Appendix 9.2

GEO-INEGRITY PHASE I GEO-ENVIRONMENTAL ASSESSMENT AND SITE WALKOVER SEPTEMBER 2023

FINAL

London Borough of Hillingdon

Phase I Environmental Desk Study Report

Hillingdon Water Sports Facility and Activity Centre (HWSFAC)

Broadwater Lake,

Moorhall Road,

Harefield,

UB9 6PE

Report No: 23-09-03A

September 2023

Geo-Integrity, 4 Church Street, Maids Moreton, Bucks. MK18 1QE

Landline: (01280) 816409 Mob.: 07858 367 125 Email: info@Geo-Integrity.co.uk

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1 September 2023	Final Report	Murray Bateman M.Sc. DIC C.Geol Pg. Cert. Director SIGNATURE 	Fiona White B.Sc. M.Sc. Graduate Engineering Geologist SIGNATURE 

CONTENTS

Geo-Integrity Mob.: 07858 367 125 Email: info@geo-integrity.co.uk

APPENDICES

APPENDIX A - PLANS AND PHOTOGRAPHS

- Site Location Plan
- Development Proposal Plan
- Potential Contamination Sources
- Historical Site Photographs
- Site Photographs

APPENDIX B - DESK STUDY INFORMATION

- Natural Cavities Risk Assessment
- Historical Borehole Logs
- Historic Ordnance Survey Maps
- Groundsure Datasheet

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1 INTRODUCTION

1.1 SCOPE AND OBJECTIVES

Geo-Integrity Ltd were commissioned by Mace Group via Purchase Order (No. MLIMPD0028877) on the 5th of September to update the existing Phase I Desk Study (Ref.22-10-12) for the proposed Hillingdon Water Sports Facility and Activity Centre (HWSFAC), Broadwater Lake, Moorhall Road, Harefield, UB9 6PE in order to inform the design and construction of the proposed development. This updated report has been given a new reference number 23-03-09B.

The updates in the report relate to changes within the development proposal and further assessment of the risk of UXO at the site. This updated report (ref.23-09-03A) supersedes the previous version (Ref.22-10-12).

The land is centred at OS Reference TQ 04373 89581.

This report is likely to be submitted as part of a planning application to redevelop the site. Once the development is completed, and as a minimum, land must not be capable of being determined as 'contaminated land' under the terms of Part IIA of the Environmental Protection Act 1990. However, it also states that "Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner." As such this desk study report is the first stage in investigating whether the site is likely to be considered "contaminated", in accordance with clause 184 of the NPPF.

The objectives of this Phase I geo-environmental desk study report are:-

- To undertake a site walkover and identify any potential pollution sources on the site.
- To gather historical, geological and environmental information.
- To complete a preliminary site conceptual model so that potential pollutant linkages can be established and investigated further.

1.2 PROPOSALS

The proposed development involves the redevelopment of the site to create the Hillingdon Watersports Facility and Activity Centre including demolition of existing Broadwater Lake Sailing Club (BSC) clubhouse at the north of the lake and erection of a building to be occupied by HOAC

and BSC including changing facilities, meeting rooms, storage, workshop and seasonal worker accommodation (sui generis), seven activity shelters; three pontoons; two concrete slipways; one boat shed; two equipment storage huts (north of lake and at entrance); boat parking and racking areas; camping area; outdoor activity areas; ecological enhancement throughout the site; new pedestrian routes through the peninsula; landscaping including new woodland, dense vegetation screens and boundary treatment; new access and access road; localised dredging and land reclamation; relocation of existing sailing area and creation of floating and fixed islands within the lake; coach drop off and turning area; vehicle parking; cycle parking; and associated works.

1.3 SOURCES OF INFORMATION

The following sources of information have been used to compile this report:-

- Extracts of available historical Ordnance Survey (OS) maps covering the period from 1865 to 2022, which are presented in the Appendices.
- Groundsure Report Ref GS-9151609 included in the Appendices.
- The British Geological Survey (BGS) and Environment Agency (EA) websites.
- A site reconnaissance visit undertaken on 27th October 2022.
- Information from various internet sites on site history and environmental setting.

It should be noted that the information provided in the desk study is obtained from independent third-party sources. It is provided in good faith, but no guarantee can be provided as to its accuracy. The desk study information is not necessarily exhaustive and further information relevant to the site may be available from other sources.

1.4 WALKOVER SURVEY

A site walkover survey was undertaken on the 27th October 2022. Site location and layout plans are included in the Appendices, along with a selection of photographs taken during the survey.

The site is located to the west of Greater London, approximately 4km northeast of Junction 16 of the M25. It is in a predominantly rural setting, with the Grand Union Canal running down the east boundary of the main site and the River Colne marking the northern and western boundary of the main site. The southern boundary of the main site is marked by a flooded former sand and gravel extraction pit, called Harefield Pit, along with a group of residential properties and an aggregates business. There were also two outlier site marked on the site plan, Site 1 was located to south of

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Harefield Pit adjacent to Moorhall Road, and Site 2 was located to the east of the site, on the opposite side of the Canal adjacent to St Mary's Road and Broadwater Farm. A viaduct destined to carry HS2 was being constructed to the immediate southwest of the site, across the route of the River Colne, and there was a construction compound to the south of the main site and to the west of Site 1, along Moorhall Road.

The main site was approximately 1.2km north to south and 600m east to west, being about 79.95 hectares in area. The majority of the site consists of the Broadwater Lake with associated island and a small area of land to the north that houses the Broadwater Sailing Club and car parking and the access track to this area, between the canal and the lake. Marker posts for a HP gas main were seen crossing the sailing club car park and land at this end of the site.

The main area of land is in the southeast corner of the lake where access is gained via the trackway from Moorhall Road to the south. This area is entered from the southeast corner where there is a small bungalow and associated gardens, the trackway extends westward from there, past an old weighbridge, then turning northward up towards the end of the land promontory. Along the trackway on either side old concrete constructions can be seen, including pits and large raised gantries. There was also a small sub-station to the east of the trackway, about halfway up. There are many small pathways off the trackway that all lead to individual or multiple fishing locations. One of these pathways leads along the southern boundary of the site and the lake, towards the River Colne. To the south of this pathway were remnants of the Harefield Pit that were overgrown with young willow sapling and marked as dangerous because of quicksand.

Site 1 was a small rectangular field with maximum dimension of 130m north to south and 60m east to west. It was located to the immediate east of the HS2 compound with Moorhall Road to the south and Harefield Pit to the north. It was covered with rough grass and weeds.

Site 2 was a small triangular site with maximum dimension of 130m from north to south and 90m across the base from east to west. Its area was approximately 0.7 hectares. Access to the site was not possible, as the route in was blocked by a transport yard and domestic housing, however, looking at the site from the opposite side of the Canal, it appeared to be complete overgrown with shrubs and trees.

There were no significant pollution sources located on the site during the walkover. However, on the main land area of the main lake there were a number of historical industrial remnants (such as

weighbridge, hoppers and conveyor gantries, electricity sub-station). These will obviously provide a point source of historical contamination, such as oil spillage.

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2 GEOLOGY

2.1 PUBLISHED GEOLOGY

Reference to the British Geological Survey website and Sheet 255; Beaconsfield 2005, indicates that the site is underlain by Worked Out Ground, Alluvium, Shepperton Gravel and Newhaven Chalk.

Alluvium is ground associated with the nearby River Colne and would consist of interbedded clays, silts, sands and gravels, with localised peat, associated with flooding events and the meandering of the river across the valley floor.

Shepperton Gravel Member is of Devensian age from the last Ice Age. It is designated as a River Terrace Gravels, which means it is formed as one of a series of level surfaces in a river valley, produced as the dissected remnants of earlier abandoned floodplains. It generally consists of sand and gravel, locally with lenses of silt, clay or peat, although this is what would have been removed across the majority of the site area.

The Newhaven Chalk formerly the Upper Chalk, is generally described by the British Geological Survey as a smooth white chalk with numerous marl seams and flint bands. The thickness of this unit in the site area is typically between 90m and 130m.

2.1.1 Historical Borehole Data

The British Geological Survey holds records of exploratory holes, historically put down across the United Kingdom during historical investigation. There are two historical boreholes located on the site, that were put down by Affinity Water in 2013. Both found Alluvium and Shepperton Gravel to depths ranging from 3.50m bgl to 6.0m bgl with Chalk beneath that to a maximum depth of 76.50m below ground level. Groundwater depth in both boreholes was encountered at between 1.20 and 1.80m bgl

2.1.2 Solution Features

Chalk, as a calcium-carbonate rich rock, is highly susceptible to dissolution by water containing carbon dioxide. This dissolution can create three common types of features within the chalk, grouped together under the generic term ‘dissolution features’. These features include:

- *Sinkholes:* Depressions at the ground surface caused by the collapse of overlying chalk or superficial deposits into underground voids created by dissolution. Shape and size dependent on underlying void feature
- *Solution pipes:* A feature in the surface of the Chalk caused by increased dissolution in an area of closely spaced discontinuities. These features may, or may not, have a ground surface expression. Up to 20 metres diameter though commonly much smaller
- *Swallow Holes:* A void within the surface of the Chalk where a stream is 'swallowed' by the Chalk to flow underground. Often occur at the junction of impermeable strata and Chalk. Infilled ancient swallow holes do exist where streams used to flow and may not have any surface expression. Up to 14m in diameter, though commonly a few metres.

2.1.3 Natural Cavities Risk Assessment

A natural cavities risk assessment has been undertaken following the paper written by Clive Edmonds in 2001, 'Predicting natural cavities in chalk'. This gives a score to various factors including; type of chalk, topography, groundwater level, strata overlying the chalk, periglacial and glacial history. The score for this site was 28, which means there is predicted to be No Anticipated Subsidence Hazard risk of natural cavities beneath this site (0% occurrence).

2.2 PREVIOUS WORK

To our knowledge there has been no previous investigation on the site.

3 HISTORY OF THE SITE

The history of the site has been established by the review of old Ordnance Survey maps going back to 1865 and internet searches. The maps and any other relevant information are included in the Appendices and indicated the following.

3.1 ORDNANCE SURVEY

The historical maps start in 1865 and it can be seen at this time that the site area is mainly open agricultural land with a network of ditches across it. It was named Harefield Moor, presumably due to the damp nature of the ground. The Grand Union Canal has been constructed along the eastern boundary at this time and the River Colne marked the northern boundary. There are no significant buildings on the site at this time, only a few farm building to the north of the site. Off-site there is a chalk pit and kilns marked to the immediate east of the canal, about halfway up the main site. In addition, there is a large industrial complex of mills 750m north of the site and a small Flour Mill to the immediate north of the site, “Jacks Mill”. Site 1 and 2 are open agricultural fields at this time.

The main site and Sites 1 and 2 remain the same, but in 1897 it can be seen that the Lime Kilns to the east of the site have expanded by that time, with a larger borrow pit having been dug also. In addition, the mill building 750m to the north of the site are marked as Asbestos Mills. This was the United Asbestos Mill which was open in this location from 1890 to 1920; these had previously been copper and paper mills.

The sites again remain undeveloped, but by the 1930s, residential development can be seen to the southeast of the main site, along Uxbridge Road; and the Brick and Cement Works to the east has expanded greatly with tramway and several disused chalk pits.

No significant change occurs until the plan of 1960, when although the site remains the same, it can be seen that gravel extraction has begun to the north and south of the site, with Harefield Pit and Troy Mill Gravel Pit both having been extracted and shown as lakes.

The plan of 1968 shows that the Cement and Brick Works had been reused as a refuse tip by that date, and it shows that gravel extraction from the main site area had start by that date with the central and southwest areas having been extracted. It is not until the plan of 2001 that the site boundaries as seen during the walkover are the same, and this involves a large amount of refilling to the west of the land promontory on the main site (therefore this is not original land). The plan shows this refilling occurring around the middle of the 1990’s. Little change occurs to Sites 1 and 2.

3.2 UNEXPLODED ORDNANCE AND BOMB SITES

Reference to an online UXO risk map produced by Zetica indicates that the site is located in an area where there is a low risk of unexploded ordnance. Low risk regions are those with a bombing density of less than 15 bombs per 1000 acres or less.

A preliminary UXO risk assessment was undertaken by Impartial Assessments Ltd. dated 11th of September 2023 ref. PRA.10144.23 and identified there is a potentially elevated likelihood of EO (Explosive Ordnance) encountered during the proposed development including potential siteworks. The salient points from the report are provided below:

- The German air force earmarked an airfield just 700m away for attack. In the event, there was an elevated local bombing density (at least 10 bombs landed within 200m of the site, including one actually on site). And there is a higher risk of UXBs falling unwitnessed on isolated farmland during WW2.
- Post-war sand / gravel extraction may not have extended down to the max bomb penetration depth and did not affect the entire site area anyway. So UXBs could conceivably remain buried on site.
- The canal was a WW2 fortified defence line. This indicates various army activities (potentially involving live ammunition) along the eastern edge of the site.

Therefore, a stage 2 detailed risk assessment has been recommended to elucidate the potential risk.

4 DESK STUDY INFORMATION

4.1 HYDROLOGY

The nearest surface water course is obviously on the site, Broadwater Lake. However, the nearest surface water abstraction licenses is 1156m south of the site at the Buckinghamshire Golf Co for top up and make up water for irrigation.

4.2 HYDROGEOLOGY

Reference to the Groundsure report indicates that the site is located on a Secondary A Superficial Aquifer, and is located on a Principal Bedrock Aquifer.

The aquifer designation data is based on geological mapping provided by the British Geological Survey. The maps are divided into two different types of aquifer designation:

Superficial (Drift) - permeable unconsolidated (loose) deposits. For example, sands and gravels.

Bedrock - solid permeable formations e.g. sandstone, chalk and limestone.

For each type there are four designations:- Principal, Secondary A, Secondary B and Unproductive Strata, ranked by importance.

The nearest active groundwater abstraction licenses are within 100m south of the site. They are run by Affinity Water at Northmoor Pumping Station.

The site is located in a Source Protection Zone 1 (SPZ1 – inner catchment). A Source Protection Zone (SPZ) is a designated area around a well or abstraction borehole. The inner catchment is the zone 50 day travel time of pollutant to source with a 50 metres default minimum radius. It is the most sensitive and means that the Environment Agency would require a developer to prove their proposals do not have the potential to pollute or harm groundwater.

4.3 WASTE

4.3.1 Landfills

Reference to records from the BGS, the Environment Agency and the Local Authority indicates that there is one historic landfill on the site. This is located to the southeast of the main site on the eastern side of the land promontory. It was run between 1993 and 2004 and was run by LaFarge Aggregates and was used to dispose of Non-Biodegradable Waste.

In addition to this there are three further landfills within 500m of the site. The closest is the old Brick and Cement Works to the east. This was used as a Refuse Tip between 1954 and 1974 run by WW Drinkwater and used for Commercial and Household waste.

The second was 189m southeast of the site at Harefield Marina from 1947 for household and industrial waste and the third was 387m to the northwest at Pynesfield Inert Landfill, Tilehouse Lane between 2018 and 2021 run by Ingrebourne Valley

4.3.2 Other Waste Treatment Sites

There are six waste exemption records within 250m of the site. These include Screening and blending of waste, treatment of waste wood, use of waste in construction, burning waste and spreading of plant matter to confer benefit. These are to do with the various industrial land uses around the site, including the Aggregates Company to the south, the pumping station on the opposite side of Moorhall Road and the HS2 construction site.

4.4 LOCAL INDUSTRY AND ENVIRONMENTAL PERMITTING

4.4.1 Local Industry

Reference to the Groundsure Datasheet indicates that there are eleven existing industrial processes within 200m of the site. These include the aggregates company, the pumping station, a haulage company to the south of Site 2, sub-stations, and lifting and handling company, a business park, electrical components company and caravan sales yard.

4.4.2 Environmental Permitting and Incidents

Reference to the Groundsure Datasheet indicates that there are no historic IPC authorisations within 500m of the site. There are no records of any Part A(1) licensed industrial activities within

INTEGRITY

500m, and one historical record of Part A(2)/B licensed pollutant release, use of bulk cement 27m south of the site. There has been one licensed discharges to controlled waters on site into the Harefield Lake in 1985 of sewage discharges. The second was for cooling water into the Greenbourne Stream

4.5 ENVIRONMENTAL DESIGNATIONS

The whole of the main site is designated as an SSSI, which are Sites providing statutory protection for the best examples of UK flora, fauna, or geological or physiographical features. Originally notified under the National Parks and Access to the Countryside Act 1949, SSSIs were renotified under the Wildlife and Countryside Act 1981. Improved provisions for the protection and management of SSSIs were introduced by the Countryside and Rights of Way Act 2000 (in England and Wales) and (in Scotland) by the Nature Conservation (Scotland) Act 2004 and the Wildlife and Natural Environment (Scotland) Act 2010.

4.6 GROUND GASES

4.6.1 Radon

Information from the British Geological Survey and the National Geoscience Information Service indicated that the site lies within an area where less than 1% of homes exceed the action level of 200Bq/m^2 for radon gas. Therefore, no radon protection measures are necessary in the construction of new dwellings or extensions on this site.

4.6.2 Landfill Gasses

In accordance with BS8576:2013 the site has been provisionally assessed for the risk of ground gases. This has been done with reference to “A pragmatic approach to ground gas risk assessment for the 21st Century” Card and Wilson, 2011.

- There are a number of possible source-pathway-receptor linkages for landfill gas migration.
- The site is located near to a historic landfill.
- The Made Ground is expected to be 5m deep or an average of 3m in thickness.
- The site is located on carbonate rich rock that can produce low levels of carbon dioxide.
- Radon protection measures are not required for this site.
- The site does lie on a potential naturally organic soil or humic or degradable Made Ground soil.

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As such it is considered that the risk of ground gas is high and ground gas monitoring is therefore recommended at this site.

4.7 POTENTIAL GEOTECHNICAL HAZARDS

The desk study information identified that the site does not lie within an area likely to be affected by significant natural cavities, coal mining or non-coal mining activities.

The risk of naturally occurring geotechnical hazards at the site is recorded in the Groundsure report to be as follows:

Ground Stability Hazard	Maximum Hazard Potential Rating
Collapsible deposits	Very Low
Compressible deposits	Moderate
Ground dissolution of soluble rocks	Very Low
Shrinking and swelling clays	Very Low
Landslides	Very Low
Running sand	Low

During the walkover survey a large area of land to the south of the main site was marked as dangerous from quicksand, this will have been from the infilling of a sand and gravel pit by silt wastes. In addition, the land areas on the site have been highly reworked and used as a landfill site in the past. As such, deep thicknesses of Made Ground should be anticipated across the whole site. Groundwater will also be within a metre or two of existing ground level

4.8 FORMER SITE USAGE AND POTENTIAL CONTAMINANTS

Historically the site has been drained marsh land adjacent to the River Colne until the 1960's when it started to be exploited for its underlying sand and gravel deposits. Processing of this material occurred towards the southeast of the site, accessed from a trackway leading down to Moorhall Road to the site. Extraction continued until the end of the 1990's. Currently the site area is a Nature Reserve and the lake is used by fishing clubs and the Broadwater Sailing Club, there is also one residential house to the very southeast corner of the main site.

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As such, the main risk of potential contaminant sources comes from its industrial history as a gravel pit between the 1960's and 1990's, and the landfilling that occurred on the site between 1993 and 2004. The following contaminants should be expected and these will be concentrated around the structures on the land promontory and in the area of the landfill, as shown on the attached site plan:-

- Metals and Inorganic Substances
- Speciated Polyaromatic Hydrocarbons (PAH)
- Benzene, Toluene, Ethylbenzene and Xylene (BTEX)
- Total Petroleum Hydrocarbons (TPH)
- Asbestos Identification and Quantification
- Semi Volatile and Volatile Organic Substances
- Polychlorinated biphenyls around the electricity sub-station (PCB's)

5 SUMMARY OF GEOTECHNICAL RISK

The site where the majority of development is expected is the land promontory to the southeast of the main site. This has been used for processing aggregate and as such it is anticipated the underlying soil profile will consists of thick Made Ground with some concrete obstructions, Shepperton Gravel with Chalk strata at approximately 6m below ground level. Groundwater is likely to be between 1m to 2m below ground level.

Therefore, it is anticipated that piled foundations will be required for any structure with specific settlement criteria; road pavements will require a flexible reinforcement and building are likely to require protection from ground gas

Site 2 is likely to be underlain by Newhaven Chalk strata, which should provide a relatively good building platform, but Site 1 will be underlain by Alluvium overlying Shepperton Gravel. The Alluvium is likely to be made up of peat and water saturated sandy clays.

Therefore it is recommended that an intrusive investigation is undertaken at an early stage to identify the soil type beneath the site, and depth to groundwater, to minimise delays during the design stage.

6 INITIAL CONCEPTUAL SITE MODEL

In accord with the Environment Agency LCRM “Land Contamination Risk Management” 2020, this desk study and site reconnaissance report constitutes a preliminary risk assessment in order to establish the potential presence of pollutant linkages.

Reference to the desk study and walkover survey indicates that the site has been in agricultural usage from at least 1881 until the 1960’s when it started to be exploited for its underlying sand and gravel deposits. Processing of this material occurred towards the southeast of the site, accessed from a trackway leading down to Moorhall Road to the site. Extraction continued until the end of the 1990’s. Currently the site area is a Nature Reserve and the lake is used by fishing clubs and the Broadwater Sailing Club, there is also one residential house to the very southeast corner of the main site.

Given the proposed development of the site as a commercial end usage, it is considered that there is a low to moderate risk to end users. However, the risk of encountered localised pockets of contamination is considered to be moderate to high. There is also a perceived moderate risk of encountered a contamination sources that may be affecting the Principal groundwater Aquifer beneath the site and as the site is in a Source Protection Zone, this would need to be dealt with as part of the development.

The surrounding uses of the site generally poses no risk of contamination, however, there is a large old landfill site to the east of the site that is undoubtedly a large source of landfill gases.

The majority of the rest of the land use on the site is a nature reserve and as such no potentially contaminative land uses have been identified.

Therefore, the following potential source/pathway/receptors may be present at and around the site;

Potential Source	Potential Pathway	Potential Receptor	Considered Risk
Historic hydrocarbons within the ground from human history in the area of aggregate processing	Volatile vapours possible	End Users	Low to moderate
	Leaching through the ground	Controlled Waters	Locally high
Historic asbestos within any made ground from human history in the area of aggregate processing	Ingestion, inhalation or absorption from direct contact with soil.	End Users	Low to moderate
	Possible contact during work phase	Construction Workers	Moderate to high
Historic metals and PAH's within any made ground from human history in the area of aggregate processing	Ingestion, inhalation or absorption from direct contact with soil.	End Users	Low to moderate
	Possible contact during work phase	Construction Workers	Moderate to high
Ground gas from nearby landfill sites	Lateral migration through River Terrace Deposits (very unlikely)	End Users	Low to moderate
PCB from electricity sub-station	Ingestion, inhalation or absorption from direct contact with soil.	End Users and Construction Workers	Low to moderate

7 CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER WORK

From the information gathered as part of this investigation are a number of potential contaminative sources on site. The site has been a Nature reserve for several years and has not been used for industrial processes; as such a certain amount of natural attenuation is likely to have occurred to any area of contamination. As such, it is considered that the site is likely not to be determined as 'contaminated land' under the terms of Part IIA of the Environmental Protection Act 1990. As such this would pass that test set out in clause 183 of the NPPF. However, it is considered that the site could be classified as being "affected by contamination" and as such the site may not pass the test set out in clause 184 of the NPPF, and some remediation may be required.

Therefore, we recommended that further intrusive site investigation works are undertaken to establish contamination levels, mainly in the promontory land on the main site area to quantify any risks. In addition, in order to establish construction methods for the proposed development the ground profile and soil parameters will be required.

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- National House Building Council (NHBC) Standards, Chapter 4.2 Building Near Trees. 2011.

APPENDIX A

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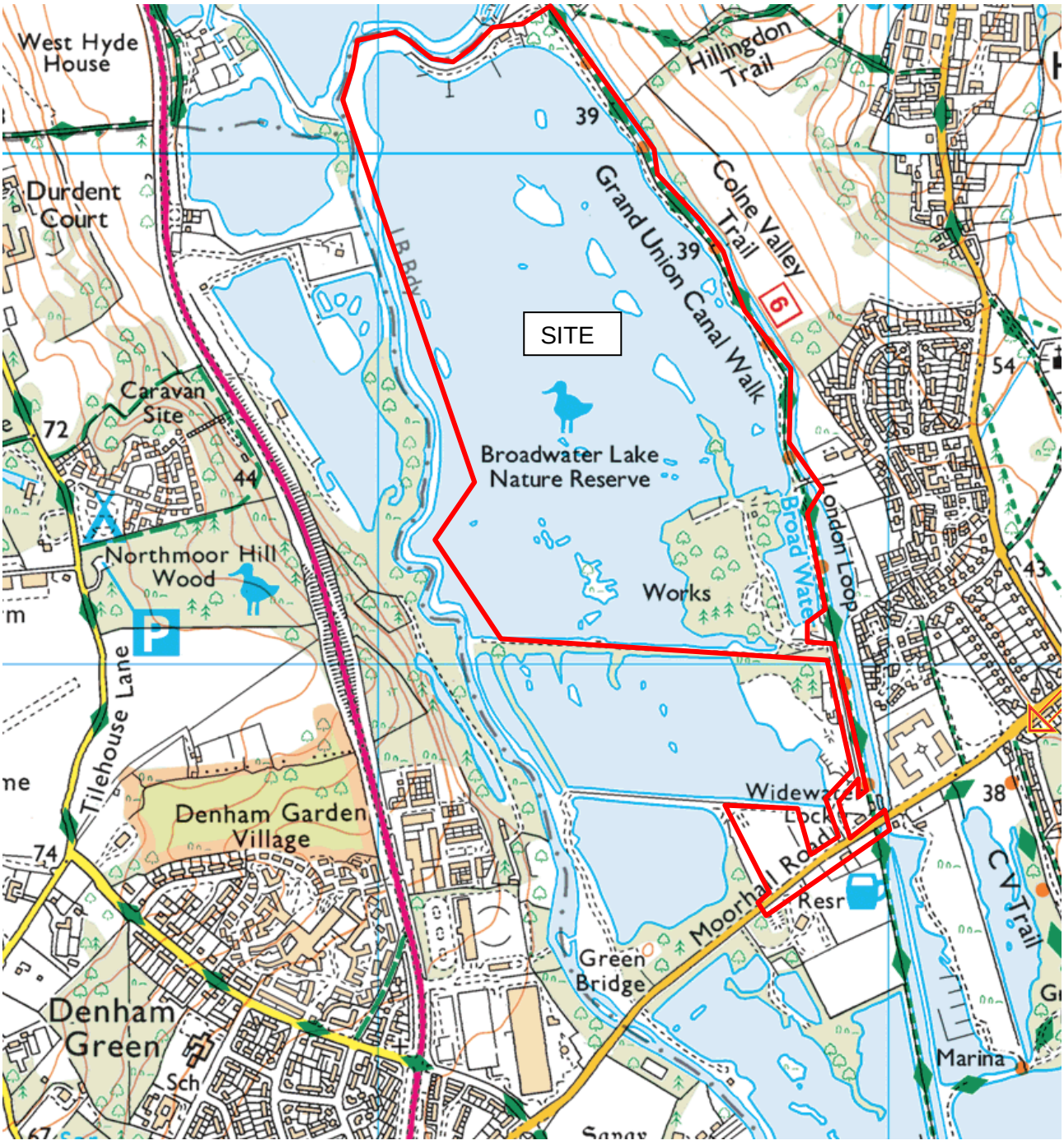
Site Plan



September 2023 **SITE LOCATION PLAN** Report No:- 23-09-03A

Geo-Integrity, - 07858 367 125 Email:- murraybateman@geo-integrity.co.uk

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te red line boundary

ual / refuge habitat provided by string of 5m x 2m modular
fabricated floating reed bed rafts to protect water for bird
uge. Monitoring to establish whether infill of protected water
h reeds is required.

ing of 5m x 2m modular prefabricated floating reed bed rafts t
ate discrete open water channel along western margin. To be
t open with periodic maintenance

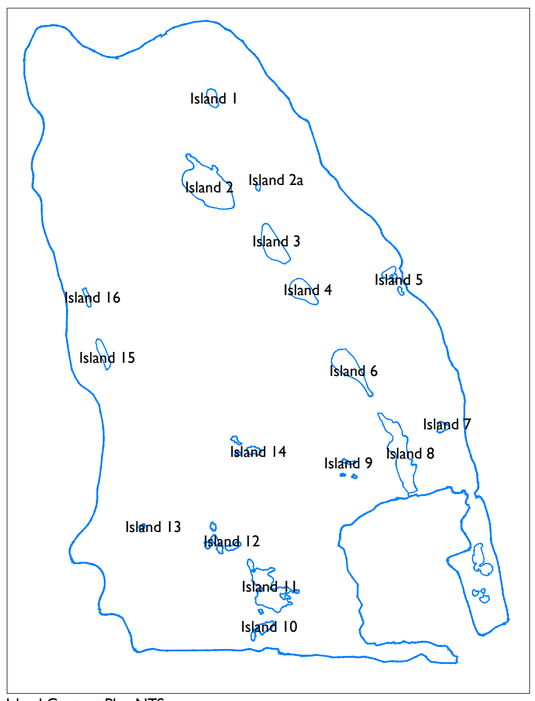
Bathymetric survey Key

Lake bed level		Winter water depth	Summer water depth
	36.5m	0.96m	0.64m
	36.0m	1.46m	1.14m
	35.5m	1.96m	1.64m
	<35.5m	>1.96m	>1.64m

Key (Lake)

Site red line boundary

1. Visual / refuge habitat provided by string of 5m x 2m modular prefabricated floating reed bed rafts to protect water for bird refuge. Monitoring to establish whether infill of protected water with reeds is required.
2. String of 5m x 2m modular prefabricated floating reed bed rafts to create discrete open water channel along western margin. To be kept open with periodic maintenance
3. Extend existing jetty for emergency access (remove adjacent jetties)
4. Keep existing entrance to Broadwater Lake Sailing Club for emergency access & retain track to jetty
5. Remove existing structures :
   - Include two parallel hedgerows 10m apart to create a sheltered grassland 'ride' for bats to forage and commute along (running east-west) and providing a sheltered area for nesting birds, mammals, otter couches etc
   - create a series of inviting mounds of varied orientation, shade and openness with aim for badger setts
   - grassland creation and enhancement in open areas to increase wildflowers
   - include small pond if possible (away from gas main)
   - care to be taken in this area with minimal digging due to the existing underground gas main
6. Anglers' WC to be connected to existing waste water in the location of the Broadwater Sailing Club
7. Floating reedbeds creating bays for young fish and sheltered angling stations.
8. Secure site boundary with Grand Union Canal using a bespoke fence sensitively located amongst existing trees, mindful of root protection zones and augmented with thorned native planting species depending on light conditions. Sections will include fence panel sections, thorny shrub planting, wire fences and trellises, to infill the open areas and strengthen more permeable vegetation. Repair and replace derelict hedgerows with laying / dry hedging techniques dependent on condition and light levels. This approaches retains habitat connectivity and desirable existing light levels
9. Enhance ground flora along the lake margin where reeds aren't proposed. Inland from here include areas of enhanced terrestrial ground flora. Enhancement of ground flora with biodiverse species (both sun loving and shade loving) for invertebrates, bats and birds. Installation of bat and bird boxes on trees in this area. Keep the access road mostly as a dark corridor for wildlife movement, with at least the one sunny spot.
10. Reprofile sediments area to required 2m depth for sailing with turbidity curtain to limit water quality effects until sediment settled
11. Diversify existing habitats on island with perimeter emergent vegetation
12. Number Not in Use
13. Enhance shallows as nursery habitat for coarse fish with artificial reefs
14. Dense barrier vegetation to visually screen eastern shore of islands and the reclaimed land from the north. Wind modeling of the lake and agreement of a minimum distance of natural wind trajectory from jetties should be agreed with sailing club
15. Maintain habitat connectivity with refurbishments or replacement of bridge over canal. Otter spraint was found beneath suggesting it is a landmark used by otters. Implement a watching brief during construction to ensure there is no harm to otters. No mitigation or enhancement for otters is needed or recommended.
16. Bat boxes on trees - here and throughout for maximum benefit
17. Bales of Christmas trees to keep out predatory fish. Monitor water flow and potentially enhance connectivity if climate change adversely reduces water levels.
18. Currently there are mature willows around much of the lagoon edge at the water line (with dense buddleia around and behind) and there are areas of high ground with unsafe steep slopes down to the water edge. High areas to be lowered to approximately 2m above water level and steep slopes reprofiled to 45degrees. Non-native buddleia to be removed and replaced with further willows. A border around the lagoon will be densely planted with native flowering, fruiting and thorny shrubs to prevent visual disturbance or direct human access to the lagoon (discrete viewing will be provided through bird hides). Woven willow panels will be used for instant screening while new planting establishes.
19. Proposed 2 m high thorn hedge to back of car park
20. Restoration to an undisturbed marginal vegetation
21. Break up existing concrete in places for root penetration
22. Main controlled access point for site
23. Existing B category tree group avoided
24. Reclaimed land with scattered native trees to visually break up views of existing building and low fertility dry well drained grass community to boatyards. The seed and plant mix for reclaimed land would only serve to make this area attractive. Although it has low potential to benefit bats (due to lighting), green walls and green roofs if feasible could be installed on buildings for invertebrates and to integrate buildings into the landscape. Judiciously located nectar providing planting would enhance the area although openness is important to minimise potential sheltering of wind for sailing.
25. Number not in use.
26. Up to 10 m wide buffer to prevent access, width will vary depending on existing vegetation, topography, presence of concrete surface, substrate and extent of land available
27. Native fruit trees as orchard / fruit walks within camping and activity area. Create an open mosaic habitat for invertebrates here and elsewhere wherever possible
28. Heron Inlet. Protect and enhance backwater with thorny planting and protective fence as required for the inlet to the south west of the peninsula to remain safe for bird and otter passage. Include some emergent vegetation and some grassland patches going down to the water for water vole and sleeping spots for birds or deer
29. Low key approach to drainage with ditches and filtering attenuation through site. Boatwash to go to foul drainage system
30. Grassland and wildflower enhancement in open areas and alongside paths of activity centre
31. Create islands in shallowest parts of the lake to create protective water to the west of the lake. These will include trees and scrub planting
32. Proposed HS2 floating mitigation island
33. Enhance as dabbling areas for birds with submerged coir matresses
34. Deeper channels for water circulation
35. Include tethered habitat rafts with solar panel to power bubbling aerators in areas of semi-enclosed water. Integrated into the masterplan for climate adaptation based on monitoring of the dissolved oxygen levels across the lake over a period of months / years
36. Restrict access to causeway to avoid public safety hazard of quicksand and disturbance to quiet backwater
37. Wildlife pond for invertebrates and dipping activities on north side of cleaving in sun
38. Floating reedbeds provide shelter for water birds
39. Concrete caissons submerged and filled with silt / substrate and planted with vegetation tolerant of submersion such as reeds and willow
40. Species rich amenity grass
41. Zone for assisted natural regeneration
42. Waterpump for circulation
43. Remodel existing island based on:
    a) retain 4 existing trees
    b) create muddy scrape in north of island at same level as the shingle finger the extends north (Summer water levels)
    c) Artificial Sand Marten habitat
44. Proposed islands to protect existing island 14
45. Tern rafts within open water



Island Context Plan NTS

0 25 50 75 100 150 200 250m

Rev	Amendments	Date	Drwn	Chkd
.11	Floating reedsbed and island layout amended	24.08.23	JR	PO
.10	Updated following comments	22.08.23	DB	PO
.09	Updated following comments	16.08.23	DB	PO
.08	Updated following workshop on 28.07.23 at LBH, Uxbridge	08.08.23	DB	PO
.07	Final QA	22.06.23	JR	PO
.06	Amendments to the masterplan	21.06.23	JR	PO
.05	Amendments to the masterplan	15.06.23	JR	PO
.04	Amendments to the masterplan	30.05.23	JR	PO
.03	Amendments to the key	23.03.23	JR	PO
.02	Amendments to the key	22.03.23	JR	PO
.01	First Issue	16.03.23	TK	PO

Project
HWSFAC

Drawing Title

Ecological Mitigation - Lake

Project No. 2121
Scale @ A1 1:2500
Project Status For planning
Drawing No. HWSFAC-COL-00-XX-DR-L-1010
Revision 11

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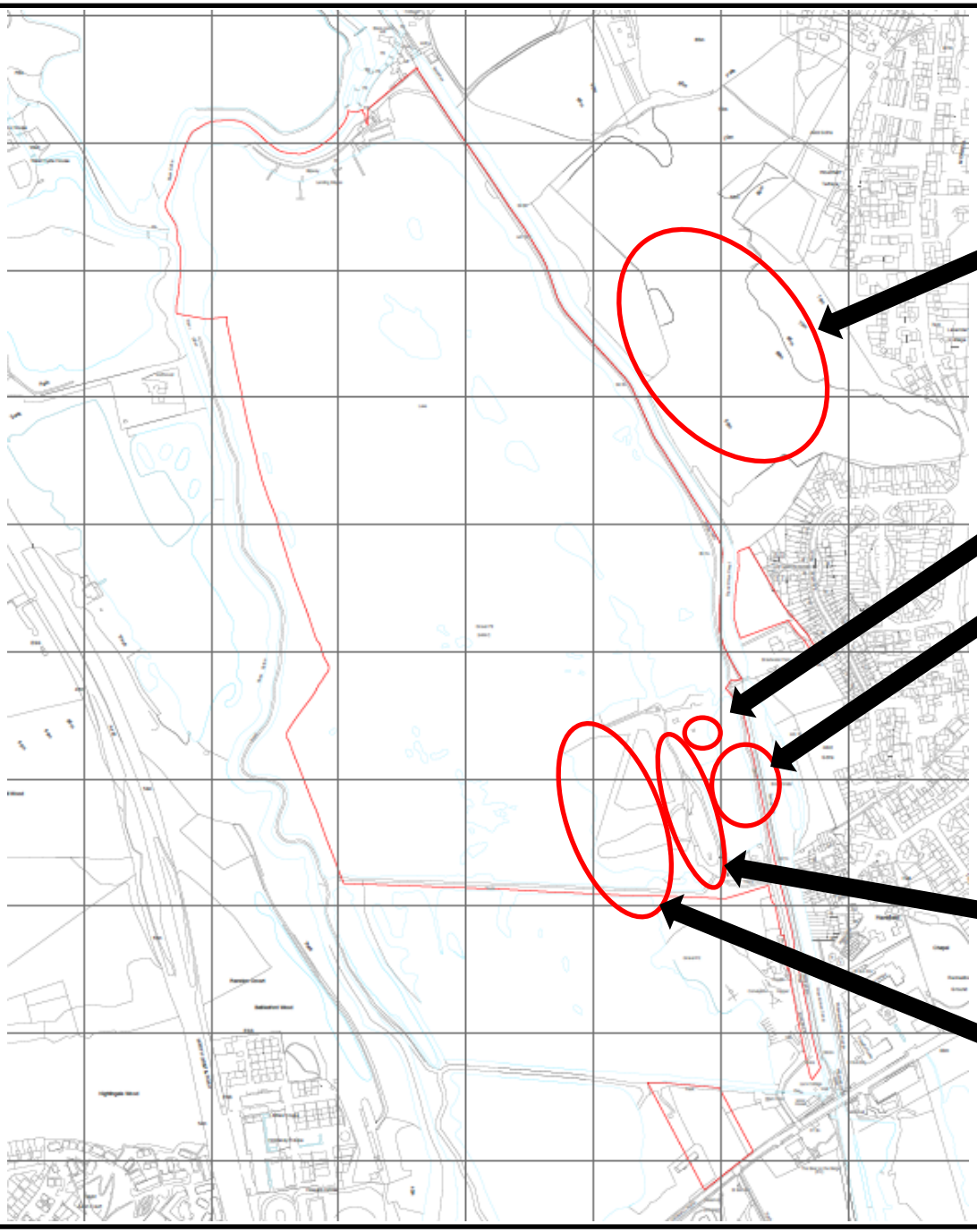
Newcastle 0191 24 24 224
York 01904 925 888
colour-udl.com

colour



Key

GEO INTEGRITY

4 Church Street
Maids Moreton
MK18 1QE

Tel:- 01280 816409
Mob:- 07858 367 125
www. geo-integrity.co.uk

Potential Contamination Source Areas

SITE:- Hillingdon Outdoor Activity Centre

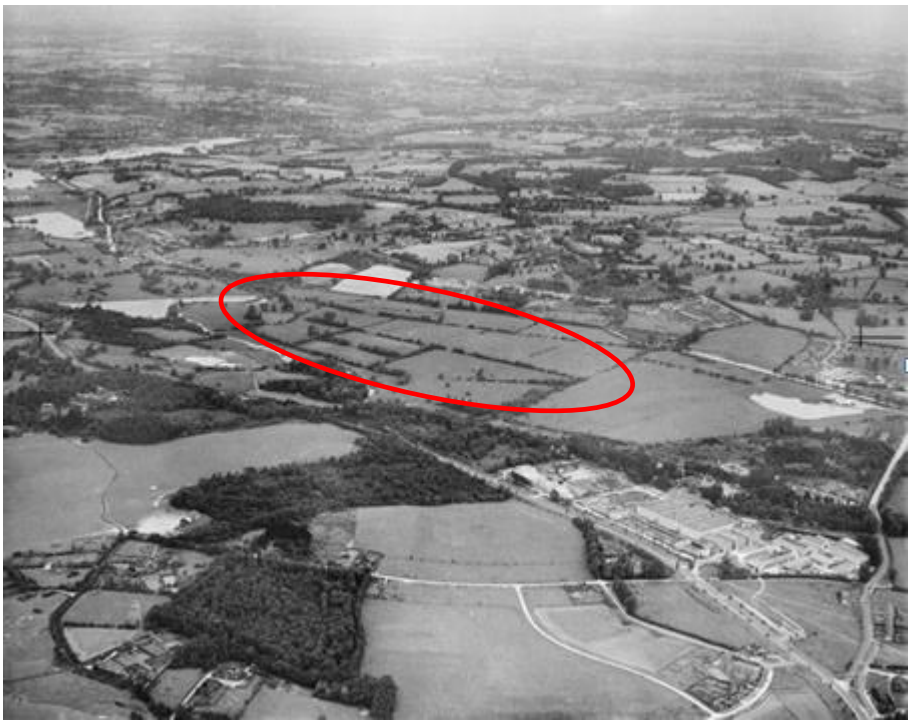
JOB NO.:- 23-09-03A

CLIENT:- MACE

Drawn	Checked
MB	SB

Scale: Not To Scale, for indicative purposes only

1933



1946

Geo-Integrity, - 07858 367 125 Email:- murraybateman@geo-integrity.co.uk

Residential House at site entrance

Weighbridge at site entrance

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Quicksand to the immediate south of the site area

Path along southern boundary of main site

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Main Lake from the south

Remnants of conveyor structure on main site

Geo-Integrity, - 07858 367 125 Email:- murraybateman@geo-integrity.co.uk

Electricity Sub-station on main site

Track leading up the east of the site towards the sailing club

Geo-Integrity, - 07858 367 125 Email:- murraybateman@geo-integrity.co.uk

Gas main at top of site

Sailing club at north of site

Geo-Integrity, - 07858 367 125 Email:- murraybateman@geo-integrity.co.uk

Looking across the Grand Union Canal towards Site 2

Site 1 from Moorhall Road – HS2 compound to the left of the photo

Geo-Integrity, - 07858 367 125 Email:- murraybateman@geo-integrity.co.uk

APPENDIX B

Geo-Integrity Mob.: 07858 367 125 Email: info@geo-integrity.co.uk

Natural Cavities Risk Assessment

Project Name : **Broadwater Lake**

Project No : **23-09-03A**

Client : **Hillingdon BC and MACE**

This site has a No Anticipated Subsidence Hazard Category

Subsidence Hazard Components	**Value**
G1 - Chalk lithostratigraphic Factor	20
G2 - Post Cretaceous Cover Deposit Factor	7
H1 - Water Table Level Factor	1
H2 - Topographic Relief and Surface Drainage/Subsurface Infiltration Factor	1
GM1 - Former Surface Water Drainage Path Factor	0
GM2 - Glaciation Factor	0

SHR_N = (G1+G2+H1+GM1+GM2)*H2 **SHR_N Value** **28**

SHR_N	**Subsidence Hazard Category**
<55	No Anticipated Subsidence Hazard
55 to 89	Very Low Subsidence Hazard
90 to 136	Low Subsidence Hazard
137 to 200	Moderately Low Subsidence Hazard
201 to 300	Moderate Subsidence Hazard
301 to 400	Moderately High Subsidence Hazard
401 to 600	High Subsidence Hazard
>600	Very High Subsidence Hazard

Regional Abbreviations used on Sheets 2 and 3

CH	Chiltern Hills
DPD	Dorset and Purbeck Downs
EA	East Anglia
END	East North Downs
L	Lincolnshire
WND	West North Downs
Y	Yorkshire

Notes:
Based on Edmonds C N : 2001 : Predicting natural cavities in chalk Geological Society, London, Engineering Special Publications, Vol 18, pp 29-38

Project Broadwater Lake
Project No. 23-09-03A
Carried out for Hillingdon BC and MACE

Table
1

Natural Cavities Risk Assessment

				Score
G1 - Chalk lithostratigraphic Factor				
	Upper Chalk	20	y	20
	Middle Chalk	2		
	Lower Chalk	1		
		G1 Total		**20**
G2 - Post Cretaceous Cover Deposit Factor				
Gc	Tertiary cover deposit present with or without superficial Quaternary cover	14		
	Quaternary cover deposit only present	6	y	6
	No cover and <200m from a Tertiary or Quaternary cover deposit margin	2		
	No cover and >200m from a Tertiary or Quaternary cover deposit margin	1		
		G2-Gc Total		**6**
Gr	**Tertiary cover deposit present:**			
	Reading Beds or Woolwich Beds (all regions)	20		
	Thanet Beds (WND, END regions)	15		
	Crag (EA region)	8		
	Thicker Tertiary sequences involving Thanet Beds overlain by Woolwich/Reading Beds and Blackheath Beds and disturbed Blackheath Beds (WND region)	4		
	Thicker Tertiary sequences involving Reading Beds overlain and overstepped by London Clay and Bagshot Beds (DPD region)	2		
	Quaternary cover deposit present:			
	Proto-Thames and Proto-Solent terrace gravels (CH and DPD regions)	20		
	Alluvial deposits (all regions) (only applicable to seasonal drainage directed across Chalk (Category 2) of topographic relief and surface drainage/subsurface infiltration factor (H_2))	13		
	Alluvial deposits (all regions) (any topographic relief and surface drainage/subsurface infiltration conditions except above)	1	y	1
	Glacial deposits (CH, EA, L, Y regions)	12		
	Low level fluvial terrace gravels or valley gravel (all regions)	6		
	High level fluvial terrace gravels or plateau gravel (all regions)	6		
	Clay with flints (all regions)	3		
	Brickearth (all regions)	1		
	Solifluction deposits (all regions)	1		
	No cover (topsoil only) (all regions)	0		
		G2-Gr Total		**1**
Gf	Reading Beds feathering margin	3		
	Thanet Beds feathering margin	4		
	Crag feathering margin	2		
	Tertiary margins where thick Tertiary sequences occur (WND, DPD regions)	1		
	Quaternary deposits feathering margin	2		
	Exception to above for alluvial deposits where seasonal drainage is not directed across Chalk (Category 2) of topographic relief and surface drainage/subsurface infiltration factor (H_2)	0	y	0
	No cover deposit (topsoil only)	0		
	No feathering margins	0		
		G2-Gf Total		**0**
		G2 Total		**7**

Notes:
Based on Edmonds C N : 2001 : Predicting natural cavities in chalk Geological Society, London, Engineering Special Publications, Vol 18, pp 29-38

Project Broadwater Lake
Project No. 23-09-03A
Carried out for Hillingdon BC and MACE

Table
1

Natural Cavities Risk Assessment

				Score
H1 - Water Table Level Factor				
a	No cover deposit present, water table below Chalk surface level	10		
b	No cover deposit present, water table close to or at Chalk surface level	1		
c	Cover deposit present, water table below Chalk/cover deposit interface	10		
d	Cover deposit present, seasonal water table level fluctuation causes water table to rise above Chalk/cover deposit interface in wet season	2		
e	Cover deposit present, water table normally at or above Chalk/cover interface	1	y	1
f	As above, but if artificial groundwater lowering to take place	3		
g	Artesian groundwater conditions present in cover deposit overlying Chalk	0		
		H1 Total		**1**
H2 - Topographic Relief and Surface Drainage/Subsurface Infiltration Factor				
Category 1 - Seasonal/permanent surface drainage and subsurface infiltration directed onto/into Chalk				
	Terrain Unit 1 - Hillside or valley side slope	6		
	Terrain Unit 2 - Minor channel to major valley floor	10		
	Terrain Unit 3 - Hilltop or flatter relief areas	4		
Category 2 - Seasonal surface drainage and subsurface infiltration directed towards/onto cover deposit from Chalk				
	Terrain Unit 1 - Hillside or valley side slope	1		
	Terrain Unit 2 - Minor channel to major valley floor	2		
	Terrain Unit 3 - Hilltop or flatter relief areas	1	y	1
Category 3 - Seasonal/permanent surface drainage and subsurface infiltration directed across Chalk (may be covered by topsoil and/or solifluction deposits or alluvium in floors of seasonal/permanent streams				
	Terrain Unit 1 - Hillside or valley side slope	1		
	Terrain Unit 2 - Minor channel to major valley floor	3		
	Terrain Unit 3 - Hilltop or flatter relief areas	1		
		H2 Total		**1**
GM1 - Former Surface Water Drainage Path Factor				
	Proto-Solent (DPD region)	10		
	Proto-Thames corridor (CH region) but not applicable to following:	10		
	where glacial deposits directly overlie Chalk	0		
	where surface drainage/subsurface infiltration is directed off the Chalk towards/onto Tertiary cover	0		
	Outside the above proto-river corridors	0	y	0
		GM1 Total		**0**
GM2 - Glaciation Factor				
	Glacial deposits directly overlie Chalk (CH, EA, L, Y regions)	5		
	Glacial deposits overlie Crag upon Chalk (EA region)	3		
	Glacial deposits overlie Reading Beds and/or proto-Thames terrace gravels upon Chalk (CH region)	0		
	Glacial deposits absent (CH, EA, L, Y regions)	0	y	0
	Extra-glacial areas	0		
		GM2 Total		**0**

Notes:
Based on Edmonds C N : 2001 : *Predicting natural cavities in chalk'* Geological Society, London, Engineering Special Publications, Vol 18, pp 29-38

Project Broadwater Lake
Project No. 23-09-03A
Carried out for Hillingdon BC and MACE

Table
1

TQ08/130

Driller...Herbie.....

SMITH & WEBB (DRILLING) LTD
BORING RECORD

Site Denham **B.H. No** 3.

Client Affinity Water Ltd.

Site Address Broadwater NGR TQ 041 893.

Boring Started 25th January 2013 **Boring Completed** 4th February 2013 **Level**.

Dia. of Bore 250mm 150mm & **Cased to** 10.50m **b.s with** 250mm **dia. casing and to** 22m **b.s. with** 150mm **dia. casing**

Water struck at: **(1)** 1.20m **b.s.** **(2)** **b.s.** **(3)** **b.s.** **(4)** **b.s.**

Standing W.L. in bore at 1.20m **on** **b.s.**

Remarks 22m of 150mm diameter steel lining tube installed. Shingle installed with bentonite seal.

	DEPTH		THICKNESS	SAMPLE DETAILS		
	FROM	TO		NO.	TYPE	DEPTH
Topsoil	G.L.	1.20	1.20			
Sand & gravel	1.20	6.00	4.80			
Gravel & chalk	6.00	6.30	0.30			
Chalk & flints	6.30	57.00	50.70 57.00			

TQ08/131

Driller...Herbie.....

SMITH & WEBB (DRILLING) LTD
BORING RECORD

Site Denham **B.H. No** 5.

Client Affinity Water Ltd.

Site Address Broadwater NGR TQ 047 896.

Boring Started 12th February 2013 **Boring Completed** 25th February 2013 **Level** .

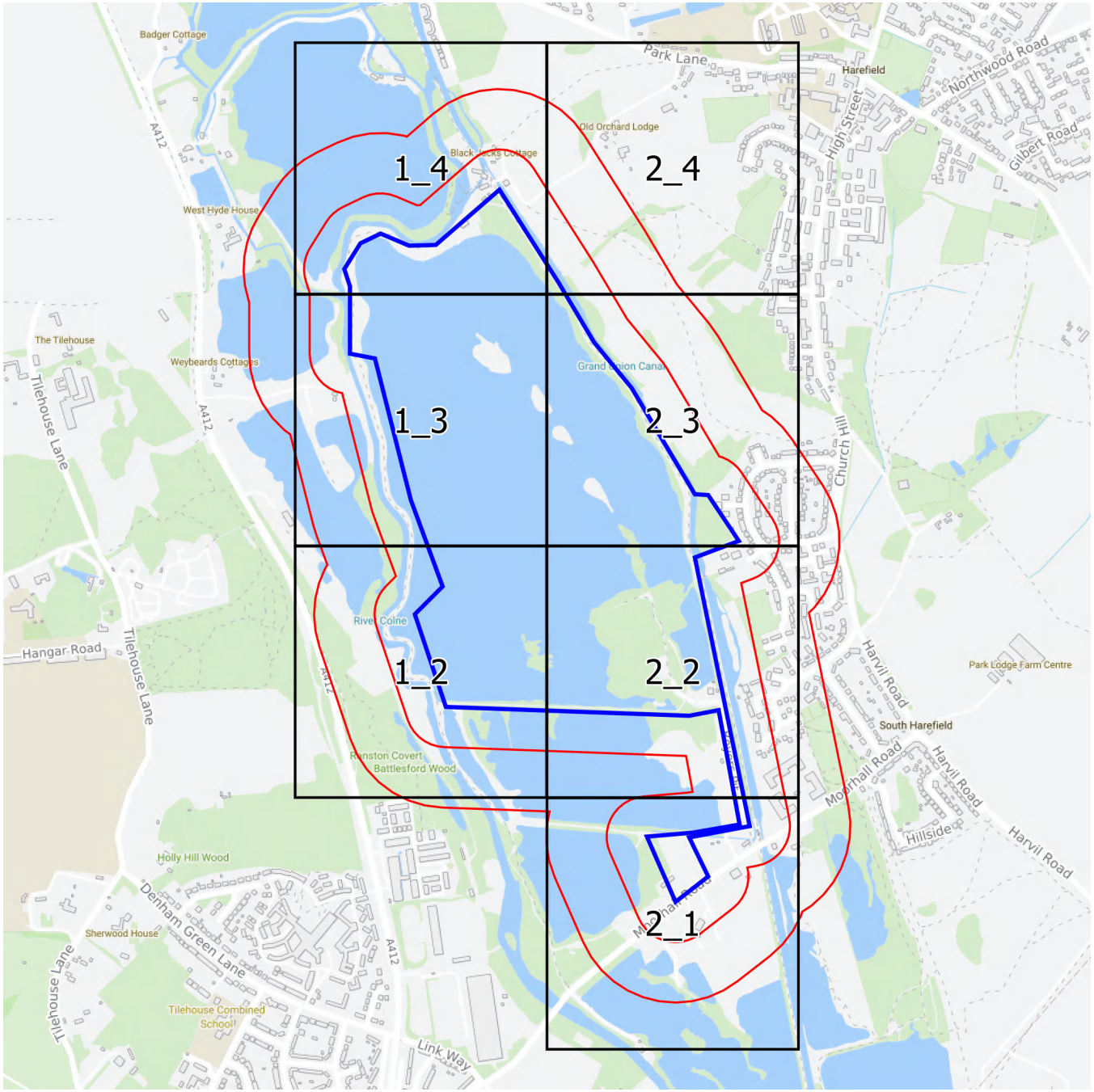
Dia. of Bore 250mm 150mm & **Cased to** 10m **b.s with** 250mm **dia. casing and to** 34.50m **b.s. with** 150mm **dia. casing**

Water struck at: (1) 1.80m **b.s.** (2) **b.s.** (3) **b.s.** (4) **b.s.**

Standing W.L. in bore at 1.10m **on** **b.s.**

Remarks 34.5m of 150mm diameter steel lining tube installed. Shingle installed with bentonite seal.

	DEPTH		THICKNESS	SAMPLE DETAILS		
	FROM	TO		NO.	TYPE	DEPTH
Topsoil	G.L.	0.30	0.30			
Silty clay	0.30	0.50	0.20			
Blue clay	0.50	1.00	0.50			
Peaty soil	1.00	1.80	0.80			
Sand & gravel	1.80	3.50	1.70			
Chalk & flints	3.50	80.00	76.50 80.00			



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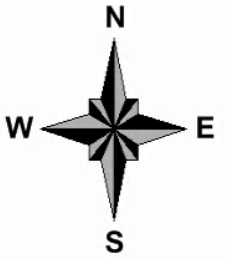

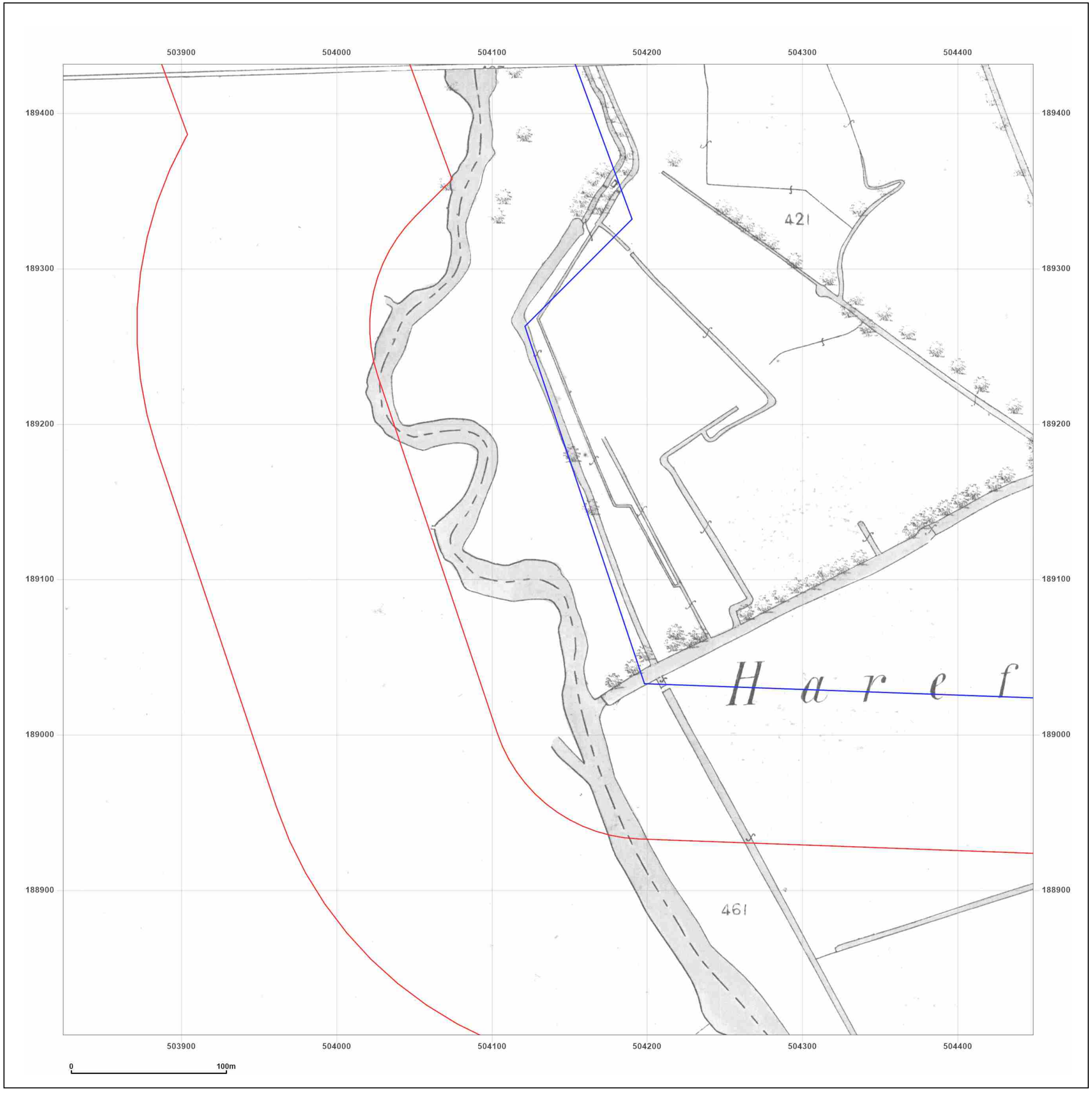

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MOORHALL ROAD, HAREFIELD,
UB9 6PE

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Grid Ref: 504136, 189119

Map Name: County Series

Map date: **1865-1866**

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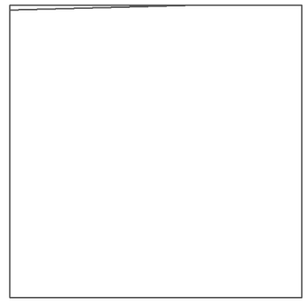

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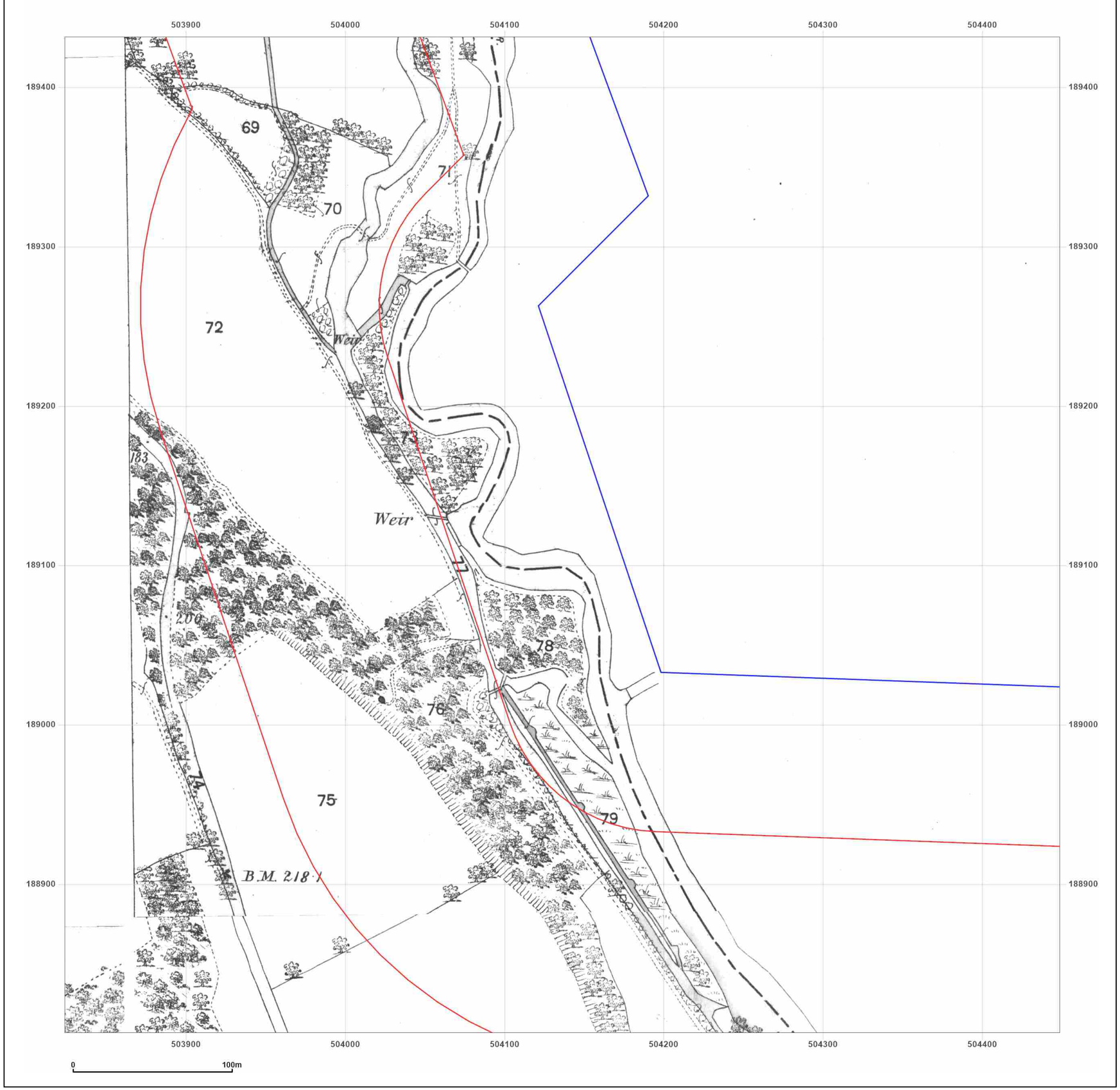

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UB9 6PE

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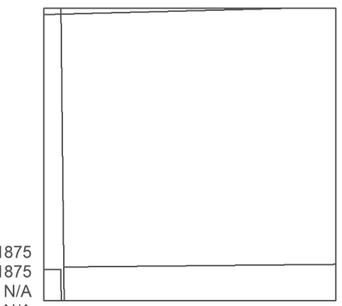

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Edition N/A
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Revised 1877
Edition N/A
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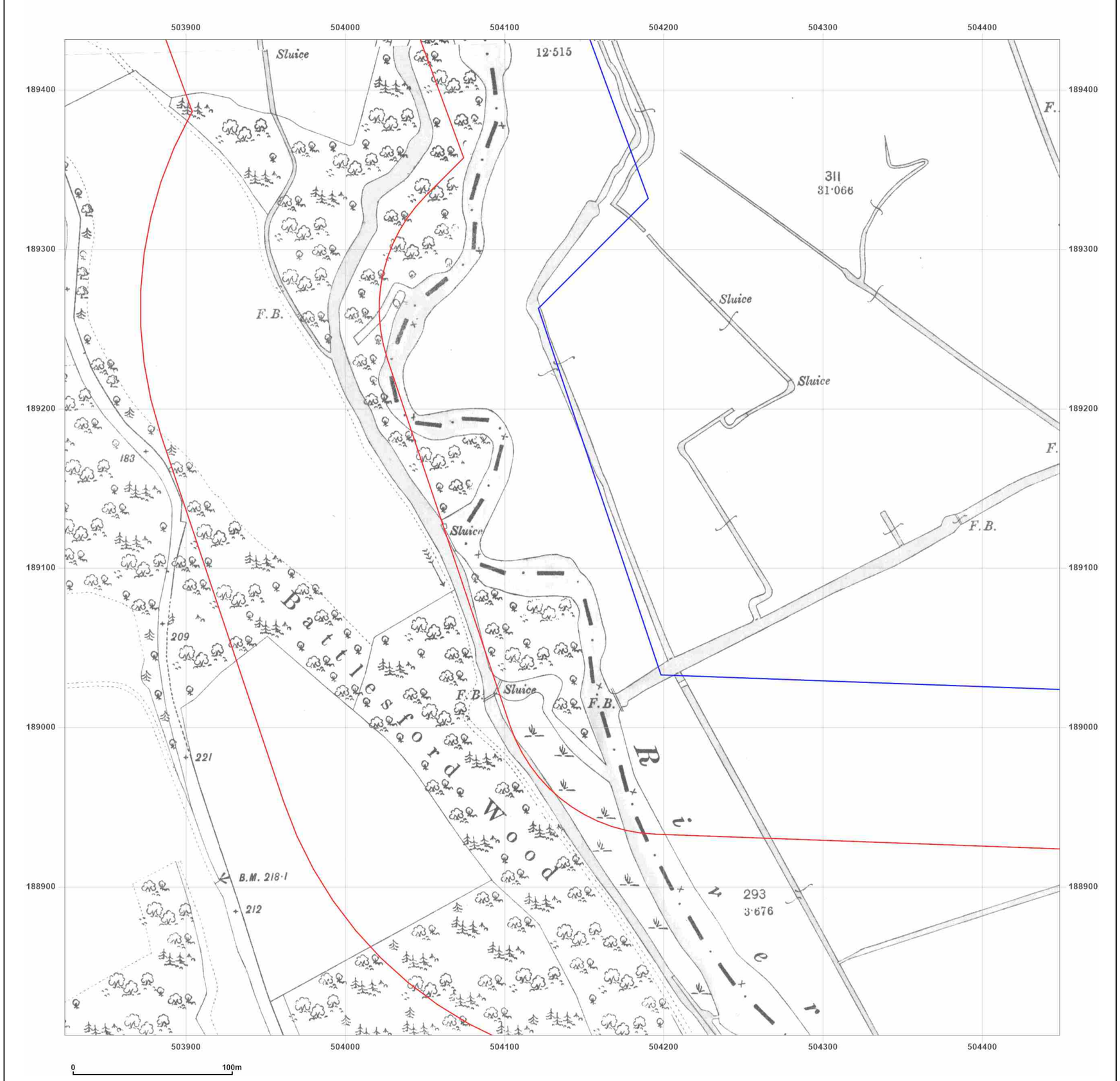

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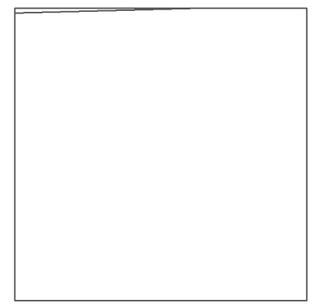

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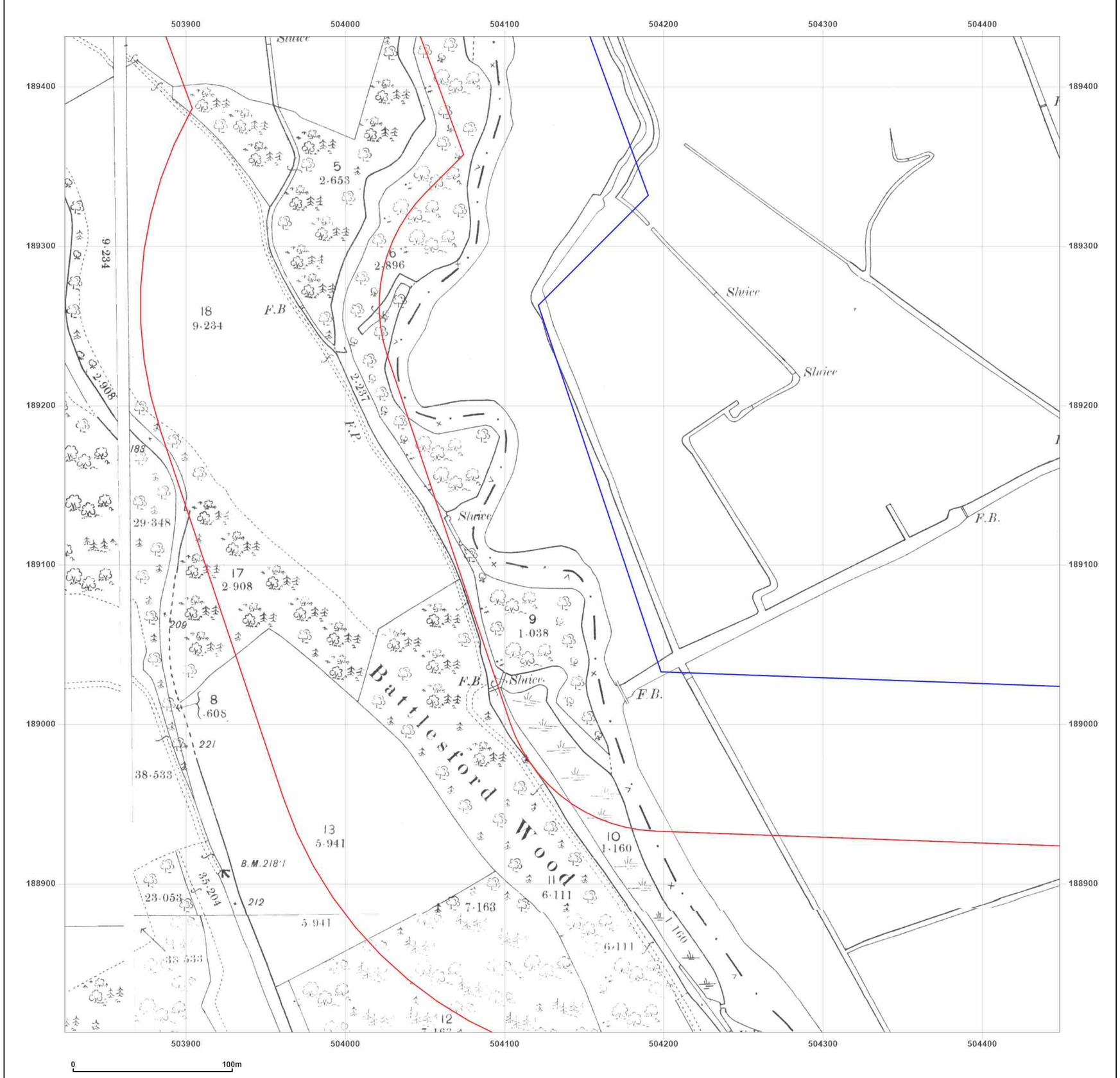

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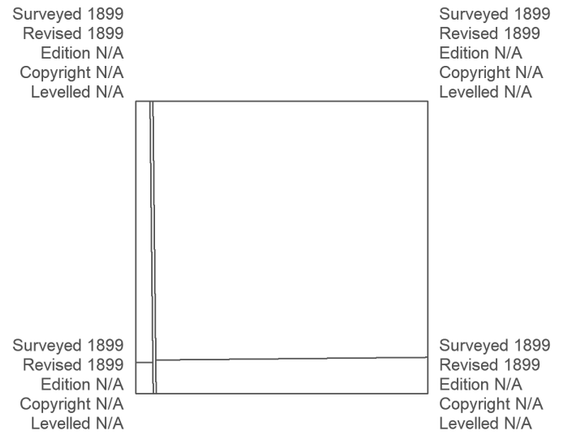

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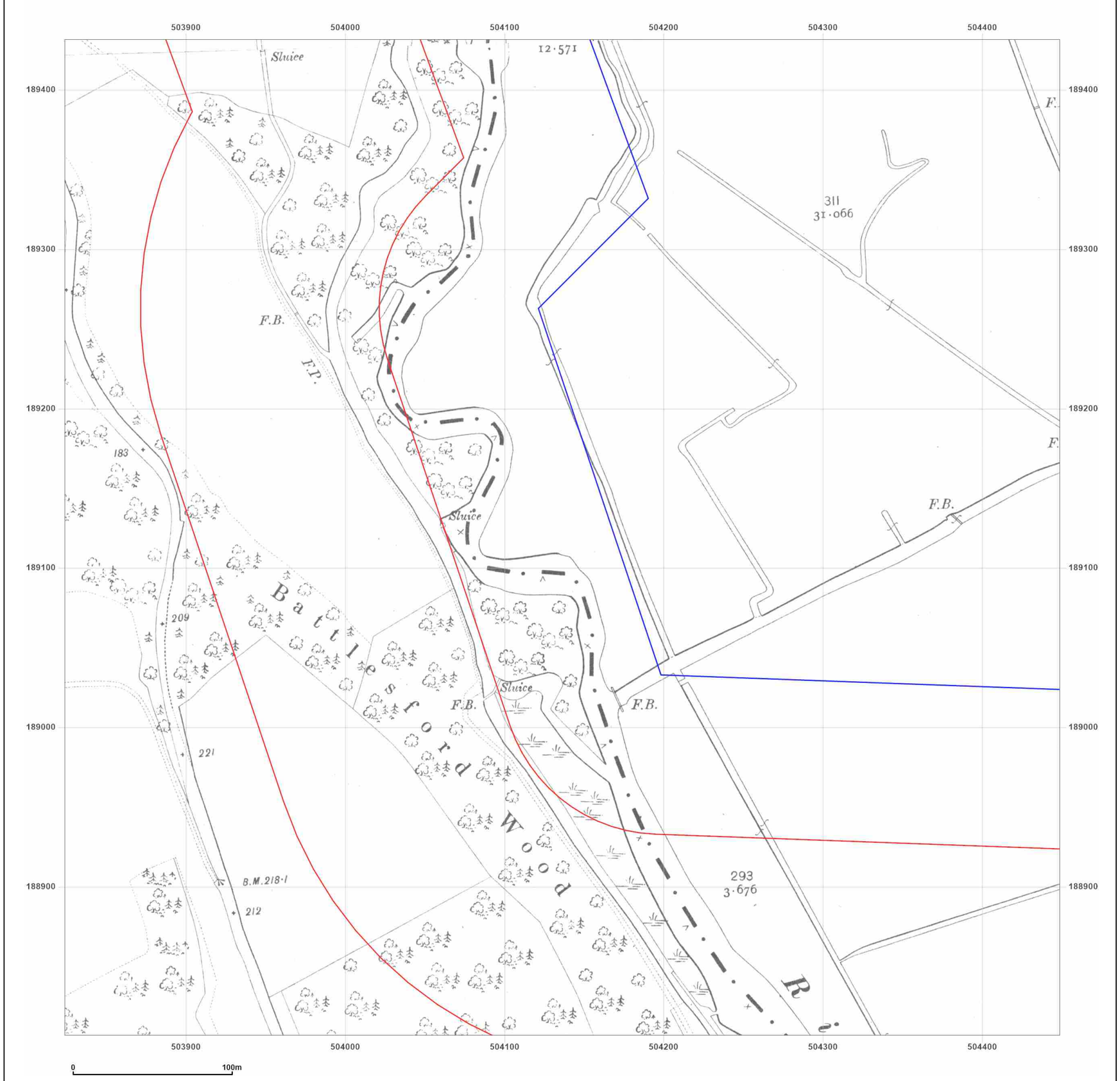

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UB9 6PE

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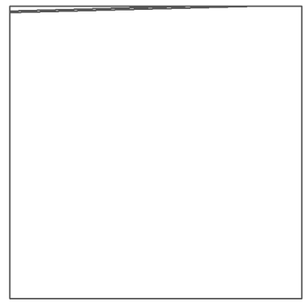

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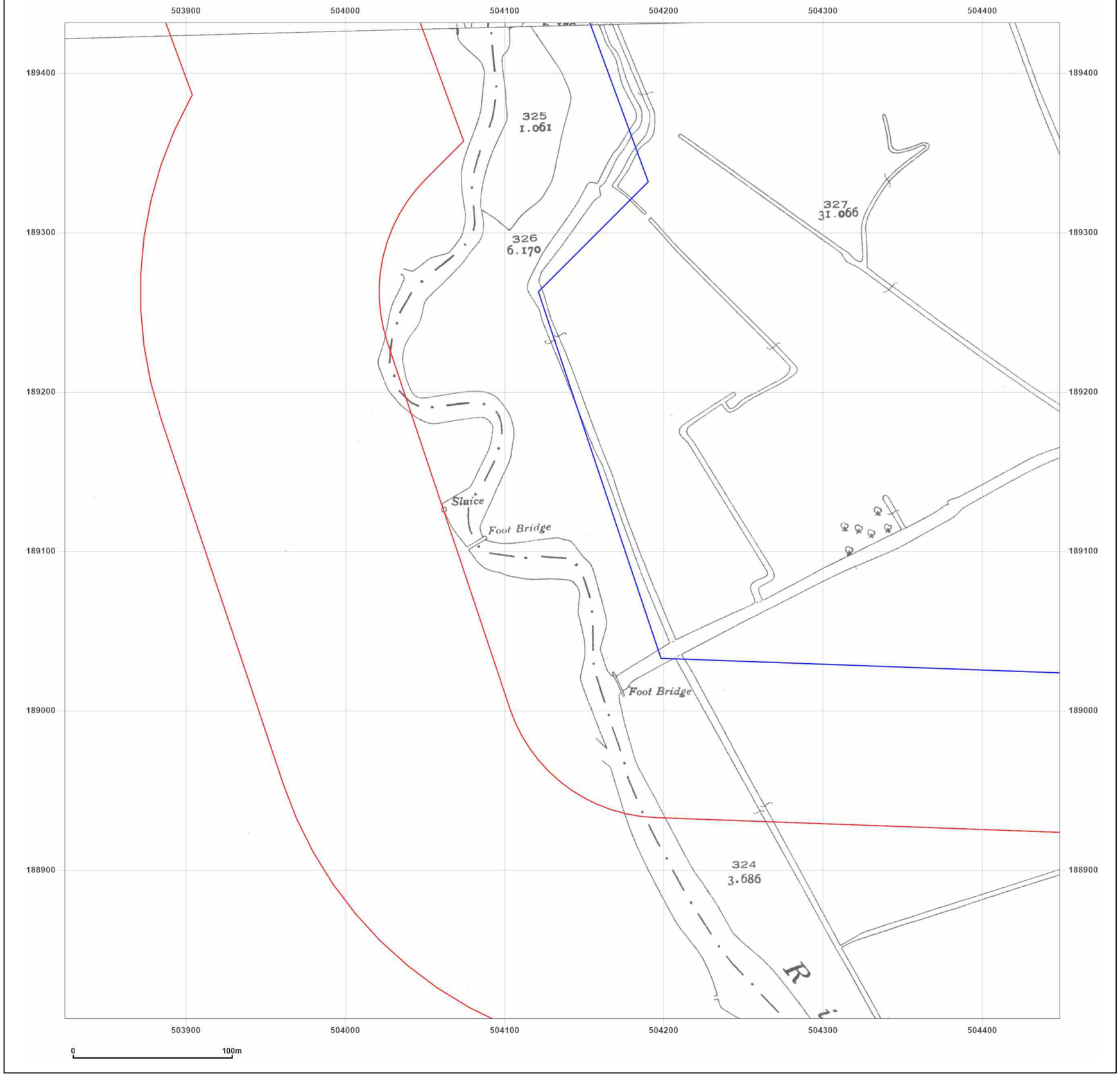

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Site Details:

BROADWATER LAKE,
MOORHALL ROAD, HAREFIELD,
UB9 6PE

Client Ref: 22-10-05
Report Ref: GS-9151608_LS_1_2
Grid Ref: 504136, 189119

Map Name: County Series

Map date: **1934**

Scale: 1:2,500

Printed at: 1:2,500

N
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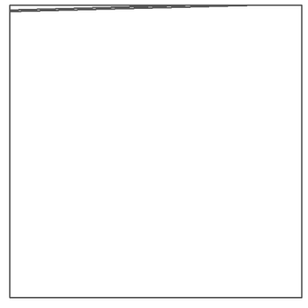
Surveyed 1934
Revised 1934
Edition N/A
Copyright N/A
Levelled N/A



Surveyed 1934
Revised 1934
Edition N/A
Copyright N/A
Levelled N/A

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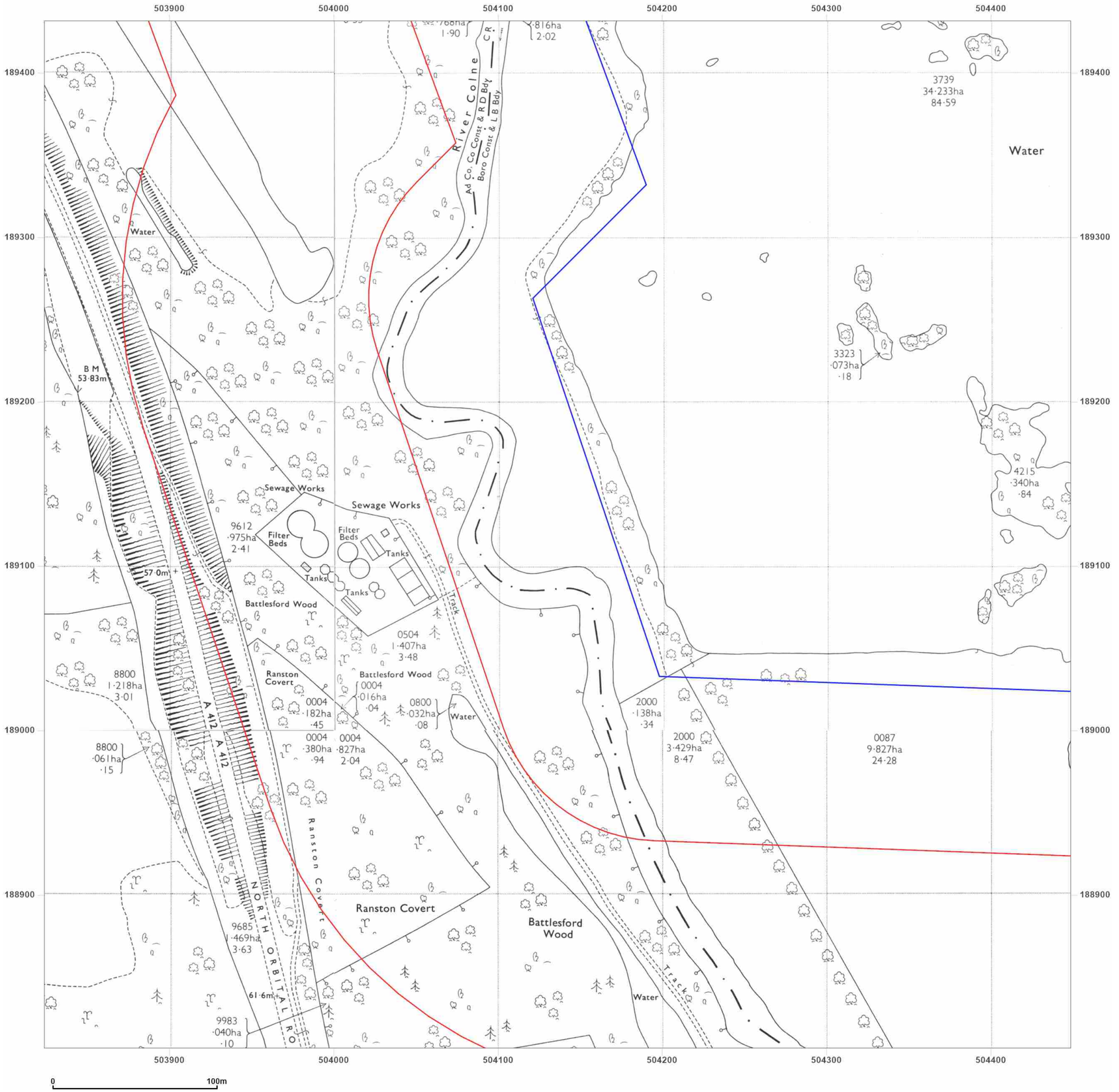

Groundsure INSIGHTS

Site Details:

BROADWATER LAKE,
MOORHALL ROAD, HAREFIELD,
UB9 6PE

Client Ref: 22-10-05
Report Ref: GS-9151608_LS_1_2
Grid Ref: 504136, 189119

Map Name: National Grid

Map date: **1972**

Scale: 1:2,500

Printed at: 1:2,500

N
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Surveyed 1971
Revised 1971
Edition N/A
Copyright 1972
Levelled 1960

Surveyed 1971
Revised 1971
Edition N/A
Copyright 1972
Levelled 1957

Surveyed 1971
Revised 1971
Edition N/A
Copyright 1972
Levelled 1957

Surveyed 1971
Revised 1971
Edition N/A
Copyright 1972
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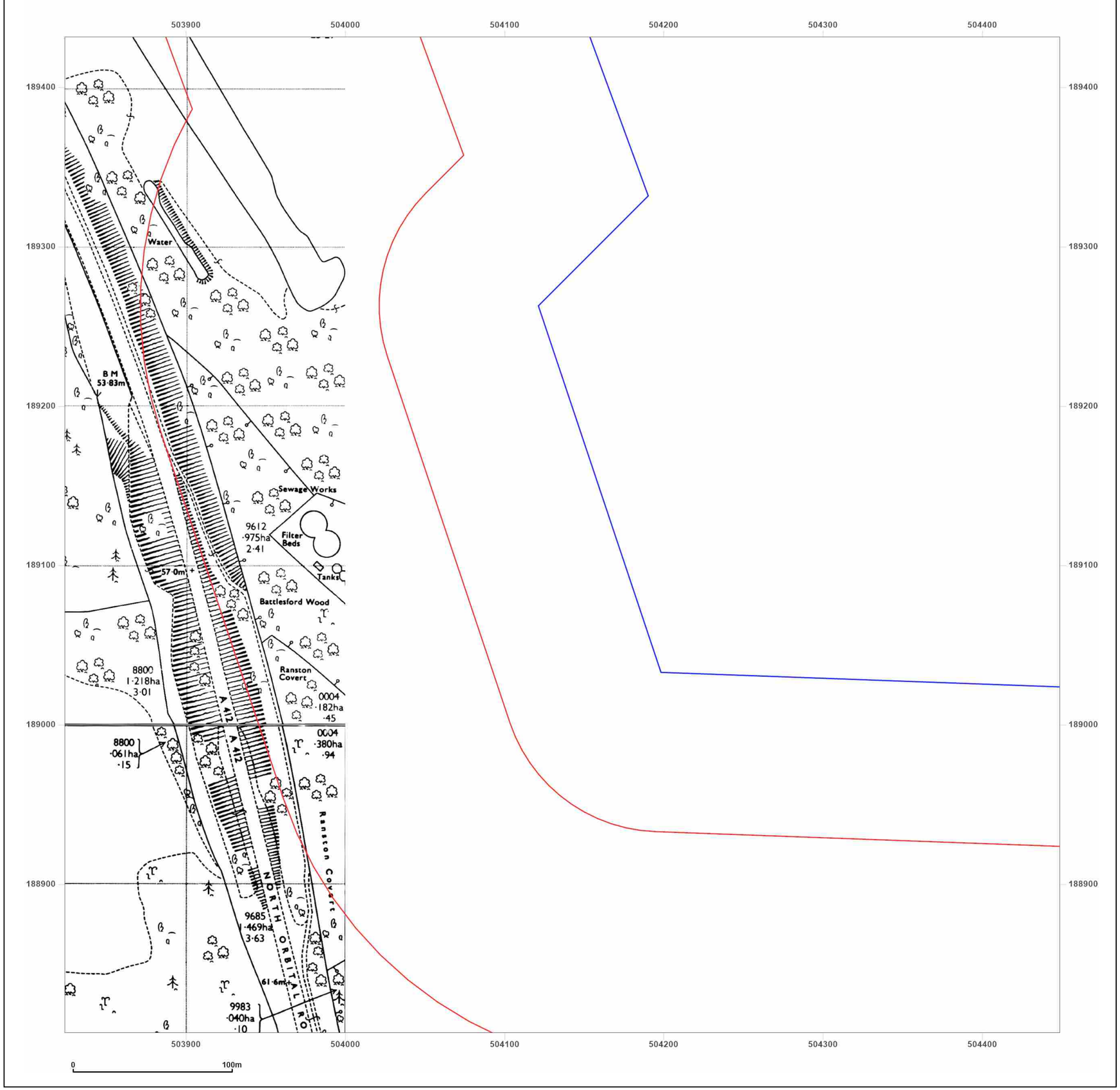

Groundsure INSIGHTS

Site Details:

BROADWATER LAKE,
MOORHALL ROAD, HAREFIELD,
UB9 6PE

Client Ref: 22-10-05
Report Ref: GS-9151608_LS_1_2
Grid Ref: 504136, 189119

Map Name: National Grid

Map date: **1972**

Scale: 1:2,500

Printed at: 1:2,500

N
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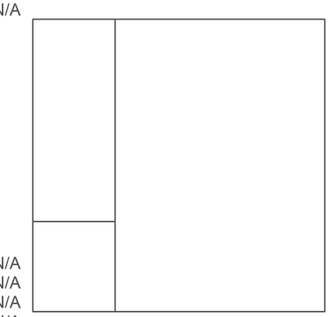
Surveyed N/A
Revised N/A
Edition N/A
Copyright N/A
Levelled N/A



Surveyed N/A
Revised N/A
Edition N/A
Copyright N/A
Levelled N/A

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Groundsure INSIGHTS

Site Details:

BROADWATER LAKE,
MOORHALL ROAD, HAREFIELD,
UB9 6PE

Client Ref: 22-10-05
Report Ref: GS-9151608_LS_1_2
Grid Ref: 504136, 189119

Map Name: National Grid
Map date: **1987-1989**
Scale: 1:2,500
Printed at: 1:2,500

N
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Surveyed 1960
Revised 1989
Edition N/A
Copyright 1989
Levelled 1960

Surveyed 1957
Revised 1987
Edition N/A
Copyright 1987
Levelled 1957

Surveyed 1957
Revised 1987
Edition N/A
Copyright 1987
Levelled 1957

Surveyed 1976
Revised 1989
Edition N/A
Copyright 1989
Levelled 1976

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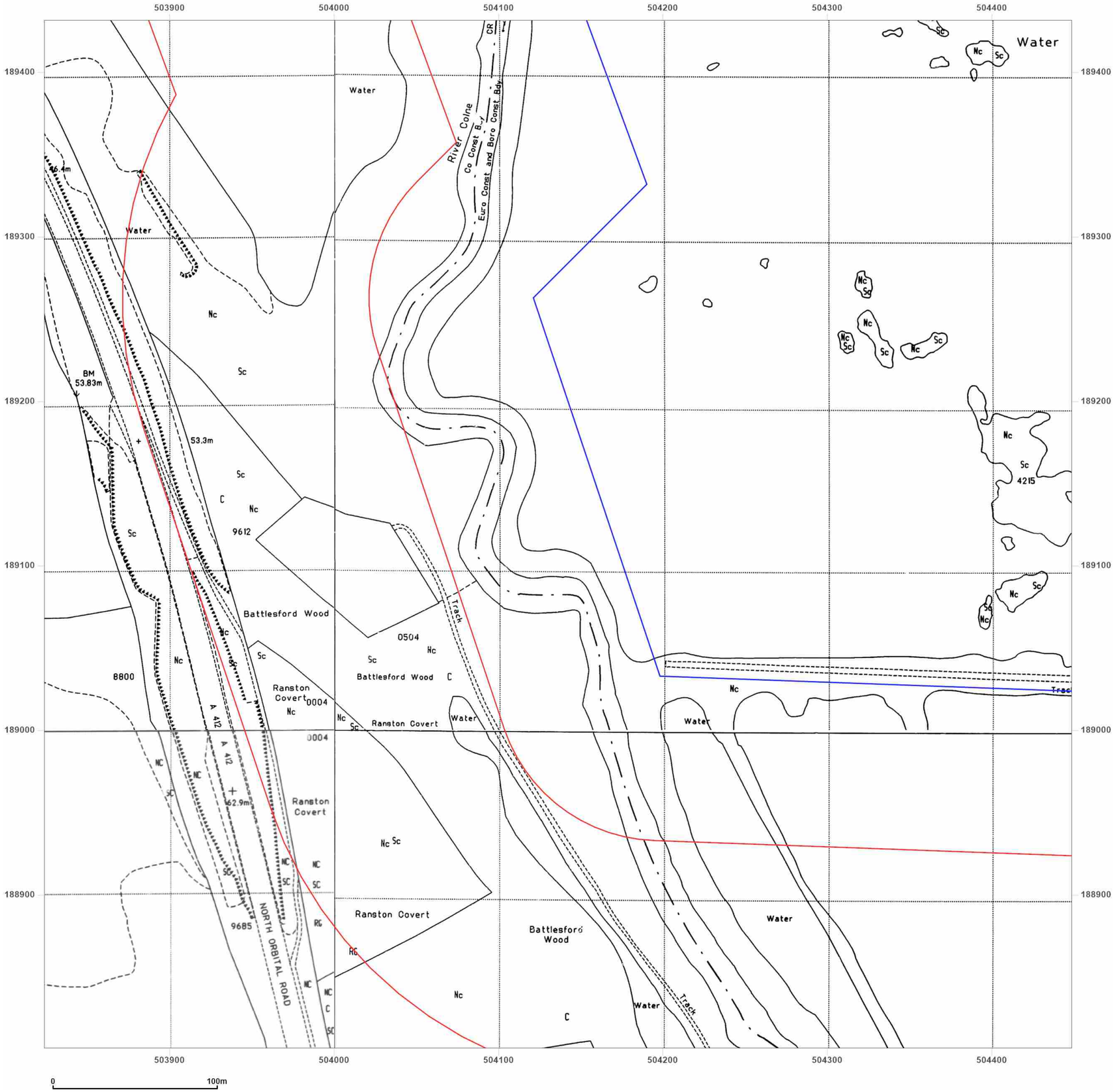

Groundsure INSIGHTS

Site Details:

BROADWATER LAKE,
MOORHALL ROAD, HAREFIELD,
UB9 6PE

Client Ref: 22-10-05
Report Ref: GS-9151608_LS_1_2
Grid Ref: 504136, 189119

Map Name: National Grid
Map date: **1992**
Scale: 1:2,500
Printed at: 1:2,500

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Surveyed N/A
Revised N/A
Edition N/A
Copyright 1992
Levelled N/A

Surveyed 1992
Revised 1992
Edition N/A
Copyright 1992
Levelled N/A

Surveyed N/A
Revised N/A
Edition N/A
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Levelled N/A

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Revised 1992
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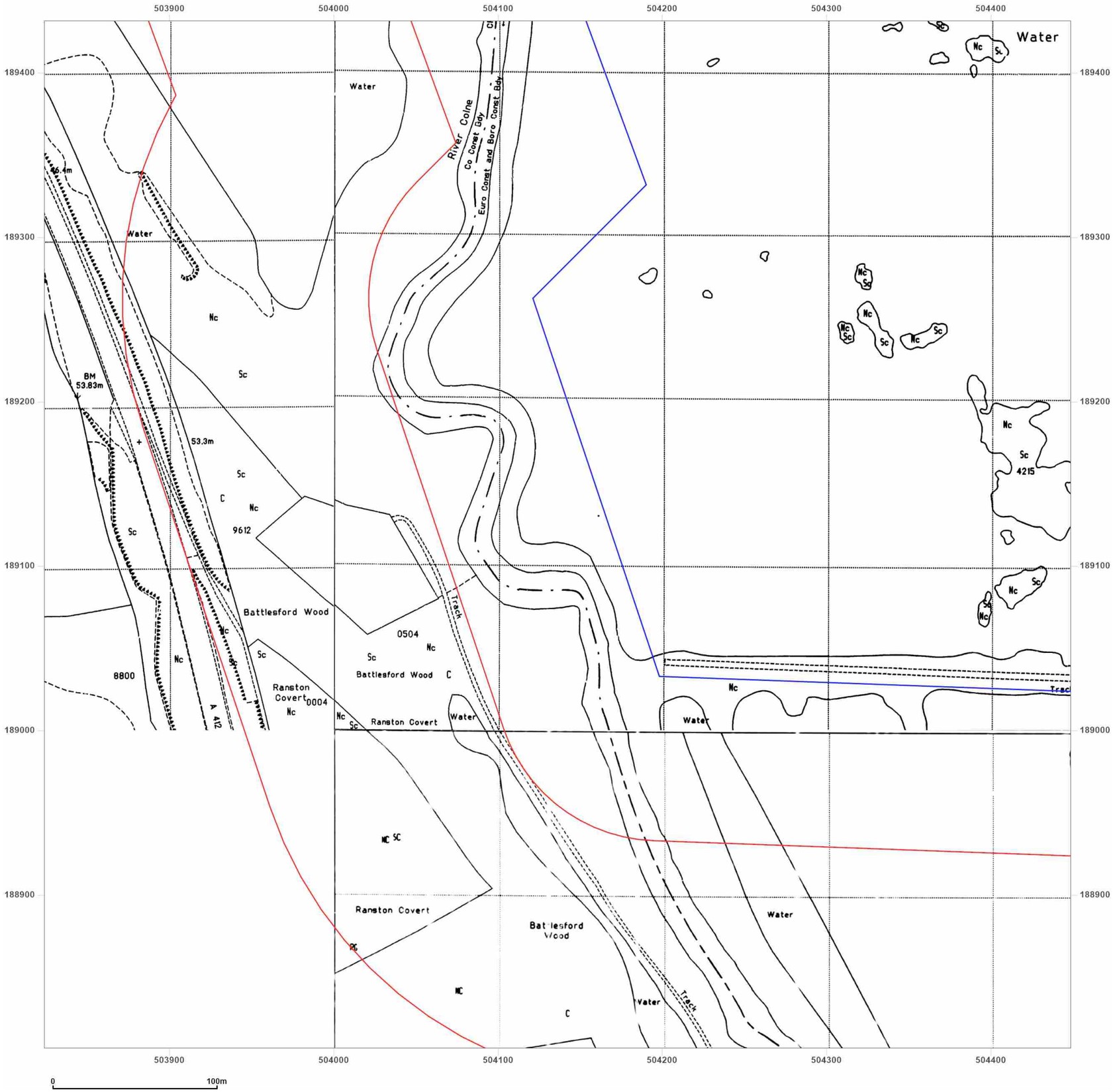

Groundsure INSIGHTS

Site Details:

BROADWATER LAKE,
MOORHALL ROAD, HAREFIELD,
UB9 6PE

Client Ref: 22-10-05
Report Ref: GS-9151608_LS_1_2
Grid Ref: 504136, 189119

Map Name: National Grid

Map date: **1992**

Scale: 1:2,500

Printed at: 1:2,500

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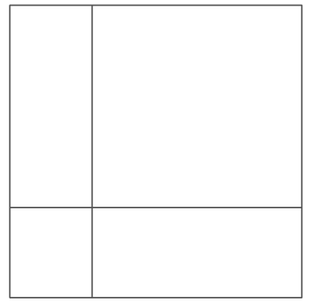
Surveyed 1992
Revised 1992
Edition N/A
Copyright 1992
Levelled N/A

Surveyed N/A
Revised N/A
Edition N/A
Copyright 1992
Levelled N/A



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Revised N/A
Edition N/A
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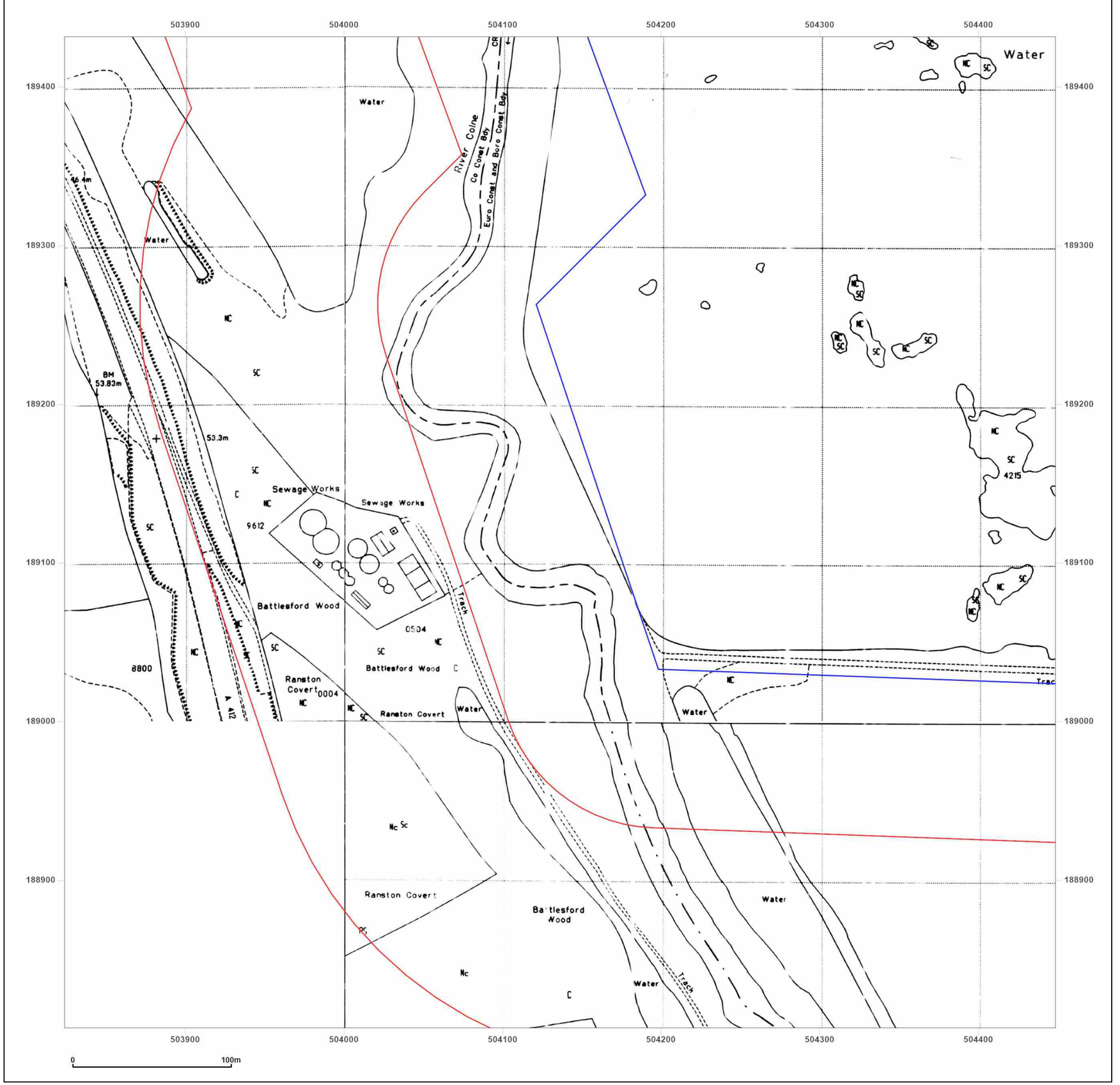

Groundsure INSIGHTS

Site Details:

BROADWATER LAKE,
MOORHALL ROAD, HAREFIELD,
UB9 6PE

Client Ref: 22-10-05
Report Ref: GS-9151608_LS_1_2
Grid Ref: 504136, 189119

Map Name: National Grid
Map date: **1992**
Scale: 1:2,500
Printed at: 1:2,500

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Surveyed N/A
Revised N/A
Edition N/A
Copyright 1992
Levelled N/A

Surveyed N/A
Revised N/A
Edition N/A
Copyright 1992
Levelled N/A

Surveyed N/A
Revised N/A
Edition N/A
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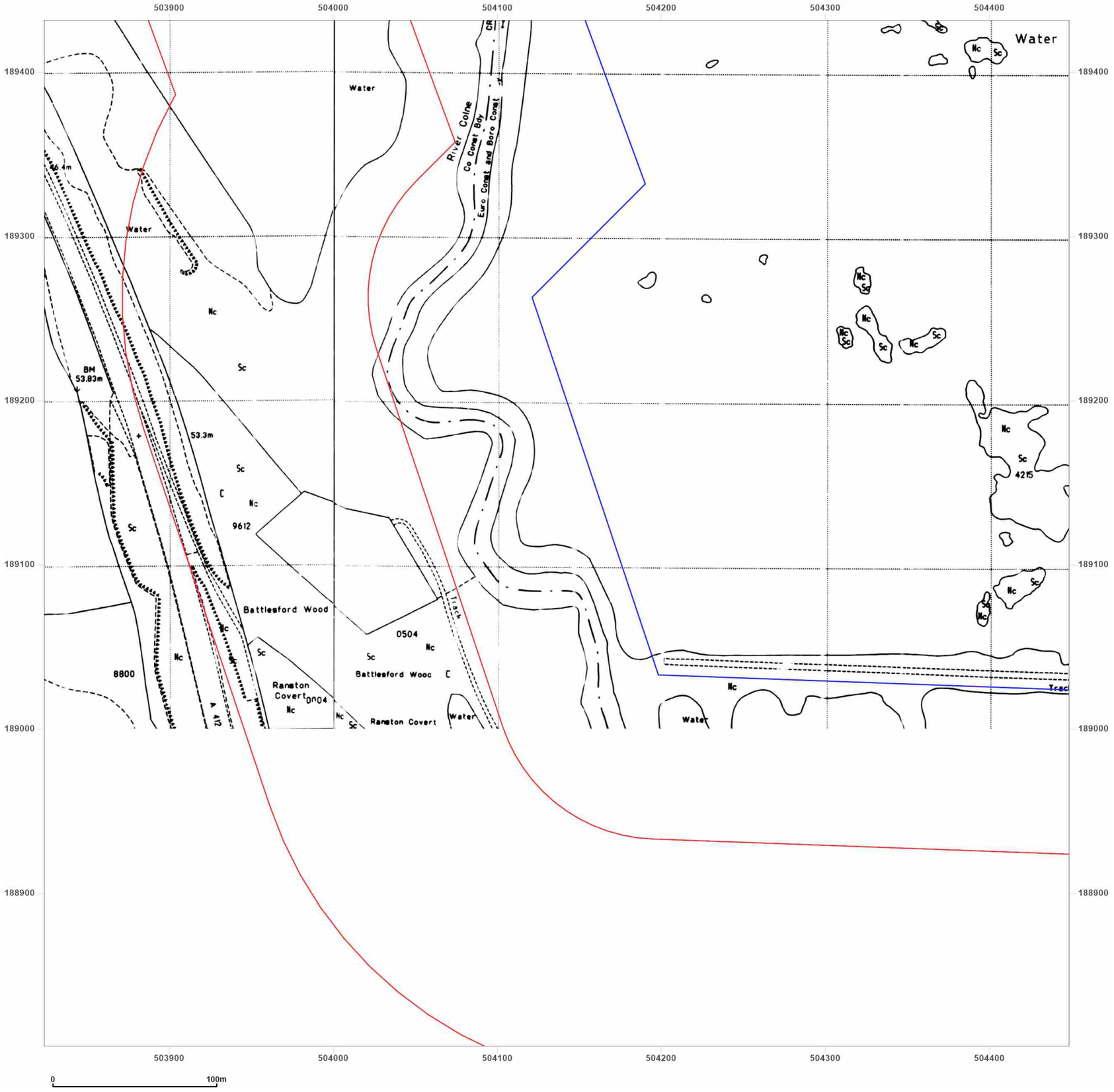

Groundsure INSIGHTS

Site Details:

BROADWATER LAKE,
MOORHALL ROAD, HAREFIELD,
UB9 6PE

Client Ref: 22-10-05
Report Ref: GS-9151608_LS_1_2
Grid Ref: 504136, 189119

Map Name: National Grid

Map date: **1992**

Scale: 1:2,500

Printed at: 1:2,500

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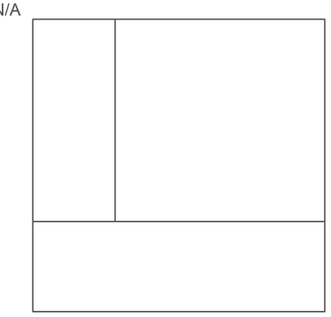
Surveyed N/A
Revised N/A
Edition N/A
Copyright 1992
Levelled N/A

Surveyed N/A
Revised N/A
Edition N/A
Copyright 1992
Levelled N/A



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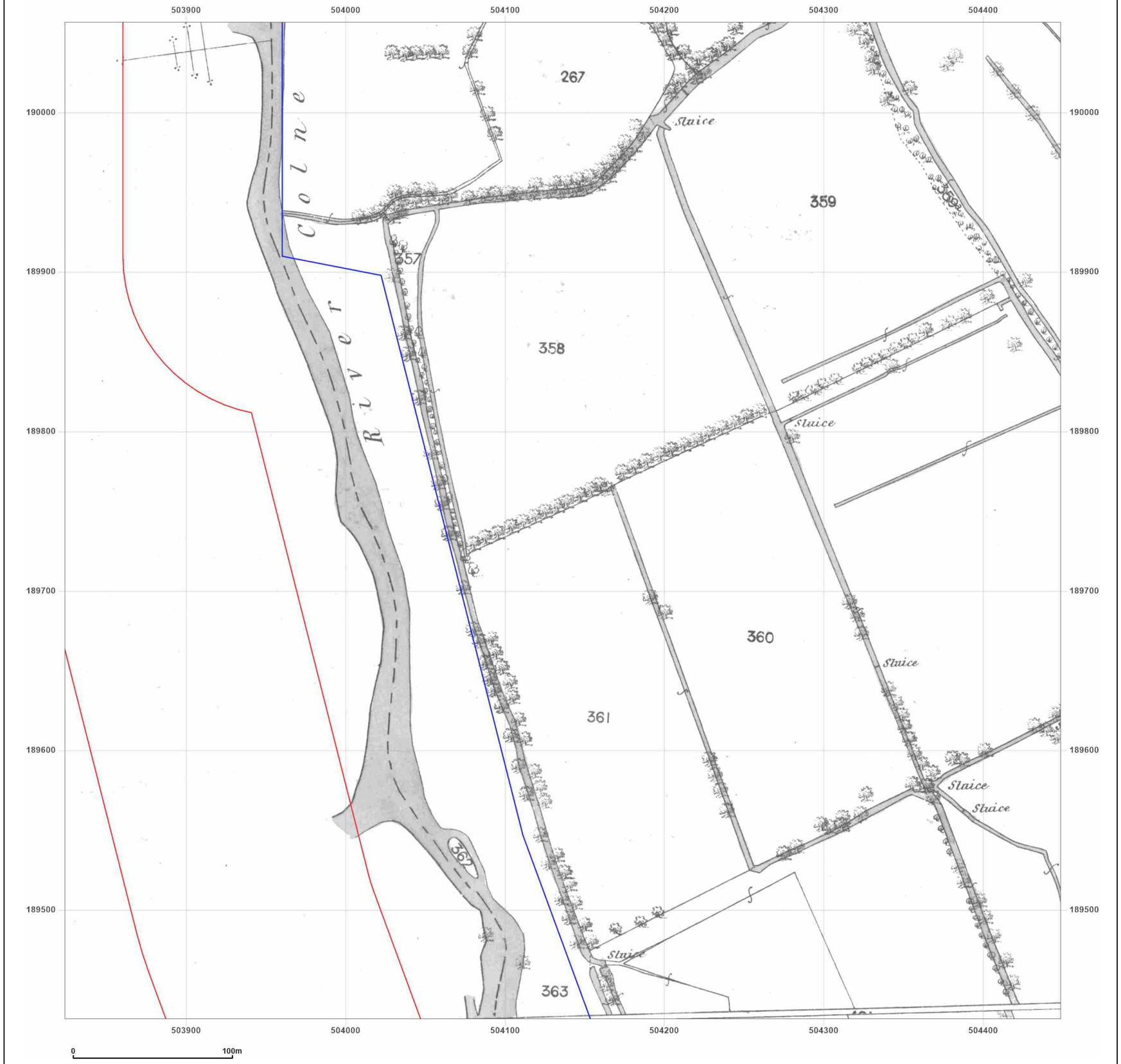

Groundsure INSIGHTS

Site Details:

BROADWATER LAKE,
MOORHALL ROAD, HAREFIELD,
UB9 6PE

Client Ref: 22-10-05
Report Ref: GS-9151608_LS_1_3
Grid Ref: 504136, 189744

Map Name: County Series

Map date: **1865-1866**

Scale: 1:2,500

Printed at: 1:2,500

N
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Surveyed 1866
Revised 1866
Edition N/A
Copyright N/A
Levelled N/A

Surveyed 1865
Revised 1865
Edition N/A
Copyright N/A
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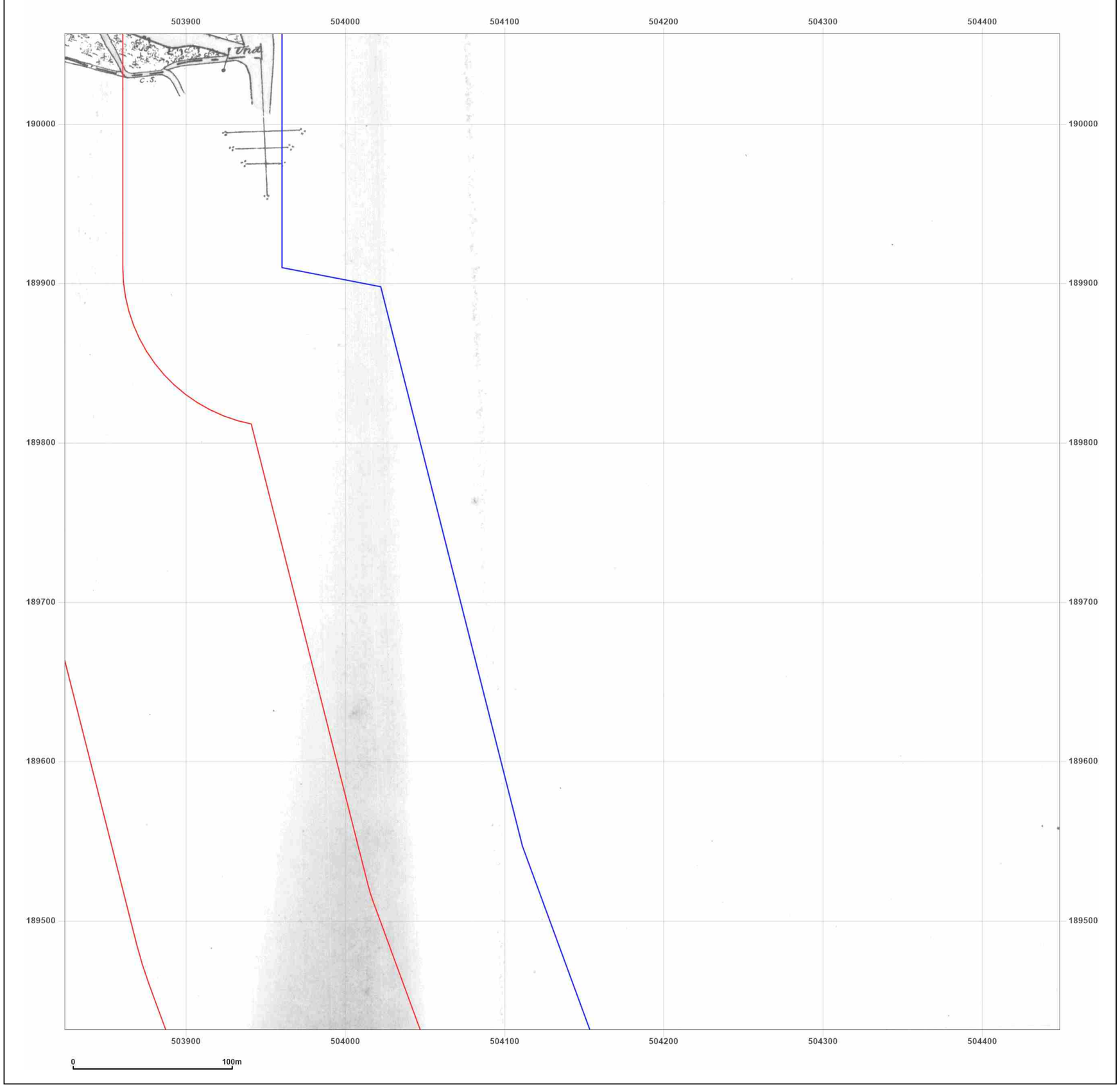

Groundsure INSIGHTS

Site Details:

BROADWATER LAKE,
MOORHALL ROAD, HAREFIELD,
UB9 6PE

Client Ref: 22-10-05
Report Ref: GS-9151608_LS_1_3
Grid Ref: 504136, 189744

Map Name: County Series

Map date: **1872**

Scale: 1:2,500

Printed at: 1:2,500

N
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Surveyed 1872
Revised 1872
Edition N/A
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