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FLOOD RISK ASSESSMENT AND SURFACE WATER DRAINAGE STRATEGY

THEWLIS QUARRY, HUDDERSFIELD

Report Reference: 3531/FRA
Final version
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GENERAL NOTES

Title of report: Flood Risk Assessment and Surface Water Drainage Strategy

Site: Thewlis Quarry, Huddersfield

Report ref: 3531/FRA

Date: July 2024

Version	Date	Issued to
Draft version D1	14th July 2023	Rick Bright, Bright & Associates
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1 INTRODUCTION

1.1 Background

Thewlis Quarry is a former mineral extraction site located on Thewlis Lane, Huddersfield. A Planning Application has been prepared to restore the quarry through the partial infilling of the void and associated land forming works, to render it suitable for subsequent re-development. The Application Area is herein referred to as 'the site'.

The site is over 1 hectare (ha) in extent; therefore a Flood Risk Assessment (FRA) is required in accordance with the National Planning Policy Framework (NPPF) and associated Planning Practice Guidance (PPG).

Hafren Water was commissioned to undertake the requisite FRA and a Surface Water Drainage Strategy in support of the Planning Application.

1.2 Scope of the assessment

This FRA considers the likelihood of flooding to and from the site. Consideration is given to the risk from fluvial and rainfall events with a return period of 1 in 100-years, unless otherwise stated.

The site is located wholly within Flood Zone 1 according to mapping produced by the Environment Agency (EA). As such it has less than 0.1% chance of flooding from rivers and the sea in any year. This FRA considers the risk of flooding to and from the site. Mitigation measures have been proposed, where appropriate. Relevant national and local policies have been reviewed in relation to the application.

The Surface Water Drainage Strategy has determined greenfield run-off rates and run-off volume generated during the 1 in 100-year + climate change rainfall event. Comment is made on drainage provision and the suitability of Sustainable Drainage Systems (SuDS).

1.3 Data sources

The following data sources were used in this assessment:

Bright and Associates

- The restoration landform (TL1181-D7v4 Rev B, April 2024)

Ordnance Survey (OS)

- 1:25,000 scale series mapping

British Geological Survey (BGS)

- Geological maps, 1:50,000-scale (England & Wales), via the Geoindex website and BGS map portal

Environment Agency (EA)

- EA flood mapping

Kirklees Council

- Calder Catchment Level 1 SFRA
- Preliminary Flood Risk Assessment (PFRA)
- Flood Risk Management Strategy (LFRMS)
- Kirklees Local Plan

2 BASELINE CONDITIONS

2.1 Location and setting

The site is located approximately 3 kilometres (km) southwest of Huddersfield town centre. It extends to approximately 9.1 ha and is located at National Grid Reference (NGR) 412035 414431. The nearest postcode is HD4 7AB.

The quarry in the east of the site is located on Crosland Hill and is approximately 4 ha in area. Thewlis Lane, from which the site is accessed, runs north–south between the stone processing area in the west and the quarry in the east. The site location is shown on *Drawing 3531/FRA/01*.

2.2 Topography

The landform of the site can be sub-divided between the relict quarry void in the east and current stone processing operations to the west of Thewlis Lane.

Elevations in the west are fairly uniform, between approximately 204 and 205 metres Above Ordnance Datum (mAOD). Surrounding land is slightly higher, at around 209 mAOD. To the south of current operations, the elevations increase to a maximum of 212 mAOD.

The topography of the quarry slopes from the entrance off Thewlis Lane in the northwest from a maximum elevation of approximately 206 mAOD. The quarry area decreases in elevation towards the base of the relict quarry void to approximately 177 mAOD. Elevations along the southern and eastern boundary are approximately 201 mAOD. Elevations decrease towards the base of the relict quarry void, to approximately 177 mAOD.

Surrounding ground elevations decrease gradually eastwards, towards the valley floor of the River Holme, located 800 m from the eastern site boundary, at approximately 80 mAOD. Ground elevations increase steadily westwards from the quarry, attaining 272 mAOD at a distance of 1.4 km.

Several east-west orientated, narrow and steep sided valleys are located in the vicinity of the site. The closest such feature, Dean Clough, is located approximately 1 km to the south of the site.

2.3 Ground conditions

The bedrock within the site and its surroundings comprises Carboniferous-age Rough Rock sandstone. This formation consists of cross-bedded, coarse-grained feldspathic sandstone. The base of the Rough Rock is sharp and erosional, in part underlain by mudstones.

There are no superficial deposits present within either the site or surrounding area.

2.4 Hydrology

2.4.1 Watercourses

The site is located within the catchment of the River Holme, which is situated 1.1 km to the east of the site, at its closest point. The river flows broadly northwards and discharges into the larger River Colne, approximately 2.5 km to the northeast of the site.

Small, generally eastwards flowing, watercourses are present within the narrow-sided valleys described above.

2.4.2 Waterbodies

A small waterbody exists in the base of the quarry void. Several other small waterbodies are located within Beaumont Park 500 m to the east.

2.5 Groundwater levels

Groundwater levels at the site have been inferred from records held by the BGS for a waterwell located 200 m north. The borehole, BGS reference SE11SW145, recorded a rest water level of approximately 100 m below ground level (mbgl).

3 PROPOSED WORKS

It is proposed to partially backfill the quarry void using selected quarry waste. Suitable materials will be utilised to ensure that the landform created is chemically inert and geotechnically stable such that it will not be subject to short or long-term settlement, heave, swelling or other physical degradation. Site won quarry waste will be crushed and graded prior to use as backfill.

The proposed works will render the site suitable for subsequent re-development. The proposed restoration design is shown in *Appendix 3531/FRA/A1*.

No changes are proposed to the current stone processing operations in the west of the site.

4 BACKGROUND AND KEY DOCUMENTS

4.1 National Planning Policy and Guidance

The FRA has been undertaken in accordance with the statutory requirements of the National Planning Policy Framework (NPPF) and Planning Practice Guidance (PPG) regarding development and flood risk.

4.2 Flood zone and vulnerability classifications

EA mapping shows that site lies entirely within Flood Zone 1 (low probability of fluvial and tidal flooding). This zone comprises land assessed as having less than a 1 in 1000 annual probability of river or sea flooding in any given year (<0.1%).

In accordance with the NPPF and associated PPG, all sites within Flood Zones 2 or 3, or 3b or over 1 ha in size must be accompanied by an FRA.

'*Minerals working and processing'* is considered to be 'Less Vulnerable' in accordance with the PPG. The Application Area is located wholly within Flood Zone 1. According to Table 2 of the PPG, it is considered appropriate for 'Less Vulnerable' development to be located within Flood Zone 1. The Sequential Test is therefore considered to be passed, and the Exception Test is not applicable.

4.3 Local Policies and Guidance

4.3.1 Calder Catchment Strategic Flood Risk Assessment

Kirklees Council, Calderdale Council and Wakefield Council commissioned a joint Calder Catchment Level 1 SFRA which was completed by JBA in April 2016.

The Flood Risk Maps provided in the SFRA show there are no records of flooding at the site and the site is not identified to be at risk of fluvial flooding.

The SFRA raises no concerns for this application.

4.3.2 Kirklees Council Preliminary Flood Risk Assessment (PFRA)

The Kirklees Council PFRA was completed in 2011 and an addendum made in December 2017. Historical incidents of flooding have been recorded across the study area, however there are no records of flooding affecting the site.

The PFRA does not raise any concerns for the proposed development.

4.3.3 Kirklees Local Flood Risk Management Strategy (LFRMS)

The LFRMS was published in February 2013 by Kirklees Council. A number of historical flood events are listed, the nearest of which relates to flooding events in August 2004 and August 2005 on the River Colne. No details are provided of specific locations affected, although as the Colne is approximately 1.5 km from the site at its nearest point, and at a significantly lower elevation, it is highly unlikely that the site was affected during these events.

The LFRMS does not raise any concerns for this assessment.

4.3.4 Kirklees Local Plan

The Kirklees Local Plan covering the period 2013-2031 was adopted in February 2019. Policies LP27 and LP28 contain information specific to flood risk and drainage and have been considered throughout this assessment.

4.4 Climate change

Climate change allowances have been specified by the EA for each management catchment and for different development lifetimes. The whole site is within the Aire and Calder Management Catchment. Peak rainfall allowances for this catchment are as shown in *Table 3531/FRA/T1*:

3531/FRA/T1: Aire and Calder Management Catchment - peak rainfall allowances				
	30-yr return period		100-yr return period	
	Central	Upper	Central	Upper
2050s	20%	35%	25%	40%
2070s	25%	40%	30%	45%

The guidance states to: '*Use '2050s' for development with a lifetime up 2060 and use the 2070s epoch for development with a lifetime between 2061 and 2125.*' Therefore, the climate change allowance of 45% for the 2070s epoch is relevant to this site.

5 FLOOD RISK AT THE SITE

5.1 Potential sources of flooding

A qualitative assessment of flood risk has been made from the following sources:

- Fluvial (river flooding)
- Pluvial (surface water run-off)
- Groundwater
- Sewer and drains
- Reservoirs, canals and lakes
- Other artificial sources

5.2 History of flooding

There is no history of flooding at the site.

5.3 Fluvial flooding

Fluvial (river) flooding occurs when a watercourse cannot accommodate the volume of water draining into it from the surrounding catchment. The EA Flood Map for Planning, shown on *Drawing 3531/FRA/01,* indicates that the site is at very low risk of flooding from rivers; it is situated entirely within Flood Zone 1, which equates to a potential risk of flooding of less than 0.1% each year. The rivers Colne and Holme are situated at elevations more than 100 m below that of the site and as such clearly pose no flood risk to it.

The overall risk of fluvial flooding is, therefore, considered to be negligible and mitigation measures are not required.

5.4 Surface water flooding

Surface water (pluvial) flooding occurs when rainwater does not drain away through the normal drainage system or soak into the ground, but instead lies on, or flows over, the ground. This can typically happen following high rainfall storm events when a drainage system is unable to accommodate the amount of surface run-off, or when ground profiles are uneven and facilitate ponding.

EA mapping provided on *Drawing 3531/FRA/02,* shows that the vast majority of the site is at 'Very Low' risk of surface water flooding. A surface water flow path is shown along part of the internal access track in the west of the site, with a risk level of 'Low' (between 0.1% and 1% annual probability) and 'Medium' (between 1% and 3.3% annual probability). However, EA flood mapping does not consider the presence of drainage systems, therefore should any

surface water flooding occur as per the mapping, flows would be directed into the on-site drainage system, and not impact the operations. As no changes are proposed in this area, the risk of surface water flooding will not increase.

Post-restoration surface water runoff in the east of the site is likely to accumulate within the lowest point of the restored quarry (see Section 6 for details of how this will be managed). Water management associated with stone processing in the west of the site will continue as per existing.

There are no records of surface water flooding affecting the site and the proposals will not obstruct any existing surface water flow paths.

The surface water flood risk to the site is therefore considered to be very low.

5.5 Groundwater flooding

Groundwater flooding occurs when the watertable rises above the ground surface. It is most likely in areas above an aquifer where water levels can rise following prolonged rainfall.

BGS Geoindex borehole data indicates that locally groundwater elevations within the bedrock are at approximately 100 mbgl; as the lowest point of the restored landform will be at approximately 184 mAOD, a substantial unsaturated zone of bedrock will exist beneath it.

The risk of flooding posed by groundwater is therefore considered to be insignificant.

5.6 Flooding from sewers and drains

Sewer flooding can result in localised short-term effects caused by intense rainfall overloading sewer capacity. Flooding can also occur due to blockage, poor maintenance, structural failure or surcharging of a system due to high water levels in a receiving watercourse.

Sewers and drains could be located in the west of the site, associated with the existing drainage system. Should flooding of such infrastructure occur, flows would likely infiltrate into surrounding ground and not pose a flood risk.

Due to the previous land use of the western part of the site, it is highly unlikely that sewers or drains are present.

Any flooding of sewers within Thewlis Lane would be contained within the highway and head northeastwards, following the topography of the area.

Therefore, the risk of sewer flooding at the site is considered to be low.

5.7 Flooding from reservoirs, canals and lakes

Reservoir and canal flooding occurs after the failure or breaching of a dam wall or canal embankment. It is rare in the UK due to regulatory inspections and maintenance.

The site is not shown on EA mapping to be at risk of flooding from reservoirs.

A small waterbody exists in the quarry void and is contained by the quarry faces. This will be removed as part of the proposed development and therefore does not pose a future flood risk.

5.8 Other artificial sources

There are no other artificial sources of flooding at or in the vicinity of the site.

6 SURFACE WATER DRAINAGE STRATEGY

As no changes are proposed to the stone processing area in the west of the site, including to the existing surface water management system, the surface water drainage strategy herein applies to the eastern part of the site (relict quarry void) only.

6.1 Principles of the surface water drainage strategy

Partial infilling of the quarry void will be achieved through the emplacement of selected quarry waste. The infilling material will comprise predominantly waste overburden generated during the extractive phase of operations. The characteristics of this rock type, being coarse-grained sandstone, which is blocky in form, are such that considerable pore space will exist after emplacement.

The proposed landform of the restored quarry is such that all rainfall-derived water from within its footprint will be contained within it, and resultant overland flow will be conveyed naturally to its lowest point.

The base of the worked-out quarry void, and also that of the final proposed landform, will be at a significantly higher elevation than groundwater within the in-situ bedrock beneath. The natural, free-draining characteristics of the bedrock, in combination with the thickness of the unsaturated zone beneath the site, indicate that the disposal of all surface water by infiltration is feasible. Proposed long-term water management will therefore be passive and undertaken entirely within the curtilage of the modified landform.

6.2 Drainage design

To enable the method of drainage described to be achieved two measures are proposed. These are shown on *Drawing 3531/FRA/03* and described below.

6.2.1 Placement of restoration materials

Maximizing the infiltration capacity of the base of the lower elevations of the restoration is key to the successful operation of the proposed passive drainage system. The placement of the quarry waste material with the highest pore space in the base of the quarry void will maximise its infiltration capacity. This relatively high pore space will facilitate the throughflow of water to the underlying in situ bedrock and also provide temporary water storage.

6.2.2 Provision of SuDS features

Grassed swales will be created along the contours of the restoration to impede overland flow of water on its relatively steep slopes. They will also promote infiltration. Narrow, long swales will be created at suitable locations on the flanks of the created landform to intercept water.

6.2.3 Greenfield run-off rates

Greenfield run-off rates and volumes have been calculated for the 4.5 ha quarry void area, using InfoDrainage 2024.0. A soil type of 0.3 has been used to represent the high permeability of the natural exposed geology. Full results are included in *Appendix 3531/FRA/A2*, with a summary provided in *Table 3531/FRA/T2* below:

3531/FRA/T2: Greenfield run-off rates and volumes		
Storm event	**Greenfield run-off rate (l/s)**	**Run-off volumes for the 6 hour storm event (m^3)**
1-year	13.6	293.7
Q_{BAR}	15.8	341.3
30-year	27.9	602.6
100-year	33.0	712.8

6.2.4 Post-restoration run-off rates and volumes

The maximum inflow rate and run-off volumes from the restored quarry area (4.5 ha) have been calculated for the post-restoration scenario using InfoDrainage 2024.0. The results are summarised in *Table 3531/FRA/T3* below, with full outputs in *Appendix 3531/FRA/A2*:

3531/FRA/T3: Post-development inflow rates and volumes		
Storm event	**Max inflow rate (l/s)**	**Run-off volumes for the critical storm (m^3)**
1-year	528	253
2-year	684	327
30-year	1,292	619
100-year	1,668	799
100-year + 45% climate change allowance	2,418	1,158

Comparison of the rates shown in the tables above show that run-off volumes are not anticipated to increase significantly post-development.

The total volume of run-off for the critical duration storm for the 1 in 100 year + climate change event equates to 1,158 m^3. This would result in an approximate water depth within the base of the quarry void of 1 m. The maximum anticipated water level will therefore remain approximately 8 m below the top of the void. Note, the modelling has assumed no infiltration, therefore actual depths will be less and the duration that this maximum level would pertain would be very limited.

Being the receptacle for site drainage it is considered highly likely that the lowermost elevations will remain damp for much of the year, with attendant wildlife benefits. However, under 'average' conditions it is anticipated that there would be no standing water in the base of the restored quarry.

7 SUMMARY AND CONCLUSIONS

The proposals comprise the partial infilling of a relict quarry void, and the preparation of the relict void and surrounding land for subsequent re-development. Existing operations in the west of the site, including the water management system, will continue as per the current situation.

The quarry is located on a raised area of land, which has a general eastwards declination. Several narrow, steep-sided valleys occur in the region, the closest such feature being Dean Clough.

The site is located within the catchment of the River Holme. The river is situated approximately 800 m to the east of the site.

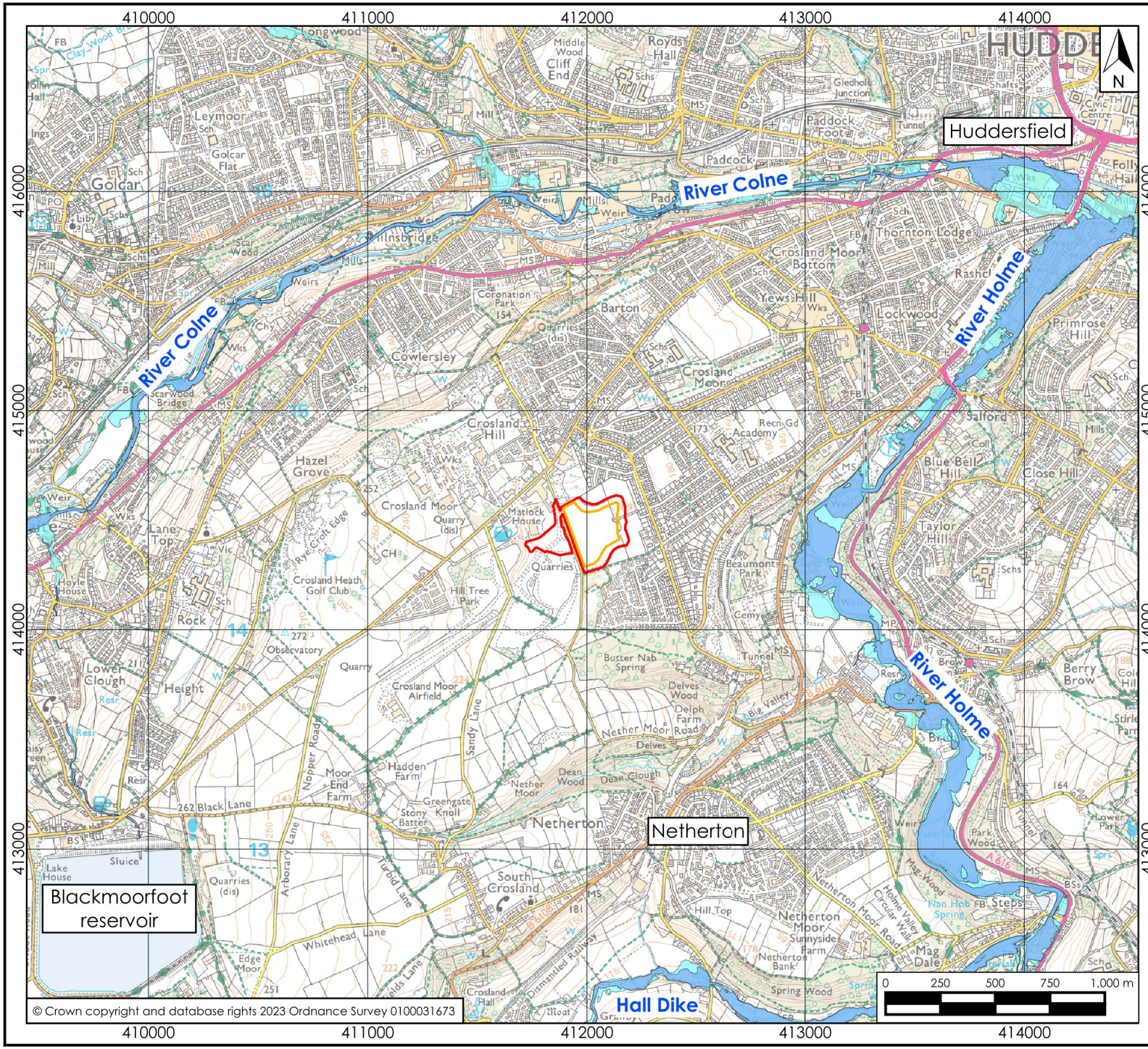
There are no surface watercourses within the site and its environs, and the quarry is characterised by being free draining. Groundwater within the bedrock is located at a depth of approximately 100 mbgl.

The site is located entirely within Flood Zone 1, as designated by the Environment Agency, and as such, is considered to be at low risk of flooding from all sources. A small area of surface water flooding has been identified in the east of the site on EA mapping, however this will be managed by the on-site water management system, and the risk is considered to be low.

Selected quarry waste will be emplaced in the base of the restored landform to maximise infiltration of surface water run-off to ground. InfoDrainage calculations indicate that a maximum water depth of approximately 1 m will occur within the base of the restored landform. However, this is regarded as a maximum, as it assumes no infiltration; therefore, in practice, it is anticipated the actual depth will be less than this. Swales will be created along the contours of the restored landform to slow the rate of run-off and encourage infiltration.

It is considered that the proposed development is acceptable in terms of flood risk, and that it can be drained passively and efficiently in perpetuity.

DRAWINGS



Scale correct at A4

Client	Bright & Associates
Title	Site location and fluvial flood zones
Project	Thewlis Quarry
Drawing	3531/FRA/01
Version	1
Date	Jul 2024
Scale	1:25,000

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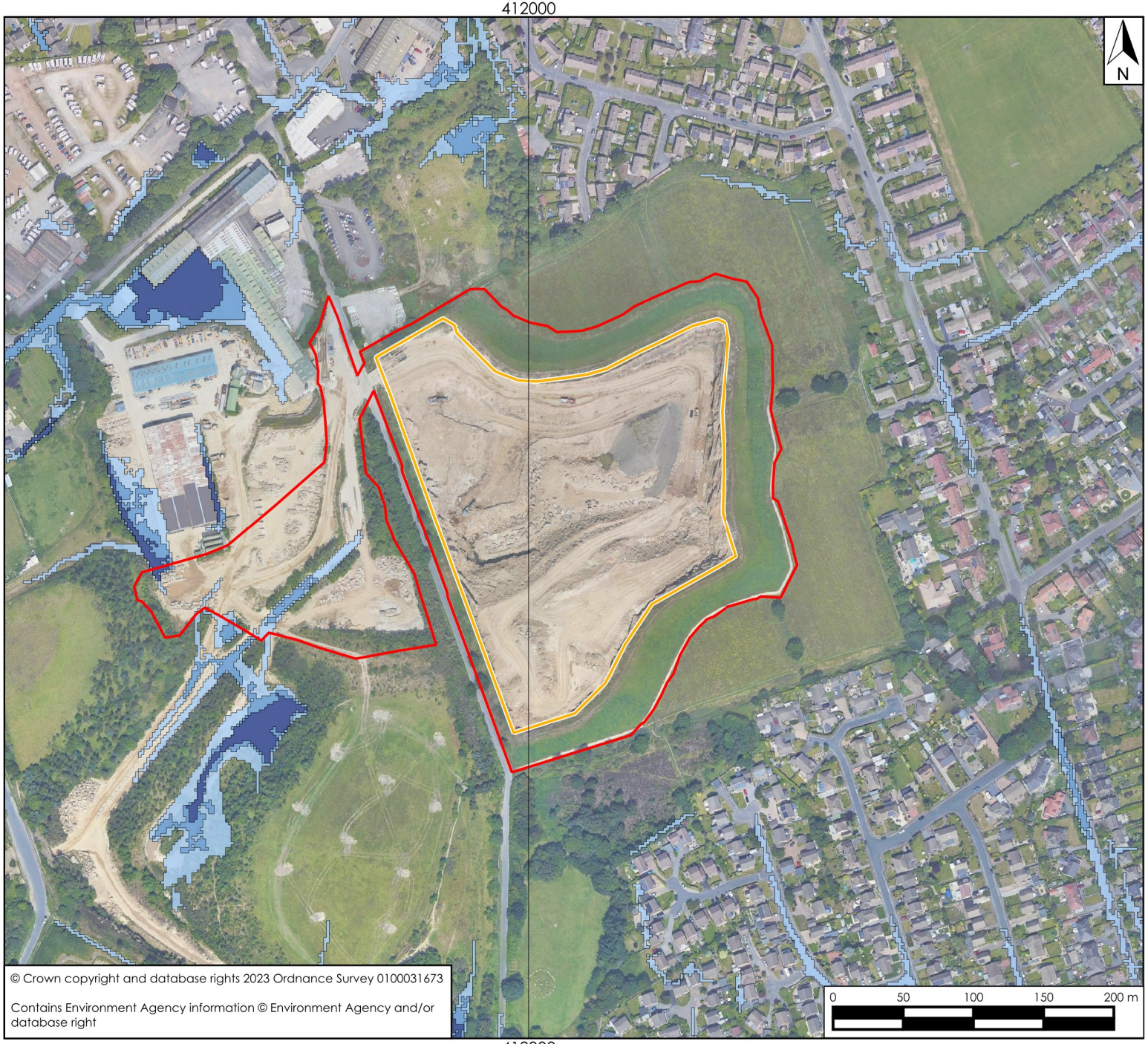
412000



412000

Key

- Application area
- Extraction area
- High risk (1 in 30 year)
- Medium risk (1 in 100 year)
- Low risk (1 in 1000 year)

Scale correct at A4

Client	Bright & Associates
Title	Surface water flood risk
Project	Thewlis Quarry
Drawing	3531/FRA/02
Version	1
Date	Jul 2024
Scale	1:4,000

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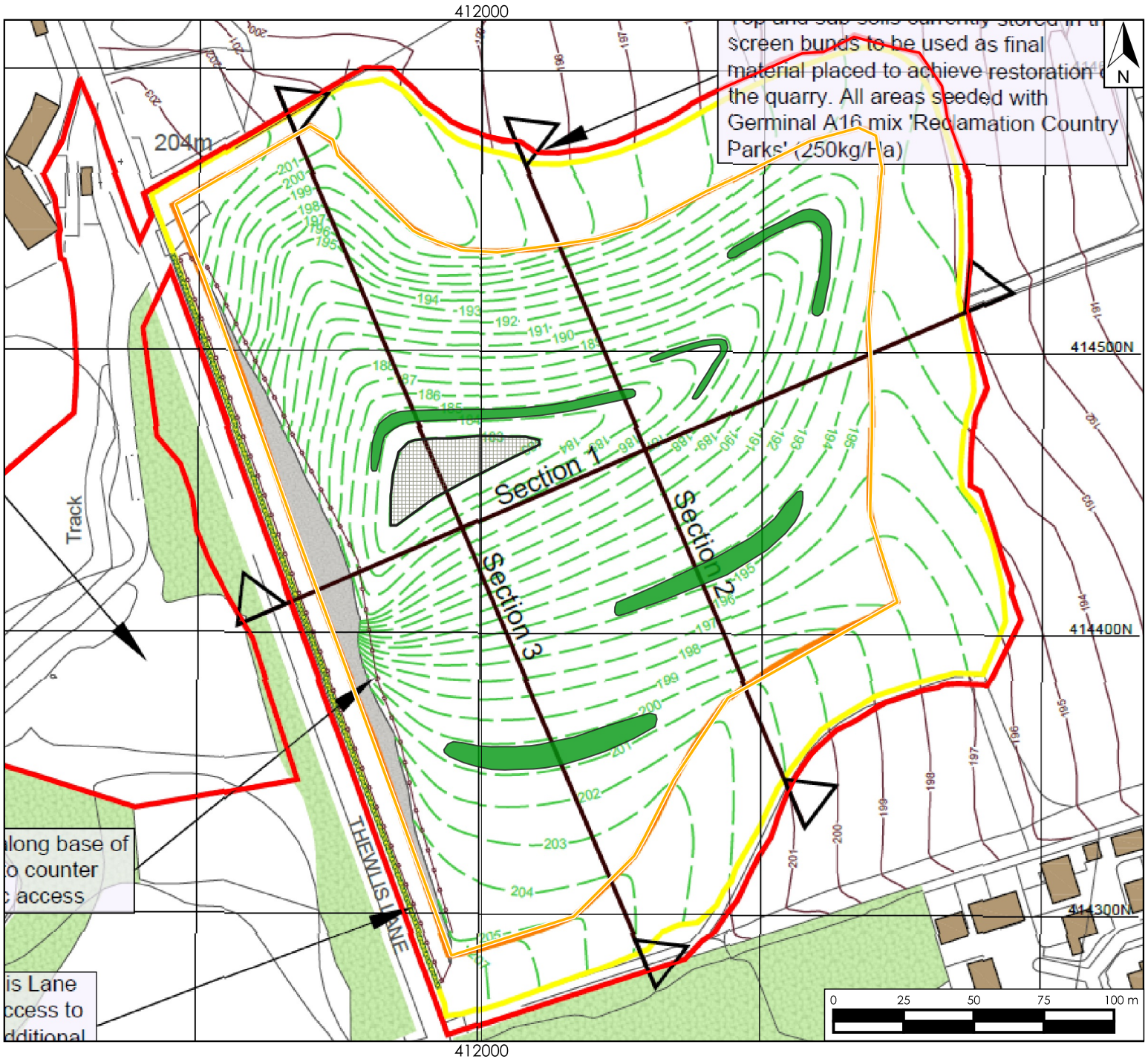

Key

- Application area
- Indicative location of swales
- Gravel filter drain
- Boundary (edge) of Quarry

Scale correct at A4

Client	Bright & Associates
Title	Restoration Drainage
Project	Thewlis Quarry
Drawing	3531/FRA/03
Version	1
Date	Jul 2024
Scale	1:2,000

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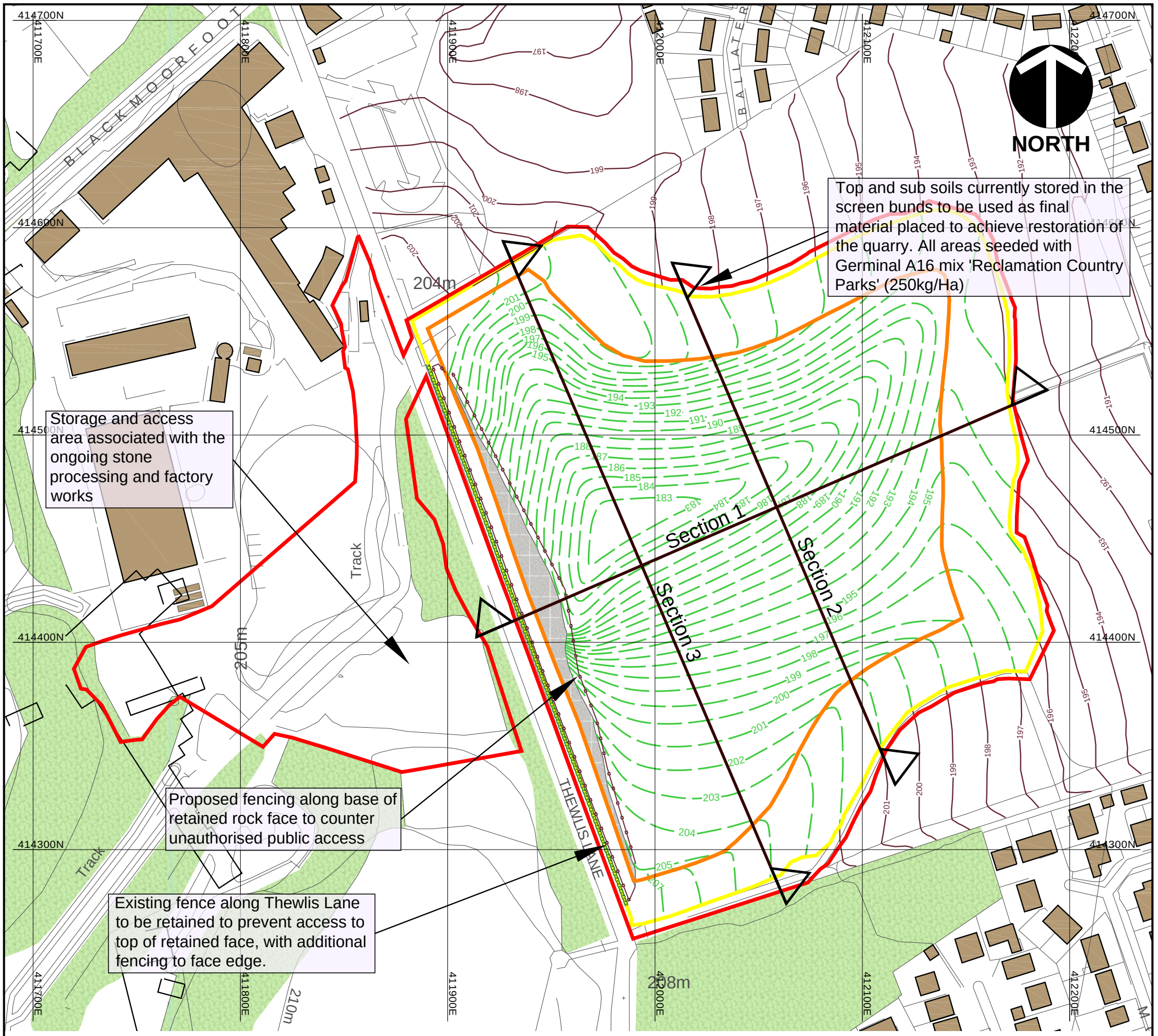
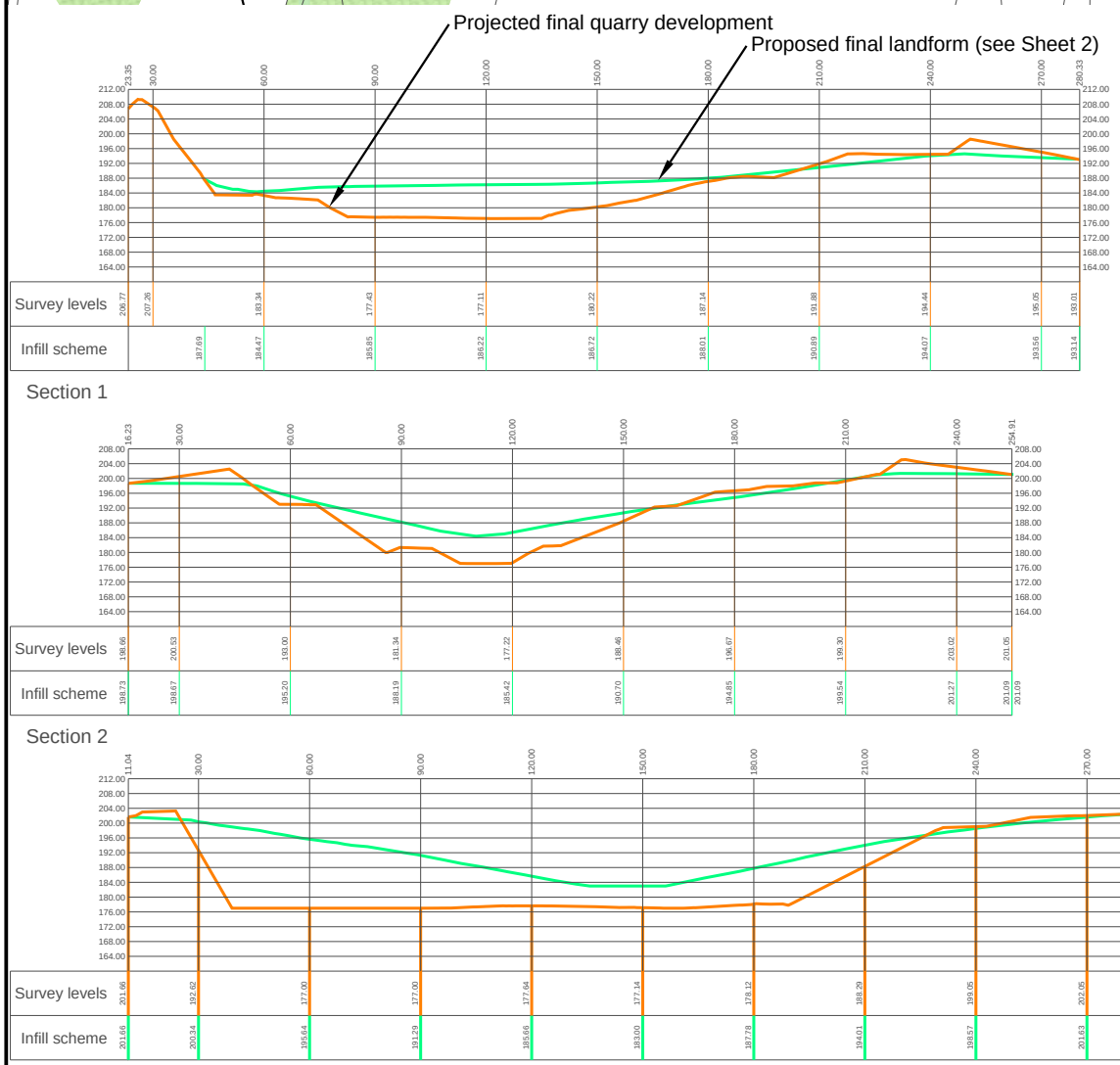
APPENDIX 3531/FRA/A1

Proposed infill design plan





Key

- Boundary of the planning consent (2013/62/90793/WO)
- Boundary (edge) of quarry
- Boundary of overall landform change
- Proposed final quarry contours (after infilling)
- Retained geological feature (incorporated into final landform)
- Existing contours beyond immediate quarry site
- Proposed native species hedgerow alongside Thewlis Lane and retaining existing boundary fencing
- Background mapping information for housing and woodland

Client: **JOHNSONS WELLFIELD**

Project: **Thewlis Quarry Restoration Scheme**
(Retaining the Western Rock Face)

Draft Issue

Title: **The Restoration Landform**

B&A CAD Ref:	Drawn by:	Scale @ A3:	Origin Date:
TL1181-D7v4 Rev B	RB	Plan & Section 1:2000	April 2024
			Amendment Date: 8-7-2024

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Drawing: **TL1181-D7 Rev B Sheet 2**

APPENDIX 3531/FRA/A2

InfoDrainage results

Thewlis Quarry: Runoff rates and volumes	Date: 12/07/2023		
	Designed by: CH	Checked by: CH	Approved By:
Report Details: Type: Inflows Storm Phase: Phase	Hafren Water: Barkers Chambers, Barker Street Shrewsbury SY1 1SB		

Catchment Area

Type : Catchment Area

Area (ha)	4.50

Dynamic Sizing

Runoff Method	Time of Concentration
Summer Volumetric Runoff	0.750
Winter Volumetric Runoff	0.840
Time of Concentration (mins)	5
Percentage Impervious (%)	100

Thewlis Quarry: Runoff rates and volumes	Date: 12/07/2023		
	Designed by: CH	Checked by: CH	Approved By:
Report Details: Type: Inflow Summary Storm Phase: Phase	Hafren Water: Barkers Chambers, Barker Street Shrewsbury SY1 1SB		

Inflow Label	Connected To	Flow (L/s)	Runoff Method	Area (ha)	Percentage Impervious (%)	Urban Creep (%)	Adjusted Percentage Impervious (%)	Area Analysed (ha)
Catchment Area			Time of Concentration	4.50	100	0	100	4.50
TOTAL		**0.0**		**4.50**				**4.50**

Thewlis Quarry: Runoff rates and volumes	Date: 12/07/2023		
	Designed by: CH	Checked by: CH	Approved By:
Report Title: Rainfall Analysis Criteria	Hafren Water: Barkers Chambers, Barker Street Shrewsbury SY1 1SB		

Runoff Type	Dynamic
Output Interval (mins)	5
Time Step	Default
Urban Creep	Apply Global Value
Urban Creep Global Value (%)	0
Junction Flood Risk Margin (mm)	300
Perform No Discharge Analysis	☐

Rainfall

FSR

Type: FSR

Region	England And Wales
M5-60 (mm)	19.0
Ratio R	0.302
Summer	☑
Winter	☑

Return Period

Return Period (years)	Increase Rainfall (%)
1.0	0.000
2.0	0.000
30.0	0.000
100.0	0.000
100.0	45.000

Storm Durations

Duration (mins)	Run Time (mins)
15	30
30	60
60	120
120	240
240	480
360	720
480	960
960	1920
1440	2880

Thewlis Quarry: Runoff rates and volumes	Date: 12/07/2023		
	Designed by: CH	Checked by: CH	Approved By:
Report Title: UK and Ireland Rural Runoff Calculator	Hafren Water: Barkers Chambers, Barker Street Shrewsbury SY1 1SB		

ICP SUDS / IH 124

Details

Method	ICP SUDS
Area (ha)	4.50
SAAR (mm)	1229.0
Soil	0.3
Region	Region 3
Urban	0
Return Period (years)	0

Results

Region	QBAR Rural (L/s)	QBAR Urban (L/s)	Q 1 (years) (L/s)	Q 30 (years) (L/s)	Q 100 (years) (L/s)
Region 3	15.8	15.8	13.6	27.9	33.0

Thewlis Quarry: Runoff rates and volumes	Date: 12/07/2023		
	Designed by: CH	Checked by: CH	Approved By:
Report Details: Type: Inflows Summary Storm Phase: Phase	Hafren Water: Barkers Chambers, Barker Street Shrewsbury SY1 1SB		

FSR: 1 years: Increase Rainfall (%): +0: Critical Storm Per Item: Rank By: Max. Inflow

Inflow	Storm Event	Inflow Area (ha)	Max. Inflow (L/s)	Total Inflow Volume (m^3)
Catchment Area	FSR: 1 years: +0 %: 15 mins: Winter	4.50	528.1	252.999

Thewlis Quarry: Runoff rates and volumes	Date: 12/07/2023		
	Designed by: CH	Checked by: CH	Approved By:
Report Details: Type: Inflows Summary Storm Phase: Phase	Hafren Water: Barkers Chambers, Barker Street Shrewsbury SY1 1SB		

FSR: 2 years: Increase Rainfall (%): +0: Critical Storm Per Item: Rank By: Max. Inflow

Inflow	Storm Event	Inflow Area (ha)	Max. Inflow (L/s)	Total Inflow Volume (m^3)
Catchment Area	FSR: 2 years: +0 %: 15 mins: Winter	4.50	683.5	327.423

Thewlis Quarry: Runoff rates and volumes	Date: 12/07/2023		
	Designed by: CH	Checked by: CH	Approved By:
Report Details: Type: Inflows Summary Storm Phase: Phase	Hafren Water: Barkers Chambers, Barker Street Shrewsbury SY1 1SB		

FSR: 30 years: Increase Rainfall (%): +0: Critical Storm Per Item: Rank By: Max. Inflow

Inflow	Storm Event	Inflow Area (ha)	Max. Inflow (L/s)	Total Inflow Volume (m^3)
Catchment Area	FSR: 30 years: +0 %: 15 mins: Winter	4.50	1291.9	618.858

Thewlis Quarry: Runoff rates and volumes	Date: 12/07/2023		
	Designed by: CH	Checked by: CH	Approved By:
Report Details: Type: Inflows Summary Storm Phase: Phase	Hafren Water: Barkers Chambers, Barker Street Shrewsbury SY1 1SB		

FSR: 100 years: Increase Rainfall (%): +0: Critical Storm Per Item: Rank By: Max. Inflow

Inflow	Storm Event	Inflow Area (ha)	Max. Inflow (L/s)	Total Inflow Volume (m^3)
Catchment Area	FSR: 100 years: +0 %: 15 mins: Winter	4.50	1667.8	798.915

Thewlis Quarry: Runoff rates and volumes	Date: 12/07/2023		
	Designed by: CH	Checked by: CH	Approved By:
Report Details: Type: Inflows Summary Storm Phase: Phase	Hafren Water: Barkers Chambers, Barker Street Shrewsbury SY1 1SB		

FSR: 100 years: Increase Rainfall (%): +45: Critical Storm Per Item: Rank By: Max. Inflow

Inflow	Storm Event	Inflow Area (ha)	Max. Inflow (L/s)	Total Inflow Volume (m^3)
Catchment Area	FSR: 100 years: +45 %: 15 mins: Winter	4.50	2418.3	1158.429

Phase
FSR: 1 years: Increase Rainfall (%): +0: 15 mins: Winter

Tables

Name	Max. Inflow (L/s)	Total Inflow Volume (m³)	Max. Outflow (L/s)	Total Outflow Volume (m³)
TOTAL	528.3	252.999	528.3	252.999

Phase
FSR: 2 years: Increase Rainfall (%): +0: 15 mins: Winter

Tables

Name	Max. Inflow (L/s)	Total Inflow Volume (m³)	Max. Outflow (L/s)	Total Outflow Volume (m³)
TOTAL	683.7	327.423	683.7	327.423

Phase
FSR: 30 years: Increase Rainfall (%): +0: 15 mins: Winter

Tables

Name	Max. Inflow (L/s)	Total Inflow Volume (m³)	Max. Outflow (L/s)	Total Outflow Volume (m³)
TOTAL	1292.2	618.858	1292.2	618.858

Phase
FSR: 100 years: Increase Rainfall (%): +0: 15 mins: Winter

Tables

Name	Max. Inflow (L/s)	Total Inflow Volume (m³)	Max. Outflow (L/s)	Total Outflow Volume (m³)
TOTAL	1668.2	798.915	1668.2	798.915

Phase
FSR: 100 years: Increase Rainfall (%): +45: 15 mins: Winter

Tables

Name	Max. Inflow (L/s)	Total Inflow Volume (m³)	Max. Outflow (L/s)	Total Outflow Volume (m³)
TOTAL	2418.9	1158.429	2418.9	1158.429