hafrenwater
environmental water management

ENVIRONMENTAL SETTING AND SITE DESIGN REPORT

SANDY LANE QUARRY

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Report prepared for:

NRS Bromsgrove Aggregates Limited
NRS House - Site 7
Meriden Park
Cornets End Lane
MERIDEN
Warwickshire
CV7 7LG

Barkers Chambers • Barker Street • Shrewsbury • United Kingdom • SY1 1SB
T: 01743 355770 • *E*: info@hafrenwater.com

GENERAL NOTES

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Author: Heather MacLeod BSc MSc FGS

Reviewer: Lawrence Brown BSc MSc CGeol

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1 INTRODUCTION

1.1 Report context

The site at Sandy Lane, Bromsgrove, Worcestershire (the 'site') comprises a former sand quarry owned by NRS Bromsgrove Aggregates Limited (NRS). The Sandy Lane complex comprises three main areas: in the centre is a completed Veolia Landfill, to the east former silt settlement lagoons and in the west a disused quarry void. This application concerns the western quarry void only.

It is proposed to remove final sand reserves, provide buttress support to the eastern quarry face and restore the remainder of the site using inert fill back to approximately pre-quarrying ground levels. The proposed after-use for the site comprises creation of wildlife habitat.

The proposed stabilisation of the failing eastern quarry face (western sidewall of the Veolia Landfill) will comprise the construction of a foundation buttress using selected fill. Extraction of 245,000 tonnes of sand will also be undertaken together with the importation of 975,000 m^3 of inert fill.

Hafren Water has been requested to prepare the Environmental Setting and Site Design (ESSD) report, which sets out the background and baseline conditions in support of the Permit Application. The format of this ESSD report is based upon the Environment Agency on-line guidance entitled 'What to include in your environmental setting and site design report", April 2021 and "Plan the environmental setting of your site" dated 30th January 2020, updated 17th February 2022.

This version F2 of the report has been generated to take into account the construction of site-specific boreholes and comments from the Environment Agency dated 9th May 2024.

1.2 Site details and context

1.2.1 Site location

The site is located adjacent to the junction between the A491 and B4091 (Madeley Road) approximately 2 km west of Junction 4 of the M5 at National Grid Reference (NGR) SO 94980 76290. The location of the site is shown on *Drawing 3308/ESSD/01*. Access to the site is via the main Veolia Landfill site off the A491, Sandy Lane, to the southeast of the site.

1.2.2 Site classification

This document is the Environmental Setting and Site Design (ESSD) that accompanies the application by NRS for a bespoke permit to allow deposit of waste for recovery at Sandy Lane Quarry, Sandy Lane, Wildmoor, Bromsgrove, Worcestershire, B61 0QT. A waste recovery plan

for the site (Westbury Environmental, August 2021) has been submitted to the Environment Agency. The permit application is being prepared by Westbury Environmental Ltd.

1.2.3 Application boundary

The site layout and proposed direction of working is shown on *Drawing 3308/ESSD/02*. The proposed permit boundary covers the remaining worked out area west of the Veolia Landfill. It totals approximately 5.5 hectares (ha). Sandy Lane parallels the southern boundary of the site and land to the north of the site comprises grazing pasture. A footpath lies between Madeley Road and the western boundary of the site and between the northern boundary and the adjacent pasture.

1.2.4 Landform

The site lies just to the west of a northeast-southwest trending interfluve, separating the valleys of the Fenn Brook to the northwest, Battlefield Brook to the southeast and Hockley Brook to the west. The elevation of the interfluve declines from over 260 metres Above Ordnance Datum (mAOD) 2.5 km to the northeast of the site to around 175 mAOD just to the southwest. The topography declines to approximately 140 mAOD at Battlefield Brook and 150 mAOD at Fenn Brook.

In the immediate vicinity of the site, the original topography has been altered, firstly by the quarrying activities and subsequently by restoration using landfilling. Immediately to the east is the restored Veolia Landfill site in which the restoration contours form a domed feature rising to just over 194 mAOD. To the south is the A491, Sandy Lane, beyond which is an active sand quarry (Wildmoor Quarry) within which elevations vary between 160 and 147 mAOD (based on LiDAR 2022). To the west, the boundary is defined by Madeley Road, beyond which is agricultural land and a group of 10 to 15 houses ('Stonebridge'). To the north the site is bounded by agricultural land with elevations rising from 167 mAOD in the west to 176 mAOD in the east.

Within the site, the elevation of the base of the void, at its deepest point, is 150 mAOD based on the topographical survey.

1.2.5 Surrounding land use

The environmental site setting is shown on *Drawing 3308/ESSD/03*.

Land to the north remains as grazing land whereas land to the east has been subject to quarrying and later restoration using non-hazardous waste. Beyond the A491, Sandy Lane, land now comprises the Wildmoor Quarry, which is an active quarry extracting sand from the Wildmoor Formation.

The nearest residential properties are on Madeley Road approximately 30 m west of the site boundary.

1.2.6 Summary of land use

A summary of the current and historical land use in a 500 m proximity to the proposed permit boundary is provided in *Table 3308/ESSD/T1* below. The environmental setting of the site is shown on *Drawing 3308/ESSD/03*.

3308/ESSD/T1: Summary of land uses within 500 m of Permit boundary	
Land use	**Distance/direction from site**
Residential properties:	
Properties off Madeley Road	20 m W
Properties off Madeley Road	293 m NNW
Properties off Sandy Lane	550 m NE
Listed Buildings:	
The Old Toll House	75 m SW
Lower Madeley Farm	424 m NNE
Fairfield Court	370 m SW
Recreation areas:	
Rough ground used as BMX track	20 m SW
Other amenity sites:	
No schools or places of worship within 500 m	
Agricultural land:	
Immediately north	
West of Madeley Road	
East of Veolia Landfill	
Southwest of Sandy Lane	
Conservation:	
Ecological & environmental conservation sites	None
Utilities:	
Gas pipeline	None
Electricity cables	None

2 SOURCE

2.1 Historical activities on-site

The site was historically used as farm land prior to quarrying commencing in the 1920's. The quarry is now operated under a Review of Old Mineral Planning Permissions (ROMP) dated 20th March 2000. However, it is currently dormant, and wildlife has been allowed to colonise. The base of the site, the quarry floor, is above the surrounding watertable and no dewatering has been undertaken at the site.

Within the wider Sandy Lane site, the far eastern quarry void was used for silt settlement to treat discharges from the mineral processing and wash plant. This area currently comprises a waterbody in the southeast and scrub/woodland vegetation elsewhere.

The central area has been landfilled by Veolia, restoring the site to a domed profile with maximum elevations of 194 mAOD in the centre. The site was lined commensurate to modern day standards and it received non-hazardous waste.

2.1.1 Historical landfill sites

Environment Agency data indicates that there are fifteen historical landfill sites within 2 km of the site boundary. The sites are shown on *Drawing 3308/ESSD/04*.

Three of these landfill sites are immediately adjacent to the site. Two are within the same former sand quarry void, Stanley Evans Sand Quarry and Harbours Hill. The third site, Cinetic Sands, is within the active Wildmoor Quarry on the south side of the A491. Details of these sites are recorded in *Table 3308/ESSD/T2*.

3308/ESSD/T2: Historical landfill sites

Map ID	Site name	WRC No	Licence holder	Last input	Waste
HL1	Stanley N Evans Sand Quarry	1800/0043	Cleanaway Limited		I, C, H, S
HL2	Harbours Hill	1800/0060	Cleanaway Limited	30/09/1985	In, I, C, H
HL3	Cinetic Sands	1800/0074	John Williams Cinetic Sands Limited	12/09/1990	In, I, S, L

In – Inert I – Industrial C – Commercial H – Household S – Special L - Liquid sludge

2.1.3 Permitted landfill sites

According to Environment Agency data, three permitted (active) landfill sites are located within 2 km of the site boundary, as indicated on *Drawing 3308/ESSD/04* and summary information provided in *Table 3308/ESSD/T3.*

3308/ESSD/T3: Active landfill sites				
Map ID	**Site name**	**Licence N°**	**Licence holder**	**Status**
PL1	Sandy Lane Landfill Site	XP3233QT	Veolia ES Landfill	Effective
PL2	Veolia ES Cleanaway (UK) Ltd	EA/EPR/BP3999CU/A001	Veolia ES Cleanaway (UK) Ltd	Modified
PL3	Pinches 3 Landfill	EA/EPR/WP3299VG/V002	V & J Kelly Ltd	Closure

According to information provided in an HRA review (Golders, 2015) for the Veolia ES Landfill site (PL1), the landfill comprises a small area of inert waste deposition in the southeast and a larger area which accepted inert, hazardous and non-hazardous waste. This larger area has an engineered composite containment liner system on the base and lower sides and an associated groundwater monitoring network for groundwater levels and quality.

No details of the other sites are currently known.

2.2 Proposed development

A Planning Application was submitted in 2021 to formalise the proposed restoration contours to enable the restoration of the site to be completed. The proposals can be summarised as follows:

- Importation of material for use in stabilisation of eastern boundary with the Veolia Landfill site
- Importation of inert material to be placed in southwestern corner to achieve restoration contours and a screening bund
- Removal of remaining sand reserves to 150 mAOD where these would be sterilised by stabilisation and restoration works
- Continued removal of remaining sand reserves and importation of inert materials to achieve restoration profile

The estimated volume of sand to be removed is 245,000 tonnes and the volume of inert fill required to complete the restoration, to a level lower than original ground levels, is 975,000 m^3.

a) Waste types

The materials to be imported into the site have been detailed in 'Waste Recovery Plan. NRS Bromsgrove Aggregates Ltd. Sandy Lane Quarry. Version 1. Westbury Environmental, July 2021', and are summarised in *Table3308/ESSD/T4* below. The site will only accept materials classified as non-hazardous, excluding wastes which are solely or mainly of dusts, powders or loose fibres, and not in a form that is either sludge or liquid.

3308/ESSD/T4: Permitted waste types				
Source	**Sub-source**	**Waste code**	**Description**	**Additional restrictions**
01: Waste resulting from exploration, mining, quarrying and physical and chemical treatment of minerals	01 01: Wastes from mineral excavation	01 01 02	Wastes from mineral non-metalliferous excavation	Restricted to waste overburden and interburden only
	01 04: Wastes from physical and chemical processing of non-metalliferous minerals	01 04 08	Waste gravel and crushed rocks other than those mentioned in 01 04 06	
		01 04 09	Waste sand and clays	
02: Waste from agriculture, horticulture, aquaculture, forestry, hunting and fishing, food preparation and processing	02 04: Wastes from sugar processing	02 04 01	Soil from cleaning and washing beet	Will be limited to placement within upper 0.5 m only
10: Wastes from thermal processes	10 12: Wastes from manufacture of ceramic goods, bricks, tiles and construction products	10 12 08	Waste ceramics, bricks, tiles and construction products (after thermal processing)	
	10 13: Wastes from manufacture of cement, lime and plaster and articles and products made from them	10 13 14	Waste concrete	
17: Construction and demolition wastes	17 01: Concrete, bricks, tiles and ceramics	17 01 01	Concrete	
		17 01 02	Bricks	
		17 01 03	Tiles and ceramics	
		17 01 07	Mixtures of concrete, bricks, tiles and ceramics other than those	Metal from reinforced concrete must have been

3308/ESSD/T4: Permitted waste types				
Source	**Sub-source**	**Waste code**	**Description**	**Additional restrictions**
			mentioned in 17 01 06	removed
	17 03: Bituminous mixtures	17 03 02	Bituminous mixtures other than those mentioned in 17 03 01	Road planings only
	17 05: Soil, stones and dredging spoil	17 05 04	Soil and stones other than those mentioned in 17 05 03	Restricted to topsoil, peat, subsoil and stones only Topsoil and peat will be limited to placement in the upper 0.5 m only
19: Wastes from waste management facilities	19 12: Wastes from the mechanical treatment of waste (eg sorting, crushing, compacting, pelletising) not otherwise specified	19 12 09	Minerals (eg sand, stones) only	Restricted to wastes from treatment of waste aggregates that are otherwise naturally occurring minerals. Does not include fines from treatment of any mixed non-hazardous waste or gypsum from recovered plasterboard
		19 12 12	Other wastes (including mixtures of materials) from mechanical treatment of waste other than those mentioned in 19 12 11	Restricted to crushed bricks, tiles, concrete, ceramics, and soils from the mechanical treatment of construction/ demolition waste. Metal from reinforced concrete must be removed. Does not include gypsum from recovered plasterboard
20 Municipal wastes (household waste and similar commercial, industrial and institutional wastes) including separately collected fractions	20 02: Garden and park wastes	20 02 02	Soils and stones	Restricted to topsoil, peat, subsoil and stones only Topsoil and peat will be limited to placement in the upper 0.5 m only.

The majority of the restoration materials will be imported from local construction activities and suitable materials produced locally eg aggregate recycling facilities. All incoming material will be subject to the rigorous Waste Acceptance Procedures as provided elsewhere in the Application. The waste will be in compliance with the Landfill Directive description of Inert waste, hence Hazardous substances are not anticipated to occur. Additional comments on specific waste codes are included below:

- Code 10 13 14 will be sourced from waste concrete from concrete manufacture; this is likely to form only a very small portion of the materials used for restoration as preference would be for re-use as a crushed aggregate, and hence poses a commensurately low risk
- Code 19 12 12 is non-hazardous; Any waste fines from construction and demolition treatment plants identified under code 19 12 12 will be subject to inert Waste Acceptance Criteria (WAC) chemical testing to ensure it meets the Inert waste WAC.
- It is not anticipated that much, if any, road planings will be deposited into the void under code 17 03 02. Provision has been allowed should it be required to facilitate vehicle transit in eg winter conditions. In this way the overall volume to be deposited is considered to be low and all deposits will be required to meet the Inert Waste WAC. It is generally preferable (financially) to recycle this material.

a) Phasing

It is proposed that restoration of the site will be completed over a period of 6 years. The first phase will involve construction of the buttress wall using selected waste that will meet the WAC criteria and a geotechnical specification. Waste will be placed in 300 mm thick layers, compacted in place.

b) Waste volumes

In order to achieve the approved restoration profile, approximately 975,000 m^3 of inert fill will be imported to the site.

c) Restoration and afteruse

The final restoration scheme and contours is provided as *Drawings 3308/ESSD/05.*

d) Site layout and design

The site layout and design is illustrated on *Drawing 3308/ESSD/02*. The site entrance, car park, offices and weighbridge are located in the east of the site. Hardstanding is present in the facilities area comprising concrete pads beneath the site offices and adjacent parking area.

No active water management currently occurs at the site as all incident rainfall infiltrates. It is apparent that during the winter months run-off from the adjacent Veolia Landfill and the parts of the hardstanding area, collects in the southeastern quarter of the site.

A small self-regulating waterbody also exists in the centre of the site and this is assumed to be groundwater level.

2.3 Proposed management measures

Management measures will be implemented in order to ensure the safe operation of the proposed waste recovery facility and ensure no environmental impact. These measures are discussed below.

2.3.1 Control of incoming waste

In order to ensure the incoming waste is appropriate for acceptance at the site there will be:

- Strict enforcement to Waste Acceptance Criteria and procedures
- Detailed knowledge of where imported waste has been generated
- Requisite testing before receipt on-site

2.3.2 Monitoring of groundwater quality

Monitoring of groundwater in boreholes surrounding the site will continue throughout the life of the proposed development including the active and post-closure phases, as described in Section 6 below. Monitoring infrastructure that becomes inoperable will be replaced as necessary.

2.3.3 Monitoring of gas concentrations

Monitoring of gas concentrations within the waste mass will be undertaken in gas monitoring borehole constructed once final fill levels have been reached. This ensures boreholes are not damaged during infilling and restoration works. Boreholes will be constructed at a density in accordance with the prevailing guidance. Monitoring infrastructure that becomes inoperable will be replaced as necessary.

2.3.4 Settlement

Differential settlement is not anticipated due to the proposed waste types to be accepted at the site. The site and its immediate vicinity are not in an area of former mining, hence subsidence due to mine failure is also not expected.

Post-settlement contours for the proposed restoration scheme are provided on *Drawing 3308/ESSD/05*.

2.3.5 Hydrogeological Risk Assessment (HRA)

A Hydrogeological Risk Assessment has been undertaken and the results are provided in report entitled Hydrogeological Risk Assessment. Sandy Lane Quarry, Ref 3308/HRA. Dated June 2024.

3 PATHWAY AND RECEPTOR

3.1 Geology

3.1.1 Bedrock

The regional bedrock geology is illustrated on *Drawing 3308/ESSD/06* and the geological succession in the area is summarised in *Table 3308/ESSD/T5*.

The area is structurally complex with a number of significant faults.

The site is underlain by sandstones of the Sherwood Sandstone Group, which in this area comprise the Helsby Sandstone Formation, Wildmoor Sandstone Member and Chester Formation. Immediately to the west of the site the Sidmouth Mudstone Formation outcrops, and stratigraphically overlies the Sherwood Sandstone Group, but is fault bounded in this locality. The Sherwood Sandstone Group rests unconformably on Carboniferous, Warwickshire Group, strata of the Clent and Salop Formations[1].

3308/ESSD/T5: Regional stratigraphy				
	Group	**Formation**		**Lithology**
Superficial Deposits			Alluvium	Clay, silt sand and gravel
			Diamicton (Till)	
			Glaciofluvial deposits	Sand and gravel
			Alluvial Fan Deposits	Sand and gravel
			Kidderminster Station Member	Sand and gravel
			Holt Heath Sand and Gravel Member	Sand and gravel
Bedrock		Sidmouth Mudstone		Mudstone and siltstone
	Sherwood Sandstone (SSG)	Helsby Sandstone		Fine- to medium-grained sandstone
		Wilmslow Sandstone	Wildmoor Sandstone Member	Silty, fine- to medium-grained sandstone and thin mudstones
		Chester		Sandstone and conglomerate
	Warwickshire	Clent		Conglomerate
		Salop	Enville Member	
			Alveley Member	Red mudstone and sandstone

[1] On the geological map, the BGS have given the Clent and Chester Formations the same colour code

Sandy Lane Quarry lies within the Wildmoor Sandstone Member, the outcrop of which is bounded to the east and west by north-south aligned faults. The Formation comprises a red brown silty, fine to medium-grained weak sandstone with subordinate and discontinuous siltstone and mudstone layers. It is reported to be up to 284 m thick in the Worcester Basin and in the Wildmoor N° 2 borehole the base is reported to be at a depth of approximately 143 m. The strata dip at around 8° to the southwest (BGS, 2009).

3.1.2 Superficial deposits

Superficial deposits are relatively sparse in the area and none are present in the immediate vicinity of the site.

To the east, alluvial deposits and sand and gravel assigned to the Holt Heath Sand and Gravel Member are confined to the floor of the Battlefield Brook valley and its tributary valleys. Alluvial Fan Deposits (sand and gravel) are present on the valley sides.

To the north, either side of Fenn Brook, are sands and gravels of the Kidderminster Station Member and Holt Heath Sand and Gravel Member. On the higher ridge line running to the northeast of the site there are deposits of Glacial Till.

3.1.3 Geology of the site

Numerous boreholes have been drilled around the wider site as part of the Veolia Landfill operation, four of these are close to the site. Groundwater monitoring boreholes SAN 800, 809, 810, and 821 are located to the northwest, southwest and north respectively. Geological logs for these boreholes are not available, however, the BGS holds logs for two other boreholes at the Veolia site; SO97NE457 and SO97NE456. These boreholes were drilled in 1991 and prove sandstone to a depth of 50 m below ground level (104 mAOD).

Four groundwater monitoring boreholes were drilled at the site in July 2023. Borehole BH1 is located in the northwest of the site and Boreholes BH2, BH3 and BH4 are located in the south from west to east respectively. The boreholes only encountered sandstone which was proven to a depth of up to 34 m and an approximate elevation of 133 m AOD. The base of the sandstone was not proven at the site. The locations of the boreholes are provided on *Drawing 3308/ESSD/02* and the Construction Quality Assurance report is provided in *Appendix 3308//ESSD/A3*.

3.2 Aquifer characteristics

3.2.1 Aquifer status and regional context

The Sherwood Sandstone Group is classed by the Environment Agency as a Principal Aquifer and is a regionally important groundwater resource for industrial use and public water supply.

The site lies within the Worcestershire Middle Severn – PT Sandstone (GB40901G300800) Groundwater body. The Cycle 3, 2019, classification is Poor for both quantitative and chemical status.

The site lies within the Kidderminster and Stourport Groundwater Management Unit (GWMU) and immediately adjacent to the boundary with the GWMU to the south (Bromsgrove West) as shown on *Drawing 3308/ESSD/07*.

This area of the aquifer is over abstracted, which has resulted in a long-term fall in groundwater levels. Consequently, there has been a loss, or reduction, in baseflow to watercourses in the area, in particular, Battlefield Brook.

The whole of the Sherwood Sandstone outcrop within the Worcestershire Middle Severn Abstraction Licence Strategy (ALS)(June 2022) report prepared by the Environment Agency, is identified as 'No Water Available' meaning the aquifer is over abstracted. Virtually the whole of the sandstone aquifer is also designated as an outer source protection zone (SPZIII). The closest groundwater source is located 1.1 km to the southeast of the site (Wildmoor public water supply abstraction).

The site is not located within a Drinking Water Safeguard Zone, for groundwater. It is located within groundwater Nitrate Vulnerable Zone (NVZ) for the West Midlands (N° G29).

3.2.2 Aquifer properties

Hydraulic conductivity is primarily controlled by granular flow. Aquifer properties for the Wildmoor Sandstone are provided in Allen et al, 1997 and shown in *Table 3308/ESSD/T6*.

3308/ESSD/T6: Hydraulic properties of the Wildmoor Sandstone

Parameter	Range	Interquartile range	Median	Geometric mean
Core hydraulic conductivity (m/d)	3.1×10^{-4} – 12.0	0.12 – 1.58	0.73	0.37
Bulk hydraulic conductivity (m/d)	0.77 – 62.6	3.06 – 19.1	12.1	8.06
Porosity (%)	17.6 – 35.3	24.2 – 28.2	26.9	26.4

The Sherwood Sandstone aquifer is known to have marked heterogeneity with the vertical hydraulic conductivity often being 10 times lower than the horizontal due to the presence of thin clay or silty horizons within the body of the aquifer.

3.2.3 Groundwater abstractions

Licensed abstractions

Please note, this section has not been updated since the issue of the Final Version F1.

Three licensed groundwater abstractions have been identified within 2 km of the site boundary, as shown on *Drawing 3308/ESSD/07*.

Licence MD/054/0006/016, Beechcroft Nurseries, Belbroughton, is located 680 m to the north of the site at NGR SO 95182 77091. The source is used for direct spray irrigation. Licence N° 18/54/07/003, Meadow Farm Alleviation borehole, is located 1.5 km southeast of the site at NGR SO 9568 7480. The source is operated by Severn Trent Water and provides remedial wetland support. This licence had an expiry date of 31st March 2021 and it is assumed that it has now been renewed.

Licence N° 18/54/07/0134 comprises two boreholes located 1.1 km southeast of the site at NGR SO 955 751. The abstraction is operated by Severn Trent Water for public water supply. Data from the BGS borehole records database describe the boreholes as being artesian on completion in 1953.

3.3 Groundwater flow

3.3.1 Groundwater levels

Environment Agency

There is one active Environment Agency monitoring borehole nearby, Fairfield N° 2, located 0.6 km southeast of the site (*Drawing 3308/ESSD/07*). Data from January 2009 onwards has been supplied by the Environment Agency and is shown on *Drawing 3308/ESSD/08a*. Data prior to 2009 has been obtained from the Veolia Environmental Services planning application (2013) and are shown on *Drawing 3308/ESSD/08b)*.

The historical data show a decline in groundwater levels in the late 1980s, when it is presumed that groundwater levels dropped below the base of the Fairfield N° 1 observation borehole. Abstraction records were not requested as part of this study, but it was inferred in the Veolia report that this decline was a consequence of increased groundwater abstraction.

Since 2009 the groundwater elevation has varied between approximately 128.5 mAOD and 133.5 mAOD.

The hydrographs show strong medium-term cyclical fluctuations in level, with peak levels in July 1996, April 2002, January 2010 and May 2015. No strong seasonal variations are apparent

in the data. Groundwater levels reached a minimum in September 2019 and have been rising since then. The reason for this cyclical behaviour is discussed below.

Veolia

There are up to twelve monitoring boreholes installed around the adjacent Veolia Landfill site, four of which (Nos SAN 800, 810, 809 and 807) lie close to the site. Their approximate locations (taken from a site plan provided by Westbury Environmental Ltd) are shown on *Drawing 3308/ESSD/07*.

Groundwater level data from these monitoring boreholes are available from the Veolia Environmental Services planning application (2013). The hydrographs, covering the period 1995 to 2012, are shown on *Drawing 3308/ESSD/09*. Groundwater levels show the same medium-term fluctuations apparent in the Fairfield No 2 borehole.

These trends can be correlated with changes in the rainfall pattern, which can be visualised using a plot of the cumulative deviation from mean rainfall (CDFM). This is shown on *Drawing 3308/ESSD/09*, calculated from the CEH dataset. This analysis illustrates that during periods when monthly rainfall exceeds the mean rainfall (rising trend on the graph) groundwater levels are rising.

The highest groundwater levels are consistently recorded in SAN821 and SAN825, located on the north side of the facility. Data for a third borehole to the northwest, SAN800, is only available from November 2010, but it recorded similar groundwater levels to SAN821 and SAN825. All the other boreholes are located along the southern boundary of the facility and together these data indicate that the groundwater level is consistently lower to the south.

The bottom hydrograph on *Drawing 3308/ESSD/09* shows data from the Veolia site recorded since 2018 (data provided in *Appendix 3308/ESSD/A1*). One significant difference from the earlier data is that the groundwater levels in SAN825 are now between 3.8 and 5.9 m lower than SAN821. There is also a sudden drop in water levels in SAN821, SAN809 and SAN805 in August 2019 with levels recovering in February 2020 (SAN805), May 2020 (SAN809) and August 2020 (SAN821). The reason for these changes is unknown.

Closest to the site, groundwater levels in SAN821, in the northeast, and SAN810 in the southeast, are in the region of 146 mAOD and 143 mAOD respectively.

On-site monitoring

Four groundwater level boreholes were constructed around the site in July 2023. Borehole BH1 is in the northwest and the remaining boreholes are located along the southern site boundary.

Groundwater levels have been recorded on three occasions, in July 2023, October 2023 and June 2024. It is apparent that the groundwater boreholes have not been levelled relative to Ordnance Datum, with only approximated elevations provided. As a result these groundwater levels have not been used in the assessment and additional data together with boreholes elevation data will be obtained. In addition, some of the data appears anomalous. Further investigation is required before absolute groundwater elevations below the site can be confirmed.

Spatial distribution

To illustrate groundwater flow directions, groundwater levels have been plotted for January 2001, a period of high groundwater levels, as shown on *Drawing 3308/ESSD/10a*. This flow direction, south-southeast, appears to have been maintained under varying groundwater level conditions between 1995 and 2012. However, the latest groundwater level data (*Drawing 3308/ESSD/10(b)*) show that groundwater flow has changed to a more easterly direction towards Battlefield Brook. The reason for this is also unknown. A change in the abstraction regime at the Wildmoor PWS abstraction would most likely result in a rise or fall in groundwater levels, rather than a change in direction of flow alone.

Recent monitoring within the site itself (October 2023 data) indicates a general southeast direction of groundwater flow, with boreholes BH1 and BH2 being up gradient of the site. The results of the groundwater level monitoring to date are provided in Appendix 3308/ESSD/A1.

The inferred hydraulic gradient is between 0.02 and 0.03 based on the 2021 groundwater contours.

Unsaturated thickness

The base of the site/floor of the quarry will be at 150 mAOD. The highest recorded groundwater level in the vicinity of the site (SAN825) is 147.67 mAOD recorded in January 2002. More recently the highest groundwater level recorded closer to the site was 146.5 mAOD at borehole SAN821 to the northeast. The site will therefore remain above the watertable, which is approximately 3.5 m below the base of the site. This represents the smallest unsaturated zone (most conservative) between the site and the groundwater in the Wildmoor aquifer as it is based on the highest groundwater elevation.

To the southeast of the site the highest groundwater level recently recorded is 144.19 mAOD recorded at Borehole SAN810. This indicates a minimum unsaturated zone of 5.81 m in the south of the site. In order to maintain a conservative assessment, the above estimated unsaturated zone of 3.5 m will be retained in the assessment within the HRA.

3.3.2 Groundwater quality

Groundwater quality data for the site are available for monitoring in July and October 2023 and June 2024. The data are provided in *Appendix 3308/ESSD/A2* and is summarised below.

3308/ESSD/T7: Groundwater quality from onsite boreholes 2023 to 2024

Parameter	Units	UK DWS	Max	Mean	Min	SD	Count	Count if > DWS
pH		9.5 - 6.5	7.4	6.7	6.1	0.35	12	0
Electrical conductivity	µS/cm	2500	1290	724.3	138	433.41	12	0
Alkalinity as CaCO3	mg/l		161	88.8	52.2	37.24	12	0
Ammoniacal nitrogen as N	mg/l		1.32		0.06	0.34	12	0
Ammonium an NH4	mg/l	0.50	0.18		0.08	0.04	8	0
Chloride as Cl	mg/l	250	305	119.1	5.4	123.26	12	3
COD (Total)	mg/l		166	58.4	11	62.83	12	0
Sulphate as SO4	mg/l	250	151	64.9	6.7	54.01	12	0
Arsenic total	mg/l	0.01	0.0011	0.00061	0.00027	0.00	12	0
Cadmium total	mg/l	0.005	0.0061	0.00148	0.00008	0.00	12	1
Calcium total	mg/l		161	83.2	21.7	44.63	12	0
Chromium total	mg/l	0.05	0.0041	0.00119	0.00051	0.00	12	0
Copper total	mg/l	2	0.2	0.0303	0.0023	0.06	12	0
Iron total	mg/l	0.2	2.7	0.3443	0.025	0.75	12	4
Lead total	mg/l	0.01	0.011	0.0016	0.0003	0.00	12	1
Magnesium total	mg/l		49.1	15.7	2.2	12.85	12	0
Manganese total	mg/l	0.05	1.6	0.44	0.0119	0.57	12	10
Mercury	mg/l	0.001	0.00001		0.00001	0.00	12	0
Nickel total	mg/l	0.02	0.068	0.0217	0.0037	0.02	12	3
Potassium total	mg/l		10	6.69	2.1	2.69	12	0
Sodium total	mg/l	200	110	51.09	3.7	41.09	12	0
Zinc total	mg/l		0.2	0.11	0.027	0.06	12	0

BTEX (benzene, toluene, ethyl benzene and xylene) concentrations were below the level of detection in all samples from all boreholes. Concentrations of PAH substances (polyaromatic hydrocarbons) were also below the level of detection in all samples with the exception of those collected on the 26th July 2023 in boreholes BH2, BH3 and BH4 in the south of the site. Detectable PAH's may have occurred on this first sampling visit as a result of residues remaining in the boreholes form the drilling. No PAH has been recorded since this first sampling round.

Low concentrations of petroleum hydrocarbons have also been detected within the longer carbon chain range of C24 to C40 at some point in all boreholes and shorter chain hydrocarbons, C10 to C16 at BH1 on the 24th October 2023 only.

Data have been provided for the period 2018 to 2020 for monitoring boreholes at the adjacent Veolia Landfill site (*Table 3308/ESSD/T7*). It should be noted that based on the more recent groundwater flow direction, eastwards, all these boreholes are down-gradient of the site. The data is provided in *Appendix 3308/ESSD/A2*.

A Hydrogeological Risk Review for the Veolia site (Golders, 2015) concluded that concentrations of the key parameters being monitored (Ammoniacal nitrogen, chloride, electrical conductivity (EC), cadmium, mercury, naphthalene, mecoprop, toluene, chlorobenzene and dichloromethane) were comparable to those recorded in the previous HRA Review undertaken in 2009, ie trends of increasing concentration are not apparent.

3308/ESSD/T8: Groundwater quality from the Veolia Landfill site (2018-21)					
Up-gradient monitoring					
Borehole	821	825			
Nº samples	10	9			
Chloride (mg/l)	5.9 – 11	9.4 – 35.5			
EC (µS/cm)	168 – 201	180 – 406			
pH	5.33 – 7.02	5.68 – 7.09			
Down-gradient monitoring					
Borehole	802	805	807	809	810
Nº samples	10	22	22	22	22
Chloride (mg/l)	27.1 – 31	10 – 13.7	7.3 – 8.9	10.8 – 30.1	34.1 – 28
EC (µS/cm)	296 – 349	166 – 207	145 – 161	198 – 304	387 – 297
pH	5.54 – 6.33	5.68 – 7.31	4.35 – 7.23	4.3 – 7.11	5.33 – 6.93

3.4 Surface water

3.4.1 Rainfall

Rainfall at the site has been estimated using the CEH-GEAR dataset available from the UK Centre for Ecology and Hydrology. The average rainfall between 2000 and 2015 is shown in *Table 3308/ESSD/T9* and is estimated as 800 mm. The maximum annual rainfall for this period was 1031 mm in 2012 and the minimum 746 mm in 2015.

3308/ESSD/T9: Average rainfall for SO 9509 7629 (2000 - 2015)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	65.2	53.2	46.5	57.8	69.7	64.9	76.2	70.4	54.8	91.2	79.3	71.1
Source: CEH Gridded Estimates of Areal Rainfall (CEH - GEAR) data licensed from NERC – Centre for ecology & Hydrology. © Database Right/Copyright NERC – Centre for Ecology & Hydrology. All rights reserved												

Historical rainfall data and evapotranspiration data have also been obtained from MAFF Technical Bulletin 34 for this area (Area 19) and are shown in *Table 3084/ESSD/T10*.

3308/ESSD/T10: Historical rainfall data from MAFF Area 30												
(mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall	62	46	47	47	61	51	59	73	60	58	71	65
PT	1	8	30	55	80	93	93	72	43	19	4	0
ER	61	38	17	0	0	0	0	1	17	39	67	65
PT – Potential Transpiration ER – Effective Rainfall												

The indicated annual Long-Term Average (LTA) rainfall is 700 mm, which is somewhat lower than that derived from more recent inferred data. The effective rainfall, based on the MAFF data is 305 mm.

If the evapotranspiration values are applied to the more recent rainfall data set, the annual effective rainfall is estimated as 359 mm.

3.4.2 Watercourses

There are three Ordinary watercourses within 2 km of the site boundary, as shown on *Drawing 3308/ESSD/11*:

- Fenn Brook lies 0.72 km to the northwest, flowing from northeast to southwest and turning westwards at Bell End. It is a tributary of Hoo Brook, which flows into the River Stour, located approximately 12 km west of the site
- Battlefield Brook is approximately 0.9 km to the southeast, flowing northeast to southwest. The brook has suffered from low flows due to a decline in groundwater levels which has reduced the baseflow into the watercourse. A borehole provides water to supplement the surface flow (Licence nº 18/54/07/003, Section 3.2.3)
- Hockley Brook rises approximately 0.96 km southwest of the site and flows westwards. Both Hockley Brook and Battlefield Brook are tributaries of the River Salwarpe.

Surface water catchment status

The site lies on the eastern edge of the 'Hoo Brook – source to confluence R Stour' Waterbody (ID GB109054044530). The 2019 classification of the catchment is 'Moderate' for ecological criteria and 'Fail' for chemical criteria. The reasons for not achieving 'Good' status were PFOS substances, sewage discharges, poor nutrient management, poor pesticide management and urbanisation. Flow was also identified as a contributor to not achieving 'Good' status, but causes were stated to be 'under investigation'.

To the east, the adjacent waterbody is the 'Battlefield Brook – source to confluence Spadesbourne Brook' (ID GB109054044240). The 2019 classification of the catchment is 'Moderate' for the ecological criteria and 'Fail' for chemical criteria. The reasons for not achieving 'Good' status were poor nutrient management, urbanisation, poor livestock management and groundwater abstraction.

Information on the surface water resource status is provided in the Environment Agency's Worcestershire Middle Severn Abstraction Licensing Strategy (ALS) (June 2022). Within the catchment in which the site is located, surface water availability is restricted for abstraction at all flows.

The site is not located within a Drinking Water Protected Area, or Safeguard Zone, for surface water. It lies within surface water Nitrate Vulnerable Zone (NVZ) S94 ('R Stour (Worcs) – conf Smestow Brook to conf R Severn').

3.4.3 Waterbodies

There are a number of bodies of open water within 2 km of the site boundary. The closest are associated with former and current sand workings in the immediate vicinity of the site.

Two waterbodies are shown within the void of Wildmoor Quarry on the 1:25,000-scale OS map. The larger of the two (WB3 on *Drawing 3308/ESSD/11)* is also present on satellite imagery. The second waterbody shown on the OS map is not present on recent satellite imagery. However, the imagery shows another body of water is present to the south in an apparent area of new mineral extraction.

Waterbody P2 lies within an area of former mineral workings to the east of the Veolia Landfill. LiDAR data suggest a water level elevation of around 152.7 mAOD.

There are two waterbodies, P3 and P4, along the course of Fenn Brook and two waterbodies (P6) on Battlefield Brook. These waterbodies are the remains of former mill ponds.

Waterbody P5 is located further from the site on a tributary of Fenn Brook.

3.4.4 Springs and wells

Two springs are located within 2 km of the site shown on the 1:25,000-scale OS map. These are shown on *Drawing 3308/ESSD/11* as 'S1', approximately 1.2 km to the southwest, and 'S2' 1.7 km to the northeast.

A well is noted on the OS map, located approximately 0.9 km east of the site near Key Hill Farm.

3.4.5 Surface water abstractions

Licensed abstractions

There are two licensed surface water abstractions within 2 km of the site boundary, both abstracting from Battlefield Brook:

- Licence N° 18/54/07/0057, located at Mill Cottage Farm at NGR SO 958 748. Abstraction is licensed for direct spray irrigation between 1st May and 30th September each year
- Licence No 18/54/07/0168 at Top Lane, Wildmoor, NGR SO 962 756. Licensed for direct spray irrigation throughout the year

3.4.6 Flood risk

Sandy Lane Quarry is located within Flood Zone 1 on the Environment Agency's Flood Map for Planning. Flood Zone 1 is land designated as having an annual probability of fluvial flooding less than 0.1 % (<1 in 1000).

3.5 Man-made sub-surface pathways

There are no known buried services located across or within 500 m of the site.

3.6 Habitats and natural heritage receptors

Statutory habitat sites

There are no sites of international importance (SAC, SPA or RAMSAR) within 5 km of the site boundary.

There are four Sites of Special Scientific Interest (SSSI) within 2 km of the site boundary: Madeley Heath Pit SSSI; Feckenham Forest; Hurst Farm Pasture and Sling Gravel Pits. Summary details are provided in *Table 3308/ESSD/T11* and their locations are shown on *Drawing 3308/ESSD/12*.

3308/ESSD/T11: SSSIs within 2 km of the site boundary		
Site name	**Distance from site boundary (km)**	**Reasons for notification**
Madeley Heath Pit	770 m NE	Notified for its geological interest Site at an elevation of just over 200 mAOD
Feckenham Forest	1.1 km SW	Notified for its oak-dominated ancient woodland associated with unimproved meadows. There are streams noted on the site and damp areas in depressions Site is located entirely on Mercia Mudstone bedrock and therefore isolated from groundwater in the underlying Sherwood Sandstone aquifer
Hurst Farm Pasture	1.7 km WSW	Notified for the diversity of semi-natural grassland Site is located entirely on bedrock comprising mudstones of the Mercia Mudstone Group
Sling Gravel Pits	1.7 km N	Notified for its geological interest

Sling Gravel Pits and Madeley Heath Pit are designated for their geological interest and are not considered further in this assessment. Both Feckenham Forest and Hurst Farm Pasture SSSI's are located on the Mercia Mudstone bedrock and are therefore unaffected by groundwater flows or quality in the Sherwood Sandstone aquifer. Of these, only Feckenham Forest is identified as a Groundwater Dependent Terrestrial Ecosystem (GWDTE).

There are no Local or National Nature Reserves within 2 km of the site boundary.

Non-statutory habitat sites

There are three non-statutory Local Wildlife Sites (LWS) located within 2 km of the Application boundary as shown on Drawing *3308/ESSD/12* and detailed below.

3308/ESSD/T12: Non-statutory conservation sites within 2 km of site boundary		
Site name	**Distance from site boundary (km)**	**Reasons for notification**
Hadley, Elmley & Hockley Brooks LWS	0.97 m SW	Site includes several National BAP habitats, rivers and streams, unimproved neutral grassland, wet woodland and marshland
Sling Pool and Marsh LWS	1.2 km NW	Carr woodland and silty swamp emergent zone at the head of the pool
Great Farley and Dale Woods LWS	1.4 km N	An extensive area of ancient woodland with varied terrain, stream valleys and three different broadleaf woodland habitats

None of these sites are down-gradient of the site.

Natural heritage sites

The closest natural heritage site is The Old Toll House, a Listed Building, located approximately 75 m southwest of the site. Other Listed Buildings in close proximity to the site are listed in *Table 3308/ESSD/T12* below.

The only Scheduled Monument in close proximity to the site is the Moated Site at Fairfield Court, 335 m southwest of the site.

3308/ESSD/T13: Natural heritage sites within 500 m of site boundary	
Land use	**Distance/direction from site**
Listed buildings:	
The Old Toll House	75 m SW
Fairfield Court	370 m SW
Lower Madeley Farmhouse	442 m N

3.7 Amenity receptors

Amenity receptors comprising those features that might be affected by noise or dust include residential properties, schools, hospitals, playing fields, business etc are listed in *Table 3308/ESSD/T1* and are shown on *Drawing 3308/ESSD/03*.

4 RECEPTORS AND COMPLIANCE POINTS

The baseline environmental and hydrogeological data have been used to develop a site conceptual model to identify the key aspects of the site, its' setting and potential pathways and receptors. The schematic cross-section of the conceptual model is provided as *Drawing 3308/ESSD/13* and cross-sections of the proposed restoration profile are appended to the Waste Recovery Plan (Westbury Environmental, July 2021).

4.1 Groundwater flow pathways

The site is above the watertable within the Sherwood Sandstone aquifer in which the site lies. A limited unsaturated zone of between 3.5 m and 5.81 m exists. Any pollutants from the waste will travel vertically through the unsaturated zone to the watertable. Pollutants would then travel in the direction of groundwater flow, ie to the east-southeast.

Superficial strata is absent from the site hence no pathways exist in superficial strata.

4.2 Groundwater receptors

No superficial aquifers exist at the site and hence these cannot be a receptor. Groundwater exists below the base of the site with the Sherwood Sandstone aquifer, and this forms the primary groundwater receptor.

The site lies within the catchment of a Severn Trent Water public supply borehole, this forms a secondary groundwater receptor. Other licensed abstractions are either up-hydraulic gradient or further away from the site than the public supply borehole.

4.3 Surface water pathway

There will be no water discharges from the site. Dewatering is not required and surface water will be managed within the curtilage of the site. Surface water does not therefore act as a direct pathway from the site.

4.4 Surface water receptor

Groundwater flow is to the east and may provide some baseflow to Battlefield Brook, which flows southwestwards, east of the site. Battlefield Brook forms a secondary receptor.

4.5 Habitat receptors

Whilst a single GWDTE or water-supported ecological site has been identified in the vicinity of the site this lies to the west and up-hydraulic gradient of the site and therefore does not form a plausible receptor.

There are no surface water-supported statutory or non-statutory environmental or ecological sites of interest within a sufficient distance to be impacted by the proposed development.

4.6 Compliance points

Groundwater compliance points will comprise groundwater beneath the site for hazardous substances and groundwater at the site boundary for non-hazardous pollutants.

As off-site discharge of surface water will not be required, surface water is not a direct receptor and surface water compliance points are not required.

5 POLLUTION CONTROL MEASURES

5.1 Site engineering

A Hydrogeological Risk Assessment has been undertaken to identify the need for pollution control measures at the site. The results of the assessment indicate that the following pollution control measures are required.

5.1.1 Basal and side slope engineering

As the site is not a landfill and due to the proposed nature of the restoration materials, leachate collection is not required, hence an artificial sealing liner is not necessary.

However, risk assessment indicated that an artificial geological barrier will be necessary to protect the water environment. This shall take the form of selected inert materials placed to achieve a layer 1 m thick with a maximum permeability of 5 x 10^{-9} m/s or equivalent.

5.1.2 Capping requirements

The site will be operating under a waste recovery permit and there is no requirement for an engineered low permeability cap. The infill will be lower permeability than the surrounding sandstone and therefore no cap is proposed.

5.2 Surface water management

5.2.1 Operational phase

Currently surface water from the part of the adjacent Veolia Landfill and from the hardstanding area at the site entrance drains into the existing void and collects before gradually soaking away. No active surface water management occurs.

It will be necessary for run-off from the east to be directed away from the void during the operational phase. This will be achieved by construction of an eastern perimeter ditch and berm to prevent inflow of surface water run-off. This will direct collected water southwards to a new retention basin north of the existing site access track and southwest of the Veolia landfill. This is subject to the agreement of Veolia.

5.3 Post-closure controls

5.3.1 After-use

The proposed after-use for the site comprises creation of wildlife habitat in line with Worcestershire's Biodiversity Targets. It will incorporate woodland blocks, further tree and shrubs, acidic species-rich grassland and marginal and wetland areas.

5.3.2 Surface water management

The agreed restoration scheme includes a sloping profile draining to a surface water management pool in the northwestern corner of the site. This will be constructed against a section of residual exposed sandstone quarry face where excess water will soak away. The size of the pool will vary seasonally, and the margins will provide varied wetland habitat. Active surface water management will therefore not be needed in the long-term.

The design has been agreed and the related planning condition signed off.

5.3.3 Subsistence and settlement

It is considered that settlement of the restored landform will be negligible due to the types of material to be accepted by the site and the method of placement. Post-settlement contours are provided as *Drawing 3308/ESSD/05*.

6 MONITORING

6.1 Weather

Weather monitoring is not required for this site.

6.2 Landfill gas

Due to the nature of the materials being imported to the site, the probability of landfill gas being generated is considered to be negligible. Therefore, it is unnecessary to undertake a landfill gas risk assessment.

Nevertheless, to help collect data to demonstrate that the site is chemically and physically stable for Permit surrender, landfill gas monitoring will be undertaken in the perimeter boreholes.

When infilling has reached final levels in-waste boreholes will be constructed at a density in accordance with current guidance, to allow confirmation of the chemical stability of the waste.

6.3 Groundwater

6.3.1 Groundwater infrastructure

Four groundwater monitoring boreholes have been constructed in the northwest and south of the site to supplement the existing Veolia monitoring points 800, 810 and 821, located to the northeast and southeast. These allow groundwater level and quality samples to be obtained.

The proposed monitoring scheme is discussed in Section 3 of the accompanying HRA report.

6.4 Surface water monitoring

The conceptual site model has indicated that surface water monitoring is not required.