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**BOW FARM ENVIRONMENTAL SETTING AND SITE  
DESIGN TO SUPPORT A DEPOSIT OF WASTE FOR  
RECOVERY ENVIRONMENTAL PERMIT APPLICATION**

**For**

**MORETON C CULLIMORE (GRAVELS) LIMITED**

**November 2025**

**Report Title:** **Bow Farm Environmental Setting and Site Design to Support a Deposit of Waste for Recovery Environmental Permit Application**

**Client:** **Moreton C Cullimore (Gravels) Limited**

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# **BOW FARM ENVIRONMENTAL SETTING AND SITE DESIGN TO SUPPORT A DEPOSIT OF WASTE FOR RECOVERY ENVIRONMENTAL PERMIT APPLICATION**

## **1. OVERVIEW OF DEVELOPMENT**

### **1.1 Report Context**

The works approved by Planning Permission 19/000048/CM (Worcestershire County Council) and Planning Permission 19/0081/TWMAJM (Gloucestershire County Council) provide for, *inter alia*, site restoration using imported inert fill material at Bow Farm, Ripple, Worcestershire (the site).

Planning Permission 19/0081/TWMAJM was approved by Gloucestershire County Council through the successful appeal (Appeal Ref. APP/T1600/W/23/3324695) by the applicant following initial refusal of Planning Permission 19/0081/TWMAJM.

Completion of the approved site restoration scheme, involving the restoration of the mineral extraction areas requires 1.4Mm<sup>3</sup> (approximately 2.45Mt using a standard conversion factor of 1.75t/m<sup>3</sup>) of imported inert fill material within Phases 1 to 9 of the excavation area in the main site area.

The thickness of imported fill to be placed within excavation area Phases 1 to 9 ranges from 0m to c. 7.5m (average 4.5m).

The approved site restoration scheme also provides for excavation and low-level restoration of Flexible Working Areas A and B in the west of the site. Flexible Working Areas A and B will only be excavated seasonally during non-high flow periods of the River Severn, located c. 25m to the west at its closest approach. Restoration of Flexible Working Areas A and B will be to wetlands and water features using only site derived mineral waste (silts and clays) and will have a final landform below pre-extraction ground levels. No imported inert fill material will be placed in Flexible Working Areas A and B.

An application is being made for a Bespoke Environmental Permit (use of waste in a deposit for recovery activity). The applicant is Moreton C Cullimore (Gravels) Limited.

The EPR Permit application is submitted on the basis that the permanent deposit of imported inert fill material within excavation area Phases 1 to 9 at the site to achieve the approved restoration scheme is a deposit for recovery activity and not a waste disposal activity.

The recovered waste will be imported inert fill material sourced from construction sites within the general Tewkesbury area.

To ensure that the recovered waste material is suitable for its intended use, the works will be managed by staff having the appropriate level of technical competence with relevant qualifications gained from one of the accepted industry schemes. Waste Acceptance Criteria inspection procedures will be in place to ensure that the inert fill material used in the works is as described on Waste Transfer Notes, is permitted by the Environmental Permit and is fit for purpose.

This report presents an Environmental Setting and Site Design (ESSD) and has been prepared to support an EPR Permit application to provide for the permanent deposit of imported inert fill material at the site as a deposit for recovery activity to achieve the approved restoration landform.

#### **1.1.1 *Operator of the Proposed Development***

Moreton C Cullimore (Gravels) Limited, Netherhills, Whitminster, Gloucestershire, GL2 7PD.

#### **1.1.2 *Agent who Completed this Report***

GWP Consultants LLP, Upton House, Market Street, Charlbury, Oxfordshire, OX7 3PJ.

## **2. DEVELOPMENT DETAILS**

### **2.1 Site Location**

The application site is located at Bow Farm, Ripple, Worcestershire (National Grid Reference SO 87565 36504).

Drawing No. BOWFEPR2511-1 shows the site location and Drawing No. BOWFEPR2511-2 shows the different areas of the site, including the excavation area Phases 1 to 9 where imported inert fill material will be placed under the EPR Permit. Drawing No. BOWFEPR2511-3 shows the EPR Permit application area within the context of the site approved under the Planning Permissions.

The total site area covers c. 65ha, straddling the county boundary between Worcestershire and Gloucestershire. An area of c. 45ha of land has been approved for mineral extraction in the north and centre of the site (this is located entirely within Worcestershire). The approved mineral extraction areas are made up of excavation area Phases 1 to 9 (c. 30.9ha), Flexible Working Area A (c. 8.8ha) and Flexible Working Area B (c. 5.3ha). The processing plant and access route will be located in Gloucestershire (eastern part of the site).

A site plan is presented as Drawing No. BOWFEPR2511-4.

The Phases 1 to 9 excavation area in the main part of the site is located c. 500m south of the village of Ripple. The processing plant and main access road is located c. 300m south of the village of Puckrup and c. 900m southwest of the village of Twyning. The town of Tewkesbury is located c. 2.5km to the south of the site.

From a geomorphological terrain perspective, the site can be split into three areas:

- a flat low lying (<10mAOD) area south of Ripple Quarry Lake;
- a raised north-west south-east trending 300m wide, 1000m long ridge rising to 14mAOD, separated from the Ripple Quarry area by the Napps Local Wildlife Site (LWS) wetland area (a former osier bed); and
- a hill side slope rising to >30mAOD, above the River Severn valley, separated from the southern end of the raised ridge and floodplain by a small stream named the Ripple Brook.

The Ripple Brook valley has an elevation of 9mAOD to 11mAOD adjacent to the site and divides the site in two.

The site is accessed from the A38 to the east of the site.

A Groundsure Enviro Insight report and a separate Geo Insight report for the site, both obtained in November 2024, are presented in Appendix 1a and Appendix 1b, respectively.

## **2.2 Site Layout**

The approved design and operation of the site reflects the three areas' different elevations and proximities to the River Severn (c. 25m to the west of the EPR Permit Application boundary and c. 400m west of the Phases 1 to 9 excavation area).

The north-south ridge in the centre of the site, approved under Planning, is where excavation area Phases 1 to 9 are situated. Phases 1 to 9 is the location for year-round sand and gravel extraction and is the area of the site where the imported inert fill material will be placed with restoration back to pre-extraction ground levels. The Phases 1 to 9 area of the site is the focus of the deposit for recovery Environmental Permit being applied for, as this is the part of the site where the imported inert fill material will be used to restore the site.

The elevated hill slope area in the east of the site will be the location for the processing plant, main site office and weighbridge, silt settlement lagoons associated with the processing plant/mineral washing and the site access road from the A38.

The low-lying area of Flexible Working Areas A and B, c. 25m to the east of the River Severn at its closest approach, will only be excavated seasonally during non-high flow periods of the river. Restoration of Flexible Working Areas A and B will be to wetlands and water features using only site derived mineral waste (silts and clays) and will have a final landform below pre-extraction ground levels. No imported inert fill material will be placed in Flexible Working Areas A and B.

## **2.3 Site Context and Rural Designations**

The EPR Permit application is to provide for site restoration using imported inert fill material within excavation area Phases 1 to 9 at Bow Farm as a deposit for recovery activity.

The following distances from the Environmental Permit application boundary have been used to identify rural designations/potential receptors:

- 1km radius – European ecological important sites including RAMSAR sites, Special Areas of Conservation, Local Wildlife Sites and Special Protection Areas;
- 1km radius – potentially sensitive receptors of ecological importance and sites of cultural and natural heritage. These include National Nature Reserves, Local Nature Reserves, Sites of Special Scientific Interest and Scheduled Monuments;
- 500m radius – all other potentially sensitive receptors *e.g.* residential, commercial, industrial, agricultural and surface water receptors.

Rural designations/potential receptors are detailed in Table 1 and are shown on Drawing Nos. BOWFEPR2511-5, 6 and 7.

**Table 1 – Rural designations/potential receptors**

Receptor name	Receptor type	Receptor direction from site	Approximate distance from application boundary
<b>Land use receptors within 500m of the application boundary (Drawing No. BOWFEPR2511-5)</b>			
Puckrup Hall Farm	Industrial/Commercial/Residential Property	Centre/East (of excavation area Phases 1 to 9)	Adjacent
Bow Farm	Industrial/Commercial	East (of excavation area Phases 1 to 9)	50m
Ripple Quarry (restored)	Industrial/Commercial	West (of excavation area Phases 1 to 9)	Adjacent
All Seasons Cars Taxi Service	Commercial	Southeast (of plant and access road area)	250m
The Crown Inn at Shuthonger	Commercial	Southeast (of plant and access road area)	450m
Tewkesbury's Hand Car Wash	Commercial	Southeast (of plant and access road area)	450m
3C Legal Limited	Commercial	East (of plant and access road area)	350m
Hilton Puckrup Hall, Tewkesbury	Commercial (accommodation and leisure)	North (of plant and access road area)	50m (to golf course grounds)
Hill View Lakes (Fishing Lakes)	Commercial/Leisure	Northeast (of plant and access road area)	320m
Tewkesbury Riding School	Commercial/Leisure	Northeast (of plant and access road area)	450m
Glebe Cottage Bed & Breakfast	Commercial/Residential	East (of plant and access road area)	400m

Properties along Bow Lane	Residential Properties	East (of excavation area Phases 1 to 9)	50m (closest)
Properties along Puckrup Lane	Residential Properties	Northeast (of connection between excavation area Phases 1 to 9 and plant and access road area)	200m (closest)
Properties within Shuthonger	Residential Properties	Southeast (of plant and access road area)	240m (closest)
Properties within Puckrup	Residential Properties	North (of plant and access road area)	300m (closest)
Properties within Church End	Residential Properties	South (of plant and access road area)	200m (closest)
Property along Bow Lane to the north of the M50	Residential Property	North (of excavation area Phases 1 to 9)	400m
Bow Lane	Local Transport Network	East (of excavation area Phases 1 to 9)	Adjacent
Puckrup Lane	Local Transport Network	East (of excavation area Phases 1 to 9)	100m
M50	Local Transport Network	North (of excavation area Phases 1 to 9)	20m
A38	Local Transport Network	East (of access road area)	Adjacent
Owls Lane	Local Transport Network	Southeast (of plant and access road area)	200m
Church End	Local Transport Network	East (of plant and access road area)	300m
River Severn	Surface Water Feature	West (of excavation area – Flexible Working Area A)	25m
		West (of excavation area Phases 1 to 9)	400m

Ripple Brook	Surface Water Feature	North to south, crossing the site between the main site area and plant and access road area	Crosses the site between the connection between excavation area and plant and access road area
Mythe Brook	Surface Water Feature	Southeast (of excavation area Phases 1 to 9)	110m
Bushley Brook	Surface Water Feature	West (of excavation area – Flexible Working Area A)	350m
Drain between Flexible Working Areas A and B	Surface Water Feature	North to southeast, crossing the site between Flexible Working Areas A and B	Crosses the site between Flexible Working Areas A and B
Pond and surface water drain/wetland areas	Surface Water Feature	West (of excavation area Phases 1 to 9)	Adjacent
Ripple Quarry Lake (restored)	Surface Water Feature	West and north (of excavation area Phases 1 to 9)	50m (closest)
Ponds at Hilton Puckrup Hall Hotel and Golf Club	Surface Water Features	North (of plant and access road area)	50m (closest)
Twyning Cricket Club	Open Ground (leisure)	North (of plant and access road area)	380m
Agricultural land	Open Ground	North, east, south and west of whole site	Adjacent (closest – south)
<b>Cultural and heritage receptors within 1km of the application boundary (Drawing No. BOWFEPR2511-6)</b>			
Puck Cottage	Listed building (closest)	East (of excavation area Phases 1 to 9)	50m
Towbury Hill camp	Scheduled Monument	East (of excavation area Phases 1 to 9)	250m
Ripple village cross	Scheduled Monument	North (of excavation area Phases 1 to 9)	630m
Cross north of St Mary's Church	Scheduled Monument	North (of excavation area Phases 1 to 9)	650m

Uckinghall cross	Scheduled Monument	North (of excavation area Phases 1 to 9)	950m
Churchyard cross in St Nicholas's churchyard	Scheduled Monument	West (of excavation area Phases 1 to 9)	1km
Church End Twyning	Historical Conservation Area	East (of plant and access road area)	300m
<b>Ecological receptors within 1km of the application boundary (Drawing No. BOWFEPR2511-7)</b>			
Ripple Lake and the Napps	Local Wildlife Site	On-site (western edge of excavation area Phases 1 to 9)	On-site
Ripple Brook	Local Wildlife Site	North to south, crossing the site between the main site area and plant and access road area	On-site
Ripple Meadow	Local Wildlife Site	Northwest (of excavation area – Flexible Working Area A)	Adjacent
		West (of excavation area Phases 1 to 9)	430m
River Severn	Local Wildlife Site	West (of excavation area – Flexible Working Area A)	25m
		West (of excavation area Phases 1 to 9)	400m
Queenhill Brickpit	Local Wildlife Site	Northwest (of excavation area Phases 1 to 9)	900m
Mythe Composite Site	Gloucester Key Wildlife Site	Northeast (of plant and access road area)	860m
Mythe Railway	Gloucester Key Wildlife Site	Northeast (of plant and access road area)	980m
Brockridge Common	Gloucester Key Wildlife Site	Northeast (of excavation area Phases 1 to 9)	830m
Priority Habitat Inventory – Deciduous Woodland	Protected Woodland	Northwest (of excavation area Phases 1 to 9)	Adjacent (closest)

Priority Habitat Inventory - Traditional Orchards	Protected Woodland	East (of plant and access road area)	230m (closest)
Priority Habitat Inventory - Coastal and Floodplain Grazing Marsh	Protected Grassland	On-site (adjacent to the north of excavation area – Flexible Working Area B)	On-site (closest)
		West (of excavation area Phases 1 to 9)	125m
Priority Habitat Inventory - Good quality semi-improved grassland	Protected Grassland	East (of excavation area Phases 1 to 9)	250m
Priority Habitat Inventory - Lowland Dry Acid Grassland	Protected Grassland	South (of plant and access road area)	830m
Priority Habitat Inventory - Lowland Meadows	Protected Grassland	East (of excavation area Phases 1 to 9)	300m
Woodpasture and Parkland BAP Priority Habitat	Woodpasture and Parkland	North (of plant and access road area)	60m (closest)

## 2.4 **Historical Landfilling**

Historical landfilling within the vicinity of the site is detailed in Section 3 of the Enviro Insight report presented in Appendix 1a.

There are two historical landfills located within 1km of the site:

- Ripple Landfill Site located c. 850m northeast of the main excavation/proposed imported inert fill area; and
- Twyning Pit (split into two areas) closest area is located c. 370m east of the main access route to the site off the A38.

## 3. **SOURCE TERM CHARACTERISATION**

### 3.1 **The Development of the Site**

#### 3.1.1 **Historical Development**

Prior to the commencement of mineral extraction, the site was in agricultural use.

The site continues to extract minerals, producing a range of crushed and graded aggregates.

#### 3.1.2 **Approved Development**

The works approved by Planning Permission 19/000048/CM (Worcestershire County Council) and Planning Permission 19/0081/TWMAJM (Gloucestershire County Council) provide for, *inter alia*, site restoration using imported inert fill material at Bow Farm, Ripple, Worcestershire.

Planning Permission 19/0081/TWMAJM was approved by Gloucestershire County Council through the successful appeal (Appeal Ref. APP/T1600/W/23/3324695) by the applicant following initial refusal of Planning Permission 19/0081/TWMAJM.

Completion of the approved site restoration scheme, involving the restoration of the mineral extraction areas requires 1.4Mm<sup>3</sup> (approximately 2.45Mt using a standard conversion factor of

1.75t/m<sup>3</sup>) of imported inert fill material within Phases 1 to 9 of the excavation area in the main site area as a deposit for recovery scheme.

The approved site restoration scheme also provides for excavation and low-level restoration of Flexible Working Areas A and B in the west of the site. Flexible Working Areas A and B will only be excavated seasonally during non-high flow periods of the River Severn. The River Severn is located c. 25m to the west of the full site area and c. 400m to the west of the Phases 1 to 9 excavation area, at its closest approach. Restoration of Flexible Working Areas A and B will be to wetlands and water features using only site derived mineral waste (silts and clays) and will have a final landform below pre-extraction ground levels. No imported inert fill material will be placed in Flexible Working Areas A and B.

Drawing No. BOWFEPR2511-4 shows the Environmental Permit application area.

The development scheme drawings for Bow Farm approved by extant Planning Permissions 16/0083/CWMAJM are presented in Appendix 2.

Approved restoration surface contours are shown on Drawing No. 2636-4-4-2-1 DR-0007 S4-P9 in Appendix 2.

For further details of the development refer to the Waste Recovery Plan which is presented as Appendix I of the EPR Permit application (GWP Consultants LLP (GWP) Report No. 250926).

### **3.1.3 Waste Types**

The recovered waste will be imported inert fill material sourced from construction sites within the general Tewkesbury area. To ensure that the recovered waste material is suitable for its intended use, the works will be managed by staff having the appropriate level of technical competence with relevant qualifications gained from one of the accepted industry schemes. Waste Acceptance Criteria inspection procedures will be in place to ensure that the inert fill material used in the works is as described on Waste Transfer Notes, is permitted by the Environmental Permit and is fit for purpose.

The waste types in Table 2 are to be provided for in the Environmental Permit (it should be noted that the waste types provide for the importation of uncontaminated wastes from brownfield developments).

**Table 2 – Waste types**

<b>Waste types</b>	
<b>Exclusions</b>	
Wastes having any of the following characteristics shall not be accepted:	
- consisting solely or mainly of dusts, powders or loose fibres	
- hazardous wastes	
- wastes in liquid form	
<b>EWC Code</b>	<b>Waste Description</b>
<b>01</b>	<b>WASTES RESULTING FROM EXPLORATION, MINING, QUARRYING AND PHYSICAL AND CHEMICAL TREATMENT OF MINERALS</b>
<b>01 01</b>	<b>wastes from mineral excavation</b>
01 01 02	wastes from mineral non-metalliferous excavation
<b>01 04</b>	<b>wastes from physical and chemical processing of non-metalliferous minerals</b>
01 04 08	waste gravel and crushed rocks other than those mentioned in 01 04 07
01 04 09	waste sand and clays
<b>17</b>	<b>CONSTRUCTION AND DEMOLITION WASTES (INCLUDING EXCAVATED SOIL FROM CONTAMINATED SITES)</b>
<b>17 01</b>	<b>concrete, bricks, tiles and ceramics</b>
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 mentioned in 17 01 06
<b>17 05</b>	<b>soil (including excavated soil from contaminated sites), stones and dredging spoil</b>
17 05 04	soil and stones other than those mentioned in 17 05 03

17 05 04 waste will be sourced from greenfield sites and/or will be waste of 'greenfield quality' sourced from brownfield sites (*i.e.* naturally occurring material for which there is no suspicion of contamination based on specific source specific environmental risk assessment, supported as necessary by laboratory analysis).

The application is submitted on the basis that the recovered waste will be suitable for its intended use and that the approved scheme a deposit for recovery activity and not a waste disposal activity.

### **3.1.4 Hydrogeological Risk Screening**

Given the inert nature of the waste and strict waste acceptance procedures and protocols, it is considered that the quantity and concentration of any hazardous substances or non-hazardous pollutants within any leachate (defined here as water coming into contact with the waste) will be minimal, hence the site falls outside the scope of the Groundwater (England and Wales) Regulations.

The Hydrogeological Risk Assessment (HRA) report prepared by GWP (GWP Report No. 251041) which accompanies the EPR Permit application (Appendix Giv) undertakes a full hydrogeological risk screening process for this development. Following this risk screening a Tier 2 Generic Quantitative Risk Assessment (GQRA), including a rogue load assessment, has been undertaken.

The risk assessment demonstrates that under normal operational and post-operational phases of inert waste recovery, hazardous substances will not be present in discernible concentrations within groundwater beneath the site. Non-hazardous pollutants will not be present in concentrations such that pollution of groundwater is caused. Therefore, it is considered that the site will be compliant with respect to the Groundwater (England and Wales) Regulations.

### **3.1.5 Restoration and Afteruse**

The restoration and afteruse scheme for the site, approved by extant Planning Permissions 19/000048/CM (Worcestershire County Council) and 19/0081/TWMAJM (Gloucestershire County Council), is shown on Drawings presented in Appendix 2.

Approved restoration surface contours are shown on Drawing No. 2636-4-4-2-1 DR-0007 S4-P9 in Appendix 2.

Restoration and aftercare will be in accordance with the requirements of extant Planning Permissions 19/000048/CM and 19/0081/TWMAJM.

Specifically, management of the completed restoration scheme at Bow Farm will be in accordance with the Detailed Restoration and Aftercare Proposals and Landscape and Ecological Management Plan (David Jarvis Associates Limited (DJA) Report ref. 2636-4-5-LM-0001) approved by extant Planning Permissions 19/000048/CM (Worcestershire County Council) and 19/0081/TWMAJM (Gloucestershire County Council).

The latest version of the Detailed Restoration and Aftercare Proposals and Landscape and Ecological Management Plan (Version P6 dated April 2025) has been included in Appendix L of the EPR Permit application.

## **3.2 Development Engineering**

### **3.2.1 Groundwater Management System**

Groundwater exists within the sands and gravel strata of the four river Terrace Deposits within and surrounding the site. The groundwater perches on the underlying impermeable mudstone bedrock of the Triassic Branscombe Mudstone Formation of the Mercia Mudstone Group (red-brown mudstones and siltstones).

The groundwater flow direction is to the west, perching on the underlying bedrock, with the sands becoming increasingly saturated in the west of the Phases 1 to 9 excavation area. There is no evidence to demonstrate an easterly groundwater flow direction within the excavation area towards the Ripple Brook.

The limited size of the Terrace Deposits restricts rainfall recharge volumes, resulting in these strata drying out during summer months at the eastern edges of the individual terraces – indeed the strata is dry all year round to the east of the northern half of the Phases 1 to 9 excavation area.

Groundwater levels suggest groundwater discharge can, and does, occur at the surface of the western edges of the Terrace Deposits, and has the potential to flow into surface water features west of the Phases 1 to 9 excavation area, including the River Severn. For the Phases 1 to 9 excavation area these groundwater flows appear to be sustained all year round, whereas some of the higher terraces on the hillslope to the east of the Phases 1 to 9 excavation area become unsaturated during the summer months.

Further details of the groundwater conditions at the site are provided in the HRA report (GWP Report No. 251041) which accompanies the EPR Permit application (Appendix Giv)).

The Phases 1 to 9 excavation area will be excavated to levels ranging from c. 6.5mAOD in the west to c. 14mAOD in the east.

To allow for the excavation activity to be undertaken efficiently in suitably dry conditions, a clay cut-off will be installed around the perimeter of the Phases 1 to 9 excavation area. The clay cut-offs will be keyed into the underlying *in situ* clay (Triassic Branscombe Mudstone Formation of the Mercia Mudstone Group) to hydraulically separate the site from the surrounding aquifer, meaning groundwater dewatering will not be required.

Groundwater flow truncation caused by the impermeable cut-off being placed around the Phases 1 to 9 excavation area, will be mitigated using a groundwater interception ditch excavated to the base of the gravel on the eastern side of this areas' perimeter. This will route water around the northern and southern sides of the excavation area to the western perimeter, where it will be allowed to infiltrate through the base of the ditch into the underlying sand and gravel aquifer – thus maintaining the pre-development groundwater through-flow water balance.

By ensuring the pre-development groundwater flow rate is maintained, any on-site groundwater flow contributions to any down-gradient water dependent receptors will be maintained throughout the operation of the site.

Flexible Working Areas A and B, to the west of the EPR Permit application area, will be worked wet and will require no pumped dewatering nor placement of an impermeable cut-off. The excavation of sand in these areas will have no effect on groundwater level lowering or flow truncation.

Prior to restoration under the deposit for recovery activity, a side slope Artificial Geological Barrier (AGB) will be constructed on a phased basis against the perimeter walls of excavation area Phases 1 to 9.

The underlying Triassic Branscombe Mudstone Formation of the Mercia Mudstone Group has low permeability and does not transmit groundwater flow.

### **3.2.2 Artificial Geological Barrier (AGB)**

The EPR Permit application is submitted on the basis that the permanent deposit of imported inert fill material within excavation area Phases 1 to 9 at the site to achieve the approved restoration scheme is a deposit for recovery activity and not a waste disposal activity.

A side slope AGB will be constructed on a phased basis within excavation area Phases 1 to 9 in order to provide protection to soil, groundwater and surface water at least equivalent to that resulting from an attenuation barrier/liner with a minimum thickness of 1.0m and a maximum permeability of  $1 \times 10^{-7}$ m/sec.

The Triassic Branscombe Mudstone Formation of the Mercia Mudstone Group underlying the site forms an adequate natural basal geological barrier.

### **3.2.3 Basal Lining System**

The deposit for recovery scheme will have an adequate natural basal geological barrier in the form of the underlying low permeability Triassic Branscombe Mudstone Formation of the Mercia Mudstone Group. An engineered basal AGB will therefore not be constructed at the site.

### **3.2.4 Side Slope Lining System**

A side slope AGB will be constructed on a phased basis against the perimeter slopes of excavation area Phases 1 to 9 using suitable indigenous clay material dug from the floor of the mineral excavation and/or site derived mineral waste (silts and clays) and will have a minimum thickness of 1m and a permeability no greater than  $1 \times 10^{-7}$ m/s.

The suitable material will be compacted in layers and brought up in lifts up to c. 7.5m high against the side slopes sub-grade formed in the superficial Terrace Deposits as the general placement of waste progresses. The maximum unsupported height of the side slopes AGB will be c. 3.75m.

The side slope AGB will be constructed in accordance with a Construction Quality Assurance Plan (CQAP) approved by the Environment Agency (EA). The CQAP (GWP Report No. 250927) is provided as Appendix M of the EPR Permit application.

Details of the components of the AGB are illustrated on Drawing No. BOWFEPR2511-8.

### **3.2.5 Capping System**

There will be no engineered capping system constructed as there will be no generation of gas or leachate.

## **3.3 Leachate Management and Monitoring Infrastructure**

### **3.3.1 Leachate Generation**

Given the inert nature of the imported waste and strict waste acceptance procedures and protocols, it is considered that the quantity and concentration of any hazardous substances or non-hazardous pollutants within any leachate (defined here as water coming into contact with the waste) will be minimal.

A HRA accompanies this EPR Permit application as Appendix Giv (GWP Report No. 251041).

Due to the inert nature of the imported waste, any water coming into contact with it will not incorporate within it measurable concentrations of pollutants. It is therefore considered that

hazardous substances will be absent and non-hazardous pollutants, if present, will be at low or insignificant concentrations. Therefore, potentially polluting leachate will not be generated.

### **3.3.2 Leachate Management and Monitoring**

Given the inert nature of the imported waste material no leachate will be generated. Therefore, no leachate management or monitoring infrastructure is required and none is proposed.

A side slope AGB will be constructed to provide sufficient attenuation between the inert fill material source within excavation area Phases 1 to 9 and any potential groundwater receptor. The AGB will be constructed to achieve a minimum thickness of 1m and maximum permeability of  $1 \times 10^{-7}$  m/s in accordance with a CQAP approved by the EA. The CQAP (GWP Report No. 250927) is provided as Appendix M of the EPR Permit application.

### **3.4 Gas Management and Monitoring Infrastructure**

Given the inert nature of the imported waste and strict waste acceptance procedures and protocols, there is no potential source of any significant quantities of gas.

A Gas Risk Assessment accompanies this EPR Permit application as Appendix Gvi (GWP Report No. 251040).

### **3.5 Surface Water Management System**

All surface water associated with the deposit for recovery scheme will be managed initially within the EPR Permit area.

#### **3.5.1 Operational Phase**

As outlined in Section 3.2.1, a clay cut-off wall will be installed around the full perimeter of the Phases 1 to 9 excavation area. The presence of this clay cut-off wall will prevent the groundwater within the river terrace sand and gravel deposits up-gradient of the site from being transmitted through the sand and gravel aquifer on site but will be routed to the west of the site through the installation of perimeter groundwater interception ditches. Therefore, water collecting within the excavation void will be rainfall-derived surface water only (no groundwater dewatering will be required). Sump pumps will be used inside the excavation pit to remove rainfall.

Surface water runoff generated within excavated areas of Phases 1 to 9 will progressively infiltrate or will be internally managed within the site area. Surface water runoff will be captured and routed from areas outside of excavations, including temporary bunds and stockpiles, to prevent turbid water entering local water courses.

There will be no direct discharge of water from the EPR Permit application area into any local surface water receptors.

During operations, direct rainfall and associated surface water runoff within the progressive Phases 1 to 9 void will be pumped out and clarified through the use of temporary silt lagoons. This cleaned water will then be transferred to infiltration basins along the western perimeter of Phases 1 to 9 to allow it to infiltrate back into the sand and gravel aquifer. Details of the surface water management scheme are provided in the *Bow Farm Surface Water Drainage Scheme* report (GWP Report No. 240707), prepared separately to discharge Condition 20 of Planning Permission Number 19/000048/CM (Worcestershire County Council). Discharge of Condition 20 was subsequently permitted by Worcestershire County Council on 2<sup>nd</sup> June 2025 through Condition discharge application 24/000035/DIS. The Surface Water Drainage Scheme report is included in Appendix 3.

#### **3.5.2 Restoration and Post-Development Phase**

Restoration of excavation area Phases 1 to 9 will be back to pre-extraction ground levels (*via* site derived materials and importation of inert waste). Restoration of Flexible Working Areas A and B will be to water bodies and wetland (using site derived mineral waste only) below pre-extraction ground levels. Thus, all the site area will be restored to or below pre-extraction ground levels, providing a net gain in floodplain storage and conveyance.

The removal of the sand and gravel from excavation area Phases 1 to 9 and their replacement with low permeability inert waste contained within a low permeability side wall liner will result in increased surface water runoff from these areas. Mitigation measures are therefore required to ensure no negative impact in terms of drainage and risk of flooding within and/or around the site area.

A runoff attenuation scheme, approved under Planning Permissions 19/000048/CM and 19/0081/TWMAJM, will be included as part of the restored site layout. The approved surface water runoff management scheme consists of a single elongated restoration infiltration basin along the western boundary of excavation Phases 1 to 9. The feature is described as an infiltration basin as its purpose is not to convey flow but to store it and, to a large extent, allow runoff infiltration. Excess runoff will be discharged from the restoration infiltration basin (*via* an overflow orifice) into a proposed wetland area that sits within the Application Site. The runoff attenuation scheme is outlined in detail within the *Bow Farm Sand and Gravel Quarry Development Hydrogeological and Hydrological Impact Assessment and Flood Risk Assessment* report (GWP Report No. 190714) included in Appendix 4. The phasing of the construction of the restoration infiltration basin is also detailed within the Surface Water Drainage Scheme report in Appendix 3.

### **3.6 Post Closure Controls**

At 6 months prior to completion of the site, a Post Closure Management Plan will be submitted to the EA detailing the proposed post closure monitoring programme. Following the approval of this Post Closure Management Plan and completion of the site, then the EPR Permit will be surrendered.

Minor differential settlement within the waste is to be anticipated under self-loading, however the magnitude will be minimal and will not impact on the long-term stability/security of the restored surface. Minor restoration surface depressions that may form as a result of waste settlement will be filled as necessary with restoration soils.

## **4. PATHWAY AND RECEPTOR TERM CHARACTERISATION**

### **4.1 Conceptual Hydrogeological Model**

The conceptual hydrogeological model is shown on Drawing No. BOWFEPR2511-9 and is discussed in the following sections.

### **4.2 Climate**

According to the Flood Estimation Handbook (FEH) Web Service, average annual rainfall (SAAR6190) at the site is 622mm.

The Defra Hydrology Data Explorer data platform has been used to obtain daily rainfall data from three rain gauges located approximately equidistant from the site to the southwest, west and northeast, respectively. The rain gauges and associated rainfall data ranges are as follows:

- Over Farm, located *c.* 17km southwest of the site. Data from 2009 to 2024;
- Ledbury (Ledbury Road), located *c.* 17km west of the site. Data from 1982 to 2024; and
- Sheriffs Lench, located *c.* 18km northeast of the site. Data from 2001 to 2024.

The average rainfall over the monitoring period at Over Farm is 773mm. The average rainfall recorded over the monitoring period at Ledbury is 684mm. The average rainfall recorded over the monitoring period at Sheriffs Lench is 699mm. Daily rainfall graphs for the three rain gauges are provided in Appendix 5. The average rainfall between the three rain gauges is 719mm, which is slightly higher than the average annual rainfall given for the area by the FEH Web Service. The nearest of the available rain gauges outlined above is *c.* 17km away from the site and so variation in rainfall amounts compared to the site location can be expected.

The direction of the prevailing wind is from the southwest (national prevailing wind direction).

### **4.3 Geological Setting**

The geological setting of the site has been determined based on a review of published information and historical and recent site investigation information.

The general geological setting of the site is shown in Sections 1.3 (Superficial geology) and 1.5 (Bedrock geology) of the Geo Insight report presented in Appendix 1b.

#### **4.3.1 Bedrock Deposits**

The solid geology underlying the site comprises the Triassic Branscombe Mudstone Formation of the Mercia Mudstone Group which consists of a sequence of red-brown mudstones and siltstones.

The Tewkesbury Fault crosses the site access road to the east of the processing plant area. The fault is therefore situated to the east of the Phases 1 to 9 excavation area of the EPR Permit application area. The Tewkesbury Fault has a north-south trend and juxtaposes limestone and shale of the younger Jurassic Rugby Limestone Member against the Branscombe Mudstone Formation.

#### **4.3.2 Superficial Deposits**

The bedrock mudstone is overlain by a series of stepped river Terrace Deposits of sand and gravel formed during the Pleistocene by the early River Severn system. The Terrace Deposits are believed to have formed in a braided river environment in which lateral variation from clay or silty channel fill to gravel islands can be expected. Erosion of the bedrock clay may lead to thickening of Terrace Deposits.

The Terrace Deposits collectively belong to the Severn Valley Formation. The youngest terrace deposit at Ripple is concealed beneath alluvial sediment of the modern River Severn.

The four lowest (youngest) of the River Severn terrace sand and gravel deposits are present on the site:

##### **Kidderminster Station Member (BGS 4th Terrace of the River Severn)**

The Kidderminster Station Member is the oldest terrace deposit on site. The upper surface level is c. 32mAOD to 33mAOD and is found only at the eastern boundary of the full site area east of Ripple Brook where it caps the higher ground above the location of the processing plant. The British Geological Survey (BGS) memoir records that at Twynning, 4.1m of sandy gravel was proven in a borehole in which Bunter Sandstone gravel predominated.

Window Sampling of this terrace was carried out in 2018 and descriptions indicate that the terrace deposit comprises predominantly brown and red brown silty sand with pockets of fine and coarse gravel beneath a thin soil cover. The maximum thickness intersected was to the east of the processing plant area, where 4.7m of reddish-brown silty sand with rare gravel present.

Historic investigations showed that the base of the terrace gravel is at 26mAOD to 28mAOD leaving a step in the bedrock levels of approximately 10m to 11m, forming the hillside above the Holt Heath Member below.

##### **Holt Heath Member (BGS 3rd Terrace or Main Terrace of the River Severn)**

The Holt Heath Member underlies the level ground lying at c. 15mAOD to 17mAOD between the processing plant area and Puckrup Lane, to the east of the Phases 1 to 9 excavation area, which is largely occupied by the golf course at the Hilton Puckrup Hall Hotel and Golf Club. The extent continues into the site area to include the footprint of the processing plant area.

A wedge shaped remnant of this terrace also lies between the northern site boundary and Ripple Brook, extending north of the M50 as far as Ripple Village. It is evident that part of the terrace has been excavated in the past, possibly during construction of the M50 bridge in 1960.

The levels of the top of bedrock mudstone in exploratory boreholes located outside of the northeastern part of excavation area Phases 1 to 9, reflect the step up in levels of bedrock (Mercia Mudstone) from the base of the Worcester Member along the site boundary in this area. There appears to be an overlap between the two terraces which may represent encroachment of material from the higher terrace over the slope.

##### **Worcester Member (BGS 2nd Terrace of River Severn)**

The Worcester Member is the main sand and gravel resource on the site within the Phases 1 to 9 excavation area and forms a prominent landform 3m to 4m above the floodplain. On the site, the front edge of the terrace forms a well-defined slope between the top of the terrace deposit at 12mAOD to 14mAOD and the floodplain at 9mAOD to 10mAOD.

South of Bow Farm the terrace was incised by the Ripple Brook which passes behind the back edge of and through the terrace. The area between the processing plant location and Ripple Brook is a remnant of this terrace.

The base of the terrace deposit is inferred to slope towards the river from c. 9.5mAOD at the eastern edge of the Phases 1 to 9 excavation area, to c. 6.5mAOD at the western edge of the same area, at a gradient of 1v in 90h to 1v in 120h. The underlying bedrock (mudstone) level rises at the back (east) of the terrace.

The terrace deposit appears to be continuous but thins to the edge of the site area against the rising bedrock mudstone adjacent to Bow Lane. A thickness of 5.5m of terrace deposit was intersected in the Trial Pits dug in 1987, however previous modelling indicates that the greatest thickness may exceed 6m close to the front edge (west) of the terrace.

The Member consists of medium dense, reddish-brown slightly clayey and occasionally pebbly fine to medium sand. The gravel and clay content varies between boreholes installed in the deposit, but the terrace deposit is always predominantly sand.

Overburden is between 0.4m and 0.8m thick across the terrace and comprises firm red-brown very sandy clay beneath thin sandy topsoil.

#### **Power House Member (BGS 1st Terrace of River Severn)**

The current channel and floodplain of the River Severn are cut into the Power House Member, the youngest of the terrace gravel deposits of the Severn Valley Formation. The deposit is entirely obscured by silty clay alluvium and overbank sediments. The approved development allows for excavation of this terrace in Flexible Working Areas A and B only.

Historic trial pits excavated within Flexible Working Areas A and B in 1987 did not reach the base of the gravel. An estimate of the level of the base of the terrace has been made by extrapolating from the neighbouring Ripple Quarry site to the north of Flexible Working Areas A and B, where levels between 2.7mAOD and 4.8mAOD were recorded. It is likely that a thin horizon of gravel continues beneath the current river channel.

The maximum thickness of sand and gravel intersected on site through previous site investigations was 3.3m in the east of Working Area B. This is consistent with reported thickness from data from the adjacent Ripple Quarry site which reported an average thickness of 3.19m over the proposed extraction area with a maximum of 6.25m and minimum of 1.5m. Similar variation is expected at Bow Farm.

Investigations at the adjacent Ripple Quarry describes the material as '*brown medium to fine grained sandy gravel*'. The average composition was reported to be 41% gravel, 49% sand and 10% silt.

Overburden above the Power House Terrace comprises river alluvium and ranges in thickness from 2m to over 4.3m. Ground levels rise from c 9.5mAOD to over 11mAOD towards the existing River Severn flood embankment to the west of Working Area A over a distance of 200m and the thickness of overburden is inferred to increase accordingly. There are no descriptions of alluvium from the site.

#### **4.4 Man-made Subsurface Pathways**

The site comprises agricultural land which has approval for mineral extraction.

The development area is not underlain by underground mine workings.

There are no underground services located at the site.

#### **4.5 Hydrological Setting**

##### **4.5.1 Surface Water Features**

Surface water features are identified in Sections 7.1 (Water Network), 7.2 (Surface water features), 7.3 (WFD Surface water body catchments) and 7.4 (WFD Surface water bodies) of the Enviro Insight report presented in Appendix 1a and are shown on the Hydrology map on Page 53 of the Enviro Insight report.

##### **4.5.2 Description of Local Water Courses**

The closest watercourses to the site are the River Severn and the Ripple Brook. The River Severn is located c. 25m to the west of the full site area and c. 400m to the west of the Phases 1 to 9 excavation area. The River Severn is affected by high tides and tidal gates on the River Avon at Tewkesbury.

The Ripple Brook flows from north to south and separates the Phases 1 to 9 and Flexible Working Areas A and B excavation areas from the processing plant area to the east. The Ripple Brook joins the Mythe Brook, which in turn flows into the River Severn c. 1.5km south of the site.

### **4.5.3 Waterbodies**

The nearest external surface water bodies are ponds and surface water drain/wetland features located adjacent to the west of the excavation areas in the north of the site and the restored Ripple Quarry Lake feature to the west of the site.

Ponds are also situated within the grounds of the Hilton Puckrup Hall Hotel and Golf Club to the north of the eastern part of the site (processing plant area).

### **4.5.4 Springs**

There are no identified springs located within c. 500m of the site.

### **4.5.5 Flows within Local Water Courses**

Daily flow and water level information and data for the River Severn measured at Saxons Lode (Station No. 54032), located c. 2.1km north of the site, has been obtained from the National River Flow Archive (NRFA) and the Defra Hydrology Data Explorer. The data are presented in graphs within Appendix 6. The NRFA reports that the River Severn Catchment to Saxons Lode is 6,850km<sup>2</sup> and that river flows have been measured since January 1970, initially using a velocity area station during 1970-1987, and a multipath ultrasonic gauge since 1987.

The catchment has a minimum elevation of 9.5mAOD (at the gauging station), a maximum elevation of 826.2mAOD and a median elevation of 130.8mAOD. Over 50% of the catchment bedrock is inferred to be of low permeability, and 20% of the catchment bedrock is described as high permeability. This suggests that river flows are significantly influenced by surface water runoff. However, a Base Flow Index (BFI) of 0.58 gives evidence that a significant proportion of river flow is derived from stored sources (*i.e.* groundwater from the bedrock and superficial deposits).

Between 1970 and 2024 average flow of the River Severn at Saxons Lode is reported to have been 89.8m<sup>3</sup>/s with a 95% exceedance (Q<sub>95</sub> baseflow) of 15.5m<sup>3</sup>/s. Over the same period, Q<sub>50</sub> was 54.0m<sup>3</sup>/s and Q<sub>10</sub> was 233m<sup>3</sup>/s. The maximum measured flow rate was recorded as 546m<sup>3</sup>/s on 12<sup>th</sup> February 2014. The NRFA reports that this ultrasonic station is reliable at low and medium flows, but it becomes progressively less reliable once stage exceeds about 4m. The station is affected by high tides and tidal gates on the River Avon at Tewkesbury.

The Ripple Brook is a tributary of the River Severn. Data from an EA station at the Ripple Brook (Station No. 2624 – now closed – located c. 900m to the south of the site) reported water levels between 0.63m and 2.55m during 90% of the time over the monitoring period (November 2012 to March 2016).

The catchment area of the Ripple Brook immediately downstream of the Application Site is c. 24.3km<sup>2</sup>. High (extreme) flows for the Ripple Brook at this location have previously been estimated for extreme rainfall events with return periods of 1:100, 1:30, and 1:1 years as 10.8m<sup>3</sup>/s, 8.5m<sup>3</sup>/s and 4.1m<sup>3</sup>/s, respectively<sup>1</sup>.

The excavation of the mineral and placement of inert waste into Phases 1 to 9 will require the excavation area to be dry and devoid of water.

As described in Section 3.2.1, a clay cut-off will be installed around the perimeter of the site and keyed into the underlying weathered bedrock clay/mudstone to create an impermeable hydraulic seal between the Phase 1 to 9 excavation area and the surrounding sand and gravel aquifer.

The placement of the impermeable seal will prevent the groundwater flow (estimated to be 1 l/s to 5 l/s) from passing westwards through the Phases 1 to 9 excavation area. The River Severn, with a Q<sub>95</sub> baseflow of 15.5m<sup>3</sup>/s (c. 15,500 l/s), will not be affected by a derogation of 1 l/s to 5 l/s.

The Ripple Brook is located up-gradient of the excavation and infilling areas. Flows within the Ripple Brook will not be affected by the development.

Flows within the River Severn and the Ripple Brook will be unaffected by the restoration of the Phases 1 to 9 excavation area using site-derived quarry waste and imported inert waste. Accordingly, it is considered that assessments of flows in the River Severn and the Ripple Brook are not required for the purposes of the EPR Permit application.

#### **4.5.6 Flood Risk and the Presence of Indicative Floodplains**

The majority of the Phases 1 to 9 excavation area is located within fluvial flood risk Flood Zone 1 (less than 0.1% annual chance of flooding from rivers) and Flood Zone 2 (between 0.1% and 1% annual chance of flooding from rivers). Only the outer extremities of the Phases 1 to 9 area is located in Flood Zone 3 (annual chance river flooding is greater than 1%). Flood defences exist on the banks of the River Severn and the Mythe Brook.

Flexible Working Areas A and B are situated within Flood Zone 3. Part of the site situated in Gloucestershire, to the east of Ripple Brook, is also located within fluvial flood risk Flood Zone 3.

The majority of the EPR Permit Application area is situated within a low (between 0.1% and 1% annual chance of flooding from surface water) or very low (less than 0.1% annual chance of flooding from surface water) pluvial flood risk area. The EPR Permit Application area is not at risk of pluvial flooding.

Flood risk maps are provided in Sections 8, 9 and 10 of the Enviro Insight report presented in Appendix 1a.

#### **4.5.7 Surface Water Abstractions**

Details of surface water abstractions are provided in Section 6.7 of the Enviro Insight report presented in Appendix 1a.

There are 10 No. identified licensed surface water abstractions within c. 1km of the site. Where surface water abstractions have a shared ID within the Enviro Insight report then these have been counted as one abstraction.

According to the Enviro Insight report, the closest surface water abstraction is on site, however this record covers a reach of the River Severn and is represented by a line between the two extremities which intersects the site boundary. The closest surface water abstraction is therefore not on the site, but c. 25m to the west of the full site boundary.

Other surface water abstractions exist c. 45m to the south of the excavation Phases 1 to 9 area at the Ripple Brook and also to the north of the processing plant area, to the east of the excavation area Phases 1 to 9. All of the surface water abstraction records within 1km of the site are for spray irrigation and most are of a historical status and have been present for several years/decades.

#### **4.5.8 Consented Discharges**

Details of licensed discharges are provided in Section 4.13 of the Enviro Insight report presented in Appendix 1a.

The only consented discharge within c. 1km of the site was from the Ripple Quarry site c. 420m northwest of the site for site drainage trade discharge, however this licence was revoked in June 2018.

#### **4.5.9 Surface Water Quality**

The River Severn (confluence of River Teme to confluence of River Avon) Water Body was given a 'Moderate' ecological status for 2022 according to the EA's Catchment Data Explorer. The chemical status was classed as 'does not require assessment'.

The Ripple Brook (source to confluence of River Severn) Water Body was given a 'Moderate' ecological status for 2022 according to the EA's Catchment Data Explorer. The chemical status was classed as 'does not require assessment'.

The River Severn has been monitored for 17 No. determinands by the EA at Uckinghall c. 750m northwest (upstream) of the site through 2023 and 2024. The River Severn has also been monitored at (Upper) Tewkesbury, c. 2.4km downstream (southeast) of the site between 2000 and 2025, with over 100 determinands sampled for during this time.

The Ripple Brook has been monitored for 34 determinands at Bow Bridge c. 75m to the east of the site between 2000 and 2021 and also at its tributary upstream of Mythe Pools, downstream of the site. The location upstream of Mythe Pools was monitored during 2021 and 2025 for 17 No. determinands.

Given the inert nature of the imported waste, the strict waste acceptance procedures and protocols, and the findings of the Quantitative HRA (HRA report (GWP Report No. 251041) which accompanies

the EPR Permit application (Appendix Giv)), it is considered that no hydrological risk is posed to the River Severn and Ripple Brook, or any surface water dependent sites of ecological sensitivity from the restoration with site-derived quarry waste material and imported inert fill within excavation area Phases 1 to 9.

During operations, direct rainfall and associated surface water runoff within the progressive Phases 1 to 9 void will be pumped out and clarified through the use of temporary silt lagoons. This cleaned water will then be transferred to infiltration basins along the western perimeter of Phases 1 to 9 to allow it to infiltrate back into the sand and gravel aquifer. Details of the surface water management scheme are provided in Section 3.5 above.

#### **4.5.10 Ecological Importance**

Given the inert nature of the imported inert fill and the strict waste acceptance procedures and protocols and mitigation measures which will be applied at the site, it is considered that no hydrological risk is posed to the River Severn and the Ripple Brook or any surface water dependent sites of ecological sensitivity from the restoration of excavation area Phases 1 to 9 using site-derived quarry waste material and imported inert waste.

#### **4.5.11 Summary**

It is considered that site restoration in excavation area Phases 1 to 9 using imported inert fill under a deposit for recovery scheme, and site-derived quarry waste material, will have no significant or measurable detrimental impact on the hydrological setting of the site and the surrounding area.

### **4.6 Hydrogeological Setting**

#### **4.6.1 Aquifer Characteristics**

Aquifer characteristics and maps are provided in Sections 6.1 (Superficial aquifer) and 6.2 (Bedrock aquifer) of the Enviro Insight report presented in Appendix 1a.

The superficial deposits, including the Worcester Member (2<sup>nd</sup> Terrace), at the site and the surrounding area is classified by the EA's Aquifer Designation Dataset for England and Wales map, accessed through the Defra Magic Map application, as a 'Secondary A' superficial aquifer, defined as 'permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of baseflow to rivers'.

The bedrock at the site and the surrounding area is shown on the Aquifer Designation map as a 'Secondary B' aquifer, defined as 'mainly lower permeability layers that may store and yield limited amounts of groundwater through characteristics like thin cracks (called fissures) and openings or eroded layers'. Site investigations have shown the solid geology underlying the site comprises the Triassic Branscombe Mudstone Formation of the Mercia Mudstone Group which consists of a sequence of red-brown mudstones and siltstones. The existence of the mudstone dominated bedrock at the site means it does not transmit groundwater flow.

The site is not located within a groundwater Source Protection Zone (SPZ).

Details of licensed groundwater abstractions are provided Section 6.6 of the Enviro Insight report presented in Appendix 1a.

There are 5 No. identified licensed groundwater abstractions within c. 500m of the site. Where surface water abstractions have a shared ID within the Enviro Insight report then these have been counted as one abstraction.

According to the Enviro Insight report, the closest of the groundwater abstractions is an area within the extent of the restored Ripple Quarry Lake c. 80m from the site at its closest point. This abstraction is for direct spray irrigation up to 30,000m<sup>3</sup> per year.

Other groundwater abstraction locations exist to the east of the Phases 1 to 9 excavation area. The closest of these is a licence for general farming and domestic purposes c. 210m to the east of the site.

Similarly to the surface water abstractions, most of the groundwater abstractions are for use in direct spray irrigation, with some under active status (relating to current regulations) and others under historical status.

#### **4.6.2 Groundwater Flow and Levels**

Previous reporting (GWP Report No. 190714 v.02) on the groundwater flow regime indicates that the regional groundwater flow direction within the Worcester Member (2<sup>nd</sup> Terrace) is to the west, towards the River Severn.

Eight piezometers (WM1 to WM8) were installed during October 2010 within the Worcester Member (2<sup>nd</sup> Terrace) on the perimeter of approved excavation area Phases 1 to 9 in the main site area. The locations of the groundwater monitoring boreholes are shown on Drawing No. BOWFEPR2511-2. Borehole logs for the monitoring boreholes are provided in Appendix 7 (borehole references in the logs go from BH1 to BH 8, which numerically correspond to references WM1 to WM8).

Groundwater level data is available from boreholes WM3 to WM8 between December 2010 to June 2019, with additional monitoring undertaken between May 2024 and September 2025. The groundwater levels recorded by the applicant between December 2010 and June 2019 were initially on roughly a quarterly basis and then approximately monthly between early 2014 and June 2019. Following the acquisition of the data so far during 2024 and 2025, it is planned to continue the groundwater level monitoring on a monthly basis. All available groundwater level data for these boreholes is included in Appendix 8. Boreholes WM1 and WM2, located on the northeastern perimeter of the site, are always dry.

The data before late 2013 is somewhat irregularly measured, and that during 2014 and 2015 is firstly affected by a flooding event in early 2014 and then evidently is affected by off-site de-watering in late 2014 and throughout 2015.

Since early 2016, groundwater levels have stabilised (presumably after restoration and de-watering cessation of other off-site gravel extractions) and a consistent seasonal fluctuation of between 0.5m and 1.0m can be observed.

A more detailed comparison of the groundwater hydrograph elevations with the reported base of the sand and gravel deposit shows that WM3 is actually seasonally dry every year (when readings must reflect measurements in the top of the underlying weathered clay) and WM4 can be dry all year round although more frequently can become partially saturated during the wettest months.

Therefore, during the summer months there are only groundwater level readings sitting within the sand and gravel deposit on the western side of the site. Groundwater level contours cannot be illustrated for this time given the 4 No. monitoring boreholes that remain partially saturated are all on the western perimeter (with groundwater levels of typically 8.9mAOD). However, it is self-evident given the elevation of the underlying surface of the impermeable mudstone and unsaturated sand and gravel to the east, that groundwater flow is towards and across the western boundary of the site.

For the winter months, WM3 does become sufficiently saturated to enable groundwater level interpolation and estimation of a hydraulic gradient across the site. WM1, WM2 and WM4 (depending on the year) remain unsaturated, confirming groundwater flow has to follow the surface of the underlying impermeable clay strata to the west.

A hydraulic gradient of  $6.6 \times 10^{-4}$  between WM3 and monitoring boreholes WM6, WM7 and WM8 on the western boundary, is shallow and indicates either high permeability or low groundwater flux. Given there is no sand and gravel aquifer up-gradient of WM3 and the geological description is of predominantly sand (and not gravel), then the low gradient is likely to reflect proximity to the eastern up-gradient boundary of the deposit and low groundwater flux.

Assuming an average sand and gravel thickness of 3m, a cross-section sand and gravel length of 1,100m (north to south), the hydraulic gradient of  $6.6 \times 10^{-4}$  and a permeability of  $5 \times 10^{-4}$  m/s, the groundwater through-flow can be calculated as 1 litre per second (94 m<sup>3</sup>/d or 34,343 m<sup>3</sup>/year).

If the hydraulic gradient is instead assumed to equate to the slope of the underlying surface of the impermeable clay ( $2 \times 10^{-3}$ ) then the groundwater flow rate increases to 3.3 l/s. This doubles to 6.6 l/s if the saturated thickness is increased to the maximum possible within the Worcester Member (2<sup>nd</sup> Terrace) of 6m.

#### **4.6.3 Groundwater Recharge**

Average annual rainfall for the site is estimated to be between 622mm/year (FEH Web Service) to 719mm/year (Defra Hydrology Data Explorer data) (see Section 4.2). Assuming 30% of rainfall

infiltrates as direct recharge then the typical pre-development average annual recharge rate can be estimated as between 187mm/year and 216mm/year.

Using the conservative lower recharge estimate, over the c. 35 hectares of the excavation area east of Ripple Lake and the Napps LWS, this equates to 65,450 m<sup>3</sup>/yr (179m<sup>3</sup>/d or 2.1 l/s). This is consistent with the estimate of groundwater through-flow across the site (see Section 4.6.2).

Groundwater recharge will also enter the perched higher elevation terraces east of the site. Groundwater recharge inflows will be limited given the small area of these raised terraces, and therefore may not sustain year-round perched groundwater bodies - WM1 and WM2 confirm the higher terrace east of the proposed excavation area yields no groundwater as these monitoring points have always been monitored as 'dry'.

#### **4.6.4 Groundwater Discharge**

There are 5 No. licensed groundwater abstractions within 1km of the site. Details of licensed groundwater abstractions are provided Section 6.6 of the Enviro Insight report presented in Appendix 1a. Of the identified abstractions, two near Twynning are reported to abstract groundwater from a hydraulically separate gravel terrace and hydraulically separate bedrock to those at the site, and is used for irrigation. The historical abstraction at Bowbridge Farm c. 210m to the east of the Phases 1 to 9 excavation area is from an isolated area of the Holt Heath Member superficial deposits, separate to the Worcester Member sand and gravel in the Phases 1 to 9 excavation area.

The groundwater abstraction reported to be c. 80m to the west of the site is recorded as abstracting from a lagoon and not a borehole. It is also reported as owned by a farm in Ryall 4km north of the site and is used for spray irrigation in summer months. It is possible the abstraction location is misplaced, although equally, satellite images appear to show abstraction infrastructure in the northern end of Ripple Quarry Lake. The licence has an annual limit of 30,000m<sup>3</sup>/year (equivalent to 1 l/s) and a maximum daily limit of 1,600m<sup>3</sup>/d (equivalent to 18 l/s).

A groundwater abstraction in this area would be consistent with the lower groundwater levels observed at the northern most WM8 borehole when compared to the other monitoring boreholes.

There are no reported unlicensed/private groundwater abstractions within 1km of the site.

Discharges of groundwater from the lower western edges of the elevated and perched sand and gravel terraces on the high ground to the east of the site can be expected. However, given the small areas covered by these individual terraces (see Section 1.3 (Superficial geology) of the Geo Insight report presented in Appendix 1b) of typically 25 hectares, then groundwater through-flow is likely to be no more than 1.5 l/s.

Groundwater flowing across the approved excavation area Phases 1 to 9 in the main site area flows in a westerly direction during the current pre-development scenario. Groundwater elevations of 9mAOD to 10mAOD demonstrate it is possible for these groundwaters to discharge through the alluvial overburden and into Ripple Lake and the Napps LWS, Ripple Quarry Lake and/or the River Severn.

Given the inert nature of the waste, the strict waste acceptance procedures and protocols, and the findings of the Quantitative HRA (GWP Report No. 251041) which accompanies this EPR Permit application as Appendix Giv, it is considered that restoration of excavation area Phases 1 to 9 using site-derived quarry waste material and imported inert fill under a deposit for recovery scheme will have no significant or measurable detrimental impact on the hydrogeological setting of the site and the surrounding area.

#### **4.6.5 Groundwater Quality**

Available groundwater quality monitoring data has been collected from existing boreholes on site between May 2024 and August 2025.

Groundwater monitoring locations are shown on Drawing No. BOWFEPR2511-2. Groundwater quality monitoring data for boreholes monitoring up-gradient (WM3) and down-gradient (WM5, WM6 and WM8) of the excavation area Phases 1 to 9, is provided in Appendix 9.

This monitoring data has been used to establish baseline groundwater quality conditions at the site.

Given the inert nature of the waste, the strict waste acceptance procedures and protocols, and the findings of the Quantitative HRA (GWP Report No. 251041) which accompanies this EPR Permit

application as Appendix Giv, it is considered that restoration of excavation area Phases 1 to 9 using site-derived quarry waste material and imported inert fill under a deposit for recovery scheme will have no significant or measurable detrimental impact on the hydrogeological setting and groundwater quality of the site and the surrounding area.

Despite this, groundwater quality monitoring will be undertaken in accordance with a monitoring scheme agreed with the EA. Details of the proposed monitoring scheme and proposed compliance limits are provided in Sections 6.3 and 6.4 of the HRA report (GWP Report No. 251041) which accompanies the EPR Permit application (Appendix Giv).

## **4.7 Receptors and Compliance Points**

### **4.7.1 *Groundwater***

For hazardous substances, the compliance point is the point at which the substance will enter the groundwater at the downstream edge of the side slope AGB to be installed within excavation area Phases 1 to 9 at the site. For non-hazardous pollutants, the primary compliance point is the downstream boundary of the site.

No hazardous substances at discernible concentrations and no non-hazardous pollutants at elevated concentrations will be expected to enter the groundwater given the inert nature of the imported fill and the strict waste acceptance criteria and protocols adopted. The Quantitative HRA (GWP Report No. 251041) which accompanies this EPR Permit application as Appendix Giv, demonstrates that restoration of excavation area Phases 1 to 9 using site-derived quarry waste material and imported inert fill will not result in any significant or measurable detrimental impact on the hydrogeological setting of the site and surrounding area.

Groundwater quality monitoring will be undertaken in accordance with a monitoring scheme to be agreed with the EA. Details of the proposed monitoring scheme and proposed compliance limits are provided in Sections 6.3 and 6.4 of the HRA report (GWP Report No. 251041) which accompanies the EPR Permit application (Appendix Giv).

### **4.7.2 *Surface Water***

All surface water associated with the approved deposit for recovery scheme will be managed initially within the EPR Permit area.

Given the inert nature of the imported waste, the strict waste acceptance procedures and protocols, and the findings of the Quantitative HRA (HRA report (GWP Report No. 251041) which accompanies the EPR Permit application (Appendix Giv)), it is considered that no hydrological risk is posed to the River Severn and Ripple Brook, or any surface water dependent sites of ecological sensitivity from the restoration of excavation area Phases 1 to 9 using site-derived quarry waste material and imported inert fill.

Surface water runoff generated within excavated areas of Phases 1 to 9 will progressively infiltrate or will be internally managed within the site area. Surface water runoff will be captured and routed from areas outside of excavations, including temporary bunds and stockpiles, to prevent turbid water entering local water courses.

There will be no direct discharge of water from the EPR Permit application area into any local surface water receptors.

During operations, direct rainfall and associated surface water runoff within the progressive Phases 1 to 9 void will be pumped out and clarified through the use of temporary silt lagoons. This cleaned water will then be transferred to infiltration basins along the western perimeter of Phases 1 to 9 to allow it to infiltrate back into the sand and gravel aquifer. Details of the surface water management scheme are provided in the *Bow Farm Surface Water Drainage Scheme* report (GWP Report No. 240707), prepared separately to discharge Condition 20 of Planning Permission Number 19/000048/CM (Worcestershire County Council). Discharge of Condition 20 was subsequently permitted by Worcestershire County Council on 2<sup>nd</sup> June 2025 through Condition discharge application 24/000035/DIS. The Surface Water Drainage Scheme report is included in Appendix 3.

A runoff attenuation scheme, approved under Planning Permissions 19/000048/CM and 19/0081/TWMAJM, will be included as part of the restored site layout. The approved surface water runoff management scheme consists of a single elongated restoration infiltration basin along the western boundary of excavation Phases 1 to 9. The feature is described as an infiltration basin as

its purpose is not to convey flow but to store it and, to a large extent, allow runoff infiltration. Excess runoff will be discharged from the restoration infiltration basin (*via* an outflow orifice) into a proposed wetland area that sits within the Application Site. The runoff attenuation scheme is outlined in detail within GWP Report No. 190714 included in Appendix 4. The phasing of the construction of the restoration infiltration basin is also detailed within the *Bow Farm Surface Water Drainage Scheme* report in Appendix 3.

#### **4.7.3 Amenity and Habitats**

Amenity and habitats risk assessments are included under separate cover as part of the EPR Permit application (see Appendix Gi of the EPR Permit application).

Given that:

- the imported fill will be strictly inert;
- the imported inert fill will be accepted using robust waste acceptance criteria and protocols;
- the site will be operated in accordance with a comprehensive Environmental Management System (see Appendix B of the EPR Permit application);

and having regard to the findings of the risk assessments completed (see Appendices Gi, Giii, Giv, Gv and Gvi of the EPR Permit application), it is considered that the operation of the site, including site restoration of excavation area Phases 1 to 9 using site-derived quarry waste material and imported inert fill will have no significant or measurable detrimental impact on the environment of the site and the surrounding area.

#### **5. SITE CONDITION REPORT**

A Site Condition Report is presented in Appendix E of the EPR Permit application.

#### **6. CONCLUSIONS**

Given that the acceptance of imported inert fill at the site will be strictly controlled using robust waste acceptance criteria and protocols, it is considered that the permanent deposit of imported inert fill within the excavation area Phases 1 to 9 at the Bow Farm site as a deposit for recovery activity will not result in any significant or measurable detrimental impact on the environmental setting of the site and surrounding area.

GWP CONSULTANTS  
NOVEMBER 2025

## **APPENDIX 1a**

### **Groundsure Enviro Insight report**

## **APPENDIX 1b**

### **Groundsure Geo Insight report**

## **APPENDIX 2**

**Earthworks drawings submitted as part of Planning Permissions  
19/000048/CM (Worcestershire County Council) and  
19/0081/TWMAJM (Gloucestershire County Council)**

## **APPENDIX 3**

***Bow Farm Surface Water Drainage Scheme report (GWP Report No. 240707)***

## **APPENDIX 4**

***Bow Farm Sand and Gravel Quarry Development  
Hydrogeological and Hydrological Impact Assessment and Flood  
Risk Assessment report (GWP Report No. 190714)***

## **APPENDIX 5**

### **Daily rainfall graphs**

## **APPENDIX 6**

### **River Severn at Saxons Lode daily flow and level graphs**

## **APPENDIX 7**

### **Borehole logs - WM1 to WM8**

## **APPENDIX 8**

### **Groundwater level data for boreholes WM3 to WM8**

## **APPENDIX 9**

### **Site groundwater quality monitoring data**