Industrial Emissions Directive – Hayle Waste Water Treatment Works (WWTW)

Secondary Containment Modelling Assessment

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Prepared for:

South West Water

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INDUSTRIAL EMISSIONS DIRECTIVE – HAYLE WASTE WATER TREATMENT WORKS (WWTW)

Secondary Containment Modelling Assessment

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INDUSTRIAL EMISSIONS DIRECTIVE – HAYLE WASTE WATER TREATMENT WORKS (WWTW)

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1.0 INTRODUCTION

Stantec have been commissioned by South West Water (SWW) to complete the permit application for Hayle Sewage Treatment Works for the Industrial Emissions Directive. Part of this application requires an assessment of the potential environmental risks associated with a loss of containment of process vessels.

This report details the 2D hydraulic modelling that has been carried out to assess the failure of process vessels, subsequent overland flows paths of the released flow and the containment measures necessary to prevent flows from reaching waterbodies.

Figure 1 below shows an aerial view of Hayle WWTW.

Figure 1: Hayle WWTW aerial view

2.0 ADBA RISK ASSESSMENT TOOL FINDINGS

The Anaerobic Digestion & Bioresources Association (ADBA) Risk Assessment Tool is based on CIRIA c736: *Containment systems for the prevention of pollution* provides requirements for the prevention of pollution: including secondary and tertiary containment, and other measures for industrial and commercial premises.

2.1 CLASS OF REQUIRED SECONDARY CONTAINMENT

To identify the class of containment deemed to provide sufficient environmental protection in the ADBA Risk Assessment, the tool uses a source, pathway, receptor model. This identifies hazards posed to the environment and assigns a class of containment based on the site hazard rating and likelihood of loss of primary containment. The approach is summarized in Figure 2 below.

Figure 2: ADBA classification framework

The ADBA Risk Assessment Tool scored the source element as 'High risk', pathway elements as 'High risk' and the receptor element as 'High risk' for the Hayle WWTW due to the significant volumes of sewage sludge stored on site and site pathways to receptors. In summary, this assessment approach indicates that Hayle WWTW has an overall site hazard rating of 'High'. The likelihood of failure was 'Low Risk' due to the type of infrastructure involved and proposed mitigation options.

According to Table 4 within the ADBA tool (box 2.2 CIRIA 736), reproduced in Figure 3 below, the combination of a high site hazard rating and a low likelihood rating, gives the overall site risk as medium. The indicated class of secondary containment for **Hayle WWTW was therefore deemed as Class 2.**

Table 4: Overall site risk rating as defined by combining ratings of site hazard and probability of containment failure *(Box 2.2 CIRIA 736)*

Possible combination	Overall Risk Rating	Indicated class of secondary containment
HH, HM, OR MH	HIGH	Class 3
MM, HL, OR LH	MEDIUM	Class 2
LL, ML, OR LM	LOW	Class 1

Figure 3: ADBA classification matrix

The ADBA assessment attached as Appendix B outlines the information and data utilised in greater detail, as well as the assumptions applied to undertake a secondary containment risk assessment. The requirement for 'Class 2' type secondary containment will be used to inform the required mitigation for secondary containment.

To achieve Class 2 secondary containment all bund wall solutions must be lined and either a leak detection system should be installed, or leak integrity assessed by an independent contractor.

3.0 ASSETS TO BE ASSESSED

The following assets on the Hayle WWTW site were identified as needing an assessment of containment using the 2D model (refer to Table 1 below). This includes all major closed containers that are above ground. Assets C, F, G and I all sit in the same general location and will be addressed by the same solution. This grouping will be referred to as 'sludge tanks'.

Table 1: Assets

Asset Reference	Asset Description	Capacity (m^3)
C	Sludge Balancing Tank	699
F	Thickened Sludge Tank	349
G	Return Liquor Balancing Tank	349
I	Imported Sludge Balancing Tank	345
L1 and L2	Primary Digester 1 and 2	1561 each
N1 and N2	Secondary Digester 1 and 2	2224 each

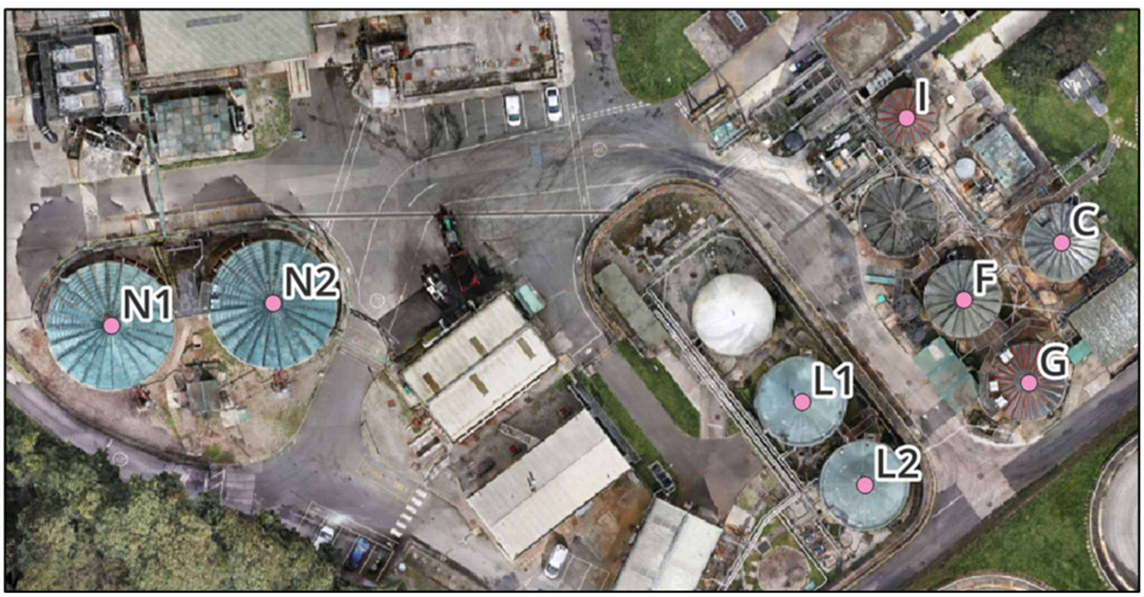


Figure 4: Hayle WWTW major above ground assets

4.0 HYDRAULIC MODEL BUILD

A 2D model of the Hayle WWTW site has been built in Infoworks ICM to assess the impact of failure or loss of containment on site. Use of a 2D hydraulic model allows the failure of containment vessel to be represented, including the subsequent overland flow and ponding of released flow.

The purpose of the model was to represent the Hayle WWTW site, including above ground buildings and vessels and the below ground drainage network, to represent the direction and path of overland flows from the spill location to a receptor (watercourse, standing water, drain etc).

The model extends to the watercourses and ponds bounding the site on the eastern, southern and southwestern sides. The northern boundary of the model is the Hayle to St Erth rail line.

Figure 5 below shows the hydraulic model, it's extent is highlighted in red and the receptors labelled with callouts.

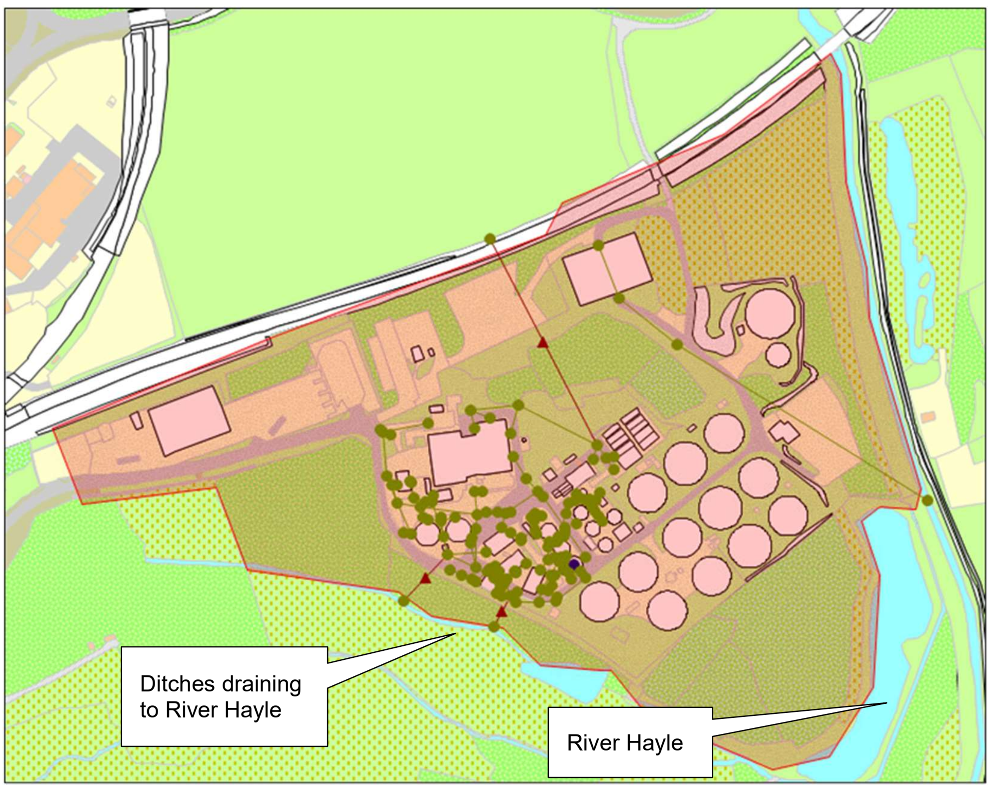


Figure 5: Hayle WWTW model

The 2D hydraulic model was built in InfoWorks ICM using existing site drainage drawings, OS Mastermap, and site photos to identify structures onsite. The following sources of ground level data were merged to best represent the terrain with available information:

- A drone survey conducted by SWW produced a digital surface model (DSM) of the site to 20mm accuracy. A GIS tool was used to isolate the ground levels from this DSM and resampled the data at 0.1m spacings. This does not cover the entire modelling extent.
- 2022 1metre LiDAR (Light Detection and Ranging) Digital Terrain Model (DTM) data was downloaded from the DEFRA Survey Data Download site. This provides elevation data at 1m spacings and has vertical accuracy of +/-15cm.

A DTM was created that prioritized the drone survey data but adopted LiDAR levels for areas that did not have drone data available.

The model build followed the process below:

- A 2D boundary was defined within ICM and any above ground structures and buildings within the boundary identified and modelled as a void. Figure 3 above shows various above ground tanks and buildings as voids. Voids are regions in the 2D zone that will not be meshed, such that overland flows must pass around these structures and cannot pass over them in the model. During simulation of each tank's failure, the failing tank was not included as a void. Subsequently, the discharge point is at an approximated ground level beneath the tank.
- Failing tank discharge was modelled using a 2D point source 'inflow' at the location of the center of the asset.
- The 2D model boundary was set as 'normal condition' where it is assumed the slope balances friction forces and depth and velocity are kept constant, so water can flow across the boundary without any losses.
- The merged DTM data was imported and a triangulated mesh created to represent the ground surface. Minimum and maximum triangle sizes of $1m^2$ and $4m^2$ were set, with a maximum height variation of 0.1m. This triangle size is smaller than what is typically advised by SWW. This model is for a small site over a short duration, so it was preferred to adopt a finer mesh to better represent surface detail. Using mesh zones to model roads was not required as the fine mesh and detailed DTM are able to define the roads well enough for the purposes of this assessment.
- The below ground site drainage network was added based on a 2020 CCTV connectivity tracing survey carried out by R & M Services.

The following assumptions have been made in the model build process:

- Existing site drainage drawings were used to define the location of known gullies, drainage pipes, manholes etc in the areas of concern.
- Where level/gradient/diameter information was not available for the drainage assets, engineering judgement was used to populate the required model information.

- The pump rates of pumping stations within the 2D zone have been assumed to be 10 l/s in the absence of any other information. Pumping stations are assumed to deliver flows back to the head of the works and therefore remove flows from the 2D zone into the treatment process.
- Waterbodies and drainage networks are assumed to have capacity to receive the spilled flows (i.e. they are not in flood).
- Default viscosity values for water have been used to represent spilled flows. This overestimates the momentum with which WwTW fluids will spill due to their higher viscosity.

5.0 HYDRAULIC MODELLING ASSESSMENT METHODOLOGY

5.1 TANK FAILURE DISCHARGE

Assets have been modelled under a catastrophic failure scenario. For the assets identified in Section 2, 110% of the tank capacity should be emptied instantaneously in line with guidance within CIRIA C736 Containment systems for the prevention of pollution.

'Inflow' files were generated to model the failure discharge from each of the tanks. These release 110% at a constant rate from the center of the relevant tank.

5.2 RAINFALL ALLOWANCE

CIRIA c736, section 4.3.3, provides guidance for rainfall allowance within secondary containment where rainfall collects over time and is removed at regular intervals. Hayle WwTW has drainage on site, it does not rely on regular emptying of site surface water. Therefore, the recommendations stated in CIRIA c736 do not directly apply for this assessment. Rainfall accumulation prior to a Hayle WwTW tank failure event will not be accounted for within containment capacity. It is assumed that infrastructure onsite can successfully drain a storm event under normal operation.

Rainfall accumulation following a tank failure event will be allowed for within the containment capacity at Hayle WwTW as the drainage network may be unable to operate effectively. As per CIRIA c736 guidance, a 1 in 10 year return period storm event occurring over 8 days following the tank failure will be considered. Rainfall accumulation during the failure event is not considered due to its short duration.

The Flood Estimation Handbook (FEH) was used to estimate the rainfall depth resulting from a 1 in 10 year storm over 8 days. The rainfall estimates from FEH for Hayle WwTW are as follows:

Table 2: FEH rainfall estimate for Hayle WWTW 10yr AEP

Rainfall Event	Rainfall depth (mm)
1 in 10 year (8 day duration)	129.52

Extracts from the FEH calculations are provided in Appendix A.

The containment solution must therefore ensure that there is sufficient freeboard of at least 130mm between the predicted top water level after the spilled flow has ponded and the top of the ultimate containment wall.

5.3 FIRE-FIGHTING ALLOWANCE

No allowance for fire-fighting water will be made, on the assumption that most of the assets being modelled contain sludge which has a low combustible nature. Digesters could require fire-fighting water in the eventuality of an explosion on the headspace that communicates with the gas system, but in such scenario the main pollution is likely to be to air.

5.4 DRAINAGE NETWORK

Site drainage leads back to the inlet works and is therefore ruled out as a pathway to a receptor. There is approximately 1,610m of drainage pipe work ranging from 100mm to 225mm in diameter providing a total 'storage' volume of approximately 25m^3. It is therefore assumed that the benefit provided by the drainage system in a catastrophic failure scenario will be minimal. This drainage storage volume and the assumed 10 l/s pump rates are insignificant when compared to the burst discharge from a failing asset.

6.0 INITIAL ASSESSMENT RESULTS

6.1 SECONDARY DIGESTER 2 (N2)

An initial run of the hydraulic model was carried out for the largest tank under consideration, N2, one of the secondary digesters. An inflow file discharging 2446.4m^3 (110% of the volume) was applied to the model in a simulation.

Figure 6 presents the spill results following the burst of secondary digester 2. Blue colour shows the depth of surface water and the red arrows show the direction of overland flow. This shows significant flows extending past both the WwTW site boundary and the modelling extent. Indicating that upon failure of the secondary digester, pollutants will enter the River Hayle and there is minimal containment to mitigate this currently.

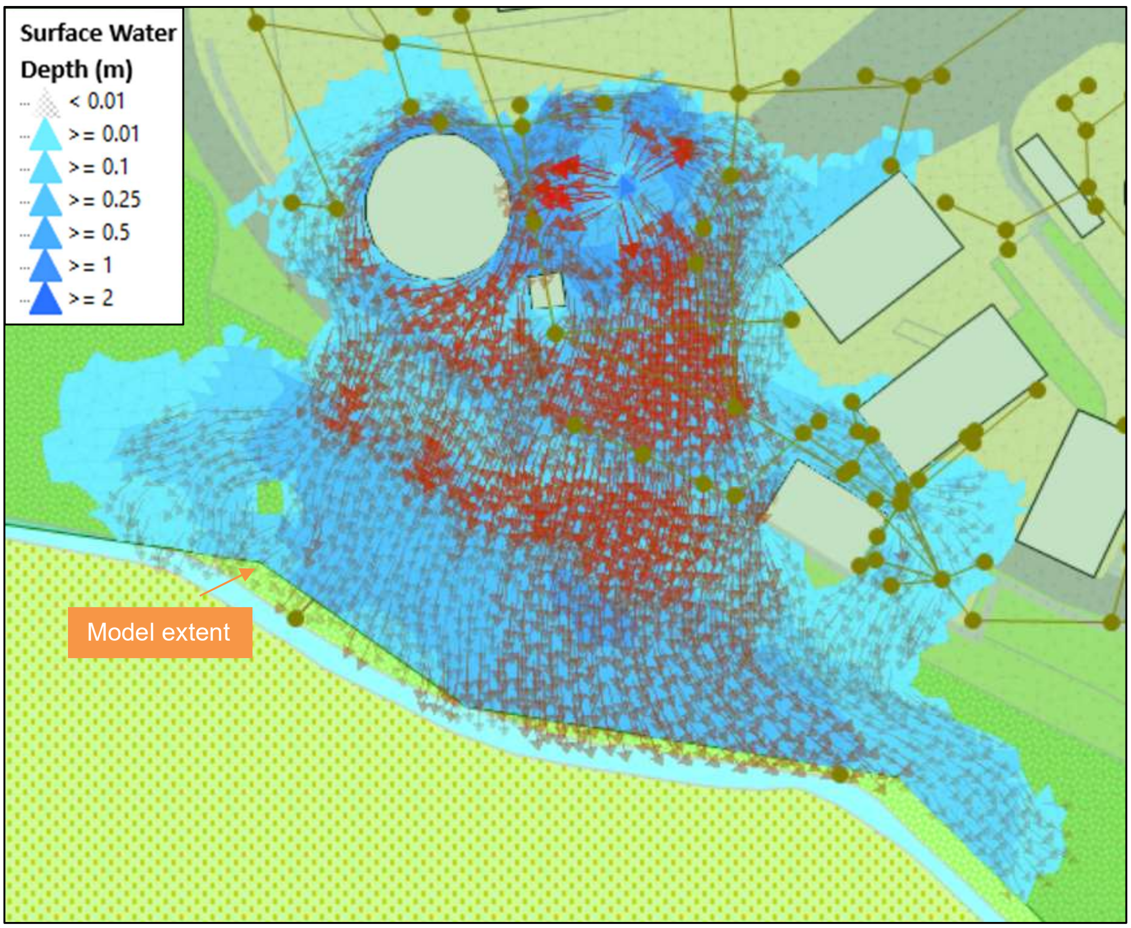


Figure 6: Hayle WwTW predicted flow paths following secondary digester burst

6.2 PRIMARY DIGESTER (L2)

A simulation with no added containment was also carried out for primary digester 2 (labelled L2 on Figure 4). An inflow file discharging 1717.1m^3 (110% of the volume) was applied at the tank's center. The results of this simulation predict the flow will reach the ditch and drain to the River Hayle as shown in Figure 7 below.

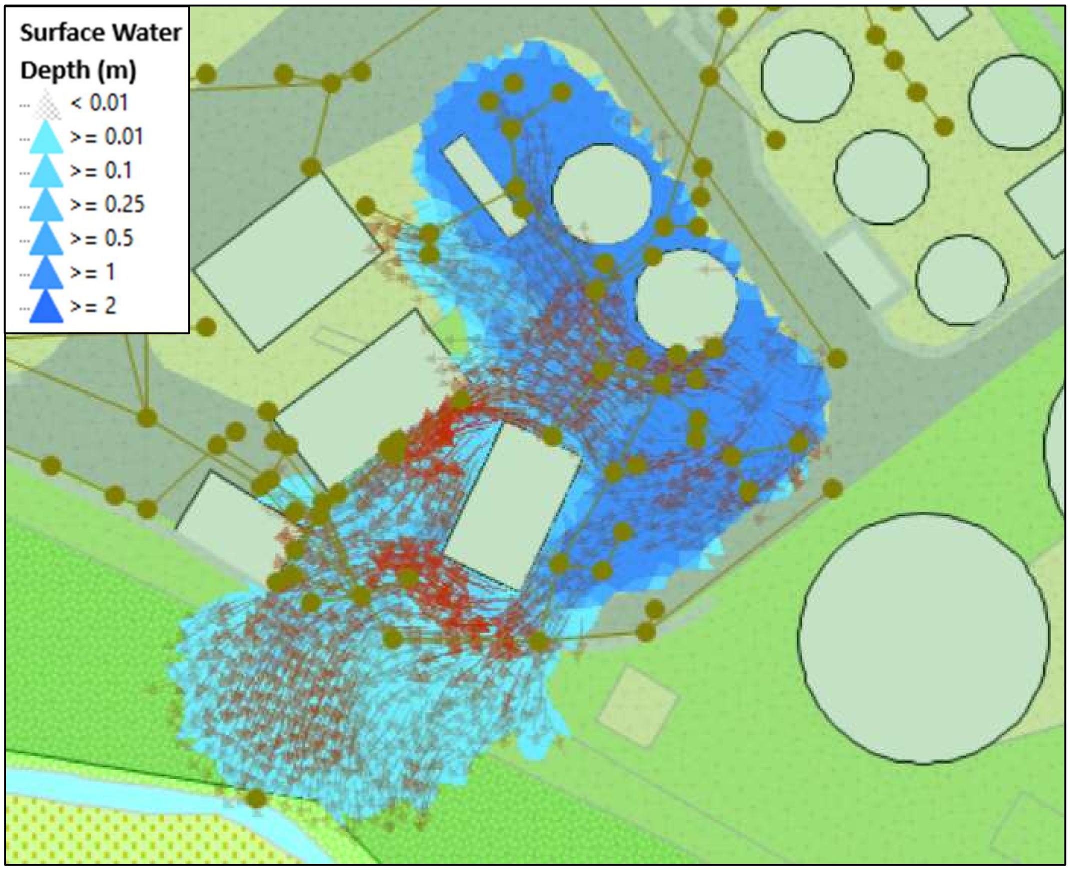


Figure 7: Hayle WwTW predicted flow paths following primary digester burst

6.3 SLUDGE BALANCING TANK (C)

A simulation with no added containment was also carried out for sludge balancing tank failure (labelled C on Figure 4). An inflow file discharging 768.9m^3 (110% of the volume) was applied at the tank's center. This predicted that spilling would cover a large portion of the WWTW site, but not reach the River Hayle. Figure 8 presents the extent of this spill.

The sludge balancing tank has greater volume and produces a greater extent of spilling than the neighboring imported sludge balancing tank, thickened sludge tank and return liquor balancing tank. Local containment surrounding these tanks is recommended to avoid site flooding in the event of any of their failures.

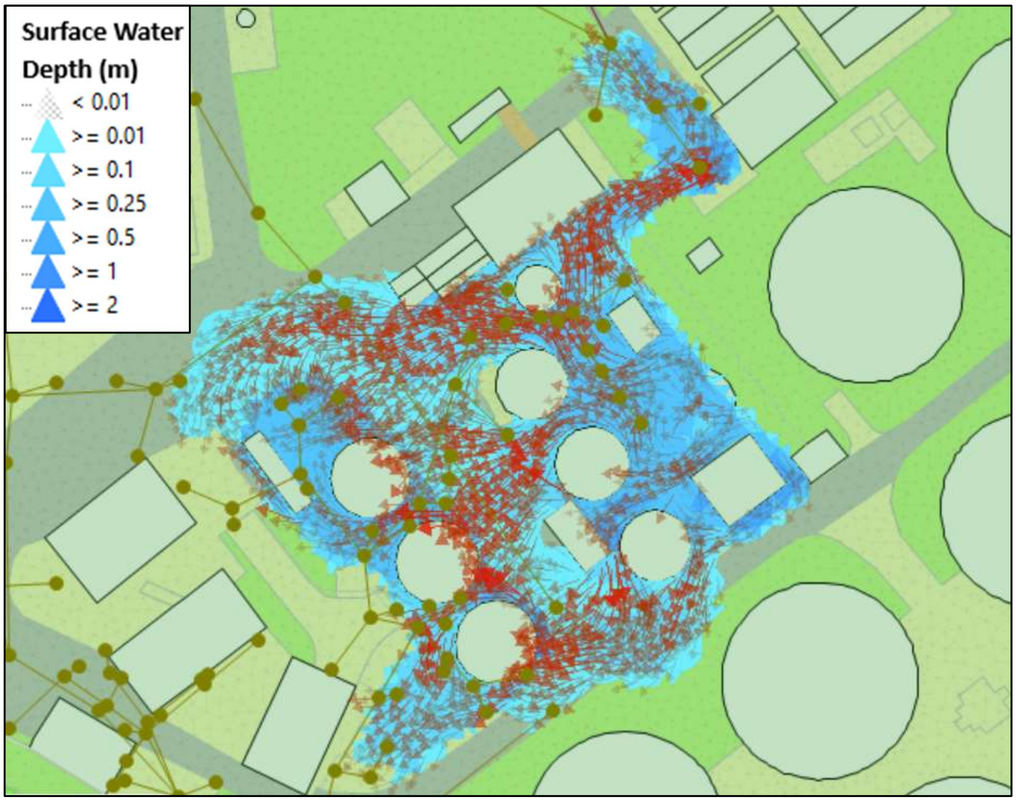


Figure 8: Hayle WwTW predicted flooding extent following sludge balancing tank burst

7.0 CONTAINMENT SOLUTION

7.1 IDENTIFIED CONTAINMENT SOLUTION

The 2D hydraulic model was used to develop a containment solution that prevents instantaneous spilling from reaching the watercourse and mitigates site flooding. The identified solution comprises of multiple impermeable walls that utilize existing site depressions to contain as much volume as possible. Figure 9 on the following page presents all walls proposed to ensure sufficient secondary containment at Hayle WwTW.

This solution has been broken down by wall sections and which failure they are designed to contain.

Secondary Digester failure (worst case):

1. 1.5m wall alongside road to the west of secondary digester 1
2. 1.5m impermeable gate at site entrance
3. 1.7m wall along southern site boundary behind carparks
4. 1.5m wall at corner of southern carpark
5. 1m wall at southern road bend

Primary Digester failure:

6. 1.5m wall around western side of primary digester depression. This contains most of its volume.

   Also requires walls 2, 3, 4 and 5 identified above, however, does not require them to be as high.

Sludge Balancing, imported sludge balancing, return liquor balancing and thickener feed tank failures:

7. 1.2m wall perimeter around tanks. This contains spilling within this area to mitigate risk to the WwTW.

These walls are labelled in yellow callouts on Figure 9.

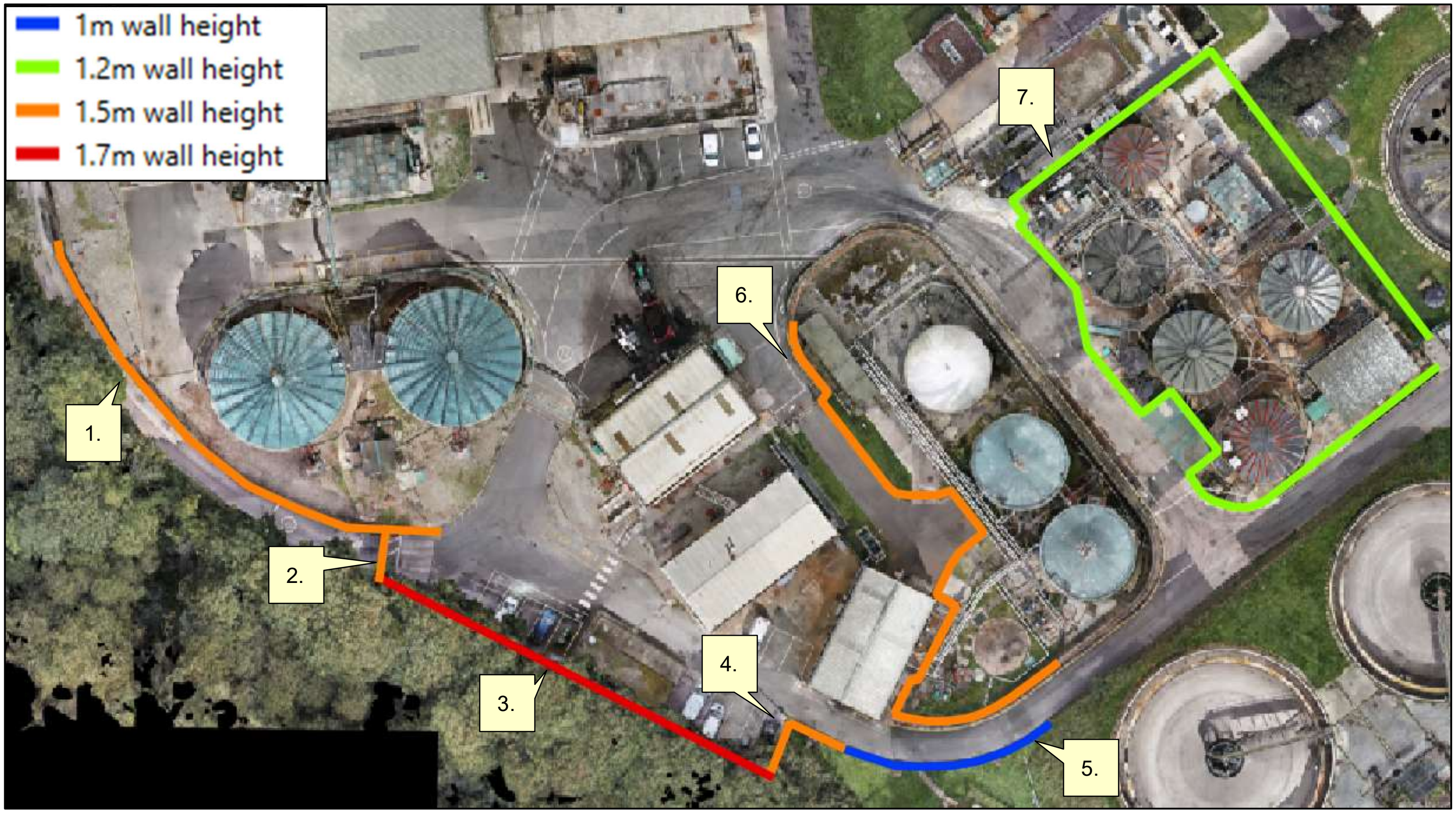


Figure 9: Hayle WWTW secondary containment solution

A determining parameter for the solution identification was keeping bund walls no higher than 1.5m wherever possible. CIRIA736, section 6.3.1, generally recommends that walls should not exceed 1.5m height to:

- Enable visual inspection of the bund walls and floor
- Facilitate firefighting operations
- Ensure relatively easy egress from a bunded area in the event of an emergency
- Reduce the risk of the bunded area becoming a confined space by encouraging natural ventilation.

For the Hayle WwTW site, the 1.7m wall proposed along the southern boundary (labelled '3.') is higher than this recommendation. Alternative solutions were investigated to check if this southern wall could be minimized to 1.5m height. For example, pump flowrates were increased from 10 l/s to 50 l/s and 60m^3 additional storage added at the southern carpark. However, an alternative solution was not identified that could avoid watercourse contamination for the secondary digester 2 failure when accommodating for rainfall depth.

CIRIA c736 notes that under some circumstances a wall higher than 1.5m is required. In which case a risk assessment should be conducted. In the simulation of worst-case failure at Hayle WwTW (secondary digester 2 burst) with the proposed solution added, only a small area exceeds 1.5m depth (this can be observed in section 8.1.3). Therefore, the risk of using a 1.7m wall is expected to be mitigatable. If a 1.7m wall is to be constructed a risk assessment will need to be undertaken.

The tank volumes and dimensions used in this modelling assessment have been estimated from the drone survey results. The actual tank volumes may differ due to tank configuration (i.e. actual freeboard). This will influence the wall height and length requirement for spill containment, although the modelled solution is considered to be conservative.

There is also limited confidence in the modelled mesh level at the southern boundary, this is right at the extent of the drone survey. It is recommended that the topography is surveyed further along the proposed wall route.

The spill modelling assessment and solution design will need revision if more accurate data becomes available for the pump stations, ground levels and asset volumes. The proposed wall heights are subject to change following this refinement.

7.2 SOLUTION CONTAINMENT VOLUMES

The proposed walls effectively form 4 bund containment areas. These are detailed in Table 3 below with the approximate capacity and the asset failures they address.

Table 3: Bund containment areas

Walls	Area	Approximate volume (m^3)	Assets contained
1		910	N1, N2
2, 3, 4, 5		2,020	N1, N2, L1, L2
6		1,020	L1, L2

7		1,700	C, F, I, G

8.0 CONTAINMENT SOLUTION ASSESSMENT

8.1 SOLUTION MODELLING ASSESSMENT RESULTS

Infoworks ICM allows impervious walls to be added into the hydraulic model, such that overland flows cannot pass through them, and flow must find an alternative route. Simulations were carried out for each asset failure with the solutions identified in Figure 9 added as impervious walls.

The following figures present the maximum depths and flow paths observed during each asset burst scenario after the walls were added. These show the effectiveness of the proposed solution to prevent spills leaving the site and mitigate risk to the WWTW.

8.1.1 Primary Digesters (L1 & L2)

Figure 10 and Figure 11 show the containment solution working for both primary digesters. The 1.5m wall surrounding these digesters is not able to contain the entire volume of a spill, this is predicted to be overtopped. However, the containment solution in conjunction with the additional wall barrier along the southern site boundary is sufficient to stop the spill from entering the surrounding environment.

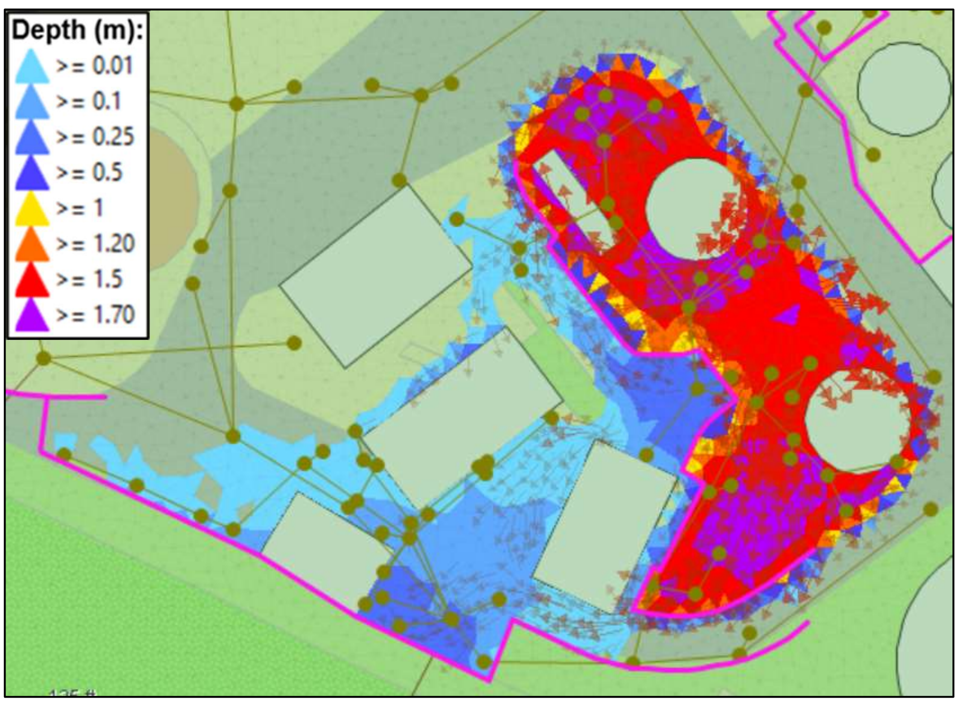


Figure 10: Maximum spill depth during primary digester 1 burst scenario

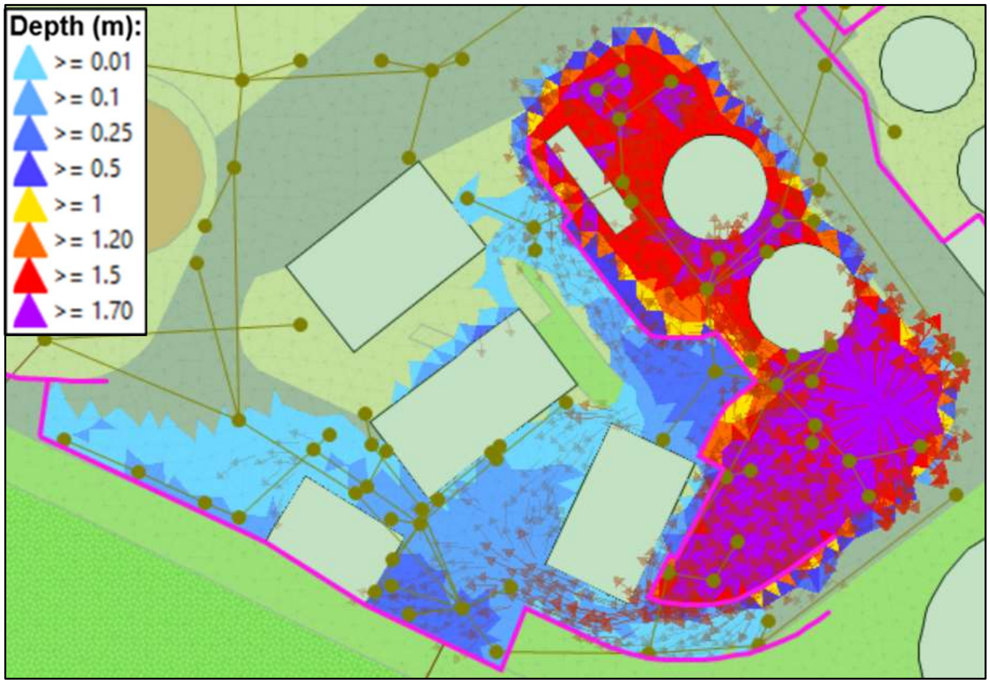


Figure 11: Maximum spill depth during primary digester 2 burst scenario

8.1.2 Sludge Tanks (C, F, G and I)

Figure 12, Figure 13, Figure 14 and Figure 15 show that the proposed 1.2m perimeter wall is able to contain the burst spills for the sludge and imported sludge balancing tanks, return liquor balancing tank, and thickened sludge tank. Drainage capacity is overwhelmed, this causes a relatively small volume to spill out by primary digester 1 via the drainage onsite. This is still retained within the site.

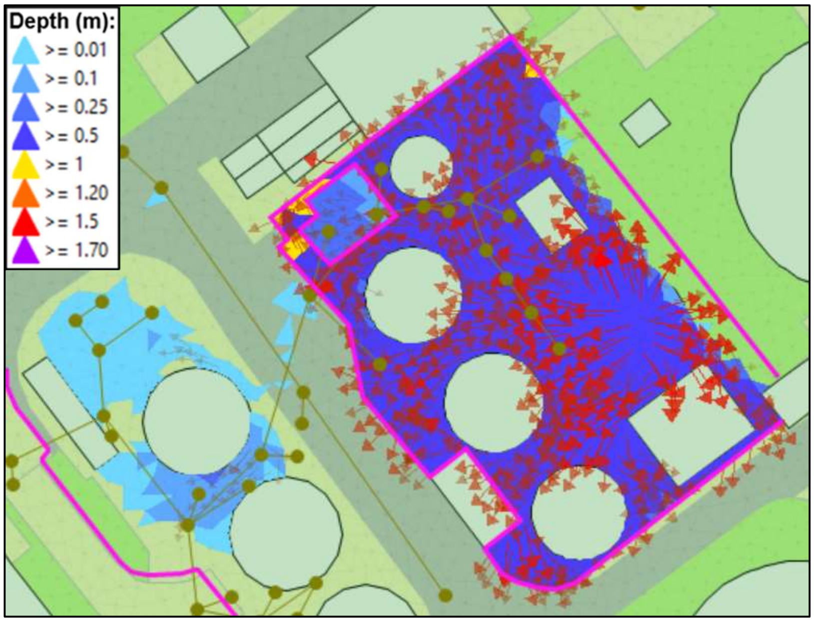


Figure 12: Maximum spill depth during sludge balancing tank burst scenario

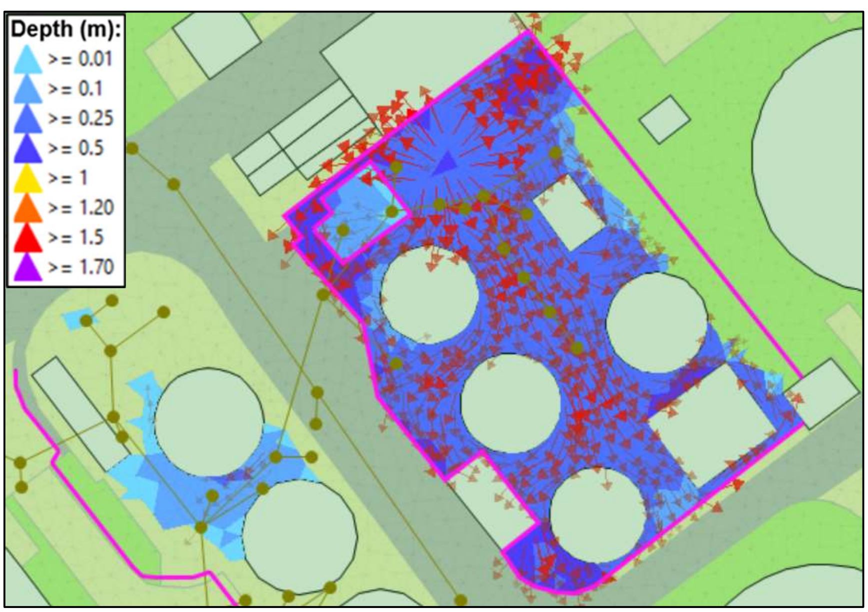


Figure 13: Maximum spill depth during imported sludge balancing tank burst scenario

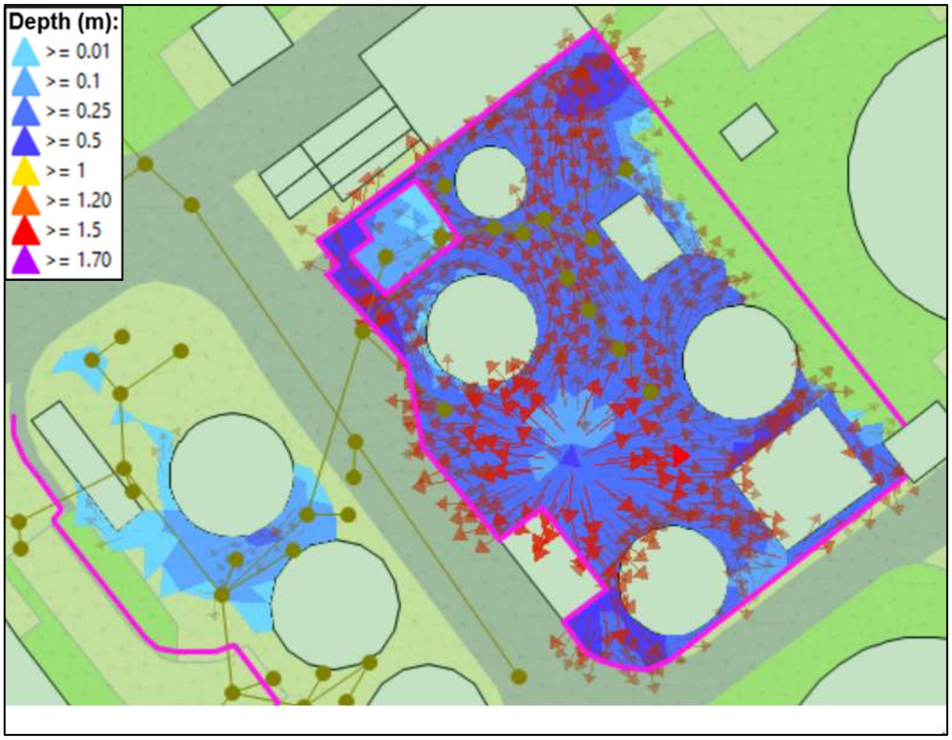


Figure 14: Maximum spill depth during thickened sludge tank burst scenario

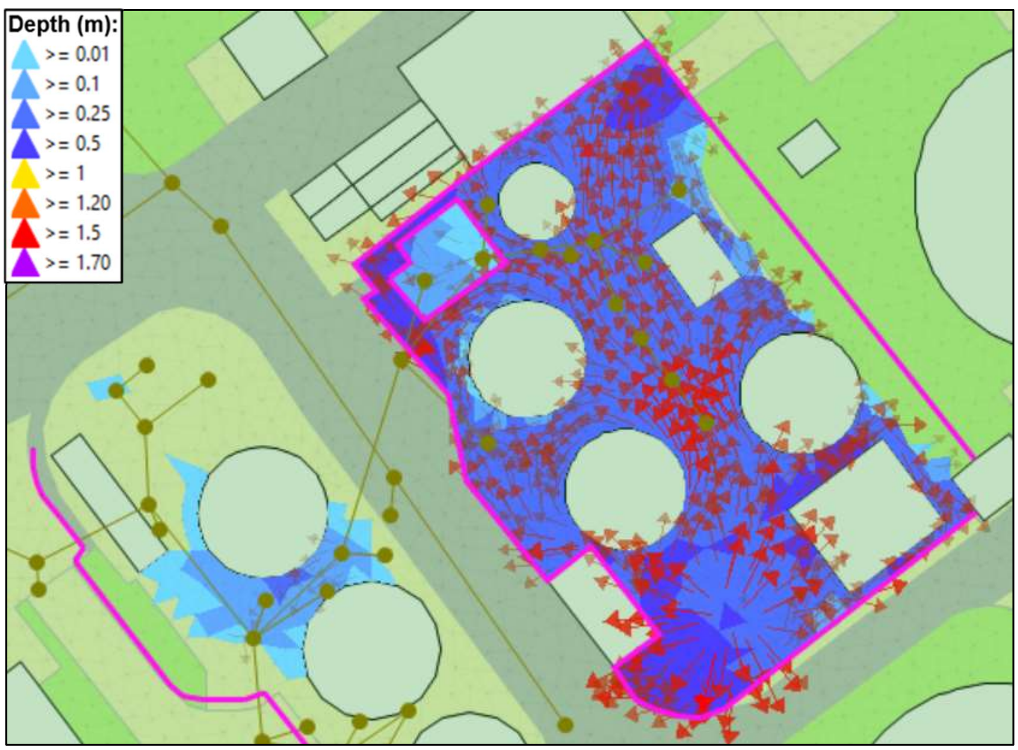


Figure 15: Maximum spill depth during return liquor balancing tank burst scenario

8.1.3 Secondary Digesters (N1 & N2)

The proposed walls are sufficiently able to contain the secondary digester flow. This can be observed in the maximum spilling depth results presented in Figure 16 and Figure 17.

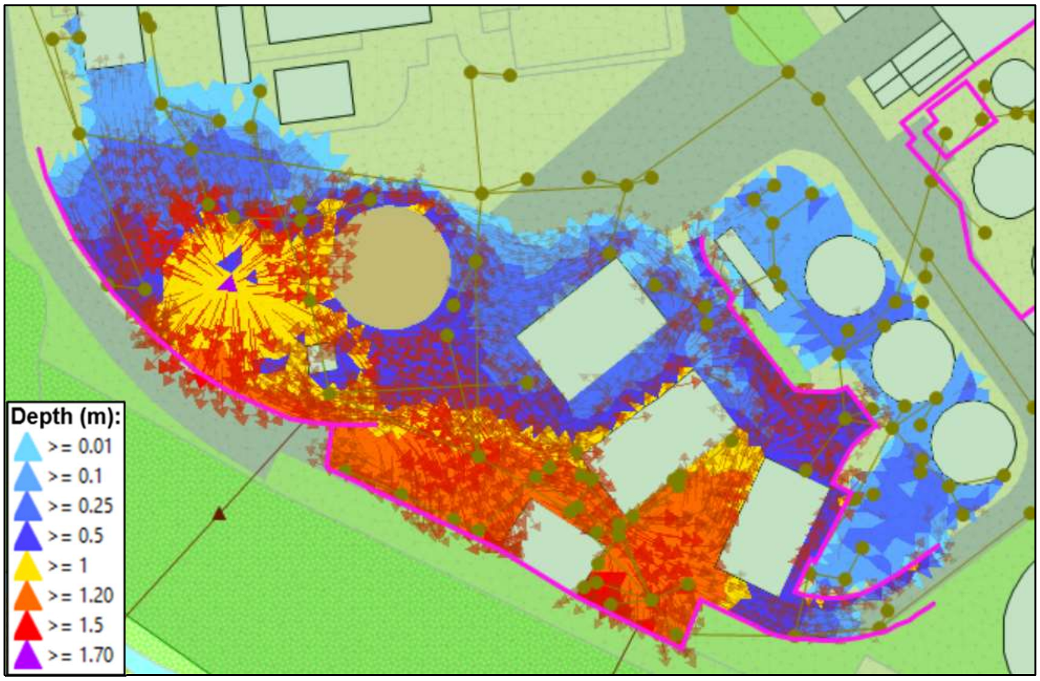


Figure 16: Maximum spill depth during secondary digester 1 burst scenario

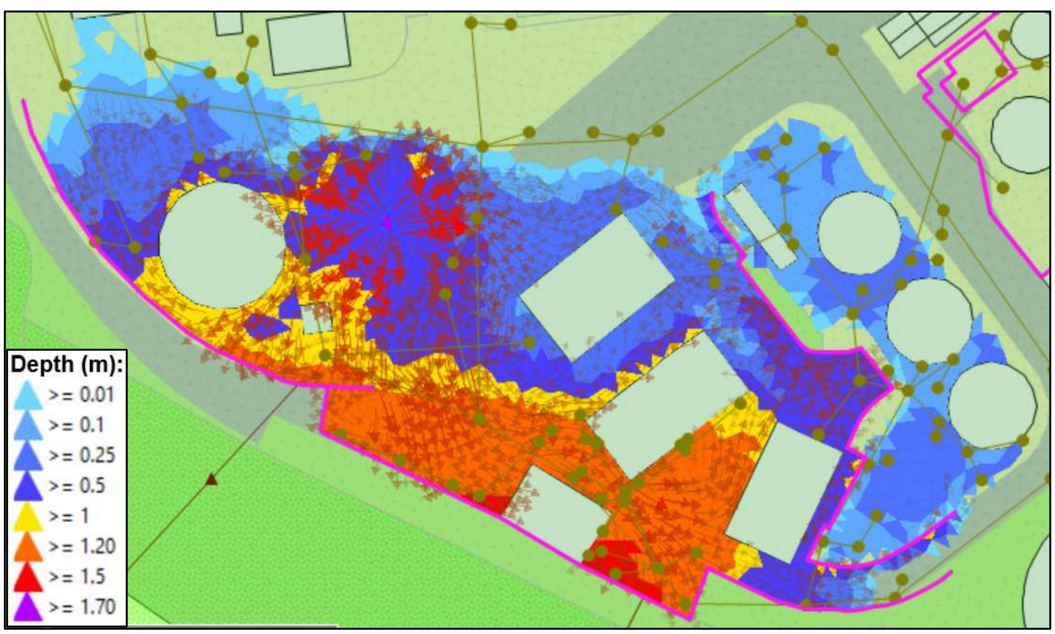


Figure 17: Maximum spill depth during secondary digester 2 burst scenario

8.2 RAINFALL CONTAINMENT ASSESSMENT

8.2.1 Secondary digester rainfall assessment (N1 & N2)

Figure 18 below presents the maximum ponded levels after the bursting of secondary digester 2. This shows how a 1.5m wall is sufficient all along the southern wall except for a section by the carparks. This is predicted to be overtopped if 130mm depth of rainfall accumulated following burst. To resolve this a 1.7m wall (solution wall '3.') is proposed along this section as indicated by the red line.

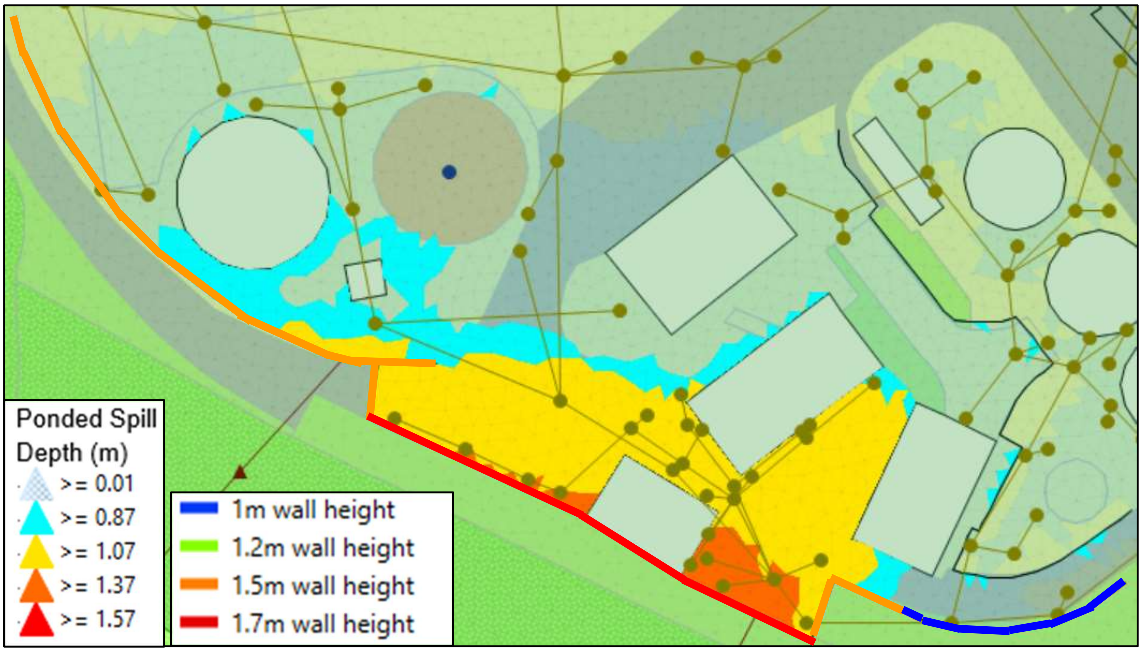


Figure 18: Assessing wall heights with rainfall considered for secondary digester 2 burst scenario

8.2.2 Primary digester rainfall assessment (L2)

Figure 19 presents the maximum ponded levels following primary digester 2 burst. This shows that the 1m height wall on the southern road bend won't be overtopped. With the solution implemented there is no predicted breach to the environment when rainfall is accounted for.

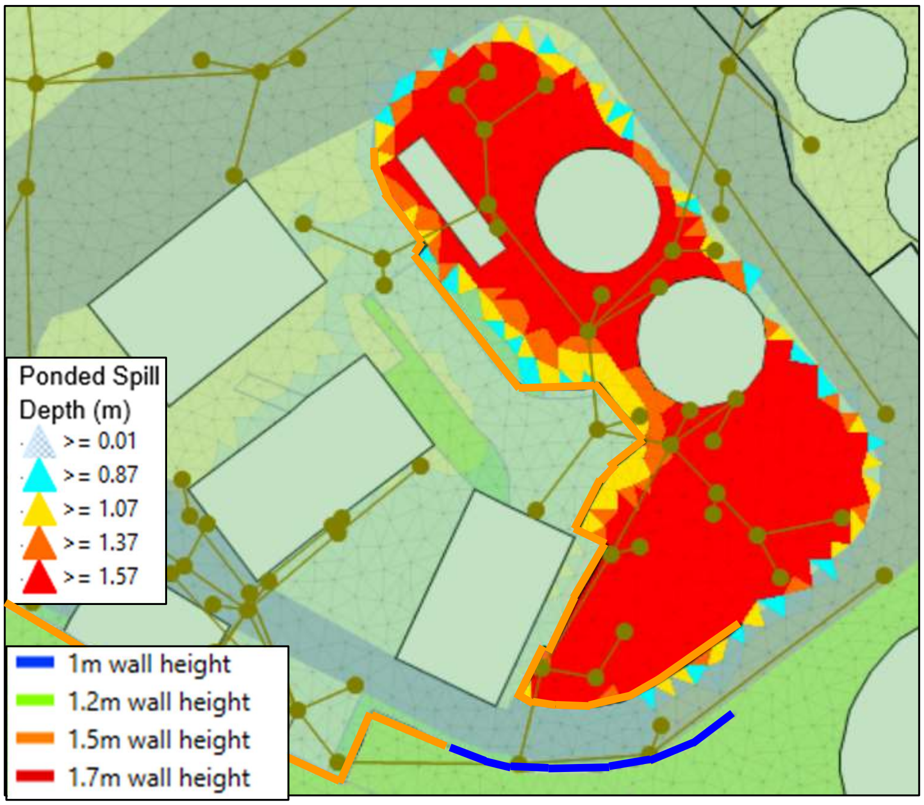


Figure 19: Assessing wall heights with rainfall considered for primary digester 2 burst scenario

8.2.3 Sludge balancing tank rainfall assessment (C)

Figure 20 presents the maximum ponded levels following failure of the sludge balancing tank. This shows that at three corners of this perimeter a 1m wall would be overtopped with the addition of the 130mm rainfall depth. A 1.2m wall will be sufficient to contain the spills and mitigate risk to the rest of the WWTW for failure of any of the sludge tanks.

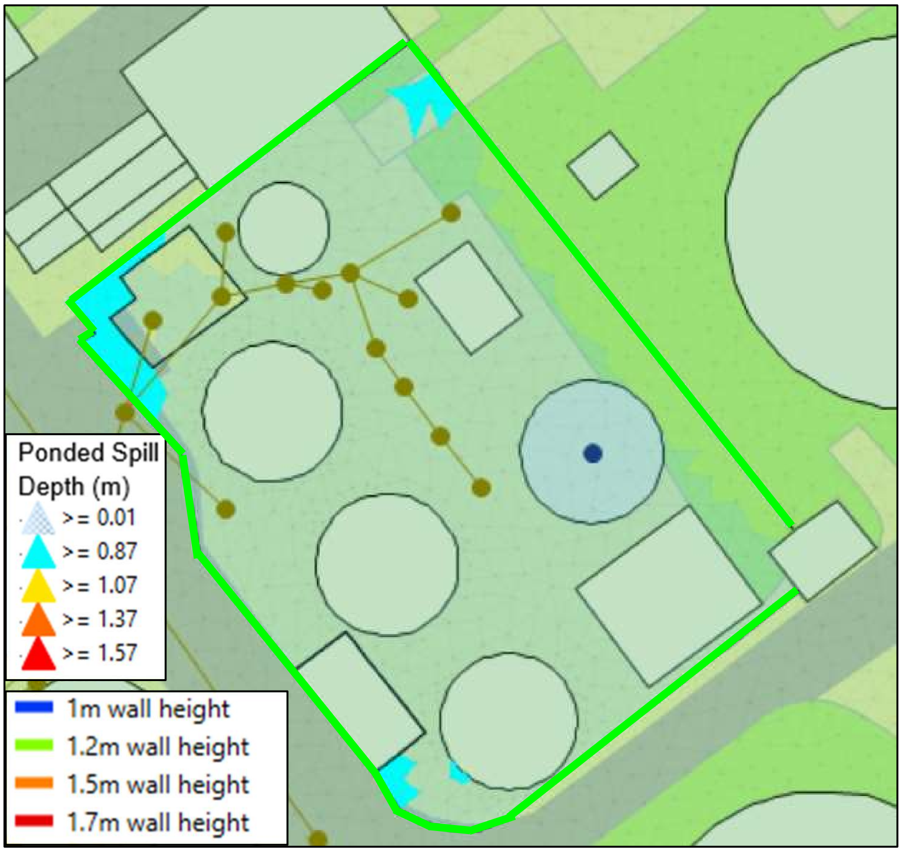


Figure 20: Assessing wall heights with rainfall considered for sludge balancing tank burst scenario

8.3 JETTING CONSIDERATION

The jetting distance from each of the tanks modelled as part of the secondary containment assessment has been calculated using the methodology proposed in CIRIA C736, Box 6.1, and the distance to the bund/containment walls adjusted in line with the calculated jetting distance. The proposed configuration of the containment solution captures the jetting distance for majority of the tanks within the site boundary. Refer to Table 4 for details.

In the case of the Secondary Digester 1, due to the vicinity to the site boundary of the tank, it is not possible to provide the calculated jetting distance to the bund wall of 1.5m height. A barrier system solution is being investigated for the mitigation of any potential jetting effects over the site boundary from Secondary Digester 1, however, the consideration for the potential full relocation of the Secondary Digesters is being evaluated alongside the installation of additional Secondary Digested Sludge capacity on site.

Table 4: Jetting Calculation summary

Asset Name	Jetting height (Zmax) (m)	Bund wall height (m)	Distance req. (l) (m)
Imported Sludge Balance Tank	4.5	1.2	6.6
Sludge Balancing Tank	5.0	1.5	7.00
Return Liquor Balancing Tank	2.7	1.2	3.05
Thickened Sludge Tank	2.7	1.2	3.05
Primary Digester 1	7.7	1.5	12.30
Primary Digester 2	7.7	1.5	12.30
Secondary Digester 1	5.7	1.5	8.30
Secondary Digester 2	5.7	1.5	8.30

8.4 RISK TO WWTW

The combined containment system solution proposed involves the installation of a bund localised to the tanks for secondary containment, and additional containment within the site boundary to contain any potential excess flows, as identified in CIRIA C736 Section 3.5, including the use of a sacrificial area (staff and visitor car park) to capture all spill volume. The connection between different containment levels includes the transfer overland using the site own topography and impermeable surfacing, and the use of the existing contained drainage systems (shown in Figure 5).

To allow for the normal drainage of rainwater during normal operation, the existing connections to the sealed drainage system are to be maintained, which implies directing all flows from rainwater or catastrophic failures towards the liquor return pumping station back to the head of the WwTW. The operation of this pumping station and the management of spills (including operational triggers) is being reviewed as the containment solutions designs evolve.

9.0 CONCLUSIONS

A 2D Infoworks ICM hydraulic model has been built for Hayle WwTW site to represent the failure of specific site assets and the resulting overland flow paths for the spilled flow. The aim of the modelling was initially to check whether failure of the named assets would result in spilled flow reaching the adjacent watercourse, and then to develop a containment solution to prevent this from occurring.

The hydraulic model was built from existing site information including OS mapping, site drainage surveys, drone survey and LiDAR data to represent the likely path of overland flows. It is recommended that the areas identified as flow paths, especially areas recommended for mitigation measures, are covered by a topographical survey. This will give confidence of protection measures already in place and confirm the extent of any additional mitigation measures that may be required.

Simulations were carried out representing the release of 110% of the volumes of key assets over a constant rate. Results from those simulations predict that spilled flows from the primary and secondary digesters would reach the watercourse on the south-western side of the site. Flows from the other assets were not predicted to impact any watercourse but flooded a significant extent of the WWTW.

An ADBA risk assessment deemed the risk of failure of Hayle WWTW assets to be classified as Class 2. All proposed 'impermeable' wall solutions should therefore be lined, and leak integrity assessed, or a leak detection system installed.

A containment solution has been developed by introducing impervious walls into the hydraulic model to prevent spilled flows from reaching the adjacent watercourse and mitigate risk to the WWTW. Various iterations of the solution were tested in the model to contain the spilled flows on site in accordance with CIRIA c736 guidelines. Allowance for a 1 in 10 year 8 day rainfall event following the burst was included in the containment capacity. It was deemed unnecessary to account for rainfall prior to asset failure as there is drainage onsite assumed to remove any accumulated surface water.

To contain jetting from Secondary Digester 1, a barrier system solution needs to be investigated due to the tank proximity to the site boundary limiting how far the bund wall can be installed. Drainage onsite will remain operational, and the operation of the liquors return pumping station and the management of spills (including operational triggers) is being reviewed as the containment solutions designs evolve.

The proposed solution comprises of the following impermeable walls mentioned in relation to which asset failure they mitigate:

Secondary Digester failure (worst case):

1. 1.5m wall alongside road to the west of secondary digester 1
2. 1.5m impermeable gate at site entrance
3. 1.7m wall along southern site boundary behind carparks
4. 1.5m wall at corner of southern carpark
5. 1m wall at southern road bend

Primary Digester failure:

6. 1.5m wall around western side of primary digester depression. This contains most of its volume.

   (Also requires walls 2, 3, 4 and 5 identified above, however, does not require them to be as high.)

Sludge Balancing, imported sludge balancing, return liquor balancing and thickener feed tank failures:

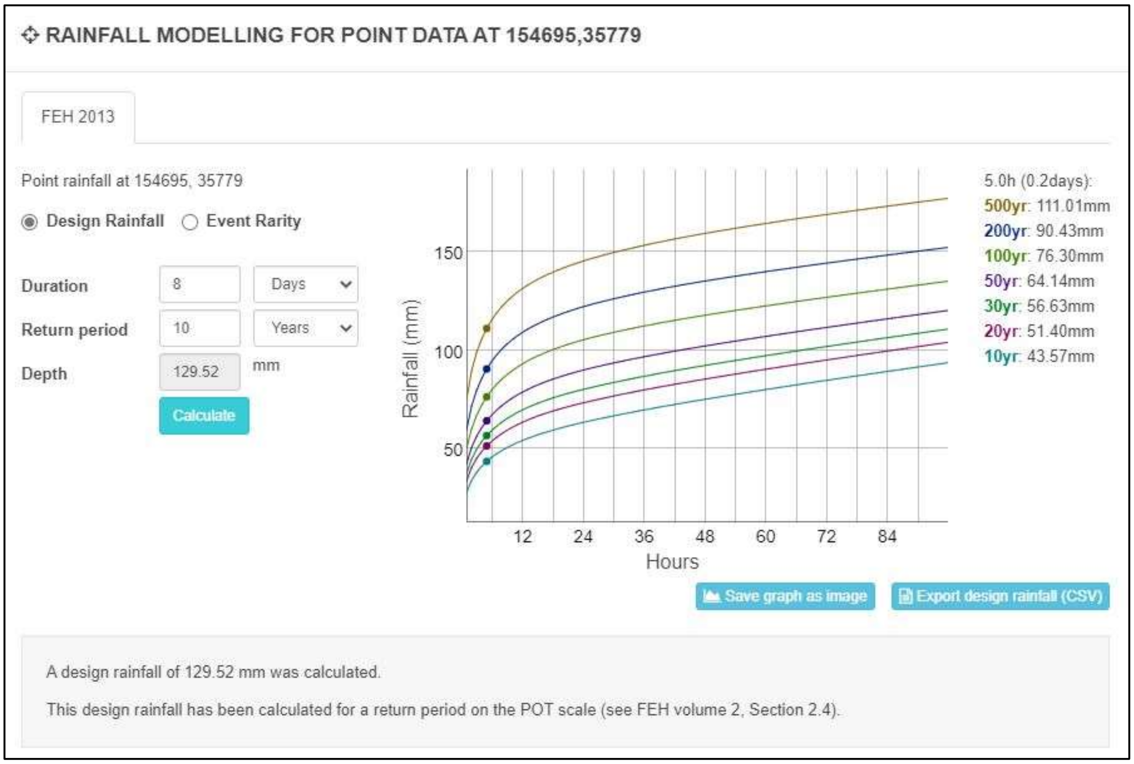
7. 1.2m wall perimeter around tanks. This contains spilling within this area to mitigate risk to the WWTW.

The spill modelling assessment and solution design will need revision if more accurate data is available, the proposed wall heights are subject to change following this refinement. If a 1.7m wall is to be constructed a risk assessment will need to be undertaken as this exceeds CIRIA c736 recommendations.

APPENDICES

Appendix A   FEH RAINFALL CALCULATION

1 in 10 Year 8 day rainfall depth



Appendix B ADBA ASSESSMENT

JOB TITLE	Hayle STW IED Permit Variation
JOB NUMBER	330202255
MADE BY	Chloe Austin-Bangs and Charlotte Watson
CHECKED BY	Simon Howard
DATE	03/01/2024
Description of spreadsheet	This spreadsheet provides a secondary containment risk assessment for Hayle STW (Sludge Treatment Works) using the Anaerobic Digestion and Biogas Association (ADBA) secondary containment risk assessment tool.
Sheet Number prefix	
Member/Location	
Drawing Reference	
Filename	https://stantec.sharepoint.com/teams/SWW-IEDRiskAssessments/ExternalSubs/Shared%20Documents/Hayle%20

CONTENTS OF SPREADSHEET

Sheet	Description
Cover	
Notes	
Introduction	Introduction to the ADBA Tool
1 a) Source	The inventory of materials for Hayle STW is provided in the worksheet 1a) Source
1 b) Pathway	The Pathway information for Hayle STW is provided in the worksheet 1) b) Pathway
1 c) Receptors	The Receptor information for Hayle STW is provided in the worksheet 1) c) Receptor
2) Site Hazard Rating	The Site Hazard Rating is displayed in the worksheet 2) Site Hazard Rating
3) Likelihood	The likelihood of loss of primary containment and the associated mitigation
4) Site Risk and Classification	The Site Hazard Rating and Classification is in this worksheet
5) Standard Containment Design	The Standard Containment Design is in this worksheet

AUTHORISATION OF LATEST VERSION

Type and method of check		Review of method, inputs and assumptions
Signatures & dates:	Made by	Chloe Austin-Bangs and Charlotte Watson
	Checked	Simon Howard
	Approved	Simon Howard

REVISIONS Current Revision V1

Rev.	Date	Made by	Checked	Description
V1	03/01/24	CA-B & CW	SH	First version

(1) Purpose of spreadsheet

This spreadsheet outlines the information and data utilised, as well as the assumptions applied to undertake a secondary containment risk assessment for Hayle STW based on the using the Anaerobic Digestion and Biogas Association (ADBA) secondary containment risk assessment tool and associated guidance. The ADBA risk assessment is based on CIRIA 736 Containment systems for the prevention of pollution: Secondary, tertiary and other measures for industrial and commercial premises.

(2) Key Assumptions

Any assumptions are outlined in the spreadsheet.

(3) Basis of calculations

ADBA Risk Assessment tool.

(4) References

All references are outlined in the spreadsheet.

(5) Special features

	Input Cell
	Key Outputs

(6) Holds or items that require Clarification

(7) Summary

Best Practice Guide

Although this tool works as a standalone tool, we recommend you read this first: ADBA CIRIA736 Bund Classification Assessment

There are 5 steps to follow:

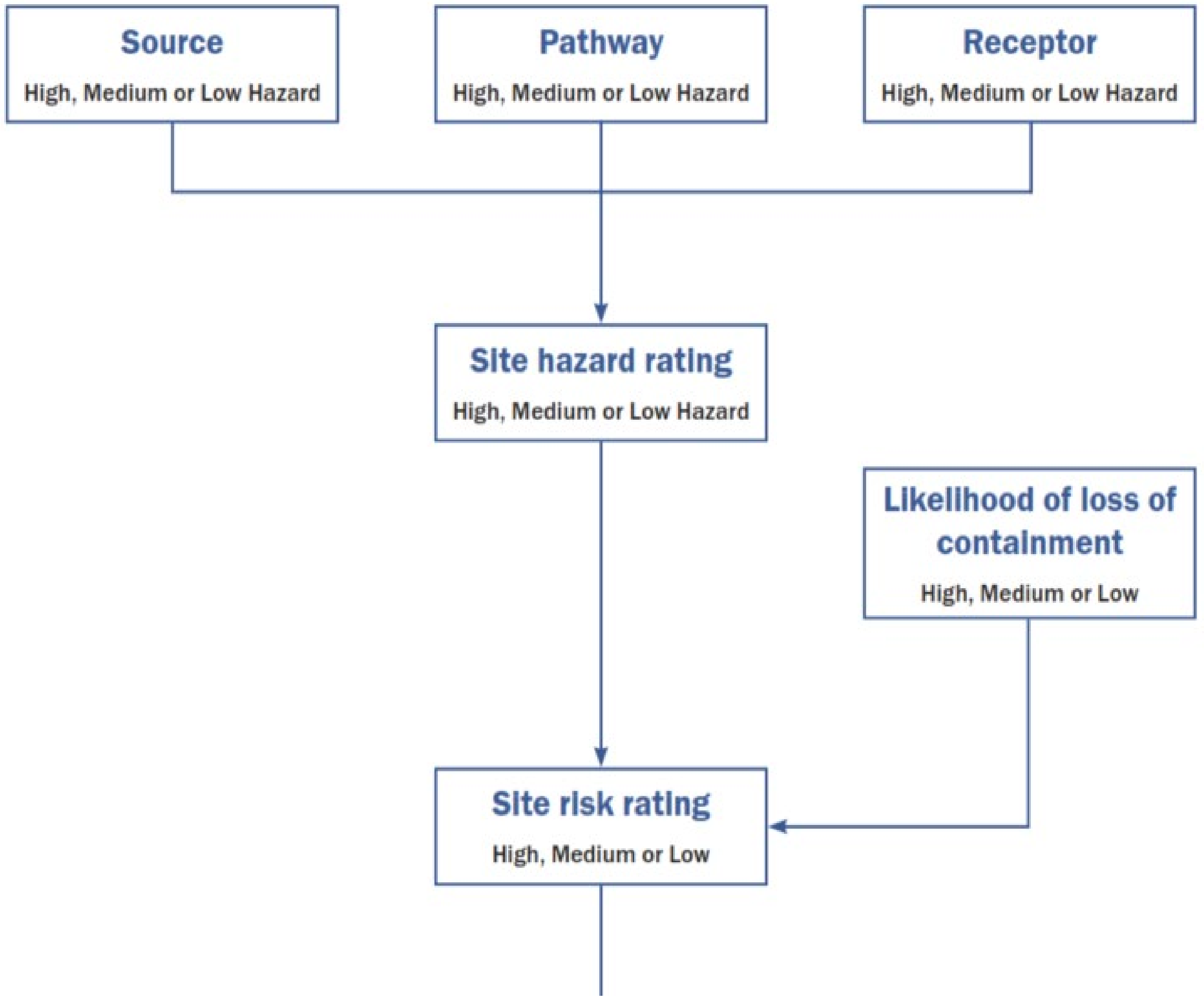
1) Identify the hazard posed to the environment by the inventory of materials held on the site and the location of the site
    a. Categorise the source
    b. Identify the pathways
    c. Identify the receptor

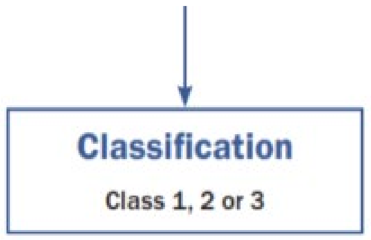
2) The Site Hazard Rating is derived by this tool from the combination of the hazards assessed above

3) Calculate the likelihood of a loss of primary containment event occurring

4) The combination of the Site Hazard Rating and the likelihood of a loss of containment occuring gives the site risk rating and required secondary containment classification

5) From the class of containment needed, identify suitable designs from the 'Standard Containment Designs' sheet





Additional Guidance

As detailed in section 2.4 of CIRIA C736, determining an overall hazard rating for the site is largely subjective, and assessing the combined effects is a judgement based on knowledge, experience and the degree of confidence in the information available.

Section 2.4 of CIRIA C736 states: "*where there is uncertainty about the correct categorisation of any of the individual source, pathway or receptor hazard ratings, it may be appropriate to move the overall site hazard category to the next higher rating*".

The worksheets in this spreadsheet are protected to prevent inadvertant damage to the tool. To remove the protection, the password is CIRIA736

The table below is partially completed to show what needs to be considered and its suggested Hazard Rating. Complete this table for your site to act as a reference and then use your judgement to assign hazard ratings in the yellow boxes. The tool then combines these to calculate the overall source hazard rating.

Material	Material	Total Enclosed Quantity	units	Storage	Flammability	Corrosive	Ecotoxicity (based on LD and quantity)	Environmental hazard rating	Justification
Feedstock									
Imported Sludge Liquid	Liquid	345	m^3	Imported Sludge Balancing Tank and Associated Pipework	Not flammable	No	Low	M	Permitted waste types are non-hazardous and the volume is below 1,000m3.
Screened Sludge Liquid	Liquid	600	m^3	Screened Sludge Tank and Associated Pipework	Not flammable	No	Low	M	Permitted waste types are non-hazardous and the volume is below 1,000m3.
Sludge Liquid	Liquid	699	m^3	Sludge Balancing Tank and Associated Pipework	Not flammable	No	Low	M	Permitted waste types are non-hazardous and the volume is below 1,000m3.
							Feedstock Overall Rating	M	All the hazards are "Medium" therefore the overall rating is medium
Process									
Thickened Sludge	Liquid	349	m^3	Thickened Sludge Holding Tank and Associated Pipework	Not flammable	No	Low	M	Permitted waste types are non-hazardous and the volume is below 1,000m3.
Digesting Sludge	Liquid	2 x 1,561	m^3	Primary Digesters x2 and Associated Pipework	Not flammable	No	Low	H	Permitted waste types are non-hazardous however the volume is significant.
Digested Sludge	Liquid	2 x 2,224	m^3	Secondary Digesters x2 and Associated Pipework	Not flammable	No	Low	H	Permitted waste types are non-hazardous however the volume is significant.
Digested Sludge Liquors	Liquid	349	m^3	Return Liquor Balancing Tank and Associated Pipework	Not flammable	No	Low	M	Permitted waste types are non-hazardous and the volume is below 1,000m3.
							Process Overall Rating	H	Any material with a "High" rating means the overall rating is high
Additives and site chemicals									
Polyelectrolyte	Solid	4,000	kg		Not flammable	No		L	Polyelectrolyte is a solid
Ferric Sulphate	Solid	30	tonnes		Not flammable	Yes		L	Low ecotoxicity for the quantities stored
Propane	Liquid	9,200	litres		Flammable	No		L	Propane has a low ecotoxicity
Lubricating Oil	Liquid	680	litres		Flammable	Yes		H	Oil has a high ecotoxicity
Diesel	Liquid	80,000	litres		Flammable	Yes		H	Diesel has a high ecotoxicity
Antifoam	Liquid	1	m^3		Not flammable	No		L	Low ecotoxicity for the quantities stored
							Chemicals Overall Rating	H	Any material with a "High" rating means the overall rating is high
Fire fighting agents and cooling water spillages									
Fire Fighting Agents harmful in their own right or contaminated by inventory	Liquid				Not flammable	No	Low	L	Low in the example in the ADBA Tool.
Fire fighting and cooling water contaminated by inventory					Not flammable	No	Low	L	Low in the example in the ADBA Tool.
							Spillages Overall Rating	L	All the hazards are "Low" therefore the overall rating is low

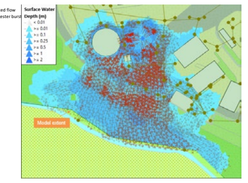
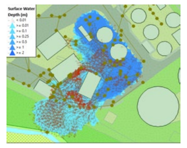
Risk quantification		
Material	Volume (m3)	Environmental Hazard Rating
Wet Sludge	0-99	Low
	100-999	Medium
	1000+	High

Sources Overall Hazard Rating: H

H
M
L

The table shows what needs to be considered and its suggested Hazard Rating. Complete this table for your site to act as a reference and then use your judgement to assign hazard ratings in the yellow boxes.
The tool then combines these to calculate the overall pathway hazard rating.

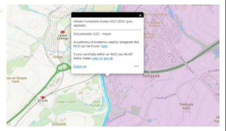
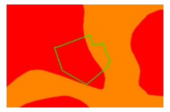
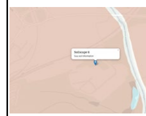
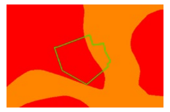
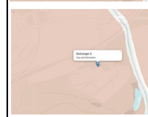
Postcode TR27 6JP

Pathway - the route from primary containment to receptor	Environmental hazard rating	Notes	Source	Description	Link	Image	Source	Description	Source	Source
Site layout and drainage										
If any of the site inventory has a runoff time of a few minutes...		N/A - Run-off time is an estimate of how long it would take to flow to the nearest receptor.								
If any of the site inventory has a runoff time of a few hours....	H	The Site is located on hardstanding and is surrounded by roads, a railway and other industrial buildings to the north. The closest surface water receptors are between 50m and 75m east and south of the Site. Should any of the Site containment systems fail and inventory flowed beyond the Site boundary, it is expected that the runoff time would be a few hours, due to the form of sludge and the distance to the receptors. Contour mapping suggests there is minimal elevation at the Site. 2D modelling has been completed for Hayle WWTW that identifies sludge would leave the site. However, realistically the physical property of sludge is slow flowing suspension and relatively immobile.	Secondary containment modelling assessment Stantec UK, January 2023 Site drainage drawings and information presented below	A 2D InfoWorks ICM hydraulic model has been built for Hayle STW site to represent the failure of specific site assets and the resulting overland flow paths for the spilled flow. The aim of the modelling was initially to check whether failure of the named tanks would result in spilled flow reaching the adjacent watercourse, and then to develop a containment solution to prevent this from occurring. The hydraulic model was built from existing site information including OS mapping, site drainage surveys, drone surveys and LiDAR data to represent the likely path of overland flows Simulations were carried out representing the release of 110% of the volumes of a primary digester, secondary digester and the sludge balancing tank. Results from those simulations indicate that the spilled flows from the primary and secondary digesters were predicted to reach the watercourse on the western side of the site. Flows from the sludge balancing tank were not predicted to impact any watercourse.	Figure 6: Hayle WwTW predicted flow paths following secondary digester burst -->		Figure 7: Hayle WwTW predicted flow paths following primary digester burst -->			
If any of the site inventory has a runoff time of a few days...		N/A - Run-off time is an estimate of how long it would take to flow to the nearest receptor.								
If any of the site inventory has a runoff time of a few weeks										
Topography, geology and hydrology										
Made ground (artificial ground)	M	No artificial deposits are shown on site in the BGS Geoviewer. However, the Environmental Quantitative Risk Assessment (EQRA) states that Made Ground has been identified in all the boreholes in the wider STW with thicknesses of approximately 3 m in the east and between approximately 2 and 4 m in the west. The Made Ground is described as consisting predominantly of sand and gravel with layers of clay; the absence of man-made materials (e.g., concrete) suggested that it is likely that this Made Ground was deposited prior to the development of the sewage works and may be associated with mine workings that are thought to pre-date it. Given the nature of the Made Ground identified, with the absence of man-made materials, a Medium Environmental Hazard Rating has been conservatively selected.	BGS geoviewer	No artificial deposits shown on Site.	GeoIndex - British Geological Survey (bgs.ac.uk)		Environmental Quantitative Risk Assessment - Hayle Waste Water Treatment Works (WWTW). Stantec UK, Revision 02, September 2022	Made Ground has been identified in all the boreholes in the wider STW with thicknesses of approximately 3 m in the east and between approximately 2 and 4 m in the west. The Made Ground is described as consisting predominantly of sand and gravel with layers of clay; the absence of man-made materials (e.g., concrete) suggested that it is likely that this Made Ground was deposited prior to the development of the sewage works and may be associated with mine workings that are thought to pre-date it.		
Alluvium - Superficial deposits - Secondary A aquifer	M	Superficial deposits are not mapped beneath the installation area. However, the alluvium in the east / south of the wider STW is classified as a Secondary A aquifer and the Tidal Flat Deposits are a Secondary undifferentiated aquifer. This is due to permeable layers they contain being capable of supporting water supplies at a local scale. The deposits of alluvium are associated with the River Hayle. The BGS Lexicon (BGS, 2021) describes alluvium as typically comprising compressible silty clay, but also containing layers of silt, sand, peat and basal gravels. It is the unconsolidated detrital material deposited by a river, stream or other body of running water. Limited tidal flat deposits may be present on the installation's northern boundary. The BGS Lexicon (BGS, 2021) describes Tidal Flat Deposits as typically comprising unconsolidated sediment, mainly mud and/or sand. Although there are no superficial deposits beneath the installation area, a Medium Environmental Hazard Rating has been selected given the Secondary A aquifer associated with the alluvium beneath the wider STW Site.	BGS geoviewer	Alluvium (Gravel, Sand, Silt and Clay), and Tidal Flat Deposits	https://mapapps2.bgs.ac.uk/geoindex/home.html?layers=BGSBedrock50,BGSSuperficial50,BGSArtificial50,BGSMass50,BGSLinearFeat50		Environmental Quantitative Risk Assessment - Hayle Waste Water Treatment Works (WWTW). Stantec UK, Revision 02, September 2022	The alluvium in the east / south of the STW is classified as a Secondary A Aquifer and the Tidal Flat Deposits are a Secondary undifferentiated aquifer. This is due to permeable layers they contain being capable of supporting water supplies at a local scale.		
Mylor Slate Formation - Bedrock (slate and siltstone) - Secondary A aquifer	M	The majority of the installation area is underlain by the Mylor Slate Formation (Bedrock) which is described by the BGS Lexicon (BGS, 2021) as slates interbedded with thin bands and laminae of sandstone, graded and locally cross-bedded siltstone, basic laval and sedimentary breccias. An inferred mineral vein is indicated to cross the southern area of the site in a east - west direction. The Mylor Slate Formation is classified as a Secondary A aquifer due to the permeable layers they contain being capable of supporting water supplies at a local scale. Consequently, a Medium Environmental Hazard Rating has been selected given the location of the installation over the Secondary A aquifer associated with the Mylor Slate Formation.	BGS geoviewer	Mylor Slate Formation	GeoIndex - British Geological Survey (bgs.ac.uk)		Environmental Quantitative Risk Assessment - Hayle Waste Water Treatment Works (WWTW). Stantec UK, Revision 02, September 2022	The Mylor Slate Formation is classified as a Secondary A Aquifer due to the permeable layers they contain being capable of supporting water supplies at a local scale.		
Drainage ditches	M	Surface water in the area is expected to generally drain to the east and south towards the River Hayle and its tributaries following the local topography. There are no surface water features present on the WWTW itself, however various streams and issues are located within the Lower Covert plantation to the south of the WWTW which flow in an easterly direction towards a large pool and the River Hayle. The closest issue and stream to the WWTW are located around 30 m to the south-west. Two smaller pools are located within the plantation close to the WWTW with the large pool lying to adjacent to the southern boundary of the STW / immediately to the west of the River Hayle. The ditches will transport any contaminants that enter them through surface water runoff, groundwater flow and other potential receptors downstream, i.e. River Hayle. A Medium Environmental Hazard Rating has been selected.	Environmental Quantitative Risk Assessment - Hayle Waste Water Treatment Works (WWTW). Stantec UK, Revision 02, September 2022	Surface water in the area is expected to generally drain to the east and south towards the River Hayle and its tributaries following the local topography. The are no surface water features present on the WWTW itself, however various streams and issues are located within the Lower Covert plantation to the south of the WWTW which flow in an easterly direction towards a large pool and the River Hayle. The closest issue and stream to the WWTW are located around 30 m to the south-west. Two smaller pools are located within the plantation close to the WWTW with the large pool lying to adjacent to the southern boundary of the STW / immediately to the west of the River Hayle.	https://stantec.sharepoint.com/:w:/r/teams/SWW-IEDRiskAssessments/ExternalSubs/Shared%20Documents/Hayle%20Resubmission/Appendices/App%206%20EQRA/7237.Stantec..HayleZZ..Z.10031.docx?d=we50a0dc3eea24cee8df8f077cc10481b&csf=1&web=1&e=FsNikn					
River Hayle	H	The River Hayle, running northerly east of the WwTW, is situated within the 'Hayle Red River and Northern Streams' waterbody. This waterbody has an overall WFD classification of 'Moderate', with an ecological status of 'Moderate' and a chemical status of 'Good'. The River Hayle will transport any contaminants that enter the river through surface water runoff, groundwater flow and other potential receptors downstream. A High Environmental Hazard Rating has been selected as there is potential for site inventory to run off from the Site to the River Hayle.	Catchment Data Explorer (CDE)	The River Hayle, running northerly east of the WwTW, is situated within the 'Hayle Red River and Northern Streams' waterbody. This waterbody has an overall WFD classification of 'Moderate', with an ecological status of 'Moderate' and a chemical status of 'Good'.	Hayle | Catchment Data Explorer | Catchment Data Explorer		Environmental Quantitative Risk Assessment - Hayle Waste Water Treatment Works (WWTW). Stantec UK, Revision 02, September 2022			
Mitigation - do these apply?										
Some secondary and tertiary containment system is present (see Likelihood assessment) Majority of spills will be contained within the hard surfaced and drained areas and returned to the WwTW for treatment.										
Path & Mitigation Overall Rating	M	Justification: - There is good secondary containment around the main storage tanks. - The majority of the sludge would be contained within hard surfaced and drained areas and returned to the WwTW for treatment. Therefore, a Medium Environmental Hazard Rating has been selected.								
Climatic conditions										
Annual rainfall < 1000 mm — 1075.84mm	M	- The annual rainfall is more than 1,000 mm Therefore, a Medium Environmental Hazard Rating has been selected	Met Office	UK climate averages Camborne, 1991-2020	Camborne (Cornwall) UK climate averages - Met Office					
Fire Fighting Water										
Flammable materials normally present on site in large quantities	M	- There are some flammable materials on the Site that would combust over long periods and may require significant volumes of fire fighting water. Therefore, a Medium Environmental Hazard Rating has been selected.	Environmental Quantitative Risk Assessment - Hayle Waste Water Treatment Works (WWTW). Stantec UK, Revision 02, September 2022	Refer to 'Source' tab for details of flammable materials stored.						
Fire fighting and cooling water contaminated by inventory	L	- If firefighting was needed on the site the site drainage system returns surface water to treatment within the WwTW. - Fire water is therefore not considered to be a pathway risk. Therefore, a Low Environmental Hazard Rating has been selected.	Environmental Quantitative Risk Assessment - Hayle Waste Water Treatment Works (WWTW). Stantec UK, Revision 02, September 2022	There is an engineered drainage system at the WWTW with ground level gullies that capture run-off and any spillages from areas of hard-standing and route them through the system to the return pumping station or incoming sewers pumping station back to the STW to be treated.						
Location										
Flooding	M	- The majority of the site (including all of the new installation boundary) is classed as Flood Zone 1. However the eastern boundary overlaps into Flood Zone 2 and 3. The adjacent river does benefit from a flood barrier which borders the eastern side of the Site mitigating the impact of flooding. Therefore, a Medium Environmental Hazard Rating has been selected.	EA Flood Map for Planning	The Hayle WwTW is mostly classified as a Flood Zone 1 (low risk of flooding). However, the eastern boundary does border Flood Zones 2 and 3.	Flood risk information for this location - Flood map for planning - GOV.UK (flood-map-for-planning.service.gov.uk)					
Site is connected to a Wastewater Treatment Works	L	- The WwTW is designed with capacity to treat peaks in flow and loads including from surface water drainage input from the site. - The Site is connected to a WwTW. The potential risk of releases via the WwTW is considered to be low. Therefore, a Low Environmental Hazard Rating has been selected.	Environmental Quantitative Risk Assessment - Hayle Waste Water Treatment Works (WWTW). Stantec UK, Revision 02, September 2022							
The site is on a built up area with a fall to the east and south	M	The STW is situated at an elevation of approximately 5 to 8 m AOD (which appears to be built up and slightly higher than the surrounding area). The ground surface at the STW locally falls to the east and to the south. Therefore, a Medium Environmental Hazard Rating has been selected.	Environmental Quantitative Risk Assessment - Hayle Waste Water Treatment Works (WWTW). Stantec UK, Revision 02, September 2022	The STW is situated at an elevation of approximately 5 to 8 m AOD (which appears to be built up and slightly higher than the surrounding area) on the lower western flank of a north-south orientated valley that contains the River Hayle at its base. In the wider area, the ground surface rises gradually westwards from close to sea level adjacent to the river to over 170 m AOD c. 3 km to the west of the STW; a smaller valley that contains a tributary to the river is situated immediately to the south of the STW. As a result, the ground surface at the STW locally falls to the east and to the south.						
Site Considerations Overall Rating	M									

Pathway Overall Hazard Rating H

The table shows what needs to be considered and its suggested Hazard Rating. Complete this table for your site to act as a reference and then use your judgement to assign hazard ratings in the yellow boxes. The tool then combines these to calculate the overall receptors hazard rating.

Postcode TR27 6JP

Receptors	Within	units		Environmental hazard rating	Notes	Source	Description	Link	Image	Source	Description	Source	Description	Source
Watercourses and bodies														
Drainage ditches and connected pools	50	m		M	Unnamed drainage ditches are located to the south of the installation, between 50 m and 100 m of the southern boundary along its length. These all flow eastwards towards the River Hayle. Historical maps (1945-1965) indicate that the drainage channel has been expanded in recent years and is fed into by smaller ditches along its path. The area was also previously marsh land. This change was likely made to accommodate the expansion of the WwTW. Two smaller pools are located within the plantation close to the WWTW. Given the likely sensitivity of this receptor, a Medium Environmental Hazard Rating has been selected.	Environmental Quantitative Risk Assessment - Hayle Waste Water Treatment Works (WWTW). Stantec UK, Revision 02, September 2022	Surface water in the area is expected to generally drain to the east and south towards the River Hayle and its tributaries following the local topography. The are no surface water features present on the WWTW itself, however various streams and issues are located within the Lower Covert plantation to the south of the WWTW which flow in an easterly direction towards a large pool and the River Hayle. The closest issue and stream to the WWTW are located around 30 m to the south-west. Two smaller pools are located within the plantation close to the WWTW with the large pool lying to adjacent to the southern boundary of the STW / immediately to the west of the River Hayle.			Map images - National Library of Scotland (nls.uk)	Ordnance Survey Mapping - 1945 shows previous extent and route of drainage ditches bordering the Site.			
River Hayle	50	m		H	The River Hayle is located 50 m east of the Site, flowing in a northern direction. This water body has an overall WFD classification of 'moderate', an ecological status of 'Moderate' and a chemical status of 'Good'. The wider area directly adjacent (west) of the River and Site falls within a nitrate vulnerable zone. Given the likely sensitivity of this receptor, a High Environmental Hazard Rating has been selected.	Drinking Water Safeguard Zones and NVZs	Groundwater G22 - Hayle	https://environment.data.gov.uk/farmers/		Water Framework Directive - 2nd River Basin Management Plans - Quality Elements | ArcGIS Hub				
Fisheries pond / large pool	75	m		M	A fisheries pond is located approximately 75 m south of the Site. Google maps indicates that this is a enclosed surface water body and not directly linked to the River Hayle (albeit is situated in close proximity <25m). Water levels may vary seasonally with rainfall. Two smaller pools are located within the plantation close to the WWTW with the large pool (fisheries pool) lying to adjacent to the southern boundary of the STW / immediately to the west of the River Hayle. Given the likely sensitivity of this receptor, a Medium Environmental Hazard Rating has been selected.	Google Maps				Environmental Quantitative Risk Assessment - Hayle Waste Water Treatment Works (WWTW). Stantec UK, Revision 02, September 2022				
Hayle Estuary and Carrack Gladden Site of Special Scientific Interest (SSSI)	200	m		H	Hayle Estuary and Carrack Gladden SSSI, noted for it biological interest, is located approximately 200m North of the Site. The estuary is fed by the River Hayle which runs adjacent to the Site. Given the sensitivity of the SSSI and relatively close proximity to the Site, a High Environmental Hazard Rating has been selected.	Magic map Site of Special Scientific Interest.	Hayle Estuary and Carrack Gladden SSSI provides biological interest.	https://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=s1003229						
Alluvium - Superficial deposits - Secondary A aquifer	50	m		M	Classified as a Secondary A Aquifer, therefore Medium Environmental Hazard Rating. Secondary A Aquifers are defined as formations with permeable layers capable of supporting water supplies at a local rather than strategic scale and in some cases forming an important source of base flow to rivers.	MAGIC Landscape Geology and Soils Aquifer Designation Map (Superficial drift), groundwater vulnerability, and Soilscape map (England), BGS Geoviewer	Secondary A Classification Medium Typology Secondary A Aquifer Designation Map (Superficial Drift) (England) Typology Secondary A Groundwater Vulnerability Map (England) Classification High Soilscape (England) reference 6 (freely draining slightly acid loamy soils)	https://magic.defra.gov.uk/magicmap.aspx						
Mylor Slate Formation - Bedrock (slate and siltstone) - Secondary A aquifer	Beneath site			M	Classified as a Secondary A Aquifer, therefore Medium Environmental Hazard Rating. No nearby groundwater source protection zones (SPZs). It is assumed that the groundwater in the bedrock will be in hydraulic connection to the Made Ground, superficial deposits and the surface water features.	MAGIC Landscape Geology and Soils Aquifer Designation Map (Bedrock) (England), BGS Geoviewer	Secondary A Classification Medium Typology Secondary A Aquifer Designation Map (Superficial Drift) (England) Typology Secondary A Groundwater Vulnerability Map (England) Classification Medium Soilscape (England) reference 6	https://magic.defra.gov.uk/MagicMap.aspx http://mapapps2.bgs.ac.uk/geoindex/home.html						
Abstractions (groundwater and surface water)	N/A	m		M	The two closest surface water abstractions are located around 800 m from the WWTW to the south-east at Trenhayle Farm, St Erth and to the north-west at Trevethoe, Hayle – Mill Leat for spray irrigation and drinking/cooking/sanitary/washing (small garden). The closest groundwater abstraction is located in the south-eastern corner of the WWTW for processing. However, it is understood from SWW that this abstraction is not currently used. There are no nearby groundwater source protection zones (SPZs). Given the distances to the closest surface water receptors and the status of the groundwater abstraction, a Medium Environmental Hazard Rating has been selected.	Magic map Source Protection Zones merged (England)	Magic map: No SPZs			Environmental Quantitative Risk Assessment - Hayle Waste Water Treatment Works (WWTW). Stantec UK, Revision 02, September 2022	The EA has provided information on 10 licenced groundwater abstractions within 4 km of the WWTW. The closest groundwater abstraction (15/49/252/G/066) is operated by South West Water Services and is located in the south-eastern corner of the WWTW for processing. It has an annual volume of 37,823 m3 and maximum daily volume of 145.4 m3. However, it is understood from SWW that this abstraction is not currently used. The EA has confirmed that there are 15 licenced surface water abstraction points within 4 km of the WWTW. Two are located around 800 m from the WWTW to the south-east at Trenhayle Farm, St Erth and to the north-west at Trevethoe, Hayle – Mill Leat for spray irrigation and drinking/cooking/sanitary/washing (small garden). These are sources from springs / drains that eventually feed into Hayle Estuary. A further abstraction is located 1.9 km south (up-stream) of the WWTW along the River Hayle for spray irrigation. An additional licence at Porthcollum Farm, Hayle located 1.9 km south of the WWTW.			
WwTWs	25	m		L	The WwTWs is a very large operation. Direct impact on operation is extremely unlikely as sludge would not accumulate to a depth where there was risk of disruption to control cabinets or other assets.									
			Water Overall Rating	H	Justification: Close proximity to the River Hayle and the Hayle Estuary and Carrack Gladden SSSI.									
Habitation														
Railway	75	m		L	The Hayle / Penzance railway line is situated on an embankment c. 75m to the north east of the Site and borders the northern boundary. The Rouse-an-Grouse Train station is located approximately 500 m west of the Site.	Google Earth (2023)								
Residences	200	m		M	Residential properties 100m east of the Site. The larger residential area of St Erth is situated approximately 600m south of the Site.	Google Earth (2023)								
Commercial / industrial	500	m		L	Commercial / industrial units are situated c. 500m north west of the compound	Google Earth (2023)								
Other														

Receptors Overall Hazard Rating H

H
M
L

The table below is filled in based on your inputs in the "hazard" worksheets 1a, 1b and 1c. The tool then combines these to calculate the overall site hazard rating.

Calculated hazard ratings:

Source	Pathway	Receptor	**Site Hazard Rating**
H	H	H	**High**

The table below shows the various combinations and their consequent overall site hazards taken from CIRIA 736 and is only provided here for your information.

Possible Combination			Site Hazard Rating
L	L	L	Low
M	M	L	Low
H	L	L	Low
M	M	M	Medium
H	M	L	Medium
H	H	L	Medium
H	M	M	High
H	H	M	High
H	H	H	High

Rating lookup table

L	1
M	2
H	3

This assessment score

	3	3	3	27

Risk	Description of Risk	UNMITIGATED LIKELIHOOD	Mitigation applied	MITIGATED LIKELIHOOD
Imported Sludge Balancing Tank 345 m3 working volume Spillage of non hazardous sludge: - catastrophic failure of tank - tank overflow or - tank leaks.	**Containment**: - Steel tank construction. Constructed in approx. 2001. - Tank is entirely above ground. - Tank has a secondary containment system in place. - The tank is surrounded by impermeable hardstanding which drains back to the Head of Works for treatment. **Failure risk:** - **Catastrophic tank failure** - This tank is approx. 22 years old. There is no knowledge of past leaks. The potential is therefore considered **medium**. - **Tank overflow or leaks** - There is no automatic overspill prevention system in place, therefore the risk of overflow is **medium**. The high-level overflow also drains into the site drainage system and is then returned to the head of the works. - **Potential for minor leakage** around pipe flanges. Emission due to leaks is therefore considered **medium**. -**Shortcomings or failure in operational control system** - the site is maintained inline with a maintenance schedule and the EMS to ensure ongoing operation of all plant items. Operators are trained in the running of plant items. Likelihood of emissions due to operational failure is **low** - **Abuse** -all site staff and tanker Operators are trained to operate the site plant. Likelihood of emissions due to abuse is **low** - **Impact** - the tank is protected by bollards. Likelihood of emissions due to impacts **low** - **Vandalism**, etc. - all plant is within a fenced and gated site, with access to the site control by security. Likelihood of emissions due to vandalism is **low** - **Fire, explosion** - the tank is vented so flammable gases would not build up in the tank. Likelihood of emissions due to fire or explosion is **low** - **Geological factors** - There has been no evidence of wider geotechnical issues during the time the plant has been operational on the site. Likelihood of emissions due to geological issues is **low** - **Ageing** - Tank constructed in 2001. Likelihood of emissions due to age is **low** - **Lightning strike** - the tank is low relative to other structures within the area therefore unlikely to be struck by lightning. Likelihood of emissions due to lightning is **low**	M	- Tanks visually inspected regularly. - Technically competent management (TCM) checks are conducted regularly. - Minor to moderate spills will be cleaned up before there has been sufficient time for infiltration into the ground. - In the event of overflow of contaminants, site operatives will react with an emergency spill response and clean up the area that has been contaminated.	L
Pipework associated with the Imported Sludge Balancing Tank - Spillage of non hazardous sludge: catastrophic failure and leaks from pipework.	**Containment:** - All pipelines are of modern construction. **Failure risk:** - **Catastrophic pipe failure** - Pipework constructed in approx. 2001, therefore the potential for catastrophic failure is considered **low.** - **Leaks from over ground pipework** - Any leaks would be contained by the site drainage. The potential for emission is therefore considered **low.** - **Leaks from underground pipework** - there is no pipework underground, the risk of emission due to leaks is therefore considered to be **low**. - **Catastrophic failure of pipe joints and flanges**, particularly downstream of the pumps - Any sudden loss of pressure related to a catastrophic pipe failure would be identified by the site SCADA system resulting all pumping being stopped and an alarm on the site SCADA system, therefore reducing any emissions. Likelihood of emissions due to catastrophic pipe failure is considered **medium**. -**Shortcomings or failure in operational control system** - the site is maintained inline with a maintenance schedule and the EMS to ensure ongoing operation of all plant items. Operators are trained in the running of plant items. Likelihood of emissions due to operational failure is **low** - **Abuse** -all site staff and tanker Operators are trained to operate the site plant. Likelihood of emissions due to abuse is **low** - **Impact** - The pipework is protected by bollards. Likelihood of emissions due to impacts **low** - **Vandalism**, etc. - all plant is within a fenced and gated site, with access to the site control by security. Likelihood of emissions due to vandalism is **low** - **Fire, explosion** - the pipework is not routed along areas of potential flammable atmosphere. Likelihood of emissions due to fire or explosion is **low** - **Geological factors** - There has been no evidence of wider geotechnical issues during the time the plant has been operational on the site. Likelihood of emissions due to geological issues is **low** - **Ageing** - The pipework was installed in approx. 2001. They are monitored to check for leakages and material failure. Likelihood of emissions due to age is **low** - **Lightning strike** - the pipework is low relative to other structures within the area therefore unlikely to be struck by lightning. Likelihood of emissions due to lightning is **low**	M	- Pipework visually inspected regularly. - TCM checks are conducted regularly. - Minor to moderate spills will be cleaned up before there has been sufficient time for infiltration into the ground. - In the event of overflow of contaminants, site operatives will react with an emergency spill response and clean up the area that has been contaminated. - Leak Detection and Repair (LDAR) Programme in place.	L
Sludge Balancing Tank 699 m3 working volume Spillage of non hazardous sludge: - catastrophic failure of tank - tank overflow or - tank leaks.	**Containment**: - Steel tank construction. Constructed in approx. 2017. - Tank is entirely above ground. - Tank has a secondary containment system in place. - The tank is surrounded by impermeable hardstanding which drains back to the Head of Works for treatment. **Failure risk:** - **Catastrophic tank failure** - This tank is approx. 6 years old. There is no knowledge of past leaks. The potential is therefore considered **medium**. - **Tank overflow or leaks** - There is no automatic overspill prevention system in place, therefore the risk of overflow is **medium**. The high-level overflow also drains into the site drainage system and is then returned to the head of the works. - **Potential for minor leakage** around pipe flanges. Emission due to leaks is therefore considered **medium**. -**Shortcomings or failure in operational control system** - the site is maintained inline with a maintenance schedule and the EMS to ensure ongoing operation of all plant items. Operators are trained in the running of plant items. Likelihood of emissions due to operational failure is **low** - **Abuse** -all site staff and tanker Operators are trained to operate the site plant. Likelihood of emissions due to abuse is **low** - **Impact** - the tank is away from the road and protected by railings. Likelihood of emissions due to impacts **low** - **Vandalism**, etc. - all plant is within a fenced and gated site, with access to the site control by security. Likelihood of emissions due to vandalism is **low** - **Fire, explosion** - the tank is vented so flammable gases would not build up in the tank. Likelihood of emissions due to fire or explosion is **low** - **Geological factors** - There has been no evidence of wider geotechnical issues during the time the plant has been operational on the site. Likelihood of emissions due to geological issues is **low**	M	- Tanks visually inspected regularly. - TCM checks are conducted regularly. - Minor to moderate spills will be cleaned up before there has been sufficient time for infiltration into the ground. - In the event of overflow of contaminants, site operatives will react with an emergency spill response and clean up the area that has been contaminated.	L

Risk	Description of Risk	UNMITIGATED LIKELIHOOD	Mitigation applied	MITIGATED LIKELIHOOD
	- Ageing - Tanks constructed in approx. 2017. Likelihood of emissions due to age is low			
	- **Lightning strik**e - the tank is low relative to other structures within the area therefore unlikely to be struck by lightning. Likelihood of emissions due to lightning is **low**			
Pipework associated with Sludge Balancing Tank - Spillage of non hazardous sludge: catastrophic failure and leaks from pipework.	**Containment:** - All pipelines are of modern construction.	M	- Pipework visually inspected regularly. - TCM checks are conducted regularly. - Minor to moderate spills will be cleaned up before there has been sufficient time for infiltration into the ground. - In the event of overflow of contaminants, site operatives will react with an emergency spill response and clean up the area that has been contaminated. - Leak Detection and Repair (LDAR) Programme in place.	L
	Failure risk:			
	- **Catastrophic pipe failure** - Pipework constructed in approx. 2017, therefore the potential for catastrophic failure is considered **low.**			
	- **Leaks from over ground pipework** - Any leaks would be contained by the site drainage. The potential for emission is therefore considered low.			
	- **Leaks from underground pipework** - there is no pipework underground, the risk of emission due to leaks is therefore considered to be **low**.			
	- **Catastrophic failure of pipe joints and flanges**, particularly downstream of the pumps - Any sudden loss of pressure related to a catastrophic pipe failure would be identified by the site SCADA system resulting all pumping being stopped and an alarm on the site SCADA system, therefore reducing any emissions. Likelihood of emissions due to catastrophic pipe failure is considered **medium**.			
	-**Shortcomings or failure in operational control system -** the site is maintained inline with a maintenance schedule and the EMS to ensure ongoing operation of all plant items. Operators are trained in the running of plant items. Likelihood of emissions due to operational failure is **low**			
	- **Abuse** -all site staff and tanker Operators are trained to operate the site plant. Likelihood of emissions due to abuse is **low**			
	- **Impact** - the pipework is away from the road and protected by railings. Likelihood of emissions due to impacts **low**			
	- **Vandalism**, etc. - all plant is within a fenced and gated site, with access to the site control by security. Likelihood of emissions due to vandalism is **low**			
	- **Fire, explosion** - the pipework is not routed along areas of potential flammable atmosphere. Likelihood of emissions due to fire or explosion is **low**			
	- **Geological factors** - There has been no evidence of wider geotechnical issues during the time the plant has been operational on the site. Likelihood of emissions due to geological issues is **low**			
	- **Ageing** - The pipework was installed in approx. 2017. They are monitored to check for leakages and material failure. Likelihood of emissions due to age is **low**			
	- **Lightning strike** - the pipework is low relative to other structures within the area therefore unlikely to be struck by lightning. Likelihood of emissions due to lightning is **low**			
Screened Sludge Tank 600 m3 working volume Spillage of non hazardous sludge: - catastrophic failure of tank - tank overflow or - tank leaks.	**Containment**: - Concrete tank construction. Constructed in approx. 1994. - Tank is partially below ground. - The tank is surrounded by impermeable hardstanding which drains back to the Head of Works for treatment.	M	- Tanks visually inspected regularly. - TCM checks are conducted regularly. - Minor to moderate spills will be cleaned up before there has been sufficient time for infiltration into the ground. - In the event of overflow of contaminants, site operatives will react with an emergency spill response and clean up the area that has been contaminated.	L
	Failure risk:			
	- **Catastrophic tank failure** - This tank is approx. 29 years old. There is no knowledge of past leaks. The potential is therefore considered **medium**.			
	- **Tank overflow or leaks** - There is no automatic overspill prevention system in place, therefore the risk of overflow is **medium**. The high-level overflow also drains into the site drainage system and is then returned to the head of the works.			
	- **Potential for minor leakage** around pipe flanges. Emission due to leaks is therefore considered **medium**.			
	-**Shortcomings or failure in operational control system -** the site is maintained inline with a maintenance schedule and the EMS to ensure ongoing operation of all plant items. Operators are trained in the running of plant items. Likelihood of emissions due to operational failure is **low**			
	- **Abuse** -all site staff and tanker Operators are trained to operate the site plant. Likelihood of emissions due to abuse is **low**			
	- **Impact** - the tank is away from the road and protected by railings. Likelihood of emissions due to impacts **low**			
	- **Vandalism**, etc. - all plant is within a fenced and gated site, with access to the site control by security. Likelihood of emissions due to vandalism is **low**			
	- **Fire, explosion** - the tank is vented so flammable gases would not build up in the tank. Likelihood of emissions due to fire or explosion is **low**			
	- **Geological factors** - There has been no evidence of wider geotechnical issues during the time the plant has been operational on the site. Likelihood of emissions due to geological issues is **low**			
	- **Ageing** - Tank constructed in approx. 1994. Likelihood of emissions due to age is **low**			
	- **Lightning strike** - The tank is partially below ground, therefore it is unlikely to be struck by lightning. Likelihood of emissions due to lightning is **low**			
Pipework associated with the Screened Sludge Tank - Spillage of non hazardous sludge: catastrophic failure and leaks from pipework.	**Containment:** - All pipelines are of modern construction.	M	- Pipework visually inspected regularly. - TCM checks are conducted regularly. - Minor to moderate spills will be cleaned up before there has been sufficient time for infiltration into the ground. - In the event of overflow of contaminants, site operatives will react with an emergency spill response and clean up the area that has been contaminated. - Leak Detection and Repair (LDAR) Programme in place.	L
	Failure risk:			
	- **Catastrophic pipe failure** - Pipework constructed in approx. 1994, therefore the potential for catastrophic failure is considered **low.**			
	- **Leaks from over ground pipework** - Any leaks would be contained by the site drainage. The potential for emission is therefore considered low.			
	- **Leaks from underground pipework** - there is no pipework underground, the risk of emission due to leaks is therefore considered to be **low**.			
	- **Catastrophic failure of pipe joints and flanges**, particularly downstream of the pumps - Any sudden loss of pressure related to a catastrophic pipe failure would be identified by the site SCADA system resulting all pumping being stopped and an alarm on the site SCADA system, therefore reducing any emissions. Likelihood of emissions due to catastrophic pipe failure is considered **low**.			
	-**Shortcomings or failure in operational control system -** the site is maintained inline with a maintenance schedule and the EMS to ensure ongoing operation of all plant items. Operators are trained in the running of plant items. Likelihood of emissions due to operational failure is **low**			
	- **Abuse** -all site staff and tanker Operators are trained to operate the site plant. Likelihood of emissions due to abuse is **low**			
	- **Impact** - the pipework is away from the road and protected by railings. Likelihood of emissions due to impacts **low**			

Risk	Description of Risk	UNMITIGATED LIKELIHOOD	Mitigation applied	MITIGATED LIKELIHOOD
	- **Vandalism**, etc. - all plant is within a fenced and gated site, with access to the site control by security. Likelihood of emissions due to vandalism is **low** - **Fire, explosion** - the pipework is not routed along areas of potential flammable atmosphere. Likelihood of emissions due to fire or explosion is **low** - **Geological factors** - There has been no evidence of wider geotechnical issues during the time the plant has been operational on the site. Likelihood of emissions due to geological issues is **low** - **Ageing** - The pipework was installed in approx. 1994. They are monitored to check for leakages and material failure. Likelihood of emissions due to age is **low** - **Lightning strike** - the pipework is low relative to other structures within the area therefore unlikely to be struck by lightning. Likelihood of emissions due to lightning is **low**			
Primary Digesters 2 x 1,561 m3 Spillage of non hazardous sludge: - catastrophic failure of tank - tank overflow or - tank leaks.	**Containment**: - Steel tank construction. Constructed in approx. 1993/4. - Tanks are entirely above ground. - Tanks have a secondary containment system in place. - Tanks are partially surrounded by impermeable hardstanding which drains back to the Head of Works for treatment. **Failure risk:** - **Catastrophic tank failure** - The tanks are approx. 30 years old. There is no knowledge of past leaks. The potential is therefore considered **medium**. - **Tank overflow or leaks** - There is no automatic overspill prevention system in place, therefore the risk of overflow is **medium**. The high-level overflow also drains into the site drainage system and is then returned to the head of the works. - **Potential for minor leakage** around pipe flanges. Emission due to leaks is therefore considered **medium**. -**Shortcomings or failure in operational control system** - the site is maintained inline with a maintenance schedule and the EMS to ensure ongoing operation of all plant items. Operators are trained in the running of plant items. Likelihood of emissions due to operational failure is **low** - **Abuse** -all site staff and tanker Operators are trained to operate the site plant. Likelihood of emissions due to abuse is **low** - **Impact** - the tanks are protected by a wall and fencing, also access is restricted within the digester tanks area. Likelihood of emissions due to impact **low** - **Vandalism**, etc. - all plant is within a fenced and gated site, with access to the site control by security. Likelihood of emissions due to vandalism is **low** - **Fire, explosion** - The tanks are designed to contain a process in which biogas generation is encouraged, this includes intentional storage of biogas within the digester headspace. Under normal operation this is not explosive due to the lack of oxygen, and as a further safeguard, equipment installed within the digester (ATEX rated) is selected to ensure that it cannot become a source of ignition. Likelihood of emissions due to fire or explosion is **medium** - **Geological factors** - There has been no evidence of wider geotechnical issues during the time the plant has been operational on the site. Likelihood of emissions due to geological issues is **low** - **Ageing** - Tank constructed in approx. 1993/4. Likelihood of emissions due to age is **medium** - **Lightning strike** - The tanks have lightning protection. Likelihood of emissions due to lightning is **low**	M	- Tanks visually inspected regularly. - TCM checks are conducted regularly. - Minor to moderate spills will be cleaned up before there has been sufficient time for infiltration into the ground. - In the event of overflow of contaminants, site operatives will react with an emergency spill response and clean up the area that has been contaminated.	L
Pipework associated with the Primary Digesters - Spillage of non hazardous sludge: catastrophic failure and leaks from pipework.	**Containment:** - All pipelines are of modern construction. **Failure risk:** - **Catastrophic pipe failure** - Pipework constructed in approx. 1993/4, therefore the potential for catastrophic failure is considered **low.** - **Leaks from over ground pipework** - Any leaks would be contained by the site drainage. The potential for emission is therefore considered **low.** - **Leaks from underground pipework** would be emitted to ground, this has been included as part of the improvement programme. The risk of emission due to leaks is therefore considered to be **high**. - **Catastrophic failure of pipe joints and flanges**, particularly downstream of the pumps - Any sudden loss of pressure related to a catastrophic pipe failure would be identified by the site SCADA system resulting all pumping being stopped and an alarm on the site SCADA system, therefore reducing any emissions. Likelihood of emissions due to catastrophic pipe failure is considered **low**. -**Shortcomings or failure in operational control system** - the site is maintained inline with a maintenance schedule and the EMS to ensure ongoing operation of all plant items. Operators are trained in the running of plant items. Likelihood of emissions due to operational failure is **low** - **Abuse** -all site staff and tanker Operators are trained to operate the site plant. Likelihood of emissions due to abuse is **low** - **Impact** - the pipework is protected by a wall and fencing, also access is restricted within the digester tanks area. Likelihood of emissions due to impact is **low** - **Vandalism**, etc. - all plant is within a fenced and gated site, with access to the site control by security. Likelihood of emissions due to vandalism is **low** - **Fire, explosion** - the pipework is not routed along areas of potential flammable atmosphere. Likelihood of emissions due to fire or explosion is **low** - **Geological factors** - There has been no evidence of wider geotechnical issues during the time the plant has been operational on the site. Likelihood of emissions due to geological issues is **low** - **Ageing** - The pipework was installed in approx. 1993/4. They are monitored to check for leakages and material failure. Likelihood of emissions due to age is **low** - **Lightning strike** - the pipework is low relative to other structures within the area therefore unlikely to be struck by lightning. Likelihood of emissions due to lightning is **low**	H	- Pipework visually inspected regularly. - TCM checks are conducted regularly. - Minor to moderate spills will be cleaned up before there has been sufficient time for infiltration into the ground. - In the event of overflow of contaminants, site operatives will react with an emergency spill response and clean up the area that has been contaminated. - Leak Detection and Repair (LDAR) Programme in place. - Improvement Programme in place to reduce likelihood of leaks from underground pipework.	L
Secondary Digesters 2 x 2,224 m3 working volumes Spillage of non hazardous sludge: - catastrophic failure of tank - tank overflow or - tank leaks.	**Containment**: - Steel tank construction. Constructed in approx. 1993/4. - Tanks are entirely above ground. - The tanks are surrounded by gravel area with vegetation. **Failure risk:** - **Catastrophic tank failure** - The tanks are approx. 30 years old. There is no knowledge of past leaks. The potential is therefore considered **medium**. - **Tank overflow or leaks** - There is no automatic overspill prevention system in place, therefore the risk of overflow is **medium**. The high-level overflow also drains into the site drainage system and is then returned to the head of the works. - **Potential for minor leakage** around pipe flanges. Emission due to leaks is therefore considered **medium**. -**Shortcomings or failure in operational control system** - the site is maintained inline with a maintenance schedule and the EMS to ensure ongoing operation of all plant items. Operators are trained in the running of plant items. Likelihood of emissions due to operational failure is **low**		- Tanks visually inspected regularly. - TCM checks are conducted regularly. - Minor to moderate spills will be cleaned up before there has been sufficient time for infiltration into the ground. - In the event of overflow of contaminants, site operatives will react with an emergency spill response and clean up the area that has been contaminated.	

Risk	Description of Risk	UNMITIGATED LIKELIHOOD	Mitigation applied	MITIGATED LIKELIHOOD
	- **Abuse** -all site staff and tanker Operators are trained to operate the site plant. Likelihood of emissions due to abuse is **low**	M		L
	- **Impact** - Tanks are away from access roads and are protected by metal barriers and fencing. Likelihood of emissions due to impacts is **low**			
	- **Vandalism**, etc. - all plant is within a fenced and gated site, with access to the site control by security. Likelihood of emissions due to vandalism is **low**			
	- **Fire, explosion** - The tanks are designed to contain a process in which biogas generation is encouraged, this includes intentional storage of biogas within the digester headspace. Under normal operation this is not explosive due to the lack of oxygen, and as a further safeguard, equipment installed within the digester is selected to ensure that it cannot become a source of ignition. Likelihood of emissions due to fire or explosion is **medium**			
	- **Geological factors** - There has been no evidence of wider geotechnical issues during the time the plant has been operational on the site. Likelihood of emissions due to geological issues is **low**			
	- **Ageing** - Tank constructed in approx. 1993/4. Likelihood of emissions due to age is **medium**			
	- **Lightning strike** - The tanks have lightning protection. Likelihood of emissions due to lightning is **low**			
Pipework associated with the Secondary Digesters - Spillage of non hazardous sludge: catastrophic failure and leaks from pipework.	**Containment:** - All pipelines are of modern construction.	H	- Pipework visually inspected regularly. - TCM checks are conducted regularly. - Minor to moderate spills will be cleaned up before there has been sufficient time for infiltration into the ground. - In the event of overflow of contaminants, site operatives will react with an emergency spill response and clean up the area that has been contaminated. - Leak Detection and Repair (LDAR) Programme in place. - Improvement Programme in place to reduce likelihood of leaks from underground pipework.	L
	Failure risk:			
	- **Catastrophic pipe failure** - Pipework constructed in approx. 1993/4, therefore the potential for catastrophic failure is considered **low.**			
	- **Leaks from over ground pipework** - Any leaks would be contained by the site drainage. The potential for emission is therefore considered low.			
	- **Leaks from underground pipework** would be emitted to ground, this has been included as part of the improvement programme. The risk of emission due to leaks is therefore considered to be **high**.			
	- **Catastrophic failure of pipe joints and flanges**, particularly downstream of the pumps - Any sudden loss of pressure related to a catastrophic pipe failure would be identified by the site SCADA system resulting all pumping being stopped and an alarm on the site SCADA system, therefore reducing any emissions. Likelihood of emissions due to catastrophic pipe failure is considered **medium**.			
	-**Shortcomings or failure in operational control system -** the site is maintained inline with a maintenance schedule and the EMS to ensure ongoing operation of all plant items. Operators are trained in the running of plant items. Likelihood of emissions due to operational failure is **low**.			
	- **Abuse** -all site staff and tanker Operators are trained to operate the site plant. Likelihood of emissions due to abuse is **low**			
	- **Impact** - pipework is away from access roads and is protected by metal barriers and fencing. Likelihood of emissions due to impacts is **low**			
	- **Vandalism**, etc. - all plant is within a fenced and gated site, with access to the site control by security. Likelihood of emissions due to vandalism is **low**			
	- **Fire, explosion** - the pipework is not routed along areas of potential flammable atmosphere. Likelihood of emissions due to fire or explosion is **low**			
	- **Geological factors** - There has been no evidence of wider geotechnical issues during the time the plant has been operational on the site. Likelihood of emissions due to geological issues is **low**			
	- **Ageing** - The pipework was installed in approx. 1993/4. They are monitored to check for leakages and material failure. Likelihood of emissions due to age is **low**			
	- **Lightning strike** - the pipework is low relative to other structures within the area therefore unlikely to be struck by lightning. Likelihood of emissions due to lightning is **low**			
Return Liquor Balancing Tank 349 m3 working volume Spillage of non hazardous sludge: - catastrophic failure of tank - tank overflow or - tank leaks.	**Containment**: - Steel tank construction. Constructed in approx. 2001. - Tank is partially below ground. - Tank has a secondary containment system in place. - The tank is surrounded by impermeable hardstanding which drains back to the Head of Works for treatment.	M	- Tanks visually inspected regularly. - TCM checks are conducted regularly. - Minor to moderate spills will be cleaned up before there has been sufficient time for infiltration into the ground. - In the event of overflow of contaminants, site operatives will react with an emergency spill response and clean up the area that has been contaminated.	L
	Failure risk:			
	- **Catastrophic tank failure** - The tank is approx. 22 years old. There is no knowledge of past leaks. The potential is therefore considered **medium**.			
	- **Tank overflow or leaks** - There is no automatic overspill prevention system in place, therefore the risk of overflow is **medium**. The high-level overflow also drains into the site drainage system and is then returned to the head of the works.			
	- **Potential for minor leakage** around pipe flanges. Emission due to leaks is therefore considered **medium**.			
	-**Shortcomings or failure in operational control system -** the site is maintained inline with a maintenance schedule and the EMS to ensure ongoing operation of all plant items. Operators are trained in the running of plant items. Likelihood of emissions due to operational failure is **low**			
	- **Abuse** -all site staff and tanker Operators are trained to operate the site plant. Likelihood of emissions due to abuse is **low**			
	- **Impact** - the tank is protected by metal railing. Likelihood of emissions due to impacts is **low**			
	- **Vandalism**, etc. - all plant is within a fenced and gated site, with access to the site control by security. Likelihood of emissions due to vandalism is **low**			
	- **Fire, explosion** - the tank is vented so flammable gases would not build up in the tank. Likelihood of emissions due to fire or explosion is **low**			
	- **Geological factors** - There has been no evidence of wider geotechnical issues during the time the plant has been operational on the site. Likelihood of emissions due to geological issues is **low**			
	- Ageing - Tank constructed in 2001. Likelihood of emissions due to age is low			
	- **Lightning strike** - The tank is partially below ground, therefore it is unlikely to be struck by lightning. Likelihood of emissions due to lightning is **low**			
Pipework associated with the Return Liquor Balancing Tank - Spillage of non hazardous sludge: catastrophic failure and leaks from pipework.	**Containment:** - All pipelines are of modern construction.		- Pipework visually inspected regularly. - TCM checks are conducted regularly. - Minor to moderate spills will be cleaned up before there has been sufficient time for infiltration into the ground. - In the event of overflow of contaminants, site operatives will react with an emergency spill response and clean up the area that has been contaminated. - Leak Detection and Repair (LDAR) Programme in place.	
	Failure risk:			
	- **Catastrophic pipe failure** - Pipework constructed in approx. 2001, therefore the potential for catastrophic failure is considered **low.**			
	- **Leaks from over ground pipework** - Any leaks would be contained by the site drainage. The potential for emission is therefore considered low.			

Risk	Description of Risk	UNMITIGATED LIKELIHOOD	Mitigation applied	MITIGATED LIKELIHOOD
	- **Leaks from underground pipework** - there is no pipework underground, the risk of emission due to leaks is therefore considered to be **low**.	M		L
	- **Catastrophic failure of pipe joints and flanges**, particularly downstream of the pumps - Any sudden loss of pressure related to a catastrophic pipe failure would be identified by the site SCADA system resulting all pumping being stopped and an alarm on the site SCADA system, therefore reducing any emissions. Likelihood of emissions due to catastrophic pipe failure is considered **medium**.			
	-**Shortcomings or failure in operational control system -** the site is maintained inline with a maintenance schedule and the EMS to ensure ongoing operation of all plant items. Operators are trained in the running of plant items. Likelihood of emissions due to operational failure is **low**			
	- **Abuse** -all site staff and tanker Operators are trained to operate the site plant. Likelihood of emissions due to abuse is **low**			
	- **Impact** - the pipework is protected by metal railing. Likelihood of emissions due to impacts **low**			
	- **Vandalism**, etc. - all plant is within a fenced and gated site, with access to the site control by security. Likelihood of emissions due to vandalism is **low**			
	- **Fire, explosion** - the pipework is not routed along areas of potential flammable atmosphere. Likelihood of emissions due to fire or explosion is **low**			
	- **Geological factors** - There has been no evidence of wider geotechnical issues during the time the plant has been operational on the site. Likelihood of emissions due to geological issues is **low**			
	- **Ageing** - The pipework was installed in approx. 2001. They are monitored to check for leakages and material failure. Likelihood of emissions due to age is **low**			
	- **Lightning strike** - the pipework is low relative to other structures within the area therefore unlikely to be struck by lightning. Likelihood of emissions due to lightning is **low**			
Thickened Sludge Tank **349 m3 working volume** Spillage of non hazardous sludge: - catastrophic failure of tank - tank overflow or - tank leaks.	**Containment**: - Steel tank construction. Constructed in approx. 2018. - Tank is partially below ground. - Tank has a secondary containment system in place. - The tank is surrounded by impermeable hardstanding which drains back to the Head of Works for treatment.	M	- Tanks visually inspected regularly. - TCM checks are conducted regularly. - Minor to moderate spills will be cleaned up before there has been sufficient time for infiltration into the ground. - In the event of overflow of contaminants, site operatives will react with an emergency spill response and clean up the area that has been contaminated.	L
	Failure risk:			
	- **Catastrophic tank failure** - The tank is approx. 5 years old. There is no knowledge of past leaks. The potential is therefore considered **medium**.			
	- **Tank overflow or leaks** - There is no automatic overspill prevention system in place, therefore the risk of overflow is **medium**. The high-level overflow also drains into the site drainage system and is then returned to the head of the works.			
	- **Potential for minor leakage** around pipe flanges. Emission due to leaks is therefore considered **medium**.			
	-**Shortcomings or failure in operational control system -** the site is maintained inline with a maintenance schedule and the EMS to ensure ongoing operation of all plant items. Operators are trained in the running of plant items. Likelihood of emissions due to operational failure is **low**			
	- **Abuse** -all site staff and tanker Operators are trained to operate the site plant. Likelihood of emissions due to abuse is **low**			
	- **Impact** - Tank is away from roads and is protected by railing. Likelihood of emissions due to impacts is **low**			
	- **Vandalism**, etc. - all plant is within a fenced and gated site, with access to the site control by security. Likelihood of emissions due to vandalism is **low**			
	- Fire, explosion - the tank is vented so flammable gases would not build up in the tank. Likelihood of emissions due to fire or explosion is **low**			
	- **Geological factors** - There has been no evidence of wider geotechnical issues during the time the plant has been operational on the site. Likelihood of emissions due to geological issues is **low**			
	- **Ageing** - Tank constructed in 2018. Likelihood of emissions due to age is **low**			
	- **Lightning strike** - The tank is partially below ground, therefore it is unlikely to be struck by lightning. Likelihood of emissions due to lightning is **low**			
Pipework associated with the Thickened Sludge Tank - Spillage of non hazardous sludge: catastrophic failure and leaks from pipework.	**Containment:** - All pipelines are of modern construction.	M	- Pipework visually inspected regularly. - TCM checks are conducted regularly. - Minor to moderate spills will be cleaned up before there has been sufficient time for infiltration into the ground. - In the event of overflow of contaminants, site operatives will react with an emergency spill response and clean up the area that has been contaminated. - Leak Detection and Repair (LDAR) Programme in place.	L
	Failure risk:			
	- **Catastrophic pipe failure** - Pipework constructed in approx. 2018, therefore the potential for catastrophic failure is considered **low.**			
	- **Leaks from over ground pipework** - Any leaks would be contained by the site drainage. The potential for emission is therefore considered low.			
	- **Leaks from underground pipework** - there is no pipework underground, the risk of emission due to leaks is therefore considered to be **low**.			
	- **Catastrophic failure of pipe joints and flanges**, particularly downstream of the pumps - Any sudden loss of pressure related to a catastrophic pipe failure would be identified by the site SCADA system resulting all pumping being stopped and an alarm on the site SCADA system, therefore reducing any emissions. Likelihood of emissions due to catastrophic pipe failure is considered **medium**.			
	-**Shortcomings or failure in operational control system -** the site is maintained inline with a maintenance schedule and the EMS to ensure ongoing operation of all plant items. Operators are trained in the running of plant items. Likelihood of emissions due to operational failure is **low**			
	- **Abuse** -all site staff and tanker Operators are trained to operate the site plant. Likelihood of emissions due to abuse is **low**			
	- **Impact** - Pipework is away from roads and is protected by railing. Likelihood of emissions due to impacts **low**			
	- **Vandalism**, etc. - all plant is within a fenced and gated site, with access to the site control by security. Likelihood of emissions due to vandalism is **low**			
	- **Fire, explosion** - the pipework is not routed along areas of potential flammable atmosphere. Likelihood of emissions due to fire or explosion is **low**			
	- **Geological factors** - There has been no evidence of wider geotechnical issues during the time the plant has been operational on the site. Likelihood of emissions due to geological issues is **low**			
	- **Ageing** - The pipework was installed in approx. 2018. They are monitored to check for leakages and material failure. Likelihood of emissions due to age is **low**			
	- **Lightning strike** - the pipework is low relative to other structures within the area therefore unlikely to be struck by lightning. Likelihood of emissions due to lightning is **low**			

The table below is filled in based on your inputs in the "Site Hazard Rating" worksheet and "Likelihood" worksheet. The tool then combines these to calculate the overall site hazard rating and the consequent class of secondary containment required.

Activity	Site Hazard Rating	Likelihood	Overall Site Risk Rating	Indicated Class of Secondary Containment Required
Site - overall summary score	High	Low	**Medium**	**Class 2**
Imported Sludge Balancing Tank	High	Low	**Medium**	**Class 2**
Pipework associated with the Imported Sludge Balancing Tank	High	Low	**Medium**	**Class 2**
Screened Sludge Tank	High	Low	**Medium**	**Class 2**
Pipework associated with the Screened Sludge Tank	High	Low	**Medium**	**Class 2**
Sludge Balancing Tank / Thickener Feed Tank	High	Low	**Medium**	**Class 2**
Pipework associated with the Sludge Balancing Tank / Thickener Feed Tank	High	Low	**Medium**	**Class 2**
Thickened Sludge Tank	High	Low	**Medium**	**Class 2**
Pipework associated with the Thickened Sludge Tank	High	Low	**Medium**	**Class 2**
Primary Digesters x2	High	Low	**Medium**	**Class 2**
Pipework associated with the Primary Digesters x2	High	Low	**Medium**	**Class 2**
Secondary Digesters x2	High	Low	**Medium**	**Class 2**
Pipework associated with the Secondary Digesters x2	High	Low	**Medium**	**Class 2**
Return Liquor Balancing Tank	High	Low	**Medium**	**Class 2**
Pipework associated with the Return Liquor Balancing Tank	High	Low	**Medium**	**Class 2**

Rating lookup table

Low	1
Medium	2
High	3

3	1	3

The text and diagrams below are intended to provide an introduction to the design requirements of secondary containment systems. All this text should be read in order to gain a useful understanding of containment construction prior to commencing procurement.

Based on industry guidelines drawn from the design of landfill containment systems, it is accepted good practice that a minimum one metre thickness of soil with a permeability of no greater than 1×10^{-9} ms^{-1} should be provided. This is particularly important beneath a tank or tank floor where any leakage may go undetected for extended periods. Further advice is provided in CA (2008b).

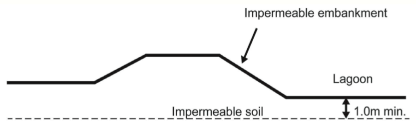
The same performance requirements could be achieved by providing a less thick layer of less permeable material.

Typical values for the permeability of soils are shown in Table 8.1 and it is evident from this that only soils with a high clay content will give the required level of impermeability. It should be noted that there are many instances of naturally occurring clays that do not meet this recommended performance requirement, or contain lenses or bands of higher permeability silts and sands.

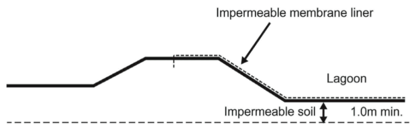
Table 8.1 ***Permeability of soils by broad category***

Soil type	Coefficient of permeability (ms^{-1})	Relative permeability
Coarse gravel	Exceeds 10^{-3}	High
Sand	10^{-3} to 10^{-7}	Medium to low
Silt	10^{-7} to 10^{-9}	Very low
Clay	Less than 10^{-9}	Impervious
Concrete (for comparison)	10^{-10} to 10^{-12}	Impervious

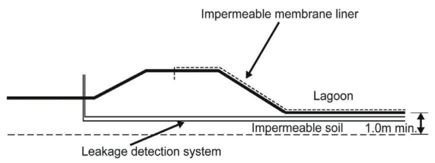
Class 1



Class 2



Class 3



It should be stressed that in all cases the ground and soil conditions should comply with the impermeability, stability and durability criteria set out previously. Where impermeable linings and leakage detection systems are required these are as an **additional** level of protection and **not** to compensate for inadequate ground and soil conditions.

Generally, experience has shown that the most suitable soils for constructing impermeable embankments and lagoons contains between 20 and 30 per cent clay, the remaining fraction being well-drained sand and gravel. Soils of this type are likely to remain stable even when subject to significant changes in moisture content. Soils with a clay content much below 20 per cent are likely to exceed the recommended permeability limit of 1 × 10-9 ms-1 whereas if the clay content is much higher than 30 per cent they are

likely to be difficult to form into a stable embankment and they will have a greater tendency to shrink and crack on drying. The clay content of a soil is determined from particle size distribution analysis completed in accordance with BS 1377-5:1990.

Where the permeability of the soil on site is found to be too high it may be possible, depending on the type of soil, to reduce it to a satisfactory level by consolidation or reworking, or by blending it with imported clay-rich soils or minerals such as bentonite.

#	Material	When used	How	Why
A	Clay	If plentiful on site	1m thick, sheepsfoot roller etc.	Low cost & effective.
B	Stabilised soil	If soil tested and is suitable	Sample and test to determine amount of lime, cement and depth.	Low cost & effective when no clay on site.
C	Bentonite matting	If A or B not suitable	Prepare sub, roll out and cover.	Moderate cost. Quick & easy to lay. Tolerant of damage.
D	Landfill liner type [illegible]	If A, B or C not suitable	Prepare sub, roll out, weld and cover.	
E	Concrete	Small areas only	Shutter, place mesh and pour fibre reinforced.	Only if A, B, C or D not suitable.