Gore Quarry: Abstraction Licence Application

25 October 2023

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Gore Quarry: Abstraction Licence Application

Prepared for

Tarmac Trading Ltd

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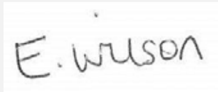
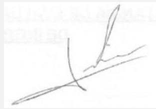
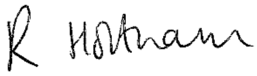
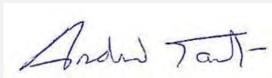
Author	Elizabeth Wilson Juan Rivera	 
Checked by	Richard Holtham	
Reviewed by	Andrew Tait	

Revision record:

Issue	Date	Status	Comment	Author	Checker	Reviewer
1	25/07/2022	Draft	Draft for client comments	EMW	RAH	AWT
2	05/09/2022	Final		EMW	RAH	AWT
3	10/10/2023	Draft Rev1	Include full abstraction licence information	EMW	JFR	AWT
4	25/10/2023	Final Rev1	Include full abstraction licence information	EMW	JFR	AWT

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1 Introduction

1.1 Background

The Gore Quarry (the Site) is located immediately to the north of Burlingjobb and 200 m to the east of the village of Old Radnor in the county of Powys (see Figure 1.1). The quarry is worked by Tarmac Trading Ltd. (Tarmac) and covers an area of approximately 36 hectares, working predominantly Precambrian "gritstone", which is a very high-quality product used for road surfaces.

Tarmac instructed Stantec UK Ltd (Stantec) to prepare and submit an abstraction licence application (ref: PAN-019189) to Natural Resources Wales (NRW) for the future dewatering at the Site. The planning permission allows working to 164 mAOD, with the quarry base currently being at c. 242 mAOD. Up to the current working depth, Tarmac have considered that the discharged water is almost entirely surface water and have, up to now, not pursued an abstraction licence application for quarry dewatering. However, as the quarry progresses downwards, groundwater will be intercepted and therefore dewatering would require an abstraction licence. Moreover, an existing Abstraction Borehole, located at SO 25669 59311 within the Site, abstracts groundwater from the same source that will be dewatered; therefore, a full abstraction licence is required. NRW confirmed the requirement of a full licence in September 2022 and returned the transfer licence application.

As part of the application process, a groundwater investigation consent (ref: PAN-019333, see Appendix A within Stantec, 2023) was issued by NRW, which required a constant rate pumping test of the Abstraction Borehole. The pumping test at the Abstraction Borehole was carried out in August 2023 to investigate the hydraulic characteristics of the aquifer at the Site and assess the quantity of groundwater available in order to confirm that the source is viable and sustainable. The effects of the abstraction on surrounding water dependant features and other users were also assessed in Stantec (2023) – see Appendix H.

The Site holds a discharge activity environmental permit that allows water discharge off site at a rate of 15 l/s. The abstraction licence pursued by the application that this report accompanies will cover the non-use transfer of dewatering water from the excavation area to the discharge points, as well as the supply for dust suppression and wheel washing purposes.

1.2 Application forms

This report provides the overarching document containing all necessary information and referencing the supporting documents for the application for submission to NRW. An assessment of the hydrogeological conditions in the area, including a water balance, has been undertaken along with a groundwater dewatering impact assessment. It is accompanied by the appropriate application forms as follows (submitted online):

- Form WRA – your details
- Form WRD – about the abstraction

Tarmac Director details are provided in Appendix A.

The application forms are sign by Delia Boulis of Tarmac (Permitting and Compliance Manager), who is authorised to do so as shown in the Letter of Signing Authority presented in Appendix B.

1.3 Application fee

The application fee will be £6,327 for a full licence, plus advertisement charge.

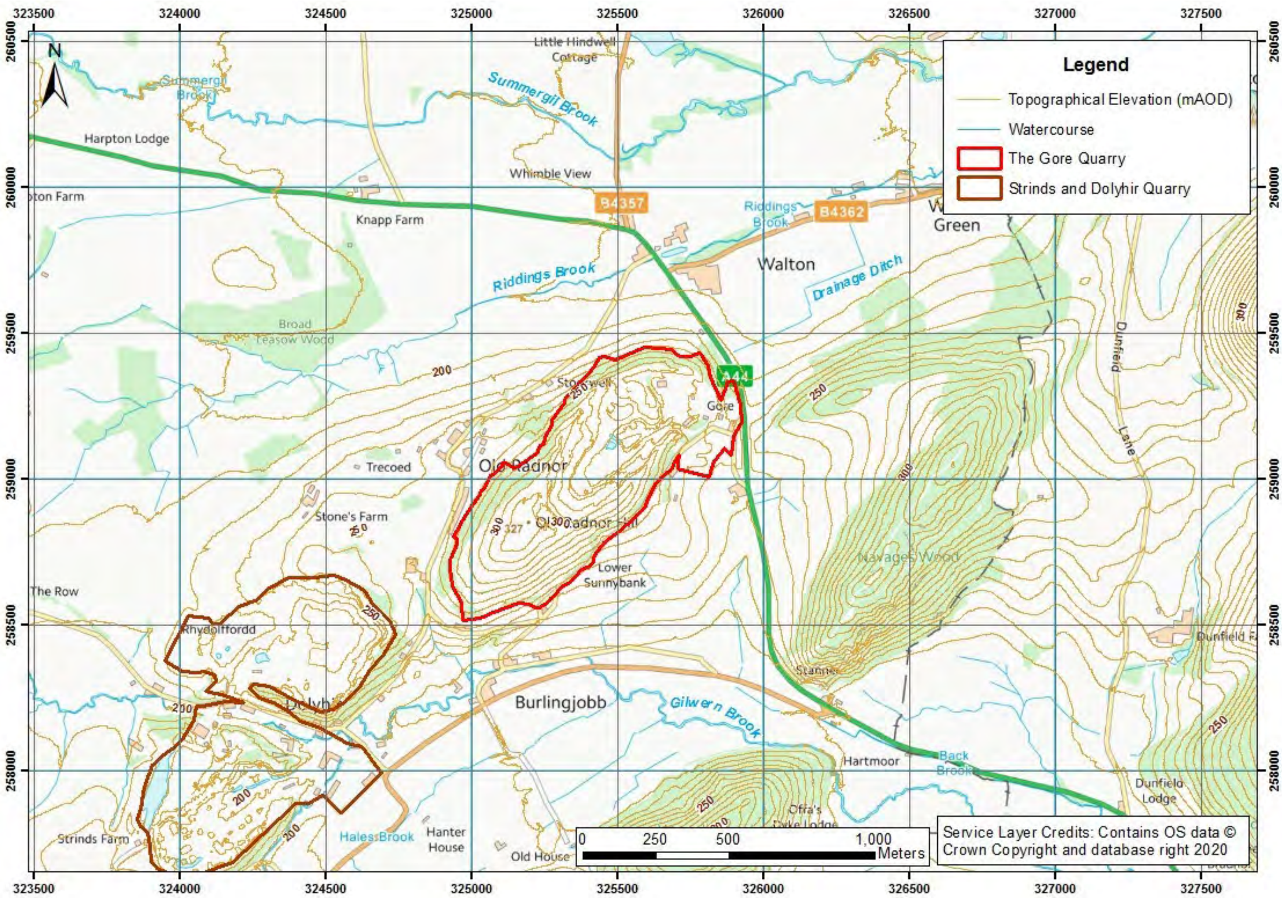
Payment of the application fee will be processed via BACs transfer.

1.4 Report outline

This report includes the following sections:

- A review of the relevant baseline conditions and hydrogeological conceptual model for the Site (Section 2);
- A summary of the potential receptors at risk of impact from the proposed quarry dewatering (Section 3);
- An assessment of the quarry development and potential inflows to the excavations (Section 4);
- A hydrogeological impact assessment of the potential receptors (Section 5);
- the requirements needed for the abstraction licence (Section 6); and
- the volumes applied for on the abstraction licence (Section 7).

Figure 1.1 Location map



2 Baseline Conditions

2.1 Site setting

The Site is located immediately to the north of the hamlet of Burlingjobb and 200 m to the east of the village of Old Radnor in the County of Powys (Figure 1.1). The Site covers an area of approximately 36 hectares; and is 300 m northeast of Dolyhir & Strinds Quarry, also operated by Tarmac.

Kington, a small market town, is located to the southeast with the village of New Radnor to the northwest of the Site. The A44 runs north/south adjacent to the Site to the east with access into the Site gained from it. The surrounding land is of predominantly agricultural land use.

2.2 Geology

2.2.1 Regional geology

The quarry works predominantly Precambrian “gritstone” (of the Strinds Formation), which is a very high-quality product used for road surfaces. The geology is summarised in Table 2.1 with the bedrock geology and superficial deposits shown in Figure 2.1 and Figure 2.2 respectively.

The metamorphosed Precambrian strata consists of micaceous sandstone (Strinds Formation) with interbedded siltstones, mudstones and sandstones (Yat Wood Formation). The Dolyhir Limestone Formation, lying unconformably on the Precambrian strata, is present off site to the northwest and southeast, and undifferentiated Silurian rocks are found to the east.

Figure 2.2 shows superficial deposits are absent below, and within 50 m of, the Site. However, Glacial till deposits are found to the north, and alluvium and glaciofluvial deposits are present to the south.

Table 2.1 Regional geology

Age	Formation	Lithological Description	Regional Thickness (m)	Local Thickness (m)
Quaternary	Glacial till	Mixture of clay, sand, gravel and boulders	0 - 15	10 – 15
Silurian	Silurian rocks - Wenlock and Ludlow Strata undifferentiated	Grey/brown mudstone, siltstone and sandstone	< 50	< 14
	Dolyhir Limestone Formation	Grey massive shelly limestone	20 - 30	5 - 45
Precambrian	Strinds Formation	Green/grey micaceous sandstone	> 150	-
	Yat Wood Formation	Siltstone, mudstone and sandstone	-	-

Figure 2.1 Bedrock geology

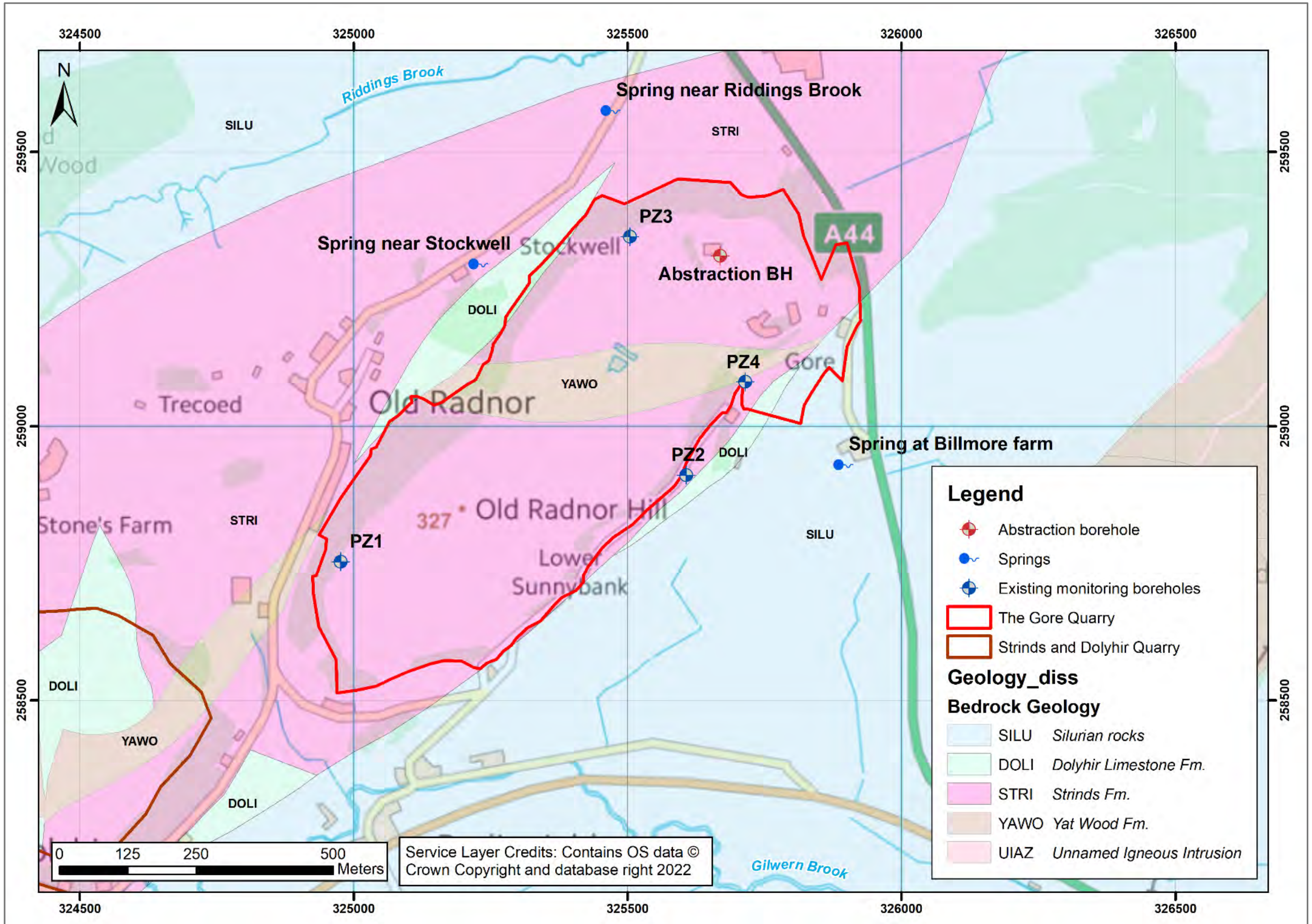
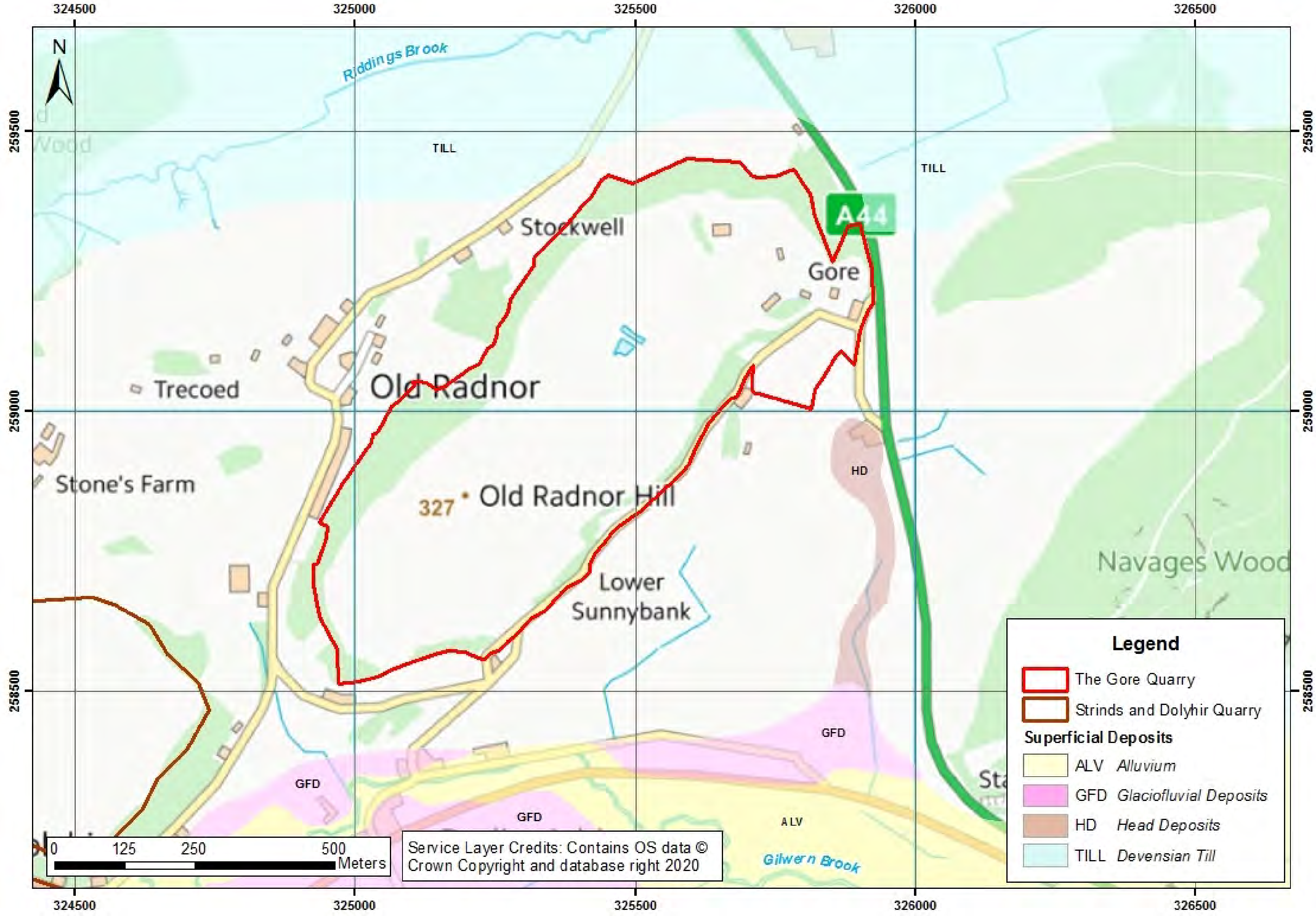


Figure 2.2 Superficial deposits



2.2.2 Local geology

Additional information concerning the geology in the vicinity of the Site has been obtained from the following boreholes, with locations shown in Figure 2.3:

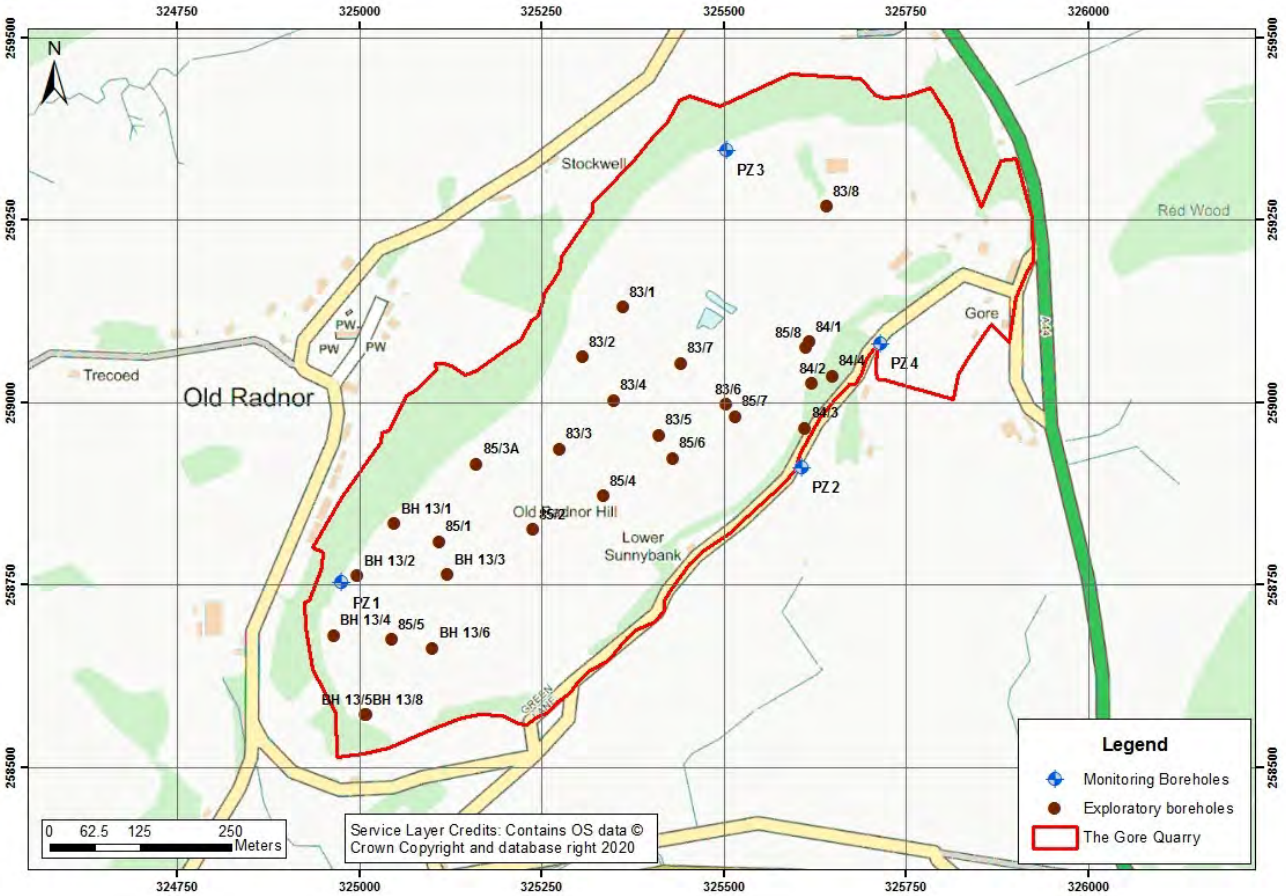
- Boreholes drilled within the quarry in 1983;
- Boreholes drilled within the quarry in 1984;
- Boreholes drilled within the quarry in 1985;
- Boreholes drilled in the southeast of the Site in 2013.

The bedrock at the Site is part of a dome of Precambrian sediments that were thrust up through Silurian strata (Minshall, C.J., 1983). These Precambrian sediments are typically dominated by sandstones that are weathered and leached near the surface. The sandstone is interbedded with conglomerate, shale and siltstone. The Strinds Formation is able to be differentiated from the Yat Wood Formation by the sandstone which is the dominant rock, whilst the belt of shale and siltstone found towards the centre of the Site represents the Yat Wood Formation.

The Strinds Formation has been proven to an elevation of 208 mAOD on the north side of the quarry (borehole 83/8), and to an elevation of 218 mAOD on the south side (borehole BH13/5); however, it is expected that Strinds Formation continue below these depths. Similarly, the Yat Wood Formation was proved to an elevation of 261 mAOD in borehole 83/2.

To the northwest and southeast of the Site, Dolyhir Limestone has been proved along the base of the hill, although it is of limited lateral extent (see Figure 2.1).

Figure 2.3 Borehole locations



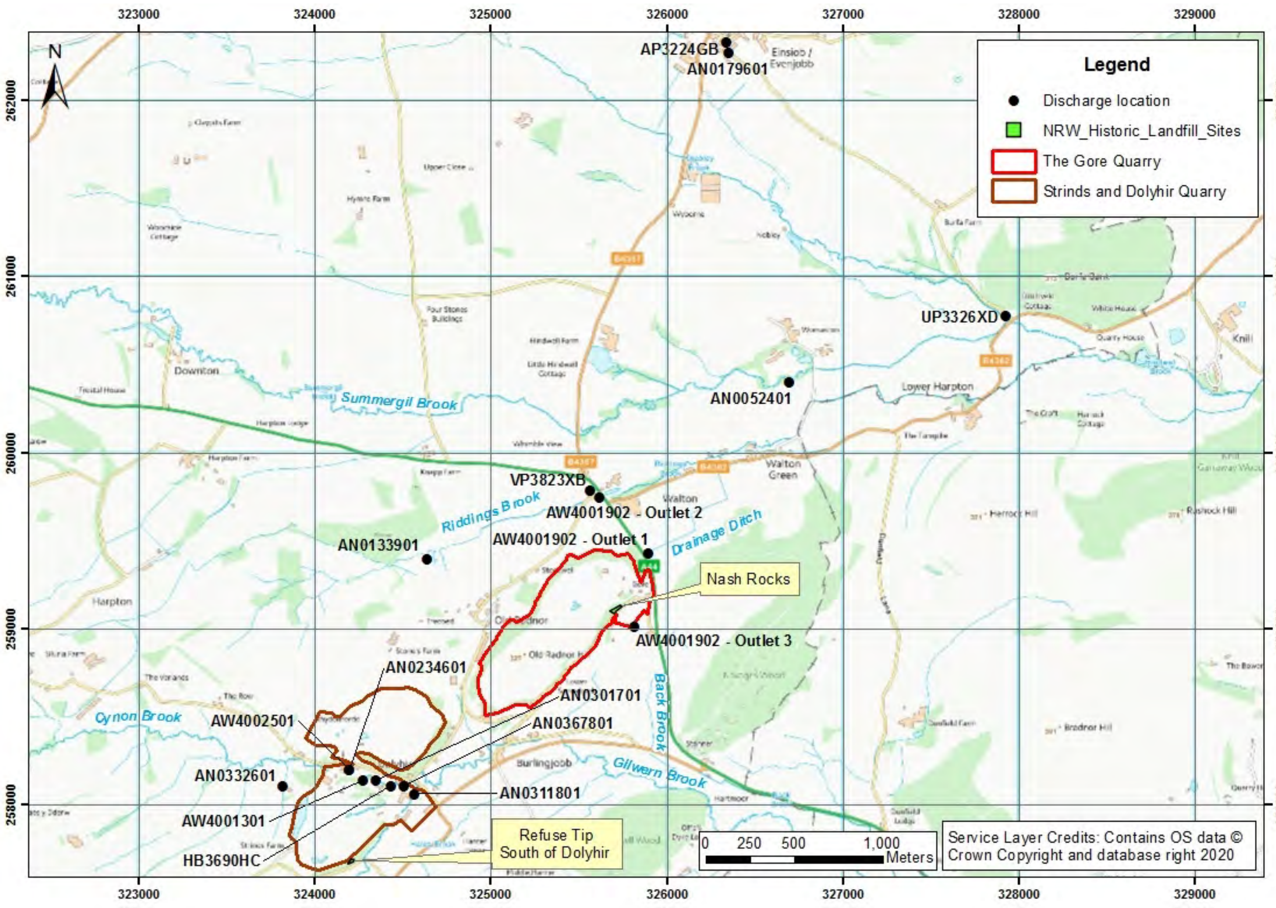
2.2.3 Infilled ground / landfilling

Details of historical landfills located within 3 km of the Site have been obtained from Natural Resources Wales (NRW) and are presented in Table 2.2 and in Figure 2.4. No active landfills are found in a 3 km radius around the Site.

Table 2.2 Landfills within the Site vicinity

Type	Quarry	Address	Operator	Waste type	Distance from Site	Site active
Historical	Nash Rocks	Gore, Powys	No data	No data	At Site	No data
	Refuse Tip south of Dolyhir	Weythel, Presteigne, Radnorshire	No data	No data	1,110 m	No data

Figure 2.4 Historical landfills and discharge consents



2.3 Hydrology

2.3.1 Rainfall

FEH (2021) quotes a long term average rainfall in the area of 926 mm/year, while data derived from CEH-GEAR (1961-2017) shows an average rainfall of 1001 mm/year for the Arrow at Titley Mill station, located 7 km away from the Site. SLR (2016) reports average rainfall and actual evapotranspiration of 1080 mm and 628 mm respectively from MORCES square 134 (1971 to 2000) which would suggest an average effective rainfall of 452 mm/a.

Extreme rainfall events for the Site are estimated from FEH as 60 mm for a two-day, five-year return period storm and 45 mm for a two day, one-year return period storm. Rainfall totals for more intense one-hour storms are 18 mm and 13.5 mm for five- year and one-year return period respectively.

2.3.2 Surface water features

The quarry is excavated into the Old Radnor Hill; this hill drains in all directions away from the Site, while the quarry drains to the northeast, towards the quarries discharge permit point. These water features are shown in Figure 2.5.The maximum height of the hill was c. 330 mAOD prior to quarrying with the floor level currently at c. 242 mAOD.

Surface water to the north is captured by the Riddings Brook, located about 245 m to the north of the Site (at an elevation of c. 185-195 mAOD) and flowing from west to east. It joins the Hindwell Brook about 3 km to the northeast which subsequently joins the River Lugg about 10 km to the northeast. A drainage ditch commencing in fields immediately to the northeast of the Site reaches the Riddings Brook about 800 m to the northeast. Two springs are located to the north of the Site, at elevations of 229 mAOD and 193 mAOD. During the Site visit on 1 December 2021, wet ground, but no flow, was observed. Additionally, Ordnance Survey mapping does not show the development of a stream.

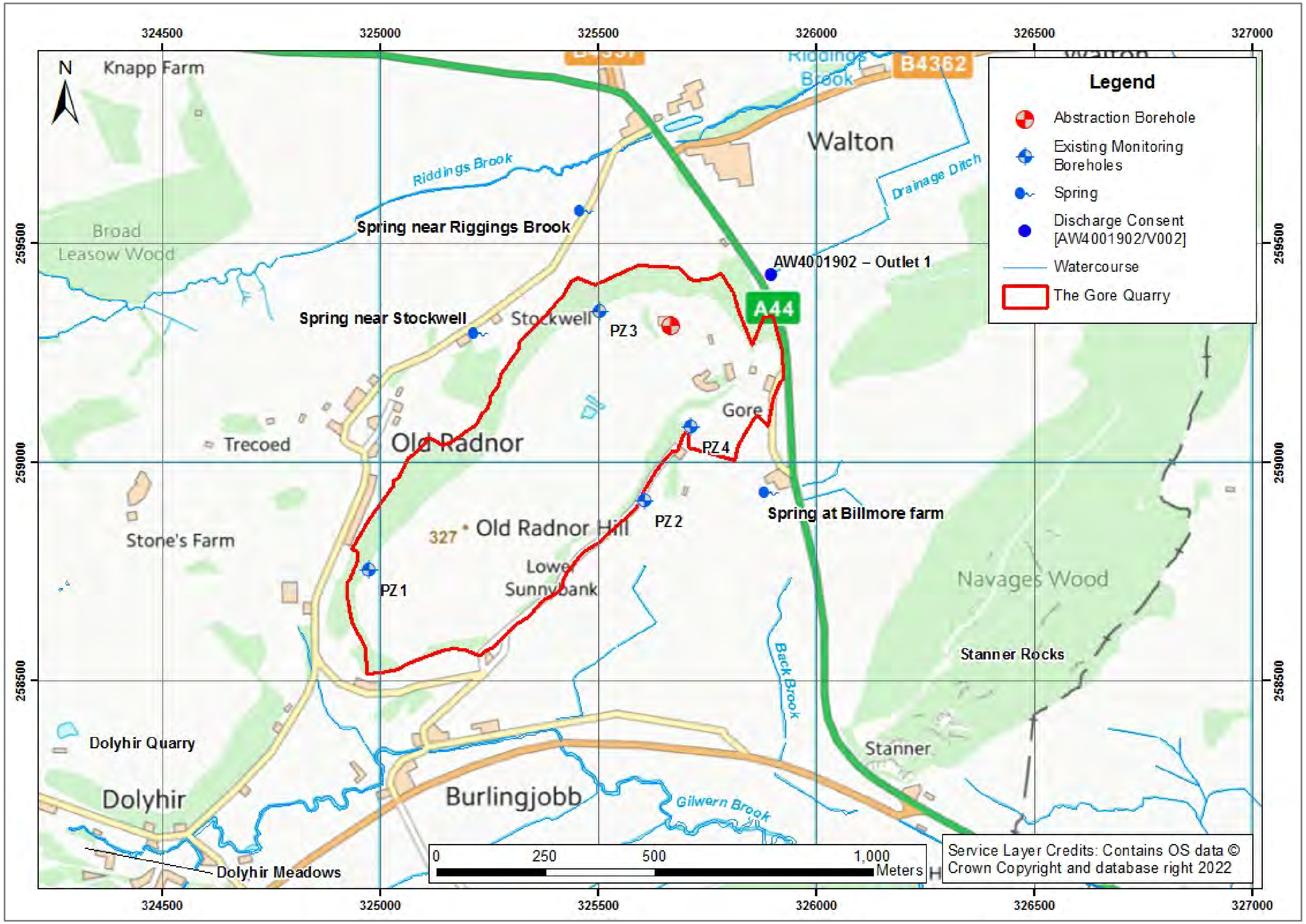
Surface water to the south is captured by the Gilwern Brook, located 155 m from the Site, or its tributaries, such as the Back Brook located 300 m south from the Site. The Gilwern Brook is a sub-catchment of the River Arrow which subsequently joins the River Lugg at Leominster. Two springs, at elevations of 237 and 231 mAOD, are shown as tributaries of the Gilwern Brook by the Ordnance Survey maps on the southern and southwestern slopes respectively. During the Site visit, flowing water was observed from the spring at Gore Barn; the spring at Yarn Farm could not be accessed. A third spring at an elevation of 210 mAOD is not shown as a tributary of the Gilwern Brook or its tributaries, and standing water and vegetation were observed during the site visit. A summary of the springs is given in Table 2.3, and the location of the springs and watercourses are shown on Figure 2.5.

Three potential springs were requested by NRW to be monitored during the pumping test and this is detailed in Stantec (2023) – see Appendix H.

Table 2.3 Springs locations

Name	East	North	Approximate surface elevation (mAOD)
Spring at Billmore farm	325894	258930	210
Spring at Gore barn	325608	258752	231
Spring at Yarn farm	324816	258644	237
Spring near Riggings Brook	325469	259576	193
Spring near Stockwell	325228	259296	229

Figure 2.5 Surface water features



2.3.3 Discharge consents

Discharge consents within a 3 km radius of the Site were requested from NRW. The discharge consents are summarised in Table 2.4 and their locations are shown on Figure 2.4. The discharge permit number AW4001902 is the discharge consent for the Site, which is further discussed in Section 4 below.

Table 2.4 Discharge consents within 3 km radius of the Site

Permit Number	East	North	Dist. from Site (m)	Discharge rate (l/s)	Limit definiton	Discharge type
AW4001902 – Outlet 3	325823	259016	7	0.60	Max	Trade - mineral workings
AW4001902 – Outlet 1	325900	259430	145	15.00	Max	Trade - mineral workings
AW4001902 – Outlet 2	325625	259745	361	1.10	Max	Trade - mineral workings
VP3823XB	325566	259785	405			Sewage - Final/treated effluent - not water company
AN0133901	324640	259400	686	0.12	Max	Sewage - Final/treated effluent - water company
AN0311801	324570	258060	881			Trade - mineral workings
AN0367801	324510	258110	888			Sewage - Final/treated effluent - not water company
HB3690HC	324435	258105	948			Trade - unspecified
AN0301701	324350	258140	995			Sewage - Final/treated effluent - not water company
AW4001301	324280	258140	1,052	0.17	Max	Trade - unspecified
AN0234601	324200	258201	1,090			Sewage - Final/treated effluent - water company

Permit Number	East	North	Dist. from Site (m)	Discharge rate (l/s)	Limit definiton	Discharge type
AW4002501	324200	258200	1,090	0.02	Max	Trade - site drainage
AN0052401	326700	260400	1,378	0.10	Max	Sewage - Final/treated effluent - not water company
AN0332601	323824	258110	1,454			Sewage - Final/treated effluent - not water company
UP3326XD	327930	260778	2,520			Sewage - Final/treated effluent - not water company
AP3224GB	326341	262334	2,955			Sewage - Final/treated effluent - not water company
AN0179601	326357	262270	2,966			Sewage - Final/treated effluent - water company

2.4 Hydrogeology

2.4.1 Groundwater classification and systems

The Strinds Formation, Yat Wood Formation and Dolyhir Limestone Formation are classified by the British Geological Survey (BGS) as Secondary B bedrock aquifers. Secondary B aquifers are predominantly lower permeability strata which may have the ability to store and yield limited amounts of groundwater by virtue of localised features such as fractures and weathering.

The presence of springs around the quarry suggest that the bedrock aquifer beneath the Site provides flow to local watercourses; however, the low hydraulic conductivity of the Devensian Till to the north indicates that the hydraulic connection between the aquifer and Riddings Brook will be limited.

2.4.2 Groundwater levels

The spring levels around the Site range from c. 193 to 237 mAOD, compared to the current quarry base of c. 242 mAOD, suggesting that the quarry base is close to the water table.

2.4.2.1 Available data

There are four groundwater level monitoring locations at the Site; one of these locations is a dual piezometer, consisting of two nested piezometers of different depth with different response zones. Monthly groundwater level data are available from September 2015 to September 2023 for all locations. The Abstraction Borehole at the Site was monitored in August and September 2023 as requested by Stantec following the pumping test. Table 2.5 provides a summary of the monitoring locations, which are shown in Figure 2.3. Borehole logs and installation details are not available; however, it is understood that the piezometers are screened in the Strinds Formation, with the response zone being across the bottom 12 m of the borehole.

Table 2.5 Groundwater monitoring boreholes

Monitoring Borehole	Easting (m)	Northing (m)	Elevation (m AOD)	Bottom of Piezometer (mbgl)	Bottom of Piezometer (mAOD)	Lithology expected
PZ1	324976	258753	277.2	46.2	231.0	Strinds Fm.
PZ2a	325607	258911	249.9	28.2	221.8 214.0	Strinds Fm.
PZ2b				35.9		
PZ3	325504	259346	260.7	77.3	183.3	Strinds Fm.
PZ4	325715	259081	244.0	54.4	189.6	Strinds Fm.
Abstraction Borehole	325669	259311	-	11.54*	-	Strinds Fm.

* m below the reference point at the top of the casing, and the stickup of the casing is c. 0.6 m above ground level

2.4.2.2 Groundwater Levels

Figure 2.6 shows the groundwater level hydrographs for the monitoring locations, and Table 2.6 presents the groundwater level data seasonal variation and the average water levels. Mean groundwater levels vary from 232 mAOD at PZ2a and PZ2b to 253 mAOD at PZ1, showing a higher water table elevation to the southwest and a lower water table elevation to the northeast.

Seasonal fluctuations vary between locations but are typically not greater than 3 m. At PZ2a and PZ2b fluctuations are much lower at around 0.45 m, and both piezometers show the same water level and seasonal variation, which suggests that both piezometers are in hydraulic connection and installed within the same hydrogeological unit. Two seasons are observed through the groundwater level monitoring data; high level season from December to April and low level season from May to November.

The quarry area provides a recharge zone for groundwater given the absence of till deposits. With the Site forming a hill, there is no potential to draw groundwater in from outside of the Site until dewatering occurs to a depth lower than the spring elevations, with any groundwater encountered above these levels being provided in the high elevation aquifer from recharge across the hill in which the quarry has been dug.

Groundwater levels are typically 15-20 m higher in PZ1 in the southwest, compared to the other monitoring locations in the northeast. This may be due to a steep hydraulic gradient due to expected moderate hydraulic conductivity of the aquifer, or may be due to the presence of perched groundwater. PZ1 is close to the edge of the quarry face of the main excavation but no seepages into the quarry are observed despite the high groundwater levels measured at this location.

Figure 2.6 Groundwater level hydrographs

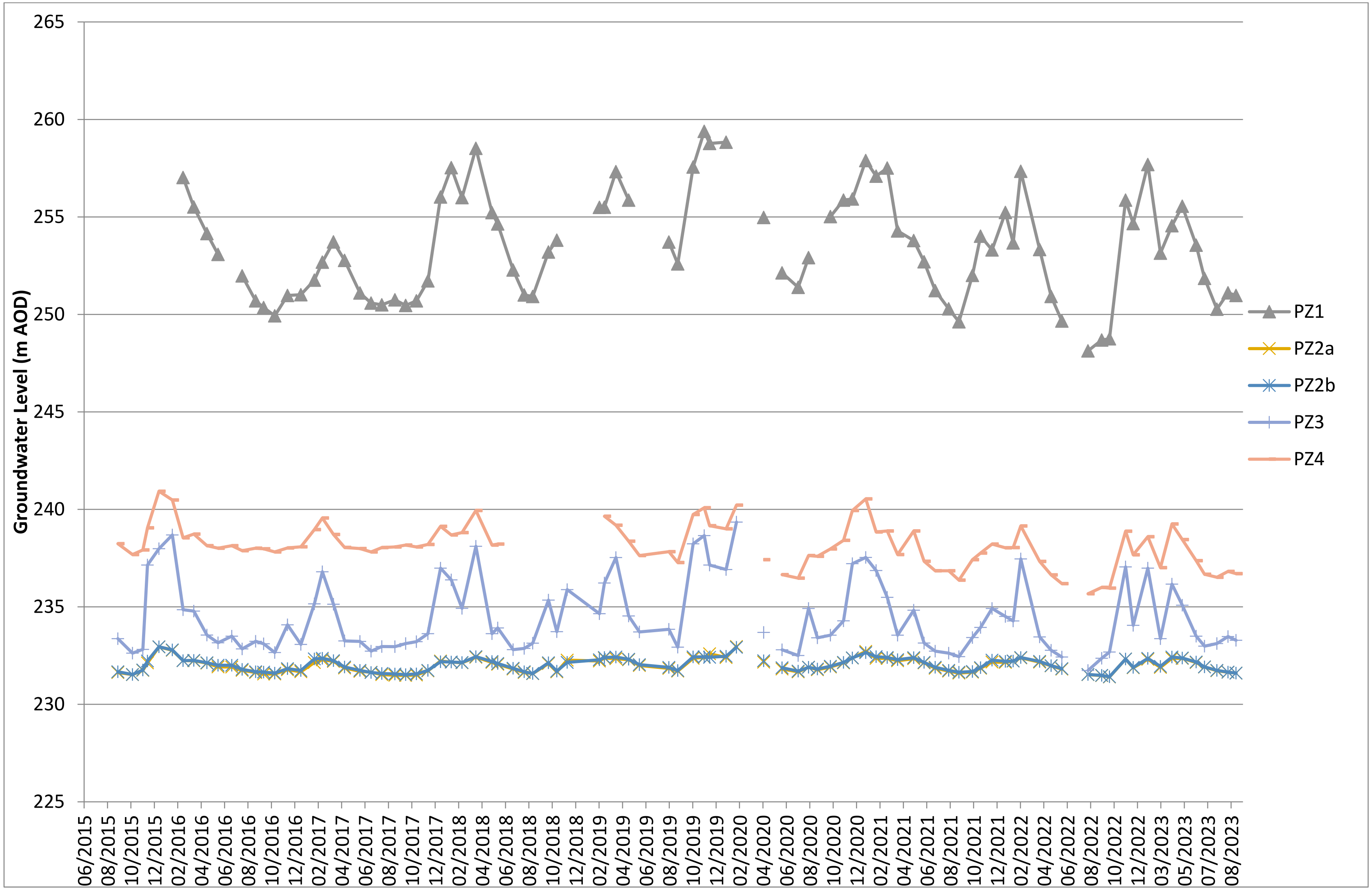


Table 2.6 Groundwater level data summary

Monitoring Borehole	Average water level (mAOD)		
	Dec-Apr	May-Nov	Annual mean
PZ1	255.26	252.25	253.49
PZ2a	232.27	231.83	232.00
PZ2b	232.30	231.86	232.04
PZ3	235.81	233.51	234.45
PZ4	238.85	237.62	238.13

2.4.3 Aquifer properties

From two samples obtained from Precambrian rocks at depths between 39 and 44 mbgl in the Kinley Farm Borehole near Telford (SJ 6716 1478), Jones et al. (2000) reported hydraulic conductivities between 5.79 x 10^{-8} and 2.08 x 10^{-6} m/s.

Hydraulic testing was undertaken at the Site on 13 January 2022 to provide site specific hydraulic data from the Strinds Formation. Two rising head tests were performed on boreholes PZ2b and PZ4, and three falling head tests on boreholes PZ2b, PZ3 and PZ4. Multiple tests were performed at each location to validate individual tests and improve accuracy. The test responses were analysed, and the hydraulic conductivity was calculated using the Hvorslev method (Hvorslev, 1951). Table 2.7 shows a summary of the tests and results, with the calculations presented in Appendix E.

The calculated hydraulic conductivity values are typical of sandstone aquifers (Freeze & Cherry, 1979), with a geometric mean of 5.7x10^{-7} m/s which represents a moderate hydraulic conductivity. Similarly, the calculated hydraulic conductivity is within the range of hydraulic conductivity values reported by Jones et al. (2000). Individual tests results ranged from 1.3x10^{-7} m/s to 1.4x10^{-6} m/s, which also fall within the range of moderate hydraulic conductivity; however, it is noted that hydraulic conductivity values for borehole PZ2b were around one order of magnitude lower than those for PZ3 and PZ4.

Table 2.7 Hydraulic conductivity estimates from slug tests

Borehole	From (mbgl)	To (mbgl)	Water Level (mAOD)	Test	Hydraulic conductivity (m/s)	Hydraulic conductivity (m/d)
PZ2b	23.93	35.93	232.37	Falling head	4.10 x 10^{-7}	3.56 x 10^{-2}
				Rising head	1.4 x 10^{-7}	1.22 x 10^{-2}
				Rising head (manual data)	1.3 x 10^{-7}	1.12 x 10^{-2}
PZ3	65.32	77.32	235.34	Falling head	1.4 x 10^{-6}	1.22 x 10^{-1}
				Falling head (manual data)	1 x 10^{-6}	8.97 x 10^{-2}
PZ4	42.36	54.36	238.34	Falling head	1.3 x 10^{-6}	1.09 x 10^{-1}
				Rising head	8.7 x 10^{-7}	7.54 x 10^{-2}

				Rising head (manual data)	9 x 10^{-7}	7.77 x 10^{-2}
Geomean					**5.67 x 10^{-7}**	**4.91 x 10^{-2} E-02**

SLR (2016) performed permeability tests in the neighbouring Dolyhir Quarry. Low hydraulic conductivities between 2.63 x 10^{-9} m/s to 2.30 x 10^{-7} m/s were estimated for the Dolyhir Limestone, while the hydraulic conductivity for the Wenlock Shale, a geological unit of the Silurian rocks, ranged from 2.37 x 10^{-7}m/s to 5 x 10^{-6} m/s.

A summary of hydraulic parameters calculated from the pumping test at the Abstraction Borehole in 2023 are detailed in Stantec (2023) (see Appendix H) including transmissivity and specific yield. Hydraulic conductivity values estimated from the average transmissivity obtained from the pumping test ranged between 10 and 150 m/d (1.16 x 10^{-4} to 1.74 x 10^{-3} m/s); these are high hydraulic conductivity values, representative of fractured or weathered rock (Kruseman and De Ridder, 2000).

2.5 Conceptual Model summary

Due to its location on the crown of a hill, surface water in the Site drains in all directions away from the Site, to the north towards the Riddings Brook and to the south towards the Gilwern Brook. The quarry works predominantly “gritstone” of the Strinds Formation and Yat Wood Formation. The Strinds Formation is composed of predominantly sandstones, while the Yat Wood Formation is composed of siltstone, mudstone and sandstone. The thickness of the Strinds and Yat Wood Formations is unknown.

The Dolyhir Limestone Formation is found to the northwest and southeast of the Site, and is believed to have a low hydraulic conductivity; however, this formation has a limited lateral extent. Silurian rocks are found to the southeast and are believed to have a similar moderate hydraulic conductivity as the Strinds Formation; therefore, these formations are expected to have some degree of hydraulic connection. The springs to the southeast of the Site are found on Silurian rocks; these springs obtain groundwater from the higher elevation hill on which the Site is located.

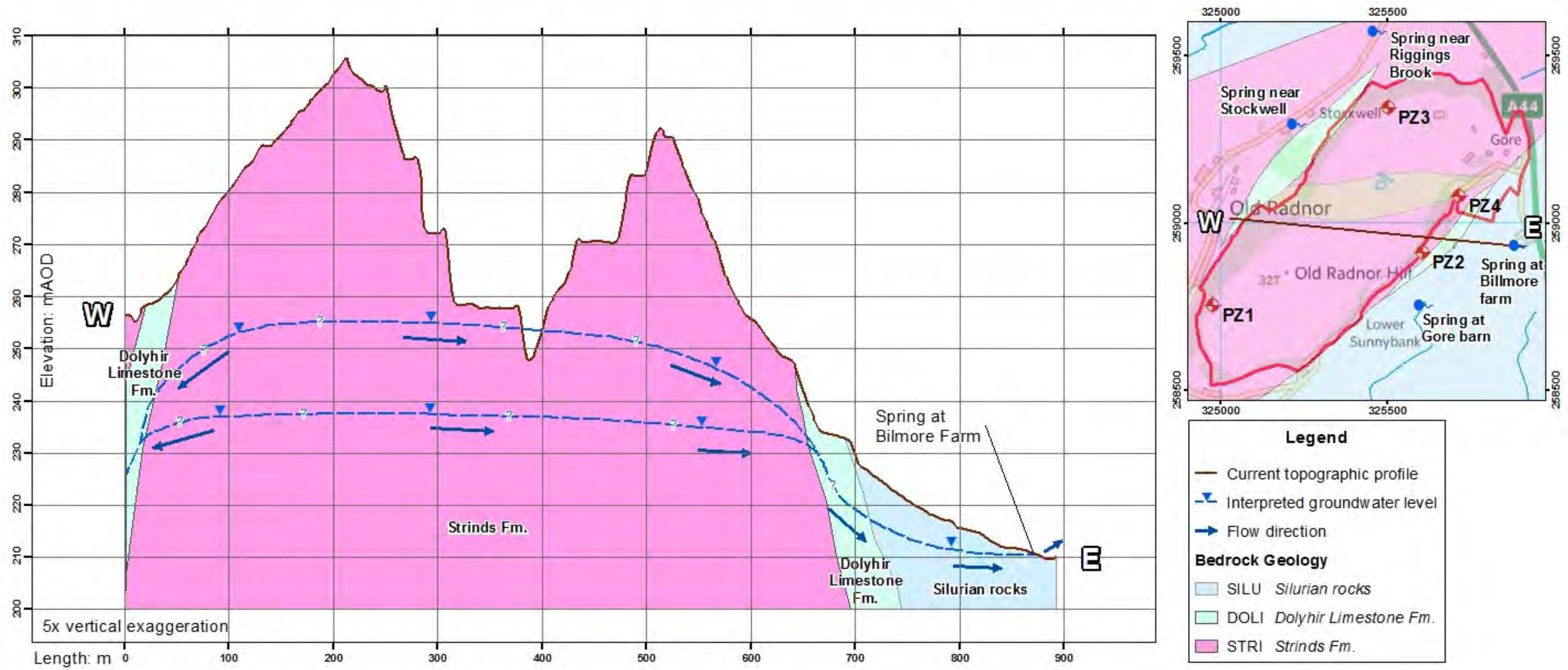
The Strinds Formation, Yat Wood Formation and Dolyhir Limestone Formation are classified as Secondary B bedrock aquifers, which are expected to store and yield limited amounts of groundwater by localised features such as fractures, thin permeable horizons and weathering. The springs around the Site are an expression of these yields.

Stantec (2023) interpreted a reduced permeability boundary formed by the Yat Wood Formation, which crosses the Site from west to east, and reduced the drawdown to the south of the Site. Similarly, due to the high transmissivities estimated, the superficial sandstone from the Strinds Formation around the Abstraction Borehole is expected to be highly fractured and/or weathered.

Although the Riddings Brook flows over superficial deposits of low hydraulic conductivity, the springs located around the quarry will provide baseflow to the Riddings Brook. Similarly, to the south, a limited hydraulic connection exists between the bedrock aquifer and the Alluvial deposits due to the difference in permeabilities; however, the springs will again provide baseflow to the Gilwern Brook. Thus, any reduction in flow from the springs and in groundwater levels may result in an impact to surface water courses.

Recharge to groundwater below the Site will only be produced by means of rainfall. The fractured / weathered nature of the Strinds Formation at the surface around the Site is expected to induce recharge; however, given the steep topography, it is anticipated that a large percentage of rainfall will form surface water runoff, reducing infiltration to the aquifer. It is expected that flow from the springs will be governed by the rainfall seasonality, with some delay in baseflow response to rainfall due to the moderate hydraulic conductivity of the Strinds Formation.

Figure 2.7 Conceptual model cross-section



3 Potential Receptors

3.1 Surface water features

The relevant surface water features identified in Section 2.3.2 within the vicinity of the Site are as follows (see Figure 2.5):

- Riddings Brook, located 245 m to the north, and associate tributaries;
- The Gilwern Brook, located 155 m to the south, and associate springs and tributaries including Back Brook located 300 m to the south;
  A drainage ditch that receives the discharge from the Site and connects to the Riddings Brook.

These are considered further within the impact assessment presented in Section 5.

3.2 Protected rights abstractions

3.2.1 Licensed groundwater abstractions

NRW has provided information of one licenced groundwater abstraction, while the Environment Agency has provided information of three licenced groundwater abstractions, within a 3 km radius of the Site. The licenced groundwater abstractions are shown Figure 3.1 and summarised in Table 3.1.

The groundwater abstraction located in Wales (Licence Nr: WA/055/0009/009) is c. 960 m southwest of the Site. This abstraction is operated by Tarmac at Strinds Quarry and is used for mineral washing. The closest groundwater abstraction located in England (Licence Nr: 19/55/9/0330) is c. 1,100 m southeast of the Site. The three abstractions included within this licence are used for public water supply by Welsh Water and are related to the Dunfield Source Protection Zone (SPZ). The Site is located c. 320 m from the border of the SPZ II (outer catchment) and c. 650 m from the border of the SPZ I (inner Protection Zone) associated with licence 19/55/9/0330 as shown in Figure 3.1. SLR (2008) indicates that the Dunfield SPZ is associated with superficial deposits; in this sense, it is expected that these Licenced Groundwater Abstractions obtain groundwater from an aquifer perched above the Silurian rocks and in connection with the Gilwern Brook. All other licensed abstractions are located over 3 km from the Site.

3.2.2 Licensed surface water abstractions

The only surface water abstraction found within a 3 km radius of the Site is located 710 m southwest of the Site (Licence Nr: 19/55/8/0132/1) and abstracts water from the Gilwern Brook. This abstraction is used by Breedon Southern Ltd. for industrial purposes. The licenced surface water abstraction is shown Figure 3.1 with the details summarised in Table 3.1.

3.2.3 Private water supplies

Information concerning private water supplies within 3 km of the Site was requested from two local authorities: Powys County Council and Herefordshire Council.

The requests confirmed twenty records of private water supply abstractions; nine being from springs and eleven from groundwater. These supplies are utilised for domestic and commercial purposes. The private water supply locations are shown Figure 3.1, and summarised in Table 3.2.

Springs taking water from Silurian rocks, which could be in hydraulic continuity with the Strinds Formation, are more than 1 km away from the Site. Springs located on glaciofluvial deposits are located c. 700 m from the Site, and are not expected to withdraw groundwater from the Strinds Formation. It is noted that none of the springs located less than 300 m from the Site, and referred to in Sections 2.3.2, are listed as private water supplies.

It is uncertain which aquifer the boreholes and wells target but, given the expected small abstraction rates, it is expected that the supplies are most likely to be sourced from the shallow superficial deposits.

Table 3.1 Licenced water supply abstractions

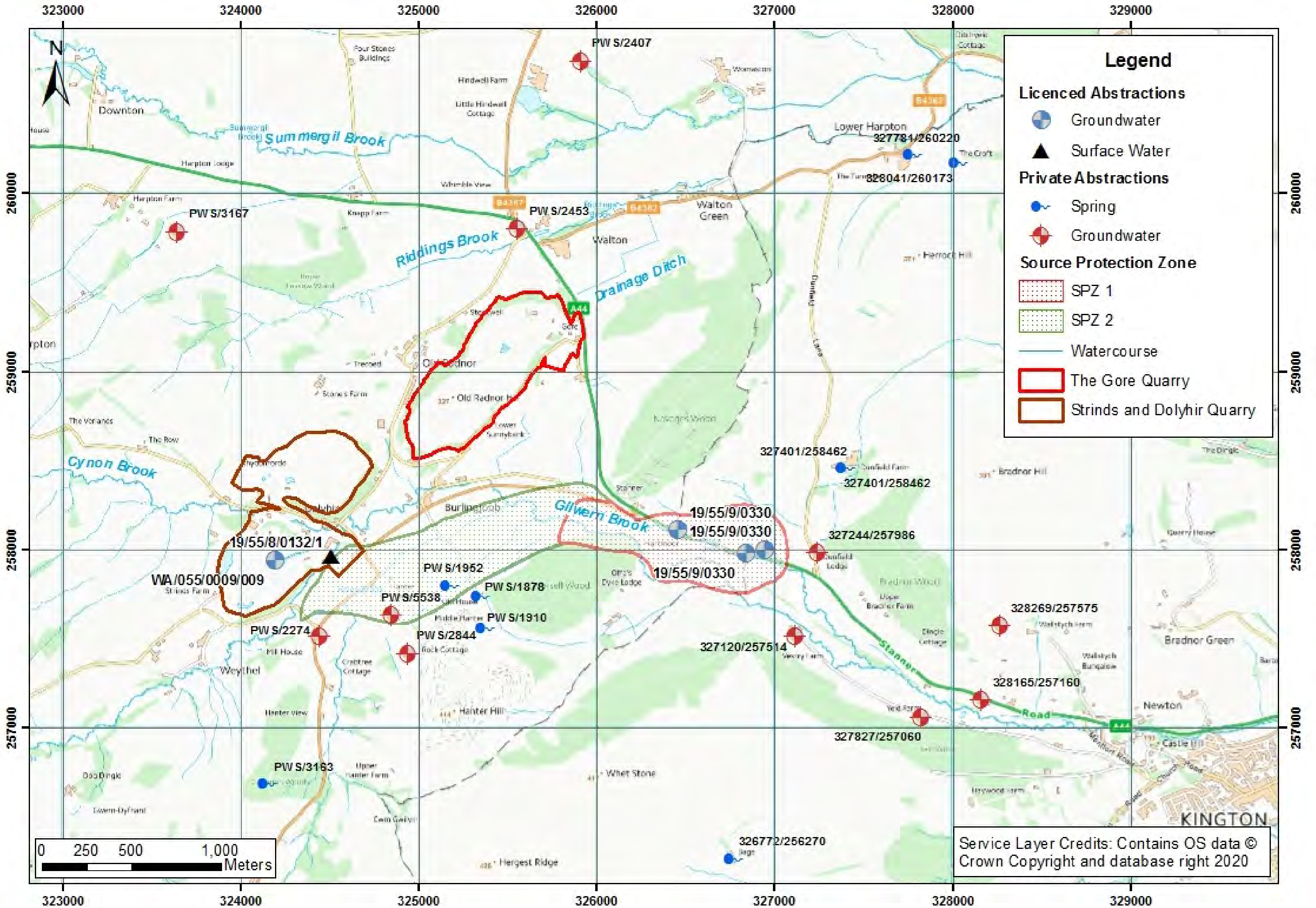
Holder	Licence No.	Distance from Site (km)	Use	Type - Source
Breedon Southern Limited	19/55/8/0132/1	0.71	Industrial, Commercial and Public Services	Surface Water – Gilwern Brook
Tarmac Trading Limited	WA/055/0009/009	0.96	Mineral washing	Groundwater – Dolyhir Limestone
Dwr Cymru Cyfyngedig (Welsh Water)	19/55/9/0330	1.10	Potable water supply	Groundwater – Alluvium
Dwr Cymru Cyfyngedig (Welsh Water)	19/55/9/0330	1.45	Potable water supply	Groundwater – Alluvium
Dwr Cymru Cyfyngedig (Welsh Water)	19/55/9/0330	1.52	Potable water supply	Groundwater – Alluvium

Table 3.2 Private water supplies within 3 km of the Site

Name	Distance from Site	Source	Use	Council
PWS/2453	0.4 km north	Groundwater	Domestic	Powys County
PWS/1952	0.7 km south	Spring	Tenanted	Powys County
PWS/1878	0.8 km south	Spring	Domestic	Powys County
PWS/5538	0.9 km south	Groundwater	Commercial	Powys County
PWS/1910	1.0 km south	Spring	Domestic	Powys County
PWS/2844	1.1 km south	Groundwater	Domestic	Powys County
PWS/2274	1.1 km southwest	Groundwater	Domestic	Powys County
PWS/2407	1.3 km north	Groundwater	Domestic	Powys County
327401/258462	1.6 km east	Spring	Commercial	Herefordshire
327401/258462	1.6 km east	Spring	Domestic	Herefordshire
PWS/3167	1.6 km northwest	Groundwater	Commercial	Powys County
327244/257986	1.7 km southeast	Groundwater	Domestic	Herefordshire

Name	Distance from Site	Source	Use	Council
327120/257514	2.0 km southeast	Groundwater	Domestic	Herefordshire
PWS/3163	2.0 km southwest	Spring	Domestic	Powys County
327781/260220	2.1 km northeast	Spring	Domestic	Herefordshire
328041/260173	2.3 km northeast	Spring	Domestic	Herefordshire
327827/257060	2.8 km southeast	Groundwater	Domestic	Herefordshire
326772/256270	2.8 km southeast	Spring	Domestic	Herefordshire
328269/257575	2.8 km southeast	Groundwater	Domestic	Herefordshire
328165/257160	3.0 km southeast	Groundwater	Domestic	Herefordshire

Figure 3.1 Licensed and private abstractions in a 3 km radius around the Site and SPZ



3.3 Designated conservation sites

The locations of designated conservation sites within the local area are shown on Figure 3.2 and listed on Table 3.3.

Dolyhir Quarry Special Scientific Interest (SSSI) is located at Strinds and Dolyhir Quarry, c. 190 m southwest from the Site; this designation is of geological interest and is not water dependent, so is not considered to be a relevant receptor from quarry dewatering.

The Site is located c. 600 m west from the Stanner Rocks SSSI and National Nature Reserve, which occupies 17 ha of land with a geological interest and diverse flora, including the rare Radnor Lily (Gagea bohemica). This SSSI is not believed to be groundwater-dependent due to the elevation at which it is located, at the top of a hill formed by an igneous intrusion and clearly above the underlying groundwater. Therefore, it is not considered as a relevant receptor.

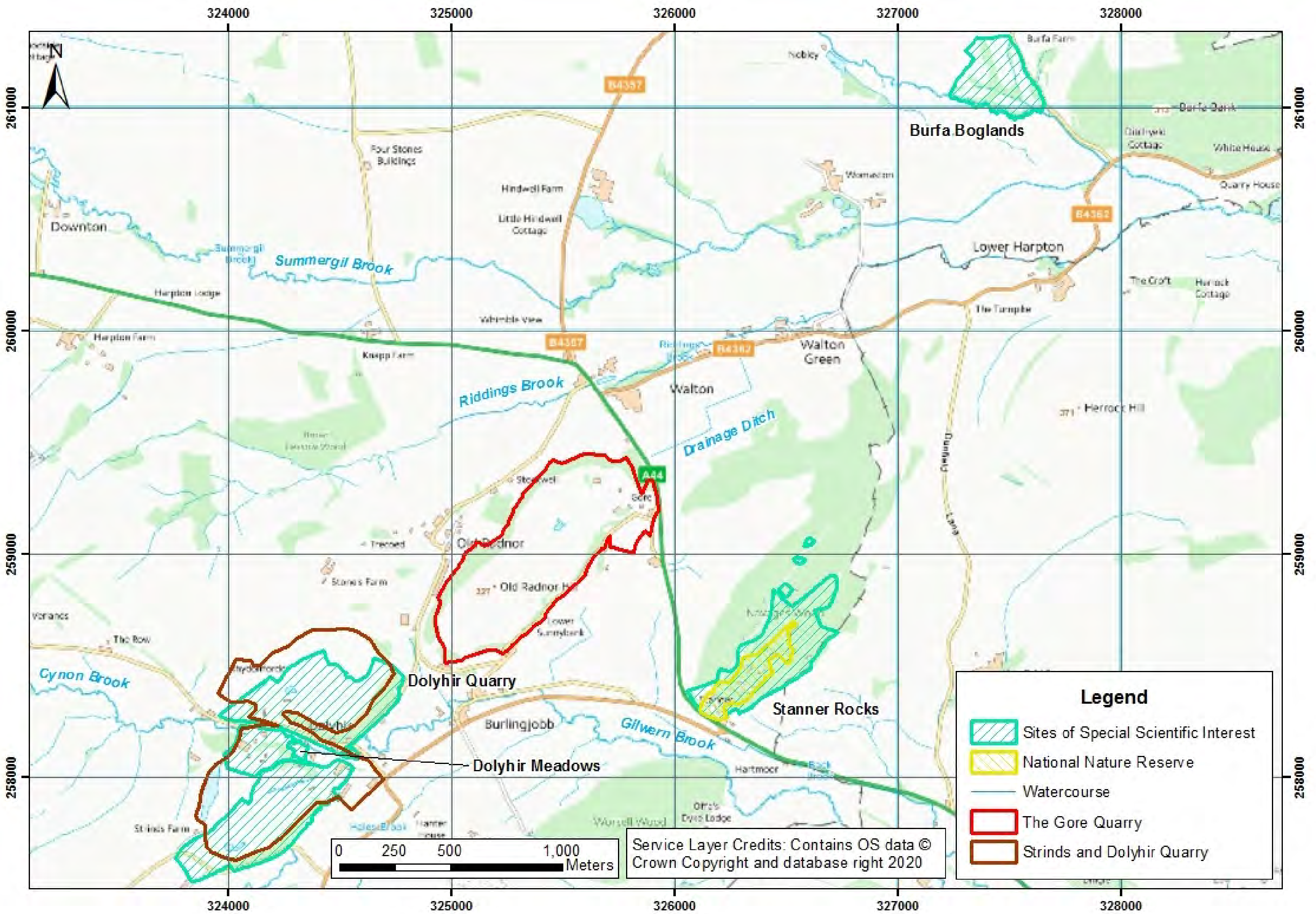
The Dolyhir Meadows SSSI is located c. 730 m to the southwest of the Site and protects two meadows that support flora and fauna. Similarly, the Burfa Boglands SSSI is located 2,200 m to the northeast of the Site and supports flora and fauna.

Gilwern Brook and Riddings Brook are tributaries of the River Lugg, which is part of the River Wye Special Area of Conservation (SAC). This SAC is located c. 28 km from the Site, and any discharge to these brooks will potentially affect this designated area.

Table 3.3 Designated sites within 3 km of the Extension Site

Site name	Designation	Distance from Extension Site	Reason for Designation	Groundwater Dependent
Dolyhir Quarry	SSSI	190 m southwest	Geological deposits	No
Stanner Rocks	National Nature Reserve and SSSI	600 m east	Biological interest and geological deposits	No
Dolyhir Meadows	SSSI	730 m southwest	Biological interest	Yes
Burfa Boglands	SSSI	2.2 km northeast	Biological interest	Yes

Figure 3.2 Designated sites in the surrounding area



4 The Development and Future Water Permitting Requirement

4.1 Quarry development

4.1.1 Operational stage

The planning permission allows working to 164 mAOD, with the quarry base currently being at c. 242 mAOD. The Quarry Development Plan for the next 4 to 5 years (see Appendix C) shows a continuation of operations by progressing existing bench levels established during the previous Quarry Development Plan, and by excavating an area called "The Sinking" down to 235 mAOD. In this development period there will be a yield of c. 2,500,000 tonnes of gritstone and a further 1,500,000 tonnes of toprock.

Development during the next 4 to 5 years will occur in four phases; during the first phase the Site will be developed to 235 mAOD and the quarry will be worked towards the southwest. The second, third and fourth phases will continue working the development levels progressively to the southwest, and "The Sinking" will be used as a quarry tip for waste material[1] from the quarry. The development will continue within the Precambrian Strinds Formation (gritstone) and Yat Wood Formation.

4.1.2 Restoration stage

The aim of the restoration is to provide sustainable after uses. Part of the Site will be restored to woodland and grassland to assimilate the restored quarry development within its local area, and to enhance the biodiversity of land, linking into adjacent habitats, in order to meet the biodiversity net gain targets set out in the Powys County Council and the National planning policies.

A waterbody will be created in the quarry void for biodiversity purposes. Woodland will be planted on the northern boundary, utilising soil and rubble material to establish a grassland ground cover, and quarry waste rock will be used to form scree slopes. Details of the proposed restoration plans are set out in Appendix C.

Restoration of the Site does not require importation of any inert fill material. On-Site overburden, subsoil and topsoil will be used to shape the waterbody, and to create the new landform and planting areas.

4.2 Current site drainage and water management

The Site has a water management plan in place. A series of drains, pipes and settlement lagoons are used to collect and convey surface water, and to allow suspended solids to settle out of suspension within the mineral processing circuit prior to discharge to a drainage ditch off site to the northeast that takes the discharged water to the Riddings Brook.

The Site discharge is governed by the discharge permit AW4001902/V002 which is appended in Appendix D. According to the discharge permit, three discharge locations are permitted; these discharge locations are shown in Figure 2.4 and summarised in Table 4.1.

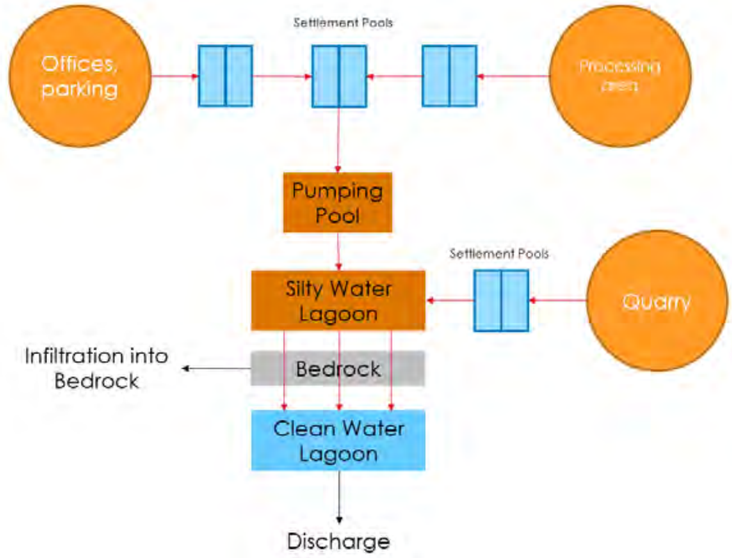
[1] Comprising quarry material, dust, soils, waste rock, silty materials scraped from haul routes etc.

Table 4.1 Quarry discharges

Discharge location	Discharge rate (l/s)	Emission limits	Receiving water	Specifications
Outlet 1	15	TSS < 80 mg/l No visible oil or grease.	Drainage ditch tributary of the Riddings Brook.	Site drainage from an area of 135,963 m^2. Storm overflow > 15 l/s allowed for a 1 in 1 year storm event.
Outlet 2	> 1.1	-	Drain leading to Riddings Brook.	Storm overflow allowed for a 1 in 1 year storm event.
Outlet 3	> 0.6	-	Field ditch leading to Back Brook.	Storm overflow allowed for a 1 in 1 year storm event.

Drainage at the Site currently predominantly consists of surface water; current groundwater inflow is discussed below. The Site is drained largely by gravity with water collected in a settlement pool system in the lowest area of the quarry near the quarry entrance, and in the quarry operations area. Water is then pumped to the Silty Water Lagoon, located in the quarry operations area, from where it is allowed to filter through the bedrock to the Clean Water Lagoon. Water is pumped from the Clean Water Lagoon to the quarry discharge point (Outlet 1), and flow and suspended solids are monitored. A schematic water management flow chart can be seen in Figure 4.1.

Figure 4.1 Water management flow chart

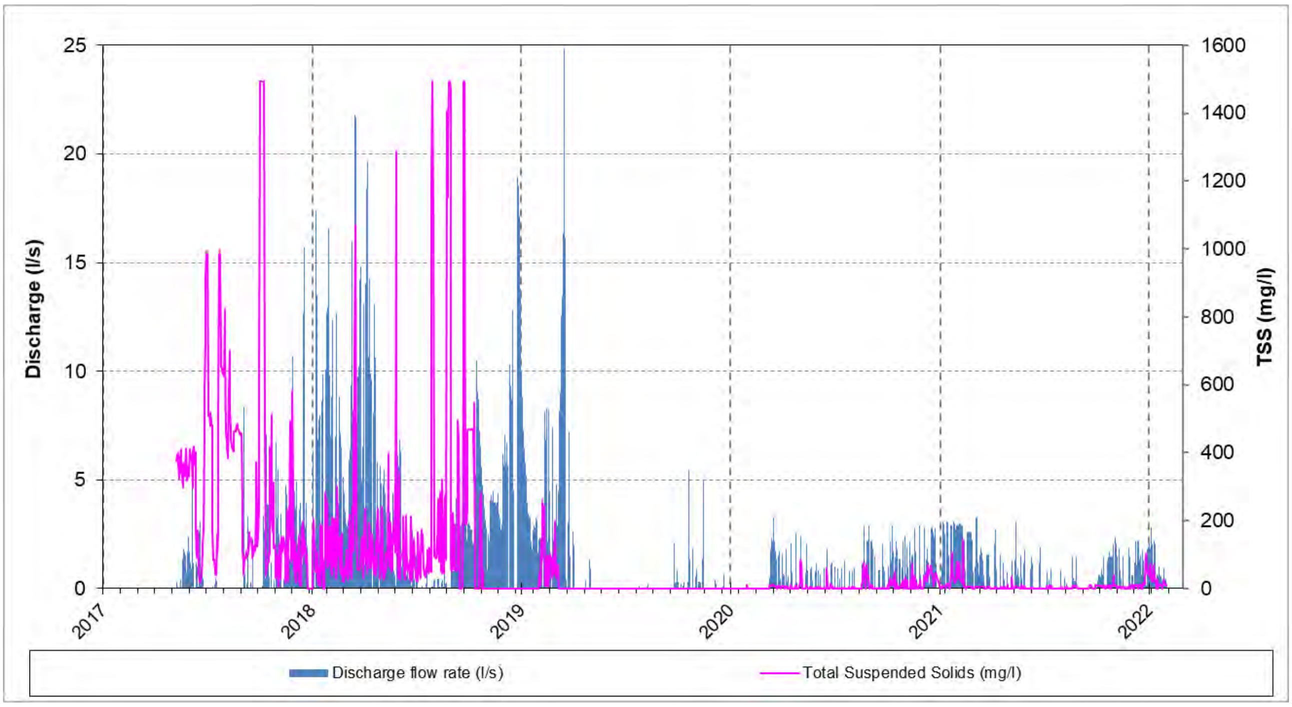


The discharge rate and the total suspended solids (TSS) content are monitored hourly at the exit of the Clean Water Lagoon. The records provided span from May 2017 to January 2022. As shown in Figure 4.1, flow rates and suspended solids have seen a significant reduction since March 2020 due to an improvement in the water management and storage capacity on Site. When the total range of records is assessed, the maximum discharge rate is 24.9 l/s and the maximum TSS value is 1,494 mg/l, while the average discharge rate is 1.6 l/s. From March 2020, the maximum discharge rate is 3.3 l/s while the maximum TSS is 144 mg/l; with averages being 0.7 l/s and 16 mg/l respectively. Table 4.2 shows the monthly average recorded discharge rates.

Table 4.2 Average discharge rates per month (in l/s)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
2017					0.9	0.8	0.1	0.0	0.6	1.5	2.3	2.7	1.1
2018	6.8	4.9	9.3	7.4	2.6	1.5	0.1	0.2	3.2	4.2	3.3	7.5	4.3
2019	3.6	3.0	5.8	0.2	0.0	0.0	0.0	0.0	0.1	0.3	0.3	0.0	1.1
2020			1.0	0.4	0.4	0.3	0.2	0.7	0.5	0.9	0.7	1.4	0.7
2021	2.0	1.9	1.0	0.3	0.4	0.3	0.1	0.2		0.7	0.6	1.0	0.8
2022	0.8												

Figure 4.2 Daily monitoring data from discharge (2017 – 2022)



4.3 Estimate of inflows to the excavation

4.3.1 Assessment of current groundwater inflows

As discussed in Section 2.4.2, mean groundwater levels vary from 232 mAOD at PZ2a and PZ2b to 253 mAOD at PZ1, with a higher water table elevation to the southwest and a lower elevation to the northeast. Seasonal fluctuations vary between locations but are typically not greater than 3 m.

The quarry area provides a recharge zone for groundwater. With the Site forming a hill, there is no potential to draw groundwater in from outside of the Site until dewatering occurs to a depth lower than the spring elevations, with any groundwater encountered above these levels being provided by the high elevation aquifer from recharge across the hill in which the quarry has been dug.

Groundwater levels are typically 15-20 m higher in PZ1 in the southwest, compared to the other monitoring locations in the northeast, with groundwater levels being 6-17 m above levels in deepest part of the quarry at 242 mAOD. The high groundwater levels measured at this location may be resulting from recharge on the hill and the moderate hydraulic conductivity of the aquifer (moderate hydraulic conductivity resulting in high hydraulic gradient), or may be due to the presence of perched groundwater.

Based on the evidence presented above, it is possible that the quarry may already be working below the water table. However, PZ1 is close to the edge of the quarry face of the main excavation but no seepages into the quarry are observed despite. Therefore, it is considered that if working is taking place below the water table then inflows are extremely small and likely < 20 m^3/d. This is evidenced by comparing the estimated average surface water runoff volumes to average discharge rates from the quarry.

Assuming a quarry operations area of 20.5 hectares, and 42% of effective rainfall available after evapotranspiration (452 mm/y, see Section 2.3.1), the average discharge from the quarry is estimated to be 254 m^3/d. However, average discharge rate from 2021 was c. 56 m^3/d, representing only 22% of the potential contribution from rainfall, In reality, this value is conservative as the processing areas, offices and parking areas are not considered. Based on these results, it is likely that a component of surface water is infiltrating to ground on the quarry floor, and therefore that the main water table remains below the quarry floor at <242 mAOD.

4.3.2 Assessment of future groundwater inflows

As discussed above, it is considered that no significant dewatering will be required until the quarry is worked to a level lower than the springs present around the Site which range in elevation from c. 193 to 237 mAOD.

Groundwater level monitoring undertaken to date across the Site indicates the average groundwater level is c. 234 mAOD in the north east which also gives an indication of when quarry dewatering may be required. As discussed above, the high groundwater level recorded at PZ1 of 248-259 mAOD is not considered to be significant with respect to potential groundwater inflows to the quarry.

With the quarry working to 235 mAOD within the current Quarry Development Plan period (next 4 to 5 years) it is likely that groundwater inflows will remain modest, and may remain below 20 m^3/d. Below this rate then an abstraction licence is not required. The long-term plan indicates a proposed working depth of c. 70 m below the water table (234 -164). This section includes theoretical analytical calculations of groundwater drawdown and inflows to the Site associated with operational dewatering based on working to:

- the proposed quarry base at 164 mAOD (assumed 70 m below water table);
- the estimated base of the next quarry bench at 220 mAOD (14 m of dewatering);
- 230 mAOD (4 m of dewatering).

The detail of the calculations is presented in Appendix E.

4.3.2.1 Radius of influence in the Strinds Formation

The radius of influence of an abstraction can be estimated using the Sichardt formula (Equation 1).

$$R_0 = C \cdot s \cdot \sqrt{K} \qquad (1)$$

Where: R_0 is the radius of influence (m);

s is drawdown (m);

K is hydraulic conductivity (m/s); and

C is an empirical factor

For radial flow, a C value of 3000 is typically used (Environment Agency, 2007).

A conservative best estimate hydraulic conductivity value of $5.7x10^{-7}$ m/s, and possible range of between $1.3x10^{-7}$ m/s and $1.4x10^{-6}$ m/s have been estimated, based on hydraulic conductivity estimates from the site specific hydraulic testing in the monitoring boreholes (reported in Section 2.4.3), which represents the hydraulic conductivity of the Strinds Formation at depth, where fractures are expected to be narrower. Using this hydraulic conductivity range and Equation 1, estimates of the radius of influence have been made and are presented in Table 4.3. For the full dewatering depth of 70 m, the radius of influence is predicted to lie in the range of 76 m to 249 m, but is most likely to be around 159 m (conservative best estimate).

A higher hydraulic conductivity between 1.16 x 10^{-4} and 1.74 x 10^{-3} m/s was estimated for the superficial Strinds Formation from the pumping test (see Appendix H). These hydraulic conductivities suggest that the rock is more fractured or weathered closer to the surface. Since the Abstraction Borehole penetrates 1.36 m of the aquifer, it was assumed that the saturated depth of the fractured / weathered rock aquifer is 4 m, similar to the (c. 230 mAOD), and a hydraulic conductivity of 5.9 x 10^{-4} m/s (51 m/d) has been applied to inflow calculations, resulting in a best estimate radius of influence and inflow of 292 m. This radius of influence is conservative, as it is wider than the extent of the hill area above 230 mAOD where the Site is located. Moreover, the Strinds Formation aquifer is limited in areal extent, due to the presence of the Dolyhir Limestone Formation which may reduce the radius of influence to the northwest and southeast from the Site.

Table 4.3 Results of radius of influence calculations

Hydraulic conductivity (m/s)	Radius of influence for a 4 m drawdown (m)	Radius of influence for a 14 m drawdown (m)	Radius of influence for a 70 m drawdown (m)
$1.3x10^{-7}$ (estimated minimum)	-	15	76
$5.7x10^{-7}$ (conservative best estimate)	-	32	159
$1.4x10^{-6}$ (estimated maximum)	-	50	249
$5.9x10^{-4}$ (estimated from pumping test)	292	-	-

4.3.2.2 Groundwater inflow from Strinds Formation

Total groundwater inflow to the quarry void during dewatering has been estimated using the Dupuit-Thiem equation (Equation 2) for steady-state flow to a well in an unconfined aquifer (Kruseman & de Ridder, 1990).

$$Q = \pi \cdot K \cdot \left(\frac{h_1^2 - h_2^2}{2.3 \cdot \log\left(\frac{r_e + R_0}{r_e}\right)} \right) \qquad (2)$$

Where: Q is the groundwater inflow per unit width of the aquifer (m^3/day/m);

K is hydraulic conductivity (m/day);

h_1 is the head in the quarry void (m);

h_2 is the static groundwater level (m);

r_e is the effective well radius (see Equation 3) (m); and

R_0 is the radius of influence (see Equation 1) (m).

The effective well radius was determined by making the pit outline circular using Equation 3. A quarry extent of 705 m x 240 m was used, assuming the maximum extent of the long-term development on the southwestern side of the quarry (Lafarge Tarmac, 2013).

$$r_e = \sqrt{\frac{a \cdot b}{\pi}} \quad (3)$$

Where: r_e is the effective well radius (m);

a is the excavation width; and

b is the excavation length (m).

Horizontal groundwater inflows from the Strinds Formation have been estimated using the parameters in Table 4.4, with the results presented in Table 4.5 to Table 4.7.

Table 4.4 Input parameters for groundwater inflow calculations

Parameter	Value(s)	Justification
Hydraulic conductivity	1.3×10^{-7}, 5.7×10^{-7}, 1.4×10^{-6} and 5.9×10^{-4} m/s	Estimates of minimum, best estimate, maximum, and estimate from pumping test values.
Drawdown	4, 14 and 70 m	Estimate based on groundwater level data and working depths.
Seepage face	0.1 m	Conservative assumption.
Radius of influence	Calculated above	See calculated values in Table 4.3 based on Equation 2.
Effective radius (r_e) of excavated phase	232 m	Calculated from equation 3 based on maximum 705 m x 240 m excavation being open at any time, assuming the full southwestern quarry extent open and dewatered.

Quarry inflow rates are presented below as follows:

- working to a depth of 230 mAOD in Table 4.5;
- working to a depth of 220 mAOD in Table 4.6;
- working to the maximum extent of the development to 164 mAOD in Table 4.7.

Based on the calculations outlined in this section, and using the estimated hydraulic conductivity of the Strinds Formation at depth, and the hydraulic conductivity estimate for the fractured / weathered rock near surface, the best estimate groundwater inflows for working to 230 mAOD is 3,152 m^3/day. However, the potential inflows are constrained by the Site's location on a hill. The estimated hill area above 330 mAOD is 67 hectares, which equates to a maximum groundwater recharge over this area of c. 1982 m3/d. Realistically, the falling topography away from the hill will ensure that the groundwater catchment to the quarry sump will be much reduced, and therefore the estimated groundwater inflows to the quarry sump at 230 mAOD have been constrained to 1000 m^3/day.

The best estimates of groundwater inflow from the fresher Strinds Formation at depth for working to 220 mAOD and 164 mAOD are 237 m^3/day and 1,458 m^3/day respectively. Addition of the higher inflows from the fractured / weathered rock near surface increases this to 1,237 m^3/day and 2,458 m^3/day respectively.

Table 4.5 Results of groundwater inflow calculations (maximum quarry extent to 230 mAOD)

Hydraulic conductivity (m/s)	Radial groundwater inflow (m^3/day)
5.9 x 10^{-4} m/s (estimated from pumping test)	1,000

Table 4.6 Results of groundwater inflow calculations (next quarry bench to 220 mAOD)

Hydraulic conductivity (m/s)	Radial groundwater inflow (m^3/day)
1.3x10^{-7} (estimated minimum)	110
5.7x10^{-7} (conservative best estimate)	237
1.4x10^{-6} (estimated maximum)	384

Table 4.7 Results of groundwater inflow calculations (maximum quarry extent to 164 mAOD)

Hydraulic conductivity (m/s)	Radial groundwater inflow (m^3/day)
1.3x10^{-7} (estimated minimum)	613
5.7x10^{-7} (conservative best estimate)	1,458
1.4x10^{-6} (estimated maximum)	2,561

4.3.2.3 Surface water ingress

In addition to groundwater inflows, incident rainfall and surface water ingress must also be removed during the dewatering activities. During the Operational Stage, it is assumed that surface water inflows will only come from rainfall events. Rainfall water inflows in the operational area will be collected by the water management infrastructure and discharged through the existing drainage ditch to the northeast of the Site under the terms of an discharge activity environmental permit.

Using the maximum extent of the quarry void area of 36 ha and the standard annual average rainfall (SAAR) from FEH (2021) of 926 mm, the average surface water ingress is estimated to be 913 m^3/day (10.6 l/s). Runoff during individual storm events will exceed this amount but the additional water can be held within the excavation before discharge. Additionally, the estimation of average inflow is conservative because losses due to interception and evapotranspiration have not been accounted for, and a portion of runoff may infiltrate to the ground prior to reaching the quarry void.

A 1 cm rainfall event over the 36 hectares catchment, with 10% evapotranspiration, would generate a water volume of 3240 m^3.

5 Assessment of Potential Impacts from Quarry Dewatering

5.1 General impacts of quarry dewatering

The range of potential hydrogeological impacts associated with quarry dewatering is well established, based on a long history of mineral working across the UK in similar hydrogeological settings. Table 5.1 lists potential impacts and the typical mitigation measures applied.

In the following sections the potential for the hydrogeological impacts listed in Table 5.1 to apply to the receptors identified in Section 3 is discussed. This exercise has been undertaken in order to identify any impacts that may be a barrier to obtaining an abstraction licence. The impact assessment methodology applied is explained in Appendix F.

Each of the identified receptors has been assigned a sensitivity from low to high and, along with the magnitude of effect at each receptor, an associated degree of impact has been deduced. Where the degree of impact is more than minor, the potential impact is considered significant and mitigation measures could potentially be required.

Table 5.1 Typical potential impacts of quarry development

No.	Type of Impact	Typical Mitigation Measures
A	Impacts from quarry operation on groundwater levels in surrounding aquifer units	
A1	Impacts on water levels in nearby abstractions	Avoid working nearby, wet working, cut off walls, recharge trenches, discharge of compensation flows to drains.
A2	Impacts on habitats sensitive to shallow groundwater levels	
A3	Impacts on baseflows from springs and watercourses sourced from the Strinds Formation aquifer	
B	Impacts from quarry operation on water quality	
B1	Impacts on groundwater and surface water quality from standard operation	Settlement lagoons, standard planning conditions regarding bunding of fuel tanks, appropriate spill response procedures etc.
C	Impacts from discharge of water from quarry operation	
C1	Impacts on receiving watercourse quality	Settlement lagoons, controlled by discharge consent.
C2	Diversion of baseflow from one catchment to another and associated impact on watercourse flows in catchment.	Relocation of discharge point, discharge of compensation flows to drains.

5.2 Assessment of impacts

The assessment of impacts below is conservatively based on the maximum quarry extent to 164 mAOD.

5.2.1 A1: Nearby abstractions

The upper estimate of the radius of influence during dewatering activities is 292 m, for the upper layer of the Strinds Formation, were the rock is fractured and/or weathered; however, the radius of influence best estimate for the fresh rock is 159 m. Effects on neighbouring protected rights abstractions have been assessed in this section. In accordance with Appendix F, all private water supplies have been assessed as low value receptors. Licenced abstractions have been classified as medium value receptors, and public water supplies, as high value receptors.

The estimated radius of influence from the quarry dewatering suggests that licenced and private abstractions are not at risk from dewatering at the Site. Table 5.2 summarises the distances and the negligible effects on each identified abstraction. Consequently, all impacts are assessed as negligible regardless of the aquifer from which groundwater is abstracted from at each abstraction.

The Dunfield SPZ associated with the Welsh Water licence (No. 19/55/9/0330) is considered to be a high value receptor. However, due to its distance (320 m to the SPZ II) and because the associated boreholes abstract groundwater from the superficial deposits, it is not considered to be at risk from dewatering at the Site.

The radius of influence based on the pumping test at the Abstraction Borehole in 2023 was concluded to not be considered significant and hence drawdown from pumping at the Abstraction Borehole can be considered negligible. More information is documented in Stantec (2023) in Appendix H.

Table 5.2 Assessment of effects on nearby abstractions at final quarry extent

Name	Source	Distance from Site	Type	Receptor Value	Degree of Effect	Degree of impact	Significant
PWS/2453	GW	0.4 km north	Private	Low	Negligible	Negligible	No
PWS/1952	Spring	0.7 km south	Private	Low	Negligible	Negligible	No
Breedon Southern Limited (19/55/8/0132/1)	SW	0.71 km southwest	Licenced	Medium	Negligible	Moderate	No
PWS/1878	Spring	0.8 km south	Private	Low	Negligible	Negligible	No
PWS/5538	GW	0.9 km south	Private	Low	Negligible	Negligible	No
Tarmac Trading Limited (WA/055/0009/009)	GW	0.96 km southwest	Licenced	Medium	Negligible	Negligible	No
PWS/1910	Spring	1.0 km south	Private	Low	Negligible	Negligible	No
PWS/2844	GW	1.1 km south	Private	Low	Negligible	Negligible	No
PWS/2274	GW	1.1 km southwest	Private	Low	Negligible	Negligible	No
Dwr Cymru Cyfyngedig (Welsh Water) (19/55/9/0330)	GW	1.1 km southeast	Licenced	High	Negligible	Negligible	No
PWS/2407	GW	1.3 km north	Private	Low	Negligible	Negligible	No
Dwr Cymru Cyfyngedig (Welsh Water) (19/55/9/0330)	GW	1.45 km southeast	Licenced	High	Negligible	Negligible	No
Dwr Cymru Cyfyngedig (Welsh Water) (19/55/9/0330)	GW	1.52 km southeast	Licenced	High	Negligible	Negligible	No
327401/258462	Spring	1.6 km east	Private	Low	Negligible	Negligible	No
327401/258462	Spring	1.6 km east	Private	Low	Negligible	Negligible	No
PWS/3167	GW	1.6 km northwest	Private	Low	Negligible	Negligible	No

Name	Source	Distance from Site	Type	Receptor Value	Degree of Effect	Degree of impact	Significant
327244/257986	GW	1.7 km southeast	Private	Low	Negligible	Negligible	No
327120/257514	GW	2.0 km southeast	Private	Low	Negligible	Negligible	No
PWS/3163	Spring	2.0 km southwest	Private	Low	Negligible	Negligible	No
327781/260220	Spring	2.1 km northeast	Private	Low	Negligible	Negligible	No
328041/260173	Spring	2.3 km northeast	Private	Low	Negligible	Negligible	No
327827/257060	GW	2.8 km southeast	Private	Low	Negligible	Negligible	No
326772/256270	Spring	2.8 km southeast	Private	Low	Negligible	Negligible	No
328269/257575	GW	2.8 km southeast	Private	Low	Negligible	Negligible	No
328165/257160	GW	3.0 km southeast	Private	Low	Negligible	Negligible	No

5.2.2 A2: Sensitive habitat sites

As explained in Section 3.3, the Dolyhir Quarry SSSI and the Stanner Rocks SSSI and Nature Reserve are not water dependant.

The Dolyhir Meadows SSSI and the Burfa Boglands SSSI support flora and fauna, thus are considered as potential high status receptors. Nevertheless, these designated conservation sites are located more than 730 m away from the Site; therefore, no groundwater drawdown is expected at this distance and to potential impact is assessed as negligible.

5.2.3 A3: Baseflows in springs and watercourses sourced from the Strinds Formation aquifer

The springs located around the Site are not listed as private water supplies or licenced abstractions and therefore have not been considered as receptors. This approach is consistent with that taken in the impact assessment for the 2008 Review of Old Mineral Permissions (ROMP) report (SLR, 2008). Therefore, the surrounding springs have not been considered in the impact assessment. However, although unlikely, it is possible that spring flow impacts may be considered further by NRW during an abstraction licence application.

The Gilwern Brook is located 155 m to the south of the Site, at the edge of the radius of influence best estimate, with the Riddings Brook and the Back Brook located further away. No groundwater drawdown in expected from quarry dewatering at these locations. Nevertheless, the flow reduction in the springs may reduce the flows in these watercourses. The flow contribution from these springs is not expected to be high, and the degree of impact is expected to be minor.

5.2.4 B1: Impacts on water quality from quarry operation

Potential impacts could occur on groundwater and surface water quality from chemical spillage or mobilisation of suspended solids associated with the quarry operation. The Strinds Formation aquifer is classified as a Secondary B aquifer, and is rarely used for private and licenced water supply abstractions. Due to its hydraulic connection with the surrounding springs, and hence with the surrounding watercourses, the Strinds Formation aquifer has been assigned as a low receptor value.

Spills at the Site could feasibly occur from the accidental loss of fluids from mobile or fixed equipment, with resulting impacts on the local groundwater environment. Due to the modest hydraulic conductivity of the bedrock, the degree of effect on the aquifer system is considered to be medium, meaning that there would be a minor degree of impact.

5.2.5 C1: Impacts on receiving watercourse quality

Water from the quarry is discharged to the existing drainage ditch to the northeast of the Site, which is connected to the Riddings Brook. These are assigned as low and medium value receptors respectively. Discharge waters contaminated with chemical spills or suspended solids contents could potentially impact these receptors, with Riddings Brook assessed as potentially at risk of a significant impact which warrants mitigation.

5.2.6 C2: Diversion of baseflow between catchments and associated impact on flows

The discharge of water to the drainage ditch to the northeast of the Site returns the captured water to the Riddings Brook. Currently, there is no consumptive use at the Site; however, when the water table is reached and dewatering commences, an increasing water volume would be diverted from the Gilwern Brook catchment to the Riddings Brook catchment unless a new discharge route to the Gilwern Brook is established.

However, the quarry area in the Riddings Brook catchment is estimated to be c. 0.26 km^2, while the total area of the catchment is c. 3 km^2. Similarly, the quarry area in the Gilwern Brook is estimated to be c. 0.21 km^2, and the total area of the Gilwern Brook catchment, up to the confluence with the Back Brook is 29.5 km^2. The small proportion of the quarry in each catchment suggests that impacts from the diversion of baseflow will be negligible.

Additionally, the quarry deepening will increase the storage volume for storm events, potentially providing a positive effect towards flood risk.

5.3 Summary of potential impacts

Table 5.3 summarises the impacts on relevant receptors during the operational and restoration stages of the Site. Mitigation activities are described below, where this is considered necessary.

5.4 Mitigation measures

Mitigation measures set out in the ROMP report (SLR, 2008) considered the mitigation of the risk of surface and groundwater quality contamination from the quarry operation. As such, the storage of soils, fuels or chemicals can be managed as per the current standard operational procedures from Tarmac environmental management systems. A spill is considered unlikely; however, were this to occur, it can be retained within the active quarry void for a sufficient length of time to allow it to be collected using oil absorbent materials. Contaminated material would then be disposed of in accordance with current best industry practices. Discharge from the quarry void should cease during this time.

The plant will be maintained and inspected regularly to identify leaks of fuel, oil, or other contaminating liquids. Vehicles refuelling will comply with the Control of Pollution (Oil Storage) (Wales) Regulations (2016).

The discharge from the Site is governed by the discharge permit AW4001902/V002 (see Appendix D). The conditions required from this permit will be maintained, including the monitoring and water management currently in place (see Section 4.2).

Table 5.3 Summary of impacts

No.	Type of Impact	Name	Type	Source	Distance from Site	Possible Effect	Receptor Value	Degree of Effect	Degree of Impact	Mitigation Required	Degree of Impact post mitigation
A	Impacts from quarry operation on groundwater levels in surrounding aquifer units										
A1	Nearby abstractions	Licenced and private abstractions		See Table 5.2; no significant impacts identified.							
A2	Sensitive sites	Dolyhir Meadows	SSSI	GW	730 m southwest	None	High	Negligible	Negligible	No	
		Burfa Boglands	SSSI	GW	2.2 km northeast	None	High	Negligible	Negligible	No	
A3	Baseflow in water courses	Gilwern Brook	Watercourse	SW	155 m south	Flow reduction due to reduced flow from springs	Medium	Negligible	Negligible	No	
		Riddings Brook	Watercourse	SW	245 m north		Medium	Negligible	Negligible	No	
B	Impacts from quarry operation on water quality										
B1	Water quality	Strinds Fm. aquifer	Aquifer	GW	At Site	Impact on water quality	Low	Medium	Minor	No	
		Springs	Spring	GW	Around Site	Impact on water quality	Low	Medium	Minor	No	
C	Impacts from discharge of water from quarry operation										
C1	Receiving water course quality	Drainage ditch	Watercourse	SW	Immediately northeast	Impact on water quality	Low	Medium	Minor	No	Low

No.	Type of Impact	Name	Type	Source	Distance from Site	Possible Effect	Receptor Value	Degree of Effect	Degree of Impact	Mitigation Required	Degree of Impact post mitigation
		Riddings Brook catchment	Watercourse	SW	970 m northeast	Impact on water quality	Medium	Medium	Moderate	Yes	Low
C2	Diversion of baseflow	Riddings Brook catchment	Watercourse, Catchment	SW-GW	At Site	Diversion of flow between catchments	Medium	Negligible	Negligible	No	
		Gilwern Brook catchment	Watercourse, Catchment	SW-GW	At Site		Medium	Negligible	Negligible	No	

6 Water Permitting Requirements

6.1 Abstraction licencing requirements

It is considered that an abstraction licence is currently not required at the current working depth to 242 mAOD, because the water inflows into the Site are deemed to be mostly surface water, with minimal groundwater input. As the quarry floor progresses downwards it will intercept the water table. In Wales, abstractions that are greater than 20 m^3/d require an abstraction licence, regardless of the source of this water.

Groundwater monitoring indicates the water table is at c. 234 mAOD and therefore it is likely that the quarry will intercept the water table after the end of the current Quarry Development Plan period in 4-5 years, at which point an abstraction licence would be required. Any groundwater inflows are likely to remain small in the current Quarry Development Plan period, but it is possible that inflows could rise above 20 m^3/d as the quarry floor approaches 235 mAOD, and therefore this application has been submitted well in advance of this occurring on a precautionary basis.

For the first 4 m of quarry development within the saturated zone (down to 230 mAOD), groundwater inflows of 1,000 m^3/d have been estimated (see Section 4.3.2 and Appendix H).

For the full quarry development down to 164 mAOD, a groundwater inflow of 2,458 m^3/d has been estimated (see Section 4.3), with inflows of 1,237 m^3/d estimated for working to 220 mAOD.

The development and restoration plans in Appendix C show the extent of the extraction area to be worked. Therefore, the co-ordinates of the abstraction location cover the entire extent due to the sump location moving as the quarry workings progress.

The existing Abstraction Borehole located within the Site, abstracts groundwater from the same source that will be dewatered and is used for wheel washing and dust suppression. Therefore, a full abstraction licence is required and has been applied for and will cover dewatering, wheel washing and dust suppression. Figure 6.1 shows the moving sump location for the dewatering aspect of the licence and the Abstraction Borehole for the wheel washing and dust suppression aspect of the licence.

6.2 Water availability for licencing

The Site is located within the River Wye catchment abstraction management strategy (CAMS) area (NRW & Environment Agency, 2015), linked to the Assessment Point at:

- River Arrow at Title Mills G/S; and
- Lugg at Byton G/S.

Within both of these catchments the CAMS status is “restricted water available” for abstraction licencing at Q95 flows, but with “water available” for licencing at Q70, Q50 and Q30 flows.

NRW (2015) state that *“there is no separate groundwater licensing policy as such and surface water availability may override local groundwater availability. Licences will only be granted if it can be demonstrated that the abstractions will have “no adverse effect” on the integrity of the River Wye SAC alone and in-combination with all other licensed abstractions”*. The principles which NRW will apply to applications for groundwater abstraction are set out in full in NRW & Environment Agency (2015) including:

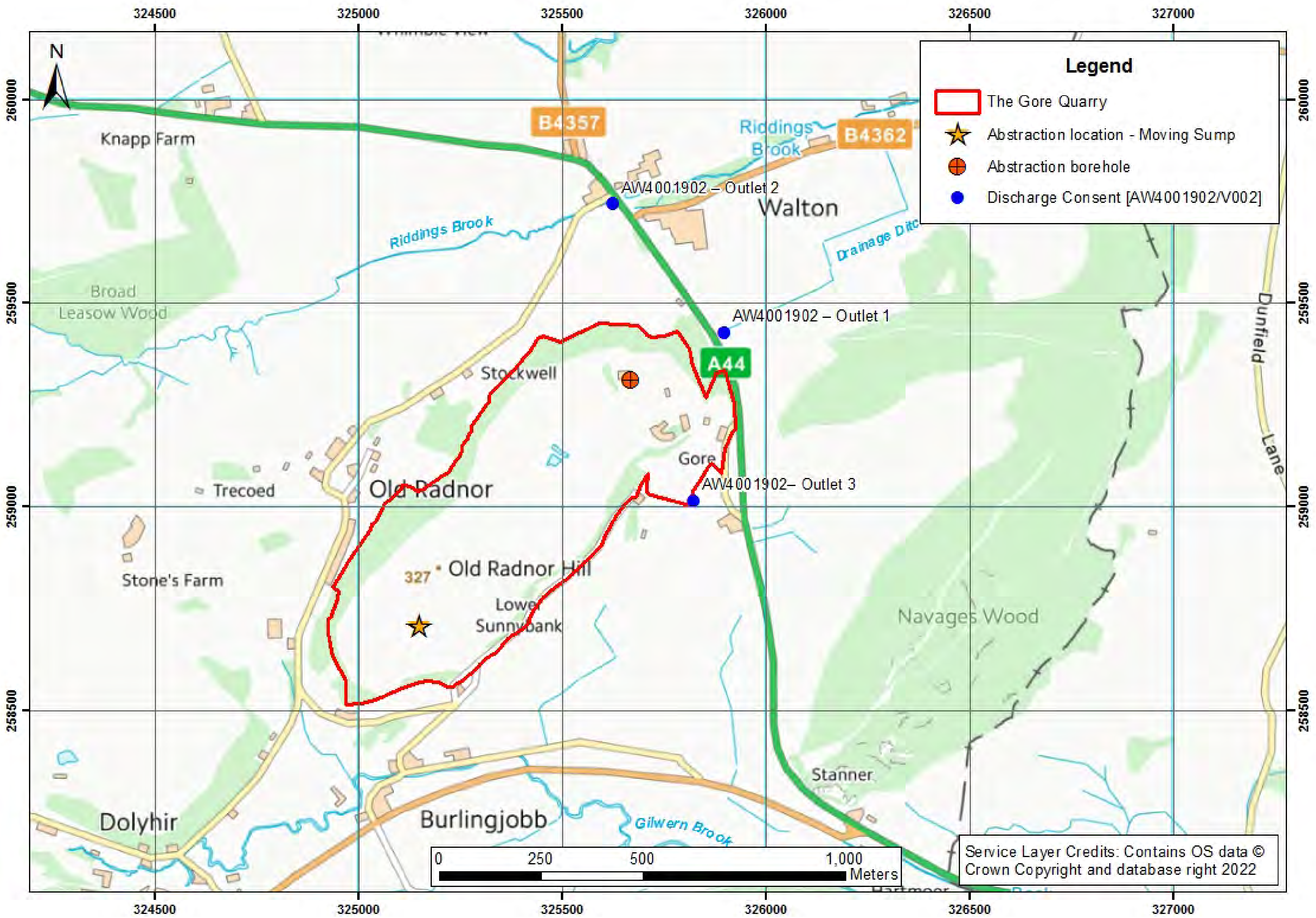
- any application for a new groundwater abstraction licence or upwards variation to an existing licence will be treated on a case by case basis;
- applications will be assessed as to their impact on designated sites and local features of importance such as watercourses, and other groundwater users;
- will not issue a licence that would cause deterioration in the ecological quality of a water body;

- River Wye SAC or designated tributaries then the surface water HOF equivalent of 1,900 Ml/d restriction at Redbrook gauging station will be applied; and
- in most cases a time limit of 31 March 2039 will be applied.

The majority of the Site is within WFD waterbody GB109055041930 (Hindwell Bk - conf Knobley Bk to conf R Lugg Water Body). In 2019 the catchment was assessed as being of “moderate” ecological status, but with a “supports good” hydrological status.

The very south of the Site is with WFD waterbody GB109055041840 (Gilwern Bk – source to conf R Arrow). The catchment has a “good” ecological status and a “supports good” hydrological status.

Figure 6.1 Abstraction licence application locations



7 Summary of Licencing Requirements

7.1 Abstraction rates

Based on the evidence provided above in Section 4.3 for the dewatering volumes and Stantec (2023) (see Appendix H) for the operational use, it is considered that the licencing requirements are as follows:

Dewatering (transfer) volumes:

- annual maximum dewatering rate = 1,230,415 m^3/yr (most likely average inflow of 3,371 m^3/d x 365 days).
- daily maximum dewatering rate = 5,698 m^3/d (most likely average daily groundwater inflow of 2,458 m^3/d + 1 cm rainfall event over 36 hectares catchment with 10% evapotranspiration of 3,240 m^3/day).
- hourly maximum dewatering rate = 633 m^3/hr – based on minimum of 9 hours pumping per day.
- peak instantaneous abstraction rate = 175 l/s.

Note that we would not expect the dewatering element to be limited by a numerical limit on flow rates as this will be heavily influenced by incident rainfall and surface water inflows which will vary from period to period.

Operational use volumes:

- annual maximum dewatering rate = 19,244 m^3/yr (2020 total).
- daily maximum dewatering rate = 100 m^3/d (typical daily requirement).
- hourly maximum dewatering rate = 12.5 m^3/hr – based on 8 hours pumping per day.
- peak instantaneous abstraction rate = 3.5 l/s.

The Abstraction Borehole will be used for the following operational purposes: wheel washing and dust suppression.

The locations of the abstraction points for dewatering volumes and operational use volumes are shown on Figure 6.1.

7.2 Water efficiency

Tarmac would follow good practice with regards to water efficiency. This would include regular inspections to identify leaks in pipes and the water storage areas, plus the re-recirculation of water through the Silty Water Lagoon and Clean Water Lagoon as described in Section 4.2. Any identified leaks would be rectified by Tarmac as soon as is practicable.

8 References

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SLR Consulting Limited, 2016. Dolyhir Quarry Northern Extension Environmental Statement – Volume 1.

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Appendices

Appendix A

Tarmac director details

Date of birth information for Directors and Secretaries.

Company Name: Tarmac Trading Limited

Companies House Link: https://find-and-update.company-information.service.gov.uk/company/00453791/officers

Date: 11 May 2022

Name		Date of Birth
1	**Shaun Davidson**	**18/08/1968**
2	**Robin John Doody**	**12/02/1975**
3	**Johanna O'Driscoll**	**09/01/1976**
4	**Peter Buckley**	**11/06/1965**
5	**Mark Thomas Wood**	**21/01/1973**
6	**Bevan John Browne**	**29/03/1980**
7	**Katie Elizabeth Smart**	**15/04/1977**

Appendix B

Letter of signing authority

To whom it may concern

21 March 2023

Dear Sirs,

Authority to Execute Permit Applications

I, the undersigned, being the Secretary of the Corporate Secretary hereby confirm that:

Lisa Sumner	Permitting and Compliance Manager
Tom Flint	Technical Manager
Delia Boulis	Permitting and Compliance Manager

are each authorised to execute, acting independently, all permit applications, variations, or surrenders on behalf of the Companies in respect of all local authorities.

For the avoidance of doubt, this letter of authority replaces any previous letters of authority provided to your agency in relation to the Companies listed in Appendix 1.

Petershill Secretaries Limited is the corporate secretary of Tarmac Secretaries (UK) Limited. The Companies House link evidencing this is https://beta.companieshouse.gov.uk/company/00532256/officers

Yours faithfully

DocuSigned by:
Andrew Yau
A66A04A78DA9427...

For and on behalf of Petershill Secretaries Limited
Company Secretary of Tarmac Secretaries (UK) Limited

TARMAC.COM

Ground Floor
T3 Trinity Park, Bickenhill Lane
Birmingham
B37 7ES
United Kingdom
0845 812 6400

Tarmac Trading Limited Registered in England and Wales. Company No. 453791
Tarmac Cement and Lime Limited Registered in England and Wales. Company No. 66558
Tarmac Services Limited Registered in England and Wales. Company No. 8197397
Registered address for all companies: **Ground Floor, T3 Trinity Park, Bickenhill Lane, Birmingham, B37 7ES, United Kingdom**
0845 812 6400

Appendix 1- the Companies

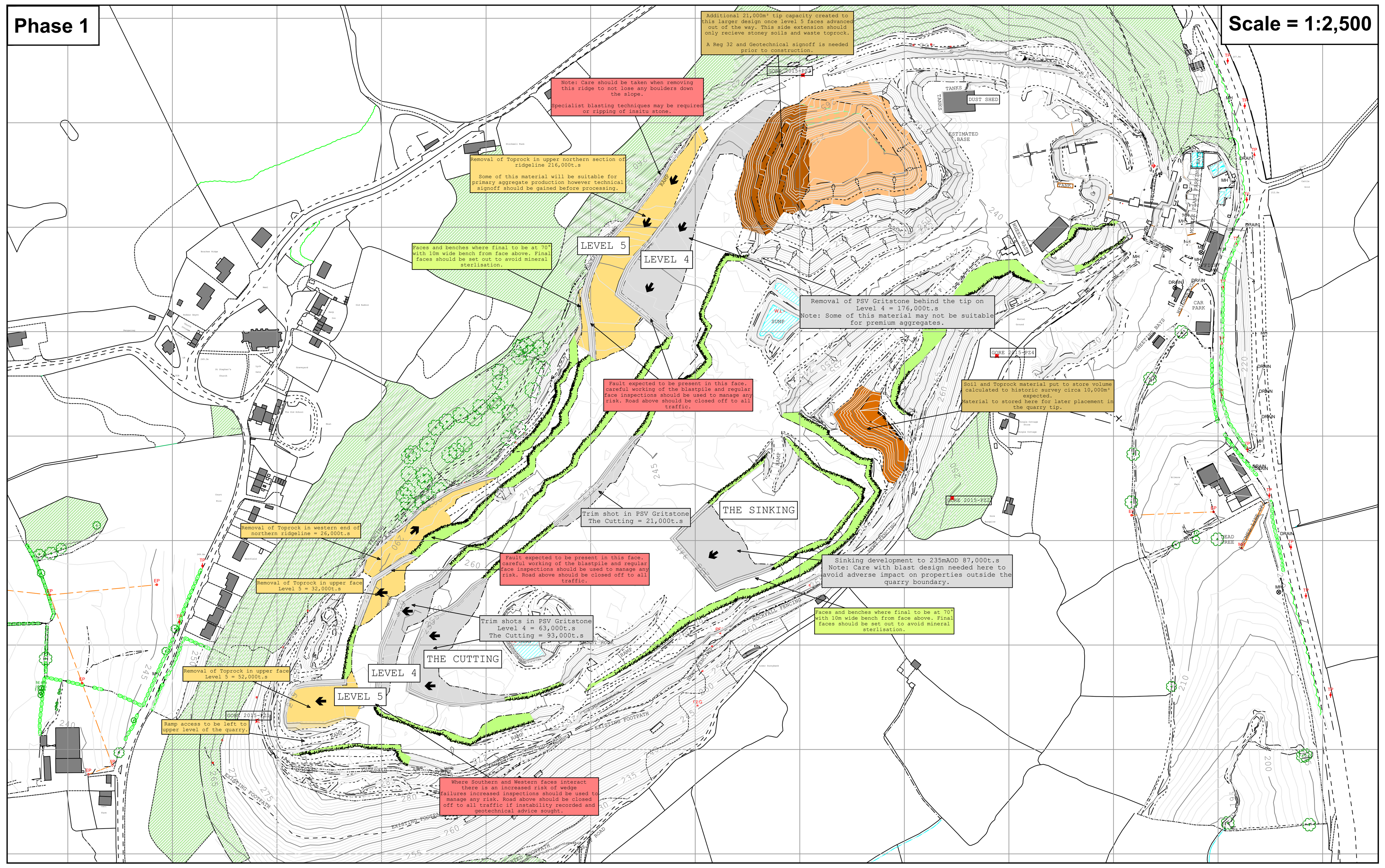
Company Name	Company Number
Cambrian Stone Limited	01579754
East Coast Slag Products Limited	00330538
GRS Rail Services Limited	02632166
Hopkins Concrete Limited	01779181
Solent Aggregates Limited	02730599
Tarmac Aggregates Limited	00297905
Tarmac Building Products Limited	04026569
Tarmac Central Limited	03140596
Tarmac Limited	05560273
Tarmac Northern Limited	03140596
Tarmac Roadstone Limited	00368254
Tarmac Topmix Limited	03132032
Tarmac Trading Limited	00453791
Tarmac Western Limited	01640664

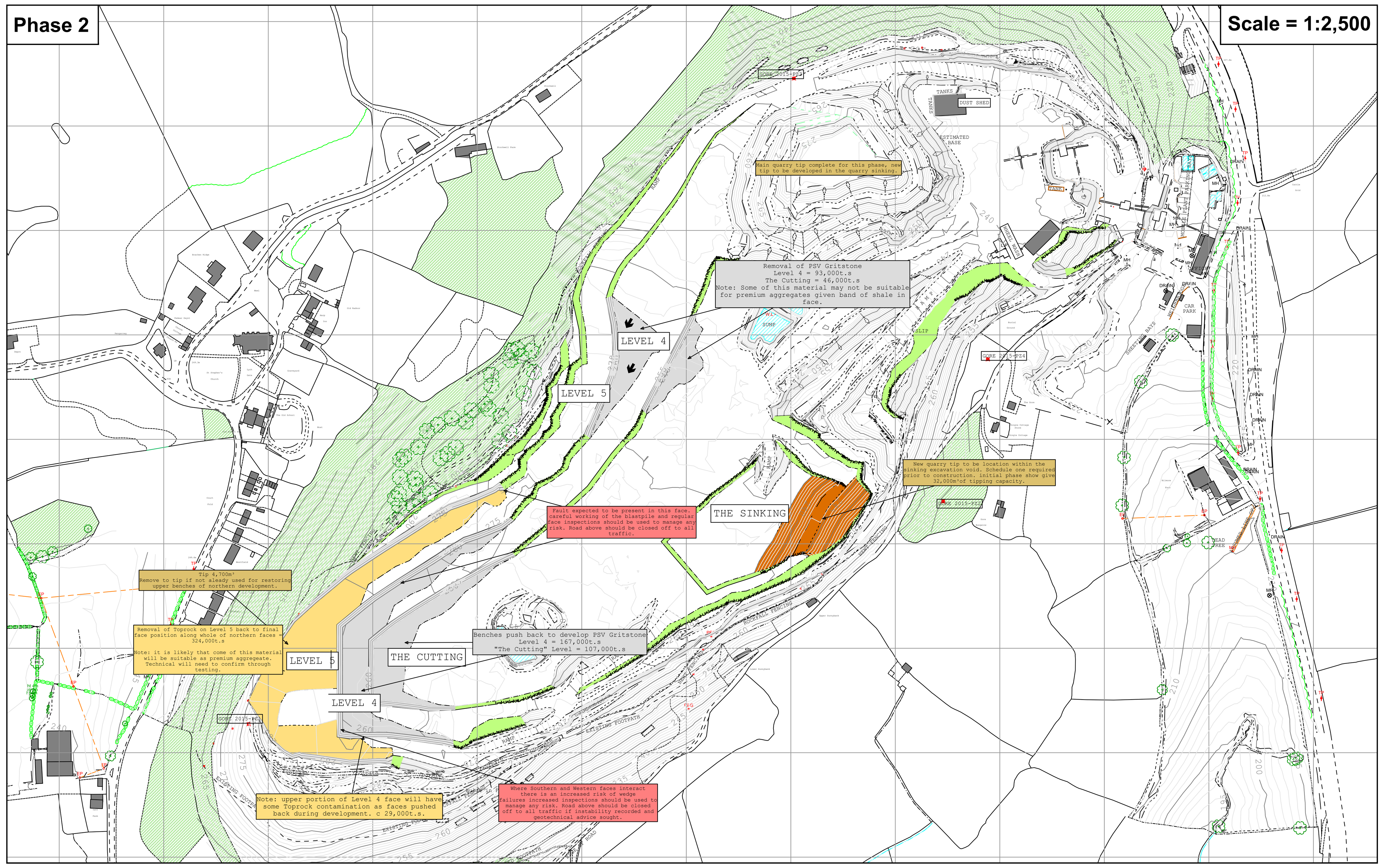
TARMAC.COM

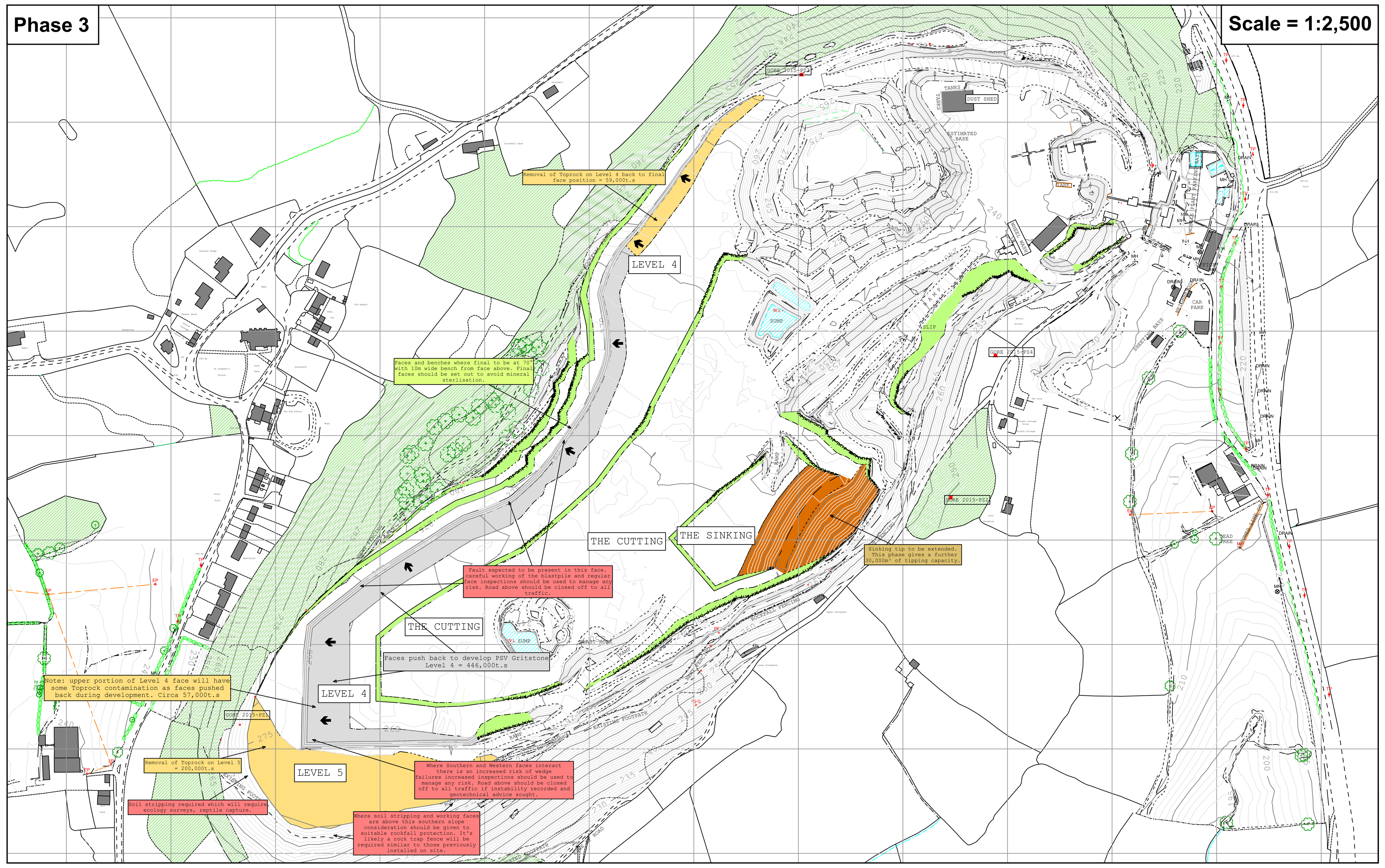
Ground Floor
T3 Trinity Park, Bickenhill Lane
Birmingham
B37 7ES
United Kingdom
0845 812 64000845 812 6400

Appendix C

Development and restoration plans







Job Cards / Additional Information

Legend

- *Toprock extraction area per phase*
- *Gritstone extraction area per phase*
- *Geotechnical hazard information*
- *Direction of progression*
- *Tips*
- *Soil stocking area*
- *Overburden*
- *Historic, dormant or final face positions*
- *Existing woodland or restored area*
- *Ramps*
- *Water bodies*

GORE QUARRY DEVELOPMENT

This plan outlines the staged working of the quarry under the present planning permission. All works are proposed over a 4 to 5 years duration, yielding approximately 2,500,000t.s of Gritstone and a further 1,500,000t.s of toprock. Excavation is aimed to meet the final face designed position in the north and west of the quarry, ensuring the reserve is maximised.

Assumptions

- Annual output 732,000 tonnes
- 2.7t/m³ conversion (Rock)
- 5% Waste

Face progression strategy

This quarry development plan should be considered in conjunction with the revised Final Quarry Design. Phasing within this plan is designed to achieve a consistency of bench levels within the quarry as development progresses, following on from levels established during the previous quarry development plan. This will ensure maximum extraction, and safe working face heights.

Most faces at Gore are designed to be no more than 13.5m high. Occasionally faces may exceed 16m over short lengths, where splitting of the face is impractical. Where faces exceed 15m the phase working scheme aims to reduce these as much as practicable.

Stripping and Restoration

Phases shown also include stripping and development of the southern working area. Overburden thickness has been calculated however varies significantly across the site. Any newly stripped soils should be placed to direct restoration on northern faces where they are back in final position.

Note: Exact volumes and locations of stripping/placement to be determined at date of strip by the restoration manager for the site and Technical Services. Future restoration phases will progress against the northern faces.

Haul route development strategy

Haul routes will remain as at present location. The existing ramp to the primary crusher will remain in its current location. Any change to ramp/ haul route strategy should be agreed prior to change.

Tips

Main Quarry Tip will be considered full after phase 1. A new tip should be developed in the quarry sinking once space allows. All tips (comprising quarry material, dust, soils, waste rock, silty materials scraped from haul routes etc will be subject to formal design, and construction and will be in accordance relevant Schedule 1 report and job cards.

Geotechncial Notes

This development scheme should be read in conjunction with the latest geotechnical assessment, and with the geotechnical assessments covering development of faces and tips.

Operations must be carried out in accordance with E&T Rules, and the geotechnical assessment.

Face design criteria

The design of the final faces and long term temporary faces is critical both to ensure safety, protect infrastructure and to reduce the requirement for remedial works. Final faces are designed to be 70 degrees from horizontal in all locations. This will be achieved by drilling and blasting to 75°, and allowing for some breakback. Future face heights will be a maximum of 15m however should be worked to nearer 13.5, bench widths will be 10m in all orientations to allow for adequate rockfall protection. All faces should be scaled, and appropriate rock trap bunding put in place before pushing faces to the final location.

Significant Change

In the event of a significant change to or deviation from this plan, and wherever possible, **3 months before** the change occurs, a Reg 32 Appraisal must be completed and returned to the company geologist below.

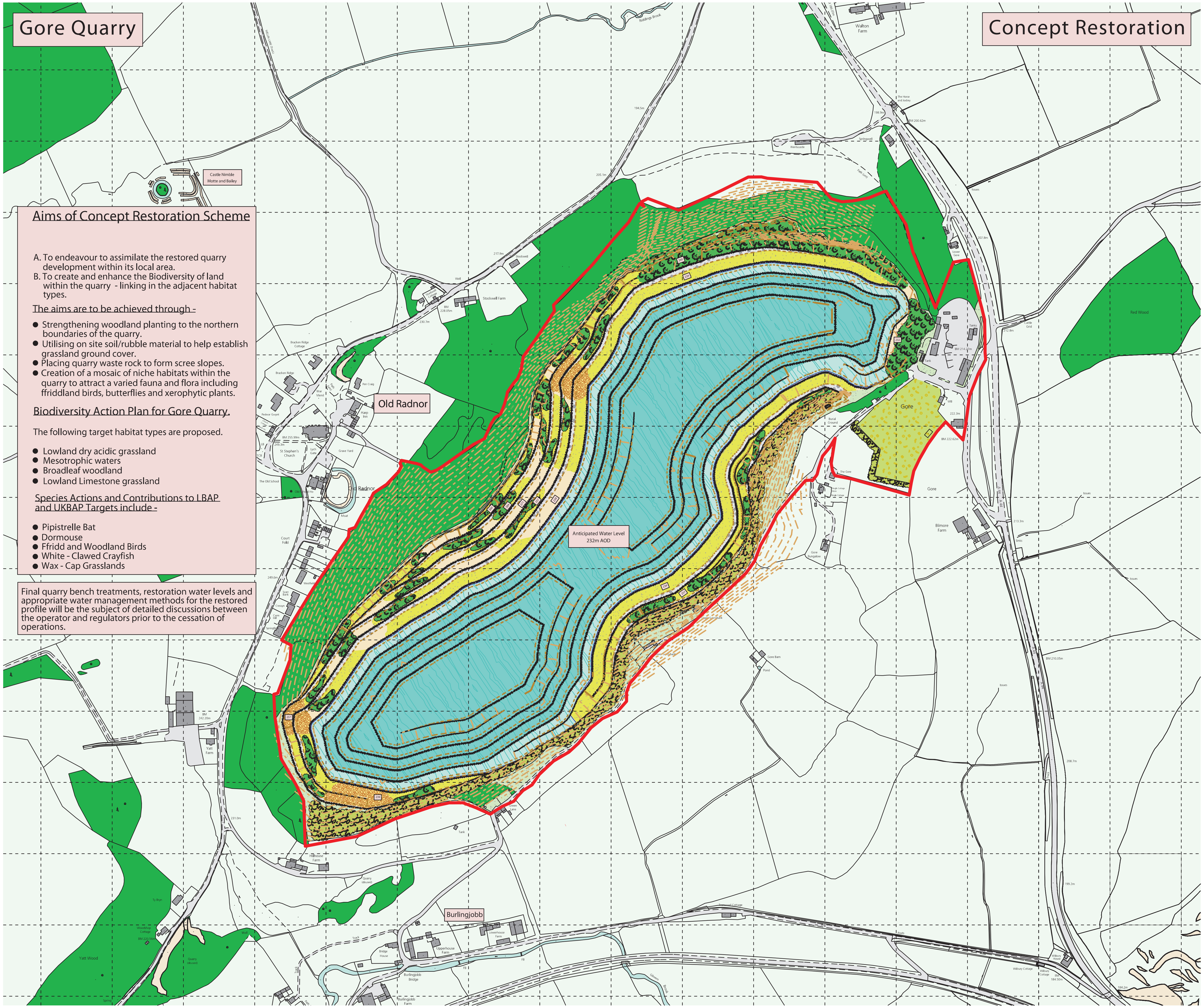
Geotechnical		
	Assesed by:	NAME COMPANY
	Schedule 1: Excavation (Rock)	13-032-R-001 S. Railton KeyGS
	Schedule 1: Excavation (S&G)	N/A
	Schedule 1: Tips (Solid)	11-264-R-001 - Southeastern Ramp 13-032-R-002 - Ramp Tip 19-272-R-001 - Tip 3 13-032-R-004 - Northwest Tip 13-032-R-005 - Southwest Tip 19-029-R-001 - Overburden, Toprock and soil tip 19-295-R-001 - In quarry tip S. Railton KeyGS
	Schedule 1: Tips (Liquid)	N/A
	Schedule 1: Stockpile	N/A

TARMAC
A CRH COMPANY

Site Name:
G056 - Gore Quarry

Drawing Name:
Quarry Development Plan

Drawn By:	Scale @ A0:
J. Sergeant	1:2,500
Date:	**Drawing Number:**
13/07/2021	G056-00081



Aims of Concept Restoration Scheme

A. To endeavour to assimilate the restored quarry development within its local area.
B. To create and enhance the Biodiversity of land within the quarry - linking in the adjacent habitat types.

The aims are to be achieved through -

- Strengthening woodland planting to the northern boundaries of the quarry.
- Utilising on site soil/rubble material to help establish grassland ground cover.
- Placing quarry waste rock to form scree slopes.
- Creation of a mosaic of niche habitats within the quarry to attract a varied fauna and flora including ffriddland birds, butterflies and xerophytic plants.

Biodiversity Action Plan for Gore Quarry.

The following target habitat types are proposed.

- Lowland dry acidic grassland
- Mesotrophic waters
- Broadleaf woodland
- Lowland Limestone grassland

Species Actions and Contributions to LBAP and UKBAP Targets include -

- Pipistrelle Bat
- Dormouse
- Ffridd and Woodland Birds
- White - Clawed Crayfish
- Wax - Cap Grasslands

Final quarry bench treatments, restoration water levels and appropriate water management methods for the restored profile will be the subject of detailed discussions between the operator and regulators prior to the cessation of operations.

Legend

- Permitted Planning Boundary
- Existing Woodland
- Surrounding Buildings and Roads
- Surrounding Land

Mitigation Proposals

- Mitigation Planting Block

Restoration Proposals

- Open Water
- Broadleaf Woodland
- Scree Slopes
- Open Rock Outcrops
- Rock Faces
- Species Rich Grassland
- Ecological Receptor Site
- Other agricultural grazing land currently being managed within the Permitted Planning Boundary

Rev A - 21/07/08 NF
Addition of Mitigation Measures
Rev B - 04/08/08 LAS
Revised water level to 232m aOD,corresponding changes to planting proposals

Tarmac

Tarmac Limited
Estates Department
P.O. Box 1, Kington
Herefordshire, HR5 3LQ
Tel. +44(0)1544 230711
Fax. +44(0)1544 232288

Gore Quarry

Concept Restoration

Drawn By R.J.S. / L.M.B.	Scale 1:5000 @ A3
Date December 2007	Drawing No GQ 3/3

Appendix D

Discharge activity permit

Notice of variation and consolidation with introductory note

The Environmental Permitting (England & Wales) Regulations 2010

Lafarge Tarmac Trading Limited

Settlement lagoons serving
Gore Quarry
Walton
Presteigne
Powys
LD8 2PL

Variation application number

AW4001902/V002

Permit number

AW4001902

Settlement Lagoons serving Gore Quarry
Permit number AW4001902

Introductory note

This introductory note does not form a part of the notice.

The following notice gives notice of the variation and consolidation of an environmental permit.

The permit has been varied to increase the discharge volume and to include three storm overflow discharges.

The schedules specify the changes made to the permit.

The status log of a permit sets out the permitting history, including any changes to the permit reference number. It is not backdated before 6 April 2010.

Status log of the permit		
Description	**Date**	**Comments**
Variation issued AW4001902/V001	16/10/2013	Varied permit issued to Lafarge Tarmac Trading Limited.
Application AW4001902/V002 (variation and consolidation)	Duly made 31/03/2015	Application to vary and update the permit to modern conditions.
Variation determined AW4001902	07/07/15	Varied and consolidated permit issued in modern condition format. Permit varied to increase discharge volume and include 3 storm overflows.

End of introductory note

Notice of variation and consolidation

The Environmental Permitting (England and Wales) Regulations 2010

The Natural Resources Body for Wales ("Natural Resources Wales") in exercise of its powers under regulation 20 of the Environmental Permitting (England and Wales) Regulations 2010 varies and consolidates

permit number
AW4001902

issued to:
Lafarge Tarmac Trading Limited ("the operator")

whose registered office is

Portland House Bickenhill Lane
Solihull
Birmingham
B37 7BQ

company registration number **00453791**

to operate a regulated facility at

Gore Quarry
Walton
Presteigne
Powys
LD8 2PL

to the extent set out in the schedules.

The notice shall take effect from 07/07/2015

Name	Date
Stephen Attwood	**07/07/2015**

Authorised on behalf of Natural Resources Wales

Schedule 1

All conditions have been varied by the consolidated permit as a result of the application made by the operator.

Schedule 2 – consolidated permit

Consolidated permit issued as a separate document.

Permit

The Environmental Permitting (England and Wales) Regulations 2010

Permit number
AW4001902

This is the consolidated permit referred to in the variation and consolidation notice for application AW4001902 authorising,

Lafarge Tarmac Trading Limited ("the operator"),

whose registered office is

Portland House Bickenhill Lane
Solihull
Birmingham
B37 7BQ

company registration number 00453791

to operate a water discharge activity at

Gore Quarry
Walton
Presteigne
Powys
LD8 2PL

to the extent authorised by and subject to the conditions of this permit.

Name	Date
Stephen Attwood	**07/07/2015**

Authorised on behalf of Natural Resources Wales

Conditions

1 Management

1.1 General management

1.1.1 The operator shall manage and operate the activities:

(a) in accordance with a written management system that identifies and minimises risks of pollution, including those arising from operations, maintenance, accidents, incidents, non-conformances and those drawn to the attention of the operator as a result of complaints; and

(b) using sufficient competent persons and resources.

1.1.2 Records demonstrating compliance with condition 1.1.1 shall be maintained.

1.1.3 Any person having duties that are or may be affected by the matters set out in this permit shall have convenient access to a copy of it kept at or near the place where those duties are carried out.

2 Operations

2.1 Permitted activities

2.1.1 The operator is only authorised to carry out the activities specified in schedule 1 table S1.1 (the "activities").

2.2 The site

2.2.1 The activities shall not extend beyond the site, being the land shown edged in green and the discharges shall be made at the points marked on the site plan at schedule 7 to this permit and as listed in table S3.2 (discharge points).

2.3 Operating techniques

2.3.1 (a) The activities shall, subject to the conditions of this permit, be operated using the techniques and in the manner described in the documentation specified in schedule 1, table S1.2, unless otherwise agreed in writing by Natural Resources Wales.

(b) If notified by Natural Resources Wales that the activities are giving rise to pollution, the operator shall submit to Natural Resources Wales for approval within the period specified, a revision of any plan or other documentation ("plan") specified in schedule 1, table S1.2 or otherwise required under this permit which identifies and minimises the risks of pollution relevant to that plan, and shall implement the approved revised plan in place of the original from the date of approval, unless otherwise agreed in writing by Natural Resources Wales.

3 Emissions and monitoring

3.1 Emissions to water

3.1.1 There shall be no point source emissions to water except from the sources and emission points listed in schedule 3.

3.1.2 The limits given in schedule 3 shall not be exceeded.

3.2 Emissions of substances not controlled by emission limits

3.2.1 Emissions of substances not controlled by emission limits (excluding odour) shall not cause pollution. The operator shall not be taken to have breached this condition if appropriate measures, including, but not limited to, those specified in any approved emissions management plan, have been taken to prevent or where that is not practicable, to minimise, those emissions.

3.2.2 The operator shall:

(a) if notified by Natural Resources Wales that the activities are giving rise to pollution, submit to Natural Resources Wales for approval within the period specified, an emissions management plan which identifies and minimises the risks of pollution from emissions of substances not controlled by emission limits;

(b) implement the approved emissions management plan, from the date of approval, unless otherwise agreed in writing by Natural Resources Wales.

3.3 Monitoring

3.3.1 Permanent means of access shall be provided to enable sampling/monitoring to be carried out in relation to the emission points specified in schedule 3 tables S3.1, S3.2 and S3.3 unless otherwise agreed in writing by Natural Resources Wales.

4 Information

4.1 Records

4.1.1 All records required to be made by this permit shall:

(a) be legible;

(b) be made as soon as reasonably practicable;

(c) if amended, be amended in such a way that the original and any subsequent amendments remain legible, or are capable of retrieval; and

(d) be retained, unless otherwise agreed in writing by Natural Resources Wales, for at least 6 years from the date when the records were made.

4.1.2 The operator shall keep on site all records, plans and the management system required to be maintained by this permit, unless otherwise agreed in writing by Natural Resources Wales.

4.2 Reporting

4.2.1 The operator shall send all reports and notifications required by the permit to Natural Resources Wales using the contact details supplied in writing by Natural Resources Wales.

4.3 Notifications

4.3.1 Natural Resources Wales shall be notified without delay following the detection of:

(a) any malfunction, breakdown or failure of equipment or techniques, accident, or emission of a substance not controlled by an emission limit which has caused, is causing or may cause significant pollution;

(b) the breach of a limit specified in the permit; or

(c) any significant adverse environmental effects.

4.3.2 Any information provided under condition 4.3.1 shall be confirmed by sending the information listed in schedule 5 to this permit within the time period specified in that schedule.

4.3.3 Where Natural Resources Wales has requested in writing that it shall be notified when the operator is to undertake monitoring and/or spot sampling, the operator shall inform Natural Resources Wales when the relevant monitoring and/or spot sampling is to take place. The operator shall provide this information to Natural Resources Wales at least 14 days before the date the monitoring is to be undertaken.

4.3.4 Natural Resources Wales shall be notified within 14 days of the occurrence of the following matters, except where such disclosure is prohibited by Stock Exchange rules:

Where the operator is a registered company:

(a) any change in the operator’s trading name, registered name or registered office address; and

(b) any steps taken with a view to the operator going into administration, entering into a company voluntary arrangement or being wound up.

Where the operator is a corporate body other than a registered company:

(a) any change in the operator’s name or address; and

(b) any steps taken with a view to the dissolution of the operator.

4.3.5 Where the operator proposes to make a change in the nature or functioning, or an extension of the activities, which may have consequences for the environment and the change is not otherwise the subject of an application for approval under the Regulations or this permit:

(a) Natural Resources Wales shall be notified at least 14 days before making the change; and

(b) the notification shall contain a description of the proposed change in operation.

4.4 Interpretation

4.4.1 In this permit the expressions listed in schedule 6 shall have the meaning given in that schedule.

4.4.2 In this permit references to reports and notifications mean written reports and notifications, except where reference is made to notification being made "without delay", in which case it may be provided by telephone.

Schedule 1 - Operations

Table S1.1 Activities		
Activity reference	**Description of activity**	**Limits of specified activity**
A1	Discharge of trade effluent consisting of treated site drainage from a quarry via Outlet 1	The site drainage shall arrive from catchment C2, C3 and C4 (Schedule 7 –site plan) with an area of 135,963m^2.
A2	Discharge of trade effluent consisting of site drainage from a quarry via storm overflow discharge point, Outlet 1	The discharge shall only occur when the storage in the attenuation ponds and storage tanks are fully utilised and only for as long as the pass forward flow to the settlement lagoons is equal to or greater than 15l/s (1 in 1 year storm event).
A3	Discharge of trade effluent consisting of site drainage from a quarry via storm overflow discharge point, Outlet 2	The discharge shall only occur when the storage in the attenuation ponds and storage tanks are fully utilised and only for as long as the pass forward flow to the settlement lagoons is equal to or greater than 1.1l/s (1 in 1 year storm event).
A4	Discharge of trade effluent consisting of site drainage from a quarry via storm overflow discharge point , Outlet 3	The discharge shall only occur when the storage in the attenuation ponds and storage tanks are fully utilised and only for as long as the pass forward flow to the settlement lagoons is equal to or greater than 0.6l/s (1 in 1 year storm event).

Table S1.2 Operating techniques			
Activity reference	**Description of documentation**	**Parts**	**Date Received**
A1, A2, A3 and A4	Gore Quarry Outline Water Treatment Plan	All	19/12/2014

Schedule 2 - Waste types, raw materials and fuels

Wastes are not accepted as part of the permitted activities and there are no restrictions on raw materials or fuels under this schedule.

Schedule 3 – Emissions and monitoring

Table S3.1 Point Source emissions to water (other than sewer) – emission limits and monitoring requirements							
Activity reference	**Discharge source and discharge point ref. & location**	**Parameter**	**Limit (including unit)**	**Reference Period**	**Limit of effective range**	**Monitoring frequency**	**Compliance Statistic**
A1	Trade effluent consisting of treated site drainage via Outlet 1	Maximum daily discharge volume	Rainfall related	N/A	N/A	N/A	Maximum
		Suspended solids (measured after drying at 105º C)	80 mg/l	Instantaneous (spot sample)	N/A	N/A	Maximum
		Visible oil or grease	No significant trace present	Instantaneous (spot sample)	N/A	N/A	No significant trace
		N/A	See table S1.1	Instantaneous (spot sample)	N/A	N/A	N/A
A2	Storm Overflow via Outlet 1	N/A	See table S1.1	Instantaneous (spot sample)	N/A	N/A	N/A
A3	Storm Overflow via Outlet 2	N/A	See table S1.1	Instantaneous (spot sample)	N/A	N/A	N/A
A4	Storm Overflow via Outlet 3	N/A	See table S1.1	Instantaneous (spot sample)	N/A	N/A	N/A

Table S3.2 Discharge points				
Activity reference	**Effluent** Name	**Discharge Point**	**Discharge point NGR**	**Receiving water**
A1	Trade effluent consisting of treated site drainage	Outlet 1	SO 25900 59430	Unnamed tributary of the Riddings Brook
A2	Storm overflow 1	Outlet 1	SO 25900 59430	Unnamed tributary of the Riddings Brook
A3	Storm overflow 2	Outlet 2	SO 25625 59745	Drain leading to the Riddings Brook
A4	Storm overflow 3	Outlet 3	SO 25823 59016	Field ditch leading to the Back Brook

Table S3.3 Monitoring points			
Activity reference	**Effluents and discharge points**	**Monitoring type**	**Monitoring point NGR**
A1	Trade effluent consisting of treated site drainage	Effluent sample point	SO 25915 59244
A2	Storm overflow 1	Storm overflow sample point 1	SO 25909 59238
A3	Storm overflow 2	Storm overflow sample point 2	SO 25855 59145
A4	Storm overflow 3	Storm overflow sample point 3	SO 25808 59022

Schedule 4 – Reporting

There is no reporting under this schedule.

Schedule 5 - Notification

These pages outline the information that the operator must provide.

Units of measurement used in information supplied under Part A and B requirements shall be appropriate to the circumstances of the emission. Where appropriate, a comparison should be made of actual emissions and authorised emission limits.

If any information is considered commercially confidential, it should be separated from non-confidential information, supplied on a separate sheet and accompanied by an application for commercial confidentiality under the provisions of the EP Regulations.

Part A

Permit Number	
Name of operator	
Location of Facility	
Time and date of the detection	

(a) Notification requirements for any malfunction, breakdown or failure of equipment or techniques, accident, or emission of a substance not controlled by an emission limit which has caused, is causing or may cause significant pollution	
To be notified within 24 hours of detection	
Date and time of the event	
Reference or description of the location of the event	
Description of where any release into the environment took place	
Substances(s) potentially released	
Best estimate of the quantity or rate of release of substances	
Measures taken, or intended to be taken, to stop any emission	
Description of the failure or accident.	

(b) Notification requirements for the breach of a limit	
To be notified within 24 hours of detection unless otherwise specified below	
Emission point reference/ source	
Parameter(s)	
Limit	
Measured value and uncertainty	
Date and time of monitoring	
Measures taken, or intended to be taken, to stop the emission	

Time periods for notification following detection of a breach of a limit	
Parameter	**Notification period**

(c) Notification requirements for the detection of any significant adverse environmental effect	
To be notified within 24 hours of detection	
Description of where the effect on the environment was detected	
Substances(s) detected	
Concentrations of substances detected	
Date of monitoring/sampling	

Part B - to be submitted as soon as practicable

Any more accurate information on the matters for notification under Part A.	
Measures taken, or intended to be taken, to prevent a recurrence of the incident	
Measures taken, or intended to be taken, to rectify, limit or prevent any pollution of the environment which has been or may be caused by the emission	
The dates of any unauthorised emissions from the facility in the preceding 24 months.	

Name*	
Post	
Signature	
Date	

* authorised to sign on behalf of the operator

Schedule 6 - Interpretation

"accident" means an accident that may result in pollution.

"annually" means once every year.

“application” means the application for this permit, together with any additional information supplied by the operator as part of the application and any response to a notice served under Schedule 5 to the EP Regulations.

“EP Regulations” means The Environmental Permitting (England and Wales) Regulations SI 2010 No.675 and words and expressions used in this permit which are also used in the Regulations have the same meanings as in those Regulations.

“emissions of substances not controlled by emission limits ” means emissions of substances to air, water or land from the activities, either from the emission points specified in schedule 3 or from other localised or diffuse sources, which are not controlled by an emission limit.

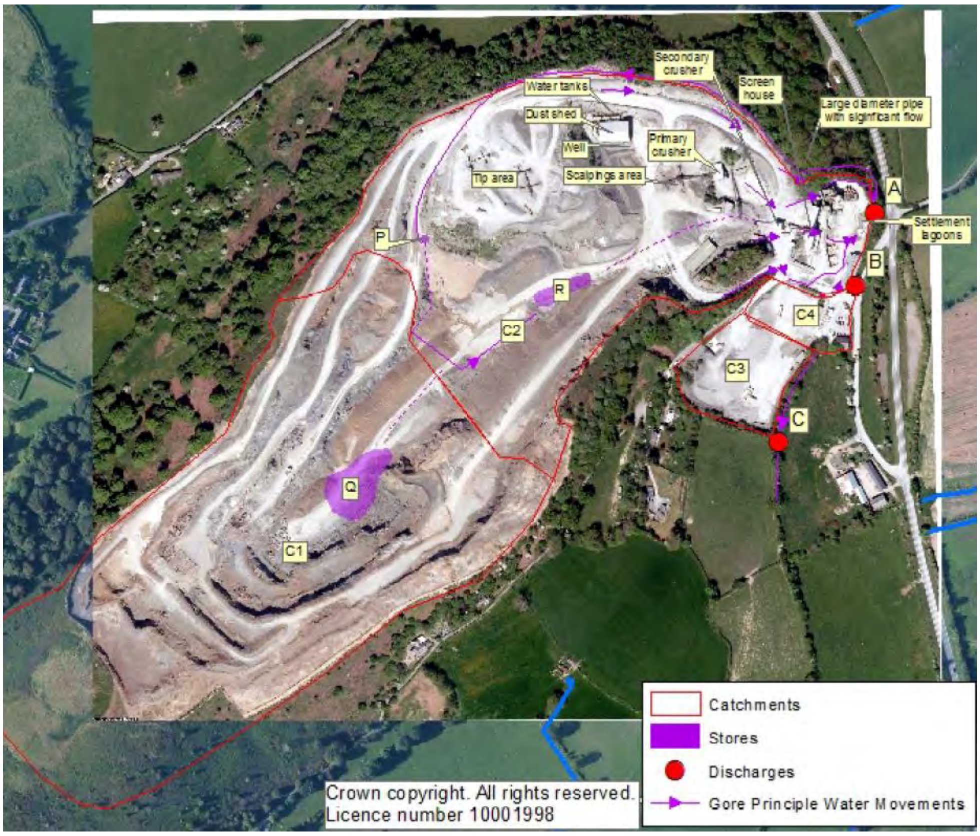
“groundwater” means all water, which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil.

*“*Natural Resources Wales*”* means the Natural Resources Body for Wales established by article 3 of the Natural Resources Body for Wales (Establishment) Order 2012. The Natural Resources Body for Wales (Functions) Order 2013 transferred the relevant functions of the Countryside Council for Wales, and functions of the Environment Agency and the Forestry Commission in Wales to the Natural Resources Body for Wales

"quarter" means a calendar year quarter commencing on 1 January, 1 April, 1 July or 1 October.

“year” means calendar year ending 31 December.

Schedule 7 – Site Plan



END OF PERMIT

Appendix E

Dewatering calculations

Dewatering ROI calculations for 4 m drawdown

21) Radius of influence (Sichardt)

$$R_0 = Cs\sqrt{K}$$

Essential input	
Optional input	
Calculated	

Empirical equation based on drawdown and permeability

		expected		min	max	
Drawdown in well	s	4	m			m
Hydraulic conductivity	K	#######	m/s			m/s
		51	m/d			
Factor	C	3000		3000 for radial flow 1500-2000 for line flow to trenches or wellpoints		
Radius of influence	R_0	291.55	m	291.55	291.55	m

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

Data sources (to complete an audit trail)

Drawdown in well	s	Estimated drawdowns from estimated water table.
Hydraulic conductivity	K	Estimated average from pumping test, using a 4 m deep aquifer.
Factor	C	radial

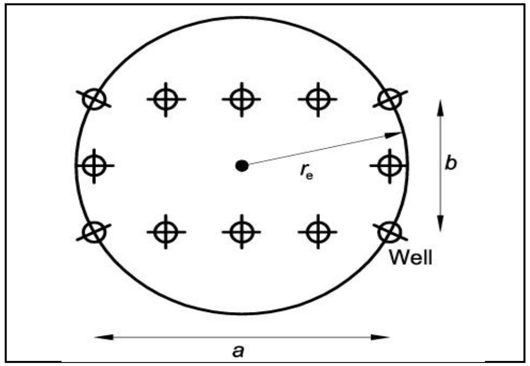
23) Effective radius

Used to convert a rectangular pit to a circular one

$$r_e = \sqrt{\frac{ab}{\Pi}}$$

Essential input
Optional input
Calculated

		expected		min	max	
Width of excavation	a	705.0	m			m
Length of excavation	b	240.0	m			m
Effective circular radius	r_e	232.07	m	232.07	232.07	m



(Figure adapted from Mansur & Kaufman, 1962)

The following assumptions apply to this equation

- horizontal flow
- closely spaced wells

Data sources (to complete an audit trail)

Width of excavation	a	Long term development width (taken from pdf)
Length of excavation	b	Long term development length (taken from pdf)

2) Dupuit-Thiem (Unconfined)

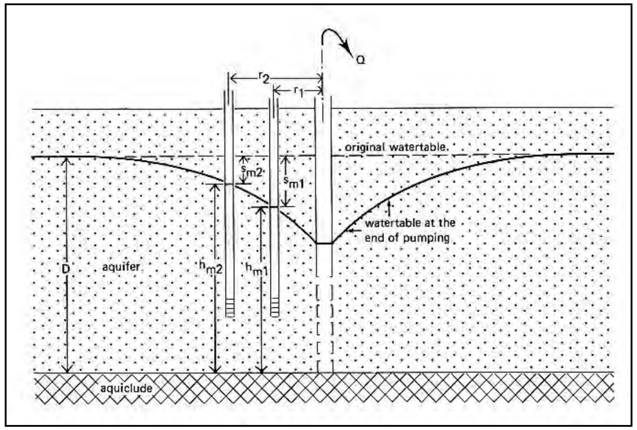
(also known as Dupuit-Forcheimer or Thiem-Dupuit)

Steady state flow to a well in an unconfined aquifer

$$Q = \Pi K \frac{(h_2^{\,2} - h_1^{\,2})}{2.3\log(\frac{r_2}{r_1})}$$

Legend
Essential input
Optional input
Calculated

		expected		min	max	
Height of water table at observation well 1	h_1	0.1	m			m
Distance to observation well 1	r_1	232.07	m			
Height of water table at observation well 2	h_2	4	m			m
Distance to observation well 2	r_2	523.62	m			
Hydraulic conductivity of aquifer	K	51	m/d			m/d
Total discharge from well	Q	3151.99	m^3/d	3151.99	3151.99	m^3/d



(Figure taken from Kruseman & de Ridder, 1994)

To find the drawdown at a given radius

$$h_2 = \sqrt{\frac{2.3Q\log\left(\frac{r_2}{r_1}\right)}{\pi K} + h_1^{\,2}}$$

Discharge	Q	3151.99	m^3/d
Radius of interest	r_2	510.00	m
WT height at radius of interest	h	3.9	m
Drawdown at radius r	s_r	0.1	m

To find the radius of a specific water level

$$r_2 = r_1 10^{\wedge}\left[\frac{\pi K(h_2^{\,2} - h_1^{\,2})}{2.3Q}\right]$$

Discharge	Q	3151.99	m^3/d
WT height at radius of interest	h_2	6.8	m
Radius of required drawdown	r_2	2439.7	m

The following assumptions apply to this equation

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

(from Kruseman & de Ridder, 1994)

Data sources (to complete an audit trail)

Height of water table at observation well 1	h_1	Height of seepage face (0.5 m) above aquifer base
Distance to observation well 1	r_1	Effective radius of working area under water table
Height of water table at observation well 2	h_2	Estimated water table
Distance to observation well 2	r_2	Radius of working + radius of influence
Hydraulic conductivity of aquifer	K	Estimated average from pumping test, using a 4 m deep aquife

Dewatering ROI calculations for 14 m drawdown

21) Radius of influence (Sichardt)

$$R_0 = Cs\sqrt{K}$$

Essential input
Optional input
Calculated

Empirical equation based on drawdown and permeability

		expected		min	max	
Drawdown in well	s	14	m			m
Hydraulic conductivity	K	#######	m/s			m/s
		0.01123	m/d			
Factor	C	3000		3000 for radial flow 1500-2000 for line flow to trenches or wellpoints		
Radius of influence	R_0	15.14	m	15.14	15.14	m

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

Data sources (to complete an audit trail)

Drawdown in well	s	Estimated drawdowns from estimated water table.
Hydraulic conductivity	K	Estimated low from hydraulic testing.
Factor	C	radial

21) Radius of influence (Sichardt)

$$R_0 = Cs\sqrt{K}$$

Legend
Essential input
Optional input
Calculated

Empirical equation based on drawdown and permeability

		expected		min	max	
Drawdown in well	s	14	m			m
Hydraulic conductivity	K	#######	m/s			m/s
		0.04925	m/d			
Factor	C	3000		3000 for radial flow 1500-2000 for line flow to trenches or wellpoints		
Radius of influence	R_0	31.71	m	31.71	31.71	m

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

Data sources (to complete an audit trail)

Drawdown in well	s	Estimated drawdowns from estimated water table.
Hydraulic conductivity	K	Estimated average from hydraulic testing.
Factor	C	radial

21) Radius of influence (Sichardt)

$$R_0 = Cs\sqrt{K}$$

Legend
Essential input
Optional input
Calculated

Empirical equation based on drawdown and permeability

		expected		min	max	
Drawdown in well	s	14	m			m
Hydraulic conductivity	K	#######	m/s			m/s
		0.12096	m/d			
Factor	C	3000		3000 for radial flow 1500-2000 for line flow to trenches or wellpoints		
Radius of influence	R_0	49.70	m	49.70	49.70	m

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

Data sources (to complete an audit trail)

Drawdown in well	s	Estimated drawdowns from estimated water table.
Hydraulic conductivity	K	Estimated high from hydraulic testing.
Factor	C	radial

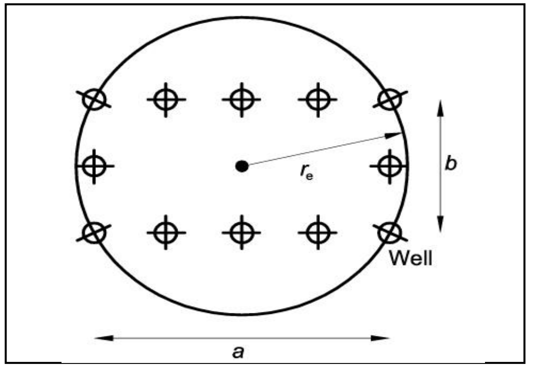
23) Effective radius

Used to convert a rectangular pit to a circular one

$$r_e = \sqrt{\frac{ab}{\Pi}}$$

Key
Essential input
Optional input
Calculated

		expected		min	max	
Width of excavation	a	705.0	m			m
Length of excavation	b	240.0	m			m
Effective circular radius	r_e	232.07	m	232.07	232.07	m



(Figure adapted from Mansur & Kaufman, 1962)

The following assumptions apply to this equation

- horizontal flow
- closely spaced wells

Data sources (to complete an audit trail)

Width of excavation	a	Long term development width (taken from pdf)
Length of excavation	b	Long term development length (taken from pdf)

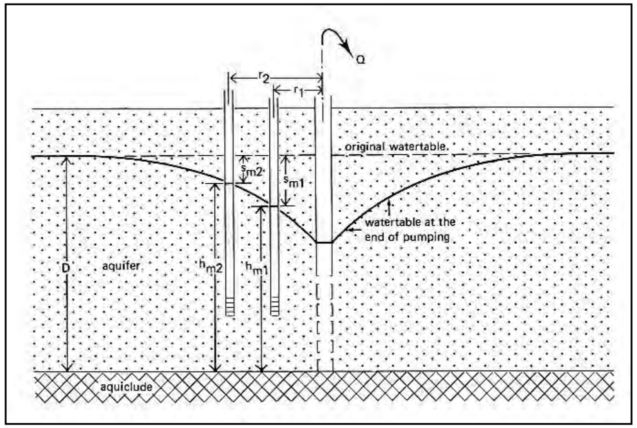
2) Dupuit-Thiem (Unconfined)

(also known as Dupuit-Forcheimer or Thiem-Dupuit)
Steady state flow to a well in an unconfined aquifer

$$Q = \Pi K \frac{(h_2^{\,2} - h_1^{\,2})}{2.3\log(\frac{r_2}{r_1})}$$

Key
Essential input
Optional input
Calculated

		expected		min	max	
Height of water table at observation well 1	h_1	0.1	m			m
Distance to observation well 1	r_1	232.07	m			
Height of water table at observation well 2	h_2	14	m			m
Distance to observation well 2	r_2	247.22	m			
Hydraulic conductivity of aquifer	K	0.01123	m/d			m/d
Total discharge from well	Q	109.53	m^3/d	109.53	109.53	m^3/d



(Figure taken from Kruseman & de Ridder, 1994)

To find the drawdown at a given radius

$$h_2 = \sqrt{\frac{2.3Q\log\left(\frac{r_2}{r_1}\right)}{\pi K} + h_1^{\,2}}$$

Discharge	Q	109.53	m^3/d
Radius of interest	r_2	95	m
WT height at radius of interest	h	#NUM!	m
Drawdown at radius r	s_r	#NUM!	m

To find the radius of a specific water level

$$r_2 = r_1 10^{\wedge}\left[\frac{\pi K(h_2^{\,2} - h_1^{\,2})}{2.3Q}\right]$$

Discharge	Q	109.53	m^3/d
WT height at radius of interest	h_2	15.5	m
Radius of required drawdown	r_2	250.8	m

The following assumptions apply to this equation
- the aquifer has infinite areal extent
- the aquifer is homogeneous, isotropic and of uniform thickness
- flat initial water table
- the aquifer is pumped at a constant discharge rate
- the pumping well is fully penetrating, therefore receiving water from the entire saturated thickness of the aquifer
- the flow to the well is in a steady state

(from Kruseman & de Ridder, 1994)

Data sources (to complete an audit trail)

Height of water table at observation well 1	h_1	Height of seepage face (0.5 m) above aquifer base
Distance to observation well 1	r_1	Effective radius of working area under water table
Height of water table at observation well 2	h_2	Estimated water table
Distance to observation well 2	r_2	Radius of working + radius of influence
Hydraulic conductivity of aquifer	K	Estimated low from hydraulic testing.

2) Dupuit-Thiem (Unconfined)

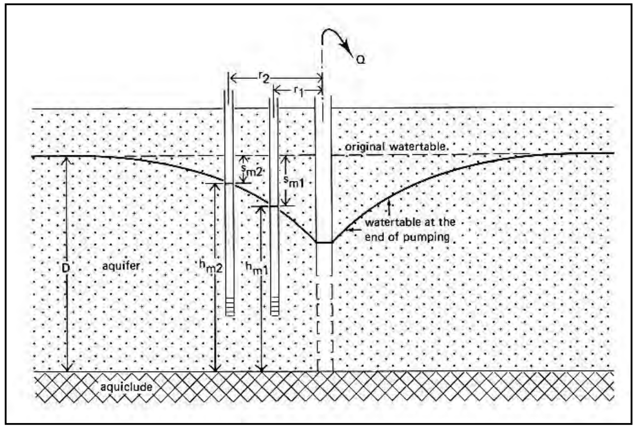
(also known as Dupuit-Forcheimer or Thiem-Dupuit)

Steady state flow to a well in an unconfined aquifer

$$Q = \Pi K \frac{(h_2^{\,2} - h_1^{\,2})}{2.3\log(\frac{r_2}{r_1})}$$

Essential input	
Optional input	
Calculated	

		expected		min	max	
Height of water table at observation well 1	h_1	0.1	m			m
Distance to observation well 1	r_1	232.07	m			
Height of water table at observation well 2	h_2	14	m			m
Distance to observation well 2	r_2	263.78	m			
Hydraulic conductivity of aquifer	K	0.04925	m/d			m/d
Total discharge from well	Q	237.03	m^3/d	237.03	237.03	m^3/d



(Figure taken from Kruseman & de Ridder, 1994)

To find the drawdown at a given radius

Discharge	Q	237.03	m^3/d
Radius of interest	r_2	199.00	m
WT height at radius of interest	h	#NUM!	m
Drawdown at radius r	s_r	#NUM!	m

$$h_2 = \sqrt{\frac{2.3Q\log\left(\frac{r_2}{r_1}\right)}{\pi K} + h_1^{\,2}}$$

To find the radius of a specific water level

Discharge	Q	237.03	m^3/d
WT height at radius of interest	h_2	6.8	m
Radius of required drawdown	r_2	239.2	m

$$r_2 = r_1 10\wedge\left[\frac{\pi K(h_2^{\,2} - h_1^{\,2})}{2.3Q}\right]$$

The following assumptions apply to this equation

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

(from Kruseman & de Ridder, 1994)

Data sources (to complete an audit trail)

Height of water table at observation well 1	h_1	Height of seepage face (0.5 m) above aquifer base
Distance to observation well 1	r_1	Effective radius of working area under water table
Height of water table at observation well 2	h_2	Estimated water table
Distance to observation well 2	r_2	Radius of working + radius of influence
Hydraulic conductivity of aquifer	K	Estimated average from hydraulic testing.

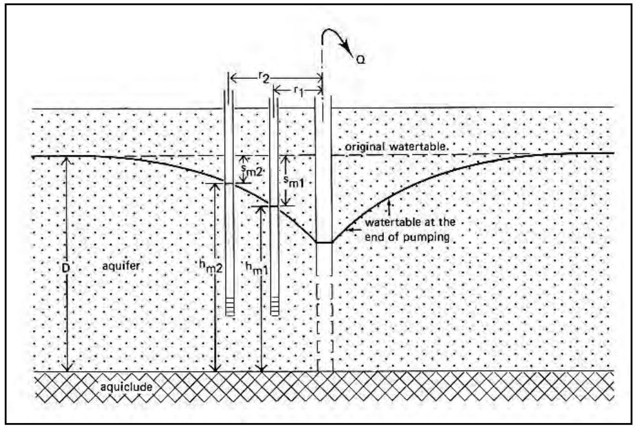
2) Dupuit-Thiem (Unconfined)

(also known as Dupuit-Forcheimer or Thiem-Dupuit)
Steady state flow to a well in an unconfined aquifer

$$Q = \Pi K \frac{(h_2^{\ 2} - h_1^{\ 2})}{2.3\log(\frac{r_2}{r_1})}$$

		expected		min	max	
Height of water table at observation well 1	h_1	0.1	m			m
Distance to observation well 1	r_1	232.07	m			
Height of water table at observation well 2	h_2	14	m			m
Distance to observation well 2	r_2	281.77	m			
Hydraulic conductivity of aquifer	K	0.12096	m/d			m/d
Total discharge from well	Q	384.27	m^3/d	384.27	384.27	m^3/d

Essential input
Optional input
Calculated



(Figure taken from Kruseman & de Ridder, 1994)

To find the drawdown at a given radius

$$h_2 = \sqrt{\frac{2.3Q\log\left(\frac{r_2}{r_1}\right)}{\pi K} + h_1^{\ 2}}$$

Discharge	Q	384.27	m^3/d
Radius of interest	r_2	198.00	m
WT height at radius of interest	h	#NUM!	m
Drawdown at radius r	s_r	#NUM!	m

To find the radius of a specific water level

$$r_2 = r_1 10^\wedge\left[\frac{\pi K(h_2^{\ 2} - h_1^{\ 2})}{2.3Q}\right]$$

Discharge	Q	384.27	m^3/d
WT height at radius of interest	h_2	1.5	m
Radius of required drawdown	r_2	232.6	m

The following assumptions apply to this equation

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

(from Kruseman & de Ridder, 1994)

Data sources (to complete an audit trail)

Height of water table at observation well 1	h_1	Height of seepage face (0.5 m) above aquifer base
Distance to observation well 1	r_1	Effective radius of working area under water table
Height of water table at observation well 2	h_2	Estimated water table
Distance to observation well 2	r_2	Radius of working + radius of influence
Hydraulic conductivity of aquifer	K	Estimated high from hydraulic testing.

Dewatering ROI calculations for 70 m drawdown

21) Radius of influence (Sichardt)

$$R_0 = Cs\sqrt{K}$$

Essential input
Optional input
Calculated

Empirical equation based on drawdown and permeability

		expected		min	max	
Drawdown in well	s	70	m	68	90	m
Hydraulic conductivity	K	#######	m/s			m/s
		0.01123	m/d			
Factor	C	3000		3000 for radial flow 1500-2000 for line flow to trenches or wellpoints		
Radius of influence	R_0	75.72	m	73.55	97.35	m

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

Data sources (to complete an audit trail)

Drawdown in well	s	Estimated drawdowns from estimated water table.
Hydraulic conductivity	K	Estimated low from hydraulic testing.
Factor	C	radial

21) Radius of influence (Sichardt)

$$R_0 = Cs\sqrt{K}$$

Essential input
Optional input
Calculated

Empirical equation based on drawdown and permeability

		expected		min	max	
Drawdown in well	s	70	m	68	90	m
Hydraulic conductivity	K	#######	m/s			m/s
		0.04925	m/d			
Factor	C	3000		3000 for radial flow 1500-2000 for line flow to trenches or wellpoints		
Radius of influence	R_0	158.55	m	154.02	203.85	m

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

Data sources (to complete an audit trail)

Drawdown in well	s	Estimated drawdowns from estimated water table.
Hydraulic conductivity	K	Estimated average from hydraulic testing.
Factor	C	radial

21) Radius of influence (Sichardt)

$$R_0 = Cs\sqrt{K}$$

Essential input
Optional input
Calculated

Empirical equation based on drawdown and permeability

		expected		min	max	
Drawdown in well	s	70	m	68	90	m
Hydraulic conductivity	K	#######	m/s			m/s
		0.12096	m/d			
Factor	C	3000		3000 for radial flow 1500-2000 for line flow to trenches or wellpoints		
Radius of influence	R_0	248.48	m	241.38	319.47	m

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

Data sources (to complete an audit trail)

Drawdown in well	s	Estimated drawdowns from estimated water table.
Hydraulic conductivity	K	Estimated high from hydraulic testing.
Factor	C	radial

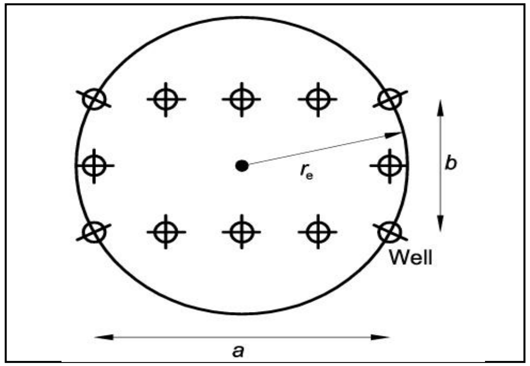
23) Effective radius

Used to convert a rectangular pit to a circular one

$$r_e = \sqrt{\frac{ab}{\Pi}}$$

Essential input
Optional input
Calculated

		expected		min	max	
Width of excavation	a	705.0	m			m
Length of excavation	b	240.0	m			m
Effective circular radius	r_e	232.07	m	232.07	232.07	m



(Figure adapted from Mansur & Kaufman, 1962)

The following assumptions apply to this equation

- horizontal flow
- closely spaced wells

Data sources (to complete an audit trail)

Width of excavation	a	Long term development width (taken from pdf)
Length of excavation	b	Long term development length (taken from pdf)

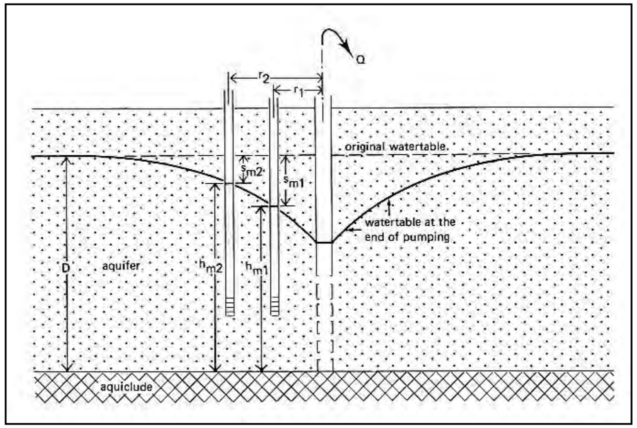
2) Dupuit-Thiem (Unconfined)

(also known as Dupuit-Forcheimer or Thiem-Dupuit)
Steady state flow to a well in an unconfined aquifer

$$Q = \Pi K \frac{(h_2^{\,2} - h_1^{\,2})}{2.3\log(\frac{r_2}{r_1})}$$

Key
Essential input
Optional input
Calculated

		expected		min	max	
Height of water table at observation well 1	h_1	0.1	m			m
Distance to observation well 1	r_1	232.07	m			
Height of water table at observation well 2	h_2	70	m	68	90	m
Distance to observation well 2	r_2	307.79	m			
Hydraulic conductivity of aquifer	K	0.01123	m/d			m/d
Total discharge from well	Q	613.03	m^3/d	578.50	1013.37	m^3/d



(Figure taken from Kruseman & de Ridder, 1994)

To find the drawdown at a given radius

$$h_2 = \sqrt{\frac{2.3Q\log\left(\frac{r_2}{r_1}\right)}{\pi K} + h_1^{\,2}}$$

Discharge	Q	613.03	m^3/d
Radius of interest	r_2	197.93	m
WT height at radius of interest	h	#NUM!	m
Drawdown at radius r	s_r	#NUM!	m

To find the radius of a specific water level

$$r_2 = r_1 10^\wedge\left[\frac{\pi K(h_2^{\,2} - h_1^{\,2})}{2.3Q}\right]$$

Discharge	Q	613.03	m^3/d
WT height at radius of interest	h_2	15.5	m
Radius of required drawdown	r_2	235.3	m

The following assumptions apply to this equation

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

(from Kruseman & de Ridder, 1994)

Data sources (to complete an audit trail)

Height of water table at observation well 1	h_1	Height of seepage face (0.5 m) above aquifer base
Distance to observation well 1	r_1	Effective radius of working area under water table
Height of water table at observation well 2	h_2	Estimated water table
Distance to observation well 2	r_2	Radius of working + radius of influence
Hydraulic conductivity of aquifer	K	Estimated low from hydraulic testing.

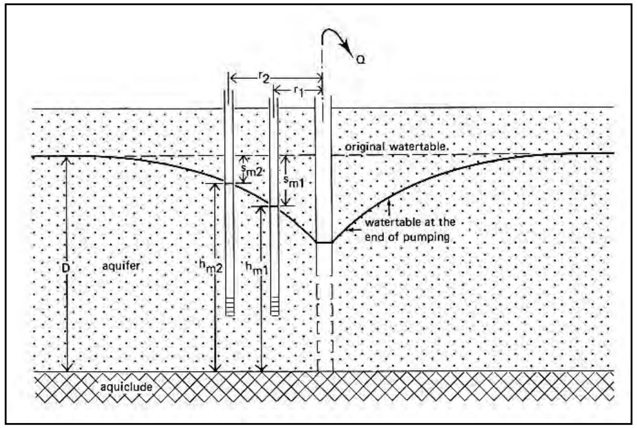
2) Dupuit-Thiem (Unconfined)

(also known as Dupuit-Forcheimer or Thiem-Dupuit)
Steady state flow to a well in an unconfined aquifer

$$Q = \Pi K \frac{(h_2^{\,2} - h_1^{\,2})}{2.3\log(\frac{r_2}{r_1})}$$

Essential input
Optional input
Calculated

		expected		min	max	
Height of water table at observation well 1	h_1	0.1	m			m
Distance to observation well 1	r_1	232.07	m			
Height of water table at observation well 2	h_2	70	m	68	90	m
Distance to observation well 2	r_2	390.62	m			
Hydraulic conductivity of aquifer	K	0.04925	m/d			m/d
Total discharge from well	Q	1457.64	m^3/d	1375.53	2409.57	m^3/d



(Figure taken from Kruseman & de Ridder, 1994)

To find the drawdown at a given radius

Discharge	Q	1457.64	m^3/d
Radius of interest	r_2	292.07	m
WT height at radius of interest	h	46.5	m
Drawdown at radius r	s_r	23.5	m

$$h_2 = \sqrt{\frac{2.3Q\log\left(\frac{r_2}{r_1}\right)}{\pi K} + h_1^{\,2}}$$

To find the radius of a specific water level

Discharge	Q	1457.64	m^3/d
WT height at radius of interest	h_2	6.8	m
Radius of required drawdown	r_2	233.2	m

$$r_2 = r_1 10^\wedge\left[\frac{\pi K(h_2^{\,2} - h_1^{\,2})}{2.3Q}\right]$$

The following assumptions apply to this equation

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

(from Kruseman & de Ridder, 1994)

Data sources (to complete an audit trail)

Height of water table at observation well 1	h_1	Height of seepage face (0.5 m) above aquifer base
Distance to observation well 1	r_1	Effective radius of working area under water table
Height of water table at observation well 2	h_2	Estimated water table
Distance to observation well 2	r_2	Radius of working + radius of influence
Hydraulic conductivity of aquifer	K	Estimated average from hydraulic testing.

2) Dupuit-Thiem (Unconfined)

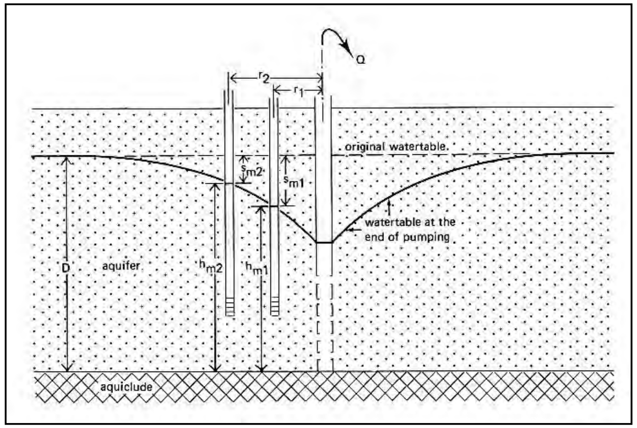
(also known as Dupuit-Forcheimer or Thiem-Dupuit)

Steady state flow to a well in an unconfined aquifer

$$Q = \Pi K \frac{(h_2^2 - h_1^2)}{2.3\log(\frac{r_2}{r_1})}$$

Legend
Essential input
Optional input
Calculated

		expected		min	max	
Height of water table at observation well 1	h_1	0.1	m			m
Distance to observation well 1	r_1	232.07	m			
Height of water table at observation well 2	h_2	70	m	68	90	m
Distance to observation well 2	r_2	480.55	m			
Hydraulic conductivity of aquifer	K	0.12096	m/d			m/d
Total discharge from well	Q	2561.05	m^3/d	2416.79	4233.57	m^3/d



(Figure taken from Kruseman & de Ridder, 1994)

To find the drawdown at a given radius

$$h_2 = \sqrt{\frac{2.3Q\log\left(\frac{r_2}{r_1}\right)}{\pi K} + h_1^2}$$

Discharge	Q	2561.05	m^3/d
Radius of interest	r_2	198.00	m
WT height at radius of interest	h	#NUM!	m
Drawdown at radius r	s_r	#NUM!	m

To find the radius of a specific water level

$$r_2 = r_1 10^\wedge\left[\frac{\pi K(h_2^2 - h_1^2)}{2.3Q}\right]$$

Discharge	Q	2561.05	m^3/d
WT height at radius of interest	h_2	1.5	m
Radius of required drawdown	r_2	232.2	m

The following assumptions apply to this equation

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

(from Kruseman & de Ridder, 1994)

Data sources (to complete an audit trail)

Height of water table at observation well 1	h_1	Height of seepage face (0.5 m) above aquifer base
Distance to observation well 1	r_1	Effective radius of working area under water table
Height of water table at observation well 2	h_2	Estimated water table
Distance to observation well 2	r_2	Radius of working + radius of influence
Hydraulic conductivity of aquifer	K	Estimated high from hydraulic testing.

Appendix F

Impact assessment methodology

Impact assessment methodology

A source-pathway-receptor methodology has been applied to the impact assessment. In the context of the impact assessment for the Site these elements may be defined as:

Source: Activities associated with mineral extraction, including dewatering;

Pathways: The groundwater flow pathways or hydrogeological linkages identified in the conceptual model;

Receptors: Key water features.

The risk assessment process can be subdivided into a number of steps as described below.

Step 1: Identification of Receptors. The identification of a risk requires the presence of all three elements in the source-pathway-receptor chain. The source for this assessment is by definition extraction within the Application Area. The first task in the risk assessment process is therefore to identify any relevant receptors.

Step 2: Identification of Pathways. Having established all potential impact sources and receptors, it is then necessary to identify potential pathways between the quarry (the source) and each water feature (the potential receptors) (i.e. determine all source-pathway-receptor linkages). In simple terms, the assessment process must establish whether the quarrying activities could potentially affect any of the identified water features. This is achieved by considering each potential source-pathway-receptor chain in the context of the conceptual model. Hence, where there is believed to be no significant groundwater pathway between the quarry and a given receptor, this receptor can be removed from the impact assessment process (note: where a pathway linkage is unclear, possibly due to uncertainty in the conceptual model, the pathway is assumed to exist at this stage of the assessment process). In effect, the risk assessment approach serves to filter the list of potential receptors.

The potential receptors are divided into potentially vulnerable receptors and those considered not vulnerable.

Step 3: Quantification of Effects. The presence of a hydrogeological pathway between the quarry and a receptor does not on its own indicate that an effect will occur at the receptor. The next step in the impact assessment process must therefore be to address whether or not there is likely to be an effect at each potential receptor resulting from quarry development (and restoration) works. This may require quantification, for example of the degree of groundwater level change at a receptor.

Step 4: Assessment of Significance. The demonstration and quantification of a potential effect does not necessarily indicate that the impact will be significant. The significance of potential effects is assessed individually for each receptor.

There are two aspects to the assessment of significance.

- It is necessary to compare the size of the potential effect with a **relevant criterion** that indicates the smallest significant impact. If the size of effect is smaller than the criterion then the effect does not represent a significant impact. In some cases it may be more appropriate to determine this on a qualitative basis.
- If the size of effect is potentially greater than the relevant criterion, it is necessary to assess the significance that the potential impact represents. The significance of an impact is dependent on the magnitude of the effect and the **importance of the receptor.**

<u>Relevant Criteria</u>

Step 4 requires a measure of impact significance (i.e. when does a predicted effect become a potentially significant impact?). The impact significance at each receptor has been evaluated separately on the basis of the conceptual understanding of the local groundwater system. To assist in this evaluation, the following interim, conservative guidelines have been adopted for screening purposes.

- For licensed groundwater abstraction boreholes a predicted groundwater level reduction in excess of 0.5 m is taken to indicate a potentially significant impact.
- For shallow wells and ponds, a predicted groundwater level reduction in excess of 0.25 m is taken to indicate a potentially significant impact.
- For spring flows, a derogation of flow in excess of 10% of mean long-term flows is taken to indicate a potentially significant impact.

Where an effect falls below the threshold criteria described above, it is taken to be negligible. Where it exceeds the critical threshold, the degree of effect (low, medium, or high) is assessed, based on the particular conditions at that receptor (e.g. natural variation in groundwater levels compared to the predicted change).

Importance of Receptors

The second factor in the consideration of degree of impact is the importance of the receptor. Receptors have been assigned to one of three status categories – low, medium or high. The methodology for assigning to a particular category is based on the following general criteria, although it is to some degree subjective:

- Low Status: Unlikely to be of significant ecological or societal value (e.g. small ephemeral pond); surface water and groundwater abstractions that supply or impact on an individual or small number of people (e.g. farm or home supply), although this may be locally significant;
- Medium Status: Of local ecological or societal value or supporting medium or high status ecological features (e.g. springs); surface water or groundwater abstractions that supply or impact on a local community (e.g. local water supply or water supply to a local amenity);
- High Status: Nationally and internationally designated ecological sites (e.g. SACs) or features supporting these (e.g. springs); surface or groundwater abstractions that feed into public water supply.

Degree of impact is determined by applying the degree of effect with the receptor status according to the matrix in the table below. Only adverse impacts that are Moderate or higher (highlighted with red text in the table above) are considered to be potentially significant and in need of mitigation.

Table 1 Impact assessment matrix

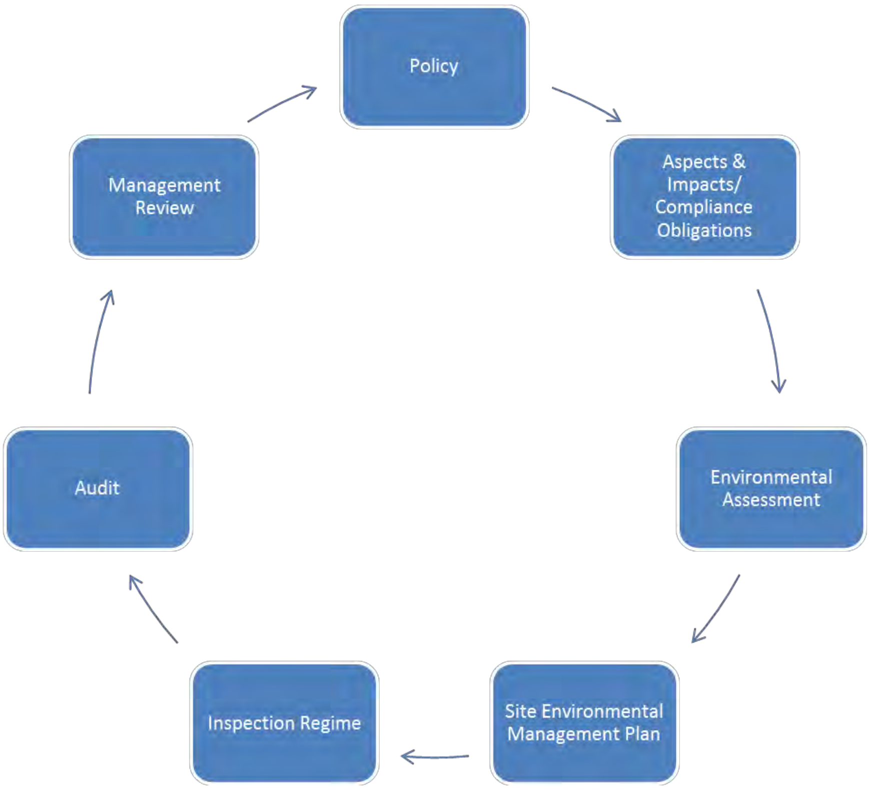
		Receptor Value		
		Low	**Medium**	**High**
Degree of effect	**Negligible**	Negligible	Negligible	Negligible
	Low	Minor	Minor	Moderate
	Medium	Minor	Moderate	Major
	High	Moderate	Major	Major

Appendix G

Environmental Management System

Summary of Environmental Management System

Tarmac Trading Limited (Tarmac) has in place an Environmental Management System (EMS) that is accredited to the international standard: ISO 140001. The site will be operated under the overarching Core EMS which covers Tarmac sites across the UK. The specific EMS procedures to support the operation of this type of regulated facility under an Environmental Permit in England have been developed with reference to relevant guidance produced by the Environment Agency (EA). The EMS follows the Plan Do Check Act (PDCA) cycled described in EA guidance [1] as illustrated below:



A copy of the EMS will be held at the site and will be available for inspection once the site is operational following the issue of the Environmental Permit for the site. A summary of the key elements of the EMS is provided below.

Company Environmental Policy

The EMS is underpinned by the company Environmental Policy which outlines its' high level vision, how it expects operations to be managed and its environmental performance to be communicated to its stakeholders and to enable the effective deployment of the related principles across its operational sites.

[1] How to comply with your environmental permit.

Tarmac is committed to preventing its activities polluting the environment and the continual improvement of its environmental performance. Through dedicated environmental and sustainability panel business objectives are developed. Environmental performance measures are also monitored by these forums and targets set to enable performance levels to be continuously improved.

Tarmac aims to minimise the environmental impacts of its activities by:

- Regularly monitoring the effective deployment of the EMS through a series of graded audits
- Prior to undertaking work on behalf of Tarmac, all sub-contract personnel will be made aware of site-specific environmental concerns and vulnerabilities through the site induction process
- Reducing the amount of waste materials generated by their activities, attempting to recycling and reuse such materials wherever practical and where this is not achievable, disposing of such waste in a responsible manner
- Seeking to use raw materials in an efficient manner, replacing them with substitute recycled raw materials where practicable and safe to do so
- Promoting the efficient and reduced use of water, fuels, and energy, thereby reducing carbon emissions, and mitigating the potential for climate change
- Purchasing, utilising, and storing materials in a manner which poses minimal risk to both individuals and the environment, as far as is practical
- Monitoring of consented permits and licences

The EMS has been deployed effectively through the company's management organisation. Managers and employees are assigned environmental responsibilities and will be expected to play a full and active part in managing the environmental aspects of the activities for which they have responsibility. Operational management are supported by a team of competent advisors and performance is monitored by environmental auditors.

Company Environmental Standards

A core suite of aspects applied to activities controlled by Tarmac is audited to monitor compliance to the relevant environmental standards. All operational sites are the subject of an Environmental Assessment and maintain an up-to-date Site Environmental Management Plan (SEMP).

Permit for Abstraction Specific Aspects

The following aspects have been identified having regard to the protection of the environment, compliance with any environmental permits and the highest standards of operation. These are in addition to the core company aspects described above.

The following aspects relevant to the abstraction at Gore Quarry will be managed in accordance with any relevant company policies and procedures, site authorisations and statutory obligations.

1. Water management and efficiency

Environmental Impact Review

The site manager is responsible for the Environmental Impact Review of the operations, in normal and abnormal conditions, to identify the key environmental aspects of its activities. Through this process the aspects of the operations, that may have significant impact on the environment, can be identified, prioritised for corrective action and improvement together with an evaluation of legal compliance at the site. The site manager/supervisor, together with representatives from the site/area and the compliance and environmental permitting personnel shall identify and prioritise the potential significant environmental impacts of the operations. The potential impacts most relevant to the abstraction at Gore Quarry have been identified to be:

1. Water Management and Monitoring
2. Resource depletion
3. Biodiversity impact
4. Legislation and documentation
5. Fuel and Chemical Storage

Site Environmental Management Plan

The Environmental Impact Review provides the prioritised potential significant environmental impacts for inclusion in the SEMP. The plan shall identify objective(s) and target(s) for each significant impact and ensure that they are relevant to achieving the overall objectives of the Business Unit. The objective (the improvement action) shall be specific to the corrective/preventative action. The target for the improvement shall have a date for completion, the person responsible for the action and verification of the completion by the authorising person. The SEMP shall be reviewed regularly and shall be consistent with legislation, environmental procedures and the Tarmac environmental policy. The SEMP may be updated at any time in order to implement changes/corrective actions identified by any management mechanism.

Each site undertakes all necessary monitoring and measuring of operational activities, as required by legislation, such as environmental permits and planning consents. All such monitoring and measuring information shall be documented and recorded on a monitoring schedule.

Environmental Occurrence/Non-Conformance Reporting System

The environmental occurrence/non-conformance reporting system has been developed in order to document, investigate and mitigate significant impacts on the environment and for initiating and implementing corrective and preventative action. All incidents shall be reported whether or not an external personal/agency is involved. Any system non-conformances are also to be documented for corrective and preventative action.

Inspection Regime and Audit

The Environment Manager shall establish and monitor an annual inspection programme ensuring that all sites under their control are audited by an ‘independent’ manager who has no responsibility for the site. The auditor shall complete an associated audit summary sheet, agreeing and summarising as necessary a list of recommended actions in consultation with the site manager. The audit summary sheet shall then be included in the SEMP and priorities and timescales assigned. A date for a follow-up visit to ensure close out of any actions has been completed will be set up by the visiting auditor and the manager/ supervisor. The follow up visit must also be used to ensure previous actions implemented are continuing to work and are effective.

In addition, the Company's own internal monitoring compliance team will carry out monthly monitoring across a range of determinants relevant to the abstraction and watercourse to ensure that the compliance levels and consent are being complied with.

Management Review

There is a tiered review of the EMS at top management level, local area level and at site management level including the procedures, environmental policy and the objectives and targets for the company in order to support its ongoing effectiveness, suitability, adequacy and stability.

Site and Equipment Maintenance Plan

Plant and machinery are subject to maintenance schedules in line with manufacturer recommendations and requirements. Site staff report problems with equipment and this is then assessed and actioned as necessary and as soon as possible.

It is in the company's interests to ensure all plant is operation and maintained which ensures both continuity of business and greater environmental protection.

Contingency Plans

In accordance with Company MS-EP-CORE-16 the Site Environmental Management Plan will include site specific contingency plans.

Accident Prevention and Management Plans

Pollution Prevention procedures for the site are outlined in MS-EP-CORE-09 Pollution Prevention. The procedures cover pollution prevention measures for dust, odour, noise and spills and inspection of equipment and emergency response. In accordance with Company MS-EP-CORE-16 the Site Environmental Management Plan will include site specific emergency response procedures.

Managing Staff Competence and Training Records

Employees will be suitably experienced and trained through various mechanisms to ensure they are competent to carry out their duties in line with company procedures and training schedules. Particular attention will be given to the familiarisation of the staff with the Environmental Permit and other compliance requirements and potential emissions and prevention of accidental emissions. Training will be recorded in accordance with the Company procedures. Contractors employed at the site will undergo a site induction and competency will be checked. Internal audits and inspection by the compliance team and internal auditors will ensure that training has been completed and actions are in line with this by employees and contractors.

Record Keeping

Records will be kept in accordance with the requirement of the Environmental Permit,

Appendix H

Stantec (2023) Pumping Test Report

Stantec

Gore Quarry Abstraction Licence Application – Pumping Test Report

5 October 2023

T1.02

Gore Quarry Abstraction Licence Application – Pumping Test Report

Prepared for

Tarmac Trading Ltd
Quorn House

Meeting Street
Quorn
Loughborough
LE12 8EX

Report reference:

331201262R2D1, October 2023

Report status: Final

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Gore Quarry Abstraction Licence Application – Pumping Test Report

Report Reference: 331201262R2D1

Report Status: Final

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Revision record:

Issue	Date	Status	Comment	Author	Checker	Reviewer
1	04/10/23	Draft		JFR/LJ	AWT	AWT
2	05/10/23	Final		JFR/LJ	AWT	AWT

Report Reference: 331201262R2D1

Report Status: Final

Contents

FIGURES

TABLES

APPENDICES

1 Introduction

1.1 Background

The Gore Quarry (the Site) is a gritstone quarry located immediately to the north of Burlingjobb, 200 m to the east of the village of Old Radnor in the County of Powys (see Figure 1-1).

Tarmac instructed Stantec UK Ltd (Stantec) to prepare and submit an abstraction licence application (ref: PAN-019189) to Natural Resources Wales (NRW) for the future dewatering at the Site. The planning permission allows working to 164 mAOD, with the quarry base currently being at c. 242 mAOD. Up to the current working depth, Tarmac have considered that the discharged water is almost entirely surface water and have, up to now, not pursued an abstraction licence application for quarry dewatering. However, as the quarry progresses downwards, groundwater will be intercepted and thus, dewatering would require an abstraction licence. Moreover, an existing Abstraction Borehole, located at SO 25669 59311 within the Site, abstracts groundwater from the same source that will be dewatered; therefore, a full abstraction licence is required.

As part of the application process, a groundwater investigation consent (ref: PAN-019333, see Appendix A) was issued by NRW, which required a constant rate pumping test of the Abstraction Borehole to assess the hydraulic characteristics of the aquifer at the Site.

1.2 Water requirements

Whilst the majority of dewatering water will not be used, only transferred, groundwater from the Abstraction Borehole will be used for operational purposes (which include wheel washing and dust suppression). The requested abstraction volumes are summarised in Table 1.1.

Table 1.1 Proposed water requirements

Type	Maximum (m^3/year)	Maximum (m^3/day)	Maximum (m^3/hour)
Abstraction	19,244[1]	100[2]	12.5[3]

[1] – 2020 total.

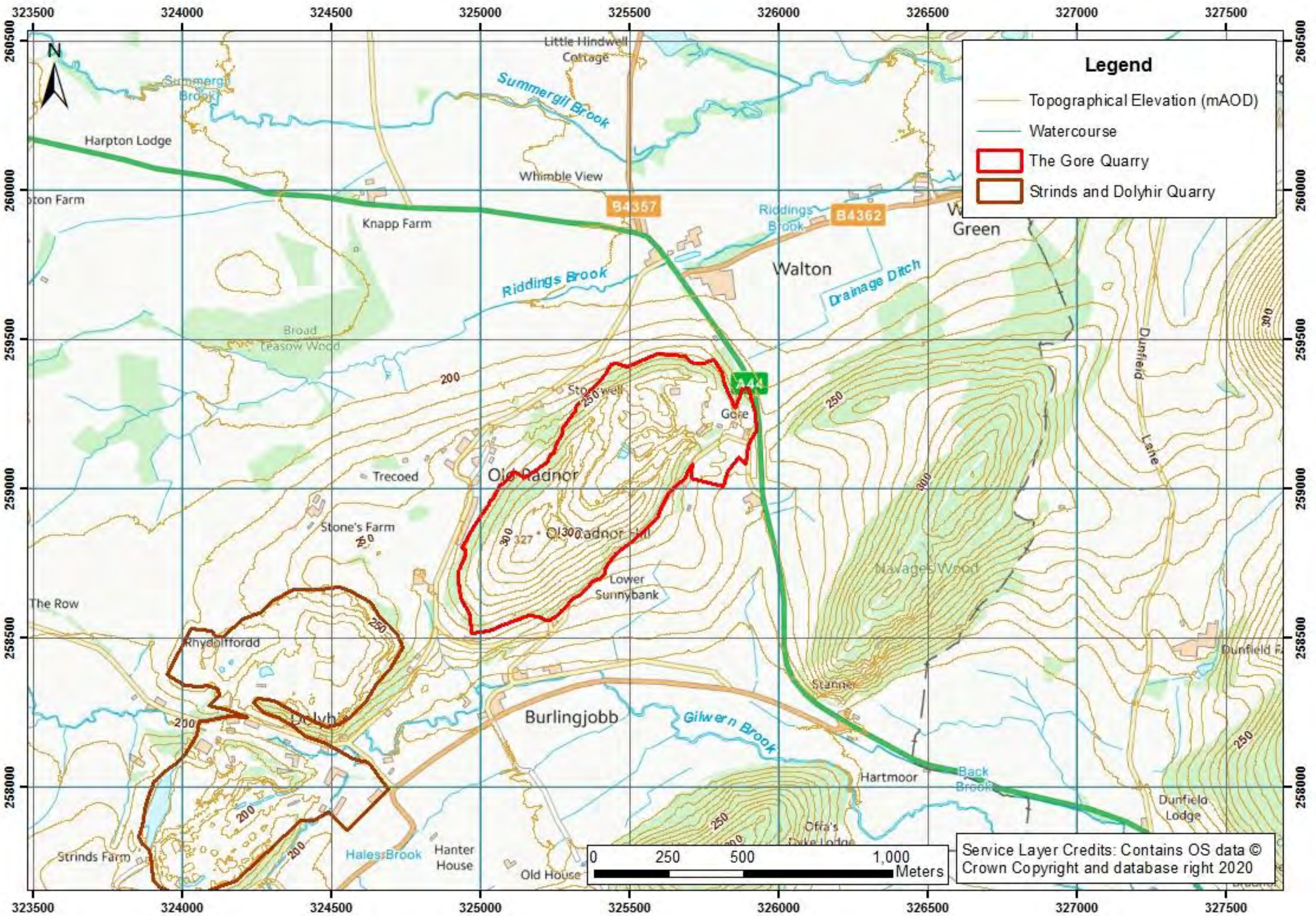
[2] – Typical daily requirement.

[3] – Based on 8 hours of abstraction per day.

1.3 Objectives and scope

The objective is to investigate the hydraulic characteristics of the aquifer at the Site through a pumping test at the Abstraction Borehole and to assess the quantity of groundwater available in order to confirm that the source is viable and sustainable. Similarly, the effects of the abstraction on surrounding water dependant features and other users are assessed.

Figure 1-1 Location map



2 Baseline conditions

2.1 Site details

The Gore Quarry is located immediately to the north of the hamlet of Burlingjobb and 200 m to the east of the village of Old Radnor in the County of Powys (Figure 1-1). The Site covers an area of approximately 36 hectares and is 300 m northeast of Dolyhir & Strinds Quarry, also operated by Tarmac. The surrounding land is of predominantly agricultural land use.

2.2 Geology

The quarry works predominantly Precambrian "gritstone" (of the Strinds Formation), which is a very high-quality product used for road surfaces. The geology is summarised in Table 2.1 with the bedrock geology and superficial deposits shown in Figure 2-1 and Figure 2-2 respectively.

The metamorphosed Precambrian strata consists of micaceous sandstone (Strinds Formation) with interbedded siltstones, mudstones and sandstones (Yat Wood Formation). The Dolyhir Limestone Formation, lying unconformably on the Precambrian strata, is present off site to the northwest and southeast, and undifferentiated Silurian rocks are found to the east.

Figure 2-2 shows superficial deposits are absent below, and within 50 m of, the Site. However, Glacial Till deposits are found to the north, and alluvium and glaciofluvial deposits are present to the south.

Table 2.1 Regional geology

Age	Formation	Lithological Description	Regional Thickness (m)	Local Thickness (m)
Quaternary	Glacial till	Mixture of clay, sand, gravel and boulders	0 - 15	10 – 15
Silurian	Silurian rocks - Wenlock and Ludlow Strata undifferentiated	Grey/brown mudstone, siltstone and sandstone	< 50	< 14
	Dolyhir Limestone Formation	Grey massive shelly limestone	20 - 30	5 - 45
Precambrian	Strinds Formation	Green/grey micaceous sandstone	> 150	-
	Yat Wood Formation	Siltstone, mudstone and sandstone	-	-

Figure 2-1 Bedrock Geology

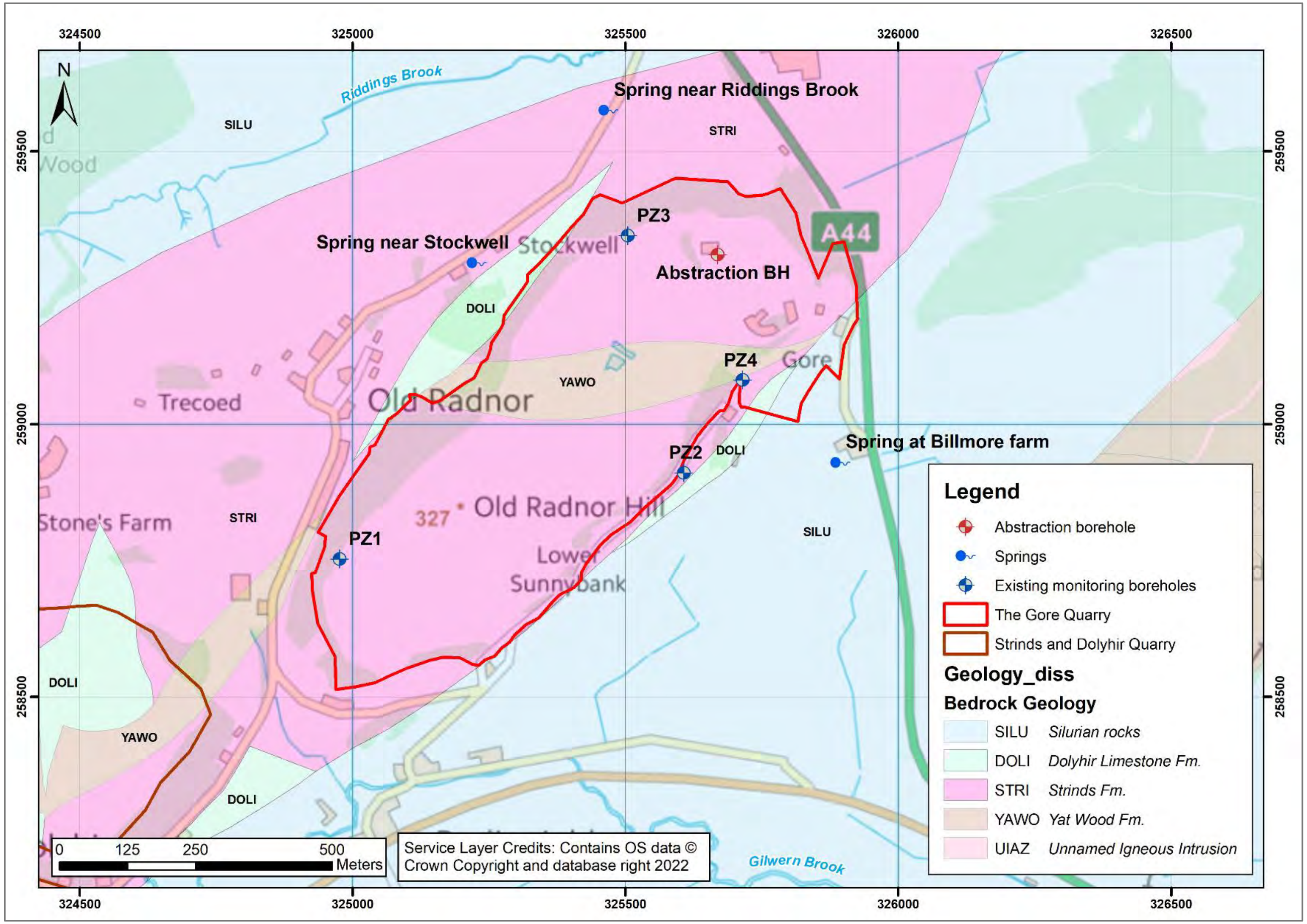
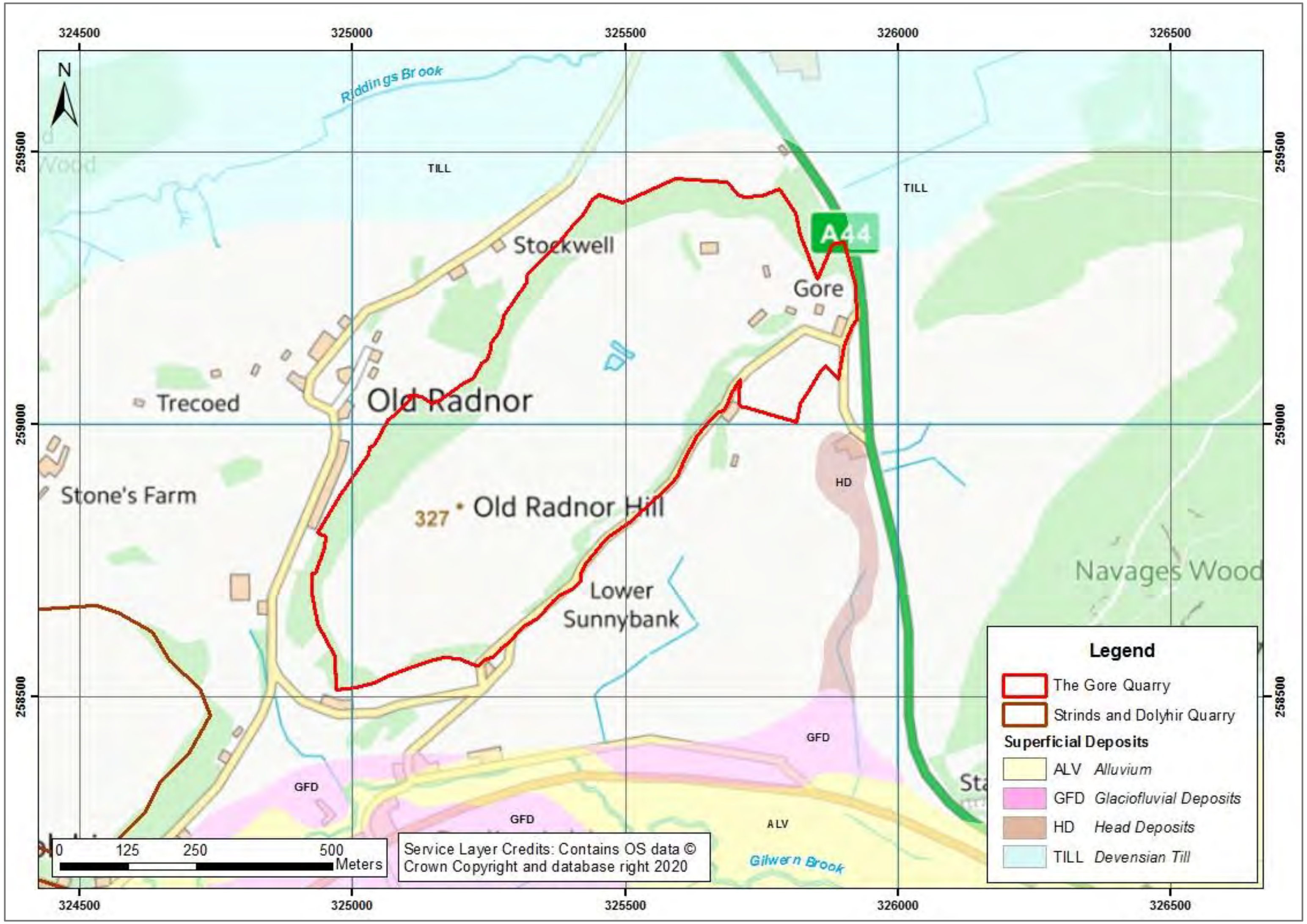


Figure 2-2 Superficial deposits



2.3 Surface water features

The quarry is excavated into the Old Radnor Hill; this hill drains in all directions away from the Site, while the quarry drains to the northeast towards the quarry discharge permit location. These water features are shown in Figure 2-3.The maximum height of the hill was c. 330 mAOD prior to quarrying with the floor level currently at c. 242 mAOD.

Surface water to the north is captured by the Riddings Brook, located about 245 m to the north of the Site (at an elevation of c. 185-195 mAOD) and flowing from west to east. It joins the Hindwell Brook about 3 km to the northeast which subsequently joins the River Lugg about 10 km to the northeast. A drainage ditch commencing in fields immediately to the northeast of the Site reaches the Riddings Brook about 800 m to the northeast.

For the pumping test, NRW requested for three potential springs to be monitored. A summary of these locations is given in Table 2.2, and the location of the springs and watercourses are shown on Figure 2-3.

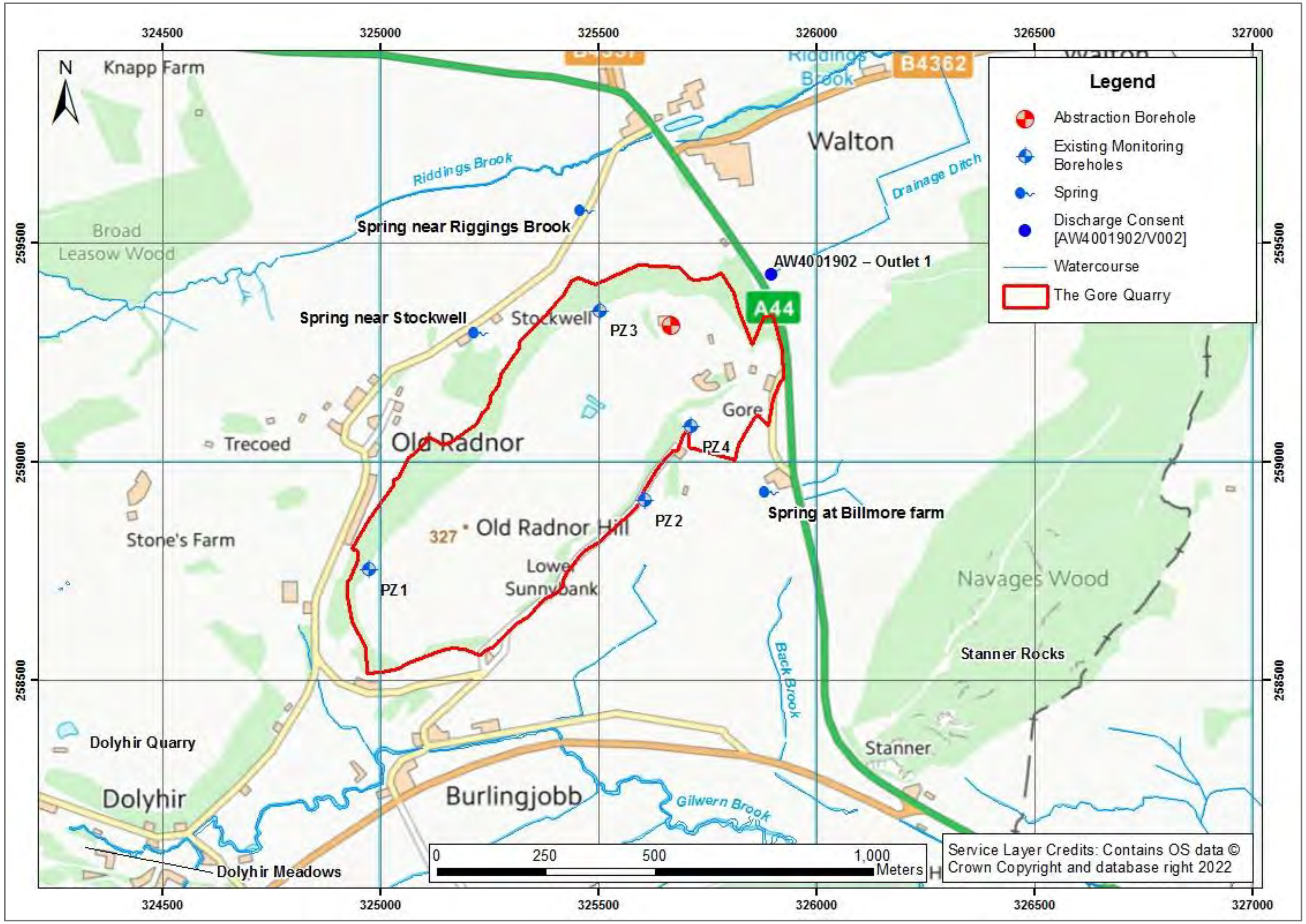
Two springs are located to the north of the Site: a spring near Riddings Brook and a spring near Stockwell, at elevations of 193 mAOD and 229 mAOD, respectively. The third is at Billmore Farm, located to the south of the Site, at an approximate elevation of 210 mAOD

Before, during and after the pumping test (dates between 25 August 2023 and 04 September 2023) wet ground, but no flow, was observed. Vegetation was present at the spring at Billmore Farm and the spring near Stockwell; however, at the spring near Riddings Brook dry vegetation was observed. Additionally, Ordnance Survey mapping does not show the development of a stream from these springs. It should be noted that the Spring at Billmore Farm could not be accessed close up for observations prior to and after the pumping test. Photographs of the springs that could be accessed are shown in Appendix B.

Table 2.2 Springs locations

Name	East	North	Approximate surface elevation (mAOD)
Spring at Billmore Farm	325894	258930	210
Spring near Riddings Brook	325469	259576	193
Spring near Stockwell	325228	259296	229

Figure 2-3 Surface water features and boreholes



2.4 Hydrogeology

The Strinds Formation, Yat Wood Formation and Dolyhir Limestone Formation are classified by the British Geological Survey (BGS) as Secondary B bedrock aquifers. Secondary B aquifers are predominantly lower permeability strata which may have the ability to store and yield limited amounts of groundwater by virtue of localised features such as fractures and weathering.

Superficial Deposits are absent around the Site, and Glacial Till is only found to the north. Due to its location on the crown of a hill, recharge at the Site is expected to be directly from rainfall infiltration on the rocks with higher theoretical hydraulic conductivities (i.e., sandstone and limestone).

The metamorphosed Precambrian strata consists of micaceous sandstone (Strinds Formation) with interbedded siltstones, mudstones and sandstones (Yat Wood Formation). The Dolyhir Limestone Formation is found to the northwest and southeast of the Site and is believed to have a low hydraulic conductivity; however, this formation has a limited lateral extent.

Silurian rocks are found to the southeast. The presence of springs to the south of the Site suggests a degree of hydraulic connection between the Precambrian rocks (Strinds and Yat Wood Formations) and the Silurian rocks.

The low hydraulic conductivity of the Glacial Till to the north indicates that the hydraulic connection between the aquifer and Riddings Brook to the north is likely to be limited.

3 Pumping test details

3.1 Technical characteristics

The Abstraction Borehole is a vertical well used for operational purposes which include wheel washing and dust suppression. It is located at SO 25669 59311 within the Site.

The Abstraction Borehole has a diameter of 0.80 m, its base is 11.54 m below the reference point (mbrp) at the top of the casing, and the stickup of the casing is c. 0.6 m above ground level. The average groundwater level monitored during four days before the pumping test is 10.18 m below the reference point, which results in an available drawdown of 1.36 m.

Construction details of the Abstraction Borehole are not available; however, it is understood the borehole is open hole.

The submersible pump is installed in the Abstraction Borehole and has a 2” PVC rising main that connects the borehole to storage tanks from where the water is taken for use.

3.2 Pumping test schedule

The pump test key dates are summarised in Table 3.1 below.

Table 3.1 Pump test key dates

Event	Date
Commencement of baseline monitoring	Friday 25th August (AM)
Pump calibration (20 to 40 minute duration)	Friday 25th August (PM)
Start of constant rate test (CRT)	Tuesday 29th August (10:35 am)
End of CRT and start of recovery	Friday 1st September (13:00 pm)
Completion of recovery / post-test monitoring	Monday 4th September (AM)

3.3 Monitoring requirements

The following monitoring requirements were set out in the groundwater investigation consent:

- Rate of pumping – to be maintained at a maximum of 100 m^3/d (c. 1.16 l/s) for a minimum duration of 48 hours;
- The duration of the test should be until water levels have stabilised in the Abstraction Borehole. Testing should be for a minimum duration of 48 hours and a maximum of 96 hours.
- The pumped water should be disposed of in such a way as to prevent re - circulation back to the aquifer.

- Water features identified during the water feature survey should be monitored throughout the pumping test. These monitoring boreholes and springs are listed in Table 3.2.

Borehole logs and installation details are not available; however, it is understood that the Abstraction Borehole and monitoring boreholes are screened in the Strinds Formation, with the response zone being across the bottom 12 m of the monitoring boreholes.

Monitoring of the static water levels commenced 4 days before the CRT. Dynamic water level monitoring continued during the CRT and after pumping stopped, to allow affected monitoring locations to recover and obtain the water level recovery data.

Other key details of the monitoring are summarised below:

- Data loggers reading groundwater levels every 10 minutes were placed in PZ2b, PZ3 and PZ4 from the pre-test period onwards. The data logger in the Abstraction Borehole recorded groundwater levels every 30 seconds prior to and after the test and every 15 seconds throughout the CRT. Regular manual dip readings were also taken at all monitoring wells.
- Barometric pressure was measured and used to correct the water level measurements as the data loggers were of the non-vented type. The top of the piezometer tubes and borehole cover at the Abstraction Borehole was used as the reference point for all water level measurements.
- Flow rates were recorded using a cumulative calibrated flow meter. The calibration certificate is presented in Appendix C.
- Observations of the springs off site were conducted prior to, during and after the constant rate test.
- All monitoring was carried out according to the relevant British Standard (BS14686:2003).

3.4 Pumping test discharge

Groundwater pumped from the Abstraction Borehole was diverted to storage tanks on the Site. There are three storage tanks, one with a capacity of 100,000 L and two tanks with capacities of 54,000 L.

Table 3.2 Key monitoring requirements

Location	Easting (m)	Northing (m)	Elevation (mAOD)	Type	Distance to Abstraction Borehole (m)	Depth to Bottom of Borehole (mbrp)	Measurement	Type of measurement	Lithology expected
Abstraction BH	325669	259311	241.4	Borehole	-	11.54	Groundwater level and flow rate	Data logger / dips, flow meter	Strinds Fm.
PZ2a	325607	258911	249.9	Borehole	404.8	28.2	Groundwater level	Dips	Strinds Fm.
PZ2b				Borehole		35.9	Groundwater level	Data logger / dips	Strinds Fm.
PZ3	325504	259346	260.7	Borehole	168.7	77.3	Groundwater level	Data logger / dips	Strinds Fm.
PZ4	325715	259081	244.0	Borehole	234.6	54.4	Groundwater level	Data logger / dips	Strinds Fm.
Spring near Stockwell	325228	259296	229	Spring	441.3	-	Visual changes	Observation	Strinds Fm.
Spring near Riddings Brook	325469	259576	193	Spring	331.9	-	Visual changes	Observation	Strinds Fm.
Spring at Billmore Farm	325894	258930	210	Spring	442.4	-	Visual changes	Observation	Silurian Rocks

4 Pumping test results and interpretation

4.1 Constant rate test

The CRT at the Abstraction Borehole commenced at 10:35 am on 29/08/2023 at a constant rate of 107.9 m^3/day, which then stabilized to 102.7 m^3/day. Small fluctuations in drawdown were noted during the test; however, these fluctuations do not seem to coincide with the pumping rate changes. The pumping rate did not vary by more than 3% after being stabilized at the beginning of the CRT, which is within reasonable limits for a constant rate test. The average pumping rate for the duration of the CRT was 101.7 m^3/day.

Drawdown in the Abstraction Borehole appeared to be stable and very mild for the first 90 minutes of the test, indicative of bore/casing storage depletion, and high hydraulic conductivity in the surrounding strata. The rate of drawdown increased between 90 and 900 minutes and increased further between 900 and 4465 minutes (end of the CRT). The steepening in the drawdown curve, compared to a theoretical time-drawdown, is interpreted by Freeze and Cherry (1979), and Kruseman and De Ridder (2000) as a reduced permeability boundary being reached by the cone of depression.

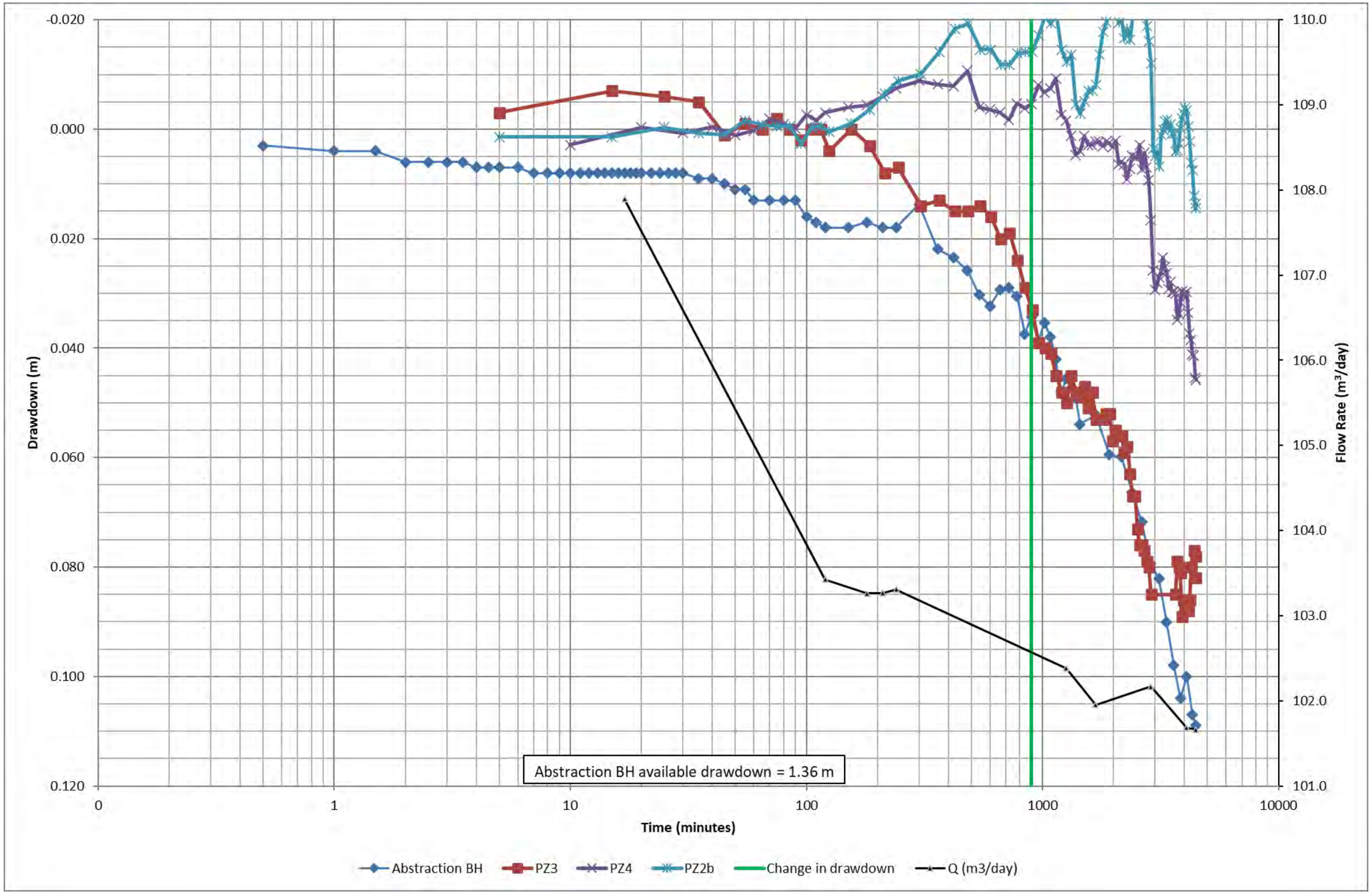
Differences in drawdown in monitoring boreholes were observed (see Figure 4-1). While PZ3 showed a similar drawdown pattern as the Abstraction Borehole, monitoring boreholes PZ2b and PZ4 showed an opposite response to pumping in the Abstraction Borehole with water level increases during the first 2885 minutes and 1260 minutes respectively. The rate of drawdown steeply increased 2820 minutes after pumping started, which was perhaps a delayed response due to the impermeable boundary interpreted at the Abstraction Borehole. Therefore, drawdown is characterized by two periods, marked by a green line in Figure 4-1.

The maximum recorded drawdown in monitoring borehole PZ3 was 0.089 m. The maximum drawdown in monitoring boreholes with a different response was less than 0.05 m, which is within the range of natural variation.

The CRT was terminated at 13:00 hours on 01/09/2023 after 74.4 hours of pumping. Drawdown in the Abstraction Borehole at the end of the CRT was 0.109 m. A semi-log plot of drawdown against time in the Abstraction Borehole and monitoring boreholes is presented in Figure 4-1. Logger data has been simplified for this figure as the high frequency of the readings compromise the legibility of the data plot. Data logger readings corroborated the manual readings.

Springs in the vicinity did not show an observable response and have been excluded from the drawdown plot. Photos of the springs were taken before, during and after the pumping test, and are available in Appendix B.

Figure 4-1 Constant rate test at Abstraction Borehole



4.2 Recovery test

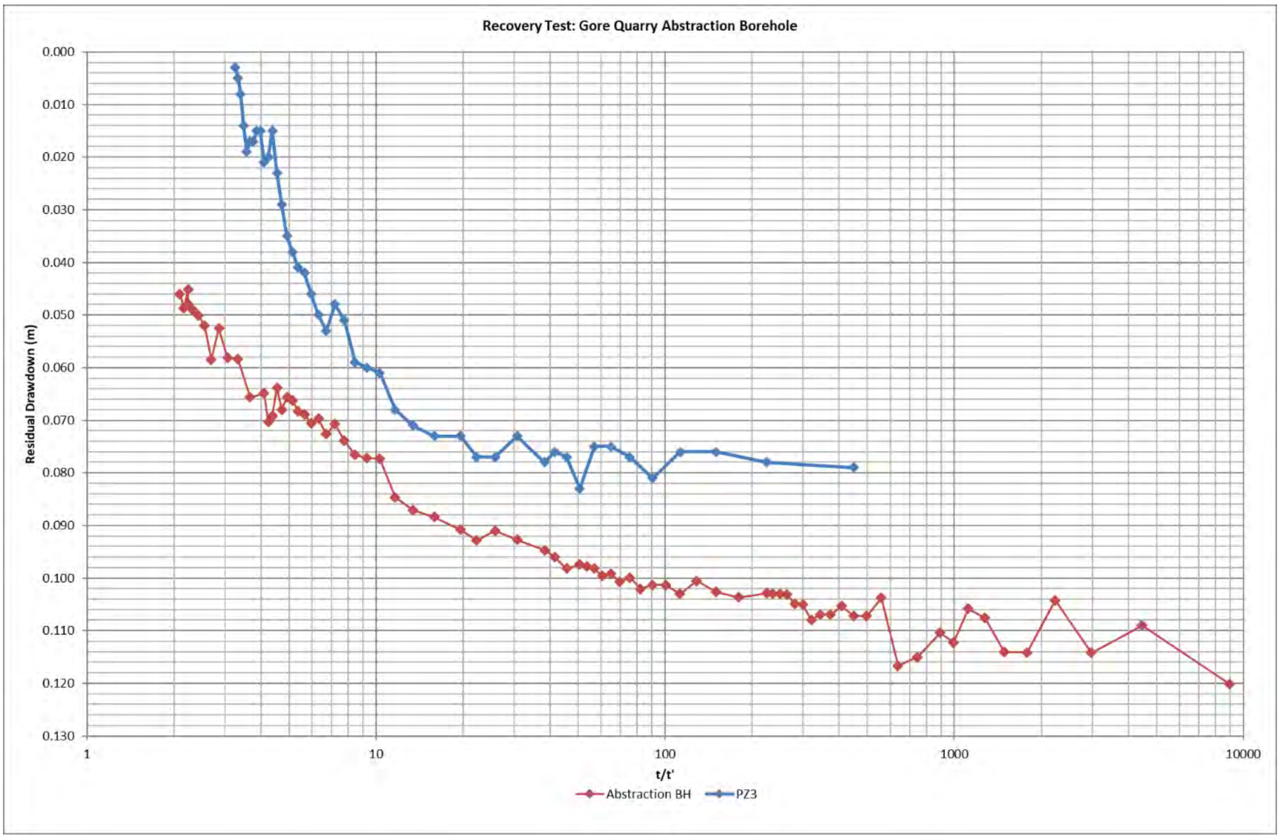
Recovery water levels were recorded in the Abstraction Borehole and monitoring boreholes for a period of 68 hours (4,080 minutes) after the cessation of pumping. The recovery data (residual drawdown versus log t/t') for the Abstraction Borehole and PZ3 is presented in Figure 4-2.

The data show the water level in the Abstraction Borehole had recovered to 58% of the original static water level within 68 hours of cessation of pumping when monitoring ceased. PZ3 was completely recovered 33 hours after pumping was stopped.

Both the Abstraction Borehole and PZ3 show a similar recovery trend, including small fluctuations. Initial recovery at the Abstraction Borehole and PZ3 was relatively slow and bouncy, approximately 2.1 cm in the initial 5 hours at the Abstraction Borehole, and 0.5 cm for the same recovery time at PZ3. The remainder of the recovery continued at a slow pace.

Similar to the CRT, the long recovery time suggests that an impermeable boundary has been intercepted and more time is required for the regional groundwater inflows to replenish the storage.

Figure 4-2 Recovery test at Abstraction Borehole



4.3 Hydraulic parameters

For the interpretation of the constant rate test and recovery test three methods were applied using the AquiferWin32 software: the Cooper-Jacob straight line method, the Theis method, and the Theis Recovery method.

Since two of the three monitoring boreholes had different responses (see Figure 4-1), the distance-drawdown method was not found suitable for interpretation.

Calculation results and graphs are shown in Appendix D. The curve deviation depicted in the semi-log time drawdown, and the log-log Theis curves, as well as the long recovery time, suggests that pumping from the Abstraction Borehole intercepted an impermeable boundary. For this reason, the hydraulic parameters were estimated for both early and late time periods. Early time values may have some influence from well losses and the surrounding geology, which could have been affected by quarry operation; however, these values will represent the maximum radius of influence. Although late time values will be influenced by the impermeable boundary interpreted to the south, these will represent the long-term impacts from pumping at the Abstraction Borehole.

A summary of characteristic hydraulic parameters derived from the pumping test are presented in Table 4.1.

4.4 Radius of influence

Drawdown at the Abstraction Borehole and monitoring boreholes has not exceeded 11 cm after 3.1 days of continuous pumping. Considering the water requirements (see Table 1.1) based on 8 hours of abstraction per day, and the location of the Abstraction Borehole at the top of a hill, this drawdown can be considered negligible. Similarly, the radius of influence is not considered to be significant.

Table 4.1 Summary of hydraulic parameters

Method	Data used	T (m^2/d)	S_y	Confidence	Results
Theis	Abstraction Borehole - Early time	6672	-	Medium	**Early time:** Geomean T: 3,689 m^2/d Geomean S_y: 0.005 **Late time:** Geomean T: 204 m^2/d Geomean S_y: 0.005
	Abstraction Borehole - Late time	146	-	High	
	PZ3 - Late time	196	0.006	T: High, S_y: Low	
	PZ4 - Late time	25	0.007	Low – different formation	
	PZ2b - Late time	0.56	0.0002	Low – different formation	
Cooper - Jacob	Abstraction Borehole - Early time	6686	-	Medium	
	Abstraction Borehole - Late time	187	-	High	
	PZ3 – Early time	1125	0.005	T: High, S_y: Low	
	PZ3 - Late time	232	0.005	T: High, S_y: Low	
Theis Recovery	Abstraction Borehole - Early time	2175	-	High	
	Abstraction Borehole - Late time	414	-	High	
	PZ3 – Early time	6262	-	Medium	
	PZ3 - Late time	141	-	High	

5 Discussion and Conclusions

The pumping test performed at the Abstraction Borehole shows a maximum drawdown of 0.109 m, while the maximum recorded drawdown in monitoring borehole PZ3 was 0.089 m. The data recorded at the Abstraction Borehole and PZ3 show a steepening in the drawdown curve in the late time data, which has been interpreted as a reduced permeability boundary being reached by the cone of depression.

Given this interpretation, hydraulic parameters were estimated for both early and late time periods. Early time values may have some influence of well losses and the surrounding geology, while late time values will be influenced by the impermeable boundary.

The analysis of drawdown on monitoring boreholes PZ2b and PZ4 during the CRT shows different response and transmissivity (T) values. Since PZ2b and PZ4 are located to the south of the Abstraction Borehole, to the south of the Yat Wood Formation outcrop (which is formed by siltstones, mudstones), and faults are not found in the area, it is interpreted that rocks from the Yat Wood Formation create the reduced permeability boundary (see Figure 2-1).

Values of T for early time data are high, with a geomean of 3,689 m^3/day. The T found for late time data, influenced by the impermeable boundary, is also high with a geomean of 204 m^3/day. The hydraulic conductivity (K) inferred from T is between 10 and 150 m/d for late time data, depending on the depth of the aquifer used (between 20 m and 1.36 m, respectively), which represents fractured or weathered rock (Kruseman and De Ridder, 2000), rather than sandstone from the Strinds Formation. K values from slug tests at monitoring boreholes PZ2, PZ3 and PZ4 (Stantec, 2022a) are generally four orders of magnitude lower than K estimates from the pumping test, suggesting that the tested section of the monitoring boreholes correspond to fresh sandstone, and that the sandstone found at the Abstraction Borehole is fractured and/or weathered.

Specific yield (S_y) values for unconfined aquifers usually range from 0.01 and 0.3 (Kruseman and De Ridder, 2000). S_y values obtained from the pumping test analyses are one order of magnitude lower, hence the low confidence assigned to these estimated values in Table 4.1. The small drawdown observed during the CRT and the small available drawdown at the Abstraction Borehole (1.36 m) could have contributed to the underestimation of the S_y.

The findings from the pumping test interpretation indicate that the Abstraction Borehole will be able to support the required pumping rate without impacting any surrounding receptor listed in Stantec (2022b). The maximum drawdown of 0.109 m at the Abstraction Borehole after 3.1 days of continuous pumping, and the measurements and observations at the other monitoring locations, indicate that drawdowns from this abstraction will have a negligible impact on the aquifer and other surrounding receptors.

REFERENCES

Freeze, R.A. and Cherry, J.A. (1979). Groundwater.

Kruseman, G.P. and De Ridder, N.A. (2000). Analysis and evaluation of pumping test data.

Stantec (2022a). The Gore Quarry: Assessment of Future Requirements Dewatering.

Stantec (2022b). Technical Note. Gore Quarry: Groundwater Investigation Consent Application.

APPENDICES

Appendix A

Groundwater Investigation Consent (ref: PAN-019333)

CONSENT TO INVESTIGATE A GROUNDWATER SOURCE

Section 32(3) Water Resources Act 1991 (as amended)

This **CONSENT** is issued by the Natural Resources Body for Wales (hereafter referred to as "Natural Resources Wales") to:

Delia Boulis of Tarmac Trading Limited ("the Consent Holder")
Ground Floor, T3 Trinity Park
Bickenhill Lane
BIRMINGHAM
B37 7ES

Company Registration Number: 00453791

This consent authorises the Consent Holder to investigate a groundwater source described in the schedule of conditions and subject to the provisions of that schedule. The consent commences from the date of signature and shall remain in force until the date of expiry shown below.

"The Consent Holder" means the person (whether an individual or organisation) to whom consent is granted. Where the Consent Holder is two or more persons (e.g. a partnership) such persons shall be jointly and severally liable for the proper fulfilment of the conditions of this consent.

This consent is effective from the date below and **expires on 30 September 2023**

Issued by: Trystan James – Technical Team Leader (Geoscience)
Date 8th November 2022

SCHEDULE OF CONDITIONS

1 Location

1.1 Underground strata comprising of Strinds Formation (Pre-Cambrian) at National Grid Reference SO 25669 59311.

2 Construction details

2.1 A borehole not exceeding 10.93 metres in depth and 800 millimetres in diameter installed into underground strata as specified in condition 1.1

2.2 Boreholes and wells must be provided with a means of measurement access (such as a dip tube) so that a cable dipper or automatic water level recorder can be lowered to measure the water level.

3 Maximum Quantities of Water to be abstracted during test pump

3.1 100 cubic metres per day

Note: A day means any period of 24 consecutive hours

4 Duration of testing

4.1 The duration of test should be until water levels have stabilised in the abstraction borehole. Testing should be for a minimum duration of 48 hours and a maximum duration of 4 days (96 hours).

4.2 The Licence Holder shall notify NRW if groundwater levels in the abstraction source have not stabilised after pumping for 4 days (96 hours).

5 Water feature assessment

The pumping test should be designed to assess the effect of this abstraction on the following water features and abstractions:

Piezometers on site – PZ2, PZ3 and PZ4.
Springs at Stockwell, Riggings Brook and Billmore Farm.

6 Discharge of water

6.1 The pumped water should be disposed of in such a way as to prevent re-circulation back to the aquifer.

6.2 Discharged water shall not contain any other cooling waters or process effluents unless otherwise authorized by an environmental permit or registered exemption.

7 Notifying Natural Resources Wales following expiry of consent

7.1 You must notify us within 14 days of the expiry date of this consent to advise us if you intend to apply for a groundwater abstraction licence.

ADDITIONAL INFORMATION

Modification or removal of consent
This consent may be modified or revoked at any time by Natural Resources Wales.

Indemnity
We shall not be liable to pay for any of the testing nor for any of the consequences that may arise from this consent. The Consent Holder shall be responsible for making good and compensating for any loss, damage or injury (whether to persons or property, including water resources generally or derogation from individual sources of supply) resulting from this consent.

Right of access
Possession of this consent no rights of entry onto land. Permission to enter land or premises must be obtained from the owner or occupier

Interpretation of conditions
Condition 2.1 The borehole, well or spring catchpit should be constructed as detailed in the application form WRC.

Condition 4.1: Sufficient data must be collected to enable analysis of aquifer properties and assess the long-term effects on identified water features.

Conditions 4.2 and 7 and for general queries the Consent Holder can contact:
Geoscience Team, Natural Resources Wales, Ty Cambria, 29 Newport Road, Cardiff, CF24 0TP
Tel: 0300 065 3000
Email: geoscience@cyfoethnaturiolcymru.gov.uk

Condition 5: The results of testing must be incorporated into a hydrogeological impact assessment to be submitted with any subsequent application for a groundwater abstraction licence. You must declare in this assessment if any complaints were received from nearby landowners or water uses during your test pumping. We will expect you to carry out the pumping tests and produce a groundwater impact assessment in line with relevant guidance and best practice, including:

- British Standard ISO 14686 (2003) "Hydrometric determinations – pumping tests for water wells – considerations and guidelines for design, performance and use".

- Environment Agency (2012) 'Hydrogeological Impact Appraisal for groundwater abstractions

- Scottish Environment Protection Agency (2013). Regulatory Method (WAT-RM-24) Pumping Test Methodology

Condition 6.1 If groundwater is re-circulated back into the aquifer during the pumping test it may affect the monitoring results

Condition 6.2 Under the Environmental Permitting Regulations 2016 it is an offence to undertake a groundwater activity without an environmental permit, or having registered an exemption.

Condition 7.1 This consent provides an exemption allowing you to test the borehole under Section 32 of the Water Resources Act. After the consent expires you must not abstract more than 20m^3 per day until you obtain an abstraction licence.

Appendix B

Spring photos

Spring near Stockwell before pumping test – 25th August 2023

Spring near Stockwell during pumping test – 31st August 2023

Spring near Riddings Brook location before pumping test – 25th August 2023

Spring near Riddings Brook location during pumping test – 31st August 2023

Spring near Riddings Brook after pumping test – 4th September 2023

Appendix C

Calibration Certificate

CALIBRATION CONTROL LTD

INSTALLATION, CALIBRATION & REPAIR OF PROCESS CONTROL EQT

Water & Admixture Calibration Report Revision 1.28 03/01/2019.	11 Speechly Drive, Rugeley Staffordshire, WS15 2PT Tel: 01889 800993. Mob: 07723 361796

SHEET 1 OF 1	DATE OF VISIT 11th August 2023	No.CB / V / 08 - 14

CUSTOMER / CLIENT…**TARMAC** …………….. SITE / DEPOT …**GORE QUARRY**…………………….

Max **1000L x 1L** **BOREHOLE** Flow meter (Count At End 50218.110 CuM)

Test Amount Measured	Actual Amount Dispensed	Error in Liters	% Error	Within 3% Tolerance (Y/N)
1000	**1004**	**+4**	**<0.5%**	**Y**

Max 800 x 1 DISCHARGE WATER Flow meter (Count At End 716.22 CuM)

Test Amount Measured	Actual Amount Dispensed	Error in Liters	% Error	Within 3% Tolerance (Y/N)

Was the equipment in good working condition	Yes / No	Was the calibration within +/- 3% allowance	Yes / No
Are pipes and valves working correctly	Yes / No	Any further action required…………………………………	
Is display working correctly	Yes / No	…………………………………………………………………	
Does the display / counter zero after use	Yes / No	Test Equipment Serial No CC/ W02 / PD01	
Do all non-return valves and diverters work	Yes / No	Equipment Test Date…14 / 07 / 2023……………………..	

Max 10000 x 10 ADMIXTURE ONE Flow meter / Weighed / Pressure

Test Amount Measured	Actual Amount Dispensed	Error in Liters	% Error	Within 5% Tolerance (Y/N)

Max x ADMIXTURE TWO Flow meter / Weighed / Pressure

Test Amount Measured	Actual Amount Dispensed	Error in Liters	% Error	Within 5% Tolerance (Y/N)

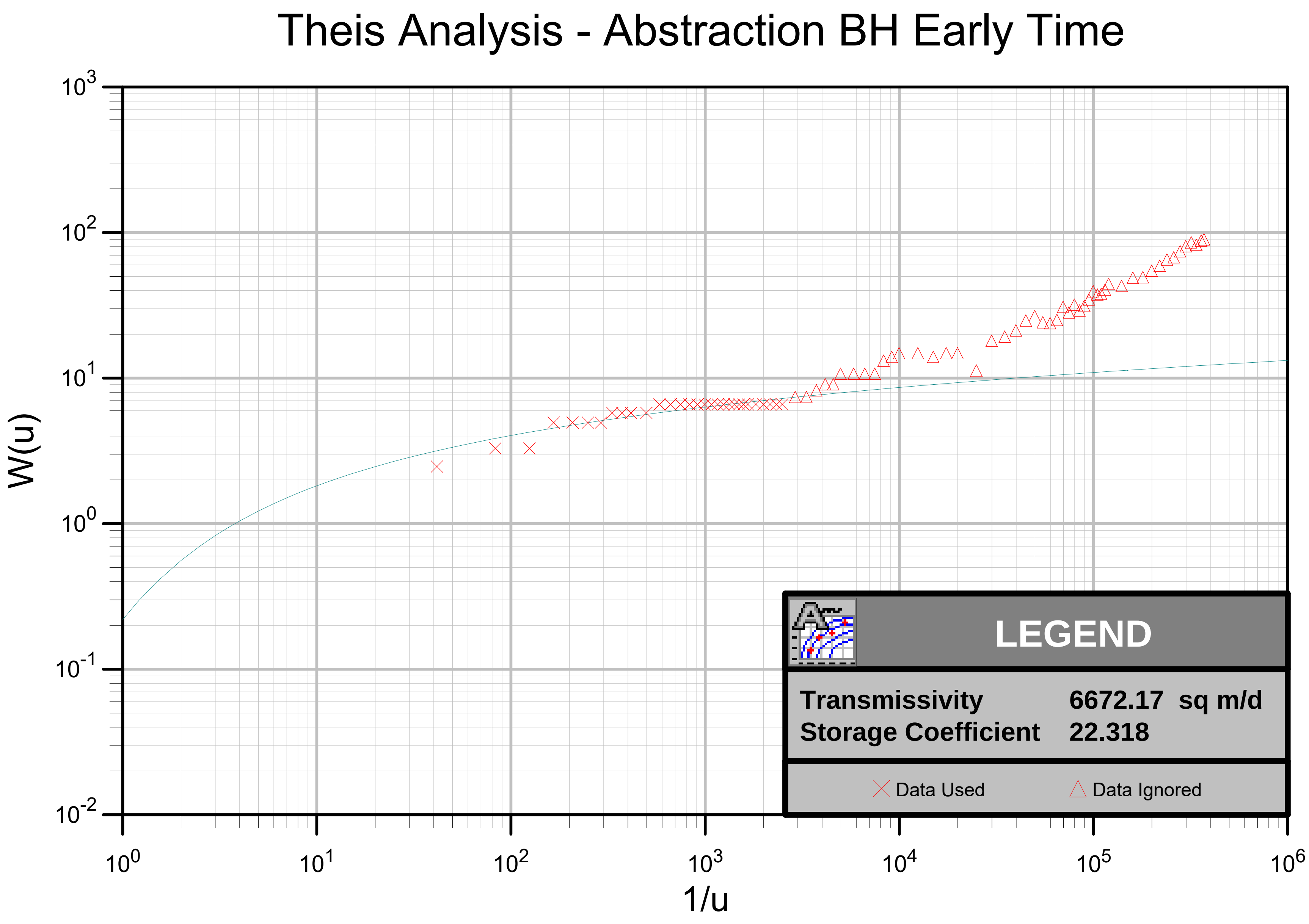
Max x ADMIXTURE THREE Flow meter / Weighed / Pressure

Test Amount Measured	Actual Amount Dispensed	Error in Liters	% Error	Within 5% Tolerance (Y/N)

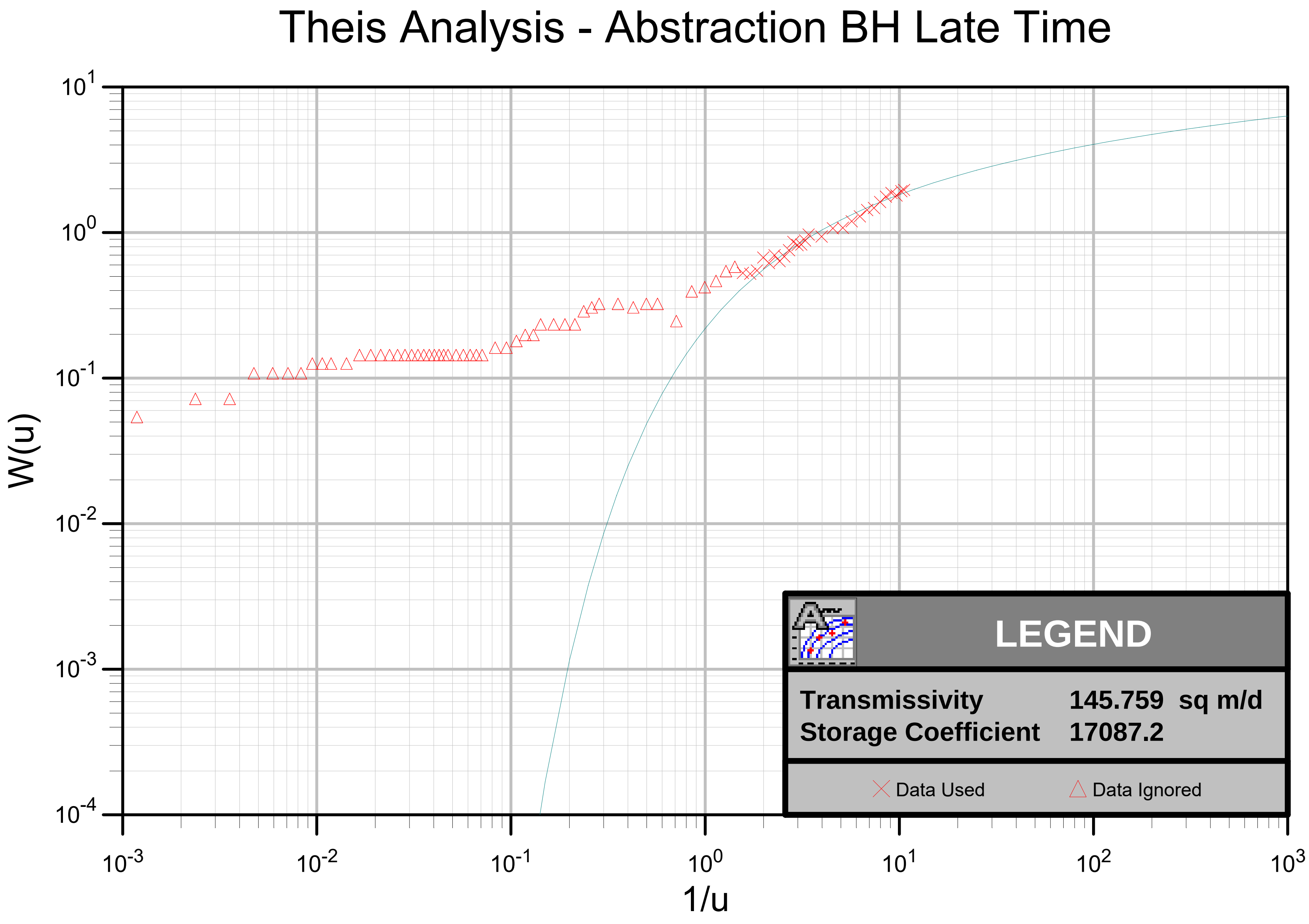
Is equipment in good working order	Yes / No	After use did the equipment return to zero	Yes / No
Are all pipes labeled correctly	Yes / No	If fitted – does water flush work	Yes / No
Do all non return valves work correctly	Yes / No	No calibration errors due to foaming	Yes / No
Is sight glass clean and legible	Yes / No	Calibration was within +/- 5%	Yes / No
Is Zero/Empty point correct	Yes / No	If fitted, does "No Flow" system work	Yes / No
Can dosage be set accurately	Yes / No	Any remedial / further action required……………………………	
		Test equipment serial number CC/ AM 01 02 03 /	

Signature of Engineer…COLIN BOYLE……………….. Signature of Plant Supervisor…NEIL CARTER …………

Appendix D
Calculation Results

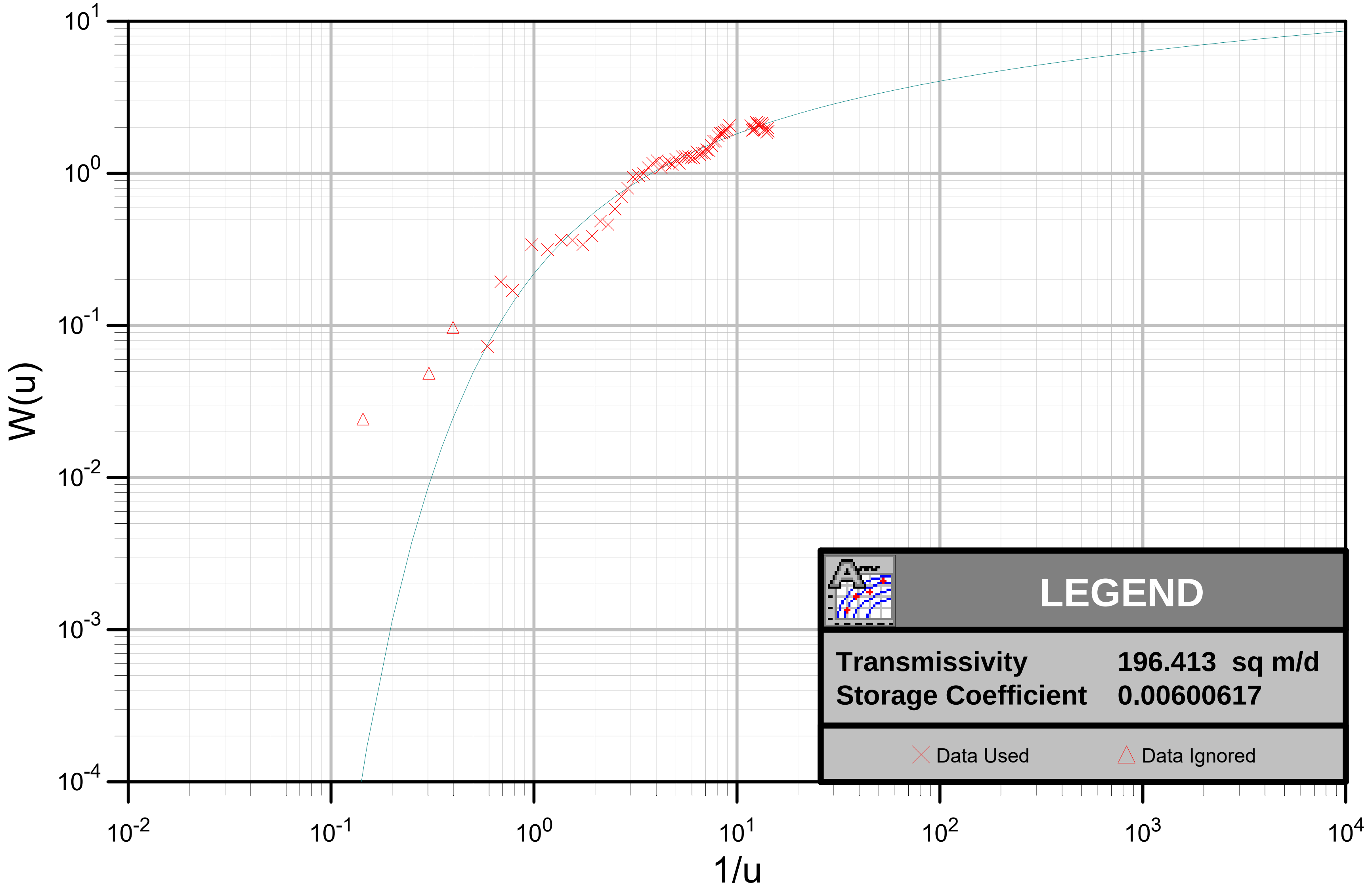


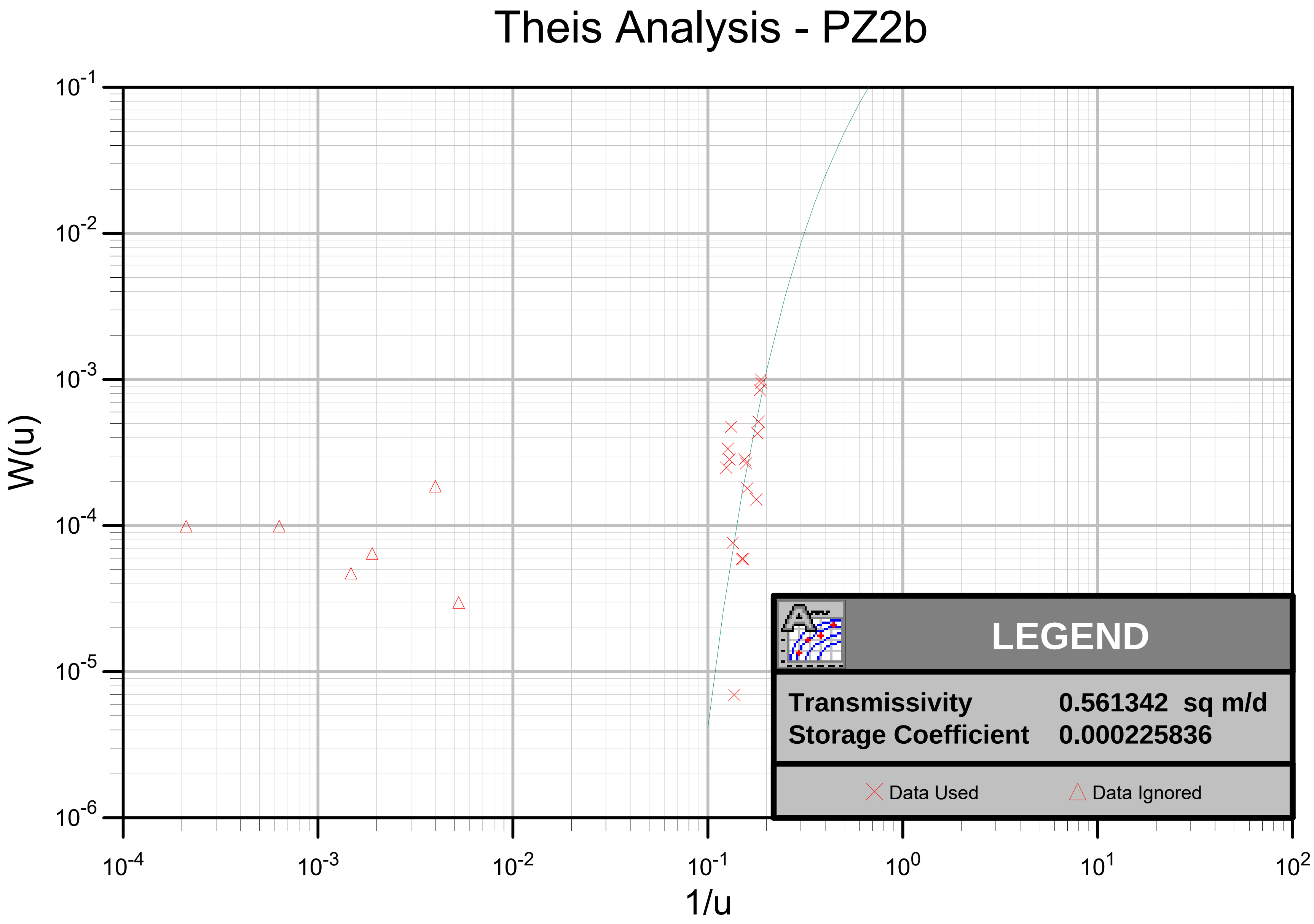
Theis Analysis - Abstraction BH Early Time
W(u)
1/u
10^3
10^2
10^1
10^0
10^-1
10^-2
10^0
10^1
10^2
10^3
10^4
10^5
10^6
LEGEND
Transmissivity 6672.17 sq m/d
Storage Coefficient 22.318
Data Used
Data Ignored

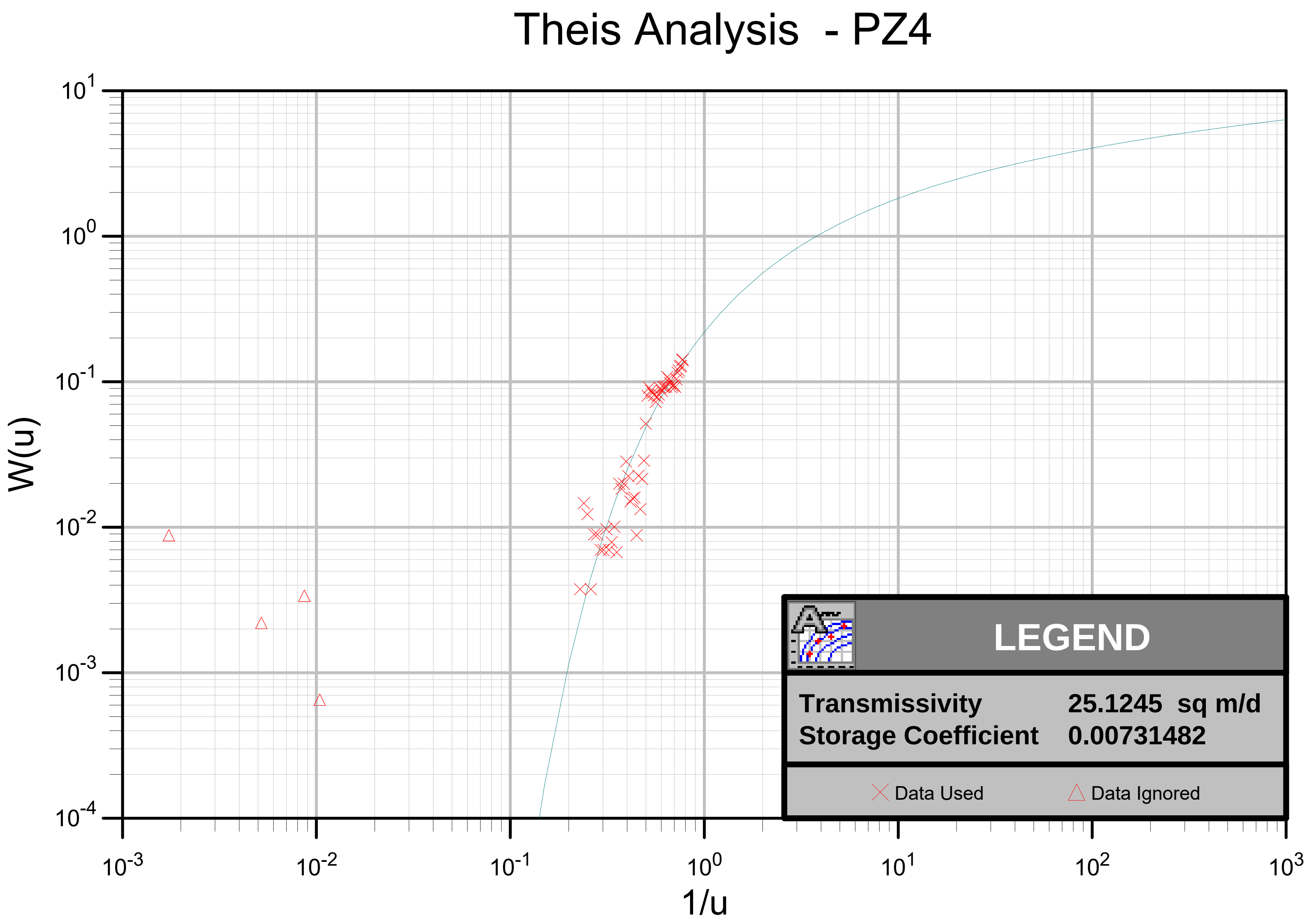


Theis Analysis - Abstraction BH Late Time
W(u)
1/u
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^-3
10^-2
10^-1
10^0
10^1
10^2
10^3
LEGEND
Transmissivity 145.759 sq m/d
Storage Coefficient 17087.2
Data Used
Data Ignored

Theis Analysis - PZ3

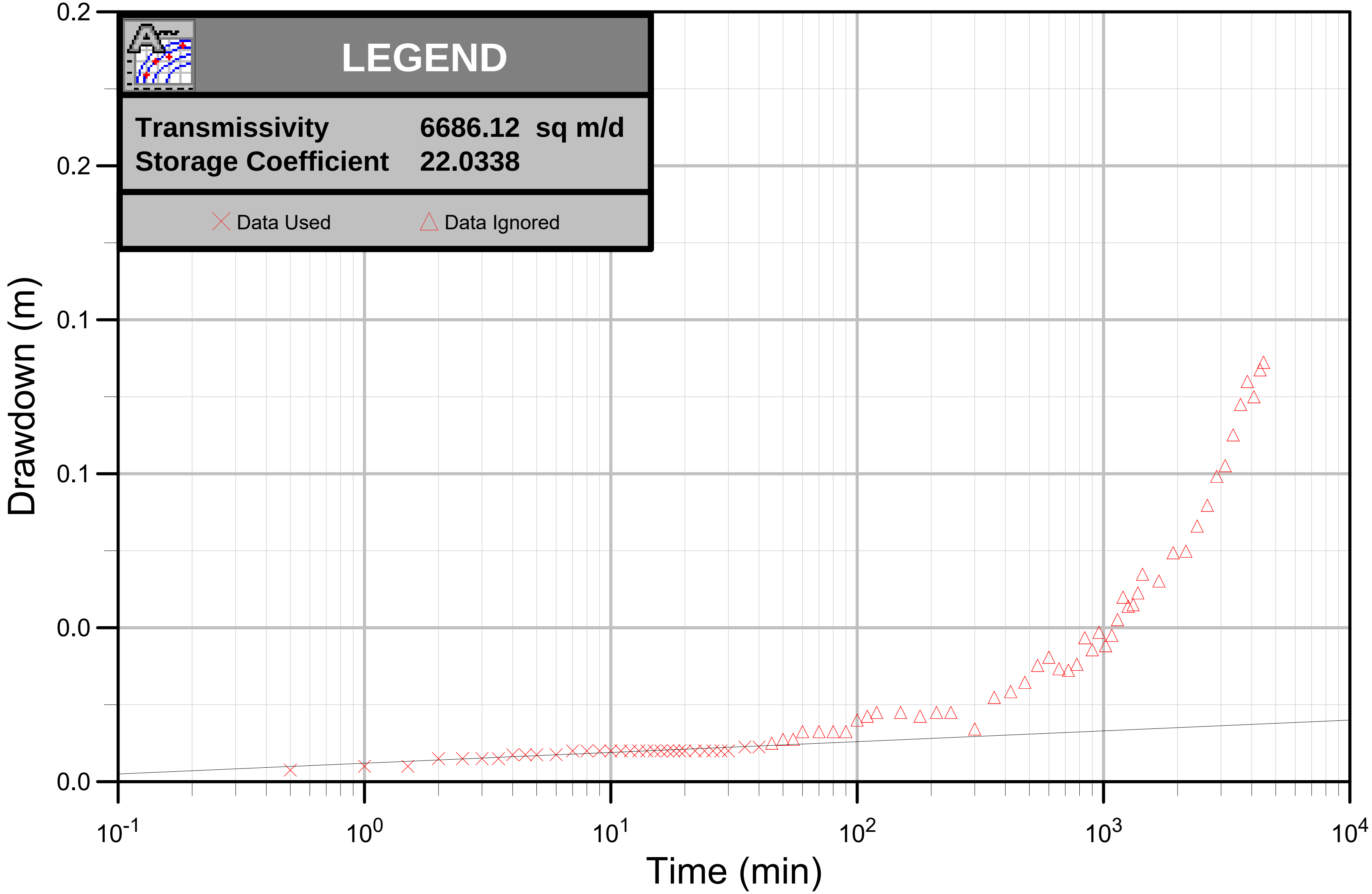


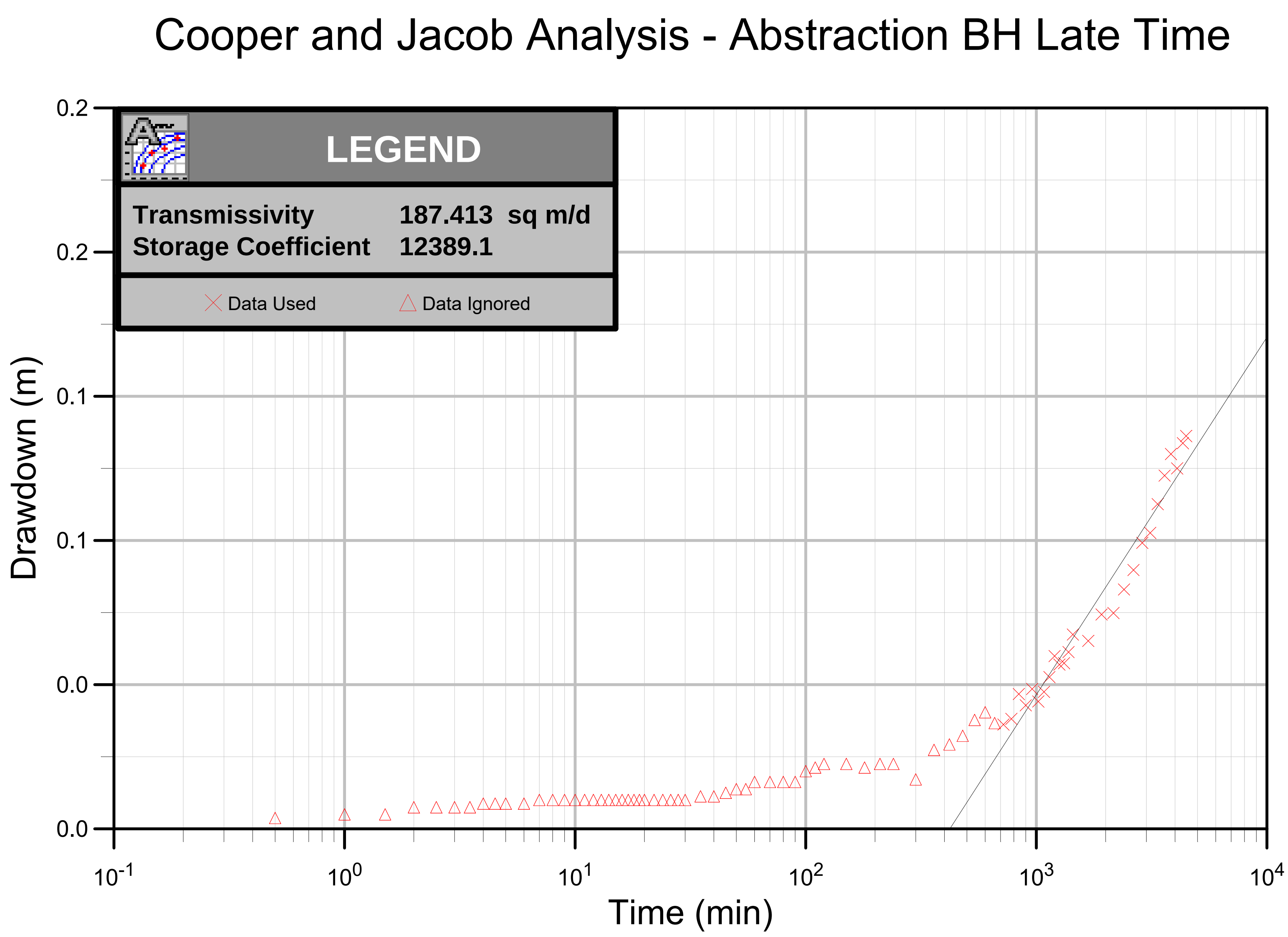

Theis Analysis - PZ2b
W(u)
1/u
10-1
10-2
10-3
10-4
10-5
10-6
10-4
10-3
10-2
10-1
100
101
102
LEGEND
Transmissivity 0.561342 sq m/d
Storage Coefficient 0.000225836
Data Used
Data Ignored

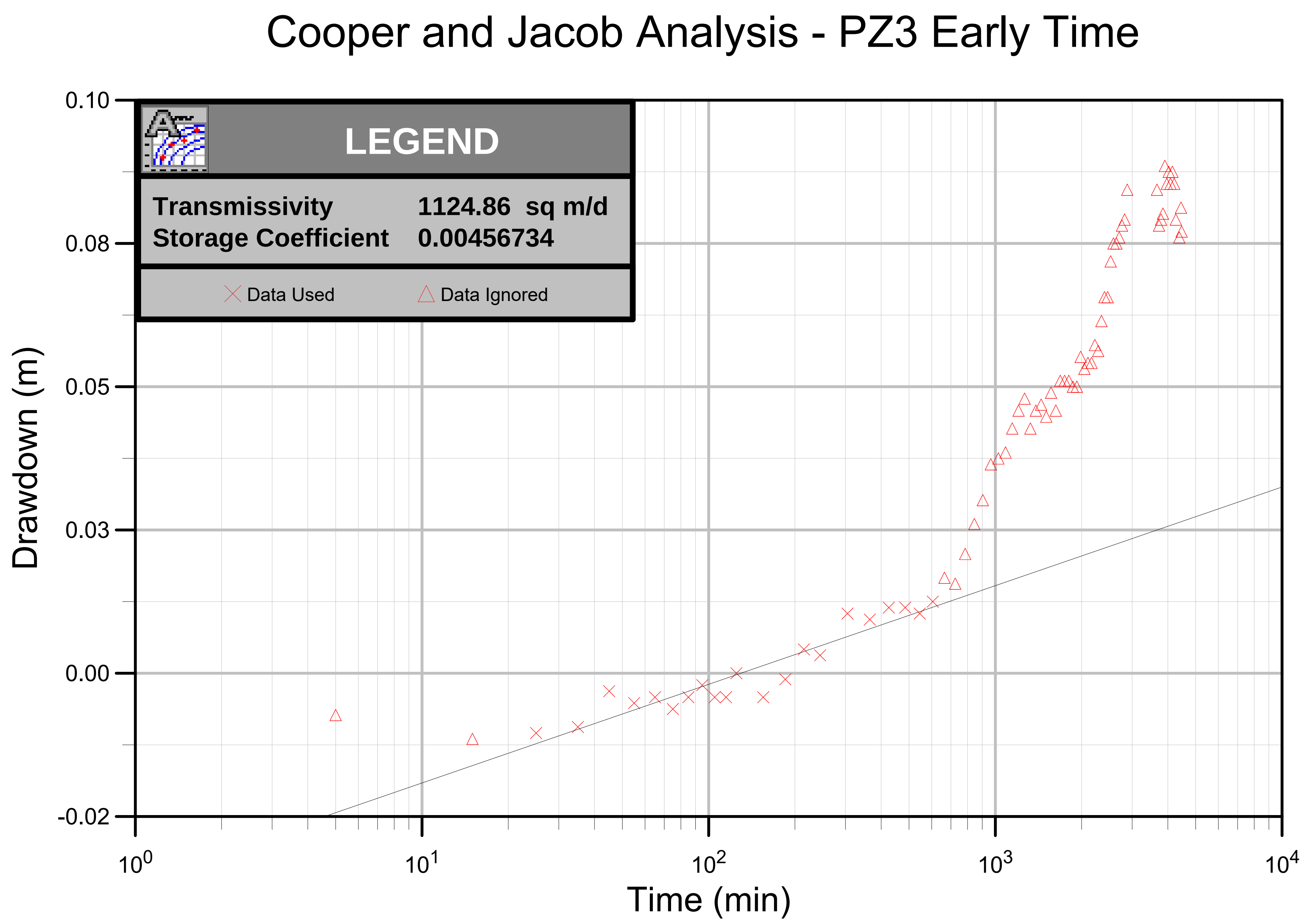


Theis Analysis - PZ4
W(u)
1/u
LEGEND
Transmissivity 25.1245 sq m/d
Storage Coefficient 0.00731482
Data Used
Data Ignored

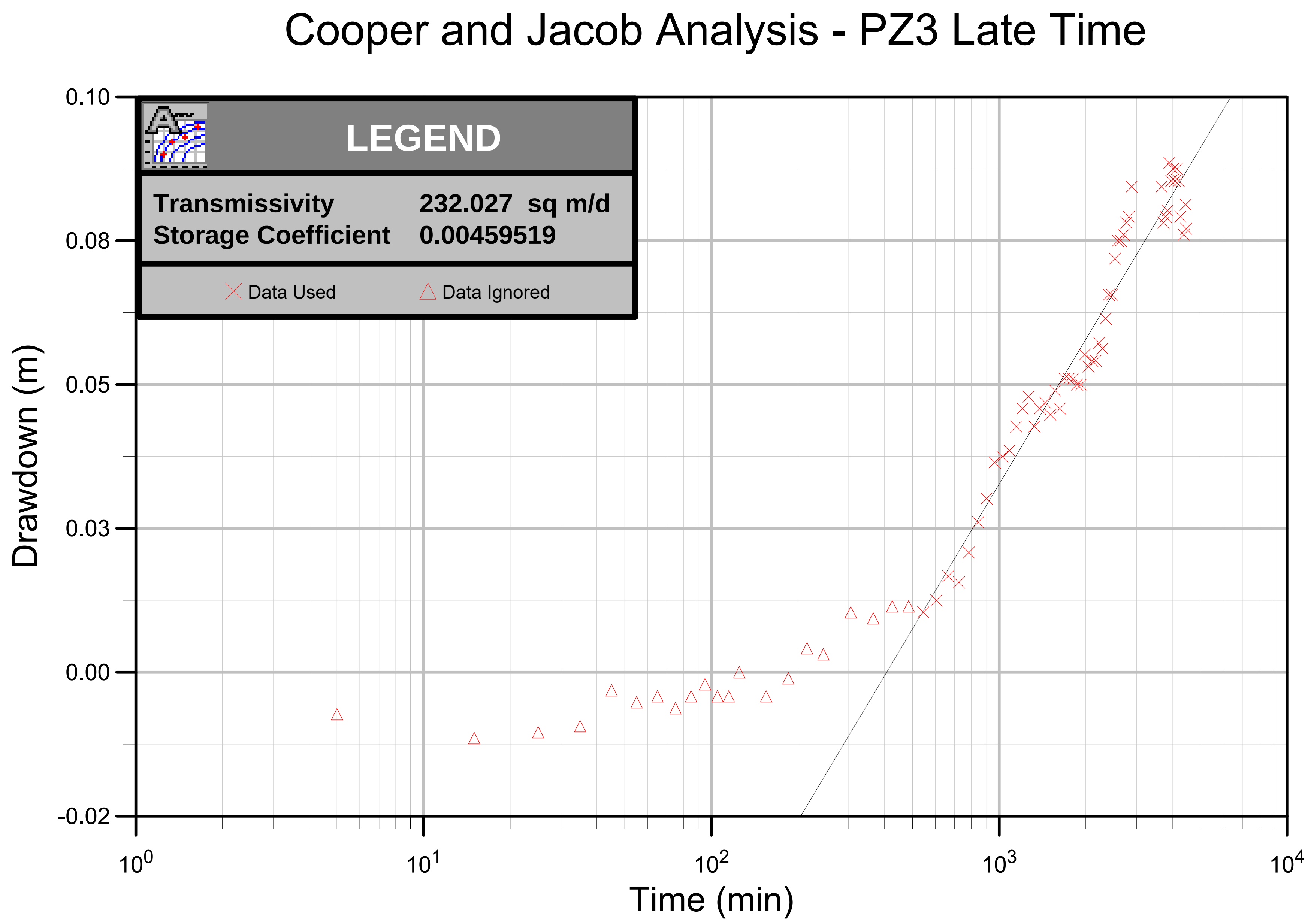
Cooper and Jacob Analysis - Abstraction BH Early Time

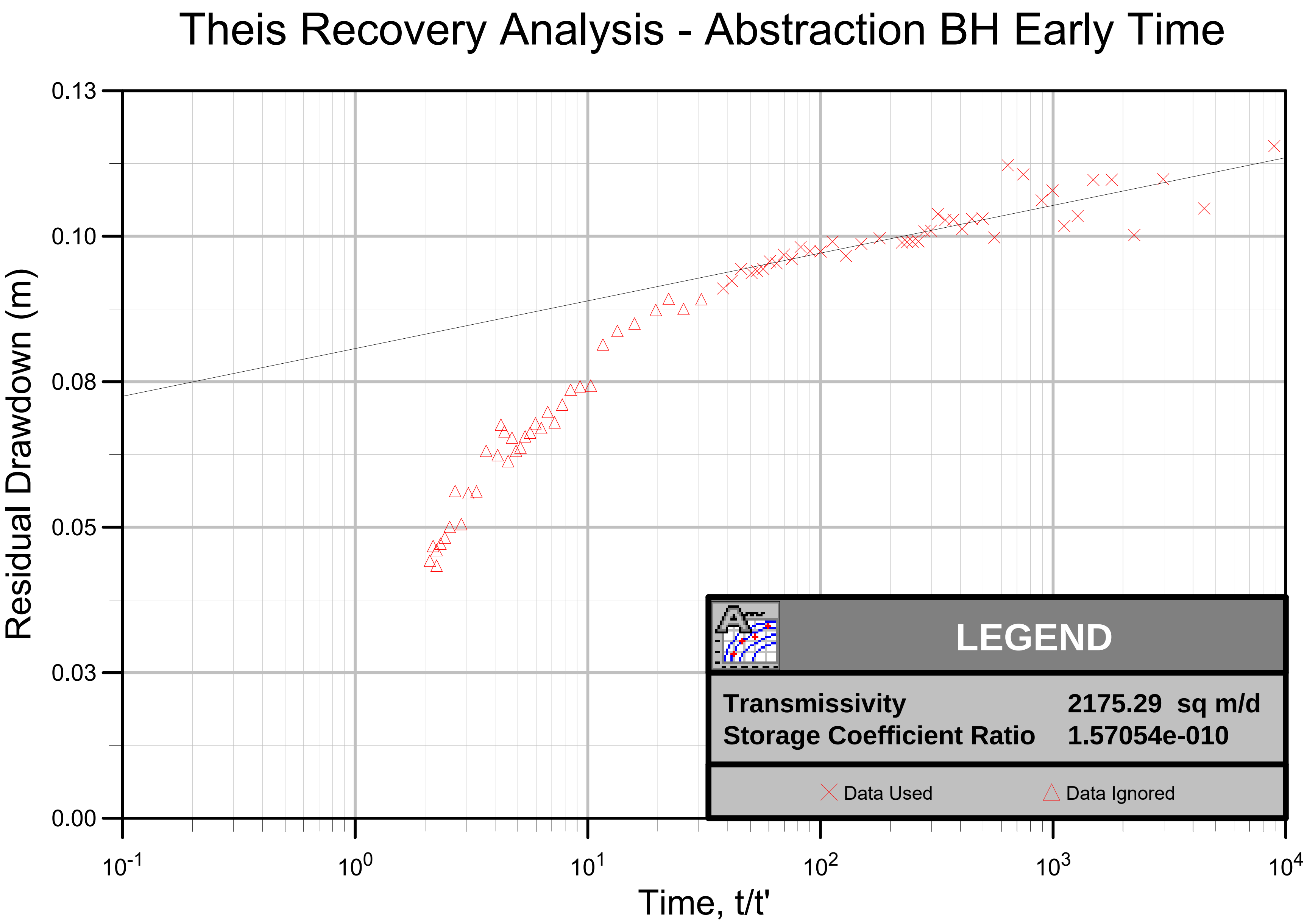


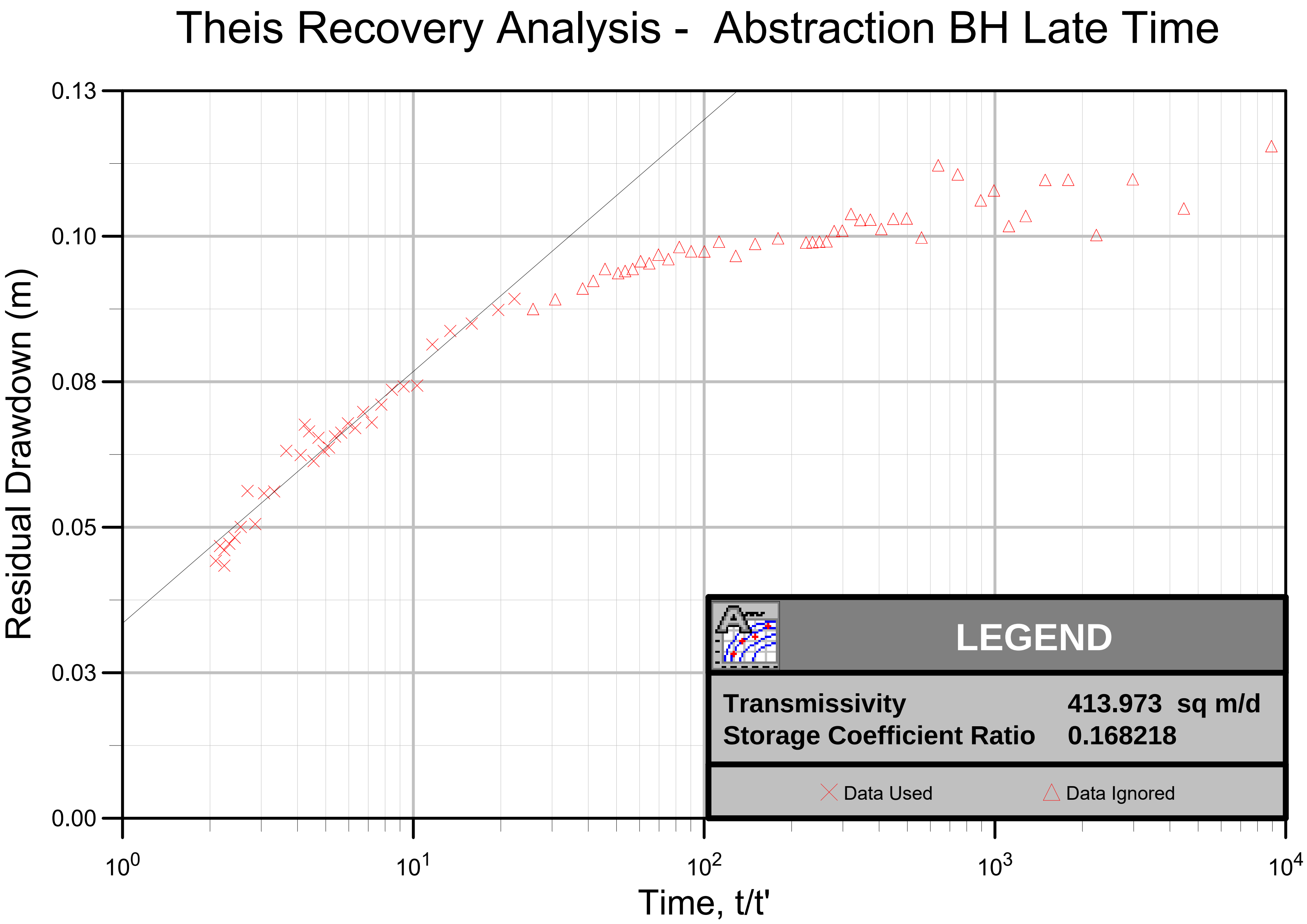

Cooper and Jacob Analysis - Abstraction BH Late Time
LEGEND
Transmissivity 187.413 sq m/d
Storage Coefficient 12389.1
Data Used
Data Ignored
Drawdown (m)
0.2
0.2
0.1
0.1
0.0
0.0
Time (min)
10-1
100
101
102
103
104



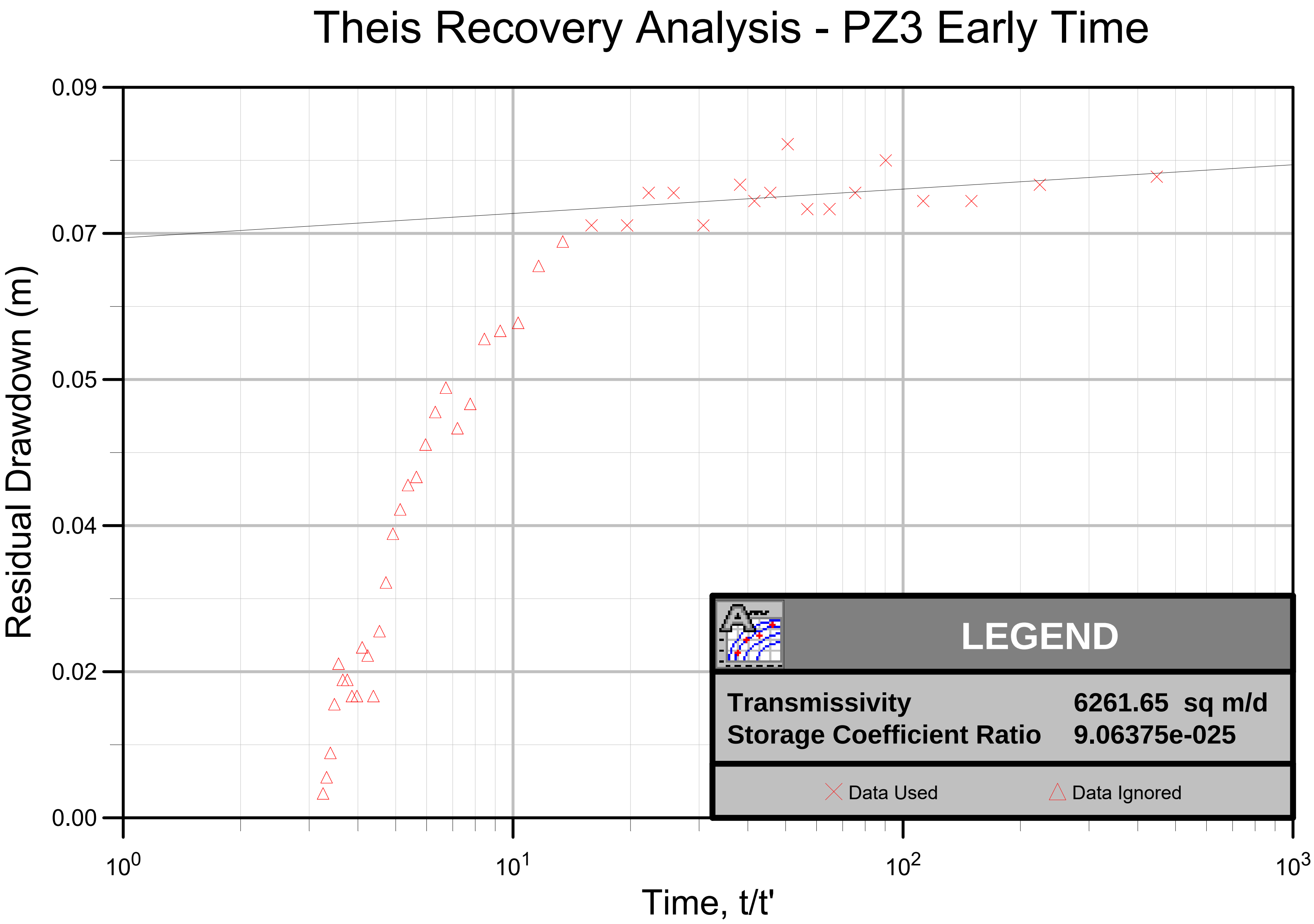
Cooper and Jacob Analysis - PZ3 Early Time
LEGEND
Transmissivity 1124.86 sq m/d
Storage Coefficient 0.00456734
Data Used
Data Ignored
0.10
0.08
0.05
0.03
0.00
-0.02
Drawdown (m)
10^0
10^1
10^2
10^3
10^4
Time (min)


Cooper and Jacob Analysis - PZ3 Late Time
LEGEND
Transmissivity 232.027 sq m/d
Storage Coefficient 0.00459519
Data Used
Data Ignored
Drawdown (m)
0.10
0.08
0.05
0.03
0.00
-0.02
10^0
10^1
10^2
10^3
10^4
Time (min)

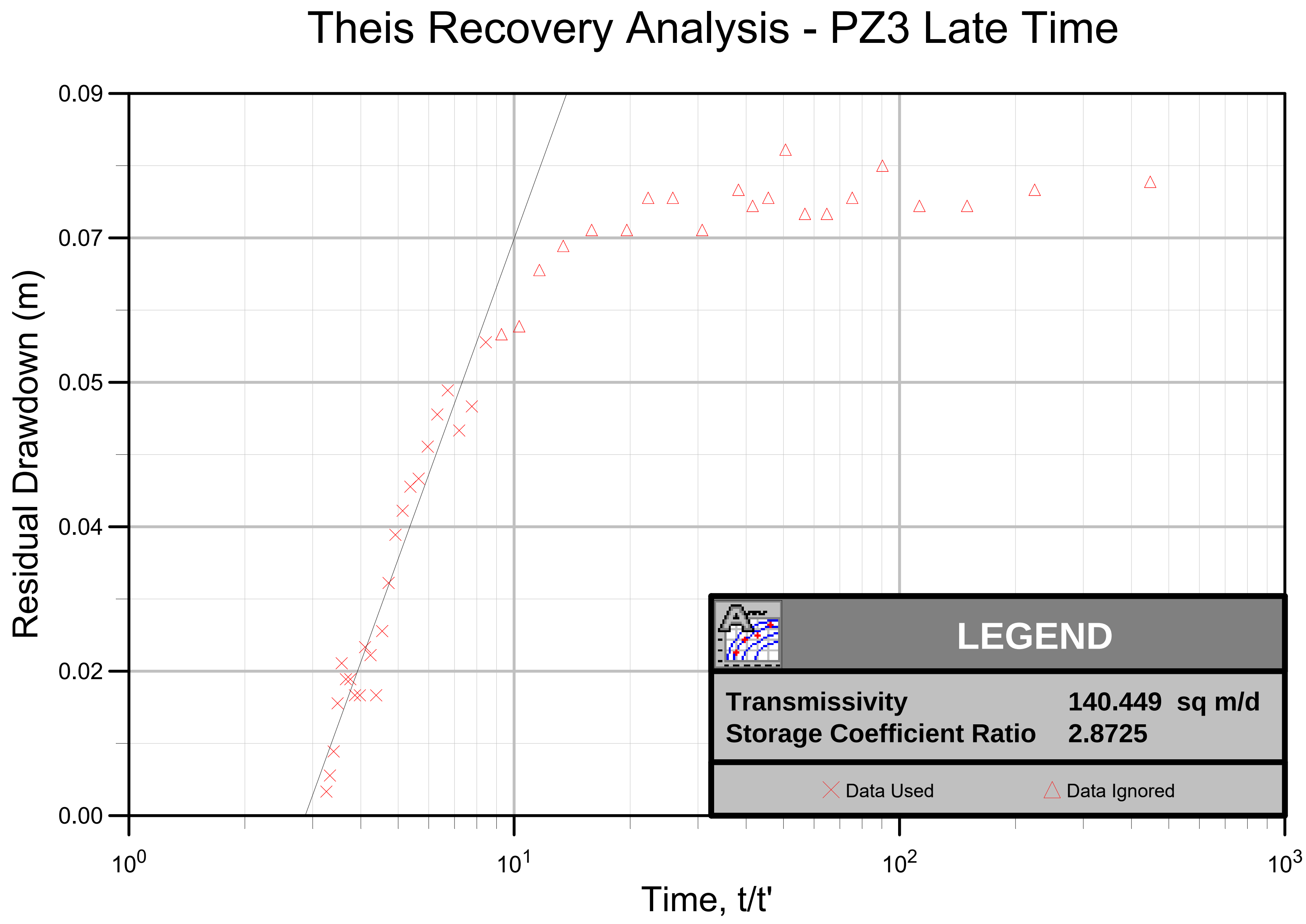

Theis Recovery Analysis - Abstraction BH Early Time
Residual Drawdown (m)
0.13
0.10
0.08
0.05
0.03
0.00
10-1
100
101
102
103
104
Time, t/t'
LEGEND
Transmissivity 2175.29 sq m/d
Storage Coefficient Ratio 1.57054e-010
Data Used
Data Ignored



Theis Recovery Analysis - Abstraction BH Late Time
Residual Drawdown (m)
0.13
0.10
0.08
0.05
0.03
0.00
10^0
10^1
10^2
10^3
10^4
Time, t/t'
LEGEND
Transmissivity 413.973 sq m/d
Storage Coefficient Ratio 0.168218
Data Used
Data Ignored



Theis Recovery Analysis - PZ3 Early Time
Residual Drawdown (m)
0.09
0.07
0.05
0.04
0.02
0.00
Time, t/t'
10^0
10^1
10^2
10^3
LEGEND
Transmissivity 6261.65 sq m/d
Storage Coefficient Ratio 9.06375e-025
Data Used
Data Ignored


Theis Recovery Analysis - PZ3 Late Time
Residual Drawdown (m)
0.09
0.07
0.05
0.04
0.02
0.00
10^0
10^1
10^2
10^3
Time, t/t'
LEGEND
Transmissivity 140.449 sq m/d
Storage Coefficient Ratio 2.8725
Data Used
Data Ignored