Wessex Water Services Limited

Trowbridge Bioresources Centre

CIRIA 736 IED Report - Secondary Containment Assessment

Addendum to Environmental Permit Application (Ref: EPR/BB3934AG)

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Disclaimer:

Contents

1 Report Context and Scope

This report has been prepared to support the Application for Environmental Permit Variation at Trowbridge Bioresources Centre (BC), issued in June 2021, Permit Ref EPR/BB3934AG.

The Environmental Permitting (England and Wales) Regulations 2016 (EPR) application was submitted due to changes to the Environment Agency (EA) interpretation of the environmental permitting exclusion for Urban Wastewater Activities (under (EPR) Schedule 1, Part 2, Chapter 5, Section 5.4). The EA interpretation now requires that anaerobic digestion (AD) plants treating over 100 tonnes/day (t/d) are classified as installations for the purposes of EPR.

The primary purpose of the report is to secure stakeholder agreement of the method, logic, assumptions and outputs in the risk assessment and the general level of intervention deemed necessary to achieve BAT 19c compliance at Trowbridge BC and specifically emissions to soil and water due to overflows and failures from tanks and vessels. Upon acceptance, detailed solutions will then be developed to satisfy the EPR.

This addendum includes:

- A full environmental risk assessment (ERA) of all existing primary and secondary containment measures at Trowbridge BC, to safeguard against the impacts of catastrophic containment failure scenarios.
- Consideration of credible modes of failure to emphasise the actual level of risk associated with each primary containment asset.
- Spill modelling of the complete loss of the inventory from each primary containment asset type to demonstrate the potential to reach key receptors.
- The nature and extent of improvements deemed necessary to contain inventory spills following catastrophic failure of primary containment to satisfy BAT 19 of the Waste Treatment BREF.

The ERA has been developed in line with CIRIA 736 'Containment Systems for the Prevention of Pollution' guidelines (CIRIA 736) and the 'ADBA Secondary Containment at AD plants: An Industry Guide' document (ADBA Guidance). Solutions align with the guidance outlined in Ciria 736 where it is practicable to do so on an existing operational site. Where it is not practicable, alternative best available techniques are proposed for acceptance. The 110% and 25% rule outlined in the CIRIA 736 guidance is adhered to as a minimum requirement.

2 General Approach

The Source-Pathway-Receptor model as prescribed by CIRIA 736, and in accordance with sector guidance, has been used to establish the level of risk of failure of BC assets containing large volumes of sludge, and the subsequent impact on local receptors. The class of containment required is based on this risk assessment.

2.1 Source

One of the key elements for determining the site hazard rating is as described in CIRIA 736 Section 2.3.1 – defining the Source of the pollution. It is the inventory of waste, surface water runoff that is contaminated by the inventory, firefighting agents that are harmful to the environment, and firefighting and cooling water that is contaminated by the inventory.

The potential pollutants present on site are assessed by the physical properties such as density and viscosity (percentage dry solids of the inventory) and the flammability that can indicate the potential impact of the inventory and severity to the receptor.

Loss of containment scenarios and the subsequent total volume of inventory released are based on catastrophic failure of BC assets, regardless of whether the mode of failure is credible or not. The minimum volume assumed for a catastrophic failure is based on the 110% and 25% rule outlined in Chapter 4 of Ciria 736.

2.1.1 Credible Failure Modes

Credible modes of failure are considered to emphasise the actual level of risk associated with each primary containment asset. This approach is important when assessing the probability of a failure mode occurring within the risk assessment to determine the required class of containment. It also helps to emphasise the design and inspection and maintenance safeguards needed to minimise the risk of smaller spills associated with higher probability events.

Credible failure modes of a tank or vessel have been established by considering the following factors:

- Containment material
- Height to width Aspect ratio
- Working volume
- Current Structural Condition
- Dry Solids content of the inventory
- Vulnerability to vehicle collision
- Site security risk with respect to an intruder causing irreputable damage
- Operating requirements of a given BC asset

For example:

A worst-case scenario:

A rapid and complete loss of containment would be reasonably expected for a glass coated steel digester (pressurised) tank which has exceeded its design life and is showing clear signs of severe corrosion and fatigue.

A low-risk scenario:

Any loss of containment from a reinforced concrete digester would be considered highly unlikely where the structure has been designed to the relevant water retaining codes, constructed under supervision, built with industry standard safeguards in place, and is routinely inspected and maintained in accordance with a robust inspection and maintenance regime.

The risk assessment will normally only include BC assets containing large working volumes, as these are likely to define the containment solution for the site. Small BC tanks / vessels, mechanical plant, and interconnecting pipework is not normally included within the assessment unless their position or alignment, in relation to the containment solution, results in a significant residual risk to receptors.

Although credible failure modes are considered in the ERA, the proposed secondary containment solution volumes align with the 110% and 25% rule outlined in Chapter 4 of CIRIA 736.

2.1.2 Inventory

For the purposes of the spill modelling, the inventory will either be raw sludge and sludge liquors or digester sludge. Section 3.5 of the ADBA Guidance notes that CIRIA 736 suggests raw sludge should be classed as a hazardous substance given its influence on the oxygen balance (of aquatic environments) and microbial contamination.

- Raw sludge is therefore classed as high risk in the risk assessment.

The ADBA guidance does acknowledge that the hazard rating for fully digested sludge may be reduced given that it may be safely spread on fields under controlled conditions.

- Fully digested sludge is therefore classed as medium risk if considered in the risk assessments.

Section 4.3.4 of CIRIA 736 focusses on recommendations for quantifying firefighting water and agents and emphasises the need to adequately provide for a resultant volume for a secondary containment solution. However, Section 3.21 of ADBA Guidance acknowledges that:

- Sludge inventory at a BC is not flammable.
- Biogas will be produced through the digestion process at relatively low volumes and pressures and accidental ignition will lead to short lived fire/explosion.
- Firefighting foam and water is therefore not anticipated to be used in significant volumes for fighting a fire or cooling a tank in this scenario.

Firefighting foam or water is therefore not normally considered for the purposes of the spill modelling. The exception is if there is potential for a fire caused by the ignition of WRC asset near the BC assets. In this case the fire itself may credibly cause failure of the BC asset. In this scenario, firefighting agents, and loss of inventory would be considered.

2.2 Pathways

Following a catastrophic failure of above ground primary containment, the escaped inventory will follow the natural topography of the ground before it reaches access points to underground drainage, duct services, surface water bodies, or permeable areas of ground.

Once a spill reaches permeable ground it will continue to migrate according to the ground topography. However, a proportion of the inventory now in contact with the ground will also start to infiltrate into the ground. The rate of infiltration will vary depending on the properties of the inventory and the permeability of the ground. From here, the escaped inventory has the potential to migrate towards receptors such as groundwater or surface water bodies.

Buried tanks or above ground tanks with features that partially extend below ground also need to be considered. These tanks will typically be reinforced concrete construction. The credible modes of failure are limited to gradual degradation caused by potentially aggressive ground conditions or the slightly corrosive nature of the inventory. This is likely to lead to leaks rather than large scale spill events.

Spill simulations are therefore focussed on the routes of the spill migration overland to identify the proportion of volume (if any) reaching surface water bodies or permeable ground. The spill simulations are then used to confirm the suitability of proposed bund solutions.

Note: The inventory volume held below ground within an asset is not included in the overland spill simulations.

Vertical and horizontal migration potential of lost inventory in the ground has been considered in the ERA. This is based on the local geology and hydrogeology described in Section 4 of this document.

2.2.1 Spill Simulation Method

Overland spill simulations from the BC assets of interest are generated using a Geographical Information Systems (GIS) “rolling ball” tool. For each BC asset, an esri ASCII grid file is created from 1km Lidar Digital Terrain Model data (point density of 1 point per square metre) with a 1km radius from the selected spill position.

The potential spillage route is determined by following the path of least resistance from the selected spill position. From this spill position, the tool will look up the eight adjacent 1m square cells and spill into the cell with the lowest ground elevation. In the next iteration, the tool will look at all cells adjacent to the two cells currently containing the spill and spill into the adjacent cell with the lowest elevation and so on.

Each iteration adds a 1metre x 1 metre x 0.1metre spill volume and iterations will continue until:

- The simulation reaches the end of the number of iterations, defined by the total credible spill volume determined by the risk assessment or,
- The spill reaches a surface water body such as a lagoon, lake, watercourse, or sea.

For any given iteration, if adjacent cells do not have a ground elevation lower than the cells containing the spillage, then the simulation adds 0.1m to the cells featuring the spillage and adjusts the remaining number of iterations based on the residual spill volume.

2.2.2 Simplifications

The model simulation is simplified in the following ways, to generate a conservative but reasonably accurate overland spill route for the loss of containment from a given source.

- All Surfaces behave as impermeable surfaces, so flows are not lost to ground in simulation.
- Small chambers such as drainage features and cabling drawpits are not included for the purposes of the rolling ball simulation.
- Buildings and structures have 100 metres added to their lidar value so the spill cannot travel through them.
- Water in the Lidar has a negative elevation value and once the spill reaches water, 100% of the residual inventory volume is assumed to also spill into the water.

- If a bund is proposed for a solution, then 0.3 metres is added to the relevant Lidar cells along the suggester permitter of the bund to represent a shallow reinforced concrete wall in the first instance.

2.2.3 Limitations

The failure mode of an asset can significantly influence how the spill volume migrates from the primary containment. For example, overtopping of a tank will normally cause flows to spill around the complete perimeter whereas tank corrosion leading to the localised rupture will result in flows discharging from a single position. The rolling ball method always assumes a point source discharge regardless of the established failure mode. A worst-case spill position is selected based on surrounding topography and proximity to nearby receptors. In certain instances, more than one spill position is required to prove that a containment solution is effective; for example, when the ground levels fall in more than one direction away from the asset.

The model simulation does not account for percentage dry solids of the spill. However, the rolling ball method described above closely represents the behaviour of water, or sludge with a very low dry solids content. The model is therefore likely to overpredict the extent of a spill where the percentage dry solids of the source’s contents is higher.

2.2.4 Other Pathway Considerations

The GIS “rolling ball” tool will generally overpredict the extent of the overland spill and therefore the risk to local receptors. However, below ground services such as surface water drainage routes or duct routes do have the potential to rapidly carry a spill to local receptors, or to bypass containment solutions. Site services are therefore acknowledged as part of the risk assessments to highlight any potential short circuiting, and this will be considered further when developing a detailed solution.

The GIS “rolling ball” tool cannot model dynamic effects caused by a relatively rapid loss of containment. It also does not account for pressurised ejections or “jetting” from a source. This could be crucial when considering containment solutions if:

- The asset is close to a defined bund perimeter,
- The asset is close to a receptor and,
- An established credible failure mode could cause surge or jetting effects.

Table 6.5 in CIRIA 736 recommends that the requirement to assess the implications of these events depends on the overall site hazard rating and hence the class of containment required. The key recommendations are summarised below:

Recommendation	Class1	Class2	Class3
c. No structure within the bund to be closer than its own height to the bund wall	Not necessary	Desirable	Recommended
g. Take account of possible jetting failure	Desirable	Recommended	Recommended
h. Take account of surge effects	Desirable	Recommended	Recommended

Figure 2.1: Extract from ADBA Guidance Summarising Examples of Key Performance Recommendations by Class from Table 6.5 CIRIA 736

Given that the volumes of inventory stored are significant at most BC, the impact of dynamic and jetting effects are always considered in addition to the spill modelling, regardless of the containment class. The potential for dynamic and jet effects are based only on the established credible failure modes of assets and subsequent movement of the escaped inventory. In certain cases, this may mean that the intended bund position does not need to align with recommendation c in Figure 2a for class 2 and class 3 containment. For this assessment, the requirements are assessed by inspection. However, at detailed design, assertions will be demonstrated by calculation for jetting where appropriate.

BC are often situated in low lying areas close to water bodies and can therefore be at risk of fluvial flooding, which may introduce an additional and more direct pathway to a receptor. Trowbridge BC is not at risk of fluvial flooding as indicated in Figure 2.2. The Site is not at risk to surface water flooding and is at a negligible risk of flooding from groundwater. This is therefore not considered further within the risk assessments.

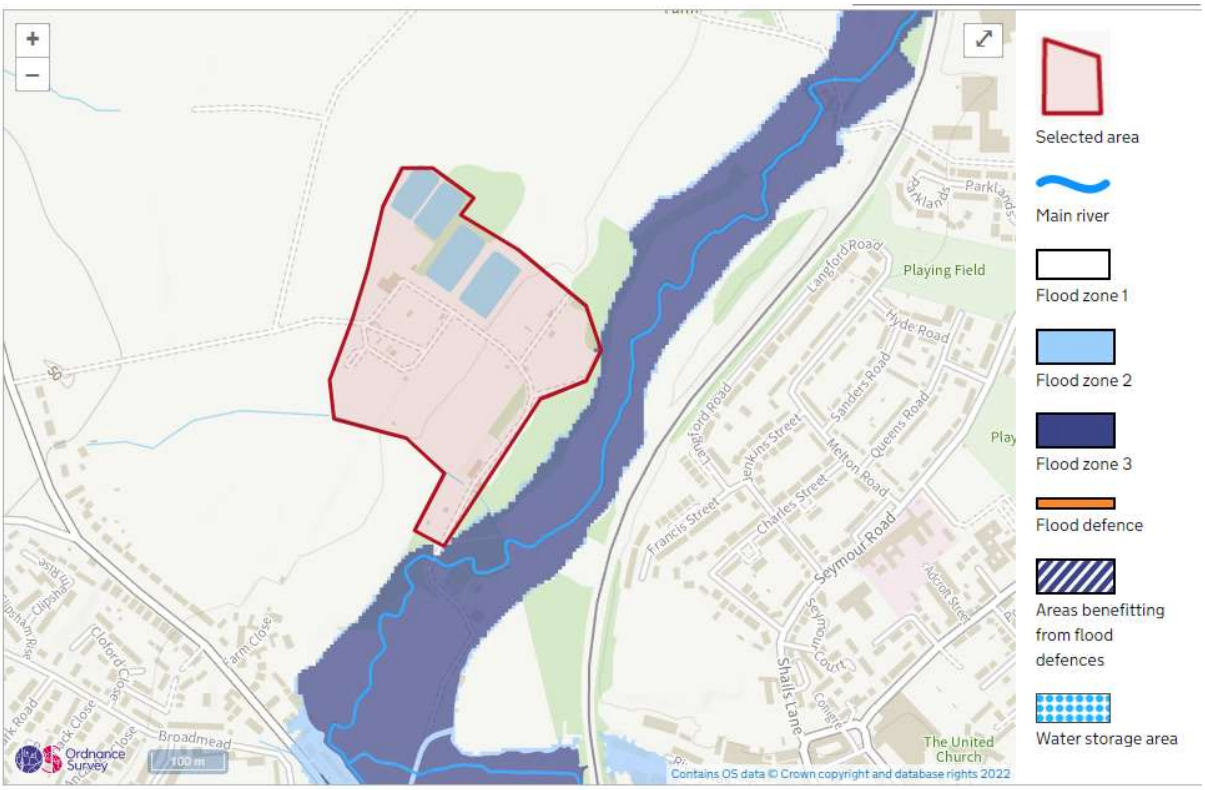


Figure 2.2: Flood Risk Map for Trowbridge BC from https://flood-map-for-planning.service.gov.uk/.

2.3 Receptors

Receptors will normally consist of permeable ground and aquifers beneath the site, surface water bodies within or near to the site, sites with environmental designations, and local commercial or residential properties. The treatment works itself is not normally considered to be a direct receptor but could act as a pathway if the spill overwhelms the treatment processes and leads to a final effluent consent failure and subsequent pollution event. It's ability to effectively treat following a spill event is therefore considered in the risk assessment.

Section 3.36 of the ADBA Guidance indicates the type of receptors that could lead to a higher hazard rating than "Low". This information is principally used to justify the hazard ratings for receptors in the risk assessments.

2.4 Approaches to Solutions

Proposed secondary containment solutions shall be developed, in accordance with the 110% and 25% rule outlined in CIRIA 736. Additional volume allowances for rainwater and firefighting agents will be considered where applicable. Solutions shall also include appropriate measures to safeguard against specific failure modes such as a vehicle collision leading to jetting from a pipe.

Two principal approaches have been taken to reach a practicable solution:

1. Fully compliant Secondary Containment solution in accordance with CIRIA 736.

   This approach is based on constructing a reinforced concrete structure locally around one or several existing primary assets to contain a volume of inventory in accordance with the 110% and 25% rules outlined in CIRIA. The impact of the solution on the operability and maintainability of the tank itself and surrounding assets is then considered with the BC's site operators.

2. Solution that prevents sludge from leaving site following Catastrophic Failure.

   This is not necessarily a "pure" CIRIA 736 secondary containment solution but can achieve an equivalent level of containment appropriate to BAT 19. The approach is based on maximising the benefits of existing site infrastructure, such as forming shallow bunds and ramps around existing impermeable hardstanding and road areas, to minimise impact on the operability and maintainability of the site. The solution will incorporate measures to demonstrate that containment infrastructure, including existing impermeable hardstanding and drainage, is in an appropriate condition.

   It is acknowledged that this approach will often involve much larger impermeable surface areas and therefore the potential for significant rainfall volumes accumulating following the catastrophic failure of an asset. Alternative methods of managing additional run off are therefore considered with this approach, which includes a controlled pumped discharge back to the site works return pump station for treatment, or the use of the tankers to maintain a volume in the bund until the 1 in 10-year storm event subsides.

   It is also acknowledged that this type of solution will result in numerous primary assets within a common containment bund. In this case, containment volume may be based on 25 percent of the total asset volume rule outlined in CIRIA 736 if the calculated volume is greater than the volume based on 110% of the largest tank within the bund.

The Environment Agency were consulted about whether they would accept this approach in principle on 15/06/22. The EA confirmed that they would accept such proposals as long as the solution provides an equivalent level of containment appropriate to BAT 19, and clear supporting justification and evidence is provided.

Secondary containment solutions will be designed to provide an equivalent level of containment to BAT 19 and justification will be provided alongside the preferred approach. The detailed design of the proposed containment solution, including walls, paving, joint details, refurbishment of existing assets, and maintenance regime specification will be reviewed by a chartered structural engineer.

Any areas designated as part of a primary or secondary containment system will be classed as such on Wessex Water's asset database and will be subject to a routine inspection/maintenance regime to ensure ongoing structural integrity. This will include suggested monthly checks by trained operators who will refer signs of deterioration to a chartered structural engineer for review. A chartered structural engineer will also carry out their own review on a suggested two-yearly basis to verify the integrity of the containment assets.

3 Information Sources

The following information sources have been used for the study presented in this report:

- General and site-specific information provided by the Operator relating to the sludge treatment process; infrastructure details / records and other relevant operational information and Process Flow Diagram, tank condition reports and P&ID.

- Environmental data report and mapping provided by GroundSure based on various publicly available information sources. - Information provided by the Environment Agency following a specific data request which included license abstraction, rainfall data (not used), discharge consents, water quality data (but nothing near the site and therefore not used).

- Additional publicly accessible information from the UK Government and the British Geological Survey (BGS).

A site visit was also conducted on 12th of January 2023. The purpose of this visit was to obtain additional information from the Operator, undertake a visual inspection of the STC assets and infrastructure and the immediate surrounding area to provide contemporary information for the purposes of this assessment. It was also used to present and discuss draft secondary containment solutions with the Operator.

4 Site Context

The Trowbridge Site (NGR: 384760, 158790) is in a rural area close to Trowbridge and Trowle Common. There is a solar farm adjacent to the western boundary that extends to the north beyond four lagoons which lie adjacent to the northern boundary. Approximately 100m away to the south and east lies the River Biss flowing in a northerly direction. A railway lies to the east of the river. The Kennet and Avon canal lies 660m north of the Site and the River Avon lies further north of the site approximately 0.8km away from the Site.

The Site is on the southern edge of a flat area at a higher ground. This is defined by a south-west to north-east orientated valley to the south-east of the Site (that contains the River Biss) and an east to west orientated valley to the north of the Site which contains the Canal and River Avon.

The Bioresources Centre (BC) covers an area of approximately 1.28 ha which includes the main sludge assets at the Water Recycling Centre (WRC) and the road to the south-eastern area where the skip storage is currently located.

The BC is comprised of both the anaerobic digestion and associated activities (as operated by Wessex Water Services Limited (WWSL) and which are within the ‘installation boundary’) and the Combined Heat Plant (CHP) and Gas to Grid activities as operated by Wessex Water Enterprises Limited (WWEL) (and which are within the ‘EPA/HB3602TR boundary’).

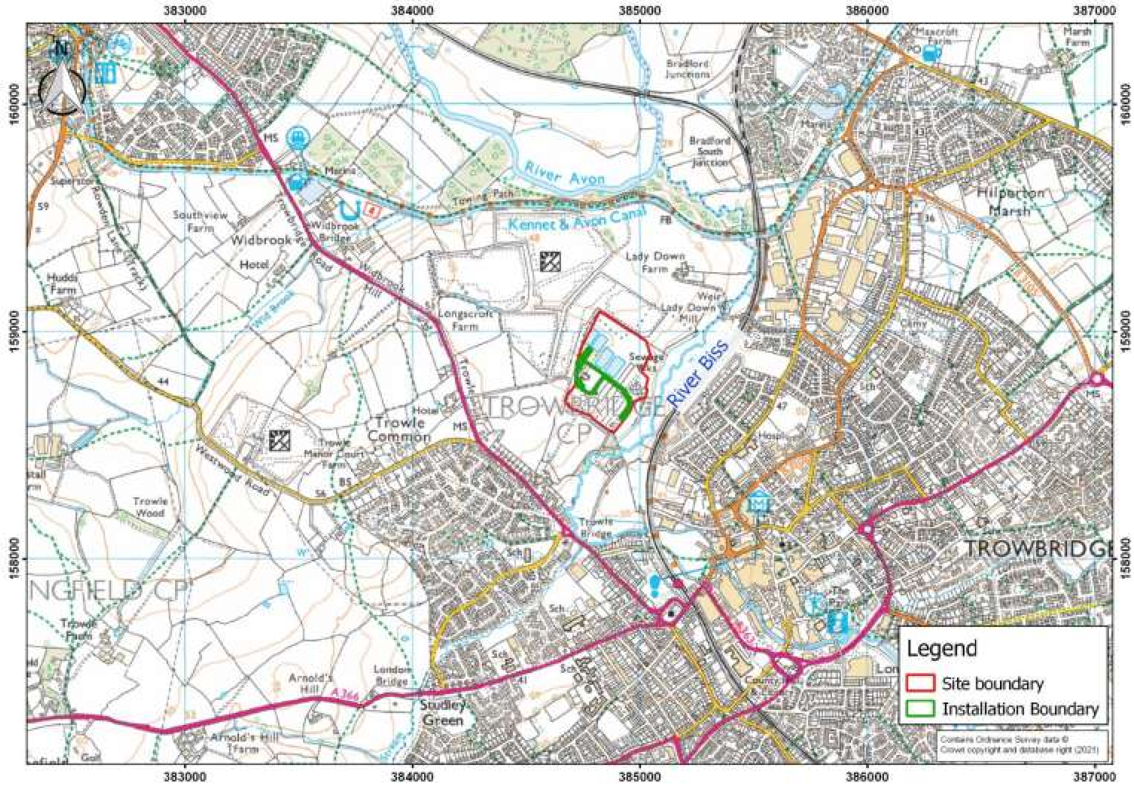


Figure 4.1: Regional Setting of “The Site”, Including the BC Installation Boundary

5 Bio-resources Centre Overview

This section provides a summary of the sludge treatment process including the key assets and associated infrastructure at the Bioresources Centre (BC). It also summarises the general topography, ground finishes, and drainage features serving the BC.

BC assets that are considered as part of the CIRIA 736 ERAs are indicated in Table 5.1 below and outlined in red in Figure 5.1.

Table 5.1: Assets Considered for CIRIA 736 ERAs

Asset Name	Ref.
Sludge Reception Tank	**A**
Pre-Thickened Tank 1	**C**
Pre-Thickened Tank 2	**D**
Post-Thickened Tank	**G**
Acid Phase Digesters	**H1-H6**
Mesophilic Digesters	**I1-12**
Post-Digested Tanks	**J1-J2**
Liquor Balancing Tanks	**N1-N2**

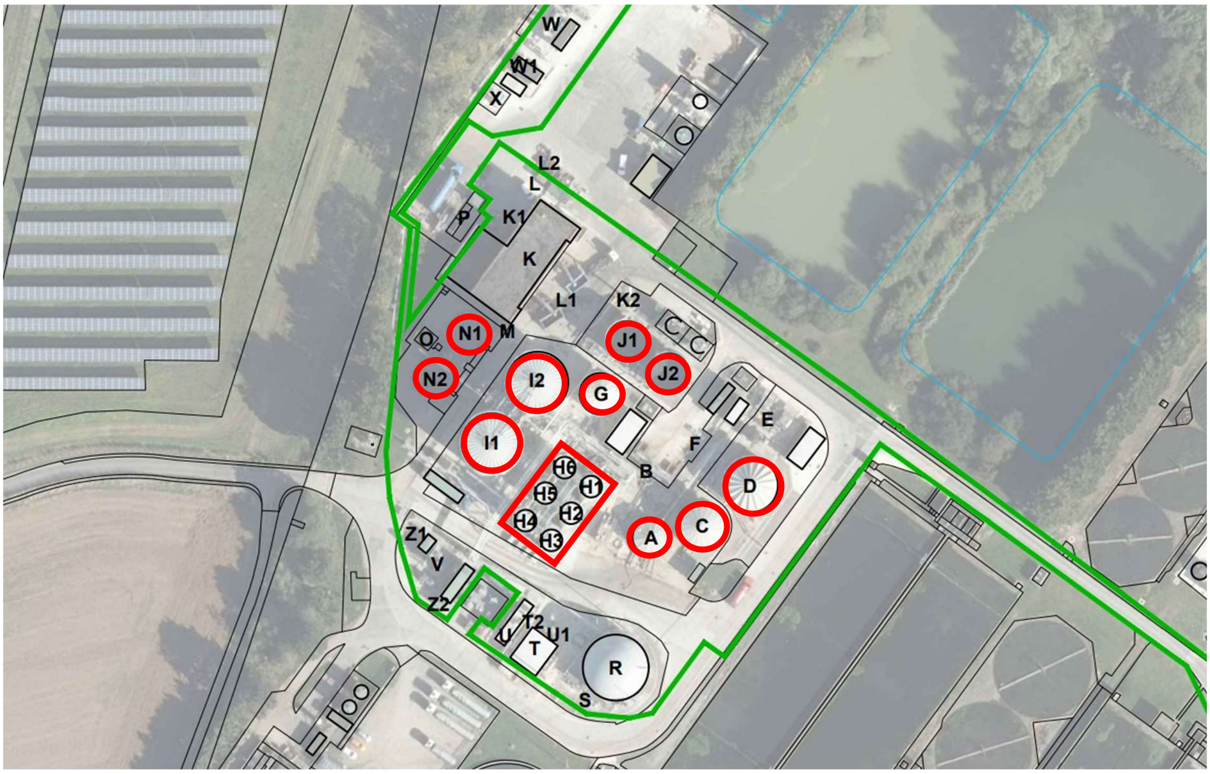


Figure 5.1 Position of BC Assets (Site Installation Boundary in Green)

5.1 Sludge Treatment Process

The following provides a summary description of the sludge treatment process at Trowbridge BC. Each asset in the summary description is provided with a corresponding letter which is referenced above in Figure 5.1.

- Imported sludge is transferred from tankers into the Sludge Reception Tank (A), as well as indigenous sludge pumped from the adjoining Trowbridge WRC.
- The sludge from the Sludge Reception Tank (A) is pumped forward to the 2no Strainpresses (B) and the strained sludge is discharged into 2no. Pre-thickened sludge tanks (C & D) for storage.
- The strained sludge is thickened by 2no Gravity belt thickeners (GBT) (E) and the resulting thickened sludge is transferred into the Thickened sludge tank (G) before being forwarded for digestion.
- Liquors from the 2no GBTs (E) are transferred to the head of the works via GBT Filtrate pumping station [F].
- The digestion process is made up of two phases:
    - The Acid Phase Digestion (APD) (H1-6) and Mesophilic Anaerobic Digestion (MAD) (I1 & I2) which make up the first phase and,
    - The Secondary Digesters (J1 & J2) making up the second phase.
- The Boilers (T) supplies heat directly to the APD (H1) which is current operated around 30°C, and supplies heat to be used in the MADs (I1 & I2) currently operated around 36°C to facilitate biological activity.
- Digested sludge is decanted from the MADs (I1 & IO2) and flows via gravity into the Secondary Digesters (J1 & J2)
- From the Secondary Digesters (J1 & J2) digested sludge is pumped to the Dewatering equipment to either 2No Dewatering Belt Press (K) with associated ventilation systems each with its own 'Belt Press Stack' (K1 & K2) or to 2No Dewatering Centrifuge (L)
- Liquor generated by the dewatering process is forwarded to the Dewatering Liquor Transfer Pumping Station (M) before being pumped into 2No Liquor balancing tanks (N1 & N2). Liquor is then returned the head of works for treatment at Trowbridge WRC via the Return liquor pumping station (O). A 'Centrate Safety Vent' (P) has been installed on the centrate line as it discharges into the existing drainage before flowing to the Dewatering Liquor Transfer Pumping Station (M).
- The digested cake ('dewatered sludge') from the dewatering activity (K & L) is conveyed to skips in Skip loading areas (L1 & L2) and transferred the Skip Storage Area (Q) before being sent off site for disposal.

The following additional assets contain or use chemicals and / or other potential contaminants that could pose a risk of pollution to ground or the local water environment. A secondary containment system is present for each and the volume is adequate for the size of the asset.

- Plant used to store and prepare liquid polymer.
- The Combined Heat Plant includes lubricant oil storage tanks.
- The Boilers includes fuel oil storage tanks.
- Load management generator lubricant oil.

5.2 Topography, Surfacing, and Drainage

Figure 5.2.1 below illustrates the ground elevation across the site. The north-west of the site is at a higher ground at approximately 42m AOD. The ground level gradually lowers towards the southeast of the site down to 36m AOD. The BC is located at a relatively high part of the Site along the western perimeter with the final WRC treatment processes situated at the lowest part of the Site, adjacent to the eastern perimeter.

The BC consists of impermeable surfacing and kerbing that directs spills and surface run-off into the below ground site drainage pipework and then to the humus desludge PS located by the Humus Settlement Tanks (HSTs). From here all drainage is returned to the inlet works upstream the Primary Settlement Tanks (PSTs) and downstream the storm overflow. There is an overflow at the humus desludge PS wet well that drains back to the Trowbridge Terminal PS where the storm overflow is located.

The skip holding area in the Southeast part of the site consists of concrete hardstanding and formal drainage that currently conveys flows to Trowbridge Terminal PS.

The approximate existing impermeable surface extents are indicated in Figure 5.2.2 and the below ground site drainage arrangement is indicated in Figure 5.2.3.

This infrastructure will have been designed principally for appropriate access and management of surface run-off and small spills associated with general operation and maintenance. However, most of the BC surfacing is impermeable with sealed drainage and can potentially be incorporated into the wider bund solution, subject to condition assessments and associated repairs.

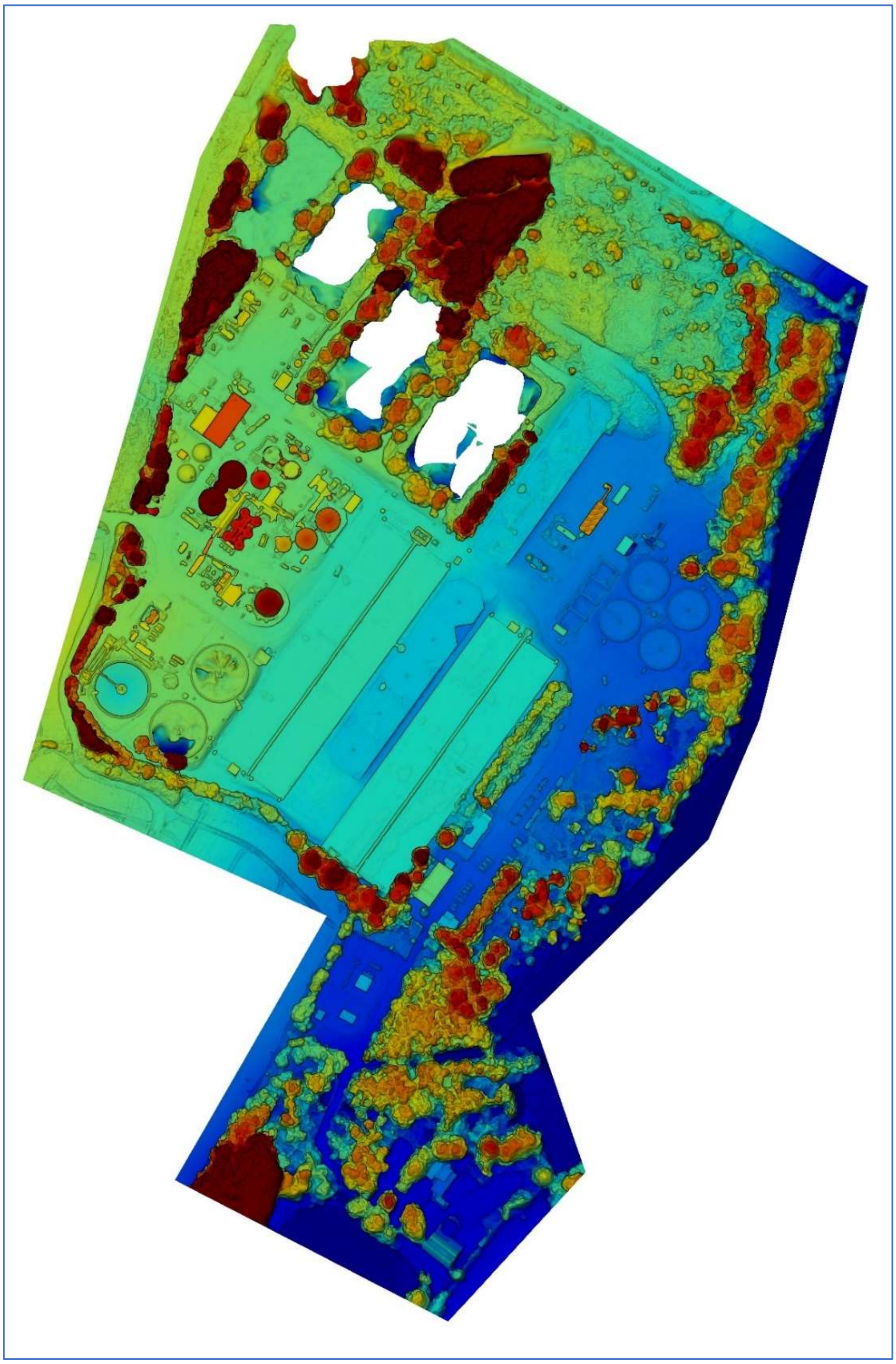


Figure 5.2.1 Elevation Export of Trowbridge WRC and BC (Deep Blue – Lower Level, Deep Red – Higher Level)

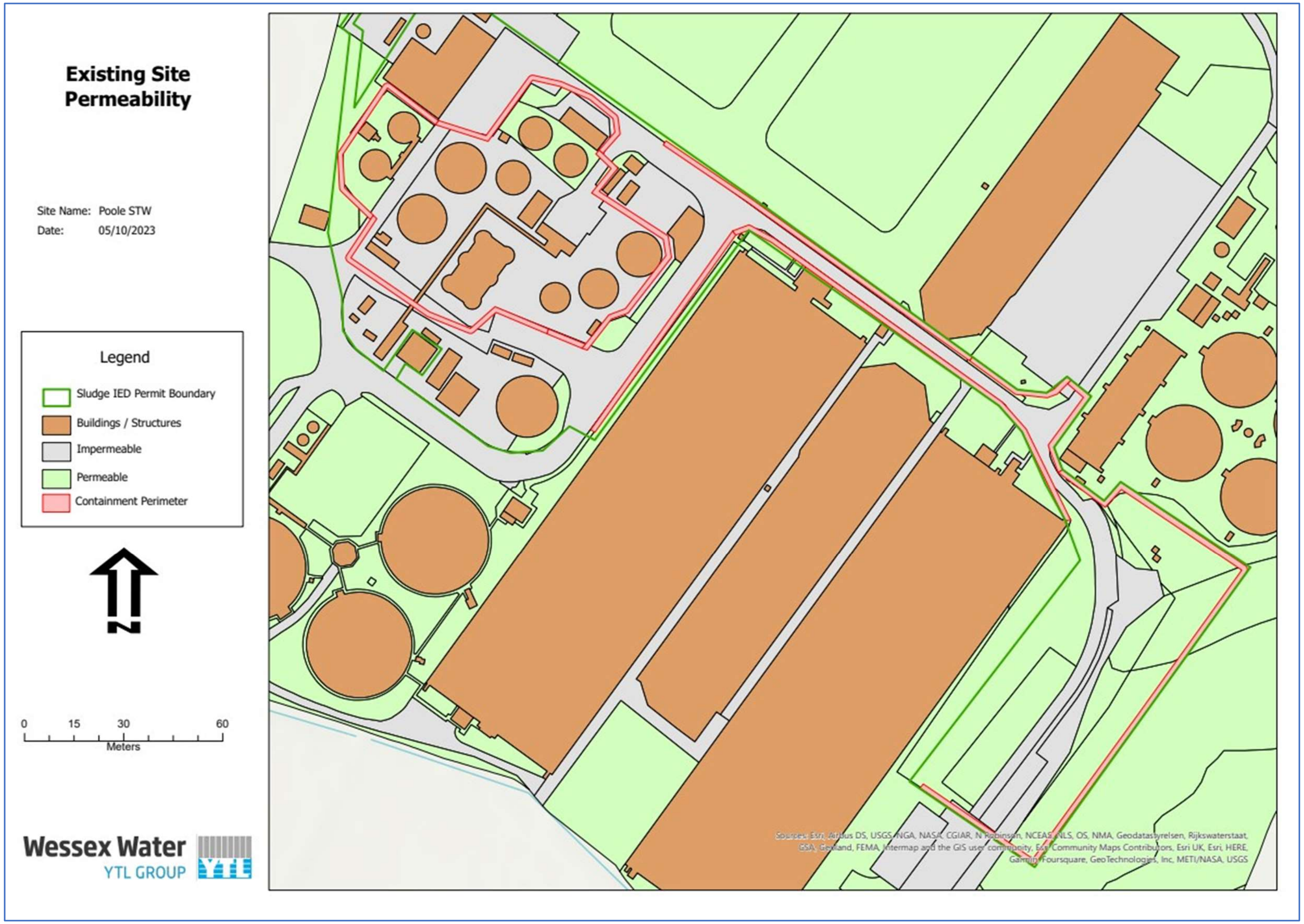


Figure 5.2.2 Existing Site Permeability Plan

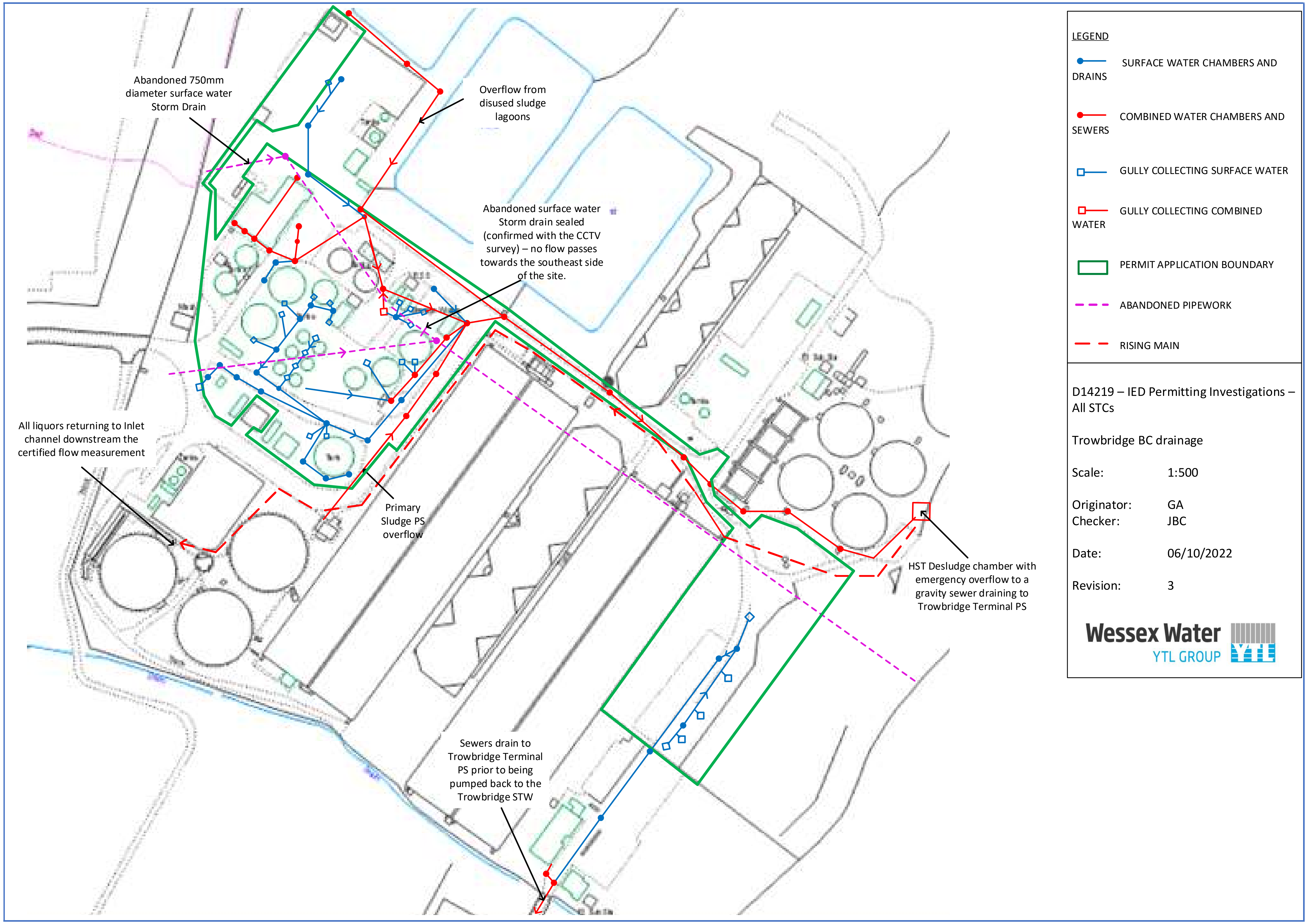


Figure 5.2.3 Trowbridge STC Drainage Plan

6 Environmental Setting

6.1 Geology

The geology at the Site may be summarised as follows:

- The Made Ground is sandy silty gravel and sandy slightly gravelly clay and is generally present at a thickness of between 0.65m to 3m across the Site (including in the main part of the BC in the north-west part of the Site). Significantly thicker Made Ground (up to 7m) is present along the east/south-east boundary of the site adjacent to the valley containing the river Biss.
- The Kellaways Formation/Oxford Clay Formation is sandy clay with occasional laminated mudstone layers at depth and is recorded at between 10m and 20m thick beneath the Site.
- The Cornbrash Formation is present to the east of the lagoons at depths of approximately 17m and is a weak thickly bedded grey fine to medium grained clayey limestone. Weathering and discontinuities are present within this unit.
- Underlying the Cornbrash Formation is a thick layer of stone and clay with harder seams of clay which is identified as the Forest Marble Formation.

6.2 Hydrology

Surface water in the area is expected to generally drain to the south-east from the higher ground where the Site is located towards the river Biss (i.e., following the local topography).

Four surface water lagoons are located immediately to the north of the Site. The most eastern two are surrounded by an embankment (approximately 1-2m high) and hence are at a greater elevation than the sludge assets within the Sludge Treatment Centre. The western two lagoons lie immediately adjacent to the hardstanding area in the north part of the site and are used for fishing/wildlife.

The majority of the Site is not at risk of surface water flooding. However the central part of the Site where the mesophilic anaerobic digesters are located has a risk of surface water flooding in a 1 in 250 year event. The Site is at a negligible risk of flooding from groundwater. There is a low risk of groundwater flooding at the river Biss which reaches up to 50m from the east of the Site.

There are two licensed discharged points for the Site. The first one is the permitted storm overflow to the river Biss at the terminal PS. The second one is the final effluent discharge point located at the River Avon located approximately 0.8km away from the site.

6.3 Hydrogeology

The alluvium to the east of the Site is classified as a Secondary A aquifer. This is due to permeable layers that they contain being capable of supporting water supplies at a local scale.

The Kellaways Formation/Oxford Clay Formation is classified as unproductive strata due to low permeability of the layers that are considered to have negligible significance for water supply. However, the underlying Cornbrash Formation and Forest Marble Formations are classified as Secondary A aquifers. This is due to permeable layers they contain being capable of supporting water supplies at a local scale.

The groundwater strike and level data suggest that there is Site wide shallow groundwater present within the Made Ground. It is considered likely that the groundwater levels that have been measured within the Made Ground and Kellaways/Oxford clay reflect the general low permeability nature of these units.

The groundwater levels along the eastern/south-eastern boundary of the Site are several metres lower than in the main part of the STC area to the west of the Site. This is where the presence of thicker Made Ground has been identified. The lower groundwater levels are to a degree assumed to reflect the lower elevation of the underlying Kellaways/Oxford Clay.

Liquor entering the ground at or below surface is likely to migrate downwards within the more permeable Made Ground deposits until it reaches the surface of the Kellaways Formation/Oxford Clay Formations. It is unlikely that there is a continuous shallow groundwater unit within the Made Ground and whilst liquor could mix with some isolated areas of groundwater that may be present, significant lateral migration within the Shallow Made Ground across most of the STC and towards the receptors is considered unlikely.

The Cornbrash Formation and Forest Marble Formations are both classified as Secondary A Aquifers and are present beneath the Kellaways Formation / Oxford Clay Formation at the Site. However, it is considered very unlikely that there will be appreciable vertical migration of liquor into and through the Kellaways Formation / Oxford Clay Formation due to the clayey nature and the thickness (>10 m) of these units. Furthermore, limited groundwater has been identified within these units at the Site; it is typically associated with the occasional isolated slightly more permeable bands of siltstone / sandstone.

7 Receptors

Key receptors, and the risk posed from emissions to surface water, groundwater, sewage, based on the information in Section 6 include:

- The lagoons
- The River Biss
- The Alluvium deposits (Secondary A Aquifer)
- Cornbrash and Forest Marble Formations (Secondary A Aquifers)
- Final Settlement Tanks (Within WRC)
- Biofilters (Within WRC)
- River Avon (County Wildlife Site)

The most sensitive receptors that may be impacted by a loss of containment at Trowbridge BC are the lagoons, due to the diverse habitat and presence of protected species, and the River Avon, which is a County wildlife site.

The most vulnerable receptors are the bio-filters at the WRC, and the River Biss, due to their position and level in relation to the BC assets. The bio-filters would need to be cleaned and re-commissioned following contamination of inventory. This is a time-consuming process. Both receptors discharge to the River Avon.

The above factors are all considered in CIRIA 736 ERAs to determine a site hazard rating.

8 Environmental Risk Assessment

An environmental risk assessment (ERA) has been prepared for the assets holding sludge inventory within the BC to determine the class of secondary containment required. The ERA adopts the source-pathway-receptor linkage principle outlined in CIRIA 736 and is based on the information presented within Sections 4 to 7 of this report.

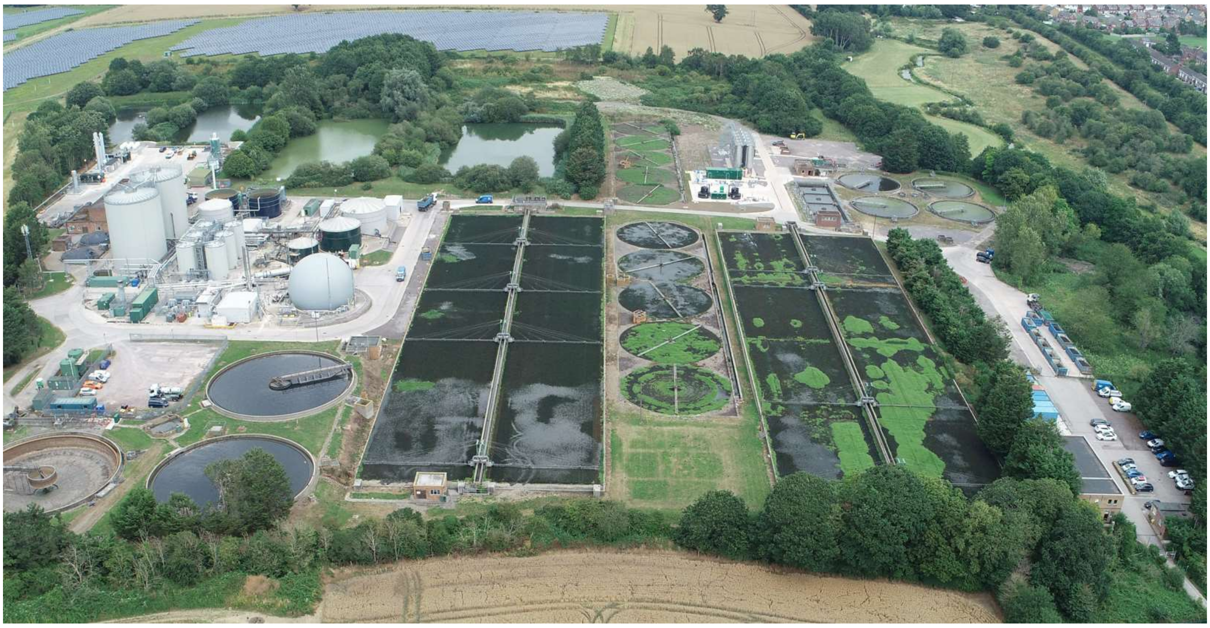


Figure 8.1 Trowbridge WRC and STC

To support the ERA further, a general overview of the inspected assets (Summarised in Table 8.1 below) and the immediate surrounding area is presented in this section.

All tank assets are subject to daily visual operator inspection, in line with asset management procedures. All tanks include connecting pipework at both high and low level and feature a high-level overflow that discharges into the local drainage system downstream the processes. They also include level indication via pressure transducers, ultrasonic instruments, or radar instruments, linked to associated alarms to alert operations of abnormal conditions. Further details can be found in the table below.

Spill model outputs are included next to the individual image of each tank and its surroundings to demonstrate the typical overland and below ground flow paths following a catastrophic failure of inventory from critical assets and the immediate surrounding area. The spill modelling outputs also indicate the receptors that are currently at risk.

Table 8.1 Trowbridge BC Sludge Storage Tanks and Sludge Reactor Tanks Overview

Tank Ref.	A	C	D	G	H1-H6	I1-I2	J1-J2	N1-N2
Asset Name	Sludge Reception Tank	Pre-Thickened StorageTank 1	Pre-Thickened Storage Tank 2	Thickened Sludge Tank	Acid Phase Digesters	Mesophilic Anaerobic Digesters	Secondary Digesters	Liquor Balancing Tanks (Filtrate Balance Tank)
Brim-full Volume (m3)	200	600	920	600	170	3500	500	250
Height (m)	3.6	5.4	6.2	7.3	7.5	18.2	6.1	3.4
Year built	2021	2013 (internal & external repairs completed in 2021)	2013	2013	2013	2013	2004	1980
Material	Stainless Steel	Glass Coated Steel	Glass Coated Steel	Glass Coated Steel	Glass Coated Steel internally lined with bitumen coating on elevated panels. Insulated external cladding to maintain operating temperature.	Glass Coated Steel internally lined with bitumen coating on elevated panels. Insulated external cladding to maintain operating temperature.	Glass Coated Steel	Reinforced Concrete
Tank covered/not covered	Covered	Covered	Covered	Covered	Covered	Covered	Not Covered	Covered – below ground tank
General condition	Excellent overall condition with no visible defects	Weathered with patch repairs and presence of emerging corrosion holes at typical sludge air interface levels – further repair works recommended to maintain long term serviceability. Recently completed tank inspection	Weathered with patch repairs and presence of emerging corrosion holes at typical sludge air interface levels – further repair works recommended to maintain long term serviceability. Recently completed tank condition assessment	Weathered with presence of emerging corrosion holes at typical sludge air interface levels. further repair works recommended to maintain long term serviceability.	Cladding over the tanks is in good condition and no visible leaks. Tank inspections are planned to verify external and internal condition.	Cladding over the tanks is in good condition and no visible leaks. Tank inspections are planned to verify external and internal condition.	Good overall condition. Tanks are drained every year for inspection.	Weathered but extent unknown. Internal tank inspection to be completed.
Approx. pipe penetration locations	Mixer and pressure transducer pipework is located at a low level. Import discharge pipe and emergency overflow is located at a high level. Strain press feed draw from tank base.	High-level pipework from strain presses and emergency overflow, Mixer, and pressure transducer pipework is above ground at a low level. Thickener feed draw off from tank base.	High-level pipework from strain presses and emergency overflow, Mixer, and pressure transducer pipework is above ground at a low level. Thickener feed draw off from tank base.	GBT feed pipe inlet and overflow at high level. Mixer, pressure transducer, APD and and bauer draw-off pipework at low level.	APD feed pipe entry at relatively low level. Above-ground pipework at a high level and low level, with overflow at a high level.	Feed pipeline above ground. Entry, mixer, level indication, heat exchanger pipework at low to mid-level. Outlet pipework and overflow at high level via limpet chamber. Sludge tanker point p/w draw off from digester hopper (below ground) and encapsulated in concrete surround to above ground connection.	Above ground high level entry feed and overflow pipework. Outlet pipework at low level.	Below ground pipework only.

Table 8.1 Trowbridge BC Sludge Storage Tanks and Sludge Reactor Tanks Overview								
Tank Ref.	**A**	**C**	**D**	**G**	**H1-H6**	**I1-I2**	**J1-J2**	**N1-N2**
Asset Name	Sludge Reception Tank	Pre-Thickened StorageTank 1	Pre-Thickened Storage Tank 2	Thickened Sludge Tank	Acid Phase Digesters	Mesophilic Anaerobic Digesters	Secondary Digesters	Liquor Balancing Tanks (Filtrate Balance Tank)
Safeguards /inhibits	Valves are manually operated at the HMI, mixer motor failure alarm, and high-level alarm. The Pre-thickened tanks are interconnected at a high level to allow sludge to cascade through the tanks prior to overflowing into the Sludge Reception tank. From this tank, sludge overflow into the existing works foul drainage system.	Mixer motor failure alarm, belt thickener shut down on high level in the tank, high-level alarm raised. The Pre-thickened tanks are interconnected at a high level to allow sludge to cascade through the tanks prior to overflowing into the Sludge Reception tank. From this tank, sludge overflow into the existing works foul drainage system.	Mixer motor failure alarm, belt thickener shut down on high level in the tank, high-level alarm raised. The Pre-thickened tanks are interconnected at a high level to allow sludge to cascade through the tanks prior to overflowing into the Sludge Reception tank. From this tank, sludge overflow into the existing works foul drainage system.	Mixer motor failure alarm, Low and high-level sensors. High level overflow.	Valve failure alarm: further failure to discharge alarm, NRV on digester feed pumps. The roof level manifold includes 2 safety pressure/vacuum relief valves. Antifoaming system (manually dosed).	Pipework rated for closed valve pressure. Flowmeter provided complete with set-point deviation alarms. Pump failure alarm. Pre-flow meter, low flow alarms. Temperature monitoring in digester and alarms. Antifoam dose point installed on the heat exchanger (manually dosed). PRVs on each MAD. Antifoaming system is used consistently.	Low and high-level sensors	Low and high-level sensors
Traffic routes & frequency of use	Tankers arrive at the main electric gate northwest of the site, drive to sludge imports tank, complete off-loading and drive through the same gate using a one-way system. This route is frequently used as there are 50 tankers off-loading per day. Vehicle containment (bollards) present.	Required to have access for operability and maintenance purposes.	Required to have access for operability and maintenance purposes.	Required to have access for operability and maintenance purposes.	Required to have access for operability and maintenance purposes.	A road between MAD and the Return Liquor Balancing tank is used frequently, and access required to be maintained. Vehicle containment (bollards) present.	Required to have access for operability and maintenance purposes.	A road between MAD and the Return Liquor Balancing tank is used frequently, and access required to be maintained
Assets in proximity	The sludge from the reception tank flow is pumped forward to the 2no. strain presses	Gravity Belt Thickeners (GBTs) and Strain presses, liquor Return PS	Gravity Belt Thickeners (GBTs) and Strain presses, liquor Return PS	Strain presses and APDs, Liquor Return PS, Disusedlime blending tanks, and mix pumps. Central MCC – access to this MCC is required at all times.	Post-thickened sludge tank and Mesophilic Digestors. There is an access road southwest of the APDs.	Dewatering plant, adjacent to the road north from the tanks	Dewatering plant, Disused Lime blending Tanks, Post-Thickened Tanks	Dewatering plant and liquor PS

Table 8.1 Trowbridge BC Sludge Storage Tanks and Sludge Reactor Tanks Overview

Tank Ref.	A	C	D	G	H1-H6	I1-I2	J1-J2	N1-N2
Asset Name	Sludge Reception Tank	Pre-Thickened StorageTank 1	Pre-Thickened Storage Tank 2	Thickened Sludge Tank	Acid Phase Digesters	Mesophilic Anaerobic Digesters	Secondary Digesters	Liquor Balancing Tanks (Filtrate Balance Tank)
Operational overview	Imported sludge is transferred from tankers into a Sludge reception tank, as well as primary indigenous sludge. This storage tank is also where the site's indigenous primary sludge is discharged. The sludge reception tank mixer pump ensures the contents are mixed ad then at a set level transfer pumps remove the sludge to the strain press.	This sludge holding tank receives strained sludge from strain presses and feeds the 2 no Gravity Belt thickeners. The Tank also has its own integral mixer pump.	This sludge holding tank receives strained sludge from strain presses and feeds the 2 no Gravity Belt thickeners.	The thickened sludge is pumped to the post-thickened tank where sludge buffers and is fed to the Acid Phase Digestors (APD)	The APD tanks receive pumped sludge from the post-thickened tank. The sludge is heated via a hot water heat exchanger. The feed to APD vessel 1 is a batched process. Sludge is transferred from one APD vessel to another via a gas-lift process until it reaches APD vessel 6	Sludge from the final APD is sent to 2no. Mesophilic digesters. Contents in these tanks are mixed using gas compressors and digested sludge is discharged and biogas is collected and transferred to the CHP, Gas to grid plant or flare stack.	Digested sludge is transferred to the 2no. Post Digested tanks where sludge is pumped to Belt presses within the dewatering building	Liquor Balance tanks receive Liquor from the Belt Presses before being transferred to the head of the works via the liquor PS.
Surrounding surface conditions	The immediate ground is impermeable (reinforced concrete). Occasional visible superficial cracks in the concrete, and vegetation at joints. There is a patch of grass in proximity.	The immediate ground is impermeable (reinforced concrete). Occasional superficial cracks in the concrete.	The immediate ground is impermeable (reinforced concrete). Occasional visible superficial cracks in the concrete and vegetation	The immediate ground is impermeable (reinforced concrete) with some permeable gravelled areas	All APD vessels are located on a reinforced concrete slab with reinforced concrete surround.	Varying ground conditions – reinforced concrete slab and surround with patches of gravelled areas.	Permeable gravelled area surrounding the tank. Patches of reinforced concrete in proximity.	Permeable gravelled surface surrounding the tanks.
Local drainage	Surface level slopes towards the road where surface water drainage gullies are located.	Surface water drainage gullies surrounding the tank.	Surface water drainage gullies surrounding the tank.	Drainage apron around the tank.	Surface water drainage gullies are installed within the concrete slab.	Drainage apron around the tanks and surface drainage gullies located within the concrete slab.	Surface water drainage gullies within the concrete slab.	Surface water drainage to the ground.
Secondary Containment provision to Ciria 736.	None. The impermeable ground surrounding the tank. The tank has been replaced in 2021 with a Stainless Steel tank, which is more resilient. Process safeguards implemented.	None. The impermeable ground surrounding the tank. Process safeguards implemented.	None. The impermeable ground surrounding the tank. Process safeguards implemented.	None. The impermeable ground surrounding the tank. Process safeguards implemented.	None. The impermeable ground surrounding the tank. Process safeguards implemented.	None. Immediate ground conditions are impermeable, bollards are installed around both tanks, and process safeguards are implemented.	None. Process safeguards implemented. Routine inspection of the tanks.	None. Process safeguards implemented.

Figure 8.1 Sludge Reception Tank

Figure 8.2 Spill Assessment model for Sludge Reception Tank

Figure 8.3 Pre-Thickened Storage Tank 1

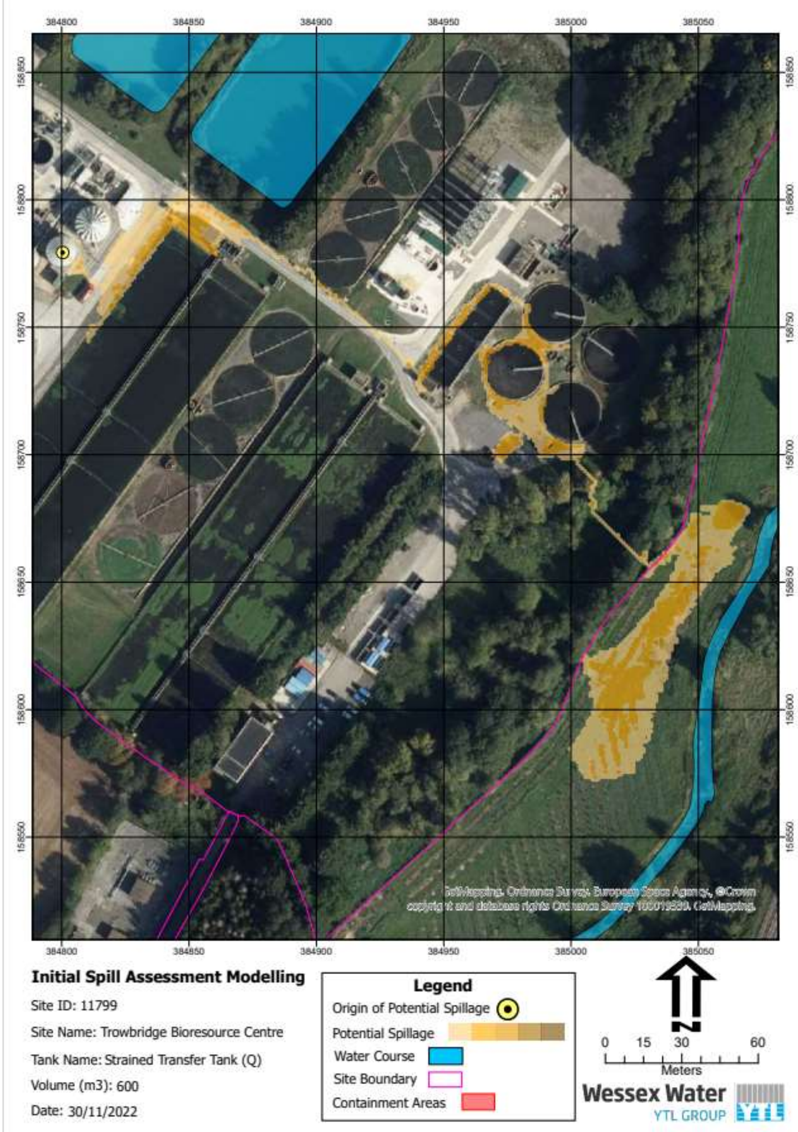


Figure 8.4 Spill Assessment for Pre-Thickened Storage Tank 1

Figure 8.5 Pre-Thickened Storage Tank 2

Figure 8.6 Spill Assessment for Pre-Thickened Storage Tank 2

Figure 8.7 Post-Thickened Tank

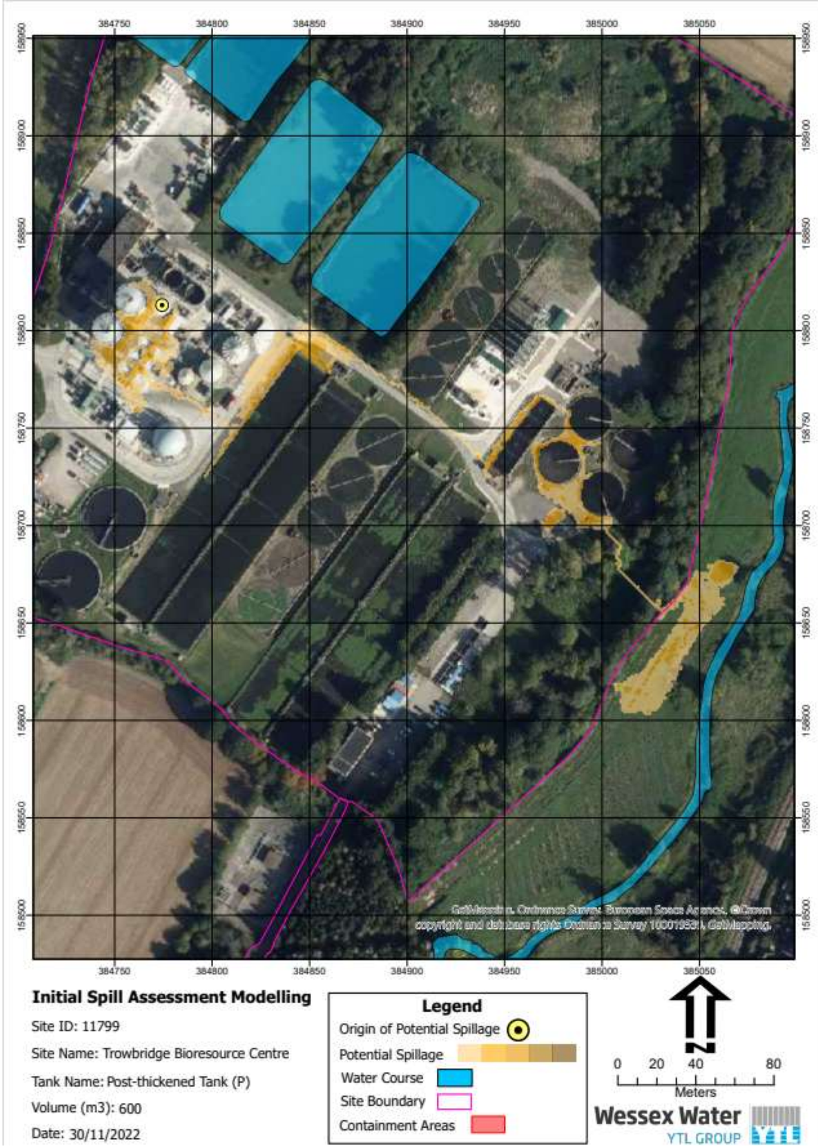


Figure 8.8 Spill Assessment for Post-Thickened Tank

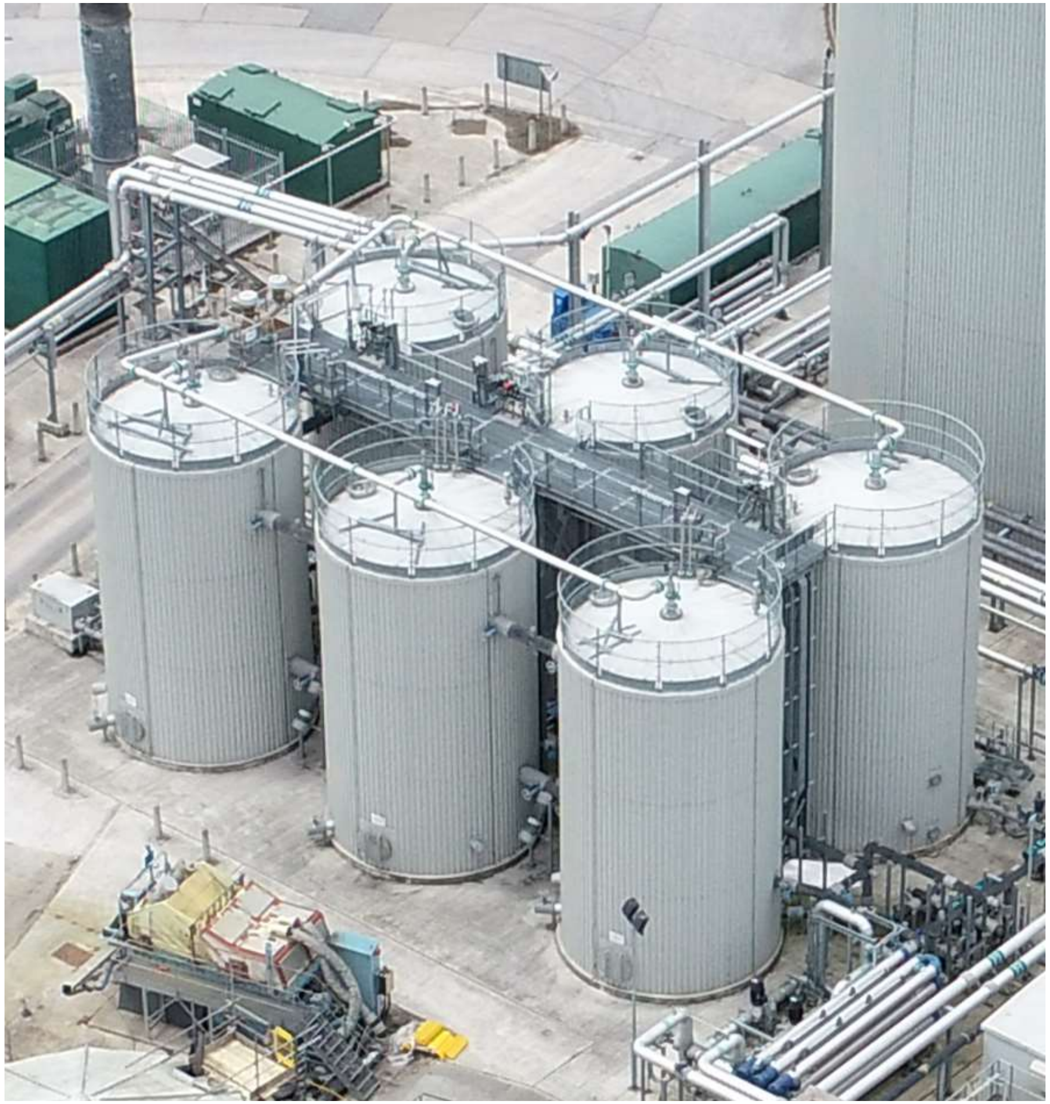


Figure 8.9 APD Plant

Figure 8.10 Spill Modelling for a single APD plant Vessel

Figure 8.11 Mesophilic Digesters

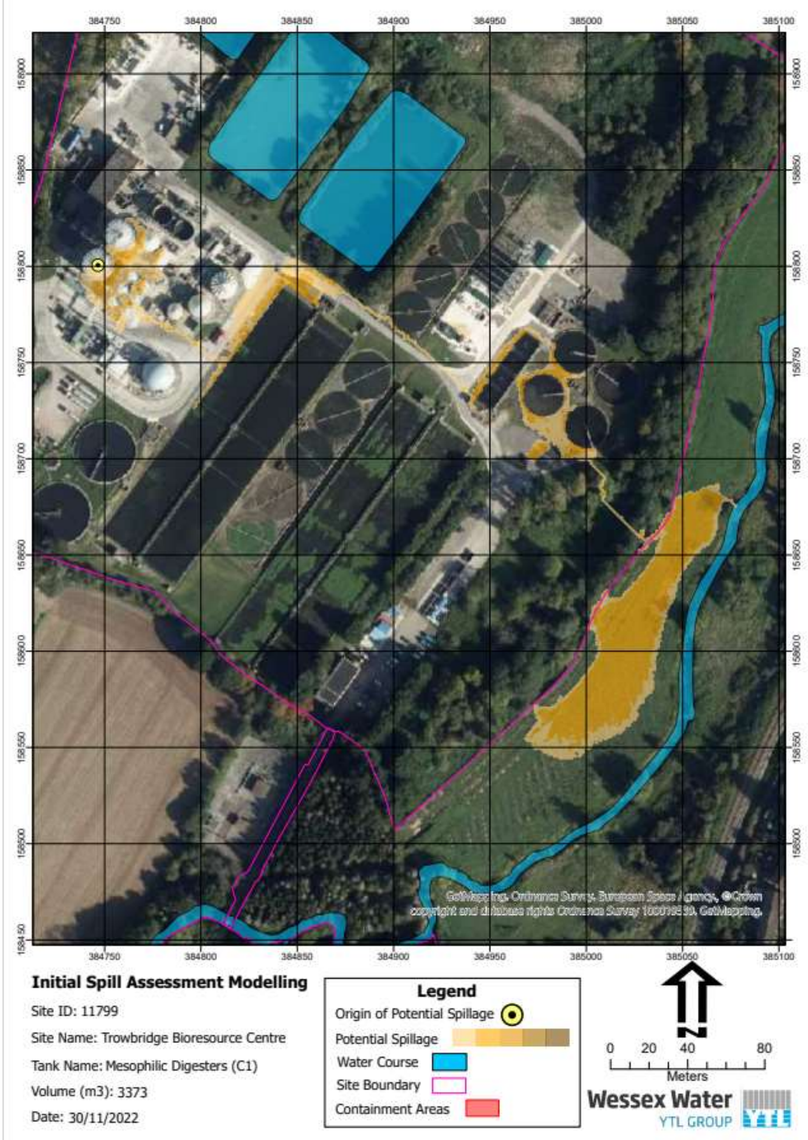


Figure 8.12 Spill Assessment for a Mesophilic Digester

Figure 8.13 Secondary Digester Tanks

Figure 8.14 Spill Assessment for a Secondary Digester

Figure 8.15 Liquor Balancing Tanks

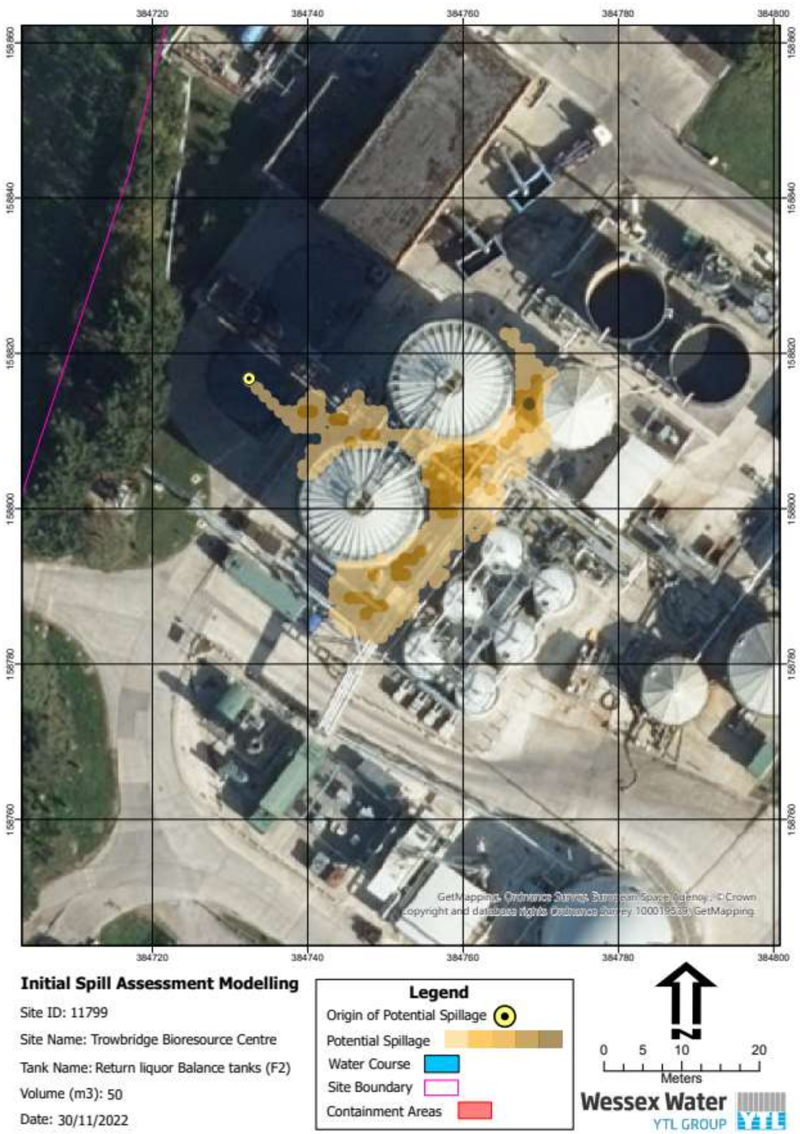


Figure 8.16 Spill Assessment for a Liquor Balancing Tank

8.1 Source – Pathway – Receptor ERA Summary

The ERA has been developed considering the BC as a whole. The ERA acknowledges specific and higher risk assets where appropriate. The main sources, credible pathways and the most severe receptors are highlighted to determine the overall and the most severe source-pathway-receptor linkage. This Risk Assessment includes the source (Table 8.1.1), and Pathway – Receptor linkage including the risk rating of all three linkages (Table 8.1.2).

Table 8.1.1 Source Summary

Source	Contents	Flammability	Corrosive	Hazard rating
Sludge Reception tank and Pre-thickened sludge tanks	Unthickened raw imported and indigenous sludge (2 - 3% DS Typ).	Not Flammable	Slightly	H
Thickened sludge tank	Thickened raw sludge (4.5 - 6% DS Typ)	Not Flammable	Slightly	H
Acid Phase, Mesophilic Phase Digestion Tanks, and Secondary Digester Tanks.	Partially digested screened sludge (3 - 4% DS Typ)	Not Flammable	Slightly	H
Liquor Balancing Tanks	Process liquors (0.14% DS Typ)	Not Flammable	Slightly	H
Rainwater run-off	Surface water, mixed with sludge	Not Flammable	No	L

Table 8.1.2 Pathway and Receptor Summary

Pathway to receptor	Time of concentration /duration of source outside	Transport Potential rating	Receptor	Damage Potential Rating	S-P-R Hazard Combination Existing	Environmental Hazard Rating Existing	S-P-R Hazard Combination with Solutions	Environmental Hazard Rating With Solutions
Infiltration of Inventory into Ground - Kellaways Formation/Oxford Clay Formation (unproductive strata) and the Cornbrash and Forest Marble (Secondary A Aquifers) The majority of the site benefits from localised reinforced concrete drainage aprons around the MAD and extensive areas of reinforced concrete hardstanding surrounding all tanks which include localised formal drainage networks. The concrete is generally in good condition. These features will help to contain sludge for small or medium scale escapes of inventory. However, the some areas around raw sludge holding tanks, secondary digesters, MADs, and liquor tanks are permeable. Therefore, any catastrophic failure and complete loss of containment would lead to a proportion of sludge flowing onto the permeable ground. Some of the escaped sludge will continue to migrate according to the topography, which is demonstrated on the existing spill model outputs. However, a proportion of the sludge and associated liquors will percolate into the made ground via the permeable areas. Due to the low permeability of Kellaways and Oxford formation and its thickness (>10m), it is highly unlikely that inventory will reach the Secondary A aquifer. This has been factored into the damage potential rating. Solution Recommendation: Although the impact of sludge to ground is already low, replacing permeable areas around the perimeter of the tanks with impermeable surfacing is relatively inexpensive and therefore an appropriate protection measure.	Hours	L	**Cornbrash Formation and Forest Marble Formations (Secondary A Aquifers) -** Kellaways Formation / Oxford Clay Formation. The latter is classified as unproductive strata due to low permeability.	L	HLL	L	H(V)LL	L

Pathway to receptor	Time of concentration /duration of source outside	Transport Potential rating	Receptor	Damage Potential Rating	S-P-R Hazard Combination Existing	Environmental Hazard Rating Existing	S-P-R Hazard Combination with Solutions	Environmental Hazard Rating with Solutions
Vertical Migration into the Alluvium - Secondary A Aquifer There is a likelihood of the vertical migration of the inventory into the ground in the east/southeast side of the site where spill models indicate the escaped sludge may pool. The Made ground in this area is thicker and the shallow groundwater present may be in hydraulic continuity with the groundwater within the alluvium present to the east of the site. If liquors did reach and mix with shallow groundwater present within made ground then there is a potential for lateral migration towards the shallow groundwater in the alluvium to the east of the Site. For these reasons, the pathway potential risk is medium. Solution recommendation: Construct a wall to prevent lost inventory migration to the eastern part of the site.	Hours	M to (V)L depending on Asset.	**Alluvium - Secondary A Aquifer** - contaminated by percolation through soil. Due to classification, the receptor is classed as medium hazard potential.	M	HMM	**M**	H(V)LM	L
Overland and Below Ground Pathways to Local Surface Waters Liquors present in the alluvium groundwater may migrate laterally onwards to the River Biss. The pre-thickened tanks and MADs present the greatest risk due to their larger volumes and further potential to spread. The more prominent pathway is overland inventory migration, which is predicted to potentially cause direct pollution to the Local surface waters following catastrophic failure of the MADs only. If the river happens to be in flood at the time of a catastrophic failure, then the pre-thickened tanks and thickened tanks may also become significant. The closest water body to the BC is the two western-most lagoons. However, the spill models predict that these receptors would be bypassed entirely due to the steep topography from the BC down to the Southeast part of the works. Part of the escaped inventory would potentially infiltrate the HST sludge return PS located by the eastern site boundary. This pumping station has an overflow to the gravity sewer upstream of the terminal pump station (TPS). There is a storm overflow at TPS and therefore a credible pathway for the sludge to overflow to the River Biss. Solution recommendation: Construct a wall to prevent lost inventory migration to the eastern part of the site. Isolate TPS from potential flows.	Minutes to Days depending on Asset.	M	**Surface waters - River Biss** This surface water body, and connecting surface water ditches, could be contaminated by loss of inventory from the BC. There are no environmental designations associated with the watercourse. Two wester-most lagoons are used for fishing/wildlife but are not predicted to be affected.	M	HMM	**M**	H(V)LM	L

Pathway to receptor	Time of concentration /duration of source outside	Transport Potential rating	Receptor	Damage Potential Rating	S-P-R Hazard Combination Existing	Environmental Hazard Rating Existing	S-P-R Hazard Combination with Solutions	Environmental Hazard Rating With Solutions
Direct Pathway to the Water Recycling Centre (WRC) Biofilters and Humus Settlement Tank (HST) This is a clear pathway direct to the WRC upon catastrophic failure of most of the tanks within the BC (except Return liquor Balance tanks) due to the topography of the site and the location of the Biofilters and HSTs. One stream of the biofilters treating 40% of wastewater flows through the site is located adjacent to the BC boundary, at a lower elevation than the BC, and with coping levels at the same as ground level. In the event of a catastrophic inventory spill, the part of this treatment stream will quickly become significantly overloaded. This would subsequently impact downstream treatment processes and may ultimately lead to compliance failure at the final effluent discharge point. The affected biofilters would need to be taken offline, cleaned and re-seeded so temporary treatment would be required in the interim to restore the required level of WRC performance. The inventory will also gravitate toward the HSTs, although the coping levels of these tanks are slightly above the ground level, so they are less vulnerable to direct contamination. Solution recommendation: Constructing a wall in front of the biofilters is a relatively inexpensive approach to remove the pathway.	Seconds to Minutes depending on Asset.	H	**Water Recycling Centre (WRC), Biofilters, Downstream Processes, and Final Effluent Discharge.** **River Avon** There is a likelihood of a single failure at the final effluent discharge point. The environmental hazard rating is low for the WRC.	L	HML	**M**	H(V)LL	L
Indirect Pathway to the Final Effluent discharge point - River Avon There is no credible overland pathway to the river Avon as it is located approx. 800m away. However, there are two indirect pathways to the river: Trowbridge WRC Final effluent is discharged into this river. Final effluent compliance and a pollution event is possible in the event of sludge infiltrating into the biofilters. Any inventory reaching the River Biss will subsequently be transported to the River Avon. Solution recommendation: See above recommendations.	Hours to Days depending on Asset.	L	**Surface waters -** River Avon This surface body is located approx. 800m away from the site but WRC final effluent discharges to it. This is a medium hazard receptor due to its local designations.	M	HLM	**M**	H(V)LM	L

The Overall Environmental Hazard Rating based on Source-Pathway-Receptor Risk Assessment is **MEDIUM**.

8.2 Frequency of Loss of Containment

As part of the Environmental Risk Assessment, a frequency of Loss of Containment assessment has been completed for all of the sludge storage and reactor tanks. This considers likely causes and probability of partial loss of containment and potential causes and probability of catastrophic loss of containment.

The assessment is based on standard failure mode risk assessments developed for the types of tank material – Glass Fused Steel, Stainless Steel, or Reinforced Concrete, combined with the operational purpose of the tank. These risk assessments were referred to alongside the individual asset specific features such as condition of the tank, surroundings, and pipework penetrations outlined in Table 8.1.

Risk ratings for potential failure modes are assigned based on CIRIA 736 methodology, where:

- low risk means a probability of less than 1 in 1 million years,
- medium / moderate risk means a probability between 1 in 100 and 1 in 1million years,
- high risk means a probability greater than 1 in 100 years.

The output is summarised in Table 8.2.1 and broadly indicates that the frequency of loss of containment is likely to fall within the medium / moderate frequency category, with marginal or partial loss of scenarios having a probability of occurrence closer to 1:100. Catastrophic scenarios identified have significantly lower probabilities of occurrence. The assets at the greatest risk of appreciable loss of containment is the APDs and MADs because they have additional failure scenarios linked to operational process deviations.

The Overall Risk Rating for the site based on the assessment is considered to be **MEDIUM**.

Table 8.2.1 Frequency of Loss of Containment Summary

Asset ID	Asset Name	Material	Condition	Catastrophic Loss of Containment Frequency Risk in Line with CIRIA 736 Method	Probability of Catastrophic Failure in Line with CIRIA 736 Method	Comments
A	Sludge Reception Tank	Stainless Steel	Good	M	In line with CIRIA 736, all of the assets lie between the 1% (1 in 100) and 0.001% (1 in 1 million) Less than 0.001% (1 in 1 million) (moderate risk) category. Marginal or partial loss of containment scenarios will have a probability of occurrence closer to 1:100 years. Catastrophic loss of containment scenarios, linked to global stability, natural or man-made disasters, major exceptional defects in the fabrication and installation, or explosion / flash fire are, to varying degrees, far less probable but are difficult to quantify. At this site, the assets most at risk of catastrophic failure is the APDs and MADs because they have additional failure scenarios linked to process deviations.	Tank is 2 years old and was subject to technical supervision during installation and water testing prior to commissioning. Simple operation to receive, mix, and transfer indigenous and imported sludge. Good condition and very resilient material to corrosion and abrasion used for both the tank and ductile iron pipework. High level overflow physical safeguard is in place. Control inhibits and level indication in place. Ability to isolate and internally inspect the asset. Tank is offset from vehicle routes. Low level pipework present secured in a localised drainage apron. Partial loss of containment possible due to operator error with low level pipework, which would be quickly rectified.
C	Pre-Thickened Storage Tank 1	Glass Coated Steel	Moderate	M		Tanks subject to technical supervision during installation and water testing prior to commissioning. Assets are 10 years old, therefore full internal inspection and subsequent maintenance planned in accordance with manufacturer's recommendations. Simple operation to store and maintain homogenous sludge mix prior to thickening. Moderate condition and moderately resilient material to corrosion and abrasion used for the tank. High level overflow physical safeguard is in place. Control inhibits and level indication in place. Ability to isolate and internally inspect the asset. Demonstration of previous maintenance in response to corrosion holes at sludge air interface, but further corrosion observed. Tank is offset from vehicle routes. Low level pipework present over impermeable surfacing. Marginal loss of containment possible due to corrosion pin holes at sludge air interface if thanks are no longer maintained. Partial loss of containment possible due to operator error with low level pipework, which would be quickly rectified.
D	Pre-Thickened Storage Tank 2	Glass Coated Steel	Moderate	M		
G	Thickened Sludge Tank	Glass Coated Steel	Moderate	M		Tank subject to technical supervision during installation and water testing prior to commissioning. Asset is 10 years old, therefore full internal inspection and subsequent maintenance planned. Simple operation to store and maintain homogenous sludge mix prior to thickening. Moderate condition and moderately resilient material to corrosion and abrasion used for the tank. High level overflow physical safeguard is in place. Control inhibits in place. Isolation and internally inspection of asset requires temporary shutdown of other processes. Tank is offset from vehicle routes. Low level pipework present over impermeable surfacing. Marginal loss of containment possible due to corrosion at sludge air interface. Partial loss of containment possible due to operator error with low level pipework, which would be quickly rectified.

Asset ID	Asset Name	Material	Condition	Catastrophic Loss of Containment Frequency Risk in Line with CIRIA 736 Method	Probability of Catastrophic Failure in Line with CIRIA 736 Method	Comments
H1-H6	Acid Phase Digesters	Glass Coated Steel, bitumen internal liner	Moderate	M	In line with CIRIA 736, all of the assets lie between the 1% (1 in 100) and 0.001% (1 in 1 million) Less than 0.001% (1 in 1 million) (moderate risk) category. Marginal or partial loss of containment scenarios will have a probability of occurrence closer to 1:100 years. Catastrophic loss of containment scenarios, linked to global stability, natural or man-made disasters, major exceptional defects in the fabrication and installation, or explosion / flash fire are, to varying degrees, far less probable but difficult to quantify. At this site, the assets most at risk of catastrophic failure is the APDs and MADs because they have additional failure scenarios linked to process deviations.	Tanks subject to technical supervision during installation and water testing prior to commissioning. Relatively complex operation to hydrolyse and digest sludge so operational failure modes such as foaming and subsequent overtopping, or under-pressurisation become credible scenarios if operating parameters are not maintained, and other protection safeguards fail. Presence of biogas means explosion and short-lived flame in the tank headspace, could occur in extreme instances when multiple safeguards fail. Assets are 10 years old, therefore full internal inspection and subsequent maintenance planned. Anti-foaming dosing in place manually and no history of foaming observed. Material with inclusion of internal bitumen liner is very resilient to corrosion at sludge air interface. External cladding may increase risk of external corrosion. High level overflow physical safeguards are in place. Control inhibits, pressure and level indication in place. Isolation and internal inspection of asset requires temporary shutdown of other processes. Tanks are offset from vehicle routes and vehicle containment is present as a secondary physical safeguard. Low level pipework present over impermeable surfacing. Partial loss of containment possible due to operator error with low level pipework, which would be quickly rectified. Partial loss of containment possible if site is not operated within defined parameters and other controls fail. Although deemed moderate risk, the likelihood of catastrophic failure is greater for these tank assets compared to other tanks due to their operating complexity.
I1-I2	Mesophilic Digesters	Glass Coated Steel, bitumen internal liner	Moderate	M		
J1-J2	Secondary Digesters	Glass Coated Steel	Good	M		Tank subject to technical supervision during installation and water testing prior to commissioning. Asset is almost 20 years old, therefore full internal inspection and subsequent maintenance planned. Previous inspection and maintenance has been carried out on the assets. Currently relatively simple operation to store sludge for secondary digestion, although other drivers may result in their abandonment or a change in use in the future. Tanks are in very good condition for their age and material moderately resilient material to corrosion and abrasion. High level overflow physical safeguard is in place. Control inhibits and level indication in place. Ability to isolate and internally inspect the asset. Tank is offset from vehicle routes. Low level lagged pipework present over but adjacent to permeable surfacing. Lagging could increase rate of corrosion but easily accessible for inspection. Partial loss of containment possible due to operator error with low level pipework, which would be quickly rectified.
N1-N2	Liquor Balancing Tanks	Reinforce d Concrete	Poor	M		Simple operation to balance liquors derived from sludge processing. Asset is almost 40 years old so within the typical design life of 60 years for an RC structure constructed in 1980. The life of the asset can exceed the design life depending on the concrete mix (i.e., its durability) and the aggressiveness of the retained liquid and external environment. However, in this case the tank stores liquor which is an aggressive liquid. The tank is reinforced concrete which is extremely resilient to catastrophic failure modes. However, given the tanks age, full internal inspection and subsequent maintenance planned. Isolation and internally inspection of asset requires temporary shutdown of other processes. High level overflow physical safeguard is in place. Tank is offset from vehicle routes. Partial loss of containment possible due to leakage paths associated with gradual deterioration.

8.3 Overall Site Risk Rating and Containment Class

Based on both, Source-Pathway-Receptor and Frequency of loss of containment risk assessments, the Site has an overall Risk rating of Medium (Table 8.3.1) which requires implementation of Class 2 containment solutions as a minimum.

Table 8.3.1 Site Risk Rating and Containment Class Summary

Description	**Hazard Rating Before Recommendations**	**Comments**	**Rating After Recommendations**
Worst Case BC Site Wide Source-Pathway-Receptor hazard rating	HMM=M	The source hazard is **H** due to large inventory volumes, high BOD, and high microbial content. The worst-case pathway potential is overland sludge flows into the River Biss from the MAD located at the centre of the STC. However, the River Biss has no environmental designation, so the receptor damage potential is Medium.	H(V)LM = L
Catastrophic Loss of containment risk rating	M	Based on Table 2.3 in CIRIA 736, **M** risk equates to: **1 in 100 years < significant spill event probability < 1 in 1 million years**.	M
Overall Site Rating	M	Based on Box 2.2 in CIRIA 736. This demonstrates that action is required, and this will consist of new secondary containment equivalent to a **Class 2** standard.	M

9 Containment Solutions

The solution for the main BC area is presented in this section. This includes a plan of the scope of works needed to achieve secondary containment solution equivalent to BAT, and spill modelling outputs (Fig. 9.1.2 – 9.1.9) to demonstrate the effectiveness of the proposed solution following a failure of the primary asset, where such an event is credible. The preferred option is presented first. Options that have been considered, but are not preferred, are also briefly discussed.

As explained within Section 2.4, a chartered structural engineer will be consulted throughout the detailed design of the selected solution and will complete a full review of the proposal. Inspection and maintenance plans, as specified by a structural engineer will be developed in addition and will be incorporated into Wessex Water's asset management systems. It is anticipated that monthly checks, by trained operators, will be routinely carried out and any signs of deterioration will be flagged to a chartered structural engineer for review. A chartered structural engineer will also be requested to carry out an independent review on a suggested two-yearly basis to verify the integrity of containment assets. A typical inspection plan for a concrete segment is provided in Section 9.3.

The solutions being proposed can adopt any of the following two principal approaches as outlined within Section 2.4. These being:

1. Fully compliant Secondary Containment solution in accordance with CIRIA 736.
2. A solution that prevents sludge from leaving the site following a Catastrophic Failure.

9.1 Proposed Solution - Combined Secondary and Tertiary Containment

This approach consists of a combined secondary and tertiary containment system. It includes a secondary containment perimeter wall around the Bioresource centre. The bund arrangement is designed to maintain existing principal traffic routes and minimise the impact on the day-to-day inspection, operation, and maintenance activities carried out by operatives. Existing reinforced concrete will be inspected and repaired where required and permeable areas will be made impermeable using tarmac. Due to the steep topography, the secondary containment can only contain approximately 20% of the required inventory volume. To contain 110% of the escaped inventory, with rainfall and surge freeboard allowance, the total height of the bund by the southwest side of the BC would exceed 2.8m, which is far higher than the recommended maximum bund wall height outlined in Ciria 736.

Tertiary containment is therefore proposed to contain the remaining inventory volume. Inventory would be transferred via the existing roadway from the BC to the skip storage area at the southeast part of the site, where the ground elevation is the lowest. The existing road will be repaired and modified to include 400mm high in-situ walls. The hardstanding in the skip storage area will be extended using tarmac and tied into a new reinforced concrete wall up to 1.7m high to contain the remaining inventory. The skip storage area will be relocated.

The solution is presented in Figure 9.1.1.

Volume of containment

The volume is based on catastrophic loss of containment from one of the Mesophilic Digesters, equating to 110% of the above ground tank volume. This scenario leads to the largest loss of inventory when applying the 110% and 25% rules outlined in CIRIA 736, as shown in Table 9.1.1 below. The effectiveness of the containment solution has been checked for the other tanks within the bund by completing spill models for all assets within the Bioresource Centre (Fig. 9.1.2 – 9.1.9).

Table 9.1.1: Summary of Spill Volumes Based on CIRIA 736 110% and 25% Rules

Tank Ref	Description	Nr of	Spill Model volume per tank (m3)	Spill Model volume asset type (m3)	110% Tank Volume (m3)	25% All Assets (m3)	25 % Volume - Grouped Assets (m3)
A	Sludge Reception Tank	1	200	200	220		
C	Pre-Thickened Tank 1	1	600	600	660		430
D	Pre-Thickened Tank 2	1	920	920	1012		
G	Post-Thickened Tank	1	600	600	660	2672	
H1-H6	Acid Phase Digesters	6	170	1020	187		2092
I1-I2	Mesophilic Digesters	2	3373	6746	3710		
J1-J2	Post-Digested Tanks	1	500	500	550		250
F1-F2	Liquor Balancing Tanks	2	50	100	55		125

Perimeter walls

Perimeter wall will be constructed from reinforced concrete and will meet a minimum requirement of tightness class 1 BS EN 1992-3:2006. The strip footing will be integrally tied to the wall and a water stop shall be installed at any required cold joints. The foundation and structural design will consider local ground conditions to manage differential settlement risks along the wall's alignment.

The height of the wall varies and is based on the 110% spill modelling outputs with the containment perimeter in place, plus a 100mm freeboard allowance. For the secondary containment area, the maximum wall height is 1.5m. The highest wall is set to be at the southwest side of the BC due to the topography of the site. For the same reason, the northwest of the bund has the lowest bund at 400mm. The rest of the containment wall height varies between 600mm and 1000m.

The tertiary containment area has a maximum wall height of up to 1.7m. This is slightly above the recommended maximum wall height outlined in CIRIA 736. However, the area is open with limited operational activity and simple means of egress, so no safety risk or inspection challenges are introduced as a result. The existing kerbs in the road connecting the two containment areas will be raised to 400mm to ensure inventory is transferred to the tertiary containment area.

At certain points, vehicles will need to enter the bunded area from road access points, shown by the green shaded areas in Figure 9.1.1. The roads will be graded to achieve the required containment heights at the access points. From here they will grade back down to the existing road level within the bunded area. Gradients will be designed to ensure that vehicles can safely turn. In general, adjustments to roads must meet WWS design standard 224, which covers road design principles, and minimum expectations to ensure safe operation can be maintained.

Flood Gate and Access Provision

The objective will be to design out the need for flood gates during detailed design. However, if one or more flood gates is necessary to facilitate construction and maintenance vehicle access into the bunded area, then the following approaches will be taken:

Specifying, Procuring, Installing, and Testing the Flood Gate.

The guidance outlined for prefabricated bunds in C736 shall be followed when specifying, procuring, installing, and testing a flood gate.

In particular, specifications will indicate that the product shall be water retaining and shall be capable of withstanding hydrostatic and hydrodyamic forces that it may experience following failure of primary containment. The anticipated forces shall be determined by calculation by a competent designer and referenced in the contract documents to the supplier.

A factory acceptance test (FAT) shall be required to confirm the product is capable of withstanding the forces it may be subjected to and to confirm that the product is water retaining. Any testing shall be witnessed and certified by a competent person not employed by the supplier of the product.

In addition to the FAT, site acceptance testing (SAT) shall be undertaken to ensure the as installed product is capable of retaining water to the required hydrostatic and hydrodynamic loads. The SAT test will be used to demonstrate effectiveness of the seal between the flood gate and concrete wall, and the threshold detail between the flood and the gate.

This will be achieved by installing a temporary flood dam, with the flood gate forming one side of the perimeter, to create a small volume. A water test shall then be carried out in accordance with section 6.3.7 of CIRIA 736. This test shall be undertaken prior to commissioning the gate and at regular intervals thereafter to demonstrate that integrity has not been compromised.

Operation of the Flood Gate

The following methods are suggested for access controls and arrangements into the bund. These will be confirmed by formal risk assessment considering HSE risks adopting ALARP principals.

The flood gate operation shall be manual and shall be limited to the following activities only:

- Vehicle entry into the containment area limited to construction purposes including new tanks, or repairs to existing primary or secondary containment where the work cannot safely be carried out using pedestrian access based on ALARP principals.
- Emergency access and egress where operator loss of life or livelihood is probable.
- Testing of gate open alarm.

At all other times the flood gate shall be locked and shall include "no entry by unauthorised persons" and "no opening by unauthorised persons" warning signage. Any workers or visitors on site shall be advised who is authorised at the site induction.

All other access to the bund will be via access staircases up and over the bund wall. These will be positioned to provide direct evacuation routes in the event of a potential or actual dangerous situation occurring within the bund. Note pedestrian access into the bund wall shall be restricted using risk assessment method statement procedures, and with locked gates and “no entry by unauthorised persons" warning signage at the access stairs.

Any works involving operation of the flood gate will be subject to a risk assessment method statement requiring review and approval from the Site Manager. For the first item, this will be task specific. For the latter two, it will be generic but reviewed prior to commencing the operation. Flood gates shall be manned by an individual who can operate the flood gate for a) for the duration in which they are open and b) while personnel are within the bunded area.

Flood gates will include instrumentation that will alarm to a central SCADA system to notify the Operator that the gate is open. The flood gate will remain open only for as long as required to allow the construction vehicle to be moved inside or for incapacitated personnel to be removed, or to prove the gate open alarm is functional.

Records of flood gate operation shall be logged and recorded by the Operator and will be available on request by the Regulator for review. The log will include time of opening, time of closing, evidence of alarm signal, approved RAMS record, and alarm testing record as appropriate.

Maintenance and Inspection of the Flood Gate

The supplier of the flood gate shall supply full instructions on inspection and maintenance requirements, including inspection frequencies, finishes and other protection measures, preventative routine maintenance, and damage repair, as outlined in Section 7.5.2 in CIRIA 736. This information will assist WWS in developing an inspection and maintenance plan for the flood gate.

The flood gate will be uniquely identified with an asset tag and included in WWS's asset management system. The necessary inspection and maintenance requirements will then be assigned to the asset. Such activities would consist of weekly observational checks by Site Operators and an annual formal inspection and test of the asset by a competent engineer.

The final regime would be developed in consultation and agreed with the relevant environmental and safety regulators to ensure it is appropriate to the criticality of the asset. As with any asset, the frequency of inspection, testing, and any subsequent intervention will change during its design life.

Duration of Time for Spill to Reach the Flood Gate

The time taken for a spill to reach the flood gate is a function of the mode of failure and the location of that failure within the bund.

For the most severe events referenced in Ciria 736 it will be instantaneous from a human perspective.

For a jetting type loss of containment event in the direction of the flood gate, it will be seconds.

For jetting in other direction, overtopping, or other modes of failure leading to steadier loss of inventory, it will be minutes or hours.

New Impermeable surfaces

Based on initial investigations Wessex Water are currently proposing to replace permeable surfaces with tarmac in lightly trafficked areas. Tarmac is now recognised as an appropriate technology for chemical containment and has the following advantages over reinforced concrete:

- Relative ease of construction in impermeable areas around existing assets.
- Lower cost and embodied carbon.
- Simpler to inspect and maintain.
- No joint details.

Where new reinforced concrete is required, it will meet a minimum requirement of tightness class 1 to BS EN 1992-3:2006. Joint detailing shall comply with Section 7.2.4 in Ciria 736.

Existing Impermeable Surfaces

Existing impermeable surfaces will be retained where possible unless a condition is so poor that it becomes simpler to demolish and replace it. Retained concrete may not comply with the requirements set out in CIRIA 736 as Wessex Water design standards do not specify the requirement for water stops at construction joints in reinforced concrete roads and footpaths. Existing joints will therefore be inspected and reinstated with an appropriate surface poly-urethane sealant. The joints will be inspected regularly and proactively repaired to ensure they remain in good condition.

Additional proprietary waterproofing epoxy products from specialists will also be considered at a detailed design to improve the robustness at concrete joints and joints across existing kerb alignments transitioning between concrete and other surfaces. Detailed design material specifications will be developed in close consultation with suppliers offering these types of products.

Vehicle Impact Protection

Containment shall be provided where there is a credible risk of vehicles damaging existing tanks. This applies to certain areas of the GCS tanks and will normally consist of bollards, armco barriers or equivalent.

The vehicle containment product selection, positioning, and foundation design will be undertaken by a competent structural engineer and checked and approved in accordance with WWS quality assurance procedures. Final positioning of containment shall also be agreed with the Site Operator but shall be far enough away from the primary containment such that a horizontal force is not transferred directly from the vehicle containment to the asset it is protecting. The design will ensure that the containment is capable of withstanding the design force that it would be subjected to following a) collision from the largest vehicle that can drive into that area and b) a maximum credible speed.

Vehicle containment will be considered an integral component of the secondary containment asset and as such will be subject to routine inspection. If vehicle containment is subject to an impact, it shall be condemned and replaced as soon as possible to an equivalent standard of the original installation.

Drainage

Existing below ground drainage conveying surface run-off will be utilised as part of the containment solution. The lines will be routinely surveyed using CCTV to confirm they remain in serviceable condition and any identified defects will be scheduled for repair. Newly installed drainage in the tertiary treatment area will be dual contained.

Dirty surface water run-off, condensate, and liquor overflow flows from the BC currently drains to the humus de-sludge PS, with the overflow to the sewer feeding the site TPS, which has its own overflow to the River Biss. Dirty surface water from the skip storage area drains direct to the TPS.

These flows will be diverted into new pumping stations within the secondary and tertiary containment areas. Any required below attenuation will be sized to accommodate the additional run-off generated by the new impermeable surface areas. The pump stations will return flows to the WRC for treatment via dedicated rising mains. These will either run above ground within defined containment areas, or below ground in a dual contained system with leak detection. Below ground dual containment may adopt dual contained pipework or pipework positioned in sealed pre-cast troughs. The details of these features will be developed at detailed design stage.

Following a catastrophic spill event, the pump station may, subject to process design assessment, pump undigested sludge and surface water back to the head of the works at a controlled flow rate that maintains the performance of the WRC. The pump station will also include a tanker point for draining down or managing sludge spills and surface water volumes within the bunded area. In this instance, tankers would export the sludge to another site for processing.

Rapid loss of level in a given tank shall lead to an emergency alarm. The pump stations serving the two containment areas will be auto inhibited by the measured drop in level to give the Operator a period of time to determine the source and severity of the incident and follow the appropriate course of action, outlined in the agreed emergency response procedure.

Emergency Response and Access

If a catastrophic or significant failure of a tank occurred, at least 20% of the sludge would collect in the secondary containment area, predominantly around the raw sludge handling tanks. Any additional spills would spill to the tertiary containment area. There would be a rapid emergency response to clean up the escaped sludge as quickly as possible. Sludge imports, which make up 80% of the sludge treated on site, would be immediately diverted to alternative sites. LTC imports to Trowbridge would also cease.

Alternative means of treatment of indigenous sludge treatment would be adopted to ensure continuity of treatment during a loss of containment scenario. In most cases this would likely require export for treatment at an alternative site until the inventory spill has been cleaned up and site sludge treatment operations are restored.

It is critical that access is maintained to the motor control centre following a catastrophic loss of containment. The building will be protected from the impacts of a spill event and a safe access / egress route can be maintained following loss of containment from the tanks within the bund.

The Site Operator will be responsible for the correct implementation of the emergency response following catastrophic failure of primary containment.

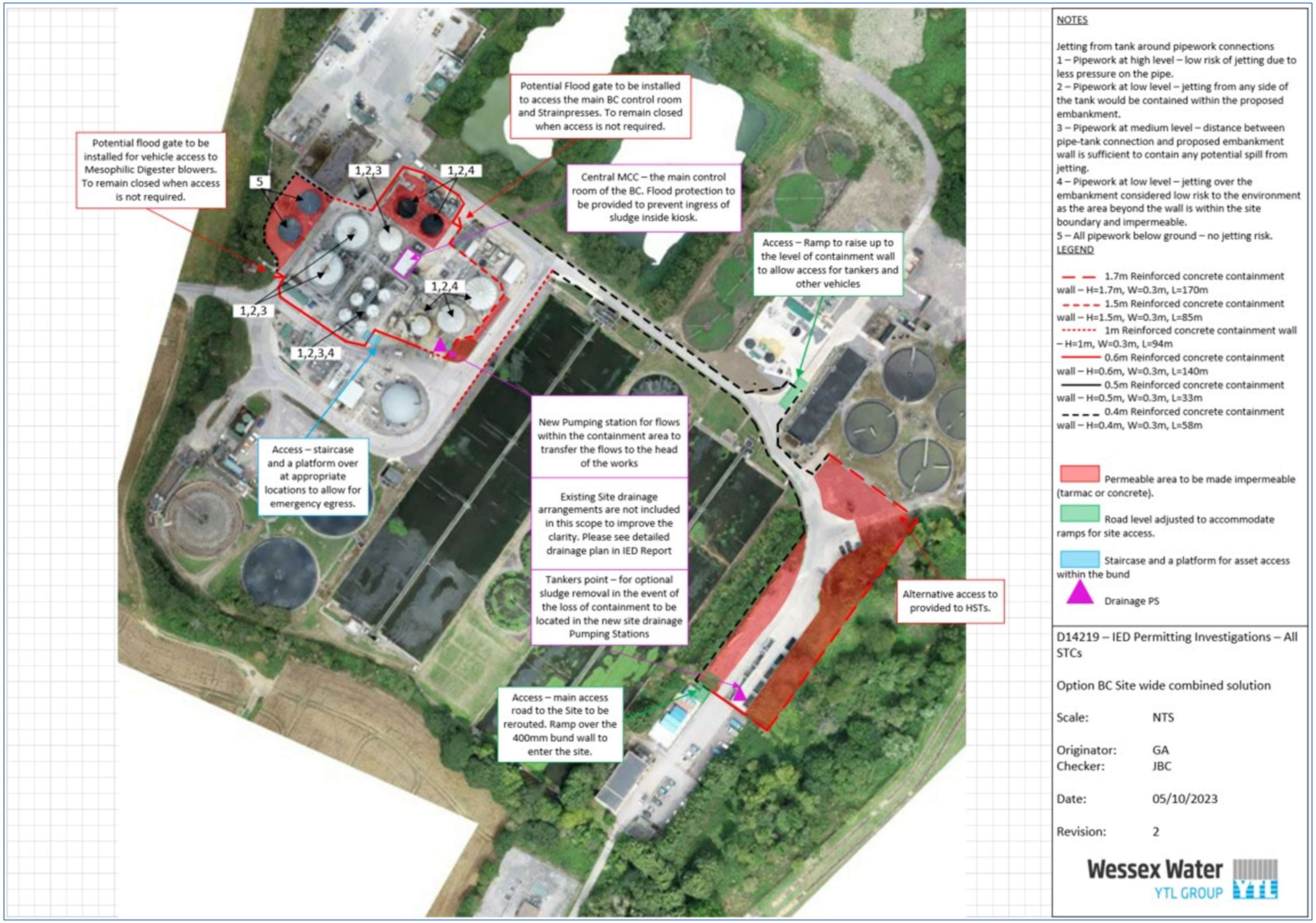
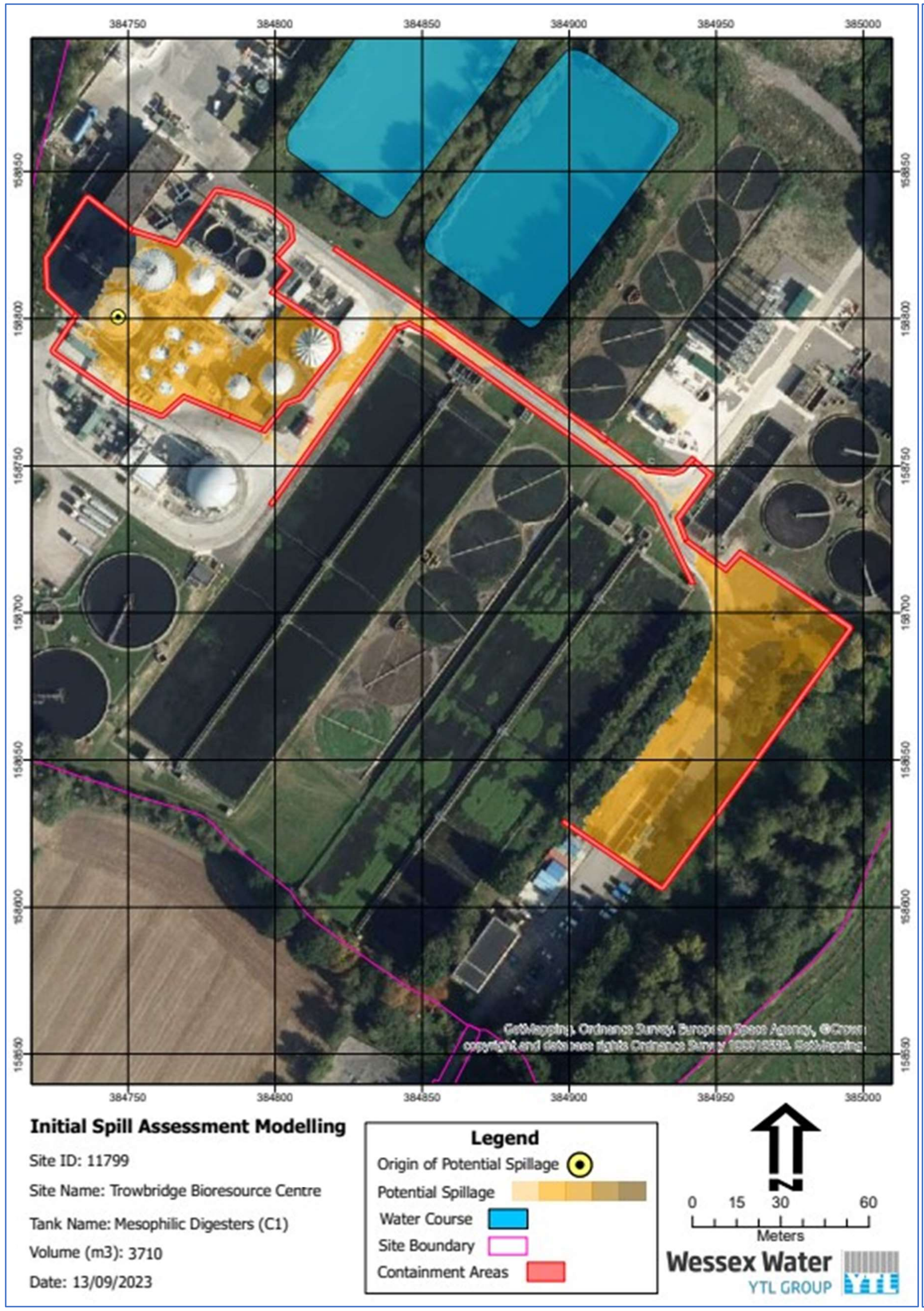


Figure 9.1.1 Proposed Combined Secondary and Tertiary Containment Solution



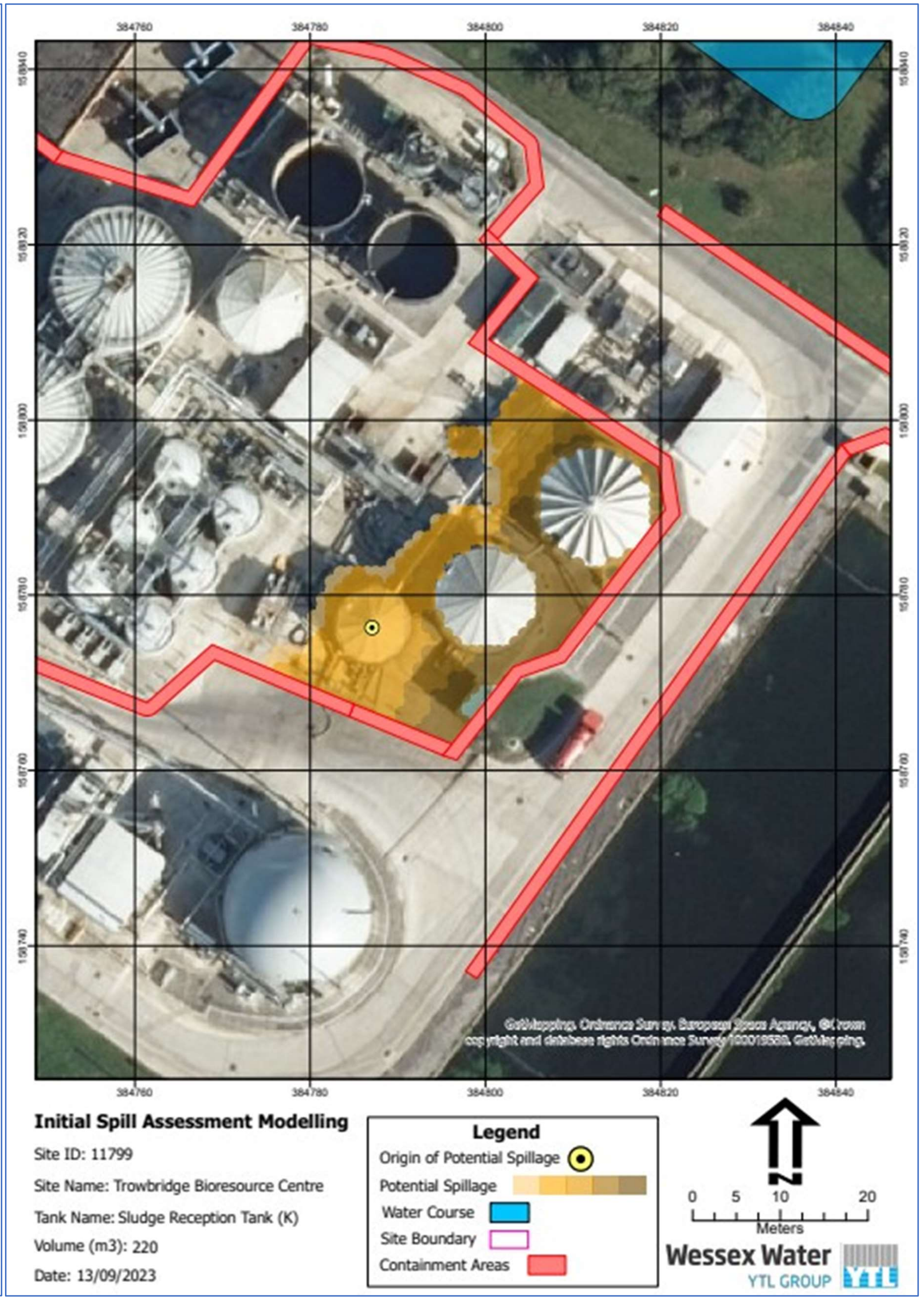
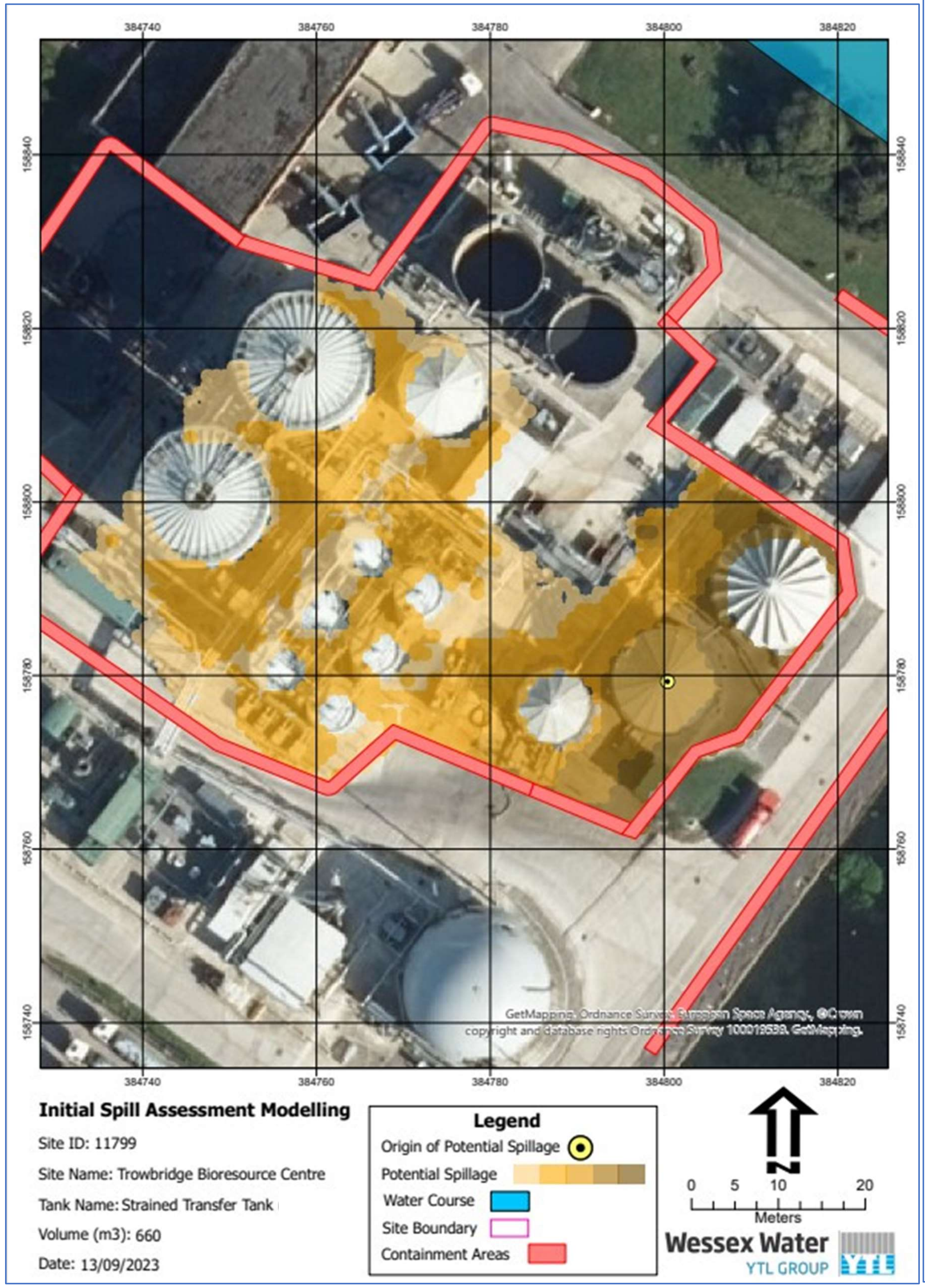


Figure 9.1.2 MAD 110% Loss of Containment Scenario and Figure 9.1.3 Sludge Reception Tank 110% Loss of Containment Scenario



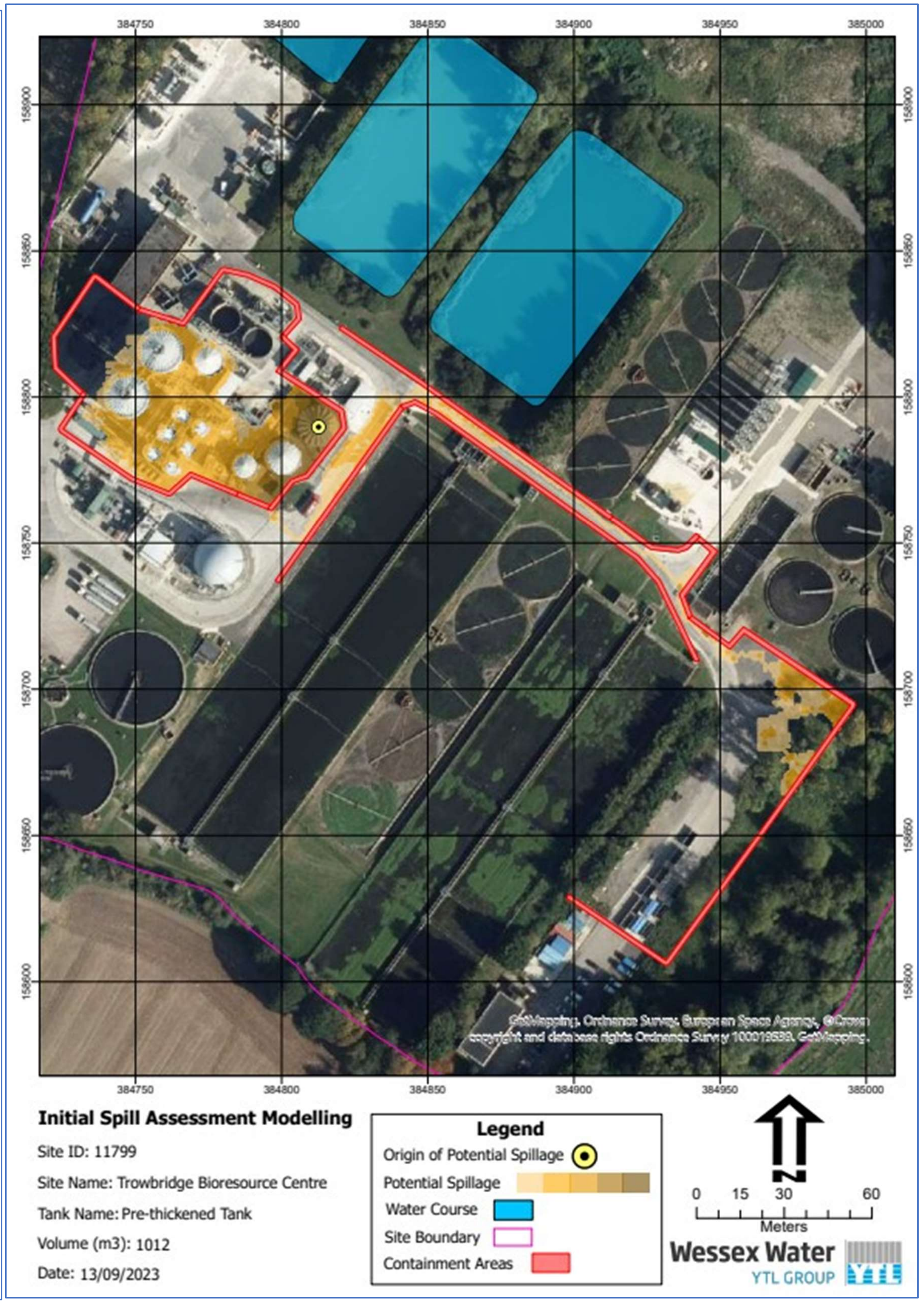


Figure 9.1.4 Pre-Thickened Sludge Tank 1 110% Loss of Containment Scenario and Figure 9.1.5 Pre-Thickened Sludge Tank 2 110% Loss of Containment Scenario

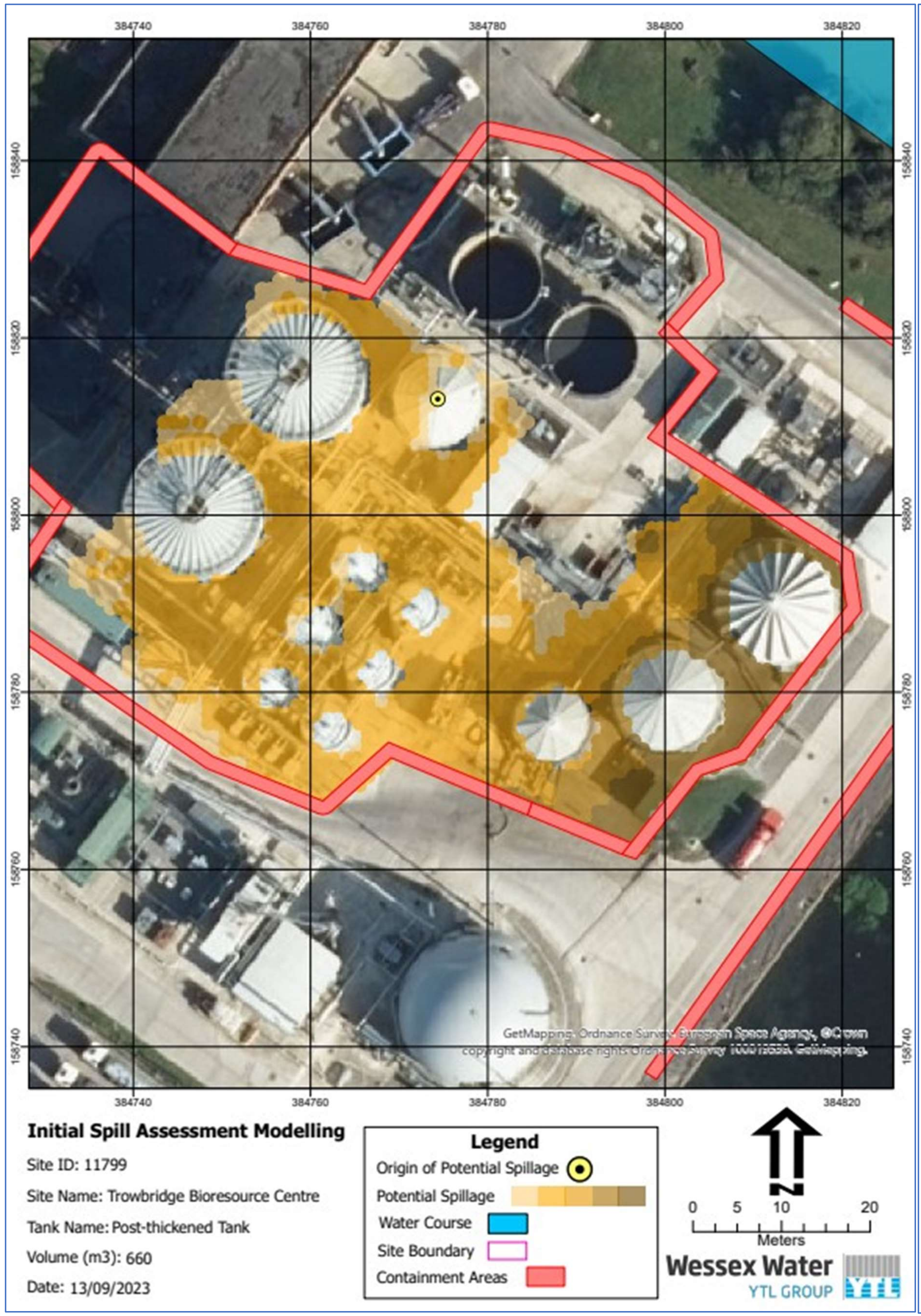
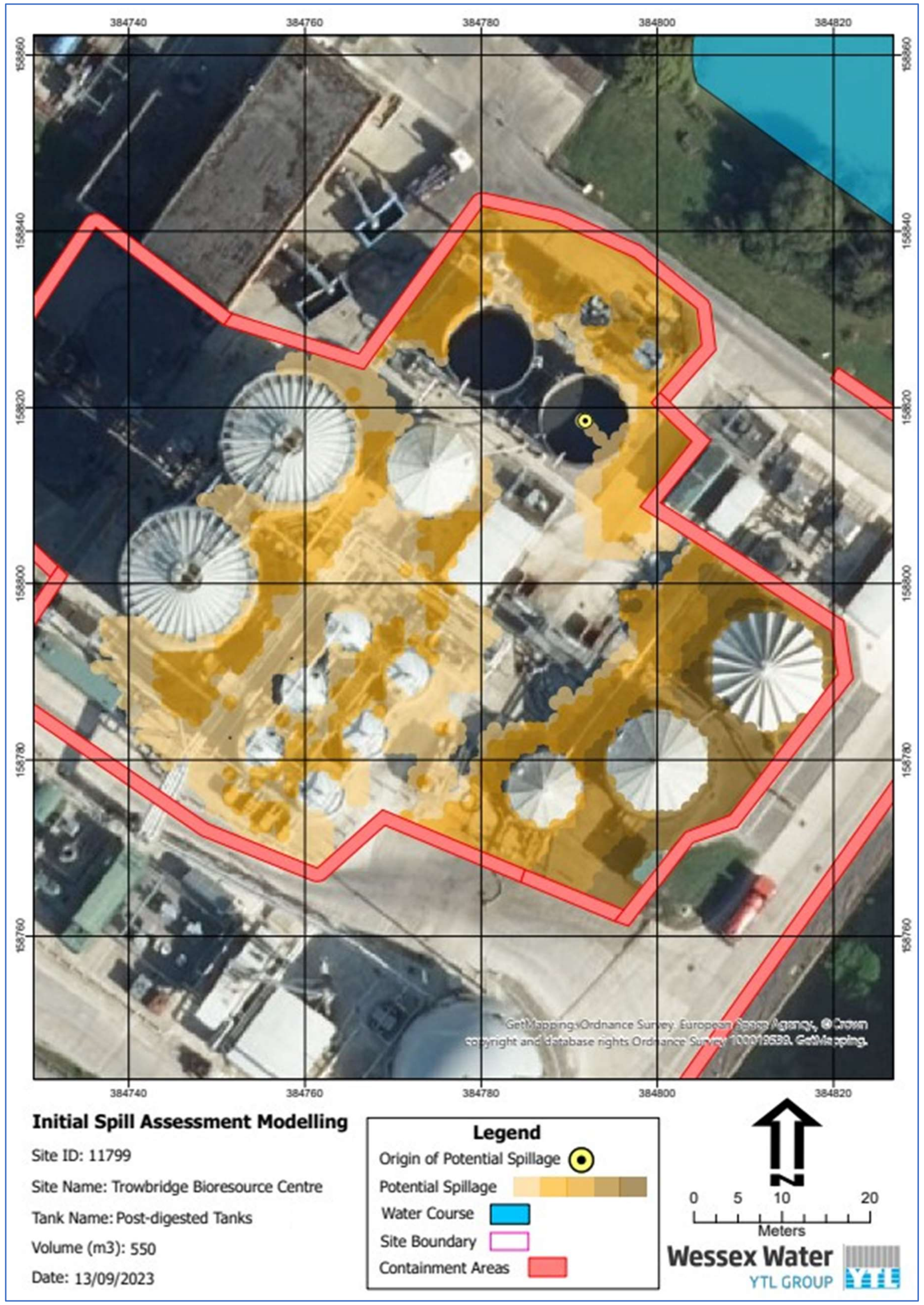


Figure 9.1.6 Post-Thickened Sludge Tank 110% Loss of Containment Scenario and Figure 9.1.7 Single APD Tank 110% Loss of Containment Scenario



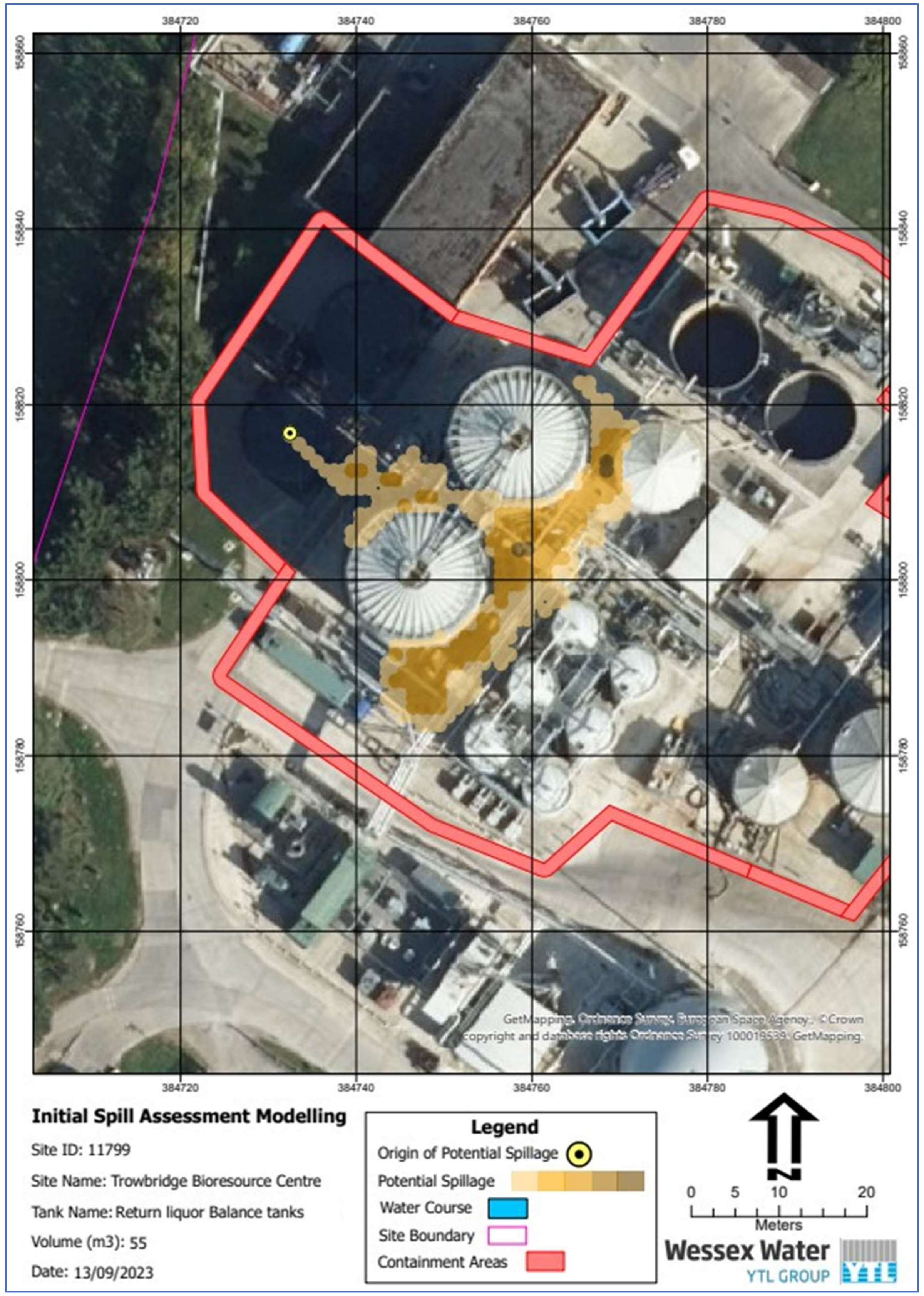


Figure 9.1.8 Secondary Digestion Tank 110% Loss of Containment Scenario and Figure 9.1.9 Liquor Balancing Tank 110% Loss of Containment Scenario

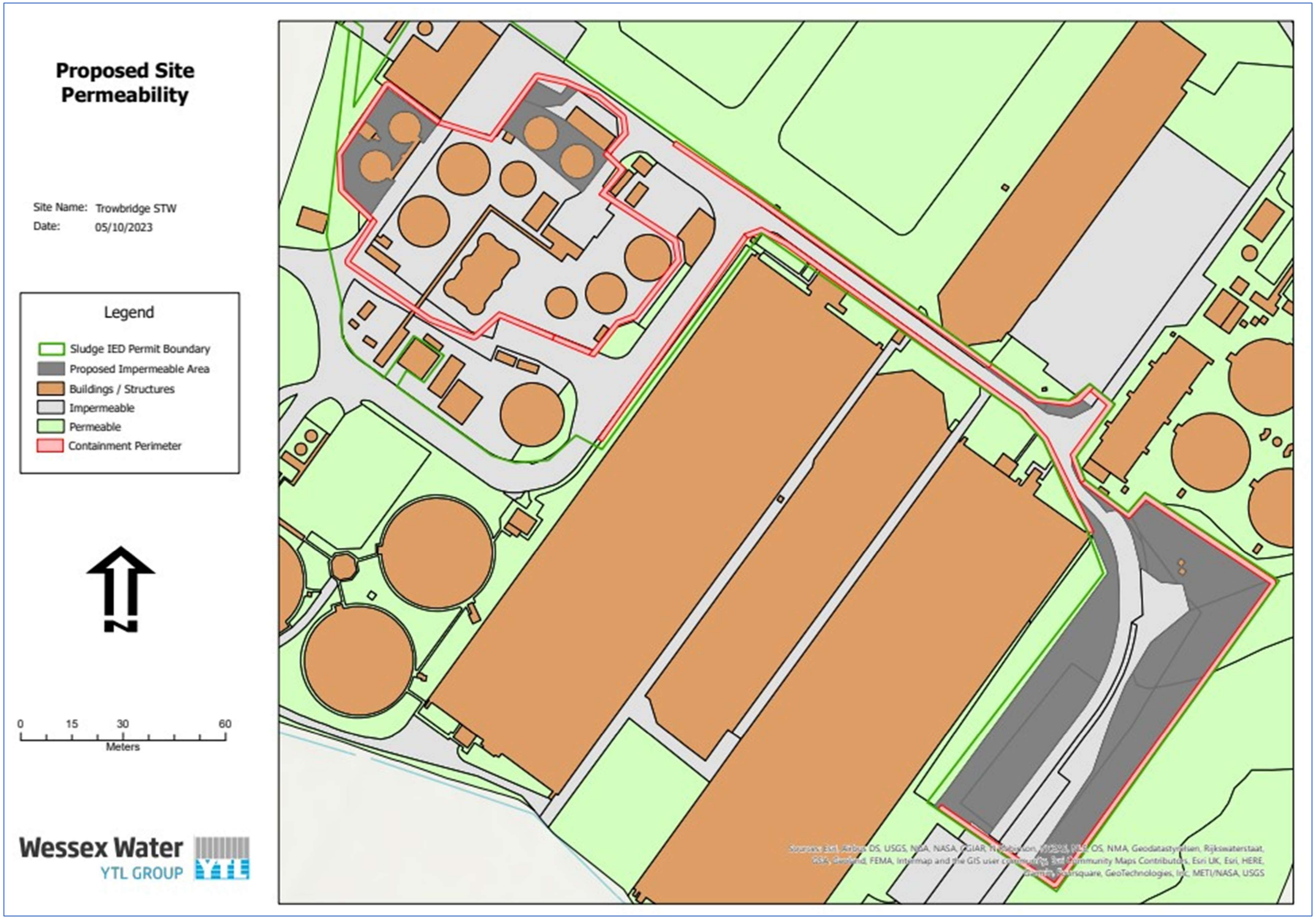


Figure 9.1.10: Site Permeability Plan Following Implementation of Preferred Solution

9.2 Other Solution Approaches Considered

CIRIA 736 Compliant secondary containment solution:

CIRIA 736 Compliant secondary containment solutions were considered for the main BC. This would be achieved by constructing new purpose-built water retaining, reinforced concrete structures locally around individual tanks or asset types (e.g., MAD tanks). The containment structure would be detailed to meet the minimum expectations outlined in Chapter 7 of CIRIA 736. For example, the specification of water bars where construction joints cannot be avoided. The approach would retain the spill local to the tank, minimise the impact on adjacent processes outside of the bund, and potentially simplify the emergency response.

The obvious problem with this approach is linked the height of the bund walls required. Section 6.3.1 in CIRIA 736 acknowledges the challenges that are introduced when walls far exceed 1.5m in height. The reality is that the volumes to be contained, coupled with the existing operational and physical constraints around the assets, makes it impracticable to implement these types of solutions in many cases. The containment structures themselves may be detrimental to the operation, inspection, and maintenance requirements in these areas.

For example, the Mesophilic Digesters would require installation of at least a 3m high bund wall to provide the required secondary containment volume.

Operator preference is for a wider containment solution that prevents sludge from leaving the site following catastrophic failure while minimising detriment to the day-to-day operation of the BC.

Utilising one of the Lagoons for a Tertiary Containment Area:

This option was briefly investigating and quickly dismissed due to the environmental sensitivity of the lagoons, and the relative cost of providing compensatory habitat and draining the lagoon to create a bund. Re-purposing the existing skip storage area is a more cost-effective approach with relatively minimal environmental detriment.

9.3 Standard Precautionary and “Soft” Solutions

The following measures will be implemented as part of a detailed design solution.

Drainage and Services

- Impermeable surfacing and drainage to be provided beneath pipework that falls outside of the specified bund perimeters. Jetting effects are to be considered for each pipe run.
- All existing site surface water drainage and newly installed surface drainage are to be reviewed to demonstrate an adequate capacity for rainfall and spill events.
- Surface water drainage systems capacity to be established to demonstrate that lost inventory is not surcharging manholes or gullies outside of the bund perimeter.

BC Control and Telemetry Systems

- Process safety engineers, operatives, and designers to HAZOP the existing site processes and operation against current industry best safeguarding practices and propose proportionate improvement recommendations where required.
- Security expert to review current unauthorised access deterrence provisions against current industry best practices and propose proportionate improvement recommendations.

- Ultrasonic level sensors in tanks to be alarmed and to be visible remotely in the event of a rapid and unanticipated drop in level within a given tank e.g., tank level dropping, feed pump and draw off pump not running.
- Existing rising mains to be installed with pressure indication and inhibits if they do not already have them.

Structural Performance

- Consider early warning tank shell or reinforcement corrosion systems for tanks where this may not be obvious during an external physical inspection.
- Carry out a condition assessment of existing hardstanding areas and, where required, propose remedial work to ensure appropriate containment for the short period of time associated with an improbable spill event.
- Propose locations for vehicle containment where appropriate to avoid any risk of collision with primary containment assets.
- Commit to a minimum of 2 yearly external structural inspections of concrete, steel assets, and pipework and an appropriate frequency for internal inspections by a chartered structural engineer or competent independent consultant for steel tanks.
- Secondary containment structures to be identified as assets on Wessex Water's asset register.
- Development of an operation and maintenance manual for the secondary containment structure by a chartered structural engineer.

Table 9.4.1 Example Inspection Plan for Existing Concrete Paving

Asset	Sub Asset	Theoretical Design Life	Inspection and Report By	Documentation	Typical Visual Observation & In Situ Testing	Method	Inspection Frequency (TBA)
Existing concrete pavement including Access Roads, and Footpaths and operational working areas.	Concrete Segments	40 years	**Originator**: Structural Engineer +2 years' experience. **Checker:** Chartered Civil or Structural Engineer. **Approver:** TBA	Inspection Report to Include: As Built Drawing or Standard Detail. Estimated Construction Date. Applicable Design Code. Observation Condition Assessments. Testing Condition Assessments.	Cracks > 0.3mm	Observation Crack Width Gauge	2 Yearly
					Cracks < 0.3mm	Observation Crack Width Gauge	2 Yearly
					Differential Settlement / Subsidence across segment or between Adjacent Segments	Observation Dumpy Level	2 Yearly
					Surface condition - Damp patches, Spalling, Biodegradation.	Observation Dumpy Level	2 Yearly
					Reinforcement	Ferroscan	First Inspection

9.4 Groundwater Monitoring

Groundwater monitoring should not be needed if the preferred solution is adopted, which includes replacing the existing buried liquor tanks with above ground tanks, ongoing inspection, and maintenance of existing buried pipework assets located over the low permeability Kellaways and Oxford formation in the main BC area, and by dual containing new below ground assets in the tertiary containment area. The Regulator will be informed at detailed design to ensure agreement with this approach.