distance to cutting, m	Feature elevation at GL, mOD	Scheme elevation / drawdown level, mOD	Further assessment required?
Well/spring	10+900	365m NW	116	112.97	Yes - Unclear if in use. Detailed assessment may be required.
Private water supply (spring)	11+000	295m SW	103	112.97	No
Ponds	11+000 - 11+100	130m W	108	112.97	No
Well/spring	11+100	330m NW	118	112.97	Yes - Unclear if in use. Detailed assessment may be required.
Wet depression	11+200 - 11+300	200m N	115-116	112.97 - 114.58	Yes - Detailed assessment required.
Seepage	11+150 - 11+500	290m S	90 - 80	112.5 - 118.27	No
Well/spring	11+550	340m S	85	118.8	No
Seepage	11+600	160m SE	100-115	119.33	No
Headwater	11+950	385m SE	106	120.26	No
Private water supply (BH)	12+100	490m E	137	120.26	Yes - Confirmation of well depth is needed; detailed assessment required.
Private water supply (BH/well)	12+100 - 12+700	495m E	135	120.26	Yes - Confirmation of well depth is needed; detailed assessment required.

Summary

13.5.13 The assessment of potential impacts of cutting construction upon groundwater levels and nearby groundwater features has noted various potential impacts. Despite the large number of potential interactions between the scheme and existing groundwater-fed features, many of these features are likely to no longer be used or of low value.

13.5.14 Where potential impacts upon higher value receptors, such as licenced abstraction or private water supplies, are noted suitable mitigations should be incorporated into the assessment to ensure that these are dealt with during detailed design.

13.6 Penglaze Cutting Groundwater Assessment

Introduction

13.6.1 The proposed A30 scheme requires a cutting between Ch 11+200 and 11+700 (referred to as Penglaze Cutting). Based on design groundwater levels determined during the Phase 1 and Phase 2 ground investigations (reported in the WSP GIR[9] and the Arup GIR Addendum[10] respectively) dewatering during construction and a permanent groundwater drainage system during operation would be required. This is anticipated to locally impact the groundwater level and flow.

13.6.2 The Newlyn Downs SAC is located approximately 270m north at the nearest point of the proposed cutting. The location of the SAC is shown on HA551502-ARP-HML-SW-DR-CH-000004. There is a potential that these activities might impact the groundwater regime within the vicinity of the SAC and consequently have a detrimental effect on water dependent ecosystems.

13.6.3 This note presents a desk study review of the hydrogeological setting of the scheme and the SAC. It examines the potential for hydraulic connectivity between the proposed cutting and the SAC and assesses the potential hydrogeological impacts of the proposed scheme on the SAC.

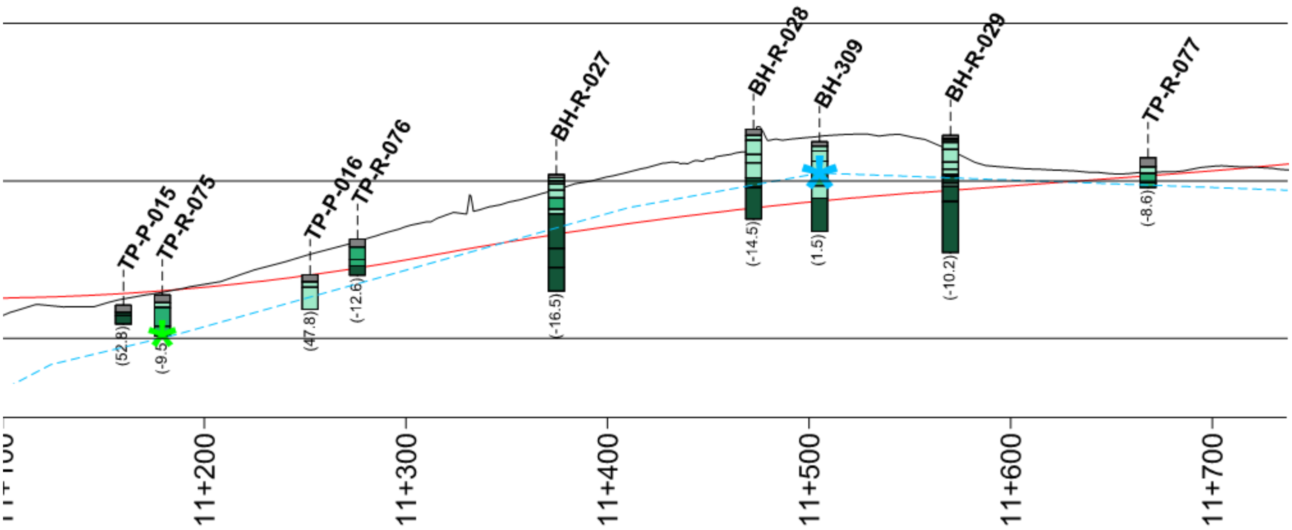
A30 scheme proposals (Ch 11+200 – 11+700)

13.6.4 Proposals are for Penglaze Cutting to reduce ground levels by up to 4.3m to levels of between 113.0 and 119.3 mOD (from west to east) as shown on Drawings HA551502-ARP-HML-SW-DR-CH-000004 and the geological long section extract presented within Figure 13-1 . The design groundwater level within the cutting is 117.5 (chainage 11+400) and 120.5mOD (chainage 11+500) resulting in potential drawdown of up to 2.3m on current groundwater levels. The radius of influence has not been derived as at this stage of design no sufficient data is available.

[9] WSP | Parsons Brinkerhoff. 2017. A30 Chiverton to Carland Cross Ground Investigation Report. Report Reference HA551502-WSP-VGT-000-RE-GE-00001

[10] Ove Arup & Partners Ltd. 2018. A30 Chiverton to Carland Cross, GIR Addendum. Report Reference HA551502-ARP-HGT-SW-RP-CE-000001.

Figure 13-1 Extract of the geological long section for Penglaze Cutting (Ch 11+200 to 11+700). Black line = existing ground level; red line = proposed ground level; blue dashed line = interpreted groundwater level; blue star = maximum monitored groundwater level within installation; green star = observation of groundwater ingress during ground investigation.



Hydrogeological setting

13.6.5 The geological setting of the scheme and the Newlyn Downs SAC site is shown on Figure 2 (based on Drawing HA551502-ARP-HGT-SW-DR-CE-000024) contained within the Arup GIR Addendum[10] and described below. The proposed cutting is underlain by between 2.5 and 3.5m of completely weathered to highly weathered Grampound Formation, becoming moderately and slightly weathered and eventually fresh and unweathered Grampound Formation. This stratum is typically described as comprising thinly interlaminated metamorphosed mudstone and siltstone (phylitte) with sporadic thin beds of metamorphosed sandstone (psammite) and sparse lenticular limestone.

13.6.6 The Environment Agency has classified these deposits as a Secondary A Aquifer. No site-specific permeability data has been obtained during ground investigations completed to date, however these investigations showed that the area of Penglaze Cutting is underlain by between 2.5 and 3.5m of completely to highly weathered rock Grampound Formation. The groundwater flow is anticipated to primarily take place within this weathered zone where the intergranular permeability is likely to be dominant. Within the unweathered rock the predominant groundwater-flow mechanism is via fractures. The Hydrogeological Map for England and Wales classifies the underlying bedrock as ‘impermeable rocks, generally without groundwater except at shallow depth’.

13.6.7 An east-west trending regional thrust fault is located within 200m north of scheme alignment. It forms a hanging wall of the Grampound Formation to the south of the Trendrean Mudstone Formation. The projected fault line transects the southernmost extent of the SAC. A north-south trending reverse fault cross cuts this thrust approximately 270m north of Ch 12+200 and continues south to intersect the proposed alignment at approx. Ch 12+100.

13.6.8 The width of these fault zones is likely to be in a range of 10 to 15m on the basis of recent geophysical investigations of faults intersecting the proposed scheme (see Arup GIR Addendum[10]). The 'fault zone' represents the zone of complex deformation associated with the fault plane and typically comprises a highly fractured system of degraded rock quality. This is likely to result in increased secondary permeability and create a preferential path for groundwater flows.

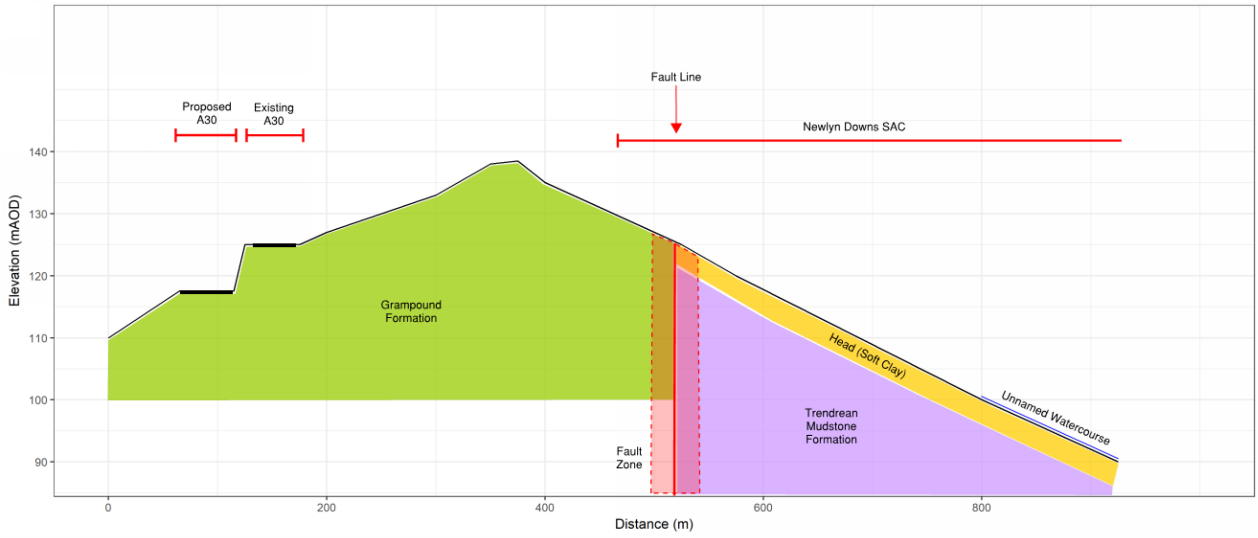
13.6.9 The topography is structurally controlled, meaning that the fluvial valley systems have exploited fault zones. Indeed, the Newlyn Downs peneplain has probably formed because of fluvial denudation along the alignment of a north-south trending regional fault. From the location of the proposed Penglaze Cutting the ground rises sharply northwards from approximately 120mOD to 140mOD forming a ridge parallel to the scheme and the SAC boundary. The ground then falls sharply northwards to 115mOD then falling gently northwards to some 70mOD. The SAC southernmost boundary is at elevation 135mOD. The ridge forms a watershed, which separates sub-catchments where the scheme area and the SAC are located.

13.6.10 The Newlyn Downs SAC site is directly underlain by the Head deposits comprising poorly sorted and poorly stratified deposits of gravel, sand and clay. Head deposits encountered within the scheme area comprised soft gravelly organic clays (see Arup GIR Addendum[10]) and it is likely that deposits of similar nature underlie the SAC site. These deposits are in turn underlain by the Trendrean Mudstone Formation comprising dark grey to black metamorphosed mudstone with upward-fining siltstone laminae and some beds of pale grey fine-grained sandstone. As with the Grampound Formation, the Trendrean Mudstone Formation has been described on the Hydrogeological Map for England and Wales as impermeable and without groundwater, except for shallow depth. The Environment Agency classed the superficial deposits as a non-productive aquifer (see WSP PSSR[11]). No ground investigation data is available for the area of the SAC.

13.6.11 The OS map shows marshy conditions prevailing across the SAC. This indicates either very high groundwater levels or poorly drained soils. Published geology indicates the site to be underlain by deposits (both superficial and solid) of relatively low permeability. Water infiltration and groundwater recharge would be limited through such deposits. Surface runoff or shallow subsurface flows (within more permeable strata) would be driven by the topography.

[11] WSP | Parsons Brinkerhoff. 2017. A30 Chiverton to Carland Cross Preliminary Sources Study. Report HAGDMS No. 29326.

Figure 13-2 Schematic representation of the hydrological setting of the proposed Penglaze Cutting and the Newlyn Downs SAC



Hydraulic connectivity

13.6.12 Hydraulic connectivity between the scheme and the SAC site has been primarily considered in a context of permeability of individual geological formations. The permeability includes the interconnection between the pores at a fundamental level within the rock (primary permeability) and fractures/joints in rock bodies (secondary porosity).

13.6.13 Both rock formations in question comprise metamorphic sedimentary layers. The permeability of these strata relies on secondary permeability interconnections. The primary porosity would control the flows within the weathered zone, with greater flows in granular than in cohesive weathered rock. Therefore, the groundwater flow is likely to be predominantly within the weathered metamorphic sandstone beds (granular) with weathered metamorphic mudstones or siltstones (cohesive) typically forming aquicludes. The ground investigations undertaken within the area of the cut encountered fractured thinly interbedded layers of metamorphic mudstones and sandstones with varied degree of weathering within the cut zone. Therefore, both groundwater flow mechanisms will be present within the affected zone of rock. The flow mechanism within the bedrock underlying the SAC site is likely to be of similar nature, however the weathered bedrock is likely to comprise cohesive materials and therefore limited groundwater flows would be expected.

13.6.14 The formations underlying the scheme and the protected area are separated by the fault zone, highly deformed and fractured complex system, which is known to have a significant impact on the hydrogeological regime. The groundwater flow is likely to be confined to the weathered metamorphic sandstone strata or through fractured layers escaping by flow along the fault zone, located between the scheme area and the SAC site, or rockhead (e.g. as a spring), or both. The presence of the watershed further limits interaction between the scheme and the SAC site Therefore, the potential for hydraulic connectivity between the two formations is considered to be very low.

Conclusions

13.6.15 The review of the hydrogeological setting of the proposed scheme and the Newlyn Downs SAC site concluded that the bedrock formations underlying both sites are unlikely to be in hydraulic continuity. Therefore, the activities associated with the construction of the proposed scheme would not affect the SAC area.

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