Cromwell Bottom Outline Water Level Management Plan

Final Report

March 2022

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Revision History

Revision Ref/Date	Amendments	Issued to

Contract

This report describes work commissioned by Robin Dalton on behalf of Calderdale Metropolitan Borough Council. Alex Jones and Steven Heathcote of JBA Consulting carried out this work.

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Purpose

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1 Introduction

1.1 Purpose of this Report

JBA Consulting was commissioned by Calderdale Metropolitan District Council (CMBC) to produce a Water Level Management Plan (WLMP) for Cromwell Bottom Local Nature Reserve (LNR) north of the River Calder.

1.2 Site Location

Cromwell Bottom Local Nature Reserve is located between the Calder and Hebble Navigation and the Calder Valley Railway, in loops created by the meandering River Calder, between Elland and Brighouse. The WLMP focuses on a central section of the reserve around a lagoon and reedbeds, in an area known as the Brookfoot Loop. The section to the south-west south of the Calder is known as the Tag Loop and is not included. The reserve is located around Ordnance Survey grid reference SE127222 and the location and features referred to are shown in Figure 1-1.

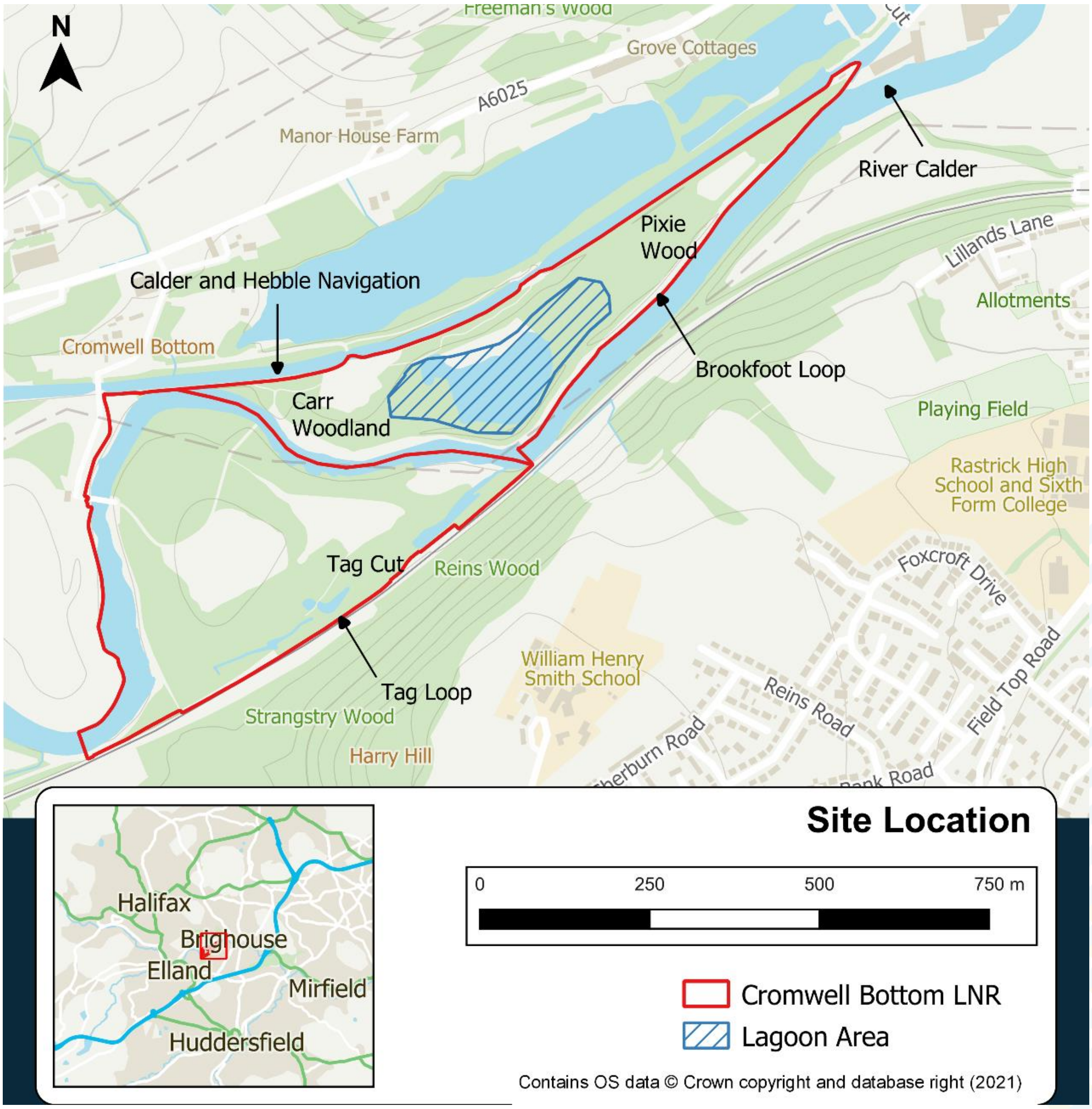


Figure 1-1: Site Location

1.3 Cromwell Bottom LNR History

The history of the site plays an important role in understanding the current habitats and their condition, and is summarised in Wilson (2017) as follows:

"Cromwell Bottom NR extends for approximately 30 ha on land that has been subject to complex disturbances over the last six decades. During the 1950s and 1960s, the glacial gravels were extracted for the building industry and then subsequently infilled with coal washery tailings, Pulverised Fuel Ash (PFA) or used as sludge lagoons during the operational period of the coal-fired Elland Power station (1960s to late 1980s/ early 1990s). Subsequently, the PFA was partially extracted to provide material for the construction of the M62 before some of the gravel pits were infilled with landfill and subsequently capped; or filled with water and managed for angling. However, the sludge lagoon, which is roughly central to Cromwell Bottom NR, was left in situ though landscaped with its mix of PFA, gravels and other materials and subsequently developed a mosaic of vegetation communities which were recognised as supporting regionally important flora and fauna, which is partly considered to be a consequence of its past use."

The site has been managed for nature conservation since 2000, when the first site management plan was produced (Calderdale Council 2000) and now comprises a mix of habitats in a publicly accessible nature reserve.

The PFA substrate is initially calcareous but over time the amount of available calcium decreased, and water testing in 2005 showed that the pH of the lagoons was circumneutral (JBA Consulting 2005). In addition, PFA potentially contains high levels of phytotoxic heavy metals, but these are locked into a relatively stable material and are not easily leached into the environment (University of Huddersfield 2021).

1.4 Previous Work

A range of previous studies have been completed assessing water level options for the site including:

- JBA Consulting (2005). Water Level Management at Cromwell Bottom. Feasibility Assessment. April 2005. Skipton: JBA Consulting (unpublished).
- JBA Consulting (2018), Cromwell Bottom Costed Scheme, March 2018, Tadcaster: JBA Consulting (unpublished).
- JBA Consulting (2019) Cromwell Bottom, Elland. Flood Risk Assessment. October 2019. Tadcaster: JBA Consulting (unpublished).
- MRB Ecology and Environment (2005) Water Level Feasibility Study. Hydro-ecological assessment final report. October 2005. Doncaster: MRB Ecology and Environment (unpublished).

In addition, JBA Consulting are currently carrying out an ecological impact assessment of the various water management options.

2 Baseline

The following sections provide a simple baseline description of the site.

2.1 Topography

Figure 2-1 and Figure 2-2 show the Environment Agency LIDAR topography of the site. The first figure classes the LIDAR into 0.5m bands to show the topography of the wider area, with the second figure showing the LIDAR in 0.1m bands to show the microtopography of the wetland floor. The two figures show the following features:

- The wetland forms a hollow surrounded by an embankment on its boundary with the River Calder to the south and the Calder and Hebble Navigation Canal.
- The wetland hollow lie at around 57.1mAOD to 57.5mAOD and is divided into three areas, by a north-south trending bund in the middle and an area of slightly higher ground in the east.
- In low flows, the water levels in River Calder lie at around 55.5mAOD with the Canal upstream of the lock lying at 59.44mAOD and downstream at 57.65mAOD.

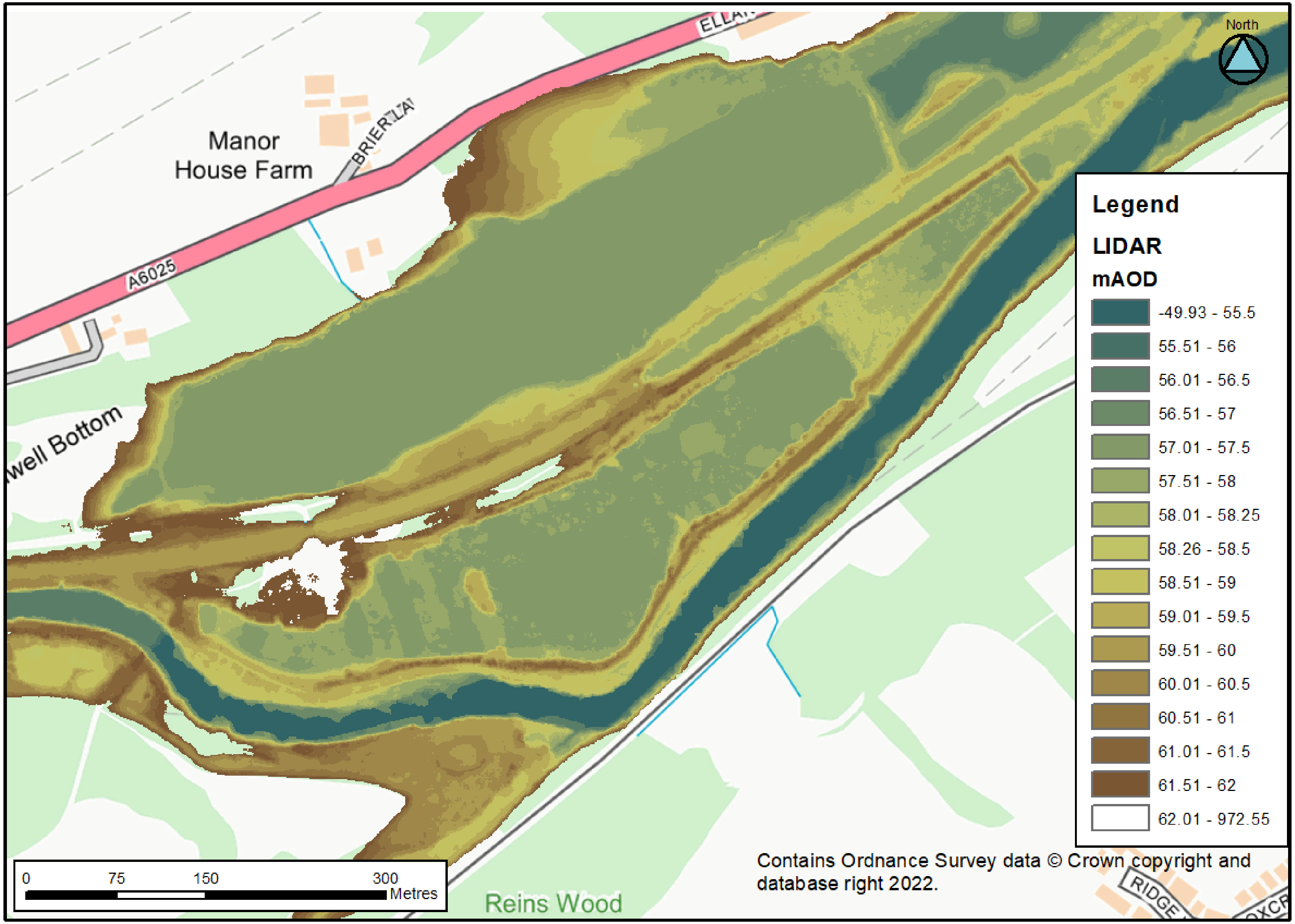


Figure 2-1: Wider Topography

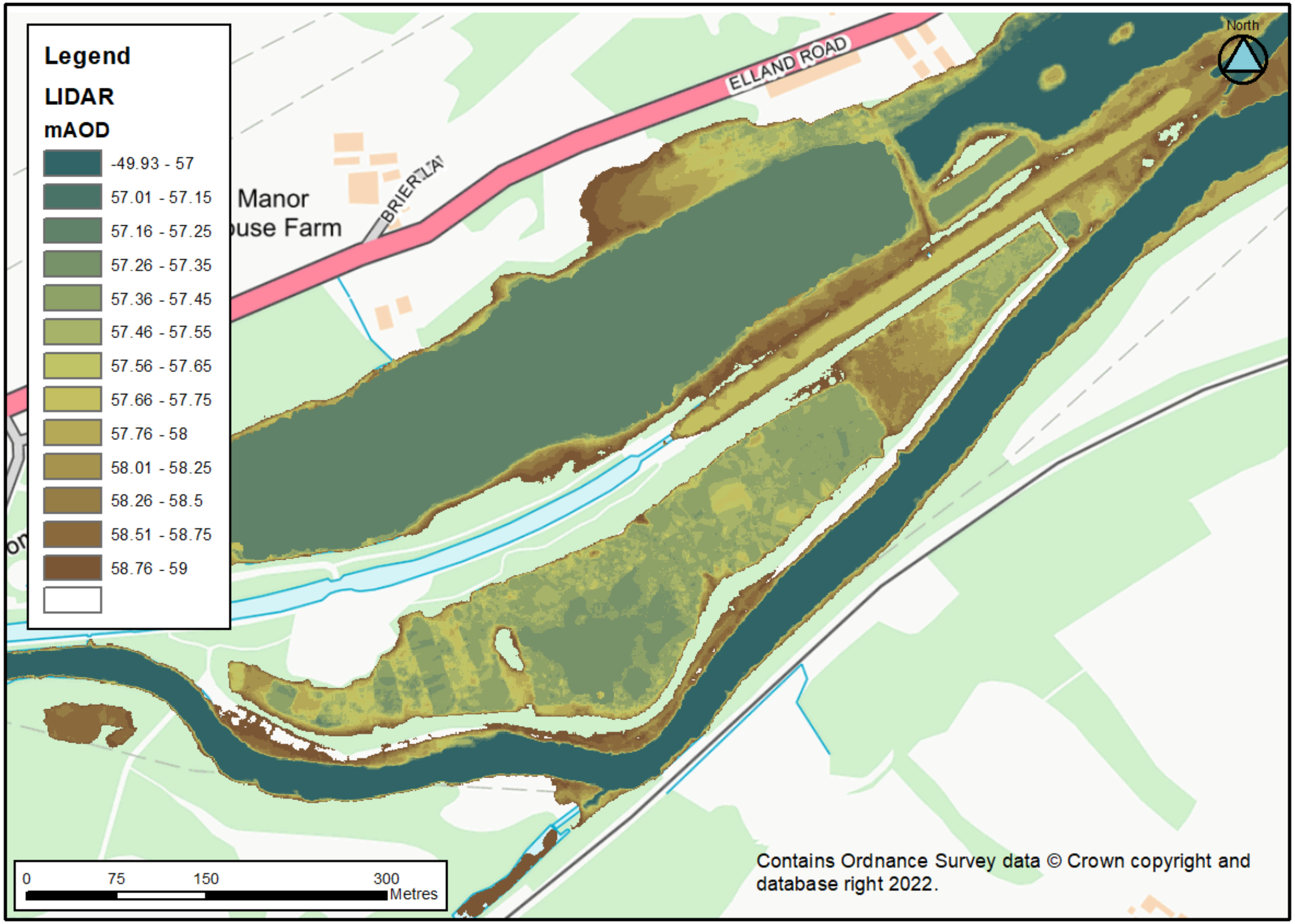


Figure 2-2: Detailed Topography of the Hollow

2.2 Ecology

2.2.1 UK Habitat Classification survey

The main parcels in the survey area constitute the open water, reedbed, and areas of woodland. They are surrounded by raised wooded banks. The layout of habitats is shown in

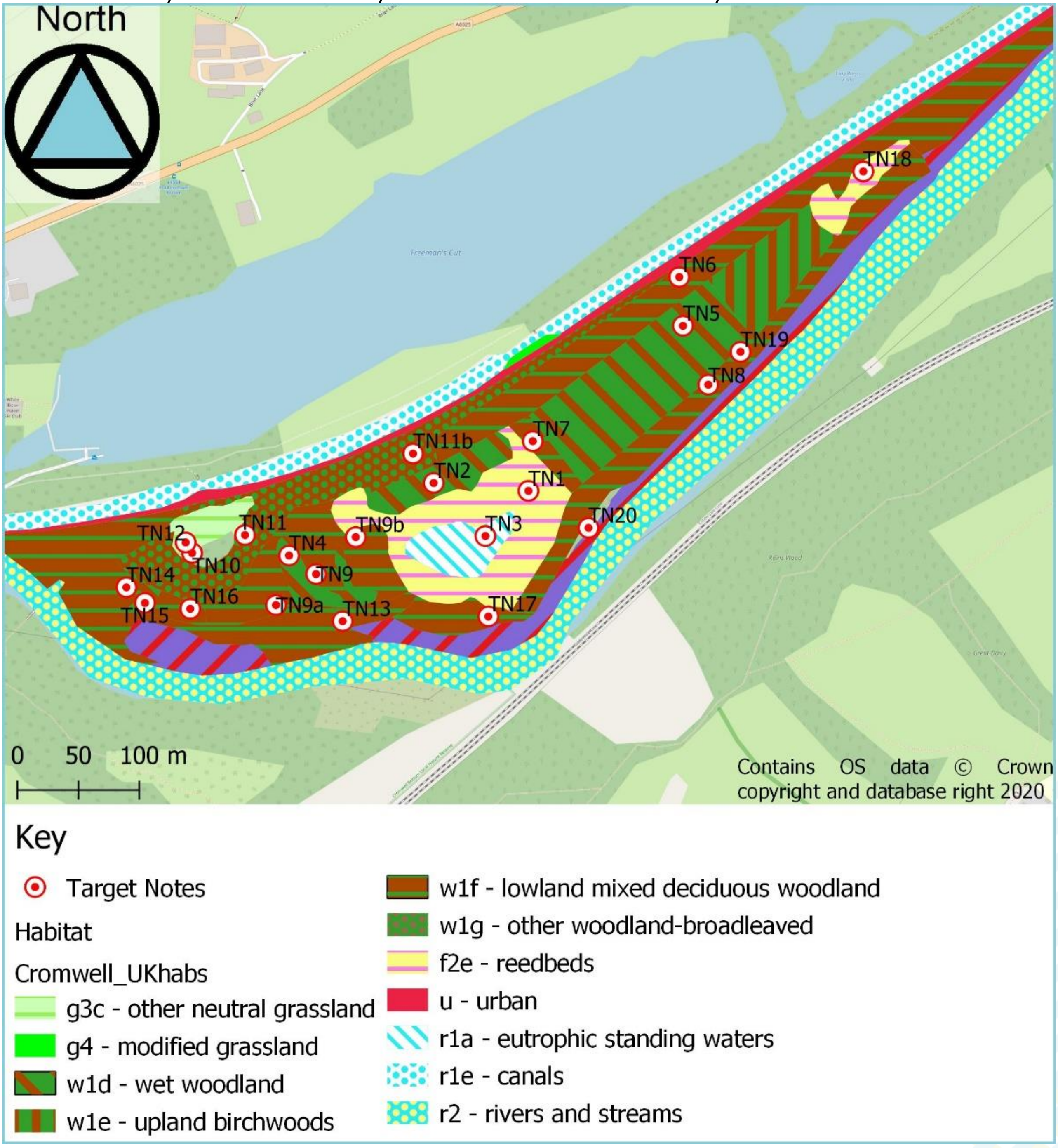


Figure 2-3. The subsequent tables present the details of the habitat classification result and the associated condition assessment, as well as a species list and relevant photos. Peripheral habitats on raised ground were mapped but their condition was not assessed.

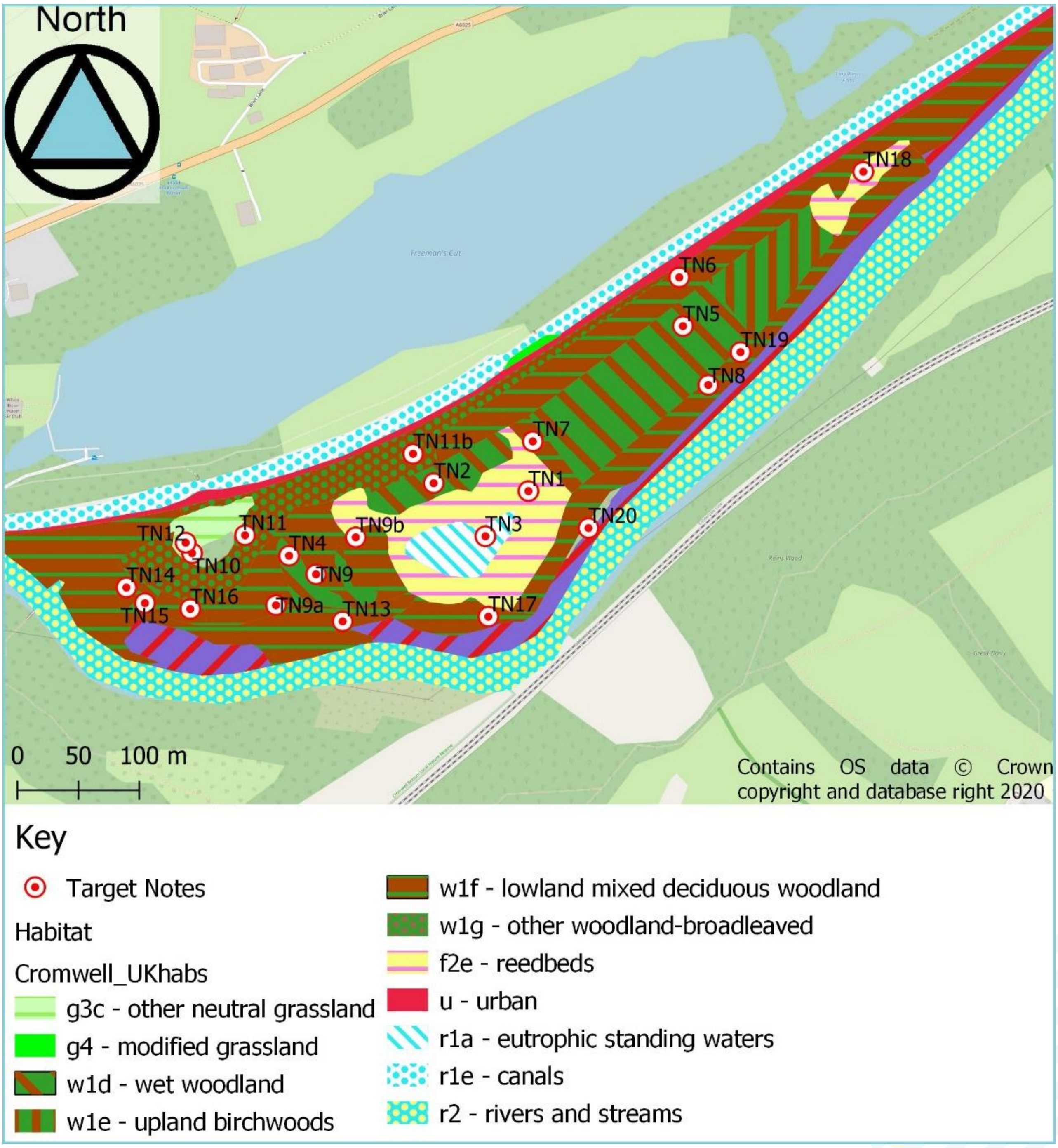


Figure 2-3. UK Habitat Classification habitat map

2.3 Water Features

The main water features on the site and the surrounding area are shown in Figure 2-4 and described in Table 2-1.

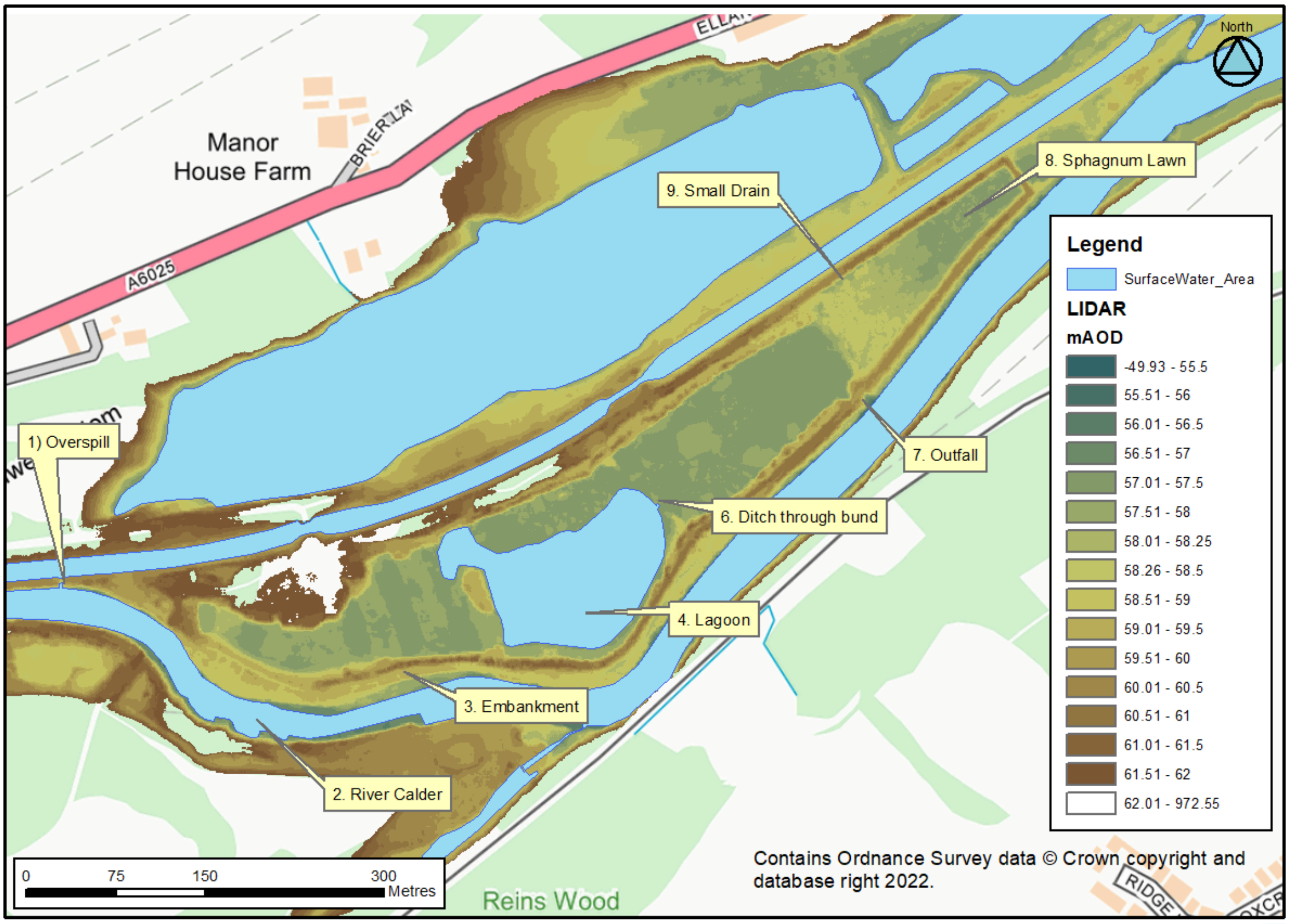


Figure 2-4: Water Features

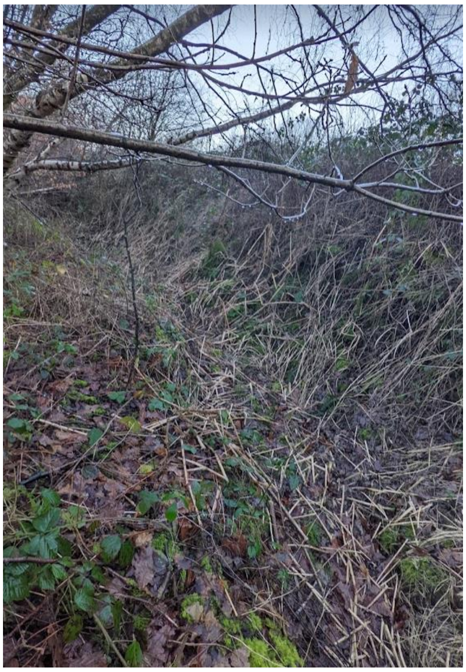
Table 2-1: Water Features

No.	Photographs and Descriptions
1	An overspill from the canal discharges via a spill to the River Calder several metres below. The height of the spill is set by a 2m wide dropboard set at 59.44mAOD  

No.	Photographs and Descriptions
2	The River Calder forms the southern boundary of the wetland 
3	The wetland is surrounded by an embankment on all sides. This appears from site observations to be a remnant of the PFA deposited on the site. 

No.	Photographs and Descriptions
4	A lagoon occupies the lowest part of the site surrounded by reedbeds. 
5	On the eastern boundary of the Lagoon is a bund that runs north-south. In the centre a ditch has been cut through. This ditch runs into the lagoon westwards and peters out as it runs through the wet woodland to the east. 

No.	Photographs and Descriptions
6.	The hollow in which the wetland lies has one outfall through the embankment. This is a culvert set at 57.15mAOD Observations by CMBC suggest that water rarely reaches this level, perhaps only in times of flood from the river. 
8	In the North-East of the site is a topographical hollow containing a Sphagnum Lawn. The hollow is formed by an embankment on three sides and rising ground in the west. 

No.	Photographs and Descriptions
9.	There is a small ditch running from the Sphagnum Lawn through a section of raised ground to the main hollow. This drain is filled with vegetation and is blocked by a path at the western end. It appears that it still acts as a flow pathway in wet conditions to allow the sphagnum lawn hollow to drain.  

2.4 Geology and Hydrogeology

As described in section 1.3, the site was a sand and gravel quarry, that was filled in the PFA, then some of it was excavated to form the topography today. The BGS GeoIndex has a large number of boreholes available for the site (available at GeoIndex - British Geological Survey (bgs.ac.uk)) – see Figure 2-5. These have been used to produce a typical cross-section (see Figure 2-6) which has the following features:

- The site was underlain by high permeability sand and gravels. These have been excavated from the centre of the site
- Low permeability PFA fills the void left behind by the sand and gravel extraction, and can be up to around 4m deep, even in the lower-lying areas.
    - This "bucket" of low permeability material allows the water in the lagoon to persist and not rapidly drain to the river which is typically 2m lower than the water in the Lagoon.
- The embankments are formed of PFA
- The sands and gravels continue to exist in a strip between the embankment and the river.
- The Canal is assumed to be lined to limit the loss of water.
- There are areas of made ground[1].

———————————————————————————————————————

1 Made ground is land where natural and undisturbed soils have largely been replaced by man-made or artificial materials. It may be composed of a variety of materials including imported natural soils and rocks with or without residues of industrial processes (such as ash) or demolition material (such as crushed brick or concrete).

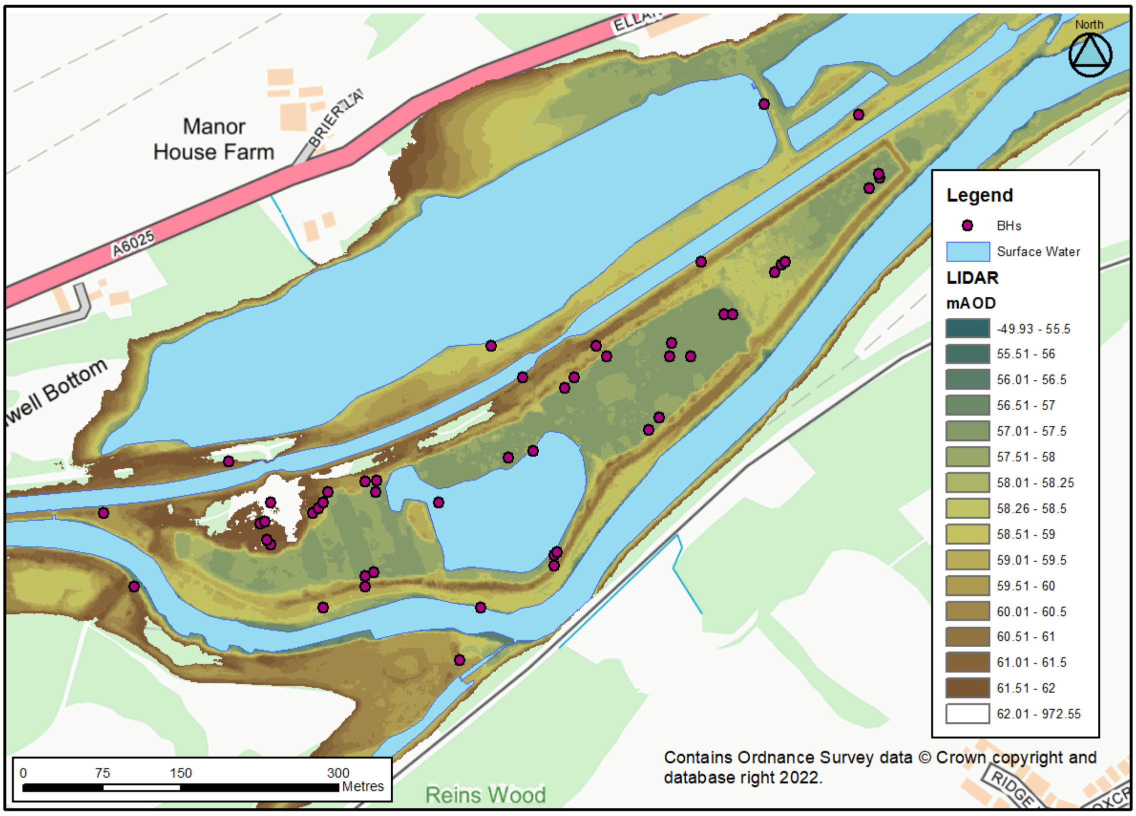


Figure 2-5: BGS Borehole Locations

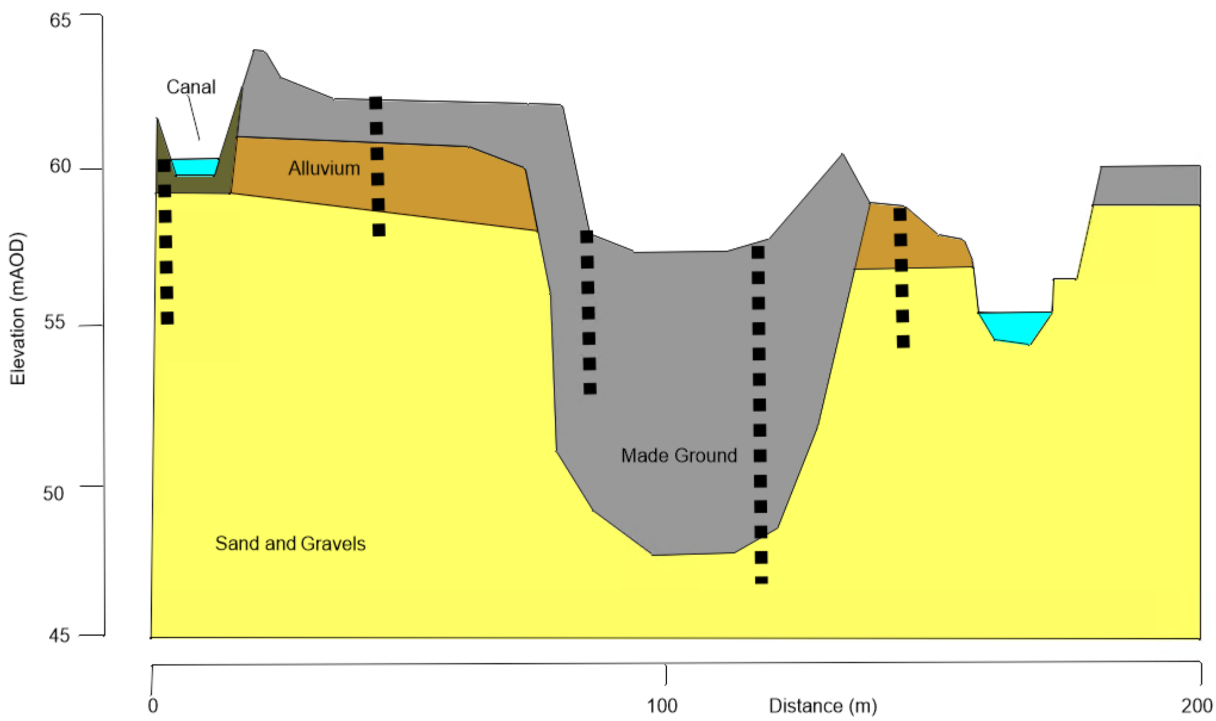


Figure 2-6: Geological Cross Section through the West of the Lagoon

2.5 Water Supplies Conditions

Current water supply inputs to the site at the moment consist of:

- Rainfall;
- Occasional flooding events from the River Calder.

Current outputs consist of:

- Evapotranspirational losses;
- Lateral groundwater movement – these are limited as the wetlands are lined with relatively low permeability PFA;
- Overspills from the outfall culvert.

Observations by CMBC show that this outfall does not operate every winter and only really operates in times of flood. Overall, this suggests that rainfall and evapotranspirational losses are relatively equal over a year. If rainfall inputs were larger, then water levels would reach the height of the outfall and discharge out.

2.6 Conceptual Model

Figure 2-7 shows the conceptual model of the site. It has the following features:

- The site is underlain by high permeability sands and gravels
    - The lake to the north and the River Calder to the south tie into the water table in this unit
- The sands and gravels were excavated in the centre of the site, and the hole backfilled with low permeability PFA.
    - The water in the lagoon is therefore perched above the local water table and there is little lateral groundwater movement out of it
- The canal is also perched above the local water table.

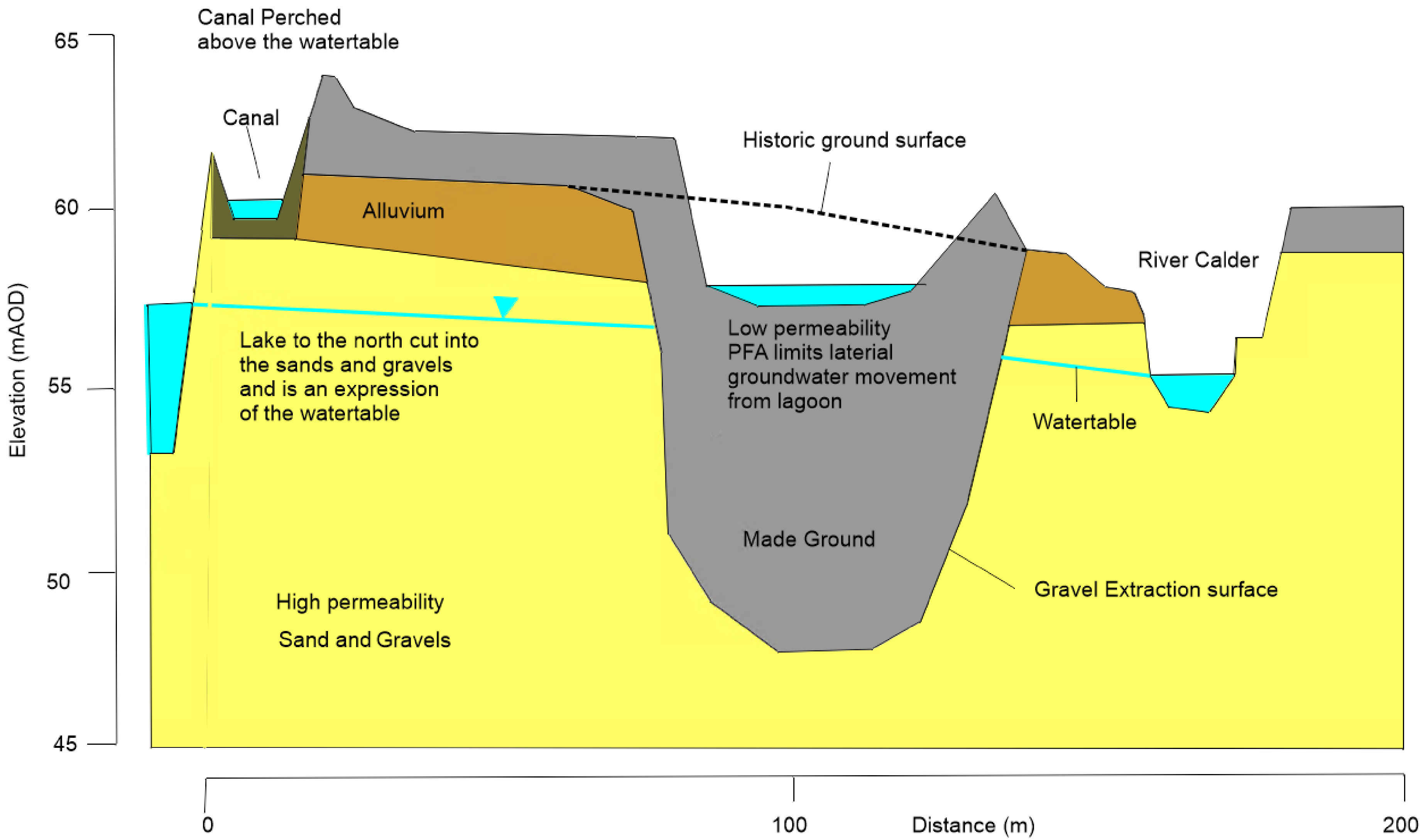


Figure 2-7: Conceptual Model

3 Water Level Requirements and Options

The following section summarises published evidence of optimum water levels in various habitats to maximise conservation interest and identify which elements are relevant to Cromwell Bottom.

3.1 Vegetation Requirements

3.1.1 Reedbed and lagoon

Reedbeds require permanently wet or waterlogged sites and healthy growth requires a reliable and predictable water regime. These conditions apparently exist at Cromwell Bottom, but the overall condition is considered too dry, which is allowing scrub to invade. Guidance on water levels to optimise the condition of reedbed are given in Wheeler et al. (2004) who compare monitoring regimes for reedbeds used for commercial reed harvest and conservation value, which are optimised with different management of water levels. They highlight that the following management regime maximises the wildlife value:

- Cut (or graze) in late summer and remove cuttings to reduce the accumulation of litter;
- Summer water level at or just below soil/litter surface;
- Winter water level above soil/litter surface.

They note that this regime will slowly reduce the proportion of reed in the vegetation, with fen species expected to increase, but will also slow the expansion of Common Reed into open water, preserving the open water lagoon for longer. Depending on the extent of the dry period though, this may also favour New Zealand Pygmyweed *Crassula helmsii* which is present at Cromwell Bottom. However, despite the risk presented the Pygmyweed, the water levels given in Table 3-1 are the target levels to improve the condition of the reedbed. There is no formal monitoring of the current hydrological regime, but anecdotally, the site is currently drier than the target levels for most of the year.

Table 3-1. Optimum water levels for reedbeds.

Season	Optimum (green) water level for Common Reed growth Mean values (m) for Max – Min measured from soil surface	Optimum regime for maximum wildlife benefit of reedbed
Winter (Dec-Feb)	+0.25 to +0.75	Up to +100
Spring (Mar-May)	+0.1 to +0.5	-
Summer (Jun-Aug)	+0.2 to -0.4	+0.05 to +0.30
Autumn (Sep-Nov)	+0.2 to 0	-

3.1.2 Wet woodland

Although there are eco-hydrological guidelines for wet woodland (Barsoum, 2005), these do not set out prescriptive water levels in the same manner as for reedbeds. Much of the woodland on site currently corresponds approximately to a young form of the NVC community **W6 *Alnus glutinosa-Urtica dioica* woodland,** closest to the *Betula pubescens* sub-community (Rodwell 1991a). This wet woodland is typical of lower depressions on floodplains, and the woodland is tolerant of variable water supply, as well as the physical impact of floodwaters and inundation. This habitat will naturally accumulate organic matter, with succession leading it towards drier woodland and in natural alluvial situations, more severe floods provide the conditions set back the succession and allow persistence of the community. However, provided the conditions remain wet, this woodland is likely to persist and be tolerant of the changes in hydrology if flowing water is brought in from the canal and allowed to flow through the wet woodland to reach the reedbed.

3.1.3 Sphagnum mire

The Sphagnum mire is formed of two distinct areas (JBA Consulting 2022), the more-Sphagnum rich area assigned to the NVC type **M6 *Carex echinata-Sphagnum recurvum/auriculatum* mire** (Rodwell 1991b) developed on a shallow peat. The western area has more of a reed-dominated structure and is difficult to place in the NVC, but has elements of **M5 *Carex rostrata-Sphagnum squarrosum* mire**. There are no eco-hydrological guidelines for M6, but details for M5 are given in Wheeler et al. (2009). As both communities are poor-fen, and in the absence of specific guidelines for M6, the guidelines for M5 are used to inform the discussion, although M5 typically occupies a slightly wetter more oligotrophic overall niche.

Stands of M5 presented in Wheeler et al. (2009) have a mean summer water table of -4cm, with a range of +10cm to -45cm. They describe the optimum water levels as:

- Typically close to surface level year-round.
- Association with buoyant basin or turf pond infill provides vertical mobility and thus some hydrological stability.
- The community usually occupies surfaces that are a little elevated above the limit of frequent inundation with more base-rich water. However, occasional flooding with base-rich water will prevent succession to community types associated with more acidic conditions. The community is therefore most likely to be persistent in more buoyant circumstances.

The extent to which the vegetation at Cromwell Bottom has a buoyant surface is unclear. The community is described in Wheeler et al. as often being of recent origin, so the relatively young age of the vegetation at Cromwell Bottom may mean it is still able to achieve good hydrological stability. However, they note that water table drawdown (or prolonged drought) is damaging and likely to lead to loss of *Sphagnum* and succession to scrub or woodland.

3.2 Potential Water Source Discussion

Currently, the site appears to be too dry. The lack of water discharging from the outfall during winter months suggests that this situation can not be resolved solely through retaining water on-site for longer (i.e. there is not water discharging from the site in the winter that could be retained keep the site wetter in the summer). This means an additional source of water is required.

Previous studies identified two potential sources of water:

- Pumping from the river,
- Spilling from the canal.

Box 1 below repeats two sections from JBA 2018. This suggests that pumping would take a minimum of 38 hours. If the pump had to be removed from site every day for security reasons, it may take 5.5 days to fill up and require a lot of resources by CMDC to fill.

Box 1: Sections From JBA 2018

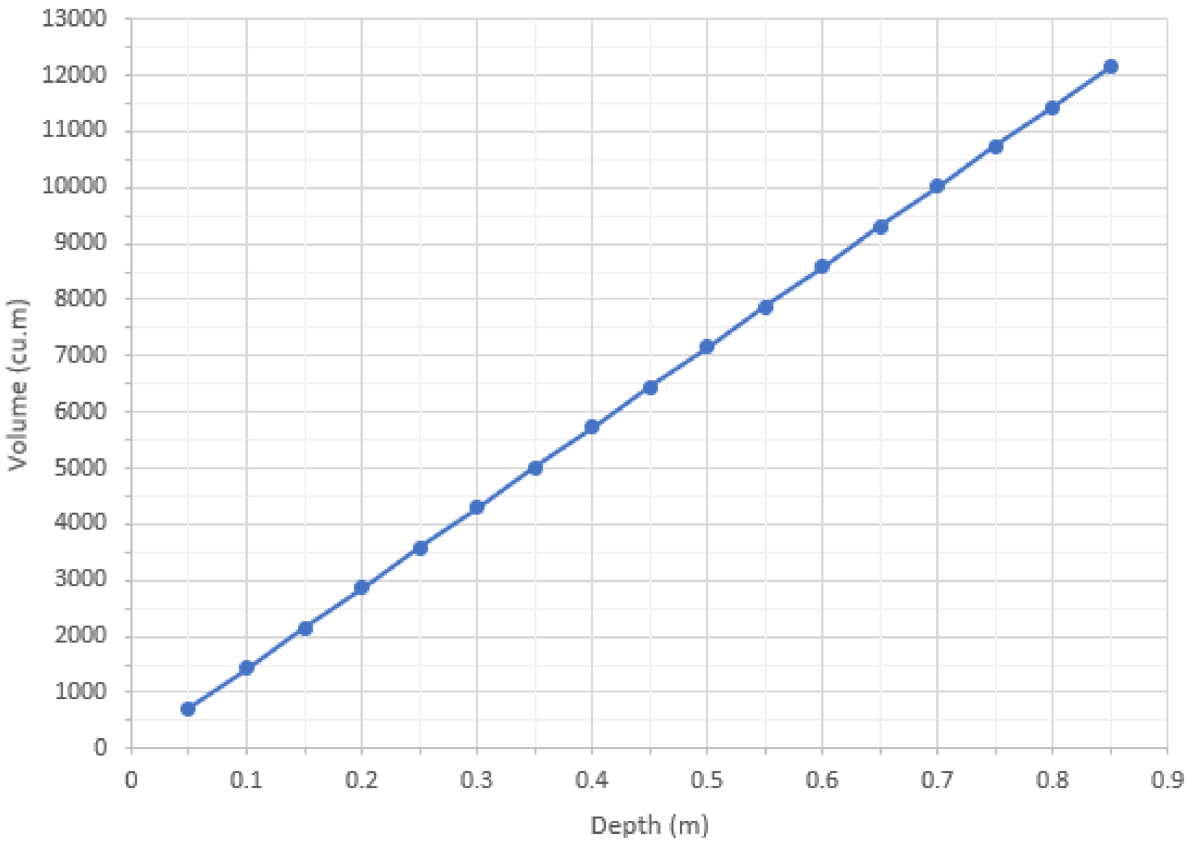
2.1.1 Pond Area

Based on the ordnance survey background mapping the pond has a surface area of approximately 14,300m2 (1.43 hectares). The 2018 water level at the time of survey was around 55.55m AOD.

The crest of the bund is elevated at around 56.7m AOD; therefore allowing 0.3m freeboard the top water level in the pond could be 56.4m AOD; this would increase the depth of the pond by some 0.85m. Figure 2-3 provides a depth-volume relationship based on an area of 14,300m2.

The maximum volume required is 12,155m3; or 12,155,000 litres.

Figure 2 3 Pond Volume



2.2.2 Time to Fill

Two pumps have been considered as discussed further in Section 2.3.

The 4” pump can delivery 32l/s (at 1500 rpm & 5m head), while the 6” pump can deliver 90l/s (at 1200 rpm & 5m head).

These figures are approximate and would require further refinement and consultation with the pump supplier due to losses within the system.

Based on the above the 4” pump would take 106hrs to fill the pond to its maximum level, while the 6” pump would take 38hrs. Fuel costs would be in the region of £185 and £350, depending on the price per litre.

The alternative to a pump is to utilise excess water from the canal. There is an existing overspill from the upper section of the canal to the river (see Figure 2-1). Observations on the site visit (19th January 2022) show that was flowing around 5l/s, this tallies with JBA 2005 observations which stated:

> *“British Waterways have indicated that the overflow is stated just above the level of the canal and only operates in times of high flow when the bywashes at the locks (overflows around the locks are unable to cope with the flow within the canal. The overflow was operating during both site visits (10/02/2005 and 16/02/2005), with a reasonable level of flow (very approximately 5l/s). However, British Waterways have indicated that there is no flow as this discharge for much of the year and that there is no discharge consent for this discharge”.*

The reach of canal which the outfall serves is around 1800m and for much of it receives run-off and flows from the higher ground to the north. The current evidence suggests that at least during the winter, when evaporative losses from the canal are minimal, flows from the overspill are relatively regular. This could be confirmed by setting up a time-lapse camera to face the overspill, recording one photograph a day. Box 2 shows that based on a conservative assumption of a flow rate of 2l/s, the system would fill over 70 days or 2.5 months over the winter period.

Box 2 – Overspill Calculations
2l/s = 172.8m3/d 12,155m3 / 172.8 = 70 days

Based on a meeting with CMDC on 28th January 2022, it was decided that a passive system like the canal overspill was preferable to a pump source of water.

4 Preferred Option

Based on the ecohydrological understanding of the site and discussions with CMBC a preferred option has been developed. The two main features of the design are:

- An overspill from the canal discharging water to the wet woodland that will find its way down to the lagoon area,
- A series of three dropboard structures would be installed to create three cells when water levels can be managed separately. Prescribed heights are not set for them, so onsite management can be used to set the levels. Maximum ranges are given so that they will not cause flooding issues.

Table 4-1: Preferred Option Elements

Element	Discussion
1	Canal Overspill An overspill structure would take excess water from the canal, which currently discharges to the River Calder, and redirect it into the wetland. The dropboard on the current overspill would be raised by a few centimetres and the new overspill to the wetland would be set at the current overspill level (59.44mAOD). This would maintain the current canal level and direct the majority of the flow to the wetland, however, the current overspill would still be active in larger flood events. Figure 4-2 presents an engineering drawing of an overspill designed by JBA in 2018. It gives an overview of the elements including the weir, pipe and outfall. The proposed option would replace the tilting weir in the JBA 2018 design with a fixed weir. This would maintain levels in the canal. It may be valuable to have the possibility of installing a dropboard on the outfall so that flows can be stopped for a period (e.g. to dry out the site for reed management). If this was the case, the raised dropboard on the current outfall would have to be replaced for that period with a dropboard sat at 59.44mAOD to maintain canal levels
2	The overspill outfall would discharge to the top of the wet woodland system. The water would find its way through the current microtopography of the area, filling hollows and spilling via low points through the area to the main lagoon. Discharging the water to the wet woodland may improve the morphology of the wet woodland and act to polish the water before it enters the lagoon.
3	An adjustable weir should be installed on the ditch on the outfall of the lagoon area. This could be managed between to a maximum height of 57.8mAOD. A typical level to set it in the winter might be 57.45mAOD (see Figure 4-1 for the extent of water at that height)2
4	This is an optional element. If more control is required to manage levels in the sphagnum lawn area, the ditch could be cleared out, a culvert set on the path at its end (invert set at 57.35mAOD). An adjustable weir (likely a dropboard structure with 10cm boards) would be installed. This could be managed between 57.35mAOD and 57.75mAOD. A typical level to set at 57.55mAOD
5	An adjustable weir structure could be installed around the face of the outfall. This would manage levels between 57.15 and 57.mAOD. Initial this structure would not be commissioned but water levels could slowly be raised if required

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2 Note heights for this structure are suggested in JBA 2018, however there appears to be an error in the topographical surveys on which those levels are based.

Figure 4-1: Preferred Option Overview

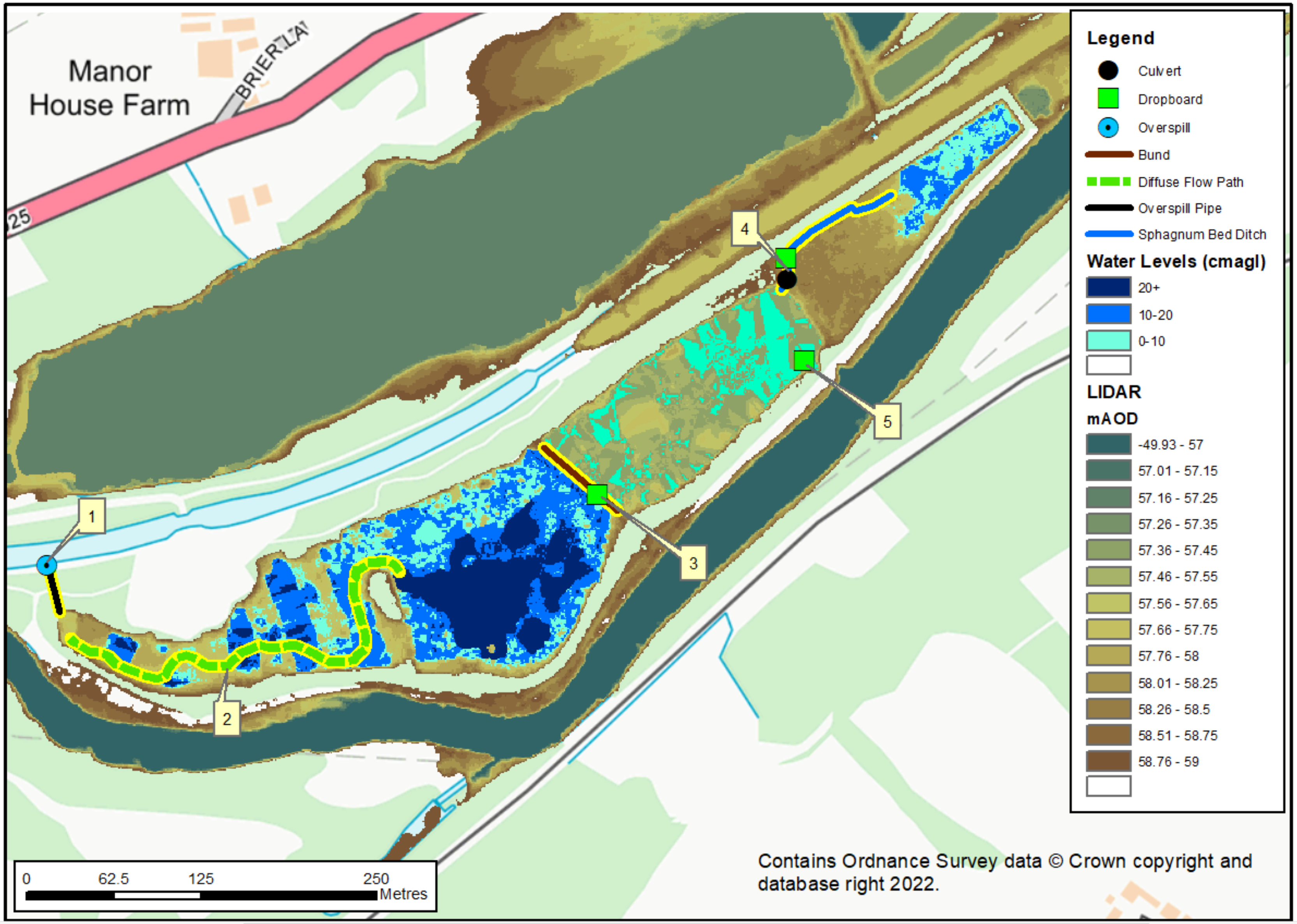
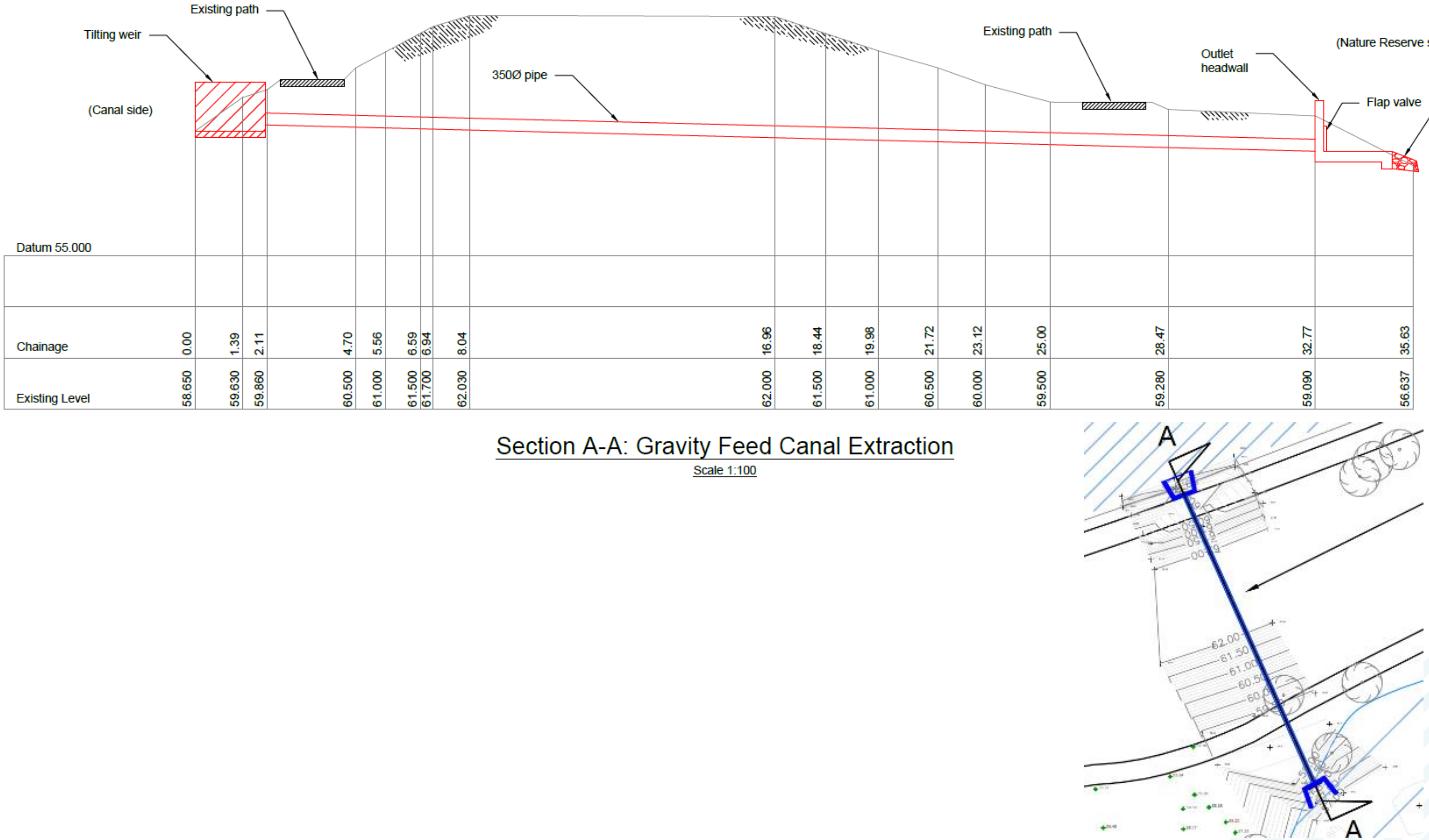


Figure 4-2: Overspill Design (JBA 2018)



5 Further Development

5.1 Development of Options

The option presented takes elements of previous designs to produce a preferred option. Further stages would be required before implementation. A number of elements have been previously taken forward to developed design stage, such as the canal feed but would need reconfiguring due to the change of location as changes in spill heights. No developed designs however have been produced for the proposed control structures

In addition to developing the design further, there are considerations regarding CDM regulation requirements, and outline considerations of consents detailed below.

5.1.1 CDM Requirements

Construction design and site work must comply with the Construction Design and Management Regulations 2015 (CDM Regulations). At future stages of development, the project must comply with the CDM Regulations.

This report provides outline design parameters for a range of options. If these are taken forward towards detailed design and implementation, we have made the precautionary assumption that work should follow the framework and fulfil the obligations outlined in the Construction (Design and Management) Regulations 2015 (CDM Regulations). At this early stage, JBA Consulting has not been designated as the Principal Designer but by proposing potential options, may be deemed to have acted as a designer. It is assumed that the role of Principal Designer currently falls with the client.

When progressing the designs further, the client should assess whether the nature and scale of the works are likely to be notifiable under CDM regulations (the criteria for it being notifiable is that the construction phase will last more than 30 working days or shifts and has more than 20 persons on-site or will involve more than 500 person days or shifts) and identify in the Project Execution Plan how CDM roles will be appointed and the regulations implemented.

Box 1 provides the body of a typical letter JBA provides to clients when we believe that we are acting as a designer. It outlines our understanding of the roles and responsibilities of the client under the Regulations.

Box 1 – Text of an example CDM Letter

We have reviewed the above project and have determined that it is likely to be a **notifiable** project involving **more than one** contractor under the CDM Regulations 2015. The criteria for it being notifiable is that the construction phase will last more than 30 working days or shifts and has more than 20 persons on site or will involve more than 500 person days or shifts.

As Designer, we have a duty under the Regulations to ensure that you, as Client, are aware of your duties. Under the Regulations, the Client shall:

- Ensure that suitable management and welfare arrangements are made for the project, including allocation of sufficient time and resources at all stages.
- Ensure these arrangements must be maintained and reviewed throughout the project.
- Ensure that construction work can be carried out reasonably without risks to health or safety of any person affected by the project.
- Ensure that welfare facilities required under Schedule 2 are provided for any person undertaking construction work.
- Provide the pre-construction information to all the designers and contractors.
- Ensure that a construction phase plan is suitably drawn up by the Principal Contractor before work commences.
- Ensure co-operation and co-ordination between the Client's employees and client contractors with the Principal Contractor where the Client's work activities overlap the construction work.
- Select and appoint a competent and resourced Principal Designer and ensure that they comply with their duties.
- Select and appoint a competent and resourced Principal Contractor and ensure that they comply with their duties.

- Ensure that the Principal Designer prepares a compliant and appropriate Health & Safety File and the client keeps this document for the duration of owning the asset.
- Subsequent to receipt of the Health and Safety File, maintain the information up to date and provide access to any person who needs it for health and safety purposes.
- Ensures that the Health & Safety File is provided to any person who acquires the asset from the Client, ensuring that they understand the File's purpose.
- Notify the HSE themselves in writing about the project as a notifiable project (e.g. F10 form).

We trust the above is satisfactory, but if you have any questions regarding your duties under the CDM Regulations or require further information or clarification, please do not hesitate to contact us.

5.1.2 Consents and Permissions

The table below presents a brief overview of potential consents and permission requirements before implementation.

Table 5-1: Consent Requirements

Consent / Permission	Discussion
Environmental Permit	The works would require a flood risk activities environmental permit as they would occur within the floodplain of a main river. This is likely to be a bespoke permit but could be supported through a modified version of the existing FRA.
Consent from the Canal and Rivers Trust	Consent would be require from the Canal and Rivers trust for the work. Options for closing/diverting the tow paths for the period of the works would need exploring, however the parallel track within the reserve may be suitable, if the work can be phased

References

Barsoum, N., Anderson, R., Broadmeadow, S., Bishop, H., Nisbet, T. (2005) *Eco-hydrological guidelines for wet woodland – Phase 1*. English Nature Report 619. Peterborough: English Nature.

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