



# ARCUS

## **SHEPHERDS' RIG WIND FARM PRELIMINARY BORROW PIT ASSESSMENT**

**VERSION 3.0**

**OCTOBER 2018**



Prepared By:

**Arcus Consultancy Services**

7<sup>th</sup> Floor  
144 West George Street  
Glasgow  
G2 2HG

**T** +44 (0)141 221 9997 | **E** [info@arcusconsulting.co.uk](mailto:info@arcusconsulting.co.uk)  
**w** [www.arcusconsulting.co.uk](http://www.arcusconsulting.co.uk)

Registered in England & Wales No. 5644976

## TABLE OF CONTENTS

<b>1</b>	<b>INTRODUCTION .....</b>	<b>2</b>
	<b>1.1 Preparation of the Borrow Pit Assessment .....</b>	<b>2</b>
	<b>1.2 The Development Site .....</b>	<b>2</b>
<b>2</b>	<b>GEOLOGY .....</b>	<b>3</b>
	<b>2.1 Superficial Soils .....</b>	<b>3</b>
	<b>2.2 Bedrock Geology .....</b>	<b>3</b>
	<b>2.3 Peat .....</b>	<b>3</b>
	<b>2.4 Hydrogeology .....</b>	<b>3</b>
	<b>2.5 Mining and Quarrying .....</b>	<b>3</b>
<b>3</b>	<b>BORROW PIT ASSESSMENT .....</b>	<b>4</b>
	<b>3.1 General .....</b>	<b>4</b>
	<b>3.2 Borrow Pit Locations and Considerations .....</b>	<b>4</b>
	<b>3.3 Findings and Recommendations .....</b>	<b>7</b>
	<b>3.4 Design .....</b>	<b>7</b>
<b>4</b>	<b>METHODS OF WORKING .....</b>	<b>9</b>
	<b>4.1 Overburden Handling .....</b>	<b>9</b>
	<b>4.2 Drainage of Borrow Pits .....</b>	<b>9</b>
	<b>4.3 Reinstatement Proposals .....</b>	<b>10</b>
	<b>4.4 Borrow Pit Working Programme .....</b>	<b>10</b>
<b>5</b>	<b>CONCLUSION.....</b>	<b>11</b>

## 1 INTRODUCTION

### 1.1 Preparation of the Borrow Pit Assessment

This Preliminary Borrow Pit Assessment (BPA) for Shepherds' Rig Wind Farm (the Development) has been prepared initially to provide details of potential borrow pit locations or aggregate extraction areas required for the construction of the wind farm.

It is anticipated that all of the turbine bases will be founded on bedrock composed of in-situ sedimentary rock types.

The purpose of the BPA is to:

- Assess potential borrow pit locations;
- Estimate available aggregate from the source location;
- Identify overlying superficial soils and define the materials that will be excavated as a result of the Development;
- Identify underlying rock types;
- Set out proposals for adequate intrusive investigations; and
- Detail management techniques for handling, storing and depositing peat for reinstatement.

Scottish Planning Policy (paragraph 243) states that Borrow Pits should only be permitted if there are significant environmental or economic benefits compared to obtaining material from local quarries, they are time-limited; tied to a particular project and appropriate reclamation measures are in place'. In the case of this particular development, progressing on-site borrowing provides significant environmental gains as the traffic volume on local roads (B class, C class and unclassified) would be significantly reduced. Additionally, one of the selected site locations has already undergone, deforestation and minor quarrying, therefore the impact on forestry and vegetation in the area is limited.

### 1.2 The Development Site

The wind farm area is situated on relatively high ground (~200 mAOD to 400mAOD) with the potential borrow pits located close to proposed turbine locations and adjacent to existing forestry tracks. The main access route originates from the south of the site via the B729 road from Carsphairn, Dumfries and Galloway.

The Development occupies an area of forestry and open hillside located to the north-west of the B729. The access road rises from approximately British National Grid (BNG) 262578, 591206 continuing north through forestry on the eastern side of Marscalloch Hill before sweeping towards the western side Cragengillan Hill. Figure 1, 'Proposed Site Layout' is included in Appendix A.

The proposed development includes a mix of new and existing track upgrade, nineteen turbines, a control room/substation, site compound and met-mast.

Four possible borrow pit locations were considered for the project, with two selected as preferred options. Details of the four borrow pits initially considered are summarised in Section 3.2 of this report. Of the two preferred, one is in the northern portion of the site and the other in the southern. The northern-most location is situated to the west of Cragengillan Hill off an existing forestry track and situated between T1 and T2 while the southern-most location is situated to the north-east of Marscalloch Hill off an existing forestry track and situated between T18 and T19. The details of each borrow pit are included in Section 3.0 of this report. The assessment has been completed through a targeted desk-based review of geological maps, Ordnance Survey (OS) contour data, aerial photography and from visual observations during site walkovers in August 2018.

No intrusive site investigation works have been undertaken to date.

## 2 GEOLOGY

### 2.1 Superficial Soils

Published geological mapping of superficial soils indicates the majority of the site to be underlain predominantly by areas vacant of significant superficial soil cover, primarily within the regions of Craigengillan Hill and Marscalloch Hill. Till deposits typically comprising clay, sand and gravel are shown across the eastern and southern site areas. Within the north-western site area, peat deposits are shown.

Figure 12.1 included in the Environmental Impact Assessment Report Volume One illustrates the superficial soils across the site area.

### 2.2 Bedrock Geology

Published bedrock geology mapping indicates the site to be underlain by Caradoc aged rocks comprising Portpatrick Formation Wacke. Localised faulting exists within the central site area at varying dip angles but generally to the south-east.

Figure 12.2 included in the Environmental Impact Assessment Report Volume One illustrates the bedrock geology across the site area.

### 2.3 Peat

Generally, the peat varies in depth according to local topographic conditions, with pockets of deep peat situated in topographically flat areas. With exception of small pockets of peat greater than 1.0m across the central site area, peat greater than 1.0m depth existed along the western areas, close to the site boundary.

Figure 12.5 included in the Environmental Impact Assessment Volume One illustrates the 'Recorded Peat Depths' across the site area.

### 2.4 Hydrogeology

The natural soils onsite are considered to be glacial till, or peat, although much of the site is shown to be vacant of superficial soils. The glacial till soils generally have a low permeability while peat is fairly permeable but will have high retention properties.

The Development site hosts several watercourses, including Goat Strand which issues on the southern slope of Craigengillan Hill and drains south before joining Craigengillan Burn with the catchment covering the majority of the northern and western part of the site.

Details of the hydrogeology are included in Chapter 13, Hydrology, Hydrogeology.

### 2.5 Mining and Quarrying

The Coal Authority interactive map viewer<sup>1</sup> indicates that the site does not lie within a 'high risk' mining area. Additionally, there are no active mines within the vicinity of the site as indicated by BGS GeoIndex<sup>2</sup>.

Following site walkover and detailed review of aerial photography and topography, there are a number of localised quarrying activities located within the site. Additionally, there are opportunities to use steep topography in low lying areas to explore as possible borrow pit search areas. The existing quarries and other search locations are located off existing tracks which are not proposed for upgrade but can be accessed easily from the proposed track network.

<sup>1</sup> <http://mapapps2.bgs.ac.uk/coalauthority/home.html>

<sup>2</sup> <http://mapapps2.bgs.ac.uk/geoindex/home.html>

### **3 BORROW PIT ASSESSMENT**

#### **3.1 General**

This section of the BPA identifies potential borrow pit locations within the Development site boundary that could be utilised in provision of aggregate for construction. This will be used in the construction of site access tracks, crane hardstanding areas, upgrades of existing forestry tracks and potentially concrete batching.

The proposed borrow pit locations have been selected based on their:

- Topography;
- Previous uses;
- Accessibility from existing or proposed access tracks;
- Orientation with respect to visibility; and
- Potential aggregate volume;
- Proximity of rock to the surface.

Steeper topography is preferable for quarrying, where soils coverage will be limited. Careful consideration was given to landscape and visualisation impacts, hence the exclusion of extension to the existing quarry on the south face of Marscalloch Hill.

Other considerations included proximity to watercourses, places of archaeological interest and forestry. The borrow pit locations are in areas where the peat cover is thin or vacant and where bedrock outcrops and aggregate reserves are expected to occur near the surface.

No intrusive site investigation works have been undertaken into the quality of rock that might be recovered at the time of preparing this BPA. However, it is anticipated that a full ground investigation will take place in advance of construction of the Development. The investigation will include the testing of material from within the proposed borrow pit areas to assess its suitability for reuse.

#### **3.2 Borrow Pit Locations and Considerations**

Four borrow pit search areas were initially identified from a combination of desk-based assessment of mapping and topography and site walkover survey. Other environmental constraints were considered also including watercourse buffers and peat. The summary of each of the four search areas identified are as follows.

##### *3.2.1.1 Borrow Pit Location 1*

Borrow Pit 1 is located at the south-western side of Craigengillan, approximate centre point BNG 262109, 595388. The site was selected due to being adjacent to existing tracks and the evidence of recent quarrying activities associated with forestry access works.

BGS superficial soils information indicates that this area of the Development is primarily vacant of any significant superficial soil cover, although areas of till and peat were recorded to the immediate west. Peat probing undertaken recorded depths of 0.1m only in the general vicinity of this borrow pit search area. The solid geology mapping indicates the underlying bedrock to be primarily Ordovician aged Portpatrick Wacke belonging to the Scour Group and consisting of massive thick-bedded turbidites of which the Sandstones are rich in andesitic detritus. A fairly significant late Silurian to early Devonian aged intrusion was present, orientated north-east to south-west across this part of the site. No geological faulting is present within the borrow pit search area or immediate vicinity. The location does not encroach any other environmental development constraints.

**Figures 3.1 and 3.2 - Existing conditions at Borrow Pit Search Area 1**



**3.2.1.2 Borrow Pit Location 2**

Borrow Pit 2 is located east of Furmiston Craig, centrally located within the southern portion of the site, at approximate centre point BNG 262142, 593572. The site was selected due to its proximity to existing tracks and the indication of previous quarrying activities from Ordnance Survey mapping. It was obvious after the site visit that the previous quarrying activities were historic and very localised and the area between was heavily overgrown with mature vegetation and forestry.

BGS superficial soils information indicates that this area of the Development is primarily vacant of any significant superficial soil cover, although areas of till and peat were recorded to the east and west respectively. Peat probing undertaken recorded depths of less than 0.5m in the general vicinity of this borrow pit search area. The solid geology mapping indicates the underlying bedrock to be Ordovician aged Portpatrick Wacke belonging to the Scaur Group and consisting of massive thick-bedded turbidites of which the Sandstones are rich in andesitic detritus. No geological faulting is present within the borrow pit search area or immediate vicinity. The location also does not encroach any other environmental development constraints.

**Figures 3.3 and 3.4 - Existing conditions at Borrow Pit Search Area 2**



**3.2.1.3 Borrow Pit Location 3**

Borrow Pit 3 is located at the north-eastern side of Marscalloch Hill, approximate centre point BNG 261879, 592536. The site was selected due to being adjacent to existing tracks and the indication of previous quarrying activities from Ordnance Survey mapping. It was obvious after the site visit that the historical quarrying activities were fairly localised and the area was heavily overgrown with mature vegetation and forestry. However, beyond the peripheral vegetation, the topographic gradient steeply rose towards the south-west.

BGS superficial soils information indicates that this area of the Development is vacant of any significant superficial soil cover. Peat in the general vicinity of this borrow pit search area was generally less than 0.5m. The solid geology mapping indicates the underlying bedrock to be Ordovician aged Portpatrick Wacke belonging to the Scaur Group and consisting of massive thick-bedded turbidites and the Sandstones are rich in andesitic detritus. No geological faulting is present within the borrow pit search area or immediate vicinity. The location also does not encroach any other environmental development constraints.

**Figures 3.5 and 3.6- Existing conditions at Borrow Pit Search Area 3**



**3.2.1.4 Borrow Pit Location 4**

Borrow Pit 4 is located at the south-eastern side of Marscalloch, approximate centre point BNG 261799, 591,855. The site was selected due to being adjacent to existing tracks and the evidence of previous quarrying activities.

BGS superficial soils information indicates that this area of the Development is primarily vacant of any significant superficial soil cover, although areas of till and peat were recorded to the immediate west. Peat probing undertaken recorded depths of less than 0.5m in the general vicinity of this borrow pit search area. The solid geology mapping indicates the underlying bedrock to be Ordovician aged Portpatrick Wacke belonging to the Scaur Group and consisting of massive thick-bedded turbidites and the Sandstones are rich in andesitic detritus. No geological faulting is present within the borrow pit search area or immediate vicinity. The location also does not encroach any other environmental development constraints.



**Figures 3.7 and 3.8 - Existing conditions at Borrow Pit Search Area 4**



### 3.3 Findings and Recommendations

Of the four assessed borrow pit locations, consultations with relevant technical specialists and a detailed topographic assessment have indicated potential constraints including landscape and visualisation issues for BP4 and shallow topography with the potential for unsuitable rocks/resource at BP2 respectively. On this basis the ground modelling of BP1 and BP 3 informs the assessment summary as set out in section 3.4. It should be noted that further investigations would be required to fully understand the feasibility of these options which would comprise rotary percussive drilling and rock sampling through coring and suitable geotechnical testing.

From here on in, borrow pit search areas 1 and 3 will be named Borrow Working 1 and Borrow Working 2 respectively, in line with the referencing in the Environmental Impact Assessment Report.

### 3.4 Design

Based on the identified search areas, a three-dimensional outline design was undertaken to establish the target capacity required from the proposed borrow pits. This involved a civil design taking account of the overall proposed site layout levels and both existing and proposed access tracks in order to develop a viable borrow area. The outline design of each borrow working included a main worked area with earthwork batters and indicative drainage cut-off ditches, and therefore was finalised as a total area situated within the initial search areas. The details of the outline borrow working design is summarised in Table 3.1 below while Borrow Working Plans and Profiles are shown in Figure 2 in Appendix A.

**Table 3.1: Borrow Working - Assessment Summary**

Borrow Working No.	Surface Area (m <sup>2</sup> )	3D Model Total Cut Volume (m <sup>3</sup> )	Interpolated Peat Depth (m)	Estimated Peat Volume (m <sup>3</sup> )	Estimated Aggregate Available (m <sup>3</sup> )
1	11,062	47,785	Peat < 0.5m	5,530	42,255
2	11,140	64,627	Peat < 0.5m	5,570	59,057
<b>TOTAL</b>	<b>22,202</b>	<b>112,412</b>	-	<b>11,100</b>	<b>101,312</b>

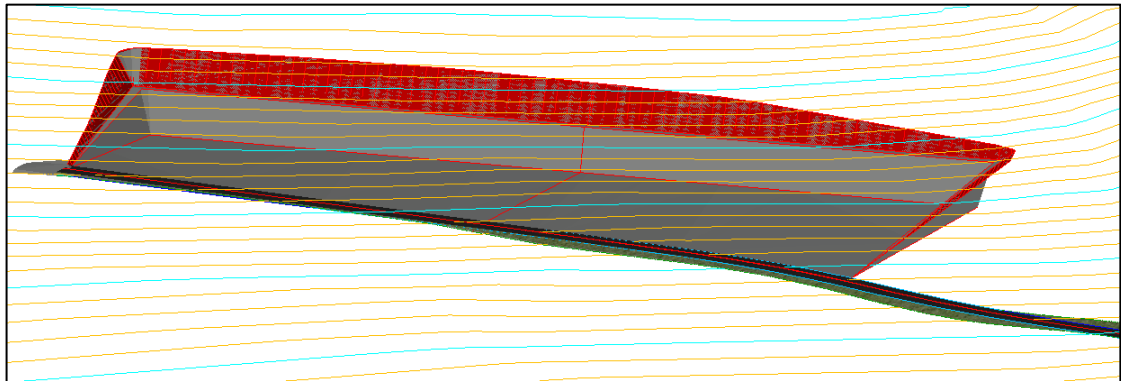
For the purposes of this outline borrow pit assessment, the volumes indicated in the table above are based on the following parameter:

- Borrow Working 1 area of approximately 145 m x 60m;
- Borrow Working 2 area of approximately 125 m x 85 m;

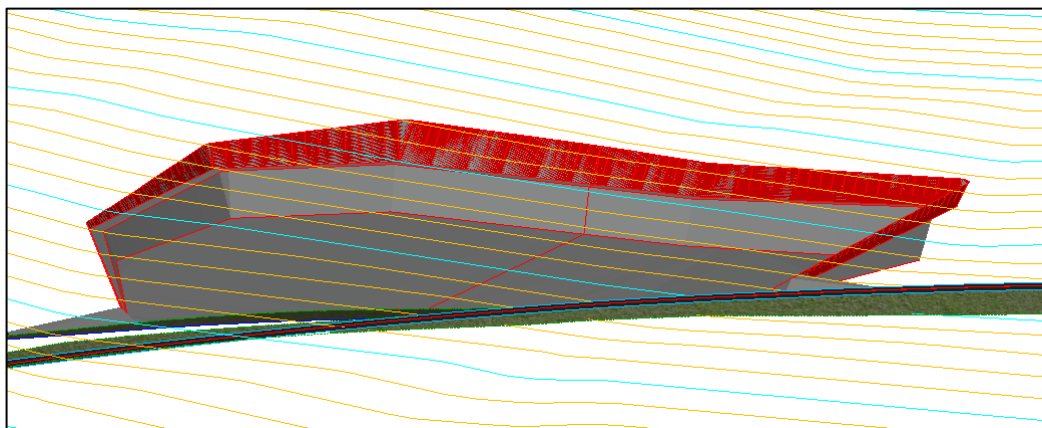
- Borrow Working floor levels taken from the levels associated with the existing access track; and
- Cut profile at 63° from borrow pit floor to 1st tier, followed by 2.0m wide benching and 63° from benching to intersection point of existing terrain.

Figures 3.9 and 3.10 below illustrate an isometric view of the borrow working design.

**Figure 3.9 – Three-Dimensional Model Borrow Working 1 Facing North-East**



**Figure 3.10 – Three-Dimensional Model Borrow Working Two Facing West**



## **4 METHODS OF WORKING**

The requirement to produce various grades of aggregate will necessitate the use of mobile quarrying plant and equipment. This operation will comprise a number of different elements which are summarised in the following Sections.

It is possible that the quarried material will require blasting methods should testing prove relatively high strengths and competencies. Where this is required, it is proposed that a lightweight crawler mounted blast hole drill rig is employed together with an attendant compressor. Explosives will need to be considered in detail by the Contractor at construction stage relating to safe operation, transportation and storage. The Contractor may also wish to consider alternative methods suitable to the quality of the rock. All aggregate materials won in borrow pits will be subject to crushing and screening. The primary component of this operation will consist of a mobile crushing and screening system.

The Contractor will provide a plant setup that meets the Development requirements processing the rock to produce the quantities, quality and sizes of the material required. The construction of the Development access tracks will be undertaken utilising the majority the aggregate produced from the borrow pit operations. It is intended that the access tracks will be constructed on the basis of normal best practice for the accommodation of wind turbine components.

The Contractor should undertake testing of the materials as the borrow pits are worked to ensure material quality is maintained, with particular reference to the ability of the materials to resist freezing/thawing and wetting/drying, and therefore serve the lifespan of the Development.

The appointed Contractor will provide a detailed risk assessment and method statement to cover the working methods employed within the borrow pits for approval during the construction phase.

### **4.1 Overburden Handling**

Prior to progressing works at borrow pits, the areas will require to be stripped of superficial material which lies above bedrock. Material storage areas should be identified and the superficial soils carefully placed in segregated stockpiles within the appropriate storage area.

Access routes to the borrow pits will form part of the enabling works prior to the mobilisation of quarry plant, although it should be noted that these locations are located off existing tracks. The main items of mobile quarry plant will be tracked, typically low ground pressure capable of traversing surfaces which have had only limited surface preparation.

### **4.2 Drainage of Borrow Pits**

Temporary interception/peripheral bunds and cut-off drainage ditches ('clean water drains') should be constructed upslope of the borrow pits and cuts to prevent surface water runoff entering the excavation. Swales to collect runoff should be placed on the downslope of borrow pits and overburden / stockpiles and will be designed to treat potentially silty runoff before discharging back into the drainage system.

A drainage and surface water management system will be required in order to control surface water run-off from borrow pit areas. Due to the nature and size of the proposed excavations, the drainage system should comprise of a peripheral cut-off ditch together with attenuation features and soakaways. Drainage ditches should be installed using a tracked excavator and, where necessary, a hydraulic breaker.

Waste water discharge onto vegetated surfaces from borrow pits and earthworks areas should be directed away from watercourses and drainage ditches to avoid direct discharge.

Any sediment suspended within the treated water should be deposited amongst the rough surface vegetation.

Figure 3 and 4 indicates a schematic drainage plan for each borrow pit and is provided in Appendix A.

### **4.3 Reinstatement Proposals**

It is envisaged that overburden/soils will be carefully stored adjacent to the extraction areas for re-use.

Each borrow pit should be suitably re-instated with topsoil and any available peat, peaty soils and turves to re-establish hydrological and ecological conditions and reduce any potential visual impacts. There is a potential for till or sands and gravels to be available for reinstatement purposes.

The reinstated peat/soil surface would be profiled to allow drainage and the re-introduction of appropriate vegetation cover and would tie into existing topography. The upper part of the quarry face would remain exposed and would be allowed to become weathered. It is envisaged that this face would acquire an appearance similar to that of other natural rock exposures in the locality.

The reinstated profile will be of varying thicknesses above the base of the borrow pit, and will be gently sloping from the track edge to the quarry face, generally with thicknesses representative to that of the peat and soils initially stripped from borrow pits areas.

The conjectured reinstatement profiles are shown in Figure 2 in Appendix A.

### **4.4 Borrow Pit Working Programme**

Of the possible borrow pits recommended, Borrow Working 2 is located closest to the site entrance and will be worked earliest in the construction programme. This borrow pit could be utilised for initial track construction, upgrade of existing tracks and any general enabling works from the site entrance including track widening where required. It is partially sited on existing tracks, but will require extension/spur tracks as the borrow pit progresses.

## 5 CONCLUSION

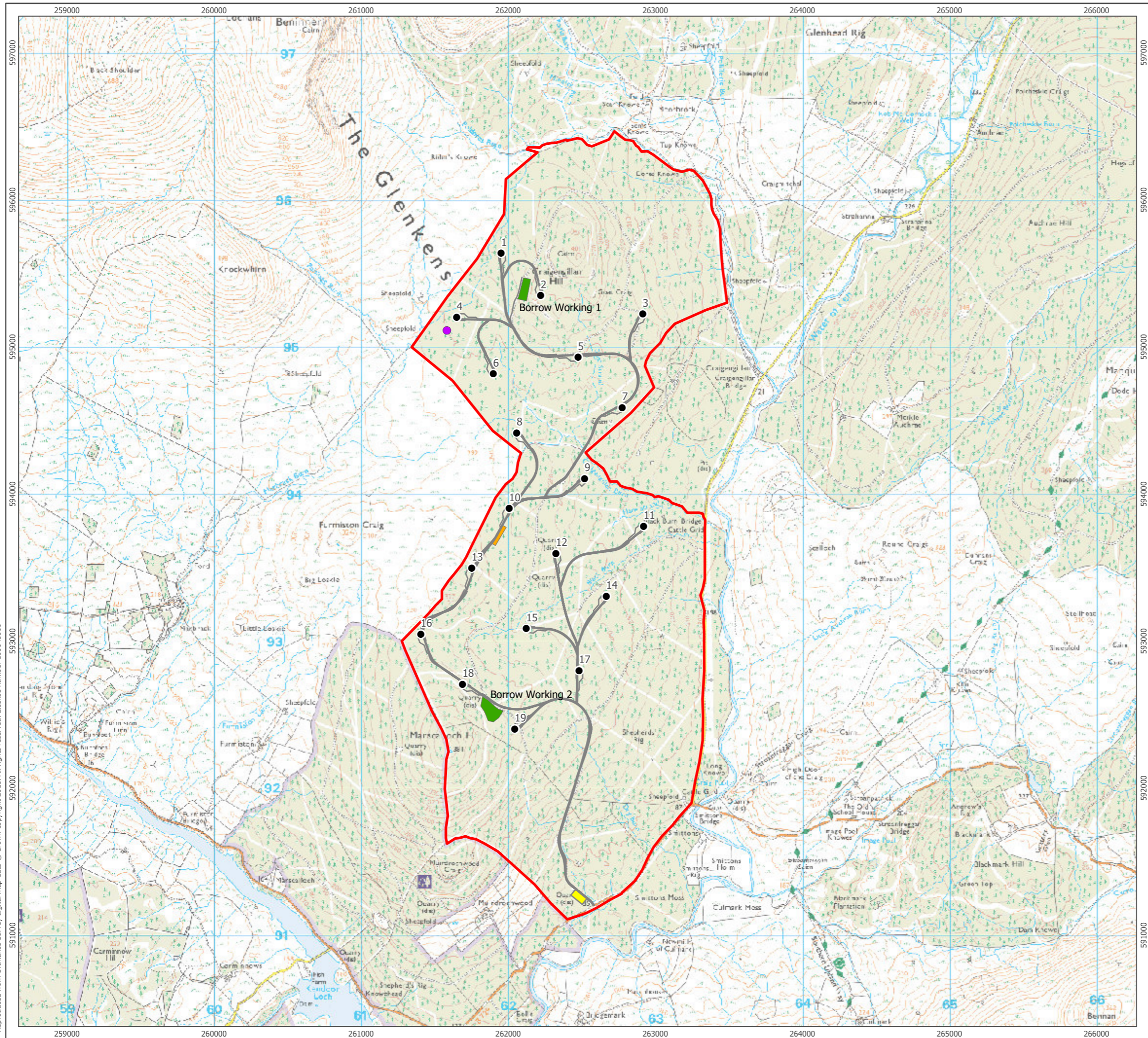
The siting of the borrow pits within the Development has been made on the basis of proximity to the existing and proposed access tracks, consideration of topography, geology and identified constraints. Based on the desk-based assessment, it is anticipated that there are adequate locations on site to position proposed borrow pits which would achieve the required aggregate quantities for the development.

Considerations for the assessment of borrow pits following consent of the Development include:

- Ground investigations and relevant geo-environmental analysis undertaken prior to finalising borrow pit proposals.
- Three-dimensional design should be undertaken following detailed design and ground investigations to confirm the capacity of the proposed borrow pits.
- Detailed profiles of borrow pit excavations including existing ground levels, proposed excavation levels and a conceptual restoration profile for each borrow pit should be produced once final borrow pit extents have been agreed.

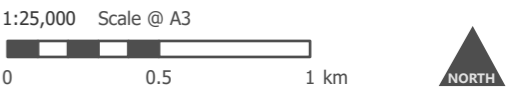
Prior to the construction of the windfarm, design and best practices and any required mitigation measures would be set out in full within a Construction Environmental Management Plan and agreed with the statutory bodies.

**APPENDIX A – FIGURES**



Reproduced from Ordnance Survey digital map data © Crown copyright 2018. All rights reserved. License number 100048606

- Site Boundary
- Turbine Location
- Met Mast Location
- Tracks Hardstanding
- Substation
- Borrow Working
- Construction Compound

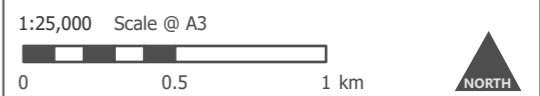
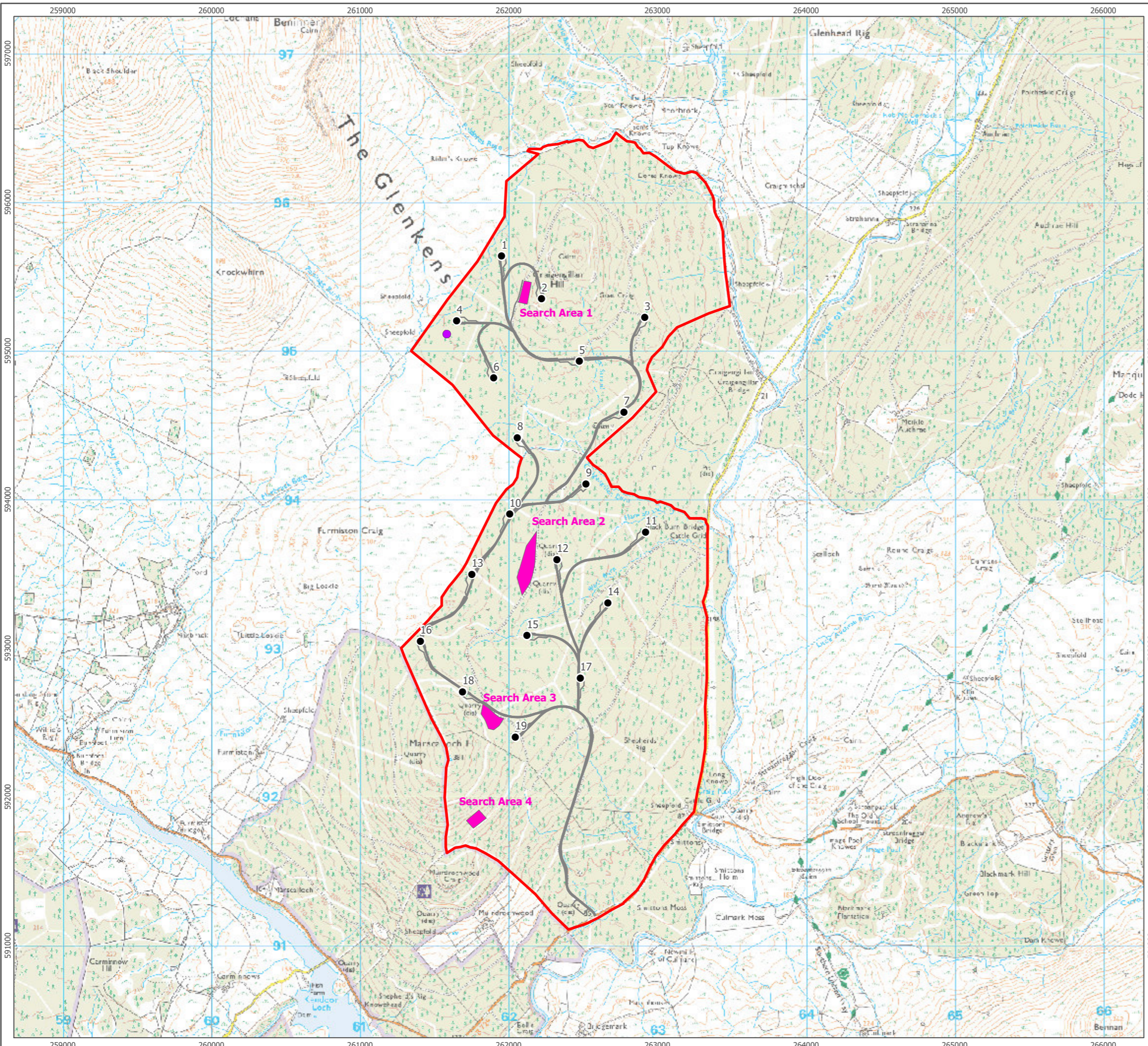


Produced By: DB	Ref: 2966-REP-045
Checked By: SC	Date: 25/10/2018

**Proposed Site Layout**  
Figure 1

**Shepherds' Rig Wind Farm**  
**Borrow Pit Assessment**

- Site Boundary
- Turbine Location
- Met Mast Location
- Tracks Hardstanding
- Borrow Pit Search Areas



Produced By: DB	Ref: 2966-REP-046
Checked By: SC	Date: 25/10/2018

**Borrow Pit Search Areas**  
Figure 2

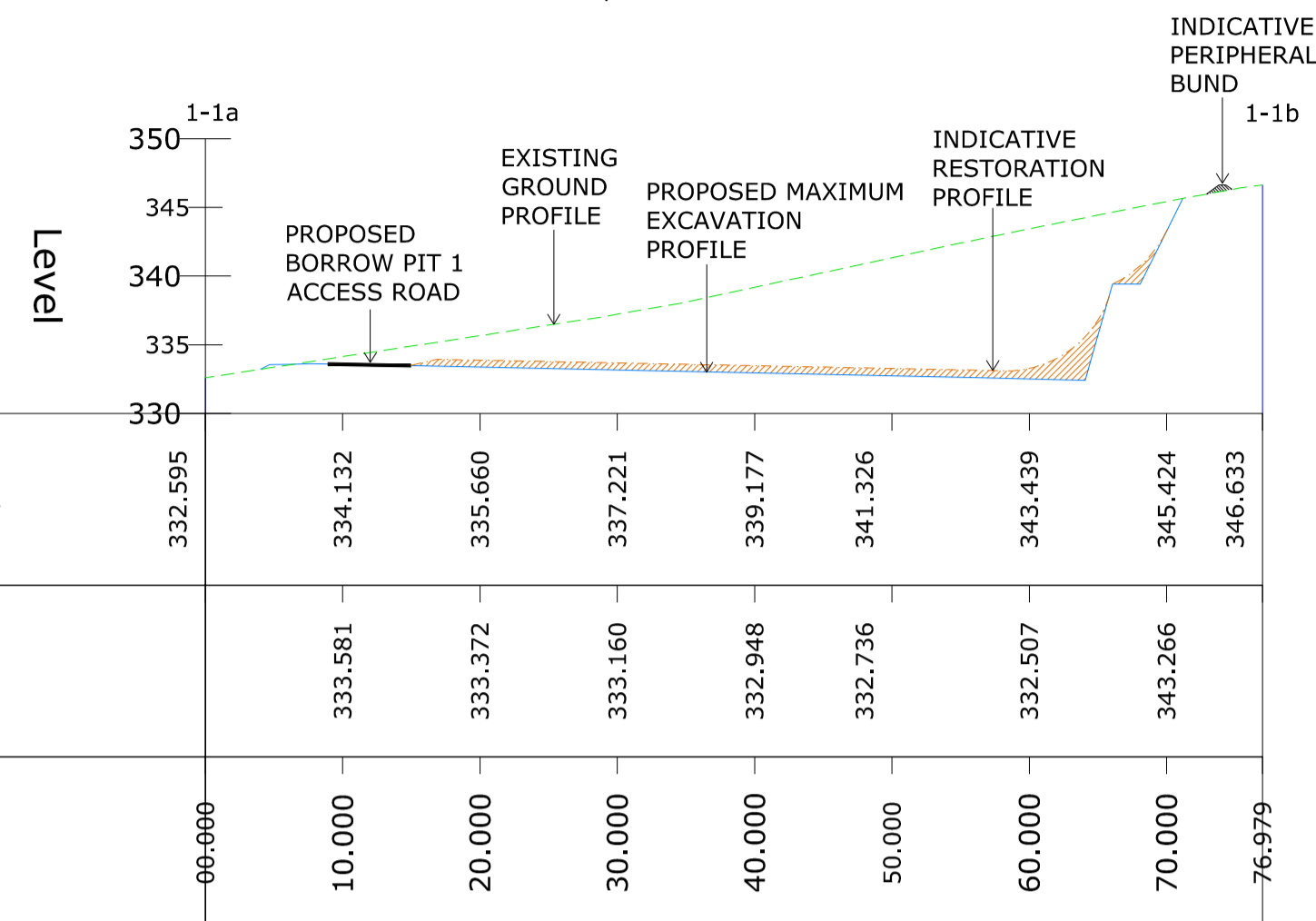
**Shepherds' Rig Wind Farm**  
**Borrow Pit Assessment**

Reproduced from Ordnance Survey digital map data © Crown copyright 2018. All rights reserved. License number 100048606



**BORROW WORKING 1 PROFILES**  
SCALE - 1:500

**ALIGNMENT - BP1-1**  
SCALE: H 1:500,V 1:500. DATUM: 330.000

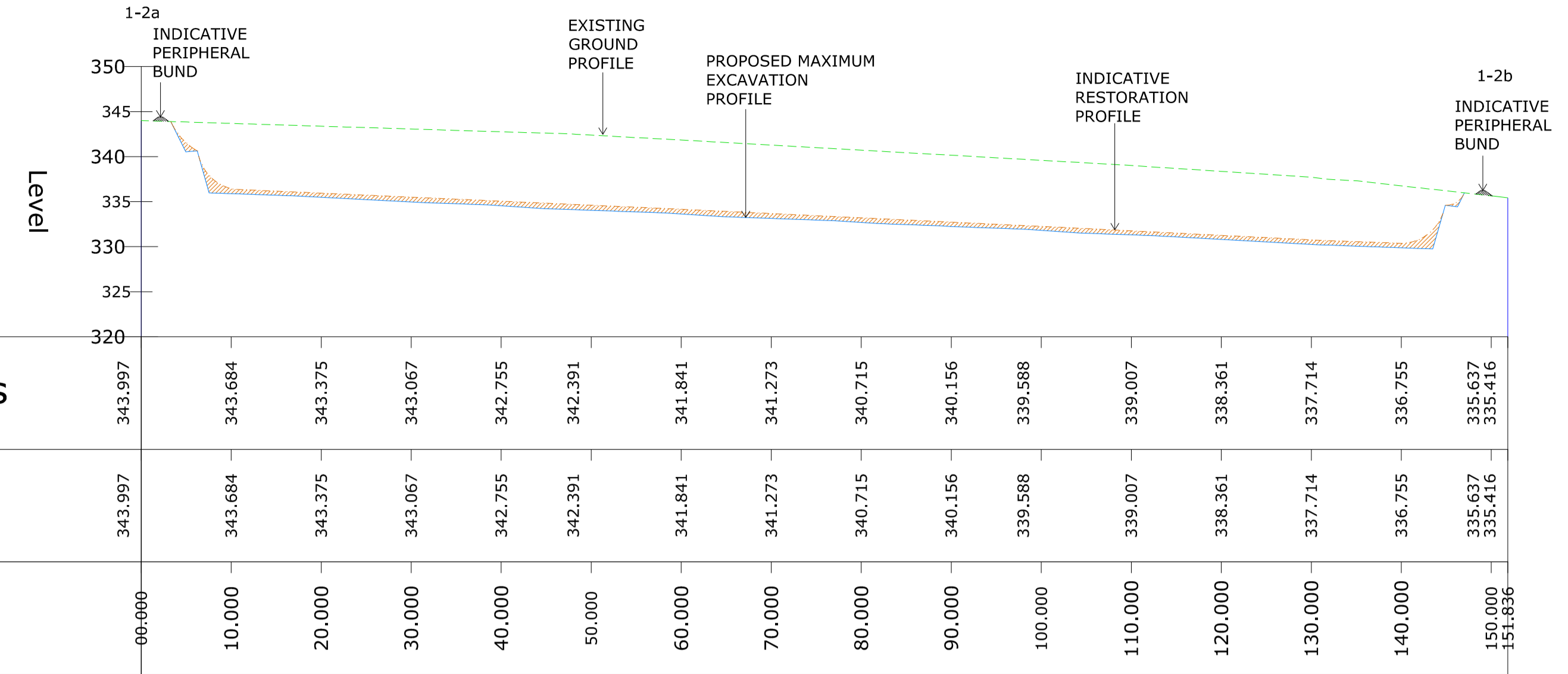


Proposed Levels

Existing Levels

Chainage

**ALIGNMENT - BP1-2**  
SCALE: H 1:500,V 1:500. DATUM: 320.000



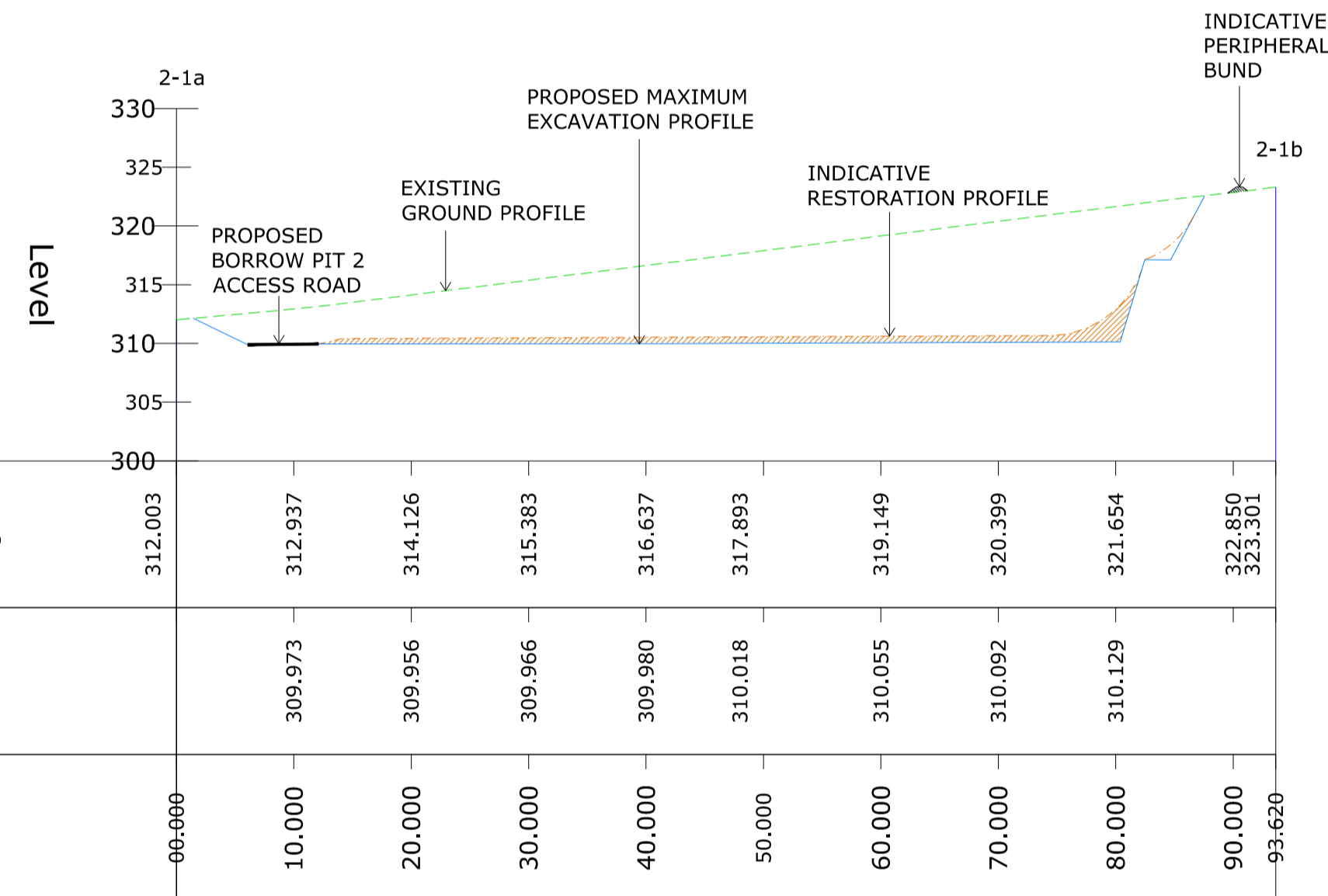
Proposed Levels

Existing Levels

Chainage

**BORROW WORKING 2 PROFILES**  
SCALE - 1:500

**ALIGNMENT - BP2-1**  
SCALE: H 1:500,V 1:500. DATUM: 300.000

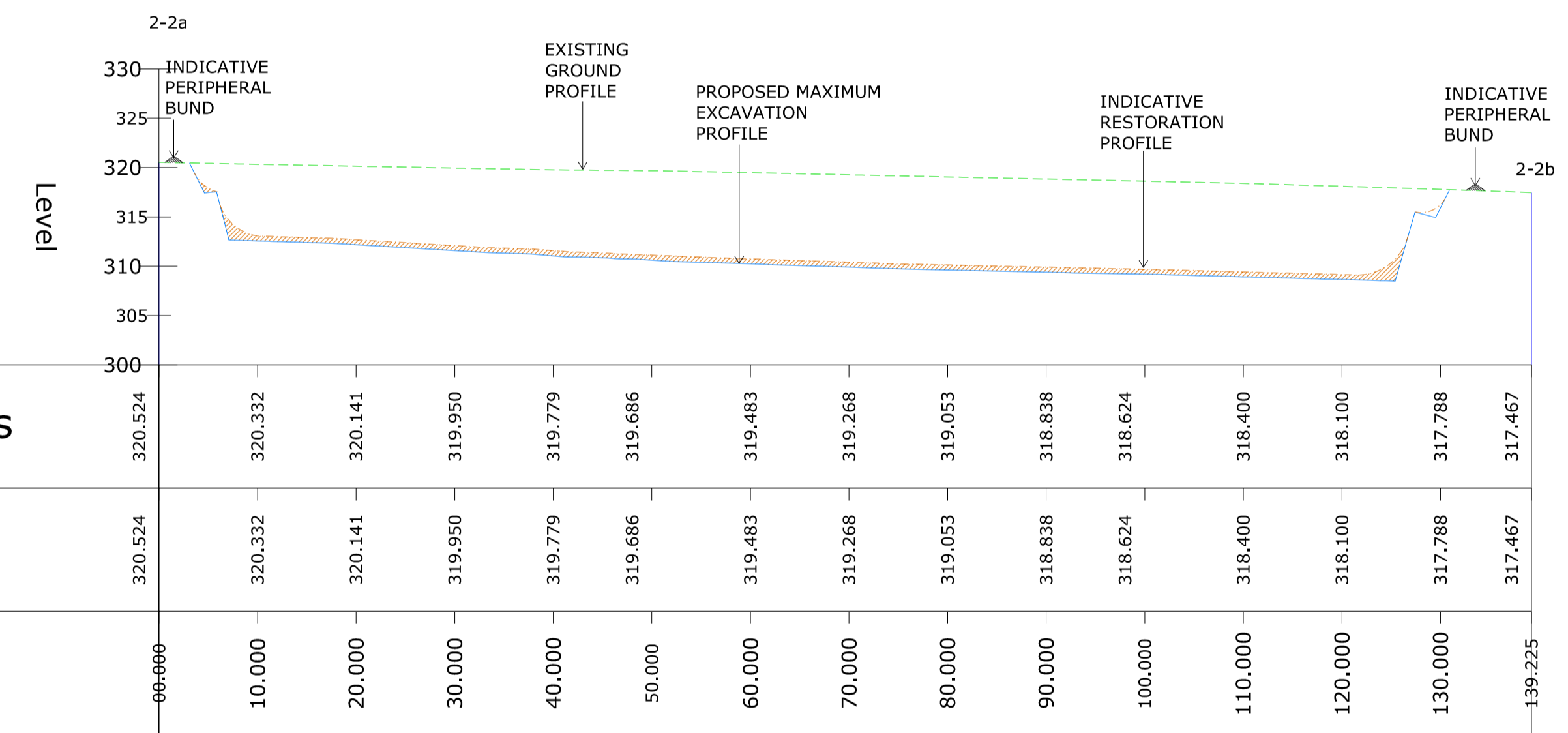


Proposed Levels

Existing Levels

Chainage

**ALIGNMENT - BP2-2**  
SCALE: H 1:500,V 1:500. DATUM: 300.000

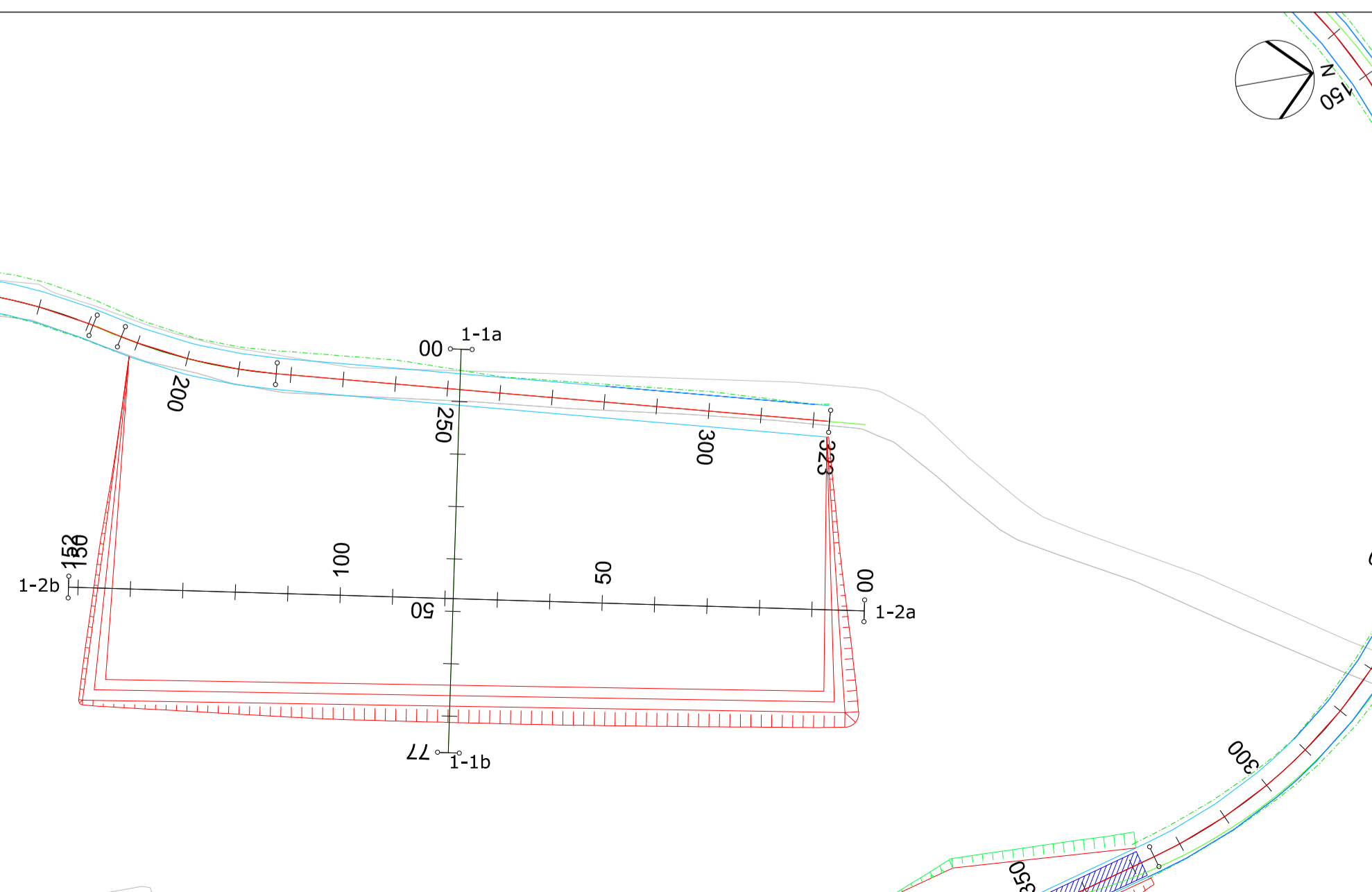


Proposed Levels

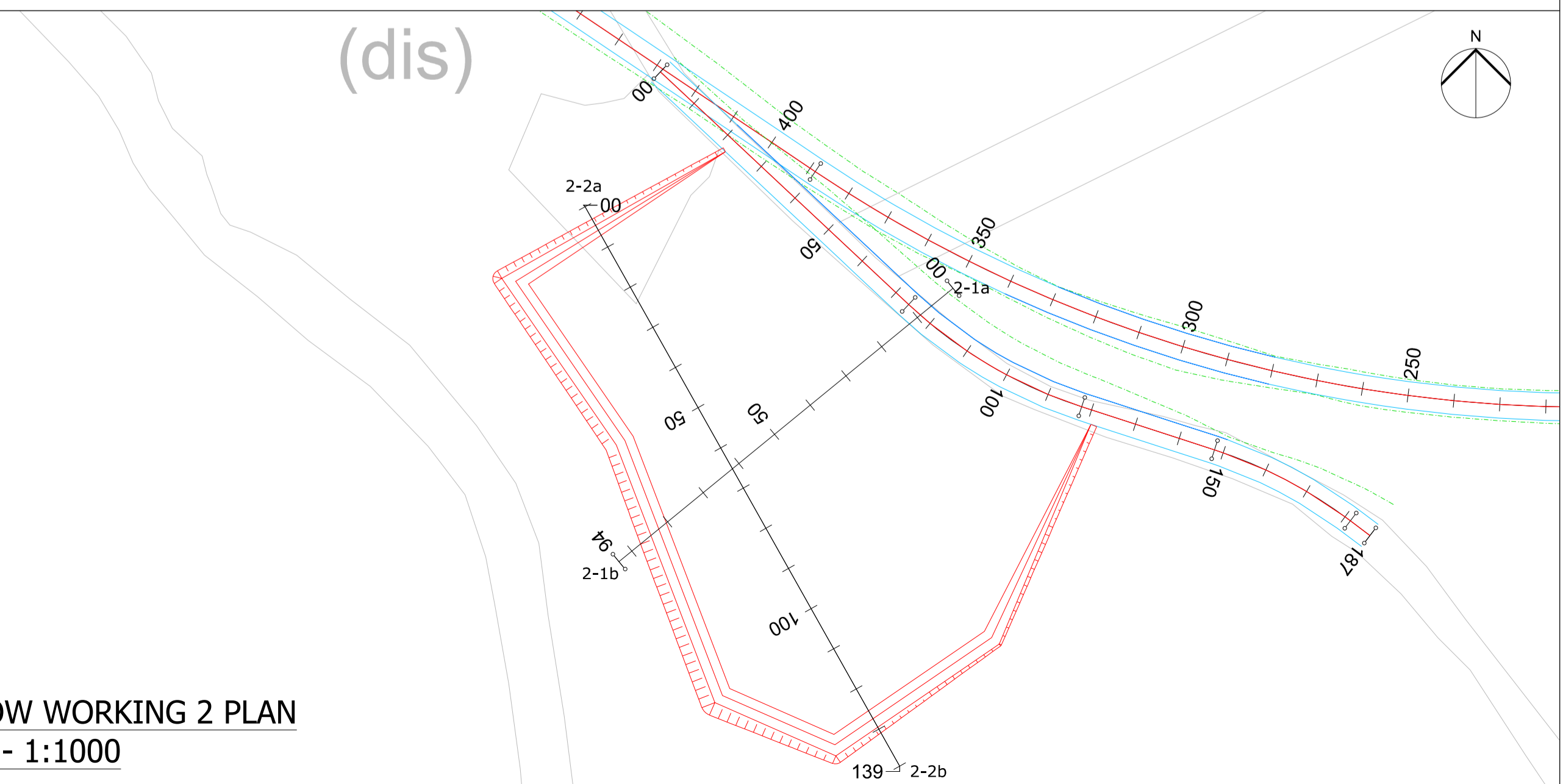
Existing Levels

Chainage

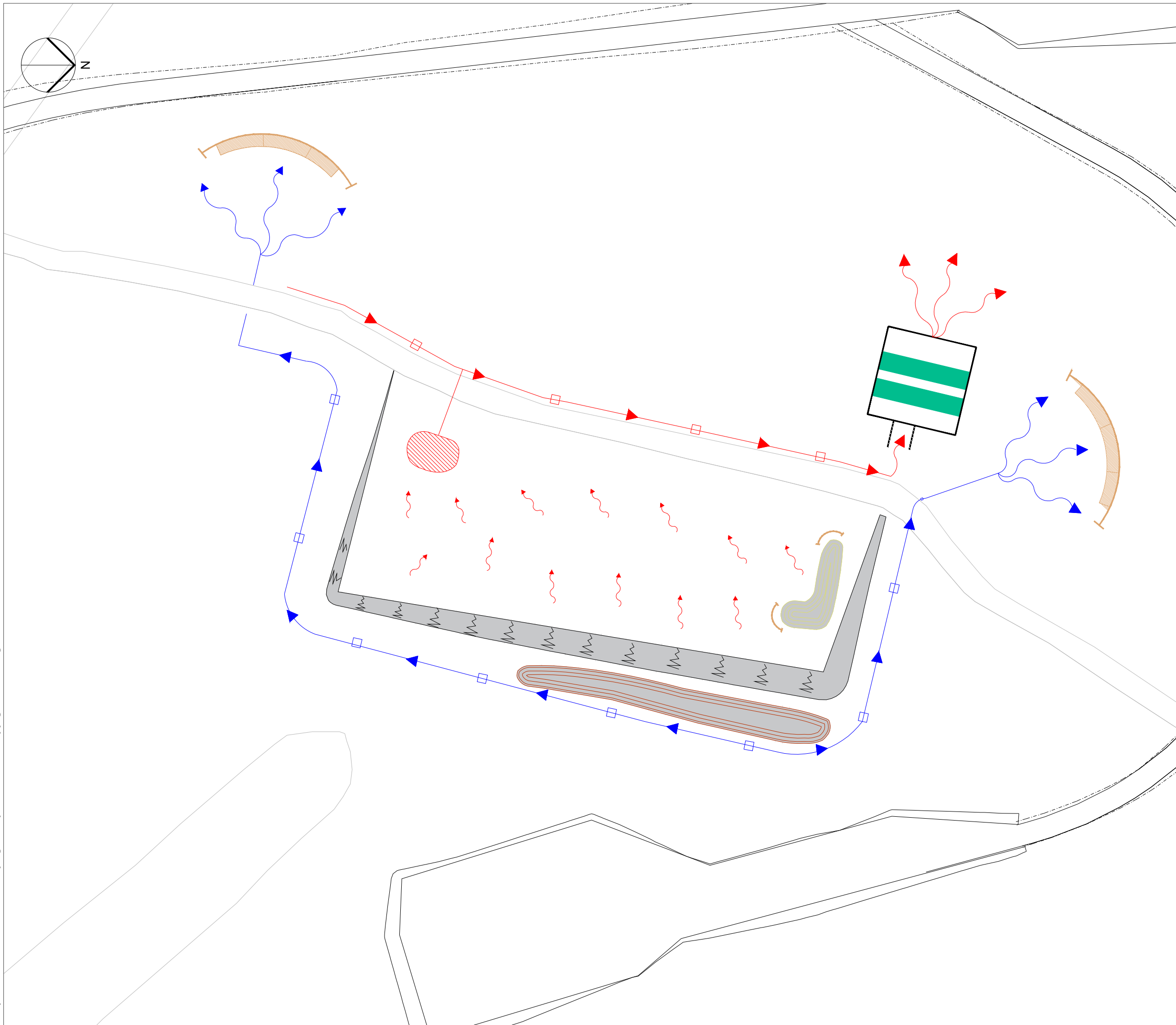
**BORROW WORKING 1 PLAN**  
SCALE - 1:1000



**BORROW WORKING 2 PLAN**  
SCALE - 1:1000



Reproduced from Ordnance Survey digital map data © Crown copyright 2015. All rights reserved. Licence number 100048606



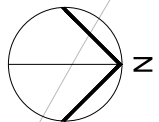
- KEY:**
- AGGREGATE STOCKPILE
  - SILT FENCE
  - SUMP
  - CHECK DAMS
  - POTENTIALLY SILTY RUN-OFF/DRAINAGE
  - CLEAN WATER RUN OFF/DRAINAGE
  - FLOW ATTENUATION MEASURES (ROCK BARS/STRAW BALES ETC)
  - STOCKPILE OF OVERBURDEN

1:1000 Scale @ A3









Produced: KB	Ref: 2966-REP-045
Reviewed: DB	Date: 09/10/18
Approved: TAT	

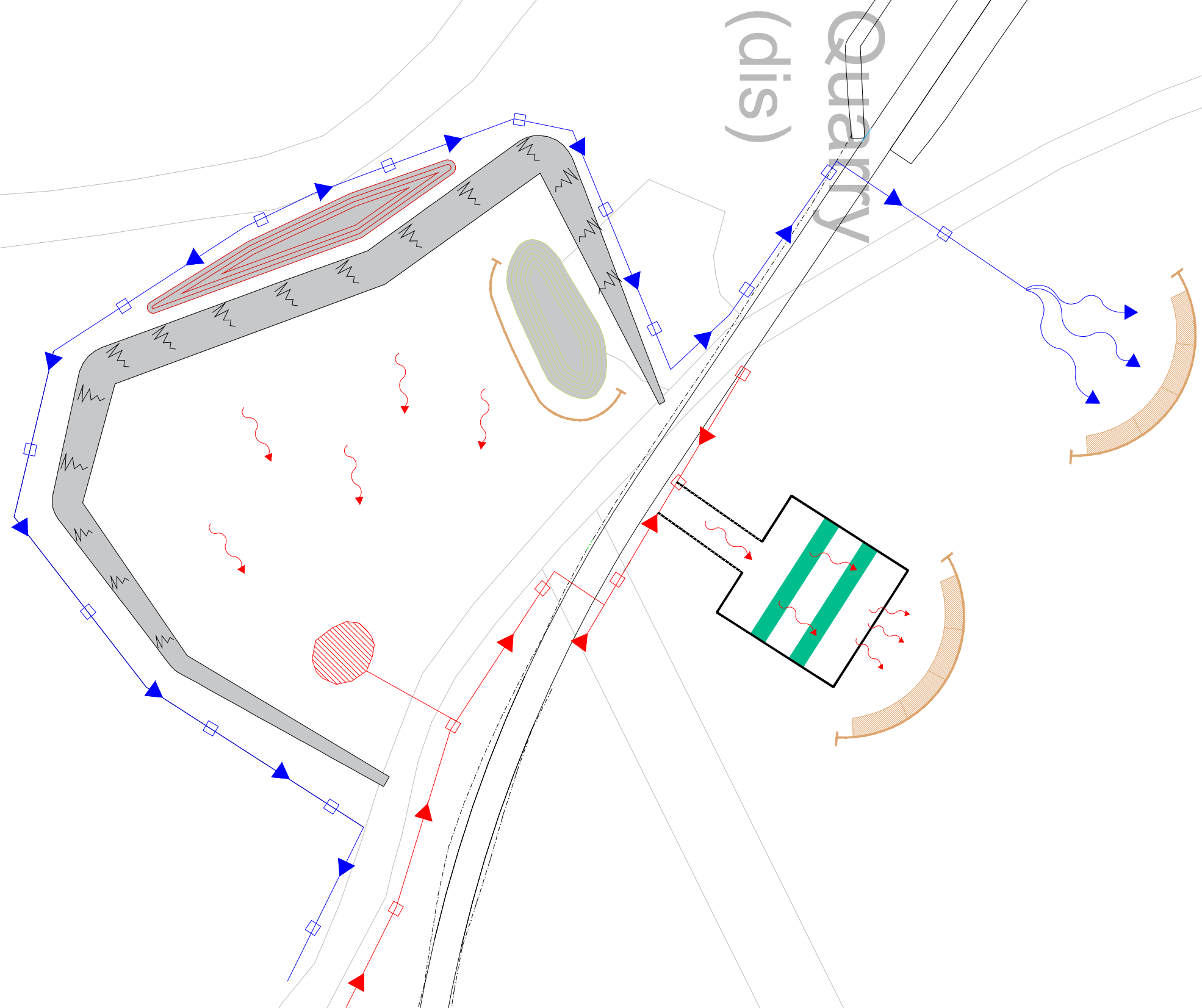
**Borrow Working 1**  
**Schematic Drainage Plan**  
 Figure 4

**Shepherds' Rig Wind Farm**  
**Borrow Pit Assessment**



KEY:

-  AGGREGATE STOCKPILE
-  SILT FENCE
-  SUMP
-  CHECK DAMS
-  POTENTIALLY SILTY RUN-OFF/DRAINAGE
-  CLEAN WATER RUN OFF/DRAINAGE
-  FLOW ATTENUATION MEASURES (ROCK BARS/STRAW BALES ETC)
-  STOCKPILE OF OVERBURDEN



1:1000 Scale @ A3

Produced: KB  
 Reviewed: DB  
 Approved: TAT

Ref: 2966-REP-045  
 Date: 09/10/18

**Borrow Working 2**  
**Schematic Drainage Plan**  
 Figure 5

**Shepherds' Rig Wind Farm**  
**Borrow Pit Assessment**