A46 Coventry Junctions (Walsgrave) Scheme number: TR010066

6.3 Environmental Statement Appendices

Appendix 13.4 Groundwater Assessment

APFP Regulations 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

A46 Coventry Junctions (Walsgrave)
Development Consent Order 202[x]

ENVIRONMENTAL STATEMENT APPENDICES
Appendix 13.4 Groundwater Assessment

Regulation Number	Regulation 5(2)(a)
Planning Inspectorate Scheme Reference	TR010066
Application Document Reference	TR010066/APP/6.3
Author	A46 Coventry Junctions (Walsgrave), Project Team & National Highways

Version	Date	Status of Version
Rev 0	November 2024	Application Issue

Table of contents

Figures

Tables

1. Introduction

1.1.1. National Highways (the Applicant) has applied for a development consent order (DCO) for the A46 Coventry Junction (Walsgrave) (the Scheme). The Scheme will ease congestion along the A46 corridor, east of Coventry. The proposed works include an alteration to the existing A46 Walsgrave Junction and B4082, east of Walsgrave.

1.1.2. This appendix report supports Environmental Statement (ES) Chapter 13 (Road Drainage and the Water Environment) **(TR010066/APP/6.1**). It provides a hydrogeological conceptual model for the Scheme and its study area, based on ground investigations covered in Section 1.7 of this report, and the necessary groundwater-specific environmental assessments as described in the Design Manual for Roads and Bridges (DMRB) LA 113 Road drainage and the water environment. These assessments identify potentially significant impacts and inform the assessment of significant effects presented in ES Chapter 13 (Road Drainage and the Water Environment) (**TR010066/APP/6.1**) which follows the assessment methodology described in DMRB LA 104 Environmental assessment and monitoring.

1.2. Scheme location

1.2.1. The Scheme is located in the West Midlands, approximately 5km to the east of Coventry city centre. ES Figure 2.1 (Location Plan) (**TR010066/APP/6.2**) shows the location of the Scheme. The Scheme involves improvements to the B4082 which runs eastwards from Clifford Bridge Road to the existing Walsgrave Junction and the A46 which runs north-south to the east of Coventry. Binley Junction, located on the A46, is approximately 1.7km to the south of the existing Walsgrave Junction and the M6 and M69 junctions are approximately 2.5km to the north of the existing Walsgrave Junction. ES Figure 2.2 (Order Limits) (**TR010066/APP/6.2**) shows the principal elements of the Scheme and the Order Limits. A Location Plan (**TR010066/APP/2.1**) is also provided with the application, which shows the location of the Scheme in its wider geographical context.

1.2.2. The Scheme is situated within the Coventry City Council and Rugby Borough Council administrative areas (ES Figure 1.1 (Regional Context) (**TR010066/APP/6.2**)). The boundary between these two administrative areas is along the western side of the A46. Rugby Borough Council's administrative area also forms part of Warwickshire County Council's administrative area, which shares the same border with Coventry City Council. The Leicestershire County Council boundary is approximately 12.5km north and east of the existing Walsgrave Junction.

1.3. Scheme overview

1.3.1. The current configuration consists of the existing A46 dual carriageway, the Walsgrave Junction and the B4082 link road; a two-lane single carriageway between the existing Walsgrave Junction and Clifford Bridge Road roundabout. The Order Limits of the Scheme is shown in Figure 1.1 below.

Figure 1.1: Scheme location plan

1.3.2. An explanation of the Scheme objectives and a detailed description of the Scheme proposals can be found in ES Chapter 2 (The Scheme) (**TR010066/APP/6.1**).

1.3.3. The Scheme consists of the following principal elements:

- Realignment of the existing A46 dual carriageway through the existing at grade roundabout (which will be removed), for approximately 880m to improve the road geometry and allow for a 50mph speed limit.
- Earthworks on the eastern side of the A46 mainline to facilitate the realignment through the existing at grade roundabout.
- A new grade separated junction over the A46 mainline, approximately 800m north of the existing Walsgrave Junction to connect the B4082 with the A46.

- A new overbridge structure across the existing A46, between the dumbbell roundabouts forming the grade separated junction.
- New merge and diverge slip roads at the grade separated junction for both northbound and southbound movements.
- Realignment of the B4082 to form a single carriageway link road, for approximately 900m, to connect the local road network to the new A46 grade separated junction with a proposed 40mph speed limit.
- Road assets and street furniture such as traffic signs and lines, variable message sign (VMS), street lighting columns, vehicle restraint systems, fences, retaining walls and kerbs.
- Drainage systems including a dry detention basin and two ponds that will be designed to be permanently wet.
- Proposed new maintenance accesses to the drainage features and VMS.
- Retention of the Hungerley Hall Farm accommodation overbridge (the existing bridge that provides farm vehicle access over the A46 mainline).
- Farm access track to the north of Hungerly Hall Farm to provide gated access to the B4082 link road.
- Improvements to facilities for walkers, cyclists and horse-riders (WCH) through provision of a signalised pedestrian crossing on the B4082; and providing enabling works, including the retention of Hungerley Hall Farm accommodation overbridge, for a potential future WCH route to be provided by others.
- Replacement and installation of new highway boundary fencing.
- Replacement vegetation planting to compensate for the vegetation that needs to be removed to facilitate the Scheme.

1.3.4. The proposed drainage design will include the use of Sustainable Urban Drainage Systems (SuDS), small scale embankments around ditches and wider maintenance regimes, as well as improvements to the existing drainage system where impermeable areas are to be increased.

1.3.5. The proposed drainage design also includes two ponds and a detention basin. Surface water will be collected in the form of gullies and surface water channels.

1.3.6. Key potential construction and operation effects on the water environment include:

- Groundwater levels and flow changes through potential construction dewatering activities (or other forms of groundwater control) and redirection of flows to receptors around permanent structures
- Contamination of groundwater by generation of suspended solids, direct contact with construction materials, or polluted construction runoff and

acceleration of contaminant travel time through creation of vertical and lateral flow pathways during construction

- Disruption to groundwater recharge through compaction of soils and storage of earth materials within the study area
- Discharge of metals and organic compounds from road drainage to surface water and groundwater
- Generation of turbidity through ground disturbance during construction and excavation
- Alteration of ground profiles, for example embankments, and creation of additional hardstanding areas, for example for access roads and construction compounds

1.4. Aims and objectives

1.4.1. This report aims to:

- Provide a hydrogeological conceptual model and identify key direct and indirect receptors within the study area
- Identify construction and operation activities specific to the Scheme that have the potential to impact on the groundwater environment
- Present simple qualitative assessments to identify which activities may result in a significant impact, and therefore require further consideration

1.4.2. The report is set out in the following structure:

- Section 2 presents the hydrogeological baseline conditions based on ground investigation results and other freely available sources of information. This informs a conceptual model and receptors, in line with the Groundwater Levels and Flows Assessment method set out in DMRB LA 113.
- Section 3 provides details of construction and operation activities and a description of the potential hydrogeological impact, prior to mitigation.
- Section 4 assesses the significance of risk to receptors, in line with the assessment methods set out in DMRB LA 113 (GWDTE, groundwater quality and routine runoff and spillage assessments).
- Section 5 summarises the activities that may result in a potentially significant impact, prior to mitigation, and that are taken forward for further consideration in the assessment of significant effects in ES Chapter 13 (Road Drainage and the Water Environment) (**TR010066/APP/6.1**).

1.5. Study Area

1.5.1. The study area encompasses groundwater and surface water features that could be affected by the Scheme. The study area is based on professional judgement to ensure that effects are sufficiently identified. It generally comprises a 1km

corridor surrounding the Order Limits, extending to 2km to encompass areas of particular significance to groundwater such as Groundwater Dependent Terrestrial Ecosystems (GWDTE). The groundwater study area is shown in Annex A Location Plan 1.

1.6. Data sources

1.6.1. This technical report has been produced utilising the following sources of information:

- British Geological Survey (BGS) 1:50,000 and 1:625,000 superficial and bedrock geological maps (BGS, 2023)
- Coventry Strategic Flood Risk Assessment (Coventry City Council, 2015)
- DEFRA's 'Magic' interactive map
- Envirocheck Report (Landmark, 2023)
- Environment Agency - National groundwater recharge assessment under climate change, project summary SC160018 (Environment Agency, 2019)
- Environment Agency - Catchment Data Explorer (Environment Agency, 2022)
- Environment Agency - Groundwater Dependent Terrestrial Ecosystems Dataset (Environment Agency, 2024)
- Environmental Scoping Report (**TR010066/APP/6.8**)
- Ground Investigation Report (ES Appendix 9.3 (**TR010066/APP/6.3**))
- Highways Agency Drainage Data Management System (HADDMS), Drainage Data Management System v5.12 (HADDMS, 2024)
- Preliminary Sources Study Report, Appendix C. Groundsure Report (National Highways, 2021)
- Warwickshire Strategic Flood Risk Assessment (Warwickshire County Council, 2013)

1.6.2. Additional information was requested from the Environment Agency for the study area in June 2023 that has also been summarised in the report, consisting of:

- licensed groundwater and surface water abstractions
- consented discharges

1.6.3. The following information was requested from Coventry City Council and Warwickshire County Council in February 2024, but both local councils indicated that they do not hold any information on:

- unlicensed abstractions
- unconsented discharges

1.6.4. A water features survey was conducted between 22 and 26 January 2024. The water features survey map is included alongside the attached WR-36 form and is available in Annex C of this report. This survey has been used to inform potential at risk groundwater receptors.

1.7. Ground investigations

2020 Ground Investigation

1.7.1. An intrusive geotechnical and geo-environmental investigation was undertaken by Groundsure for AECOM on behalf of National Highways and reported on in Appendix C of the Preliminary Sources Study Report (National Highways 2021a). Information on nearby aquifers, BGS boreholes, groundwater vulnerability, groundwater abstractions, Water Framework Directive (WFD) groundwater bodies, groundwater flooding and environmentally designated sites was utilised.

2023 Ground Investigation

1.7.2. An Envirocheck Report (Landmark, 2023) was completed in July 2023 and informed the Environmental Scoping Report (**TR010066/APP/6.8**).

1.7.3. A second ground investigation was undertaken by Strata Geotechnics in 2023 and reported on in Appendix C of the Ground Investigation Report (ES Appendix 9.3 (**TR010066/APP/6.3**)).

1.7.4. The objective of the investigation was to obtain information on the ground and groundwater conditions relating to the design of the Scheme. The investigation comprised cable percussive boreholes, dynamic sample boreholes, trial pits and dynamic probes. In situ soakaway tests, groundwater level monitoring, and laboratory testing of soil and groundwater, were also undertaken. Details of the results from this investigation are summarised in Section 2 of this report.

1.7.5. There were a total of 36 boreholes and window samples completed for the scheme and three trial pits, 14 of the boreholes (referred to as BH104 – 127) and 6 of the window sample installations (referred to as WS102 – 109) were completed for monitoring.

1.7.6. Groundwater level monitoring comprising monthly dip rounds was undertaken by Strata Geotechnics from May 2023 for a period of 12 months. In addition, data loggers were installed in all 20 monitoring boreholes to monitor groundwater levels at hourly intervals.

1.7.7. Groundwater quality analyses were undertaken on 19 samples, which were collected between May 2023 and June 2023. The Ground Investigation Report

(ES Appendix 9.3 (**TR010066/APP/6.3**)) discusses the results of this investigation.

1.7.8. A location plan of drilled boreholes is shown in Annex A Location Plan 1. A hydrogeological section along the main line is shown in Annex B. The geological long section is taken from Appendix A of the Ground Investigation Report (ES Appendix 9.3 (**TR010066/APP/6.3**)) alongside supporting information.

1.8. Limitations and uncertainty

1.8.1. Structures may require excavation into superficial deposits and bedrock. An initial assessment of potential dewatering requirements has been undertaken (refer to Annex E). However, more detailed assessments will be undertaken at a later stage of the Scheme when the detailed design has been confirmed and construction requirements are known.

1.8.2. This groundwater assessment is constrained by the information available. The ground investigation has provided comprehensive data relating to the geology and hydrogeology within the Scheme Order Limits, but data is limited outside of this. The data collected may therefore not necessarily fully represent the regional hydrogeological conditions, particularly with respect to hydraulic gradients and direction of regional groundwater flow. As only 12 months of groundwater level monitoring data has been collected, it is possible that this does not reflect long term seasonal maximum and minimum groundwater levels. Further groundwater level monitoring would be required to confirm groundwater level extremes and long-term trends.

1.8.3. There is no Environment Agency groundwater level monitoring within the study area.

1.8.4. Further limitations in the datasets used include the extents of the groundwater flooding susceptibility dataset, which is limited to a 500m corridor around the existing road. Despite data requests, no information on unlicensed groundwater abstractions and discharges was available from the local authorities.

2. Hydrogeological baseline conditions

2.1. Topography and drainage

2.1.1. The study area follows a general slope from north-east to south-west between 92m AOD and 71m AOD from Walsgrave Hill towards the flood plain of the River Sowe and Smite Brook. The land is drained by the River Sowe at the western extent of the study area, which marks a topographic low point. The hydraulic gradient reflects topography to some degree with a predominantly western component.

2.1.2. Much of the site comprises agricultural fields, alongside the A46 and B4082. The study area minorly intersects Valencia Road and Brinklow Road in the south, aside from this urban interference is minimal. Coombe Pool Site of Special Scientific Interest (SSSI) is also directly adjacent to the Scheme to the east.

2.2. Geology

2.2.1. The regional superficial geology at (1:25,000 scale) is presented in Annex A Location Plan 1. The descriptions provided below are based on the 2023 ground investigation and the spatial extents as presented in Annex B.

2.2.2. The study area has extensive Pleistocene superficial deposits overlying mid-late Triassic Mercia Mudstone Group with early mid Triassic Helsby Sandstone Formation beneath and outcropping 1 to 2 km to the west. The superficial deposits are predominantly sands and gravels with lenses of silt, clay and peat as well as glacial lacustrine muds and diamicton. The superficial geology and bedrock are described in further detail below.

Made ground

2.2.3. Made ground in the form of gravelly sand with quartzite and brick was present in WS102 –103 and BH102 – 103. As stated in the Ground Investigation Report Hardstanding bituminous material at ground level which required coring was encountered at BH109 and BH117 and comprised of gravelly, silty, sandy clay with quartzite and red brick (reference ES Appendix 9.3 (Ground Investigation Report) (**TR010066/APP/6.3**)).

Alluvium and river terrace deposits

2.2.4. Alluvium and river terrace deposits are abundant across the study area comprising clay, silt, sand and gravel with low to medium cobble content in some locations. Close to the banks of the River Sowe, fibrous sandy peat is also found within alluvium in WS109. Adjacent to the B4082, and Smite Brook, alluvium runs towards Coombe Pool. Sands and gravels are generally fine to coarse and

subrounded to rounded and unit is roughly 2 to 10m thick across the study area. At boreholes where alluvium is not present, either river terrace deposits or Wolston Glacigenic Formation is instead found (reference ES Appendix 9.3 (Ground Investigation Report) (**TR010066/APP/6.3**)).

Wolston Glacigenic Formation

2.2.5. This unit is comprised of both the Bosworth Clay Member and Thrussington Till Member which are present in the north of the study area along the transect of the main carriageway. The Bosworth Clay Member consists of reddish brown glacial lacustrine muds, locally mottled to stiff grey clay. The Thrussington Till Member consists of pebbly, gravelly clay and is associated with the earlier Proto-Soar River. These are of variable thickness of up to 20m but typically 1 to 9m in the study area with a maximum thickness of 13.35m recorded in the borehole logs. The Wolston Glacigenic Formation overlies the Baginton Sand and Gravel Formation north of WS104, with the latter pinching out around BH106 and 109 in the central portion of the Scheme (reference ES Appendix 9.3 (Ground Investigation Report) (**TR010066/APP/6.3**)).

Baginton Sand and Gravel Formation

2.2.6. The Baginton Sand and Gravel Formation (also abbreviated to Baginton Sands and Gravels) are superficial deposits comprising of orangish brown and locally mottled grey, fine to medium-grained silty sands and gravels with silt and clay lenses and is typically loose to very dense. Gravels are rounded to subangular in shape and unit thickness is roughly 2 to 5m in boreholes drilled but c. 16.5m (BGS, 2023). The deposits primarily outcrop in the area surrounded Hungerley Hall Farm within the study area and extend both southwards and north-eastwards of the Scheme, although is absent immediately adjacent to Smite Brook. The Baginton Sand and Gravel Formation is overlain by alluvium and river terrace deposits in the southern and central portions of the Scheme and the Wolston Glacigenic Formation to the north.

Mercia Mudstone Group

2.2.7. The Mercia Mudstone Group underlies most of the study area, occasionally outcropping at the surface in the north-east, and is described as a stiff to very stiff silty clay with occasional extremely weak to medium strong mudstone bands and thinner beds of gypsum and anhydrite. It also comprises weathered medium to fine-grained moderately strong sandstone bands. The deposits are encountered in all boreholes which reached bedrock with recognisable reddish-brown colour, greyish reduction spots and gleying. Fracturing is common and typically planar smooth, closely spaced and often infilled with clay or gypsum.

logs for the nearest abstraction borehole at Bodmin Road, Wyken suggest the base of the Mercia Mudstone Group to be at roughly 50mbGL.

Helsby Sandstone Formation

2.2.8. The Helsby Sandstone Formation is part of the Sherwood Sandstone Group. It largely comprises red-brown sandstones and conglomerates of fluvial origin with bands of red marls and tea greens. Across most of the study area, it is overlain by the Mercia Mudstone Group, although it outcrops approximately 1 to 2km to the north-west. The deposits are of variable thickness with a maximum of 1500m (BGS, 2023). The Helsby Sandstone Formation was not encountered in any of the ground investigation boreholes.

2.3. Hydrogeology

Aquifer designations

2.3.1. Table 2.1 summarises Environment Agency aquifer designations, along with their approximate extents within the study area, as per ES Figure 13.4 (Aquifer and Environmental Designations) (**TR010066/APP/6.2**). Where geological units are not present at surface, an assumed aquifer designation has been used.

Table 2.1: Aquifer Designations

Geological Unit		EA Aquifer Designation	Approximate Extents
Alluvium and river terrace deposits		Secondary A aquifer	Alluvium and river terrace deposits are present along the line of the watercourses (River Sowe and Smite Brook) and its tributaries. River terrace deposits overlie the Baginton Sand and Gravel Formation at the southern extents of the Scheme. Alluvium follows Smite Brook to the interception with Coombe Pool, before reappearing again further east of the Scheme.
Baginton Sand and Gravel Formation		Secondary A aquifer	The Baginton Sands and Gravels intersects the Scheme immediately to the north and south of the Walsgrave junction and at the southern extents. The sands and gravels are relatively extensive to the southwest of the Scheme, and in an additional ribbon following the northern bank of the Coombe Pool.
Wolston Glacigenic Formation	**Thrussington Till Member**	Secondary (undifferentiated) aquifer	The Thrussington Till Member intersects the Scheme from the north and is relatively extensive to the west of the River Sowe. It is absent in drilled cores south of the centre of the study area and predominantly found between BH118 and BH119.
	Bosworth Clay Member	Unproductive strata	The Bosworth Clay Member intersects the Scheme from the north beginning at Walsgrave Hill, the outcrop is more extensive to the west of the

Geological Unit	EA Aquifer Designation	Approximate Extents
		Scheme appearing alongside the Thrussington Till Member.
Mercia Mudstone Group	Secondary B aquifer	The Mercia Mudstone Group is present beneath the entire site below superficial deposits and outcropping where there are no superficial deposits, immediately to the north and south of the Walsgrave junction roundabout. To the east of the River Sowe, it confines the Helsby Sandstone Formation by up to 80m but thins significantly towards the west and north-west, limited fissuring and extensive weathering have been identified.
Helsby Sandstone Formation	Principal aquifer	The Helsby Sandstone Formation underlies the entire Scheme at a relatively significant depth of approximately 50 to 80m. The aquifer is shown on 1:50:000 mapping to outcrop 1 to 2km to the west of the Scheme.

2.3.2. The Helsby Sandstone Formation is a Principal aquifer. Principal aquifers are strata that have high intergranular and/or fracture permeability, and as such usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale.

2.3.3. The superficial alluvium, river terrace deposits and Baginton Sands and Gravels are classified as Secondary 'A' aquifers. Secondary A aquifers are permeable layers capable of supporting water supplied at a local, rather than strategic scale, and in some cases, form an important source of baseflow to rivers.

2.3.4. The Mercia Mudstone Group is classified as a Secondary B aquifer, defined as a lower permeability layer that may store and yield limited amounts of groundwater through characteristics such as cracks, openings and eroded layers. There is potential for limited groundwater flow through fractures in the uppermost, weathered horizons.

2.3.5. The Thrussington Till Member is classified as a Secondary (undifferentiated) aquifer. Secondary (undifferentiated) aquifers are classified as such where it is not possible to apply either a Secondary A or B definition because of the variable characteristics of the rock type. As such Secondary (undifferentiated) aquifers are likely to contain lower permeability layers and perched aquifers.

2.3.6. The Bosworth Clay Member is classified as unproductive strata. These rocks have negligible significance for water supply or baseflow to rivers, lakes, and wetlands. They consist of bedrock or superficial deposits with low permeability that naturally offer protection to any aquifers that may be present beneath.

2.3.7. The bedrock and superficial aquifers have a combined groundwater vulnerability classification of medium-high risk. There are also areas of medium risk in the north-east of the study area.

Existing below-ground structures and utilities

2.3.8. Utility searches have identified that there is statutory undertaker's equipment located within the Order Limits belonging to various utility companies. Most notably, this includes overhead transmission lines operated by National Grid with below-ground foundations and a high-pressure sewer main operated by Severn Trent. The overhead transmission line runs north-south on the western side of the A46 with foundations either side, crossing the B4082 immediately west of the existing Walsgrave Junction. This overhead transmission line would not be impacted by the Scheme.

2.3.9. A high-pressure sewer main runs north–south along the western side of the A46 and is within the Order Limits. North of the new junction location it turns westwards towards the River Sowe. Any protection works required to the sewer would be identified with the utility company during the detailed design stage.

2.3.10. There is a Vodafone ducted cable asset located in the western verge of the A46 south of the existing Walsgrave Junction. This has been located by trial hole. This asset does not require diversion due to the Scheme proposals. Proposed drainage outfalls will cross beneath the asset, these works will be coordinated with Vodafone.

Groundwater levels and flows

Regional groundwater level monitoring

2.3.11. Regional groundwater monitoring is limited in the area. There is an Environment Agency groundwater monitoring point at Court House Green (0588GW) approximately 3.1km to the west of the study area at a datum of 94.1mAOD. The yearly groundwater range was 10.81 – 11.72mbGL (82.38 – 83.29mAOD) between November 2022- 2023 and records water levels in the Helsby Sandstone Formation.

2.3.12. The water table at Court House Green is historically stable with a very slight upward trend and has not deviated outside of its 81 – 84mAOD range since 1995, providing a good indicator of any indirect effects of the Scheme on groundwater levels in the Helsby Sandstone Formation aquifer.

2.3.13. An attempt was made during the water features survey in January 2024 to measure water levels at Court House Green borehole, but the headworks could not be located.

Site groundwater level monitoring

2.3.14. Groundwater strikes recorded during ground investigation were primarily in the Wolston Glacigenic Formation and the underlying Mercia Mudstone Group. Strikes were also noted in the river terrace deposits, alluvium and the Baginton Sand and Gravel Formation.

2.3.15. The 2023 groundwater monitoring installations were primarily installed in groundwater bearing horizons. Manual groundwater level data has been collected from the site at approximately monthly intervals from May 2023 onwards. 20 standpipes were also installed with groundwater level loggers that have also been recording groundwater levels from May 2023 to present. A table summarising available groundwater level monitoring data is presented below in Table 2.2. Borehole locations are shown in Annex A Location Plan 1.

Table 2.2: Groundwater level monitoring summary (June 2023 – June 2024)

BH Ref. Number	Datum mAOD	Response Zone Depths mbDAT	Monitoring Horizon	Min GW level mbGL	Min GW level maOD	Date	Max GW level mbGL	Max GW level maOD	Date
BH104	71.709	5.2 – 9.79	Mercia Mudstone Group	1.54	70.17	11/09/23	0.08	71.63	02/01/24
BH105	72.754	3.2 – 10	Mercia Mudstone Group	2.67	70.08	11/10/23	0.66	72.09	22/02/24
BH106	76.013	3.5 – 10.4	Mercia Mudstone Group	4.10	71.91	17/09/23	1.87	74.14	22/02/24
BH107	75.958	0.4 – 2.2	Alluvium	Dry	Dry	N/A	Dry	Dry	N/A
BH109	79.170	1.5 – 4.2	Baginton Sand and Gravel Formation	3.12	76.05	12/10/23	1.87	77.30	04/01/24
BH110	79.351	5.5 – 20	Mercia Mudstone Group	5.75	73.60	11/10/23	3.74	75.61	22/02/24
BH111	78.546	1.5 – 3.8	Baginton Sand and Gravel Formation	3.04	75.51	10/10/23	1.24	77.31	23/02/23
BH112	79.044	1.3 – 5.1	Baginton Sand and Gravel Formation	3.79	75.25	09/10/23	2.25	76.79	22/02/24
BH117	74.068	2.1 – 6.7	Wolston Glacigenic Formation	1.34	72.73	07/07/23	0.31	73.76	02/01/24
BH121	73.761	6.5 – 16	Mercia Mudstone Group	0.66	73.10	08/07/23	- 0.07*	73.83	23/02/24
BH123	78.332	2.8 – 8.9	Wolston Glacigenic Formation/ Mercia Mudstone Group	3.78	74.55	12/09/23	2.22	76.11	22/02/24
BH125A	74.578	3.6 – 8.0	Baginton Sand and Gravel Formation	1.49	73.09	28/08/23	0.49	74.09	02/01/24
BH126	76.933	5.4 – 7.8	Wolston Glacigenic Formation	3.20	73.73	13/09/23	1.89	75.04	22/02/24

BH Ref. Number	Datum mAOD	Response Zone Depths mbDAT	Monitoring Horizon	Min GW level mbGL	Min GW level maOD	Date	Max GW level mbGL	Max GW level maOD	Date
BH127	74.761	6.9 – 9.5	Mercia Mudstone Group	0.86	73.90	08/07/23	0.08	74.68	29/03/24
WS102	71.340	2.9 – 3.7	Baginton Sand and Gravel Formation	1.23	70.11	03/01/24	- 0.20*	71.54	03/01/24
WS103	77.622	1.6 – 2.3	Baginton Sand and Gravel Formation	1.36	76.26	11/05/24	0.09	77.53	02/01/24
WS104	75.563	1.9 – 3.9	Wolston Glacigenic Formation/ Baginton Sand and Gravel Formation	2.20	73.36	25/08/23	0.20	75.36	02/01/24
WS105	74.711	1.2 – 3.9	Wolston Glacigenic Formation	1.28	73.43	15/07/23	0.15	74.71	22/02/23
WS106	77.087	2.3 – 5.0	Mercia Mudstone Group	3.21	73.88	16/09/23	0.15	76.94	02/01/24
WS109	71.191	1.0 – 3.0	Alluvium	1.72	69.47	08/06/24	- 0.10*	71.29	03/01/24

*Uncertainty with respect to datum elevation.
GW = groundwater

2.3.16. Groundwater levels are plotted on the hydrographs in Figure 2.1 to Figure 2.4. Boreholes have been grouped according to the response zone aquifer units as stated in the logs in Appendix C of the Ground Investigation Report (ES Appendix 9.3) (**TR010066/APP/6.3**)). A plan showing groundwater flow directions is presented in Figure 2.5. This is based on typical maximum groundwater levels as observed on 2 January 2024.

2.3.17. Maximum seasonal groundwater levels during the monitoring period were measured to be within the range of -0.20mbGL to 3.74mbGL. Boreholes in the south and central part of the Scheme predominantly monitor the Mercia Mudstone Group, the Baginton Sand and Gravel Formation, river terrace deposits and alluvium. Towards the north of Scheme, boreholes monitor groundwater levels in the Wolston Glacigenic Formation, which confines the Baginton Sand and Gravel Formation in this area.

2.3.18. Groundwater levels peaked in most boreholes in response to high rainfall between 2 and 3 January 2024 as well as 22 and 23 February 2024.

Figure 2.1: Groundwater level datalogger and manual dips hydrograph (alluvium)

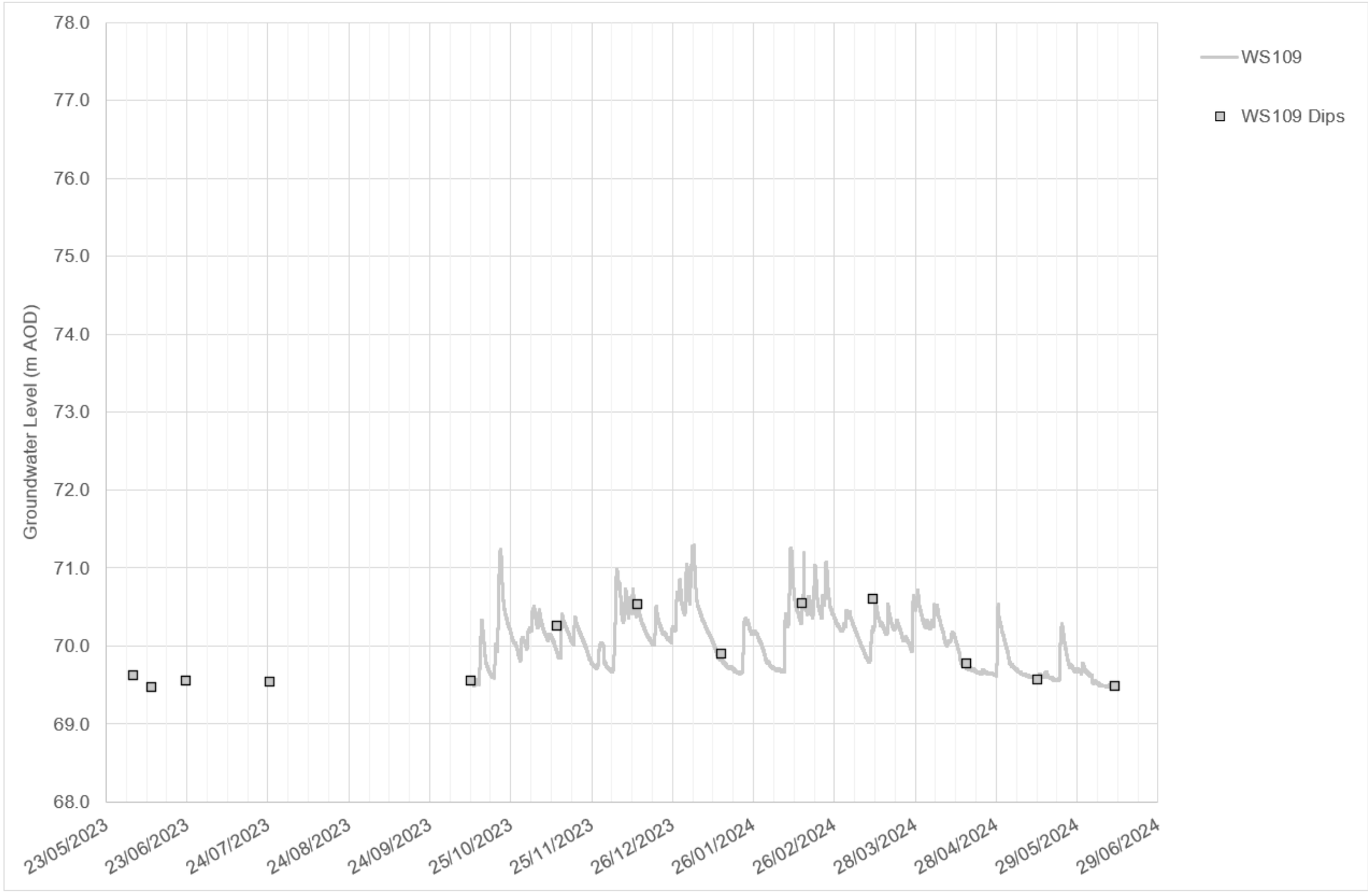


Figure 2.2: Groundwater level datalogger and manual dips hydrograph (Wolston Glacigenic Formation)

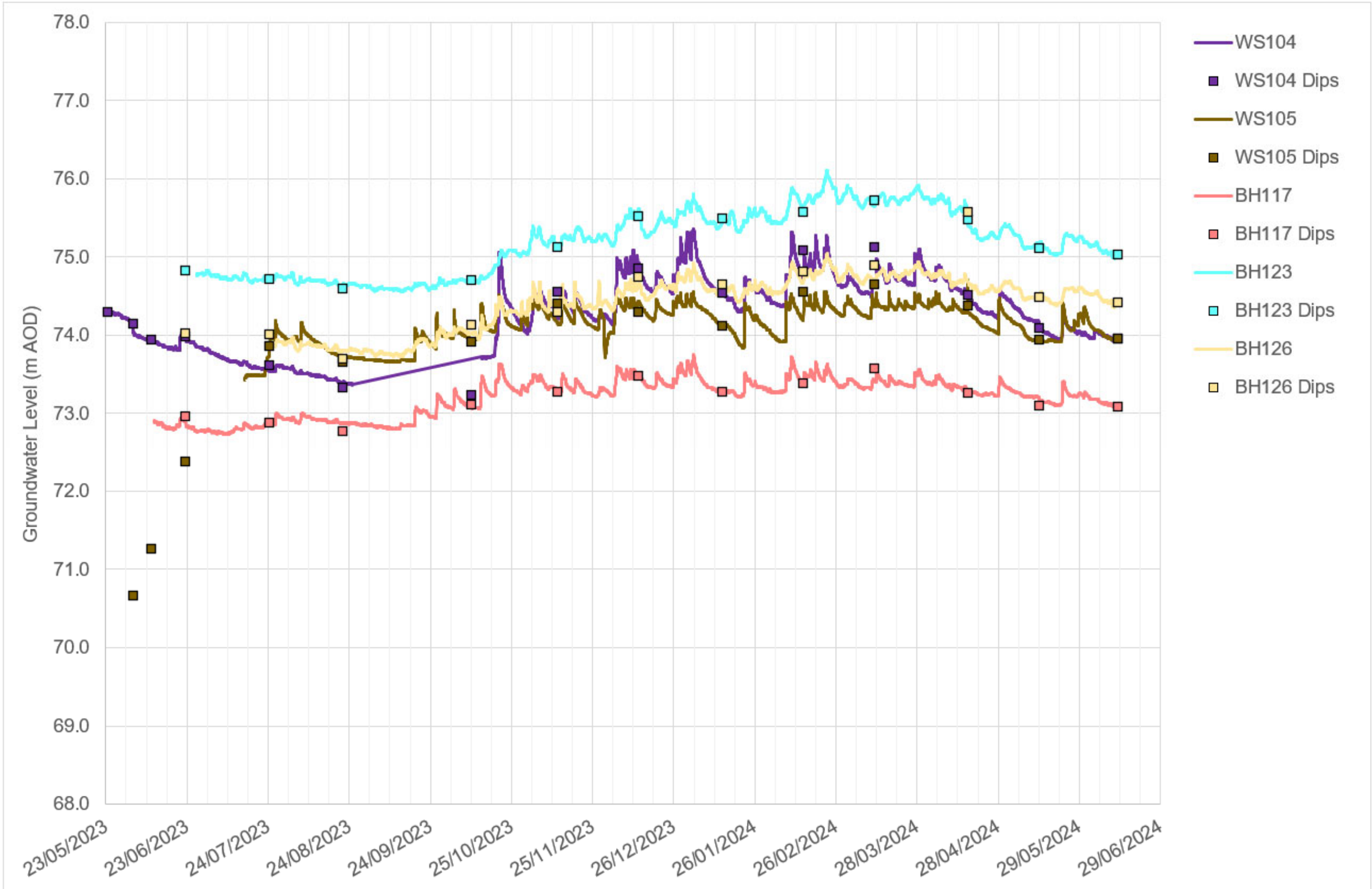


Figure 2.3: Groundwater level datalogger and manual dips hydrograph (Baginton Sand and Gravel Formation)

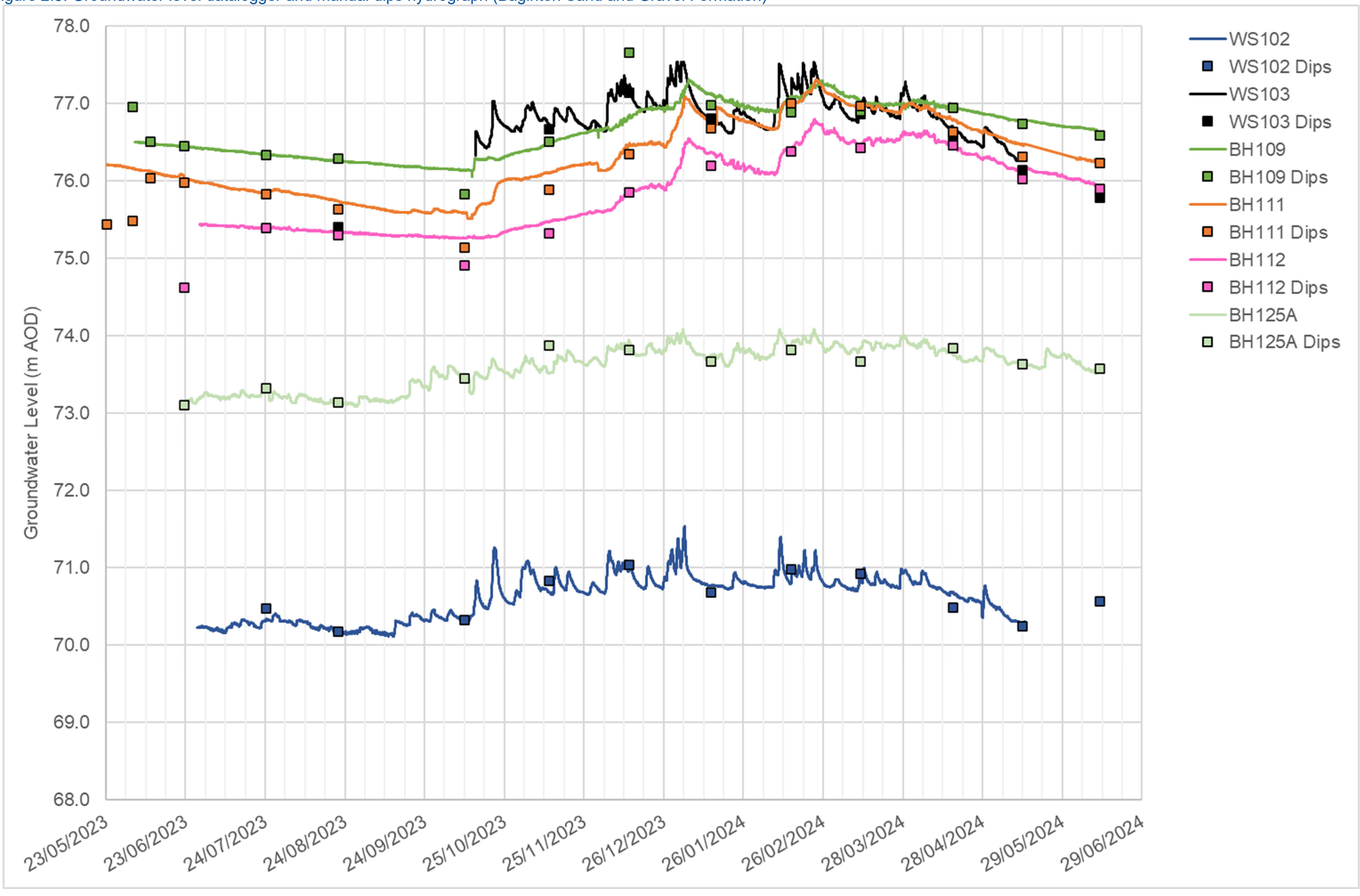


Figure 2.4: Groundwater level datalogger and manual dips hydrograph (Mercia Mudstone Group)

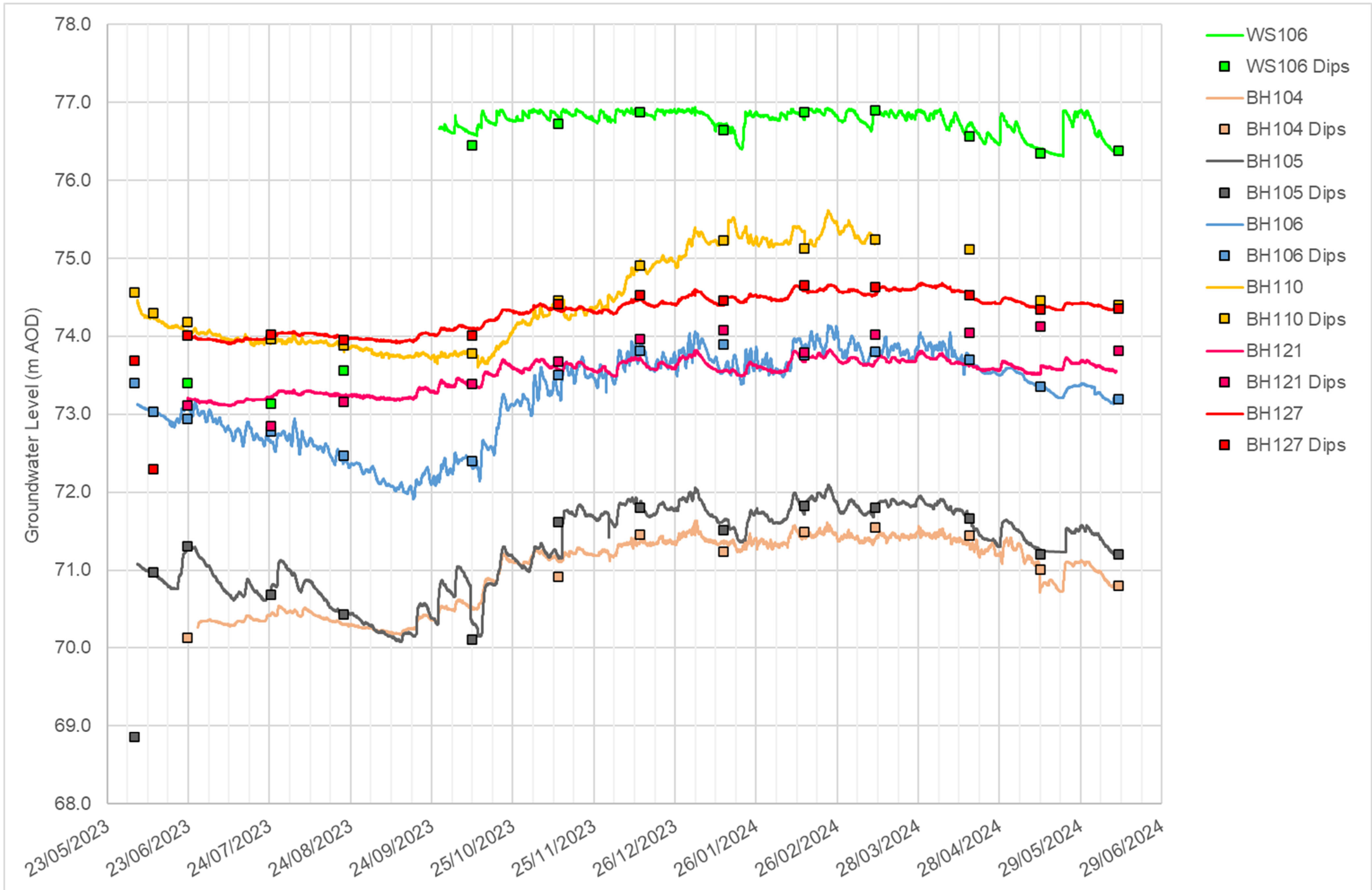
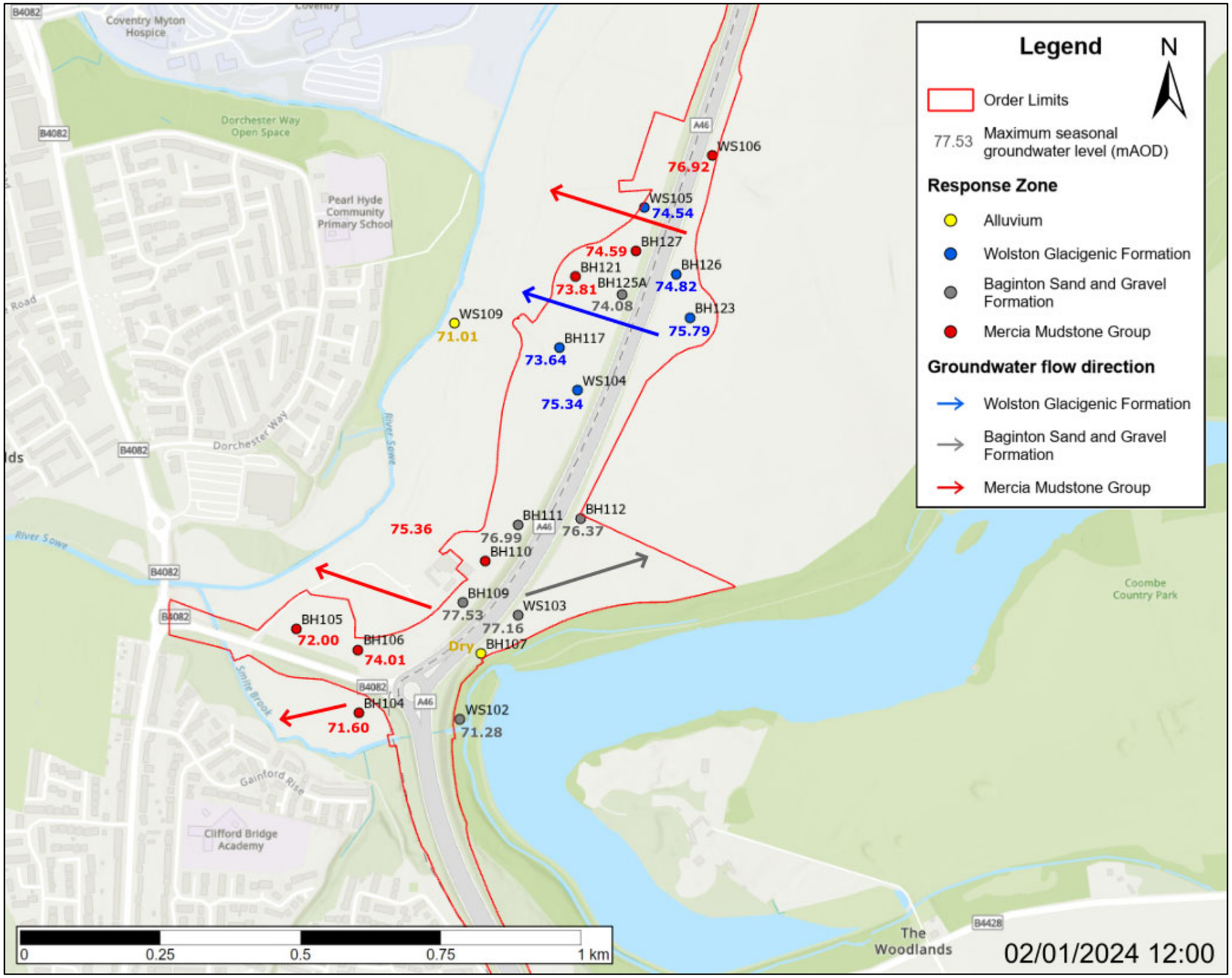


Figure 2.5: Maximum groundwater levels and flow directions (2 January 2024 monitoring data)



Discussion of groundwater level monitoring

2.3.19. Groundwater levels generally follow topographic variation across the study area, with the lowest groundwater levels occurring adjacent to the River Sowe and Smite Brook, suggesting groundwater provides baseflow to the watercourses. Groundwater levels are highest where the Baginton Sand and Gravel Formation is present at surface around Hungerley Hall farm and west of Coombe Pool (WS103, BH109, 111 and 112). It is assumed that there is hydraulic continuity between the alluvium and the Baginton Sand and Gravel Formation, where these are both present. The Mercia Mudstone Group outcrops in the central portion of the Scheme and therefore potentially restricts lateral groundwater flow between superficial aquifers.

2.3.20. Although groundwater level is largely governed by topography there are distinct patterns and anomalies present across the four aquifer units. BH107 and WS109 have a response zone in the alluvium, as presented in Figure 2.1. BH107 is situated to the east of the A46 between Coombe Pool and the road and has been dry since logger installation, this is likely due to the very shallow response zone (0.4 – 2.2mbGL). WS109 has recorded high variance within approximately a 1.8m range in groundwater levels since logger installation. Major peaks occurred around the beginning of December 2023, January 2024, and February 2024 with smaller fluctuations in between. Groundwater level response within the alluvium following a rainfall event is likely a result of its unconfined nature and limited extent, monitoring also began after a period of drought which may have resulted in an abnormally large groundwater level increase.

2.3.21. Figure 2.2 shows that the highest maximum seasonal groundwater levels in the Wolston Glacigenic Formation are recorded in BH123 to the east of the A46, and the lowest at BH117 to the west of the A46, supporting the assumption of flow direction from east to west. Groundwater levels in general are variable within a range of around 1 to 2m for each of WS104, 105, BH117, 123 and 126. Figure 2.2 highlights that groundwater levels are relatively flashy, with a rapid apparent response to rainfall events. This is likely to be indicative of low storage capacity within the Wolston Glacigenic Formation.

2.3.22. Figure 2.3 demonstrates that the Baginton Sand and Gravel Formation has higher maximum seasonal groundwater levels of 76.79 – 77.53mAOD in boreholes where the unit is unconfined (BH109, 111, 112 and WS103) around Hungerley Hall Farm. Values are lowest where the unit is overlain by the Wolston Glacigenic Formation (74.09mAOD in BH125A) and alluvium (71.54mAOD in WS102).

2.3.23. The groundwater high in unconfined superficial deposits around Hungerley Hall Farm is indicative of a recharge area, with discharge likely to Smite Brook and

the River Sowe. Where confined by the overlying Wolston Glaciogenic Formation, groundwater in the Baginton Sand and Gravel Formation appears to be sub-artesian or even artesian during wetter periods. To the north of Smite Brook, the Baginton Sand and Gravel Formation is disconnected from the river, and groundwater flow is to the north-east as shown on Figure 2.5.

2.3.24. A distinct pattern can be seen across boreholes in the unconfined Baginton Sand and Gravel Formation, with a gradual decrease in groundwater level from early June to mid-October 2023 followed by a sharper increase and, in some cases, a peak level in early January 2024. A secondary peak occurs in late February 2024 followed by another gradual decline through to June 2024.

2.3.25. Figure 2.4 shows that maximum seasonal groundwater levels in the Mercia Mudstone Group are varied across the site between 71.63 – 76.94mAOD. Logger data from BH104, 105, 106 and 110 in the southern and central portions of the Scheme highlight significant recharge events that occurred from September 2023 onwards. A rise in groundwater level where confinement is limited in these boreholes may be indicative of increased recharge to the Mercia Mudstone Group around Hungerley Hall Farm. The rapid and flashy response to rainfall events is indicative of low storage capacity within the Mercia Mudstone Group where it is unconfined. At some of the above borehole locations, the Mercia Mudstone Group is only overlain by around 3m of permeable superficial deposits. BH104 and 105 have the lowest groundwater levels (70 -72mAOD) and are adjacent to Smite Brook and the River Sowe respectively. This indicates that the upper most section of the Mercia Mudstone Group is likely to be in hydraulic continuity with the overlying superficial deposits at these locations.

2.3.26. To the north-west of the Scheme, groundwater level variation in the Mercia Mudstone Group at BH121 and 127 is more muted as boreholes are confined by up to 8m of superficial deposits. WS106 has the highest groundwater levels of any boreholes in the Mercia Mudstone Group, it is situated to the north-east of the A46 dual carriageway and is only confined by superficial deposits to around 1.2m, which may have allowed for greater recharge. The data shows that groundwater levels flattened between December 2023 and January 2024, suggesting that WS106 may have been overflowing or flooded, or possibly controlled by existing road drainage such as filter drains.

Surface water and groundwater interactions

2.3.27. The River Sowe is the most notable surface water feature in the study area in terms of governing surface water and groundwater interactions, it flows southwards adjacent to the western edge of the Order Limits before exiting at the south-west boundary. Coombe Pool discharges over a weir to Smite Brook immediately to the east of the Scheme. Smite Brook is culverted under the

existing A46 and flows west before discharging to the River Sowe. Groundwater level monitoring indicates a strong component of baseflow towards the River Sowe (see Figure 2.5).

2.3.28. A water features survey was undertaken in January 2024, and the details of this survey are summarised in Annex C. Some key findings are summarised below.

2.3.29. To the north of the Scheme there are several natural ponds (WF38, 40, 41 and 43) overlying the Wolston Glacigenic Formation, due to the low permeability of this strata, these ponds are not considered to be in hydraulic continuity with groundwater. Similarly, in the south-east there are several old clay pits (WF20 and 21) in the Mercia Mudstone Group which create seasonal ponding on farmland but are not considered to be in continuity with groundwater.

2.3.30. The water features survey identified several wetland communities 1.45km south of the Scheme ranging from open water through swamp and fen to marsh (WF80, 83, 84, 85, 86) and two disused boreholes (WF81 and 87). Manual dip measurements were not carried out due to silt accumulation in the casing and a contamination risk from the nearby Binley Colliery which closed in 1963 (Orriss, 2020). The area is underlain by the Baginton Sand and Gravel Formation and designated as the Herald Way Marsh SSSI / Local Nature Reserve (LNR); this is discussed in further detail in Section 2.6.

Aquifer properties

2.3.31. The alluvium is considered to be semi-permeable within the study area and unconfined, the unit is anticipated to have a hydraulic conductivity range of 10^{-9} – 10^{-3} m/s (Freeze and Cherry, 1979). Permeability in the alluvium is likely variable considering the recorded heterogenous nature of the unit which comprises a combination of sand, silt, gravels and clay.

2.3.32. The Wolston Glacigenic Formation largely comprises low permeability clays and silts, there are sandy and pebbly clay lenses present that may result in variable hydraulic conductivities across the formation with a likely hydraulic conductivity range of around 10^{-12} – 10^{-4} m/s (Freeze and Cherry, 1979).

2.3.33. The Baginton Sand and Gravel Formation is likely to be very permeable and have a high hydraulic conductivity range of 10^{-7} – 10^{-2} m/s (Freeze and Cherry, 1979) depending on local characteristics.

2.3.34. The Mercia Mudstone Group has anticipated hydraulic conductivity range 10^{-7} – 10^{-4} m/s (Freeze and Cherry, 1979). The Mercia Mudstone Group is expected to be relatively impermeable, except towards the top where the strata are likely to be more weathered and fractured.

2.4. Groundwater quality

2.4.1. Groundwater and soil quality sampling was carried out as part of the 2023 ground investigation, risks to groundwater from the Scheme have been assessed through comparing the chemical laboratory data against appropriate generic assessment criteria. Results are presented in the Ground Investigation Report (ES Appendix 9.3 (**TR010066/APP/6.3**)) and summarised in ES Chapter 9 (Geology and Soils) (**TR010066/APP/6.1**). The UK Drinking Water Standards (DWS) and World Health Organisation (WHO) (WHO, 2022) guidelines for drinking water quality have been used for protection of the identified potentially sensitive aquifer receptors. A total of 19 groundwater samples were analysed for suites including metals, inorganics, polycyclic aromatic hydrocarbons and total petroleum hydrocarbons, phenols, volatile organic compounds and semi-volatile organic carbons. Groundwater samples were generally below the assessment criteria. Where concentrations exceeded these criteria (metals, nitrate and sulphate), the exceedances were negligible and therefore do not pose an unacceptable risk to controlled waters.

2.4.2. Table 2.3 provides groundwater sampling results from the 2023 ground investigation and subsequent groundwater quality sampling for key road drainage metal pollutants, including copper, zinc and chloride.

Table 2.3: Summary of baseline groundwater quality results

Location	Sample lithology	Copper (µg/l)	Zinc (µg/l)	Chloride (mg/l)
BH104	Mercia Mudstone Group	1.2	14	22
BH105	Mercia Mudstone Group	3.1	19	41
BH106	Mercia Mudstone Group	3	17	47
BH109	Baginton Sand and Gravel Formation	14	4.9	10
BH110	Mercia Mudstone Group	8.1	6.4	53
BH111	Baginton Sand and Gravel Formation	7.1	18	19
BH112	Baginton Sand and Gravel Formation	16	7.8	19
BH117	Wolston Glacigenic Formation/ Mercia Mudstone Group	3	9.5	13
BH121	Mercia Mudstone Group	6.2	14	22
BH123	Wolston Glacigenic Formation	9	10	44
BH125A	Wolston Glacigenic Formation/ Mercia Mudstone Group	8.5	14	19
BH126	Wolston Glacigenic Formation	11	13	13
BH127	Mercia Mudstone Group	4.7	27	19
WS102	Alluvium	2.8	30	21
WS103	Wolston Glacigenic Formation	16	21	10
WS104	Wolston Glacigenic Formation	6.8	19	35
WS105	Wolston Glacigenic Formation	14	47	39
WS106	Mercia Mudstone Group	9.7	27	34
WS109	Alluvium/ river terrace deposits	6.5	34	6.6

2.4.3. Dissolved copper concentrations in groundwater samples across the site ranged from 1.2 to 16µg/l, dissolved zinc concentrations ranged between 4.9 and 47µg/l, and chloride concentrations ranged between 6.6 and 53 mg/l.

2.4.4. There are no Environment Agency groundwater quality network monitoring points within the study area.

2.5. Groundwater resources

Licensed abstractions

2.5.1. There are no source protection zones (SPZ) within 2km of the Scheme. An SPZ 3 is located approximately 3km west of the Scheme.

2.5.2. A request was made to the Environment Agency (June 2023) for information on licensed abstractions and active discharge consents. There are two licensed groundwater abstractions within 2km of the Scheme. These are used for industrial and commercial purposes as well as mineral and processing options and are listed below in Table 2.4 and presented in ES Figure 13.6 (Groundwater Abstractions and Source Protection Zones) (**TR010066/APP/6.2**).

2.5.3. There is one active licensed abstraction borehole in the Sherwood Sandstone at Bodmin Road Wyken (18/54/11/0141) 850m north-west of the Order Limits, within the 1km study area (ES Figure 13.6 (Groundwater Abstractions and Source Protection Zones) (**TR010066/APP/6.2**)). It is operated by Aluminium Surface Engineering for industrial and commercial purposes and has a pump intake at approximately 63m below ground level. As the Sherwood Sandstone is likely to be hydraulically isolated from the Scheme due to the overlying Mercia Mudstone Group, this abstraction is not considered further in the assessment.

2.5.4. Brinklow Quarry boreholes (MD/054/0010/022) are 2km to the south-east and up-gradient of the Scheme. Therefore, they are not considered further in this assessment.

Table 2.4: Summary of licensed groundwater abstractions

Licensed groundwater abstraction location	Abstraction Type Licence number	Grid Ref.	Location	Geology	Use	Max annual abstracted quantity (m^3/yr)	Max daily abstracted quantity (m^3/d)
Bodmin Road, Wyken, Coventry – Aluminium Surface Engineering	Borehole 18/54/11/0141	437521 280317	853m north-west of Scheme	Sherwood Sandstone Group	Industrial and commercial purposes	30000	100
Brinklow Quarry	Boreholes MD/054/0010/022	Area between: 440650 279329 440554 278596 442433 278053 442682 278958	1.96km east of the Scheme	Mercia Mudstone Group	Mineral extraction and processing options, abstraction, and transfer licence but no off-site dewatering	-	-

2.5.5. Requests were submitted to Coventry City Council and Warwickshire County Council in February 2024 for details of unlicensed abstractions. Both local authorities responded that this information was not available. No unlicensed abstractions were identified during the water features survey.

Consented discharges

2.5.6. There are no known consented discharges to groundwater within a 2km study area of the Scheme, as shown in ES Figure 13.6 (Groundwater Abstractions, Discharges, and Source Protection Zones) (**TR010066/APP/6.2**).

2.5.7. Requests were submitted to Coventry City Council and Warwickshire County Council in February 2024 for details of private active discharge consents to groundwater within the study area. Both local authorities responded that this information was not available. No private discharge locations were identified during the water features survey.

2.6. Designations

Water Framework Directive

2.6.1. The study area is located within the Warwickshire Avon – Secondary Mudrocks groundwater body (WBID GB40902G990900) and is part of the Avon Warwickshire - Secondary Mudrocks Operational Catchment. Outcropping just within the 1km study area to the north-west of the Scheme is the Warwickshire Avon - PT Sandstone Warwick/Avon Confined Water Body (GB40901G300700). Details of the WFD groundwater bodies are summarised below in Table 2.5.

Table 2.5: WFD groundwater body catchments within the study area

WFD Groundwater body	Description/quality	
WFD Groundwater body name	Warwickshire Avon - PT Sandstone Warwick/Avon Confined	Warwickshire Avon – Secondary Mudrocks
Water body ID	GB40901G300700	GB40902G990900
Operational Catchment	Avon Warwickshire - Permo-Triassic Sandstone Warwick and Avon Confined Operational Catchment	Avon Warwickshire - Secondary Mudrocks Operational Catchment
Management Catchment	Severn England GW Management Catchment	Severn England GW Management Catchment
River Basin District	Severn	Severn
Type	Groundwater Body	Groundwater Body
Overall Classification (Cycle 3 – 2019)	Poor	Good
Current Quantitative Quality (Cycle 3 – 2019)	Poor	Good

WFD Groundwater body	Description/quality	
Quantitative Objective	Poor (by 2015; disproportionately expensive)	Good (by 2015)
Current Chemical Quality (Cycle 3 – 2019)	Good	Good
Chemical Objective	Good (by 2015)	Good (by 2015)
Protected Area	Nitrates Directive and Drinking Water Protected Area	Nitrates Directive and Drinking Water Protected Area

2.6.2. The Warwickshire Avon – Secondary Mudrocks groundwater body has 'Good' Chemical and Quantitative status (2019 cycle 3). The objective is to maintain 'Good' Quantitative status. There are no "Reasons for not achieving good" (RNAG) listed.

2.6.3. The Warwickshire Avon - PT Sandstone Warwick/Avon Confined groundwater body has 'Good' Chemical and 'Poor' Quantitative status (2019 cycle 3), the reason stated is - 'Disproportionately expensive: Unfavourable balance of costs and benefits.' The objective is to achieve 'Good' Quantitative status. There are no "Reasons for not achieving good" (RNAG) listed.

2.6.4. The Warwickshire Avon – PT Sandstone Warwick/Avon Confined groundwater body is overlain by a significant thickness of the low permeability Mercia Mudstone Group within the Order Limits and much of the study area, only outcropping west of the River Sowe. As it is considered unlikely that there is any measurable hydraulic connection between groundwater underlying the Scheme and this groundwater body, it is scoped out of further assessment.

Designated Sites

2.6.5. Designated sites within the study area, which are potentially hydraulically linked to the Scheme are considered in this assessment. These are shown in ES Figure 13.4 (Aquifer and Environmental Designations) (**TR010066/APP/6.2**).

2.6.6. There are no Ramsar, Special Areas of Conservation (SAC), Special Protected Areas (SPA), or National Nature Reserves (NNR).

SSSIs

2.6.7. There are two SSSIs within 2km of the Scheme.

2.6.8. Coombe Pool SSSI is designated for its ornithological importance. Coombe Pool itself is considered to be hydraulically isolated from groundwater.

2.6.9. Herald Way Marsh SSSI is located approximately 1.6km south south-west of the Scheme and designated for its range of wetland habitats and assemblages of invertebrates. It is likely to be in hydraulic continuity with the superficial aquifers and is therefore considered as a GWDTE in this assessment.

LNRS

2.6.10. There are two LNRs within 2km of the Scheme.

2.6.11. Stoke Floods LNR is 650m south-west of the Scheme and designated for its large lake supporting wetland plants and migrating birds. Stoke Floods LNR is located on the western banks of the River Sowe and is therefore not directly downgradient of the Scheme.

2.6.12. Herald Way Marsh LNR is 1.45km south-west of the Scheme, the extents of which correlate with the Herald Way Marsh SSSI.

Priority Habitats

2.6.13. A review of MAGIC mapping (DEFRA, 2024) identified the following priority habitats potentially dependent on groundwater within 500m of the proposed scheme:

- Coastal and floodplain grazing marsh within approximately 50m of the Scheme on the western banks of the River Sowe.
- Lowland fen approximately 650m and 1.6km to the south-west of the Scheme (Stoke Floods LNR and Herald Way Marsh SSSI / LNR respectively). Stoke Floods LNR is located on the western banks of the River Sowe, whereas Herald Way Marsh SSSI / LNR is some distance from the river and appears to be dependent on groundwater.

2.7. Groundwater flooding

2.7.1. As groundwater levels within the study area can be at or close to surface, the Scheme has the potential for groundwater flooding to occur. Both Warwickshire County Council (Warwickshire County Council. 2023) and Coventry City Council (Coventry City Council, 2015) Strategic Flood Risk Assessments (SFRAs) were taken into consideration during analysis of the baseline flood risk from groundwater as outlined in ES Appendix 13.1 (Flood Risk Assessment) (**TR010066/APP/6.3**). The SFRAs indicate that the susceptibility to groundwater flooding is between 25% and 75%.

2.7.2. The British Geological Survey's susceptibility to groundwater flooding map is shown in ES Figure 13.7 (Susceptibility to Groundwater Flooding) (**TR010066/APP/6.2**) (BGS, 2023). This indicates that much of the Scheme either has the potential for groundwater flooding to occur at surface or the potential for groundwater flooding of property situated below ground level. Within

the study area, permeable superficial deposits associated with the River Sowe and Smite Brook have potential to cause groundwater flooding to occur at surface, including where Smite Brook crosses the Scheme.

2.7.3. The Groundsure report within Appendix C of the Preliminary Sources Study Report (National Highways, 2021a) indicates no reported incidents of groundwater flooding within the Order Limits at the time the report was prepared (September 2020).

2.8. Climate change

2.8.1. Climate change projections (Environmental Agency, 2019) suggest that the future annual recharge volumes for groundwater are broadly stable, although the groundwater recharge season is likely to be shorter and more intense, leading to more variable groundwater levels and a greater drought vulnerability.

2.9. Groundwater levels and flows assessment

2.9.1. This section provides a summary of findings, in the form of a conceptual hydrogeological model, and highlights receptors and uncertainties relating to the datasets considered. This forms the basis of the Groundwater Levels and Flows assessment as required by DMRB LA 113.

Hydrogeological conceptual model

2.9.2. The main aquifer units in the study area are the alluvium and river terrace deposits, which are present along the route of the River Sowe and Smite Brook, and the Baginton Sand and Gravel Formation which is present across the central and southern portion of the Scheme. Both these units are considered Secondary A aquifers. The Wolston Glacigenic Formation partially confines the Baginton Sand and Gravel Formation towards the north of the Scheme and is largely comprised of cohesive material. Groundwater in the Wolston Glacigenic Formation may be present in limited quantities. Where the Baginton Sand and Gravel Formation is unconfined, around the Hungerley Hall Farm area, direct recharge occurs to the aquifer. Alluvium directly overlies the Baginton Sands and Gravels at the southern extents of the Scheme and adjacent to Smite Brook culvert (BH103 and WS102). Both units are also found at the north-western extents of the Scheme (WS107) adjacent to unlined drainage ditches as discussed in Table 4.2 of Section 4: Risk assessment.

2.9.3. The study area is primarily underlain by the Mercia Mudstone Group, a Secondary B aquifer, which makes up the Warwickshire Avon – Secondary Mudrocks WFD groundwater body (GB40902G990900). The Mercia Mudstone Group outcrops or has a limited thickness of overlying permeable superficial deposits in the southern and central portions of the Scheme, and in particular around Hungerley Hall Farm. In this area, rainfall recharge occurs, although

groundwater levels are relatively flashy highlighting the limited storage capacity within the Mercia Mudstone Group. Further north, where the Mercia Mudstone Group is overlain by the Wolston Glacigenic Formation, groundwater levels show a typical confined response.

2.9.4. The Helsby Sandstone Formation is the Principal aquifer in the region and makes up the Warwickshire Avon – PT Sandstone Warwick/Avon Confined WFD groundwater body (GB40901G300700). It underlies the entire site but is hydraulically isolated from the superficial aquifers by the Mercia Mudstone Group at depths of roughly 50m. Although the Helsby Sandstone Formation also outcrops within 1km of the Order Limits, it is isolated from the Scheme by the Mercia Mudstone Group.

2.9.5. Groundwater levels and flow directions are largely driven by topography and converge on the River Sowe and Smite Brook to the west of the Scheme, though at site-scale, hydraulic gradients are likely to be more complex. Figure 2.5 shows likely groundwater flow directions based on maximum groundwater levels during the monitoring period (2 January 2024).

2.9.6. There are two active licensed abstraction boreholes in the Study Area. One abstracts from the Sherwood Sandstone Group, which is likely to be hydraulically isolated from the Scheme. The second abstraction is 2km from, and up hydraulic gradient of the Scheme. These abstractions are not considered further in the assessment.

2.9.7. There is one GWDTE within the study area, Herald Way Marsh SSSI /LNR, which is located approximately 2km south of the Scheme. The GWDTE is underlain by the Baginton Sand and Gravel Formation and therefore a hydraulic pathway between the Scheme and the SSSI exists.

Receptors

2.9.8. The main direct groundwater receptors within the study area are as follows:

- Superficial Secondary aquifers (alluvium, river terrace deposits and Baginton Sand and Gravel Formation)
- Mercia Mudstone Group Secondary B aquifer. This also forms the Warwickshire Avon – Secondary Mudrocks (WBID GB40902G990900) groundwater body

2.9.9. The main indirect groundwater receptors within the study area are the:

- River Sowe and Smite Brook
- Herald Way Marsh SSSI/ LNR, identified as a GWDTE

2.9.10. The Helsby Sandstone Formation is not considered to be a direct or indirect receptor, due to the significant thickness of the low permeability Mercia Mudstone Group overlying the Helsby Sandstone Formation.

3. Potential impacts

3.1.1. The key activities and intrusive structures that may have an impact on groundwater as part of the Scheme are as follows:

- Satellite site compound
- S01 – Walsgrave Overbridge – reinforced soil wall foundations
- S02 – VMS Gantry No 35 – piled foundations
- Cuttings associated with B4082 link road
- Earthworks associated with the southern detention basin, and the central and northern ponds.

3.1.2. At present, there are no utility diversions required throughout the Scheme as discussed in Section 2 of this report; any protection works will be coordinated with the relevant utility companies at the detailed design stage.

3.1.3. The proposed drainage design includes road drainage in the form of two unlined drainage ditches in the north-west of the Scheme, specifically catchments 5 and 6. It also includes existing and proposed filter drains in catchments 2 to 6, with proposed drains receiving road drainage in catchment 1 planned to be lined. Annex A Location Plan 2 shows drainage features both inside and outside the Order Limits and maximum seasonal groundwater levels.

3.1.4. Annex D shows catchment plan sheets 1 to 3 with the spatial extents of each catchment (1 through to 6).

3.1.5. Groundwater levels have been reviewed in areas around excavation activities to assess whether dewatering may be required. A preliminary assessment of potential dewatering requirements is presented in Annex E.

3.1.6. A simple hydrogeological assessment of the construction and operational activities relating to these structures is presented in Table 3.1 and Table 3.2. This is based on a source – pathway – receptor approach of identifying whether there is a pathway between specific construction, or operational activities associated with the Scheme, and receptors identified in Section 2.9: Groundwater levels and flows assessment.

Table 3.1: Summary of hydrogeological impacts to identified receptors from potential activities during construction of the Scheme

Activity	General Description of Potential Impact	Structure	Direct Receptor	Indirect receptor	Site specific potential impact	Potential impact
Construction						
Drainage from construction areas, including site compounds	Potential contamination of groundwater from surface water drainage contaminated by construction materials, where topsoil is removed. Where the existing road is to be upgraded, there may also need to be demolition of road infrastructure, planing of surfaces and removal of existing drainage. Accidental spillages / leakage of construction materials including refuelling activities in such areas may result in contamination of groundwater. Runoff from stockpiles may also result in contamination of groundwater.	General and site compounds	Baginton Sand and Gravel Formation and Mercia Mudstone Group	River Sowe and Smite Brook Herald Way Marsh SSSI	Where construction areas overly permeable strata such as the Baginton Sand and Gravel Formation there is a risk of groundwater contamination. The main compound on Brinklow Road is a pre-existing structure and presents no further construction impacts. A temporary satellite compound is planned to the north-west of the Scheme atop the Wolston Glacigenic Formation. Construction of the compound area will include removal and compaction of topsoil and placement/ compaction of engineering fill to create the temporary surface. Segregated waste skips will also be stored within each compound and emptied as required. BH127 nearby shows the Baginton Sand and Gravel Formation at 4.2 – 6.9mbGL and Mercia Mudstone Group at	Yes (no additional impact from compound areas)

Activity	General Description of Potential Impact	Structure	Direct Receptor	Indirect receptor	Site specific potential impact	Potential impact
Construction						
					>6.9mbGL, both significantly lower than the new subbase.	
Drainage from construction areas, including excavations and cuttings	Excavations reduce the thickness of unsaturated zone above the receptor aquifer, thus increasing its vulnerability to groundwater contamination risks because of accidental spillages / leakage	Cuttings that extend below the water table	Superficial aquifers and Mercia Mudstone Group	River Sowe and Smite Brook Herald Way Marsh SSSI	Cuttings in catchments 3 and 4, particularly the B4082 drainage cutting, have medium – high groundwater vulnerability as they are underlain in part by alluvium, river terrace deposits and the Baginton Sand and Gravel Formation. Excavations for the B4082 have the potential to intersect the superficial deposits by 1.3mbGL or more which would increase the vulnerability of underlying aquifers.	Yes
		S01	Baginton Sand and Gravel Formation and Mercia Mudstone Group	River Sowe	The bridge abutments will consist of bankseats on a reinforced soil wall structure. The foundations for the reinforced soil wall structure may require ground treatment in the form of an Excavate and Replace (E&R). Excavations could intersect the Wolston Glacigenic Formation at a depth of 1.5mbGL reducing the unsaturated zone above the Baginton Sand and Gravel Formation, which lies	Yes

Activity	General Description of Potential Impact	Structure	Direct Receptor	Indirect receptor	Site specific potential impact	Potential impact
Construction						
					at 4.6mbGL in BH121 and 3.2mbGL in BH125A nearby. Vulnerability of the Mercia Mudstone Group would also be increased which is ~5mbGL at shallowest.	
		Detention basin in catchment 3	Alluvium, river terrace deposits and Mercia Mudstone Group	River Sowe and Smite Brook	Excavations of 2.5mbGL required for the southern detention basin in catchment 3 have the potential to reduce the unsaturated zone in the alluvium (0.4 – 3.2mbGL at BH105), increasing its vulnerability and that of the Mercia Mudstone Group (>3.2mbGL), particularly given the shallow groundwater levels. Once construction has been completed ponds will be fitted with an impermeable liner.	Yes
		Ponds in catchments 5 and 6	Baginton Sand and Gravel Formation and Mercia Mudstone Group	River Sowe	Excavations of 2.5mbGL required for the ponds in catchments 5 and 6 have the potential to reduce the unsaturated zone in the Wolston Formation (0.4 –	Yes

Activity	General Description of Potential Impact	Structure	Direct Receptor	Indirect receptor	Site specific potential impact	Potential impact
Construction						
					2.75mbGL at WS104) and increase the vulnerability of the Baginton Sand and Gravel Formation (2.75 – 3.4mbGL) and Mercia Mudstone Group (>3.4mbGL) below. Once construction has been completed the ponds will be fitted with an impermeable liner.	
Construction of below-ground structures, including excavations	Groundwater control requirements during any excavation works (including construction of ponds, detention basins, cuttings, service trenches and overbridge) resulting in a reduction in local groundwater levels and therefore a loss of groundwater flow/ resource to nearby receptors	S01	Baginton Sand and Gravel Formation and Mercia Mudstone Group	River Sowe	Ground-bearing foundations are expected to be at a depth of 1.5mbGL in the Wolston Glacigenic Formation and are likely to intercept shallow groundwater but not the Baginton Sand and Gravel Formation, therefore any dewatering required is likely to be small-scale and unlikely to affect recharge to the River Sowe.	No
		Detention basin in catchment 3	Alluvium and river terrace deposits and Mercia Mudstone Group	River Sowe and Smite Brook	Excavations required for the southern detention basin in catchment 3 are likely to intersect a proportion of the alluvium deposits. Temporary dewatering requirements have the potential to cause a reduction in groundwater levels and baseflow from the alluvium and river terrace	Yes

Activity	General Description of Potential Impact	Structure	Direct Receptor	Indirect receptor	Site specific potential impact	Potential impact
Construction						
					deposits to the River Sowe and Smite Brook.	
		Ponds in catchments 5 and 6	Baginton Sand and Gravel Formation and Mercia Mudstone Group	River Sowe	Excavations required for the ponds in catchments 5 and 6 are likely to intersect a proportion of the Wolston Formation and potentially the Baginton Sand and Gravel Formation if over-digging is required. Temporary dewatering requirements have the potential to cause a reduction in groundwater levels and baseflow from the Baginton Sand and Gravel Formation to the River Sowe.	Yes
		B4082 drainage cutting	Baginton Sand and Gravel Formation and Mercia Mudstone Group	River Sowe and Smite Brook	The maximum depth of excavations at B4082 is expected to be approximately 1.3mbGL into the Baginton Sand and Gravel Formation. The highest seasonal groundwater level at BH111 nearest to the deepest section of the cutting is 1.24mbGL. Note that this borehole does not necessarily reflect ground and groundwater conditions across the entire cutting. Small scale temporary dewatering may be required,	Yes

Activity	General Description of Potential Impact	Structure	Direct Receptor	Indirect receptor	Site specific potential impact	Potential impact
Construction						
					depending on timing of construction activities and site specific ground conditions across the cutting.	
	Potential for contamination of groundwater through direct contact with contaminated construction materials and/or generation of turbidity where groundwater is likely to be intercepted by excavations	S01	Baginton Sand and Gravel Formation and Mercia Mudstone Group	River Sowe	An E&R scheme may require below ground works of 1.5mbGL depth which could intercept groundwater in the Wolston Glacigenic Formation, causing a potential for direct contact with contaminated construction materials, though it is possible that that this unit is not in hydraulic continuity with the Baginton Sand and Gravel Formation and Mercia Mudstone Group below.	Yes
		Detention basin in catchment 3	Alluvium, river terrace deposits and Mercia Mudstone Group	River Sowe and Smite Brook	Excavations required for the southern detention basin in catchment 3 are likely to intercept shallow groundwater in the alluvium, with a potential for direct contact with contaminated materials, and contaminant transport via baseflow towards the River Sowe and Smite Brook.	Yes

Activity	General Description of Potential Impact	Structure	Direct Receptor	Indirect receptor	Site specific potential impact	Potential impact
Construction						
		Ponds in catchment 5 and 6	Baginton Sand and Gravel Formation and Mercia Mudstone Group	River Sowe	Excavations required for the ponds in catchments 5 and 6 are likely to intercept shallow groundwater in the Wolston Glacigenic Formation, with a potential for direct contact with contaminated materials, infiltration into the Baginton Sand and Gravel Formation and baseflow towards the River Sowe.	Yes
	Construction dewatering discharges may contain suspended solids and may therefore result in contamination of receiving waterbody	S01, detention basin in catchment 3, ponds in catchments 5 and 6 and drainage cut on B4082	Superficial deposits and Mercia Mudstone Group	River Sowe, Smite Brook and Herald Way Marsh SSSI	Discharge direct to ground via infiltration galleries or into the River Sowe and Smite Brook may be required. Dewatering discharges have the potential to contaminate groundwater due to suspended solids. Note that any small-scale dewatering is likely to be tankered off site.	Yes
Piled foundations that extend below the water table	Potential for contamination of groundwater through smearing of contaminants from surface / creation of pathway for migration of groundwater between different aquifer units / direct contact with construction materials, generation of turbidity etc	S02	Superficial aquifers and Mercia Mudstone Group	River Sowe	Piles associated with the gantry are to a planned depth of 5.5mbGL (67.655mAOD) and may intercept the Wolston Glacigenic Formation, Baginton Sand and Gravel Formation and Mercia Mudstone Group below. There is a subsequent potential for vertical flow	Yes

Activity	General Description of Potential Impact	Structure	Direct Receptor	Indirect receptor	Site specific potential impact	Potential impact
Construction						
					pathway creation between aquifer units.	
Placement of below ground structures that extend below the water table (i.e. piles, sheet piling, lined drainage ponds) during construction	Redirection of flows around underground structures. Groundwater mounding may occur, resulting potential groundwater flooding risks and a reduction in groundwater flows immediately down-gradient.	S01	Baginton Sand and Gravel Formation and Mercia Mudstone Group	River Sowe	Ground-bearing foundations required for abutments are expected to be largely within the unsaturated zone and do not fully intercept the Baginton Sand and Gravel Formation, thus allowing for groundwater movement around the abutments.	No
		S02	Baginton Sand and Gravel Formation and Mercia Mudstone Group	River Sowe and Smite Brook	Gantry piles have the potential to fully penetrate the Baginton Sand and Gravel Formation but do not create a continuous vertical barrier, and groundwater is likely to flow around the piles. Therefore, the zone of influence is likely to be minimal.	No
		Detention basin in catchment 3, ponds in catchments 5 and 6	Superficial deposits and Mercia Mudstone Group	River Sowe and Smite Brook	Both the detention basin in catchment 3 and ponds in catchments 5 and 6 will be fitted with an impermeable liner due to high groundwater. Maximum seasonal groundwater levels in the detention basin in catchment 3 are 0.66mbGL (BH105) and 0.20mbGL (WS104) in the pond in	Yes

Activity	General Description of Potential Impact	Structure	Direct Receptor	Indirect receptor	Site specific potential impact	Potential impact
Construction						
					catchment 6 suggesting groundwater is likely to rise above the base of the impermeable liners (2.5mbGL) for a large proportion of the year.	
All activities	Potential for contamination of groundwater through creation of pathways between potentially contaminated ground & underlying aquifers	All structures	Superficial deposits and Mercia Mudstone Group	River Sowe, Smite Brook and Herald Way Marsh SSSI	No piles, excavations or cuttings intercept contaminated land or groundwater. However, diversion of flow pathways may result in redirection of existing contamination plumes.	Yes
Alteration of ground profiles, for example embankments, and creation of additional hardstanding areas, for example for access roads and construction compounds during the construction period.	Additional hardstanding reduces potential area of effective recharge to aquifers and may reduce groundwater flow to receptors.	New road layout	Superficial deposits and Mercia Mudstone Group	River Sowe and Smite Brook	Within the area where superficial deposits outcrop there is a increase in impermeable area in relation to the extents of the outcrops, however, existing road drainage currently discharges to surface waterbodies.	Yes

Table 3.2: Summary of hydrogeological impacts to identified receptors from potential activities during operation of the Scheme

Activity	General Description of Potential Impact	Structure	Direct Receptor	Indirect receptor	Site specific potential impact	Potential impact
Operation						
Routine road drainage	Routine road drainage may result in contamination of receiving aquifer	Existing and proposed filter drains in catchments 2 to 6	Superficial deposits and Mercia Mudstone Group	River Sowe and Smite Brook	Existing road drainage currently discharges to surface waterbodies; whilst the final outfall points are still the River Sowe and Smite Brook, additional proposed filter drains have the potential to allow road drainage to reach receiving aquifers across the site and impact water quality. An assessment of risk has been calculated in Section 4.2 Groundwater quality and routine runoff assessment.	Yes
		Unlined drainage ditches in catchments 5 and 6	Superficial deposits and Mercia Mudstone Group	River Sowe	Existing road drainage currently discharges to surface waterbodies; the new proposed routes via two existing unlined ditches still have final outfall points at the River Sowe, though there is the potential for infiltration thought the ditches into alluvium deposits and other permeable horizons <100m from the river. An assessment of risk has been calculated in the Section 4.2 Groundwater quality and routine runoff assessment.	Yes
	Accidental spillages collected by road drainage may result in contamination of receiving aquifer	Existing and proposed filter drains in	Superficial deposits and Mercia Mudstone Group	River Sowe and Smite Brook	Spillage assessments, undertaken as part of ES Appendix 13.3 (Water Quality Assessment) (**TR010066/APP/6.3**), show the risk	No

Activity	General Description of Potential Impact	Structure	Direct Receptor	Indirect receptor	Site specific potential impact	Potential impact
Operation						
		catchments 2 to 6 and unlined drainage ditches in catchments 5 and 6			of impact from spillage pass the assessment.	
Permenant alteration of ground profiles, for example embankments, and creation of additional hardstanding areas, for example for access roads.	Additional hardstanding reduces potential area of effective recharge to aquifers and may reduce groundwater flow to receptors.	New road layout	Superficial deposits and Mercia Mudstone Group	River Sowe and Smite Brook	Within the area where superficial deposits outcrop there is an increase in impermeable area in relation to the extents of the outcrops, however, existing road drainage currently discharges to surface waterbodies.	Yes
Permanent subsurface drainage of cuttings	Permanent drainage for cuttings may result in a local reduction in groundwater levels, and therefore local redirection of groundwater flows	S01 and drainage cut at B4082	Superficial deposits and Mercia Mudstone Group	River Sowe and Smite Brook	Shallow groundwater within the Baginton Sand and Gravel Formation may be intercepted depending on time of year.	Yes
Permanent placement of below-ground structures, i.e. piles, abutments	Redirection of flows around permanent underground structures. Groundwater mounding may occur, resulting in potential groundwater	S01	Baginton Sand and Gravel Formation and Mercia Mudstone Group	River Sowe	Abutments have the potential to create a barrier to groundwater flow, as well as cause groundwater mounding, though foundations are expected to be largely within the unsaturated zone and do not fully intercept the Baginton Formation,	No

Activity	General Description of Potential Impact	Structure	Direct Receptor	Indirect receptor	Site specific potential impact	Potential impact
Operation						
and drainage basins	flooding risks and a reduction in groundwater flows immediately down-gradient of overbridge and gantry.				thus allowing for groundwater movement around the abutments.	
		S02	Baginton Sand and Gravel Formation and Mercia Mudstone Group	River Sowe and Smite Brook	Gantry piles have the potential to fully penetrate the Baginton Sand and Gravel Formation but do not create a continuous vertical barrier, and groundwater is likely to flow around the piles. Therefore, the zone of influence is likely to be minimal. There are also currently no utilities diversions.	No
		Detention basin in catchment 3, ponds in catchments 5 and 6	Superficial deposits and Mercia Mudstone Group	River Sowe and Smite Brook	Both the detention basin in catchment 3 and ponds in catchment 5 and 6 will be fitted with an impermeable liner due to high groundwater levels. Maximum seasonal groundwater levels in the detention basin in catchment 3 are 0.81mbGL (BH105) and 0.17mbGL (WS104) in the pond in catchment 6 suggesting groundwater is likely to rise above the base of the impermeable liners (2.5mbGL) for a large proportion of the year.	Yes

4. Risk assessment

4.1. Introduction

4.1.1. Infiltration to ground has been included in the drainage design. Groundwater quality and routine runoff assessments have been completed for filter drains across the Scheme. These assessments are discussed in Section 4.2.

4.1.2. GWDTEs have been identified as receptors to construction and operation activities. These are therefore considered further in Section 4.3.

4.2. Groundwater quality and routine runoff assessment

Simple assessment

4.2.1. Groundwater quality and routine runoff assessments for road drainage were completed to assess the risk of impact upon groundwater quality from unlined road drainage. The assessment is based on the 'source-pathway-receptor' model, as per Appendix C of DMRB LA 113.

4.2.2. Combined filter drains are proposed in catchments 2 to 6 across the Scheme and are all likely to receive road drainage directly. The drainage design is subject to change based on further consultation with the Environment Agency at the detailed design stage.

4.2.3. Carrier drains in catchment 1 have been designed with an impermeable liner in accordance with DMRB LA 113 guidance. This is due to the presence of a nearby landfill site and the underlying Baginton Sand and Gravel Formation which may be in hydraulic continuity with Herald Way Marsh GWDTE in this area (see Section 4.3).

4.2.4. Unlined drainage ditches in catchments 5 and 6 will also likely receive direct road drainage with upstream treatment in the form of filter drains and ponds in catchments 5 and 6.

4.2.5. Input parameters were derived from ground investigation data and publicly available information. These are in line with the conceptualisation outlined in Section 2 and are summarised below in Table 4.1 with catchments 2 to 6 combined for filter drain inputs and catchment 5 (north of the proposed dumbbell junction) and catchment 6 (area west of the proposed dumbbell junction) separated for unlined drainage ditch inputs.

4.2.6. Four boreholes were selected to represent underlying conditions for both catchments 5 and 6. Soil samples from BH125A, WS105 and 109 were used to determine clay content and background values for total organic carbon and pH

within the unsaturated zone in catchment 5, whilst BH117, 125A and WS109 were used for catchment 6.

4.2.7. BH125A and WS109 are included in both assessments to represent response zones in both the Baginton Sand and Gravel Formation and alluvium beneath the ditches close to the River Sowe. WS105 and BH117 both have response zones in the Wolston Glacigenic Formation nearer to the A46 dual carriageway. For filter drains in catchments 2 to 6 all available borehole samples were utilised to provide a site-wide average.

4.2.8. The Highways England water risk assessment tool (HEWRAT) assessments for filter drains in catchments 2 to 6 and unlined drainage ditches in catchments 5 and 6 produced a medium risk result, and as a result a detailed hydrogeological assessment is required.

Table 4.1: Summary of HEWRAT risk assessment input parameters

Input parameter	Detail
Traffic flow	AADT traffic flow selected for individual road to be serviced by filter drains (>50,000 to <100,000 AADT).
Rainfall depth (annual averages)	Average based on warm/dry climatic region from nearest UK HEWRAT rainfall monitoring site at Birmingham (<740 to >1060mm).
Drainage area ratio	Determined as 'drainage area of road'/'active surface area of infiltration device', where the surface area is that part of the device through which most downward discharge will occur. Filter drains assumed to be 1.2m deep and 0.3m wide (<=50).
Infiltration method	"Continuous", shallow linear (e.g. unlined ditch, swale, grassed channel) – selected to reflect overall dimensions of filter drains.
Unsaturated zone	Taken using maximum seasonal groundwater levels in monitoring boreholes across the Scheme (<=5m).
Flow type	"Dominantly intergranular" (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)" selected to represent the variability within the different superficial deposits.
Unsaturated zone clay content	Particle size distribution results were available for a number of ground investigation borehole samples across the site. Boreholes generally yielded results ranging from 20 to 40% clay content (ES Appendix 9.3 (Ground Investigation Report) (**TR010066/APP/6.3**)) (>=15% clay minerals).
Organic carbon	Soil organic matter results from ground investigation borehole samples at depths representative of unsaturated zone are between 0.1 to 2.3% across the Scheme but generally <1% for all catchments (<=1% TOC).
Unsaturated zone soil pH	pH results from ground investigation borehole samples in the area at depths representative of the unsaturated zone range between 4.5 to 9.5 but predominantly sit within a range of 6.5 to 8.5 for all catchments (pH <8 to >5).

Detailed assessment

4.2.9. The detailed hydrogeological assessment has been completed in line with guidance provided at www.susdrain.org, and specifically the SuDS Manual (CIRIA C753) and should be agreed with National Highways and the Environment Agency. It considers the baseline ground and groundwater conditions and environmental sensitivity of the receiving waterbodies, as well as the baseline and road runoff water quality. Table 4.2 sets out the hydrogeological baseline for medium risk catchments, this will form part of a consultation with the National Highways and the Environment Agency at detailed design to make any necessary amendments to the drainage design.

4.2.10. In addition, details of the road drainage design have been provided below, with particular reference to treatment prior to the point of discharge and its efficacy. ES Appendix 13.3 (Water Quality Assessment) (**TR010066/APP/6.3**) has been undertaken for the final outfall receptor, the River Sowe. This is based on the HEWRAT for surface water.

Baseline hydrogeological conditions

4.2.11. Baseline conditions are summarised for each medium risk catchment in Table 4.2 and are based on details presented in Section 2 of this report.

Table 4.2: Hydrogeological baseline conditions of medium risk catchments

Feature	Catchments	Geology	Infiltration capacity	Groundwater levels	Baseline groundwater quality	Environmental receptors
Filter drains	2 to 6	Varied geology with areas of permeable superficial deposits, including alluvium, river terrace deposits and the Baginton Sand and Gravel Formation, outcropping at the surface.	Potentially high infiltration capacity across all catchments within the Scheme, particularly catchment 4 where filter drains directly pass through the Baginton Sand and Gravel Formation at surface. Elsewhere, in areas where this unit is at shallow depth or where alluvium and river terrace deposits outcrop, infiltration capacity is also high but will largely constitute as baseflow to the River Sowe and Smite Brook.	Maximum seasonal groundwater levels across the Scheme are between 3.75 mbGL to 0.20maGL.	Across all boreholes, dissolved copper concentrations ranged between 1.2 and 16µg/l, dissolved zinc ranged between 4.9 and 47µg/l and chloride ranged between 6.6 and 53µg/l.	Alluvium and river terrace deposits – Secondary A (receiving aquifers) Baginton Sand and Gravel Formation – Secondary A (receiving aquifer) Mercia Mudstone Group – Secondary B (receiving aquifer) River Sowe Smite Brook
Unlined drainage ditches	5	At BH125A, Wolston Glacigenic Formation is 0 to ≥3.90mbGL at WS105 and 0.50 to 3.20mbGL. Baginton Sand and Gravel Formation is 3.20 to 8mbGL and	Wolston Glacigenic Formation and Mercia Mudstone Group are relatively impermeable due to high clay content, though Weathered Grade IVa material is gravellier. Alluvium, river terrace deposits and the Baginton Sand and Gravel Formation	Nearest groundwater monitoring location to unlined ditch is WS105 in the Wolston Glacigenic Formation. An estimated maximum seasonal groundwater level of 0.15mbgl (74.71mAOD) can be assumed from WS105.	In nearest boreholes, dissolved copper concentrations ranged between 4.7 and 14µg/l, dissolved zinc ranged between 27 and 47µg/l and chloride ranged between 6.6 and 39mg/l.	Alluvium and river terrace deposits – Secondary A (receiving aquifers) Baginton Sand and Gravel Formation – Secondary A (receiving aquifer)

Feature	Catchments	Geology	Infiltration capacity	Groundwater levels	Baseline groundwater quality	Environmental receptors
		Weathered Mercia Mudstone Group is 8 to ≥25mbGL. Alluvium is 0 to 2.60mbGL and river terrace deposits 2.60 to ≥3mbGL at WS109.	have higher permeability due to sand and gravel content. Infiltration is primarily expected to be into the Wolston Glacigenic Formation, although due to this being thin in this location, infiltration to the Baginton Sand and Gravel Formation is expected. Infiltration into the alluvium is also likely to the west of the Order Limits near the River Sowe but will largely constitute as baseflow.	Nearest groundwater level in the Baginton Sand and Gravel Formation is BH125A, with an estimated maximum of 0.49mbGL (74.09mAOD). Groundwater is likely flowing towards the River Sowe and WS109 at 0.10maGL (71.29mAOD).		Mercia Mudstone Group – Secondary B (receiving aquifer) River Sowe
Unlined drainage ditches	6	At BH117, Wolston Glacigenic Formation is 1.70 to 8mbGL, Baginton Sand and Gravel Formation is 8 to 9mbGL and Weathered Mercia Mudstone Group is 9 to ≥15.5mbGL. At BH125A, Wolston Glacigenic Formation is 0.50 to 3.20mbGL, Baginton Sand and	Wolston Glacigenic Formation and Mercia Mudstone Group expected to be relatively impermeable due to high clay content, though Weathered Grade IVa material is gravellier. Alluvium, river terrace deposits and the Baginton Sand and Gravel Formation higher permeability due to sand and gravel content. Infiltration is primarily expected to be into the	Nearest groundwater monitoring location to the unlined ditch is BH117 in the Wolston Glacigenic Formation to the north-west of the Scheme. An estimated maximum seasonal groundwater level of 0.31mbgl (73.76mAOD) can be assumed from BH117. Nearest groundwater level in the Baginton Sand and Gravel Formation is BH125A, with an	In nearest boreholes, dissolved copper concentrations ranged between 3 and 6.5µg/l, dissolved zinc ranged between 9.5 and 34µg/l and chloride ranged between 6.6 and 19mg/l.	Alluvium and river terrace deposits – Secondary A (receiving aquifers) Baginton Sand and Gravel Formation – Secondary A (receiving aquifer) Mercia Mudstone Group – Secondary B (receiving aquifer) River Sowe

Feature	Catchments	Geology	Infiltration capacity	Groundwater levels	Baseline groundwater quality	Environmental receptors
		Gravel Formation is 3.20 to 8mbGL and Weathered Mercia Mudstone Group is 8 to ≥25mbGL. Alluvium is 0 to 2.60mbGL and river terrace deposits 2.60 to ≥3mbGL at WS109.	Wolston Glacigenic Formation, although due to this being thin in this location, infiltration to the Baginton Sand and Gravel Formation is expected. Infiltration into the alluvium is also likely to the west of the Order Limits near the River Sowe but will largely constitute as baseflow.	estimated maximum of 0.49mbGL (74.09mAOD). Groundwater is likely flowing towards the River Sowe and WS109 at 0.10maGL (71.29mAOD).		

Road drainage design – filter drains (catchments 2 to 6)

4.2.12. The road drainage has been designed in accordance with DMRB, and specifically CG 501 Design of highway drainage systems (National Highways, 2022), CD 532 Vegetated drainage systems for highway runoff (National Highways, 2021b) and Construction industry research and information association (CIRIA C753): The SUDS manual. Full details of the drainage strategy are provided in ES Appendix 13.6 (Drainage Strategy Report) (**TR010066/APP/6.3**).

4.2.13. Where feasible, the proposed drainage strategy will replicate the existing drainage arrangement and conditions. The treatment incorporated into the road drainage system has been designed to be protective of receiving watercourses, namely the River Sowe, at the point of outfall.

4.2.14. Filter drains are designed to attenuate flows and therefore promote sedimentation. They include a geotextile wrap whereby ensuring that any sediment laden pollutants do not enter the unsaturated zone. CG501 specifies 60% efficacy for removal of suspended solids, 0% efficacy for removal of dissolved copper and 45% efficacy for removal of dissolved zinc concentrations to the final outfall.

4.2.15. A kerb and gully system has been incorporated into the design of the B4082, whereas a more rural approach, without a kerb, will be included in the rest of the Scheme to reduce any pollution that may occur in the event of a spillage. Triangular surface water channels are proposed in the central reserve of the mainline A46. Details of maintenance requirements are provided in ES Appendix 13.6 (Drainage Strategy Report) (**TR010066/APP/6.3**) and include regular inspections for blockages and to ensure mechanical devices such as penstocks are in working order, removal of litter, sediment accumulation and unwanted vegetation growth, and replacement of filter material where required.

Road drainage design – unlined drainage ditches (catchments 5 and 6)

4.2.16. Within catchments 5 and 6 surface water will be collected in a series of gullies, surface water channels and filter drains with run-off being conveyed to the outfalls via a combination of carrier drains, ditches and ponds. The overall efficacy of the road drainage treatment train for discharges to the final outfall, the River Sowe, has also been assessed in ES Appendix 13.3 (Water Quality Assessment) (**TR010066/APP/6.3**). This is based upon the HEWRAT assessment results for surface water.

4.2.17. Attenuation or retention ponds are designed to retain water and attenuate flows by accepting large inflows and discharging slowly. They are also a form of

treatment as they can allow suspended solids to settle out. CG501 specifies 60% efficacy for removal of suspended solids, 40% efficacy for removal of dissolved copper and 30% efficacy for removal of dissolved zinc concentrations.

4.2.18. Detention basins are landscaped depressions that are usually dry, except during and after rainfall events, designed to temporarily store water to attenuate flows and, where vegetated, provide treatment of pollution. The southern pond within the Scheme is likely to be drier throughout the years and resemble more of a detention basin.

4.2.19. Unlined ditches can allow for infiltration of runoff through soil and vegetation where residence times are long, whilst lined ditches can behave as containment basins for runoff between the road and receiving watercourse.

Summary of risk to groundwater

4.2.20. All filter drains pose a medium risk to groundwater across the Scheme as groundwater levels are consistently shallow. New filter drains are to be lined in consultation with the Environment Agency. Filter drains in catchment 1, south of the existing Smite Brook culvert, have already been removed due to water quality risks.

4.2.21. The detailed assessment highlights that the unlined drainage ditches in catchments 5 and 6 are underlain by low permeability Wolston Glacigenic Formation within the Order Limits that is likely to impede infiltration to ground. Adjacent to the River Sowe and outside the Order Limits, however, alluvium is present that is likely to be of higher permeability, allowing infiltration to ground and ultimately to the river. The HEWRAT assessment for surface water indicates that catchments 5 and 6 both pass, given the proposed treatment train in the form of two ponds, for each respective unlined drainage ditch.

4.2.22. As unlined drainage ditches are outside the Order Limits, and filter drains are present in the existing road drainage network. These are to be reviewed at the detailed design stage, in consultation with National Highways and the Environment Agency.

4.3. Groundwater Dependent Terrestrial Ecosystems assessment

4.3.1. Identified GWDTEs within 2km of the Order Limits have been assessed following the methodology set out in DMRB LA 113 to determine hydrogeological links to the Scheme, the importance of each GWDTE, the magnitude of any potential impact on the GWDTE and thereby the overall significance of risk to the GWDTE.

4.3.2. Designated sites with a potential hydraulic link to the study area have been identified using professional judgement. Herald Way Marsh biological SSSI is the only GWDTE within a 2km radius of the Scheme. This contains nationally

rare wetland communities such as swamp, fen and marsh as well as terrestrial areas of grassland, woodland and shrub is designated for its assemblage of invertebrates which are scarce throughout the UK. Fen in particular can be influenced by the fluctuating water table.

Potential hydrogeological link between the scheme and GWDTE

4.3.3. Herald Way Marsh SSSI is underlain by the Baginton Sand and Gravel Formation and is therefore likely to be fed by groundwater from within this unit.

4.3.4. Groundwater flow within the Scheme is predominantly westwards with a southern component, shown in Figure 2.5. As discussed in Section 2 of this report, hydraulic gradients in the area are likely controlled by the River Sowe and Smite Brook.

4.3.5. Groundwater flow is also controlled in part by the extents of the aquifer units. There is potentially some discontinuity in the Baginton Sand and Gravel Formation around the Walsgrave Junction, but to the south of this, local hydraulic gradients within the Baginton Sand and Gravel Formation may have a southern flow component, towards the Herald Way Marsh SSSI. Groundwater within the Baginton Sand and Gravel Formation to the south of the Walsgrave Junction therefore has the potential to support groundwater flow, flux and levels in Herald Way Marsh SSSI.

Assessment of GWDTE importance

4.3.6. Table 4.3 presents the overall importance for the GWDTE. This is taken as highest of the 'flora and fauna' and 'habitat' receptors, based on SSSI and LNR citation (Natural England, 1988) and UKTAG guidance for national vegetation classification (UKTAG, 2009).

Table 4.3: Summary of GWDTE classification and importance based on flora and fauna, and habitat receptors

GWDTE	Flora and fauna receptor	Flora and fauna importance	Habitat receptor	Habitat importance	Overall importance
Herald Way Marsh SSSI / LNR	Nationally rare invertebrate assemblages W2a – Alnus glutinosa, Salix spp., Carex spp., Juncus spp., Phragmites australis W6a – Alnus glutinosa, Salix spp.	Moderate	SSSI	High	High

GWDTE	Flora and fauna receptor	Flora and fauna importance	Habitat receptor	Habitat importance	Overall importance
	Gradation between W2a and W6a through invasion of alder and fewer tall herbs and sedges NVC dependency on groundwater – level 2				

Assessment of potential impacts

4.3.7. Table 4.4 presents the assessment of potential risks to the GWDTE, from activities highlighted as having the potential to have an impact (see Table 3.1 and Table 3.2). Risks are assessed prior to mitigation.

4.3.8. Potential impacts on the GWDTE are limited to groundwater quality and are described in further detail below.

4.3.9. Potential for contamination from accidental spillages or leakages reaching the Baginton Sand and Gravel Formation because of removal of topsoil or a reduced unsaturated zone, where ground is to be excavated may increase the vulnerability of the aquifer directly beneath them, but the risk of any potential contamination subsequently reaching the Herald Way Marsh SSSI is not significant due to its distance from the excavation areas. Furthermore, the Second Iteration Environmental Management Plan (EMP) will identify areas particularly vulnerable to contamination and best practise measures will ensure that risks of accidental spillages are minimised. This will be developed prior to construction and is secured by Requirement 4 of Schedule 2 of the draft DCO (**TR010066/APP/3.1**).

4.3.10. Whilst there is the potential for dewatering activities to result in contamination of groundwater, if water is to be disposed of via infiltration to ground, the magnitude of such an impact is negligible due to the distance between the nearest required dewatering activity and the GWDTE. Furthermore, it is likely that treatment in the form of settlement would be required as a condition of abstraction licensing and environmental permits associated with the dewatering activities.

4.3.11. Contamination has been identified within catchment 1 and road drainage infiltrating to ground in this area therefore has the potential to impact on groundwater quality. In this catchment, unlined drainage features such as filter drains have not been included in the drainage design, in line with CG501.

Table 4.4: Summary of overall risk to GWDTE

Impact type	Activity	Description of potential impact	Magnitude of impact on GWDTE	Overall risk to GWDTE
Groundwater quality	Drainage from construction areas overlying the Baginton Sand and Gravel Formation	Any potential contamination to aquifer unlikely to have significant impact on GWDTE due to distance between activity and GWDTE (>2km)	Negligible	Negligible
	Excavation in catchments 3 and 4, particularly B4082 drainage cutting reducing the thickness of unsaturated zone above the receptor aquifer	A reduced thickness of unsaturated zone above the Baginton Sand and Gravel Formation may result in an increase of potentially toxic chemicals within the aquifer unit, although these are unlikely to have a significant impact due to the distance between activity and GWDTE (>2km)	Negligible	Negligible
	Temporary dewatering discharges into shallow unsaturated zone, limited natural attenuation of potential suspended solids from dewatering activities	Only discharges made directly into the Baginton Sand and Gravel Formation to the south of Smite Brook would have potential to flow towards the GWDTE. This is unlikely considering the location of excavations requiring dewatering.	Negligible	Negligible
	All activities lend to the possibility of the creation of new pathways from potentially contaminated ground to underlying aquifers	Contamination identified within catchment 1 – road drainage infiltrating to ground in this area has the potential to increase potentially toxic chemicals within the aquifer unit and thus the GWDTE, although is unlikely to be significant due to the distance between activity and GWDTE (>2km)	Negligible	Negligible

4.3.12. In all cases these impacts have been identified as having negligible magnitude, and therefore negligible risk to the GWDTE.

5. Conclusions

5.1.1. This section summarises the activities that might result in a potentially significant impact, prior to mitigation, and are therefore taken forward for further consideration in the assessment of significant effects in ES Chapter 13 (Road Drainage and the Water Environment) (**TR010066/APP/6.1**).

- Construction activities:
  - Drainage of construction areas including excavations, cuttings and satellite compound
  - Excavations, including ponds and detention basin
  - Temporary dewatering activities associated with excavations for abutments, ponds and detention basins and the B4082 drainage cutting
  - Placement of piled foundations
  - Alteration of ground profiles, for example embankments, and creation of additional hardstanding areas, for example for access roads and satellite compound
- Operation activities:
  - Filter drains and unlined drainage ditches within the road drainage design
  - Permanent placement of below-ground structures, i.e. piles and bankseat abutments
  - Permanent subsurface drainage of cuttings

5.1.2. The groundwater levels and flows assessment identified the following receptors for consideration in the assessment of significant impacts:

- The main direct groundwater receptors within the study area are:
  - Secondary aquifers and superficial deposits:
    - Alluvium
    - River terrace deposits
    - Wolston Glacigenic Formation
    - Baginton Sand and Gravel Formation
  - Bedrock aquifer units:
  - Mercia Mudstone Group, which makes up the Warwickshire Avon – Secondary Mudrocks groundwater body (WBID: GB40902G990900)
- The main indirect groundwater receptors within the study area are:
  - watercourses:
    - River Sowe
    - Smite Brook

    - designated sites:
        - Herald Way Marsh SSSI and LNR

5.1.3. Groundwater receptors screened out based on the groundwater levels and flows assessment are:

- The Helsby Sandstone Formation, which makes up the Warwickshire Avon - PT Sandstone Warwick/Avon Confined groundwater body (WBID: GB40901G300700)
- Abstraction boreholes:
    - Bodmin Road, Wyken, Coventry (Licence number: 18/54/11/0141)
    - Brinklow Quarry (Licence number: MD/054/0010/022)

5.1.4. A summary of hydrogeological impacts on identified receptors relating to the potential construction and operation activities from the Scheme is provided in Table 3.1 and Table 3.2.

5.1.5. Groundwater quality and routine runoff assessments were completed to assess the risks of impacts upon groundwater quality from unlined road drainage. The detailed assessment identified that road runoff poses a potential risk to groundwater receptors in terms of water quality and infiltration to saturated aquifer units due to the limited thickness of the unsaturated zone. The use of filter drains, and unlined drainage ditches will therefore require further reassessment at the detailed design stage and discussion with the Environment Agency to confirm the risk due to the presence of shallow groundwater across the Scheme.

5.1.6. The simple GWDTE assessment considered potential hydraulic links between the Scheme and a designated site, Herald Way Marsh SSSI, to the south. The assessment concluded negligible risk to the site in terms of groundwater quality and quantity due to significant distance from construction and operational activities, and embedded mitigation in the form of lined drains south of the Smite Brook culvert. Best practice mitigation measures would be set out in the Second Iteration EMP to address these risks, and no further mitigation is required.

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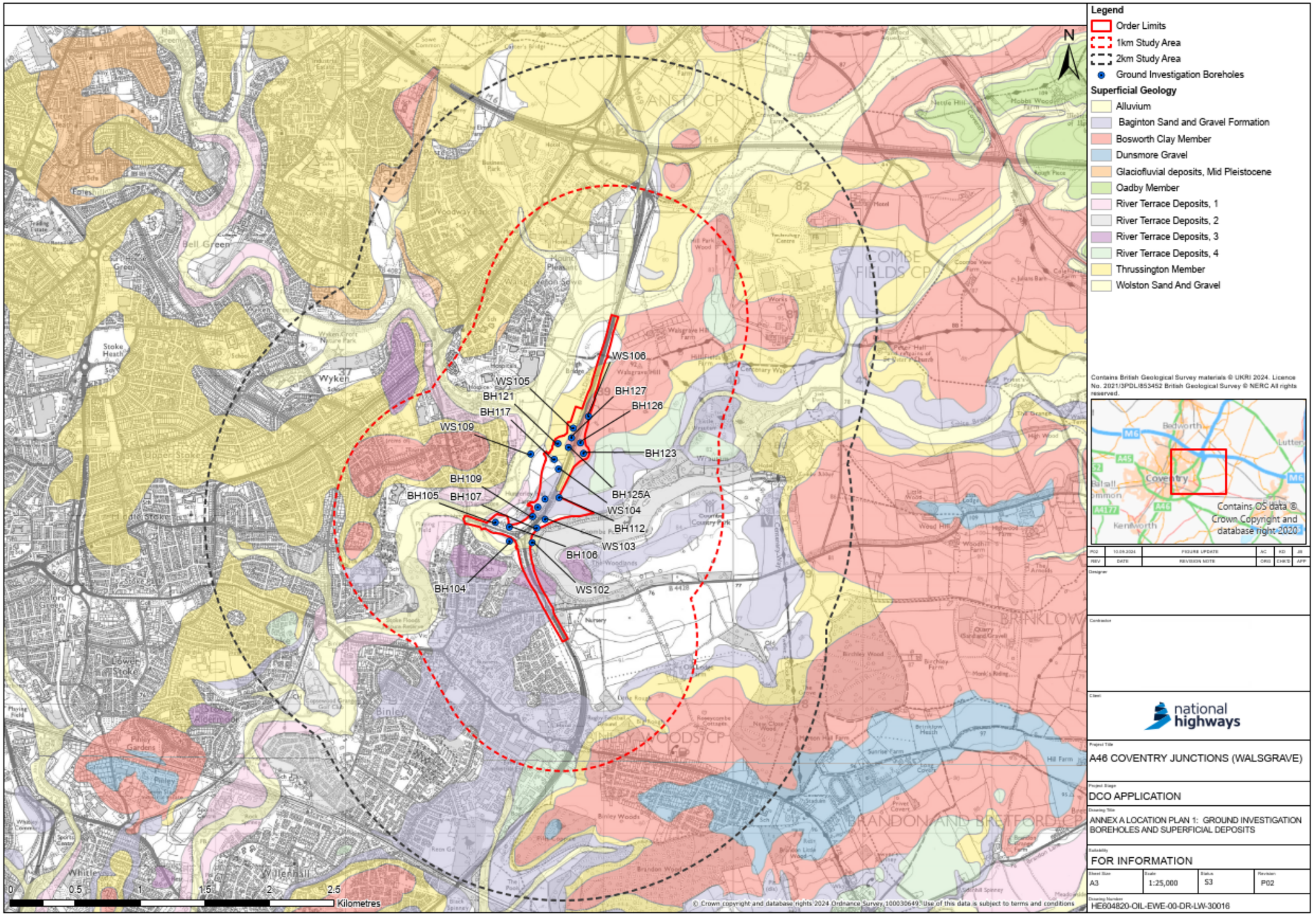
Annex A. Location Plans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WS106
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BH121
BH117
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BH126
WS109
BH123
BH109
BH105
BH107
BH125A
WS104
BH112
WS103
BH106
BH104
WS102
Wyken
Stoke Heath
Upper Stoke
Lower Stoke
Bell Green
Whitley
Willenhall
Binley
0
0.5
1
1.5
2
2.5
Kilometres
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Legend
Order Limits
1km Study Area
2km Study Area
Ground Investigation Boreholes
Superficial Geology
Alluvium
Baginton Sand and Gravel Formation
Bosworth Clay Member
Dunsmore Gravel
Glaciofluvial deposits, Mid Pleistocene
Oadby Member
River Terrace Deposits, 1
River Terrace Deposits, 2
River Terrace Deposits, 3
River Terrace Deposits, 4
Thrussington Member
Wolston Sand And Gravel
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A46 COVENTRY JUNCTIONS (WALSGRAVE)
DCO APPLICATION
ANNEX A LOCATION PLAN 1: GROUND INVESTIGATION BOREHOLES AND SUPERFICIAL DEPOSITS
FOR INFORMATION
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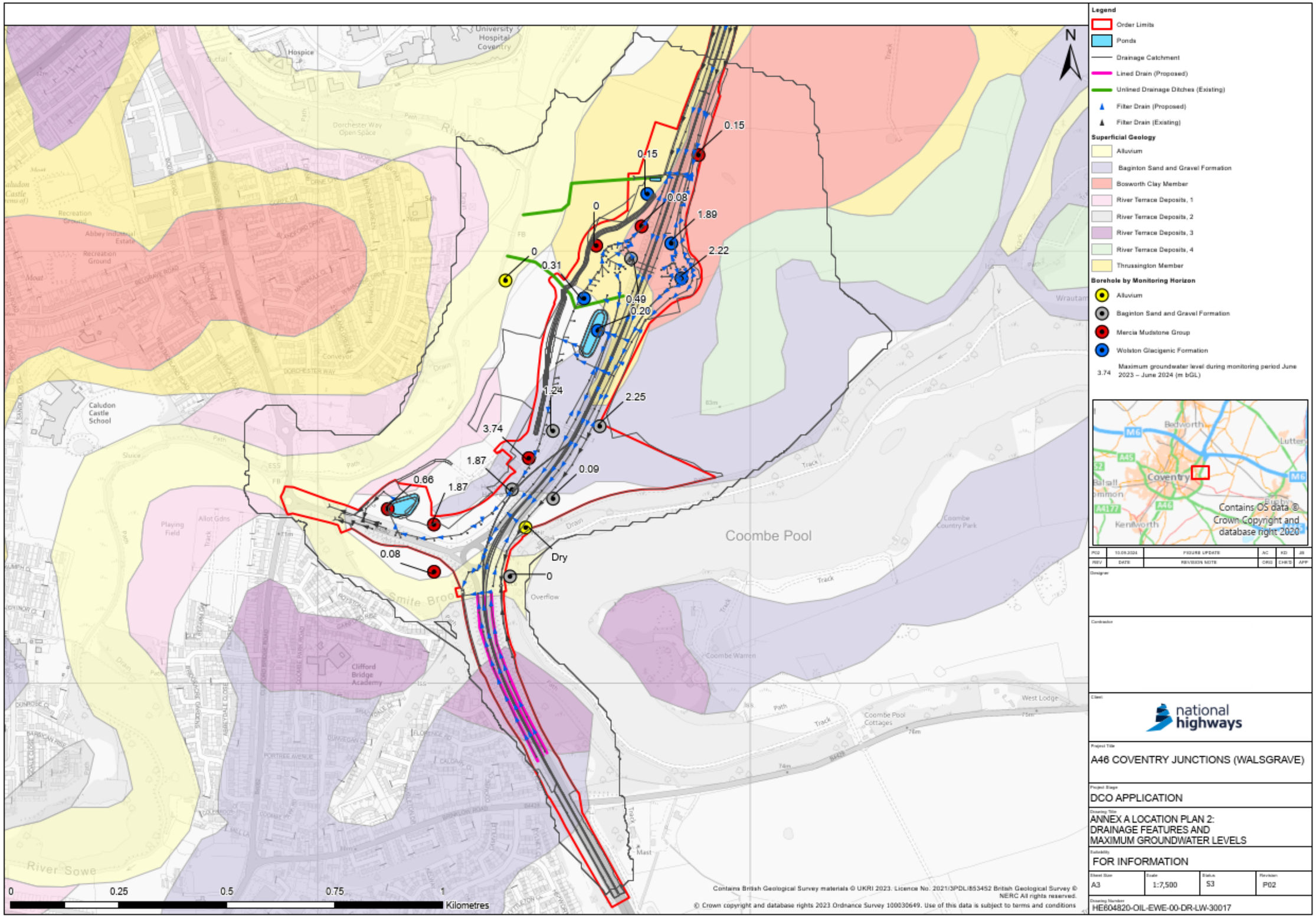
S3
P02
HE604820-OIL-EWE-00-DR-LW-30016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1.24
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3.74
1.87
0.09
0.66
1.87
0.08
Dry
0
Coombe Pool
River Sowe
Smite Brook
0
0.25
0.5
0.75
1
Kilometres
Legend
Order Limits
Ponds
Drainage Catchment
Lined Drain (Proposed)
Unlined Drainage Ditches (Existing)
Filter Drain (Proposed)
Filter Drain (Existing)
Superficial Geology
Alluvium
Baginton Sand and Gravel Formation
Bosworth Clay Member
River Terrace Deposits, 1
River Terrace Deposits, 2
River Terrace Deposits, 3
River Terrace Deposits, 4
Thrussington Member
Borehole by Monitoring Horizon
Alluvium
Baginton Sand and Gravel Formation
Mercia Mudstone Group
Wolston Glacigenic Formation
3.74 Maximum groundwater level during monitoring period June 2023 – June 2024 (m bGL)
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P02 10.09.2024 FIGURE UPDATE AC KD JB
REV DATE REVISION NOTE ORIG CHKD APP
national highways
A46 COVENTRY JUNCTIONS (WALSGRAVE)
DCO APPLICATION
ANNEX A LOCATION PLAN 2:
DRAINAGE FEATURES AND
MAXIMUM GROUNDWATER LEVELS
FOR INFORMATION
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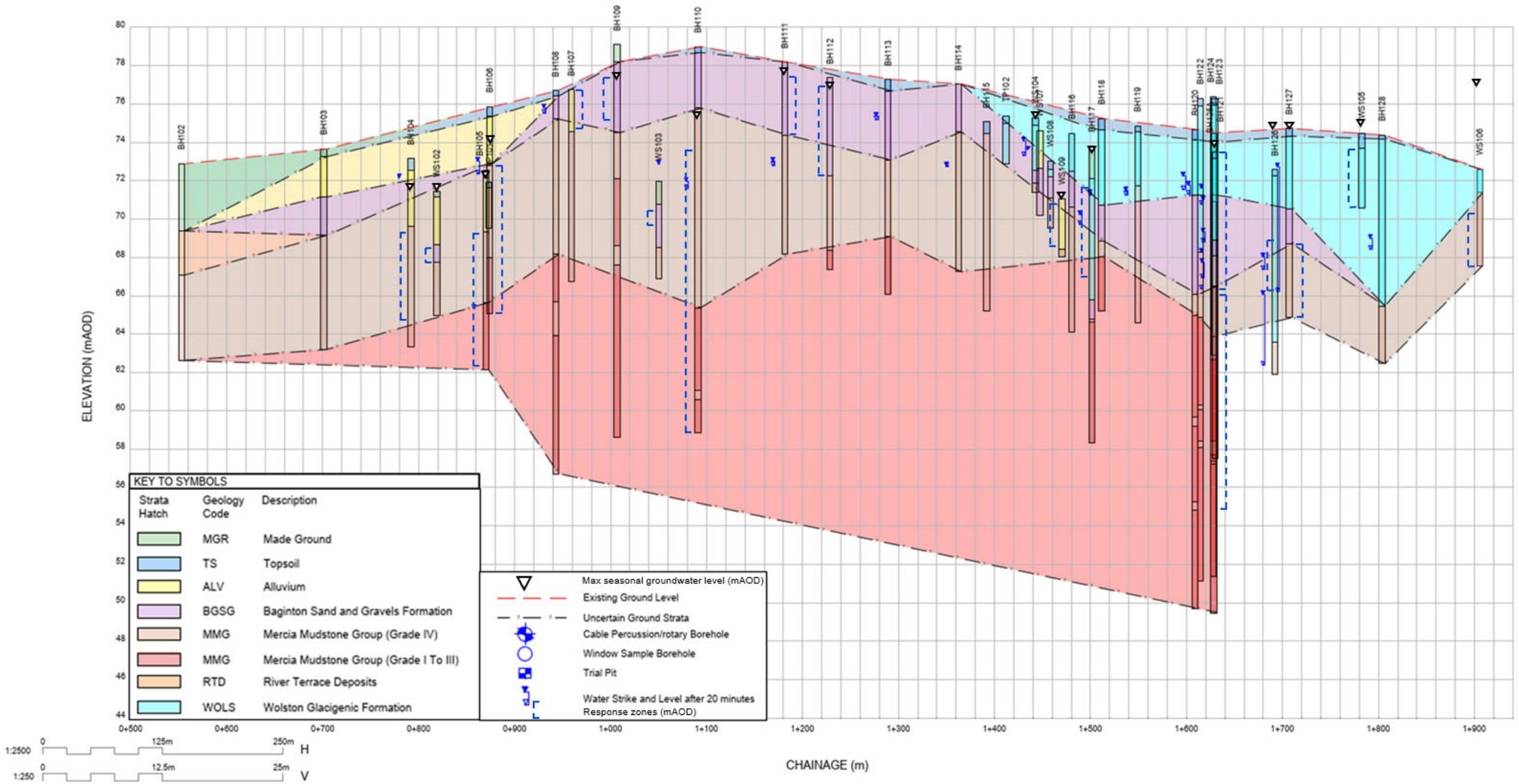
1:7,500
S3
P02
HE604820-OIL-EWE-00-DR-LW-30017

Annex B. Mainline hydrogeological section


ELEVATION (mAOD)
80
78
76
74
72
70
68
66
64
62
60
58
56
54
52
50
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44
BH102
BH103
BH104
WS102
BH105
BH106
BH108
BH107
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BH111
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BH113
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TP102
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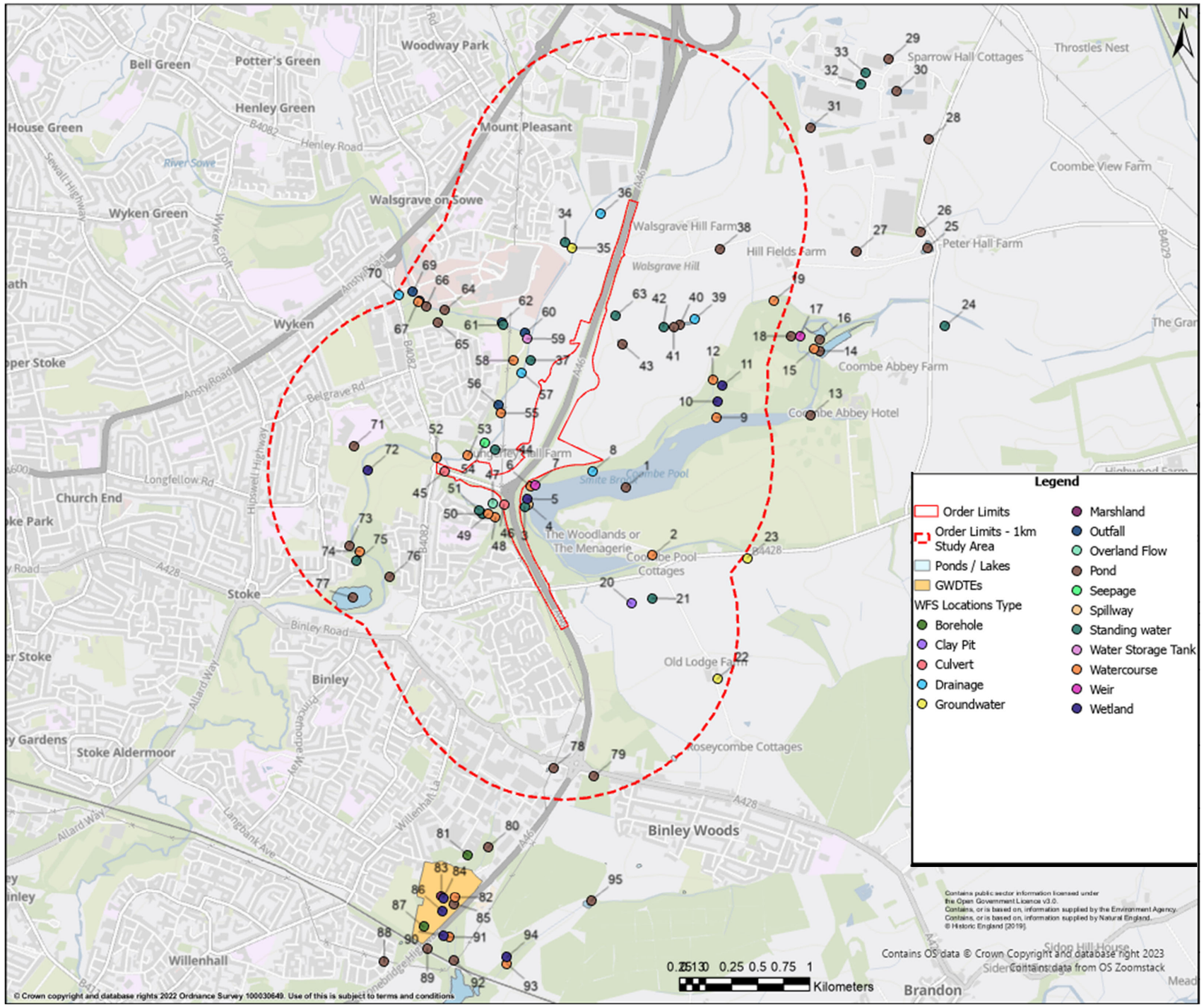
WS107
WS108
WS109
BH116
BH117
BH118
BH119
BH120
BH122
BH124
BH123
BH125
BH127
WS105
BH128
WS106
KEY TO SYMBOLS
Strata Hatch
Geology Code
Description
MGR
Made Ground
TS
Topsoil
ALV
Alluvium
BGSG
Baginton Sand and Gravels Formation
MMG
Mercia Mudstone Group (Grade IV)
MMG
Mercia Mudstone Group (Grade I To III)
RTD
River Terrace Deposits
WOLS
Wolston Glacigenic Formation
Max seasonal groundwater level (mAOD)
Existing Ground Level
Uncertain Ground Strata
Cable Percussion/rotary Borehole
Window Sample Borehole
Trial Pit
Water Strike and Level after 20 minutes
Response zones (mAOD)
0+500
0+600
0+700
0+800
0+900
1+000
1+100
1+200
1+300
1+400
1+500
1+600
1+700
1+800
1+900
CHAINAGE (m)
1:2500
0
125m
250m
H
1:250
0
12.5m
25m
V

Annex C. Water Features Survey


N
Bell Green
Potter's Green
Woodway Park
Henley Green
House Green
Mount Pleasant
Henley Road
B4082
River Sowe
Sewall Highway
Wyken Green
Wyken Croft
Walsgrave on Sowe
Ansty Road
Wyken
Belgrave Rd
A46
Walsgrave Hill Farm
Walsgrave Hill
Hill Fields Farm
Sparrow Hall Cottages
Throstles Nest
Coombe View Farm
Peter Hall Farm
B4029
Coombe Abbey Farm
Coombe Abbey Hotel
Coombe Pool
The Woodlands or The Menagerie
Coombe Pool Cottages
B4428
Old Lodge Farm
Roseycombe Cottages
Binley Woods
Stoke
Binley
Stoke Aldermoor
Church End
Willenhall
Brandon
Longfellow Rd
Binley Road
A428
Allard Way
Princethorpe Way
Langbank Ave
Willenhall La
Hipswell Highway
Legend
Order Limits
Order Limits - 1km Study Area
Ponds / Lakes
GWDTEs
WFS Locations Type
Borehole
Clay Pit
Culvert
Drainage
Groundwater
Marshland
Outfall
Overland Flow
Pond
Seepage
Spillway
Standing water
Water Storage Tank
Watercourse
Weir
Wetland
0 0.125 0.25 0.5 0.75 1
Kilometers
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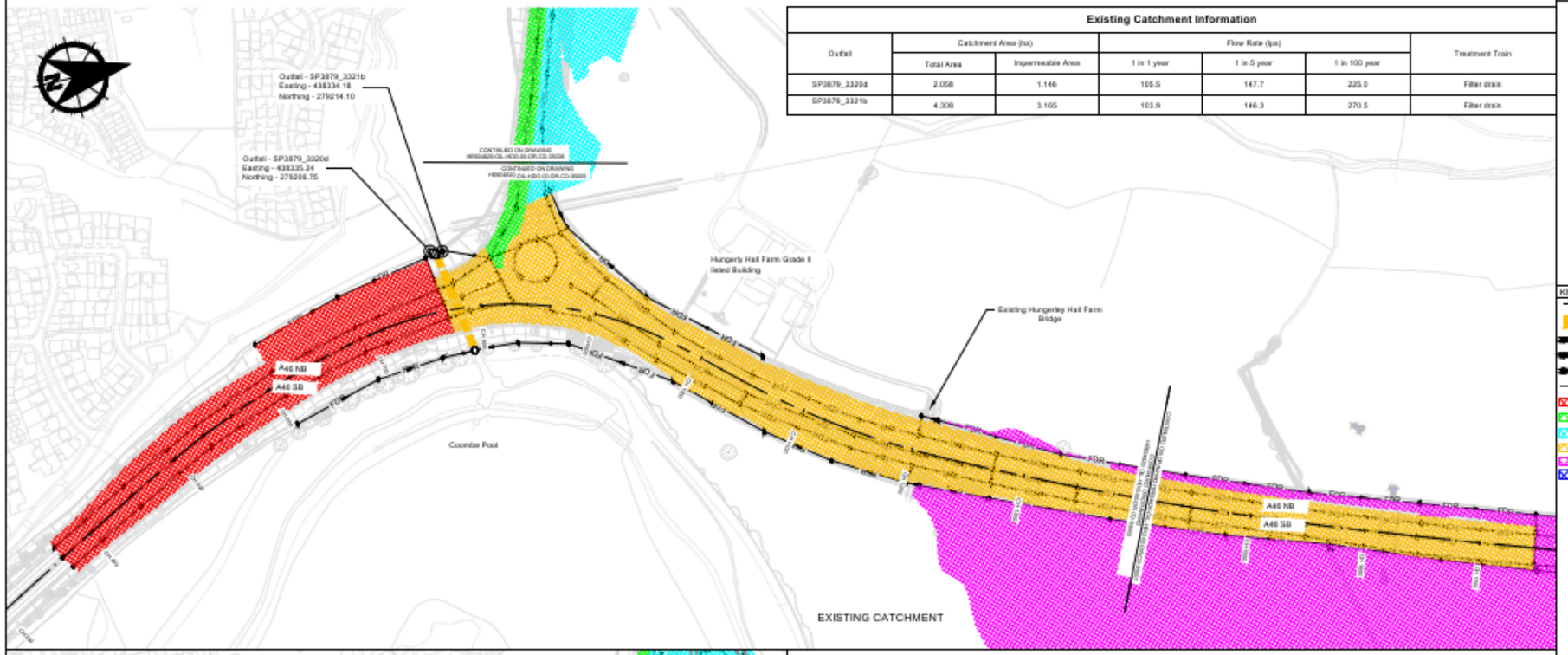
Annex D. Drainage catchment areas

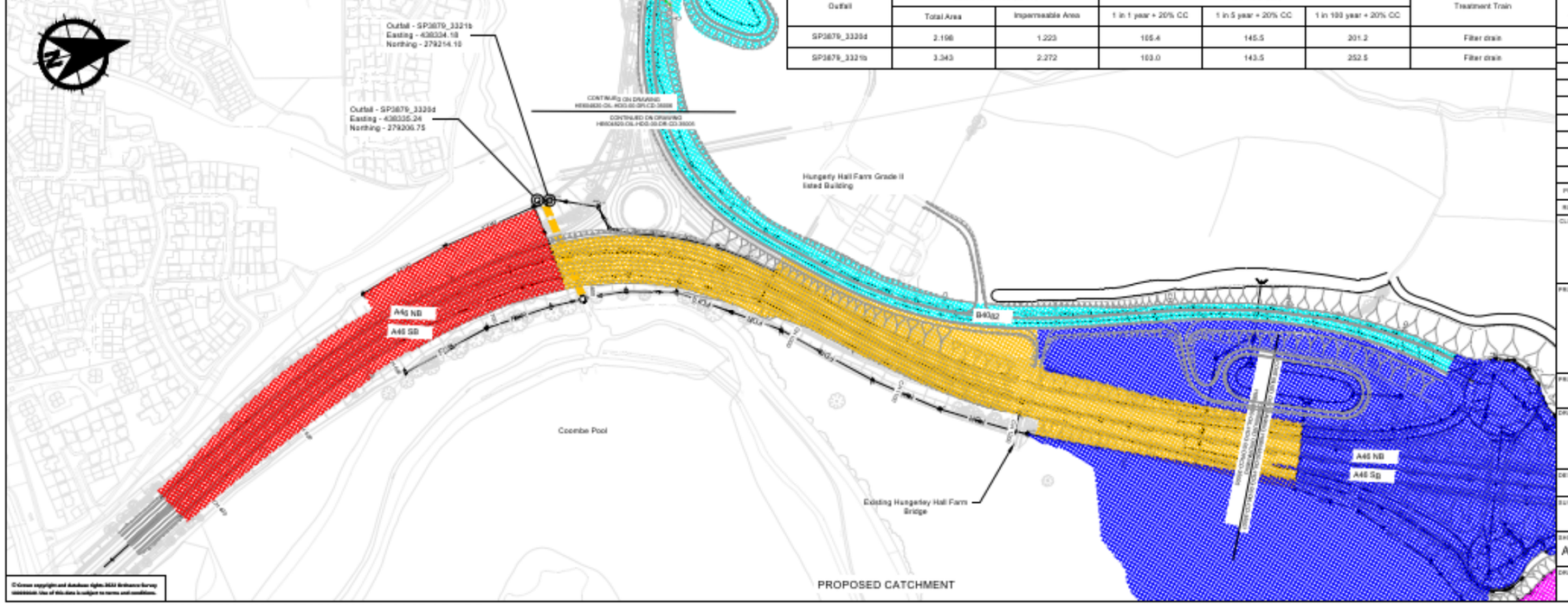
Existing Catchment Information

Outfall	Catchment Area (ha)		Flow Rate (lps)			Treatment Train
	Total Area	Impermeable Area	1 in 1 year	1 in 5 year	1 in 100 year	
SP3879_3320d	2.058	1.146	165.5	147.7	225.9	Filter drain
SP3879_3321b	4.308	3.165	163.9	146.3	270.5	Filter drain



Proposed Catchment Information

Outfall	Catchment Area (sq.m.)		Flow Rate (lps)			Treatment Train
	Total Area	Impermeable Area	1 in 1 year + 20% CC	1 in 5 year + 20% CC	1 in 100 year + 20% CC	
SP3879_3320d	2.198	1.223	165.4	145.5	201.2	Filter drain
SP3879_3321b	3.343	2.272	163.0	143.5	252.5	Filter drain



NOTES

1. This drawing is to be read in conjunction with all other relevant documentation.
2. Do not scale from this drawing, use only printed dimensions.
3. All dimensions, chainages, levels and coordinates are in meters unless otherwise stated.
4. Refer to Drainage plans.
5. Refer to Drainage Strategy Report for drainage schedules.

KEY TO SYMBOLS

- Route Chainage
- Existing Culvert
- FDR — Filter Drain
- CDR — Channel Drain
- SWC — Surface Water Channel
- Ditch Outline
- Catchment Area 1
- Catchment Area 2
- Catchment Area 3
- Catchment Area 4
- Catchment Area 5
- Catchment Area 6

1:2000 0 100m 200m

REV	DATE	REVISION NOTE	ORIG	CHKD	APP'D
P01	12/03/24	For Information	SLen	SWic	Bllo

CLIENT: national highways

PROJECT TITLE: A46 COVENTRY JUNCTIONS (WALSGRAVE)

PROJECT STAGE: DCO APPLICATION

DRAWING TITLE: CATCHMENT PLAN SHEET 1 OF 3

DEVELOPMENT CONSENT ORDER (DCO) - APPLICATION NUMBER: TR010066/APP/6.3

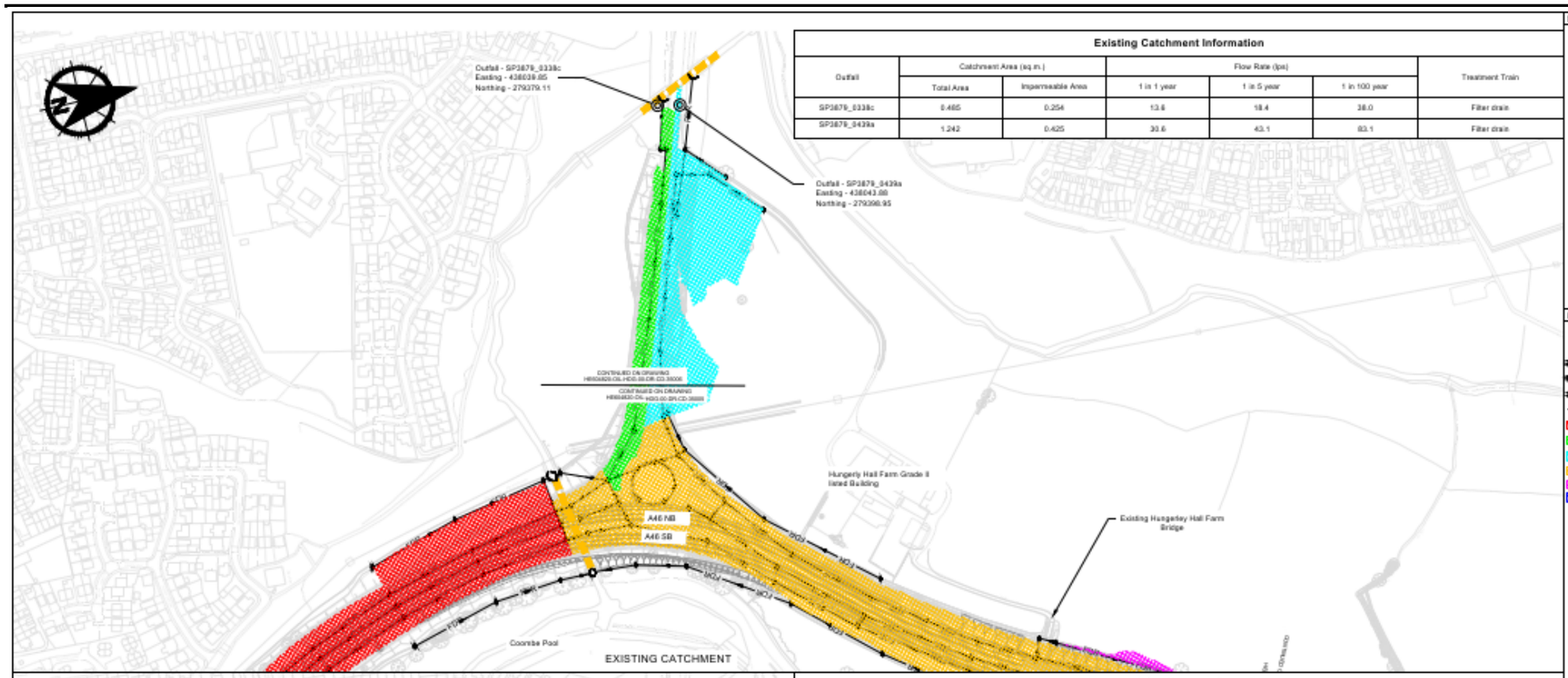
SUITABILITY: FOR INFORMATION

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:2000	S2	P01

DRAWING NUMBER: HE604820-OIL-HDG-00-DR-CD-35005

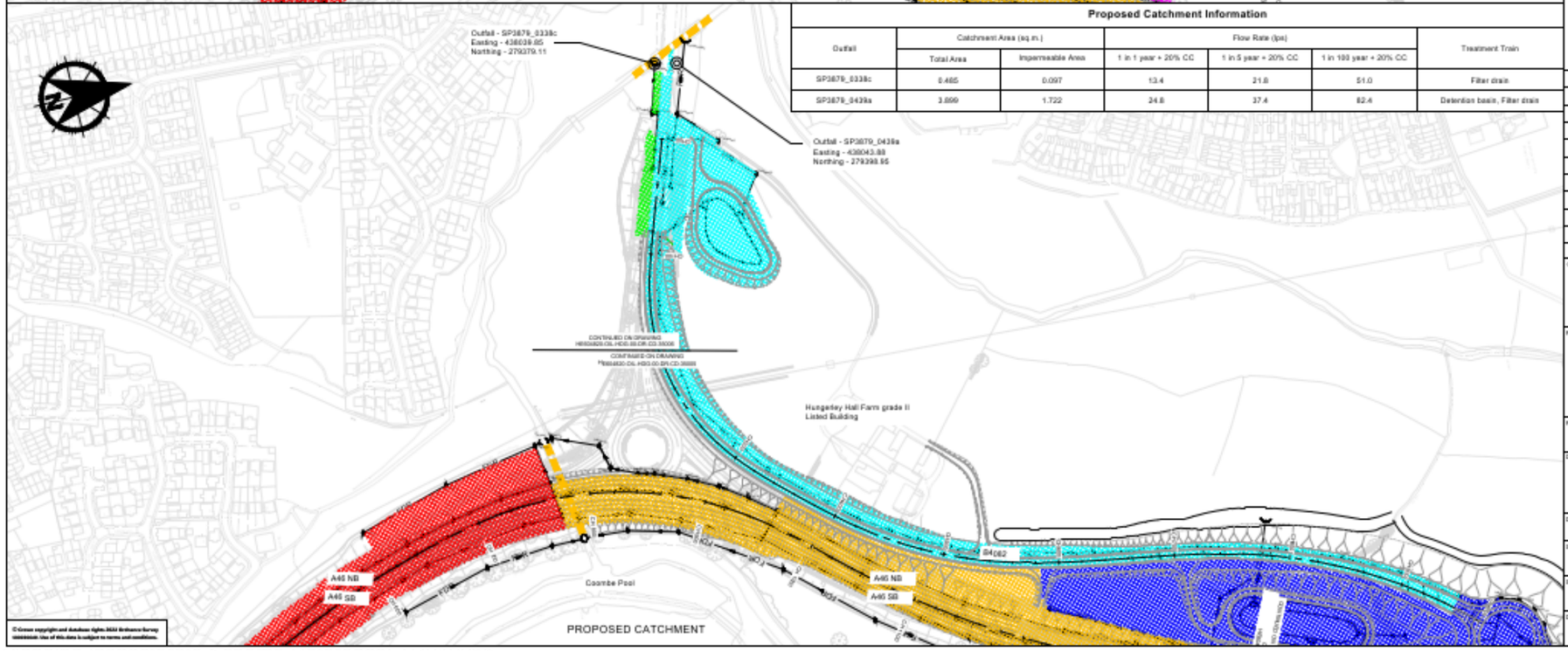
Existing Catchment Information

Outfall	Catchment Area (sq.m.)		Flow Rate (lps)			Treatment Train
	Total Area	Impermeable Area	1 in 1 year	1 in 5 year	1 in 100 year	
SP3679_0338c	0.465	0.254	13.6	18.4	38.0	Filter drain
SP3679_0439a	1.242	0.425	30.6	43.1	83.1	Filter drain



Proposed Catchment Information

Outfall	Catchment Area (sq.m.)		Flow Rate (lps)			Treatment Train
	Total Area	Impermeable Area	1 in 1 year + 20% CC	1 in 5 year + 20% CC	1 in 100 year + 20% CC	
SP3679_0338c	0.465	0.097	13.4	21.8	51.0	Filter drain
SP3679_0439a	3.899	1.722	24.8	37.4	82.4	Detention basin, Filter drain



NOTES

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2. Do not scale from this drawing, use only printed dimensions.
3. All dimensions, chainages, levels and coordinates are in meters unless otherwise stated.
4. Refer to Drainage plans
5. Refer to Drainage Strategy Report for drainage schedules.

KEY TO SYMBOLS

- Route Chainage
- Existing Culvert
- FDR — Filter Drain
- CDR — Channel Drain
- SWD — Surface Water Channel
- Ditch Outline
- Catchment Area 1
- Catchment Area 2
- Catchment Area 3
- Catchment Area 4
- Catchment Area 5
- Catchment Area 6

1:2000 0 100m 200m

REV	DATE	REVISION NOTE	ORIG	CHKD	APP'D
P01	12/03/24	For Information	SLen	SWin	Ellis

CLIENT: national highways

PROJECT TITLE: A46 COVENTRY JUNCTIONS (WALSGRAVE)

PROJECT STAGE: DCO APPLICATION

DRAWING TITLE: CATCHMENT PLAN SHEET 2 OF 3

DEVELOPMENT CONSENT ORDER (DCO) - APPLICATION NUMBER: TR010066/APP/6.3

SUITABILITY: FOR INFORMATION

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:2000	S2	P01

DRAWING NUMBER: HE604820-OIL-HDG-00-DR-CD-35006

national highways

Existing Catchment Information

Outfall	Catchment Area (ha)		Flow Rate (lps)			Treatment Train
	Total Area	Impermeable Area	1 in 1 year	1 in 5 year	1 in 100 year	
SP3880_4708a	27.882	1.589	173.7	244.7	444.2	Filter drain

Outfall - SP3880_4708a
Easting - 438471.18
Northing - 280082.27

River Sowe

Outfall - SP3880_7318a
Easting - 438734
Northing - 280149

A46 NB
A46 SB

EXISTING CATCHMENT

Proposed Catchment Information

Outfall	Catchment Area (ha)		Flow Rate (lps)			Treatment Train
	Total Area	Impermeable Area	1 in 1 year + 20% CC	1 in 5 year + 20% CC	1 in 100 year + 20% CC	
Network 3	18.575	1.466	200.2	291.6	572.8	Filter drain
Network 2B (NW2B)	12.556	1.536	24.0	36.1	91.1	Ditch, Filter drain, Detention basin

Outfall - SP3880_4708a
Easting - 438471.18
Northing - 280082.27

River Sowe

Outfall - Network 2B
Easting - 438566.49
Northing - 279912.75

Outfall - Network 3
Easting - 438731
Northing - 280166

A46 NB
A46 SB

PROPOSED CATCHMENT

NOTES

1. This drawing is to be read in conjunction with all other relevant documentation.
2. Do not scale from this drawing, use only printed dimensions.
3. All dimensions, chainages, levels and coordinates are in meters unless otherwise stated.
4. Refer to Drainage plans.
5. Refer to Drainage Strategy Report for drainage schedules.

KEY TO SYMBOLS

- Route Chainage
- Existing Culvert
- FDR — Filter Drain
- CDR — Channel Drain
- SWC — Surface Water Channel
- Ditch Outline
- Catchment Area 1
- Catchment Area 2
- Catchment Area 3
- Catchment Area 4
- Catchment Area 5
- Catchment Area 6

1:2000 0 100m 200m

REV	DATE	REVISION NOTE	ORIG	CHKD	APP'D
P01	13/03/24	for information	SLan	GWin	RBe
P02	04/07/24	Catchment areas updated	RRee	GWin	JLee

CLIENT: national highways

PROJECT TITLE: A46 COVENTRY JUNCTIONS (WALSGRAVE)

PROJECT STAGE: DCO APPLICATION

DRAWING TITLE: CATCHMENT PLAN SHEET 3 OF 3

DEVELOPMENT CONSENT ORDER (DCO) - APPLICATION NUMBER: TR010068/APP/6.3

SUITABILITY: FOR INFORMATION

EXHIBIT SIZE	SCALE	STATUS	REVISION
A1	1:2000	S2	P02

DRAWING NUMBER: HE604820-OIL-HDG-00-DR-CD-35007

Annex E. Radius of Influence (Sichardt) assessment

1.1.1 For each major structure requiring excavation, the potential zone of influence (ZoI) due to dewatering has been estimated using the Sichardt equation. Permeability (K) values have been estimated using book values (Freeze and Cherry, 1979) and a worst-case scenario has been presented to provide a likely maximum ZoI.

1.1.2 A vertical limit of deviation of 1m downwards and horizontal limit of deviation of 3m should be taken into consideration for ponds, earthworks associated with the A46 dumbbell junction overbridge roundabouts and slip roads as well as earthworks associated with the B4082 cutting. Therefore, 1m has been added to the depth of excavations for all cuttings.

1.1.3 The empirical Sichardt equation (CIRIA C750) is commonly used to estimate the zone or radius of influence (R_0) under steady state conditions and assuming radial flow:

- $R_0 = C (H_0 – h_w) \sqrt{K}$
  - where:
    - H_0 = water level above the base of the aquifer prior to dewatering (i.e. at R_0)
    - H_w = water level at the equivalent radius (r_e) of the excavation
    - therefore $H_0 - h_w$ = target drawdown
    - K = hydraulic conductivity of the aquifer
    - C = an empirical calibration factor

1.1.4 The Sichardt equation assumes that the:

- aquifer is unconfined
- aquifer has infinite areal extent
- aquifer is homogenous, isotropic and of uniform thickness
- initial water table is flat
- aquifer is pumped at a constant discharge rate
- pumping well is fully penetrating, therefore receiving water from the entire saturated thickness of the aquifer flow to the well is in a steady

1.1.5 Note that the Sichardt equation is empirical and may underestimate the ZoI and overestimate inflow rates. Estimated ZoIs for the likely range of permeability values are presented in Table E.1 below.

	Approximate excavation depth		Excavated strata**	Nearest borehole[2]	Maximum groundwater level		Water strikes		Permeability (K) value from literature (Freeze and Cherry, 1979) ****	Likely ZoI from literature (Freeze and Cherry, 1979)
UNIT>	mbGL	mAOD			mbGL	mAOD	Strike (mbGL)	After 20 mins rose to (mbGL)	m/s	m
S01 Walsgrave overbridge	2.5	73.09	Wolston Glacigenic Formation	BH123[1] (east pile location)	2.22	76.11	7.5	6.95	Glacial till 10^{-12} – 10^{-6}	0.01 – 13
			Wolston Glacigenic Formation	BH125A (west pile location)	-	-	-	-	Silty sand 10^{-7} - 10^{-4}	2 – 75
			Baginton Sands and Gravels	BH125A (west pile location)	0.49	74.09	3.5	2.7	Sandy gravel 10^{-4} – 10^{-2}	35 – 1089
Southern pond (Catchment 3)	3.5	69.09	Alluvium	BH105	-	-	-	-	Sandy gravel 10^{-4} – 10^{-2}	224 – 2245
			Mercia Mudstone Group		0.66	72.09	7.15	7.2	Silty sand 10^{-7} - 10^{-4}	7 – 224
			Alluvium	WS109[1]	- 0.10	71.19	-	-	Silty sand 10^{-7} - 10^{-3}	10 – 1001
Central pond (Catchment 6)	3.5	71.73	Wolston Glacigenic Formation	WS104[1]	0.20	75.36	2	1.2	Silty sand 10^{-7} - 10^{-4}	10 - 311
			Baginton Sands and Gravels		-	-	-	-	Sandy gravel 10^{-4} – 10^{-2}	37 - 1160
Northern pond (Catchment 5)	3.5	71.36	Wolston Glacigenic Formation	WS105	0.15	74.71	-	-	Silty sand 10^{-7} - 10^{-4}	4 - 113
B4082 cutting***	2.3*	77.84	Baginton Sands and Gravels	BH111	1.24	77.31	5.4	5.14	Silty sand 10^{-7} - 10^{-4}	4 - 127
			Baginton Sands and Gravels	BH110	-	-	-	-	Silty sand 10^{-7} - 10^{-4}	4 - 127
			Mercia Mudstone Group		3.74	75.61	7.4	7	Silty sand 10^{-7} - 10^{-4}	2 - 77
			Baginton Sands and Gravels	BH109	1.87	77.30	-	-	Sandy gravel 10^{-4} – 10^{-2}	33 – 1035
			Alluvium	BH106	-	-	-	-	Silty sand 10^{-7} - 10^{-3}	3 - 265
			Mercia Mudstone Group		1.87	74.14	3.5	2.81	Silty sand 10^{-7} - 10^{-4}	3 - 84

Table E.1: Estimated zones of influence

* Maximum depth of cut at deepest location along linear excavation. The depth will vary along the structure.
**Based on the intercepted / recorded strata at a specified GI location and approximate total excavation depth specified at given location
***A linear excavation with a maximum depth of approximately 2.3mbGL across the length of the cut. The cutting will intercept multiple lithologies.
**** Literature values for permeability (K) are based on the recorded lithologies for a specified GI location.
[1]Screened across multiple lithologies.

[2]Nearest boreholes may not be close to proposed structure but includes site-specific data for lithologies likely to be intercepted at the location of the proposed structure.
A dash (-) denotes no groundwater level data for specified location.