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Ref: 1803-HRA

Hydrogeological Risk Assessment

Went Edge Quarry, Smeaton, Pontefract

Contents

Disclaimer

1. Introduction

McDonnell Cole Ltd has been commissioned by AA Environmental Ltd to prepare a Hydrogeological Risk Assessment (HRA) in support of a permit application for a deposit for recovery scheme at Went Edge Quarry, Smeaton, Pontefract. The site was granted planning permission in September 2018, reference C8/45/13 AL/PA, for extraction of limestone in discrete areas. The deposit for recovery permit will enable subsequent restoration in line with the requirements of the planning permission. In one area, referred to as Area 6, this requires restoration to original ground levels. Elsewhere the restoration involves fill to stabilise slopes. The centre of the quarry has established businesses (Smeaton Industrial Estate), which remain in place following restoration.

The restoration as proposed in the original planning permission, involved infilling upwards from a basal depth of 20m AOD. Extraction has only proceeded to 25m AOD and there is no intention to extract any deeper. This affects the total volume required to infill and will increase the basal footprint remaining, as side slopes are shortened. An additional factor regarding volumes for infilling is an existing 60,000m3 within the quarry footprint, which is washplant residues and have been approved by the Environment Agency (EA) for use in the deposit for recovery scheme in CAR report 100437/0423019, dated 25/4/22.

This risk assessment is to support a permit application for the southern section of the restoration, including Phase 6. The permit boundary is indicated in green in Figure 1. A permit variation will be submitted for subsequent phases of the restoration. The total estimated volume for this application, including the washplant residues is approximately 296,900 m^3. The restoration will cover an area of approximately 62,500m^2.

Information sources used in this assessment includes the following:

- Key GeoSolutions: 2015: Stability Assessment Went Edge Quarry. Reference: 15-180-L-001.
- Avison Young: 2021: Waste Recovery Plan, Went Edge Quarry, Smeaton, Pontefract
- AAe: 2023: Report reference 203040/ESSD. Went Edge Quarry, Environmental Setting and Site Design.

2. The Site

2.1. Location

Went Edge Quarry is located east of Wentbridge and west of Kirk Smeaton, approximately 5km southeast of Pontefract. The A1 road runs north to south approximately 400m west of the site. The site address is Went Bridge Quarry, Kirk Smeaton, Pontefract, WF8 3LU and the centre of the site can be located by National Grid reference SE 49978 17081. Figure 1 shows the location of the site within a meander of the River Went, such that the river flows past the northwestern and northeastern edges of the quarry area. The south of the site is formed by Wentedge Road. There are several businesses within the base of the quarry, which are accessed from a private road leading off Wentbridge Road.

The perimeter of the quarry is at an elevation around 50 - 60m AOD, where original ground level remains. The base of the quarry has been worked to 25m AOD. The northwest and northeastern

edges of the quarry are wooded and slope down to the River Went at levels below 20m AOD. The rest of the surrounding area is open farm land.

Figure 1: Site Location Plan (taken from AAe drawing 203040/D/001)

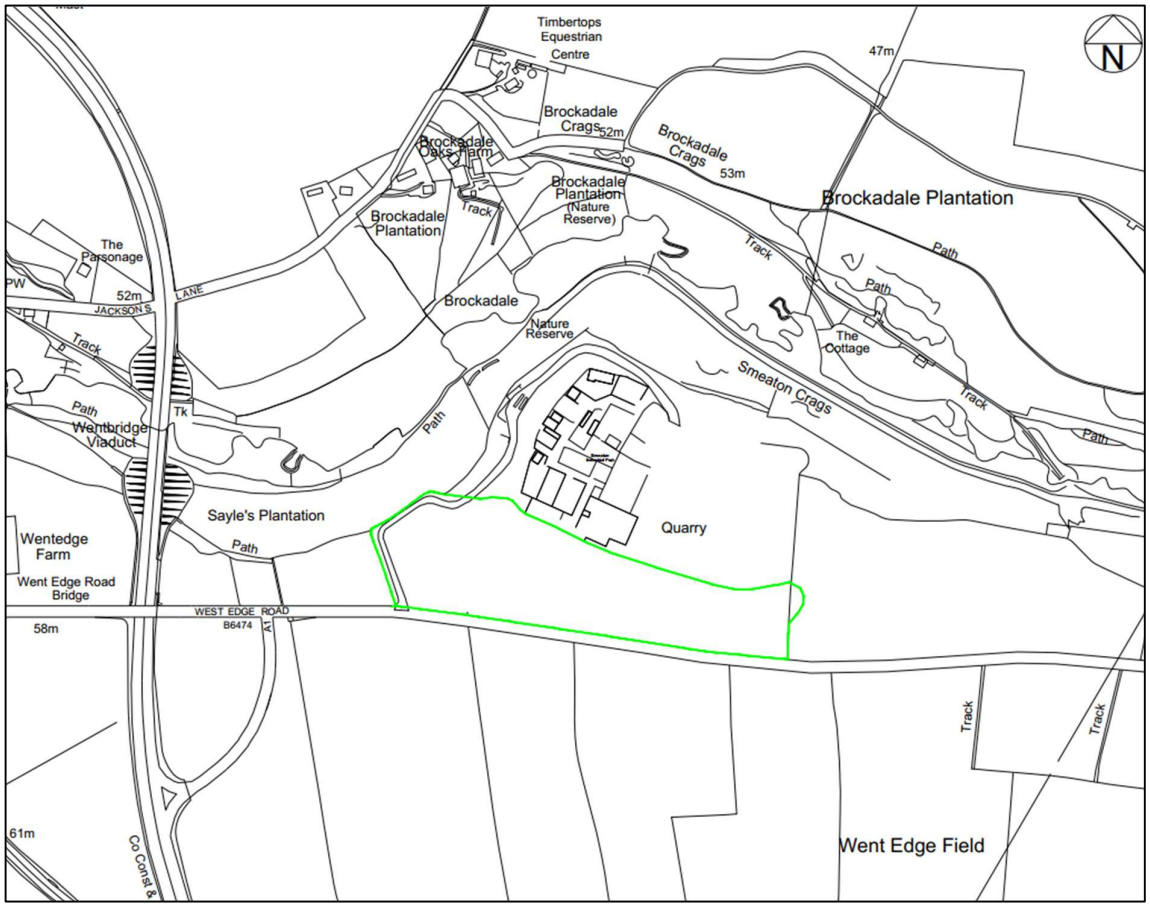
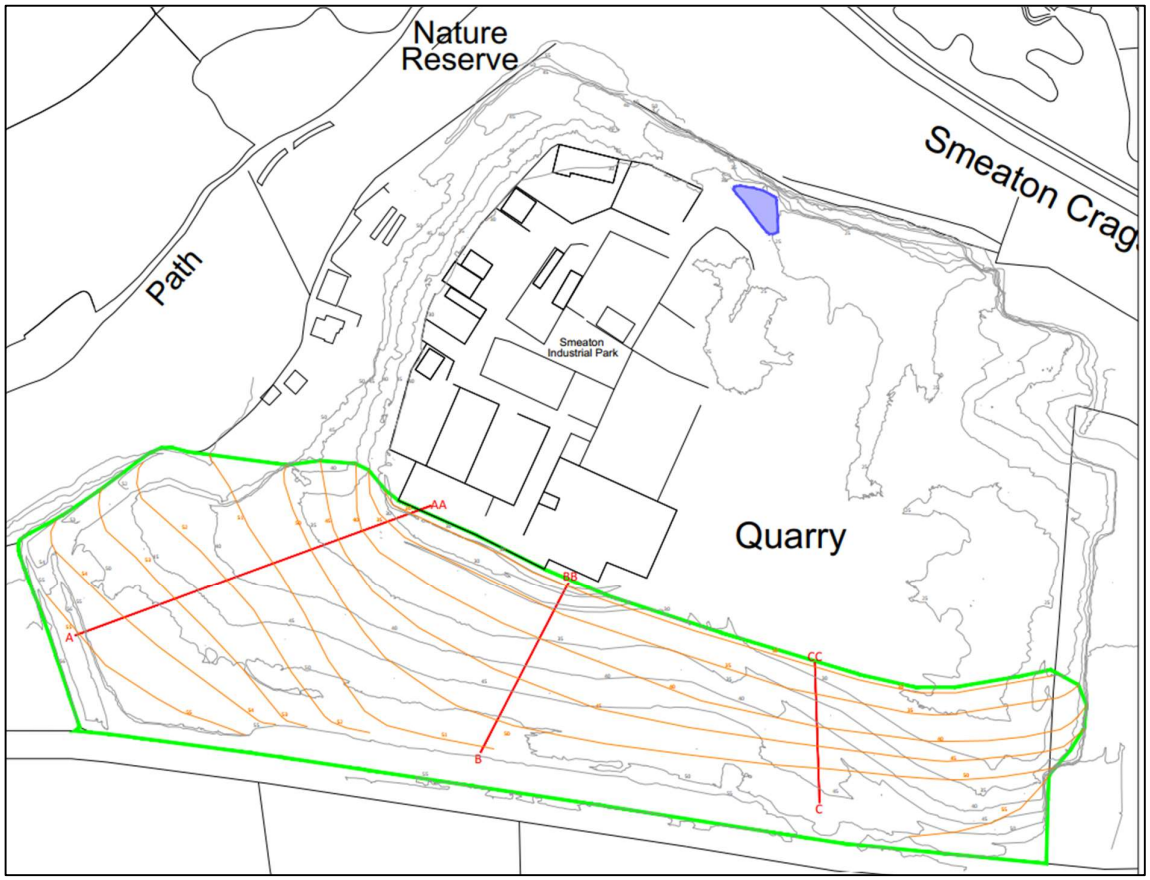


Figure 2 shows the revised restoration contours for the site. The greatest area of fill is in the southwest, which is Area 6. There is filling to stabilise slopes further to the southeast. The thickness of fill will be an average of 10m in Area 6.

Figure 2: Restoration Contours (taken from AAe drawing 203040/D/006)



2.2. Environmental Setting

The site is set within agricultural land on the south side of the River Went. The Went is a steep-sided valley flowing east past the site and the quarry has been worked for limestone to a level above that of the river. Environmental features close to the site are summarised in Table 1.

Table 1: Environmental Features

Feature	Nature of feature	Distance from site
Residential/Work-Place/Amenity - Between 0 and 250 m	Quarry industrial estate The Cottage	Adjacent 200m NE of quarry
Residential/Work-Place/Amenity - Between 250 and 1000 m	Properties off Jackson's Lane Properties in Wentbridge New Rectory Farm	300m NW of the quarry 600 m W 800m SE

Feature	Nature of feature	Distance from site
	Pear Tree Farm	1 km SW
Habitats		
Habitats Directive sites	None within 2km	
CROW Act 2000 sites	Brockdale SSSI	Adjacent N
Other habitat sites	None within 2km	
Groundwater		
Aquifer	Cadeby Formation – dolostone of the Lower Magnesian Limestone	Principal aquifer
Groundwater protection zone	None	
Groundwater abstractions	None within 2km	
Nitrate vulnerable zone	Yes	
Surface Water		
Closest surface water	River Went	75m N of quarry
Direct runoff from site?	Site drainage is collected in a quarry sump	
Surface water abstractions	Haigh & Son Falkingham Baine Ltd Haigh & Son	350m NE 1.3 km E 1.35km E
Wells and springs		
Wells	None recorded on OS maps within 1km	
Springs	None recorded on OS maps within 1km	
Air quality management zone	No. Zone exists to west of A1	
Flood zone	Zone 1 – low probability	

2.3. Site History

Went Edge Quarry began minerals extraction in 1947. It was worked intermittently until the 1990s and is described as becoming fully active in 1993. The September 2018 planning permission reference NY/2016/0185/ENV (C8/45/13AL/PA) relates to extraction of 4.4 million tonnes of limestone to a depth of 20m AOD in areas 4, 5, 6 and 7 of the quarry. The site is now at the stage of restoration in line with the planning permission.

2.4. Development Summary

The September 2018 planning permission requires Area 6 to be returned to original ground level, while the rest of the site will have stabilisation of quarry faces using engineered fill at slopes of 1 in 2.5. This will allow businesses to continue in the base of the quarry. A further planning permission granted in November 2018 allows for a new access road from Wentedge Road. This will follow the eastern

side of the restored Area 6. In 2019 an additional planning application was submitted for extension eastwards into Area 8. Extension works to the east are not covered by this report.

3. Geology and Hydrogeology

3.1. Geology

3.1.1. British Geological Survey Information

The British Geological Survey (BGS) Geology of Britain viewer shows there to be no superficial geological deposits in the area of the site. There are alluvial deposits and Head along the course of the River Went, north of the site.

The solid geology is shown as the Cadeby Formation and is described as dolostone. This was formerly known as the Lower Magnesian Limestone. The BGS Lexicon of Named Rock Units describes the lithology of the Cadeby Formation as grey to buff grey, commonly oolitic or granular, with subordinate mudstone, dolomitic siltstone and sandstone. BGS geological sheet 78 (Wakefield) indicates the dip of the limestone to be northeastwards and gives a thickness of up to 70m.

To the west of the site in the Wentbridge area, Carboniferous sandstone is in outcrop. To the east of Kirk Smeaton the mudstones of the Edlington Formation and the limestones of the Brotherton Formation are in outcrop.

BGS borehole logs are available along the route of the A1, associated with the construction of the Wentbridge bypass viaduct in 1992. Boreholes show the base of the Cadeby Formation to be at around 35m AOD. The limestone is directly underlain by sandstone, described as the Ackworth division. As the line of the A1 crosses the River Went, boreholes indicate Alluvium directly underlain by sandstone. The Cadeby limestone has been eroded by the course of the River Went. East of the site, by approximately 700m, there are coalfield exploration boreholes which show the base of the Cadeby Formation to be at around 7.5m AOD. Extrapolating between the two borehole locations, this would make the base of the Cadeby at around 20m AOD in the vicinity of the site.

3.1.2. 2019 planning Application Information

In 2019 an Environmental Statement was prepared by Cromwell Mining Consultants (Cromwells) to support an application to extend the limestone workings eastwards. This report contains a summary of geological and hydrogeological conditions at the site. Cromwells report that there have been previous intrusive site investigations undertaken in 2000 by T&T Aggregates and in 2003 by Ennstone Breedon. The geology is reported as 30 metres of Permian limestone, underlain by marl, underlain in turn by Coal Measures mudstone and sandstone. The base of the limestone at the site is underlain by a bed of red marl reported as 3m in thickness, underlain in turn by 3m of basal Permian sand. This is reported to overlie a Coal Measures mudstone of 4m thickness, below which is the Ackworth Rock sandstone. The

contact between the Permian and Carboniferous strata is unconformable and the dip of the strata is towards the east.

The floor level in the west of the site, which is also taken to be the base of the limestone, is at 26m AOD. With the east / northeasterly dip of the beds the base of the limestone will be lower on the east of the site and is taken to be 20m AOD, based on the maximum reported working depth and information gleaned from the BGS, as described in 3.1.1.

3.2. Hydrogeology

The Cadeby Formation is classified as a principal aquifer in the vicinity of the site.

The BGS Minor Aquifers Technical Report WD/00/04, see references, refers to the Ackworth Rock within the Upper Carboniferous Coal Measures as an important aquifer horizon, however, this and other sandstone units of the Coal Measures are of limited lateral extent. The Environment Agency classifies the sandstone as a secondary A aquifer.

Information from the 2019 Environmental Statement produced by Cromwells describes groundwater conditions at the site. It describes site inspections since 1999, during which time the quarry has been dry. It is reported that the site is above the groundwater table by at least 12m and when the floor is worked to 20m AOD it remains 6m above the groundwater level, recorded as 14m AOD. It is stated that groundwater level is below the level of the River Went, which is reported to be at 19m AOD as it flows eastwards past the site.

Cromwells describe a low permeability for the Ackworth sandstone, in the range of 1×10^{-9} to 1×10^{-7} m/s, with groundwater flow within the aquifer predominantly due to fissuring.

Comment is provided on the potential downward migration of rainwater through the fines on the quarry floor to the underlying aquifer, but note that this will be impeded by the presence of marl. It is reported that rainfall may percolate to the base of the limestone, but then flow eastwards down dip of the strata.

Cromwells report no groundwater abstractions within 1km of the site and state that Selby Council have no records of local water supplies from the limestone in this area. The 2023 Envirocheck report contained in the AAe 2023 ESSD, confirms that there are no groundwater abstractions within 2km of the site.

The site is not within a groundwater source protection zone, the closest being 4km north of the site.

The direction of groundwater flow from the site is likely to be northeastwards, based on the proximity of the River Went and the northeasterly dip of the limestone indicated on BGS Sheet 78. Hydraulic gradients are likely to be low based on the recorded depth to groundwater

being within the Ackworth sandstone aquifer, with relatively high transmissivity.

3.3. Hydrology

3.3.1. The River Went

The River Went flows from west to east around the northern boundary of the site. Ordnance Survey data indicates the elevation of the river is between 20 and 15m AOD. Levels of 19m AOD are close to the existing site and levels of 16m AOD further east in the proposed direction of extension are quoted by Cromwells in the 2019 Environmental Statement.

The quality of the River Went is given in the Envirocheck report as Grade C to the west of the site and Grade B to the east, indicating it improves downstream, potentially due to increase in flow. Cromwells report the River Went as good quality since 2000. Information from the Environment Agency's Catchment Data Explorer for the Went from Hoyle Mill Stream to Blowell Drain indicates moderate physico-chemical quality, with high quality in relation to ammonia, dissolved oxygen and pH.

The 2023 Envirocheck report lists an abstraction in the name of Haigh & Son 200m northeast of the site (National Grid reference SE 5027 1726) for general agricultural use. There are two further abstractions 1.2 to 1.3km east of the site. There are no listed discharge consents within the search area.

There is an EA flow gauging station approximately 5km east of the site at Walden Stubbs. Flow is recorded as above 0.332 m^{3}/s for 50% of the time and above 0.164 m^{3}/s 95% of the time (Q95).

3.3.2. Site Drainage

Cromwells, 2019, describe drainage of the quarry. The water ponds on the quarry floor above the limestone fines in the base and from there seeps through the base. A sump is described in the west of the quarry, where the water is reported to pond above basal marl and is stored for dust suppression and the wash plant.

AAe, 2023, confirm that the quarry and its ancillary infrastructure all discharge to ground. This includes quarry operations, the wash plant, the industrial park and the soft landscaping. The quarry sump is described as being in the north of the site and it receives surface runoff from all areas of the quarry. Given the angle of slope of the restoration area it is considered that the majority of incident rainfall will become runoff. An infiltration drain will be constructed at the toe of the restoration area to control runoff.

4. Conceptual Model

4.1. General

The conceptual model considered in this hydrogeological risk assessment is the import of engineered fill (the source) to infill Area 6 to original ground level and to reprofile the southern quarry face, in line with the requirements of the planning permission.

The restoration materials will be placed against the Cadeby Formation limestone of the quarry walls. At the base of the quarry the fill will overlie a 3m thickness of Permian marl in the west. Due to the easterly dip of the beds, there may be up to 6m of limestone below the base of the fill on the east of the site before the marls are encountered. Downward seepage of infiltration through the engineered fill will be inhibited by the presence of the basal marl. Seepage would continue eastwards, down dip of the limestone, over the surface of the marl. The limestone is dry in the vicinity of the quarry. Seepage would need to travel hundreds of metres east down dip before encountering groundwater at elevations around 14m AOD. With true dip indicated to be northeastwards on BGS Sheet 78, seepage may travel down dip to meet the River Went.

4.2. Source

4.2.1. Waste Acceptance Controls

The imported material will be inert and will be controlled by inert waste acceptance criteria (WAC). The table below compares inert WAC solids expressed in mg/kg at 10: 1 extract, with the equivalent leachability in mg/l; the UK Drinking Water Standards (UKDWS) and the freshwater environmental quality standards (EQS).

Table 2: Waste Acceptance Criteria

Determinand (total concentration)	WAC Leachate Criteria (LS=10l/kg) (mg/kg)	Solid results (mg/kg)	Equivalent leachability (mg/l)	UKDWS (mg/l)	EQS (mg/l)
Arsenic	0.5		0.05	0.01	0.05
Barium	20		2	n/a	
Cadmium	0.04		0.004	0.005	0.00025 [3]
Chromium	0.5		0.05	0.05	0.0047
Copper	2.0		0.2	2	0.001 [2]
Mercury (inorganic)	0.01		0.001	0.001	0.00007 MAC
Nickel	0.4		0.04	0.02	0.004 [2]
Lead	0.5		0.05	0.01	0.0012 [2]
Molybdenum	0.5		0.05	n/a	n/a
Antimony	0.06		0.006	0.005	n/a
Selenium	0.1		0.01	0.01	n/a

Determinand (total concentration)	WAC Leachate Criteria (LS=10l/kg) (mg/kg)	Solid results (mg/kg)	Equivalent leachability (mg/l)	UKDWS (mg/l)	EQS (mg/l)
Zinc	4.0		0.4	n/a	0.0109 [2] + background
Chloride	800		80	250	250
Fluoride	10		1	1.5	5
Sulphate (SO4)*	1000		100	250	400
Phenol	1.0		0.1	n/a	0.0077
TDS	4000		n/a	n/a	n/a
DOC	500		n/a	n/a	n/a
BTEX (TPH C5 – C10)		6	n/a	0.01 [1] (benzene)	0.01 benzene
Mineral oil (C10 – C40)		500	n/a	0.09 [1]	n/a
PCB		1	n/a	n/a	n/a
PAH (total)		100	n/a	0.0001	0.00017 BaP as marker

1 – World Health Organisation (WHO); 2 - Bio- bioavailable; 3 - EQS for hard water in dolostone catchment

Table 3 highlights where the equivalent leachability exceeds the lower of the UKDWS, or EQS. As an additional precaution leachability testing will be required for those determinands with exceedances. The Importation Protocol (AAe report reference 203040/IP) requires the additional leaching assessment criteria as given in Table 3. The leaching assessment criteria include slightly higher criteria for chloride, fluoride and sulphate than given in the WAC, based on the risk assessment presented in section 5 of this report. Additionally, consideration is also given to European Union Council Decision 2003/33/EC, in relation to sulphate and chloride, which notes:

1) If the waste does not meet the values for sulphate, it may still be considered as complying with the acceptance criteria if the leaching does not exceed either of the following values: 1 500 mg/l as C0 at L/S = 0,1 l/kg and 6 000 mg/kg at L/S = 10 l/kg.
2) The values for total dissolved solids (TDS) can be used alternatively to the values for sulphate and chloride.

On the basis of the above, slightly higher limits are acceptable and the risk assessment in section 5 is used to demonstrate that there is a low likelihood of adverse impact on the hydrogeological setting of this site.

Table 3: Leaching Assessment Criteria

Determinand	Leachate Criteria (L:S 10:1 leachate test) (ug/l)	Environmental Assessment Level (EAL)
Arsenic (total)	10	UKDWS
Cadmium (total)	0.25	EQS
Chloride	250,000	EQS
Chromium (total)	4.7	EQS
Copper	1	EQS
Fluoride	1500	UKDWS
Lead (total)	1.2	EQS
Mercury (inorganic)	0.07	EQS
Nickel (total)	4	EQS
Phenol	7.7	EQS
Sulphate	400,000	EQS
Zinc	10.9 (=9.5-background)	EQS

4.2.2. Material Types

The site will import materials that comply with the Landfill Directive definition of inert, as presented in Table 4.

Table 4: Inert Materials

Description	EWC code
Concrete	17 01 01
Bricks	17 01 02
Tiles and ceramics	17 01 03
Mixtures of concrete, bricks, tiles and ceramics	17 01 07
Natural soils and stones (must be proven prior to receipt)	17 05 04 20 02 02
Wastes from mineral non-metalliferous excavation	01 01 02
Waste gravel and crushed rocks	01 04 08
Waste sand and clays	01 04 09
Silts and clays from soil washing	19 02 06
Minerals from waste facilities	19 12 09
Subsoil and stones from soil remediation	19 13 02

4.3. Pathways

4.3.1. Pathway 1

The first pathway considered in this assessment is infiltration of rainfall through the fill/ restoration materials, followed by seepage through the base to encounter the low permeability basal red marl. From here seepage travels down dip over the surface of the marl to emerge into the valley of the River Went.

The rate of infiltration will be governed by effective rainfall. The site lies within catchment area

12 of the ADAS 1982 publication on Climate and Drainage, which gives a total annual rainfall of 643mm and a potential transpiration of 486mm. This gives an effective rainfall of 157mm per annum.

4.3.2. Pathway 2

Pathway 2 is of lower likelihood than pathway 1. It is assumed that there is some seepage through the basal marl that continues downwards through the unsaturated zone and into the groundwater within the Ackworth Sandstone at 6 to 12m below the base of the site.

The vertical hydraulic conductivity of the unsaturated zone will be low for the marl, likely to be around 1 x 10^{-9} m/s. The BGS Minor Aquifers Technical Report gives ranges of permeabilities for Upper Coal Measures sandstones of between 1 x 10^{-8} and 1 x 10^{-6} m/s. Cromwells, 2019, report likely permeabilities an order of magnitude lower. Given the thickness of the marl and the low permeabilities of the unsaturated zone this scenario is considered of very low likelihood.

4.4. Receptors

The principal receptor is considered to be the surface waters of the River Went.

4.5. Qualitative Risk Assessment

A qualitative environmental risk assessment summarising the above is presented in Table 5. The likelihood of impacts to the quality of the surface water regime is addressed in more detail in Section 5.

Table 5: Qualitative Environmental Risk Assessment

Source/Hazard	Pathway	Receptor	Risk Management technique	Probability of exposure	Consequence	Overall risk
Imported Fill with the potential to leach chemical determinands at concentrations above the EAL	Rainwater infiltration through fill and unsaturated layer	Cadeby Formation principal aquifer	Waste acceptance procedures limit fill to inert waste, with additional leachability controls. This should ensure incoming wastes can only leach at concentrations below the EAL.	Probability of leachate entering the groundwater within the Cadeby Formation principal aquifer directly below the site at concentrations above the UKDWS – Very Low. Aquifer is dry in vicinity of site and mostly extracted in the area of fill.	Release of hazardous substances to groundwater. Pollution of groundwater by non-hazardous pollutants above existing background concentrations. Site in breach of the Environmental Permitting Regulations. No source protection zone. Aquifer dry. Consequence considered – Medium.	Very Low
Imported Fill with the potential to leach chemical determinands at concentrations above the EAL	Rainwater infiltration through fill and unsaturated layer	Ackworth sandstone	Waste acceptance procedures limit fill to inert waste, with additional leachability controls. This should ensure incoming wastes can only leach at concentrations below the EAL.	Probability of leachate entering the groundwater within the Ackworth sandstone directly below the site at concentrations above the UKDWS. Requires migration through 3m of basal marls and a further 3 – 9m of unsaturated zone Very Low.	Release of hazardous substances to groundwater. Pollution of groundwater by non-hazardous pollutants above existing background concentrations. Site in breach of the Environmental Permitting Regulations. No source protection zone. Consequence considered – Medium.	Very Low
Imported Fill with the potential to leach chemical determinands at concentrations	Lateral migration over surface of basal marls.	Surface waters of the River Went	Waste acceptance procedures limit fill to inert waste, with additional leachability controls. This should ensure incoming wastes can only leach at	Probability of leachate reaching surface water after migration over the surface of the basal marls through the dry Cadeby Formation -	Contamination of the Grade B surface waters to concentrations above natural background and the EQS. - Medium	Low

Source/Hazard	Pathway	Receptor	Risk Management technique	Probability of exposure	Consequence	Overall risk
above the EAL			concentrations below the EAL.	Low		
Imported Fill with the potential to leach chemical determinands at concentrations above the EAL.	Run off from recontoured areas	River Went	Waste acceptance procedures limit fill to inert waste, with additional leachability controls. This should ensure incoming wastes can only leach at concentrations below the EQS. Runoff controlled within quarry sump.	No direct pathway to River Went. Only movement will be over the surface of the basal marls. Concentrations likely to be lower than that from leachate arising from the base of the fill due to reduced contact time with the fill – Very Low.	Contamination of a surface water source above the EQS - Medium	Very Low

5. Risk Assessment

5.1. Potential Linkages

The qualitative assessment has considered the potential linkages to the groundwater and surface water receptors associated with the site. The risks are considered to be low, however, based on the site's setting in close proximity to the River Went, it is considered appropriate to assess the risk to the River Went quantitatively. If all waste acceptance procedures are adhered to there is a low likelihood that fill could generate leachate at concentrations above the UKDWS, or EQS. However, the quantitative risk assessment will examine the potential effects of unknowingly accepting non-inert waste. This is sometimes referred to as a rogue load assessment.

5.2. Management of Spills and Non-conforming Wastes

The site will operate an Environmental Management System that will have procedures in place for the management of spillages during the reprofiling works. In addition to the Importation Protocol, visual conformance checks will be made on incoming materials. This will enable a rapid response to the removal of non-conforming materials.

5.3. Monitoring

The wider quarry has an existing drainage sump and on the basis that all fill will be above the level of the existing floor, it is possible that if there is basal seepage from the fill it will drain to the quarry sump. The sump water is used for dust suppression and within the wash plant. The intention is to separate runoff from the restoration area using drainage at the toe of the embankment. The action plan for monitoring of the restoration runoff is given below.

Action Plan for Restoration Runoff

1. An infiltration drain will be constructed at the base of the restoration slope.
2. Visual assessment will be undertaken for evidence of discolouration, or sheen.
3. Inspections at the toe and slopes of the restoration areas for signs of seepage.
4. Bunding will be employed as required to ensure no lateral spread.
5. Records will be kept in site diary, together with details of weather conditions at the time of inspection.
6. If visual assessment indicates contamination, sample and carry out water quality analysis on the infiltration drain.
7. Assess findings against EQS.
8. Carry out further testing and inspection after next rainfall event to confirm whether conditions have improved.
9. Employ tankering of collected water if required.

Based on proximity to the River Went, it is recommended that monitoring is undertaken up and downgradient of the site. The recommended monitoring regime is presented in Table 6. Data should be reviewed quarterly to ensure there are no significant changes to background concentrations and that the proposed monitoring regime remains appropriate.

Table 6: Surface Water Monitoring

Monitoring Location	Determinands	Frequency	Standard/method
River Went – upgradient and downgradient	pH, electrical conductivity, suspended solids, Metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Sb, Zn) chloride, fluoride, sulphate, phenol, PAH, BTEX, TPH	Pre-start Two samples During development Quarterly sample Post development Quarterly for 1 year	Spot sample. Sampling in accordance with EA technical guidance M18.

5.4. Quantitative Risk Assessment

A quantitative risk assessment is presented in Appendix 2. The assessment considers the infiltration of rainfall through the restoration fill, with seepage at the base of the fill being inhibited by the low permeability of the basal Permian marls and therefore, migrating down dip to the River Went. The assessment follows the methods presented by the EA in their guidance: Surface-Water-Pollution-Risk-Assessment-for-your-Environmental-Permit. As the assessment is for risks to surface water from seepage through engineered fill, rather than a direct surface water discharge, reference is also made to EA document "End-of-waste and by-product hazard and risk assessment", 2014.

The assessment indicates that there is a low likelihood of determinands within the imported materials impacting upon the quality of the River Went at concentrations above 10% of the EQS. It also indicates that there is tolerance in the event that rogue loads are accepted at the site.

6. Summary and Conclusions

The suitability of the restoration scheme at Went Edge Quarry has been assessed both qualitatively and quantitatively. The site is within the Cadeby Formation, which is generally regarded as a principal aquifer, but has been extracted in the area of the quarry. The likelihood of seepages from the restoration fill migrating into the surface water regime has been assessed quantitatively and the scheme is considered to be acceptable.

The strict importation controls will limit material types and require both WAC analysis and leachability testing as presented in Tables 2 and 3 of this report. A rogue load assessment has demonstrated that there is tolerance within the acceptance criteria, such that an unknown acceptance of a quantity of non-inert material will have a low likelihood to cause unacceptable impacts on the surface water regime.

It is recommended that monitoring of the River Went is undertaken and details are presented in Table 6.

REFERENCES

1. AAe: 2023: Report reference 203040/ESSD. Went Edge Quarry, Environmental Setting and Site Design.
2. AAe: 2023: Report reference 203040/IP. Went Edge Quarry Importation Protocol.
3. Avison Young: 2021: Waste Recovery Plan, Went Edge Quarry, Smeaton, Pontefract
4. BGS: 1998: 1: 50,000 scale geological map: Sheet 78, Wakefield. British Geological Survey.
5. BGS: 2000: The Physical Properties of Minor Aquifers in England and Wales. Technical Report WD/00/04. British Geological Survey.
6. Cromwell Mining Consultants: 2019: Environmental Statement, Went Edge Quarry, Area 8 Extension. Report reference 0919-001.
7. Environment Agency: 2014: End-of-waste and by-product hazard and risk assessment.
8. Key GeoSolutions: 2015: Stability Assessment Went Edge Quarry. Reference: 15-180-L-001.

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APPENDIX 1

APPENDIX 1 – SURFACE WATER RISK ASSESSMENT

This risk assessment follows the methods presented by the Environment Agency (EA) in their guidance:
https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit

As the assessment is for risks to surface water from seepage through engineered fill, rather than a direct surface water discharge, reference is also made to EA document "End-of-waste and by-product hazard and risk assessment", 2014. A source-pathway-receptor assessment is followed with a tiered approach: Tests 1 to 4 of the surface water pollution risk assessment guidance are applied.

The source is defined by the proposed importation criteria presented in Table 2 of the main report. In this assessment it will also be considered whether it may be possible for some determinands to be present at concentrations above those given in Table 2. This is sometimes referred to as a rogue load assessment.

The EA methodology for the assessment of risks to surface waters requires consideration of the following:

- Source area
- Infiltration rate
- Water chemistry
- Volume of flow in the receiving water course.

The conceptual model has the following elements

Source – the imported fill material

Pathway – infiltration through the restoration materials, which is assumed to be of higher permeability than that of the underlying basal Permian marls, followed by lateral migration over the surface of the natural in situ clays to the River Went. In reality, any infiltration through the engineered fill will reach the base and migrate laterally into the quarry drainage and sump. Here it will be diluted by incident rainfall and surface runoff.

Receptor – the River Went, approximately 75m north of the quarry.

Test 1

Test 1 is a comparison of the leachate quality data with the environmental standard. In the first instance the environmental standard is taken as 10% of the freshwater environmental quality standard (EQS), Water Framework Directive (WFD) 2015. Where the EQS is hardness dependent the lowest value is assumed.

The leachable importation criteria are set equal to the EQS and therefore, all determinands fail at Test 1 and are taken to the next stage of assessment.

Test 2

This test introduces the dilution available in the receiving water. The assessment checks whether the process contribution (PC) of leachate from the base of the restoration materials is more than 4% of the EQS. PC is the concentration of a discharged chemical / element in the water after it's been diluted.

The following steps are required:

1. Multiply the effluent flow rate (EFR) by the release concentration of the pollutant in the effluent (RC).
2. Add the value for the EFR to the river flow rate (RFR).
3. Divide the result of step 1 by the result of step 2 to give PC.

If the value for PC is 4% or less of the EQS, it is not necessary to carry out tests 3 and 4.
If the PC is more than 4% of the EQS tests 3 and 4 are needed.

EFR =	rate of seepage of infiltration through base of fill x fill area (Inf x A)				
Inf =	157	mm/yr	4.98E-09	m/s	Effective rainfall
A =	62500	m2			
EFR =	0.000311	m3/s			
RFR =	0.164	m3/s	14170	m3/d	Q95 Walden Stubbs
EFR + RFR =	0.164311	m3/s			

There is a flow gauging station on the River Went at Waldon Stubbs west of the site, National Grid reference SE550163. The flow exceeded 95% of the time (Q95) is given as 0.164 m3/s.

The results of Test 2 are presented in Table A1-1. All determinands pass the assessment at Test 2 and therefore, Tests 3 and 4 are not required.

Table A1-1 – Surface Water Test 2

Determinand	RC = EQS (mg/l)	10% of EQS (mg/l)	4% of EQS (mg/l)	Step 1 EFR*RC	Step 2 EFR+RFR	Step 3 (PC) = Step 1/ Step 2	PC < 4% EQS?
Arsenic	0.05	5.00E-03	2.00E-03	1.56E-05	1.64E-01	9.47E-05	YES
Cadmium (dissolved)	0.00025	2.50E-05	1.00E-05	7.78E-08	1.64E-01	4.73E-07	YES
Chromium (dissolved)	0.0047	4.70E-04	1.88E-04	1.46E-06	1.64E-01	8.90E-06	YES
Copper (dissolved)	0.001	1.00E-04	4.00E-05	3.11E-07	1.64E-01	1.89E-06	YES
Mercury (dissolved)	0.00007	7.00E-06	2.80E-06	2.18E-08	1.64E-01	1.33E-07	YES
Nickel (dissolved)	0.004	4.00E-04	1.60E-04	1.24E-06	1.64E-01	7.57E-06	YES
Lead (dissolved)	0.0012	1.20E-04	4.80E-05	3.73E-07	1.64E-01	2.27E-06	YES
Zinc (dissolved)	0.0109	1.09E-03	4.36E-04	3.39E-06	1.64E-01	2.06E-05	YES
Chloride	250	25	1.00E+01	7.78E-02	1.64E-01	4.73E-01	YES
Fluoride (UKDWS)	1.5	0.15	4.00E-02	4.67E-04	1.64E-01	2.84E-03	YES
Sulphate (as SO4)	400	40	1.60E+01	1.24E-01	1.64E-01	7.57E-01	YES
Phenol	0.0077	7.70E-04	3.08E-04	2.40E-06	1.64E-01	1.46E-05	YES
Benzene	0.01	1.00E-03	4.00E-04	3.11E-06	1.64E-01	1.89E-05	YES

Rogue Load Assessment

A rogue load assessment looks at the potential effect of loads with concentrations of determinands above that of the importation criteria being imported to site.

Test 2 of the surface water pollution risk assessment guidance checks whether the process contribution (PC) of leachate from the restoration materials is more than 4% of the EQS, as shown above. Test 3 of the surface water pollution risk assessment guidance checks whether the process contribution (PC) is more than 10% of the EQS.

This assessment looks at whether there can be an increase in the source concentration such that the process contribution (PC) is less than 10% of the EQS.

Table A1-2 presents the values for PC and calculates the factor by which the source concentration RC could increase such that PC = 10% of the EQS. This enables calculation of the maximum source concentration that can be accepted without exceeding 10% of the EQS. RLA Steps 1 to 3 carry out a calculation check on the maximum source concentration, which demonstrates that the PC is equal to 10% of the EQS when the maximum source concentration is applied. The results indicate that all leachable source concentrations, as given in Table 2 of the main report, can be increased by a factor of 50 before the PC exceeds 10% of the EQS.

The results of this assessment indicate that in the event of receipt of rogue loads there should remain a low likelihood of impact to the quality of the River Went.

Table A1-2: Rogue Load Assessment

Determinand	RC = EQS (mg/l)	10% of EQS (mg/l)	Level 2 Step 1 EFR*RC	Level 2 Step 2 EFR+RFR	Level 2 Step 3 (PC) = Step 1/ Step 2	ROGUE LOAD ASSESSMENT	Increase (factor) in RC such that PC equals 10% of EQS	RC MAX Increased source concentration (mg/l)	RLA Step 1 EFR*RC	RLA Step 2 EFR+RFR	RLA Step 3 (PC) = Step 1/ Step 2	PC < 10% EQS?
Arsenic	0.05	5.00E-03	1.56E-05	0.164311	9.47E-05		53	2.64	8.22E-04	0.164311	5.00E-03	equals
Cadmium (dissolved)	0.00025	2.50E-05	7.78E-08	0.164311	4.73E-07		53	0.01	4.11E-06	0.164311	2.50E-05	equals
Chromium (dissolved)	0.0047	4.70E-04	1.46E-06	0.164311	8.90E-06		53	0.25	7.72E-05	0.164311	4.70E-04	equals
Copper (dissolved)	0.001	1.00E-04	3.11E-07	0.164311	1.89E-06		53	0.05	1.64E-05	0.164311	1.00E-04	equals
Mercury (dissolved)	0.00007	7.00E-06	2.18E-08	0.164311	1.33E-07		53	0.00	1.15E-06	0.164311	7.00E-06	equals
Nickel (dissolved)	0.004	4.00E-04	1.24E-06	0.164311	7.57E-06		53	0.21	6.57E-05	0.164311	4.00E-04	equals
Lead (dissolved)	0.0012	1.20E-04	3.73E-07	0.164311	2.27E-06		53	0.06	1.97E-05	0.164311	1.20E-04	equals
Zinc (dissolved)	0.0109	1.09E-03	3.39E-06	0.164311	2.06E-05		53	0.58	1.79E-04	0.164311	1.09E-03	equals
Chloride	250	2.50E+01	7.78E-02	0.164311	4.73E-01		53	13202	4.11E+00	0.164311	25	equals
Fluoride	1	1.00E-01	4.67E-04	0.164311	2.84E-03		53	79	2.46E-02	0.164311	0.10	equals
Sulphate (as SO4)	400	4.00E+01	1.24E-01	0.164311	7.57E-01		53	21123	6.57E+00	0.164311	40	equals
Phenol	0.0077	7.70E-04	2.40E-06	0.164311	1.46E-05		53	0.41	1.27E-04	0.164311	7.70E-04	equals
Benzene	0.01	1.00E-03	3.11E-06	0.164311	1.89E-05		53	0.53	1.64E-04	0.164311	1.00E-03	equals