J840 – STC IED Containment

Mogden STW – Containment Options Report

B22849AZ-JA-MOGDS1ZZ-024-RP-C-0001

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1.0	28/10/2022	First Issue	WS	SMNS	SC	HG
2.0	18/12/2023	Updates to PFD/IED Plan/Tank Names	CR	SMNS	SC	HG
3.0	10/12/2024	Clarifications to tanks table in response to EA Schedule 5 Mogden EPR/WP3533LT/V006 queries	OF	SMNS	SC	HG

Contents

1. Executive Summary

Thames Water is required by the Environment Agency to provide secondary containment to their sludge treatment centres (STC) to satisfy provisions of the Industrial Emissions Directive and to safeguard the operation of the adjacent sewage treatment works. Twenty-five sludge treatment centres have been identified where containment proposals are required. This report deals with the proposal for Mogden.

Mogden STW is located in Isleworth in West London near the Twickenham Rugby Stadium and is receiving sewage from eight boroughs in the northwest London region. Mogden STW serves a population equivalent to 2,100,000 people. There are 36 active sludge storage tanks at Mogden STW within the permit area, 20 of which are above ground and will require sludge containment under the IED.

CIRIA Report 736 – Containment systems for the prevention of pollution sets out principles and direction. This report sets out options to apply the CIRIA 736 principles within the accepted constraints of a retrofitted solution.

This assessment focuses on site-specific risks and outlines the options available for providing secondary containment of a catastrophic tank or digester failure.

One option was developed in detail for sludge containment at Mogden STW – 3 containment areas, with interconnection between Areas 1 and 3. This option will have a bund wall maximum height of 1.84m (inc. freeboard) in Area 2. Areas 1 and 3, will have a maximum bund height of 1.31m (inc. freeboard). Areas 2 and 3 will be vehicle accessible via ramps. Replacement of permeable surfaces will minimise clean-up time and effort. The key features of each containment area are summarised in Table 1.

Table 1 – Containment Area Summaries

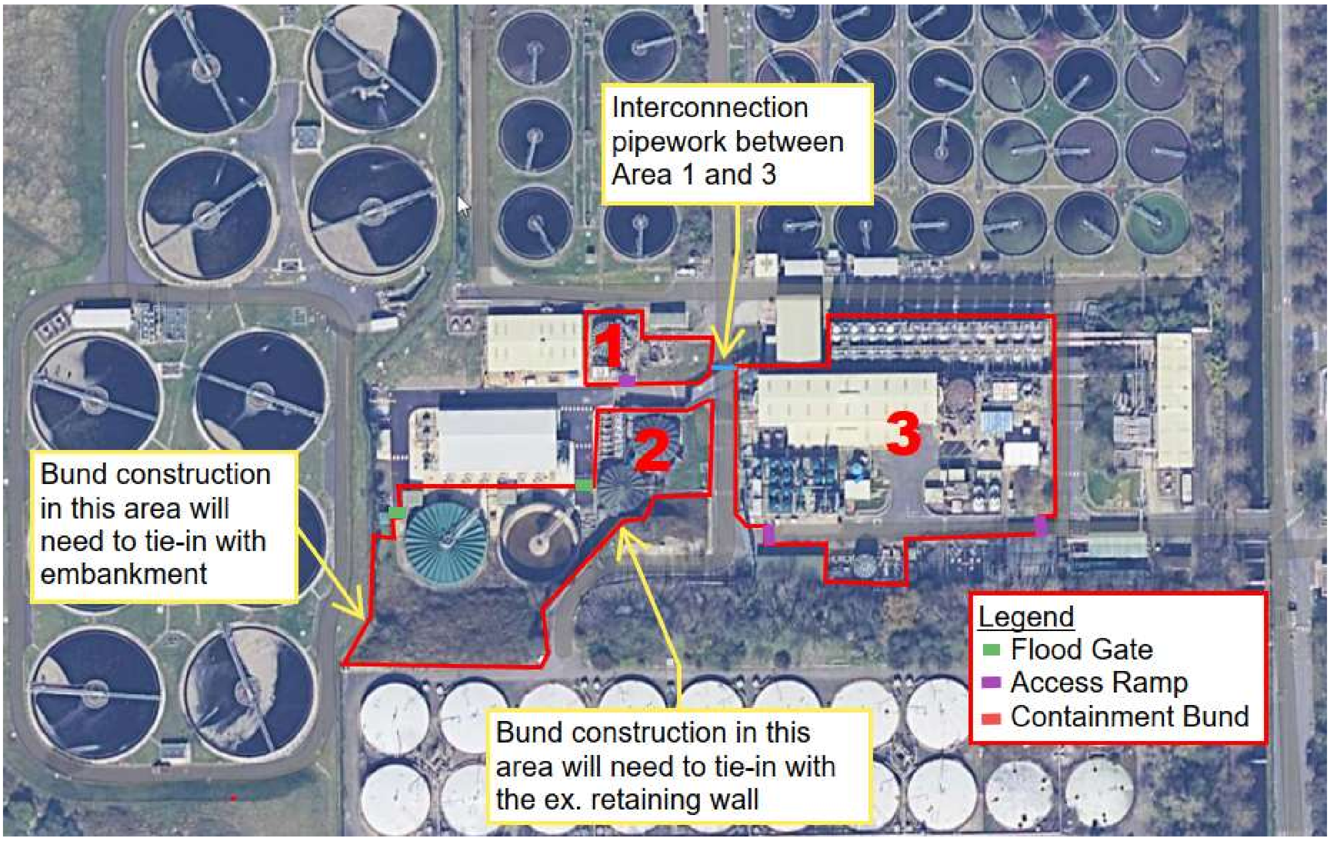
Containment Area	Description of containment
Area 1 & 3	• Close containment with the top water level of containment at 6.61mAOD, bund walls will be 1.31m at the highest point. • A transfer pipeline will convey sludge from Area 1 to Area 3 in the case of a spill. • 3 large ramps will provide access for vehicles as the area is frequently visited during the day.
Area 2	• Close containment with the top water level of 7.59mAOD, the reinforced concrete wall to be constructed will be 1.84m at its highest to contain spillage. • Access provided for infrequent vehicular access by large flood gates.

Existing gravelled and grass areas within the containment will be replaced with concrete. Elements of the site roads will be replaced/repaired to allow them to present an impermeable surface.

In addition to the containment elements, isolation of the site drainage system linked to the containment area will be required to mitigate the risk of unmanaged flows impacting the sewage treatment works.

Jetting is a risk in some locations on this site due to space constraints; notably north and west of the raw sludge holding tanks in Area 2, and south of the two southern tanks in Area 3. In the rare event that jetting occurs in these locations, in the undesirable orientation, it is expected that the tertiary site drainage will transfer the overtopped spill volume back to the head of the works.

General Layout of the Proposed Solution:


Interconnection pipework between Area 1 and 3
1
2
3
Bund construction in this area will need to tie-in with embankment
Bund construction in this area will need to tie-in with the ex. retaining wall
Legend
Flood Gate
Access Ramp
Containment Bund

2. Background

Following initial audits by the Environment Agency (EA) in 2019 that examined the primary, secondary, and tertiary containment provisions for Thames Water's anaerobic digestion (AD) process and associated tanks, the EA reported "there is no provision of secondary containment for the AD process at any of Thames Water's sites. Catastrophic tank failure may impact nearby receptors and the operation of adjacent sewage treatment activities". Jacobs was appointed to assess site risks and outline the options available for providing secondary containment of a catastrophic tank or digester failure across 25 Thames Water sites. Based on CIRIA C736 and ADBA risk assessment tools this containment report addresses the site-specific risks and outlines the options available for providing secondary containment in the event of a catastrophic tank or digester failure.

Mogden STW is located in Isleworth in West London near the Twickenham Rugby Stadium and is receiving sewage from eight boroughs in the northwest London region, refer to Figure 2-1. Mogden STW serves a population equivalent to 2,100,000 people. There are 41 active sludge storage tanks at Mogden STW within the permit areas, 18 of which are above ground and will require sludge containment under the IED.

The current assessment identified gaps between the existing conditions of the sludge assets, refer to Figure 2-2, in Mogden STW and the requirements to meet the industrial standard (i.e., CIRIA C736 and The Anaerobic Digestion and Bioresources Association Limited (ADBA)). Site-specific risks, failure scenarios and design containment volume for the Mogden STW were identified through a desktop study (Document Number: W_STC_RP_16), Light Detection and Ranging Analysis (LiDAR) analysis and a site visit.

Figure 2-1 - Satellite view of Mogden Sewage Treatment Works

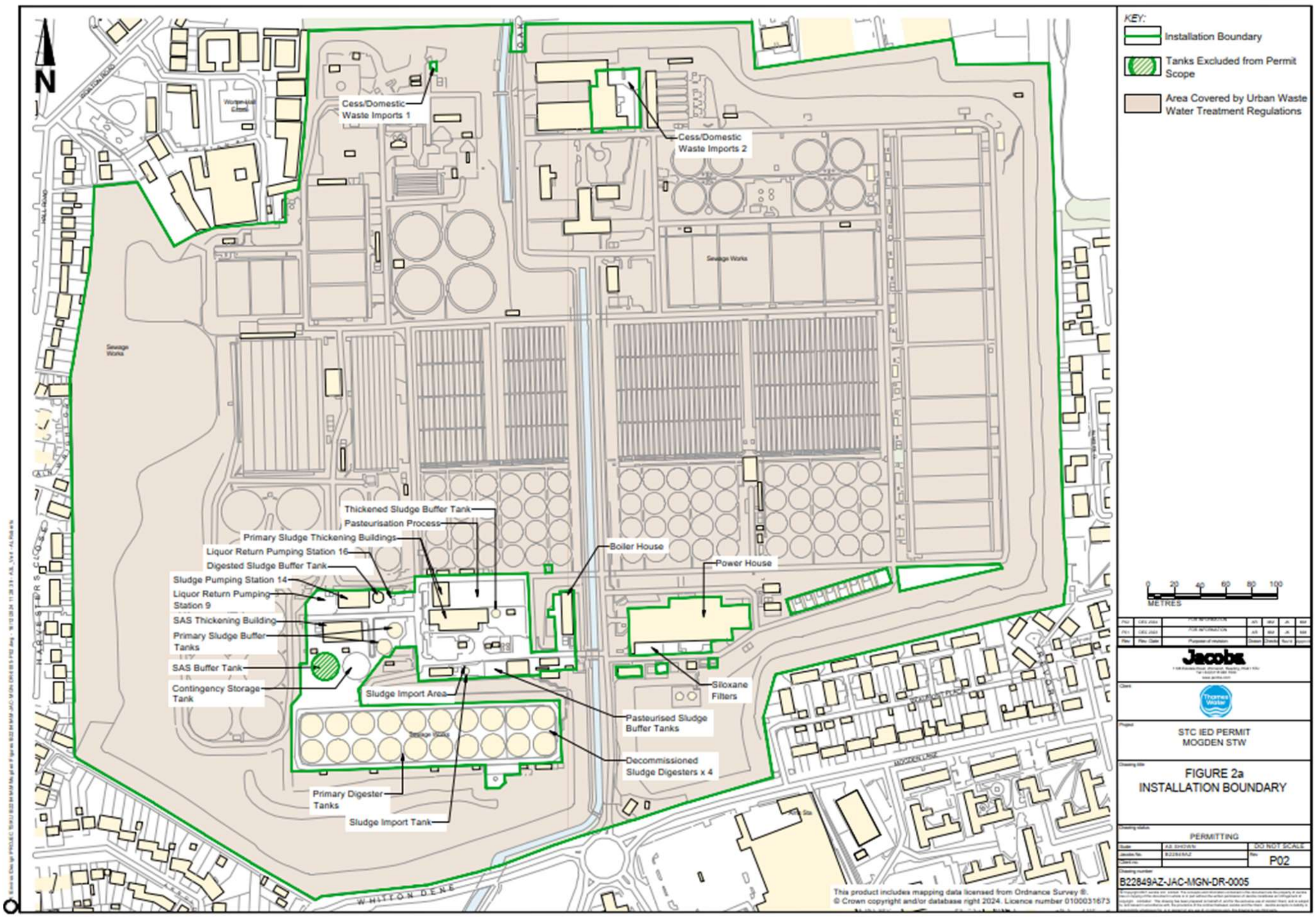


Figure 2-2 - Boundary of the permitted IED area and the assets contained within Mogden STW

3. Proposed Containment at Mogden STW

3.1 CIRIA C736

This containment option report has been prepared using CIRIA C736 as the basis of design and guidelines. Where a deviation from C736 has been recommended it is highlighted in the text.

CIRIA guidance document C736 *(Containment systems for the prevention of pollution – Secondary, tertiary, and other measures for industrial and commercial premises, 2014)* describes various options for the containment of spillages from a credible failure scenario refers to a key plan, reproduced below.

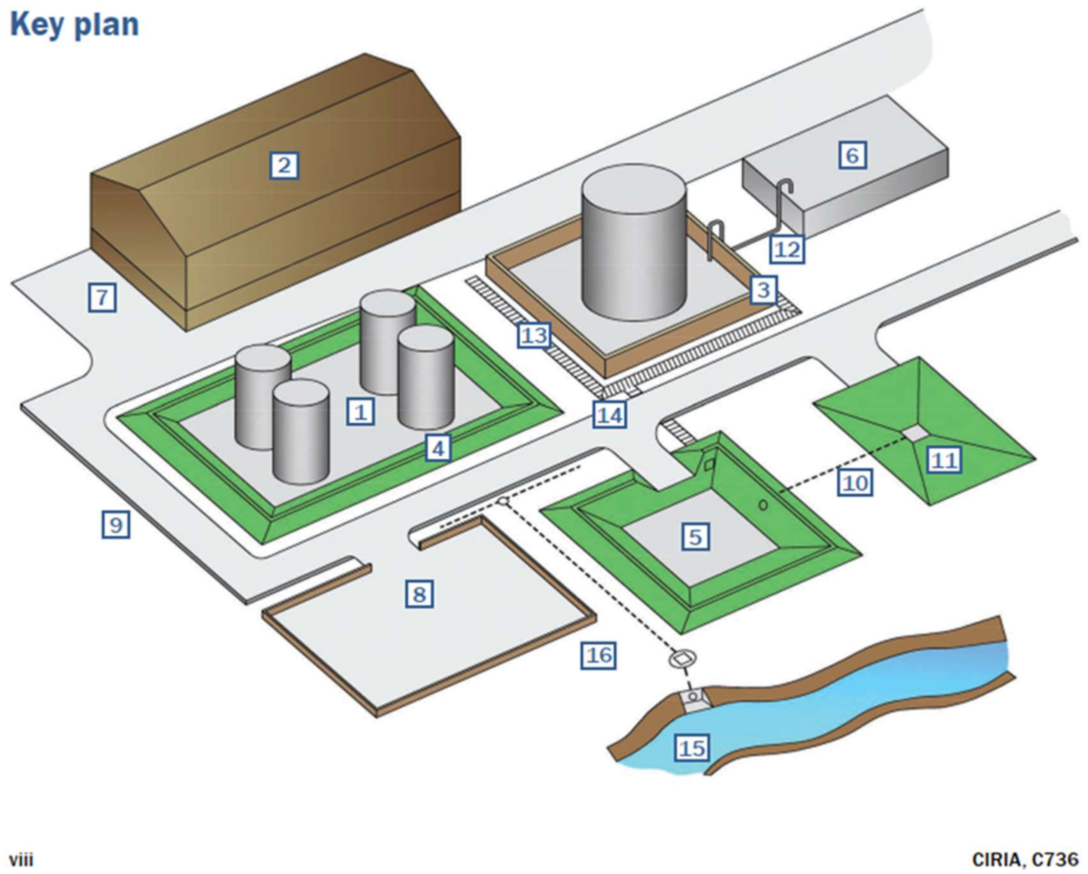


Figure 3-1 - Diagram of primary, secondary and tertiary containment examples

-**Primary containment** is provided by the actual tank or vessel [1]

-**Secondary containment** is provided by a bund immediately surrounding the primary vessel e.g. [3] and [4], or by a lagoon [5] or tank [6]. If containment is provided away from the primary vessels this is known as **remote containment** and may be considered as either **remote secondary** or **tertiary containment**.

-**Tertiary containment** can be provided by a number of means including lagoons [5], or impermeable areas such as car parks [8]. Roadways with the high kerbing of sufficient height [9] can also form part of a tertiary containment system or the **transfer system** to the remote containment.

The distinction between *remote secondary* and *tertiary* containment is not always clear but, if properly designed, a combined system can be provided that can provide the necessary degree of environmental protection. The overriding concern is not the terminology but the robustness and reliability of the system which depends on a number of factors such as;

- Its complexity – the more there is to go wrong, the greater the risk. Passive systems relying solely on gravity are more reliable than pumped.
- Whether manual intervention is relied on to make the system work or whether the system can be automated to include fail-safes and interlocks.
- The ease of maintenance and monitoring of the system's integrity, and repair of any defects.

During and after an incident any rainfall runoff from the secondary storage areas, the spillage catchment areas and the transfer systems must also be prevented from reaching any outfall(s) to surface water by closure of control valve(s).

3.2 Objectives of secondary containment

The objectives of the secondary containment measures proposed in this report are to safely contain spillages from credible failure scenarios and prevent them from:

- escaping off-site
- entering surface waters
- percolating into groundwater
- being discharged to the inlet of the sewage works in an uncontrolled manner.

As the project is retrofitting the provisions of CIRIA 736 to an existing facility, the secondary containment may seek to maximise the use of existing impermeable surfaced areas.

The interface between the contained area and existing process/site drainage return systems is managed to protect the sewage treatment works from shock loads that might otherwise arise from a tank failure.

3.2.1 Uncontained Spill modelling

Hydraulic modelling has been applied to assess the uncontained spill following a catastrophic failure of the largest digester tank within the site only (using a tank volume above ground of 2,347 m3), without any contribution from rainfall. The 2D model generated uses the TUFLOW software package (Version 2020-10-AC), which can be used for simulating depth-averaged, one and two-dimensional free-surface flows exhibited with floods and tides. TUFLOW's implicit 2D solver solves the full two-dimensional, depth-averaged, momentum and continuity equations for free-surface flow using a 2nd order semi-implicit matrix over a regular grid of square elements. Furthermore, it includes the viscosity or sub-grid scale turbulence term that other mainstream software omits.

The Digital Terrain Model (DTM) used in the model was of 1m resolution and the footprints of buildings and tanks were omitted from the model. The dimensions of the tank were used to calculate a constant flow of liquid in all directions from the circumference until it was emptied. Areas with different roughness coefficients were delineated using aerial imagery e.g., the liquid would flow more easily over roads and paths as opposed to vegetated ground. The model outputs are 2m resolution with a timestep of one second. The model was run until the liquid front was no longer moving. Default parameters were used in the simulation and the model was stable with a mass balance error below the acceptable 1%.

Figure 3-2 shows the sludge spill mapping of an uncontained event at Mogden STW. An escape in the vicinity of the digesters identified that flow is contained within the site, however, passive containment should be implemented to safeguard site operations. According to the model, the spill will reach the fullest extent of spread in approximately 1 minute following the failure of one of the digesters.

Initially, the spill will fill the Primary Digesters area. Since the topography of the area acts as a natural bund wall around the digester area, this will prevent most of the spill from spreading elsewhere on site. The only area lacking a bunding effect is in the northwest corner of the digester area. This means that in the event a of catastrophic failure of one of the digesters, some sludge could potentially spread to the SAS Buffer and Emergency Digested Sludge Holding Tanks and will eventually reach the SAS Dewatering Plant building, Sludge Transfer Buffer Tank and Pumping Station.

Figure 3-2 - Uncontained Spill Model Results

3.3 Site Classification

Based on the use of the ADBA risk assessment, considering the source, pathway and receptor risk Mogden site hazard rating is deemed to be high. When considering the mitigated likelihood as low a Class 2 secondary containment is required.

Source Risk	Pathway Risk	Receptor Risk	Site Hazard Rating	Likelihood	Overall Site Risk Rating
High	Medium	Medium	High	Low	Medium (Class 2)

Refer to Appendix 1 for a more detailed summary of the ADBA risk assessment tool.

3.4 Summary of Containment Volumes and Assets

There are 36 sludge tanks in total, 20 of which are above ground and will require containment under the IED guidelines. The assets are identified in Figure 2-2

The principal sludge holding and digestion tanks at Mogden contained within the IED-permitted area are detailed in Table 3.1.

Table 3.1 – Sludge Tanks and Volumes

Tank Purpose	Containment Area (Fig 3.3)	Number	Operational Volume (m^3)	Total Operational Volume (m^3)	Material	Below/ Above/ Partially in ground
Primary Sludge Buffer Tanks	2	2	1,505	3,010	Steel	Above
Sludge Import Tank	3	1	331	331	Steel	Above
Thickened Sludge Buffer Tank	3	1	320	320	Steel	Above
Pasteurisation Tanks	3	12	200	2,400	Steel	Above
Pasteurised Sludge Buffer Tanks	3	2	150	300	Steel	Above
Primary Digester Tanks	N/A	16	4,125	66,000	Concrete	Below
Digested Sludge Buffer Tank	1	1	520	520	Steel	Above
Contingency Storage Tank	2	1	1957	1,957	Steel	Above

Notes:
The Primary Digester Tanks have no above ground storage; these tanks are not included within containment solution.

Contingency Storage Tank volume not included as this tank is normally empty and only used for emergencies.

3.5 Containment Option 1

The proposed option for containment at this site involves three bunded containment areas, with Areas 1 and 3 connected to allow a practical bund height in the restricted footprint of Area 1, refer to Figure 3-3.

Several (5) other variations of bund alignments were modelled, but ultimately, Option 1 is the only solution that was modelled that demonstrated practical wall heights that meet operational safety requirements. For this reason, the critical spill volumes and modelling figures throughout the remainder of the report relate to Option1 only.

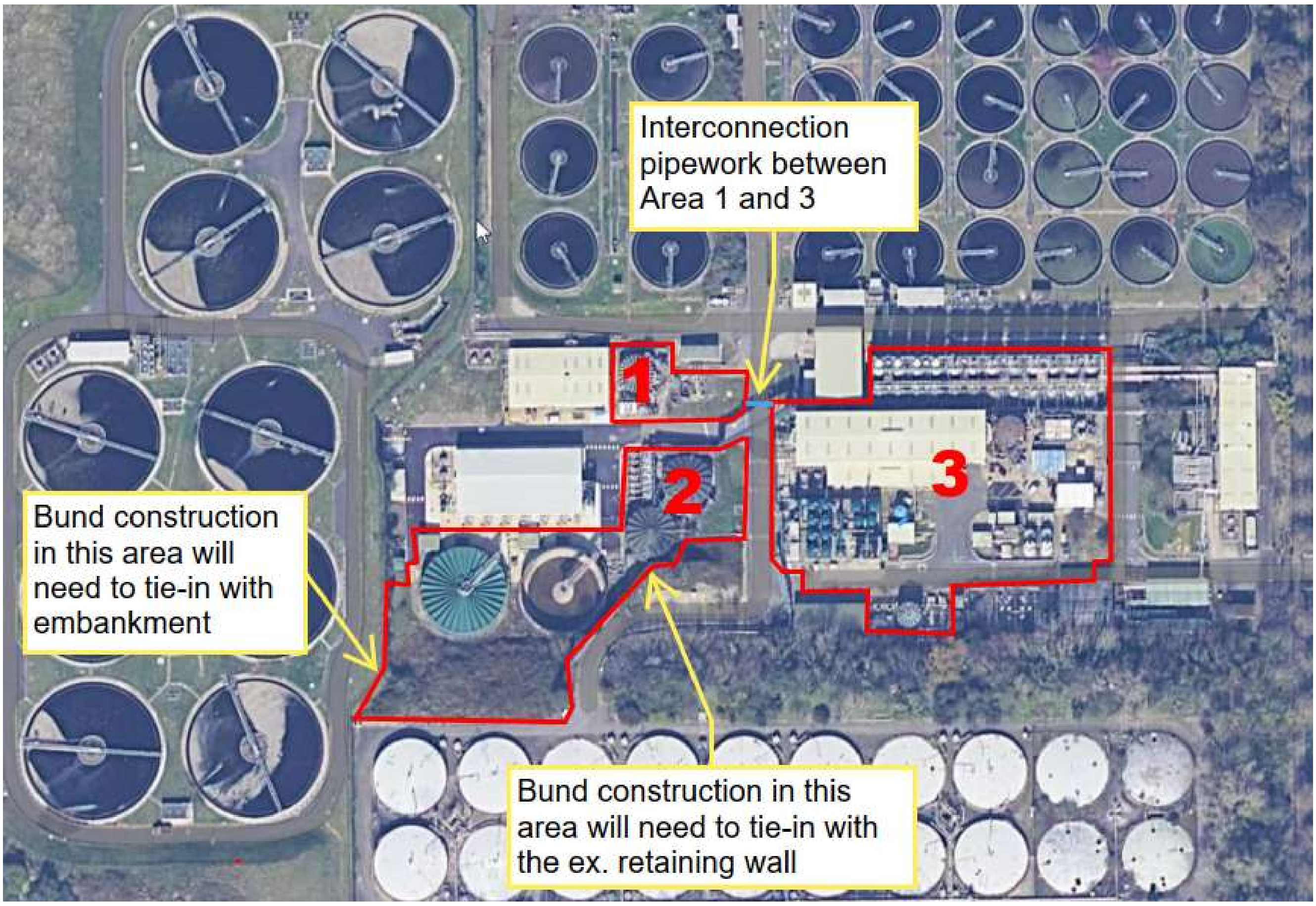


Figure 3-3 – Option 1 Containment Area

3.6 Total Spill Volumes

For each containment area, the containment volume has been checked against the largest tank + rainfall, the 110% and 25% rule and for each, the largest tank + rainfall applies.

Table 3.2- Estimating critical spill volumes

Containment Area	25% Scenario (m^3)	110% Scenario (m^3)	Largest Tank + Rainfall Scenario (m^3)	Critical Spill Volume (m^3)
Area 1 and 3 (Interconnected)	738	572	1230	1230
Area 2	753	1656	2051	2051

3.7 Constrained Spill Modelling

Modelling outputs for the three containment areas in Option 1 have been generated.

For Areas 1 and 3, the containment areas have been modelled together, with an open channel in between to represent a gravity connection pipe. The top water level (spill height), seen in Figure 3-4 is 6.36 m AOD. This represents a maximum water depth of 0.36m in Area 1, the majority of spill volume is contained in Area 3.

Figure 3-5, shows the different spill scenarios for Areas 1 and 3, notably that in a smaller spill event (50% or less of the critical spill volume) the majority of sludge will be contained entirely within Area 2.

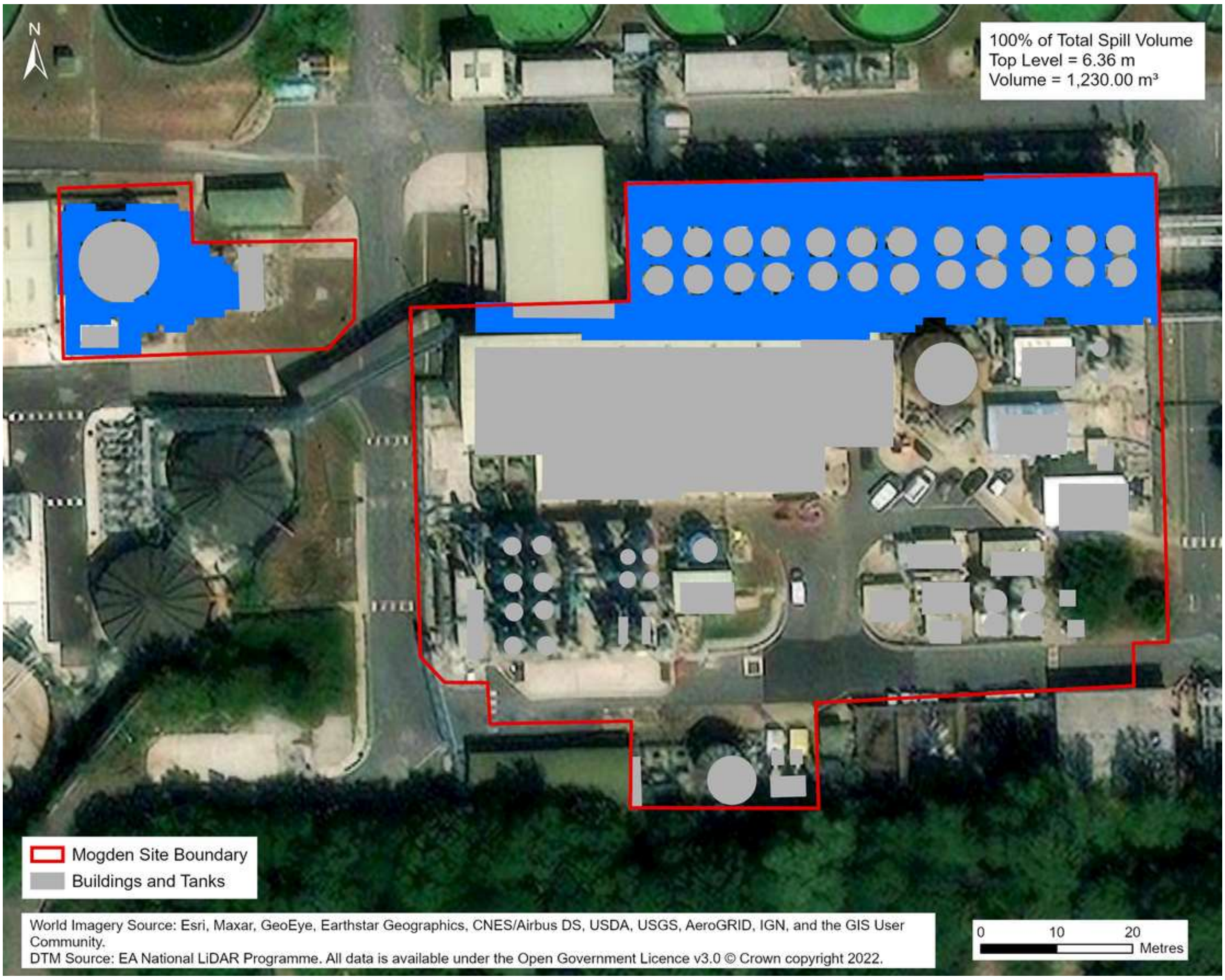


Figure 3-4 – Interconnected Area 1 and 3 Mogden 100% Contained Model

Figure 3-5 – Interconnected Area 1 and Area 3 Contained Spill Modelling

For Area 2, the Top level (spill height), seen in Figure 3-6 is 7.34 m AOD. This represents a water depth of up to 1.57m in the far north-western corner of the bund due to the topography of the area.

Figure 3-7, shows the different spill scenarios for Area 2, due to the topography of the area the depth of the spill is the driving change rather than the footprint of the area.

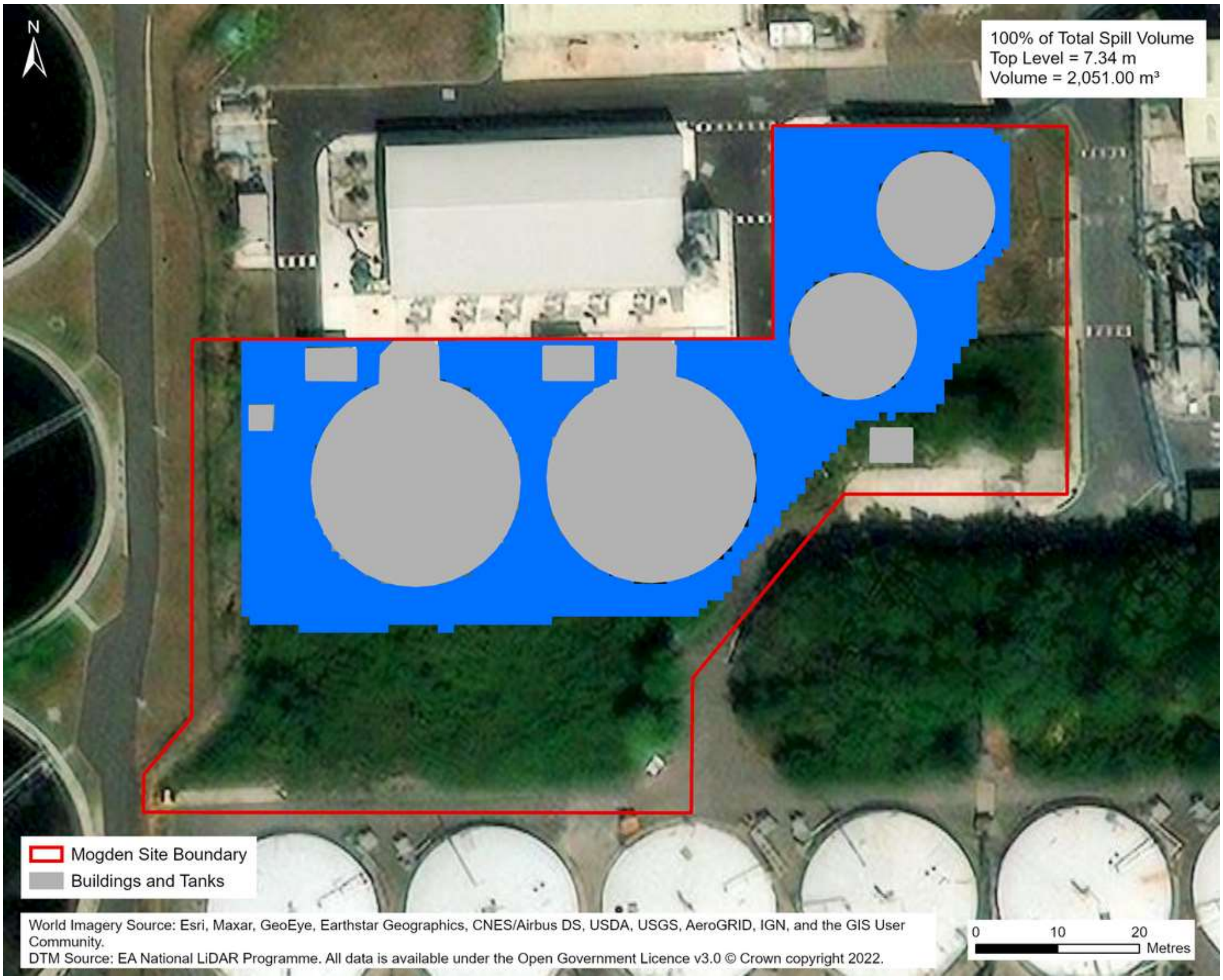


Figure 3-6 – Area 2 Mogden 100% Contained Model

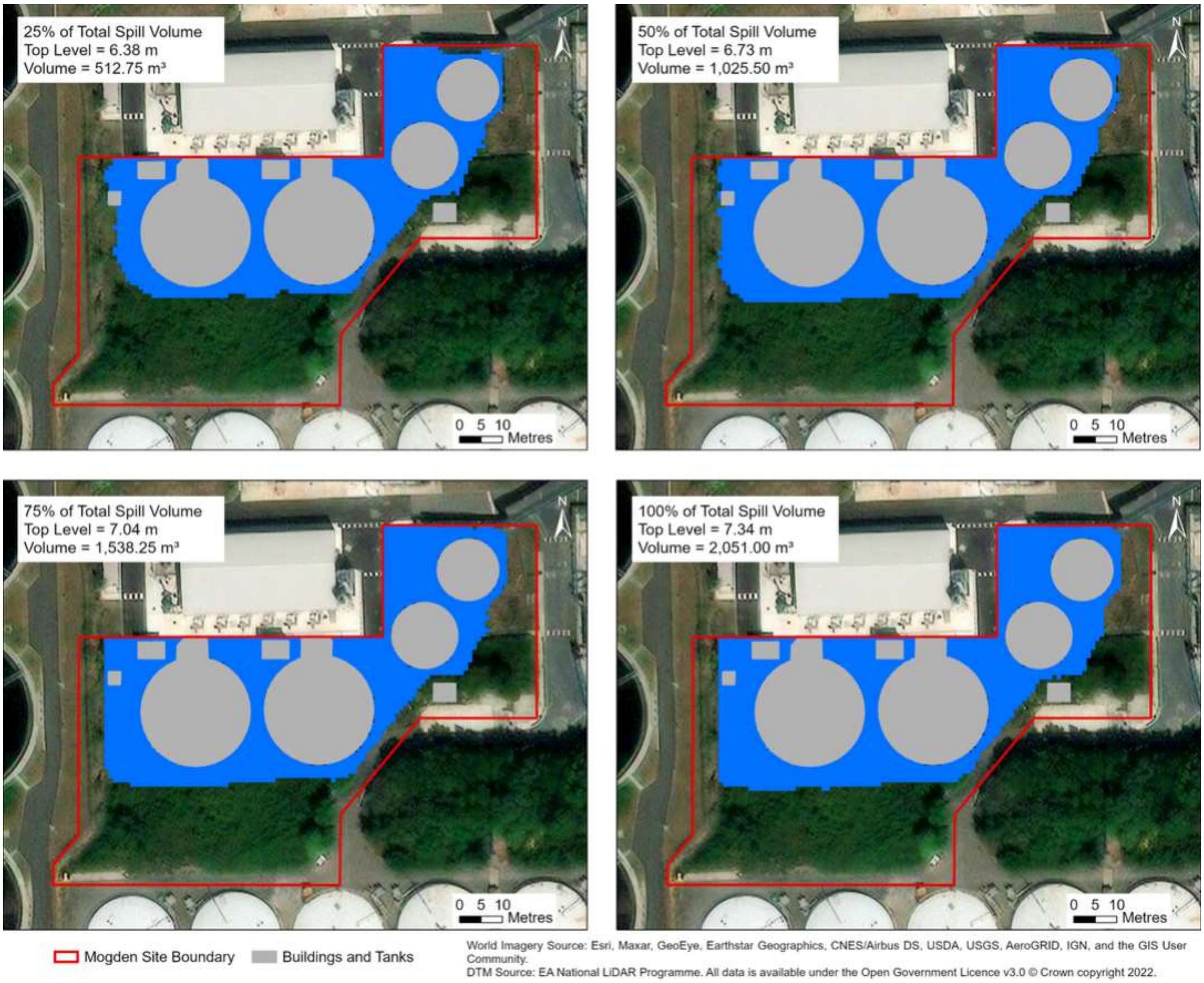


Figure 3-7 - Area 2 Contained Spill Modelling

3.8 Site Topography

Mogden Sewage Treatment Works is surrounded by ground up to 10-15m higher than the site which hides its existence from its surrounding environment, these raised bunds should prevent any spillage from reaching the residential areas surrounding the STW. A public footpath and culverted channel run through the centre of the site.

Considering the topography of the sludge area, the Primary Digesters are positioned on higher ground than the Final Settlement Tanks and the Duke of Northumberland River. All the digesters are semi-submerged underground. Surrounding the area of the digesters are thick walls with a gap in the northwest corner just south of the SAS Buffer tank and the Emergency Digested Sludge Holding Tank. In the event of catastrophic failure from one of the tanks, these walls would act as bunding to prevent the flow from leaving the digester area. However, the large gap in the northwest corner of the digester area could allow sludge to spread towards other areas within the site.

The paths and internal roads in Mogden STW are concreted, however, it is observed that the area is surrounded by vegetation which could be potentially impacted in the event of an uncontained release of sludge either by seeping into a medium-high or medium-low groundwater vulnerability risk (Source: Magic Maps) on the western side of the site (Figure 3-8).

The contours for Area 1 and 3, and Area 2 are shown in Figure 3-9 and Figure 3-10, respectively.

Figure 3-8 - Digital Terrain Model of Mogden Sewage Treatment Works

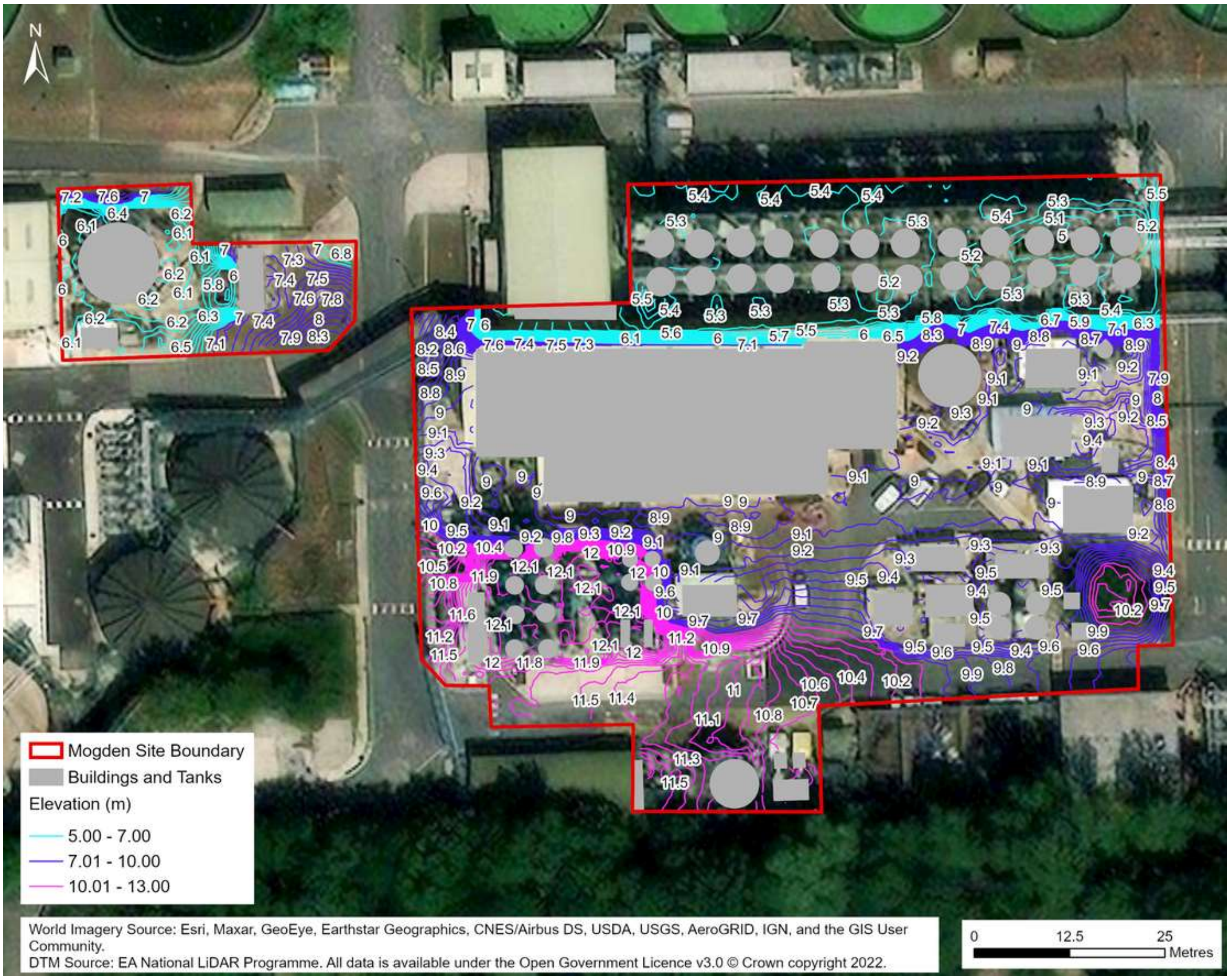


Figure 3-9 – Contour Plot for Interconnected Areas 1 and 3

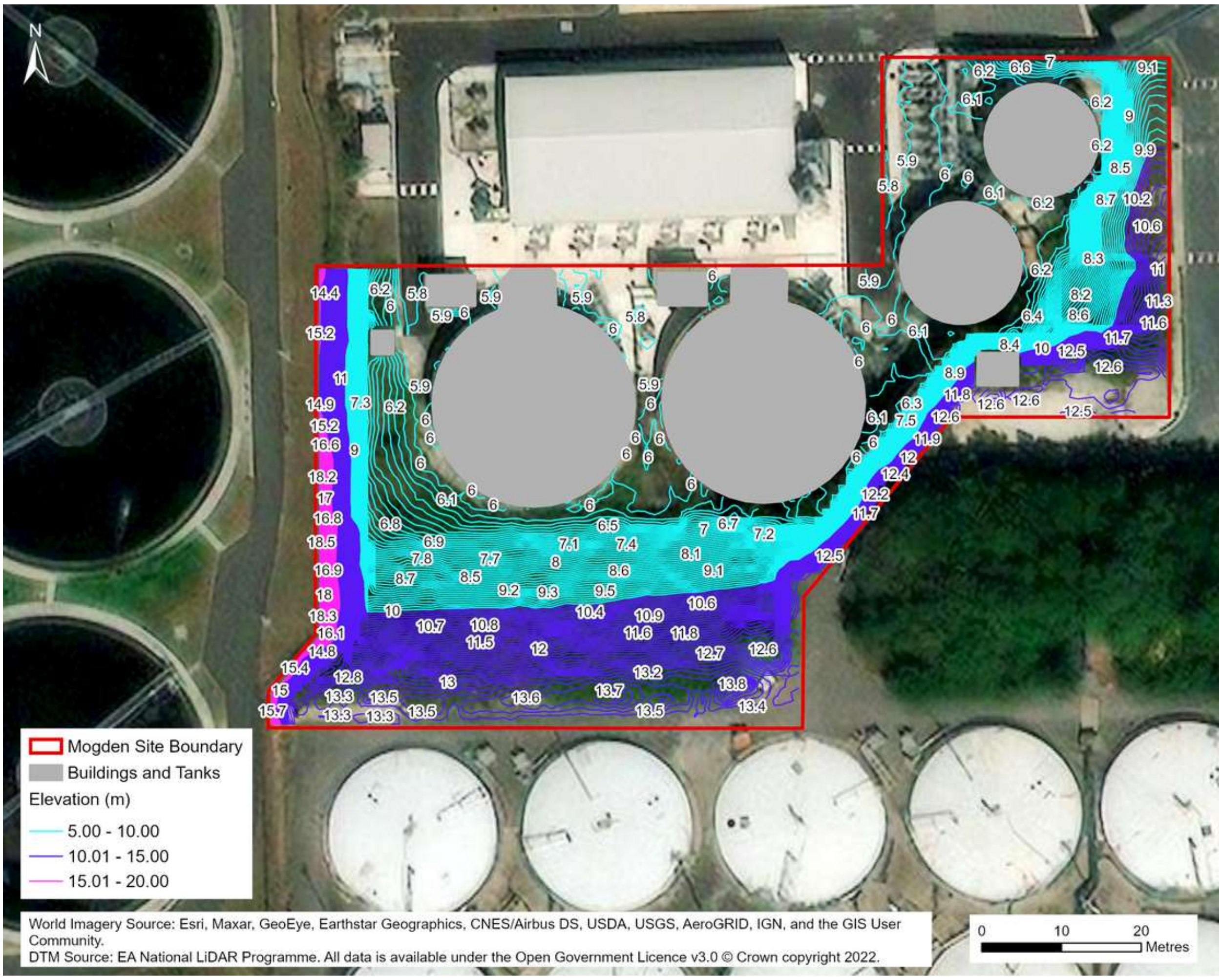


Figure 3-10 – Contour Plot for Area 2

3.9 Operational constraints

3.9.1 Clean-up time

The time to recovery and return site back to operation has been set at 3 days following direction by Thames Water. The containment volume, when not dictated by the 110% or 25% containment rules allows for three days of rain during the recovery period and one day of rain immediately preceding an event.

3.9.2 Surface cleaning

The existing ground surfaces around the sludge treatment tanks consist mainly of grass and gravel that will need to be replaced with an impermeable surface, such as concrete, to facilitate the clean-up. The impermeable surface will be gently sloped to aid with the sludge spill flow path towards the drainage network.

It is noted that concreting these areas may slow emergency access to underground surfaces and there is a trade-off between the advantages of digging up existing surfaces (in grass or gravel) vs. decreasing the clean-up effort required in the event of a sludge spill.

Whilst the site is identified as requiring Class 2 containment (impermeable soil with a liner and leakage detection system), the proposed solution is intending to use concrete (with no liner) based on the permeability of the concrete, inherent strength, and long-term mechanical resistance. Remedial works to existing concrete slabs/roads will be undertaken to ensure that they provide a competent surface, for example resealing of joints.

3.9.3 Access and Traffic Thoroughfare

Vehicular access through the flow-guiding walls will be via ramps (speed humps) restricted to nominal 250 mm in height and 1:15 slope, these have been incorporated into Areas 1 and 3.

Flood gates have been included at the proposed entry points into Area 2, refer to Figure 3-11.

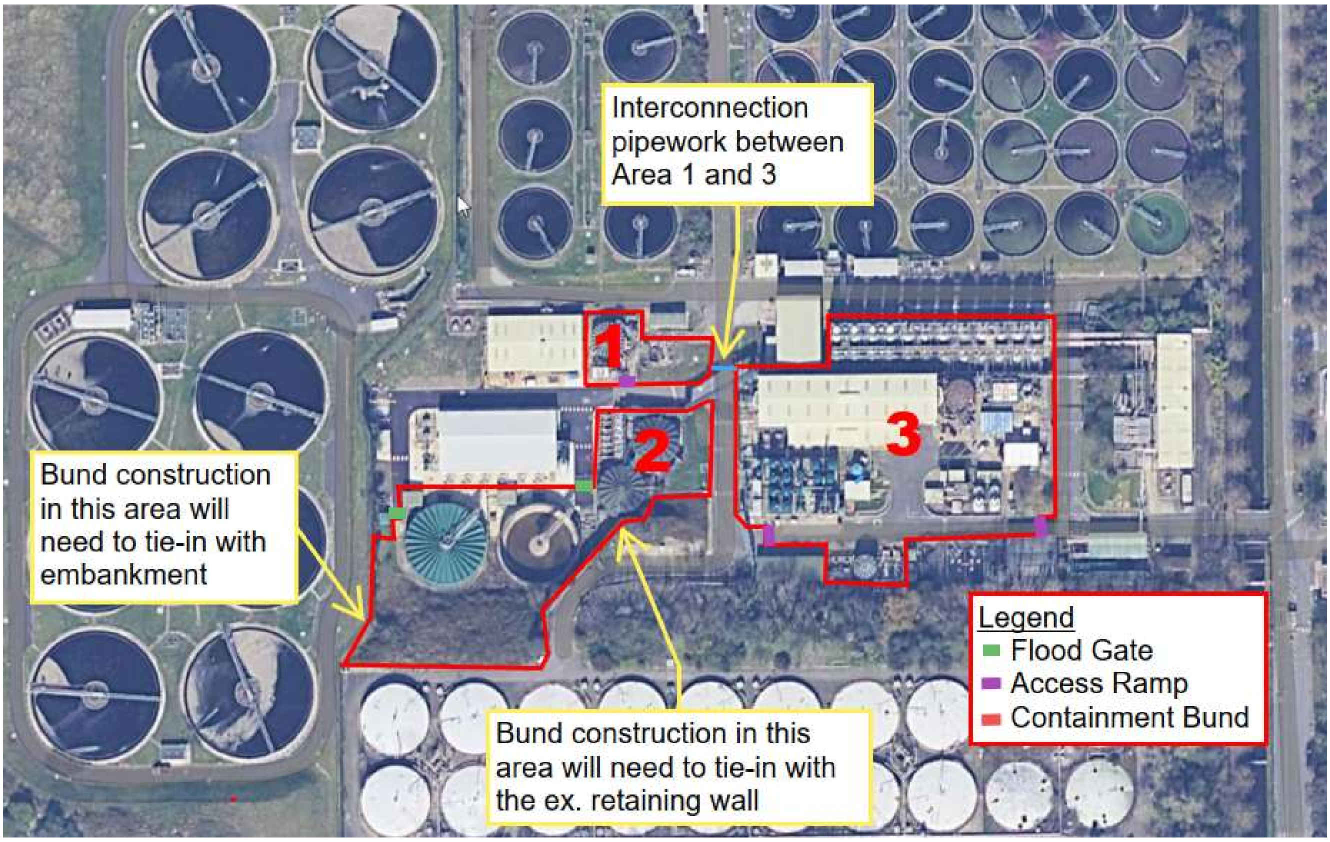


Figure 3-11 – Option 1 Access Points

3.10 Geotechnical and Environmental constraints

The construction of the bund wall in Area 2 will need to tie in with the existing retaining wall and steep embankments. Concrete lining this area and the embankment will be difficult and likely require some structural design and landscaping. Biodiversity in this area will be reduced as the grassy embankment will be concreted.

Some vegetation removal is expected on the southern bund length of Area 3 due to space constraints.

3.11 Other constraints

Due to the brownfield nature and lack of open space of the Basingstoke treatment site, several existing assets will need to be established or modified to install the proposed bund arrangements, notably:

- Several above-ground pipes can be seen from aerial images which may need to be relocated (temporary or permanent) during the construction of the bund wall. Notably, the pipework in Area 3 between the Raw Sludge dewatering building needs to be assessed for relocation and the ability to co-exist with the bund wall alignment in this area.

- The connecting gravity pipework between Areas 1 and 3 will need to be pipe jacked underneath the built-up site access road.

3.12 Design allowance for rainfall

In addition to the maximum volume arising from a credible failure scenario, extra allowance for rainfall that may accumulate within the contained area before and after an incident has been made. The CIRIA guidance recommends that the containment volume should include an allowance for the total rainfall accumulated in response to a 1 in 10-year return period events for the 24 hours preceding the incident and for the duration of the incident, a three-day period in this case. The rainfall allowance is some 72 mm based upon the Flood Estimating Handbook.

4. Secondary Containment

The constituent parts of secondary containment are;

- The contained area itself.
- The transfer system.
- Isolation of the drainage from both the contained area and from the transfer system.

For Mogden, where possible, existing features of the site (e.g. suitable structures and impermeable surfaces) are used as much as possible to provide the secondary containment to reduce cost. The options considered, modifications and their functionality at Mogden STW are listed below:

- Bund/walls to contain liquid. The heights of bund/walls are the minimum heights required such that the top of the bund/wall is equal to the top water level plus a 250mm freeboard consideration for potential surge (to reflect the planned use of concrete walls with a recurved profile to return flow on itself) by CIRIA. Containment ramps provide a barrier for the liquid on roads that still need to be accessible to vehicles for site operation. The maximum height of these will be 250mm to avoid issues with vehicle passage. The risk of the spill at the ramps is mitigated by conveyance of the flow to site drainage and return to the head of the works.
- Interconnection of Area 1 and 3 to optimise the bund wall height of Area 3 to a practical height.

4.1 Bund Wall Height

The maximum and minimum bund wall heights have been calculated and are shown in Table 4.1. Note that the bund height in Area 1 is up to 1.84m in the north-western corner of the site – this could be reduced/evened out if this area of the site is degraded to avoid a relatively high water/sludge spill depth.

Spot height maps for Areas 1 and 3, and Area 2 are shown in Figure 4-2 and Figure 4-2.

Table 4.1– Summary of Bund Wall Heights

Containment Area	Final Spill Height, Top Water Level (TWL) (mAOD)	Typical Spot Mapping Height (mAOD)	Typical Containment Wall Height (TWL +. Freeboard) (mAOD)	Typical Bund Wall Height inc. freeboard (m)
Area 1 and 3 (Interconnected)	6.36	6.20	6.61	0.41
Area 2	7.34	6.10	7.59	1.49 m

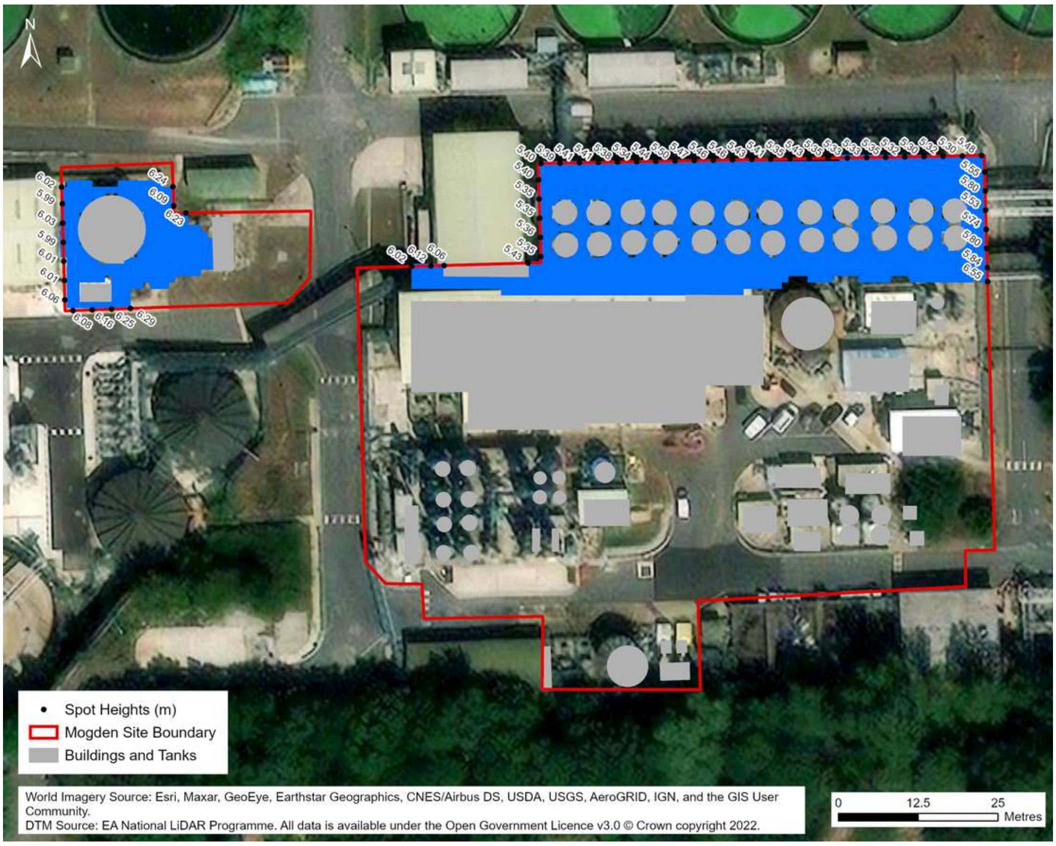


Figure 4-1 – Interconnected Area 1 and 3 Spot Height Mapping

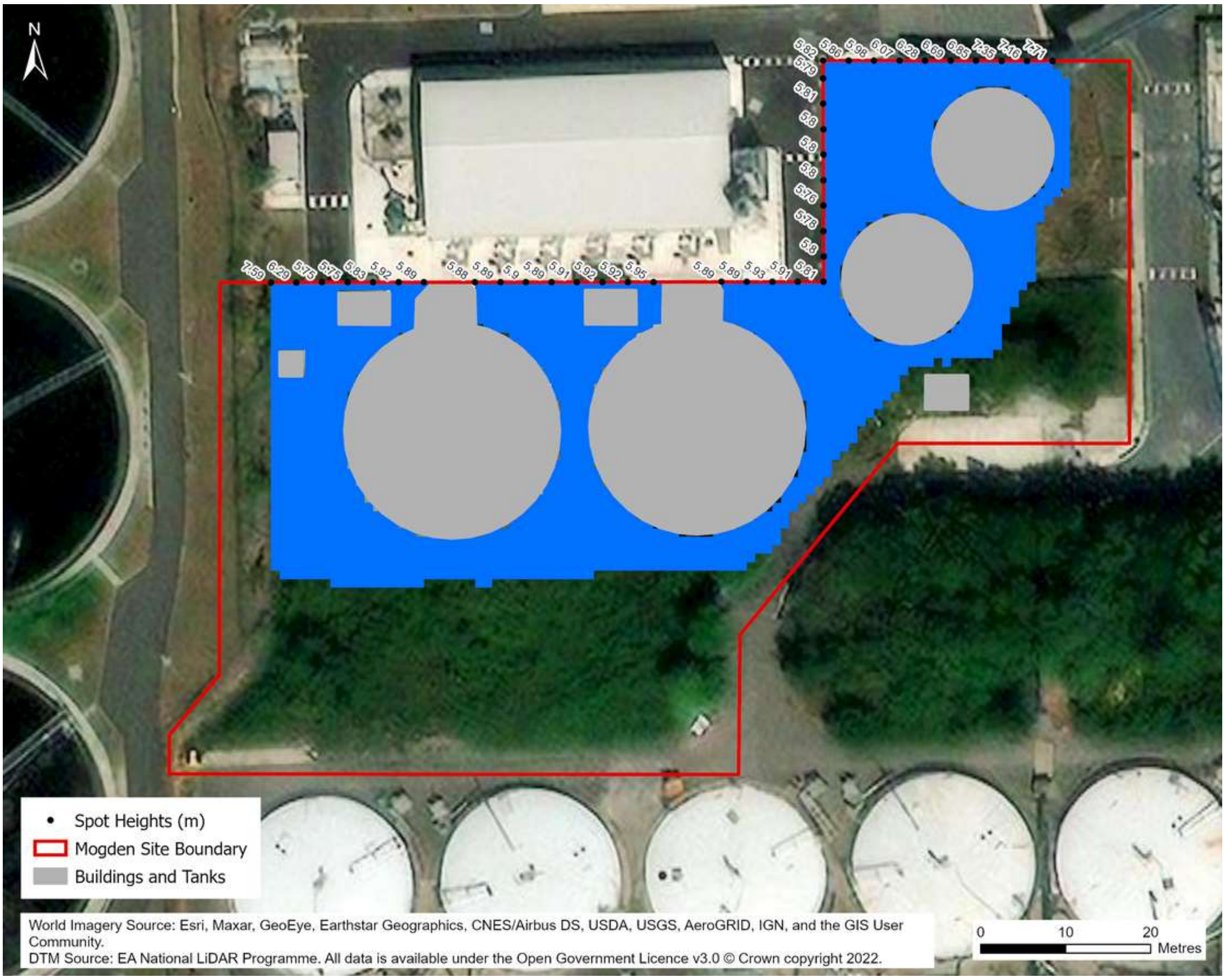


Figure 4-2 – Area 2 Mogden Spot Height Mapping

4.2 Mitigation of Site-Specific Risks

4.2.1 Jetting and Surge Flows

Surge effects have been mitigated by the bund profile (recurved to return flows on itself) and the distance of the bund wall to the tanks.

Jetting is a risk in some locations on this site due to space constraints; notably north and west of the raw sludge holding tanks in Area 2, and south of the two southern tanks in Area 3. In the rare event that jetting occurs in these locations, in the undesirable orientation, it is expected that the tertiary site drainage will transfer the overtopped spill volume back to the head of the works.

4.2.2 Flooding

According to the UK Government's Flood Map for Planning, the sludge and digester area is within Flood Zone 1, as shown in Figure 4-3. The Flood Zone definitions listed in Appendix A provide additional detail of the areas of concern, which in the case of Mogden STW, should be less than 1 in 1000 annual probability of the site flooding.

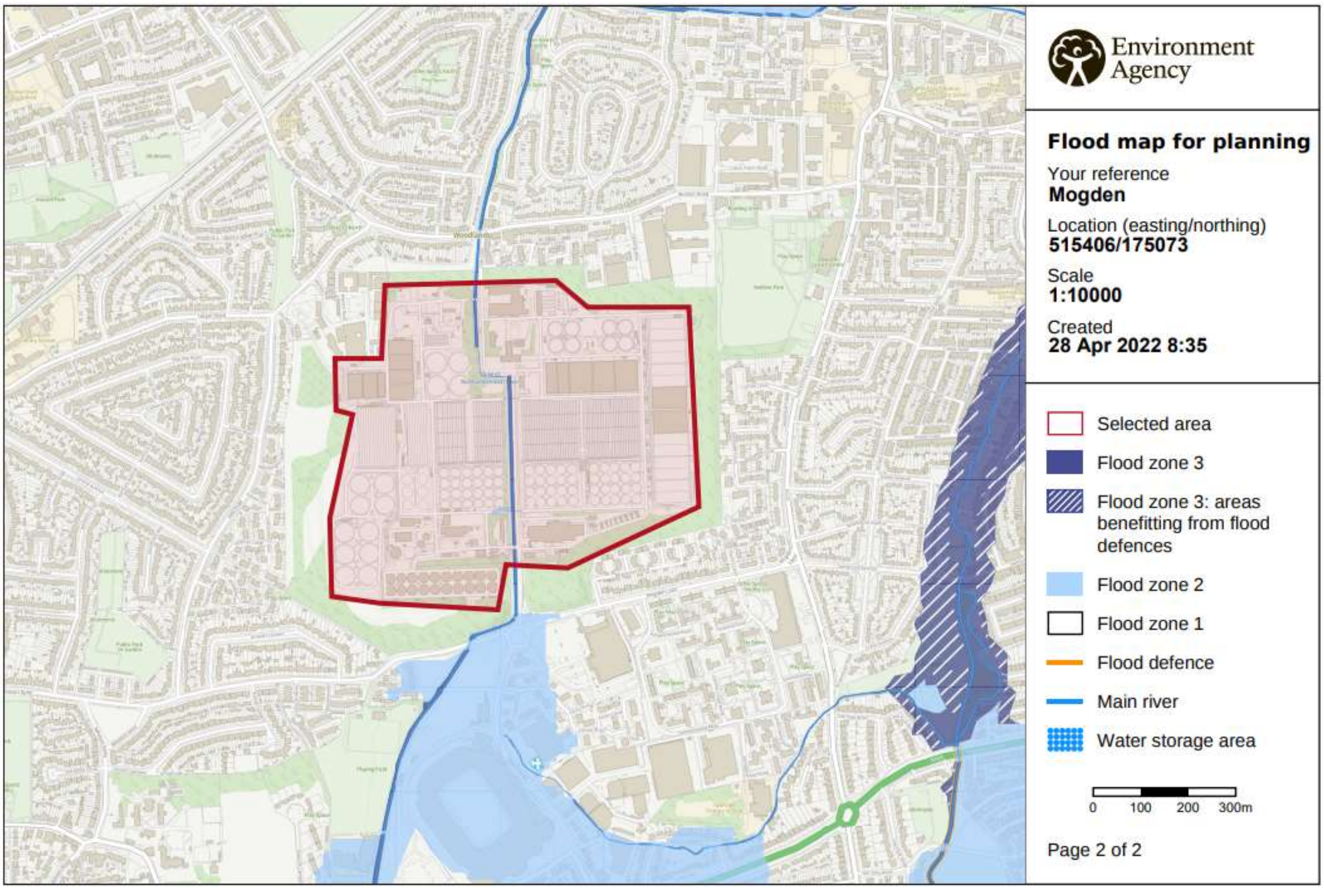


Figure 4-3- Extent of Fluvial flooding in Mogden due to extreme weather events

4.3 Potential issues for solution detail (Inc H&S)

- Construction of the bund in Area 2 will require a tie-in with the existing retaining wall and steep embankment.
- Difficult constructability access for the concrete lining required for the embankment in Area 2 and Area 1.
- To aid spill clean-up impervious areas within the wide containment area are proposed to be replaced with concrete. This will have long terms implications for maintenance and emergency access to underground services.
- Area 2 in the critical spill scenario will have a water depth of up to 1.57m in the far north-western corner of the bund due to the topography of the area. This is relatively high and could be minimised/evened out via reprofiling of the northwest corner.

5. Site Drainage and liquor return

A copy of the Process Flow Diagram is held in Figure 5-1.

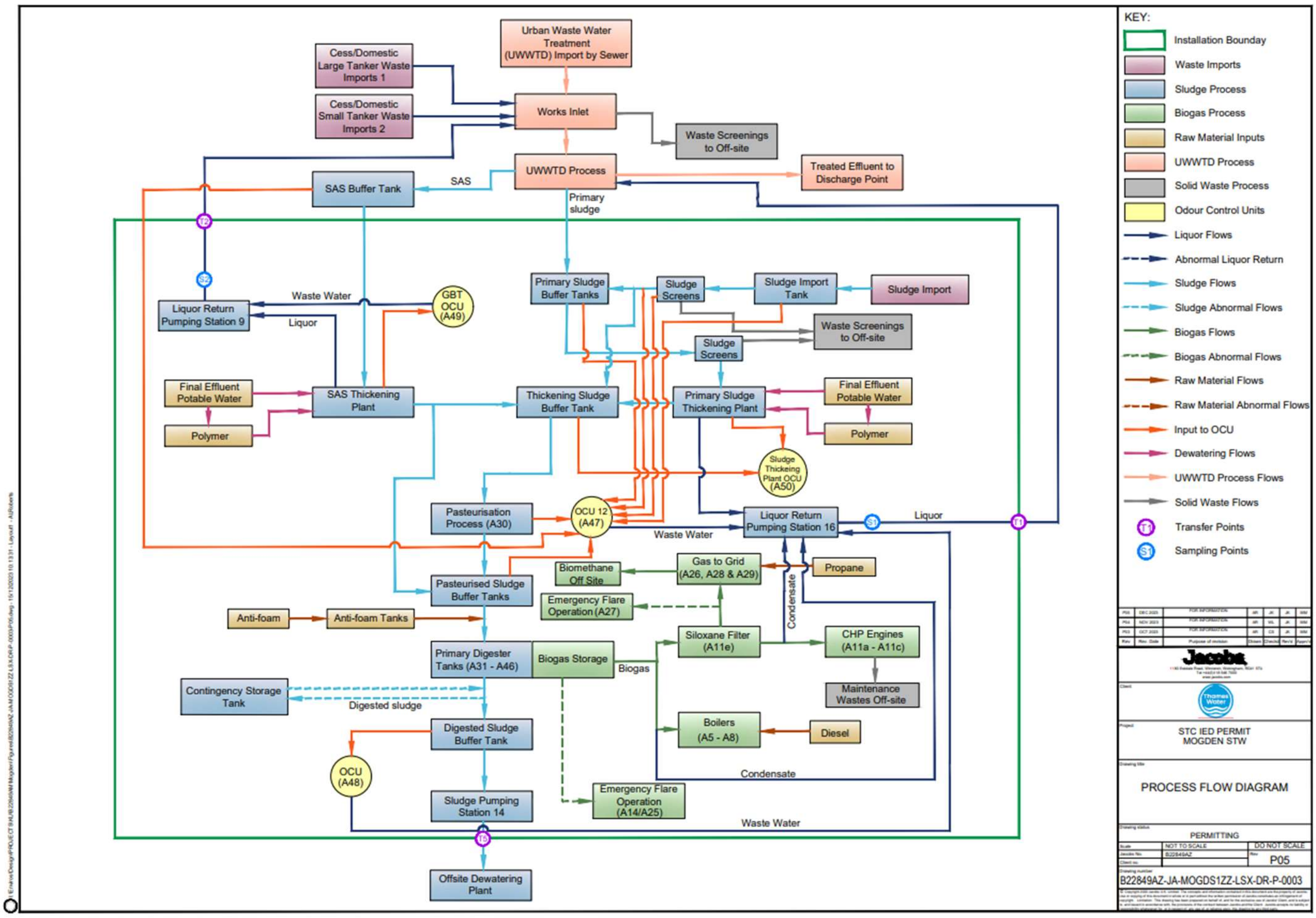


Figure 5-1 – Process Flow Diagram

5.1 Foul, Process and Effluent Drainage

Site drainage assessments are based on Mogden Sewage Works Layout Plan Drawing Numbers MOGDS1ZZ-DPL-001 & 002, last updated in 2020, refer to Figure 5-2. The Sewage Works Layout Plan for Mogden shows some surface water drainage lines within the containment boundary but seems to be incomplete, especially around the digestion tanks, pre-thickening tanks and the raw sludge dewatering buildings. In the operating manual, it is stated that all surface water drainage returns to the head of the works. However, site operatives suggest that it is closer to 95% with some road run-off, particularly in front of the security gate that goes directly to surface water. There is currently a drainage survey underway to confirm existing drainage pathways around the sludge treatment works.

In the event of sludge entering the head of the works, the shock load could adversely impact the sewage works treatment process. Therefore, in the event of a catastrophic loss of containment, this line should be isolated, or pumping should be inhibited to allow operations to manage the use of the available treatment capacity. For this site, the entire proposed containment area drains to the head of the work via several different pipes. Meaning a manual isolation valve that would need to be installed on each of the connecting drainpipes, to enable operators to isolate the affected drainage line in the event of a significant sludge spill that has the potential to overwhelm the head of the works.

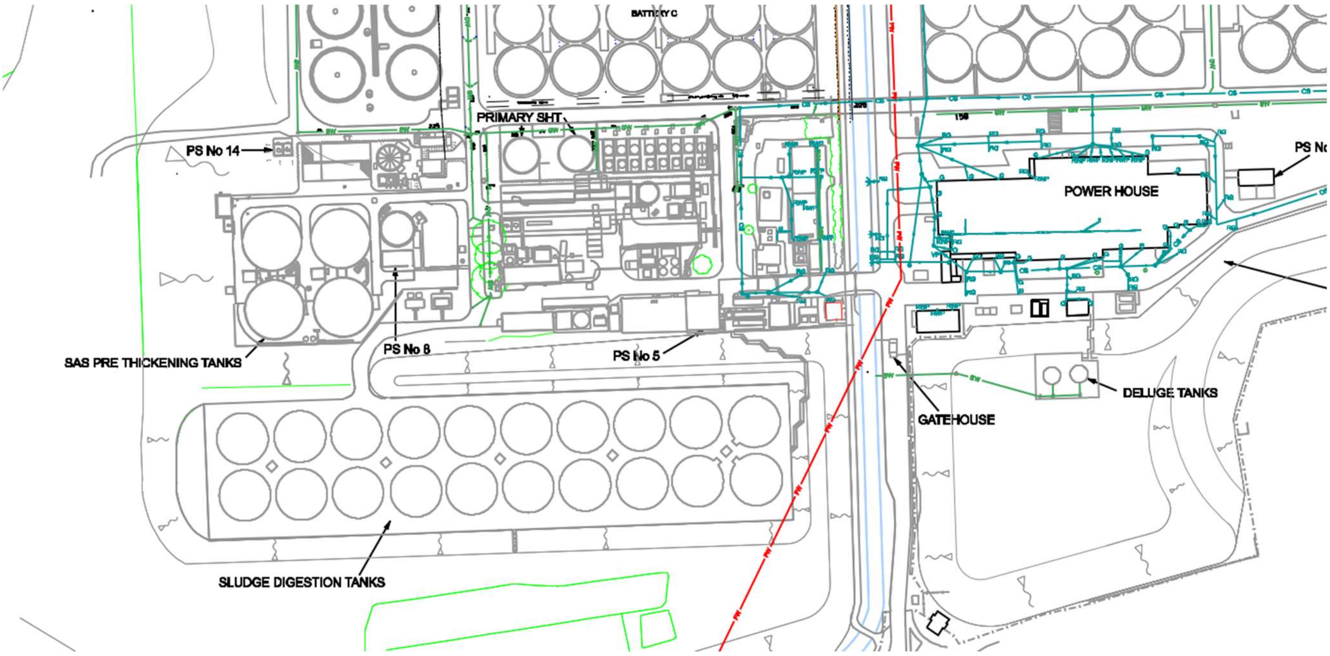


Figure 5-2- Sludge area drainage

5.2 Automatic Isolation Valves – Site Drainage and Tanks

For the catastrophic loss of containment scenarios for the Digester area discussed, such a loss could be automatically detected by the level sensors in the tanks. A catastrophic failure would be identified by the rate of change in tank level being larger than expected at normal operation. The signal from the sensors would be used to generate an alarm.

In the event of a catastrophic sludge spill, flows entering the head of the works via the drainage pipes could adversely impact the sewage works treatment process. Therefore, in the event of a catastrophic loss of containment, this line should be isolated.

It is recommended that float-operated isolation valves are installed on all outgoing drainage lines from the containment area. These valves will remain normally open but will close when high levels in the existing drainage system are encountered. This drainage configuration will have the following impacts:

- In heavy or intense rain events these drainage isolation valves may be triggered, and operators onsite will need to manual operate these valves to release flows into the existing drainage network.
- In minor or slow-flow tank spill events, the sludge spill will flow into the existing drainage network (and into the head of the works) unless operators intervene to isolate the drainage networks. Due to the flow to full treatment at Mogden being large, minor spill flows will not adversely impact the process.
- In most locations, to accommodate the new isolation valves, new manholes need to be constructed over the existing drainage lines.

6. Conclusions

This section summarises the findings of the containment assessment options report for Mogden STW.

Based upon the Anaerobic Digestion Bioresources Association (ADBA) containment assessment tool; the site carries an overall site risk rating of Medium meaning that Class 2 containment is needed.

This assessment focuses on site-specific risks and outlines the options available for providing secondary containment of a catastrophic tank or digester failure.

One option was developed in detail for sludge containment at Mogden STW – 3 containment areas, with interconnection between Areas 1 and 3. This option will have a bund wall maximum height of 1.84m (inc. freeboard) in Area 2. Areas 1 and 3 will have a maximum bund height of 1.31m. 2 and 3 will be vehicle accessible via ramps. Replacement of permeable surfaces will minimise clean-up time and effort. The key features of each containment area are summarised in table 6-1.

Table 6.1 – Containment Area Summaries

Containment Area	Description of containment
Area 1 & 3	• Close containment with the top water level of at 6.61mAOD, bund walls will be 1.31m at the highest point. • A transfer pipeline will convey sludge from areas 1 to area 3 in the case of a spill. • 3 large ramps will provide access for vehicles as the area is frequently visited during the day.
Area 2	• Close containment with the top water level of 7.59mAOD, the reinforced concrete wall to be constructed will be 1.84m at the highest point. • Access provided for infrequent vehicular access by large flood gates.

Existing gravelled and grass areas within the containment will be replaced with concrete.

In addition to the containment elements, isolation of the site drainage system linked to the containment area will be required to mitigate the risk of unmanaged flows impacting the sewage treatment works.

Jetting is a risk in some locations on this site due to space constraints; notably north and west of the raw sludge holding tanks in Area 2, and south of the two southern tanks in Area 3. In the rare event that jetting occurs in these locations, in the undesirable orientation, it is expected that the tertiary site drainage will transfer the overtopped spill volume back to the head of the works.

Appendix 1 - ADBA Site Hazard Risk Assessment Summary for Mogden STW

ADBA Industry Guide and CIRIA C736 state how the site hazard rating and, the site risk and classification are to be calculated. A summary of the hazard risks for Mogden STW are as follows:

Source – Two sources have been identified:

1. Domestic and trade effluent Wastewater sludges, both in a raw, semi-treated and treated state.
2. Polyelectrolyte chemicals for sludge thickening.

The Source Hazard rating was determined as **High**.

Pathway – Two pathways have been identified:

1. The process and site drain take any liquid to the head of the works which could negatively impact the process stability on site eventually impacting the receiving watercourse.
2. The site inventory has a runoff time of 5 minutes when uncontained.

Consequently, the Pathway Hazard rating was determined as **Medium**.

Receptor – There are six potential receptors which have been identified:

1. The site drainage system and the head of the works.
2. There is a "medium-high" and "medium-low" groundwater vulnerability within the site boundary to the west of the digesters.
3. The habitation of large populaces nearby, the nearest of which is to the south and west.
4. The Duke of Northumberland River passes through the site, at a lower elevation than the rest of Mogden STW. The river has a rating of flood zone 3.
5. Tesco, a supermarket to the south.
6. Worton Hall industrial/commercial estate to the west.

The Receptor Hazard rating was determined as **Medium**.

Likelihood – For this assessment, the likelihood of mitigated and unmitigated risks was calculated based on the assumption that the likelihood hazard rating is Low.
Pre-mitigation measures and operational failures were highlighted as a high risk, and shortfalls in design (provision of alarms and monitoring) together with structural failure were highlighted as a medium risk.

Post-mitigation measures operational failures were re-scored as a medium risk, and the previous two medium risk items remained as a medium.

Therefore, the final Likelihood Hazard rating was determined as **Medium**.
Based on the information above the overall site risk rating was calculated to be high which means that class 2 secondary containment is required.

Source Risk	Pathway Risk	Receptor Risk	Site Hazard Rating	Likelihood	Overall Site Risk Rating
High	**Medium**	**Medium**	**High**	**Low**	**Medium (Class 2)**