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Flood Risk Assessment

Symmetry Park, Huyton

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Executive Summary

The proposed development would be expected to remain dry in all but the most extreme conditions. Providing the recommendations made in this FRA are instigated, flood risk from all sources would be minimised, the consequences of flooding are acceptable, and the development would be in accordance with the requirements of the NPPF.

This FRA demonstrates that the proposed development would be operated with minimal risk from flooding, would not increase flood risk elsewhere and is compliant with the requirements of the NPPF. The development should not therefore be precluded on the grounds of flood risk.



1. Introduction

1.1 Background

This Flood Risk Assessment (FRA) has been prepared by Tier Consult at the request of Tritax Symmetry Huyton Limited for the proposed development at the Former Cronton Quarry. This FRA has been carried out in accordance with guidance contained in the National Planning Policy Framework (NPPF)¹, associated National Planning Practice Guidance (NPPG)² and the NPPG 'Site-specific flood risk assessment checklist (para 068 Reference ID: 7-068-20140306. This FRA identifies and assesses the risks of all forms of flooding to and from the development and demonstrates how these flood risks will be managed so that the development remains safe throughout the lifetime, taking climate change into account.

It is recognised that developments which are designed without regard to flood risk may endanger lives, damage property, cause disruption to the wider community, damage the environment, be difficult to insure and require additional expense on remedial works. The development design should be such that future users will not have difficulty obtaining insurance or mortgage finance, or in selling all or part of the development, as a result of flood risk issues.

1.2 National Planning Policy Framework (NPPF)

One of the key aims of the NPPF is to ensure that flood risk is taken into account at all stages of the planning process; to avoid inappropriate development in areas at risk of flooding and to direct development away from areas of highest risk. It advises that where new development is exceptionally necessary in areas of higher risk, this should be safe, without increasing flood risk elsewhere, and where possible, reduce flood risk overall.

A risk-based approach is adopted at stages of the planning process, applying a source pathway receptor model to planning and flood risk. To demonstrate this, an FRA is required and should include:

- whether a proposed development is likely to be affected by current or future flooding from all sources;
- whether it will increase flood risk elsewhere;
- whether the measures proposed to deal with these effects and risks are appropriate;
- if necessary, provide the evidence to the Local Planning Authority (LPA) that the Sequential Test can be applied; and
- whether the development will be safe and pass part c) of the Exception Test if this is appropriate.

¹ Ministry of Housing, Communities and Local Government (2019) National Planning Policy Framework.

² Department for Communities and Local Government (2014) Planning Practice Guidance - Flood Risk and Coastal Change.



1.3 Report Structure

This FRA has the following report structure:

- Section 2 details the sources of information that have been consulted;
- Section 3 describes the location area and the existing and proposed development;
- Section 4 outlines the flood risk to the existing and proposed development;
- Section 5 details the proposed surface water drainage for the site;
- Section 6 describes the risk management methods used to mitigate all sources of flood risk; and
- Section 7 presents a summary and conclusions.



2. Sources of Information

2.1 Discussion with Regulators

Consultation and discussions with the relevant regulators have been undertaken during this FRA including the Environment Agency, the Local Planning Authority (LPA), the Lead Local Flood Authority (LLFA) and Sewerage Undertakers.

2.2 Environment Agency

The Flood and Water Management Act 2010 gives the Environment Agency a strategic overview role for all forms of flooding and coastal erosion. They also have direct responsibility for the prevention, mitigation and remediation of flood damage for main rivers and coastal areas. The Environment Agency is the statutory consultee with regards to flood risk and planning. Information regarding the current flood risk at the application site, local flood defences and flood risk has been obtained from the Environment Agency.

The Environment Agency has made the following comments (see Appendix B):

“Flood Zones 2&3 associated with Foxes Bank Brook through the old Cronton Colliery site do appear somewhat misaligned with the watercourse in certain places and probably stems from the first generation of national Flood Map modelling undertaken nearly 20-years ago. Because of the limited amount of local development pressures since that time and the fact that there aren’t any existing properties (houses) located within the flood outlines, the justification to carry out an updated (and more accurate) modelling study hasn’t existed.

Any future Flood Risk Assessment carried out in support of a planning application for development on the site should consider multiple data sources, including site-specific hydraulic modelling where the risk is considered necessary. The published surface water flood map quoted is again the product of a national modelling exercise and produced to provide an initial estimation of areas susceptible to surface water flood risk only.

Ideally surface water attenuation ponds should be located within Flood Zone 1 only, as attenuation ponds can’t fulfil their primary purpose of storing excess run-off from new development sites if already full of fluvial flood flows from adjacent watercourses or rivers.”

The Environment Agency have confirmed the following in their response dated the 9th November 2020:

“Flood Risk

The development would need to be carried out in accordance with the submitted flood risk assessment (ref: September 2020/T.18.2126.FRA/Tier Consult) and the mitigation measures it details.

As identified in the FRA, the main river Fox's Bank Brook passes through the site. The Environmental Permitting (England and Wales) Regulations 2016 require a permit to be obtained for any activities which will take place:



- on or within 8 metres of a main river (16 metres if tidal)
- on or within 8 metres of a flood defence structure or culverted main river (16 metres if tidal)
- on or within 16 metres of a sea defence
- involving quarrying or excavation within 16 metres of any main river, flood defence (including a remote defence) or culvert
- in a floodplain more than 8 metres from the river bank, culvert or flood defence structure (16 metres if it's a tidal main river) and you don't already have planning permission

For further guidance please visit <https://www.gov.uk/guidance/flood-risk-activities-environmental-permits> or contact our National Customer Contact Centre on 03708 506 506. The applicant should not assume that a permit will automatically be forthcoming once planning permission has been granted, and we advise them to consult with us at the earliest opportunity."

Further correspondence was received from the Environment Agency on the 30th November 2020 after a meeting to discuss the project (see Appendix B):

"While I understand the concept of not wanting to increase the risk of flooding elsewhere, I don't recall receiving too many consent or permit applications that had effective tapering diameters. As discussed, generally speaking culvert capacity is only usually a problem to us if the capacity is too small - culvert depths should be oversized to allow for the natural watercourse gradient to be continued through the structure by constructing the base well below the bed of the watercourse. This will also guard against the increased risk of scour erosion from affecting the structure.

If there is an additional requirement to store floodwaters on the site, then rather than create this by throttling flow passing through the watercourse using an undersized structure – this should be provided by other means. For example, through the creation of low-lying floodplain directly adjacent to the channel."

2.3 Knowsley Metropolitan Borough Council

Knowsley Metropolitan Borough Council is the LPA and LLFA and has responsibilities for 'local flood risk', which includes surface runoff, groundwater and ordinary watercourses. Planning guidance written by Knowsley Metropolitan Borough Council regarding flood risk was consulted to assess the mitigation policies in place. The Knowsley Metropolitan Borough Council Strategic Flood Risk Assessment (SFRA) and the Knowsley Metropolitan Borough Council Preliminary Flood Risk Assessment (PFRA) which cover the site have been reviewed.

Knowsley Metropolitan Borough Council as the Lead Local Flood Authority (LLFA) has made the following comments:

"Please take a look at our Strategic and Preliminary Flood Risk Assessments. They can be found on Knowsley Council's Lead Local Flood Authority website.



The Strategic Flood Risk Assessments provide an overview of flood risk in Knowsley. The SFRA Part 1 focuses on future development in the borough but does not focus upon individual properties or sites. The SFRA Part 2 provides more detailed information regarding the nature of flood risk at a number of sites allocated within the Local Plan. The Preliminary Flood Risk Assessment (PFRA) report was submitted to the Environment Agency and approved in October 2011. According to the guidelines set by the Environment Agency / DEFRA, Knowsley does not have a nationally significant flood risk.

Further information on sustainable drainage can be found in Knowsley MBC's 'Sustainable Drainage & Surface Water Management - Technical Guidance for Developers' document (v06) for your information.

Guidance on the production of Flood Risk Assessments can be found here: <https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications>

From the limited information provided: the LLFA considers the development site to be greenfield and will require the surface water discharge rate be restricted to greenfield (Qbar) runoff rates, in accordance with our technical guidance and the Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015) or any subsequent replacement national standards.

The LLFA will require a comprehensive and detailed Flood Risk Assessment and Drainage Strategy, together with a corresponding detailed surface water drainage scheme to be submitted, together with hydraulic drainage calculations for a 1:2yr, 1:30yr and a 1:100yr plus an appropriate climate change allowance design storm event. (summer and winter storms, for all storm durations from 15mins to 10080mins). The drainage plan should be annotated with the pipe numbers from the calculations and show any attenuation, restricted discharge, exceedance storage and overland flow routes.

If the development is classified as Major Development under Article 2(1) of the Town and Country Planning (Development Management Procedure) (England) Order 2015; the development must include Sustainable Urban Drainage Systems (SuDS) unless it can be demonstrated that it is inappropriate for the site.

With regards to historical flooding; I have checked our records, and we do not have any recorded incidents of historical flooding within the development area. However, this does not necessarily mean that no historical flooding has occurred, just that none were reported to Knowsley Council.

Any works on or near a main river may need an Environmental Permit for Flood Risk Activities from the Environment Agency (EA). Any works on or near an ordinary watercourse will need Ordinary Watercourse Consent (OWC) from the Lead Local Flood Authority.

With regards to Surface Water, Groundwater, Coastal flooding; I have directed you towards our Strategic and Preliminary Flood Risk Assessments for this information. We do not have any additional information or knowledge at this time.

Knowsley MBC do not have any modelling for the area and SuDS will not be adopted by the Local Authority.



As a general comment the LLFA requires, a site wide flood risk assessment (FRA) report (for the whole of the Halsnead development and not just parcels of land in isolation) for all sources of flood risk, including recommendations for mitigation for any part of the area which is at flood risk from any source e.g. finished floor level minimum height etc.

In addition, the LLFA will require a surface water drainage strategy and layout encompassing and demonstrating an integrated drainage system (SuDS), which takes account of the site constraints, the masterplan and any pre-application discussions. The integrated site specific drainage strategy must ensure the individual requirements of each development parcel are taken into consideration and its layout is consistent with the masterplan, and demonstrates that the proposal does not prejudice other development parcels. See the information required section for a list of information that should be included.

It is recommended that the proposal seeks opportunities to reduce flood risk post-development through provision of flood storage betterment and/or improvement in flood flow conveyance.

The LLFA advise all opportunities are taken to ensure no negative impact on water quality. SuDS at source, alongside roads, verges, open areas, footpaths and near receptors can control flows and potentially improve water quality on receiving watercourses.

The FRA should include but not exhaustive:

- *Desk and initial ground investigation and geotechnical survey (boreholes, trial pits) to establish variations in soil and geology conditions, position of groundwater table (winter/summer), constraints on infiltration and a recommendations for the use of infiltration method (e.g. soakaway, deep bore, blanket etc) and other SuDS features. Results should be supported with a map in geotechnical 'bands' e.g. infiltration band etc*
- *Values for pre and post development impermeable area in hectares.*
- *Information on existing drainage (hard engineering and natural drainage) on the site, including current discharge method(s) and any outfall locations.*
- *Consideration of the possibility of runoff from existing neighbouring sites and, if so, recommendations for how this should be managed.*
- *An assessment of how the integrated sustainable drainage system takes account of the natural site catchment, including all existing watercourses and water bodies such as Big Water, and ensures that any proposals do not impact upon the natural catchment, water quality (treatment train) and enjoyment of these features.*
- *Pre and post development peak surface water discharge rates and discharge volumes, in line with Defra's Technical Standards for SuDS and taking account of the 'upper end' climate change allowance. To be submitted in MicroDrainage format. Recommendation for the rate at which the development parcel should discharge surface water at, and what attenuation volume is required to achieve the proposed discharge rates.*



- *Recommendations for surface water treatment trains for each discharge point, particularly for surface water bodies (watercourses, Big Water etc).*
- *Comprehensive, drainage layout plans / drawings of pre- and post-development sustainable drainage recommended option.*
- *Recommendations for surface water drainage during construction and phasing of the sustainable drainage system to ensure that no part of the development site is prejudiced. E.g. temporary drainage measures, pollution prevention, sediment capture, protection of existing/part built drainage systems.*
- *Recommendation for in perpetuity maintenance of each part of the sustainable drainage system e.g. S104, S106, S38, Private (deeds)."*

The LLFA has advised that applications forming part of the Halsnead Garden Village will need to undertake FRAs that cover the whole of the Halsnead development rather than for different parcels in isolation. The advice received from the LLFA is shown above.

The surface water drainage regimes for the parcels of land north and south of the M62 are entirely separate, with their own access to watercourses for discharging surface water and being notably separated by the physical barrier of the M62.

The plots to the north of the M62, which are to be developed by a number of different developers, will need to collaborate on a site wide drainage strategy in order to effectively store and discharge surface water to a limited number of outfall points, such as Big Water. This is because some of the plots have no direct access to an outfall point and will therefore need to direct surface water through third party land.

On the southern side of the M62, there are only two distinct applicants, those being the applicant for this site, Tritax Symmetry, and Maro Developments, who control the land to the west of the site. The advantage of this approach is that the Tritax application covers the majority of the land south of the M62 and enables a site-wide drainage strategy to be developed by one applicant.

The Maro site has direct access to Fox's Bank Brook to discharge its own surface water, which will be subject to appropriate storage and greenfield discharge rates. Therefore, there is no potential for the Tritax proposals to isolate the Maro site and restrict its ability to deliver its own drainage system. As such, the two sites do not need to be part of the same surface water drainage system. Indeed, draining the Maro site through the proposed country park system would be impractical given the distance to the ponds compared with the proximity to the watercourse and the need to pump water back upstream to make use of the proposed ponds in the country park.

It is also the case that all development parcels within the Halsnead Garden Village will be required to achieve greenfield runoff rates through the delivery of appropriate surface water storage systems, thus ensuring that the developments will not have any cumulative effect on the risk of flooding off-site.



In accordance with the above, the FRA and drainage strategy for the site take a proportionate approach based on an appreciation of the drainage and flood risk across the entire Garden Village area as well as the site-specific conditions. Accordingly, there are no cumulative effects on drainage and flood risk associated with the proposed development.

2.4 United Utilities

United Utilities is responsible for the disposal of waste water and supply of clean for this area. Information with regards to sewer and water main flooding contained within the Knowsley Metropolitan Borough Council SFRA and the Knowsley Metropolitan Borough Council PFRA have been consulted. All Water Companies have a statutory obligation to maintain a register of properties/areas which are at risk of flooding from the public sewerage system, and this is shown on the DG5 Flood Register.



3. Location & Description

3.1 Site Location

The site is located at the Former Cronton Colliery, Fox's Bank Lane, Widnes, Prescot, L35 3SU (see Drawing T/18/2126/FRA/1).

3.2 Existing Development

The former colliery site is currently a mixture of woodland and farmland, it was restored in 1995 to its present form.

3.3 Proposed Development

The application is for a hybrid planning application (part outline and part full) comprising:

- Full application for the development of 15,273 sq m of storage and distribution floorspace (Use Class B8), with ancillary offices and light industrial (Use Class B1); site access road; landscaping; and associated works; and
- Outline application with details of part-access and part-landscaping (details of part-access, part-landscaping, appearance, scale and layout are reserved) for the development of up to 77,629 sq m of storage and distribution floorspace (Use Class B8), with ancillary offices and light industrial (Use Class B1); details of earthworks to form development platforms, country park and drainage attenuation ponds; details of point of access; public car park to serve country park; pedestrian / cycle route connecting existing M62 footbridge with proposed country park including new footbridge over proposed access road; and associated works.

The warehouse units will be located to the north and west of the site, the country park will be located to the south east of the site (see Appendix C).

The proposed development will include the diversion of the Fox's Bank for approximately 150m and the creation of two new culverts under access roads. The diverted channel will have the same dimensions to the existing channel.

3.4 Ground Levels

A topographical survey of the site has recently been undertaken (see Appendix D). Overall, the site slopes in a south westerly direction. Ground levels are highest in the north eastern corner of the site, approximately 40 to 47mAOD, decreasing to 18mAOD in the western corner adjacent to the M62 roundabout.

3.5 Catchment Hydrology / Existing Drainage

Fox's Bank Brook enters the site from the east, it appears to run around the southern boundary until just east of Park Villas, at which point it heads north before turning eastwards again. After approximately 400m it heads south westwards beneath the A5080 to meet with Chapel Brook, after



which the watercourse is known as Ochre Brook. Environment Agency data on the watercourse is inconsistent. In addition to the above, there are also a number of other drains within the site that appear to connect to Fox's Bank Brook, and there a number of small ponds. The site is currently drained through a network of ditches/open watercourses flowing in a general southwest direction, following the local gradient.

3.6 Ground Conditions

The British Geological Survey (BGS) Map indicates that the site is underlain by Glaciofluvial Deposits, Mid Pleistocene - sand and gravel. Superficial deposits formed up to 2 million years ago in the Quaternary Period. The bedrock deposits underlying the site consist of the Edwalton Member - mudstone. Sedimentary bedrock formed approximately 228 to 237 million years ago in the Triassic Period.

The superficial deposits at the site were found to comprise the following during Site Investigations^{3, 4}:

- Manufactured topsoil (blend of colliery spoil, paper mill crumb and sewage cake) underlain by colliery spoil in the southern and eastern areas of the site underlain by Till (Devensian – Diamicton); and,
- Topsoil underlain by Till (Devensian – Diamicton) in the northern area of the site.

The superficial deposits were anticipated to be underlain by the Pennine Middle Coal Measures Formation comprising sandstones, mudstones and coal seams across the majority of the site, with competent rockhead encountered at depths between 28.82m and 32.30mAOD.

The superficial deposits in the eastern area of the site were anticipated to be underlain by the Kinnerton Sandstone Formation. Competent rockhead of the Kinnerton Formation was encountered at 37.94mAOD. A north-south trending normal fault is shown on available BGS maps.

During the intrusive investigation works, no olfactory or visual evidence of hydrocarbon or similar contamination was observed. Localised shallow obstructions comprising concrete and brick were encountered.

It is anticipated that shallow perched groundwater bodies will be present within the superficial soils, notably the colliery spoil mounds within the southern and eastern areas. Information from the National Soil Resources Institute⁵ details the site area as being situated on slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils with impeded drainage.

³ Tier Environmental, Preliminary Risk Assessment (Report Ref. TE1163PRA dated July 2020).

⁴ Tier Environmental, Preliminary Ground Investigation Report (Report Ref. TE1163PGIR dated July 2020).

⁵ National Soil Resources Institute (NSRI) 2013. The Soils Guide. Available: www.landis.org.uk. Cranfield University, UK. Last accessed 05/08/2020.



4. Flood Risk

4.1 Sources of Flooding

All sources of flooding have been considered, these are; fluvial (river) flooding, tidal (coastal) flooding, groundwater flooding, surface water (pluvial) flooding, sewer flooding and flooding from artificial drainage systems/infrastructure failure.

4.2 Historic Flooding

Knowsley Metropolitan Borough Council has confirmed that the site has not historically flooded and have made the following comments:

“With regards to historical flooding; I have checked our records, and we do not have any recorded incidents of historical flooding within the development area. However, this does not necessarily mean that no historical flooding has occurred, just that none were reported to Knowsley Council.”

There are no records of anecdotal information of flooding at the site including within the British Hydrological Society “Chronology of British Hydrological Events⁴”. No other historical records of flooding for the site have been recorded. Therefore, it has been assumed that the site has not flooded within the recent past.

4.3 Existing and Planned Flood Defence Measures

The Fox’s Bank Brook culverted river section is given a Standard of Protection (SoP) of 20% (1 in 5 years), the condition is Very Poor (5) and the structure is privately maintained. Fox’s Bank Brook is culverted around the south of the site it cannot be confirmed what the actual SoP and condition of the watercourse is. The SoP is 20% (1 in 5 years), the condition is unconfirmed, and the structure is privately maintained, however, as indicated above this does not match the available mapping for the site.

Further risk management measures will be used to protect the site from flooding these are discussed in Section 6.0.

4.4 Environment Agency Flood Zones

A review of the Environment Agency’s flood map indicates that the majority of the site is located within Flood Zone 1 and therefore has a ‘low probability’ of fluvial flooding, with less than a 1 in 1000 annual probability of river (<0.1%) (see Drawing T/18/2126/FRA/2). However, a small proportion of the site, to the south east, is located within Flood Zone 2 and 3 and therefore has a ‘medium to high’ probability of fluvial flooding, with less than a 1 in 1000 annual probability of river flooding (1% - 0.1%) to a 1 in 100 or greater annual probability of river flooding (>1%) in any year.

The Environment Agency Flood Zones and acceptable development types are explained in Table 4.1. The Flood Zones are the current best information on the extent of the extremes of flooding from rivers or the sea that would occur without the presence of flood defences, because these can be breached, overtopped and may not be in existence for the lifetime of the development. However, due to the



small size of the upper catchment the flood risk from the adjacent watercourses including the Fox's Bank Brook may not be accurately shown on the Environment Agency's flood map.

The existing flood map in this location is based on coarse resolution JFLOW modelling, as such the flood outlines do not align to the watercourses in the area.

The Environment Agency have confirmed the following: *"Flood Zones 2&3 associated with Foxes Bank Brook through the old Cronton Colliery site do appear somewhat misaligned with the watercourse in certain places and probably stems from the first generation of national Flood Map modelling undertaken nearly 20-years ago. Because of the limited amount of local development pressures since that time and the fact that there aren't any existing properties (houses) located within the flood outlines, the justification to carry out an updated (and more accurate) modelling study hasn't existed."*

The Knowsley Metropolitan Borough Council SFRA states: *"A visual inspection indicates that they may not match the true nature of flooding in this location and as such are suspect. In addition it is not possible to quantify the flood risk from the other watercourses / drains on site."*

Therefore, a detailed 1D/2D linked hydraulic model of the Fox's Bank Brook has been developed to confirm the flood risk posed to the site and to inform this FRA. A river channel survey has been undertaken to inform the channel geometry of the hydraulic model.

Table 4.1 - Environment Agency Flood Zones and Appropriate Land Use

Flood Zone	Probability	Explanation	Appropriate Land Use
Zone 1	Low	Less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%)	All development types generally acceptable
Zone 2	Medium	Between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% 0.1%) in any year	Most development type are generally acceptable
Zone 3a	High	A 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year	Some development types not acceptable
Zone 3b	'Functional Floodplain'	Land where water has to be flow or be stored in times of flood. SFRAs should identify this zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1% flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes)	Some development types not acceptable



4.5 Flood Risk Vulnerability

In the Planning Practice Guidance to the NPPF (Table 1) appropriate uses have been identified for the Flood Zones. Applying the Flood Risk Vulnerability Classification in Table 2 and 3 of the Planning Practice Guidance to the NPPF, the development is classified as 'less vulnerable'. Table 3 of the Planning Practice Guidance to the NPPF states that 'less vulnerable' uses are appropriate within Flood Zones 1, 2 and 3.

Table 4.2 - Flood Risk Vulnerability and Flood Zone 'Compatibility' as identified in Table 3 of the Planning Practice Guidance to the NPPF

Flood Risk Vulnerability Classification	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception test required	✓	✓
Zone 3a	Exception test required	✓	✗	Exception test required	✓
Zone 3b 'Functional Floodplain'	Exception test required	✓	✗	✗	✗

Key: ✓: Development is appropriate, ✗: Development should not be permitted.

4.6 Climate Change

Projections of future climate change, in the UK, indicate more frequent, short-duration, high intensity rainfall and more frequent periods of long duration rainfall. Guidance included within the NPPF recommends that the effects of climate change are incorporated into FRA. Recommended precautionary sensitivity ranges for peak rainfall intensities and peak river flows are outlined in the associated Planning Practice Guidance to the NPPF⁶.

Table 4.3 shows peak river flow climate change allowances by river basin district. The flood risk assessments: climate change allowances guidance recommends that for 'less vulnerable' uses in Flood Zone 2 and 3 that the high central allowances are used. Therefore, the design flood level for the site is the 1 in 100 year (+35%) event.

Table 4.3 - Peak River Flow Allowances by River Basin District (use 1961 to 1990 baseline)

River Basin District	Allowance Category	2015 to 2039	2040 to 2059	2060 to 2115
North West	H++	+25%	+45%	+95%
	Upper end	+20%	+35%	+70%
	High central	+20%	+30%	+35%
	Central	+15%	+25%	+30%

⁶ <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#high-allowances>.



4.7 Fluvial (river) Flooding

The Fox's Bank Brook is located to the south of the site. Fox's Bank Brook is a small watercourse in scale, the channel is approximately 2m wide and approximately 0.50m in depth (see Figure 4.1 and 4.2). The channel is approximately 3m below the existing ground levels of the site (see Figure 4.3), a maximum 'normal' water level of between 25.40m AOD and 25.80m AOD has been recorded. Figure 4.4 shows a cross section of Fox's Bank Brook at the upstream of the site and Figure 4.5 shows a cross section of Fox's Bank Brook at the downstream of the site.

The likelihood of the Fox's Bank Brook rising over 3.00m and inundating the site is very minimal. The site has no history of flooding and has not flooded during the largest flood events. The water levels of the Fox's Bank Brook would have to rise from 25.80m AOD to 29.00m AOD for the site to be inundated with floodwater which is very unlikely.



Figure 4.1 - Fox's Bank Brook at the Upstream of the Site



Figure 4.2 - Fox's Bank Brook at the Downstream of the Site



Figure 4.3 - Fox's Bank Brook River Bank at the Upstream of the Site

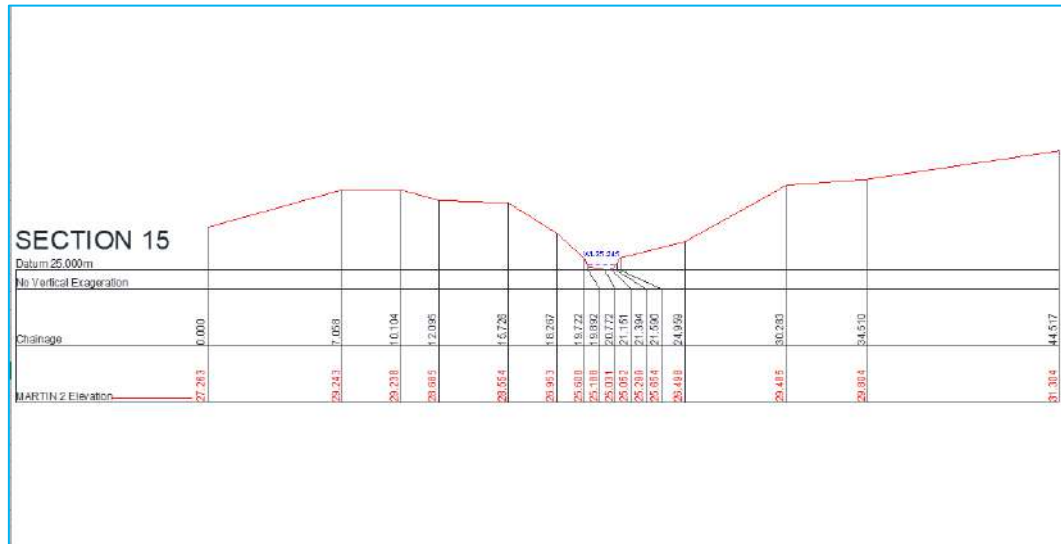


Figure 4.4 - Cross Section of Fox's Bank Brook at the Upstream of the Site

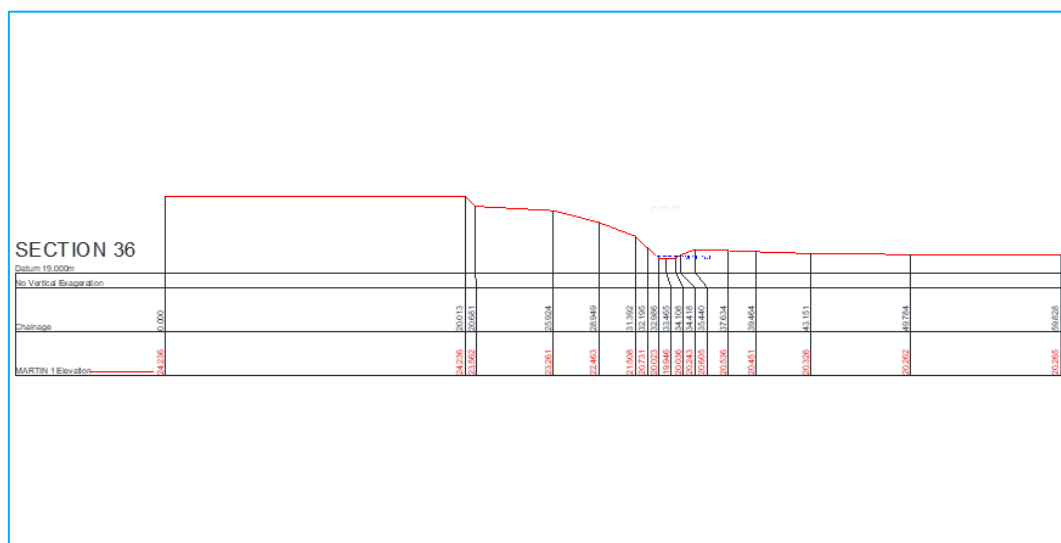


Figure 4.5 - Cross Section of Fox's Bank Brook at the Downstream of the Site

The Environment Agency and Knowsley Metropolitan Borough Council have both confirmed that the flood risk from the Fox's Bank Brook is misaligned with the watercourse and does not match the true nature of flooding posed to the site. The current Environment Agency's flood map covering the development site is based upon national JFLOW modelling and the flood outlines do not align to the watercourses in the area, therefore detailed hydraulic modelling is required to confirm flood risk to the site. The hydraulic model will be run for a range of return periods including two climate change scenarios. As per the request of the Environment Agency a blockage scenario of the culvert under Cronton Road is required. The modelling report and modelling outputs are contained within Appendix E.

The results of the baseline scenario for the 1 in 100 year (+35%) and 1 in 1000 year events are shown in Figure 4.6. The modelled results indicate that the site is not at high risk of fluvial flooding. Flooding within the site is mostly confined along the south of the site boundary, adjacent to the south bank of the Fox's Bank Brook. The majority of the site is not at risk of flooding. The floodwaters are restricted from entering the site boundary by the surrounding topography.

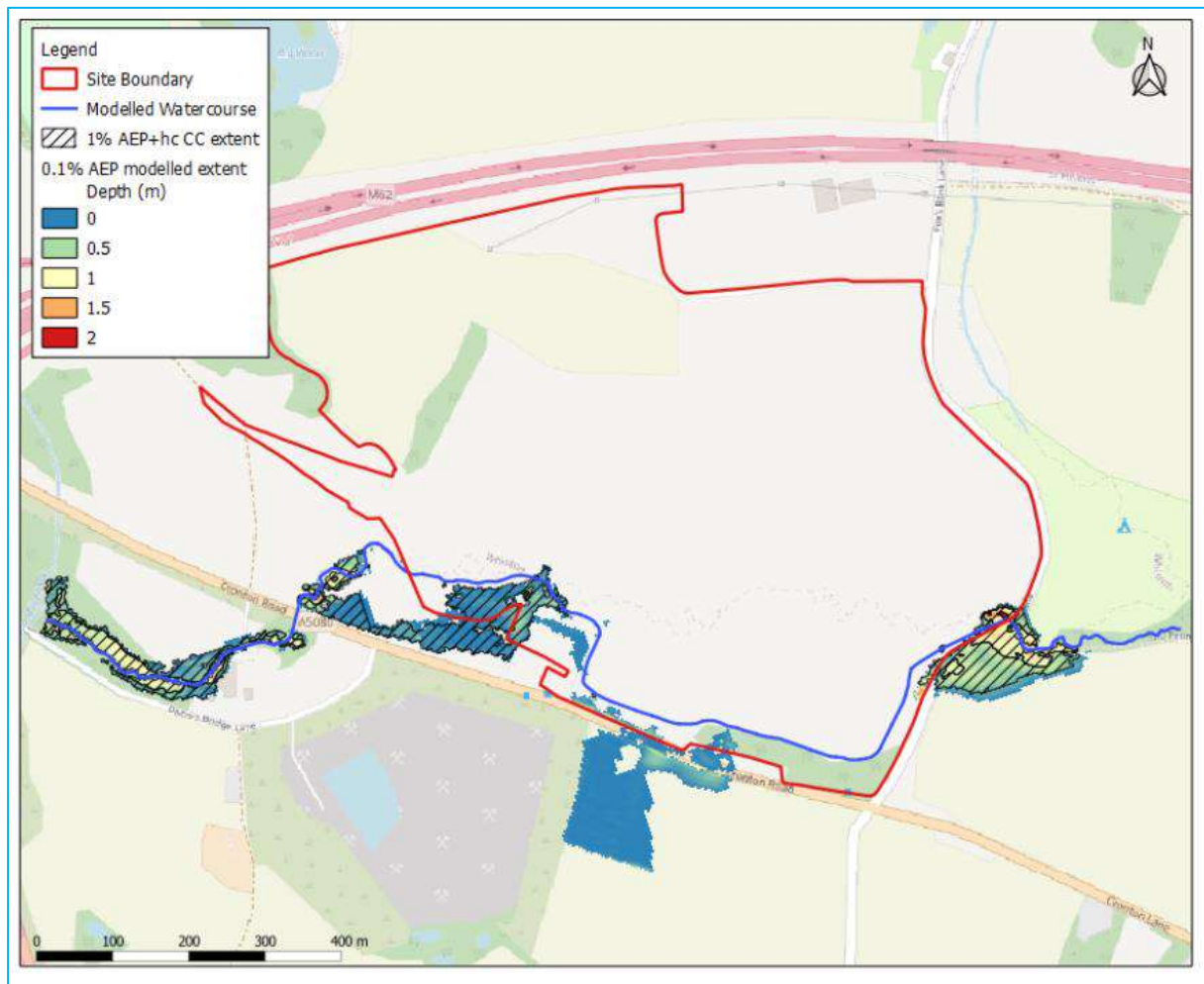


Figure 4.6 - Baseline Condition: 1 in 100 Year (35%) and 1 in 1000 Year Event Modelled Results

Drawing T/18/2126/3 shows the 1 in 100 year modelled flood outline. The modelled results indicate that the site is not at high risk of fluvial flooding with less than 0.50% of the site at risk during the 1 in 100 year event. Flooding within the site is mostly confined along the south of the site boundary, adjacent to the south bank of the Fox's Bank Brook. The only area of proposed built development that may be inundated with floodwater is a very small proportion of the proposed car park which may be inundated with floodwater to a maximum depth of 0.25m. The majority of the site is not at risk of flooding. The floodwaters are restricted from entering the site boundary by the surrounding topography.



Drawing T/18/2126/4 shows the 1 in 100 year (+35%) modelled flood outline. The modelled results indicate that the site is not at high risk of fluvial flooding with approximately 1.40% of the site at risk during the 1 in 100 year (+35%) event. Flooding within the site is mostly confined along the south of the site boundary, adjacent to the south bank of the Fox's Bank Brook. Across the site flood depths average 0.229m.

During the 1 in 100 year (+35%) event maximum flood depths within the site reach 1.90m in a wooded area in the far east of the site boundary where there is a culvert under Fox's Bank Road. The only area of proposed built development that may be inundated with floodwater is a very small proportion of the proposed car park which may be inundated with floodwater to a maximum depth of 0.34m. The majority of the site is not at risk of flooding. The floodwaters are restricted from entering the site boundary by the surrounding topography.

Drawing T/18/2126/5 shows the 1 in 100 year (+70%) modelled flood outline. The modelled results indicate that the site is not at high risk of fluvial flooding during the 1 in 100 year event. Flooding within the site is mostly confined along the south of the site boundary, adjacent to the south bank of the Fox's Bank Brook. The only area of proposed built development that may be inundated with floodwater is a very small proportion of the proposed car park which may be inundated with floodwater to a maximum depth of 0.42m. The majority of the site is not at risk of flooding. The floodwaters are restricted from entering the site boundary by the surrounding topography.

Drawing T/18/2126/6 shows the 1 in 1000 year modelled flood outline. During the 1 in 1000 year event, the flood extent within the site is shown to increase to cover 2.30% of the site. The maximum flood depth within the site boundary increases to 2.21m, with average depths also increasing slightly to 0.249m. As with the 1 in 100 year (+35%) event the largest flood depth is seen along the western boundary of the site, and flood risk is confined to the south of the site and the south of the Fox's Bank Brook. The only area of proposed built development that may be inundated with floodwater is a very small proportion of the proposed car park which may be inundated with floodwater to a maximum depth of 0.45m and the proposed access road to a maximum depth of 0.011m. The majority of the site is not at risk of flooding. The floodwaters are restricted from entering the site boundary by the surrounding topography.

Correspondence with the Environment Agency confirmed the requirement for running a blockage event on the culvert beneath Cronton Road at NGR: 346939, 389093. It is understood that there is a debris screen on the inlet to the culvert which is maintained by the Environment Agency however the screen is susceptible to blockage during flood events. The blockage scenario has been run for the baseline scenario assuming 100% blockage of the indicated culvert (to ensure model stability 99% blockage is modelled) for the 1 in 1000 year event. The change in modelled flood depth for the blockage scenario vs the baseline scenario are presented below in Figure 4.7.

The modelled results indicate that flood risk within the site boundary does not increase in response to the blockage of the culvert under Cronton Road. The modelled flood depths are shown to increase to the immediate north of the blockage however the floodwaters are restricted from entering the site boundary by the surrounding topography.

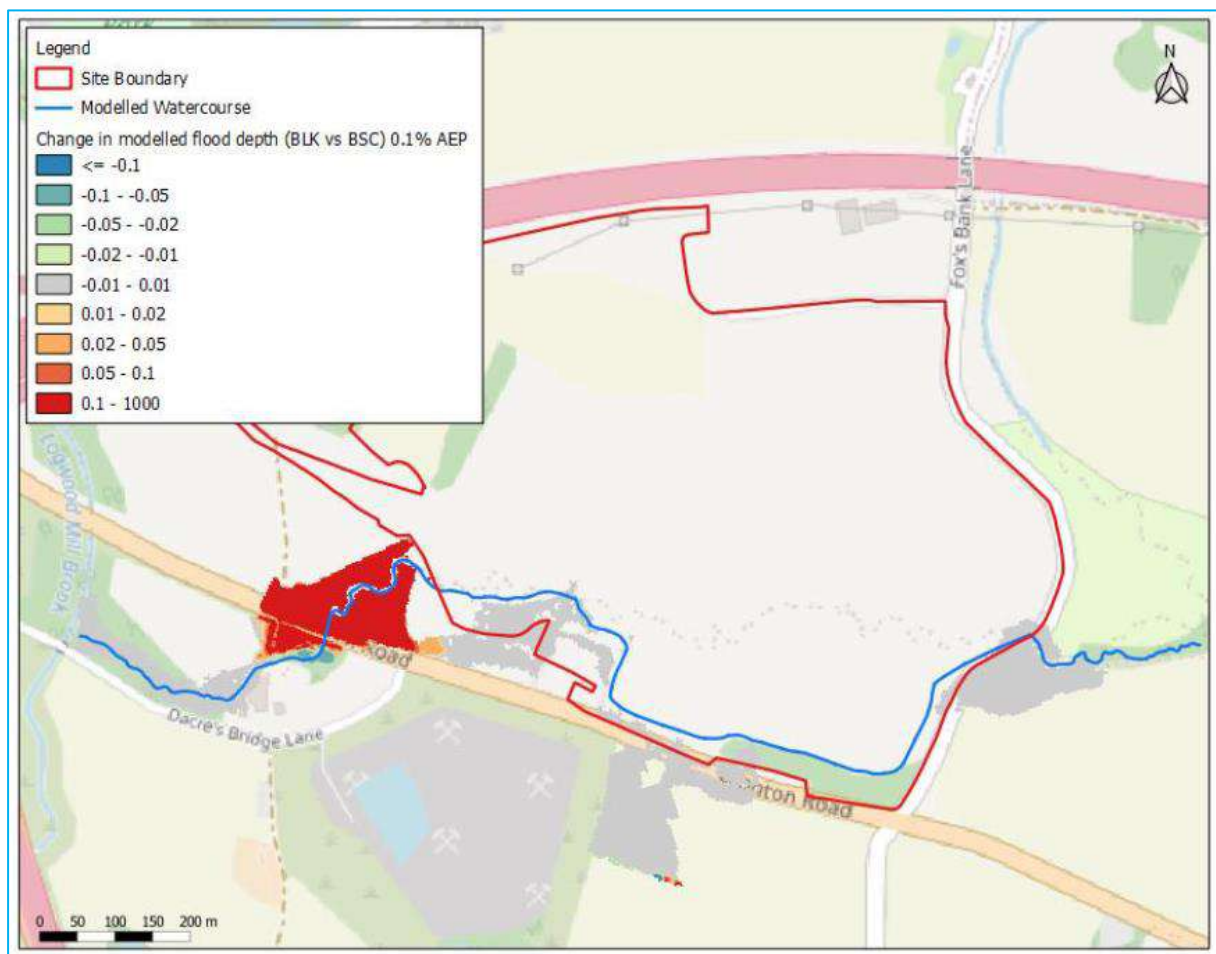


Figure 4.7 - 1 in 1000 Year Event Blockage Scenario Modelled Change in Modelled Flood Depths

In conclusion, the outputs from the detailed hydraulic model of the Fox's Bank Brook show that the majority of the site will not be inundated with floodwater for all events up to and including the 1 in 1000 year event. The actual flood risk posed to the site, compared to the Environment Agency's Flood Zones, is much less, the majority of flows will be contained within the channel of Fox's Bank Brook for all events up to and including the 1 in 1000 year event.

There is a small area of inundation to the south of the site, where ground levels are lower. However, the large area of the site, to the south east, which is shown to be located within the Environment Agency's Flood Zone 3 will not be inundated with floodwater during the 1 in 100 year (+35%) and 1 in 1000 year events and should be considered as being located within Flood Zone 1 (see Drawing T/18/2126/7). The area of the proposed country park and attenuation lagoons is shown to be not inundated with floodwater for all events up to and including the 1 in 100 year (+35%) and 1 in 1000 year events and is not located within Flood Zones 2/3 and should be designated as Flood Zone 1.

The likelihood of a rapid river level rise and possible rapid inundation of areas posing a risk to life is considered to be minimal. The site is located within a low risk area where the onset of flooding is



gradual as per Flood Risk Assessment Guidance for New Development Phase 2, R&D Technical Report FD2320/TR2. The speed of inundation and rate of floodwater rise would be low.

Any overbank flow would follow the contours of the surrounding area and would flow directly to the west rather than flowing towards the site. The flood risk can also be considered to be limited due to the difference in elevations. The ground levels of the site are located a minimum of 3.00m above the normal water level of the Fox's Bank Brook. The flood risk would be confirmed to the river channel and areas immediately adjacent.

Given the scale and nature of the proposed development and the size and location of the fluvial flooding sources it has been concluded that fluvial flooding poses a low flood risk to the site therefore, the risk of fluvial flooding is considered to be of low significance.

4.8 Tidal (coastal) Flooding

The site is not located within the vicinity of tidal flooding sources and the risk of tidal flooding is considered to be not significant.

4.9 Groundwater Flooding

Groundwater flooding is defined as the emergence of groundwater at the ground surface or the rising of groundwater into man-made ground under conditions where the normal range of groundwater levels is exceeded. Groundwater flooding tends to occur sporadically in both location and time. When groundwater flooding does occur, it tends to mostly affect low-lying areas, below surface infrastructure and buildings (for example, tunnels, basements and car parks) underlain by permeable rocks (aquifers).

The susceptibility of the site to groundwater flooding, based on the underlying geological conditions, is low. There are no records of groundwater flooding at or near to the site. It can therefore be concluded that the risk of groundwater flooding is not significant.

4.10 Surface Water (pluvial) Flooding

The soil condition at the site and within the vicinity of the site and the topography of the site suggest that the site is relatively well drained and surface water flooding would not be expected to accumulate to any significant depths. Surface water flooding tends to occur sporadically in both location and time.

The Environment Agency Surface Water flood map shows that the majority of the site has very low risk of surface water flooding with a chance of flooding of less than 1 in 1000 (0.1%) years (see Drawing T/18/2126/8). However, small areas of the site have a low to high risk of surface water flooding with a chance of flooding of 1 in 1000 (0.1%) years to greater than 1 in 30 (3.3%) years.

This is associated with the identified ditches / watercourses, low spots within the site and ponds within the site. The surface water runoff is shown to follow the topographical lows with runoff discharging to the south west. This may result in ponding of 300-900mm in depth and water velocities of less than 0.25m/s on a very small proportion of the site. The risk of flooding from surface water flooding is considered to be of low significance.



4.11 Sewer Flooding

Sewer flooding occurs when urban drainage networks become overwhelmed and maximum capacity is reached. This can occur if there is a blockage in the network causing water to back up behind it or if the sheer volume of water draining into the system is too great to be handled. Sewer flooding tends to occur sporadically in both location and time such flood flows would tend to be confined to the streets around the development.

There are existing public sewers within roads adjacent to the site these will inevitably have a limited capacity so in extreme conditions there would be surcharges, which may in turn cause flooding. Flood flows could also be generated by burst water mains, but these would tend to be of a restricted and much lower volume than weather generated events and so can be discounted for the purposes of this assessment. Given the design parameters normally used for drainage design in recent times and allowing for some deterioration in the performance of the installed systems, which are likely to have been in place for many years, an appropriate flood risk probability from this source could be assumed to have a return period in the order of 1 in 10 to 1 in 30 years.

The provision of adequate level difference between the ground floors and adjacent ground level would reduce the annual probability of damage to property from this source to 1 in 100 years or less. Therefore, sewer flooding poses a low flood risk to the site. It can therefore be concluded that the risk of sewer flooding is considered to be not significant.

4.12 Flooding from Artificial Drainage Systems/Infrastructure Failure

There are no other nearby artificial water bodies, water channels and artificial drainage systems that could be considered a flood risk to the site. The Environment Agency Reservoir flood map shows that the site is not at risk of reservoir flooding (see Drawing T/18/2126/FRA/9). The risk of flooding from reservoir failure is considered to be not significant.

4.13 Effects of the Development on Flood Risk

The proposed warehousing units will be located within Flood Zone 1 and the area of the proposed country park and attenuation lagoons is not located within Flood Zones 2/3 and should be designated as Flood Zone 1. This has been confirmed with the modelling of the Fox's Bank Brook which shows that the majority of the site is not at risk of flooding. The floodwaters are restricted from entering the site boundary by the surrounding topography.

During the 1 in 100 year (+35%) event the only area of proposed built development that may be inundated with floodwater is a very small proportion of the proposed car park which may be inundated with floodwater to a maximum depth of 0.34m. The majority of the site is not at risk of flooding. The floodwaters are restricted from entering the site boundary by the surrounding topography.

The house at NGR: 347233, 389043 is shown to be not inundated with floodwater for all events up to and including the 1 in 1000 year event. During all modelled events, the house at NGR: 347200, 389056 may only be inundated with floodwater to a maximum depth of 0.011m.



The proposed development will include the diversion of the Fox's Bank for approximately 150m and the creation of two new culverts under access roads. The diverted channel will have the same dimensions to the existing channel.

The ground levels of the proposed car park and the proposed access road will be kept as existing therefore, there will be no loss of floodplain storage capacity and the proposed development will have no impact on the movement of water.

The proposed development scenario has been modelled to assess the impact of the proposed development on flood risk. A number of different options for the culvert dimensions have been modelled to ascertain the optimum solution which does not increase flood risk. The modelling report and modelling outputs are contained within Appendix E.

There will be no detriment to the flood storage capacity of the site. The overall direction of the movement of water will be maintained within the developed site and surrounding area. The conveyance routes (flow paths) will not be blocked or obstructed. The proposed development will have no impact on the movement of floodwater across the site. There will be no increase in the floodwater levels due to the proposed development. There will be no loss in flood storage capacity and no change in the on-site and off-site flood risk.

4.14 Summary of Site-Specific Flood Risk Assessment

A summary of the sources of flooding and a review of the risk posed by each source at the site is shown in Table 4.3.

Table 4.3 - Risk Posed by Flooding Sources

Sources of Flooding	Potential Flood Risk	Potential Source	Probability/Significance
Fluvial (river) Flooding	Yes	Fox's Bank Brook	Low
Tidal (coastal) Flooding	No	None Reported	Not significant
Groundwater Flooding	No	None Reported	Not significant
Surface Water (pluvial) Flooding	Yes	Low Spots	Low
Sewer Flooding	No	None Reported	Not significant
Flooding from Artificial Drainage Systems/Infrastructure Failure	No	None Reported	Not significant

The site is unlikely to flood except in extreme conditions. The primary, but unlikely, flood risk posed to the site is from fluvial flooding from Fox's Bank Brook however, the site has no history of flooding. The existing flood map in this location is based on coarse resolution JFLOW modelling, as such the flood outlines do not align to the watercourses in the area as agreed by both the Environment Agency and the Knowsley Metropolitan Borough Council SFRA. Therefore, a detailed 1D/2D linked hydraulic model of the Fox's Bank Brook has been developed to confirm the flood risk posed to the site and to inform this FRA.



The likelihood of the Fox's Bank Brook rising over 3.00m and inundating the site is very minimal. The site has no history of flooding and has not flooded during the largest flood events. The outputs from the detailed hydraulic model of the Fox's Bank Brook show that the majority of the site will not be inundated with floodwater for all events up to and including the 1 in 1000 year event. The actual flood risk posed to the site, compared to the Environment Agency's Flood Zones, is much less the majority of flows will be contained within the channel of Fox's Bank Brook for all events up to and including the 1 in 1000 year event.

During the 1 in 100 year event the only area of proposed built development that may be inundated with floodwater is a very small proportion of the proposed car park which may be inundated with floodwater to a maximum depth of 0.25m.

During the 1 in 100 year (+35%) event the only area of proposed built development that may be inundated with floodwater is a very small proportion of the proposed car park which may be inundated with floodwater to a maximum depth of 0.34m.

During 1 in 100 year (+70%) event the only area of proposed built development that may be inundated with floodwater is a very small proportion of the proposed car park which may be inundated with floodwater to a maximum depth of 0.42m.

During the 1 in 1000 year event the only area of proposed built development that may be inundated with floodwater is a very small proportion of the proposed car park which may be inundated with floodwater to a maximum depth of 0.45m and the proposed access road to a maximum depth of 0.011m.

The majority of the site is not at risk of fluvial flooding. The floodwaters are restricted from entering the site boundary by the surrounding topography. Flooding within the site is mostly confined along the south of the site boundary, adjacent to the south bank of the Fox's Bank Brook.

In conclusion, the outputs from the detailed hydraulic model of the Fox's Bank Brook show that the majority of the site will not be inundated with floodwater for all events up to and including the 1 in 1000 year event. The actual flood risk posed to the site, compared to the Environment Agency's Flood Zones, is much less the majority of flows will be contained within the channel of Fox's Bank Brook for all events up to and including the 1 in 1000 year event.

There is a small area of inundation to the south of the site, where ground levels are lower. However, the large area of the site, to the south east, which is shown to be located within the Environment Agency's Flood Zone 3 will not be inundated with floodwater during the 1 in 100 year (+35%) and 1 in 1000 year events and should be considered as being located within Flood Zone 1 (see Drawing T/18/2126/7). The area of the proposed country park and attenuation lagoons is shown to be not inundated with floodwater for all events up to and including the 1 in 100 year (+35%) and 1 in 1000 year events and is not located within Flood Zones 2/3 and should be designated as Flood Zone 1.

Given the scale and nature of the proposed development and the size and location of the fluvial flooding sources it has been concluded that fluvial flooding poses a low flood risk to the site therefore, the risk of fluvial flooding is considered to be of low significance. A secondary flooding source has been identified which may pose a low risk to the site. This is:



- Surface Water (pluvial) Flooding

The risk of flooding from all sources is considered to be low or not significant. The flooding sources will only inundate the site to a relatively low water depth and water velocity, will only last a short period of time, in very extreme cases and will not have an impact on the whole of the proposed development site.

The proposed development is classified as 'less vulnerable', 'less vulnerable' uses are appropriate within Flood Zones 1, 2 and 3 after the completion of a satisfactory FRA. The proposed warehousing units will be located within Flood Zone 1 and the area of the proposed country park and attenuation lagoons is not located within Flood Zones 2/3 and should be designated as Flood Zone 1. Therefore, there will be no loss of floodplain storage capacity and the proposed development will have no impact on the movement of water.

The proposed development scenario has been modelled to assess the impact of the proposed development on flood risk. A number of different options for the culvert dimensions have been modelled to ascertain the optimum solution which does not increase flood risk. There will be no detriment to the flood storage capacity of the site. The overall direction of the movement of water will be maintained within the developed site and surrounding area. The conveyance routes (flow paths) will not be blocked or obstructed. The proposed development will have no impact on the movement of floodwater across the site. There will be no increase in the floodwater levels due to the proposed development. There will be no loss in flood storage capacity and no change in the on-site and off-site flood risk.

The flood risk at the site, will be further managed and mitigated by using a number of risk management techniques, and mitigation strategies to manage and reduce the overall flood risk at the site. The application is for a new, suitable flood-resilient design. The exposure of people and property will be reduced and minimised compared to existing site conditions. The chance of flooding each year is low each year. This takes into account the effect of any flood defences that may be located within the vicinity of the site as well property level protection measures.



5. Surface Water Management

5.1 Discharge of Surface Water

There are three possible options to discharge the surface water runoff in accordance with requirement H3 of the Building Regulations, this hierarchy is also promoted within the NPPF. Rainwater shall discharge to one of the following, listed in order of priority:

- an adequate soakaway or some other adequate infiltration system; or, where that is not reasonably practicable,
- a watercourse; or where that is not reasonably practicable,
- a sewer.

It is necessary to identify the most appropriate method of controlling and discharging surface water. The design should seek to improve the local runoff profile by using systems that can either attenuate runoff and reduce peak flow rates or positively impact on the existing surface water runoff.

A separate Surface Water Drainage Strategy⁷, Drainage Layout Drawings⁸ and SuDS Maintenance Plan⁹ have been undertaken for the proposed development.

5.2 Soakaway/Infiltration System

In determining the future surface runoff from the site, the potential of using infiltration devices has been considered. The Site Investigations report¹⁰ concludes that *"It is considered at this stage that infiltration methods are unlikely to be suitable across the majority of the site due to the likely presence of low permeability strata and the potential risk of causing unacceptable settlements within the colliery spoil and fill materials. Therefore, it will not be possible to discharge surface water runoff from the site via infiltration methods."*

5.3 Watercourse

Should infiltration be found to be unsuitable, the next option is discharge to a watercourse. Fox's Bank Brook is located to the south of the site. Therefore, it will be possible to discharge surface water runoff from the site into a watercourse.

5.4 Sewer

In the event that discharge of surface water via infiltration or discharge to a watercourse is deemed unsuitable, then discharge to the public sewer is the next option. However, there is also no surface water sewer within a reasonable distance from the site furthermore, it is proposed to discharge the surface water into a watercourse therefore, this option is not required.

⁷ Tier Consult, Drainage Strategy 001 (Ref. 2126 dated August 2020).

⁸ Tier Consult, Drainage Layout (Ref. 55-00, 55-01, 55-02, 55-03 and 55-04 dated August 2020).

⁹ Tier Consult, SuDS Maintenance Plan (Ref. 2126 SuDS 001 dated August 2020).

¹⁰ Tier Environmental, Preliminary Ground Investigation Report (Report Ref. TE1163PGIR dated July 2020).



5.5 Proposed Surface Water Drainage Strategy

The objective of this Surface Water Drainage Strategy is to ensure that a sustainable drainage solution can be achieved which reduces the peak discharge rate to manage and reduce the flood risk posed by the surface water runoff from the site. One of the aims of the NPPF is to provide not only flood risk mitigation but also to maximise additional gains such as improvements in runoff quality and provision of amenity and biodiversity. Systems incorporating these features are often termed SuDS and it is the requirement of NPPF that these are considered as the primary means of collection, control and disposal for storm water as close to source as possible.

There is limited space within the proposed site layout for the attenuation storage, the limited space has been maximised as much as possible. It is proposed the surface water for the development will discharge into Fox's Bank Brook at Greenfield runoff rates for all events up to and including the 1 in 100 year (+40%) events.

As a consequence of limiting the rate of discharge from the site, at times of heavy rainfall the volume of water leaving the site will be significantly less than that draining from it. In order to prevent this water backing up in the system and causing flooding, linked attenuation lagoons will be incorporated into the site layout of attenuation storage will be provided. The size of this attenuation storage has been calculated such that the proposed development has the capacity to accommodate the 100 year rainfall event including a 40% increase in rainfall intensity that is predicted to occur as a result of climate change.

The remainder of the site that is not formally drained, i.e. landscaped areas, will be permeable (grass). The majority of rainwater falling on these areas will soak into the ground. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

These methods will reduce peak flows, the volume of runoff, and slow down flows and will provide a suitable SuDS solution for this site. These preliminary considerations are based on the outline development scheme provided and hence the design purposes. The adoption of a Surface Water Drainage Strategy for the site represents an enhancement from the current conditions as the current surface water runoff from the site is uncontrolled, untreated, unmanaged and unmitigated. In adopting these principles, it has been demonstrated that a scheme can be developed that does not increase the risk of flooding to adjacent properties and development further downstream.

5.6 Designing for Local Drainage System Failure/Design Exceedance

When considering residual risk, it is necessary to make predictions as to the impacts of a storm event that exceeds the design event, or the impact of a failure of the local drainage system. The SuDS Strategy applies a safe and sustainable approach to discharging rainfall runoff from the site and this reduces the risk of flooding however, it is not possible to completely remove the risk. This section of the FRA is therefore associated with the way the residual risk is managed.

As part of the Surface Water Drainage Strategy it must be demonstrated that the flooding of property would not occur in the event of local drainage system failure and/or design exceedance. It is not economically viable or sustainable to build a drainage system that can accommodate the most



extreme events. Consequently, the capacity of the drainage system may be exceeded on rare occasions, with excess water flowing above ground¹¹.

The attenuation requirements have been designed to accommodate the 1 in 100 year event plus climate change (+40%). The design of the site layout provides an opportunity to manage this local drainage system failure/exceedance flow and ensure that indiscriminate flooding of property does not occur.

There will not be an extensive sewerage network on the proposed development site and therefore any potential exceedance flooding would be from the drains connecting the buildings to the linked attenuation lagoons. It is very unlikely that a catastrophic failure would occur. An exceedance or blockage event of the drains would not affect the proposed buildings because the finished floor level will be raised above surrounding ground levels, ensuring any exceedance flooding would not affect the buildings.

Exceedance flows would be contained within the highways within the site and adjacent to the site and would flow to the lower ground levels where the landscaped areas are located. In particular, the landscaped areas will include preferential flow paths that convey water away from buildings. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas. It is not considered that there is an increased risk to the properties on the site or located adjacent to the site.

When considering the impacts of a storm event that exceeds the 1 in 100 year (+40%) event, there is safety factor for attenuation storage, even under the design event conditions. Consequently, if this event were to be exceeded there is additional capacity with the system to accommodate this. If this freeboard was to be exceeded the consequences would be similar, if not less than for the local drainage system failure. Drainage gullies, manholes and pipework will provide additional water storage and provide betterment. Consequently, the impact of an exceedance event is not considered to represent any significant flood hazard.

The above manages and mitigates the flood risk from surface water runoff to the proposed properties from surface water runoff generated by the site development and to offsite locations as well the risk from surface water runoff generated offsite.

¹¹ CIRIA (2006) Designing for exceedance in urban drainage – good practice.



6. Risk Management

6.1 Introduction

In this flood zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area through the layout, form of the development and the use of flood mitigation measures including SuDS techniques. The flooding sources will have to be mitigated on the site by using a number of techniques, and mitigation strategies to manage and reduce the overall flood risk at the site. These will be used to ensure the development will be safe and there is:

- Minimal risk to life;
- Minimal disruption to people living and working in the area;
- Minimal potential damage to property;
- Minimal impact of the proposed development on flood risk generally; and;
- Minimal disruption to natural heritage.

6.2 Minimum Floor Level

There is no minimum finished floor level proposed as a result of flooding. However, the minimum finished floor level will be 29.50mAOD well above any flood levels. The ground levels of the site are located a minimum of 3.00m above the normal water level of the Fox's Bank Brook. Furthermore it is recommended that generally all buildings are located above the highways by 150mm to enable the full capacity of any secondary flood conveyance to be utilised.

6.3 Flood Resilience and Resistance

The development of the layout should always consider that the site is potentially at risk from an extreme event and as such the implementation of flood resilience and resistance methods should be assessed. Relatively simple measures such as raising utility entry points, using first floor or ceiling down electrical circuits and sloping landscaping away from properties can be easily and economically incorporated into the development of the site.

To make the buildings more resistant to seepage the following measures will be incorporated. Sealant will be used around external doors and windows. All external doors and windows will be constructed from durable materials and the walls of the buildings will be thick.

To improve the buildings resilience to flooding the following measures will be incorporated. All electrics wiring, switches, sockets, socket outlets etc. to be located a minimum of 450mm above the finished floor levels.



6.4 Flood Warning

The site will participate in the Environment Agency flood warning telephone service. The site will register contact details with the Environment Agency' Flood Warning Service (Floodline 0345 988 1188) in order to receive Flood Alerts

The Environment Agency operate a free flood warning service providing alerts by phone, text or email when flooding is anticipated providing an opportunity for owners to take necessary precautions, giving enough time for the buildings to be safely evacuated and mitigation measures to be put in place.

All occupants of the site will be made aware of the Environment Agency Floodline telephone number (Call Floodline on 0345 988 1188) and the Flood Warning Codes and their meaning. The Environment Agency uses Flood Warnings Codes. They can be issued in any order, usually ending with an 'all clear'. They are issued by the Environment Agency through their website and Floodline. The flood warning will be passed onto the occupants and visitors of the site verbally, by telephone and/or in person. It will be ensured that everyone receives the flood warnings when required.

6.5 Flood Plan

A Flood Plan outlining the precautions and actions you should take when a flood event is anticipated to help reduce the impact and damage flooding may cause will be developed. Sensible precautions would include raising electrical items, irreplaceable items and sentimental items off the ground or where possible moving them to a higher floor, rolling up carpets and turning off utilities. In addition, consider what actions you would take should the property need to be evacuated including access and egress routes and preparing a flood kit in advance containing warm clothing, medication, a torch, food and wellingtons.

The Flood Plan is a 'living' document and therefore should be periodically reviewed and updated to provide advice and guidance to occupants in the event of an extreme flood. The Flood Plan will therefore reduce the vulnerability of the occupants to flooding and makes them aware of the mechanisms of flooding at the site.

6.6 Safe Access and Egress Routes

The NPPF requires that, where required, safe access and escape is available to/from new developments in flood risk areas. Access routes should be such that occupants can safely access and exit their buildings in design flood conditions. These routes must also provide the emergency services with access to the development during a flood event and enable flood defence authorities to carry out any necessary duties during the period of flood.

Safe access and egress routes, including emergency access can be maintained for vehicles and/or by foot can be maintained. The access route into the site has been shown to be dry for all events up to and including the 1 in 100 year (+70%) event and to a depth of 0.011m during the 1 in 1000 year event.

The likelihood of a rapid river level rise and possible rapid inundation of urban areas posing a risk to life is considered to be minimal. The site is located within a low risk area where the onset of flooding is very gradual (many hours) as per Flood Risk Assessment Guidance for New Development Phase 2,



R&D Technical Report FD2320/TR2. The speed of inundation and rate of floodwater rise would be low. Therefore, safe access and egress can be maintained in accordance with the NPPF and Environment Agency Guidance. People should make their way to areas outside of the flood zone.

In the event of a Flood Warning, vital belongings, including waterproof clothing, necessary medication and essentials will be collected. It should be ensured that all occupiers and visitors to the site are accounted for, and then exit the site. Facilities such as community centres, shops etc. are located within the vicinity of the site which may be used in the event of a flood event. It should be ensured that all occupiers and visitors to the site are accounted for, and then exit the site using the route shown in Drawing T/18/2126/FRA/10.

6.7 Flooding Consequences

The mitigation measures detailed above show that the flood risk can be effectively managed and therefore the consequences of flooding are acceptable.



7. Summary and Conclusion

7.1 Introduction

This report presents an FRA in accordance with the NPPF for the proposed development at the Former Cronton Quarry. This FRA identifies and assesses the risks of all forms of flooding to and from the development and demonstrates how these flood risks will need to be managed so that the development remains safe throughout the lifetime, taking climate change into account.

7.2 Flood Risk

The site is unlikely to flood except in extreme conditions. The primary, but unlikely, flood risk posed to the site is from fluvial flooding from Fox's Bank Brook however, the site has no history of flooding. The existing flood map in this location is based on coarse resolution JFLOW modelling, as such the flood outlines do not align to the watercourses in the area as agreed by both the Environment Agency and the Knowsley Metropolitan Borough Council SFRA. Therefore, a detailed 1D/2D linked hydraulic model of the Fox's Bank Brook has been developed to confirm the flood risk posed to the site and to inform this FRA.

The likelihood of the Fox's Bank Brook rising over 3.00m and inundating the site is very minimal. The site has no history of flooding and has not flooded during the largest flood events. The outputs from the detailed hydraulic model of the Fox's Bank Brook show that the majority of the site will not be inundated with floodwater for all events up to and including the 1 in 1000 year event. The actual flood risk posed to the site, compared to the Environment Agency's Flood Zones, is much less the majority of flows will be contained within the channel of Fox's Bank Brook for all events up to and including the 1 in 1000 year event.

During the 1 in 100 year event the only area of proposed built development that may be inundated with floodwater is a very small proportion of the proposed car park which may be inundated with floodwater to a maximum depth of 0.25m.

During the 1 in 100 year (+35%) event the only area of proposed built development that may be inundated with floodwater is a very small proportion of the proposed car park which may be inundated with floodwater to a maximum depth of 0.34m.

During 1 in 100 year (+70%) event the only area of proposed built development that may be inundated with floodwater is a very small proportion of the proposed car park which may be inundated with floodwater to a maximum depth of 0.42m.

During the 1 in 1000 year event the only area of proposed built development that may be inundated with floodwater is a very small proportion of the proposed car park which may be inundated with floodwater to a maximum depth of 0.45m and the proposed access road to a maximum depth of 0.011m.

The majority of the site is not at risk of fluvial flooding. The floodwaters are restricted from entering the site boundary by the surrounding topography. Flooding within the site is mostly confined along the south of the site boundary, adjacent to the south bank of the Fox's Bank Brook.



In conclusion, the outputs from the detailed hydraulic model of the Fox's Bank Brook show that the majority of the site will not be inundated with floodwater for all events up to and including the 1 in 1000 year event. The actual flood risk posed to the site, compared to the Environment Agency's Flood Zones, is much less the majority of flows will be contained within the channel of Fox's Bank Brook for all events up to and including the 1 in 1000 year event.

There is a small area of inundation to the south of the site, where ground levels are lower. However, the large area of the site, to the south east, which is shown to be located within the Environment Agency's Flood Zone 3 will not be inundated with floodwater during the 1 in 100 year (+35%) and 1 in 1000 year events and should be considered as being located within Flood Zone 1 (see Drawing T/18/2126/7). The area of the proposed country park and attenuation lagoons is shown to be not inundated with floodwater for all events up to and including the 1 in 100 year (+35%) and 1 in 1000 year events and is not located within Flood Zones 2/3 and should be designated as Flood Zone 1.

Given the scale and nature of the proposed development and the size and location of the fluvial flooding sources it has been concluded that fluvial flooding poses a low flood risk to the site therefore, the risk of fluvial flooding is considered to be of low significance. A secondary flooding source has been identified which may pose a low risk to the site. This is:

- Surface Water (pluvial) Flooding

The risk of flooding from all sources is considered to be low or not significant. The flooding sources will only inundate the site to a relatively low water depth and water velocity, will only last a short period of time, in very extreme cases and will not have an impact on the whole of the proposed development site.

The proposed development is classified as 'less vulnerable', 'less vulnerable' uses are appropriate within Flood Zones 1, 2 and 3 after the completion of a satisfactory FRA. The proposed warehousing units will be located within Flood Zone 1 and the area of the proposed country park and attenuation lagoons is not located within Flood Zones 2/3 and should be designated as Flood Zone 1. Therefore, there will be no loss of floodplain storage capacity and the proposed development will have no impact on the movement of water.

The proposed development scenario has been modelled to assess the impact of the proposed development on flood risk. A number of different options for the culvert dimensions have been modelled to ascertain the optimum solution which does not increase flood risk. There will be no detriment to the flood storage capacity of the site. The overall direction of the movement of water will be maintained within the developed site and surrounding area. The conveyance routes (flow paths) will not be blocked or obstructed. The proposed development will have no impact on the movement of floodwater across the site. There will be no increase in the floodwater levels due to the proposed development. There will be no loss in flood storage capacity and no change in the on-site and off-site flood risk.

The flood risk at the site, will be further managed and mitigated by using a number of risk management techniques, and mitigation strategies to manage and reduce the overall flood risk at the site. The application is for a new, suitable flood-resilient design. The exposure of people and property will be reduced and minimised compared to existing site conditions. The chance of flooding each year is



low each year. This takes into account the effect of any flood defences that may be located within the vicinity of the site as well property level protection measures.

7.3 Surface Water Drainage Strategy

The Surface Water Drainage Strategy ensures that a sustainable drainage solution can be achieved which reduces the peak discharge rate to manage and reduce the flood risk posed by the surface water runoff from the site. One of the aims of the NPPF is to provide not only flood risk mitigation but also to maximise additional gains such as improvements in runoff quality and provision of amenity and biodiversity. Systems incorporating these features are often termed SuDS and it is the requirement of NPPF that these are considered as the primary means of collection, control and disposal for storm water as close to source as possible.

There is limited space within the proposed site layout for the attenuation storage, the limited space has been maximised as much as possible. It is proposed the surface water for the development will discharge into Fox's Bank Brook at Greenfield runoff rates for all events up to and including the 1 in 100 year (+40%) events.

As a consequence of limiting the rate of discharge from the site, at times of heavy rainfall the volume of water leaving the site will be significantly less than that draining from it. In order to prevent this water backing up in the system and causing flooding, linked attenuation lagoons will be incorporated into the site layout of attenuation storage will be provided. The size of this attenuation storage has been calculated such that the proposed development has the capacity to accommodate the 100 year rainfall event including a 40% increase in rainfall intensity that is predicted to occur as a result of climate change.

The remainder of the site that is not formally drained, i.e. landscaped areas, will be permeable (grass). The majority of rainwater falling on these areas will soak into the ground. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

These methods will reduce peak flows, the volume of runoff, and slow down flows and will provide a suitable SuDS solution for this site. These preliminary considerations are based on the outline development scheme provided and hence the design purposes. The adoption of a Surface Water Drainage Strategy for the site represents an enhancement from the current conditions as the current surface water runoff from the site is uncontrolled, untreated, unmanaged and unmitigated. In adopting these principles, it has been demonstrated that a scheme can be developed that does not increase the risk of flooding to adjacent properties and development further downstream.

7.4 Risk Management

The flooding sources will be managed on the site by using a number of mitigation strategies to manage and reduce the overall flood risk at the site and will ensure the development will be safe. Measures used:



Minimum Floor Level - There is no minimum finished floor level proposed as a result of flooding. However, the minimum finished floor level will be 29.50mAOD well above any flood levels. The ground levels of the site are located a minimum of 3.00m above the normal water level of the Fox's Bank Brook. Furthermore it is recommended that generally all buildings are located above the highways by 150mm to enable the full capacity of any secondary flood conveyance to be utilised.

Flood Resilience and Resistance - To make the buildings more resistant to seepage the following measures will be incorporated. Sealant will be used around external doors and windows. All external doors and windows will be constructed from durable materials and the walls of the buildings will be thick.

To improve the buildings resilience to flooding the following measures will be incorporated. All electrics wiring, switches, sockets, socket outlets etc. to be located a minimum of 450mm above the finished floor levels.

Flood Warning - The site will participate in the Environment Agency flood warning telephone service. The site will register contact details with the Environment Agency' Flood Warning Service (Floodline 0345 988 1188) in order to receive Flood Alerts.

Flood Plan - A Flood Plan outlining the precautions and actions you should take when a flood event is anticipated to help reduce the impact and damage flooding may cause will be developed. Sensible precautions would include raising electrical items, irreplaceable items and sentimental items off the ground or where possible moving them to a higher floor, rolling up carpets and turning off utilities. In addition, consider what actions you would take should the property need to be evacuated including access and egress routes and preparing a flood kit in advance containing warm clothing, medication, a torch, food and wellingtons.

Safe Access and Egress Routes - Safe access and egress routes, including emergency access can be maintained for vehicles and/or by foot can be maintained. The access route into the site has been shown to be dry for all events up to and including the 1 in 100 year (+70%) event and to a depth of 0.011m during the 1 in 1000 year event.

The likelihood of a rapid river level rise and possible rapid inundation of urban areas posing a risk to life is considered to be minimal. The site is located within a low risk area where the onset of flooding is very gradual (many hours) as per Flood Risk Assessment Guidance for New Development Phase 2, R&D Technical Report FD2320/TR2. The speed of inundation and rate of floodwater rise would be low. Therefore, safe access and egress can be maintained in accordance with the NPPF and Environment Agency Guidance. People should make their way to areas outside of the flood zone.

In the event of a Flood Warning, vital belongings, including waterproof clothing, necessary medication and essentials will be collected. It should be ensured that all occupiers and visitors to the site are accounted for, and then exit the site. Facilities such as community centres, shops etc. are located within the vicinity of the site which may be used in the event of a flood event. It should be ensured that all occupiers and visitors to the site are accounted for, and then exit the site.



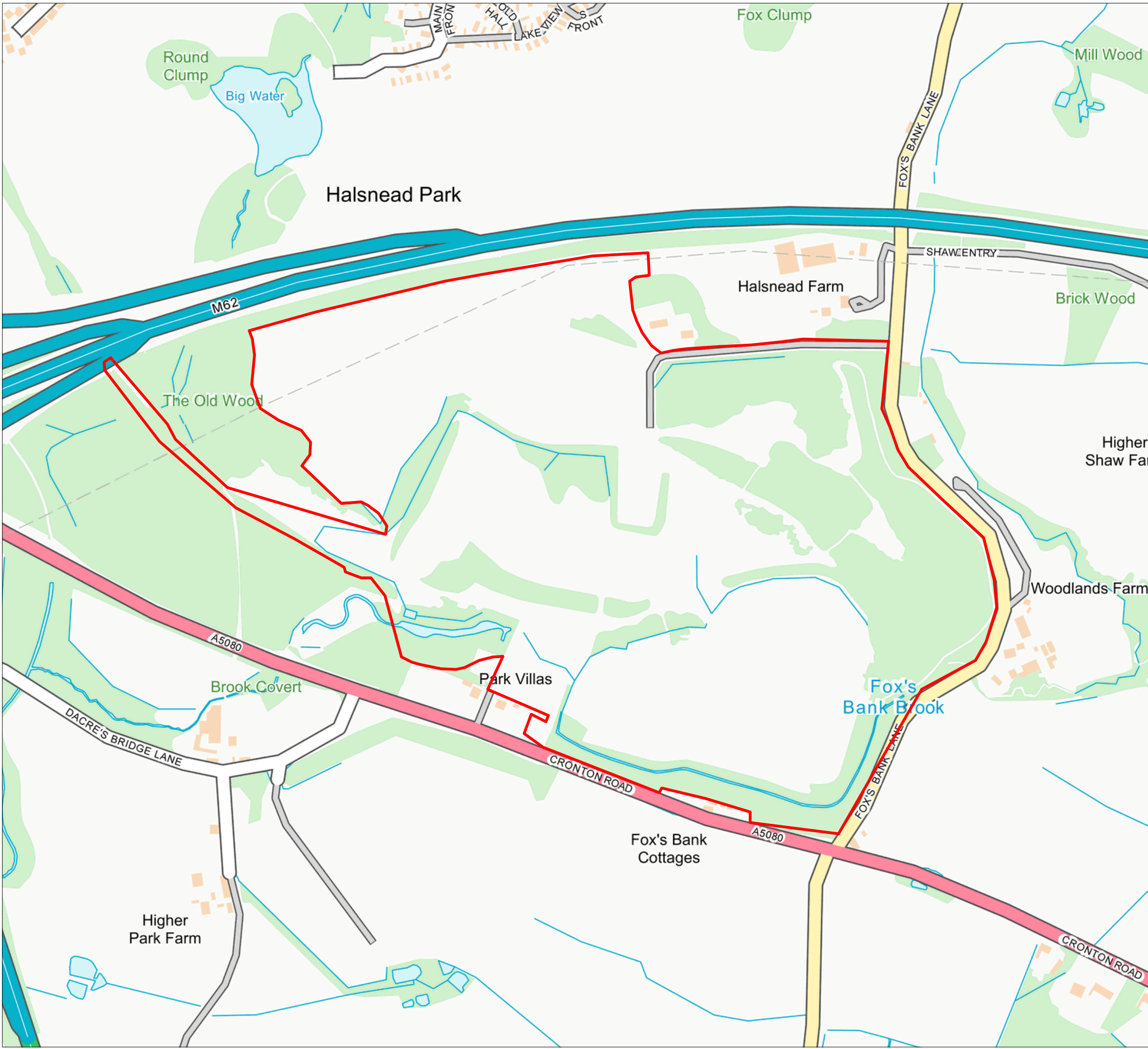
7.5 Conclusion

In conclusion, the proposed development, would be expected to remain dry in all but the most extreme conditions. The proposed development will provide betterment compared to the existing situation. Providing the recommendations made in this FRA are instigated, flood risk from all sources would be minimised, the consequences of flooding are acceptable, and the development would be in accordance with the requirements of the NPPF.

This FRA demonstrates that the proposed development would be operated with minimal risk from flooding, would not increase flood risk elsewhere and is compliant with the requirements of the NPPF. The development should not therefore be precluded on the grounds of flood risk.



Appendix A – Drawings

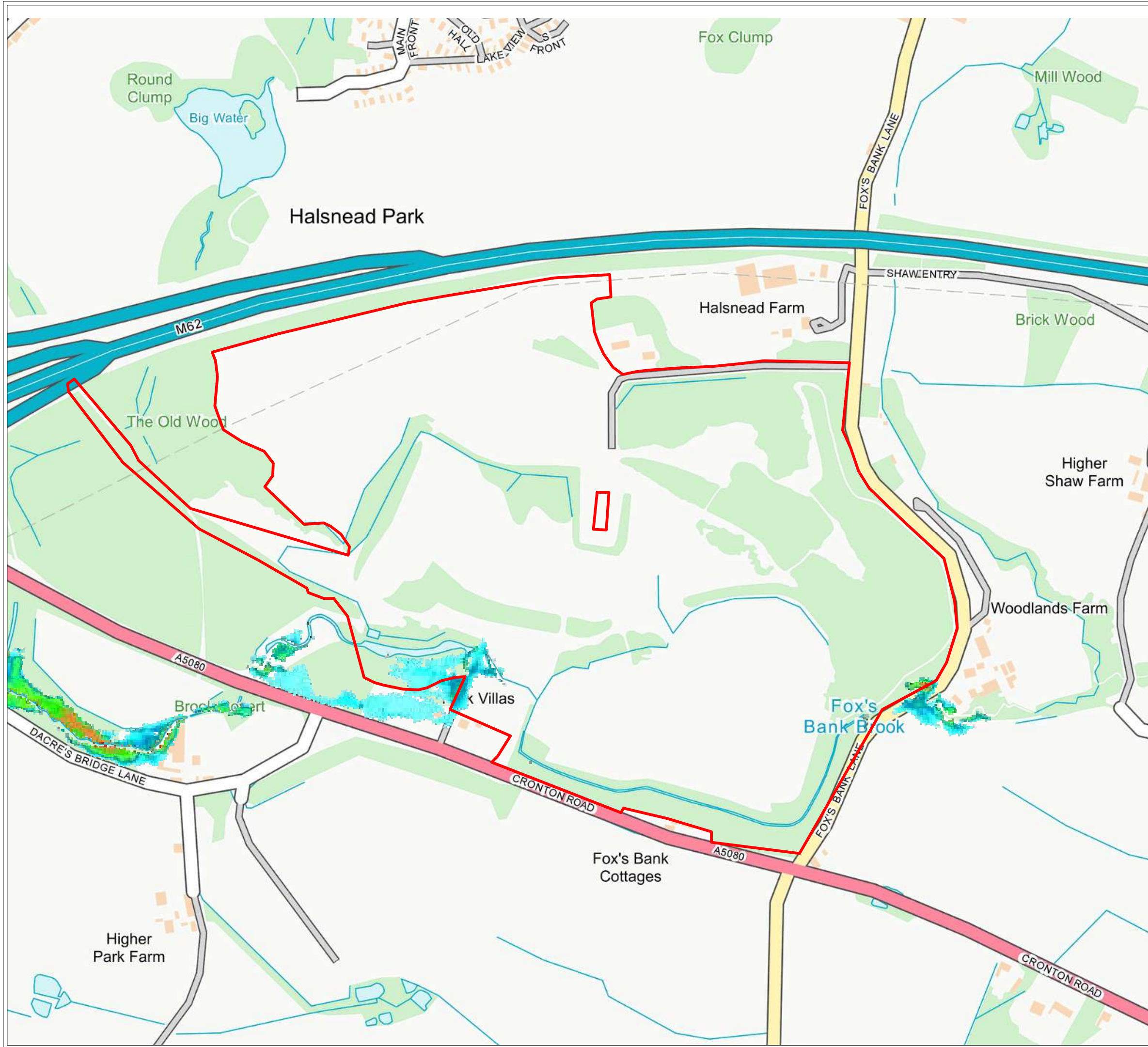


KEY

 Site Boundary



PROJECT	Symmetry Park, Merseyside
CLIENT	Tritax Symmetry Huyton Limited
TITLE	Site Location
PROJECT REF	T/18/2126/FRA
DRAWING NO	T/18/2126/FRA/1
SCALE	NTS@A3
DATE	August 2020



KEY

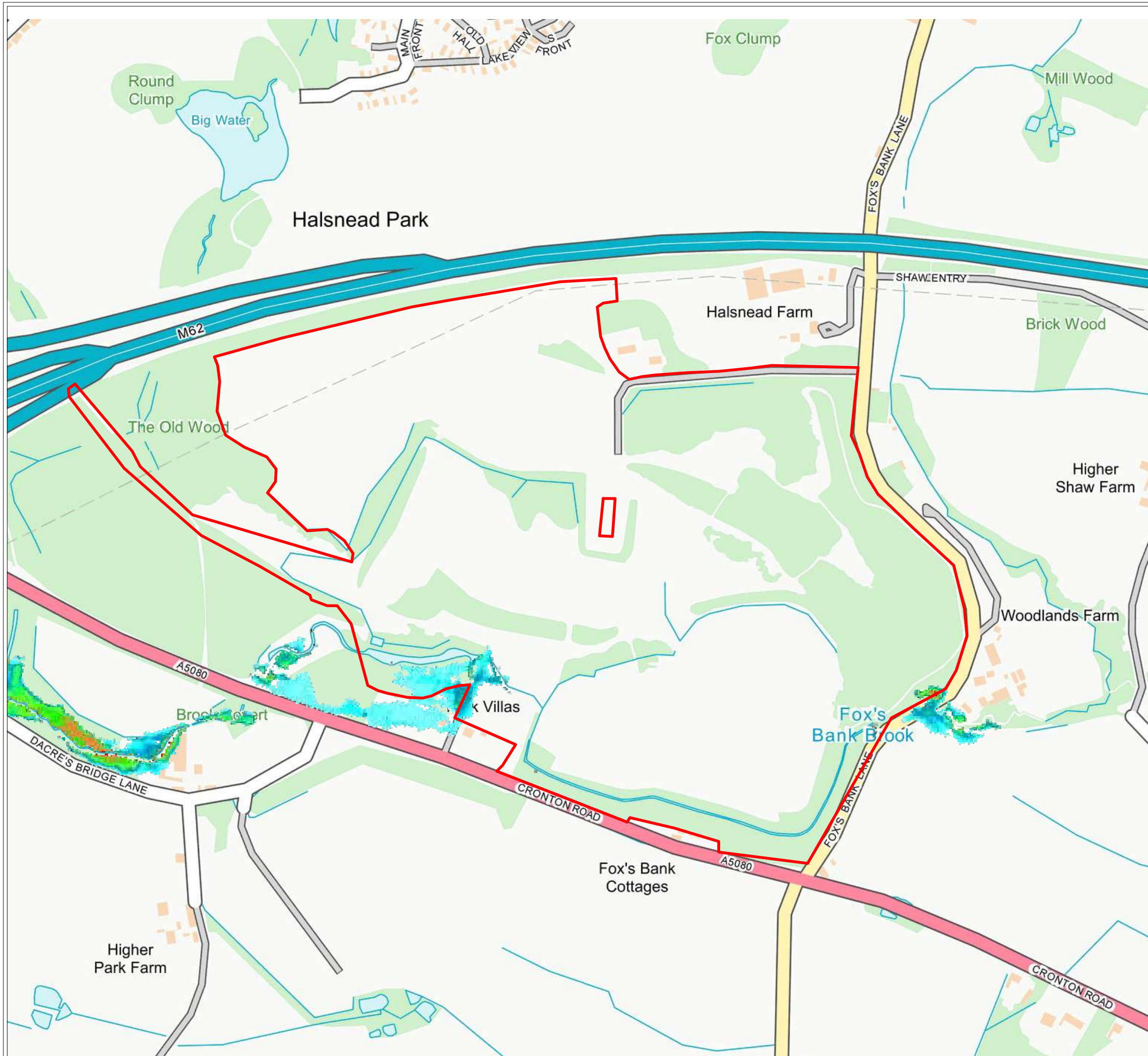
 Site Boundary

Water Depths (m)

	1.42
	1.26
	1.11
	0.95
	0.79
	0.63
	0.47
	0.32
	0.16
	0.00



PROJECT	Symmetry Park, Huyton
CLIENT	Tritax Symmetry Huyton Limited
TITLE	1 in 100 Year Modelled Flood Outline
PROJECT REF	T/18/2126/FRA
DRAWING NO	T/18/2126/FRA/3
SCALE	NTS@A3
DATE	September 2020



KEY

Site Boundary

Water Depth (m)

1.93

1.72

1.50

1.29

1.07

0.86

0.64

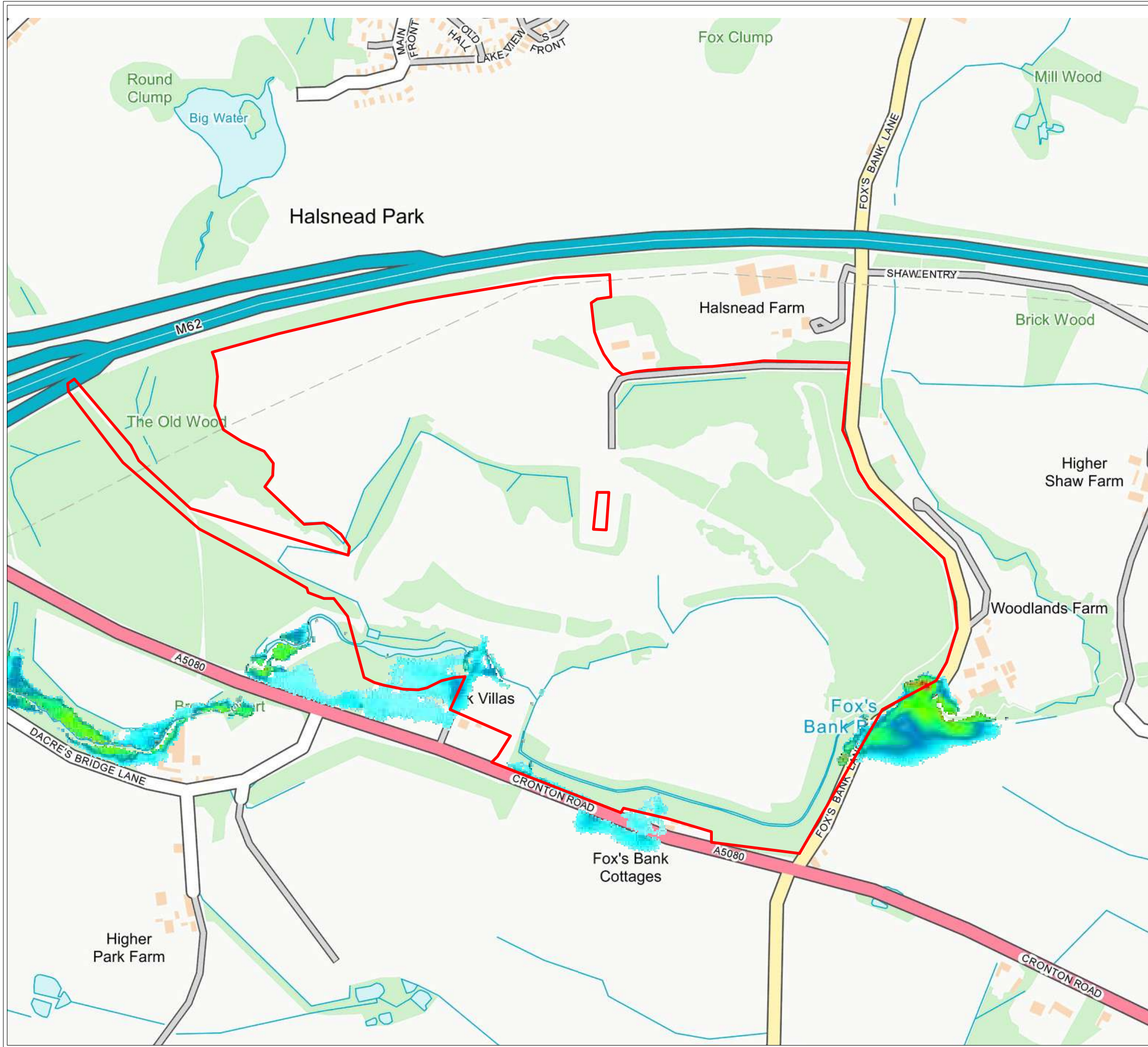
0.42

0.21

0.00



PROJECT	Symmetry Park, Huyton
CLIENT	Tritax Symmetry Huyton Limited
TITLE	1 in 100 Year (+35%) Modelled Flood Outline
PROJECT REF	T/18/2126/FRA
DRAWING NO	T/18/2126/FRA/4
SCALE	NTS@A3
DATE	September 2020



KEY

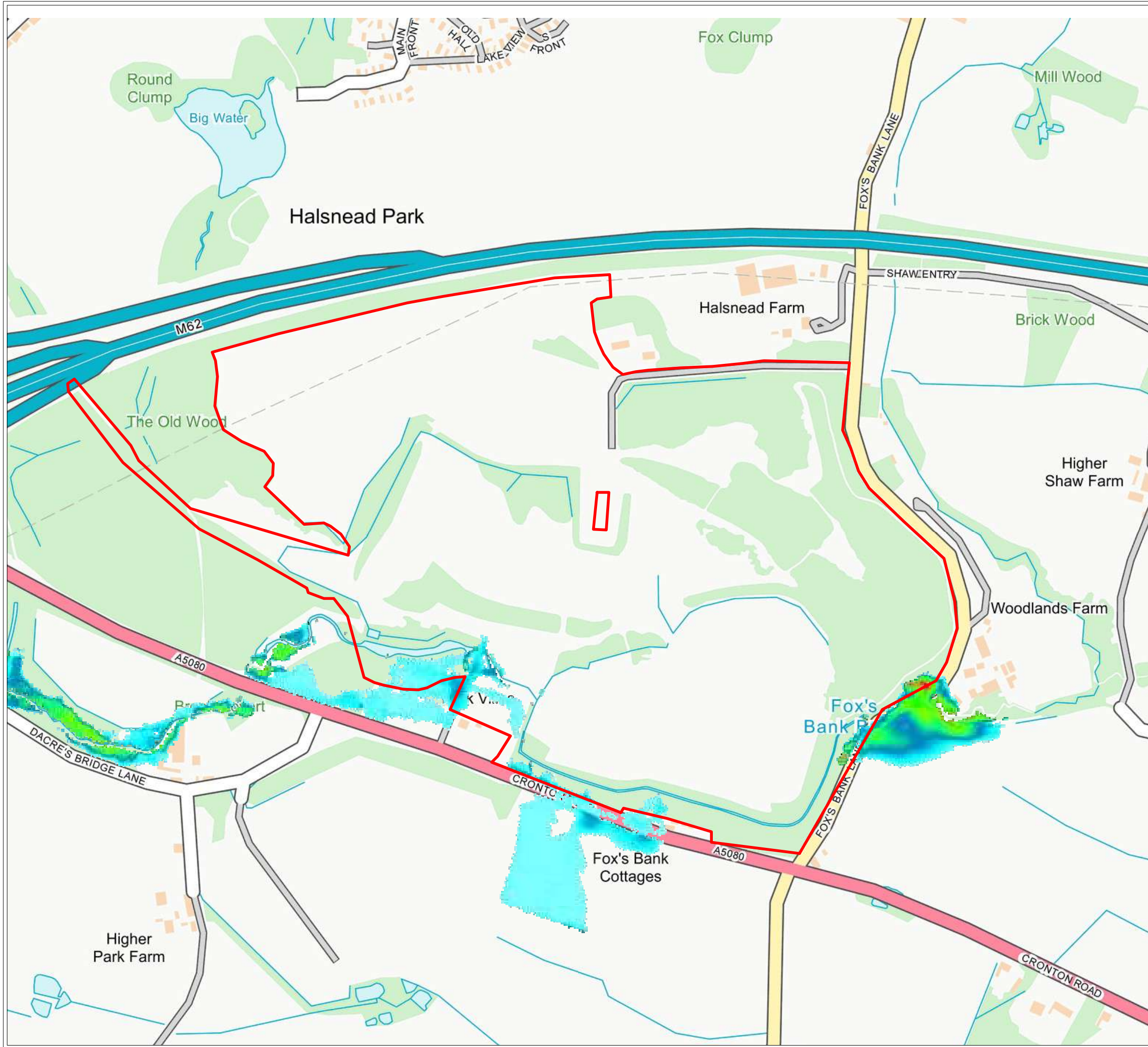
 Site Boundary

Water Depth (m)

	2.18
	1.937
	1.69
	1.45
	1.21
	0.97
	0.73
	0.48
	0.24
	0.00



PROJECT	Symmetry Park, Huyton
CLIENT	Tritax Symmetry Huyton Limited
TITLE	1 in 100 Year (+70%) Modelled Flood Outline
PROJECT REF	T/18/2126/FRA
DRAWING NO	T/18/2126/FRA/5
SCALE	NTS@A3
DATE	September 2020

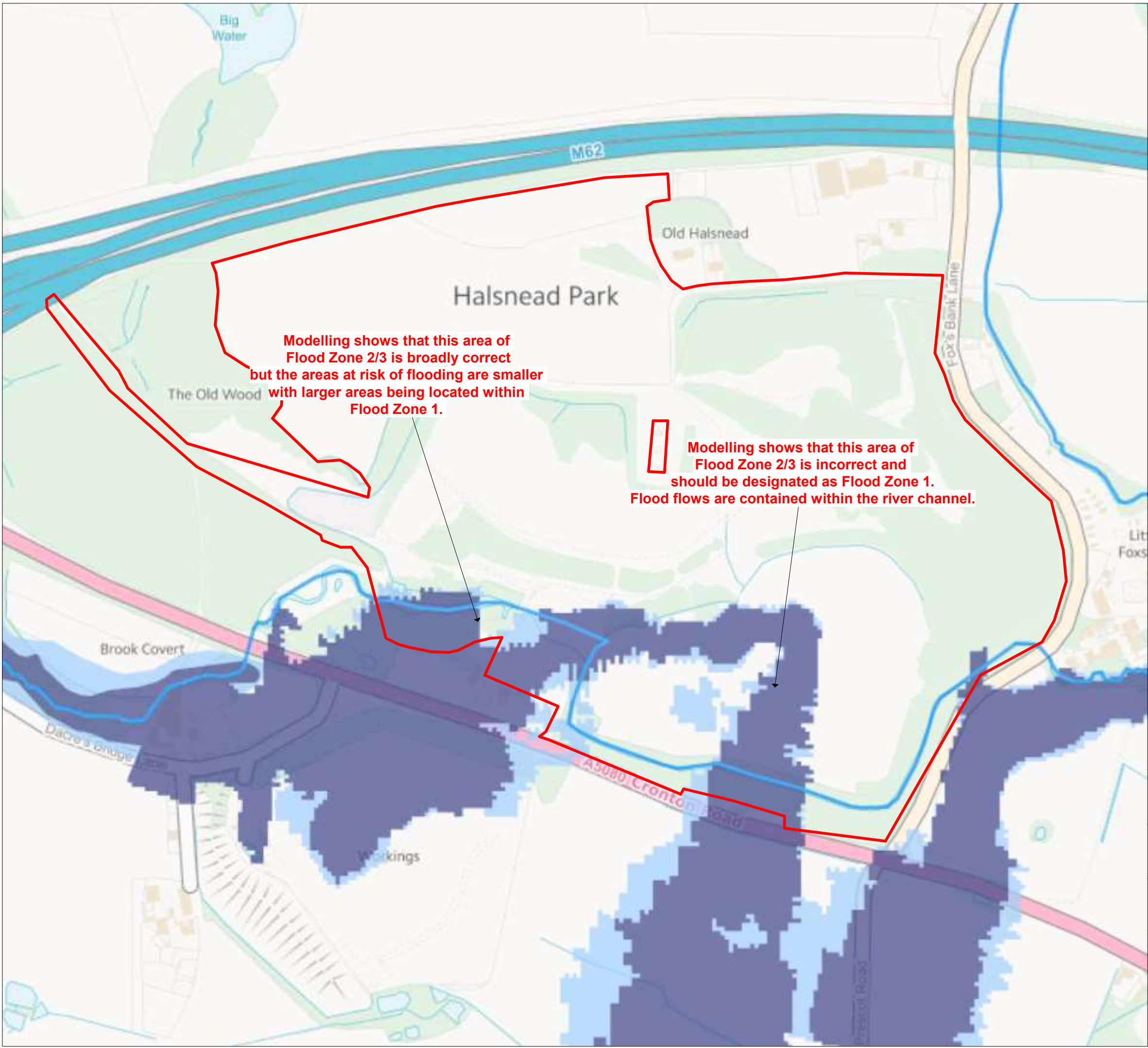


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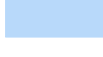
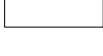
-  Site Boundary
- Water Depth (m)
-  2.21
 -  1.96
 -  1.72
 -  1.47
 -  1.23
 -  0.98
 -  0.74
 -  0.49
 -  0.25
 -  0.00



PROJECT	Symmetry Park, Huyton
CLIENT	Tritax Symmetry Huyton Limited
TITLE	1 in 1000 Year Modelled Flood Outline
PROJECT REF	T/18/2126/FRA
DRAWING NO	T/18/2126/FRA/6
SCALE	NTS@A3
DATE	September 2020

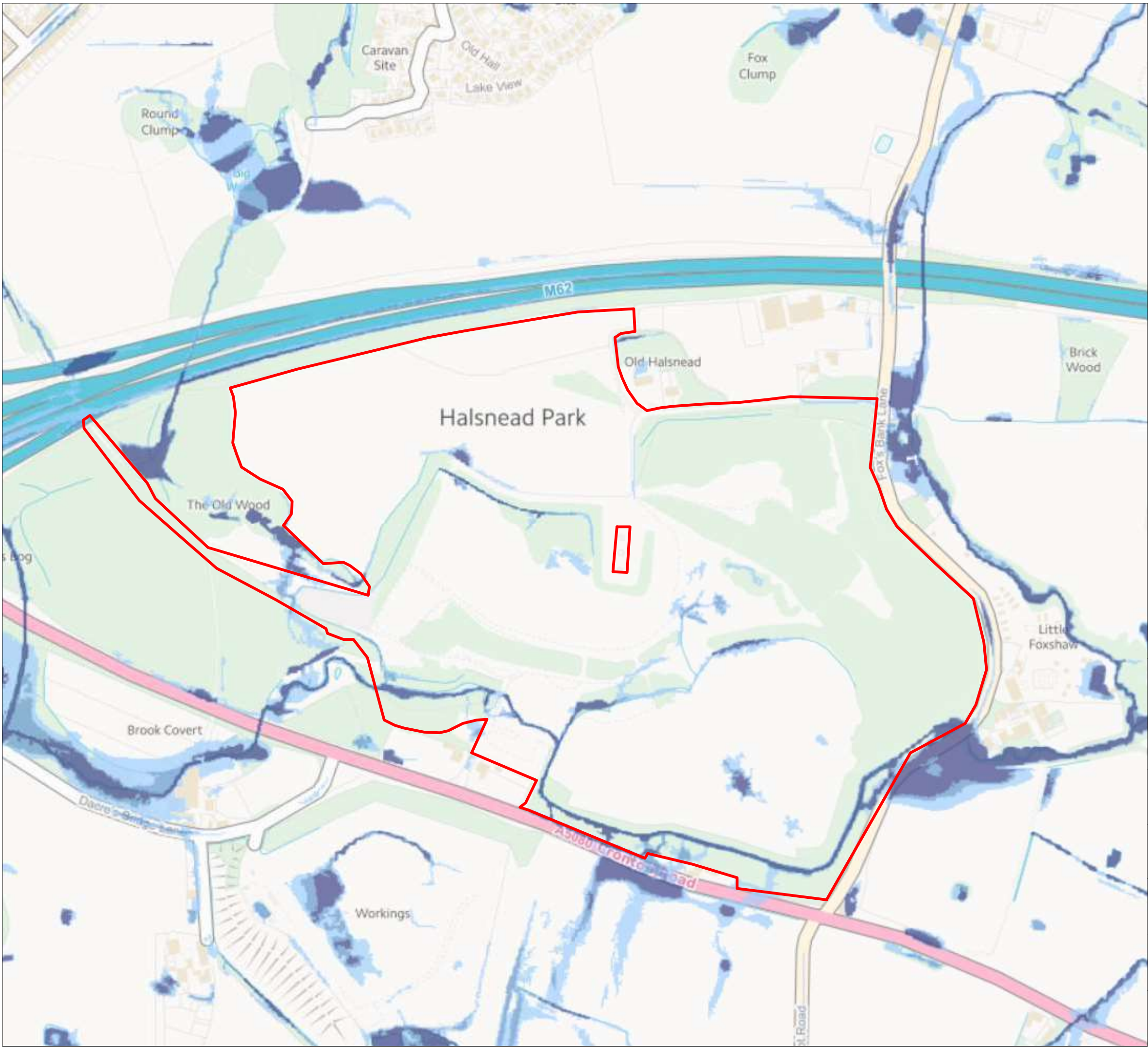


KEY

-  Site Boundary
-  Flood Zone 3
-  Flood Zone 2
-  Flood Zone 1



PROJECT	
Symmetry Park, Huyton	
CLIENT	
Tritax Symmetry Huyton Limited	
TITLE	
Environment Agency Flood Zones	
PROJECT REF	
T/18/2126/FRA	
DRAWING NO	
T/18/2126/FRA/7	
SCALE	
NTS@A3	
DATE	
August 2020	



KEY

Site Boundary

Very Low

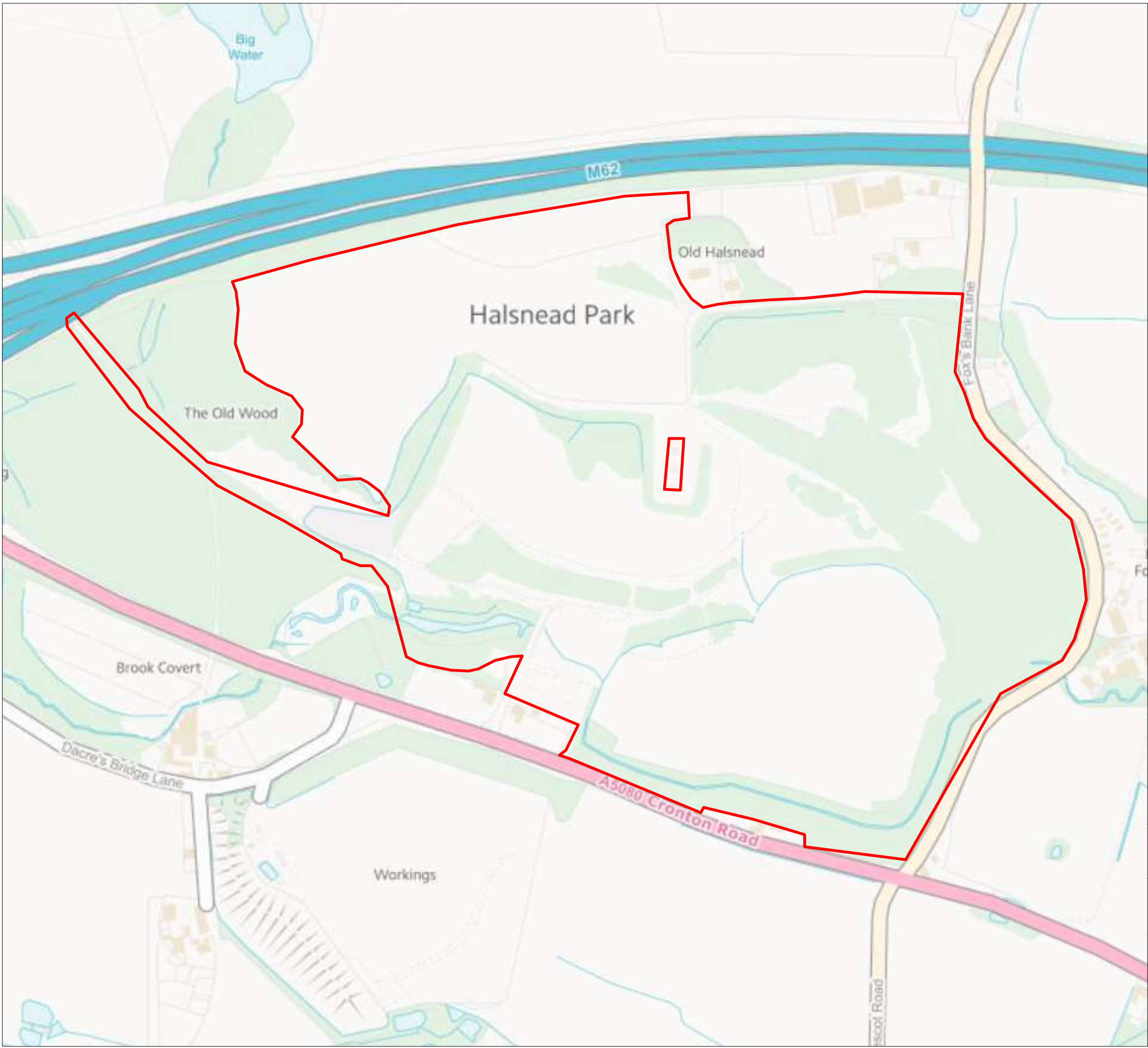
Low

Medium

High



PROJECT	Symmetry Park, Huyton
CLIENT	Tritax Symmetry Huyton Limited
TITLE	Environment Agency Surface Water Flood Map
PROJECT REF	T/18/2126/FRA
DRAWING NO	T/18/2126/FRA/8
SCALE	NTS@A3
DATE	August 2020

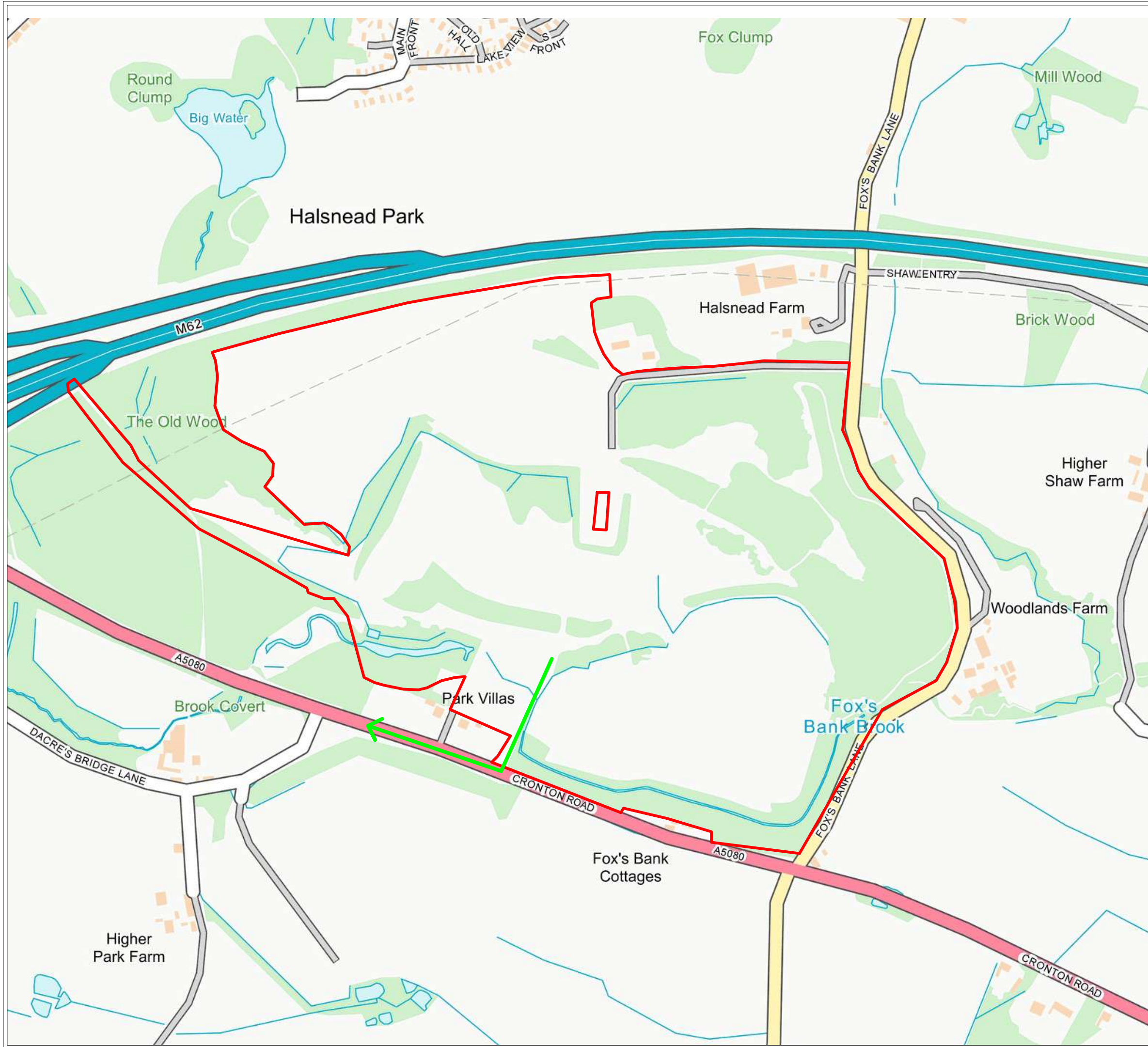


KEY

-  Site Boundary
-  Reservoir Flood Outline



PROJECT
CLIENT
Tritax Symmetry Huyton Limited
TITLE
Environment Agency Reservoir Flood Map
PROJECT REF
T/18/2126/FRA
DRAWING NO
T/18/2126/FRA/9
SCALE
NTS@A3
DATE
August 2020



KEY

-  Site Boundary
-  Safe Access and Egress Route



PROJECT	Symmetry Park, Huyton
CLIENT	Tritax Symmetry Huyton Limited
TITLE	Safe Access and Egress Route
PROJECT REF	T/18/2126/FRA
DRAWING NO	T/18/2126/FRA/10
SCALE	NTS@A3
DATE	August 2020



Appendix B – Environment Agency Correspondence

Keelan

From: Todd, Graham <graham.todd@environment-agency.gov.uk>
Sent: 30 November 2020 16:58
To: Keelan
Cc: Templeman, Jeni; Morris, Gary
Subject: RE: GMMC168263AB Cronton Quarry

Hello Keelan,

It was good to talk to you earlier. Further to your enquiry below, I would add the following response regarding culvert capacity.

While I understand the concept of not wanting to increase the risk of flooding elsewhere, I don't recall receiving too many consent or permit applications that had effective tapering diameters. As discussed, generally speaking culvert capacity is only usually a problem to us if the capacity is too small - culvert depths should be oversized to allow for the natural watercourse gradient to be continued through the structure by constructing the base well below the bed of the watercourse. This will also guard against the increased risk of scour erosion from affecting the structure.

If there is an additional requirement to store floodwaters on the site, then rather than create this by throttling flow passing through the watercourse using an undersized structure – this should be provided by other means. For example, through the creation of low-lying floodplain directly adjacent to the channel.

Regards, Graham.

Graham Todd

Flood & Coastal Risk Management

Greater Manchester, Merseyside & Cheshire Area

Environment Agency | Richard Fairclough House, Knutsford Road, Warrington, WA4 1HT

graham.todd@environment-agency.gov.uk

External: 020 302 50604

From: Keelan [mailto:Keelan@krsenvironmental.com]
Sent: 30 November 2020 14:28
To: Todd, Graham <graham.todd@environment-agency.gov.uk>
Subject: RE: GMMC168263AB Cronton Quarry

Hi Todd,

Thank you for your ongoing advice with regards to the development at Cronton Quarry.

As discussed in today's meeting, for the previous design of the diverted watercourse the most optimal solution for the culvert entrance under the maintenance track in terms of flood risk was an entrance of 2.40m and a height of 1.10m with the rest at 3.00m wide as well as the inclusion of a headwall tying into high ground to the north and the existing embankment to the south, preliminary set at 24.90mAOD with existing ground levels to be maintained at the site entrance. The attached maps show the depth difference between the baseline and proposed development.

Our modelling results show that having the entrance of the culvert at 3.00m was passing too much water downstream and results in increased flooding downstream and having a narrower culvert entrance resulted in increased flooding upstream.

After today's meeting I understand you would be happy with the whole culvert to be 3.00m wide in terms of flood risk. Would this be correct? If so please can you confirm by return of email.

If you have any queries do not hesitate to contact me.

Regards,

Keelan Serjeant | Director
BSc, MSc, MCIWEM
KRS Environmental Ltd

T: 01686 668957

T: 01484 437420

M: 07857 264 376

E: keelan@krsenvironmental.com

W: krsenvironmental.com

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From: Todd, Graham <graham.todd@environment-agency.gov.uk>

Sent: 14 April 2020 10:47

To: Keelan <Keelan@krsenvironmental.com>

Cc: PSO_Warrington <PSOWarrington@environment-agency.gov.uk>; GMMC Info Requests <InfoRequests.GMMC@environment-agency.gov.uk>

Subject: RE: GMMC168263AB Cronton Quarry

Hello Keelan,

Further to your email enquiry below I would provide the following information.

Flood Zones 2&3 associated with Foxes Bank Brook through the old Cronton Colliery site do appear somewhat misaligned with the watercourse in certain places and probably stems from the first generation of national Flood Map modelling undertaken nearly 20-years ago. Because of the limited amount of local development pressures since that time and the fact that there aren't any existing properties (houses) located within the flood outlines, the justification to carry out an updated (and more accurate) modelling study hasn't existed.

Any future Flood Risk Assessment carried out in support of a planning application for development on the site should consider multiple data sources, including site-specific hydraulic modelling where the risk is considered necessary. The published surface water flood map quoted is again the product of a national modelling exercise and produced to provide an initial estimation of areas susceptible to surface water flood risk only.

Ideally surface water attenuation ponds should be located within Flood Zone 1 only, as attenuation ponds can't fulfil their primary purpose of storing excess run-off from new development sites if already full of fluvial flood flows from adjacent watercourses or rivers.

With regard to future pre-planning related enquiries regarding the site please contact the local EA Sustainable Places team in the first instance here:

SPPlanning.RFH@environment-agency.gov.uk

Kind regards. Graham.

Graham Todd

Flood & Coastal Risk Management

Greater Manchester, Merseyside & Cheshire Area

Environment Agency | Richard Fairclough House, Knutsford Road, Warrington, WA4 1HT

graham.todd@environment-agency.gov.uk

External: 020 302 50604

From: GMMC Info Requests

Sent: 09 April 2020 16:26

To: PSO_Warrington <PSOWarrington@environment-agency.gov.uk>

Subject: FW: GMMC168263AB Cronton Quarry

Dear Team,

Please can you have a look at the attached request. If possible, please can you provide the data by 20/4/20 so that we can keep within our service commitment of 10 working days.

Many thanks,

Anne

Anne Ball

Customer and Engagement Officer

Greater Manchester, Merseyside and Cheshire

Office address: Richard Fairclough House, Knutsford Road, Latchford, Warrington, WA4 1HT

Email address: [**Inforequests.GMMC@environment-agency.gov.uk**](mailto:Inforequests.GMMC@environment-agency.gov.uk)

External: 020 302 51232

Internal: 51232

Mobile: 07769285094

From: Enquiries, Unit

Sent: 09 April 2020 11:00

To: 'Keelan@krsenvironmental.com' <Keelan@krsenvironmental.com>

Subject: GMMC168263AB Cronton Quarry

Hi,

I have passed your e-mail to the local customer team who will deal with your request.

The Freedom of Information Act and Environmental Information Regulations state that a public authority must respond to requests for information within 20 working days, but we aim to respond to all enquiries as quickly as we can.

You can find more information about our service commitment by clicking on the link below:

<https://www.gov.uk/government/publications/environment-agency-customer-service-commitment>

You can contact our customer team directly on the contact details below, or call the National Customer Contact Centre on 03708 506506 who will transfer you to the area team.

Please quote your enquiry reference **200409/JMK13** in any correspondence with us regarding this matter.

Customers and Engagement
Environment Agency
Greater Manchester, Merseyside and Cheshire Area
Richard Fairclough House
Knutsford Road
Latchford
Warrington
WA4 1HT

Kind regards,
James Morris-Knight
Customer Service Adviser
Contact Centre Services
Operations: Regulation, Monitoring and Customer



From: Keelan [<mailto:Keelan@krsenvironmental.com>]
Sent: 08 April 2020 10:57
To: Enquiries, Unit <enquiries@environment-agency.gov.uk>
Subject: 200409/JMK13 Cronton Quarry

Dear Sir/Madam,

We are looking at the flood risk posed to Cronton Quarry as shown on the attached.

The attached Environment Agency flood zones through the quarry do not follow any existing watercourse and are located on higher ground compared to the surrounding land, see attached. The Environment Agency's surface water flood map shows a more realistic representation of the flood risk posed from fluvial sources, see attached.

Can you provide comments on the accuracy of the flood zones? Would it be possible to construct attenuation ponds within the flood zones?

If you have any queries do not hesitate to contact me.

Regards,

Keelan Serjeant | Director
BSc, MSc, MCIWEM
KRS Environmental Ltd

Due to the current Covid-19 outbreak all KRS Environmental staff are home working. Please contact them directly on the mobile number provided or by email / MS Teams.

T: 01686 668957

T: 01484 437420

M: 07857 264 376

E: keelan@krsenvironmental.com

W: krsenvironmental.com

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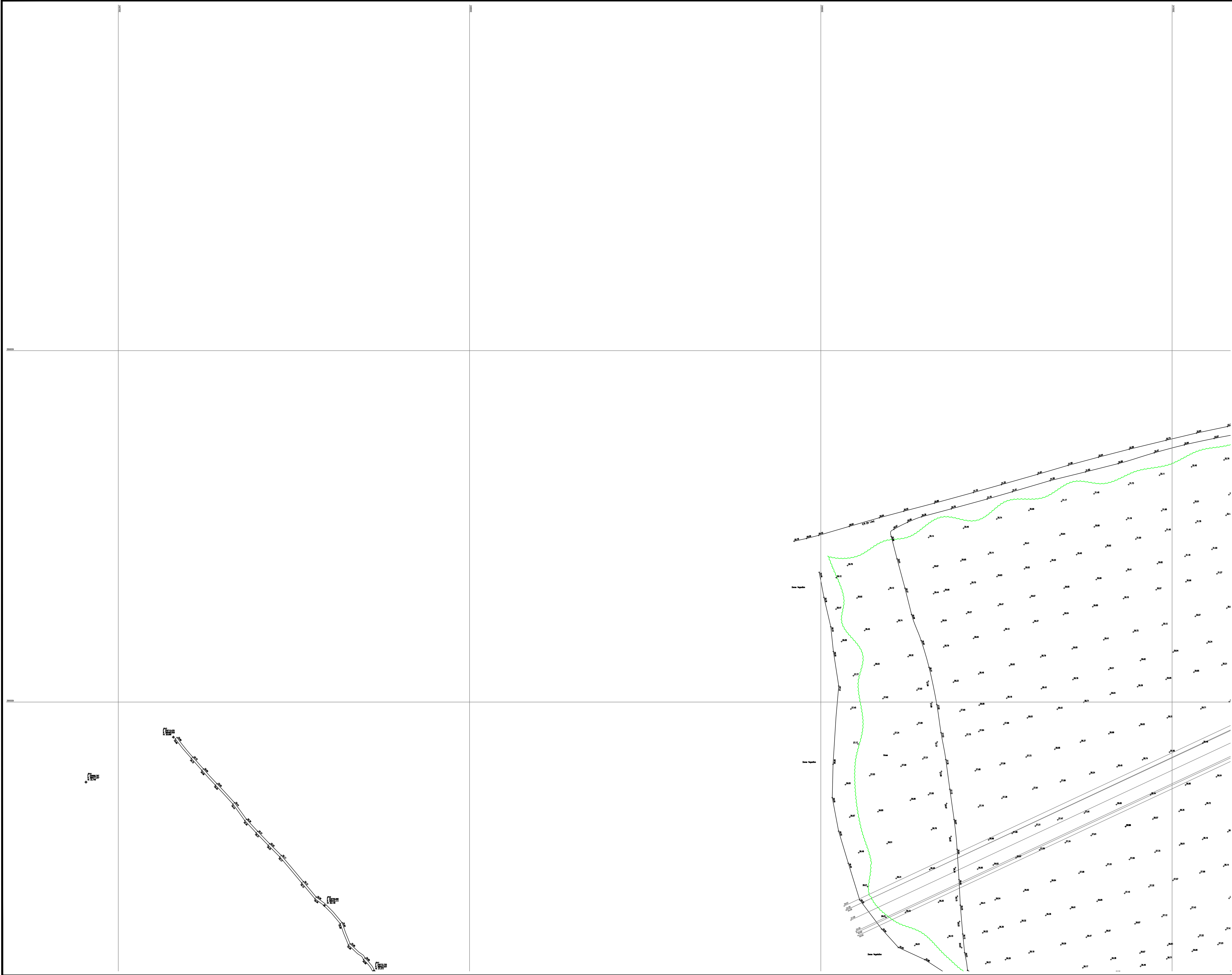
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Appendix C – Proposed Site Layout



Appendix D – Topographical Survey



NOTES

KEY

Grid & Datum - Local Plane Grid related to OS National Grid & Datum
By GNSS RTK Observations

STANDARD ABBREVIATIONS

STREET FURNITURE

AC - AIR CONDITIONING
AE - AERIAL
AV - AIR VALVE
BA - BUCKYARD
BB - BELUSH REASON
BD - BUILDING DIVIDE
BH - BOREHOLE
BL - BASEMENT LIGHT
BO - BOLLARD
BP - BOUNDARY POST
BR - BOULDER
BS - BUS STOP
BU - BUSH
CB - CONTROL BOX
CC - CLOSE CIRCUIT TV
CB - CLOSURE BIN
CO - COLUMN
CT - CLOSE CIRCUIT TV POLE
CP - DOWN PIPE
DR - DRAIN
D-CH - DRAINAGE CHANNEL
DU - DUCT
EL - ELECTRIC
EP - ELECTRICITY POLE
FA - FENDOR ANCHOR
FB - FLOWMETER
FH - FIRE HYDRANT
FL - FLOODLIGHT
FS - FLAG STAFF
GA - GAS METER
G - GATE
GU - GULLY
GV - GAS VALVE
HY - HYDRANT
IC - INSPECTION COVER
IT - TRAFFIC COVER
JB - JUNCTION BOX
KO - KERB OFFLET
LA - LANDSCAPE
LB - LITTER BIN

LC - LIGHTING COLUMN
LI - LIGHT
LP - LAMP POST
MO - MOORING BOLLARD
MA - MANHOLE
MD - MONUMENT
MP - MONITORING WELL
MR - MONITORING RING
NH - NAME PLATE
OH - OVERHEAD
OSBM - ORDNANCE SURVEY BENCH MARK
PA - PLAY APPARATUS
PB - PUBLIC BOX
PH - PUBLIC HOUSE
PI - PIPE
PL - PLANT
PM - PAVING METER
PO - POST
PP - PETROL PUMP
RH - RIDGE HEIGHT
RS - ROAD SIGN
RTW - RETAINING WALL
RWP - RAINWATER PIPE
SA - STANCHION
SC - SPEED CAMERA
SD - SATELLITE DISH
SF - SAFETY FENCE
SG - SIGNAL
SI - SIGN
SMP - SERVICE MARKER POST
SS - SECURITY SENSOR
ST - STOP TAP
SU - STUMP
SV - STOP VALVE
SW - SWITCHGEAR
SY - STAY
TA - TAP
TBM - TEMPORARY BENCH MARK
TCB - TELEPHONE CALL BOX
TE - TELEPHONE
TM - TICKET MACHINE
TS - TRAFFIC SIGNAL
TP - TELEGRAPH POLE

UTL - UNABLE TO LIFT
VDP - VEHICLE DETECTOR PAD
VP - VENT PIPE
WB - WHISTLE BLOW
WM - WATER METER
WO - WASH OUT
WP - WASTE PIPE

FENCE TYPES

BW - BARBED WIRE
CB - CLOSE BOARD
CJ - CORRUGATED IRON
CP - CONCRETE PANEL
HR - HANDRAIL
IR - IRON RAILING
PAL - PALISADE
PC - POST & CHAIN
PP - POST & PANEL
PS - PESTICIDE SAFETY
RB - RAILING
RW - RAILING
WM - WIRE MESH

SYMBOLS

HEDGE

TREE CANOPY

TREE

GATE

CONTROL STATION

BUILDING

TACTILE PAVING

SHEET LAYOUT

Rev	Date	Drawn	Description	Ch'd	App'd

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CHARTERED GEOMATIC SURVEYORS

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Client

TIER UK
ELM HOUSE FARM
CHESTER
CH3 6EN

Title

CRONTON COLLIERY
KNOWSLEY

TOPOGRAPHICAL SURVEY
SHEET 1 OF 14

Surveyed	PG/JP/DG	Drawn	BW	Drawn Date
Checked	AM	Approved	NDO	11/10/2019

Scale

1:500 @ A1

Project

10208

CAD File

10208-001.dwg

Status

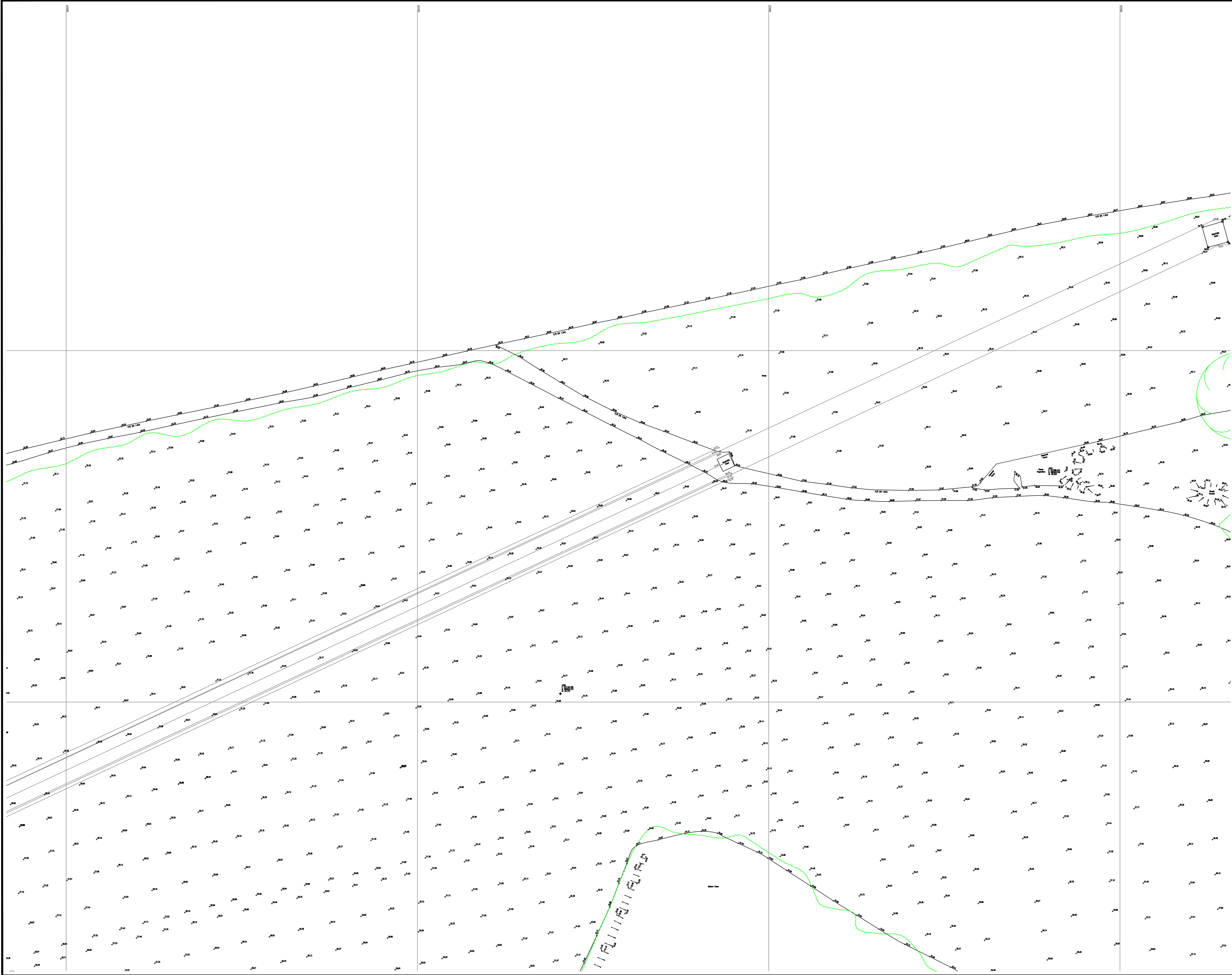
ORIG

Drawing No

10208 / 001 / 1

Rev

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NOTES

KEY

Grid & Datum - Local Plane Grid related to OS National Grid & Datum
By GNSS RTK Observations

STANDARD ABBREVIATIONS

STREET FURNITURE

AC - AIR CONDITIONING
AE - AERIAL
AL - ALARM
AM - AIR MANHOLE
BA - BUOYANCY AID
BB - BELLEFRA REACH
BD - BUILDING DIVIDE
BH - BORNHOLE
BL - BASEMENT LIGHT
BO - BOLLARD
BP - BOUNDARY POST
BR - BRICK
BS - BUS STOP
BU - BUSH
CA - CABLE
CB - CONTROL BOX
CC - CLOSE CIRCUIT TV
CB - CLOSURE BOLLARD
CO - COLUMNS
CT - CLOSE CIRCUIT TV POLE
CP - DOWN PIPE
DR - DRAIN
DCH - DRAINAGE CHANNEL
DU - DUCT
EL - ELECTRIC
EP - ELECTRICITY POLE
FA - FENCIBLE
FB - FENCIBLE
FI - FIRE HYDRANT
FL - FLOODLIGHT
FS - FLAG STAFF
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IC - INSPECTION COVER
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LA - LANDSCAPE
LB - LITTER BIN

LC - LIGHTING COLUMN
LI - LIGHT
LP - LAMP POST
MB - MOORING BOLLARD
MA - MANHOLE
MD - MONUMENT
MP - MONUMENT
MR - MONUMENT
NR - NAME PLATE
OH - OVERHEAD
OS - ORDNANCE SURVEY
PB - PAVEMENT
PA - PLAY APPARATUS
PH - PUBLIC HOUSE
PI - PIPE
PL - PLANT
PM - PAVING METER
PO - POST
PP - PUMP
R - ROAD
RH - RIDGE HEIGHT
RS - ROAD SIGN
RTW - RETAINING WALL
RW - RAINWATER PIPE
SA - STANCHION
SC - SPEED CAMERA
SD - SATELLITE DISH
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SG - SIGNAL
SI - SIGN
SMP - SERVICE MARKER POST
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FENCE TYPES

BW - BARBED WIRE
CB - CLOSE BOLLARD
C1 - CORRUGATED IRON
CR - CONCRETE PANEL
HR - HANDRAIL
IR - IRON RAILING
PAL - PALISADE
PC - POST & CHAIN
PP - POST & PANEL
PS - PILE DRIVEN SAFETY
RB - RAILING
RW - RAILING
WM - WIRE MESH

LEVELS

BL43.45 - BED LEVEL
BL43.45 - LAKE LEVEL
BL43.45 - INVERT LEVEL
BL43.45 - SPOT LEVEL
RF43.45 - ROOF LEVEL
SL43.45 - RIDGE LEVEL
SL43.45 - SOFT BED LEVEL
SL43.45 - SOFFIT LEVEL
TH43.45 - THRESHOLD LEVEL
WL43.45 - WATER LEVEL

SYMBOLS

HEDGE

TREE CANOPY

TREE

GATE

CONTROL STATION

BUILDING

TACTILE PAVING

SHEET LAYOUT

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Rev

Date

Drawn

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Title

CRONTON COLLIERY
KNOWSLEY

TOPOGRAPHICAL SURVEY

SHEET 2 OF 14

Surveyed

PG/JP/DG

Drawn

BW

Drawn Date

11/10/2019

Checked

AM

Approved

ND

Project

10208

Status

ORIG

Scale

1:500 @ A1

CAD File

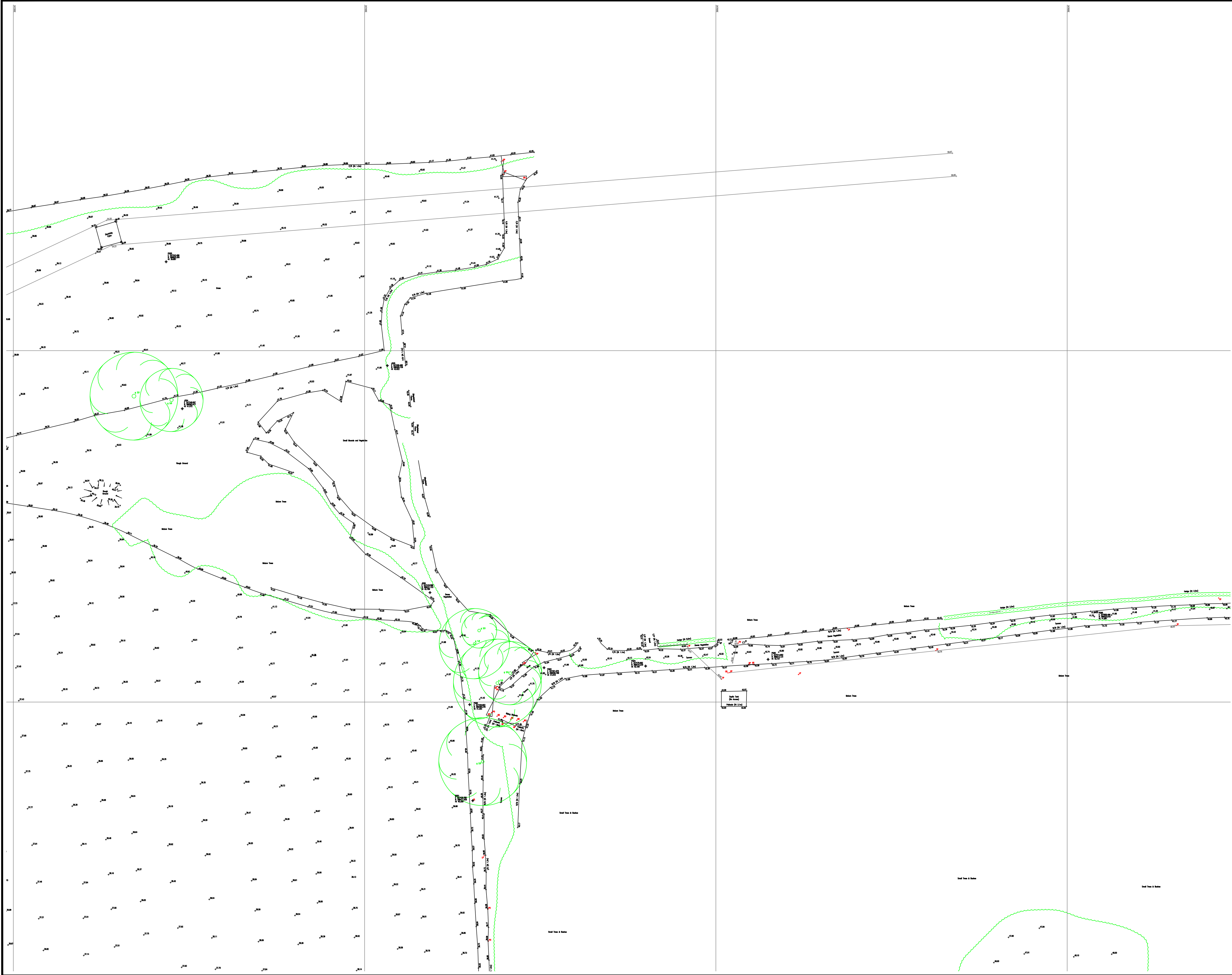
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Drawing No

10208 / 001 / 2

Rev

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NOTES

KEY

Grid & Datum - Local Plane Grid related to OS National Grid & Datum
By GNSS RTK Observations

STANDARD ABBREVIATIONS

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AG - AIR CONDITIONING
AE - AERIAL
AL - ALARM
AM - AIR METER
BA - BUOYANCY AID
BB - BELLEH REASON
BM - BURNING
BL - BASEMENT LIGHT
BO - BOLLARD
BP - BOUNDARY POST
BR - BRICK
BS - BUS STOP
BU - BURN
CA - CABLE
CB - CONTROL BOX
CC - CLOSE CIRCUIT TV
CD - CLOSURE BAY
CO - COLUMB
CT - CLOSE CIRCUIT TV POLE
CP - DOWN PIPE
DR - DRAIN
DZ - DRAINAGE CHANNEL
DU - DUCT
EL - ELECTRIC
EP - ELECTRICITY POLE
FA - FENDON ANCHOR
FB - FLOWMETER
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GN - GAS METER
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LI - LIGHT
LP - LAMP POST
MBO - MOORING BOLLARD
MA - MANHOLE
MD - MONUMENT
MP - MONUMENT
MR - MONITORING WELL
NF - NAME PLATE
OH - OVERHEAD
OSBM - ORDNANCE SURVEY
PB - PAVEMENT
PA - PLAY APPARATUS
PH - PUBLIC HOUSE
PL - PLANT
PM - PAVING METER
PO - POST
PP - PUMP
R1 - RETAIL PUMP
R2 - ROAD SIGN
R3 - ROAD SIGN
RTW - RETAINING WALL
RW - RAINWATER PIPE
SA - STANCHION
SC - SPEED CAMERA
SD - SATELLITE DISH
SF - SAFETY FENCE
SG - SIGNAL
SI - SIGN
SMP - SERVICE MARKER POST
SS - SECURITY SENSOR
ST - STOP TAP
SU - STUMP
SV - STOP VALVE
SW - SWITCHGEAR
SY - STAY
TA - TAP
TMS - TEMPORARY BENCH MARK
TCB - TELEPHONE CALL BOX
TE - TELEPHONE
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TS - TRAFFIC SIGNAL
TP - TELEGRAPH POLE

UTL - UNABLE TO LIFT
VDP - VEHICLE DETECTOR PAD
WB - WASTE BLOW
WM - WASTE METER
WO - WASH OUT
WP - WASTE PIPE

FENCE TYPES

BW - BARBED WIRE
CB - CLOSE BOLLARD
C1 - CORRUGATED IRON
CP - CONCRETE PANEL
HR - HANDRAIL
HR - HANDRAIL
PAL - PALISADE
PC - POST & CHAIN
PP - POST & PANEL
PS - PILEDRIFT SAFETY
R1 - RAILING
R2 - RAILING
R3 - RAILING
R4 - RAILING
R5 - RAILING
R6 - RAILING
R7 - RAILING
R8 - RAILING
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R95 - RAILING
R96 - RAILING
R97 - RAILING
R98 - RAILING
R99 - RAILING
R100 - RAILING

SYMBOLS

HEDGE

TREE CANOPY

TREE

GATE

CONTROL STATION

BUILDING

TACTILE PAVING

SHEET LAYOUT

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Rev

Date

Drawn

Description

Ch'd

App'd

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Title

CRONTON COLLIERY
KNOWSLEY

TOPOGRAPHICAL SURVEY
SHEET 3 OF 14

Surveyed

PG/JP/DG

Drawn

BW

Drawn Date

11/10/2019

Checked

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Approved

NDO

Scale

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Project

10208

Status

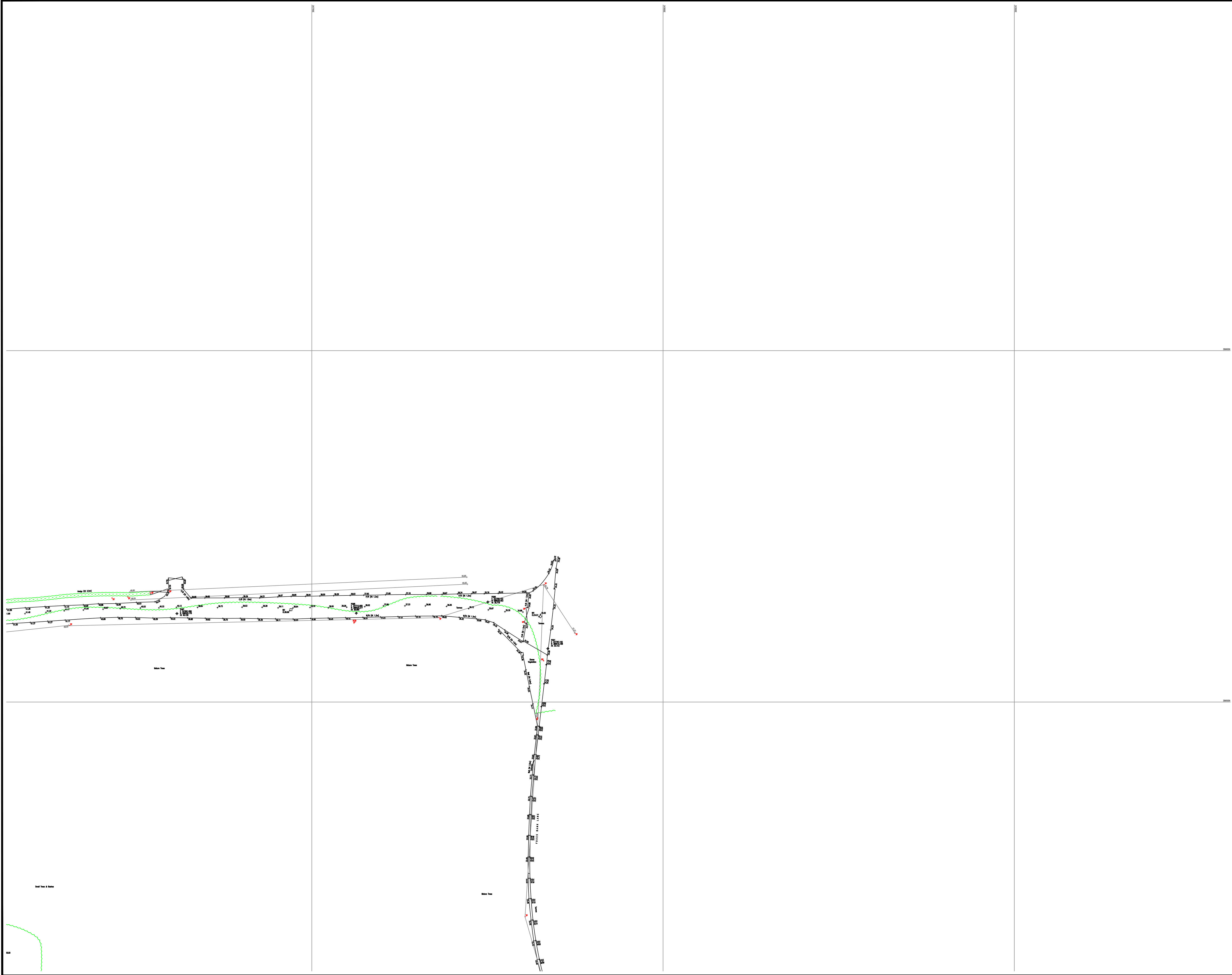
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Drawing No

10208 / 001 / 3

Rev

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NOTES

KEY

Grid & Datum - Local Plane Grid related to OS National Grid & Datum
By GNSS RTK Observations

STANDARD ABBREVIATIONS

STREET FURNITURE

AC - AIR CONDITIONING
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BA - BUOYANCY AID
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BS - BUS STOP
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CB - CONTROL BOX
CC - CLOSE CIRCUIT TV
CB - CLOSURE BOLLARD
CC - CLOSURE BOLLARD
CP - CLOSE CIRCUIT TV POLE
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DCH - DRAINAGE CHANNEL
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IC - INSPECTION COVER
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LB - LITTER BIN

STREET FURNITURE

LC - LIGHTING COLUMN
LI - LIGHT
LP - LAMP POST
MBO - MOORING BOLLARD
MA - MANHOLE
MB - MONUMENT
MR - MONITORING RING
MW - MONITORING WELL
NP - NAME PLATE
OH - OVERHEAD
OSBM - ORDNANCE SURVEY BENCH MARK
PA - PLAY APPARATUS
PB - PUBLIC BOX
PH - PUBLIC HOUSE
PI - PIPE
PL - PLANT
PM - PAVING METER
PO - POST
PP - RETRO REFLECTOR
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STREET FURNITURE

UTL - UNABLE TO LIFT
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SYMBOLS

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SHEET LAYOUT

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001 / 12

001 / 13

001 / 14

Rev

Date

Drawn

Description

Ch'd

App'd

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Client

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CHESTER
CH3 6EN

Title

CRONTON COLLIERY
KNOWSLEY

TOPOGRAPHICAL SURVEY
SHEET 4 OF 14

Surveyed

PG/JP/DG

Drawn

BW

Drawn Date

Checked

AM

Approved

NDO

11/10/2019

Scale

1:500 @ A1

Project

10208

Status

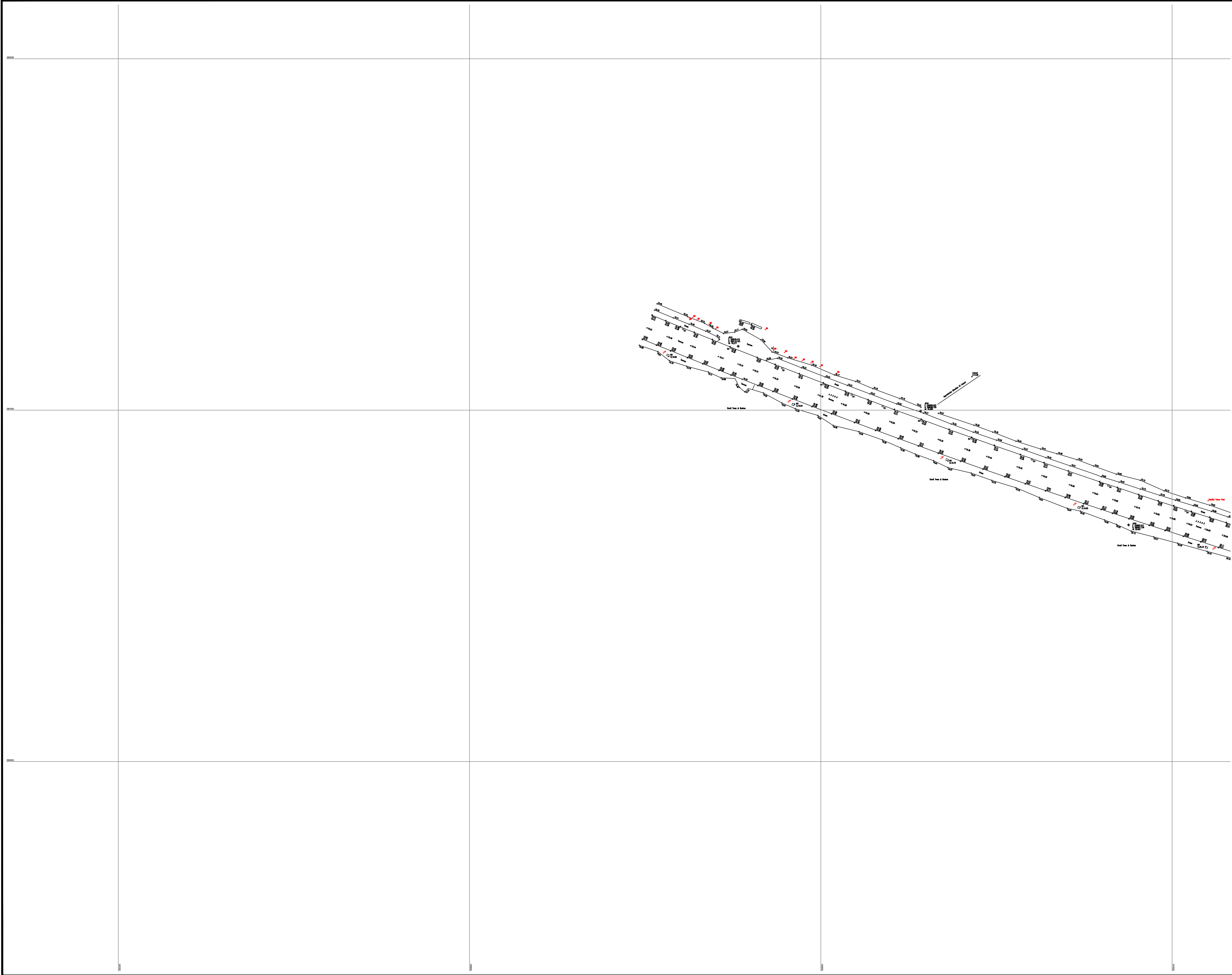
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Drawing No

10208 / 001 / 4

Rev

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NOTES

KEY

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CE - CEMENT
CF - CLOSURE FENCE
CH - CHIMNEY
CI - CLOSURE INLET
CL - CLOSURE LINE
CM - CLOSURE METER
CN - CLOSURE NOT
CO - CLOSURE OFF
CP - CLOSURE POINT
CR - CLOSURE ROAD
CS - CLOSURE SIGN
CT - CLOSURE TAP
CU - CLOSURE UNIT
CV - CLOSURE VALVE
CW - CLOSURE WALL
CX - CLOSURE CROSSING
CY - CLOSURE YARD
DZ - DRAINAGE ZONE
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LEVELS

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SYMBOLS

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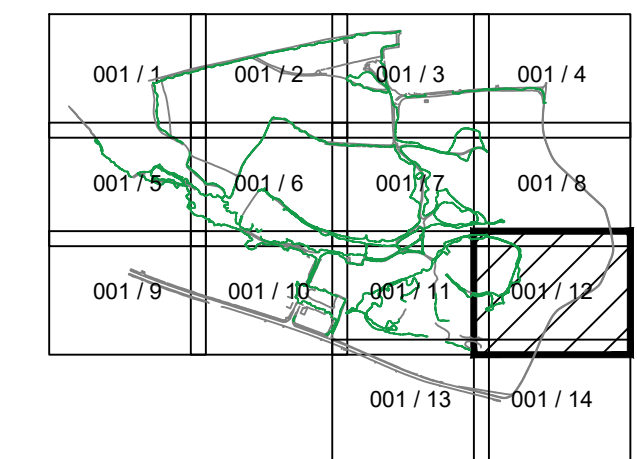
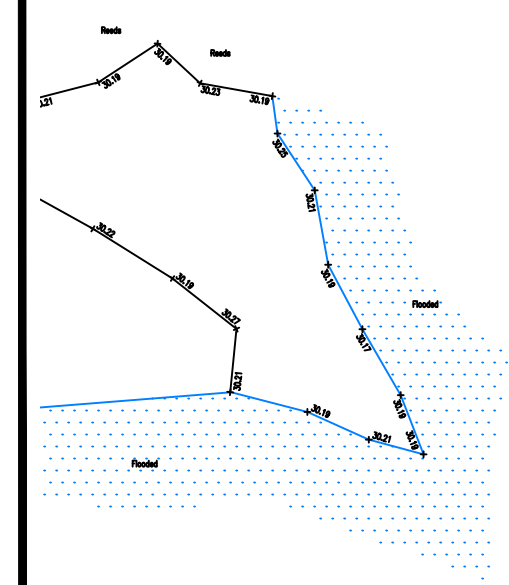
TIER UK
ELM HOUSE FARM
CHESTER
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Title

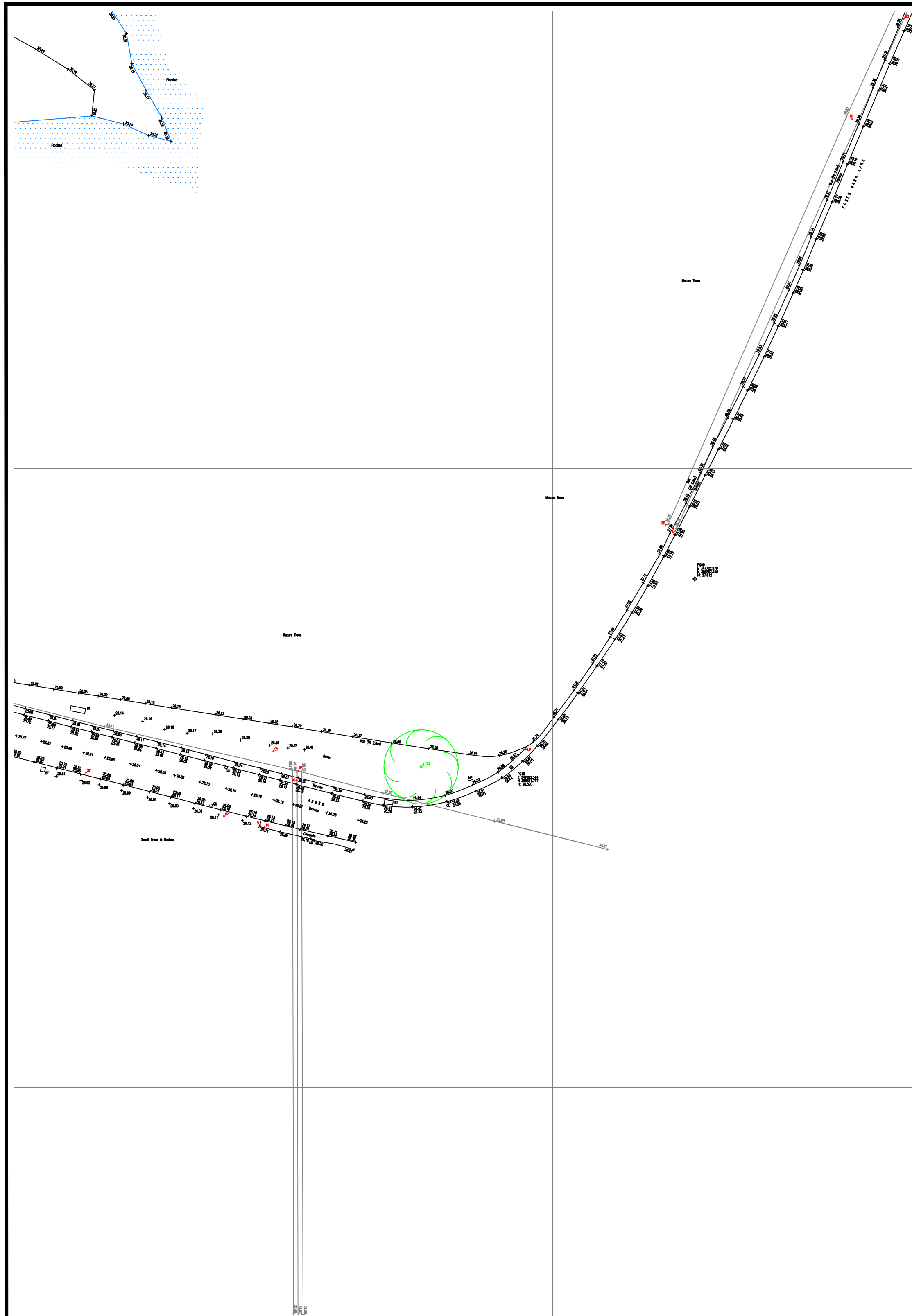
CRONTON COLLIERY
KNOWSLEY

TOPOGRAPHICAL SURVEY
SHEET 9 OF 14

Surveyed	PG/JP/DG	Drawn	BW	Drawn Date
Checked	AM	Approved	NDO	11/10/2019
Scale	1:500 @ A1	Project	10208	Status
		CAD 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10208 / 001 / 9	0			



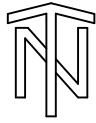
INDO-SEI Project / 10208 / DRAWING: 10208_001.DWG		
Drawing No	10208 / 001 / 12	Rev 0



NOTES

KEY

Grid & Datum - Local Plane Grid related to OS National Grid & Datum
By GNSS RTK Observations



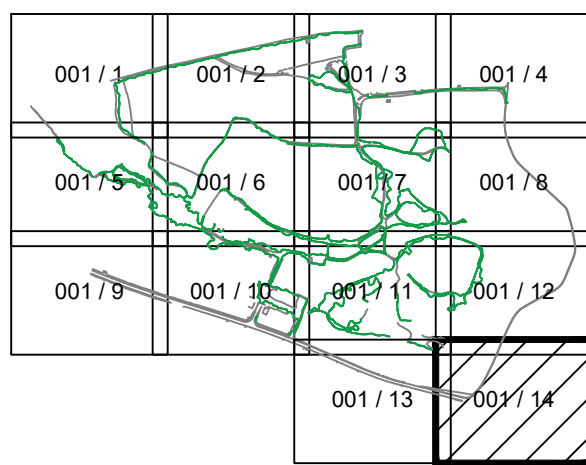
STANDARD ABBREVIATIONS

ACCT FURNITURE		L - LIGHTING COLL		UNABLE TO LIFT	
AD	AIR CONDITIONING	LD	LOAD	LD	LOAD
AL	ALUMINUM	LI	LAMP POST	VL	VENT PIPE
AM	AMERICAN	MD	MATERIAL	WM	WASTELINE
AN	ANCHOR	MA	MAST	WM	WATER METER
AP	APPROXIMATE	MC	MASONRY	WM	WATER
AR	ARMED	MD	MENTION	WM	WASTE PIPE
AS	ASBESTOS	MD	MEN		
BA	BALANCE	MD	MENDING		
BB	BALANCE	MD	MENDING		
BC	BALANCE	MD	MENDING		
BD	BALANCE	MD	MENDING		
BE	BALANCE	MD	MENDING		
BF	BALANCE	MD	MENDING		
BH	BALANCE	MD	MENDING		
BI	BALANCE	MD	MENDING		
BJ	BALANCE	MD	MENDING		
BK	BALANCE	MD	MENDING		
BL	BALANCE	MD	MENDING		
BM	BALANCE	MD	MENDING		
BN	BALANCE	MD	MENDING		
BO	BALANCE	MD	MENDING		
BP	BALANCE	MD	MENDING		
BQ	BALANCE	MD	MENDING		
BR	BALANCE	MD	MENDING		
BS	BALANCE	MD	MENDING		
BT	BALANCE	MD	MENDING		
BU	BUSH	PA	PEELER	IR	IRON RAILING
BV	BUSH	PF	PELLER BOX	IR	IRON RAILING
BW	BUSH	PI	PIPE	PC	POST & CHAIN
BX	BUSH	PI	PIPE	PC	POST & CHAIN
BY	BUSH	PI	PIPE	PC	POST & CHAIN
BZ	BUSH	PI	PIPE	PC	POST & CHAIN
CA	CABLE	PI	PIPE	PC	POST & CHAIN
CB	CABLE	PI	PIPE	PC	POST & CHAIN
CC	CABLE	PI	PIPE	PC	POST & CHAIN
CD	CABLE	PI	PIPE	PC	POST & CHAIN
CE	CABLE	PI	PIPE	PC	POST & CHAIN
CF	CABLE	PI	PIPE	PC	POST & CHAIN
CG	CABLE	PI	PIPE	PC	POST & CHAIN
CH	CABLE	PI	PIPE	PC	POST & CHAIN
CI	CABLE	PI	PIPE	PC	POST & CHAIN
CJ	CABLE	PI	PIPE	PC	POST & CHAIN
CK	CABLE	PI	PIPE	PC	POST & CHAIN
CL	CABLE	PI	PIPE	PC	POST & CHAIN
CM	CABLE	PI	PIPE	PC	POST & CHAIN
CN	CABLE	PI	PIPE	PC	POST & CHAIN
CO	CABLE	PI	PIPE	PC	POST & CHAIN
CP	CABLE	PI	PIPE	PC	POST & CHAIN
CQ	CABLE	PI	PIPE	PC	POST & CHAIN
CR	CABLE	PI	PIPE	PC	POST & CHAIN
CS	CABLE	PI	PIPE	PC	POST & CHAIN
CT	CABLE	PI	PIPE	PC	POST & CHAIN
CU	CABLE	PI	PIPE	PC	POST & CHAIN
CV	CABLE	PI	PIPE	PC	POST & CHAIN
CW	CABLE	PI	PIPE	PC	POST & CHAIN
CX	CABLE	PI	PIPE	PC	POST & CHAIN
CY	CABLE	PI	PIPE	PC	POST & CHAIN
CZ	CABLE	PI	PIPE	PC	POST & CHAIN
DA	DANCE	PA	PEELER	IR	IRON RAILING
DB	DANCE	PF	PELLER BOX	IR	IRON RAILING
DC	DANCE	PI	PIPE	PC	POST & CHAIN
DD	DANCE	PI	PIPE	PC	POST & CHAIN
DE	DANCE	PI	PIPE	PC	POST & CHAIN
DF	DANCE	PI	PIPE	PC	POST & CHAIN
DG	DANCE	PI	PIPE	PC	POST & CHAIN
DH	DANCE	PI	PIPE	PC	POST & CHAIN
DI	DANCE	PI	PIPE	PC	POST & CHAIN
DJ	DANCE	PI	PIPE	PC	POST & CHAIN
DK	DANCE	PI	PIPE	PC	POST & CHAIN
DL	DANCE	PI	PIPE	PC	POST & CHAIN
DM	DANCE	PI	PIPE	PC	POST & CHAIN
DN	DANCE	PI	PIPE	PC	POST & CHAIN
DO	DANCE	PI	PIPE	PC	POST & CHAIN
DP	DANCE	PI	PIPE	PC	POST & CHAIN
DQ	DANCE	PI	PIPE	PC	POST & CHAIN
DR	DANCE	PI	PIPE	PC	POST & CHAIN
DS	DANCE	PI	PIPE	PC	POST & CHAIN
DT	DANCE	PI	PIPE	PC	POST & CHAIN
DU	DANCE	PI	PIPE	PC	POST & CHAIN
DV	DANCE	PI	PIPE	PC	POST & CHAIN
DW	DANCE	PI	PIPE	PC	POST & CHAIN
DX	DANCE	PI	PIPE	PC	POST & CHAIN
DY	DANCE	PI	PIPE	PC	POST & CHAIN
DZ	DANCE	PI	PIPE	PC	POST & CHAIN
EA	EARTH	PA	PEELER	IR	IRON RAILING
EB	EARTH	PF	PELLER BOX	IR	IRON RAILING
EC	EARTH	PI	PIPE	PC	POST & CHAIN
ED	EARTH	PI	PIPE	PC	POST & CHAIN
EE	EARTH	PI	PIPE	PC	POST & CHAIN
EF	EARTH	PI	PIPE	PC	POST & CHAIN
EG	EARTH	PI	PIPE	PC	POST & CHAIN
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EJ	EARTH	PI	PIPE	PC	POST & CHAIN
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EL	EARTH	PI	PIPE	PC	POST & CHAIN
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EV	EARTH	PI	PIPE	PC	POST & CHAIN
EW	EARTH	PI	PIPE	PC	POST & CHAIN
EX	EARTH	PI	PIPE	PC	POST & CHAIN
EY	EARTH	PI	PIPE	PC	POST & CHAIN
EZ	EARTH	PI	PIPE	PC	POST & CHAIN
FA	FLOOR	SD	SAFETY	IR	IRON RAILING
FB	FLOOR	SD	SAFETY	IR	IRON RAILING
FC	FLOOR	SD	SAFETY	IR	IRON RAILING
FD	FLOOR	SD	SAFETY	IR	IRON RAILING
FE	FLOOR	SD	SAFETY	IR	IRON RAILING
FF	FLOOR	SD	SAFETY	IR	IRON RAILING
FG	FLOOR	SD	SAFETY	IR	IRON RAILING
FH	FLOOR	SD	SAFETY	IR	IRON RAILING
FI	FLOOR	SD	SAFETY	IR	IRON RAILING
FJ	FLOOR	SD	SAFETY	IR	IRON RAILING
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FN	FLOOR	SD	SAFETY	IR	IRON RAILING
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FP	FLOOR	SD	SAFETY	IR	IRON RAILING
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FT	FLOOR	SD	SAFETY	IR	IRON RAILING
FU	FLOOR	SD	SAFETY	IR	IRON RAILING
FV	FLOOR	SD	SAFETY	IR	IRON RAILING
FW	FLOOR	SD	SAFETY	IR	IRON RAILING
FX	FLOOR	SD	SAFETY	IR	IRON RAILING
FY	FLOOR	SD	SAFETY	IR	IRON RAILING
FZ	FLOOR	SD	SAFETY	IR	IRON RAILING
GA	GAS METER	SV	STOP TAP	IR	IRON RAILING
GB	GAS METER	SV	STOP TAP	IR	IRON RAILING
GC	GAS METER	SV	STOP TAP	IR	IRON RAILING
GD	GAS METER	SV	STOP TAP	IR	IRON RAILING
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GF	GAS METER	SV	STOP TAP	IR	IRON RAILING
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GI	GAS METER	SV	STOP TAP	IR	IRON RAILING
GJ	GAS METER	SV	STOP TAP	IR	IRON RAILING
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GL	GAS METER	SV	STOP TAP	IR	IRON RAILING
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GX	GAS METER	SV	STOP TAP	IR	IRON RAILING
GY	GAS METER	SV	STOP TAP	IR	IRON RAILING
GZ	GAS METER	SV	STOP TAP	IR	IRON RAILING
HA	HAND	TA	TAP	IR	IRON RAILING
HB	HAND	TA	TAP	IR	IRON RAILING
HC	HAND	TA	TAP	IR	IRON RAILING
HD	HAND	TA	TAP	IR	IRON RAILING
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IB	IRON	TA	TAP	IR	IRON RAILING
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IZ	IRON	TA	TAP	IR	IRON RAILING
JA	JACK	TA	TAP	IR	IRON RAILING
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JC	JACK	TA	TAP	IR	IRON RAILING
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KO	KITCHEN	TA	TAP	IR	IRON RAILING
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KV	KITCHEN	TA	TAP	IR	IRON RAILING
KW	KITCHEN	TA	TAP	IR	IRON RAILING
KX	KITCHEN	TA	TAP	IR	IRON RAILING
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KZ	KITCHEN	TA	TAP	IR	IRON RAILING
LA	LAMP	TA	TAP	IR	IRON RAILING
LB	LAMP	TA	TAP	IR	IRON RAILING
LC	LAMP	TA	TAP	IR	IRON RAILING
LD	LAMP	TA	TAP	IR	IRON RAILING
LE	LAMP	TA	TAP	IR	IRON RAILING
LF	LAMP	TA	TAP	IR	IRON RAILING
LG	LAMP	TA	TAP	IR	IRON RAILING
LH	LAMP	TA	TAP	IR	IRON RAILING
LI	LAMP	TA	TAP	IR	IRON RAILING
LJ	LAMP	TA	TAP	IR	IRON RAILING
LK	LAMP	TA	TAP	IR	IRON RAILING
LL	LAMP	TA	TAP	IR	IRON RAILING
LM	LAMP	TA	TAP	IR	IRON RAILING
LN	LAMP	TA	TAP	IR	IRON RAILING
LO	LAMP	TA	TAP	IR	IRON RAILING
LP	LAMP	TA	TAP	IR	

SYMBOLS

	HEDGE		GATE		BUILDING
	TREE CANOPY		CONTROL STATION		TACTILE PAVING
	TREE				

SHEET LAYOUT



Rev	Date	Drawn	Description	Ch'k'd	App'd



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CHESTER
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Title

CRONTON COLLIERY
KNOWSLEY

TOPOGRAPHICAL SURVEY
SHEET 14 OF 14

Surveyed	PG/JP/DG	Drawn	BW	Drawn Date:
Checked	AM	Approved	NDO	11/10/2019
Scale	Project 10208			Status
1:500 @ A1	CAD File			ORIG
INDO-5612/Project/10208/DRAWINGS/10208_01.DWG				
Drawing No	10208 / 001 / 14			Rev
				0



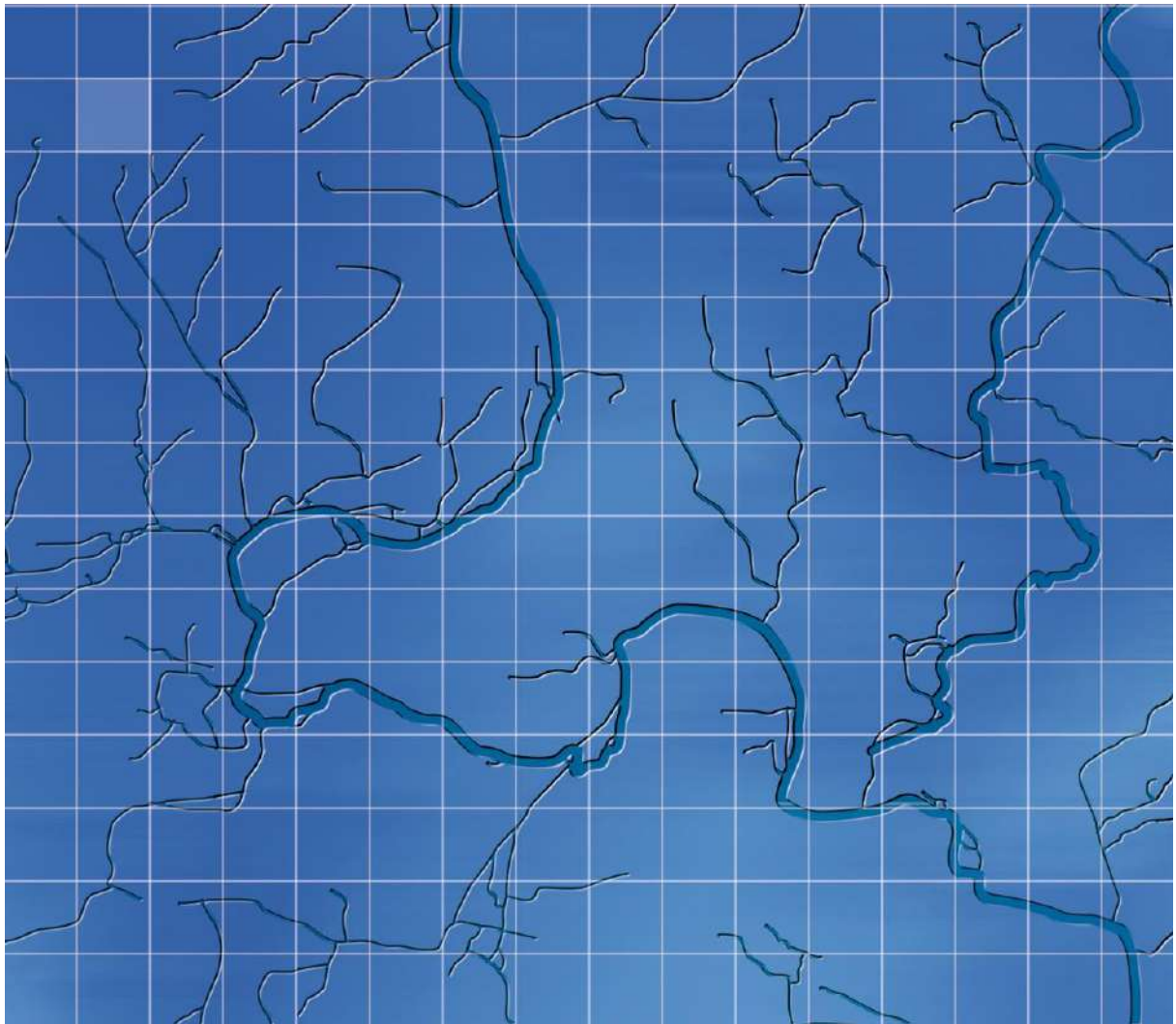
Appendix E – Hydraulic Modelling Report

KRS Environmental

August 2020

Cronton Quarry

Hydraulic Modelling Report



WHS

KRS Environmental

Cronton Quarry Hydraulic Modelling Report

Document issue details

WHS1769

Version	Issue date	Issue status	Prepared By	Approved By
1	15/09/2020	Draft	Jessica Pearce (Consultant)	Brett Park (Senior Consultant)

For and on behalf of Wallingford HydroSolutions Ltd.

This report has been prepared by WHS with all reasonable skill, care and diligence within the terms of the Contract with the client and taking account of both the resources allocated to it by agreement with the client and the data that was available to us. We disclaim any responsibility to the client and others in respect of any matters outside the scope of the above. This report is confidential to the client and we accept no responsibility of any nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report at their own risk.



The WHS Quality & Environmental Management system is certified as meeting the requirements of ISO 9001:2015 and ISO 14001:2015 providing environmental consultancy (including monitoring and surveying), the development of hydrological software and associated training.



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Appendix A EA Correspondence

Appendix B Survey Data

Appendix C Hydrological Assessment

Appendix D Modelled Results

1 Introduction

1.1 Scope

Wallingford HydroSolutions Ltd has been commissioned by KRS Environmental to complete bespoke hydraulic modelling of the Fox's Bank Brook in Knowsely to support a site-specific Flood Risk Assessment (FRA). The FRA is required to support a planning application at Cronton Quarry, Knowsely, NGR: SJ 47486 89037.

The current Environment Agency's (EA) flood map covering the development site is based upon national JFLOW modelling and the flood outlines do not align to the watercourses in the area, therefore detailed hydraulic modelling is required to confirm flood risk to the site. The hydraulic model will be run for a range of return periods including two climate change scenarios. As per the request of the EA¹ a blockage scenario of the culvert under Cronton road is required.

1.2 Methodology

A 1D/2D hydraulic model of the Fox's Bank Brook, which runs to the south of the development site, has been developed to assess flood risk to the site. The current EA online flood map² indicates that the site may be at risk of fluvial flooding, with areas of the site shown to lie within Flood Zone 3, however the flood outline is misaligned to the watercourse. Correspondence with the EA confirmed that the existing flood extent has been determined by JFLOW modelling and that detailed, site-specific hydraulic modelling is required to confirm flood risk.

The hydraulic model has been produced utilising TUFLOW/ESTRY software and flows into the model have been informed by hydrological estimate of the watercourse. The modelling has also been informed by survey data collected in July 2020 provided to WHS by KRS Environmental.³

1.3 Data sources

The data sources used to inform this hydraulic modelling study are as follows:

- EA correspondence from May 2020
- EA online flood maps and flood map for planning²
- River Channel Survey of the Fox's Bank Brook and topographic site survey both supplied by KRS Environmental (July 2020)³
- WHS Hydrological Estimates⁴
- LiDAR data⁵

1.4 Assumptions

- It is assumed that the LiDAR and survey data are both suitable for use to inform the hydraulic model.
- Where the survey data is not appropriate channel sections have been interpolated between the two nearest cross sections
- It is assumed the culverts are maintained and free from blockage during the baseline scenario.

¹ EA correspondence, 14/05/2020, available as Appendix A

² Environment Agency Flood Map For Planning. Accessed via: <https://flood-map-for-planning.service.gov.uk/confirm-location?easting=347235&northing=389042&placeOrPostcode=L35%201QR>

³ Survey data from KRS Environmental, July 2020, Available as Appendix B

⁴ Available as Appendix C

⁵ LiDAR data obtained from DEFRA available via: <https://environment.data.gov.uk/DefraDataDownload/?Mode=survey>

2 Site Description

2.1 Site Location

The proposed development is situated at Cronton Quarry, Knowsely, NGR: SJ 47486 89037. The site location is shown in Figure 1. The site is situated approximately 1.2km to the south of Halsnead Park and 1.8km to the north west of the town of Cronton, the Fox's Bank Brook is situated to the immediate south of the site and flows in a westerly direction to its confluence with the Chapple Brook situated approximately 1km downstream of the site. There are a series of drainage ditches visible within the site boundary.

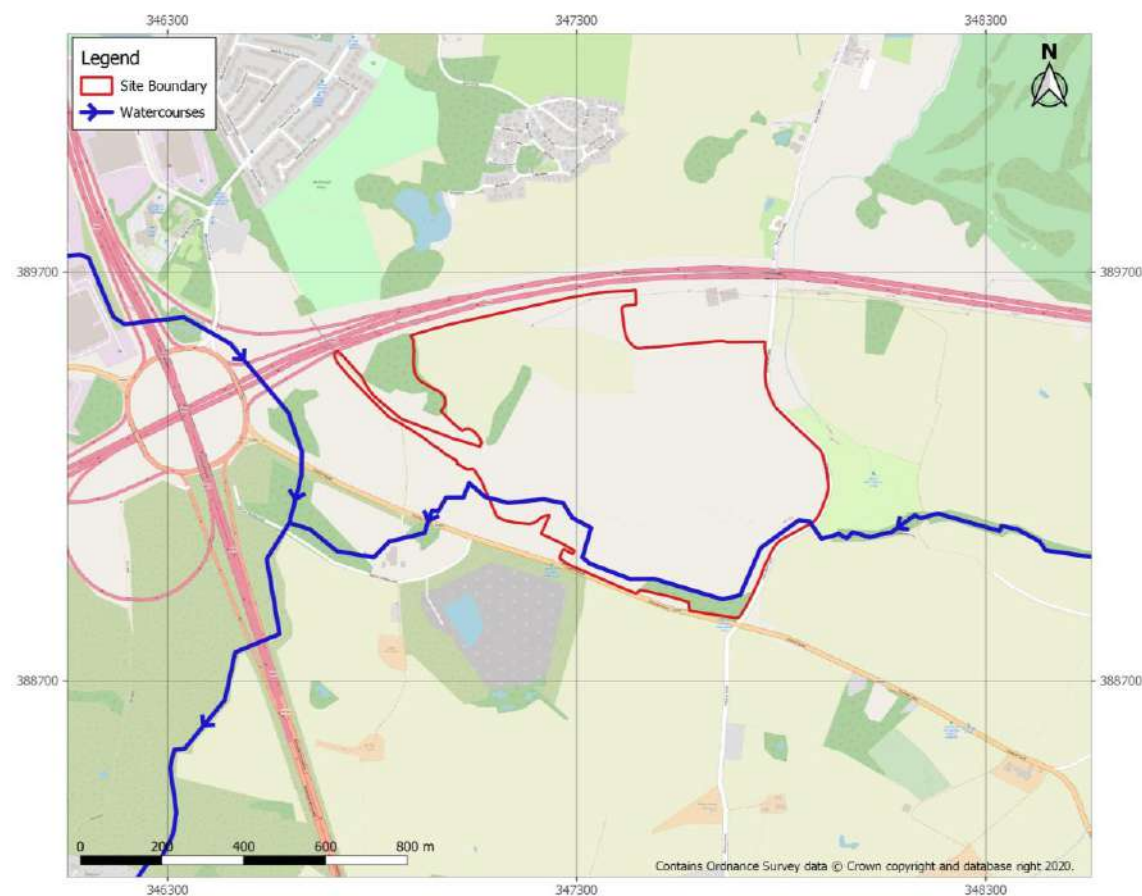


Figure 1: Site Location

2.2 Historic Flooding

The Environment Agency's historic flood map indicates that there have been no recorded flood events at the proposed development site. Correspondence with the EA¹ has confirmed that there are no records of flooding affecting the site however warn that this does not mean flooding has not occurred in the past.

2.3 Existing Flood Defences

There are no known flood defences within the vicinity of the development site.

3 Hydrology Assessment

To inform flows into the hydraulic model hydrology estimates have been calculated at one direct and one lateral inflow location, the inflow catchment boundaries are shown in Figure 2. The hydrology for each of the direct inflows was assessed by extracting the relevant catchment descriptors from the FEH webservice and then applying the FEH methods. The FEH methods in this case include the statistical method applied in WINFAP-FEH (v4.2) and the rainfall-runoff method applied in ReFH2.2.

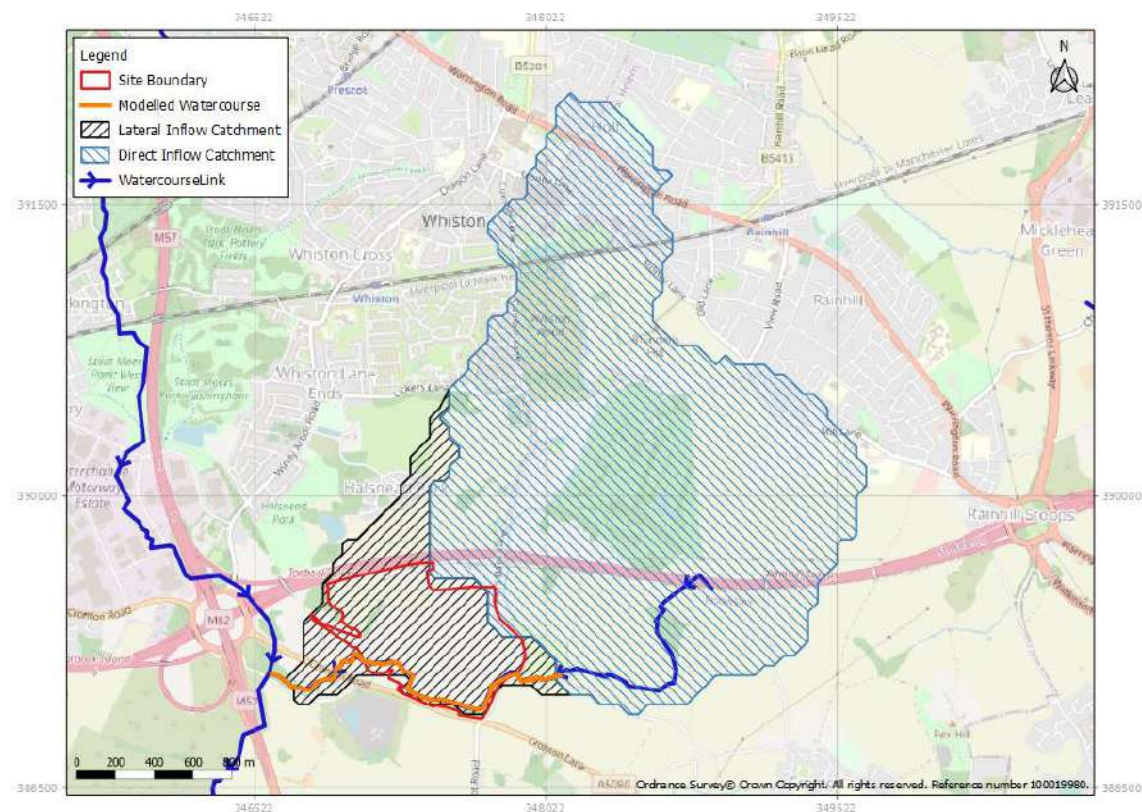


Figure 2: Inflow catchment Boundaries

The final peak flow estimates are presented in

Table 1 below and the full hydrology report available in Appendix B .

Table 1: Final Peak Flow Estimates

Return Period (years)	Peak Flow estimate (m ³ /s)	
	Foxes Bank Brook	Lateral Catchment
2	1.34	0.38
25	2.76	0.83
50	3.27	0.98
100	3.88	1.17
500	5.81	1.76
1000	6.92	2.09

4 Hydraulic Model Build

4.1 1D Domain

4.1.1 Model Extent

The extent of the 1D model and the proposed modelling methodology was agreed with the Environment Agency in May 2020¹. The Fox's bank brook has been modelled from approximately 280m upstream of the site just after its confluence with the Whiston Brook (NGR: 348097, 389072), to its confluence with the Logwood Mill Brook (NGR: 346611, 389083), approximately 650m downstream of the site. The entire modelled length stretches 1.97km. It was confirmed that detailed modelling of the drainage ditches within the site was not required as they are to be included within the hydrology estimation as a lateral inflow. A schematic of the modelled extent is shown in Figure 3 below.

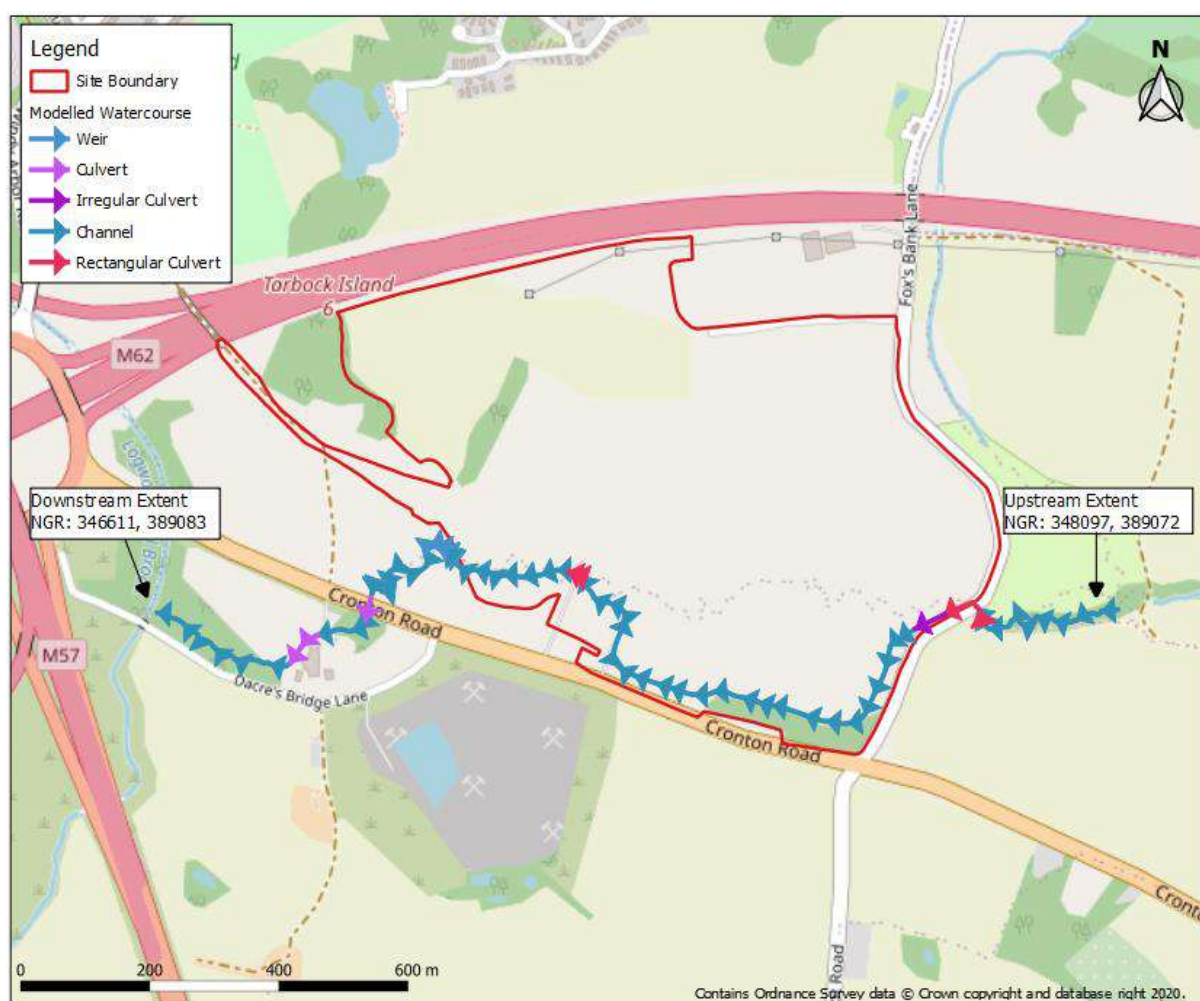


Figure 3: 1D model extent

The model's upstream extent includes the culvert under Fox's Bank Lane, and downstream of the site includes the culvert under Cronton Road. The EA have requested that a blockage scenario is to be modelled on this culvert (100% blockage) to assess the consequence of blockage on flood risk which may propagate upstream towards the site.

4.1.2 River Channel Geometry

The river channel geometry of the hydraulic model has been informed by survey data provided by KRS Environmental collected in May 2020. This survey data is available in Appendix B. The cross sections are spaced at 25m on average with distance between the sections ranging from 10-60m.

4.1.3 Boundary Conditions

Inflow into the 1D model has been applied by a QT (flow/time) boundary with a 1d_bc point placed at the upstream end of the 1D network line to represent the hydrograph. A lateral inflow has been applied along an approximate 1.1km stretch of the 1D network as a QT boundary with a 1d_bc region placed along the modelled section being influenced by the drainage ditches within the site boundary.

As per the approach agreed with the Environment Agency⁶ a HT (Head/Time) boundary has been applied to the downstream node of the model. The level has been set to 15.41m AOD which represents the maximum modelled flood level during a 0.1% AEP flood event within the Longwood Mill Brook. This level has been taken from a point just downstream of the confluence with the Fox's Bank Brook at NGR: 346542, 389004. This modelled flood level was provided by the environment agency in August 2020 and is available in Appendix A.

4.1.4 Initial Conditions

Initial conditions have been applied throughout the model by calculating initial water levels in the channel, prior to a storm event. The water levels were calculated by first running the model using a steady baseflow, which is the flow that occurs in the first timestep of the storm hydrographs. The water levels were applied by snapping a 1d_iwl point to each river section which contains the initial water level for the corresponding cross section.

⁶ Correspondence with the EA in August 2020, EA correspondence is available in Appendix A.

4.1.5 River Channel Roughness

The manning's values used to represent the surface roughness are summarised in Table 2. The selected values are based on engineering judgement and published guideline values⁷. In addition to the manning's number along the open channel reaches, hydraulic structures such as bridges and culverts also have roughness values. The manning's roughness for the structures such as bridge and culverts are summarised in Table 2 and are discussed in detail within the structure section of this report.

Table 2 - Summary of Manning's Values

Domain	Description	Manning's n
1D	Natural Channel	0.030 - 0.070
1D	Structures	0.011 - 0.025

Some examples of the different manning's values used are provided in Table 3 below.

Table 3 - Example of manning's (n) values

Node: CRONT_001		
Chosen manning's numbers and Description		
Left Bank (n): 0.07	Bed (n):0.03	Right Bank (n):0.07
Main channel, clean, straight, full stage, no rifts or deep pools with more stones and weeds. Banks with medium to dense brush in the summer.		
Example Photograph		
		

⁷ Chow, V T (1959). *Open-channel Hydraulics*. McGraw-Hill.

Node: CRONT_020

Chosen manning's numbers and Description

Left Bank (n):
0.07

Bed (n):0.035

Right Bank
(n):0.07

Main channel, clean, straight with some weeds, banks with more weeds and brush

Example Photograph



Node: CRONT_065

Chosen manning's numbers and Description

Left Bank (n):
0.06

Bed (n):0.035

Right Bank
(n):0.07

Main channel, clean and straight, banks are sluggish with weeds.

Example Photograph

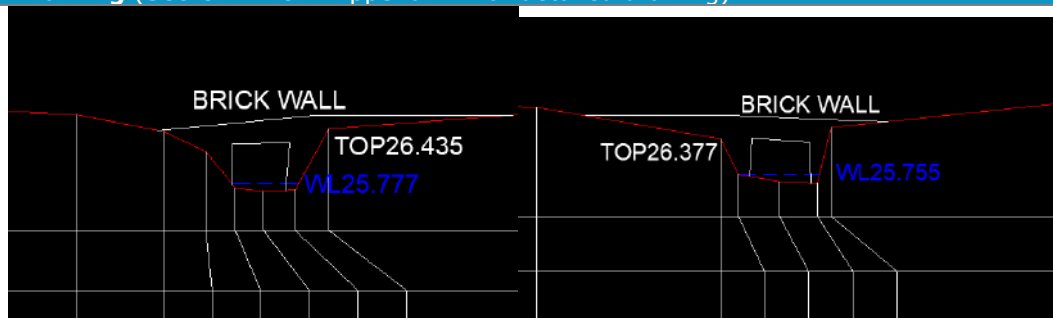


4.1.6 River Channel Structures

Node	CRONT_009a and CRONT_009b	Type	Rectangular Culvert
Source of Data	Survey Data provided by KRS Environmental	Modelled	Yes
NGR	347885, 389069		

- CRONT_009a and CRONT_009b is a rectangular culvert which has a different geometry at its inlet and outlet and has hence been modelled as two culverts with equal length. The culvert has been modelled as an R type culvert.
- The culvert has a total length of 4.05m with an invert level of 25.641m AOD and a downstream invert level of 25.593m AOD. The first half of the culvert has a width of 0.91m and height of 0.796m, the second half has a width of 1.044m and a height of 0.742m.
- The culvert has a manning's n of 0.025 along its entire length.
- HCon: 0.6, WCon: 0.9, Entry Loss- 0.50, Exit loss- 1.00
- A spill over the culvert has been modelled within the 2D domain.

CAD Drawing (See CAD file in Appendix B for detailed drawing)



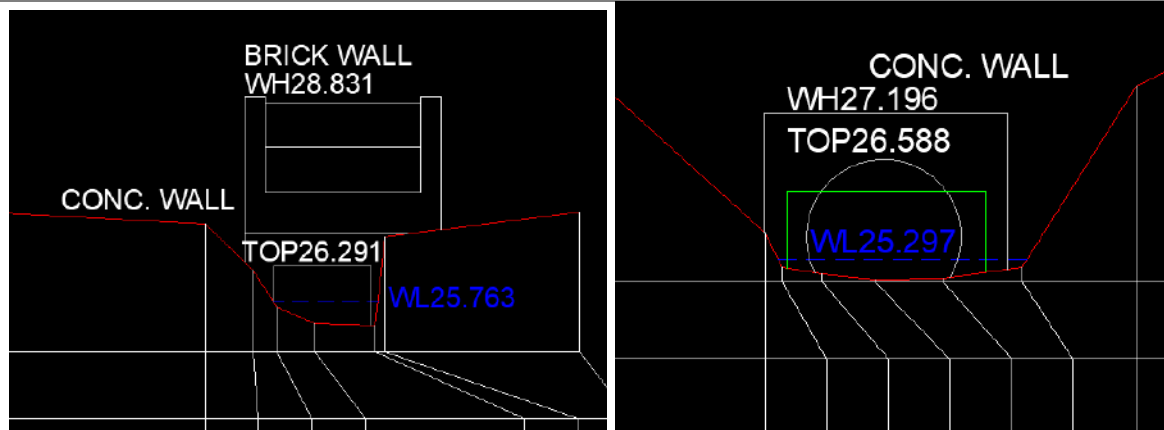
Photograph



Node	CRONT_011a and CRONT_011b	Type	Culvert
Source of Data	Survey Data provided by KRS Environmental	Modelled	Yes
NGR	347848, 389076		

- CRONT_011a and CRONT_011b is a culvert which changes geometry between its inlet and outlet. Therefore the first half of the culvert has been modelled as an R type culvert with a width of 1.47m and height of 0.89m. The second half of the culvert has an irregular geometry defined by a HW table.
- The culvert has a total length of 101.18m and a manning's n of 0.011.
- The culvert has an US invert level of 25.404m AOD and a DS invert of 25.025m AOD as per the surveyed cross sections
- The first half of the culvert has a HCon of 0.6 and Wcon of 0.9, an entry loss of 0.5 and an exit loss of 1
- The HCon of the irregular culvert is set to 0.8 and WCon at 1. There is a trash screen located on the culvert outlet, the exit loss has therefore been set to 1.

CAD Drawing (See CAD file in Appendix B for detailed drawing)



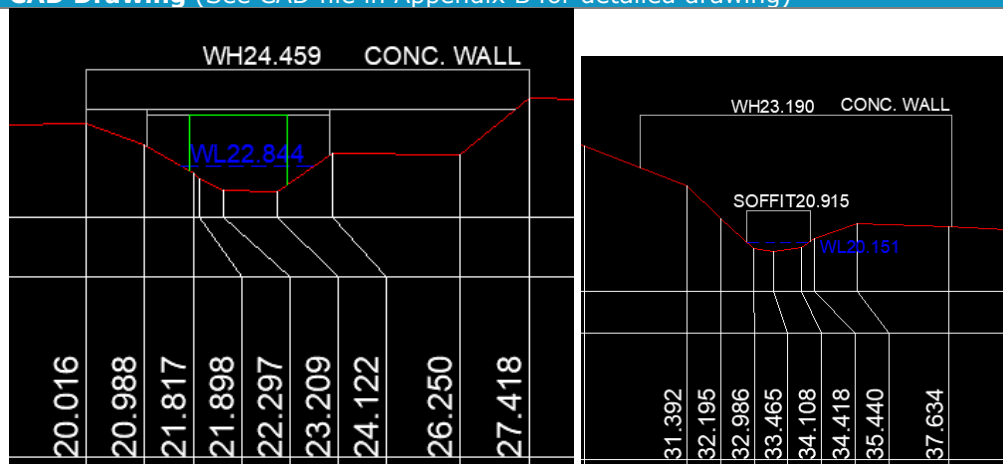
Photograph



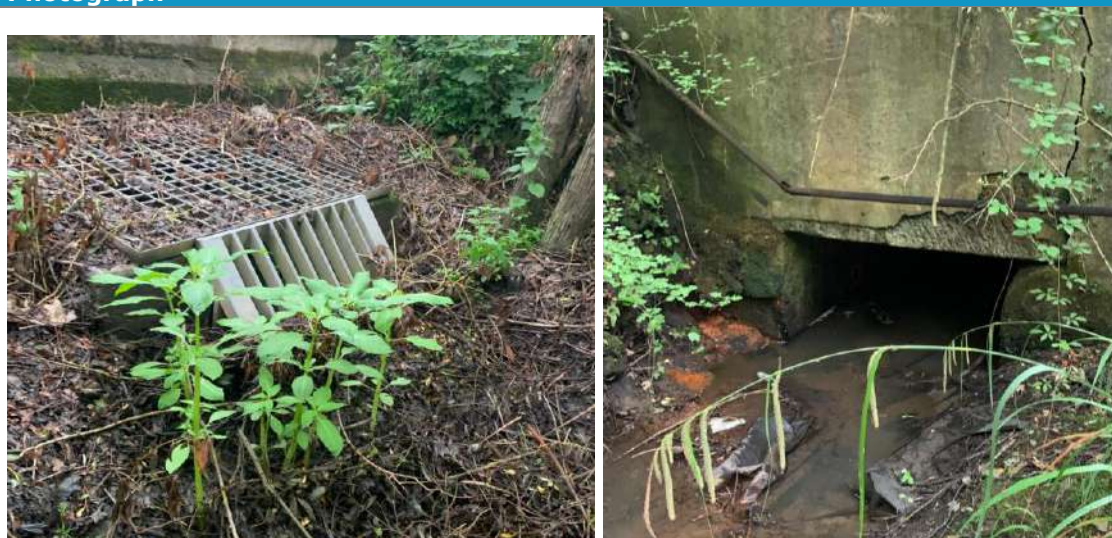
Node	CRONT_035a and CRONT_035b	Type	Rectangular Culvert
Source of Data	Survey Data provided by KRS Environmental	Modelled	Yes
NGR	347258, 389137		

- CRONT_035a and CRONT_035b is a rectangular culvert with changing geometry. The culvert has been modelled as two R type culverts each with a length of 10.775m.
- The culvert has an US invert level of 22.415m AOD and a DS invert of 19.956m AOD as per the surveyed cross sections. The culverts have a manning's n value of 0.013.
- The upstream culvert has a width of 1.642m and height of 1.282m and the downstream culvert has a width of 1.511m and height of 0.969m.
- HCon: 0.6, WCon: 1
- There is a trash screen on the culvert inlet hence the culvert has an entry loss of 1 and exit loss of 1.
- The culvert appears to be relatively blocked at its inlet however the client has informed WHS that the debris can be removed upon request.

CAD Drawing (See CAD file in Appendix B for detailed drawing)



Photograph

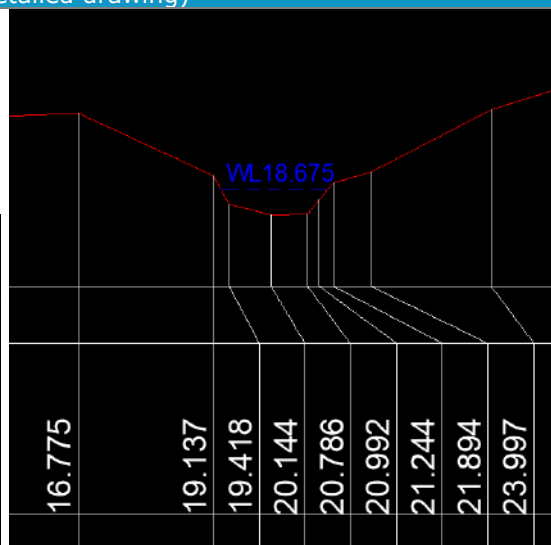
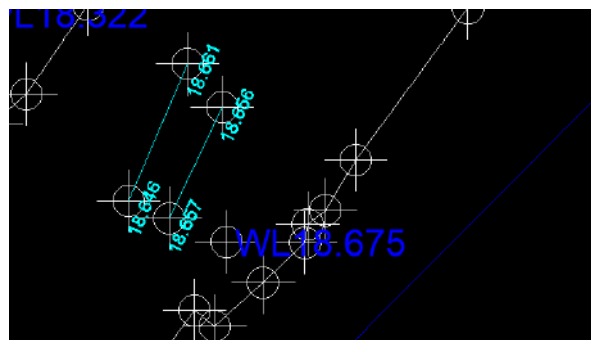


Node	CRONT_044W	Type	Weir
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Source of Data	Survey Data provided by KRS Environmental	Modelled	Yes- W Type
NGR	347061, 389172		

- CRONT_044W is a broad-crested weir that has been modelled as a W type.
- The weir's geometry has been defined by a cross section detailing the weir elevation as per the surveyed data. The weir has a crest level of 18.646m AOD and a length of 0.519m.

CAD Drawing (See CAD file in Appendix B for detailed drawing)



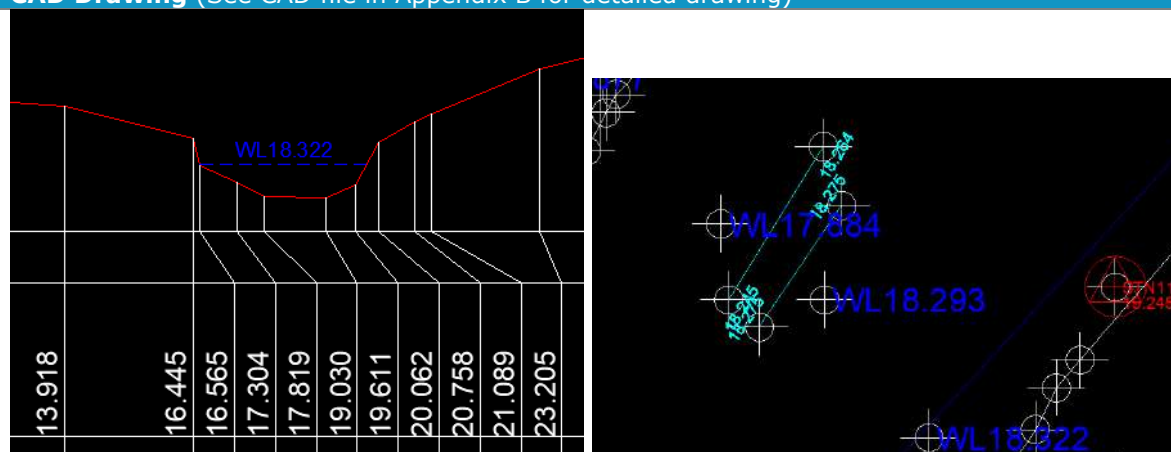
Photograph



Node	CRONT_045W	Type	Weir
Source of Data	Survey Data provided by KRS Environmental	Modelled	Yes – W Type
NGR	347057, 389175		

- CRONT_044W is a broad-crested weir that has been modelled as a W type.
- The weir's geometry has been defined by a cross section detailing the weir elevation as per the surveyed data. The weir has a crest level of 18.245m AOD and a length of 0.545m.

CAD Drawing (See CAD file in Appendix B for detailed drawing)



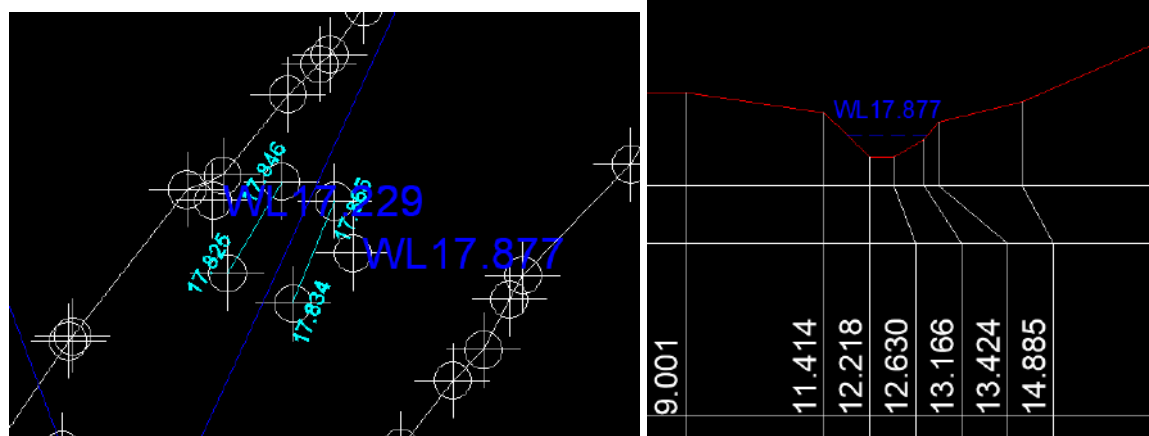
Photograph



Node	CRONT_046W	Type	Weir
Source of Data	Survey Data provided by KRS Environmental	Modelled	Yes – W Type
NGR	347053, 389178		

- CRONT_046W is a broad-crested weir that has been modelled as a W type.
- The weir's geometry has been defined by a cross section detailing the weir elevation as per the surveyed data. The weir has a crest level of 17.843m AOD and a length of 0.604m.

CAD Drawing (See CAD file in Appendix B for detailed drawing)



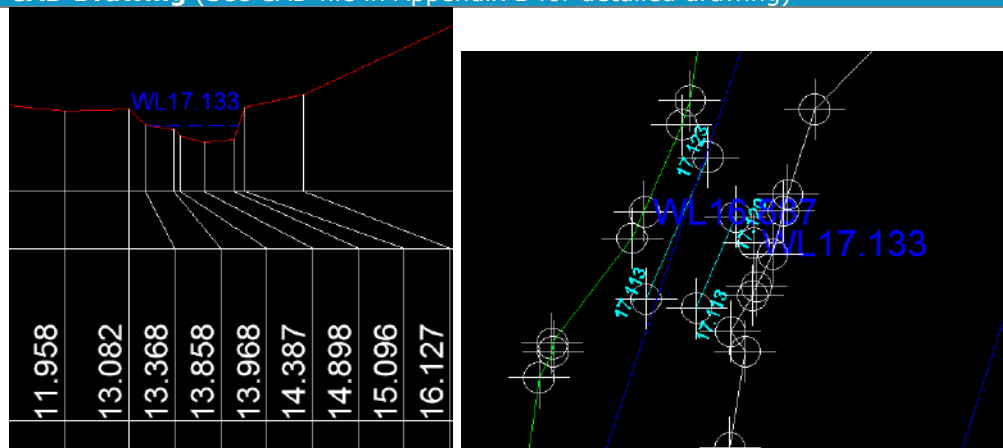
Photograph



Node	CRONT_048W	Type	Weir
Source of Data	Survey Data provided by KRS Environmental	Modelled	Yes- W Type
NGR	347045, 389184		

- CRONT_048W is a broad-crested weir that has been modelled as a W type.
- The weir's geometry has been defined by a cross section detailing the weir elevation as per the surveyed data. The weir has a crest level of 17.113m AOD and a length of 0.562m.

CAD Drawing (See CAD file in Appendix B for detailed drawing)



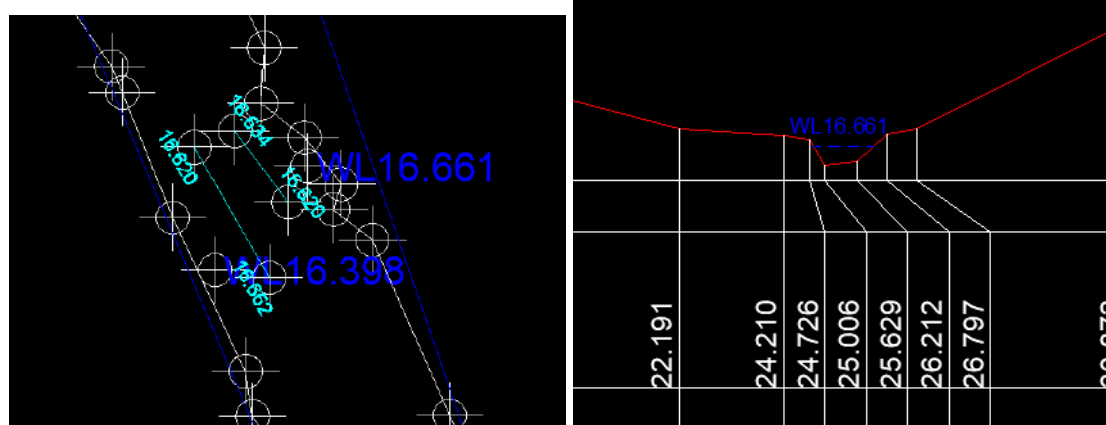
Photograph



Node	CRONT_050W	Type	Weir
Source of Data	Survey Data provided by KRS Environmental	Modelled	Yes- W Type
NGR	347034, 389183		

- CRONT_048W is a broad-crested weir that has been modelled as a W type.
- The weir's geometry has been defined by a cross section detailing the weir elevation as per the surveyed data. The weir has a crest level of 16.634m AOD and a length of 0.597m.

CAD Drawing (See CAD file in Appendix B for detailed drawing)



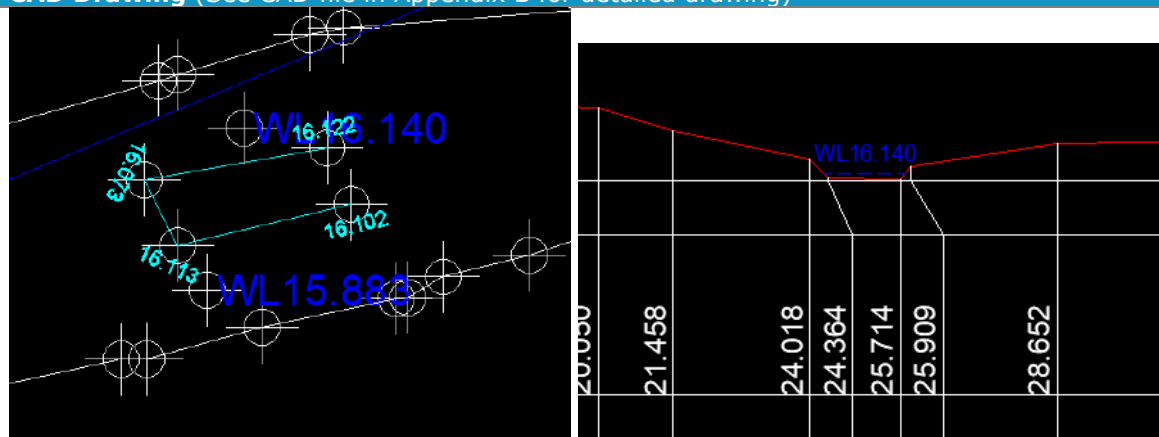
Photograph



Node	CRONT_052W	Type	Weir
Source of Data	Survey Data Provided by KRS Environmental	Modelled	Yes- W Type
NGR	347027, 389171		

- CRONT_052W is a broad-crested weir that has been modelled as a W type.
- The weir's geometry has been defined by a cross section detailing the weir elevation as per the surveyed data. The weir has a crest level of 16.113m AOD and a length of 0.689m.

CAD Drawing (See CAD file in Appendix B for detailed drawing)



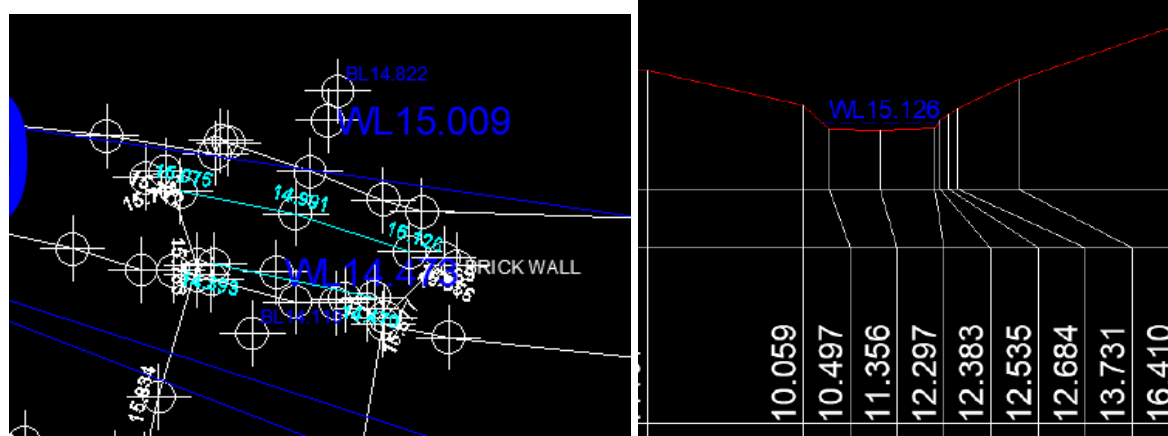
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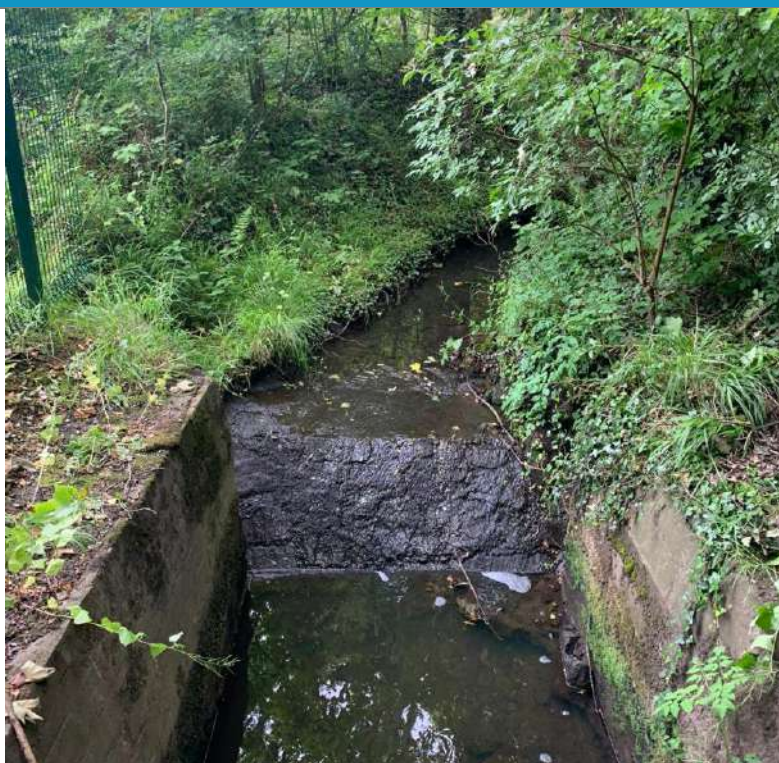
Node	CRONT_059W	Type	Weir
Source of Data	Survey data provided by KRS Environmental	Modelled	Yes- W Type
NGR	346943, 389113		

- CRONT_059W is a broad-crested weir that has been modelled as a W type.
- The weir's geometry has been defined by stating the US and DS ivert as per the surveyed data. The weir has a crest level of 15.064 AOD and a length of 0.445m.

CAD Drawing (See CAD file in Appendix B for detailed drawing)



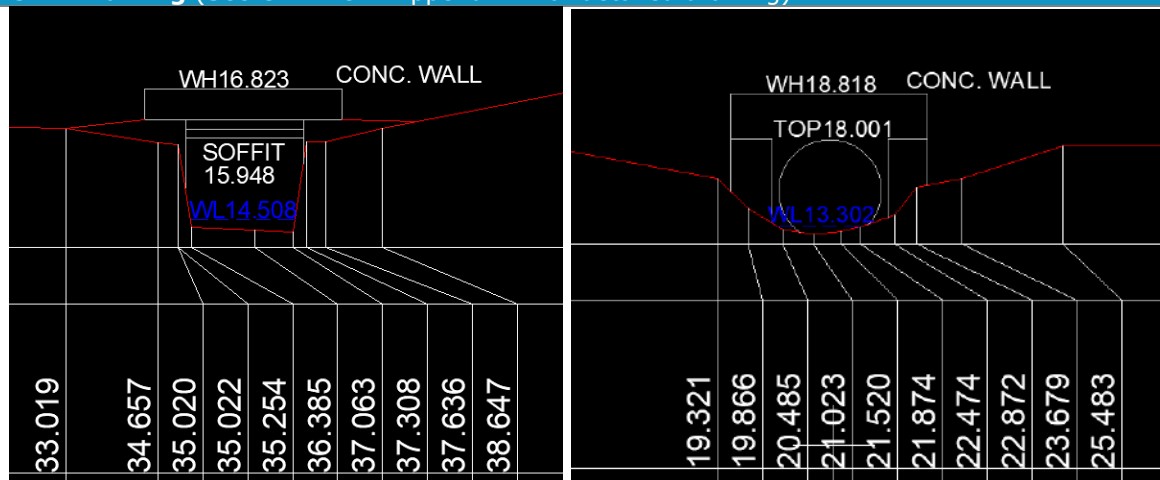
Photograph



Node	CRONT_061	Type	Culvert
Source of Data	Survey Data provided by KRS Environmental	Modelled	Yes- C type
NGR	346943, 389110		

- CRONT_061 is a circular culvert. The culvert has been modelled as a C culvert.
- The culvert has an US invert level of 14.277m AOD and a downstream invert of 14.159m AOD as per the surveyed cross sections. The culvert has a diameter of 0.911m.
- The culvert has a length of 42.83m
- Manning's n: 0.013
- W conf- 1.00
- The culvert has a trash screen on its inlet therefore the entry loss has been calculated as 0.78 as per guidance from the Queensland Urban Drainage Manual.
- Exit loss- 1.00

CAD Drawing (See CAD file in Appendix B for detailed drawing)



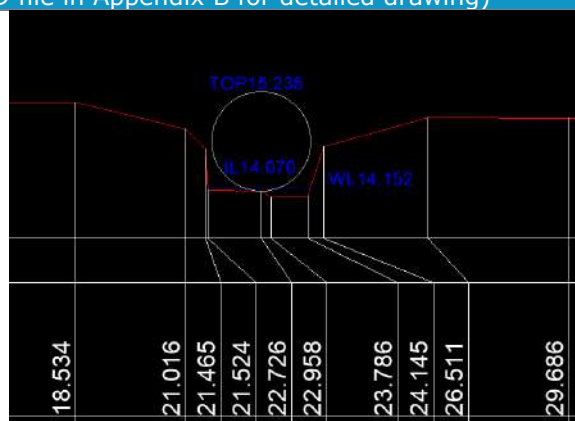
Photograph



Node	CRONT_065 and CRONT_065d	Type	Culvert
Source of Data	Survey Data Provided by KRS Environmental	Modelled	Yes- C type
NGR	346835, 389032		

- CRONT_065 is a circular culvert, a cross section was only provided at the upstream face of the culvert hence the downstream invert and channel section have been interpolated based upon the downstream cross section (CRONT_066). The culvert has been assigned a length of approximately 6m, digitised using google satellite imagery.
- CRONT_065d is a dummy section of which the geometry has been informed by interpolation of cross sections CRONT_065 and CRONT_066.
- The culvert has an US invert level of 14.07m AOD and a downstream invert of 14.04m AOD. The culvert has a diameter of 2.235m.
- The first part of the culvert has a diameter of 2.235m and the second part a diameter of 1.282m.
- Manning's n: 0.013
- W conf- 1.00, Entry Loss- 0.50, Exit loss- 1.00

CAD Drawing (See CAD file in Appendix B for detailed drawing)



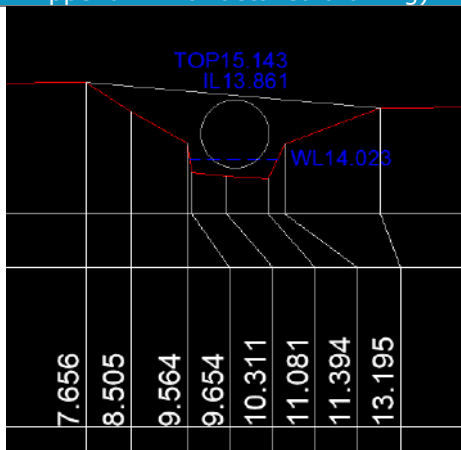
Photograph



Node	CRONT_066	Type	Culvert
Source of Data	Survey Data Provided by KRS Environmental	Modelled	Yes- C type
NGR	346814, 389003		

- CRONT_066 is a circular culvert which has been modelled as a C type channel. A cross single cross section of the upstream invert was provided, hence the downstream invert was interpolated between CRONT_066 and CRONT_067 assuming a culvert length of 5m.
- The culvert has an US invert level of 13.861m AOD and a downstream invert of 13.842m
- The culvert has a diameter of 1.282m.
- Manning's n: 0.013
- W conf- 1.00, Entry Loss- 0.50, Exit loss- 1.00

CAD Drawing (See CAD file in Appendix B for detailed drawing)



Photograph



4.2 2D Domain

The 2D domain was modelled using TUFLOW's latest 2020 release (2020-01-AB), which was run on a Graphic Processing Unit (GPU) using the Heavily parallelised Compute (HPC) solver. The new release brings the addition of the QuadTree mesh, which allows for recursive division of TuFLOW cells into smaller squares where specified, meaning that the cells all share a common orientation, thus routing water through the mesh identically. The areas where refinement was specified are detailed in Section 4.2.3. Further details on the 2D model build are presented in this section.

4.2.1 Extent

The extent of the 2D domain is displayed in Figure 4. The active area has been digitised around the maximum flood extent for the 1000-year event and the site boundary to optimise model run time and ensure no glass walling occurs.

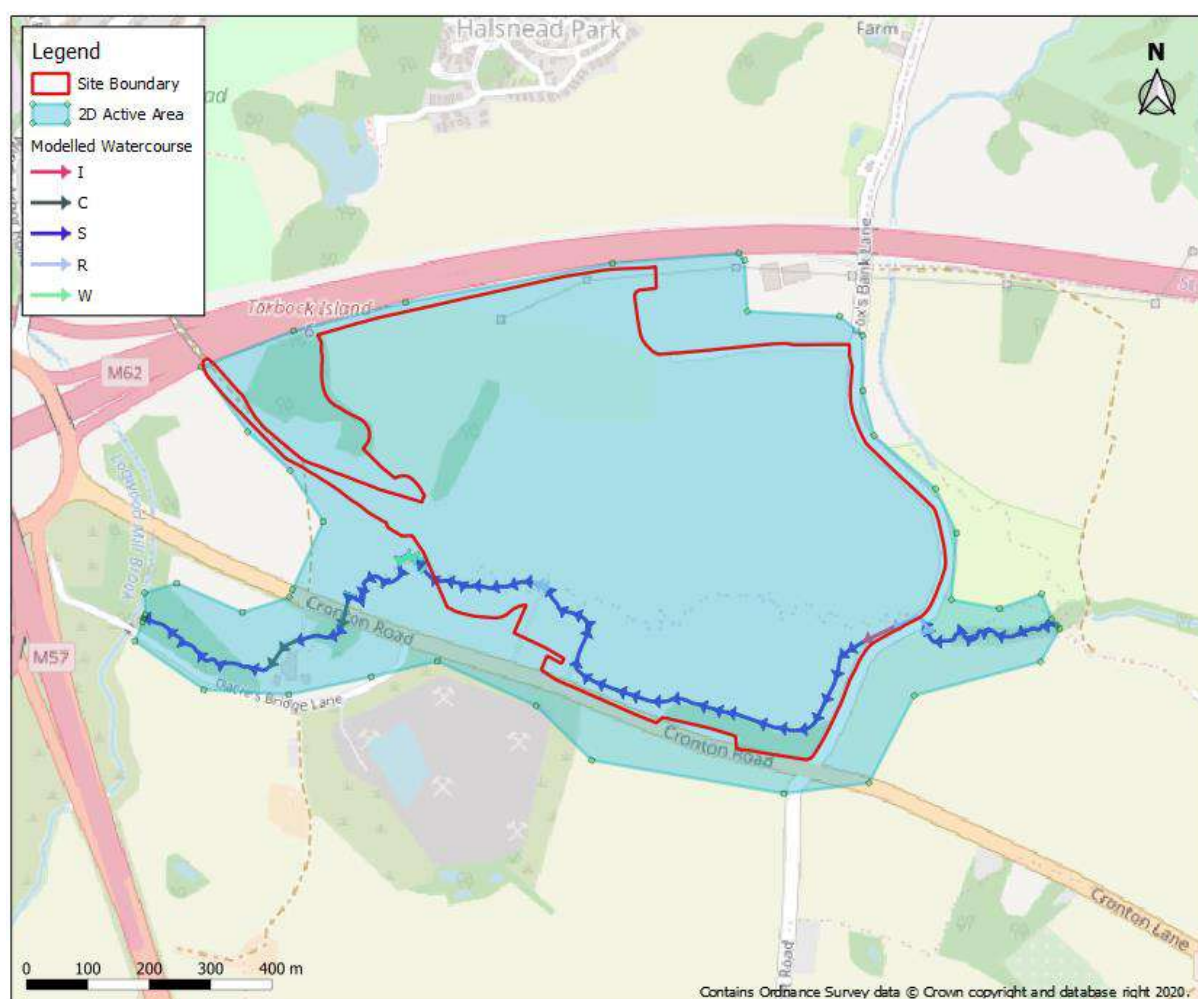


Figure 4: 2D model domain

4.2.2 Grid Size and Orientation

The model grid size has been set to 4m and the orientation of the grid is defined by the location line, which is digitised so that the orientation of the grid is in the predominant direction of flow of the river channel towards the west.

4.2.3 Mesh Refinement

Using the new QuadTree mesh function, the grid size has been refined at the entrance to the culvert at CRONT_061 to improve model stability. The grid size was refined by applying a user specified GIS polygon containing a GIS nesting layer, a nesting layer of 3 was selected, resulting in a cell size of 1m being applied in this area. The mesh has also been refined to 2m in areas where spills are present in the 2D domain to ensure appropriate representation. This cell size achieved the balance between efficient model run times and the appropriate resolution for predicting flow behaviour within the vicinity of the structure.

4.2.4 LiDAR data

LiDAR data at a resolution of 1m has been used to inform the topography of the floodplain. The LiDAR data was flown in 2006 and 2009.

4.2.5 DTM Modifications

The DTM was modified at the entrance to the culvert located at CRONT_061 to accurately represent the head wall around the structure. Z points containing the elevation of the wall, as surveyed in the data provided by KRS environmental, were placed along the entrance to the culvert and read into the model snapped to a Z shape region to tie in the elevations to the LIDAR level. Figure 5 shows the representation of the wall within the model.

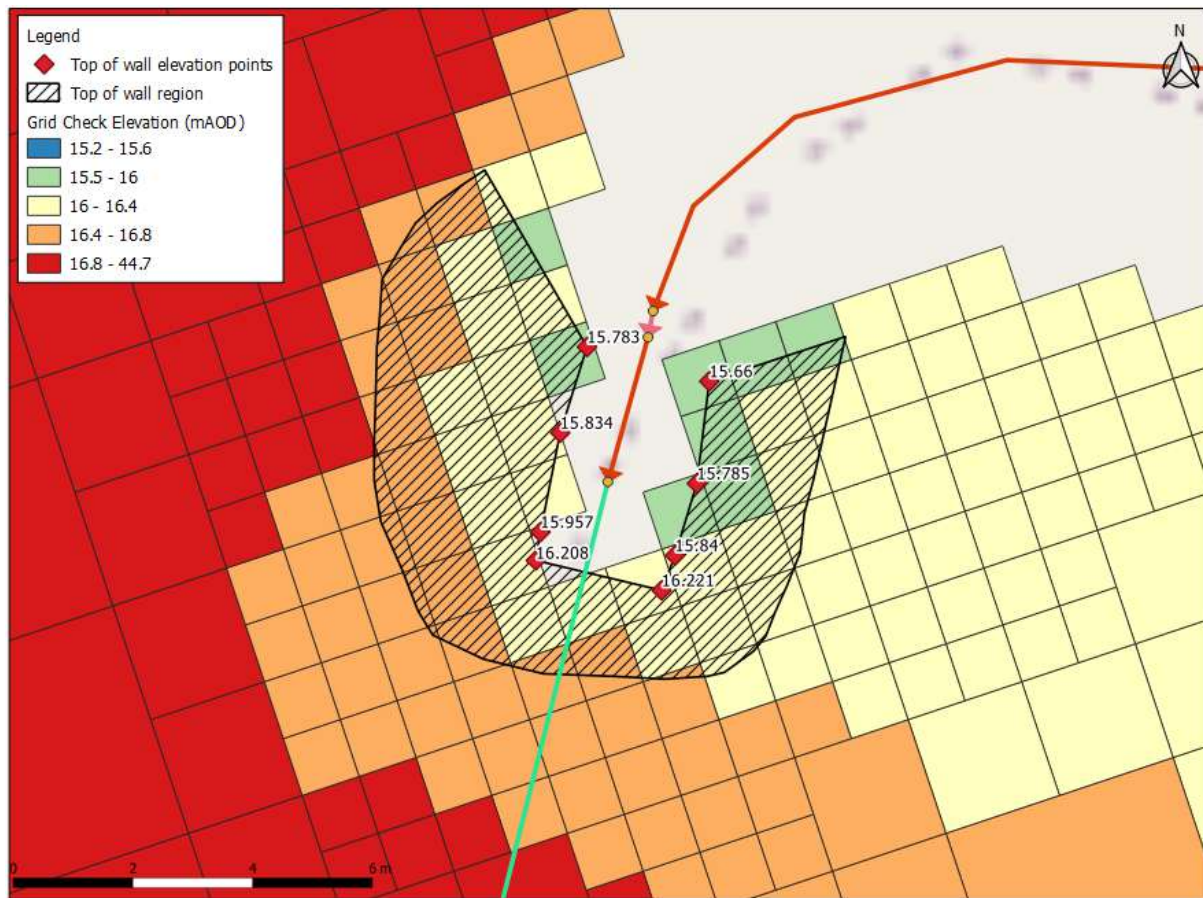


Figure 5: DTM modification

4.2.6 Boundary Conditions

A downstream boundary has been applied to the downstream extent of the 2D domain to prevent 'glass walling' and to allow water to flow out of the model domain. The boundary type used was a "HT" boundary. The boundary has been assigned an elevation of 15.41m AOD to represent the modelled flood level during the 0.1% AEP flood event within the Longwood Mill Brook, this data was provided by the Environment Agency and is Available in Appendix A. By assigning the 0.1% AEP level to the downstream boundary we provide a conservative estimate of flood risk. The location of the boundary is shown in Figure 6.

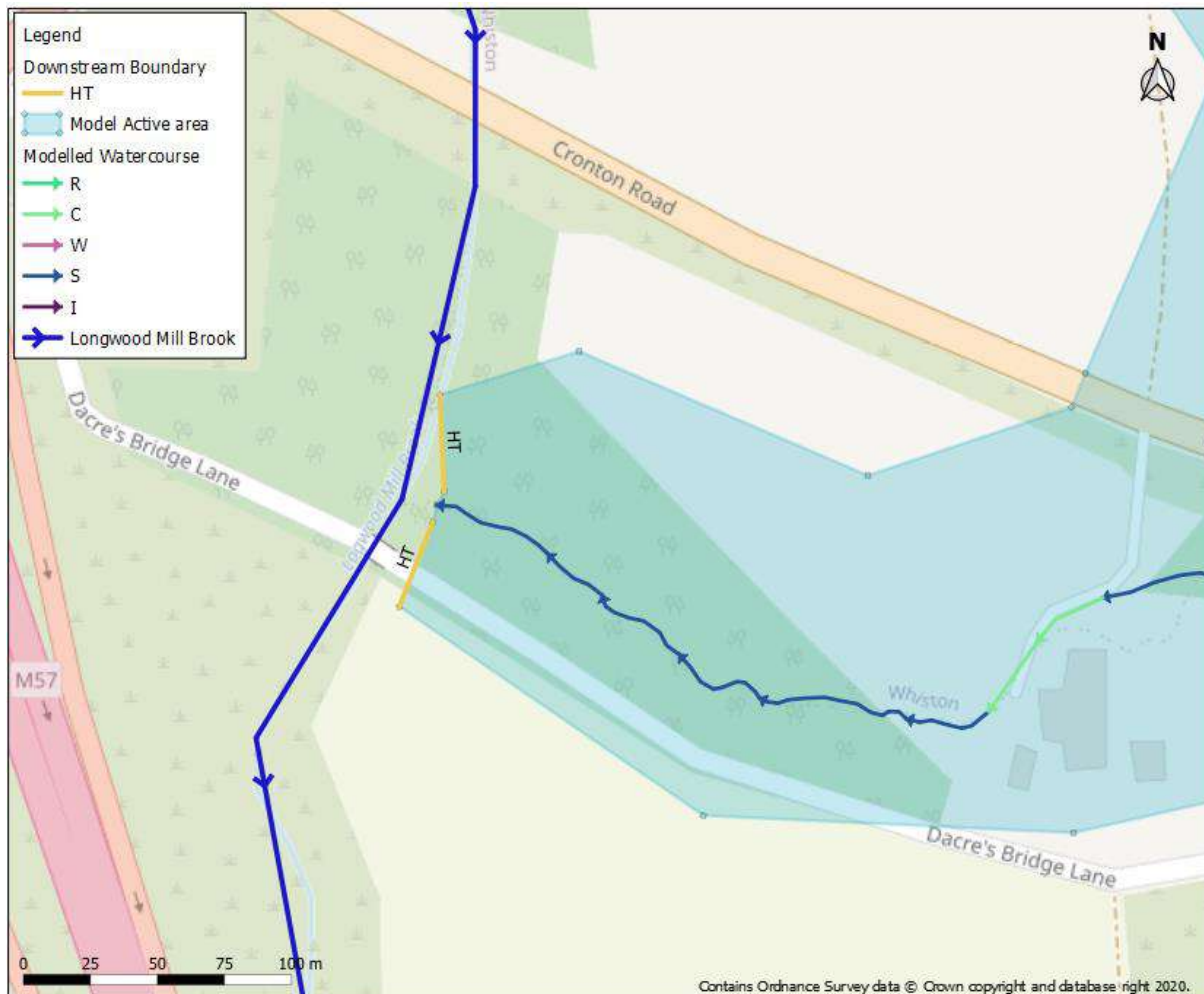


Figure 6: Downstream boundary positioning

Following initial model runs it was identified that glass walling occurred during the 0.1% AEP event along a portion of the south east of the model active area. Following a review of the surrounding topography it was determined that this water would naturally flow in a southerly direction, away from the site. As such a 2D HQ boundary was applied along this section of the active area. The slope of the boundary was determined by the change in lidar elevation perpendicular to the digitized boundary line.

4.2.7 2D Initial Water Levels

An initial water level of 15.41m AOD has been applied to the downstream extent of the model to reflect the influence of the water levels within the Longwood Mill Brook on the Fox's Bank Brook. The initial water levels have been set using a 2d_iwl shapefile.

4.2.8 Surface Roughness

The flood plain roughness has been defined using the Manning's n roughness coefficient. The land use has been identified using a mixture of OS and satellite mapping to define roads, railways, buildings and grass land within the model domain.

2D material files have been produced with an associated code referenced within a TUFLOW materials file where they are assigned an appropriate roughness coefficient. These are detailed in Table 4 below.

Table 4: 2D domain surface roughness values

Land Use	Manning's Coefficient
Fields/Natural land	0.035
Water Bodies	0.025
Buildings	0.500
Railway	0.040
Roads, Tracks and Paths	0.020
Woodlands	0.100
Stability	0.500

5 Design Runs

5.1 Summary of Design Runs

The hydraulic model has been run for the following events:

- 1.0% AEP event
- 1.0% AEP event + higher central climate change estimate (35%)
- 1.0% AEP event + upper climate change estimate (70%)
- 0.1% AEP event

The climate change allowances have been applied in line with the EA⁸ guidance for climate change estimation for the North West river basin district. The hydraulic model will be run for each of the above events to obtain baseline results.

5.2 Baseline Scenario Modelled Results

The results of the baseline scenario for the 1% AEP +35% climate change and the 0.1% AEP events are presented below in Figure 7. Appendix D provides the outputs of all other modelled events.

The modelled results indicate that the site is not at high risk of fluvial flooding with approximately 1.4% of the site at risk during the 1% AEP event including the higher central climate change allowance. Flooding within the site is mostly confined along the south of the site boundary, adjacent to the south bank of the Fox's Bank Brook. Maximum flood depths within the site reach 1.9m in a wooded area in the far east of the site boundary where there is a culvert under Fox's Bank road. Across the site flood depths average 0.229m. The majority of the site is not at risk of flooding.

During the 0.1% AEP event, the flood extent within the site is shown to increase to cover 2.3% of the site. The maximum flood depth within the site boundary increases to 2.211m, with average depths also increasing slightly to 0.249m. As with the 1% AEP+CC event the largest flood depth is seen along the western boundary of the site, and flood risk is confined to the south of the site and the south of the fox's bank brook.

⁸ Environment Agency, Flood risk assessments: Climate change allowances. Available via: <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

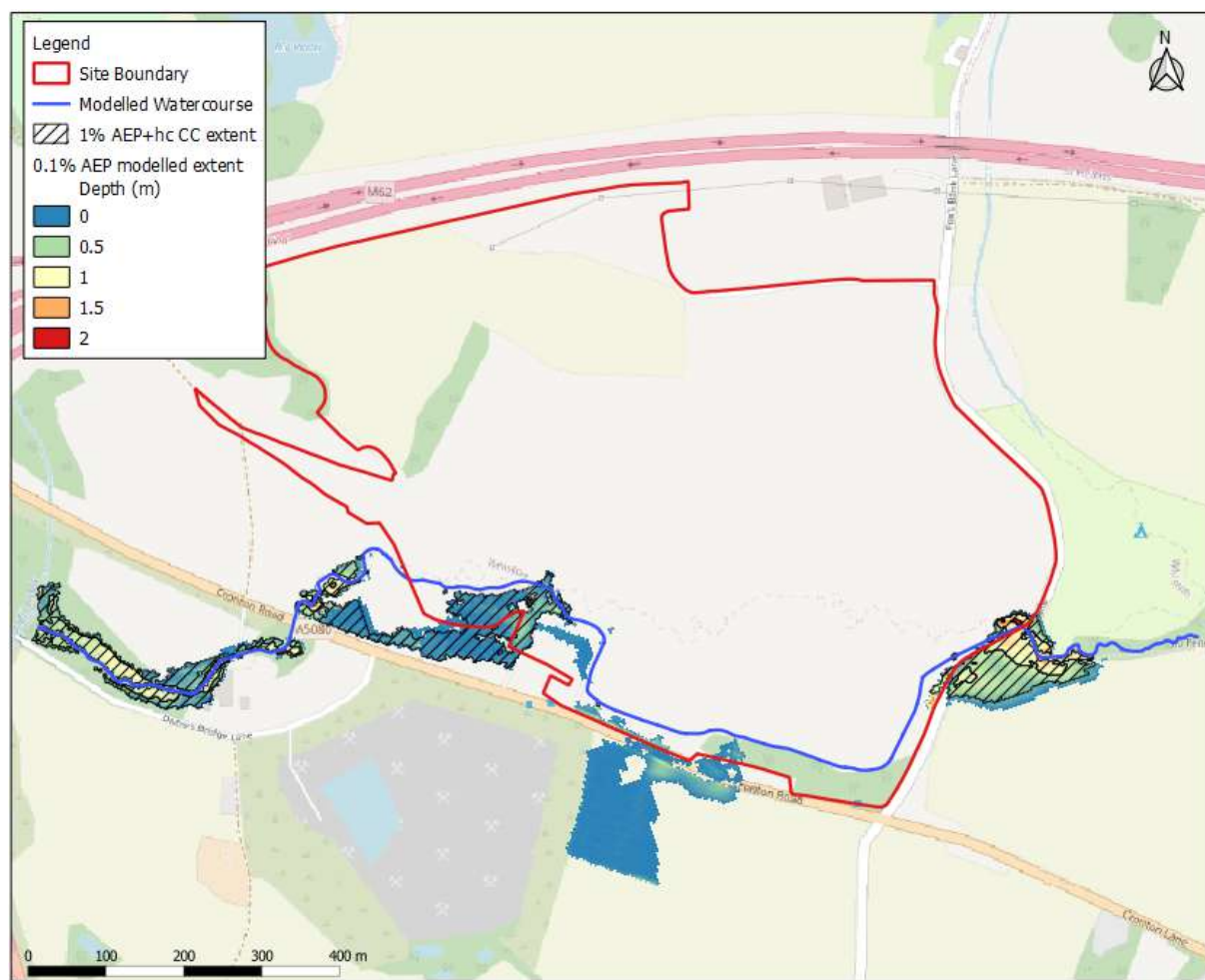


Figure 7: BSC 0.1% AEP and 1% AEP+HC CC modelled results

6 Risk of Breaches and Blockages

6.1 Environment Agency Blockage Scenario Requirements

Correspondence with the EA confirmed the requirement for running a blockage event on the culvert beneath Cronton Road at NGR: 346939, 389093. It is understood that there is a debris screen on the inlet to the culvert which is maintained by the EA however the screen is susceptible to blockage during flood events. The blockage scenario has been run for the baseline scenario assuming 100% blockage of the indicated culvert (to ensure model stability 99% blockage is modelled) for the 0.1% AEP fluvial event. The change in modelled flood depth for the blockage scenario vs the baseline scenario are presented below in Figure 8.

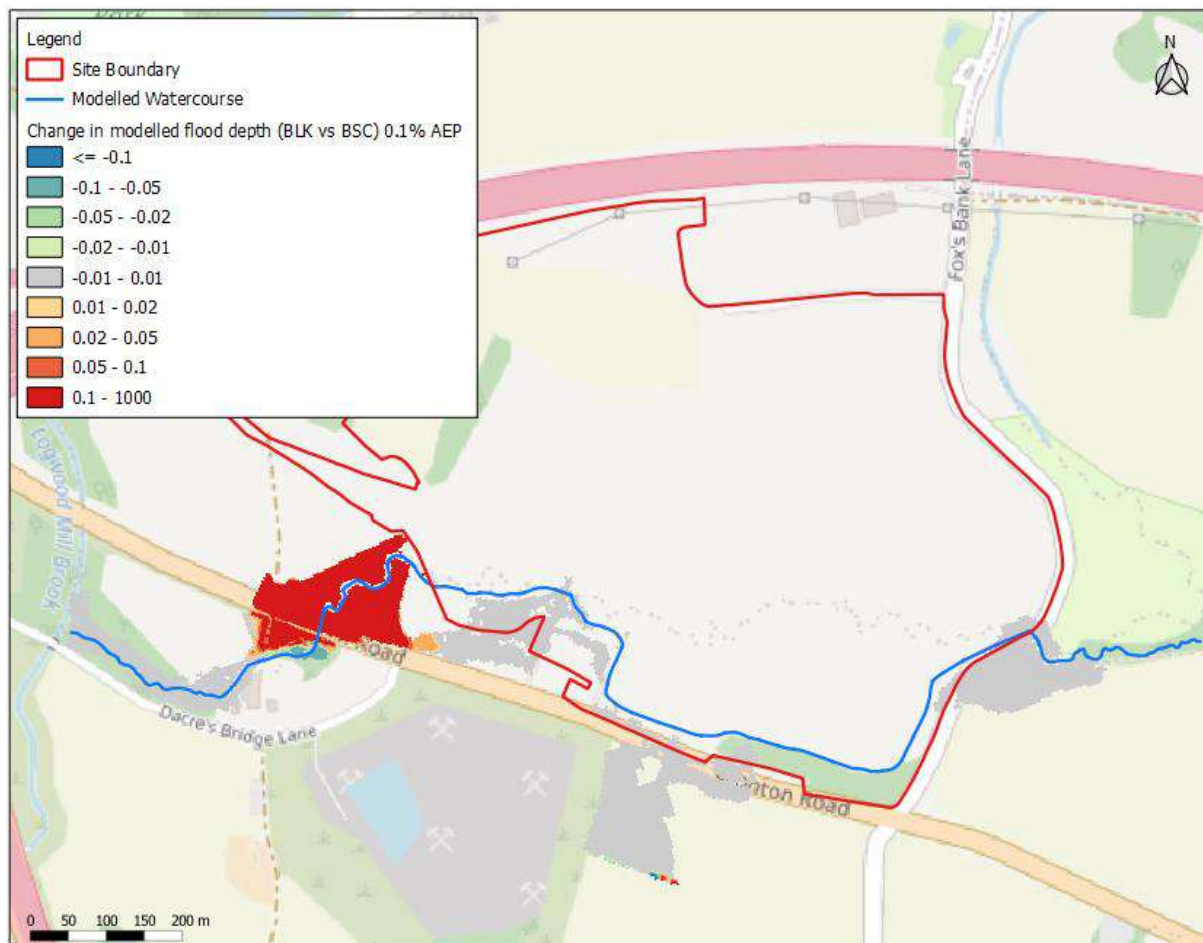


Figure 8: 0.1% AEP blockage scenario modelled change in modelled flood depth flood depths

The modelled results indicate that flood risk within the site boundary does not increase in response to the blockage of the culvert under Cronton Road. The modelled flood depths are shown to increase to the immediate north of the blockage however the flood waters are restricted from entering the site boundary by the surrounding topography.

7 Sensitivity Analysis

Sensitivity analysis has been carried out on the baseline 0.1% AEP fluvial event on the following parameters:

- Manning's n: Roughness coefficients for channels, floodplains and structures have been increased and decreased by +/- 20% respectively.
- Downstream boundary water level: Increased by the difference between the 1% AEP and 0.1% AEP maximum modelled level within the Longwood Mill Brook.

The sensitivity of the model to changes in flow is to be assessed by comparing modelled flood levels during the 1% AEP event and 1% AEP event plus 35% climate change (higher central) event.

The results of the sensitivity analysis have been assessed at three points within the model domain, the sensitivity sample point locations are shown in Figure 9.

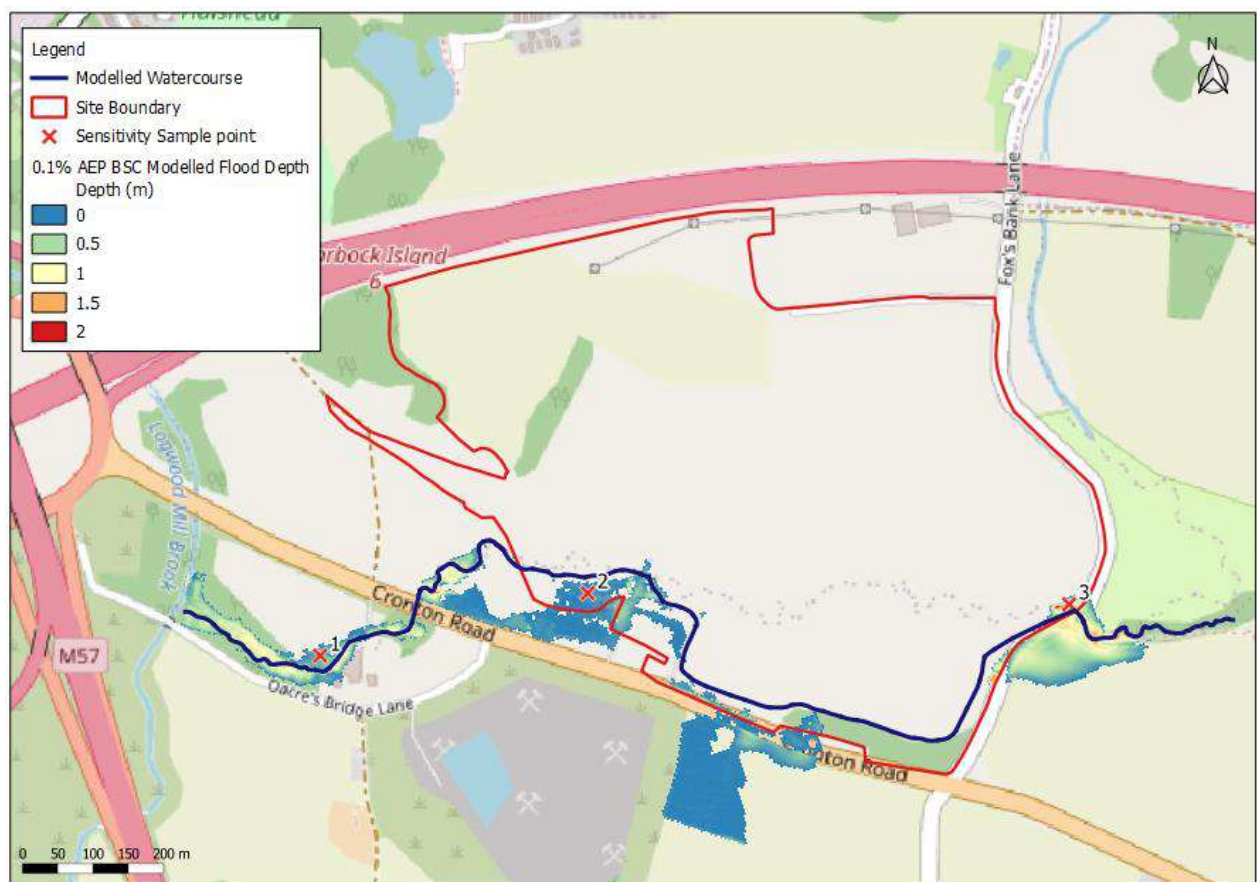


Figure 9: Sensitivity sample point locations

The following sections compare the results of the respective sensitivity tests in relation to the baseline flood levels.

7.1 Manning's N

The results of the sensitivity analysis are displayed in Table 5 below.

Table 5- Manning's N sensitivity analysis

Sensitivity Point	Baseline Water level (mAOD)	N+20% (mAOD)	Difference (m)	N-20% (mAOD)	Difference (m)
1	15.517	15.522	0.005	15.526	0.009
2	21.991	21.995	0.004	21.981	-0.010
3	28.123	28.144	0.021	28.089	-0.034

As indicated above, the modelled water levels in the site are not overly sensitive to changes in roughness and follow expected patterns with levels increasing with higher roughness, and falling with lower roughness.

There is a single point where modelled flood levels increase with lower mannings at Point 1. This is due to reduced flooding upstream in response to lower friction leading to more out of bank flow at the downstream end of the model. The largest change in modelled flood level is +21mm at point 3. A larger extent of flooding to the south of the site boundary is seen during the increased mannings sensitivity run.

7.2 Downstream Boundary Water Level

To assess the sensitivity of the model to changes in the downstream boundary, the HT boundary was altered to increase water levels by the difference between the maximum modelled flood level in the Longwood mill brook during the 1% AEP event and the 0.1% AEP event. As such the downstream boundary was increased by 380mm to 15.79m AOD. It is thought that applying the difference between the 1.0% and 0.1% events on top of the 0.1% event would result in a conservative maximum water level. The slope of the downstream boundary to the south of the development site was increased by 20%.

The results of the sensitivity analysis are displayed in Table 6 below.

Table 6- Downstream Boundary sensitivity analysis

Sensitivity Point	Baseline Water level (mAOD)	Dsbdy SEN(+) (mAOD)	Difference (m)
1	15.517	15.890	0.373
2	21.991	21.990	-0.001
3	28.123	28.123	-

The above indicates that the model is only minimally sensitive to changes in the downstream boundary, with the largest increase in modelled flood level seen at the most downstream point (1) with an increase of 373mm. Given the proximity of Point 1 to the downstream boundary the increase in modelled flood level is expected, with no change observed at the upstream of the model (Point 3).

7.3 Flow

The results of the sensitivity analysis are displayed in Table 7 below.

Table 7- Flow sensitivity analysis

Sensitivity Point	1% AEP Water Level (mAOD)	1% AEP +35% CC Water Level(mAOD)	Difference (m)
1	15.512	15.512	-
2	21.888	21.900	0.012
3	27.545	27.841	0.296

As expected the modelled waterlevels at the sensitivity sample points are shown to be sensitive to changes in flow, resulting in an increase in modelled flood level when flow is increased. The most prominent changes are seen at the upstream of the model where flood levels are shown to increase by 296mm. This value lies within the nominal 300mm freeboard allowance suggested for developments in close proximity to flood risk.

The results of the sensitivity testing indicate that the model is only minimally sensitive to changes in mannings. The model is sensitive to changes in downstream boundary and flow however the model behaves as expected given the changes and the increases in flooding lie within the standard 300mm freeboard allowance.

8 Model Stability and Limitations

8.1 2D Model Stability and Limitations

With the HPC solver, one of the main indicators of model stability is the time step selected by TuFLOW. This has been reviewed and plotted in Figure 10.

Ideally, the time step should not fall below one tenth of the timestep that would have been used with the classic solver. For this model, a timestep of between 0.5 and 0.2 would have been selected for the smallest grid resolution of 1m, hence the HPC timestep should not fall below 0.05 and 0.02 seconds. The plot of the evolution of the 2d timestep (dtStar) indicates that the timestep does not drop below 0.1 for the duration of the model run.

In addition to the 2d timestep, there are three control numbers which must be satisfied:

- A Nu value of 1.0 or greater may indicate that the velocity is unusually high, or the cell size is too small for the modelled velocity.
- A Nc value of 1.0 or higher can be caused by large depths in relation to the cell size.
- A Nd value of 0.3 or higher, might suggest that there is poor boundary setup, or insufficient SX cells linked to a 1D structure or the cell size is too small.

Whilst the Nd value exceeds a value of 0.3 for a small portion of the model run, all other model stability parameters lie within the acceptable values for the duration of the model run.

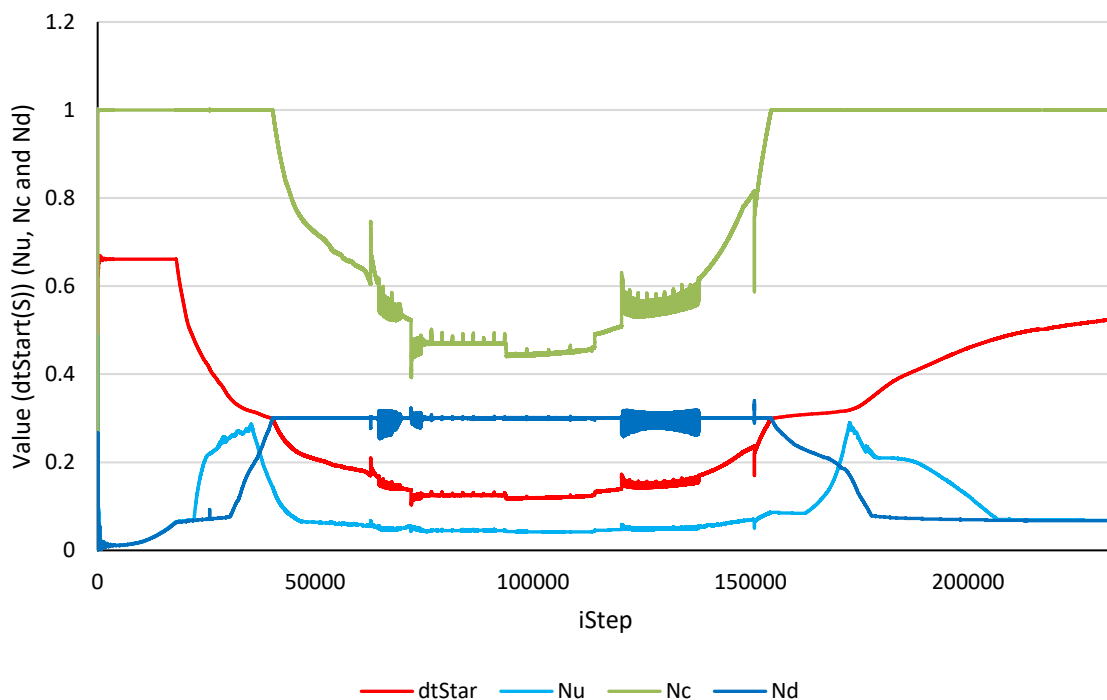


Figure 10: Model Stability indicators

8.2 Checks and Warning Messages

8.2.1 2D Checks and Warnings

A number of *Check* and *Warning* messages are present in the TUFLOW log file upon completion of the model runs, which for the 0.1% AEP flood event are summarised in Table 8. These have been reviewed and they are all considered to be acceptable.

Table 8: TUFLOW Check and Warning messages

ID	Count	Comment
Check 1152	6	Centre cross-sections for weirs and culverts used, ignoring end cross-sections
Check 1284	1	Connecting a 1D H boundary to a 2D HX link
Warning 2807	1	Trying to apply more than 1 level boundary to cell

9 Conclusion and Recommendations

This report has detailed the methodology used to produce a hydraulic model of the Fox's Bank Brook which runs through a proposed development site at Cronton Quarry. The hydraulic modelling was required to confirm baseline flood risk to the development site. The methodology for the hydraulic modelling was confirmed with the EA prior to model completion, this also confirmed the requirement for the modelling of a blockage scenario on the culvert flowing under Cronton Road.

- The model results indicate that the site is at low risk of fluvial flooding with flooding confined to the far south of the development site, to the southern bank of the Fox's Bank Brook.
- Only 1.4% of the site is shown to flood during the 1% AEP+HC CC event with 2.3% flooding during the 0.1% AEP event.
- Sensitivity analysis completed on the baseline hydraulic model for manning's n values, downstream boundary and flows indicates that the model is responsive to changes within these parameters, with the changes in modelled flood level lying within the 300mm freeboard allowance. Therefore, the model is deemed suitable to inform flood risk within the site boundary.
- The hydraulic model has been run for the 1% AEP, 1% AEP plus higher central and upper climate change allowances and the 0.1% AEP event.
- Maximum flood depths within the site boundary are seen along the far eastern boundary of the site in a forested area.
- As requested by the EA a blockage scenario was completed on the culvert under Cronton Road. The results indicate that flood risk within the site does not significantly increase in response to the blockage of this culvert.
- A review of the model stability and checks and warning messages indicates that the model is stable and suitable to inform flood risk.

Appendix A EA Correspondence

Keelan

From: GMMC Info Requests <InfoRequests.GMMC@environment-agency.gov.uk> on behalf of GMMC Info Requests
Sent: 20 August 2020 11:23
To: Jessica Pearce
Subject: GMMC177875CC Response attached from the Environment Agency
Attachments: GMMC177875CC - DFM.PDF; GMMC177875CC - Table.pdf
Flag Status: Flagged

Dear Jessica,

Thank you for your enquiry which was received on 16/7/20.

We respond to requests under the Freedom of Information Act 2000 and Environmental Information Regulations 2004.

I enclose the data requested.

Defences - There are no flood defences in the vicinity of the site.

Historic - We have no records of flooding affecting the site. However, this does not mean flooding has not occurred in the past or that it will not flood in future. We recommend that you also contact United Utilities and Knowsley Council who may hold additional information (the former especially in relation to sewer flooding).

Please be aware you can check your risk of flooding on our external website <https://flood-warning-information.service.gov.uk/long-term-flood-risk/>

Here are some useful links below:

<https://www.gov.uk/guidance/flood-risk-assessment-local-planning-authorities>

<https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

Please refer to the [Open Government Licence](#) which explains the permitted use of this information.

Information not held by us

We do not hold any 2D floodplain levels for this site.

In this case, the information you have requested is not held by the Environment Agency, and we are therefore refusing your request on the grounds that there is no information we can provide.

Where a request is for environmental information, the Regulations allow us to refuse to disclose it if the exception at EIR Regulation 12(4)(a) applies. The regulation states that a public authority may refuse to disclose environmental information to the extent that it does not hold that information when an applicant's request is received.

It is not possible for us to conduct a public interest balancing test because the reason for non-disclosure is that the information is not held.

Rights of appeal

If you are not satisfied with our response to your request for information, you can contact us within 2 calendar months to ask for our decision to be reviewed. If you are still not satisfied following this, you can make an appeal to the Information Commissioner, who is the statutory regulator for Freedom of Information. The address is: Office of the Information Commissioner, Wycliffe House, Water Lane, Wilmslow, Cheshire SK9 5AF.

Tel: 01625 545700.

Fax: 01625 524 510.

E-mail: mail@ico.gsi.gov.uk.

Website: <http://www.informationcommissioner.gov.uk>

Kind regards,

Anne Ball

Customer and Engagement Officer

Greater Manchester, Merseyside and Cheshire

Email: InfoRequests.gmmc@environment-agency.gov.uk

	For the latest guidance: - INTRANET.EA.GOV - NHS.UK/coronavirus - GOV.UK/coronavirus	 Environment Agency
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From: Jessica Pearce [<mailto:jessica.pearce@hydrosolutions.co.uk>]

Sent: 16 July 2020 10:55

To: GMMC Info Requests <InfoRequests.GMMC@environment-agency.gov.uk>

Subject: Product 4 data request. NGR: SJ 46607 89109

Hi Team,

Please could I request Product 4 data if available for the Logwood Mill Brook at NGR: SJ 46607 89109. As per the recommendation from the flood risk team below:

'We would advise picking up all ditches and run-off from with the site boundary as part of the hydrology investigation. No specific modelling of arterial drainage ditches away from Fox's Bank Brook would be required. The downstream boundary condition should ideally be the corresponding modelled flood level in Logwood Mill Brook. Flood level data may be available as a Product 4 data request from our GMMC Info Requests Team <InfoRequests.GMMC@environment-agency.gov.uk>. If not available, then bank full +0.5m is recommended to account for additional floodplain height.'

Kind regards,

Jess

Jess Pearce

Consultant

Wallingford HydroSolutions Ltd

Castle Court, 6 Cathedral Road, Cardiff, CF11 9LJ

Email : jessica.pearce@hydrosolutions.co.uk



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www.hydrosolutions.co.uk

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Keelan

From: Davies, Andy <Andy.Davies1@environment-agency.gov.uk> on behalf of Davies, Andy
Sent: 14 May 2020 10:56
To: jessica.pearce@hydrosolutions.co.uk
Cc: Todd, Graham
Subject: RE: Knowsely, North West England Hydraulic Modelling Scope
Attachments: Proposed model extent.png; RE: GMMC168263AB Cronton Quarry (102 KB)

Hi Jessica,

Thank you for your further enquiry following on from initial pre-app discussions held with our flood risk team. I hope you and your wider team are well during this difficult time.

For detailed site-specific advice, questions and documentation reviews, we would normally need to utilise our charge agreement service (which will also be necessary for any subsequent technical discussions on this matter). As part of our charged for service we will provide a dedicated project manager to act as a single point of contact to help resolve any problems. We currently charge £100 per hour, plus VAT. We will provide you with an estimated cost for any further discussions or review of documents. The terms and conditions of our charged for service are available [here](#).

For the purpose of this enquiry we have the following response:

“We propose to model this watercourse from approximately 500m upstream of the site at NGR: SJ 48125 89124, to account for any potential influences of the culvert under Fox’s Bank Lane, to NGR: SJ 46607 89109, at confluence of the Fox’s Brank Brook with the Chapel Brook”

The proposed modelling extent (500m upstream) seems sensible however, it should be confirmed that the that the inflows used in the hydrology account for those generated from both Whiston Brook and Fox’s Bank Brook which arrive at their confluence, SJ4810489090. The proposed downstream extent of modelling, the confluence with Chapel Brook (we term the Main river, Logwood Mill Brook) appears to be appropriate.

“I am aware of a number of drainage ditches surrounding the site however these appear to be represented within the LiDAR and are included within the Fox’s bank Brook catchment. We are proposing to estimate peak flow hydrology for the catchment to inform model inflows and put a bank full boundary at the downstream end of the model”

We would advise picking up all ditches and run-off from with the site boundary as part of the hydrology investigation. No specific modelling of arterial drainage ditches away from Fox’s Bank Brook would be required. The downstream boundary condition should ideally be the corresponding modelled flood level in Logwood Mill Brook. Flood level data may be available as a Product 4 data request from our GMMC Info Requests Team <InfoRequests.GMMC@environment-agency.gov.uk>. If not available, then bank full +0.5m is recommended to account for additional floodplain height.

Further to the above, it should be noted that there is a culvert beneath Cronton Road (A5080) through which Fox’s Bank Brook passes. There is a debris screen on the upstream side of the culvert which the EA maintains. The noted debris screen is not monitored via telemetry and therefore could be susceptible to blockage during a flood event without prior warning being available of debris build up. Due to this limitation, some sensitivity testing of culvert blockage should be undertaken as part of the modelling exercise utilising best practice guidance. Consideration should be given to a worst case scenario i.e. 100% blockage and the likely associated consequences (overtopping of the road and/ or impact upon the development site).

Should you have any queries regarding this response, then please do not hesitate to get in contact.

Kind regards,

Andy

Andy Davies

Planning Advisor, Sustainable Places Team | Greater Manchester, Merseyside, Cheshire
Environment Agency | Richard Fairclough House, Knutsford Road, Latchford, Warrington WA4 1HT
Email: SPPlanning.RFH@environment-agency.gov.uk



I am currently working remotely and have limited access to emails due to capacity issues on our remote server.

I will respond to your email at the earliest opportunity. However, if your query is urgent please contact me on my mobile

From: Jessica Pearce [<mailto:jessica.pearce@hydrosolutions.co.uk>]

Sent: 29 April 2020 17:59

To: SPPlanning.RFH <SPPlanning.RFH@environment-agency.gov.uk>

Subject: FW: Knowsely, North West England Hydraulic Modelling Scope

Hi Team,

I hope you are well. In light of a conversation (attached) regarding flood risk at a proposed development site in Knowsely, NGR: SJ 47486 89037 we have been contracted to complete hydraulic modelling of the Fox's Bank Brook to the south of the proposed site.

I am writing to confirm the appropriateness of our proposed hydraulic modelling extent and discuss any requirements for blockage/ design scenarios. Having reviewed the site it appears that the main source of flood risk is from the Fox's Bank Brook to the immediate south. As such, we propose to model this watercourse from approximately 500m upstream of the site at NGR: SJ 48125 89124, to account for any potential influences of the culvert under Fox's Bank Lane, to NGR: SJ 46607 89109, at confluence of the Fox's Brank Brook with the Chapel Brook. I am aware of a number of drainage ditches surrounding the site however these appear to be represented within the LiDAR and are included within the Fox's bank Brook catchment. We are proposing to estimate peak flow hydrology for the catchment to inform model inflows and put a bank full boundary at the downstream end of the model.

We proposed to run the model for the 1%, 1%+CC and 0.1% AEP events. Do you have any blockage scenario requirements. Also could you please confirm if the suggested model extent is acceptable to confirm flood risk at the site or if additional modelling of the drainage ditches is required.

I have attached a schematic of our proposed extent. I hope to hear from you soon.

Kind regards,
Jess Pearce
Consultant

Wallingford HydroSolutions Ltd

Castle Court, 6 Cathedral Road, Cardiff, CF11 9LJ

Direct Tel : +44 2920647742

Email : jessica.pearce@hydrosolutions.co.uk



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Keelan

From: Todd, Graham <graham.todd@environment-agency.gov.uk>
Sent: 14 April 2020 10:47
To: Keelan
Cc: PSO_Warrington; GMMC Info Requests
Subject: RE: GMMC168263AB Cronton Quarry

Hello Keelan,

Further to your email enquiry below I would provide the following information.

Flood Zones 2&3 associated with Foxes Bank Brook through the old Cronton Colliery site do appear somewhat misaligned with the watercourse in certain places and probably stems from the first generation of national Flood Map modelling undertaken nearly 20-years ago. Because of the limited amount of local development pressures since that time and the fact that there aren't any existing properties (houses) located within the flood outlines, the justification to carry out an updated (and more accurate) modelling study hasn't existed.

Any future Flood Risk Assessment carried out in support of a planning application for development on the site should consider multiple data sources, including site-specific hydraulic modelling where the risk is considered necessary. The published surface water flood map quoted is again the product of a national modelling exercise and produced to provide an initial estimation of areas susceptible to surface water flood risk only.

Ideally surface water attenuation ponds should be located within Flood Zone 1 only, as attenuation ponds can't fulfil their primary purpose of storing excess run-off from new development sites if already full of fluvial flood flows from adjacent watercourses or rivers.

With regard to future pre-planning related enquiries regarding the site please contact the local EA Sustainable Places team in the first instance here:

SPPlanning.RFH@environment-agency.gov.uk

Kind regards. Graham.

Graham Todd

Flood & Coastal Risk Management
Greater Manchester, Merseyside & Cheshire Area
Environment Agency | Richard Fairclough House, Knutsford Road, Warrington, WA4 1HT

graham.todd@environment-agency.gov.uk

External: 020 302 50604

From: GMMC Info Requests
Sent: 09 April 2020 16:26
To: PSO_Warrington <PSOWarrington@environment-agency.gov.uk>
Subject: FW: GMMC168263AB Cronton Quarry

Dear Team,

Please can you have a look at the attached request. If possible, please can you provide the data by 20/4/20 so that we can keep within our service commitment of 10 working days.

Many thanks,

Anne

Anne Ball
Customer and Engagement Officer
Greater Manchester, Merseyside and Cheshire

Office address: Richard Fairclough House, Knutsford Road, Latchford, Warrington, WA4 1HT

Email address: **Inforequests.GMMC@environment-agency.gov.uk**

External: 020 302 51232

Internal: 51232

Mobile: 07769285094

From: Enquiries, Unit
Sent: 09 April 2020 11:00
To: 'Keelan@krsenvironmental.com' <Keelan@krsenvironmental.com>
Subject: GMMC168263AB Cronton Quarry

Hi,

I have passed your e-mail to the local customer team who will deal with your request.

The Freedom of Information Act and Environmental Information Regulations state that a public authority must respond to requests for information within 20 working days, but we aim to respond to all enquiries as quickly as we can.

You can find more information about our service commitment by clicking on the link below:

<https://www.gov.uk/government/publications/environment-agency-customer-service-commitment>

You can contact our customer team directly on the contact details below, or call the National Customer Contact Centre on 03708 506506 who will transfer you to the area team.

Please quote your enquiry reference **200409/JMK13** in any correspondence with us regarding this matter.

Customers and Engagement
Environment Agency
Greater Manchester, Merseyside and Cheshire Area
Richard Fairclough House
Knutsford Road
Latchford
Warrington
WA4 1HT

Kind regards,
James Morris-Knight
Customer Service Adviser
Contact Centre Services
Operations: Regulation, Monitoring and Customer



From: Keelan [<mailto:Keelan@krsenvironmental.com>]
Sent: 08 April 2020 10:57
To: Enquiries, Unit <enquiries@environment-agency.gov.uk>
Subject: 200409/JMK13 Cronton Quarry

Dear Sir/Madam,

We are looking at the flood risk posed to Cronton Quarry as shown on the attached.

The attached Environment Agency flood zones through the quarry do not follow any existing watercourse and are located on higher ground compared to the surrounding land, see attached. The Environment Agency's surface water flood map shows a more realistic representation of the flood risk posed from fluvial sources, see attached.

Can you provide comments on the accuracy of the flood zones? Would it be possible to construct attenuation ponds within the flood zones?

If you have any queries do not hesitate to contact me.

Regards,

Keelan Serjeant | Director
BSc, MSc, MCIWEM
KRS Environmental Ltd

Due to the current Covid-19 outbreak all KRS Environmental staff are home working. Please contact them directly on the mobile number provided or by email / MS Teams.

T: 01686 668957
T: 01484 437420
M: 07857 264 376
E: keelan@krsenvironmental.com
W: krsenvironmental.com

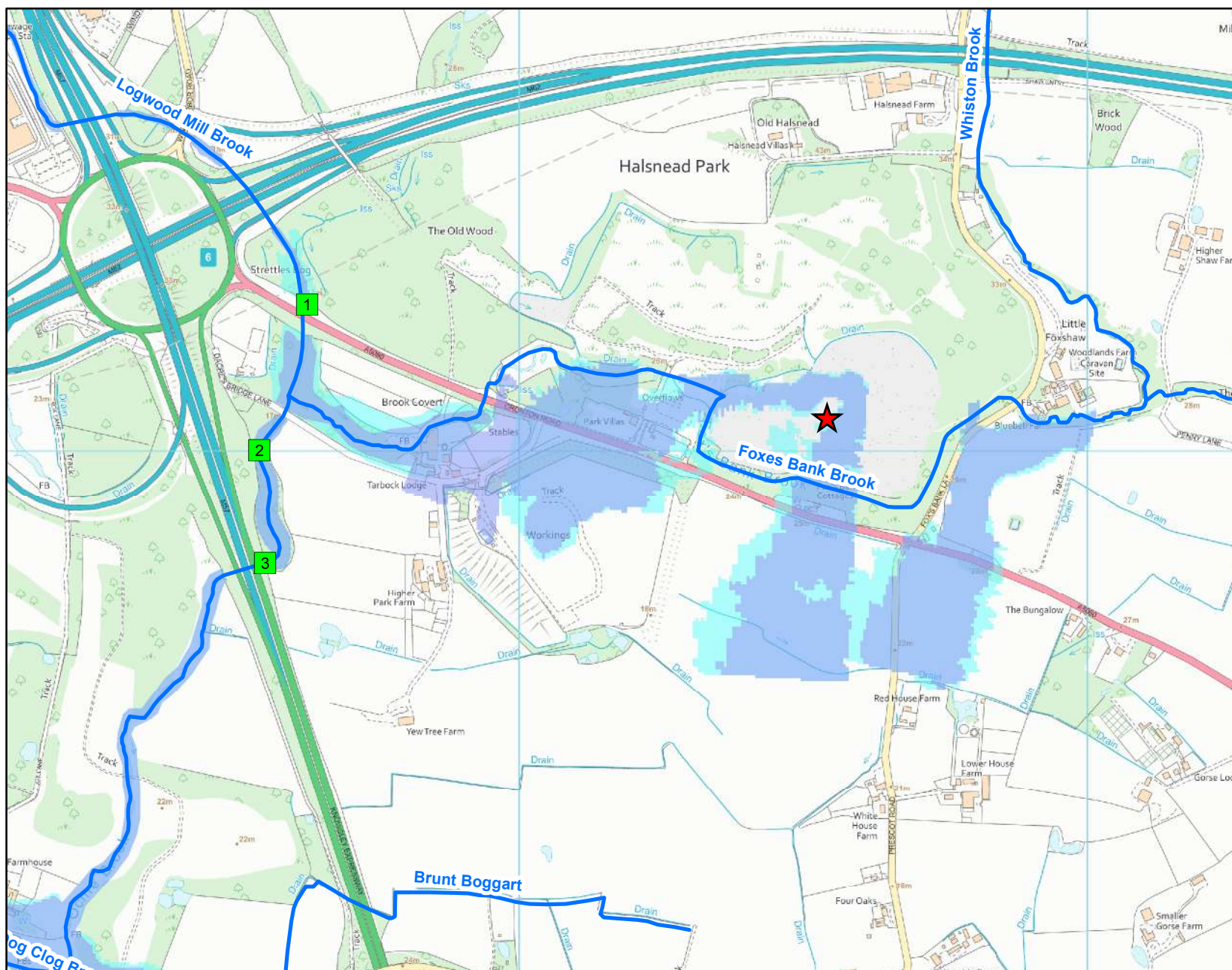
Please think about the environment, only print this email if you need to.

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Detailed Flood Map centred on Cronton Lane, Knowsley, L35 1QR. Created on 18/08/2020 [GMMC177875CC]



1:10,001



Legend

-  Site Location
-  Model Measurements
-  Main River
-  Flood Zone 3
-  Flood Zone 2

Map Reference	Model Node Reference	Easting	Northing	Data	Undefended						
					10 % AEP (1 in 10 year)	4 % AEP (1 in 25 year)	1.33 % AEP (1 in 75 year)	1 % AEP (1 in 100 year)	1 % AEP (1 in 100 year) + 20% increase in flow	0.5 % AEP (1 in 200 year)	0.1 % AEP (1 in 1000 year)
1	ea013_0168_Logwood_079	346634	389259	Modelled Water Level (m aodN)	15.42	15.59	15.89	15.99	16.41	16.35	17.38
				Modelled Flow (cumecs)	6.85	8.27	10.48	11.25	13.31	13.10	18.56
2	ea013_0168_Logwood_081	346542	389004	Modelled Water Level (m aodN)	14.65	14.79	14.96	15.03	15.15	15.14	15.41
				Modelled Flow (cumecs)	7.83	9.04	11.44	12.21	14.56	14.24	19.52
3	ea013_0168_Logwood_083	346554	388808	Modelled Water Level (m aodN)	14.45	14.60	14.74	14.80	14.89	14.88	15.12
				Modelled Flow (cumecs)	7.82	9.02	11.41	12.21	14.55	14.23	19.52

Model data taken from Longwood Mill Brook 2012 Study

AEP - Annual Exceedence Probability

m aodN - metres above ordnance datum Newlyn

cumecs - cubic metres per second

Notes: *Climate Change Scenario - We only hold climate change measurements based on the previous climate change guidance (20% increase in flow). The new climate change guidance is available at <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>. The location of the site and the type (vulnerability) of development determine the climate change allowances to consider in any flood risk assessment.

Appendix B Survey Data

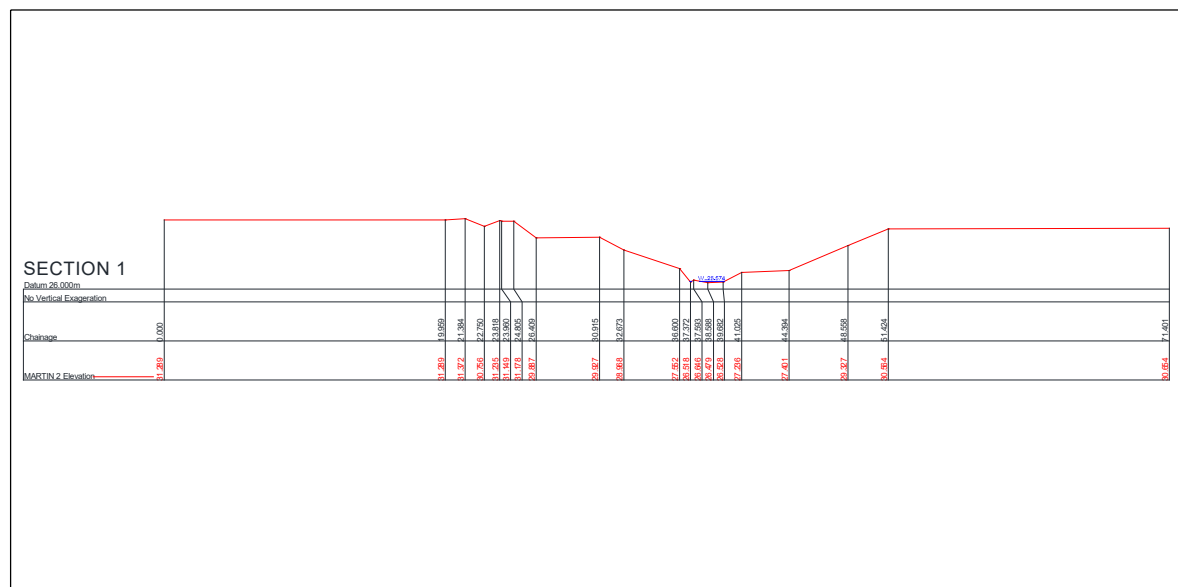
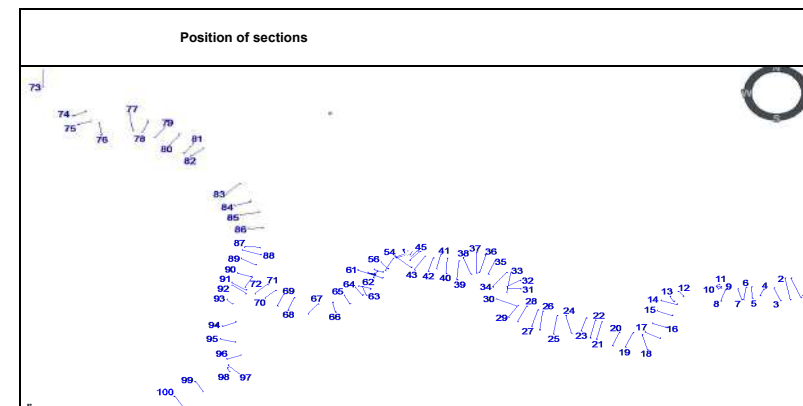
Section 1

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						348104.550	389036.300	31.289
19.959						348103.283	389056.219	31.289
21.384						348103.167	389057.639	31.372
22.750						348103.053	389059.000	30.756
23.818						348103.119	389059.931	31.235
23.960						348103.172	389060.062	31.149
24.805						348103.135	389060.776	31.178
26.409						348102.637	389062.301	29.887
30.915						348101.488	389066.658	29.927
32.673						348100.332	389067.982	28.968
36.600						348098.475	389071.442	27.552
37.372						348097.918	389071.895	26.518
37.593						348097.762	389071.738	26.646
38.588						348097.107	389072.471	26.479
39.682						348096.458	389073.352	26.528
41.025						348095.640	389074.417	27.236
44.394						348093.157	389076.694	27.401
48.558						348090.696	389080.053	29.327
51.424						348089.000	389082.364	30.564
71.401						348076.996	389098.332	30.654

Distance to Downstream cross-section X (m)	
	0.00

Water Level (mAOD)	26.574
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



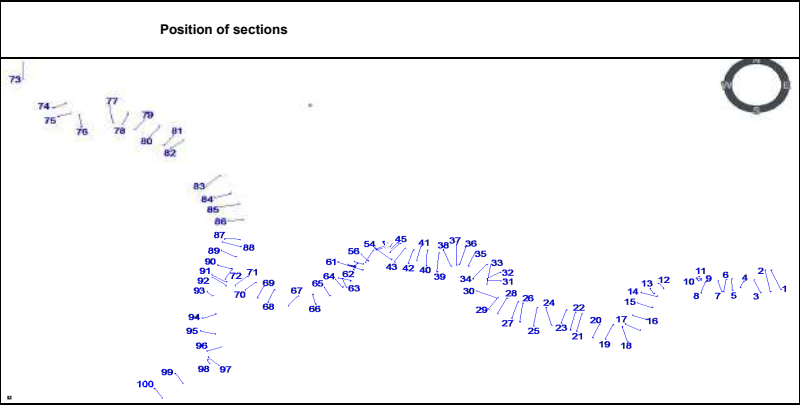
Section 2

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						348075.489	389028.813	30.249
19.977						348076.322	389048.773	30.237
23.139						348076.130	389051.929	30.335
24.567						348076.137	389053.357	29.381
25.528						348076.370	389054.289	29.325
26.348						348076.500	389055.099	29.611
29.573						348076.163	389058.306	29.591
31.509						348075.550	389060.142	28.674
33.460						348075.388	389062.087	28.553
36.192						348074.330	389064.605	26.983
40.478						348073.088	389068.708	27.047
40.809						348072.965	389069.015	26.419
41.360						348072.889	389069.561	26.350
43.046						348072.609	389071.223	26.376
43.743						348072.203	389071.790	27.216
49.769						348069.581	389077.216	30.430
53.222						348068.180	389080.371	30.891
73.113						348061.352	389099.054	30.927

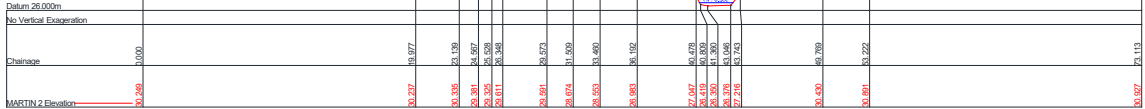
Distance to Downstream cross- section X (m)	
	26.14

Water Level (mAOD)	26.580
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



SECTION 2



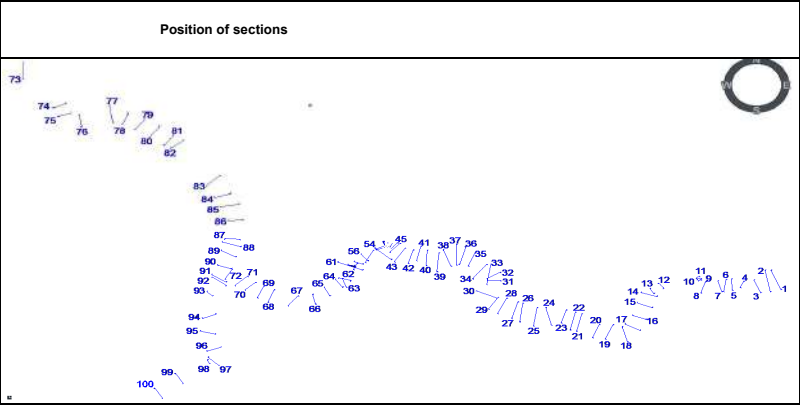
Section 3

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						348049.540	389025.959	29.071
20.707						348039.863	389044.266	29.071
21.270						348039.746	389044.816	28.889
21.988						348039.434	389045.463	28.939
23.738						348038.534	389046.964	29.312
26.749						348037.046	389049.582	29.188
28.344						348036.564	389051.102	28.516
30.735						348035.938	389053.410	28.078
32.741						348035.134	389055.248	26.411
33.523						348035.177	389056.028	26.207
33.907						348035.186	389056.412	26.182
35.235						348034.404	389057.486	26.193
35.432						348034.375	389057.681	26.734
38.200						348033.293	389060.228	26.898
43.946						348031.553	389065.704	30.659
45.923						348030.852	389067.553	30.652

Distance to Downstream cross- section X (m)	
	65.63

Water Level (mAOD)	26.659
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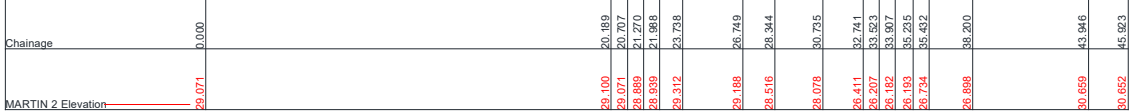
Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



SECTION 3

Datum 26.000m

No Vertical Exaggeration



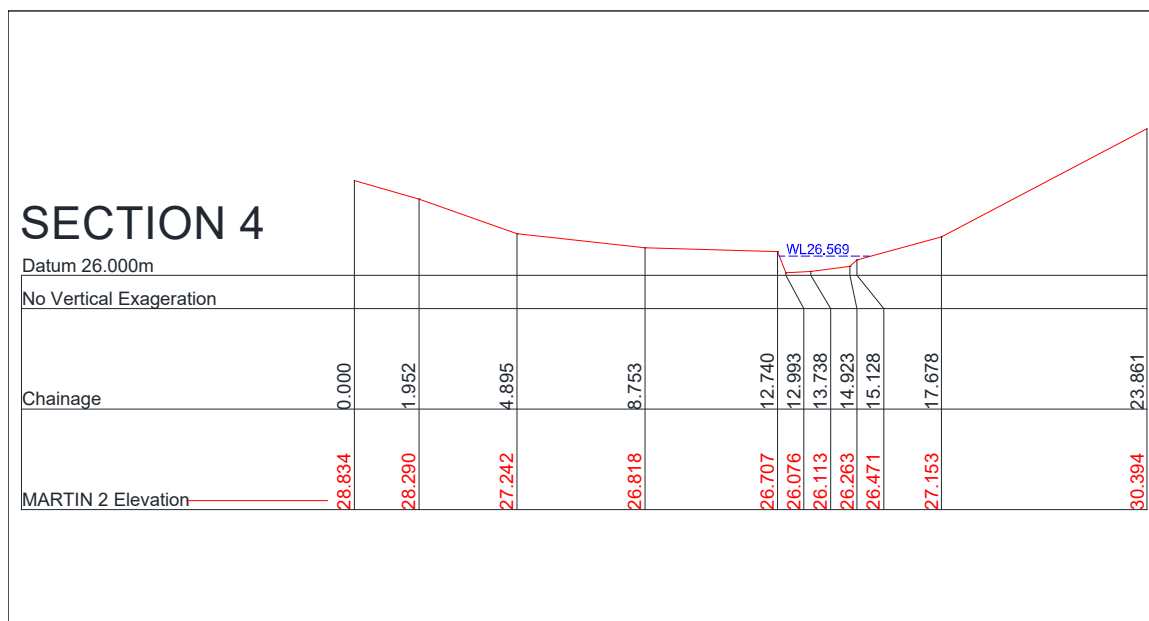
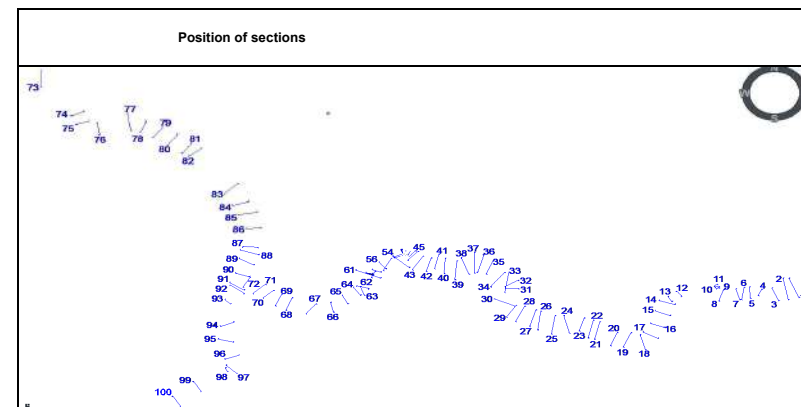
Section 4

[illegible]

Distance to Downstream cross-section X (m)	
	104.93

Water Level (mAOD)	26.569
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



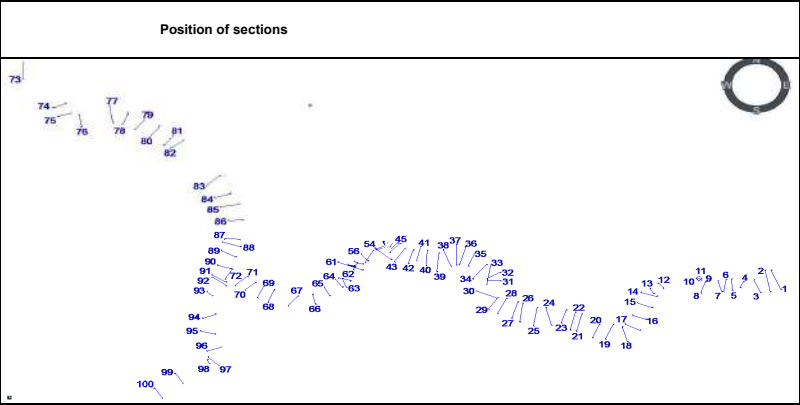
Section 5

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347973.102	389033.726	28.141
3.847						347972.603	389037.541	27.792
4.654						347972.611	389038.347	28.183
8.848						347972.308	389042.531	28.238
12.488						347972.013	389046.159	27.257
18.270						347972.093	389051.940	26.877
23.420						347972.711	389057.053	26.890
27.610						347972.629	389061.242	26.672
28.014						347972.711	389061.638	26.286
29.153						347973.100	389062.708	26.219
29.955						347973.150	389063.508	26.141
30.253						347972.867	389063.602	26.485
31.279						347972.750	389064.622	26.781
34.277						347972.137	389067.556	29.058
38.419						347971.290	389071.611	31.965

Distance to Downstream cross- section X (m)	
	132.30

Water Level (mAOD)	26.535
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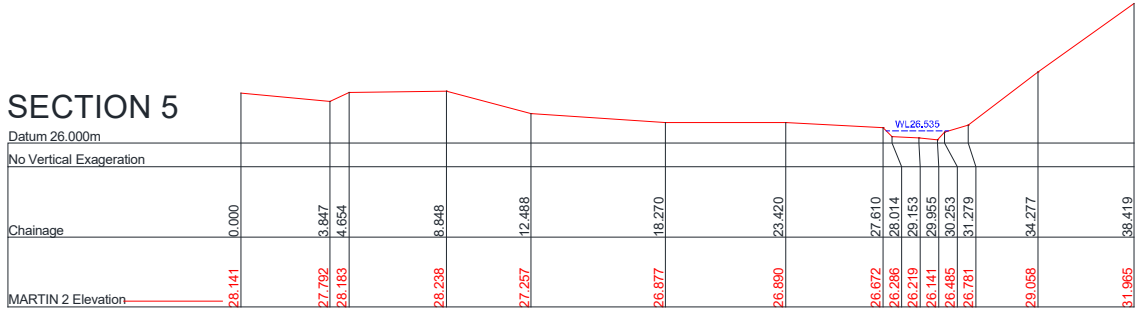
Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



SECTION 5

Datum 26.000m

No Vertical Exageration



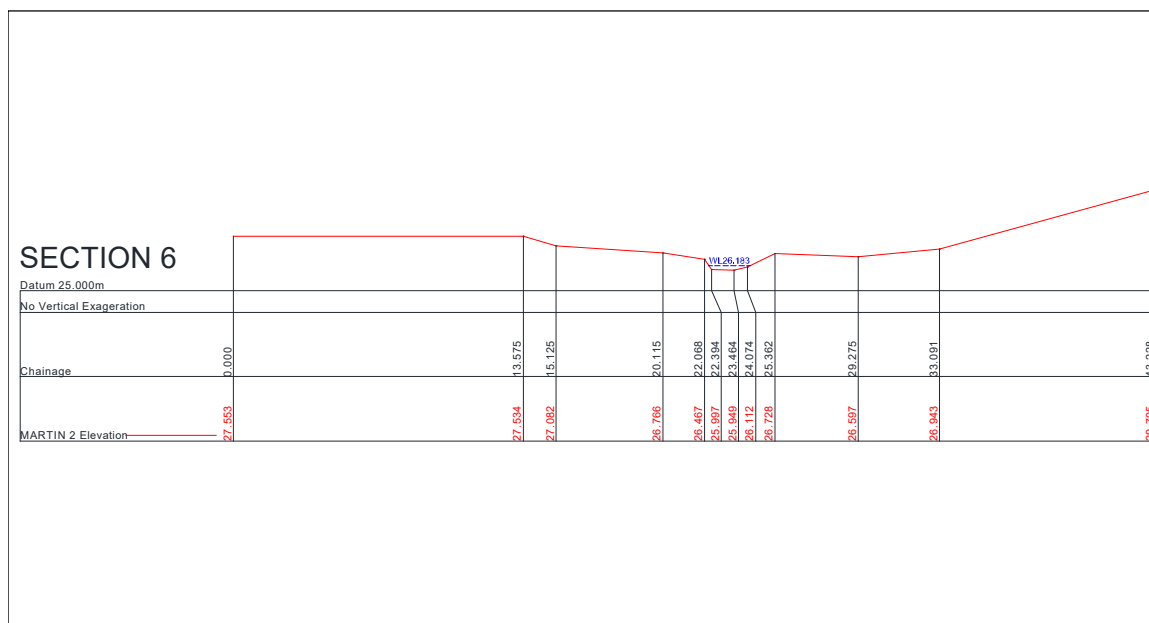
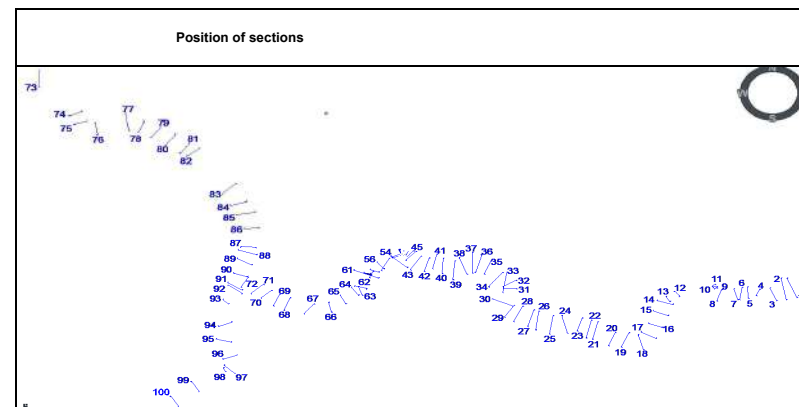
Section 6

[illegible]

Distance to Downstream cross-section X (m)	
	158.83

Water Level (mAOD)	26.183
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



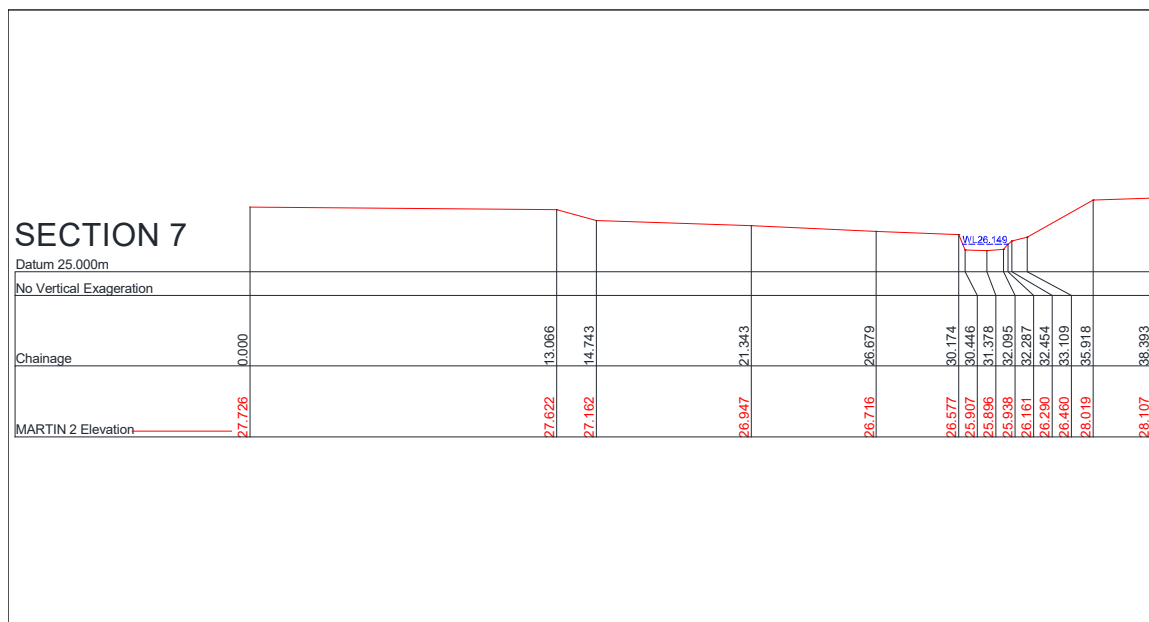
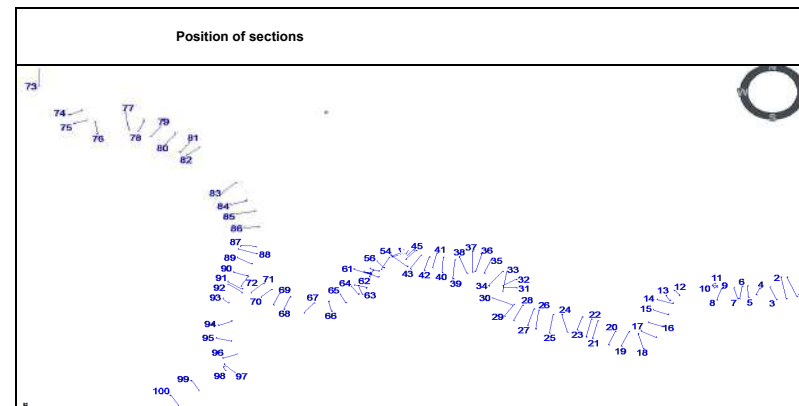
Section 7

[illegible]

Distance to Downstream cross-section X (m)	
	172.26

Water Level (mAOD)	26.149
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



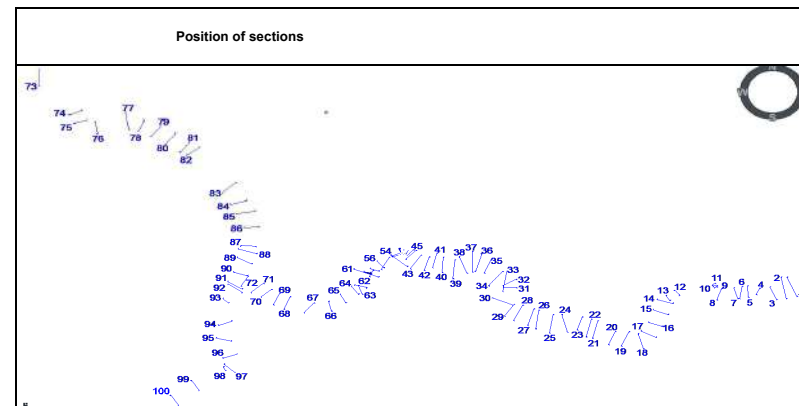
Section 8

[illegible]

Distance to Downstream cross-section X (m)	
	212.72

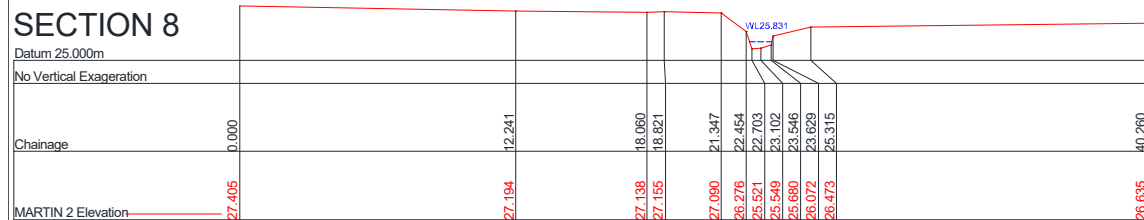
Water Level (mAOD)	25.831
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



Datum 25.000m

No Vertical Exaggeration



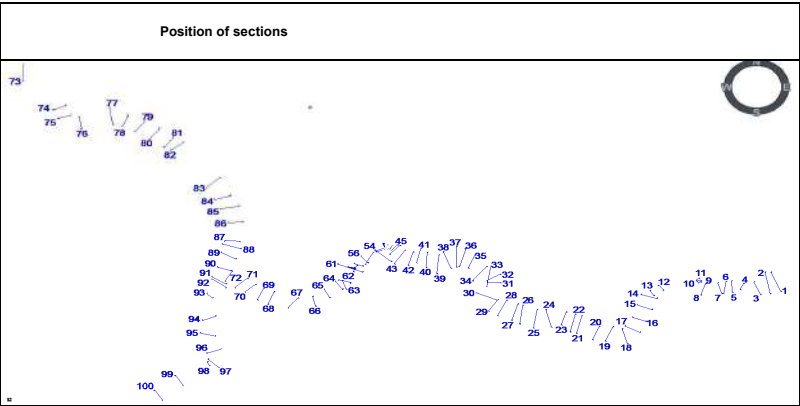
Section 9

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347880.689	389065.894	27.013
2.153						347882.602	389066.881	26.910
3.595						347883.823	389067.649	26.630
4.297						347884.478	389067.903	26.299
8.590						347880.689	389065.894	27.013
10.743						347882.602	389066.881	26.910
12.185						347883.823	389067.649	26.630
12.888						347884.478	389067.903	26.300
13.365						347884.952	389067.954	25.696
13.833						347885.415	389068.028	25.641
14.360						347885.921	389068.174	25.670
14.909						347886.458	389068.288	26.669
18.051						347889.530	389068.945	26.902

Distance to Downstream cross- section X (m)	
	238.57

Water Level (mAOD)	25.777
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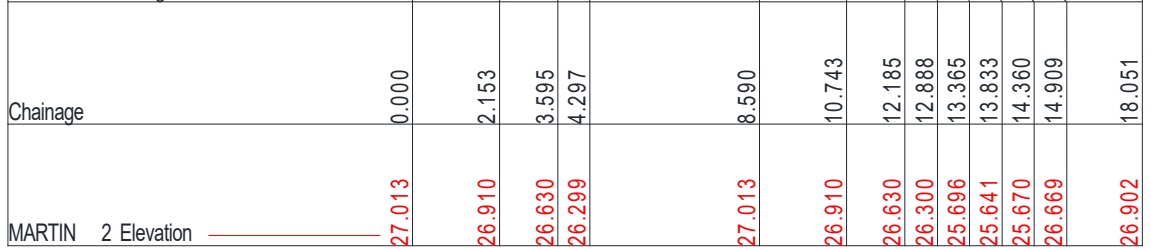
Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



SECTION 9

Datum 25.000m

No Vertical Exageration



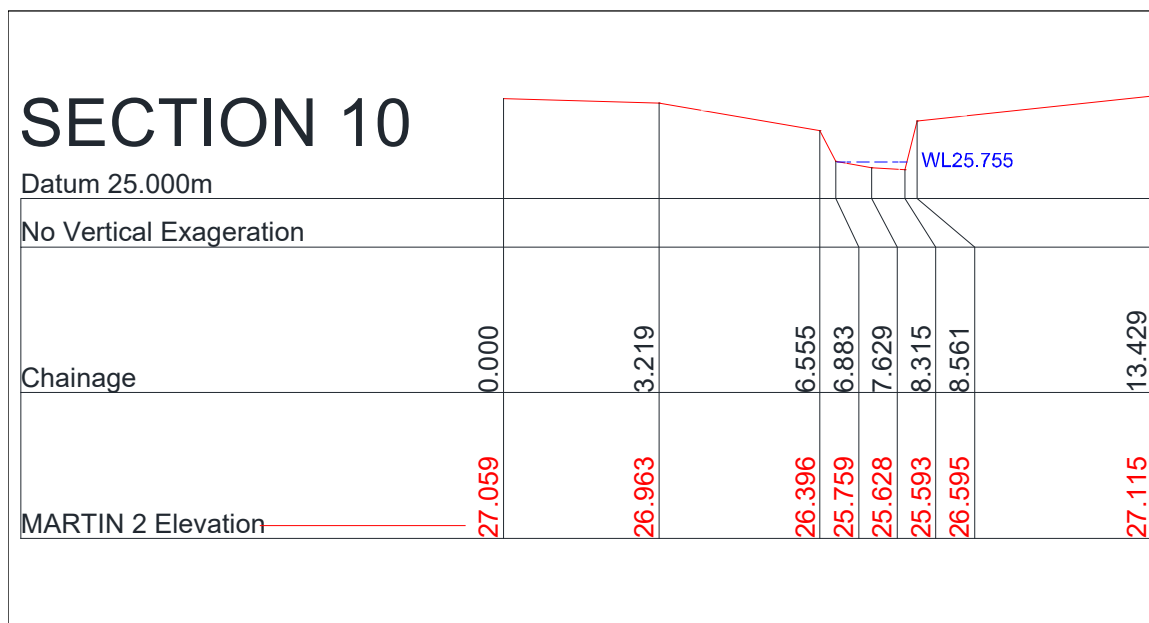
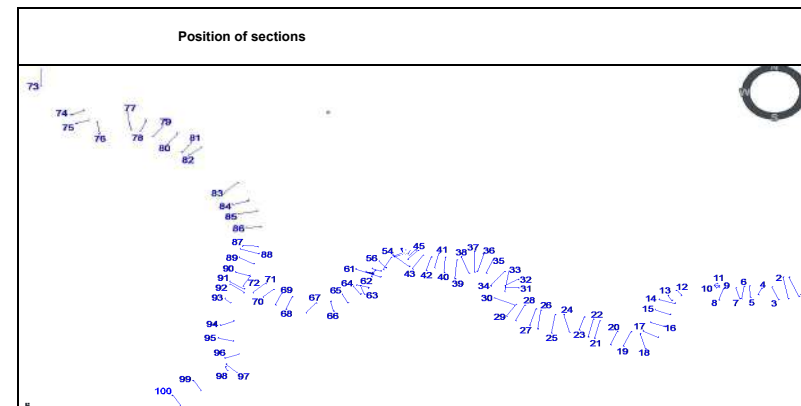
Section 10

[illegible]

Distance to Downstream cross-section X (m)	
	242.62

Water Level (mAOD)	25.755
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



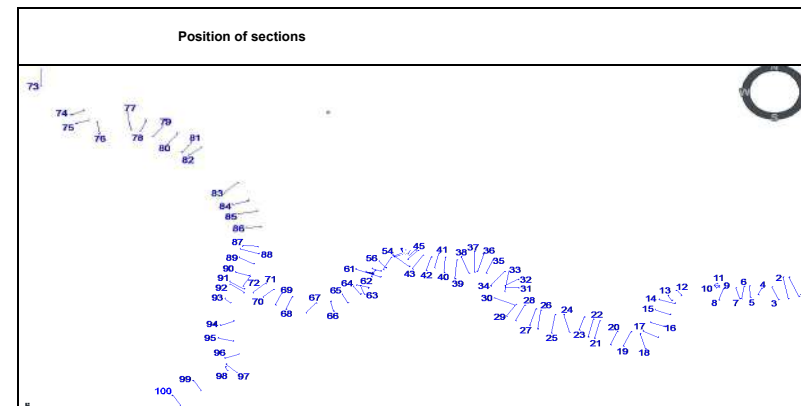
Section 11

[illegible]

Distance to Downstream cross-section X (m)	
	248.75

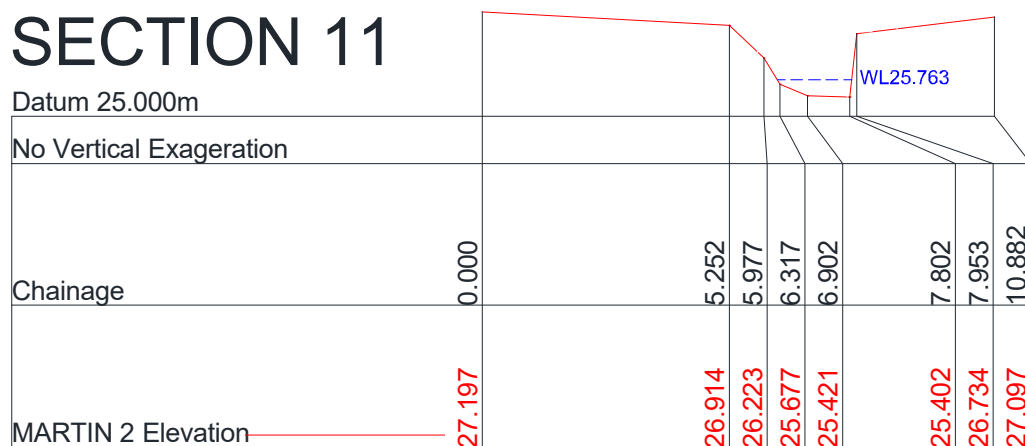
Water Level (mAOD)	25.763
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



Datum 25.000m

No Vertical Exaggeration



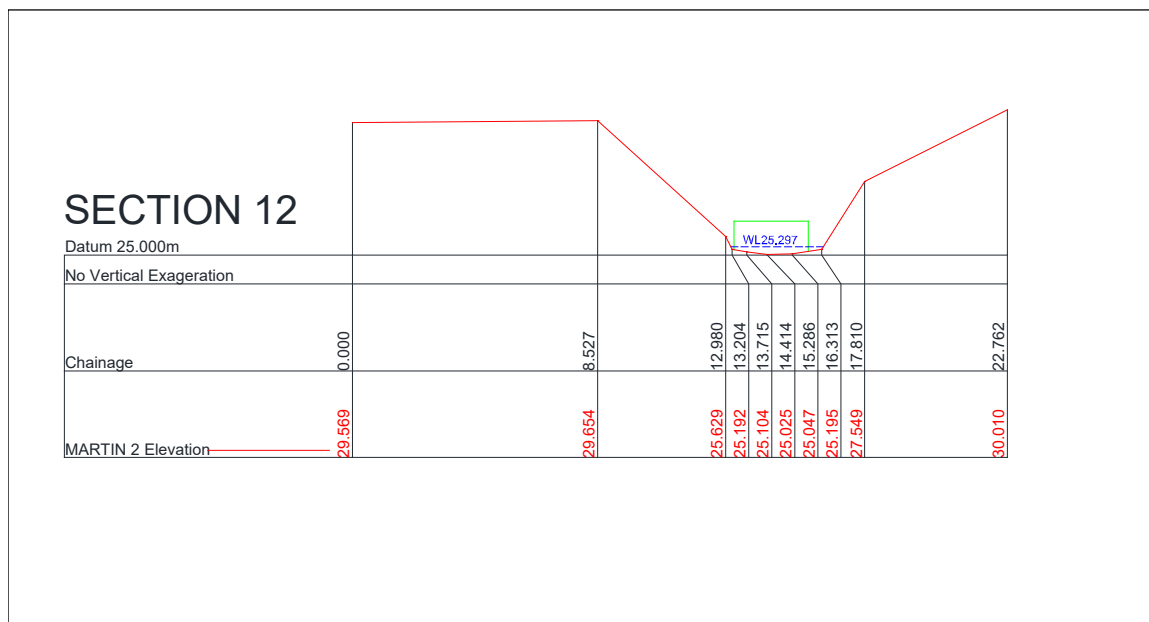
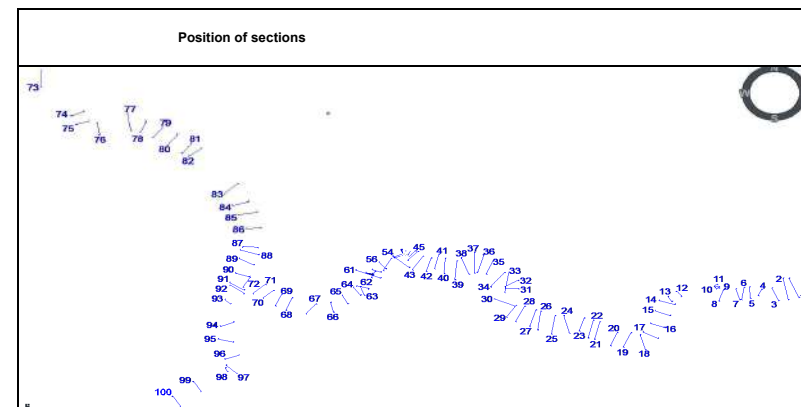
Section 12

[illegible]

Distance to Downstream cross-section X (m)	
	349.93

Water Level (mAOD)	25.297
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



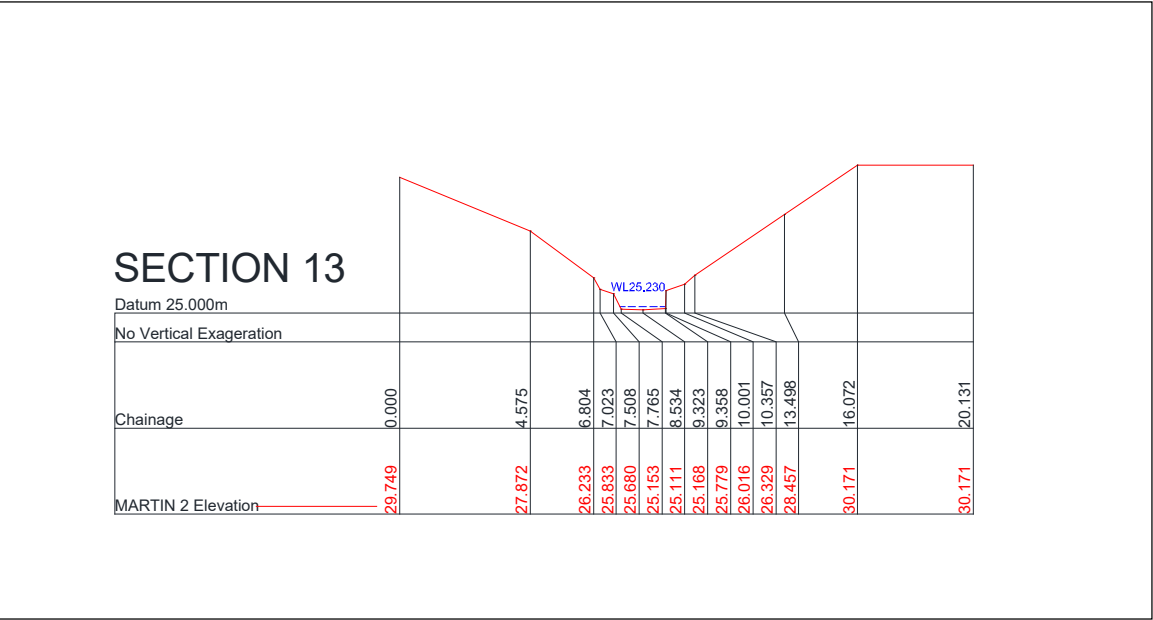
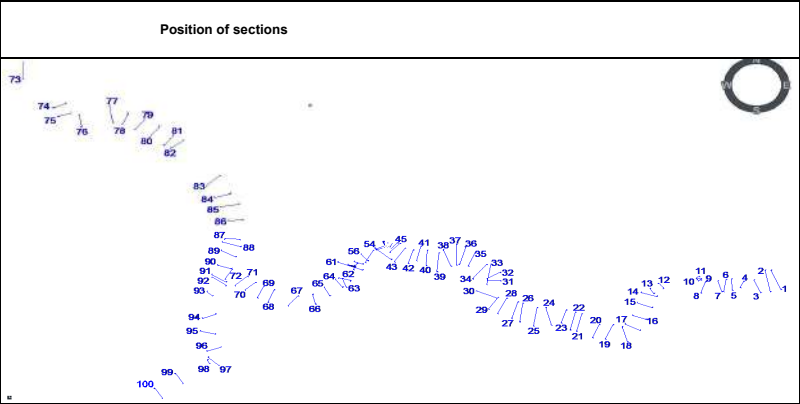
Section 13

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347767.182	389027.334	29.749
4.575						347760.215	389027.294	27.872
6.804						347759.357	389029.351	26.233
7.023						347759.169	389029.464	25.833
7.508						347758.803	389029.781	25.68
7.765						347758.723	389030.026	25.153
8.534						347758.288	389030.66	25.111
9.323						347757.904	389031.349	25.168
9.358						347757.92	389031.38	25.779
10.001						347757.66	389031.968	26.016
10.357						347757.556	389032.309	26.329
13.498						347755.577	389034.748	28.457
16.072						347753.772	389036.583	30.171
20.131						347747.25	389033.85	30.171

Distance to Downstream cross- section X (m)	
	380.74

Water Level (mAOD)	25.230
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



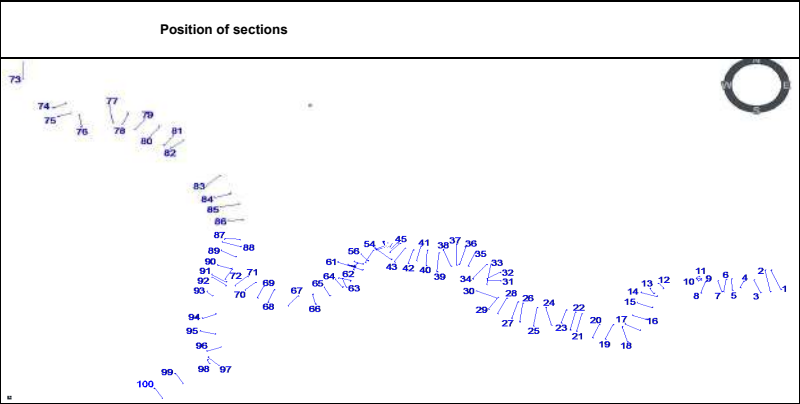
Section 14

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347771.358	389014.516	27.044
8.171						347763.426	389016.477	29.473
11.362						347760.271	389016.954	29.095
14.800						347756.888	389017.568	29.178
16.384						347755.309	389017.695	28.719
19.087						347752.614	389017.898	28.440
21.832						347749.949	389018.559	28.126
24.515						347747.336	389019.168	26.101
24.833						347747.042	389019.287	25.811
25.786						347746.118	389019.520	25.470
26.131						347745.773	389019.535	25.120
27.172						347744.911	389020.119	24.918
27.589						347744.507	389020.212	25.034
27.678						347744.435	389020.160	25.463
34.648						347737.979	389022.787	30.208
36.838						347735.910	389023.505	30.422
46.860						347726.480	389026.899	31.176

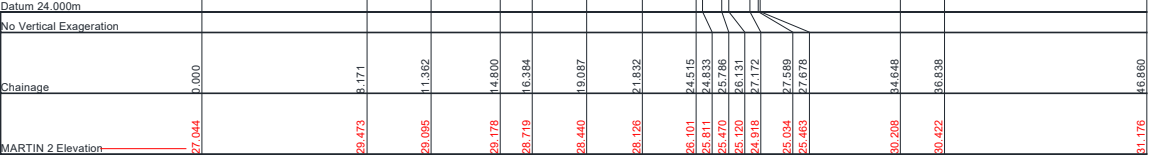
Distance to Downstream cross- section X (m)	
	397.56

Water Level (mAOD)	25.154
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



SECTION 14



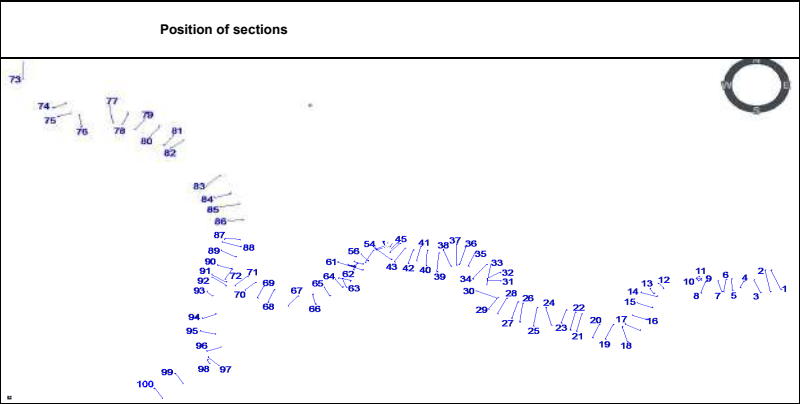
Section 15

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347757.467	388978.648	27.263
7.058						347750.836	388981.065	29.243
10.104						347747.988	388982.147	29.238
12.095						347746.135	388982.873	28.685
15.726						347742.842	388984.404	28.554
18.267						347740.441	388985.236	26.953
19.722						347739.050	388985.664	25.608
19.892						347738.903	388985.748	25.188
20.772						347738.146	388986.197	25.031
21.151						347737.784	388986.308	25.052
21.394						347737.586	388986.450	25.299
21.590						347737.391	388986.437	25.654
24.959						347734.169	388987.421	26.498
30.283						347729.121	388989.115	29.485
34.510						347725.292	388990.906	29.804
44.417						347715.952	388994.497	31.304

Distance to Downstream cross- section X (m)	
	431.91

Water Level (mAOD)	25.245
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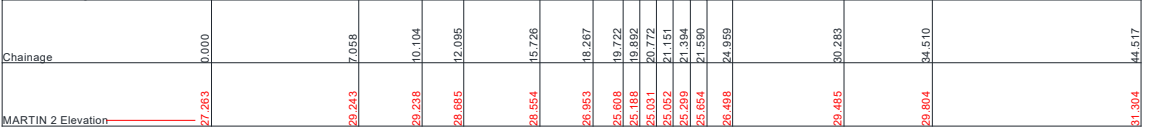
Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



SECTION 15

Datum 25.000m

No Vertical Exageration



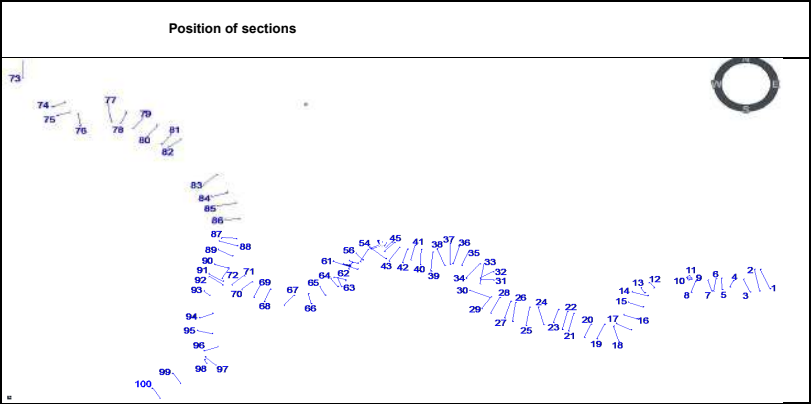
Section 16

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347742.190	388940.666	28.430
7.976						347734.419	388942.464	28.430
9.976						347732.444	388942.775	29.959
11.473						347730.992	388943.142	29.063
17.419						347725.261	388944.725	29.000
20.265						347722.721	388946.008	27.185
22.065						347721.014	388946.582	25.522
22.395						347720.726	388946.743	25.880
22.694						347720.440	388946.829	25.255
23.065						347720.098	388946.685	24.887
23.650						347719.558	388946.910	24.869
24.666						347718.627	388947.316	25.009
24.881						347718.446	388947.433	25.621
27.728						347715.841	388948.581	27.510
31.648						347712.251	388950.154	30.459
41.575						347703.203	388954.239	30.954

Distance to Downstream cross- section X (m)	
	475.37

Water Level (mAOD)	24.964
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



SECTION 16

Datum 24.000m

No Vertical Exaggeration



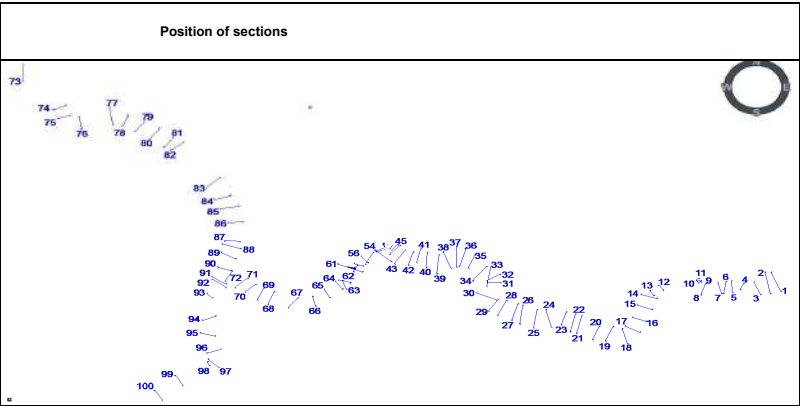
Section 17

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347724.403	388905.26	28.463
10.011						347715.373	388909.581	28.462
11.281						347714.251	388910.176	28.940
11.644						347713.891	388910.223	29.034
12.548						347713.012	388910.437	28.511
17.182						347709.499	388913.458	28.304
21.836						347705.397	388915.657	25.629
22.394						347704.876	388915.458	24.900
23.133						347704.34	388915.968	24.703
24.070						347703.43	388916.189	25.035
24.515						347703.037	388916.397	25.582
25.348						347702.302	388916.789	26.169
27.848						347699.983	388917.724	27.716
30.967						347697.371	388919.428	29.495
46.487						347683.857	388927.061	31.133

Distance to Downstream cross- section X (m)	
	509.92

Water Level (mAOD)	25.053
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



SECTION 17

Datum 24.000m

No Vertical Exaggeration



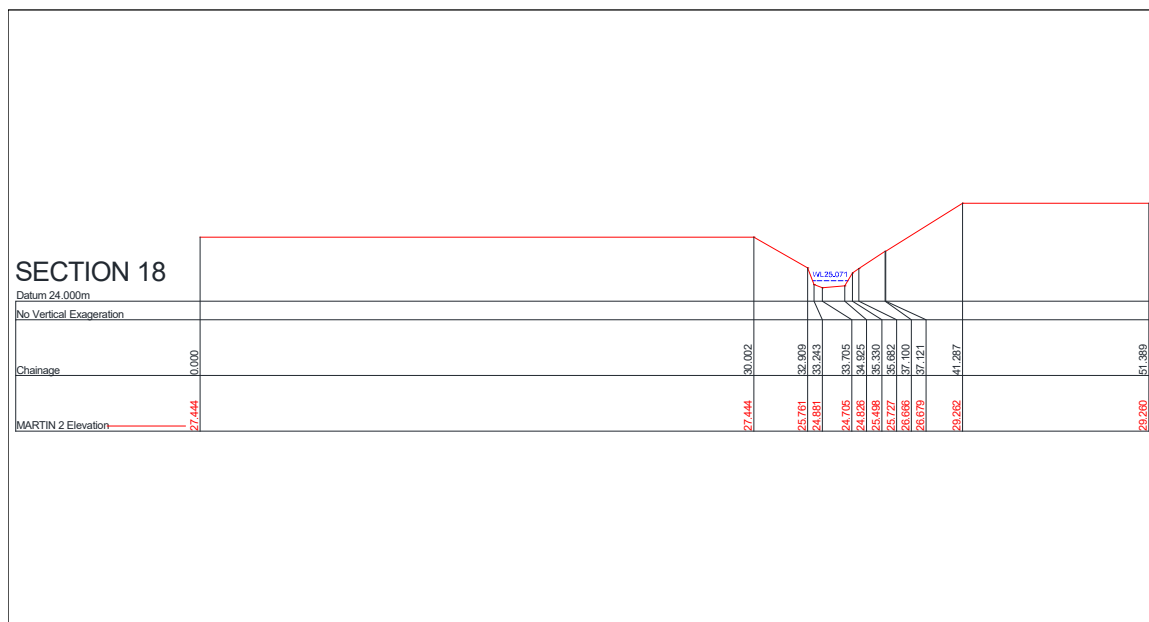
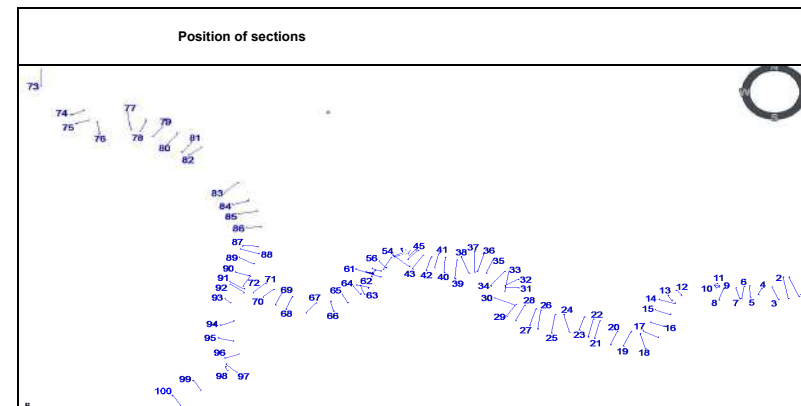
Section 18

[illegible]

Distance to Downstream cross-section X (m)	
	539.20

Water Level (mAOD)	25.071
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



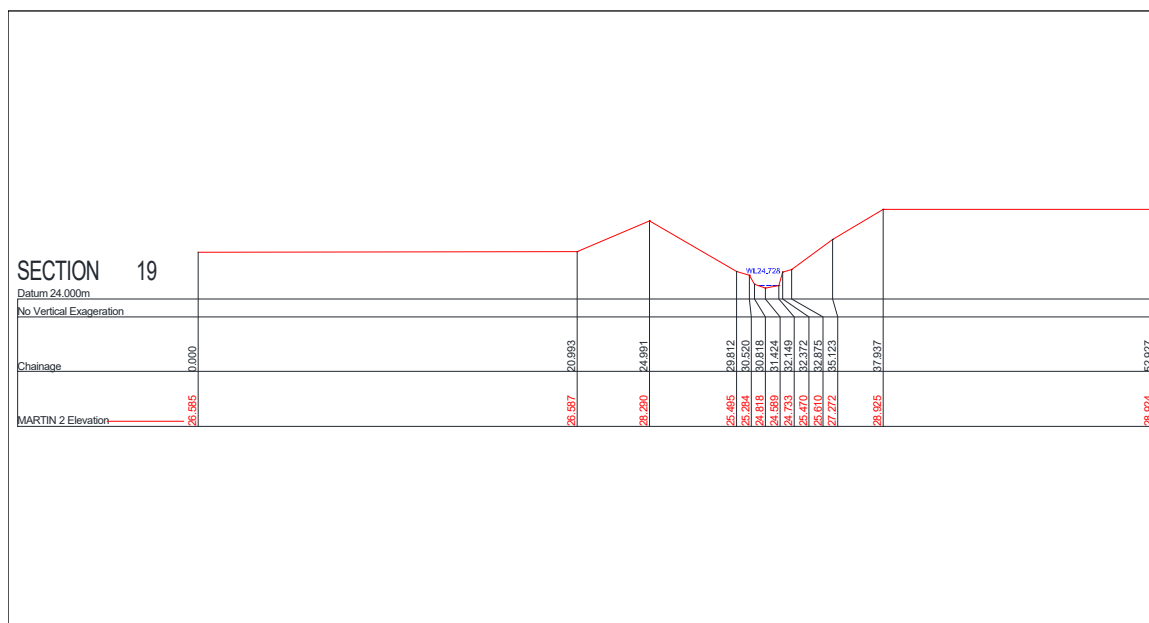
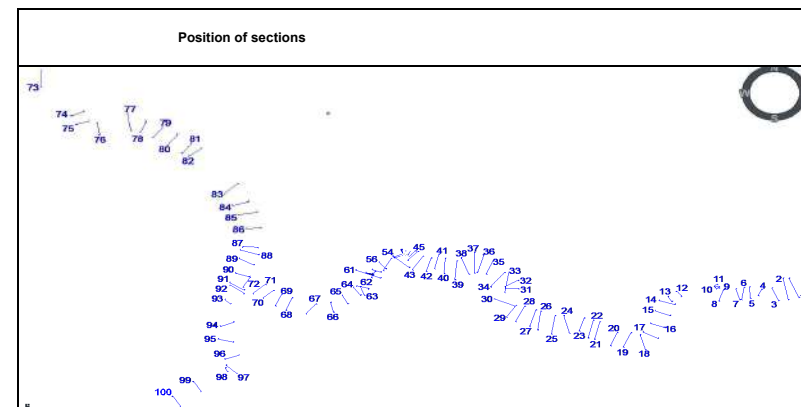
Section 19

[illegible]

Distance to Downstream cross-section X (m)	
	573.08

Water Level (mAOD)	24.728
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



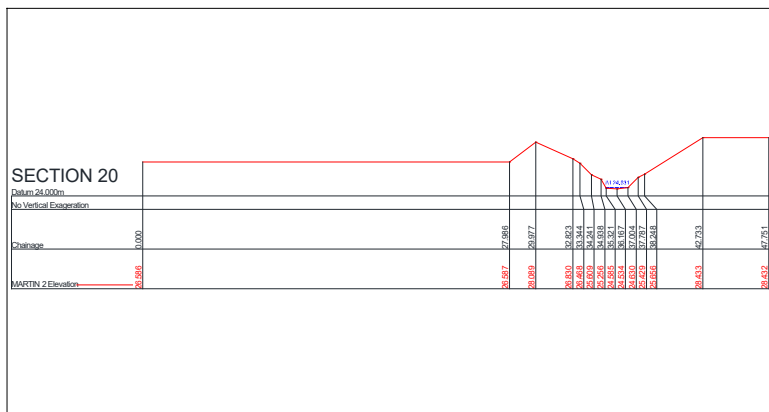
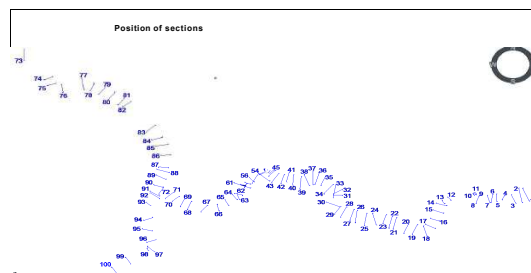
Section 20

[illegible]

Distance to Downstream cross-section X (m)	
	607.26

Water Level (mAOD)	24.631
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



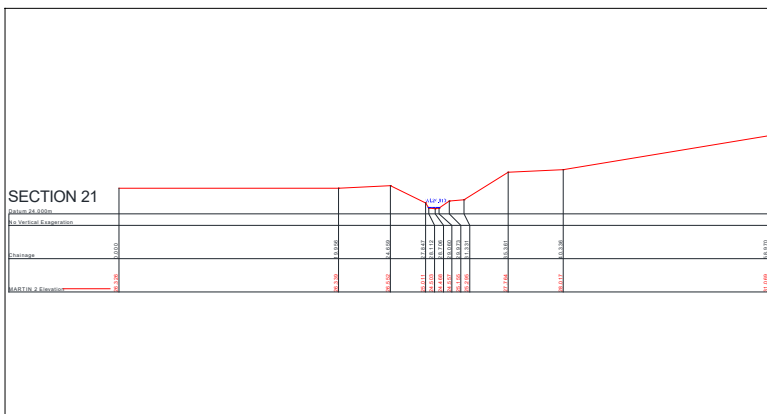
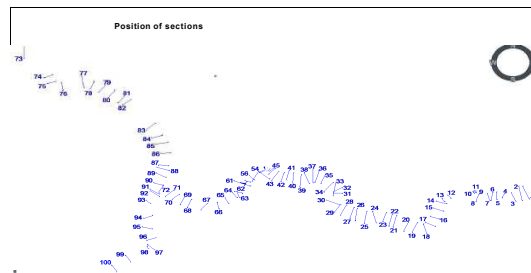
Section 21

[illegible]

Distance to Downstream cross-section X (m)	
	659.81

Water Level (mAOD)	24.610
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



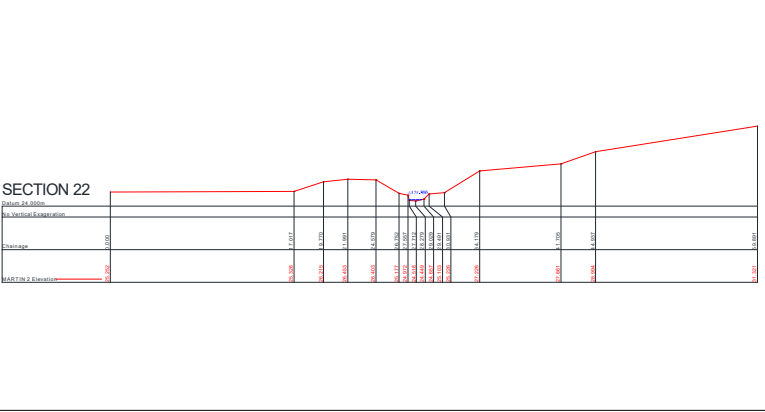
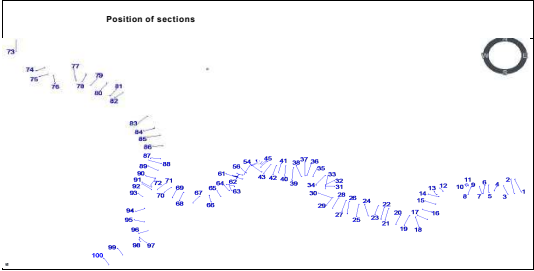
Section 22

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347536.386	388907.464	25.252
17.017						347539.146	388924.258	25.326
19.770						347539.604	388926.971	26.215
21.991						347539.807	388929.182	26.453
24.579						347540.104	388931.753	26.403
26.752						347540.787	388933.816	25.177
27.557						347540.96	388934.602	24.972
27.712						347540.979	388934.759	24.516
28.279						347541.202	388935.277	24.449
29.029						347541.291	388936.027	24.857
29.491						347541.39	388936.46	25.103
30.931						347541.749	388937.855	25.226
34.179						347542.708	388940.959	27.226
41.705						347544.741	388942.204	27.861
44.937						347546.593	388950.853	28.994
59.891						347550.625	388965.253	31.321

Distance to Downstream cross- section X (m)	681.85
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Water Level (mAOD)	24.589
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



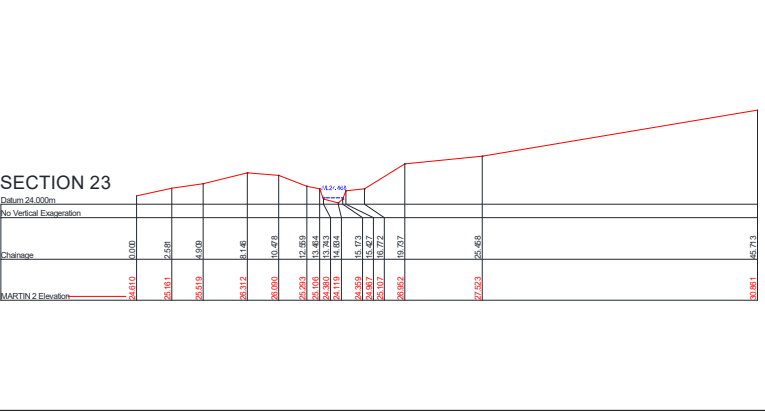
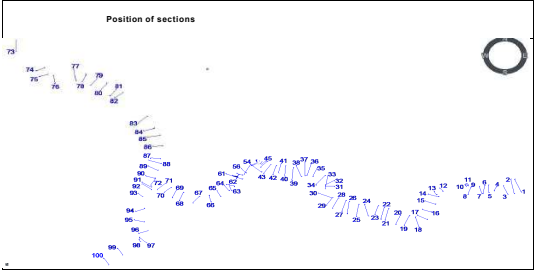
Section 23

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347511.63	388929.16	24.61
4.909						347513.152	388933.827	25.519
8.146						347513.715	388937.015	26.313
10.479						347514.454	388939.227	26.106
12.559						347515.343	388941.108	25.293
13.464						347515.795	388941.892	25.106
13.743						347515.796	388942.171	24.38
14.834						347516.042	388943.234	24.119
15.173						347516.213	388943.527	24.355
15.427						347516.317	388943.758	24.967
16.772						347516.929	388944.956	25.107
19.737						347517.295	388947.899	26.952
25.458						347519.599	388953.148	27.523
45.713						347526.879	388972.395	30.861

Distance to Downstream cross- section X (m)	
	708.23

Water Level (mAOD)	24.465
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Relative Path Length		
Left Floodplain	Distance	RPL
Channel		
Right Floodplain		



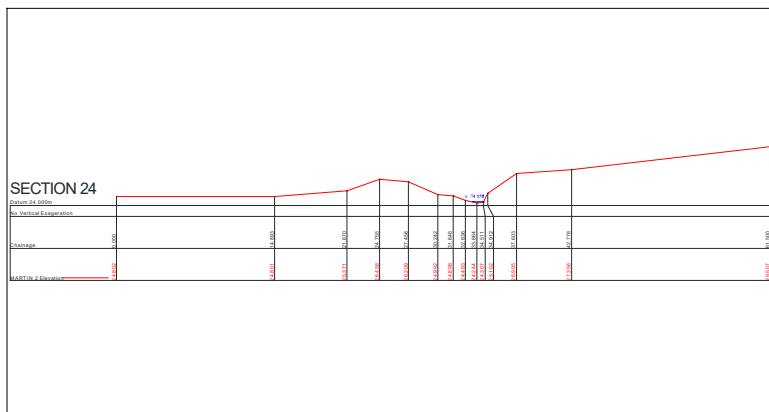
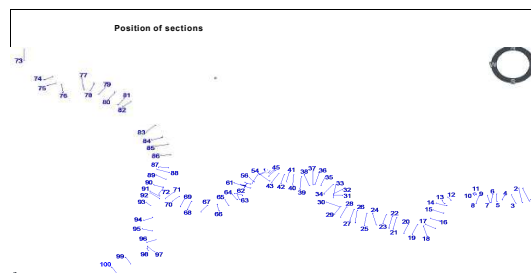
Section 24

[illegible]

Distance to Downstream cross-section X (m)	
	753.71

Water Level (mAOD)	24.335
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



347470.3	388979.5	29.507	SECT38
347470	388960.8	27.356	SECT38
347470.4	388955.6	26.995	SECT38
347471.3	388953.1	25.102	SECT38
347471.4	388952.7	24.307	SECT38
347471.5	388952.1	24.244	SECT38
347472.1	388951.2	24.493	SECT38

347473.1	388950.5	24.898	SECT38
347473.9	388949.4	24.992	SECT38
347475.9	388947.5	26.209	SECT38
347475.8	388944.8	26.458	SECT38
347476.7	388941.8	25.371	SECT38
347479.2	388935.7	24.8	SECT38
347485.4	388922	24.802	SECT38

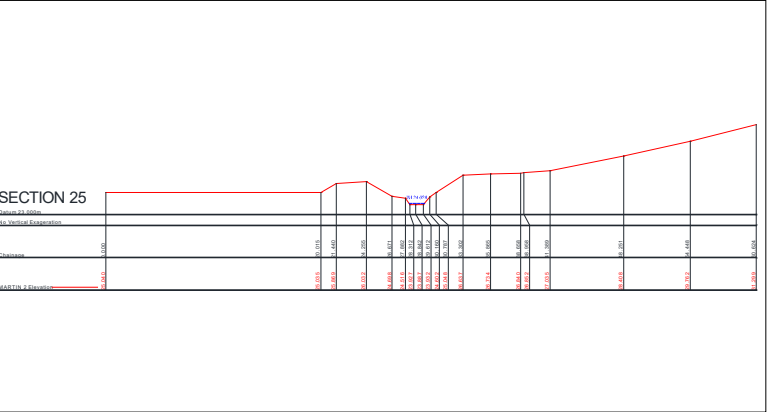
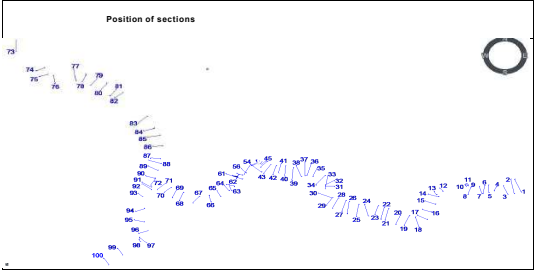
Section 25

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347437.211	388919.899	25.04
20.015						347439.621	388939.788	25.035
21.440						347440.192	388941.091	25.069
24.255						347440.545	388943.878	26.032
26.671						347440.707	388946.289	24.698
27.882						347440.534	388947.487	24.516
28.312						347440.504	388947.916	23.927
28.842						347440.601	388949.437	23.887
29.812						347440.741	388949.195	23.932
30.160						347441.154	388949.555	24.602
30.787						347441.097	388950.179	25.048
33.302						347441.804	388952.593	26.637
35.865						347441.444	388955.13	26.734
41.389						347442.854	388960.486	27.035
48.251						347444.656	388967.092	28.408
54.448						347445.797	388973.183	29.762
60.624						347447.188	388979.201	31.299

Distance to Downstream cross- section X (m)	784.61
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Water Level (mAOD)	24.024
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Relative Path Length		
Left Floodplain	Distance	RPL
Channel		
Right Floodplain		



347447.2	388979.2	31.299	SECT37
347445.8	388973.2	29.762	SECT37
347444.7	388967.1	28.408	SECT37
347442.9	388960.5	27.035	SECT37
347441.4	388955.1	26.734	SECT37
347441.8	388952.6	26.637	SECT37
347441.1	388950.2	25.048	SECT37
347441.2	388949.6	24.602	SECT37
347440.7	388949.2	23.932	SECT37
347440.6	388948.4	23.887	SECT37
347440.5	388947.9	23.927	SECT37
347440.5	388947.5	24.516	SECT37
347440.7	388946.3	24.698	SECT37
347440.5	388943.9	26.032	SECT37
347440.2	388941.1	25.869	SECT37
347439.6	388939.8	25.035	SECT37
347437.2	388919.9	25.04	SECT37

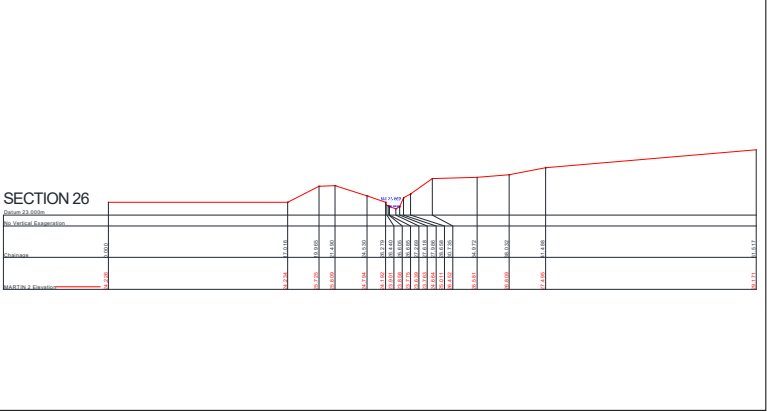
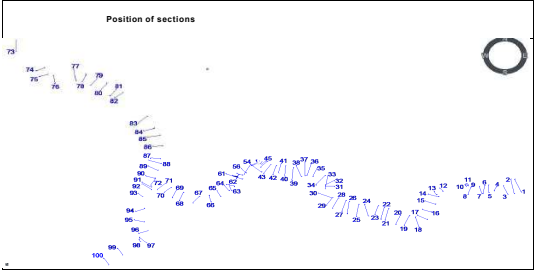
Section 26

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347400.415	388933.011	24.226
17.016						347403.959	388949.654	24.234
19.965						347404.588	388952.535	25.725
21.490						347404.915	388954.025	25.809
24.530						347404.833	388957.063	24.794
26.279						347405.245	388958.763	24.192
26.440						347405.276	388958.921	23.901
26.603						347405.251	388959.081	23.858
26.695						347405.285	388959.157	23.775
27.269						347405.309	388959.741	23.839
27.618						347405.417	388960.072	23.763
27.986						347405.552	388960.415	24.664
28.658						347405.754	388961.059	25.011
30.735						347406.319	388963.054	26.452
38.032						347407.736	388970.212	26.809
41.488						347408.093	388973.65	27.495
61.517						347409.124	388993.652	29.171

Distance to Downstream cross- section X (m)	
	821.83

Water Level (mAOD)	23.862
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



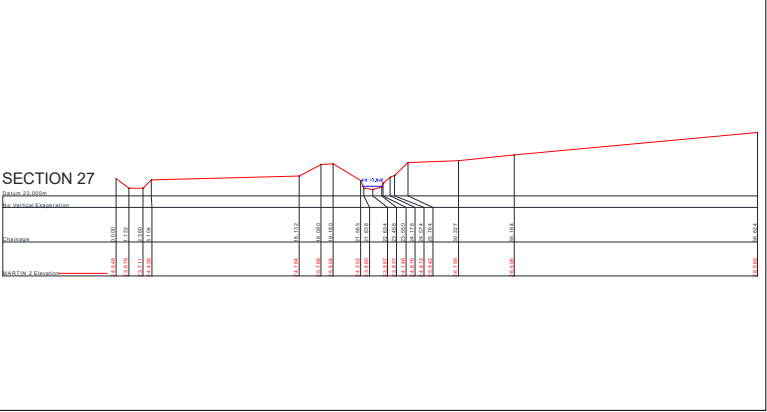
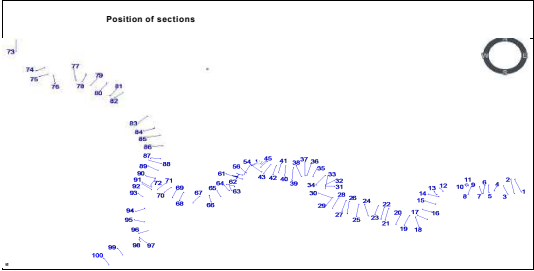
Section 27

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347378.167	388944.146	24.548
1.122						347378.486	388945.222	23.679
2.360						347378.647	388946.449	23.711
3.104						347378.601	388947.192	24.426
16.132						347382.445	388959.64	24.764
18.090						347382.896	388961.545	25.768
19.180						347383.27	388962.569	25.804
21.565						347384.015	388964.835	24.352
21.838						347384.085	388965.096	23.68
22.634						347384.34	388965.853	23.587
23.456						347384.319	388966.674	23.837
23.550						347384.368	388966.754	24.148
24.178						347384.418	388967.38	24.676
24.574						347384.325	388967.765	24.812
35.164						347384.759	388968.873	25.942
35.164						347387.583	388977.839	26.806
56.624						347395.107	388997.937	28.565

Distance to Downstream cross- section X (m)	
	843.87

Water Level (mAOD)	23.645
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Relative Path Length		
Left Floodplain	Distance	RPL
Channel		
Right Floodplain		



347395.1	388997.9	28.565	SECT35
347387.6	388977.8	26.606	SECT35
347384.8	388968.9	25.942	SECT35
347384.3	388967.8	24.812	SECT35
347384.4	388967.4	24.676	SECT35
347384.4	388966.8	24.148	SECT35
347384.3	388966.7	23.837	SECT35
347384.3	388965.9	23.587	SECT35
347384.1	388965.1	23.68	SECT35
347384	388964.8	24.352	SECT35
347383.3	388962.6	25.804	SECT35
347382.9	388961.5	25.768	SECT35
347382.4	388959.6	24.764	SECT35
347378.6	388947.2	24.426	SECT35
347378.6	388946.4	23.711	SECT35
347378.5	388945.2	23.679	SECT35
347378.2	388944.1	24.548	SECT35
347378.2	388944.1	24.547	SECT35

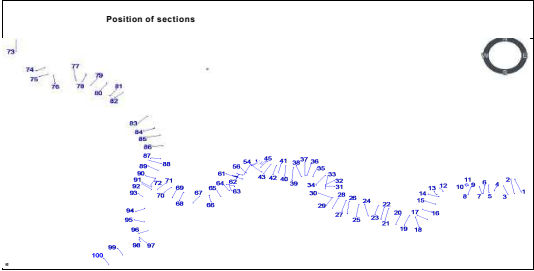
Section 28

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347339.472	388959.41	24.204
1.935						347340.261	388961.177	24.212
2.561						347340.653	388961.665	23.742
3.556						347340.839	388962.835	23.802
5.118						347341.423	388964.095	24.572
12.573						347344.47	388970.899	24.491
16.221						347346.235	388974.092	24.741
17.963						347347.136	388975.562	25.085
21.196						347349.376	388977.914	24.729
21.315						347349.421	388978.024	23.739
21.902						347349.732	388978.522	23.551
22.831						347349.917	388979.432	23.736
23.417						347350.189	388979.951	24.491
24.537						347350.447	388981.041	25.213
33.132						347353.329	388989.138	25.439
37.932						347355.92	388993.179	26.62
57.931						347366.145	389010.367	27.553

Distance to Downstream cross- section X (m)	880.82
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Water Level (mAOD)	23.841
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



SECTION 28



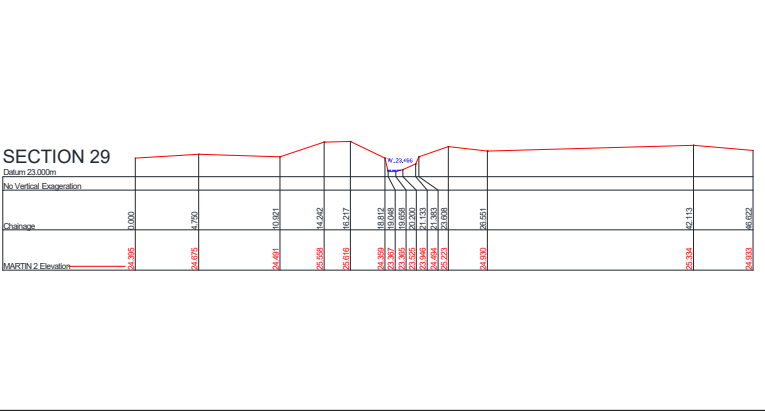
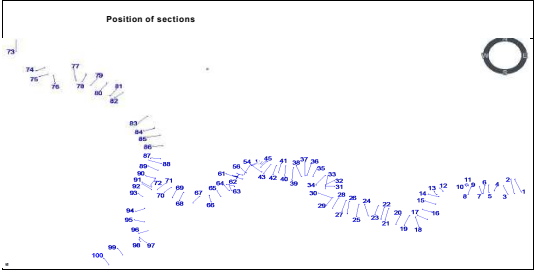
Section 29

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347315.326	388974.791	24.395
4.750						347317.962	388978.743	24.675
10.921						347320.602	388984.32	24.491
14.242						347323.002	388986.816	25.558
16.217						347324.267	388988.133	25.616
18.812						347325.696	388990.299	24.359
19.048						347325.818	388990.501	23.367
19.868						347326.276	388990.904	23.365
20.200						347326.687	388991.257	23.525
21.133						347327.216	388992.025	23.946
21.383						347327.304	388992.259	24.494
23.608						347328.85	388993.86	25.223
26.551						347330.522	388996.281	24.93
42.113						347330.512	388996.286	25.334
46.622						347342.162	389012.546	24.933

Distance to Downstream cross- section X (m)	
	907.35

Water Level (mAOD)	23.465
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



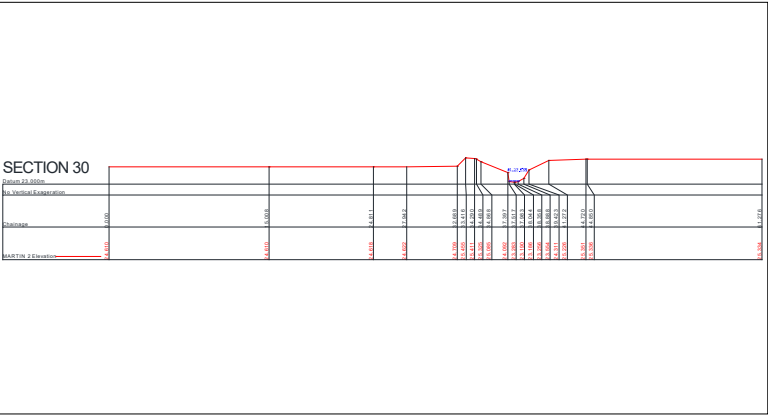
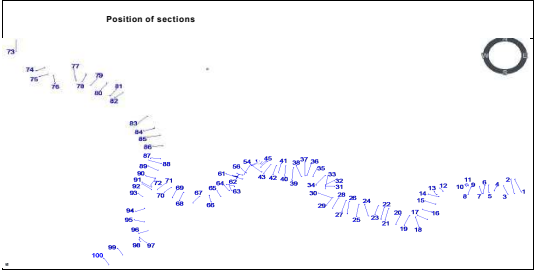
Section 30

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347283.192	389033.541	24.61
15.008						347296.227	389026.102	24.61
24.811						347304.802	389021.352	24.618
32.889						347311.905	389017.945	24.709
33.416						347312.532	389017.577	25.455
34.290						347313.348	389017.264	25.411
34.489						347313.501	389017.137	25.325
34.968						347313.844	389016.974	25.085
37.307						347318.231	389016.14	24.092
37.517						347316.351	389016.147	23.283
37.983						347316.814	389016.093	23.19
38.044						347316.87	389016.089	23.186
38.358						347317.179	389016.012	23.256
38.888						347317.708	389015.959	23.354
39.423						347318.233	389016.049	24.311
41.272						347320.053	389015.723	25.226
44.720						347323.323	389014.629	25.351
44.850						347323.426	389014.549	25.336
61.276						347342.47	389008.411	25.334

Distance to Downstream cross- section X (m)	934.55
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Water Level (mAOD)	23.335
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



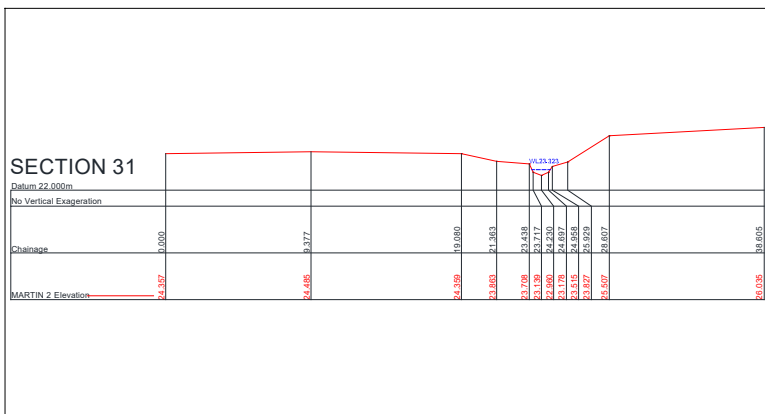
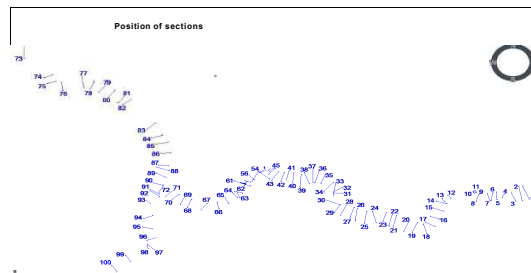
Section 31

[illegible]

Distance to Downstream cross-section X (m)	
	987.38

Water Level (mAOD)	23.323
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



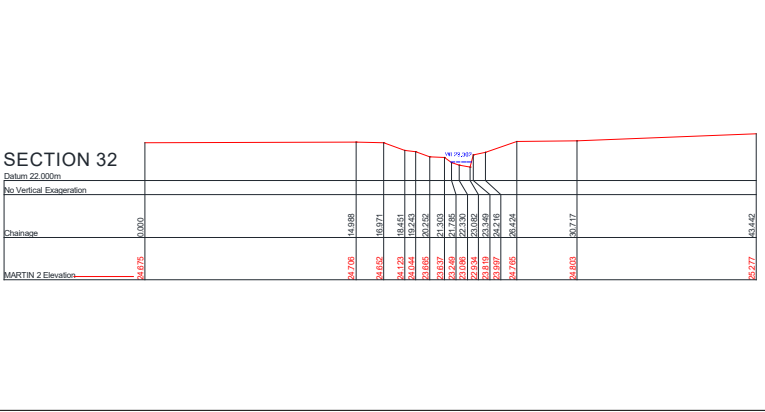
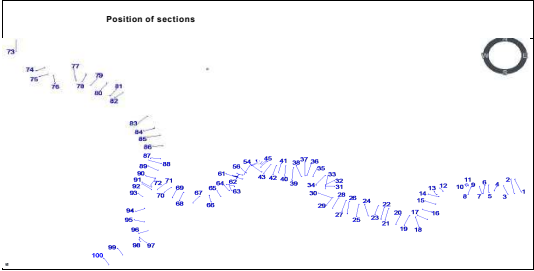
Section 32

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347311.684	389071.464	24.675
14.988						347326.336	389074.621	24.706
16.971						347327.982	389075.728	24.652
18.451						347328.133	389078.657	21.123
19.243						347329.83	389077.033	24.044
20.252						347330.592	389077.694	23.665
21.303						347331.328	389078.445	23.637
21.785						347331.502	389078.894	23.249
22.330						347332.005	389078.104	23.086
23.082						347332.717	389079.346	22.934
23.349						347332.965	389079.444	23.819
24.216						347333.688	389079.924	23.967
26.424						347335.32	389081.411	24.765
30.717						347338.021	389084.747	24.803
43.442						347341.198	389098.62	25.277

Distance to Downstream cross- section X (m)	
	1002.62

Water Level (mAOD)	23.362
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Relative Path Length		
Left Floodplain	Distance	RPL
Channel		
Right Floodplain		



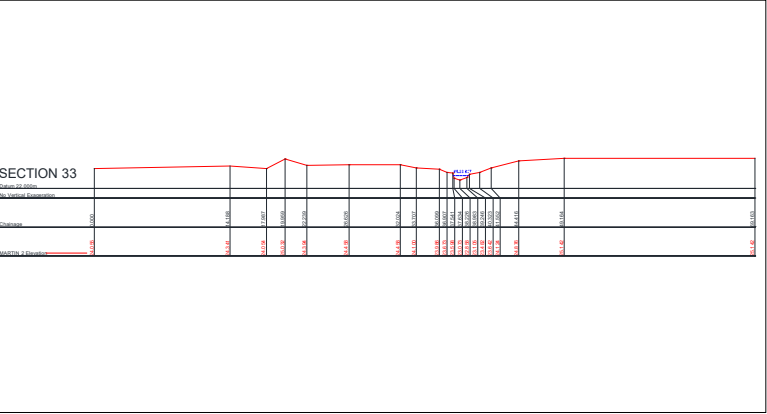
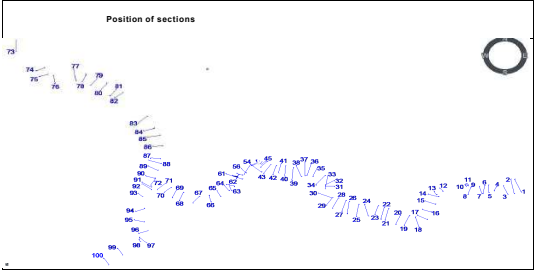
Section 33

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347310.983	389052.381	24.055
17.987						347310.908	389070.368	24.054
19.959						347310.901	389072.34	25.532
22.239						347310.672	389074.606	24.394
26.626						347311.136	389078.97	24.458
32.024						347310.83	389084.36	24.458
33.707						347311.18	389086.006	24.1
36.009						347311.187	389086.399	23.986
36.907						347311.241	389089.204	23.673
37.541						347311.493	389089.786	23.598
37.634						347311.541	389089.866	23.073
38.226						347311.902	389090.335	22.858
38.983						347312.004	389091.069	23.105
39.246						347312.116	389091.331	23.482
40.323						347312.416	389092.365	23.642
41.552						347312.377	389093.593	24.124
44.416						347312.638	389096.445	24.876
49.164						347314.408	389100.851	25.142
69.163						347322.482	389119.161	25.142

Distance to Downstream cross- section X (m)	
	1024.85

Water Level (mAOD)	23.367
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Relative Path Length		
Left Floodplain	Distance	RPL
Channel		
Right Floodplain		



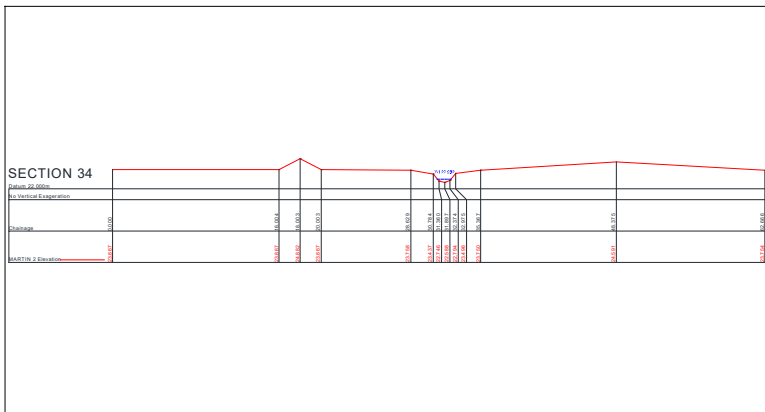
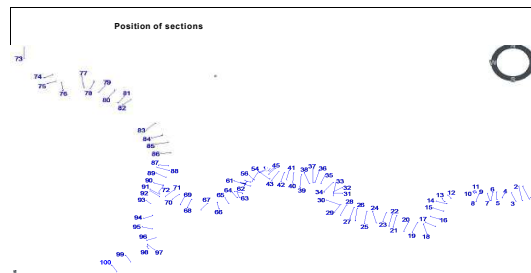
Section 34

[illegible]

Distance to Downstream cross-section X (m)	
	1050.98

Water Level (mAOD)	22.952
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



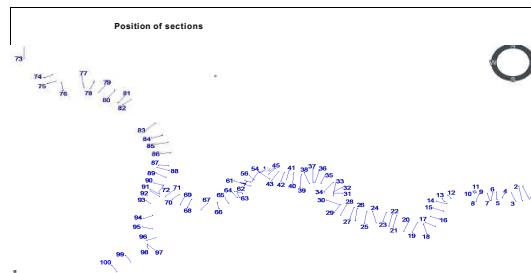
Section 35

[illegible]

Distance to Downstream cross-section X (m)	
	1090.35

Water Level (mAOD)	22.844
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



Datum 22.000m

No Vertical Expansion.



MARTIN 2 Elevation: _____

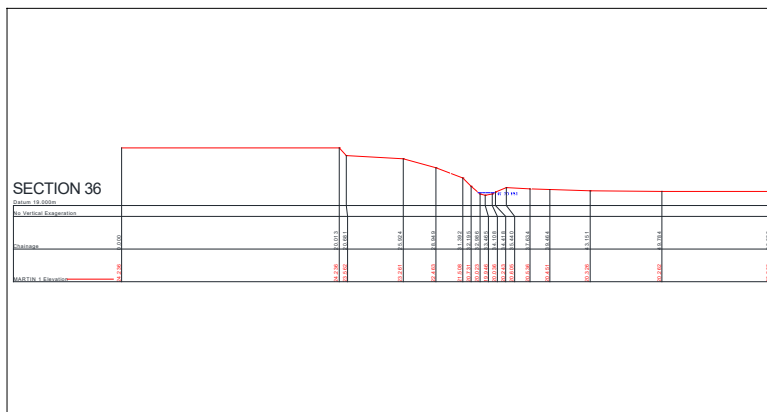
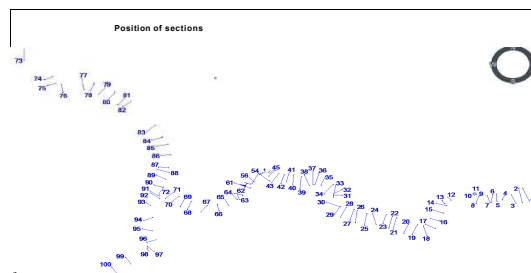
Section 36

Chainage (m)	Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000					347254.761	389172.98	24.236
20.013					347250.25	389153.482	24.236
20.681					347250.304	389152.816	23.562
25.924					347250.357	389147.573	23.261
28.849					347249.176	389144.789	22.463
31.392					347248.485	389142.445	21.508
32.195					347248.481	389141.842	20.731
32.986					347248.152	389140.923	20.023
33.465					347248.116	389140.445	19.946
34.108					347247.988	389139.815	20.036
34.418					347247.896	389139.519	20.243
35.440					347247.708	389139.515	20.605
37.634					347246.634	389136.601	20.536
43.151					347243.859	389131.832	20.326
49.784					347241.704	389125.599	20.262
59.828					347237.509	389116.433	20.265

Distance to Downstream cross-section X (m)	
	1111 90

Water Level (mAOD)	20.151
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Relative Path Length		RPL
	Distance	
Left Floodplain		
Channel		
Right Floodplain		



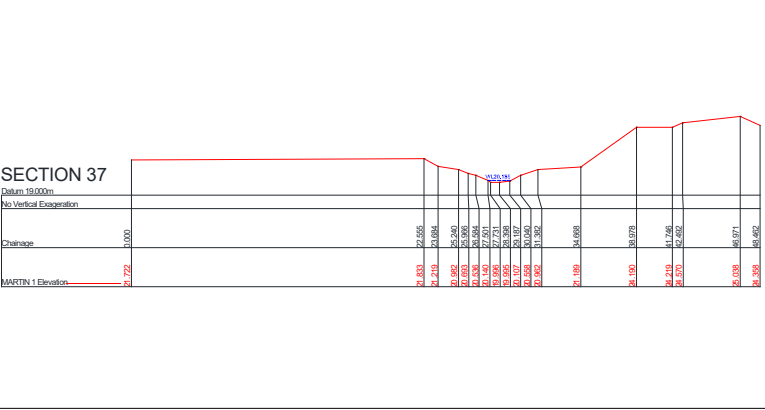
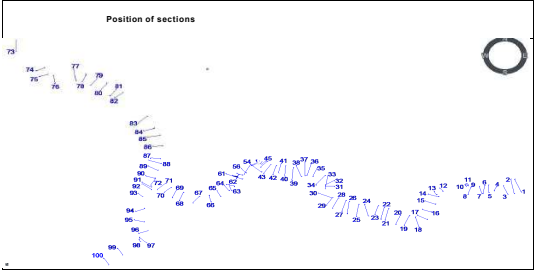
Section 37

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347229.418	389114.751	21.722
22.555						347230.819	389137.282	21.833
23.884						347230.993	389138.388	21.219
25.240						347231.201	389139.916	20.982
25.966						347231.186	389140.641	20.693
26.584						347231.172	389141.259	20.536
27.501						347231.211	389142.175	20.14
27.731						347231.212	389142.405	19.996
28.398						347231.273	389143.07	19.995
29.187						347231.088	389143.837	20.107
30.040						347230.706	389144.599	20.558
31.382						347230.485	389145.919	20.962
34.668						347230.445	389149.205	21.389
38.978						347230.283	389153.511	24.15
41.746						347230.312	389156.279	24.216
42.492						347230.117	389158.999	24.57
46.971						347230.291	389161.475	25.038
48.462						347230.22	389162.964	24.358

Distance to Downstream cross- section X (m)	
	1128.91

Water Level (mAOD)	20.135
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Relative Path Length		
Left Floodplain	Distance	RPL
Channel		
Right Floodplain		



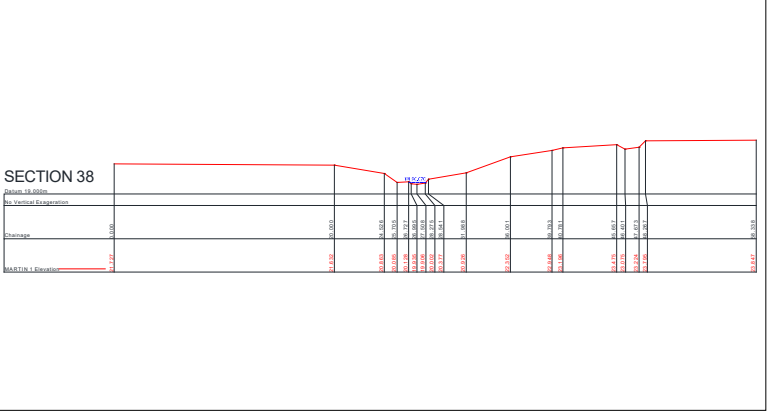
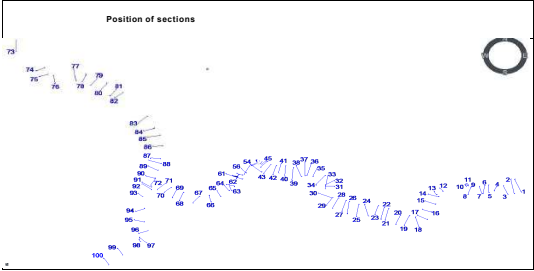
Section 38

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347214.883	389110.256	21.727
20.000						347209.141	389129.414	21.632
24.526						347207.809	389133.714	20.863
25.705						347207.423	389134.854	20.085
26.727						347207.01	389135.788	20.128
26.995						347206.954	389136.05	19.935
27.508						347206.854	389136.554	19.906
28.275						347206.485	389137.226	20.002
28.541						347206.431	389137.486	20.377
31.988						347205.001	389140.623	20.926
36.001						347203.526	389144.355	22.352
38.793						347201.871	389147.767	22.948
40.761						347201.47	389148.677	23.196
45.657						347199.197	389152.983	23.475
46.401						347198.847	389153.64	23.075
47.673						347198.243	389154.76	23.224
48.267						347198.074	389155.329	23.795
58.338						347193.417	389164.259	23.847

Distance to Downstream cross- section X (m)	1154.67
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Water Level (mAOD)	20.070
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



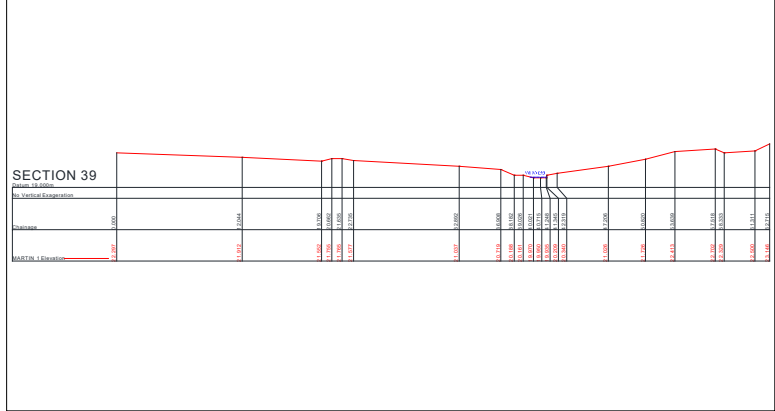
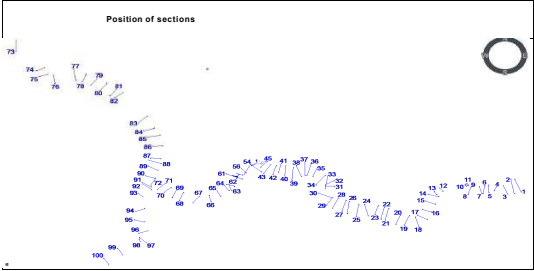
Section 39

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347177.329	389093.31	22.297
12.044						347175.452	389105.207	21.912
19.706						347175.602	389112.867	21.552
20.662						347175.627	389113.823	21.755
21.635						347176.12	389114.662	21.765
22.735						347176.321	389115.743	21.577
32.892						347176.935	389125.882	21.037
36.906						347177.386	389129.975	20.719
38.182						347177.593	389131.141	20.188
39.026						347177.511	389131.985	20.161
40.021						347177.681	389132.966	19.97
40.715						347177.565	389133.65	19.95
40.248						347177.484	389134.177	19.935
41.345						347177.439	389134.262	20.209
42.319						347177.504	389135.234	20.34
47.206						347178.747	389139.961	21.626
50.820						347179.369	389143.521	21.726
53.639						347179.932	389146.283	22.413
57.518						347180.956	389150.024	22.702
58.333						347181.131	389150.62	22.329
61.311						347182.354	389153.536	22.5
62.715						347182.621	389154.914	23.146

Distance to Downstream cross- section X (m)	
	1183.51

Water Level (mAOD)	20.030
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



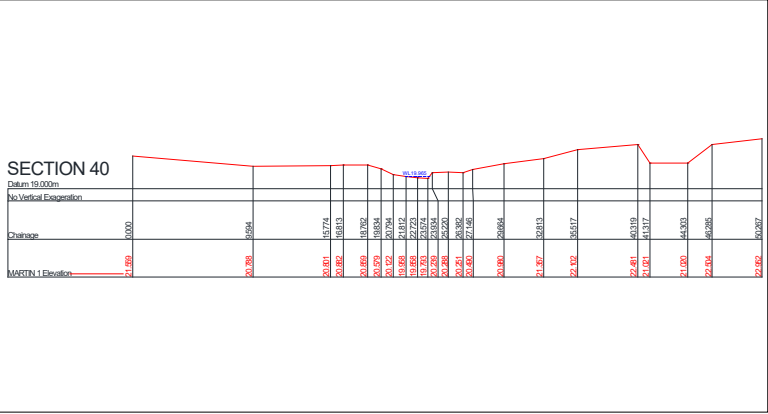
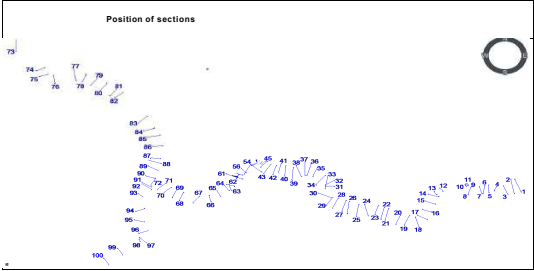
Section 40

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347147.855	389113.655	21.559
9.594						347147.852	389123.242	20.787
15.774						347148.011	389125.428	20.801
18.813						347147.991	389130.487	20.882
18.792						347147.983	389132.416	20.859
19.834						347148.018	389133.487	20.579
20.794						347148.096	389134.444	20.122
21.812						347147.996	389135.456	19.858
22.723						347148.046	389136.365	19.858
23.574						347148.03	389137.216	19.793
23.934						347148.068	389137.574	20.239
26.382						347148.673	389139.946	20.251
27.146						347148.947	389140.659	20.49
29.684						347149.611	389143.086	20.98
32.813						347150.449	389146.124	21.357
35.517						347150.824	389148.802	22.102
40.319						347149.649	389153.458	22.481
41.317						347149.792	389154.445	21.021
44.303						347150.057	389157.42	21.02
46.285						347150.246	389159.392	22.504
50.267						347150.618	389163.357	22.952

Distance to Downstream cross- section X (m)	
	1213.34

Water Level (mAOD)	19.965
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Relative Path Length		
Left Floodplain	Distance	RPL
Channel		
Right Floodplain		



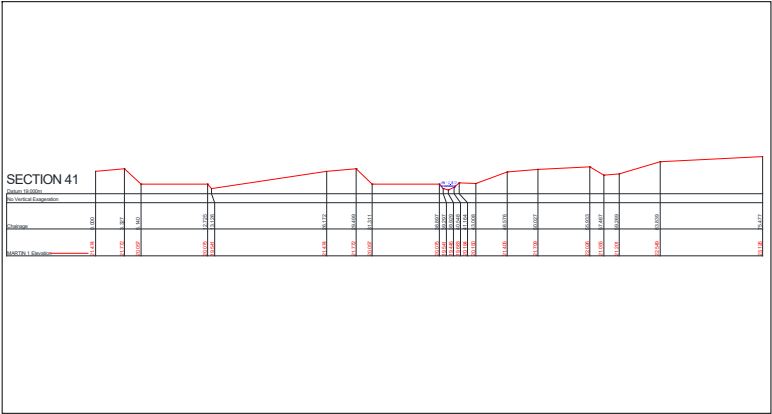
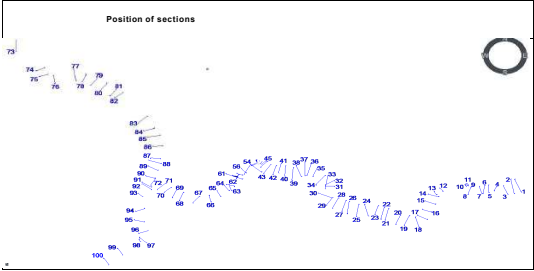
Section 41

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347122.118	389128.097	21.474
3.327						347123.054	389131.29	21.772
5.140						347123.734	389132.97	20.857
12.725						347125.428	389140.364	20.875
39.297						347125.308	389140.747	19.541
39.929						347125.485	389141.353	19.445
40.548						347125.785	389141.906	19.663
41.164						347125.773	389142.521	20.184
43.008						347126.295	389144.25	20.15
46.576						347127.163	389147.751	21.405
50.027						347127.81	389151.141	21.709
55.933						347130.047	389158.607	22.026
57.487						347130.632	389158.025	21.855
59.289						347131.22	389159.728	21.201
63.839						347131.342	389164.296	22.549
75.477						347133.816	389175.668	23.126

Distance to Downstream cross- section X (m)	1236.45
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Water Level (mAOD)	19.822
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Relative Path Length		
Left Floodplain	Distance	RPL
Channel		
Right Floodplain		



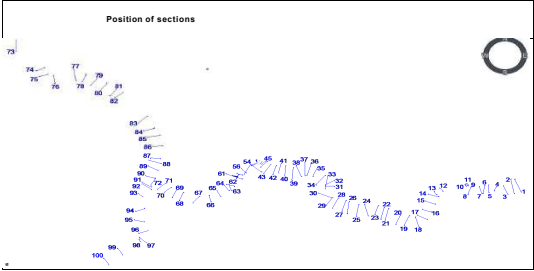
Section 42

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347099.83	389119.595	21.511
10.076						347100.119	389129.667	21.545
11.152						347100.313	389130.725	22.22
13.178						347100.097	389132.714	21.869
16.483						347100.171	389136.044	20.867
21.737						347101.949	389140.988	20.863
23.901						347103.158	389142.782	20.115
25.521						347104.052	389144.134	19.872
25.860						347104.147	389144.435	19.858
26.274						347104.231	389144.854	19.824
26.730						347104.284	389145.317	19.665
27.489						347104.469	389146.053	20.113
29.857						347104.97	389148.367	20.14
33.892						347105.802	389152.315	20.59
35.980						347106.975	389154.043	21.195
37.675						347107.791	389155.529	21.34
38.688						347108.307	389156.4	21.346
39.711						347108.852	389157.266	20.862
47.785						347113.233	389164.024	20.863

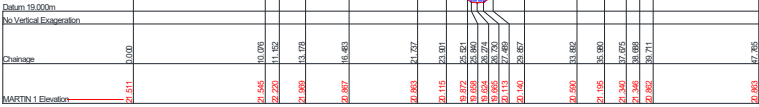
Distance to Downstream cross- section X (m)	1257.89
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Water Level (mAOD)	19.751
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



SECTION 42



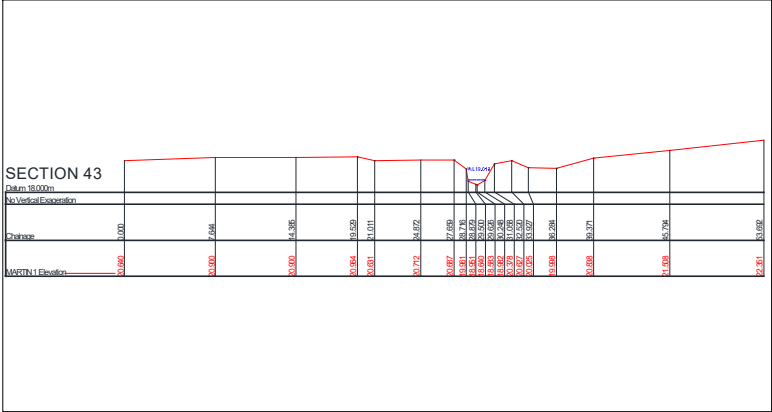
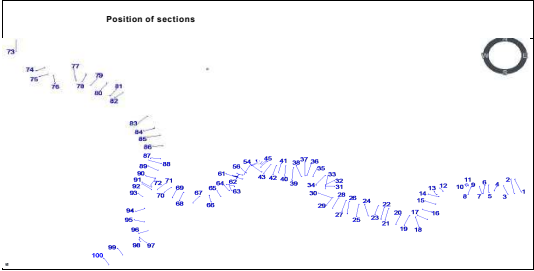
Section 43

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347062.735	389125.334	20.64
7.644						347066.748	389131.84	20.9
14.385						347070.276	389137.584	20.9
19.529						347072.924	389141.994	20.964
21.011						347073.864	389143.14	20.831
24.872						347077.697	389148.572	20.687
27.659						347078.112	389149.544	19.961
28.716						347078.275	389149.536	18.951
28.879						347078.815	389149.841	18.64
29.500						347078.814	389149.967	18.583
29.626						347078.162	389150.483	18.982
30.248						347078.112	389149.882	19.013
31.058						347078.915	389150.781	20.378
32.520						347080.382	389152.167	20.627
33.927						347081.171	389153.331	20.025
36.284						347082.531	389155.257	19.998
39.371						347084.349	389157.751	20.838
45.794						347088.808	389162.375	21.508
53.692						347091.592	389169.766	22.351

Distance to Downstream cross- section X (m)	1283.97
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Water Level (mAOD)	19.013
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



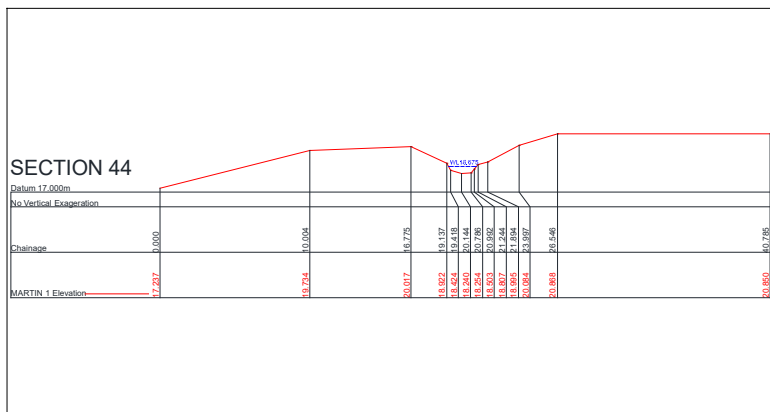
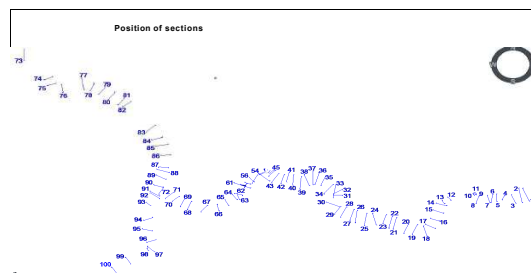
Section 44

[illegible]

Distance to Downstream cross-section X (m)	
	1310.62

Water Level (mAOD)	18.675
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



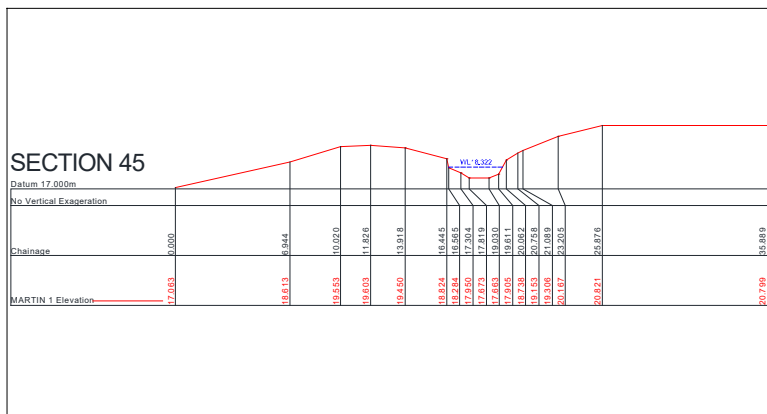
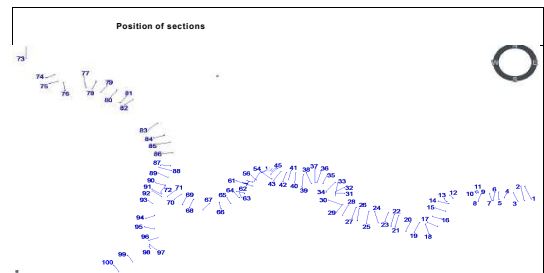
Section 45

Chainage (m)	Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (MAOD)
0.000					347047.351	389160.974	17.063
10.020					347054.351	389168.178	19.553
11.826					347055.527	389169.517	19.603
13.018					347057.011	389170.992	19.845
16.445					347059.041	389172.456	18.824
16.565					347059.148	389172.552	18.284
17.304					347059.801	389172.898	17.95
17.819					347060.193	389173.231	17.673
19.030					347060.884	389174.228	17.563
19.611					347061.142	389174.746	17.865
20.062					347061.438	389175.087	18.738
23.205					347063.491	389177.467	20.167
25.876					347065.088	389179.608	20.821
35.889					347071.508	389187.292	20.769

Distance to Downstream cross-section X (m)	
	1314.04

Water Level (mAOD)	18.322
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



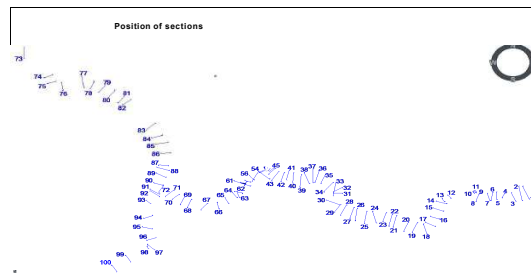
Section 46

[illegible]

Distance to Downstream cross-section X (m)	
	1320.69

Water Level (mAOD)	17.877
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



Datum 17.000m

No Vertical Exaggeration

[illegible]

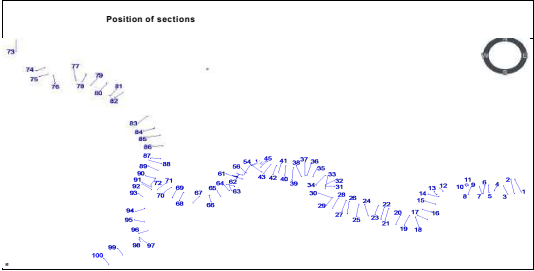
Section 47

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347046.01	389168.619	17.193
8.062						347048.515	389172.955	17.191
8.990						347048.97	389173.764	16.187
12.180						347050.56	389176.53	18.286
13.669						347051.397	389177.761	17.939
13.732						347051.436	389177.81	16.951
15.485						347052.516	389179.191	16.458
15.849						347052.855	389179.325	16.435
16.827						347053.489	389180.086	16.598
17.242						347053.765	389180.377	16.886
17.374						347053.864	389180.464	17.266
17.928						347054.187	389180.914	17.616
22.196						347055.371	389185.015	19.285
23.733						347055.614	389186.532	20.333
29.163						347054.762	389191.895	20.363

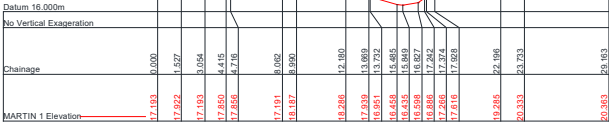
Distance to Downstream cross- section X (m)	
	1323.84

Water Level (mAOD)	17.229
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



SECTION 47



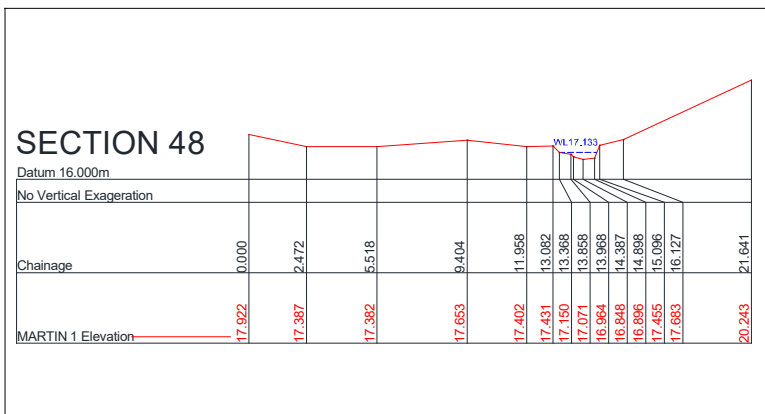
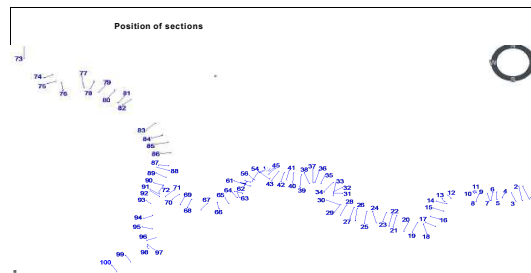
Section 48

[illegible]

Distance to Downstream cross-section X (m)	
	1332.15

Water Level (mAOD)	17.133
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



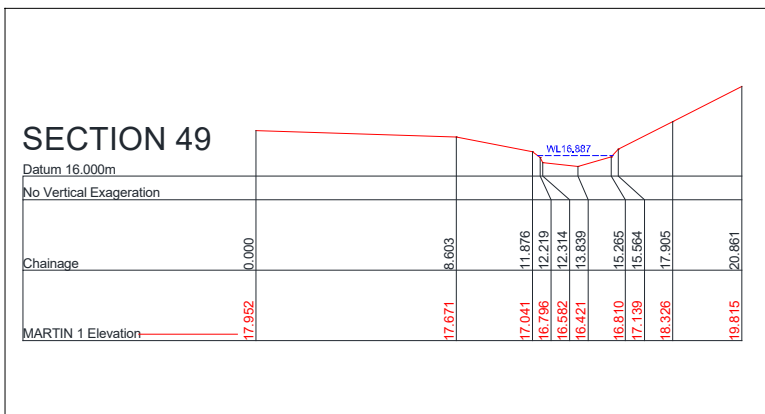
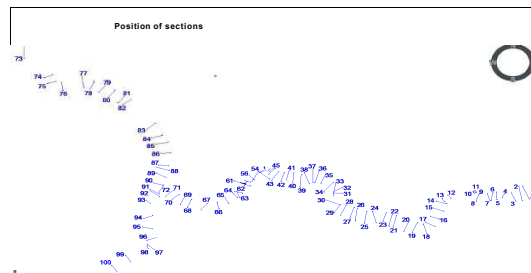
Section 49

[illegible]

Distance to Downstream cross-section X (m)	
	1333.76

Water Level (mAOD)	16.887
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



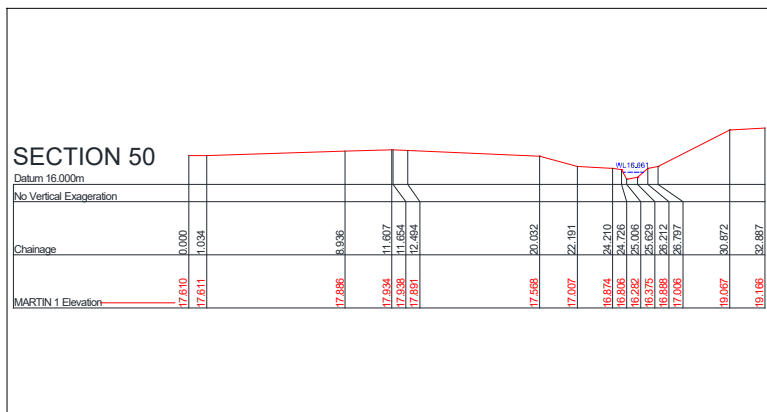
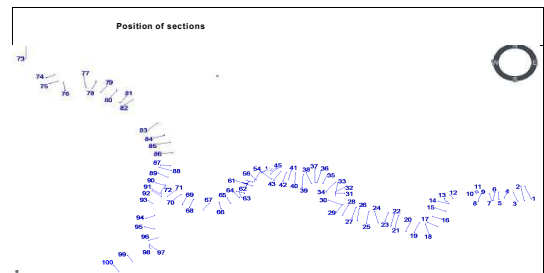
Section 50

[illegible]

Distance to Downstream cross-section X (m)	
	1342.70

Water Level (mAOD)	16.661
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



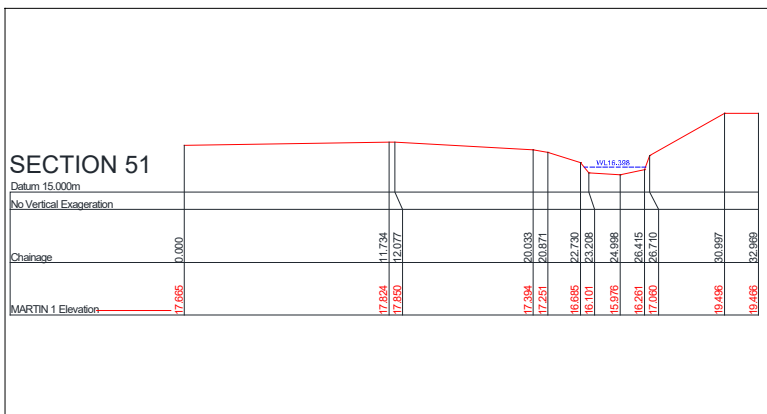
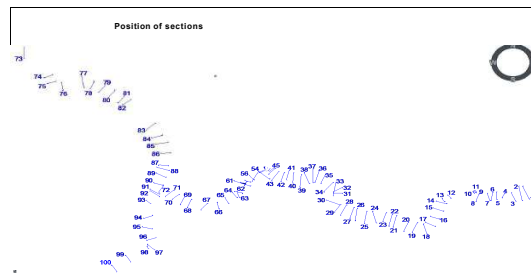
Section 51

[illegible]

Distance to Downstream cross-section X (m)	
	1344.44

Water Level (mAOD)	16.398
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



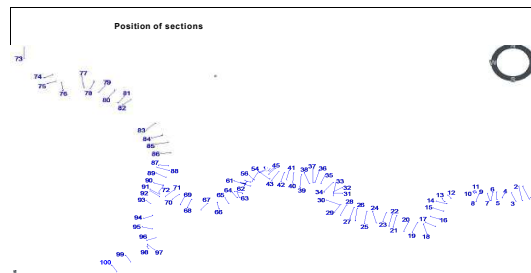
Section 52

[illegible]

Distance to Downstream cross-section X (m)	
	1356.51

Water Level (mAOD)	16.410
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



Datum 16.000m

No Vertical Exaggeration



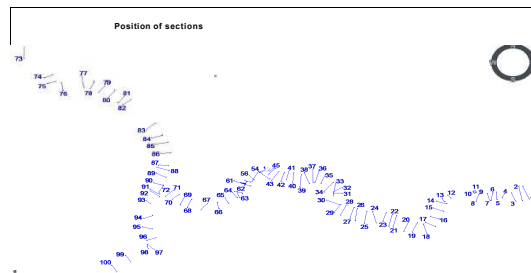
Section 53

[illegible]

Distance to Downstream cross-section X (m)	
	1359.18

Water Level (mAOD)	15.883
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



Datum 15.000m

No Vertical Exaggeration

[illegible]

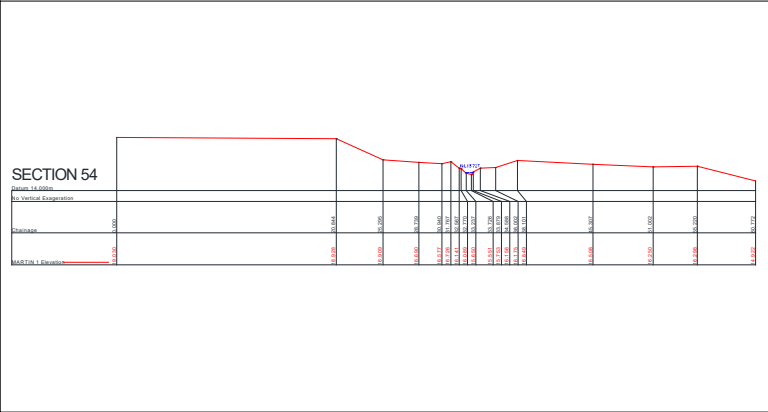
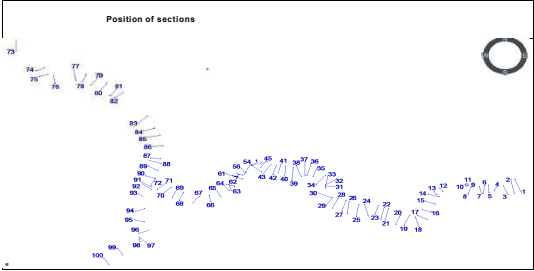
Section 54

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						347054.335	389132.242	19.03
20.844						347038.082	389145.293	18.928
25.295						347034.802	389148.301	18.809
28.739						347032.213	389150.573	18.69
30.940						347030.242	389151.552	16.577
31.767						347029.508	389151.933	16.726
32.567						347028.8	389152.305	16.141
32.770						347028.597	389152.305	16.089
33.237						347028.181	389152.517	15.85
33.726						347027.802	389152.785	15.551
33.879						347027.654	389152.825	15.753
34.588						347027.141	389153.314	16.156
36.002						347025.978	389154.118	16.175
38.101						347024.516	389155.825	16.849
45.307						347018.354	389159.36	16.508
51.002						347013.928	389162.944	16.25
55.220						347010.707	389165.668	16.298
60.772						347009.042	389170.964	14.922

Distance to Downstream cross- section X (m)	1376.81
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Water Level (mAOD)	15.727
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



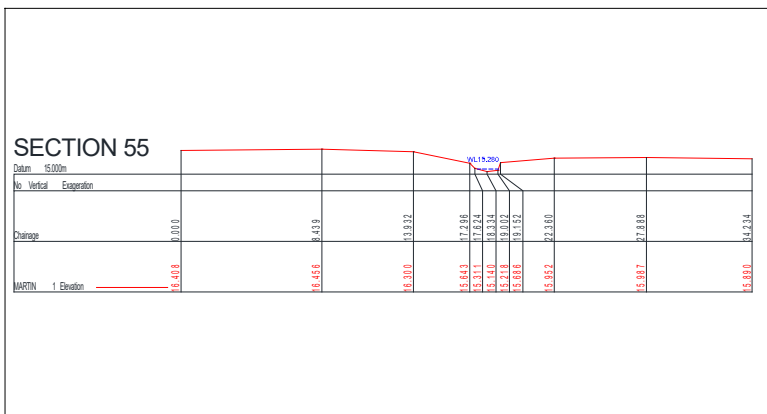
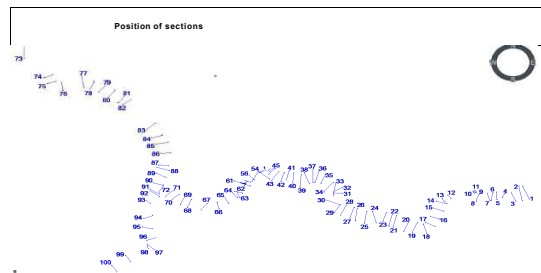
Section 55

[illegible]

Distance to Downstream cross-section X (m)	
	1407.43

Water Level (mAOD)	15.280
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



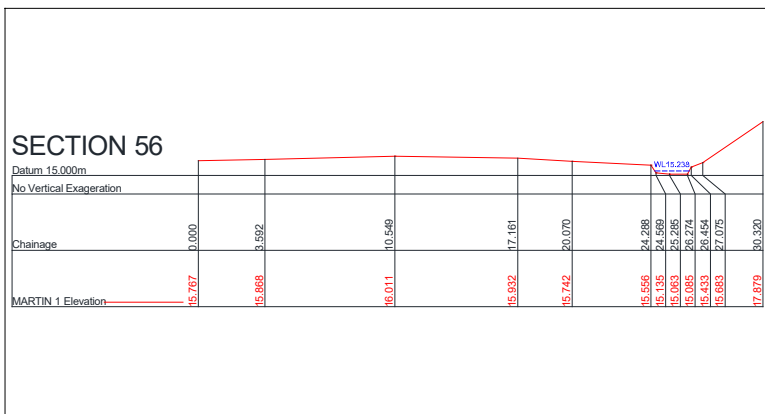
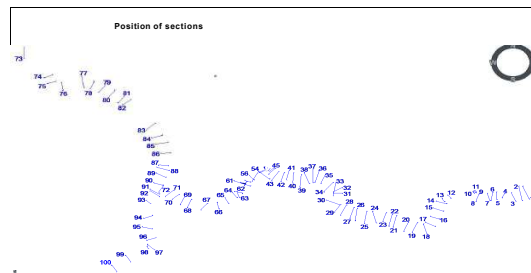
Section 56

[illegible]

Distance to Downstream cross-section X (m)	
	1431.22

Water Level (mAOD)	15.238
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



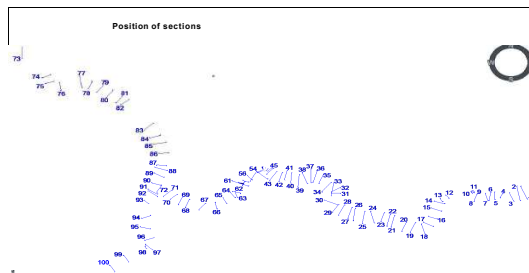
Section 57

[illegible]

Distance to Downstream cross-section X (m)	
	1457.70

Water Level (mAOD)	15.077
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



Datum 14.000m

No Vertical Exaggeration

[illegible]

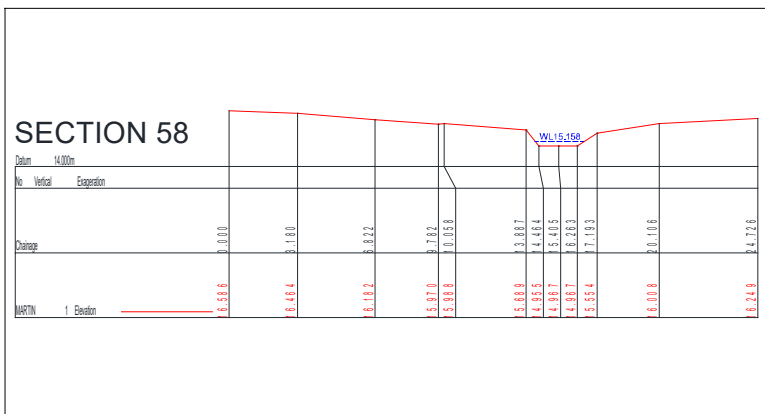
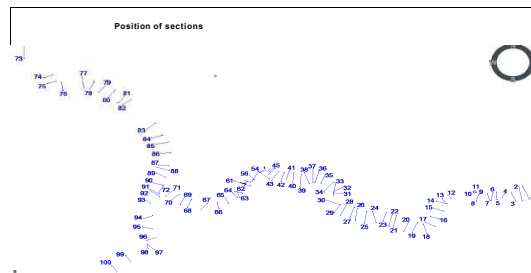
Section 58

[illegible]

Distance to Downstream cross-section X (m)	
	1470.95

Water Level (mAOD)	15.158
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



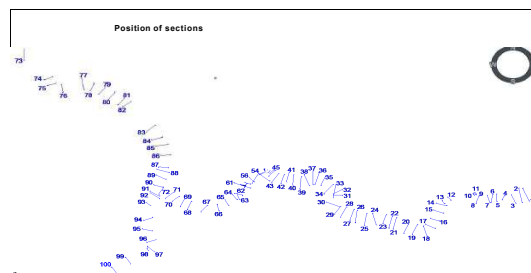
Section 59

[illegible]

Distance to Downstream cross-section X (m)	
	1487.02

Water Level (mAOD)	15.126
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



Datum 14.000m

No Vertical Exaggeration



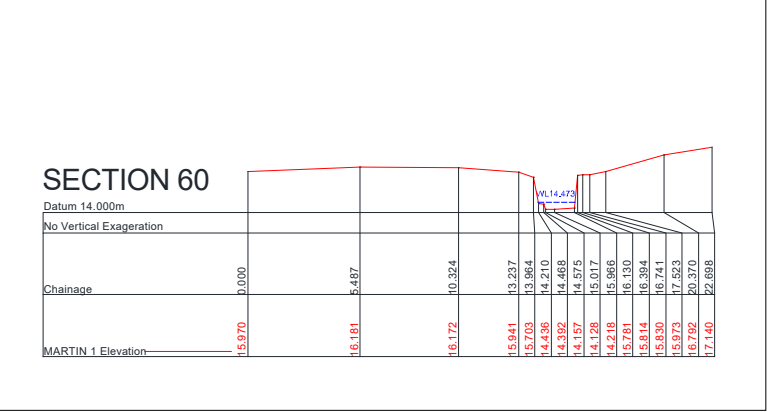
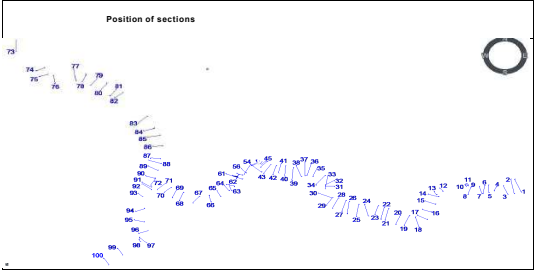
Section 60

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						346957.794	389107.398	15.97
5.487						346953.013	389110.09	16.181
10.324						346948.638	389112.154	16.172
13.237						346945.742	389112.462	15.941
13.964						346945.03	389112.609	15.703
14.210						346944.848	389112.775	14.436
14.468						346944.613	389112.881	14.392
14.575						346944.515	389112.838	14.157
15.017						346944.073	389112.85	14.128
15.966						346943.156	389113.096	14.218
16.130						346942.999	389113.142	15.781
16.394						346942.74	389113.193	15.814
16.741						346942.393	389113.198	15.83
17.523						346941.646	389113.43	15.973
20.370						346938.864	389114.036	16.792
22.698						346936.551	389114.295	17.14

Distance to Downstream cross- section X (m)	
	1488.43

Water Level (mAOD)	14.473
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



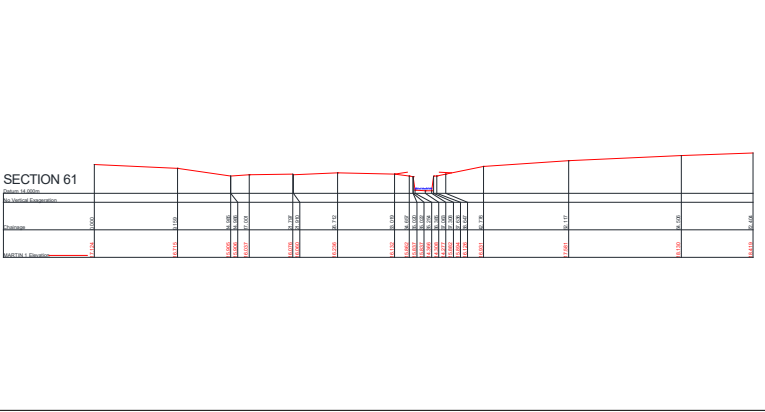
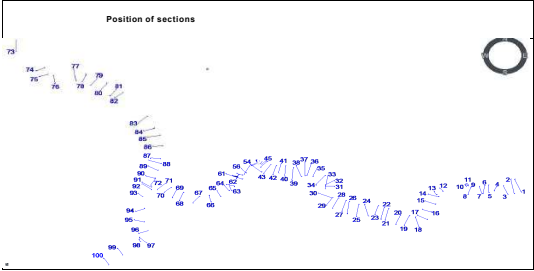
Section 61

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						348978.407	389102.044	17.124
9.159						348969.334	389103.299	16.715
17.001						348961.593	389104.555	16.037
26.712						348952.588	389106.186	16.236
33.019						348946.504	389108.847	16.132
34.657						348944.956	389110.382	15.862
35.020						348944.622	389110.529	15.838
35.254						348944.393	389110.559	14.366
36.385						348943.352	389111.001	14.369
37.063						348942.675	389111.032	14.277
37.308						348942.433	389111.073	15.882
37.636						348942.106	389111.088	15.894
38.647						348941.122	389111.319	16.126
42.776						348937.386	389113.077	16.931
52.117						348929.065	389117.323	17.581
64.506						348918.228	389123.326	18.13
72.404						348911.09	389126.708	18.419

Distance to Downstream cross- section X (m)	1490.43
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Water Level (mAOD)	14.505
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Relative Path Length		
Left Floodplain	Distance	RPL
Channel		
Right Floodplain		



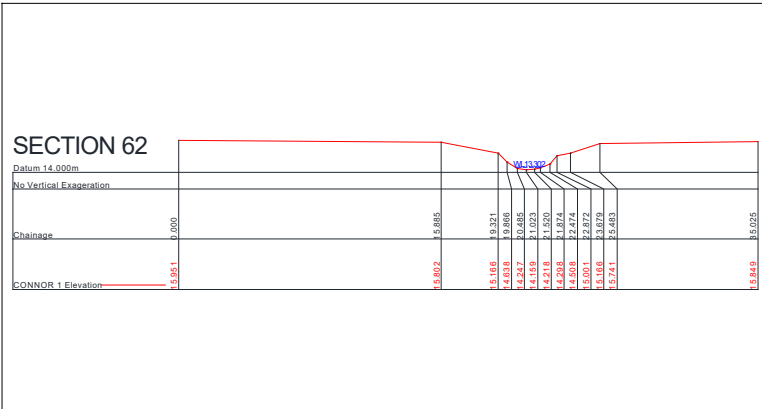
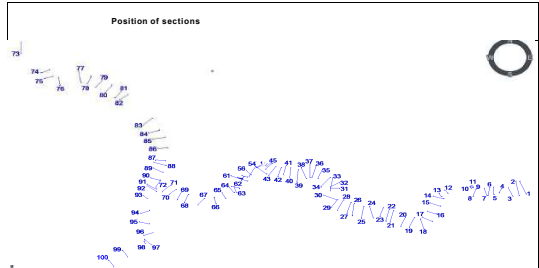
Section 62

[illegible]

Distance to Downstream cross-section X (m)	
	1533.26

Water Level (mAOD)	13.302
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



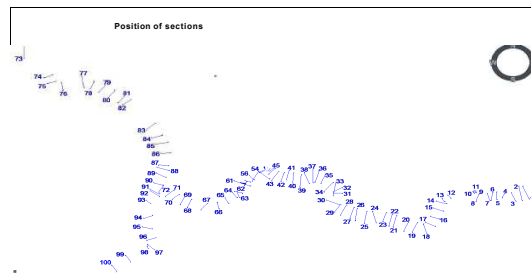
Section 63

[illegible]

Distance to Downstream cross-section X (m)	
	1546.00

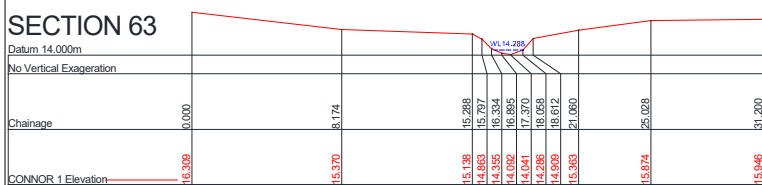
Water Level (mAOD)	14.288
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



Datum 14.000m

No Vertical Exaggeration



CONNOR 1 Elevation

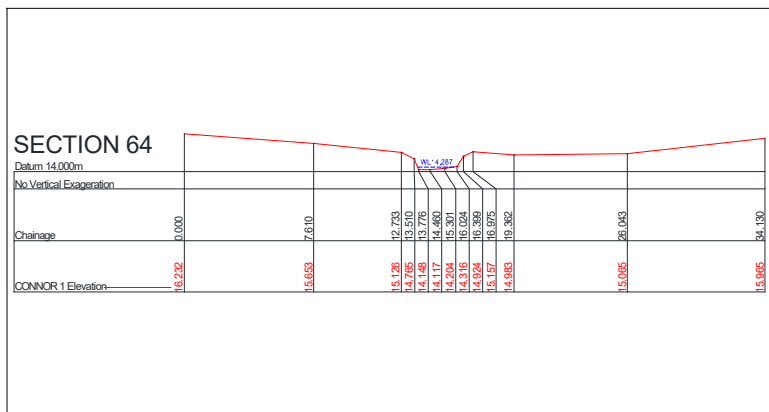
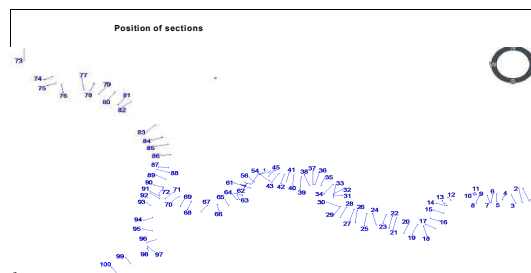
Section 64

[illegible]

Distance to Downstream cross-section X (m)	
	1561.21

Water Level (mAOD)	14.287
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



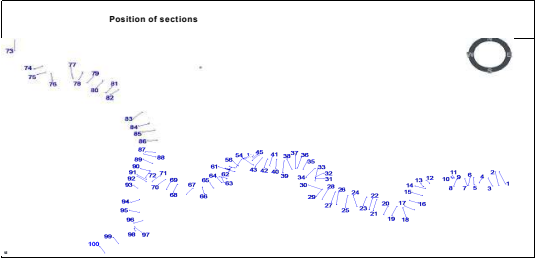
Section 65

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000						3468663.656	389024.268	16.169
9.055						3468662.327	389033.225	16.023
15.936						3468661.210	389040.015	16.047
18.534						3468660.129	389042.377	16.072
21.016						3468660.309	389044.724	15.471
21.465						3468660.055	389045.094	15.013
21.524						3468660.050	389045.035	14.076
22.726						3468559.421	389046.059	14.070
22.958						3468559.343	389046.277	13.937
23.786						3468559.065	389047.085	13.944
24.145						3468558.794	389047.291	15.058
26.411						3468558.400	389049.624	15.725
29.686						3468557.987	389052.772	15.702
34.357						3468557.256	389057.395	15.671
44.071						3468556.086	389066.993	16.041
52.544						346860.498	389075.270	16.424
62.797						346862.906	389085.237	16.805

Distance to Downstream cross- section X (m)	
	1614.21

Water Level (mAOD)	14.152
--------------------	--------

Relative Path Length	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



SECTION 65



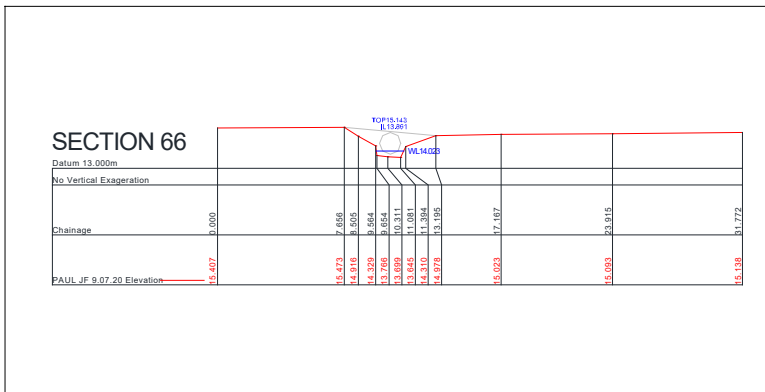
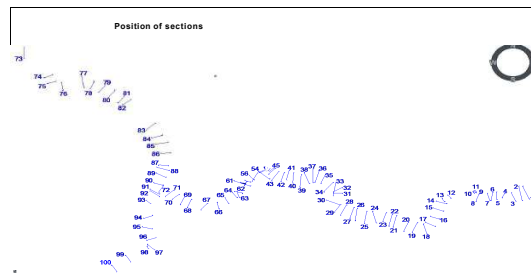
Section 66

[illegible]

Distance to Downstream cross-section X (m)	
	1673.23

Water Level (mAOD)	14.023
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



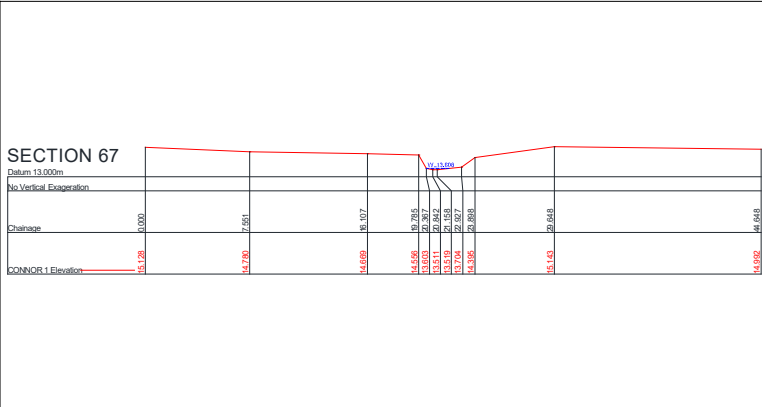
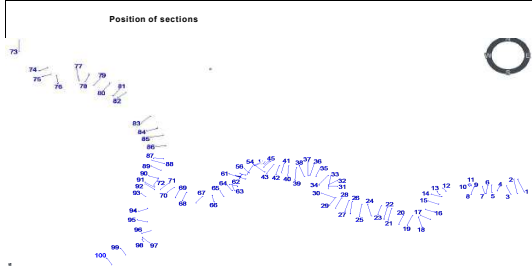
Section 67

[illegible]

Distance to Downstream cross-section X (m)	
	1705.94

Water Level (mAOD)	13.608
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



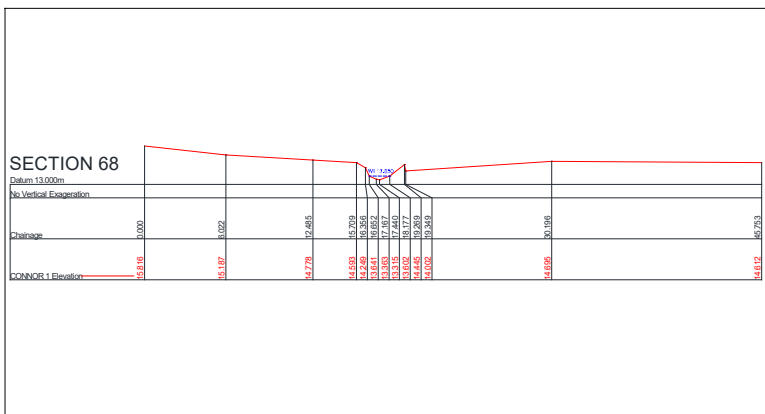
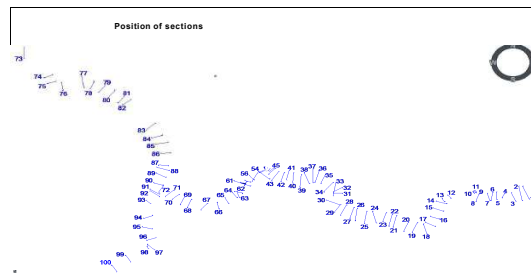
Section 68

[illegible]

Distance to Downstream cross-section X (m)	
	1760.76

Water Level (mAOD)	13.630
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



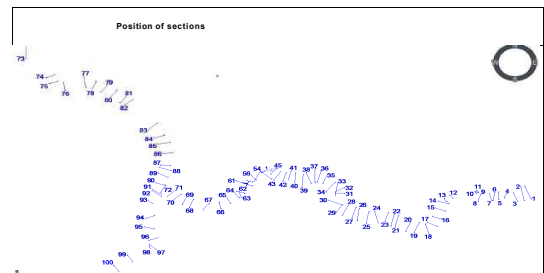
Section 69

[illegible]

Distance to Downstream cross-section X (m)	
	1794.94

Water Level (mAOD)	13.613
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



Datum 13.000m

No Vertical Exaggeration

	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970	1969	1968	1967	1966	1965	1964	1963	1962	1961	1960	1959	1958	1957	1956	1955	1954	1953	1952	1951	1950	1949	1948	1947	1946	1945	1944	1943	1942	1941	1940	1939	1938	1937	1936	1935	1934	1933	1932	1931	1930	1929	1928	1927	1926	1925	1924	1923	1922	1921	1920	1919	1918	1917	1916	1915	1914	1913	1912	1911	1910	1909	1908	1907	1906	1905	1904	1903	1902	1901	1900	1899	1898	1897	1896	1895	1894	1893	1892	1891	1890	1889	1888	1887	1886	1885	1884	1883	1882	1881	1880	1879	1878	1877	1876	1875	1874	1873	1872	1871	1870	1869	1868	1867	1866	1865	1864	1863	1862	1861	1860	1859	1858	1857	1856	1855	1854	1853	1852	1851	1850	1849	1848	1847	1846	1845	1844	1843	1842	1841	1840	1839	1838	1837	1836	1835	1834	1833	1832	1831	1830	1829	1828	1827	1826	1825	1824	1823	1822	1821	1820	1819	1818	1817	1816	1815	1814	1813	1812	1811	1810	1809	1808	1807	1806	1805	1804	1803	1802	1801	1800	1799	1798	1797	1796	1795	1794	1793	1792	1791	1790	1789	1788	1787	1786	1785	1784	1783	1782	1781	1780	1779	1778	1777	1776	1775	1774	1773	1772	1771	1770	1769	1768	1767	1766	1765	1764	1763	1762	1761	1760	1759	1758	1757	1756	1755	1754	1753	1752	1751	1750	1749	1748	1747	1746	1745	1744	1743	1742	1741	1740	1739	1738	1737	1736	1735	1734	1733	1732	1731	1730	1729	1728	1727	1726	1725	1724	1723	1722	1721	1720	1719	1718	1717	1716	1715	1714	1713	1712																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
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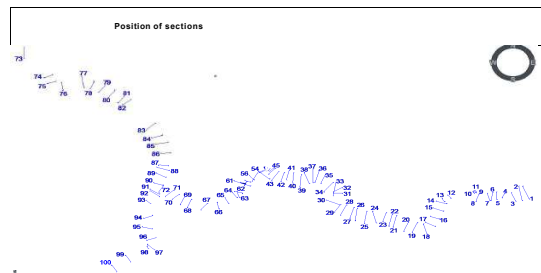
Section 70

[illegible]

Distance to Downstream cross-section X (m)	
	1830.87

Water Level (mAOD)	13.678
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



Datum 13.000m

Datum 13.000m
No Vertical Expansion

		2019		2018		2017		2016		2015		2014		2013		2012		2011		2010		2009		2008		2007		2006		2005		2004		2003		2002		2001		2000		1999		1998		1997		1996		1995		1994		1993		1992		1991		1990		1989		1988		1987		1986		1985		1984		1983		1982		1981		1980		1979		1978		1977		1976		1975		1974		1973		1972		1971		1970		1969		1968		1967		1966		1965		1964		1963		1962		1961		1960		1959		1958		1957		1956		1955		1954		1953		1952		1951		1950		1949		1948		1947		1946		1945		1944		1943		1942		1941		1940		1939		1938		1937		1936		1935		1934		1933		1932		1931		1930		1929		1928		1927		1926		1925		1924		1923		1922		1921		1920		1919		1918		1917		1916		1915		1914		1913		1912		1911		1910		1909		1908		1907		1906		1905		1904		1903		1902		1901		1900		1899		1898		1897		1896		1895		1894		1893		1892		1891		1890		1889		1888		1887		1886		1885		1884		1883		1882		1881		1880		1879		1878		1877		1876		1875		1874		1873		1872		1871		1870		1869		1868		1867		1866		1865		1864		1863		1862		1861		1860		1859		1858		1857		1856		1855		1854		1853		1852		1851		1850		1849		1848		1847		1846		1845		1844		1843		1842		1841		1840		1839		1838		1837		1836		1835		1834		1833		1832		1831		1830		1829		1828		1827		1826		1825		1824		1823		1822		1821		1820		1819		1818		1817		1816		1815		1814		1813		1812		1811		1810		1809		1808		1807		1806		1805		1804		1803		1802		1801		1800		1799		1798		1797		1796		1795		1794		1793		1792		1791		1790		1789		1788		1787		1786		1785		1784		1783		1782		1781		1780		1779		1778		1777		1776		1775		1774		1773		1772		1771		1770		1769		1768		1767		1766		1765		1764		1763		1762		1761		1760		1759		1758		1757		1756		1755		1754		1753		1752		1751		1750		1749		1748		1747		1746		1745		1744		1743		1742		1741		1740		1739		1738		1737		1736		1735		1734		1733		1732		1731		1730		1729		1728		1727		1726		1725		1724		1723		1722		1721		1720		1719		1718		1717		1716		1715		1714		1713		1712		1711		1710		1709		1708		1707		1706		1705		1704		1703		1702		1701		1700		1699		1698		1697		1696		1695		1694		1693		1692		1691		1690		1689		1688		1687		1686		1685		1684		1683		1682		1681		1680		1679		1678		1677		1676		1675		1674		1673		1672		1671		1670		1669		1668		1667		1666		1665		1664		1663		1662		1661		1660		1659		1658		1657		1656		1655		1654		1653		1652		1651		1650		1649		1648		1647		1646		1645		1644		1643		1642		1641		1640		1639		1638		1637		1636		1635		1634		1633		1632		1631		1630		1629		1628		1627		1626		1625		1624		1623		1622		1621		1620		1619		1618		1617		1616		1615		1614		1613		1612		1611		1610		1609		1608		1607		1606		1605		1604		1603		1602		1601		1600		1599		1598		1597		1596		1595		1594		1593		1592		1591		1590		1589		1588		1587		1586		1585		1584		1583		1582		1581		1580		1579		1578		1577		1576		1575		1574		1573		1572		1571		1570		1569		1568		1567		1566		1565		1564		1563		1562		1561		1560		1559		1558		1557		1556		1555		1554		1553		1552		1551		1550		1549		1548		1547		1546		1545		1544		1543		1542		1541		1540		1539		1538		1537		1536		1535		1534		1533		1532		1531		1530		1529		1528		1527		1526		1525		1524		1523		1522		1521		1520		1519		1518		1517		1516		1515		1514		1513		1512		1511		1510		1509		1508		1507		1506		1505		1504		1503		1502		1501		1500		1499		1498		1497		1496		1495		1494		1493		1492		1491		1490		1489		1488		1487		1486		1485		1484		1483		1482		1481		1480		1479		1478		1477		1476		1475		1474		1473		1472		1471		1470		1469		1468		1467		1466		1465		1464		1463		1462		1461		1460		1459		1458		1457		1456		1455		1454		1453		1452		1451		1450		1449		1448		1447		1446		1445		1444		1443		1442		1441		1440		1439		1438		1437		1436		1435		1434		1433		1432		1431		1430		1429		1428		1427		1426		1425		1424		1423		1422		1421		1420		1419		1418		1417		1416		1415		1414		1413		1412		1411		1410		1409		1408		1407		1406		1405		1404		1403		1402		1401		1400		1399		1398		1397		1396		1395		1394		1393		1392		1391		1390		1389		1388		1387		1386		1385		1384		1383		1382		1381		1380		1379		1378		1377		1376		1375		1374		1373		1372		1371		1370		1369		1368		1367		1366		1365		1364		1363		1362		1361		1360		1359		1358		1357		1356		1355		1354		1353		1352		1351		1350		1349		1348		1347		1346		1345		1344		1343		1342		1341		1340		1339		1338		1337		1336		1335		1334		1333		1332		1331		1330		1329		1328		1327		1326		1325		1324		1323		1322		1321		1320		1319		1318		1317		1316		1315		1314		1313		1312		1311		1310		1309		1308		1307		1306		1305		1304		1303		1302		1301		1300		1299		1298		1297		1296		1295		1294		1293		1292		1291		1290		1289		1288		1287		1286		1285		1284		1283		1282		1281		1280		1279		1278		1277		1276		1275		1274		1273		1272		1271		1270		1269		1268		1267		1266		1265		1264		1263		1262		1261		1260		1259		1258		1257		1256		1255		1254		1253		1252		1251		1250		1249		1248		1247		1246		1245		1244		1243		1242		1241		1240		1239		1238		1237		1236		1235		1234		1233		1232		1231		1230		1229		1228		1227		1226		1225		1224		1223		1222		1221		1220		1219		1218		1217		1216		1215		1214		1213		1212		1211		1210		1209		1208		1207		1206		1205		1204		1203		1202		1201		1200		1199		1198		1197		1196		1195		1194		1193		1192		1191		1190		1189		1188		1187		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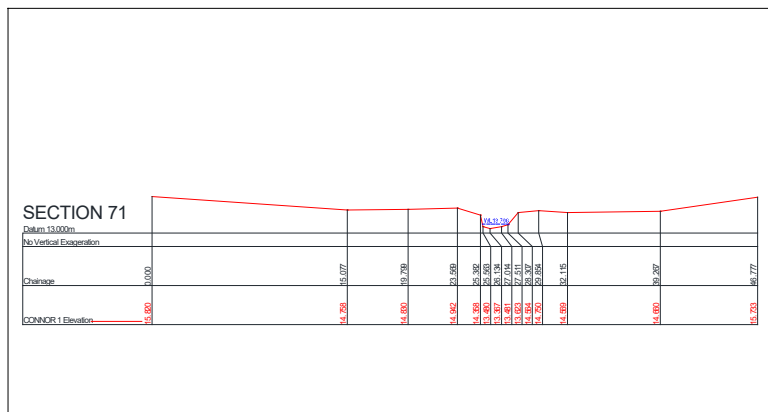
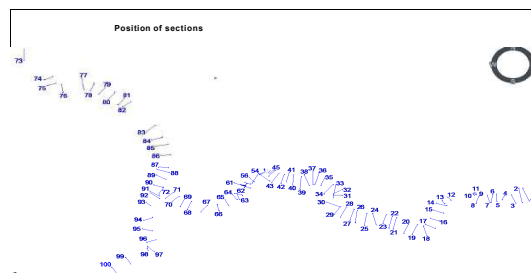
Section 71

[illegible]

Distance to Downstream cross-section X (m)	
	1858.18

Water Level (mAOD)	13.706
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



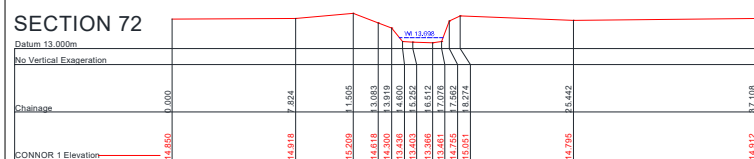
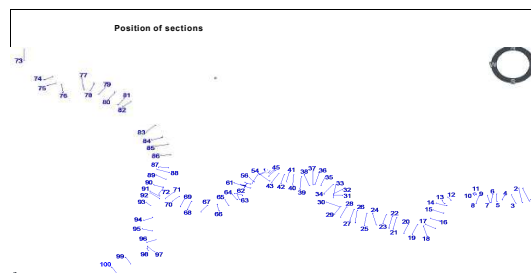
Section 72

[illegible]

Distance to Downstream cross-section X (m)	
	1902.73

Water Level (mAOD)	13.698
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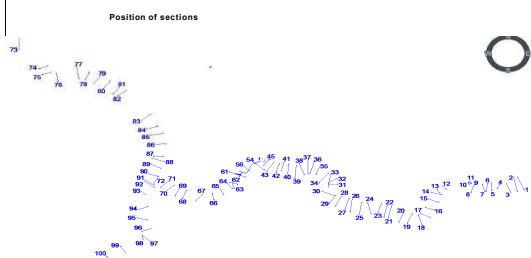
Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



Chainage (m)	Mannings N	Panel Markers	R/L	Bank Markers	Easting	Northing	Elevation (mAOOD)
0.000					346059.465	369711.552	23.11
6.093					346060.645	369717.53	23.03
6.129					346060.664	369717.56	22.94
16.829					346063.588	369727.653	22.93
16.862					346063.606	369727.88	22.94
22.292					346065.451	369732.987	22.96
24.975					346067.909	369734.063	22.56
26.078					346066.616	369736.884	20.83
26.660					346066.392	369737.421	20.83
33.431					346064.973	369739.801	21.04
31.650					346065.093	369740.306	20.83
36.568					346064.984	369741.237	21.04
39.805					346064.286	369744.851	22.80
44.742					346064.579	369748.075	23.05
44.863					346063.845	369752.957	22.96
49.329					346063.776	369753.03	23.02
49.403					346062.859	369757.422	22.85
55.403					346062.909	369757.476	23.03
59.403					346061.483	369763.304	23.15

Distance to Downstream cross- section X (m)	

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



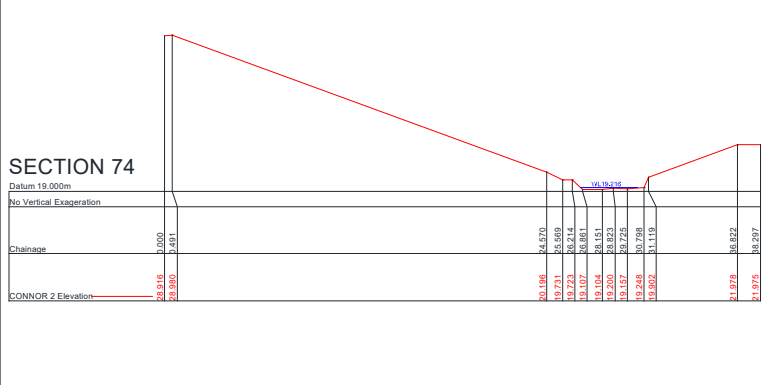
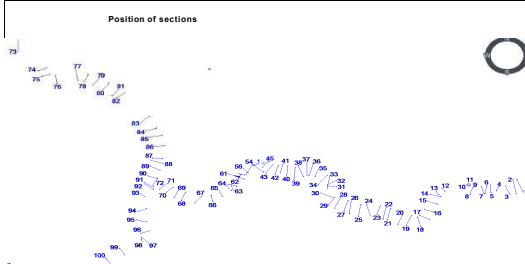
Section 74

Chains (m)	Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000					346177.267	389623.894	28.916
0.451					346176.808	389632.721	28.980
24.570					346154.143	389624.591	20.796
25.569					346153.153	389624.454	19.131
29.723					346152.503	389624.317	19.723
28.861					346151.895	389624.162	19.107
28.151					346150.737	389623.592	19.104
28.823					346150.129	389623.306	19.200
29.723					346149.278	389623.005	19.157
30.798					346148.400	389622.390	19.248
31.119					346148.132	389622.212	19.902
38.822					346143.649	389618.687	21.978
38.297					346142.263	389618.182	21.975

Distance to Downstream cross-section X (m)	
	173.63

Water Level (mAOD)	19.216
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



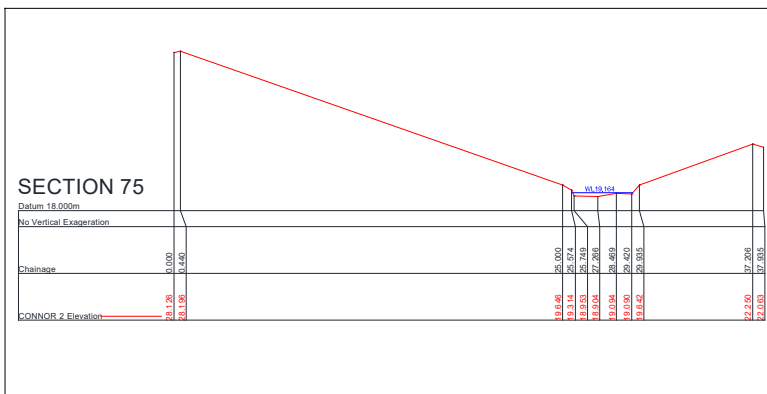
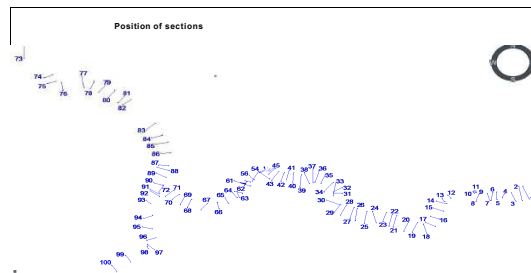
Section 75

[illegible]

Distance to Downstream cross-section X (m)	
	207.97

Water Level (mAOD)	19.164
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



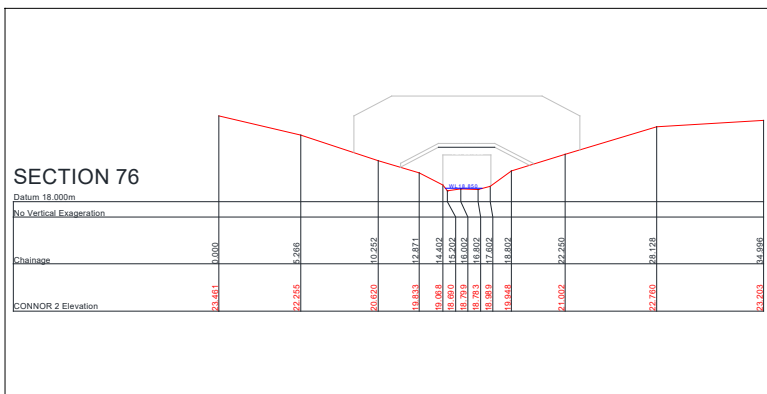
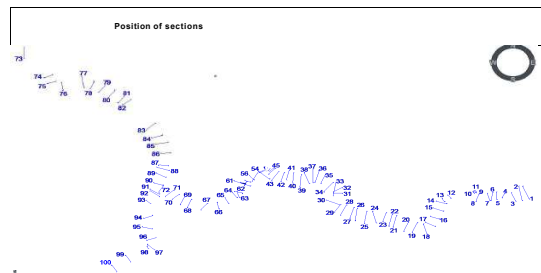
Section 76

[illegible]

Distance to Downstream cross-section X (m)	
	248.57

Water Level (mAOD)	18.850
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



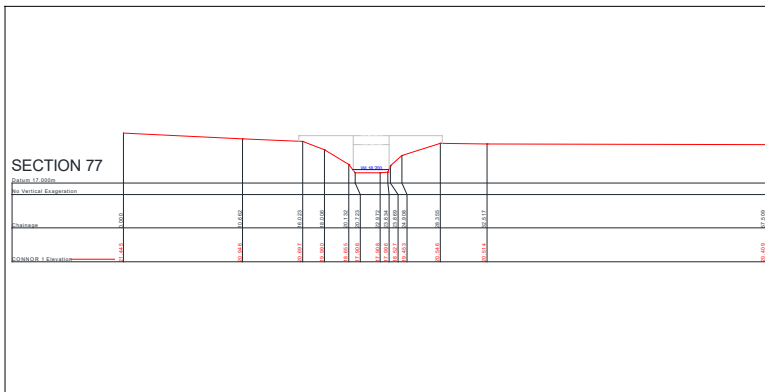
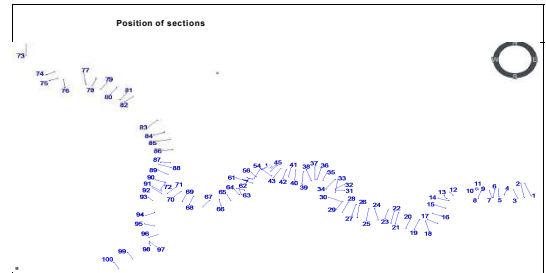
Section 77

Chainage (m)	Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAGD)
0.000					3463309.105	389576.013	21.445
10.862					3463304.596	389581.399	20.946
16.023					3463302.168	389586.501	20.897
18.006					3463301.347	389588.396	19.899
20.132					3463300.3	389590.246	18.655
20.723					3463300.122	389593.081	17.908
22.972					346299.855	389593.686	17.996
23.634					346299.835	389593.92	18.527
23.869					346299.225	389593.778	18.227
24.908					346299.52	389594.911	19.453
28.355					346298.848	389598.291	20.546
32.517					346297.451	389602.212	20.514
37.509					346293.709	389626.922	20.409

Distance to Downstream cross-section X (m)	
	357.82

Water Level (mAOD)	18.200
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



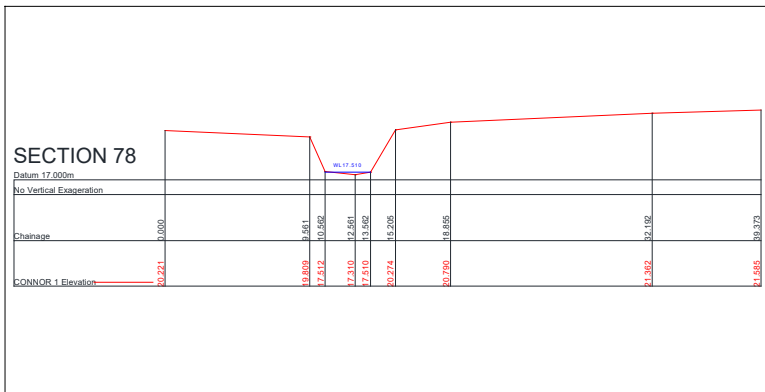
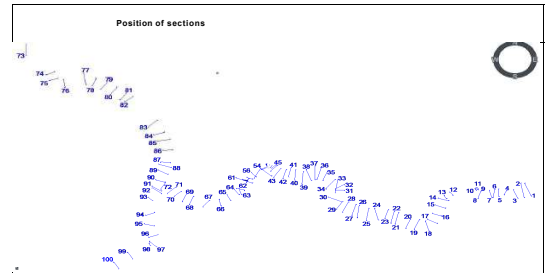
Section 78

[illegible]

Distance to Downstream cross-section X (m)	
	397.72

Water Level (mAOD)	17.510
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



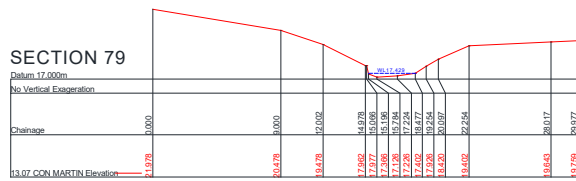
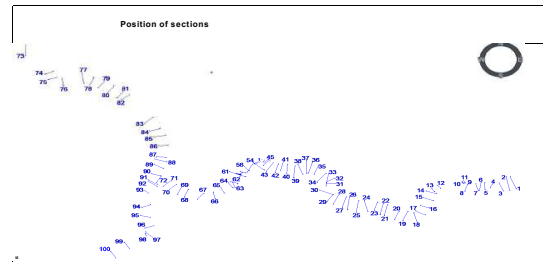
Section 79

Chainage (m)	Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (mAOD)
0.000					3463934.386	389587.183	21.978
9.000					3463911.131	389578.792	20.478
12.002					3463900.055	389575.990	19.478
14.978					3463888.988	389573.212	17.962
15.998					3463883.000	389573.256	17.977
15.198					3463888.923	389573.121	17.365
15.784					3463888.506	389572.706	17.126
17.224					3463887.104	389572.379	17.226
18.717					3463855.880	389571.431	17.402
19.254					3463855.495	389571.325	17.226
20.097					3463855.913	389569.773	18.402
22.254					3463853.662	389568.968	18.402
25.717					3463830.961	389562.015	18.431
29.977					3463830.688	389561.409	19.759

Distance to Downstream cross-section X (m)	
	446.53

Water Level (mAOD)	17.429
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



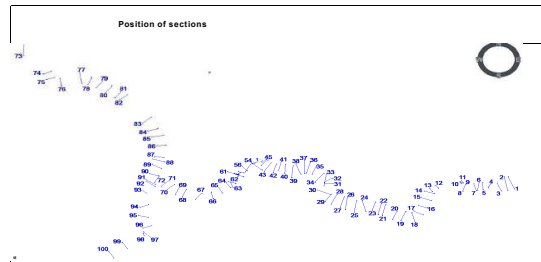
Section 80

[illegible]

Distance to Downstream cross-section X (m)	
	495.22

Water Level (mAOD)	17.156
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



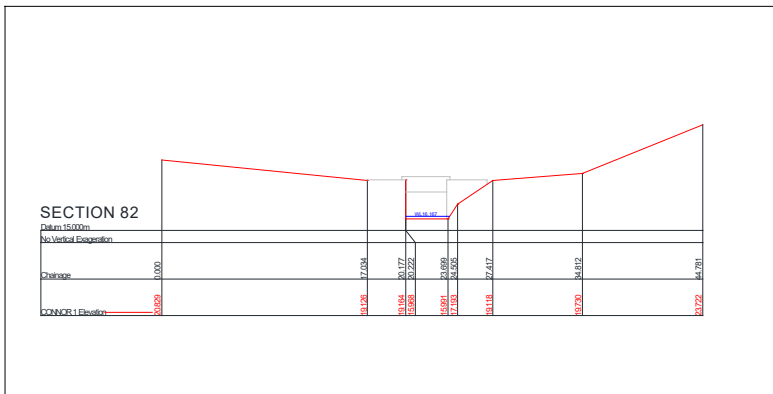
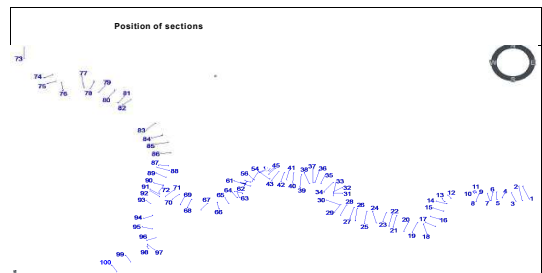
Section 81

[illegible]

Distance to Downstream cross-section X (m)	
	536.34

Water Level (mAOD)	16.851
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



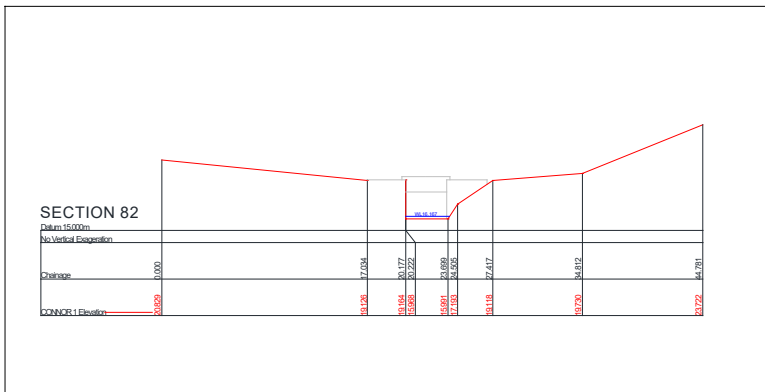
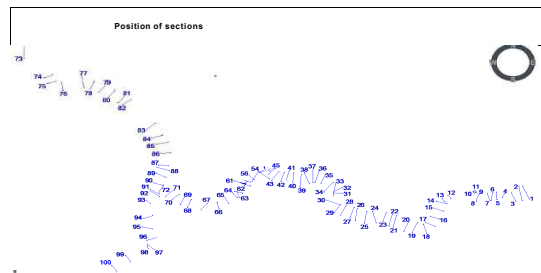
Section 82

[illegible]

Distance to Downstream cross-section X (m)	
	557.93

Water Level (mAOD)	16.167
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



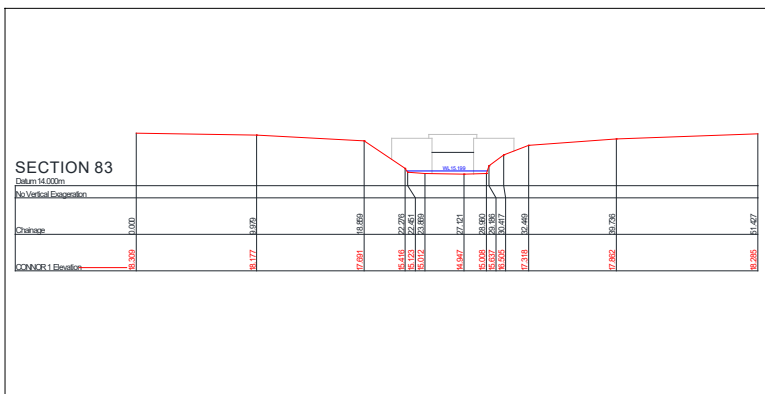
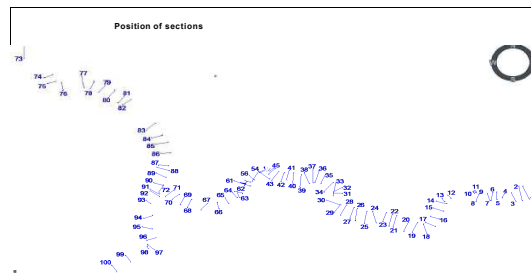
Section 83

[illegible]

Distance to Downstream cross-section X (m)	
	709.26

Water Level (mAOD)	15.199
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		

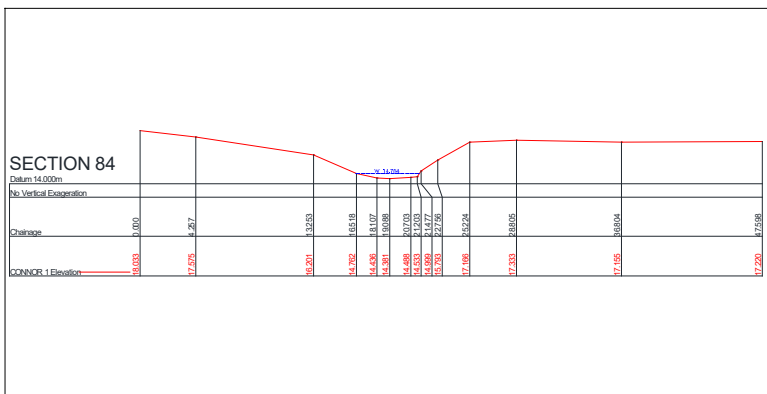
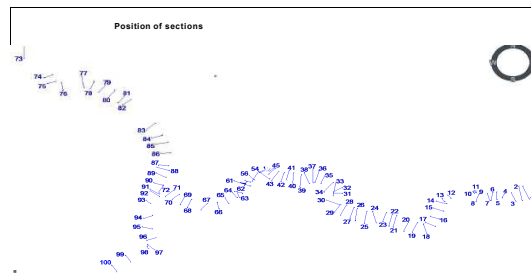


346555	389371.8	18.309	sec22e
346562	389378.78	18.177	sec22e
346568.1	389385.3	17.691	sec22e
346571.2	389386.7	15.416	sec22e
346571.3	389386.9	15.123	sec22e
346572.2	389388	15.012	sec22e
346573.1	389387.1	15.199	wl
346571.5	389392.2	14.947	sec22e
346573.3	389392.9	15.008	sec22e
346573.5	389393	15.637	sec22e
346574.5	389393.8	16.505	sec22e
346575.9	389395.2	17.318	sec22e
346581.7	389399.7	17.862	sec22e
346591.9	389405.3	18.285	sec22e

[illegible]

Water Level (mAOD)	14.764
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



346576.9	389334.1	17.22	sec25
346586.2	389339.5	17.155	sec25
346593.6	389342.5	17.333	sec25
346597.8	389339.9	17.166	sec25
346599.8	389342.1	15.793	sec25
346600.9	389342.9	14.999	sec25
346601.1	389343.1	14.533	sec25
346601.6	389343.3	14.488	sec25
346602.9	389344.2	14.381	sec25
346603.8	389343.9	14.436	sec25
346604.0	389343.9	14.764	wl
346605.3	389343.3	14.762	sec25
346608.4	389344.4	16.201	sec25
346617.4	389344.7	17.575	sec25
346621.3	389346.8	18.033	sec25

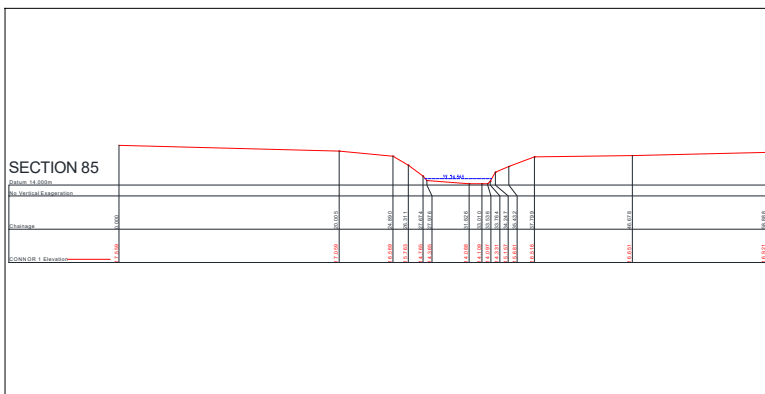
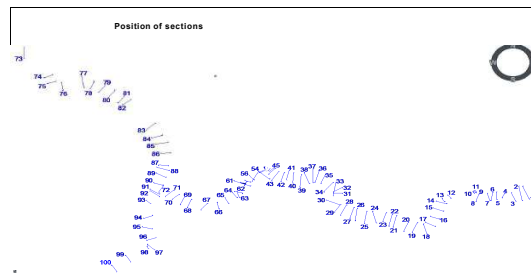
Section 85

[illegible]

Distance to Downstream cross-section X (m)	
	805.95

Water Level (mAOD)	14.548
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



346646.1	389313.8	17.559	sec2c4
346626.8	389308.7	17.059	sec2c4
346621.9	389308.7	16.569	sec2c4
346620.6	389308.2	15.763	sec2c4
346619.6	389307.2	14.785	sec2c4
346619.4	389307.2	14.365	sec2c4
346619.2	389302.1	14.088	sec2c4
346617.8	389302.5	14.109	sec2c4
346617.3	389302.6	14.097	sec2c4
346617.2	389302.4	14.331	sec2c4
346616.7	389302.5	15.157	sec2c4
346617.2	389301.6	14.548	wf
346615.5	389302.5	15.681	sec2c4
346613.3	389303.3	16.516	sec2c4
346604.4	389303.7	16.651	sec2c4
346592.3	389305	16.921	sec2c4

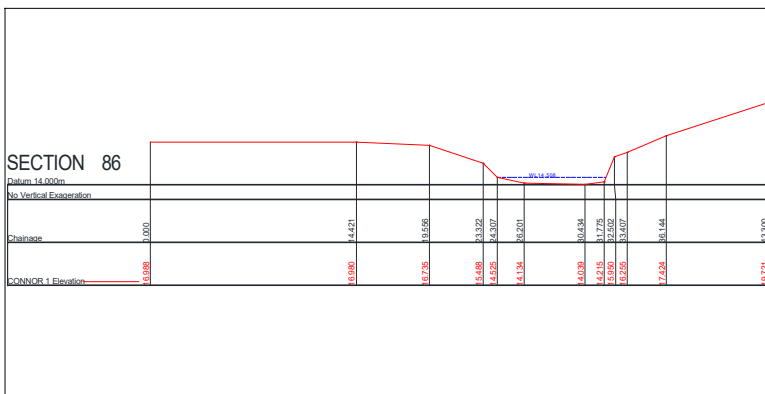
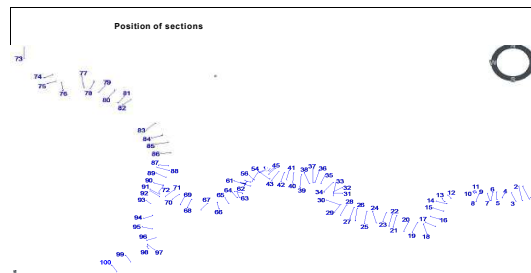
Section 86

[illegible]

Distance to Downstream cross-section X (m)	
	846.32

Water Level (mAOD)	14.508
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



346612.2	389259.8	19.721	secc23
346619.1	389262	17.424	secc23
346621.7	389262.7	16.255	secc23
346622.6	389262.6	15.95	secc23
346622.8	389263.3	14.215	secc23
346623.6	389264.4	14.039	secc23
346627.7	389263.4	14.134	secc23
346629.5	389264.1	14.525	secc23
346629.5	389264.1	14.508	wt
346630.4	389263.7	15.488	secc23
346634	389262.8	16.735	secc23
346638.9	389262	16.98	secc23
346653.7	389259.3	16.988	secc23

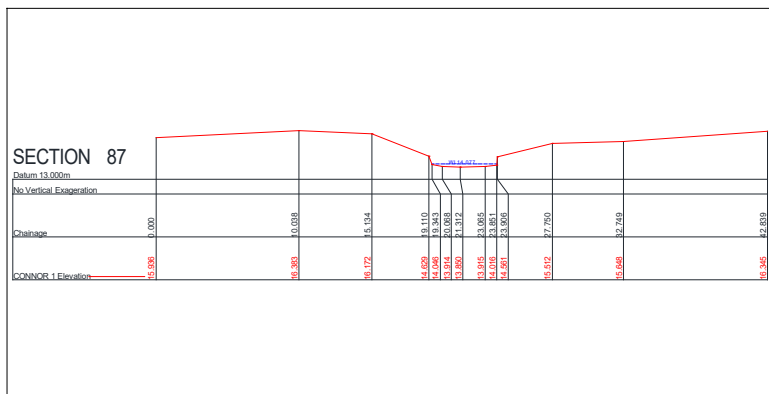
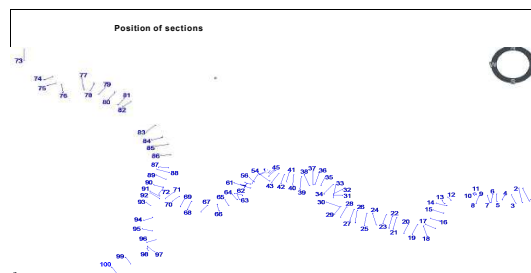
Section 87

[illegible]

Distance to Downstream cross-section X (m)	
	910.45

Water Level (mAOD)	14.077
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



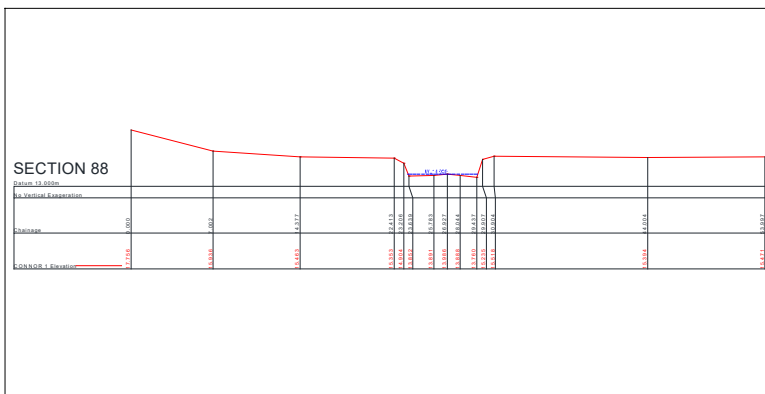
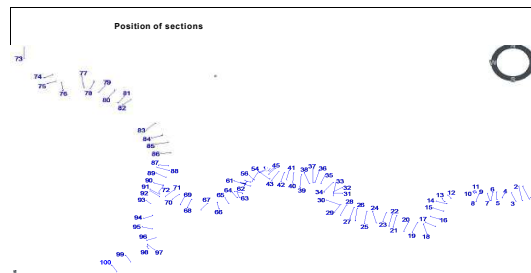
Section 88

Chainage (m)		Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (MAOD)
0.000						346648.259	389172.875	17.756
7.002						346642.401	389174.286	15.936
14.377						346635.428	389176.688	15.463
22.413						346627.611	389178.548	15.353
33.208						346626.822	389178.834	14.904
23.639						346626.541	389178.964	13.852
25.783						346624.706	389180.073	13.891
26.927						346623.622	389180.438	13.866
28.044						346622.507	389180.882	13.888
29.237						346621.244	389181.213	13.747
29.907						346620.775	389181.242	15.235
30.904						346619.836	389181.579	15.518
44.004						346607.353	389185.55	15.394
53.997						346597.889	389188.76	15.471

Distance to Downstream cross-section X (m)	
	830.20

Water Level (mAOD)	14.000
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



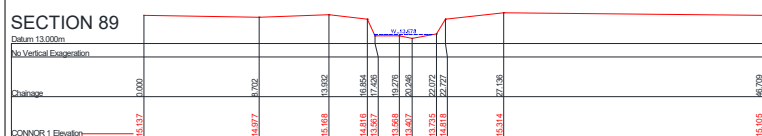
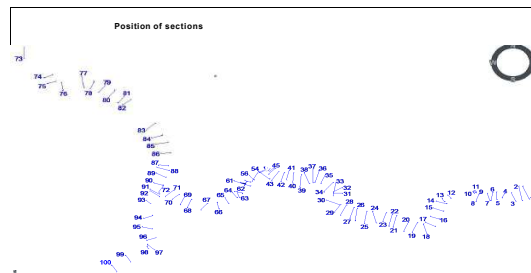
Section 89

[illegible]

Distance to Downstream cross-section X (m)	
	965.18

Water Level (mAOD)	13.675
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



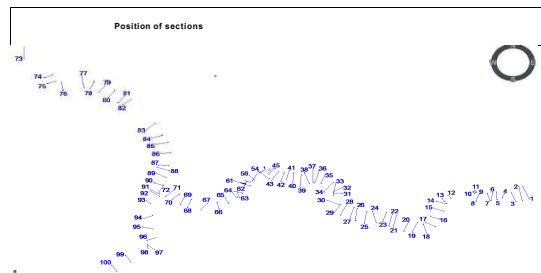
Section 90

[illegible]

Distance to Downstream cross-section X (m)	
	1004.72

Water Level (mAOD)	13.591
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



Datum 13.000m

No Vertical Exaggeration

[illegible]

CONNOR 1 Elevation

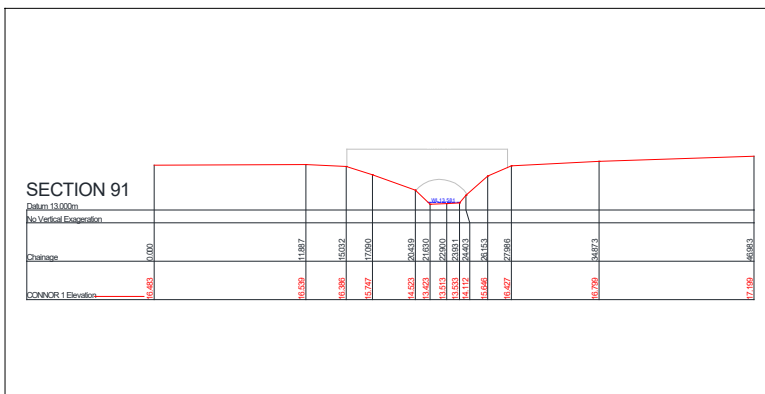
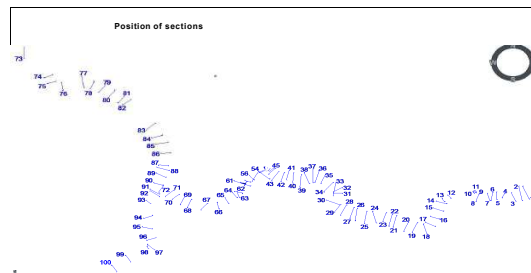
Section 91

[illegible]

Distance to Downstream cross-section X (m)	
	1043.44

Water Level (mAOD)	13.581
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



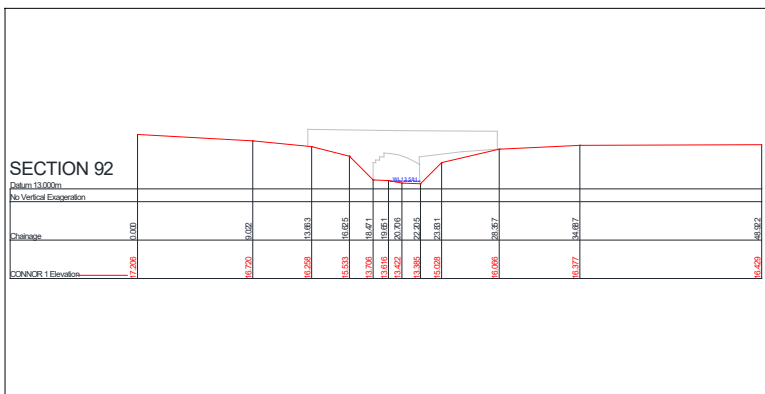
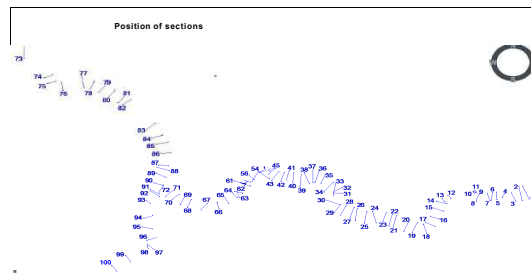
Section 92

[illegible]

Distance to Downstream cross-section X (m)	
	1053.76

Water Level (mAOD)	13.581
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



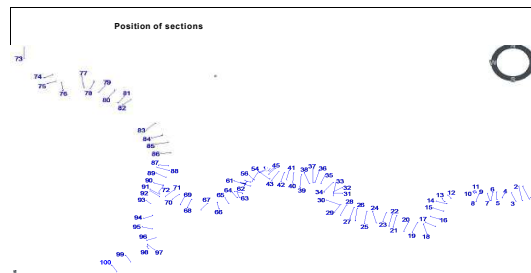
Section 93

[illegible]

Distance to Downstream cross-section X (m)	
	1099.47

Water Level (mAOD)	12.967
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



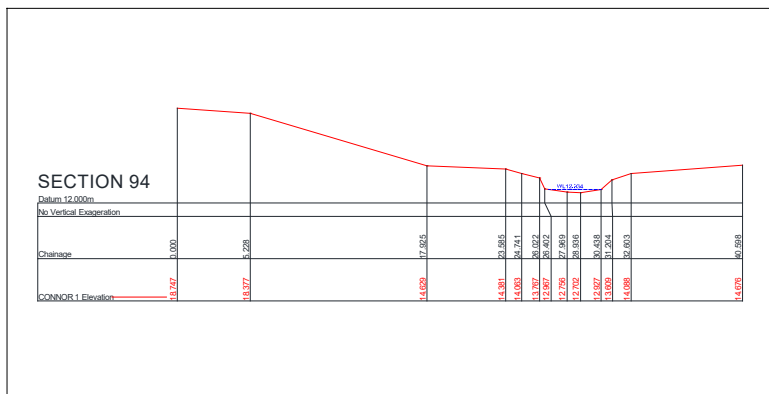
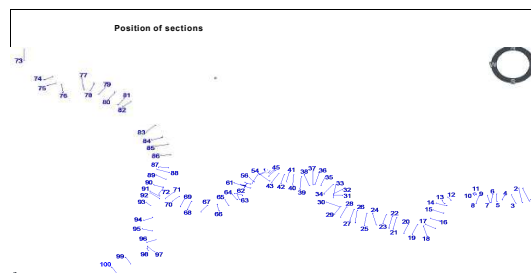
Section 94

[illegible]

Distance to Downstream cross-section X (m)	
	1175.48

Water Level (mAOD)	12.934
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



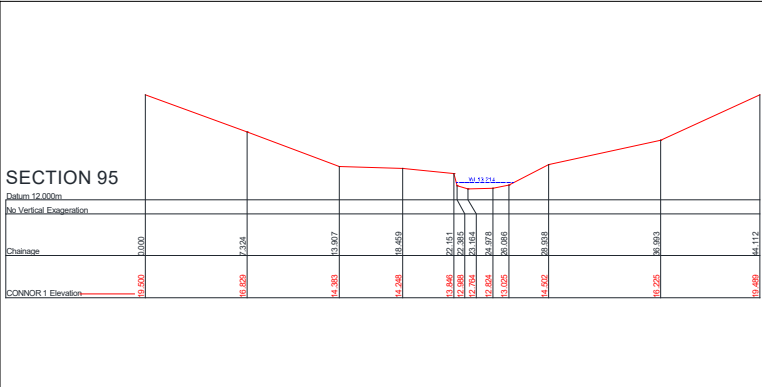
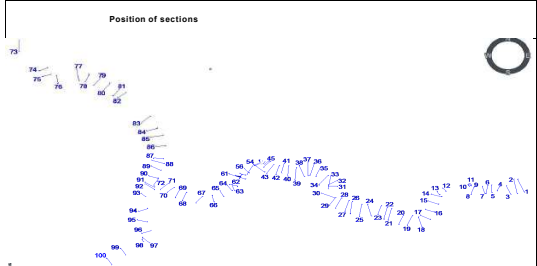
Section 95

[illegible]

Distance to Downstream cross-section X (m)	
	1226.14

Water Level (mAOD)	13.214
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



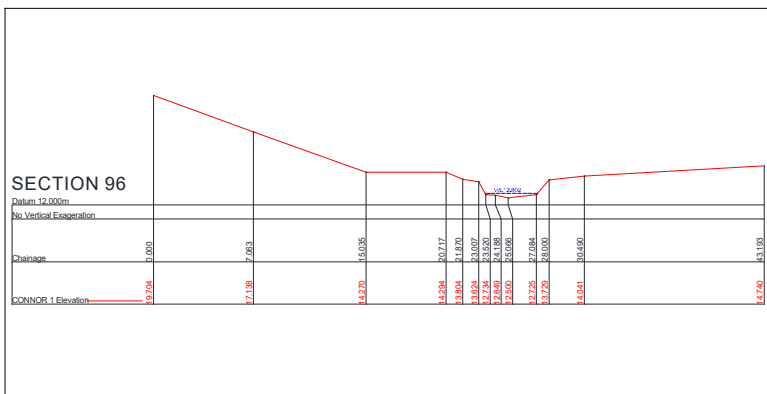
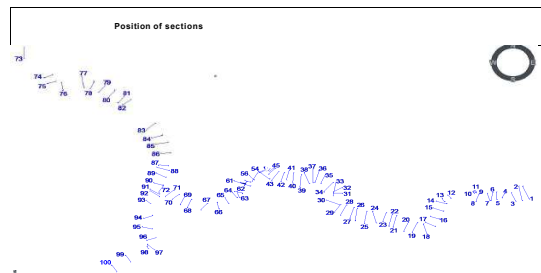
Section 96

[illegible]

Distance to Downstream cross-section X (m)	
	1285.29

Water Level (mAOD)	12.802
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



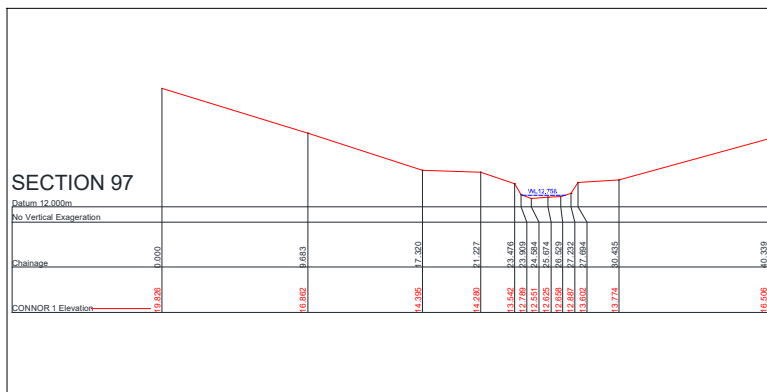
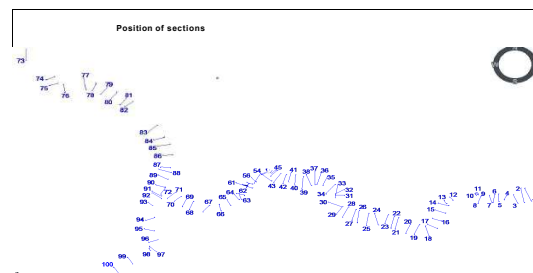
Section 97

[illegible]

Distance to Downstream cross-section X (m)	
	1316.03

Water Level (mAOD)	12.758
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		

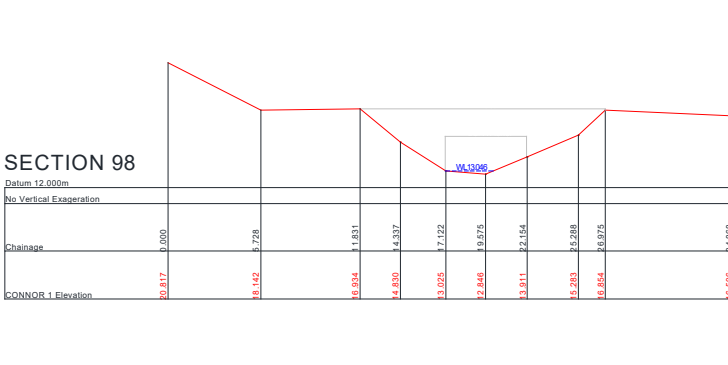
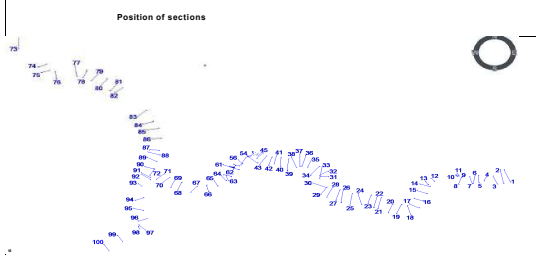


[illegible]

Distance to Downstream cross-section X (m)	
	1326.

Water Level (mAOD)	13.0
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



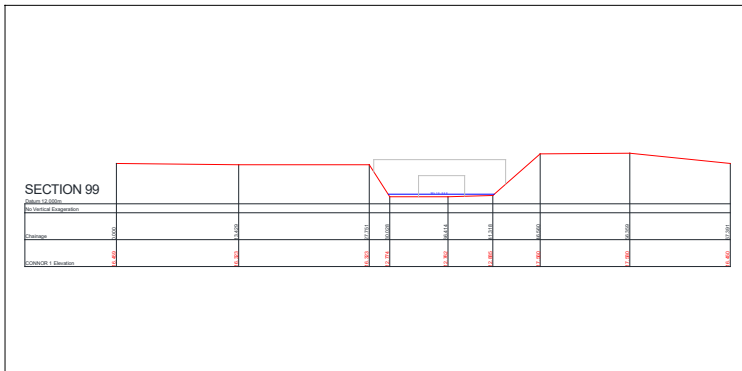
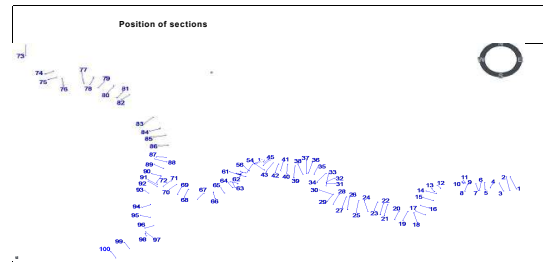
Section 99

[illegible]

Distance to Downstream cross-section X (m)	
	1410.00

Water Level (mAOD)	13.020
--------------------	--------

Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		



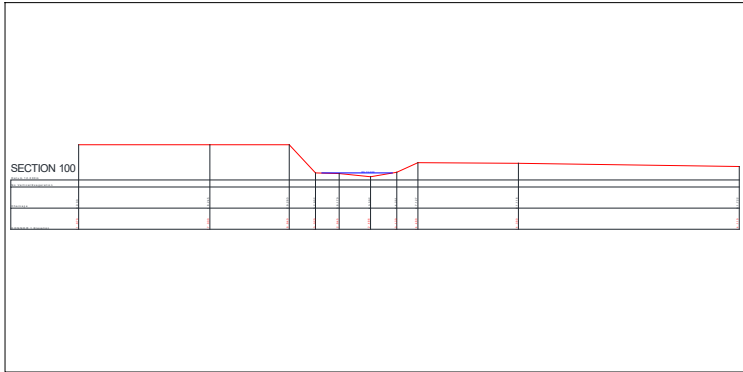
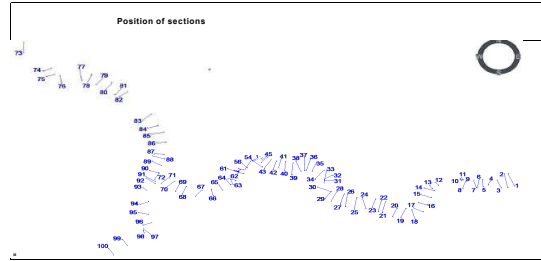
Section 100

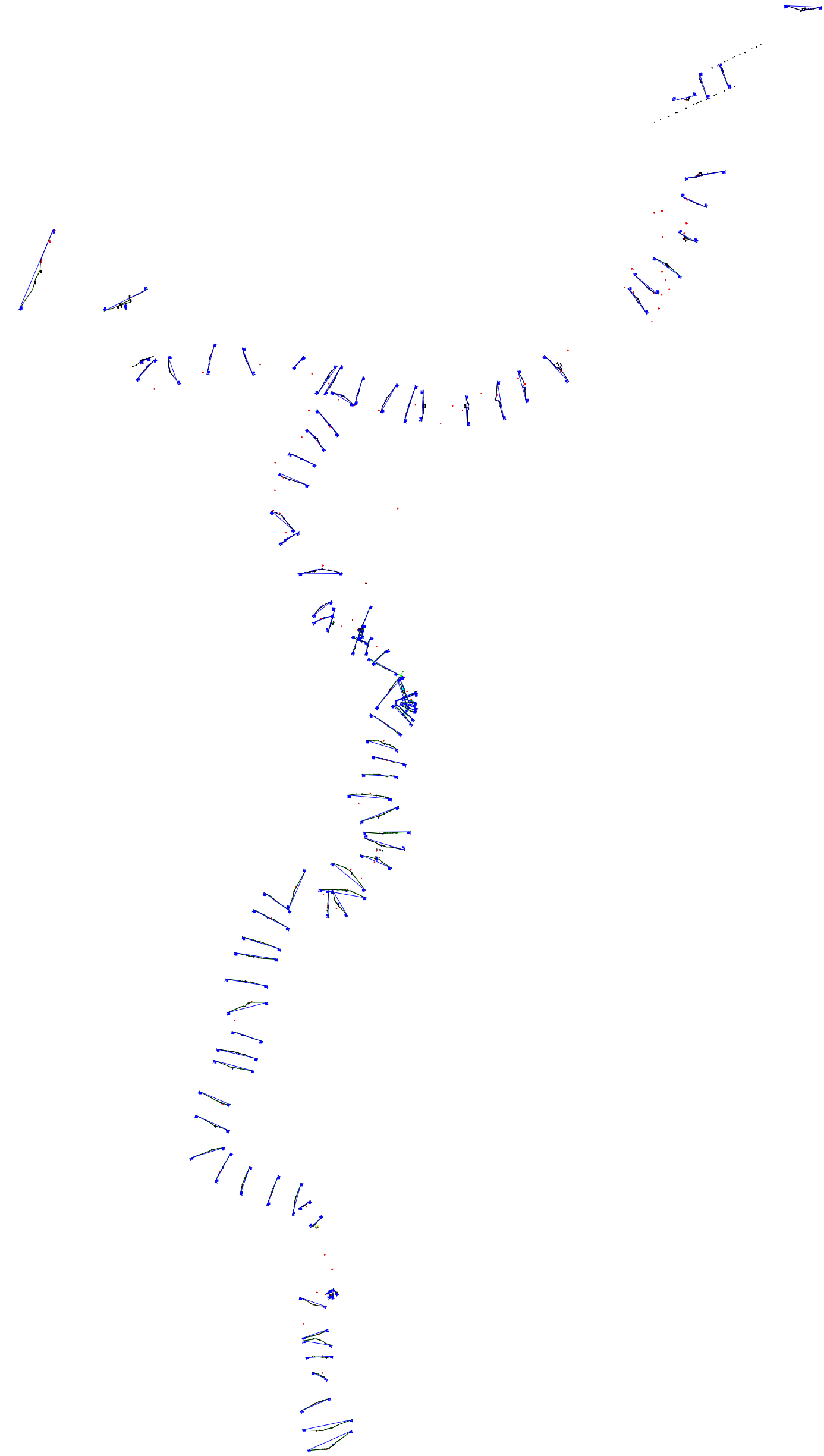
Chainage (m)	Mannings N	Panel Markers	RPL	Bank Markers	Easting	Northing	Elevation (MAOD)
0.000					346476.229	388636.529	11.970
18.245					346460.848	388646.952	17.000
29.263					346449.996	388649.604	16.940
32.952					346446.870	388650.975	13.020
38.170					346443.726	388652.507	12.945
40.492					346439.794	388654.558	12.486
44.251					346436.481	388656.115	13.120
47.127					346433.934	388657.474	14.460
61.116					346419.161	388658.555	14.380
91.722					346391.001	388669.943	14.110

Distance to Downstream cross-section X (m)	
	1538.53

Water Level (mAOD)	13.000
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Relative Path Length		
	Distance	RPL
Left Floodplain		
Channel		
Right Floodplain		





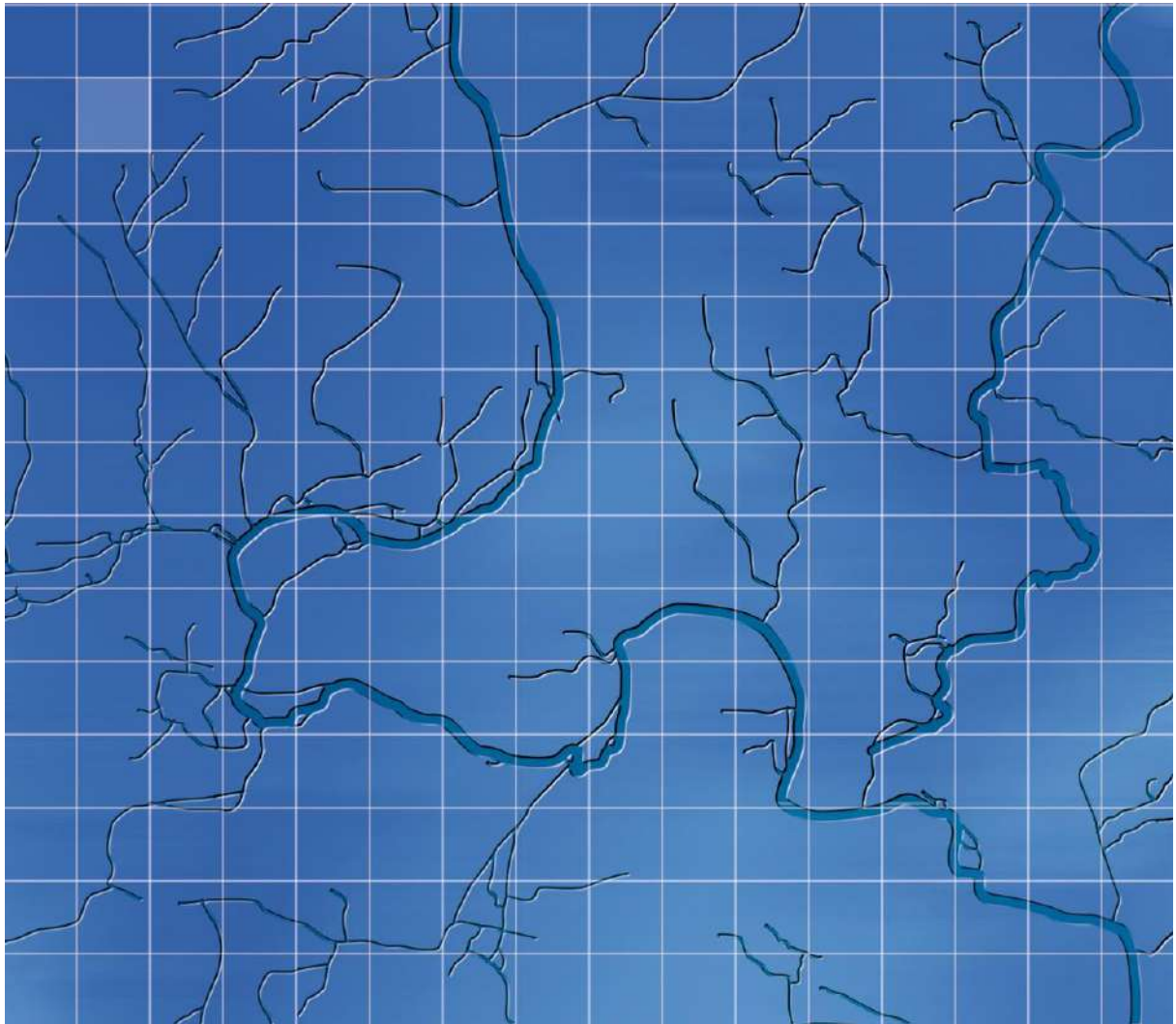
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Appendix C Hydrological Assessment

KRS Environmental

August 2020

Peak Flow Assessment for Cronton Quarry



WHS

KRS Environmental

Peak Flow Assessment for Cronton Quarry

Document issue details

WHS 1769

Version	Issue date	Issue status	Prepared By	Approved By
1.0	10/08/2020	Draft	Jessica Pearce (Consultant)	Daniel Hamilton (Senior Consultant)

For and on behalf of Wallingford HydroSolutions Ltd.

This report has been prepared by WHS with all reasonable skill, care and diligence within the terms of the Contract with the client and taking account of both the resources allocated to it by agreement with the client and the data that was available to us. We disclaim any responsibility to the client and others in respect of any matters outside the scope of the above. This report is confidential to the client and we accept no responsibility of any nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report at their own risk.



The WHS Quality & Environmental Management system is certified as meeting the requirements of ISO 9001:2015 and ISO 14001:2015 providing environmental consultancy (including monitoring and surveying), the development of hydrological software and associated training.



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1 Requirements

The client requires hydraulic modelling of the Fox's Bank Brook to inform a Flood Risk Assessment for a proposed development at Cronton Quarry (NGR: SJ 47383 89254). As part of the modelling exercise, peak flows and hydrographs are required as inputs. These will inform inflows into the watercourse which runs to the south of the site boundary.

2 Study Area and Catchments

The hydraulic model is of the Fox's Bank Brook which runs along the south of the proposed site boundary in a westerly direction to its confluence with the Ochre Brook at NGR: 346498, 389061. A number of small drainage channels are present within, and to the immediate north of the site boundary, which drain into the main Fox Bank Brook channel.

Peak flows and hydrographs are required for i). the Fox Bank Brook Catchment upstream of the site and ii). the Fox Bank Brook catchment between the site and confluence with the Ochre Brook. The division of contributing catchments is displayed below in Figure 1.

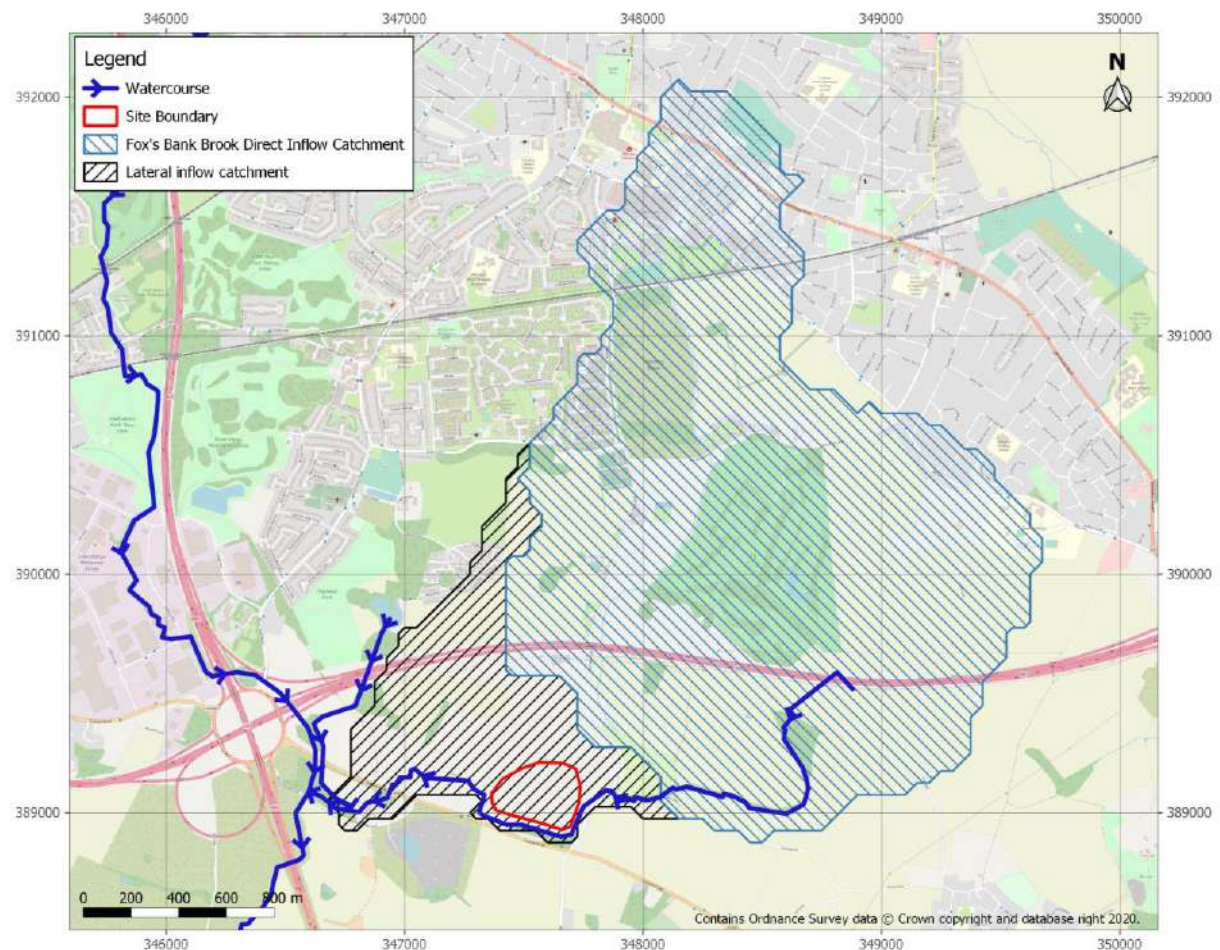


Figure 1- Study area and catchments

3 Outline of Methodology

The flood estimates have been developed using the Flood Estimation Handbook statistical and rainfall runoff methods. The statistical methods are those as published by the Institute of Hydrology in 1999¹ with updates included in the latest version of WINFAP-FEH 4² as described by Kjeldsen *et al.*,³ and the WHS technical guidance⁴. These methods require the estimation of a normalised flood frequency curve, termed the flood growth curve and the estimation of the normalising variable; the median annual flood, QMED. The current version of NRFA Peak Flows dataset available for use in this study was NRFA Peak Flows v8⁵.

The rainfall-runoff methods are those first published by Kjeldsen⁶, which were subsequently updated in 2015 and implemented within the ReFH2.3 software⁷ as described in the WHS technical guidance⁸. Note, the latest BFIHOST19 descriptor, which determines the baseflow characteristics of a catchment, is used in the estimation of the rainfall-runoff flows.

4 Fox's Bank Brook (Direct Inflow)

4.1 Catchment

The catchment boundary is presented in Figure 2. The FEH Web Service⁹ was used to derive the catchment descriptors. The area of the FEH Web Service boundary is 4.12 km². Table 1 presents the relevant catchment descriptors. The catchment has an URBEXT2000 value of 0.0825 hence is classed as 'moderately urbanised' according to FEH guidance. The catchment is moderately permeable, assigned a BFIHOST19 characteristic of 0.490. The catchment is not affected by the presence of lakes, being assigned a FARL value of 1.00.

¹ Robson, A. and Reed, D., 1999. *Flood Estimation Handbook Volume 3: Statistical Procedures for Flood Frequency Estimation*. Institute of Hydrology, Wallingford, pp338.

² <https://www.hydrosolutions.co.uk/software/winfap-4/>

³ Kjeldsen, T.R., Jones, D.A., and Bayliss, A.C., 2008. *Improving the FEH statistical procedures for flood frequency estimation*. Environment Agency, Bristol, pp137.

⁴ <https://www.hydrosolutions.co.uk/software/winfap-4/literature/>

⁵ <https://nrfa.ceh.ac.uk/peak-flow-data>

⁶ Kjeldsen, T. R. 2007. The revitalised FSR/FEJ rainfall-runoff method. Supplementary Report No.1. CEH.

⁷ <https://www.hydrosolutions.co.uk/software/refh-2/>

⁸ https://www.hydrosolutions.co.uk/software/refh-2/supporting_literature/

⁹ <https://fehweb.ceh.ac.uk/GB/map>

Table 1. Relevant catchment descriptors from the FEH Web Service¹⁰

Catchment Descriptor	Value
Area (km ²)	4.12
SAAR (standard average annual rainfall 1961 - 1990mm)	882
BFIHOST (baseflow index derived from HOST soils data)	0.505
BFIHOST19 (baseflow index derived from HOST soils data)	0.490
FARL (index of flood attenuation due to reservoirs and lakes)	1.00
FPEXT (extent of flood plain)	0.153
PROPWET	0.370
URBEXT 2000	0.0825

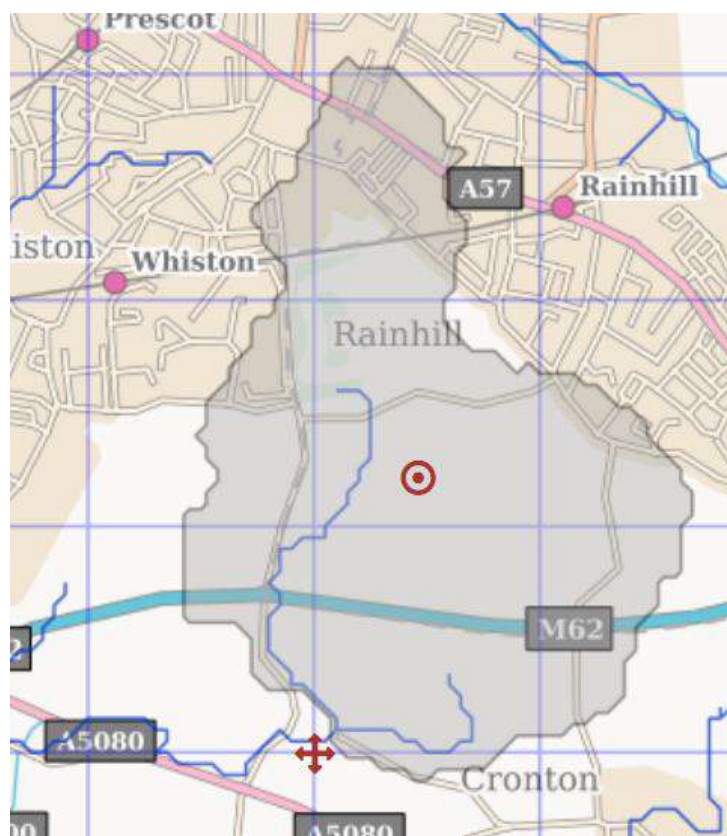


Figure 2 The FEH Web Service derived catchment is shown by the grey boundary. Contains OS data © Crown Copyright (2020) Contains CEH data © and database right NERC (CEH) 2020

¹⁰ Results based upon FEH methodology and data, CEH (2015) 'CEH 2015. The Flood Estimation Handbook (FEH) Online Service, Centre for Ecology & Hydrology, Wallingford, Oxon, UK'

4.2 Peak Flow Estimation using the statistical method

As the site is ungauged, the approach adopted for estimating QMED has been to develop an FEH catchment descriptor-based estimate and to review the availability of potentially suitable donor catchments to form the basis of a data transfer exercise that would improve the QMED estimate. This is the standard application of the FEH methodology. The pooled methodology for estimation of the growth curve is then applied. The same approach has been applied to the other two catchments within this study which are also ungauged.

4.2.1 Derivation of the Median Annual Flood

The QMED was first estimated from catchment descriptors ($Q_{med_{cds}}$) as $1.51 \text{ m}^3\text{s}^{-1}$.

Estimates of QMED from observed data ($Q_{MED_{obs}}$) at donor stations can be used to adjust the estimate of $Q_{MED_{cds}}$ at the subject site. Possible donor catchments are initially sought on the basis of being geographically close. Along with geographical distance the similarity of catchment descriptors; Area, SAAR, FARL and BFIHOST with the target catchment are also considered.

The general pattern of $Q_{MED_{cds}}$ to the $Q_{MED_{obs}}$ for the six closest stations is for the catchment descriptor equation to overestimate $Q_{MED_{obs}}$. The Bradshaw Brook at Bradshaw Tennis Club (69046), and Wheeler at Bodfari (66004) were rejected on the basis of having significantly different SAAR (+/- 20%) and/or BFIHOST values (+/- 20%) than the target catchment. The Weaver at Ashbrook (68001) and Wever at Audlem (68005) which lie outside of the six closest stations share many of the same characteristics as the target catchment and were therefore substituted into the donor group. Six stations were chosen in the donor group, which inform the QMED estimate. Table 2 presents the geographically closest ten stations, indicating those which were accepted and rejected as donor stations.

The donor adjusted rural QMED value was $1.22 \text{ m}^3\text{s}^{-1}$. To account for urbanisation within the catchment an urban adjustment factor (UAF) of 1.10 was applied to the rural estimate. This yielded a final urban QMED value of $1.34 \text{ m}^3\text{s}^{-1}$. This value should be used to scale the flood growth curves.

Peak Flow Estimate for Southern Gateway

Table 2. List of donor catchments considered for QMED adjustment¹¹

Station	Distance (km)	URBEXT2000	QMED Observed (m ³ s ⁻¹)	QMED CDs (m ³ s ⁻¹)	Area (km ²)	SAAR (mm)	BFIHOST	FARL	Years of data	Accept or Reject	Comments
68011 (Arley Brook @ Gore Farm)	20.08	0.021	6.109	9.608	33.76	831	0.437	0.998	7	Accept	
68020 (Gowy @ Bridge Trafford)	26.13	0.017	14.962	18.023	148.66	729	0.538	0.994	39	Accept	
68007 (Wincham Brook @ Lostock Gralam)	30.72	0.02	20.402	21.778	148.34	818	0.508	0.942	54	Accept	
69046 (Bradshaw Brook @ Bradshaw Tennis Club)	36.55	0.023	22.9	13.67	36.87	1384	0.345	0.781	17	Reject	SAAR Higher (+20%) & BFIHOST Lower (-
66004 (Wheeler @ Bodfari)	38.23	0.004	3.651	6.633	62.91	863	0.696	0.975	44	Reject	BFIHOST Higher (+20%)
67008 (Alyn @ Pont-y-capel)	40.23	0.029	21.59	35.712	225.65	917	0.591	0.99	53	Accept	
68001 (Weaver @ Ashbrook)	42.93	0.027	46.538	58.213	622.68	732	0.513	0.955	81	Accept	
67009 (Alyn @ Rhydymwyn)	43.81	0.002	8.681	15.308	81.6	968	0.615	0.99	62	Reject	BFIHOST Higher (+20%)
68005 (Weaver @ Audlem)	47.21	0.007	13.86	21.617	201.38	719	0.502	0.95	49	Accept	
72817 (New Mill Brook @ Hollowforth Hall)	48.52	0.021	20.777	18.557	33.19	1110	0.387	0.992	34	Reject	BFIHOST Lower (-20%)

¹¹ Results based upon FEH methodology and data, CEH (2015) 'CEH 2015. The Flood Estimation Handbook (FEH) Online Service, Centre for Ecology & Hydrology, Wallingford, Oxon, UK'

4.2.2 Derivation of the Growth Curve

Within the FEH methodology flood growth curves for ungauged sites are formed by pooling annual maxima data from similar catchments which are flagged as being suitable for pooling. A threshold of 500 station-years is required (a sum of record lengths) and thus an initial pooling group was formed for the development of the flood growth curve by pooling data from 15 catchments. Following a review of the pooling group all stations were considered suitable for pooling and derivation of the growth curve.

A final pooling group containing 15 stations and 521 station years was derived. Table 3 shows the full list of pooling group members. The distance shown is the distance from each candidate station to the sites in a similarity distance space (the FEH distance measure).

Peak Flow Estimate for Southern Gateway

Table 3. Pooling group selection and reasons for retaining or removing from final pooling group.¹²

Station	Distance SDM	AREA (km ²)	SAAR (mm)	FARL	URBEXT 2000	Accept or Reject	Comments
27073 (Brompton Beck @ Snainton Ings)	1.38	8.06	721	1	0.008	Accept	Permeable Adjustment Applied
76011 (Coal Burn @ Coalburn)	1.62	1.63	1096	1	0	Accept	
27051 (Crimple @ Burn Bridge)	1.83	8.17	855	1	0.006	Accept	
45816 (Haddeo @ Upton)	1.84	6.81	1210	1	0.005	Accept	
28033 (Dove @ Hollinsclough)	2.03	7.92	1346	1	0	Accept	
26802 (Gypsey Race @ Kirby Grindalythe)	2.35	15.85	757	1	0	Accept	Permeable Adjustment Applied
25019 (Leven @ Easby)	2.35	15.09	830	1	0.004	Accept	
47022 (Tory Brook @ Newnham Park)	2.34	13.43	1403	0.942	0.014	Accept	
25003 (Trout Beck @ Moor House)	2.4	11.40	1905	1	0	Accept	
49005 (Bolingey Stream @ Bolingey Cocks Bridge)	2.42	16.08	1044	0.991	0.006	Reject	
25011 (Langdon Beck @ Langdon)	2.43	12.79	1463	1	0.001	Accept	
71003 (Croasdale Beck @ Croasdale Flume)	2.49	10.71	1882	1	0	Accept	
206006 (Annalong @ Recorder)	2.61	14.44	1704	0.981	0	Accept	
27010 (Hodge Beck @ Bransdale Weir)	2.67	18.82	987	1	0.001	Accept	
91802 (Allt Leachdach @ Intake)	2.71	6.54	2554	0.992	0	Accept	

¹² Results based upon FEH methodology and data, CEH (2015) 'CEH 2015. The Flood Estimation Handbook (FEH) Online Service, Centre for Ecology & Hydrology, Wallingford, Oxon, UK'

4.2.3 Results

A three-parameter generalised logistic (GL) distribution was used, which is the FEH recommended distribution for use within UK flood data to model the growth curve. Figure 3 shows the estimated flood frequency curve for the subject site and Table 4 presents the flood growth curve indexed by return period.

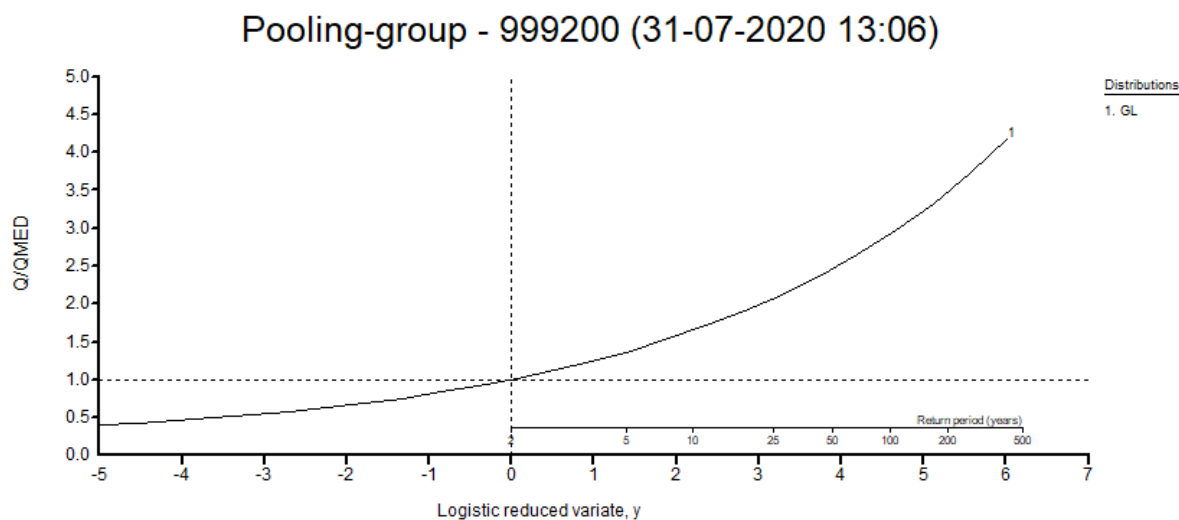


Figure 3 Growth curve

Table 4. Growth curve¹³

Return Period (years)	Growth Curve for Location
2	1
25	2.05
50	2.44
100	2.89
500	4.32
1000	5.15

The final peak flow is presented in Table 5. These represent the QMED value (2 year return period) scaled by the growth curve.

¹³ Results based upon FEH methodology and data, CEH (2015) 'CEH 2015. The Flood Estimation Handbook (FEH) Online Service, Centre for Ecology & Hydrology, Wallingford, Oxon, UK'

Table 5 Flood Peak flow estimate

Return Period (years)	Peak Flow estimate (m ³ /s)
2	1.34
25	2.76
50	3.27
100	3.88
500	5.81
1000	6.92

4.3 Peak Flows Estimation using the Rainfall- Runoff methodology

The catchment was modelled using the ReFH 2.3 software. This uses standard design rainfall events and catchment descriptors to produce hydrographs for the site. A duration and timestep of 7.50 hours and 0.50 hours were used to define the rainfall event. This is the recommended duration at the downstream extent of the Fox Bank Brook and is considered most applicable to flood risk at the site. Default parameters for urbanisation were used.

Table 6 Peak Flow Estimates as Returned by ReFH 2 Software¹⁴

Return Period (years)	Peak Flow estimate (m ³ /s)
2	1.24
25	2.29
50	2.70
100	3.23
500	4.98
1000	5.89

¹⁴ Results based upon FEH methodology and data, CEH (2015) 'CEH 2015. The Flood Estimation Handbook (FEH) Online Service, Centre for Ecology & Hydrology, Wallingford, Oxon, UK'

5 Lower Fox Bank Brook Catchment & Drainage Ditches (Lateral Inflow)

5.1 Catchment

The catchment boundary is presented in Figure 4. It is an incremental area and was derived by subtracting the upstream catchment area (the direct inflow catchment, from the downstream catchment area at NGR: 346700, 389050). The downstream catchment area was defined using the FEH Web Service. The area of the derived lateral catchment boundary is 0.88 km².

The catchment descriptors SAAR, BFIHOST, BFIHOST19 and PROPWET were calculated for the Lateral catchment by weighting the descriptors from the upstream and downstream catchments by area. For URBEXT2000 and FPEXT, which represent the proportions of the areas which are urban or in the flood plain respectively, the areas of the upstream and lateral catchment were calculated and then the proportion appropriate to the weighted downstream area determined. FARL was calculated for the Lateral catchment independently using appropriate methods, accounting for the lake features and their associated draining areas within the catchment.

Table 7 presents the relevant catchment descriptors. The catchment has an URBEXT2000 value of 0.000 hence is classed as 'essentially rural' according to FEH guidance. The catchment is moderately permeable, assigned a BFIHOST19 characteristic of 0.52. The catchment is assigned a FARL value of 1, whilst a lake is located in the lower catchment, it is a significant distance downstream of the site and should therefore not act to attenuate flows.

Table 7. Relevant catchment descriptors

Catchment Descriptor	Value
Area (km ²)	0.88
SAAR (standard average annual rainfall 1961 - 1990mm)	859
BFIHOST (baseflow index derived from HOST soils data)	0.45
BFIHOST19 (baseflow index derived from HOST soils data)	0.52
FARL (index of flood attenuation due to reservoirs and lakes)	1.00
FPEXT (extent of flood plain)	0.19
PROPWET	0.37
URBEXT 2000	0.00

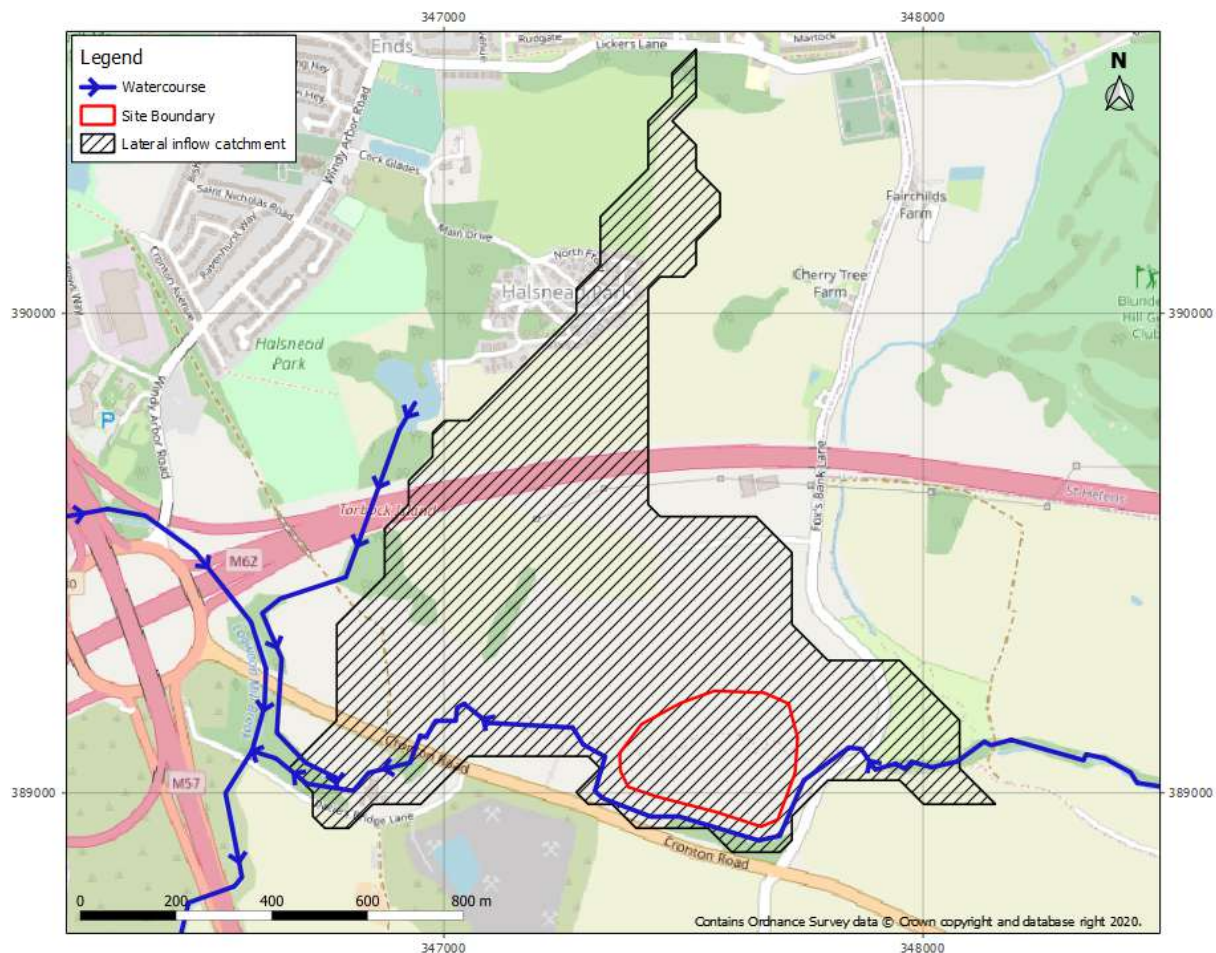


Figure 4 Derived catchment Contains OS data © Crown Copyright (2019) Contains CEH data © and database right NERC (CEH) 2019

5.2 Peak Flow Estimation using the statistical method

5.2.1 Derivation of the Median Annual Flood

The QMED was first estimated from catchment descriptors ($Q_{med_{cds}}$) as $0.45 \text{ m}^3\text{s}^{-1}$.

The general pattern of $Q_{med_{cds}}$ to the $Q_{med_{obs}}$ for the six closest stations is for the catchment descriptor equation to overestimate $Q_{med_{obs}}$. The Bradshaw Brook at Bradshaw Tennis Club (69046), Wheeler at Bodfari (66004) and Alyn at Pont-y-capel (67008) were rejected on the basis of having significantly SAAR (+/- 20%) and/or BFIHOST values (+/- 20%) than the target catchment.

The Weaver at Ashbrook (68001) and Weaver at Audlem (68005) shared many of the same characteristics as the target catchment and were therefore substituted into the donor group. As a result five donor stations were used to inform the QMED estimate. Table 8 presents the geographically closest ten stations, indicating those which were accepted and rejected as donor stations.

The donor adjusted rural QMED value was $0.38 \text{ m}^3\text{s}^{-1}$. As the lateral catchment is rural an urban adjustment factor (UAF) of 1 is applied, hence the rural QMED value is retained and should be used to scale the flood growth curves.

Peak Flow Estimate for Southern Gateway

Table 8. List of donor catchments considered for QMED adjustment¹⁵

Station	Distance (km)	URBEXT2000	QMED Observed (m ³ s ⁻¹)	QMED CDs (m ³ s ⁻¹)	Area (km ²)	SAAR (mm)	BFIHOST	FARL	Years of data	Accept or Reject	Comments
68011 (Arley Brook @ Gore Farm)	20.2	0.021	6.109	9.608	33.76	831	0.437	0.998	7	Accept	
68020 (Gowy @ Bridge Trafford)	26.01	0.017	14.962	18.023	148.66	729	0.538	0.994	39	Accept	
68007 (Wincham Brook @ Lostock Gralam)	30.83	0.02	20.402	21.778	148.34	818	0.508	0.942	54	Accept	
69046 (Bradshaw Brook @ Bradshaw Tennis Club)	36.79	0.023	22.9	13.67	36.87	1384	0.345	0.781	17	Reject	SAAR too high (+20%) & BFIHOST too low (-20%)
66004 (Wheeler @ Bodfari)	37.98	0.004	3.651	6.633	62.91	863	0.696	0.975	44	Reject	BFIHOST too high (+20%)
67008 (Alyn @ Pont-y-capel)	39.99	0.029	21.59	35.712	225.65	917	0.591	0.99	53	Reject	BFIHOST too high (+20%)
68001 (Weaver @ Ashbrook)	42.87	0.027	46.538	58.213	622.68	732	0.513	0.955	81	Accept	
67009 (Alyn @ Rhydymwyn)	43.57	0.002	8.681	15.308	81.6	968	0.615	0.99	62	Reject	BFIHOST too high (+20%)
68005 (Weaver @ Audlem)	47.12	0.007	13.86	21.617	201.38	719	0.502	0.95	49	Accept	
66001 (Clwyd @ Pont-y-cambwll)	48.87	0.006	49.432	59.022	404.56	910	0.588	0.993	43	Reject	

¹⁵ Results based upon FEH methodology and data, CEH (2015) 'CEH 2015. The Flood Estimation Handbook (FEH) Online Service, Centre for Ecology & Hydrology, Wallingford, Oxon, UK'

5.2.2 Derivation of the Growth Curve

For the lateral catchment, the growth curve derived for the downstream catchment at NGR: 346700, 389050 is used. An initial pooling group was formed for the development of the flood growth curve by pooling data from 15 catchments. Following a review of the pooling group all stations were considered suitable for pooling and derivation of the growth curve.

A final pooling group containing 15 stations and 526 station years was derived. Table 9 shows the full list of pooling group members. The distance shown is the distance from each candidate station to the sites in a similarity distance space (the FEH distance measure).

Table 9. Pooling group selection and reasons for retaining or removing from final pooling group.¹⁶

Station	Distance SDM	AREA (km ²)	SAAR (mm)	FARL	URBEXT 2000	Accept or Reject	Comments
27073 (Brompton Beck @ Snainton Ings)	1.184	8.06	721	1	0.008	Accept	Permeable Adjustment Applied
27051 (Crimple @ Burn Bridge)	1.788	8.17	855	1	0.006	Accept	
45816 (Haddeo @ Upton)	1.832	6.81	1210	1	0.005	Accept	
76011 (Coal Burn @ Coalburn)	1.898	1.63	1096	1	0	Accept	
28033 (Dove @ Hollinsclough)	2.005	7.92	1346	1	0	Accept	
26802 (Gypsey Race @ Kirby Grindalythe)	2.195	15.85	757	1	0	Accept	Permeable Adjustment Applied
25019 (Leven @ Easby)	2.214	15.09	830	1	0.004	Accept	
47022 (Tory Brook @ Newnham Park)	2.247	13.43	1403	0.942	0.014	Accept	
49005 (Bolingey Stream @ Bolingey Cocks Bridge)	2.267	16.08	1044	0.991	0.006	Accept	
25003 (Trout Beck @ Moor House)	2.309	11.4	1905	1	0	Reject	
25011 (Langdon Beck @ Langdon)	2.331	12.79	1463	1	0.001	Accept	
71003 (Croasdale Beck @ Croasdale Flume)	2.424	10.71	1882	1	0	Accept	
206006 (Annalong @ Recorder)	2.479	14.44	1704	0.981	0	Accept	
27010 (Hodge Beck @ Bransdale Weir)	2.521	18.82	987	1	0.001	Accept	
44008 (South Winterbourne @ Winterbourne Steepleton)	2.558	20.18	1012	0.992	0	Accept	Permeable Adjustment Applied

¹⁶ Results based upon FEH methodology and data, CEH (2015) 'CEH 2015. The Flood Estimation Handbook (FEH) Online Service, Centre for Ecology & Hydrology, Wallingford, Oxon, UK'

5.2.3 Results

A three-parameter generalised logistic (GL) distribution was used, which is the FEH recommended distribution for use within UK flood data to model the growth curve. Figure 5 shows the estimated flood frequency curve for the subject site and Table 10 presents the flood growth curve indexed by return period. The growth curve was adjusted for urbanisation.

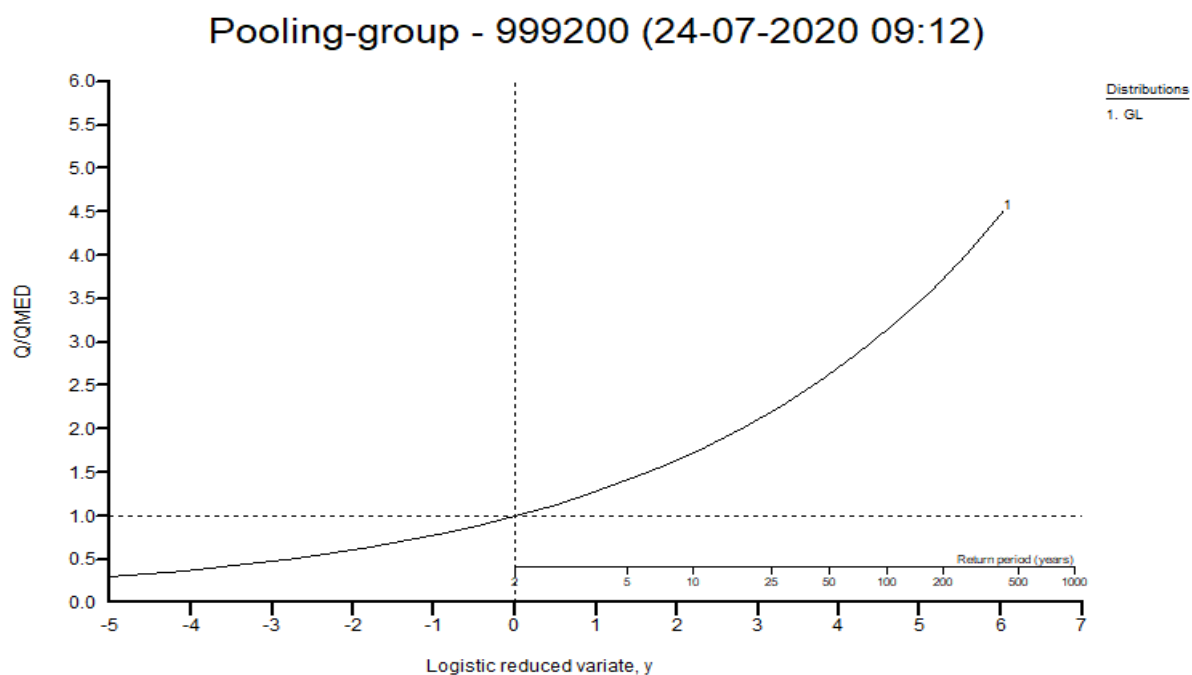


Figure 5 Growth curve

Table 10. Growth curve¹⁷

Return Period (years)	Growth Curve for Location
2	1
25	2.17
50	2.59
100	3.08
500	4.61
1000	5.48

¹⁷ Results based upon FEH methodology and data, CEH (2015) 'CEH 2015. The Flood Estimation Handbook (FEH) Online Service, Centre for Ecology & Hydrology, Wallingford, Oxon, UK'

The final peak flow is presented in Table 11. These represent the QMED value (2 year return period) scaled by the growth curve.

Table 11 Flood Peak flow estimate

Return Period (years)	Peak Flow estimate (m ³ /s)
2	0.38
25	0.83
50	0.98
100	1.17
500	1.76
1000	2.09

5.3 Peak Flows Estimation using the Rainfall- Runoff methodology

The catchment was modelled using the ReFH 2.3 software. This uses standard design rainfall events and catchment descriptors to produce hydrographs for the site. The duration and timestep for the dominant catchment in the study area (the downstream catchment) of 7.50 hours and 0.50 hours respectively were used to define the rainfall event. Default parameters for urbanisation were used, however as the catchment is essentially rural the final peak flows are not sensitive to these.

Table 12 Peak Flow Estimates as Returned by ReFH 2 Software¹⁸

Return Period (years)	Peak Flow estimate (m ³ /s)
2	0.27
25	0.50
50	0.59
100	0.71
500	1.12
1000	1.34

¹⁸ Results based upon FEH methodology and data, CEH (2015) 'CEH 2015. The Flood Estimation Handbook (FEH) Online Service, Centre for Ecology & Hydrology, Wallingford, Oxon, UK'

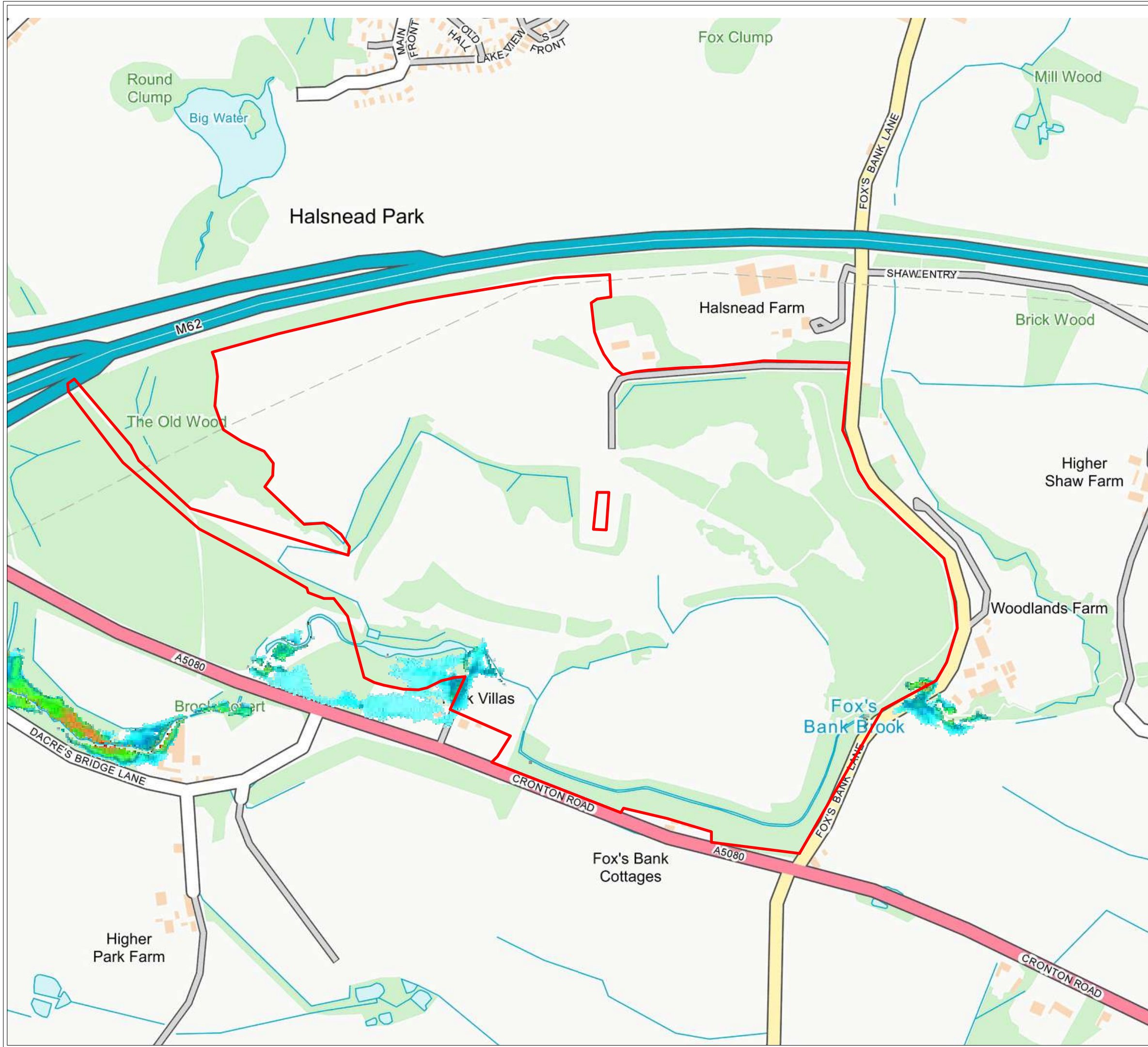
6 Final Hydrology

The flood peaks estimated using the statistical method are higher than those produced using the rainfall runoff methodology for both catchments. Therefore, the final flood peak estimates have been taken from the results of the statistical method to provide a more conservative approach to estimating peak flows and flood risk. The hydrographs estimated in ReFH2.3 are scaled to the statistical peak flows. The final flood peaks are presented in Table 13.

Table 13-Final Peak Flow Estimates

Return Period (years)	Peak Flow estimate (m ³ /s)	
	Foxes Bank Brook (Direct)	Lateral Catchment
2	1.34	0.38
25	2.76	0.83
50	3.27	0.98
100	3.88	1.17
500	5.81	1.76
1000	6.92	2.09

Appendix D Modelled Results



KEY

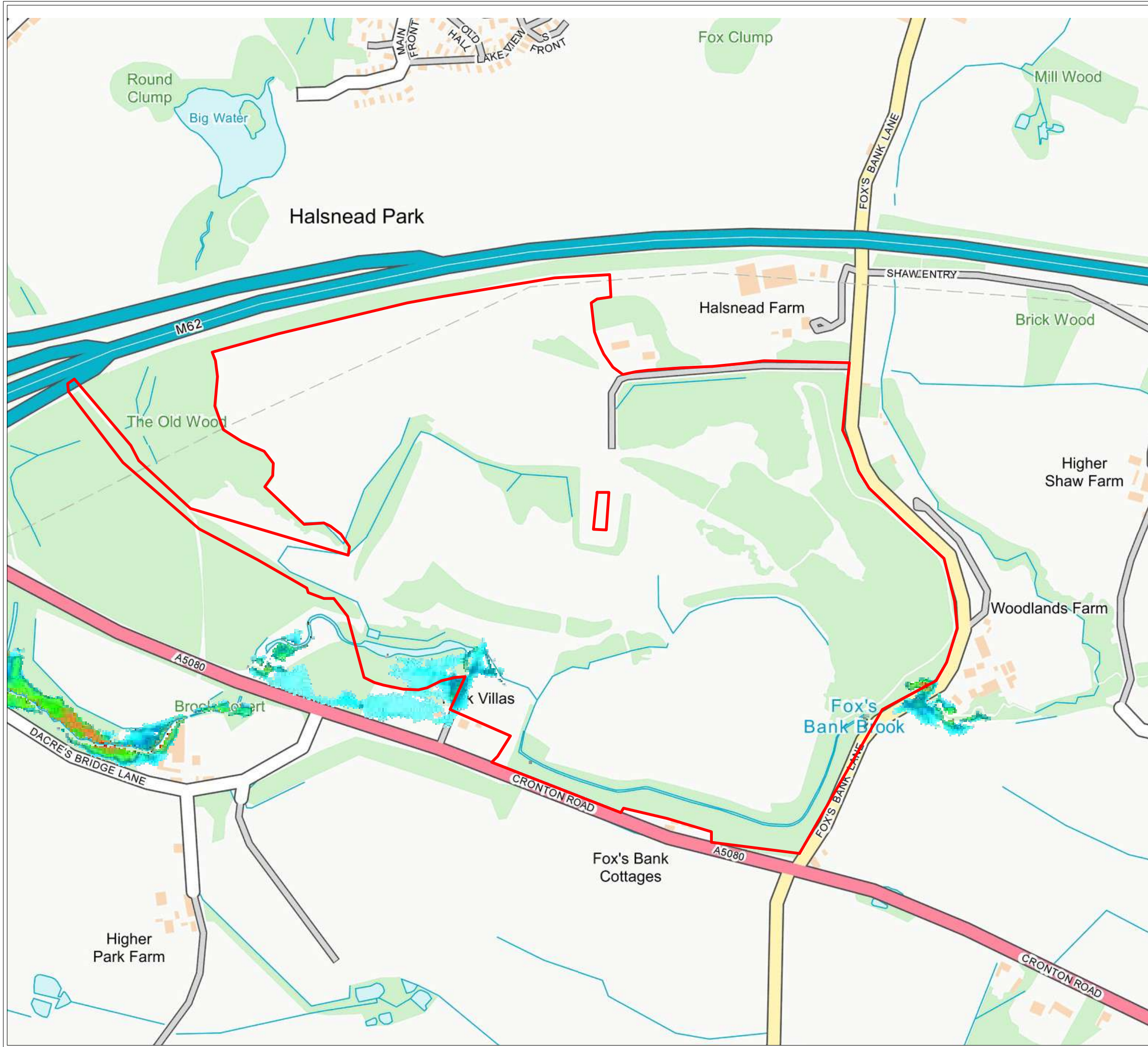
 Site Boundary

Water Depths (m)

	1.42
	1.26
	1.11
	0.95
	0.79
	0.63
	0.47
	0.32
	0.16
	0.00



PROJECT	Symmetry Park, Huyton
CLIENT	Tritax Symmetry Huyton Limited
TITLE	1 in 100 Year Modelled Flood Outline
PROJECT REF	T/18/2126/FRA
DRAWING NO	T/18/2126/FRA/3
SCALE	NTS@A3
DATE	September 2020



KEY

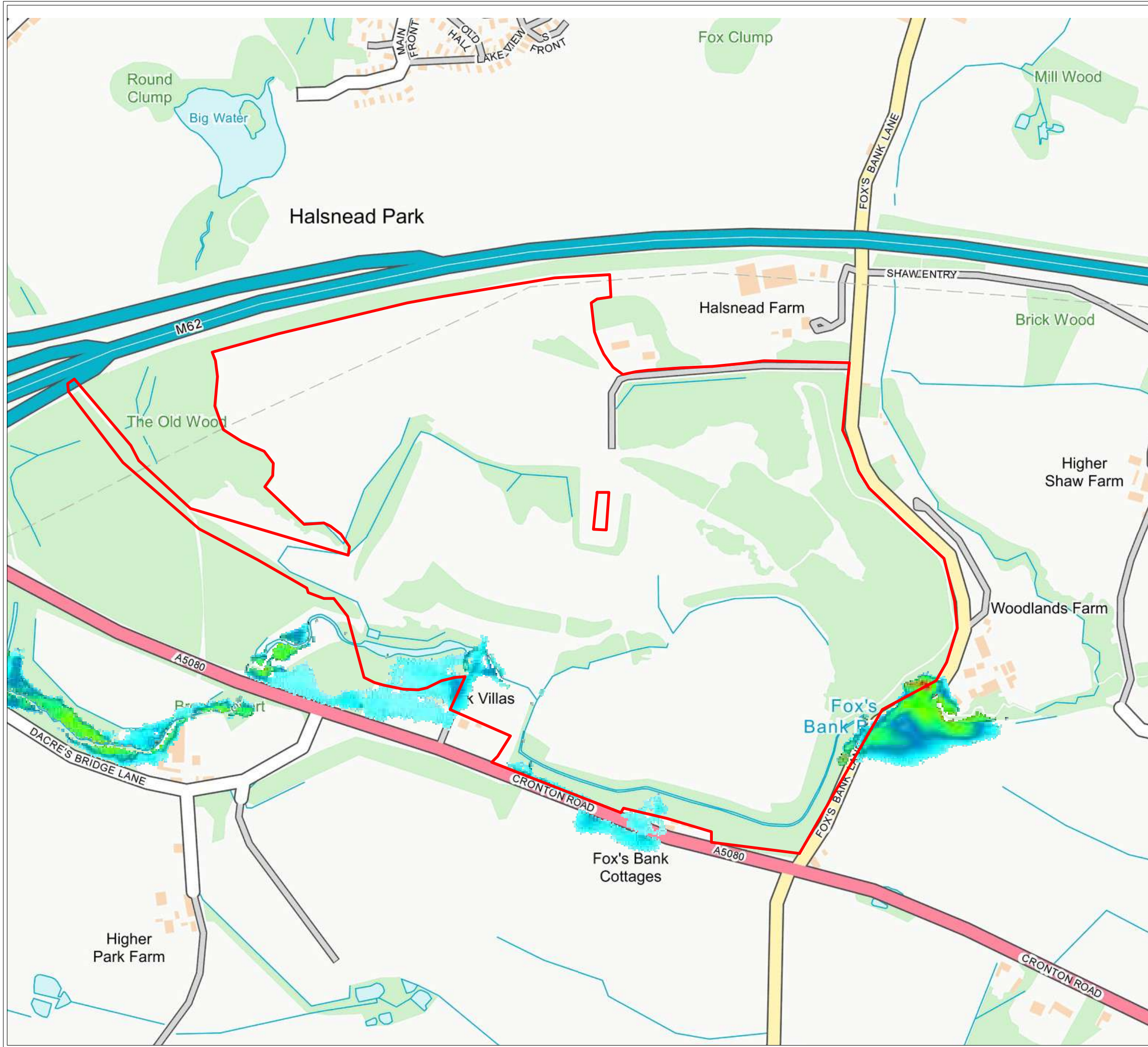
Site Boundary

Water Depth (m)

	1.93
	1.72
	1.50
	1.29
	1.07
	0.86
	0.64
	0.42
	0.21
	0.00



PROJECT	Symmetry Park, Huyton
CLIENT	Tritax Symmetry Huyton Limited
TITLE	1 in 100 Year (+35%) Modelled Flood Outline
PROJECT REF	T/18/2126/FRA
DRAWING NO	T/18/2126/FRA/4
SCALE	NTS@A3
DATE	September 2020



KEY

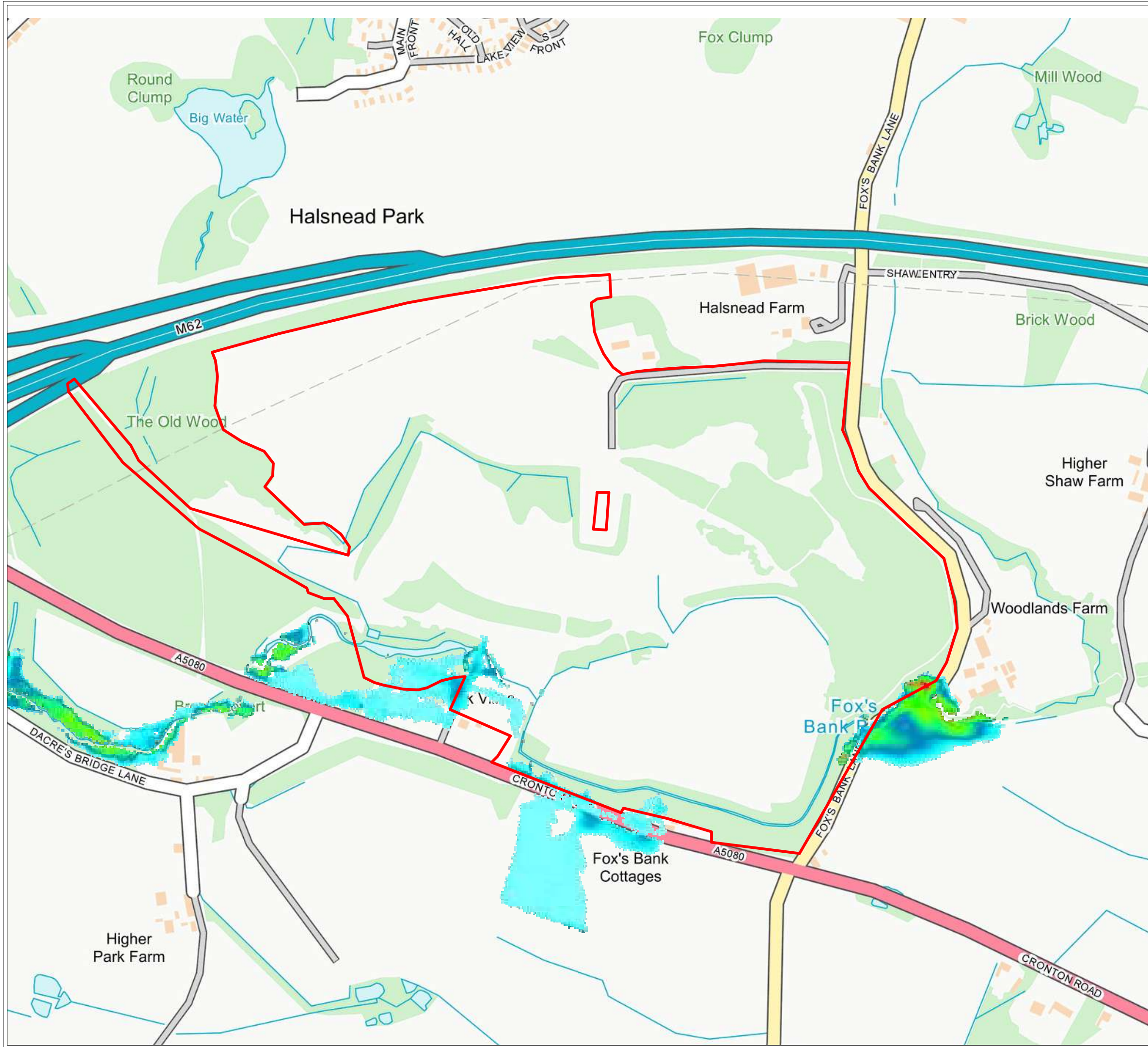
 Site Boundary

Water Depth (m)

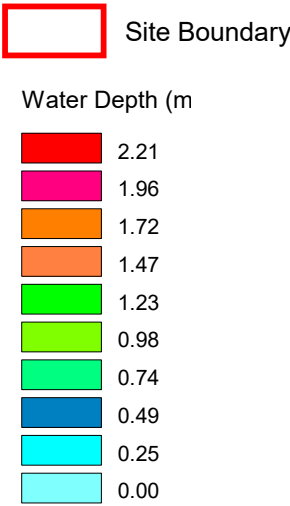
	2.18
	1.937
	1.69
	1.45
	1.21
	0.97
	0.73
	0.48
	0.24
	0.00



PROJECT	Symmetry Park, Huyton
CLIENT	Tritax Symmetry Huyton Limited
TITLE	1 in 100 Year (+70%) Modelled Flood Outline
PROJECT REF	T/18/2126/FRA
DRAWING NO	T/18/2126/FRA/5
SCALE	NTS@A3
DATE	September 2020



KEY



PROJECT	Symmetry Park, Huyton
CLIENT	Tritax Symmetry Huyton Limited
TITLE	1 in 1000 Year Modelled Flood Outline
PROJECT REF	T/18/2126/FRA
DRAWING NO	T/18/2126/FRA/6
SCALE	NTS@A3
DATE	September 2020