



EOS Inc Limited and Firethorn Trust

Gateway 36 Development Site – Phase 3

Ground Treatment Validation Report

325389-R06 (00)

RSK GENERAL NOTES

Project No.: 325389

Title: Gateway 36 Development Site – Phase 3: Ground Treatment Validation Report

Client: EOS Inc Limited and Firethorn Trust

Date: November 2022

Office: RSK Environment Limited, Spring Lodge, 172 Chester Road, Helsby, Chester, WA6 0AR. Tel 01928 726006

Status: Rev 00

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Revision control sheet				
Revision ref.	Date	Reason for revision	Amended by:	Approved by:
Rev 00	11/11/2022	First issue	n/a	see above

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Where field investigations have been carried out, these have been restricted to a level of detail required to achieve the stated objectives of the work.

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1 INTRODUCTION

1.1 Commissioning

RSK Environment Limited (RSK) was commissioned by EOS Inc. Limited (the client) to carry out Ground Treatment to the building footprint at the Gateway 36 Phase 3 development site, near Barnsley. The project was carried out to an agreed brief as set out in RSK proposal 325389TL02(01) dated 21 October 2021.

This report is subject to the RSK service constraints agreed within the appointment and novation agreements between EOS, the Plot purchaser and developer Firethorn Trust, and RSK.

1.2 Definition of roles

EOS Inc Limited (EOS) are the Client for the ground treatment works.

Firethorn Trust are the site purchasers and developer.

Howard Civil Engineering (HCE) Limited – is the Contractor responsible for the construction of the ground treatment works which included cut operations and surcharge placement. Who used sub-contractors for some of the earthworks including UK Scrapers.

JPG (JPG) Group Engineering Consultant – are the engineering consultant appointed by the EOS and have produced the surcharge earthworks strategy drawings and an earthworks specification relating to these drawings.

RSK Environment Limited – are the geotechnical and environmental consultants and are responsible for the ground treatment design, supervision, settlement monitoring and validation that these ground treatment works are in compliance with the RSK ground treatment specification (325389-R04 (00) dated July 2021).

1.3 Proposed development

It is understood that the site is being redeveloped for commercial end-use, including a large single warehouse building with a finished floor level of 127.4m above ordnance datum (AOD), with supporting offices and external yard areas.

1.4 Background

Historically, the site was subject to deep underground mining (Rockingham Colliery from pre-1893 to 1980) and was used for opencast coal mining (1991 to 1997). The materials used to backfill the opencast voids include re-worked superficial soils and re-worked Pennine Middle Coal Measures moved locally to minimise haulage. This backfill material is recorded as being placed in an uncontrolled manner and restoration of the wider site was completed by 2002.

The Phase 3 site is proposed for development with a large single warehouse building with supporting offices, car parks and road pavements and landscaping areas. Ground treatment works are required to improve the engineering properties of the opencast backfill (and in particular the near surface materials) beneath the proposed building area.

RSK produced ground treatment specification, reference 325389-R04 (00) dated July 2021, which detailed the ground treatment requirements for the proposed building and office area plus a 5m perimeter buffer extending beyond the building line. A copy of the specification is included in **Appendix A**.

Geotechnical modelling reported within RSK report 325389-R04 (00) indicated that 5m height of surcharge would be adequate to induce sufficient settlement and reduce the residual construction load settlement to a tolerably low order. However, it was agreed that an accelerated programme of ground treatment should be adopted, to induce the settlement in a shorter timeframe, using a 6m high surcharge mound. On this basis, a surcharge height of 6m of site-won material was to be constructed above the finished floor level of 127.4m AOD. The geotechnical modelling indicated that 124mm of settlement needed to be induced by the surcharge mounds, and that most of this settlement will be induced within a relatively short period of time after placement of the full height of surcharge. It was expected that significantly more settlement would occur in areas where levels had to be raised to reach the development platform as these would require significant thicknesses to be placed in the respective part of the surcharge mound.

Given the required volume of material for surcharging the ground treatment has had to be undertaken in two separate phases: the first area, Mound 1 was constructed over the western half of the building and the second stage of treatment Mound 2 covered the remaining building area to the east.

Mound 1 was constructed between July and August 2021 and settlement monitoring was completed during this time and for three months thereafter. Confirmation that sufficient ground settlement had been induced in the Mound 1 treatment area was confirmed by RSK in November 2021 (written confirmation in RSK letter 325389PL05 (00), dated 29 November 2021).

Mound 2 surcharge construction started on 24 November 2021 and was completed by 27 January 2022, representing a 64-day construction period. Prior to construction of Mound 2 pre-existing ground levels beneath a relatively small part of the area to the north and north-east of Mound 2 were between 1.0m and 4.0m below the proposed development final floor level. The surcharge mound infilled these areas before placement of the main (6m high) surcharge mound. Previous geotechnical modelling for the external yard area (RSK report 325389PL03 (00)) indicated that where levels were to be raised by up to 5.5m in external yard areas, then the applied loads could induce settlements of up to 123mm.

1.5 Scope of works

The scope of this validation report is to:

- provide as built information for the monitoring infrastructure installed
- collate and present the findings of the monitoring data obtained
- confirm that the requirements of the RSK Ground Treatment specification have been achieved.

The works were undertaken in two stages, Mound 1 to the west and Mound 2 to the east. The ground treatment for the Mound 1 area was completed in November 2021, and the ground treatment for Mound 2 was completed by 27 April 2022 and left in place until June

2022 before removal was started. This validation report has been prepared for both stages of ground treatment.

1.6 Previous reports

RSK have issued interim settlement monitoring reports for Mound 1 (325389PL05 dated 29 November 2022) and Mound 2 (325389PL06(00) dated 9 May 2022).

2 SITE DETAILS

2.1 Site description

The centre of the site is located at National Grid reference 435405 401137 and is shown in **Figure 1**. It is understood that the site is being considered for redevelopment for commercial end-use, including a large single warehouse building with supporting offices and external yard areas. The planned layout of the site is shown in **Figure 2**.

The site covers an area of approximately 10.5 hectares. Prior to ground treatment, the site was generally occupied by grass land and woodland, with a public footpath crossing the site from the south-west to the north-east.

Access onto the site is from the recently constructed estate road leading off the Dearne Valley Parkway roundabout.

Historical mapping indicates a legacy of mining operations at the site with extensive opencast (surface) mining in the 1990's. The backfilling of this was largely completed by 1997 with final restoration completed by 2002. Along the corridor of the Dearne Valley Parkway the opencast backfill was placed as an engineered fill, but in the surrounding areas, including Phase 3, it was uncontrolled.

3 WORKS UNDERTAKEN

3.1 Site supervision

An RSK engineer carried out full-time supervision of the works including overseeing installation of settlement monitoring infrastructure and construction of both surcharge mounds.

The monitoring infrastructure included a total of three Hydrostatic Profile Gauge (HPG) loops which were installed at the base elevations prior to surcharging. One loop (HPG3-1) was installed under the Mound 1 area and two loops (HPG3-2 and HPG3-3) were installed under Mound 2 prior to placement of materials. In addition, a total of 29 Permanent Ground Markers (PGMs) were installed at base levels before surcharging: 12 beneath Mound 1 and 17 beneath Mound 2.

3.2 Settlement monitoring

Settlement monitoring for the HPG infrastructure was conducted at regular intervals during and post construction of the surcharge mounds. With some exceptions, due to access issues, measurements were taken weekly during and after construction of each surcharge mound. The PGMs were measured by precise levelling at the time of installation, and then again when they became accessible after the removal of the surcharge.

3.3 Chronology

The key works undertaken on the Phase 3 development are summarised in chronological order in **Table 1** below:

Table 1: Phase 3 mound 1 and mound 2 surcharging chronology

Site activity undertaken	Commencement date	Completed date
Site preparation (tree stump and vegetation removal)	September 2020 Phase 3 roundabout topsoil and trees removed in 11.2020	October 2020
Topsoil strip	01.07.2021	02.07.2021
Installation of HPG loops	3-1 – 14.07.2021 3-2 – 09.09.2021 3-3 – 10.09.2021	3-1 – 14.07.2021 3-2 – 28.09.2021 3-3 – 28.09.2021
HPG measurement	15.07.2021	27.04.2022
Installation of PGM infrastructure	Mound 1 – 05.07.2021 Mound 2 – 15.11.2021	Mound 1 – 05.07.2021 Mound 2 – 16.11.2021
PGM measurement	Mound 1 – 05.07.2021 Mound 2 – 15.11.2021	Mound 1 – 06.12.2021 Mound 2 – 04.10.2022*
Surcharge construction Mound 1	16.07.2021	18.08.2021

Site activity undertaken	Commencement date	Completed date
Surcharge removal Mound 1	24.11.2021	27.01.2022
Surcharge construction Mound 2	24.11.2021	27.01.2022
Surcharge removal Mound 2	20.06.2022	November 2022

A photolog is presented in **Appendix B**.

3.4 Site clearance

Prior to any surcharging works, tree stumps and vegetation were removed from the ground surface and topsoil was stripped from across the site in late 2020. The materials derived from this were then used in the construction of part of Mound 1. The remaining material required for Mound 1 being generated by cut to development level from the adjacent Mound 2 area.

3.5 Installation of monitoring infrastructure

3.5.1 Hydrostatic profile gauge loops

Hydrostatic profile gauge loop (HPG3-1) was installed by HCE under RSK supervision with construction works completed by 14 July 2021, prior to the placement of surcharge material. HPG3-1 extended beneath the north-western corner of the Mound 1 position (west side of Phase 3 development plot).

There was a limited area in which the HPG infrastructure could be installed beneath Mound 1, this was largely due to the uneven and elevated ground surface level at the onset of the works. Therefore, only one HPG loop was able to be installed in this area.

A trench, approximately 500mm in depth, was excavated beneath the existing ground level in a curved/ arcuate pattern extending from the toe of the engineered fill into and across the area to be surcharged. Each trench was surveyed by GPS and the locations are presented on **Figure 3**.

An access pipe was laid into the trench with a gravel surround backfill/bedding material. The access pipe was to be used as a conduit for running the hydrostatic profile gauge through. By traversing the probe horizontally through the access pipe during and upon completion of surcharging, then a profile of settlement at fixed points (every 3m) over time beneath the surcharge mound were established.

Monitoring loops HPG3-2 and HPG3-3 were later constructed (in September 2021) beneath the Mound 2 position using the same methodology as HPG3-1. These two locations were beneath the northern edge and north-eastern corner of Mound 2 in areas where the maximum thicknesses of fill and surcharge were required beneath the building footprint. Due to a blockage within HPG 3-2, it was decided that subsequent monitoring would be carried out by traversing the probe from both ends (HPG-3-2 and HPG3-2(2)) of the pipe to ensure as many points could be measured as possible.

The results of the monitoring are discussed in Section 4.1.1 and 4.2.1.

3.5.2 Permanent ground markers

Permanent ground markers (PGMs) were installed across the site on completion of the clearance works and in advance of the construction of the surcharge mounds.

In total 29 PGMs were installed across Phase 3, with 12 installed under the position of Mound 1 and 17 were installed under the position of Mound 2.

The markers were installed in approximately 100mm deep hand dug pits. On completion and base line surveying the markers were covered with a sand for protection and to aid visibility after future removal of the surcharge mound.

On removal of the surcharge mounds the PGMs were precise levelled in order to provide total settlement figures across the footprint of the plots which also assists in verification of the settlement recorded by the HPG loops. Due to site traffic, some PGMs were damaged in the process of placement/unloading of the materials.

The location of each marker was captured by precise levelling techniques, which are shown on **Figure 3**. The results of the monitoring are discussed in Section 4.1.2 and 4.2.2.

3.6 Surcharge construction

The surcharge construction began in the position of Mound 1 on 16 July 2021 and was completed on the 18 August 2021. This stayed in place until 24 November 2021 when removal of the material began.

Materials for construction of the mounds were sourced from the pre-existing stockpile from a former loading test, from topsoil stripped from the site surface as well as the opencast backfill material generated from the site cutting operations including the eastern part of the proposed building. During construction of both Mound 1 and Mound 2, material classified as topsoil was segregated from other materials and was stockpiled separately in a specified area, which was surveyed to allow continued future segregation of the material.

The material from Mound 1 was then moved to the Mound 2 position. This was carried out between 24 November 2021 to 27 January 2022. Following monitoring and review of results the ground treatment was deemed complete by RSK on 27 April 2022 (after 3 months placement), however the mound stayed in-situ until 20 June 2022 when its removal was started, and materials placed into the final development landform by the enabling works contractor.

As built drawings for the surcharge mounds are provided on **Figure 4**.

3.7 Monitoring methodology

3.7.1 Hydrostatic profile gauge loops

Baseline reference readings were taken for each HPG loop following installation, and monitoring data was collected at 3m intervals by retracting the probe through the installed pipework.

Each reading was referenced to datum points comprising PGMs installed at each end of the monitoring loop. These PGMs were precise levelled monthly to ensure that the results were not being influenced by ground movement at the datum point.

Results were captured periodically (generally weekly) throughout the works, with duplicate readings of each HPG taken for each monitoring round.

3.7.2 Permanent ground markers

The location of each PGM was surveyed at the time of installation and their elevation precisely levelled.

Upon removal of the surcharge mounds, the PGMs were located using the as installed coordinates, and once exposed their elevations were precise levelled to determine the total settlement of the PGM.

3.8 Materials sampling and testing

In accordance with the RSK ground treatment specification, bulk samples of the surcharge mound were sampled by the contractor and scheduled for geotechnical classification testing to inform the earthworks specification for the enabling works contractor. A copy of the laboratory certificates are included in **Appendix E**.

4 MONITORING RESULTS

4.1 Mound 1 settlement data

4.1.1 Hydrostatic profile gauge data

Settlement monitoring results from 15 July to 10 November represent a 118-day monitoring period, of which 84 days are post-surge construction.

The recorded settlement monitoring results for Mound 1 indicate that settlement ranged from -80mm to -145mm, with an average settlement of -112mm. Measured settlement indicates that 76 percent (-88mm) of the average total recorded settlement had occurred by the 18 August, when construction of the surge mound was completed. The maximum recorded settlement (-145mm) in the period from 14 October to 10 November indicate negligible on-going settlement. These results are in line with the expected values.

The results of the HPG monitoring for Mound 1 are presented in graphical form within **Appendix C**, which include surge height data above the HPG installation during the ground treatment.

4.1.2 Permanent ground marker data

A total of 12 PGMs were installed across the original landform area before any surge material was placed to construct Mound 1. These PGMs were installed, and precise level surveyed on 5 July 2021. The location of these PGMs can be seen on **Figure 3**. Due to the uneven ground level upon which these PGMs were installed, each PGM was subject to a different covering thickness of surge material, therefore different loads and consequently they will have experienced variable settlements.

The PGMs that were closest to HPG3-1 were installed with the intention of providing a cross check of the settlement recorded by the HPG loop. Unfortunately, however as the Mound 1 surge material was removed the PGM datums were compromised and either damaged or completely removed and were not able to be surveyed.

4.2 Mound 2 settlement data

4.2.1 Hydrostatic profile gauge data

Settlement monitoring results from 18 November 2021 to 27 April 2022 represent a 160-day monitoring period, of which 89 days are post-surge construction.

The recorded settlement monitoring results for Mound 2 indicate that settlement ranged from -186mm to -276mm, with an average settlement of -240mm.

Measured settlement indicates that 68 percent (-163mm) of the average total recorded settlement (-240mm) had occurred by the 26 January, when construction of the surge mound was completed. The average recorded settlement over the 48-day period from 10 March to 27 April indicates negligible on-going settlement.

Recorded settlements beneath Mound 2 were greater than those recorded beneath Mound 1 (cf. Mound 1 -80mm to -145mm) due to HPG3-3 being installed at a lower elevation. As such up to 9.4m of load overlaid HPG3-3 in the northern section of the loop

where original ground levels reduced most, which corresponded to where greatest settlements were recorded. These recorded results are in line with the expected values.

A second monitoring loop (traversed in both directions as HPG3-2 and HPG3-2(2)) was originally installed, however extensive damage and repairs were carried out, along with re-setting of the reference datums, and data is considered unreliable and is not included.

The results of HPG3-3 monitoring for Mound 2 are presented in graphical form within **Appendix C**, which include surcharge height data above the HPG installation during the ground treatment.

4.2.2 Permanent ground marker data

A total of 17 PGMs were placed across the Mound 2 area before any surcharging was placed at elevations ranging from 125.2m AOD to 127.3m AOD with an average elevation and surcharge height of 126.6m AOD and 6.8m.

Total recorded settlement ranged from -55mm (PGM16) to -329mm (PGM10), with an average surveyed settlement of -175mm. These results are in line with the expected values.

The reported settlement values are in general agreement with recorded near-by HPG recorded settlement. For example PGM05 -248mm is in general agreement with HPG3-3 P66 -263mm, and PGM01 -218mm is in general agreement with HPG3-3 P24 -239mm.

The results of the PGM monitoring for Mound 2 are presented in **Appendix D**.

5 CONCLUSIONS

RSK have previously completed site investigation and assessment work at the Gateway 36 Phase 3 development site, including borehole and trial pit investigations. A large-scale settlement load test was also historically completed by RSK, which demonstrated that significant settlement could be induced by construction loads and that ground improvement works were required to improve the engineering properties of the opencast backfill.

RSK subsequently designed the ground treatment works for the building footprint (and 5m perimeter buffer). Geotechnical modelling indicated that 5m height of surcharge would be adequate to induce sufficient settlement and reduce the residual construction load settlement to a tolerably low order. However, it was agreed that an accelerated programme of ground treatment should be adopted, to induce the settlement in a shorter timeframe, using a 6m high surcharge mound. The geotechnical modelling indicated that 124mm of settlement needed to be induced by the 6m surcharge mound placed above the proposed finished floor level of 127.4m AOD, and that significantly more settlement was expected in areas where levels across parts of the plan area of the surcharge mound had to be raised to reach the development platform elevation before placement of the 6m high surcharge treatment mound.

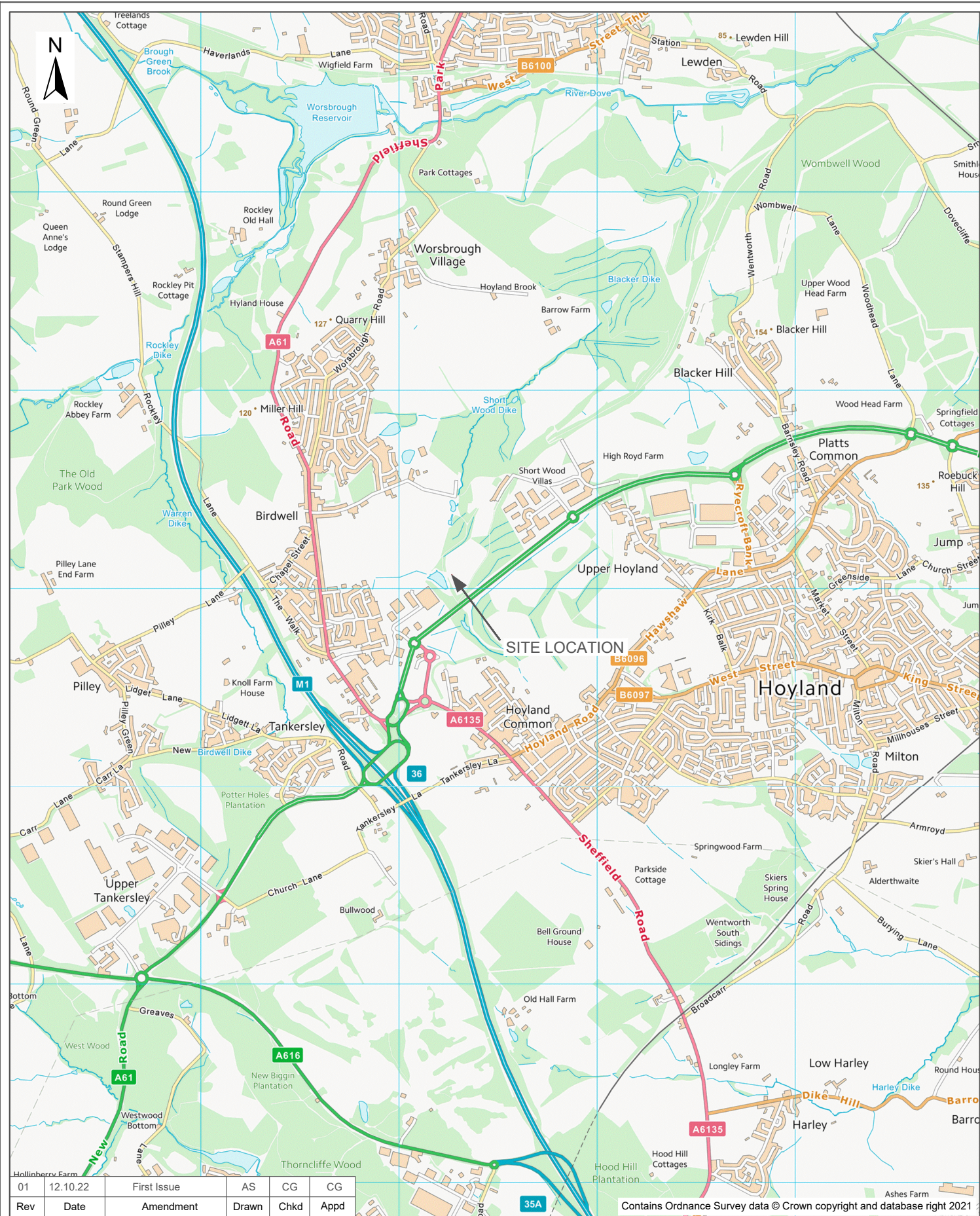
Ground treatment by surcharging was undertaken in two phases (Mound 1 and Mound 2) and was completed between 16 July 2021 and 27 April 2022 under full-time supervision by RSK. Settlement was monitored during and following surcharge construction using hydrostatic profile gauges, and permanent ground markers that were installed before the surcharge mounds were constructed, and were then re-surveyed once they were exposed following surcharge removal.

Monitoring data confirmed that recorded settlement was as expected and that the required settlement has been induced. Comparison of the total settlement recorded by the permanent ground markers agrees with the total settlement recorded by the hydrostatic profile gauge.

Settlement monitoring has confirmed that the required settlement has been induced and that construction can proceed once all surcharge materials and uncontrolled fill have been removed, and the final landform completed.

FIGURES

FIGURE 1 SITE LOCATION PLAN



01	12.10.22	First Issue	AS	CG	CG
Rev	Date	Amendment	Drawn	Chkd	Appd

Client EOS Inc Limited		
Project Name Gateway 36 Development Site - Phase 3		
Description Site Location Plan		
Dimension m	Size A4	Scale 1:25,000
Geolocation 435532, 401190	Project ID 325389	Drawing no. Figure 1
Rev 01	File name 325389-Site Location Plan	

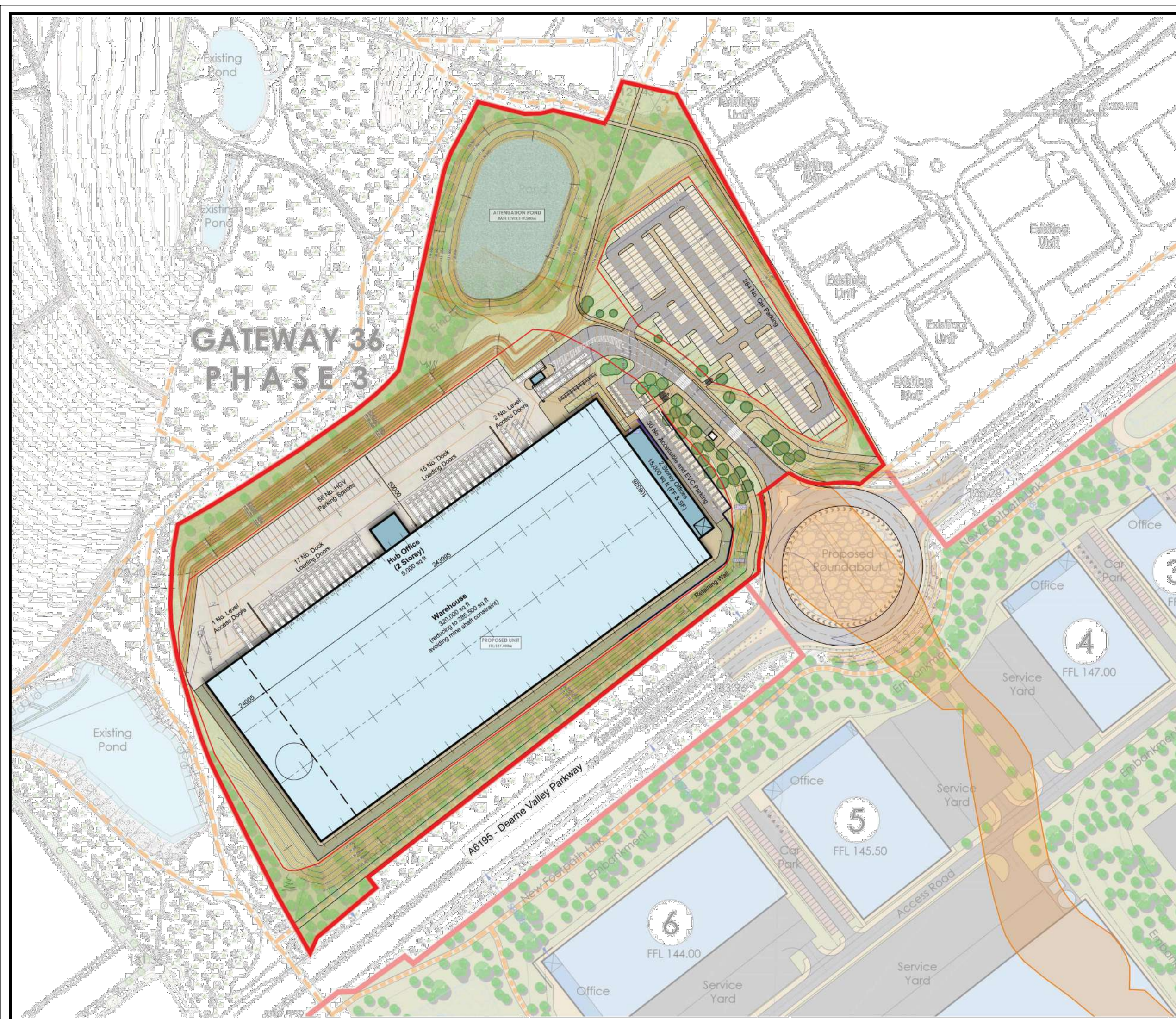


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FIGURE 2 PROPOSED DEVELOPMENT LAYOUT



LEGEND:

Site boundary

NOTE:
Proposed layout '21049_F0004[C]_Site Layout - Option 3 Revision E, dated 27.01.2021

01	24.08.21	FIRST ISSUE	HD	SR	SR
REV	DATE	DESCRIPTION	BY	CHD	APR.
Dimensions		Projection	Scale	Orig Size	
m			1:2,000	A3	

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CLIENT	EOS INC LIMITED				
PROJECT	GATEWAY 36 DEVELOPMENT SITE - PHASE 3				
TITLE	PROPOSED DEVELOPMENT LAYOUT				
JOB No.:	DRAWING FILE:				
325389	FIGURE 02				
BY:	DATE:	CONTRACT NO.	FIGURE 2	REV:	
HD	24.08.21			01	

Scale 1 : 2,000

0

20

40

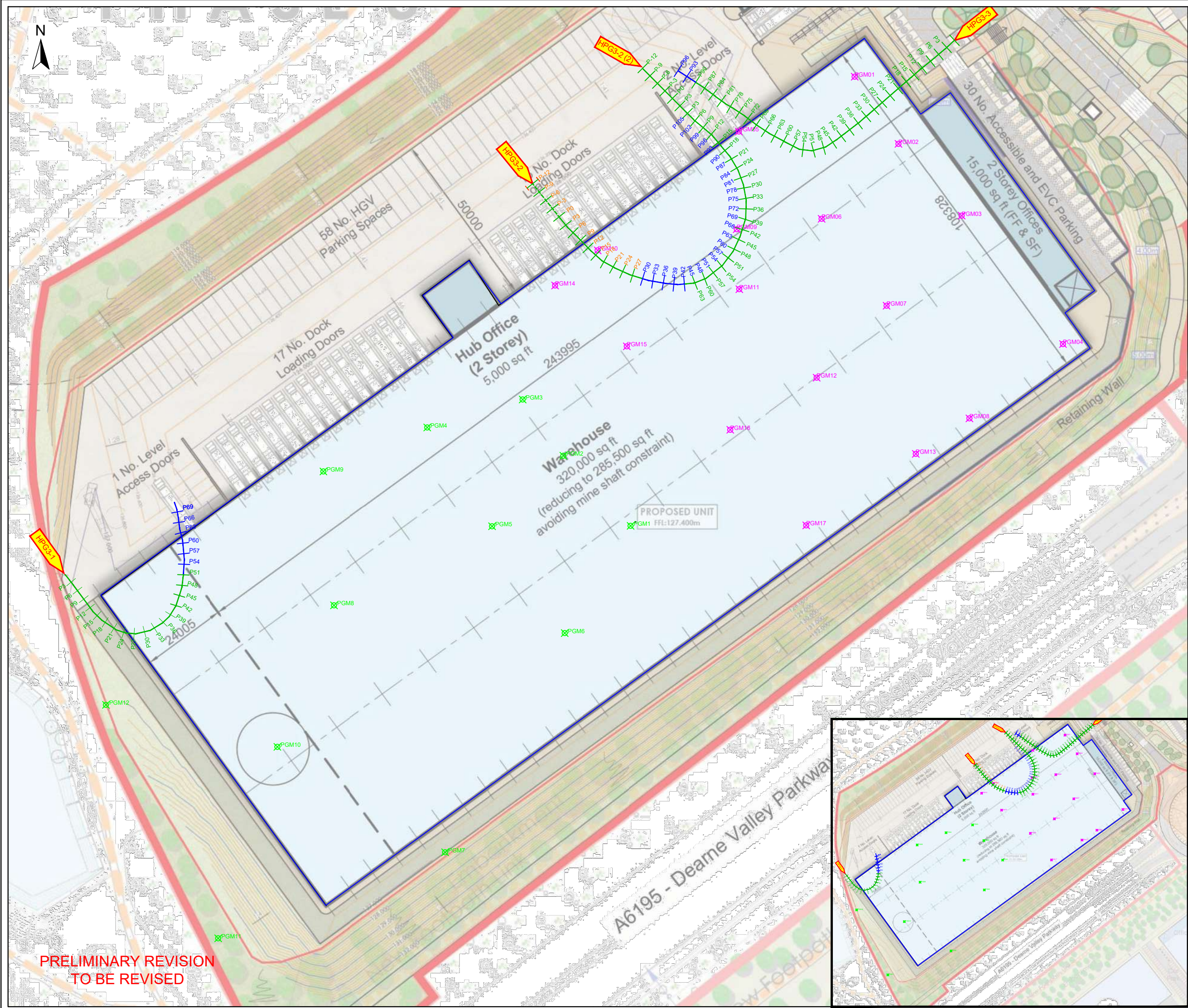
60

80

100m



FIGURE 3 PHASE 3 SETTLEMENT MONITORING INFRASTRUCTURE



LEGEND

- Site boundary
- Original position of monitoring point, no longer accessible.
- Hydrostatic profile gauge monitoring loop, installed 21.09.2021
- Permanent ground markers (PGMs) installed 5th July 2021
- Permanent ground markers (PGMs) installed 9th November 2021
- Active HPG points
- Tag location indicates station the HPG is placed during measurements.
- Indicates location of Coupler added post November 2021.

Notes:
Proposed layout '21049_F0004[C]_Site Layout - Option 3 Revision E, dated 27.01.2021.

03	20.10.22	Third Issue	AS	CG	CG
02	13.10.22	Second Issue	AS	CG	CG
01	12.10.22	First Issue	AS	CG	CG
Rev	Date	Amendment	Drawn	Chkd	Appd



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Client
EOS Inc Limited

Project Name
Gateway 36 Development Site - Phase 3

Description
Phase 3 Settlement Monitoring Infrastructure

Project ID	Drawing no.	Revision
325389	Figure 3	03

File name
325389-Phase 3 Settlement Monitoring Infrastructure

Dimensions	Scale	Size
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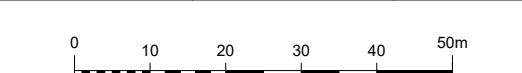
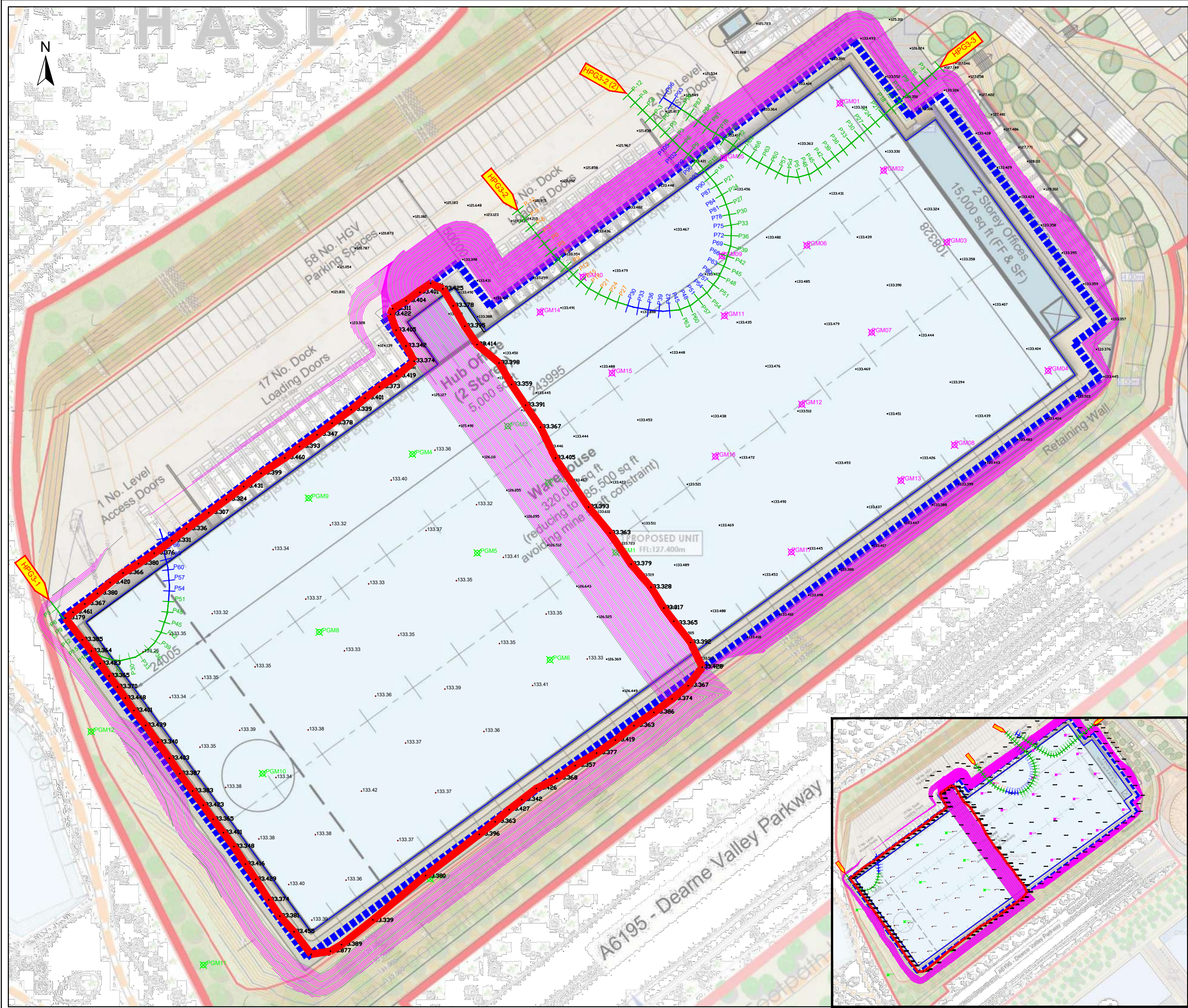


FIGURE 4 AS BUILT SURCHARGE MOUNDS



LEGEND

- Site boundary
- Original position of monitoring point, no longer accessible.
- Phase 3 Surcharge Mound 1 As-Built Survey 13-10-21
- 5m extent of surcharge crest beyond building line as per RSK specification 325389-R04 (00)
- Hydrostatic profile gauge monitoring loop, installed 21.09.2021
- Permanent ground markers (PGMs) installed 5th July 2021
- Permanent ground markers (PGMs) installed 9th November 2021
- Phase 3 Mound 2 As-Built Completed Survey 27-01-22
- Active HPG points
- Tag location indicates station the HPG is placed during measurements.
- Indicates location of Coupler added post November 2021.

Notes:

Proposed layout '21049_F0004[C]_Site Layout - Option 3 Revision E, dated 27.01.2021.

04	20.10.22	Fourth Issue	AS	CG	CG
03	20.10.22	Third Issue	AS	CG	CG
02	13.10.22	Second Issue	AS	CG	CG
01	12.10.22	First Issue	AS	CG	CG
Rev	Date	Amendment	Drawn	Chkd	Appd



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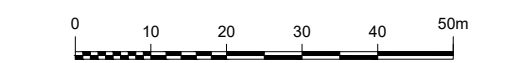
Project Name
Gateway 36 Development Site - Phase 3

Description
As-built Surcharge Mounds

Project ID	Drawing no.	Revision
325389	Figure 4	04

File name
325389-As-built Surcharge Mounds

Dimensions	Scale	Size
m	1:1000	A3



APPENDICES

APPENDIX A

RSK GROUND TREATMENT SPECIFICATION



EOS Inc Limited and Firethorn Trust

Gateway 36 Development Site – Phase 3

Ground Treatment Specification

325389-R04 (00)

RSK GENERAL NOTES

Project No.: 325389-R04 (00)

Title: Ground Treatment Specification: Gateway 36 Development Site – Phase 3

Client: EOS Inc Limited and Firethorn Trust

Date: 30 July 2021

Office: RSK Environment Limited, Spring Lodge, 172 Chester Road, Helsby, Cheshire, WA6 0AR. Contact: Siôn Roberts, Tel: 01928 726006.

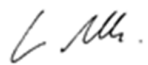
Status: Rev 00

Author	<u>Siôn Roberts</u>	Technical reviewer	<u>Gary McGuicken</u>
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Signature	<u></u>	Signature	<u></u>
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Date:	<u>July 2021</u>	Date:	<u>July 2021</u>
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Project manager	<u>Siôn Roberts</u>	Quality reviewer	<u>Ang Wallis</u>
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Signature	<u></u>	Signature	<u></u>
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Date:	<u>July 2021</u>	Date:	<u>July 2021</u>
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Revision control sheet

Revision reference	Date	Reason for revision
Rev 00	July 2021	First issue

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Where any data supplied by the client or from other sources have been used, it has been assumed that the information is correct. No responsibility can be accepted by RSK for inaccuracies in the data supplied by any other party. The conclusions and recommendations in this report are based on the assumption that all relevant information has been supplied by those bodies from whom it was requested.

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Where field investigations have been carried out, these have been restricted to a level of detail required to achieve the stated objectives of the work.

This work has been undertaken in accordance with the quality management system of RSK Environment Ltd.

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APPENDICES

Appendix A	JPG reports and drawings
Appendix B	Geotechnical modelling
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1 INTRODUCTION

1.1 Commissioning

RSK Environment Limited (RSK) was commissioned by EOS Inc Limited (EOS site vendors) and Firethorn Trust (site purchasers and developers) to prepare this ground treatment specification for the Gateway 36 Phase 3 development site, near Barnsley. The project was carried out to an agreed brief as set out in RSK's proposal 325389T102(00) dated 30 July 2021.

This report is subject to the RSK service constraints agreed within the appointment between EOS and RSK.

1.2 Objectives

This document (or any subsequent revision) provides detail on the ground treatment requirements for the Phase 3 building development platform.

This document forms part of the contract documents for the ground works, which will include a ground treatment specification for the Phase 3 development platform (this document). The ground works and subsequent building works will be designed and undertaken by the developer.

1.3 Definition of roles

EOS Inc Limited and Firethorn Trust are the Client for the ground treatment works.

Howard Civil Engineering Limited – is the Contractor responsible for the construction of the ground treatment works which will include cut operations and surcharge placement prior to handover of the site. The contractor will be required to place the surcharge mounds detailed in this document.

JPG Group Engineering Consultant – are the engineering consultant appointed by the Client and have produced the surcharge earthworks strategy drawings and an earthworks specification relating to these drawings.

Rex Proctor and Partners – will be the Employer's Agent and Quantity Surveyor for the ground treatment works.

RSK Environment Limited – are the geotechnical and environmental consultants and are responsible for the assessment of the site ground conditions and the production of the performance requirements for the ground treatment works. They will also be responsible for ground treatment design, supervision of ground treatment, and carrying out settlement monitoring and providing validation that all works are in compliance with this specification following completion.

1.4 Proposed development

The centre of the site is located at National Grid reference 435403 401141 and is shown in **Figure 1**. It is understood that the site is being considered for redevelopment for commercial end-use, including a large single warehouse building with supporting offices and external yard areas. The planned layout of the site is shown in **Figure 2**.

1.5 Site history

The site covers an area of approximately 10.5 hectares. It is generally occupied by grass land and woodland, with a public footpath crossing the site from the south west to the north east. An access estate road leading off the Dearne Valley Parkway is currently under construction, and a scheme of ground treatment (surcharging) of the building footprint was started in July 2021.

Historically, the site was subject to deep underground mining (Rockingham Colliery pre-1893 and 1980) and used for opencast coal mining (1991 to 1995), and subsequent backfilling and restoration, which was completed by 2002.

2 SITE INFORMATION

This section lists all Site information that is currently available.

2.1 RSK reports

RSK have completed site investigation and assessment work including borehole and trial pit investigation and a large-scale settlement load test. Details of work completed to date can be found in the latest versions of the reports referenced below:

- 325389-R01 (00) Gateway 36 – Phase 3 Development Summary Geo-environmental Report, April 2021
- 325389-R02 (00) Gateway 36 – Phase 3 Development Non-technical Ground Conditions Summary Report, April 2021
- 325389-R03 (00) Gateway 36 – Phase 3 Development Mineshaft Investigation Factual Report, July 2021

2.2 RSK drawings

The RSK drawings that accompany this specification are:

- 325389-R04 (00) Figure 1 Site location plan
- 325389-R04 (00) Figure 2 Proposed development layout
- 325389-R04 (00) Figure 3 Schematic of two-stage surcharge treatment
- 325389-R04 (00) Figure 4 Settlement monitoring infrastructure

2.3 JPG reports

The JPG documents that accompany this specification are:

- 4652-2-JPG-XX-XX-SP-G-0402-S1-P03-Phase_3_Earthworks_Specification

2.4 JPG drawings

The JPG drawings that accompany this specification are:

- 4652-2-JPG-P3-ZZ-DR-C-1202-S2-P03-Earthworks_Strategy_Stage_01
- 4652-2-JPG-P3-ZZ-DR-C-1203-S2-P03-Earthworks_Strategy_Stage_02

The JPG report and drawings are presented in **Appendix A**.

3 GROUND TREATMENT WORKS

Ground improvement works are required to improve the engineering properties of the opencast backfill and in particular the near surface materials in order that the performance requirements for the proposed development can be met.

The design for the ground treatment works are set out below and surcharge treatment shall be carried out in accordance with this specification.

3.1 Geotechnical modelling

In order to determine the potential ground settlement under the assumed design loads, the settlement data from the large scale load test completed in the Phase 3 site, has been back analysed to produce characteristic stiffness values for the non-engineered made ground. These have then been verified against the in-situ SPT results from site investigation works.

The resultant stiffness values have then been used to model the structural loads on pad foundations and ground bearing slab based on assumed foundation loads of 100kN/m², on pad foundations of nominal 1m dimensions and a ground bearing floor slab load of 50kN/m².

Details of this assessment is provided in **Appendix B**.

3.1.1 Load induced settlement

The previously reported large scale load test has confirmed that the opencast backfill is susceptible to significant settlement when loaded.

The proposed development will impose additional loading from (1) placement of engineered fill in part of the northern building to provide level development platforms, and (2) construction of the new building.

In order to assess the settlement which can be expected from these loads RSK have undertaken settlement modelling. This included back analysing the settlement data from the reported large scale load test and using SPT profile data from the drilling records at the site to form a ground model including a stiffness depth profile. This model was then modified to add surface loads and additional surface layers to mimic the proposed development loads and for these scenarios the induced settlement was calculated from computer modelling. This was carried out using the OASYS PDISP 20.0.0.2 software package. Full details of this modelling work is provided in **Appendix B**.

Based on the results of the large-scale loading test and the settlement modelling presented in **Appendix B**, significant settlements can be expected to be induced from future loading from the structural loads of the new buildings. In order to permit development, the anticipated settlements will have to be induced in advance of construction by ground treatment. This can only be practically achieved by placement of surcharge materials to effectively pre-load the development areas and induce settlements which are of a similar magnitude to those expected from the building loads and ensure that any residual settlements are of a tolerably low order and achieve the performance requirements set out below.

3.2 Performance requirements beneath building footprints

The performance requirements for the finished surface upon completion of the ground treatment works includes:

- allowable ground bearing pressure: 100kN/m² beneath building foundation
- anticipated floor slab load for settlement calculation purposes: Imposed Load up to 50kN/m². The imposed load will vary over time and across the footprint of the building depending on the amount of goods being stored within the building
- maximum Residual Ground Movement: 25mm
- maximum Differential Movement: 1 in 500.

3.3 Ground treatment required

The requirements for ground treatment by surcharging are detailed below. The following works will be carried out:

3.3.1 Vegetation clearance

In accordance with the JPG Earthworks Specification presented in **Appendix A**.

3.3.2 Surface strip

Strip of 'topsoil' and any organic subsoil in accordance with JPG Earthworks Specification presented in **Appendix A**.

3.3.3 Install monitoring infrastructure

The performance of the ground treatment works will be recorded by RSK using settlement monitoring equipment installed in advance of placing surcharge materials. Following vegetation removal and topsoil strip, the Contractor will install the required monitoring infrastructure as shown on **Figure 4**. The installation of settlement monitoring infrastructure will be supervised by RSK, and all monitoring will be undertaken by RSK.

The Contractor will allow safe access to RSK and any third-party staff to undertake monitoring and supervise installation, which may require the Contractor to cease working in particular areas during monitoring visits.

3.3.3.1 Hydrostatic profile gauge monitoring loops

The Contractor is required to provide plant and materials to install monitoring tubing in a number of shallow excavations and to subsequently protect monitoring infrastructure which is outlined below:

- excavation of a series of trenches each approximately 100m in length, 0.5m deep and 0.45m wide, for the installation of pipework outlined below. Indicative locations are provided on **Figure 4**. Access for monitoring will be required to the end positions of each loop and these areas should be made (by the Contractor) free draining and safely accessible
- the contractor shall provide pipework (MDPE water pipe, 50mm ID, such as Wavin MDPE Pipe Blue 50mm x 100m or similar, any joints internally flush coupled) and a

suitable pipe bedding material to sufficiently bed and protect the pipe as the trench is backfilled also ensuring that excess surface water ingress is prevented. The pipework installed in each backfilled excavation will form a settlement monitoring loop for subsequent monitoring

- the Contractor shall survey the top of the installed pipe and provide this to RSK.

3.3.3.2 *Permanent ground markers*

In advance of placement of any surcharge materials, the Contractor will install surface mounted ground anchors (permanent ground markers (PGMs)). These should be installed at a slightly reduced level in shallow hand dug pits and their precise elevation and co-ordinates recorded prior to covering with coloured sand (or similar to facilitate subsequent inspection and monitoring on removal of surcharge). The indicative number and positions of PGMs are presented on **Figure 4**.

The PGMs need to be robust as they will have to withstand the construction process required to place and subsequently remove the surcharge before completion monitoring can be carried out. The Contractor will agree with RSK practical positions for the PGMs and the measures necessary to protect them during the early stages of surcharge placement.

RSK will undertake precise levelling of the installed PGMs prior to protection with sand and commencement of the surcharging. The Contractor will allow safe access to RSK and any third-party staff to undertake monitoring and supervise installation, which may require the Contractor to cease working in particular areas during monitoring visits.

The contractor will install monitoring infrastructure under supervision from RSK as shown in **Figure 4**.

3.3.4 **Materials for use as surcharge**

Materials to be used as surcharge treatment can include the 'topsoil' and any subsoil material stripped from the Phase 3 site as well as the underlying opencast backfill materials. The opencast backfill materials will be subsequently used by the developer as engineered fill to create the final development landform.

As different materials are required to be used, they should be segregated. This includes segregation of 'topsoil' as well as opencast backfill in order to preserve both material types for future re-use. Where 'topsoil' is used within the same surcharge mound as other materials the 'topsoil' will need to be recorded and surveyed to facilitate separation when the surcharge is moved.

It is understood that the finished floor level for the development platform level beneath the new building is 127.4m AOD and given that existing ground levels are between 125m and 133m AOD, a significant volume of material required to form both stages of the surcharge treatment is already in situ.

The materials available on Phase 3 for use as surcharge include the existing former load test stockpile and materials which will be generated from a surface scrape of existing topsoil, proposed pond and car park area. Limited over-dig within the building footprint may also be required.

Available volumes for surcharge material are provided with JPG earthworks strategy drawings in **Appendix A**. The volume of material available for the works will require that the surcharging is carried out in two stages; initially over approximately half the building area to the west (stage or Mound 1) and then over the eastern area (stage or Mound 2).

3.3.5 Handling of materials for use as surcharge

Materials are to be handled in such a way that materials remain segregated and are suitable for future re-use either as engineered fill or landscaping purposes.

3.3.6 Surcharging methodology

As the existing load test stockpile and most of the in-situ materials are located over the western half of the building this should be the first loaded area before moving the surcharge treatment to the eastern half. These areas are indicated as Mound 1 and Mound 2 on **Figure 3**. The top of the surcharge mound would need to extend over the building footprint plus a perimeter area of 5m. As the opencast backfill material required to form the mound(s) will have to be used as engineered fill for the final development platform (at a later time by others) it is VERY important that, at all times, this material is segregated from the topsoil strip materials.

On the basis of the surcharge treatment being carried out in two stages (as Mound 1 and Mound 2 in **Figure 3**), the following sequence of works is anticipated:

- installation of monitoring equipment in western area (NB only limited installation and monitoring will be possible. Contractor to work with RSK to facilitate installation)
- preliminary earthworks in the Mound 1 treatment area should be carried out to segregate topsoil materials and the stockpiled materials (opencast backfill) – NB this is required to maximise re-use on completion
- site-wide strip of vegetation and generation of topsoil materials for surcharging
- placement of topsoil material in the Mound 1 treatment area to achieve accelerated surcharge mound level with segregation of materials
- excavation of opencast backfill materials over the surrounding areas including the Mound 2 treatment area, pond area and eastern borrow pit (if required) to be brought to the Mound 1 treatment area and placed to achieve accelerated surcharge mound level over the remainder of the Mound 1 treatment area (materials to be segregated)
- on completion of surcharge placement works for Mound 1, all necessary monitoring will be completed before the treatment is deemed successful (at this stage it is anticipated that Mound 1 will be in situ for only a few months post-completion, but longer-term monitoring might be recommended to demonstrate sufficient settlement has been induced)
- during the monitoring period for Mound 1 the Contractor will assist RSK to install more extensive settlement monitoring instrumentation across the Mound 2 treatment area.
- once the treatment of the Mound 1 area is approved then the materials from this area will be moved to the eastern Mound 2 treatment area. Again, topsoil and opencast backfill materials will be segregated and placed in separate areas

- during construction of the Mound 2 treatment area, monitoring will be carried out to confirm the effectiveness of the works and to measure induced settlement
- on completion of surcharge placement works for Mound 2, all necessary monitoring will be completed before approval for removal (at this stage it is anticipated that Mound 2 will be in-situ for only a few months post-completion, but longer-term monitoring might be recommended to demonstrate sufficient settlement has been induced)
- after approval of the treatment all materials can be removed from the Mound 2 treatment area and used as part of the site-wide earthworks.

3.4 Surface water inundation tests

As part of the agreed scope under the Phase 2 and 3 Contract, a surface water inundation test will be constructed and inundated by HCE prior to Mound 2 being constructed. RSK will undertake the installation and precise levelling of the PGMs.

4 SETTLEMENT MONITORING AND TESTING REQUIREMENTS

The performance of the ground treatment works will be recorded by RSK using settlement monitoring equipment installed by the Contractor under supervision in advance of placing surcharge materials.

4.1 Settlement monitoring

RSK will undertake weekly settlement monitoring of the HPG loops during surcharge construction. Weekly monitoring shall continue until the required settlement has been induced and approval is given by RSK that ground treatment has induced adequate settlement.

Monitoring of the HPG loops will also be carried out during the unloading stage for both Mound 1 and Mound 2.

Following removal of the Stage 1 surcharge (and at a later time for Mound 2), the Contractor shall give sufficient and timely notice to RSK so that the buried PGMs can be precise levelled once these are exposed.

4.2 Testing requirements

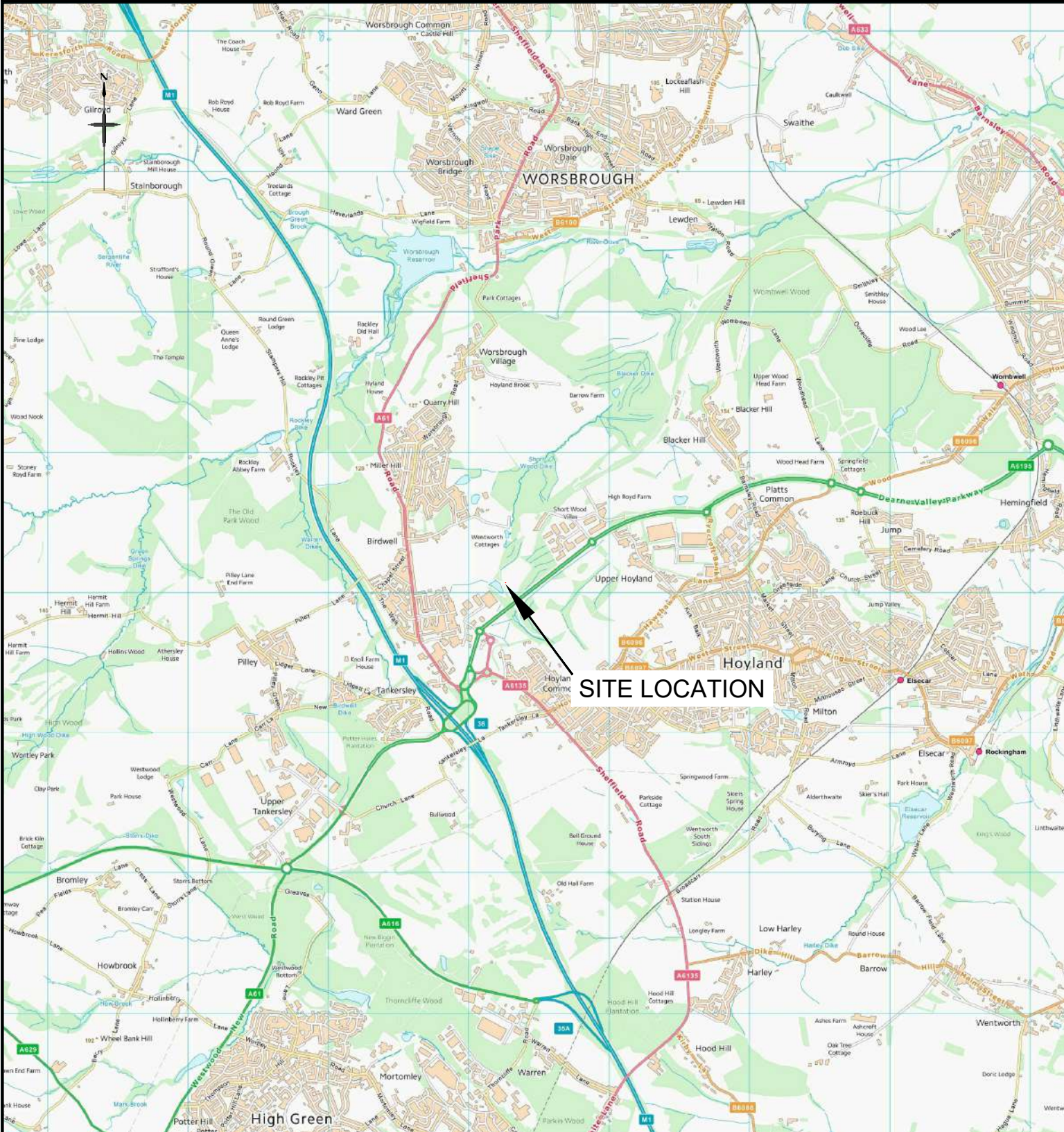
The Contractor will be required to carry out bulk sampling and testing of placed surcharge materials. These results will be made available to the plot developer as a record of the material classification and chemical status of the surcharge materials upon completion of ground treatment. The testing requirements and frequency are detailed in **Appendix C**.

5 REPORTING REQUIREMENTS

RSK will provide a ground treatment validation report following completion of the final stage of ground treatment (Mound 2) and subsequent monitoring.

The Contractor is to provide all testing and surveying data and as-built drawings of each completed surcharge mound, and reduced levels where this has taken place. Drawings shall be supplied in CAD and pdf format.

FIGURES



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Client

EOS INC LIMITED

Project Title

GATEWAY 36 DEVELOPMENT SITE -
PHASE 3

Drawing Title

SITE LOCATION PLAN

Drawn

Date

HD

27.07.21

Checked

Date

SR

27.07.21

Approved

Date

SR

27.07.21

Project No.

325389

Drawing File

325389-R04(00)D001A

Scale
NTS

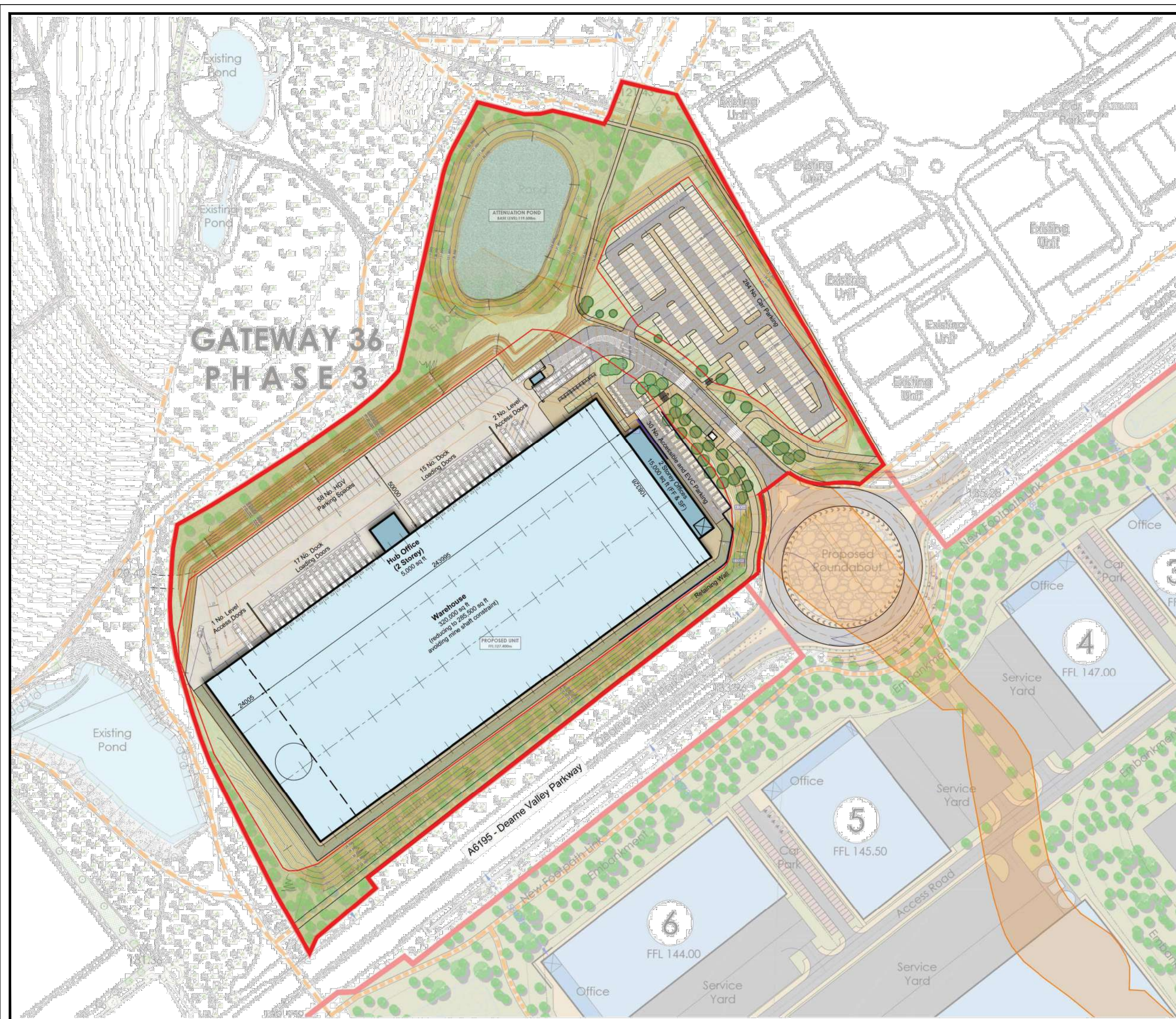
Orig Size
A4

Dimensions
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Drawing No.

FIGURE 1

Rev.
A



GATEWAY 36 PHASE 3

LEGEND:

Site boundary



NOTE:
Proposed layout '21049_F0004[C]_Site Layout - Option 3 Revision E, dated 27.01.2021

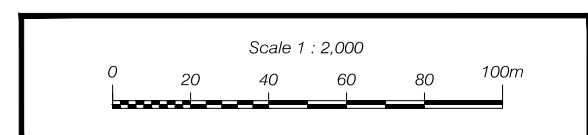
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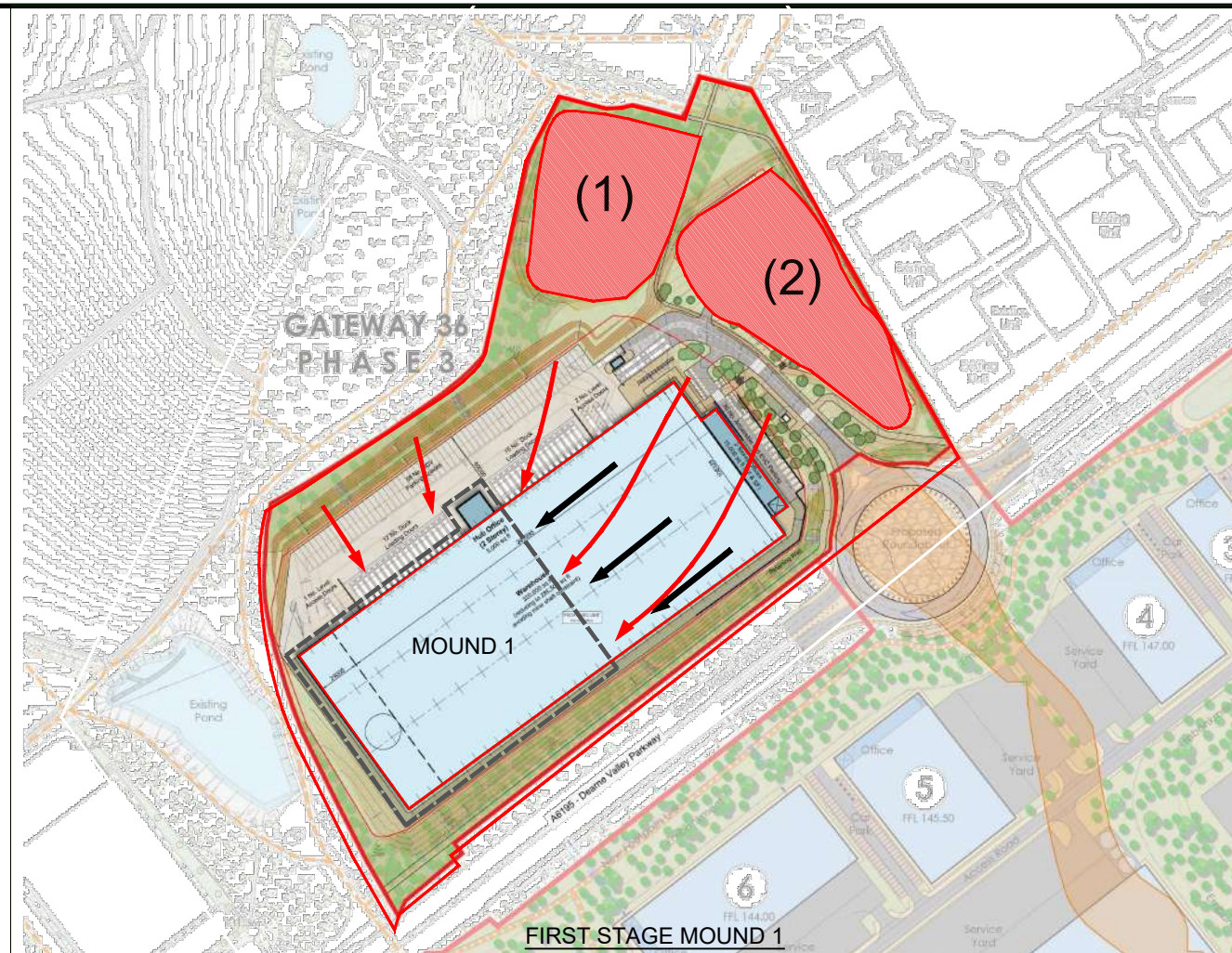


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CLIENT		EOS INC LIMITED			
PROJECT		GATEWAY 36 DEVELOPMENT SITE - PHASE 3			
TITLE		PROPOSED DEVELOPMENT LAYOUT			
JOB No.:		DRAWING FILE:			
325389		325389-R04(00)D002A			
BY:	DATE:	CONTRACT NO.	REV:		
HD	27.07.21		FIGURE 2		A



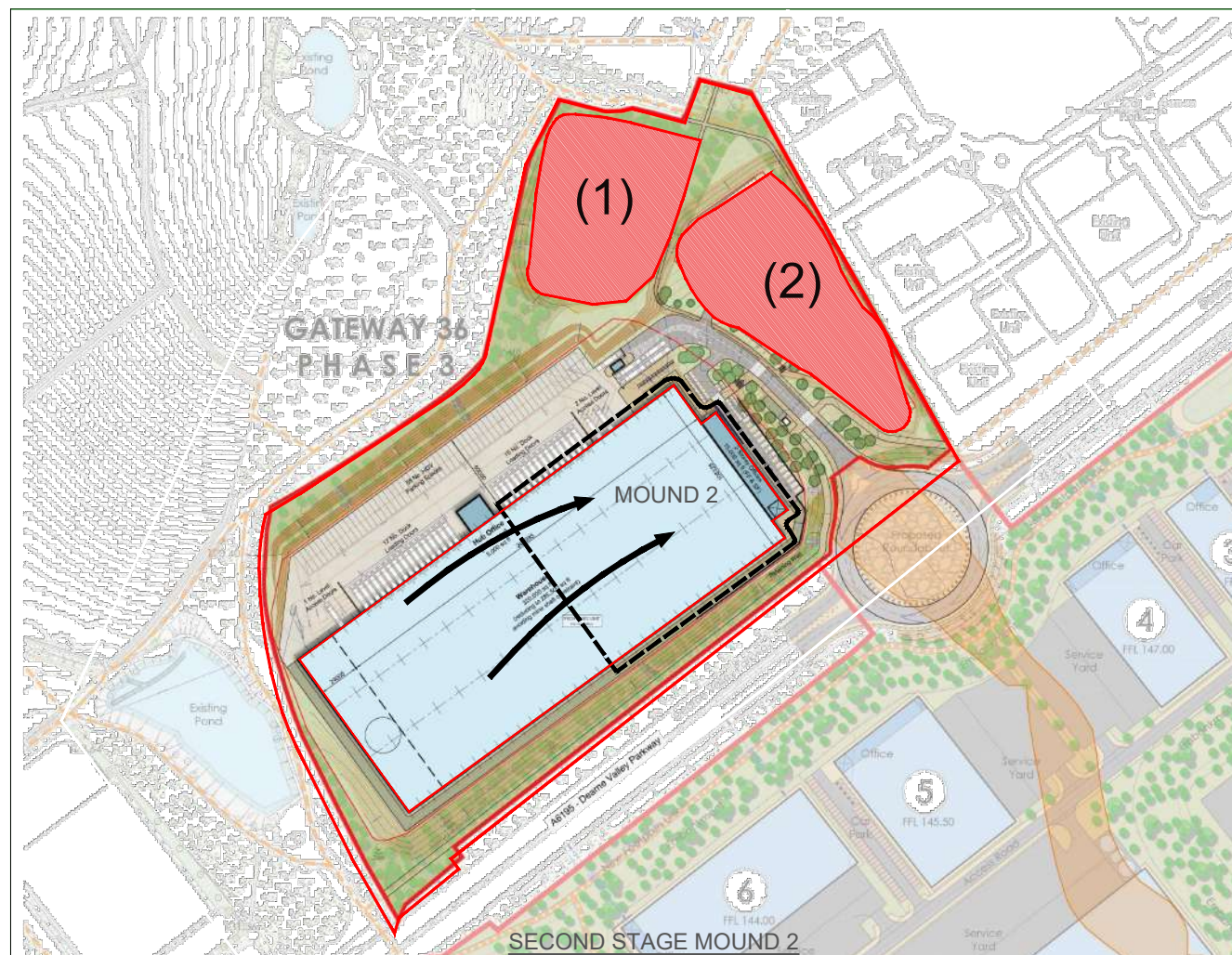


KEY:

-  Topsoil strip (from full Phase 3 area)
-  Opencast backfill (from the area where it is to be cut)

NOTE:

Material from the topsoil strip and from the opencast backfill, including load test mound, to be SEGREGATED to permit future re-use)



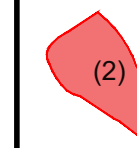
KEY:

-  Movement of materials from Mound 1 to Mound 2 (to include the segregated topsoil strip and opencast backfill materials (but also including the underlying opencast backfill where it is to be cut)

NOTE:

Materials to be be SEGREGATED to permit future re-use

LEGEND:

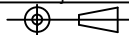
-  Site boundary
-  Outline of the top of the surcharge area (for Mound 1 and subsequently Mound 2)
-  Surcharge materials from proposed pond area
-  Surcharge material from potential borrow - pit (if required)



NOTE:

Proposed layout '21049_F0004[C]_Site Layout - Option 3 Revision E, dated 27.01.2021

REV	DATE	DESCRIPTION	BY	CHD	APR
A	27.07.21	FIRST ISSUE	HD	SR	SR

Dimensions	Projection	Scale	Orig Size
m		See scale bar	A3



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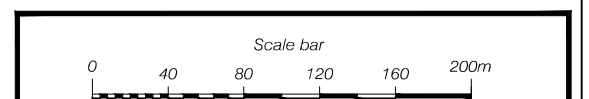
CLIENT	EOS INC LIMITED
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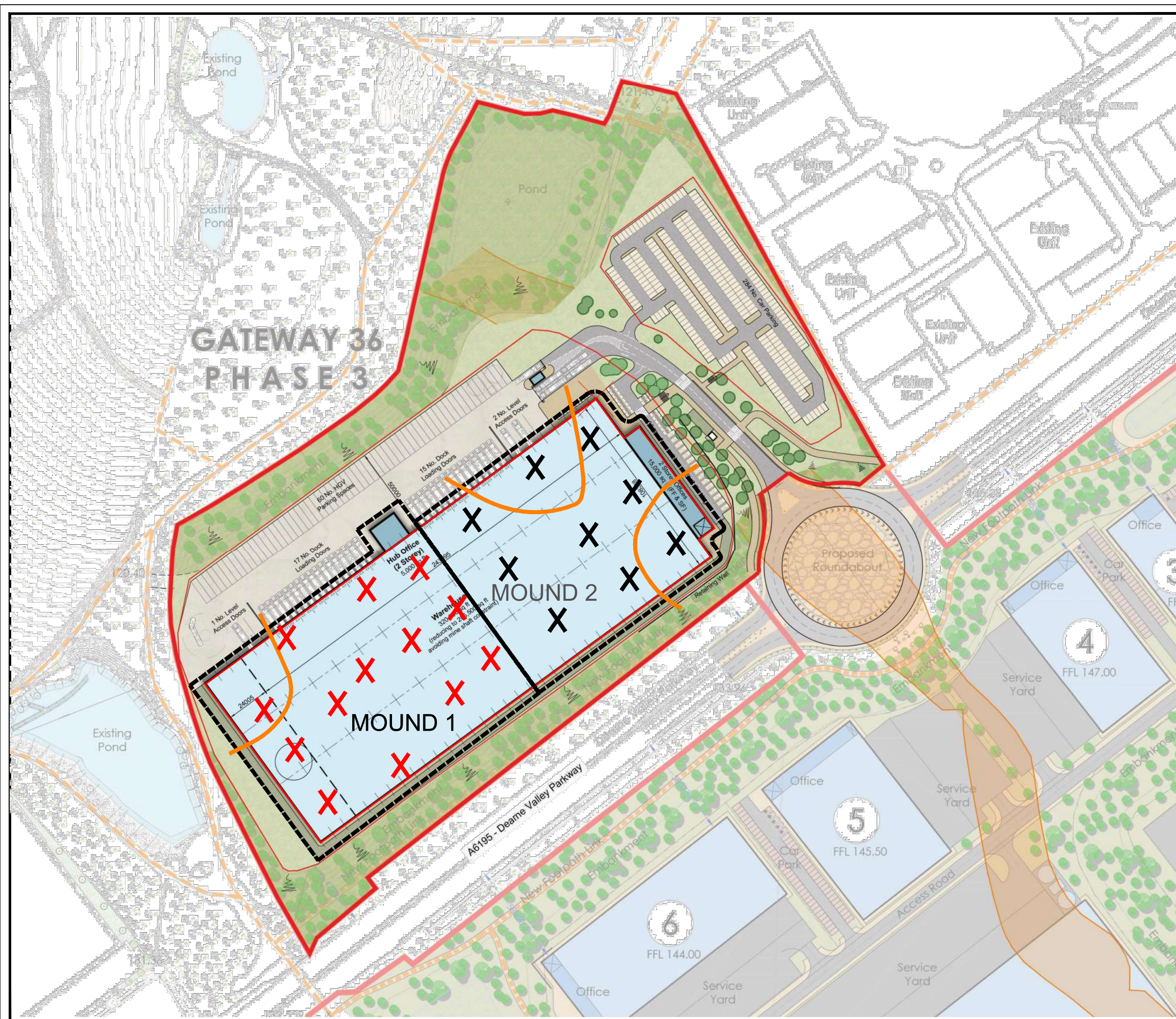
PROJECT	GATEWAY 36 DEVELOPMENT SITE - PHASE 3
---------	---------------------------------------

TITLE	SCHEMATIC OF TWO-STAGE SURCHARGE TREATMENT
-------	--

JOB No.:	DRAWING FILE:
325389	325389-R04(00)D003A

BY:	DATE:	CONTRACT NO.	REV:
HD	27.07.21		A





LEGEND:

- LEGEND:**
-  Site boundary
 -  Outline of the top of the surcharge area (for Mound 1 and subsequently Mound 2)
 -  Surcharge Stage 1 ground markers, indicative position at sub-current ground level and moved locally according to ground conditions
 -  Surcharge Stage 2 ground markers, indicative position at approximate cut formation level
 -  HPG monitoring loop and headworks installed by HCE. RSK to monitor
- 

NOTES:

- Ends of HPG trench to extend at least 3m beyond the toe of the proposed surcharge mound to facilitate access (provided and installed by Contractor)
- Trench to be a minimum 0.5m deep, with pipe bedding at base (provided and installed by Contractor)
- Base of the trench to rise at a gentle gradient towards the ends to enable the settlement probe to traverse the access pipe
- Base of trench to be surveyed by HCE
- Trench to be filled with pipe bedding (provided and installed by Contractor)
- Measures should be taken by the Contractor to protect the monitoring loop from plant movement to prevent the pipe from being crushed
- Headworks to be installed comprising 2m x 2m pad with shuttering and gravel to form a flat and stable monitoring platform with a ground marker datum installed (provided and installed by Contractor)
- Installation to be supervised by RSK

NOTE:

Proposed layout '21049_F0004[C]_Site Layout -
Option 3 Revision E, dated 27.01.2021

A	27.07.21	FIRST ISSUE	HD	SR	SR
REV	DATE	DESCRIPTION	BY	CHD.	APR.
Dimensions		Projection	Scale	Orig. Size	
m			1:2,000	A3	



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CLIENT

EOS INC LIMITED

PROJECT

GATEWAY 36 DEVELOPMENT SITE -
PHASE 3

TITLE

SETTLEMENT MONITORING INFRASTRUCTURE

JOB No.:

325389

DRAWING FILE:

325389-R04(00)D004A

BY:

DATE:

CONTRACT NO.

REV:

HD

27 07 21

FIGURE 4

A

