AMBER PLANNING
Flood Risk & Hydrology

Flood Risk Assessment
March 2023
Version 1

Ash Road
Protos
Ellesmere Port
CH2 4LB

FORSA ENERGY

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EXECUTIVE SUMMARY

Site Area	0.99ha + 0.118ha access road
Existing / Historic Use	Brownfield
Proposed Use	Installation of a 49.5MW Gas Powered Standby Electricity Generation Plant to provide back-up power for the National Grid.
Flood Zone	**Indicative:** Defended Flood Zone 3a (High Risk) **Assessed Fluvial Flood Risk:** Defended Flood Zone 3a (High Risk) ▪ Fluvial Flood defences: 1000 yr. standard of protection. ▪ Tidal Flood Defences: 200 yr. standard of protection. Flood defence policy to maintain standard of protection over time. Mitigation and management measures are outlined to reduce residual flood risks to an acceptable level throughout the development lifetime.
Groundwater Flooding	Low
Infrastructure Failure	Reservoir Failure: No. Raised Waterways: No. Flood Defence Breach / Failure: Yes. Flood management proposed to reduce residual risk to acceptably low level.
Overland Flow - Flooding	Very Low
Sewer Flooding	Very Low
Change to Site Surface Finishings (Y/N)	Yes. An uplift in the runoff coefficient is anticipated to arise from proposals. Full surface water management is proposed in line with best practice for new development.
Infiltration Potential?	Precluded by clay geology in tidal setting.
Attenuation Storage Proposed	405m^3. Attenuation pond and swale.
Potential Receptor for Surface Water Discharges	SuDS based drainage will promote infiltration at source, with excess runoff discharged at restricted (*greenfield*) rates to local watercourses following upstream attenuation, discharge control and water quality treatment.
Climate Change Allowance	25% Central allowance to 2060.

1.0 INTRODUCTION

1.1 Background

1.1.1 Amber Planning Ltd was originally commissioned in June 2017 and again in September 2021 to prepare a Flood Risk Assessment (FRA) in support of two separate planning applications at the subject site for the installation of a 49MW Battery Energy Reserve Facility and Gas Powered Standby Electricity Generation Plant, respectively, to provide back-up generation for the National Grid. The original Flood Risk Assessment has been subject to revision to account for differing layouts as follows:

- Version 1 – Jun. 2017: Application for 49MW Battery Energy Reserve Facility (Planning Ref. 16/03516/FUL & 17/01912/S73).
- Version 2 – Sept. 2021: Application for 49.5MW Gas Powered Standby Electricity Generation Plant. Flood Risk and Drainage comments supplied within Conditions 10, 12, 19, & 20 of the 2017 application were reviewed as input to the 2021 assessment.

1.1.2 This document represents Version 3 and considers a fresh application on behalf of Forsa Energy Gas Holdings Ltd. for a 49.5MW Gas Powered Standby Electricity Generation Plant, with associated infrastructure and access within a 0.99ha plot of land at Ash Road, Ellesmere Port, CH2 4LB, and with this subject to a revised layout. Ellesmere Port falls within the administrative remit of Cheshire West and Chester Council.

1.1.3 Reference to Environment Agency (EA) online Flood Maps indicates the study area to be situated within Flood Zone 3a (High Risk) for the tidal River Mersey / Manchester Ship Canal, Figure 001.

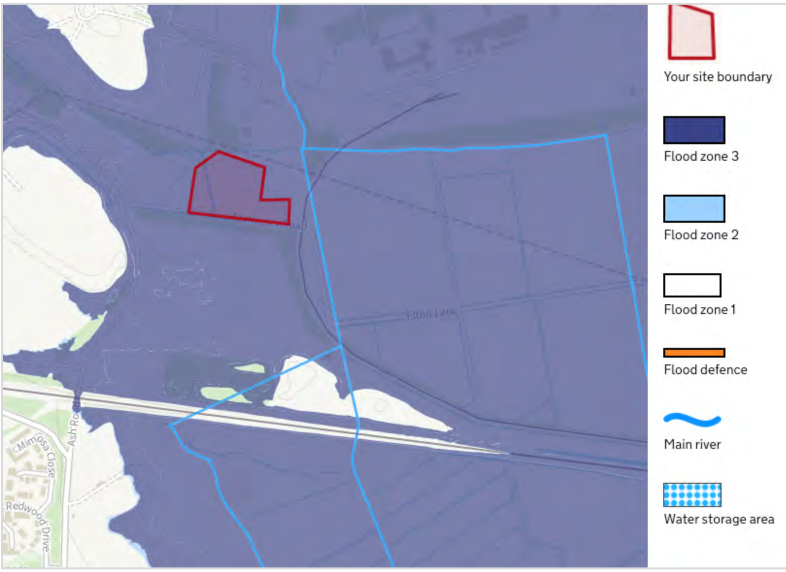


Figure 001: Environment Agency Flood Map

1.1.4 This assessment has been prepared in accordance with the National Planning Policy Framework (NPPF) and its Planning Practice Guidance (PPG). The requirements of the Environment Agency and Cheshire West and Chester Council have also been accounted for within this study.

1.2 Objectives

1.2.1 The objectives of this study are to:

- Review national and local planning policy documents and identify any issues they raise, and which need to be addressed in relation to flooding and hydrology;
- Review readily available information on flooding using data provided by the EA and, where available, the Strategic Flood Risk Assessment (SFRA);
- Evaluate the background hydrology;
- Assess the risks from all sources of flooding, including tidal and fluvial;
- Consider the impacts of the development on predeveloped rates and volumes of surface water runoff;
- Recommend the mitigation and / or management measures required to prevent detrimental impacts to surface water flooding or hydrology at the site or within downstream receptors;
- Identify opportunities for the incorporation of Sustainable Drainage Systems (SuDS); and
- Provide recommendations for the design and delivery of surface water management. This includes the design of a drainage scheme which accounts for the requirements of the Environment Agency and the Lead Local Flood Authority.

1.2.2 Local development framework documents, including strategic policy and technical studies, have been reviewed as part of this study.

1.3 Confidentiality

1.3.1 Amber Planning has prepared this report solely for the use of The Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from Amber Planning; a charge may be levied against such approval.

2.0 SOURCES OF INFORMATION

2.1 General

2.1.1 In preparing this assessment background information has been sought from the following sources:

- Communities and Local Government (July 2021). National Planning Policy Framework[1];
- Communities and Local Government (*Living Document*). Planning Practice Guidance[2];
- UK Government Guidance (May 2022). Flood Risk Assessments: Climate Change Allowances[3];
- CIRIA (2015). C753: The SUDS Manual V.6;
- Cheshire West and Cheshire Council website, Planning Policy page[4];
- Cheshire West and Cheshire Council website, Local Plan Consultation page[5];
- Cheshire West and Chester Council (2015). Local Plan (Part One) Strategic Policies;
- Cheshire West and Chester Council (2019). Local Plan (Part Two) Land Allocations and Detailed Policies;
- Cheshire West and Chester Council. Local Plan Interactive Map[6];
- Cheshire West and Chester Council (2016). Strategic Flood Risk Assessment: Level 1;
- Gov.uk website[7];
- Defra Magic online mapping geographical and environmental data[8];
- British Geological Survey online mapping[9];
- Centre for Ecology and Hydrology Flood Estimation Handbook (FEH) Web Service, hydrometric data[10]; and
- Topographical survey (Aug. 2021).

2.2 Planning Context - National Planning Policy

National Planning Policy Framework

2.2.1 The National Planning Policy Framework (NPPF) Section 14: Meeting the Challenge of Climate Change, Flooding and Coastal Change, considers the implications of flooding within the planning process. According to the NPPF:

'A site-specific flood risk assessment is required for:

- *All development within Flood Zones 2 (Medium Risk) and 3 (High Risk);*

In flood zone 1 an assessment should accompany all proposals involving:

- *Sites of 1ha or more;*
- *Land identified by the Environment Agency as having critical drainage problems;*
- *Land identified in a Strategic Flood Risk Assessment as being at increased flood risk in future; or*

[1] https://www.gov.uk/government/publications/national-planning-policy-framework--2
[2] https://www.gov.uk/government/collections/planning-practice-guidance
[3] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#table-2
[4] https://inside.cheshirewestandchester.gov.uk/policies_plans_and_strategies/planning_policy
[5] https://consult.cheshirewestandchester.gov.uk/kse/
[6] https://maps.cheshirewestandchester.gov.uk/cwac/localplan
[7] www.gov.uk
[8] http://magic.defra.gov.uk/MagicMap.aspx
[9] http://mapapps.bgs.ac.uk/geologyofbritain/home.html
[10] https://fehweb.ceh.ac.uk/GB/map

- *Land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use.'*

2.2.2 Paragraph 167 of the NPPF states the following regarding the consideration of flood risk within the planning application process:

'When determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood-risk assessment. Development should only be allowed in areas at risk of flooding where, in light of this assessment (and the sequential and exceptions tests, as applicable), it can be demonstrated that:

a) Within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;

b) The development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment;

c) It incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;

d) Any residual risk can be safely managed; and

e) Safe access and escape routes are included, where appropriate, as part of an agreed emergency plan.'

2.3 Planning Context - Local Planning Policy

Local Plan (Part One) Strategic Policies

2.3.1 The Cheshire West and Chester Local Plan (Part One): *Strategic Policies*, provides the overall vision, strategic objectives, spatial strategy and planning policies for the Borough to 2030. It is supported by the 2019 Cheshire West and Chester Local Plan (Part Two) Land Allocations and Detailed Policies Plan. Together, both documents supersede the archived Ellesmere Port and Neston Borough Council Local Plan.

2.3.2 Local Plan Policies relevant to the consideration of Flood Risk and Drainage are:

- ENV 1: Flood risk and Water Management
- STRAT 4: Ellesmere Port
- DM 40: Development and Flood risk
- DM 41: Sustainable Drainage Systems (SuDS)
- DM 42: Flood Water Storage
- DM43: Water Quality, Supply and Treatment

2.3.3 Strategic objective SO14 is also relevant to the consideration of flood risk and climate change.

2.3.4 Review of the Local Plan Policies Map (Figure 002) indicates the property to be situated on land formerly occupied by Ince Power Stations A and B. The SFRA Section 6.5 (*Potential Development Sites Review*), Local Plan retained policy EMP7 (2015) and revised Local Plan (2019) Policy EP2.A note this land to be allocated for employment use, subject to application of the Exception Test.

Local Plan Conversation - 2021

2.3.5 Council Cabinet agreed in April 2022, following a Local Plan engagement exercise from June – September 2021, that the Council commits to an update of the Local Plan (Part One) and commences initial work. A report setting out the scope and timetable will be approved at a future Council Cabinet meeting.

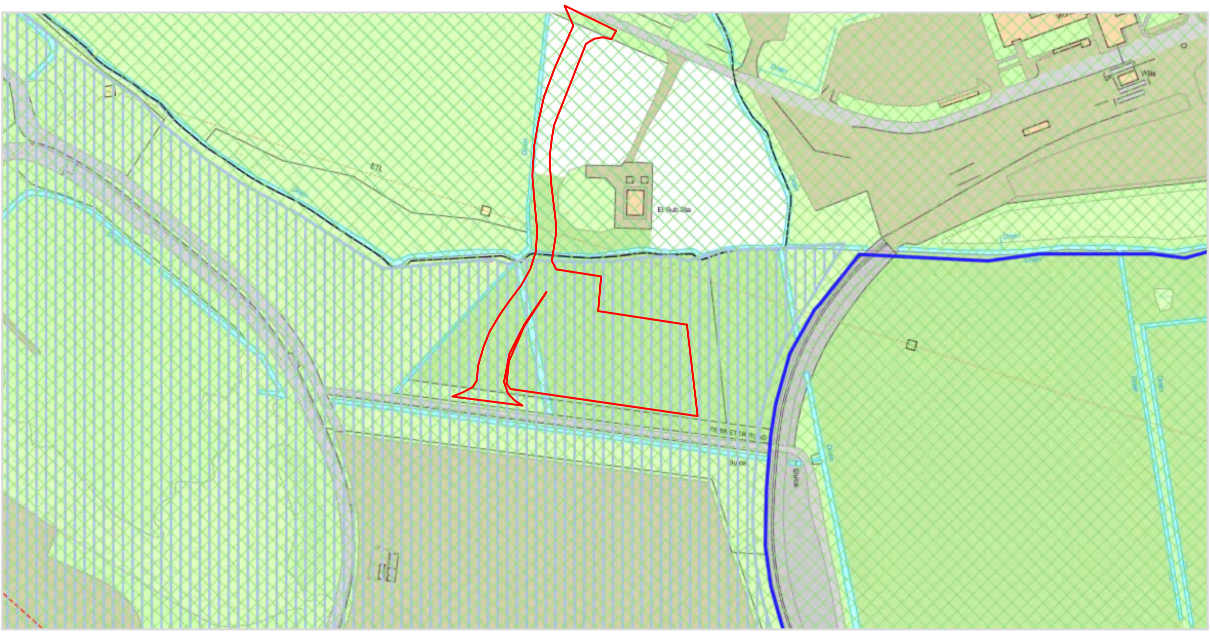


Figure 002: Excerpt from Local Plan Policy Maps

Strategic Flood Risk Assessment

2.3.6 The SFRA forms a critical part of the Council's evidence base in terms of informing / identifying appropriate locations for development. This document also underpins wider decision making within the planning process and has been reviewed as input to this study.

3.0 BACKGROUND AND DATA REVIEW

3.1 Site Setting

Property Address	Land off Ash Road / Perimeter Road. Ellesmere Port, CH2 4LB
National Grid Reference	346605, 376127
Area	0.99ha + 0.118ha access road

Table 001: Site Setting

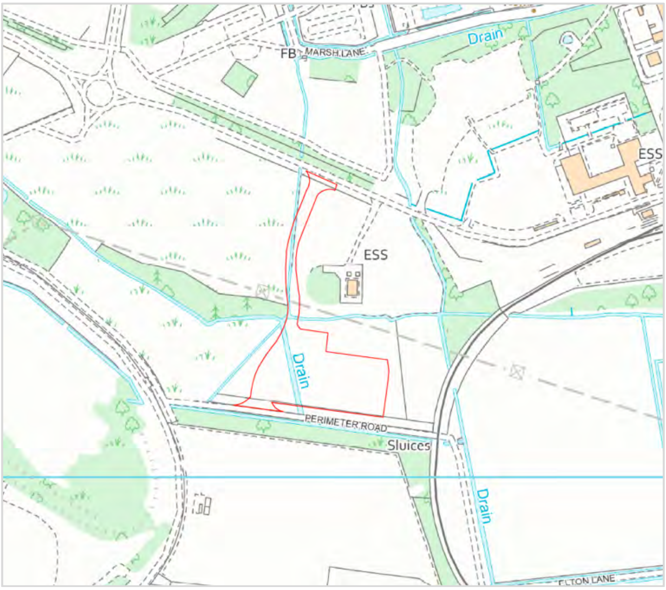


Figure 003: Site Location Plan

3.2 Current Layout

Figure 004: Existing Site Layout – Aerial Photograph

3.2.1 The property comprises a 0.99ha plot of brownfield land (Figures 003 & 004), with a 0.118ha proposed access road, situated north of the M56 and north east of the junction between Ash Road and Perimeter Road. Historically the plot formed part of the former Ince Power Station, although the surface finishings are currently soft landscaped. A dual access is proposed, with the first via a gateway off Perimeter Road on the southern boundary and a second via Marsh Lane to the north.

3.3 Surrounding Area

3.3.1 The property is situated within industrial land associated with the former Ince Power Station. The nearest settlement is Elton, which is located c.0.5km south west. The River Mersey / Manchester Ship Canal are present c.1.25km north.

3.4 Proposed Development

3.4.1 A 49.5MW Gas Powered Standby Electricity Generation Plant is proposed with associated access and infrastructure including:

- 11 no. engine units + Switch Room + Auxiliary Transformers: 1,938m^2
- Access Road: 1,825m^2
- Turning head: 1,126m^2
- 3 no. car parking spaces: 48m^2
- DNO: 29m^2
- Office & Welfare: 14.5m^2
- Facilities Buildings x 2: 9m^2
- Heat Store: 28.25m^2
- Gas Metering Kiosk: 19m^2
- Gas Pressure Reducing Station: 23m^2
- Electric Vehicle Charging Point (EVCP)
- Transformer Unit: 87m^2
- Oil Tanks (clean & waste): 12m^2
- Attenuation Pond: 1,012m^2
- Gravel Cover: 4,370m^2

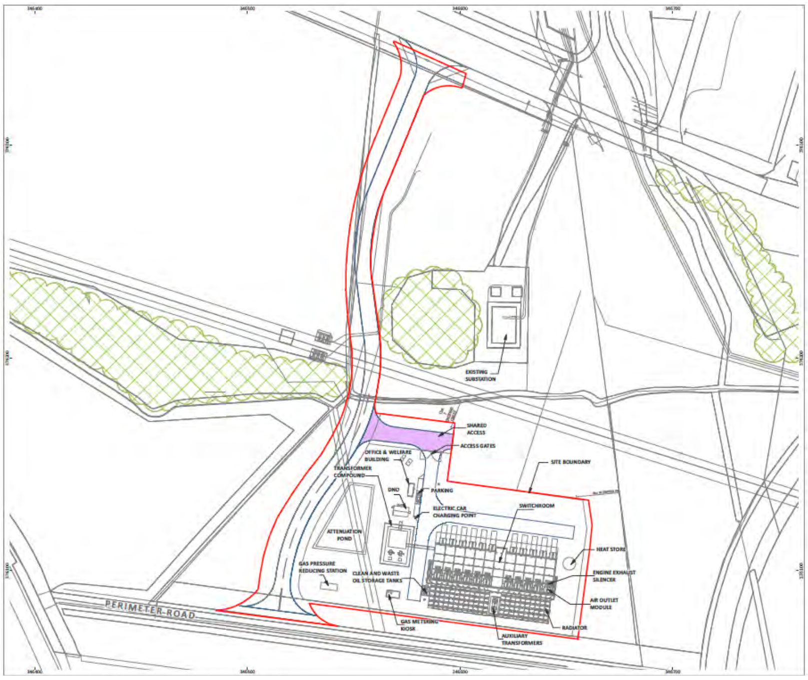


Figure 005: Proposed Development Layout

3.4.2 The proposals are understood to involve no significant material change to the ground profile, aside from the input of formalised level surfaces. Figure 005 provides a summary of the proposed layout, with full details contained within Drawing FE/017/488: *Plan and Elevations*, located to the rear of this report. The proposals are non-residential in nature with a designated lifetime of <30 years.

3.5 Topographical Survey

3.5.1 Topographical survey data obtained in August 2021 (Drawing S21-748), indicates uniform ground levels ranging between 4.2m AOD and 4.5m AOD. Access will be via the southern and northern boundaries, where surface elevations are located at 4.6m AOD and 4.5m AOD, respectively.

3.6 Hydrogeology

3.6.1 Regional geological mapping suggests the underlying bedrock to comprise the Kinnerton Sandstone Formation, overlain by Tidal Flat Deposits (Clay, Silt and Sand).

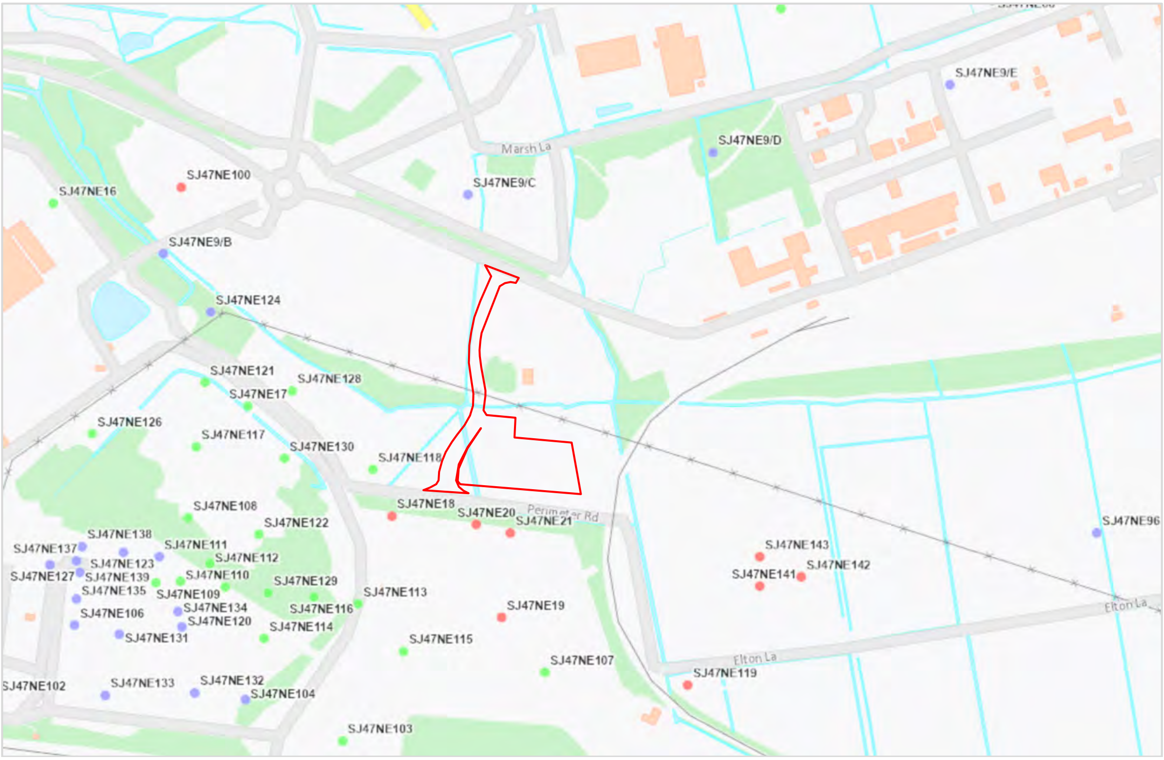


Figure 006: British Geological Survey Borehole Location Map

3.6.2 BGS borehole log data is available immediately south west (SJ47NE20 & 21), which dates from 1984 (Figure 006). This confirms the presence of Clay between 0m bgl and 17m bgl with a thick layer of peat logged between 2.2m bgl and 5m bgl. Sandstone is recorded below the clay layer (17m bgl) up to the maximum depth of the borehole (86m bgl).

3.6.3 Resting water levels of between 0.9m and 1.1m bgl are recorded within these boreholes. This is considered to comprise perched water present at the interface between shallow and deeper overlying soils, with main groundwater situated at depth.

3.6.4 Mapping data downloaded from Defra's Magic website indicates the area to be external to Groundwater Source Protection Zones.

3.6.5 Based on consideration of the above data and accounting for the intended nature of use, the proposed development is indicated to be at **Low** risk from groundwater flooding, with no requirement for further assessment.

3.6.6 It is anticipated that main groundwater is located at depth with perched water tables present at the base of the overlying soils, and with potential impacts on surface water storage and management systems likely to be limited.

3.7 Tidal Flooding

3.7.1 The property is situated 1.25km south of the Manchester Ship Canal and River Mersey, both of which flow in a north westerly direction and are tidally influenced in this locale. The application area is indicated to be within defended Flood Zone 3a for the above watercourses, with further assessment required.

Environment Agency Tidal Flood Data

3.7.2 Peak still water tidal flood levels were originally supplied by the Environment Agency for West Central Drain 1 in 2016, which are summarised in Table 002. Flow node locations are shown in Figure 007, with nodes 2, 3 & 4 closest to the application area. The EA has been contacted to confirm that this data remains current, with their response awaited at the time of writing.

Node Reference	100yr. (Existing)	100yr.+20%	200yr.	1000yr.
1	7.07	7.93	7.22	7.22
2	6.96	7.81	7.11	7.11
3	6.99	7.84	7.14	7.14
4	6.99	7.84	7.14	7.14
5	7.02	7.87	7.17	7.17
6	7.05	7.91	7.21	7.21

Table 002: Environment Agency Tidal Flood Levels

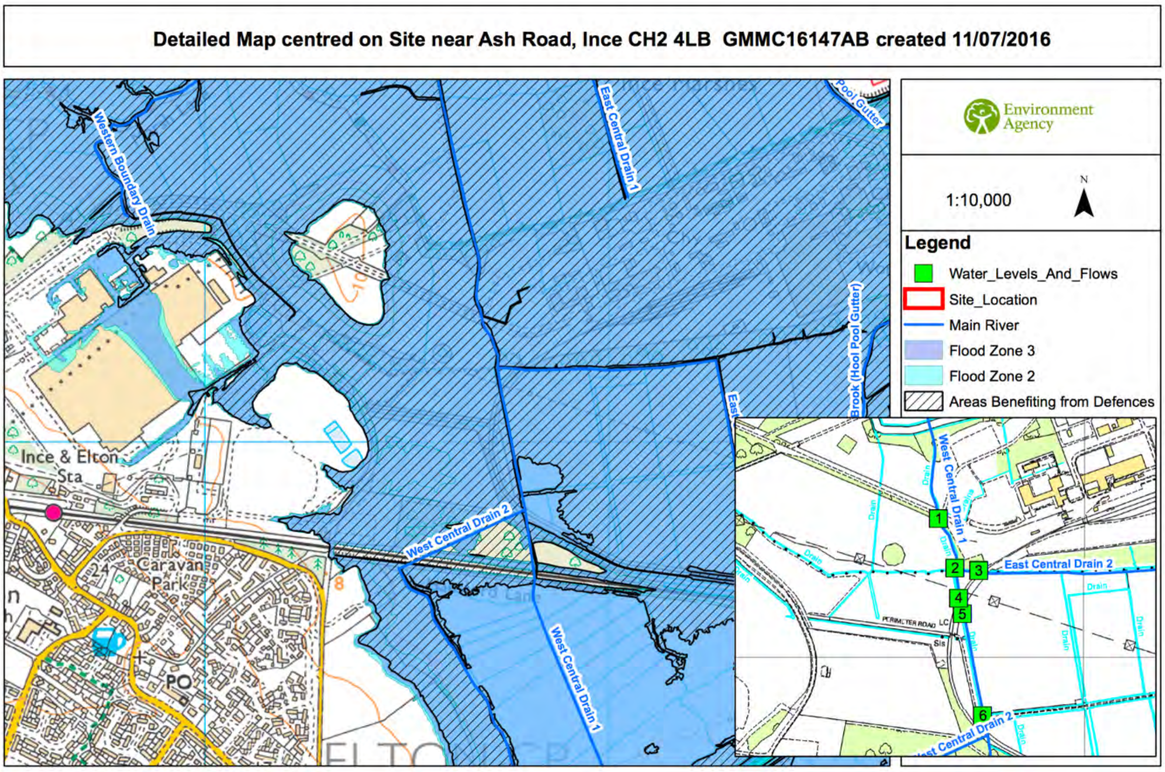


Figure 007: Environment Agency Detailed Flood Map

3.8 Climate Change

Tidal Allowance

3.8.1 The tidal flood levels supplied by the EA do not account for climate change. Table 3 of the Government's current guidance on Flood Risk and Costal Change[11] provides guidance on the application of climate change to sea levels within north west catchments, which is summarised in Figure 008 below.

Area of England	Allowance	2000 to 2035 (mm)	2036 to 2065 (mm)	2066 to 2095 (mm)	2096 to 2125 (mm)	Cumulative rise 2000 to 2125 (metres)
North west	Higher central	4.5 (158)	7.3 (219)	10 (300)	11.2 (336)	1.01
North west	Upper end	5.7 (200)	9.9 (297)	14.2 (426)	16.3 (489)	1.41

Figure 008: Excerpt from Flood Risk & Coastal Change Table 3 Sea Level Allowance

3.8.2 The original tidal flood levels are understood to have been derived in 2015. Based on the above guidance, updated tidal flood levels have been calculated which are summarised in Table 003. A total climate change allowance of 35yrs has been applied (to 2050) accounting for a 25 year development lifetime with an additional 2 yrs for implementation of grant of planning / construction. The EA supplied 200 year and 1000 year tidal flood levels are the same and therefore the 200 year tidal flood level is considered to be representative of both return period events.

Node Reference	200yr.	200yr. (2050) Higher Central	200yr. (2050) Upper End
1	7.22	7.41	7.47
2	7.11	7.30	7.36
3	7.14	7.33	7.39
4	7.14	7.33	7.39
5	7.17	7.36	7.42
6	7.21	7.40	7.46

Table 003: Environment Agency Tidal Flood Levels – Including Climate Change

Rainfall Allowance

3.8.3 Government Guidance on Climate Change Allowances to Peak Rainfall Intensity (Table 2), requires application of climate change factors of up to 25% (Central Allowance) for the 2050s epoch (2022-2060), e.g. development with a lifetime up to <37 years.

3.8.4 NB the Peak Rainfall Allowances Map appears to include the subject catchment within the Lower Mersey Management Catchment, this despite being shown as outside of the red line boundary within the online mapping software. Analysis was undertaken for other postal codes closer to Frodsham which also appeared to be included within this catchment. On this basis, the Climate Change stated by the online software is understood to be correct.

[11] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#types-of-allowances

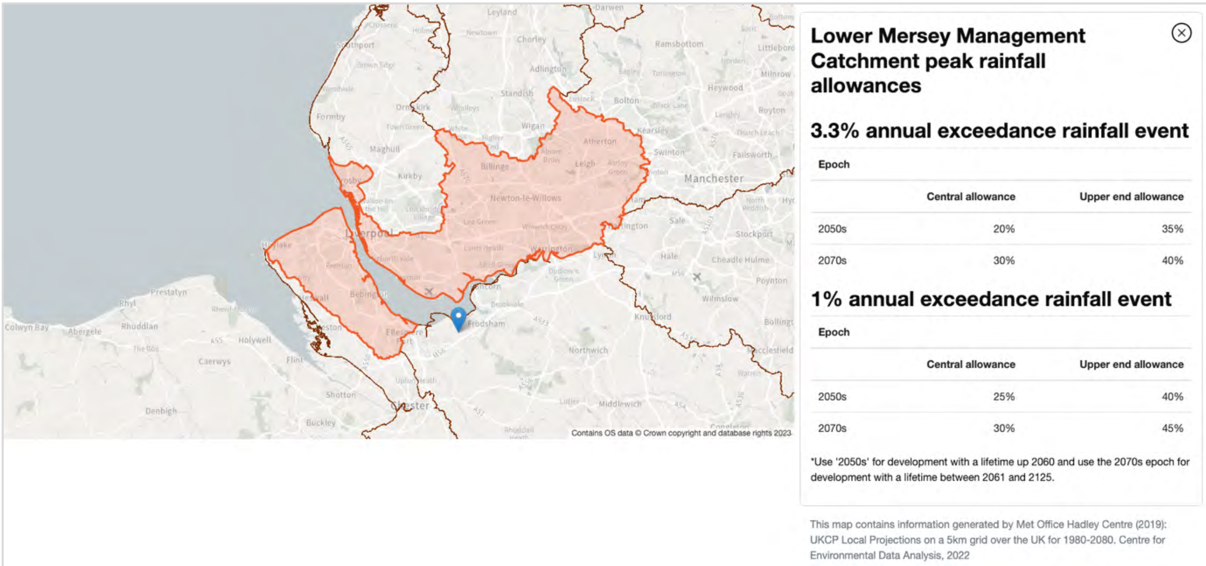


Figure 009: Climate Change Allowances – Rainfall Intensity

3.9 Fluvial Flooding & Hydrology

3.9.1 The property is situated within the Ince and Frodsham Marshes. Water levels within the Marshes are understood to be artificially controlled by a pumped drainage system which was historically maintained by the Environment Agency, with the responsibility for this system understood to have recently been transferred to a number of third parties, including land owners, farmers and businesses, through a Partnership Management Arrangement.

3.9.2 The application area is surrounded by a network of land drains, all of which are laterally extensive and which discharge into the West Central Drain 1, a designated Main River, situated c.20m from the eastern boundary which flows in a northerly direction in this locale.

3.9.3 According to data downloaded from the CEH Flood Estimation Handbook web data service (Sept. 2021), the headwaters of the West Central Drain 1 are located at Hapsford, from where it flows north through a gently sloping catchment, passing beneath the M56, whence it flows as a number of diffuse field drains, which are culverted beneath Hapsford Lane and the Railway Line via two main drainage channels, the West Central Drain 1 and West Central Drain 2 (both Main Rivers). These convene downstream of the railway line forming a single channel, which is referred to as the West Central Drain 1 and which drains an upstream catchment c.3.0km^2 in area.

3.9.4 Downstream of the property, the WCD1 continues north eventually discharging into the Manchester Ship Canal via a pumped outfall / sluice 1.57km north east.

3.9.5 The application area is indicated by EA flood mapping to be affected by flooding from a 100 year return period fluvial flood event (undefended), with further assessment required.

Catchment Data

3.9.6 Catchment descriptor information has been downloaded for the area from the CEH Flood Estimation Handbook web data service (Mar. 2023), which is summarised in Table 004. This indicates a small, moderately urbanised catchment, with low topographical relief, largely permeable geology and low average annual rainfall.

3.9.7 Flows within local watercourses are likely to be predominated by baseflow (BFIHOST), with more minor contributions from overland flow (SPRHOST) and with a moderately low catchment response to incident rainfall anticipated. At a local scale the catchment response to rainfall may be elevated within urban areas or where less permeable overlying geology is present.

Catchment Descriptor	Value
Area	4.43km²
River Baseflow Index (BFIHOST-19)	0.514
Standard Percentage Runoff (SPRHOST)	32.59
Drainage Path Length (DPLBAR)	2.03km
Drainage Path Slope (DPSBAR)	12.70m/km
Flood Attenuation by Rivers and Lakes (FARL)	1.00
Proportion of time soils are wet (PROPWET)	0.37
Standard Annual Average Rainfall (SAAR)	715mm
Urban Extent (URBEXT: 2000)	0.1127

Table 004: FEH Catchment Descriptor Information

Environment Agency Fluvial Flood Data

Node Reference	100yr.	100yr.+20%	200yr.	1000yr.
1	3.72	3.84	3.76	3.95
2	3.93	3.99	3.97	4.16
3	3.79	3.89	3.83	4.04
4	3.79	3.89	3.82	4.03
5	3.77	3.87	3.81	4.00
6	3.75	3.86	3.79	3.98

Table 005: Environment Agency Defended Fluvial Flood Levels

Node Reference	100yr.	100yr.+20%	200yr.	1000yr.
1	5.69	6.23	5.69	7.26
2	5.54	6.20	5.54	7.14
3	5.57	6.21	5.57	7.17
4	5.57	6.21	5.57	7.17
5	5.61	6.22	5.61	7.20
6	5.66	6.23	5.66	7.25

Table 006: Environment Agency Undefended Fluvial Flood Levels

3.9.8 Modelled flood levels were originally supplied by the Environment Agency for the West Central Drain 1 in 2016. This is summarised in Tables 005 and 006, with a full copy located at Appendix I. This data is taken from the 2011 EA Ince and Frodsham Marshes Strategic Study. The Environment Agency has been contacted to confirm that this data remains current, with a response awaited at the time of writing.

3.10 Flood Defences

Tidal Flood Defences

3.10.1 Desk based investigation indicates the area to benefit from privately owned and maintained tidal flood defences, with the Manchester Ship Canal forming the primary means of flood defence from the tidal River Mersey.

3.10.2 The Environment Agency has previously (2021) confirmed the wider area to be protected from tidal flooding with existing flood defences considered to offer a 200 year standard of protection from tidal flooding. The property is also indicated to be situated within the Flood Warning Area[12] for '*Ince, Cheshire West and Chester*.'

Fluvial Flood Defences

Asset ID	Standard of Protection (yrs.)	Condition Grade	U/S Crest Level (m AOD)	D/S Crest Level (m AOD)
34291	5	Fair	3.84	3.12
34292	5	Fair	3.12	4.77
184581	5	Fair	4.77	4.02
184582	100	Fair	3.04	3.84
185538	100	Fair	4.61	5.12

Table 007: Environment Agency Flood Defence Asset Data

3.10.3 The property is located in an area which benefits from the presence of fluvial flood defences. The nearest are located on the western banks of the West Central Drain and are indicated to provide a 1000 year standard of protection upstream in this locale. The closest sections of flood defence are 185538 & 184581; refer to Table 007.

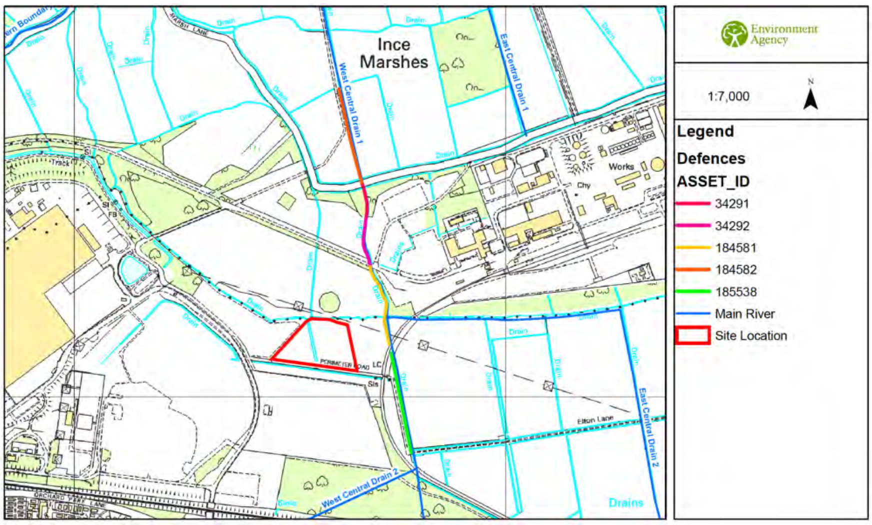


Figure 010: Environment Agency Flood Defences

12 https://flood-warning-information.service.gov.uk/warnings

3.10.4 According to the 2008 SFRA the Ince Marsh system comprises a pumped catchment, with the pumps having been maintained historically by the EA, although responsibility for this system is understood to have recently been transferred to third party landowners. Highly managed drainage catchments, especially those reliant on pumped outfalls, are susceptible to flooding in the event of pump failure. The residual risks associated with this therefore require further assessment.

3.11 Historic Flooding

3.11.1 The SFRA notes the following in relation to historic flooding in the Cheshire West and Chester area:

3.11.2 *'CWaCC have limited records regarding any historical flood incidents. This is not to say such incidents have not occurred, but that they have not been fully recorded.'*

3.11.3 The SFRA Historic Flood Map contains outlines of past fluvial, tidal and groundwater flooding. Review of this indicates the application area not to have suffered from flooding historically although this may be attributed to a lack of recorded incidents rather than an absence of flooding. Flood data supplied by the EA in July 2016 also indicates a lack of recorded historical flooding.

3.11.4 Further desk based investigation[13] reveals no further evidence of historic flooding in this area. Caution should be exercised when reviewing historic flood records; this information is largely anecdotal and does not always include consideration of either the antecedent conditions giving rise to flooding (e.g. flood source), or reference to a flood return period. Furthermore, a lack of recorded incidents is no guarantee that an area has never flooded.

3.12 Flood Zone Classification

3.12.1 Environment Agency Flood Maps indicate the application area to be located within Flood Zone 3a (High Risk), with further assessment of the risks posed by tidal and fluvial flooding required.

3.13 Flood Risk Vulnerability

3.13.1 The installation of a 49.5MW Standby Electricity Generation Plant is proposed to provide back-up power for the National Grid. Table 2 of the PPG defines this as '*infrastructure for electricity supply including generation, storage and distribution systems*' and classifies this use as *'Essential Infrastructure.'* Table 3 of the PPG considers this an appropriate use within Flood Zones 1, 2 and 3a.

	Flood Risk Vulnerability Class'n (PPG Table 2)	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Flood Zone (PPG Table 1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	Exception Test Required	✓	✓	✓
	Zone 3a	Exception Test Required	x	Exception Test Required	✓	✓
	Zone 3b (Functional Floodplain)	Exception Test Required	x	x	x	✓

Key:
✓ Development is appropriate x Development should not be permitted

Table 008: PPG Table 3 – Flood Risk Vulnerability and Flood Zone Compatibility

[13] https://environment.data.gov.uk/DefraDataDownload/?mapService=EA/HistoricFloodMap&Mode=spatial

3.14 NPPF Sequential and Exception Tests

3.14.1 The Sequential Test steers development preferentially towards Flood Zone 1 (Low Risk), considering Flood Zone 2 (Medium Risk) and then Flood Zone 3 (High Risk) only if land cannot be identified as available for development in zones at lower risk from flooding.

3.14.2 The Sequential Test is generally carried out at a strategic level by the Local Planning Authority with input from the Environment Agency, as part of the Local Plan process and should be informed by a Strategic Flood Risk Assessment.

3.14.3 Review of the Planning Policies Map indicates the plot to be situated on land formerly occupied by the Ince A & B Power Stations, which is allocated for development by both SFRA mapping and the Local Plan retained policies, with the proposed nature of use stated to be Employment / Energy Generation.

3.14.4 It is therefore considered that the application is commensurate with strategic land allocations, which have been underpinned by a SFRA and which would have applied a sequential approach to land allocation, in line with the requirements of the NPPF.

3.14.5 Furthermore, the proposals comprise '*Essential Infrastructure*' situated within defended Flood Zone 3a and therefore fulfil the requirements of the Flood Risk Sequential Test by default, with no requirement for application of the Exception Test. Nevertheless, element two of the Exception Test is addressed within this FRA.

3.14.6 The proposed power generation facility will also be key to the delivery of the development outlined in the Policies Maps for the wider Ince Power Station / Marsh areas.

3.15 Infrastructure Failure

3.15.1 Flooding from artificial sources occurs when man made infrastructure e.g. flood defences, raised channels or surface water storage features, including reservoirs, becomes overwhelmed leading to breach or failure. The probability of failure is low owing to regular inspection and maintenance regimes. However, in the event of a breach occurring, the consequences can be significant.

3.15.2 Review of the National Reservoir Flood Maps indicates the house to be unaffected by reservoir flooding, with no further assessment required.

3.15.3 The Manchester Ship Canal is present 1.25km north. While a breach or failure of the canal walls could lead to flooding, the risk associated with this water body in isolation is considered to be low as it is situated down gradient of the proposed development, with a vast intervening floodplain present which would intercept water. It is also considered that a breach would most likely arise from elevated water levels associated with tidal storm surge events, with this assessed as part of the flood defence breach analysis discussed below.

3.15.4 The Ash Road area benefits from the presence of tidal and fluvial flood defence infrastructure the breach or failure of which could lead to flooding. Whilst the probability of failure is low, owing to regular inspection and maintenance regimes, the consequences of a breach can be significant, with a potentially significant associated risk and with further assessment required.

3.16 Surface Water Flooding

3.16.1 Detailed EA pluvial mapping downloaded from the EA website, assesses three main scenarios, Low Risk (0.1% - 1% probability of flooding annually), Medium Risk (3.3% - 1%) and High Risk (>3.3%). The findings of this assessment are summarised in Figure 011.

3.16.2 This data indicates the application area to be at **Very Low** risk from pluvial flooding with no further assessment required.

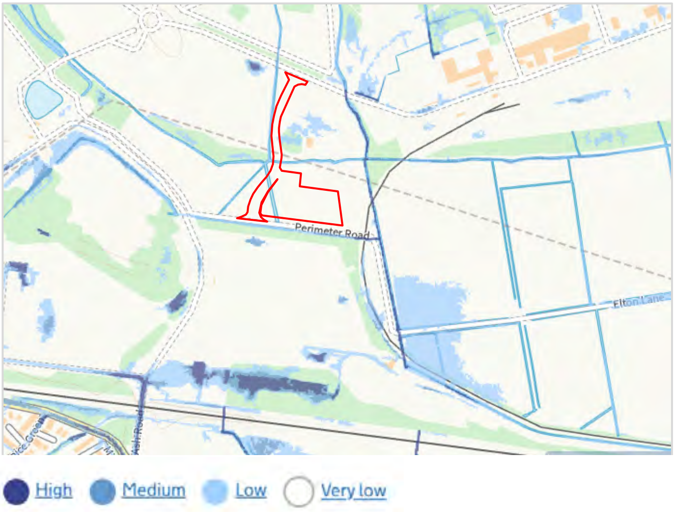


Figure 011: Environment Agency Surface Water Flood Map

3.17 Sewers

3.17.1 The Property is considered to be remote from surface water sewers, with the nearest likely to be present beneath Perimeter Road to the south. The potential flood outlines are likely to be similar to that outlined for pluvial flooding, Figure 011, with a **Very Low** associated flood risk and with no further assessment required.

4.0 FLOOD RISK ASSESSMENT

4.1 Flood Risk Screening Opinion

4.1.1 In accordance with the NPPF Section 14 it is necessary to consider all forms of flood risk. A flood risk scoping exercise has therefore been completed, the results of which are outlined in Table 009.

Nature of Flood Risk	Flood Risk to Site?
Groundwater	No. Main groundwater is located at depth. Underlying Clay geology further reduces this risk.
Tidal	Yes. The area is situated within defended Flood Zone 3a (High Risk), for the tidal River Mersey / Manchester Ship Canal system.
Fluvial	Yes. The plot is located within defended fluvial Flood Zone 3a (High Risk) for the West Central Drain.
Infrastructure Failure (Reservoirs, Canals and Other Artificial Sources)	Reservoir Failure: Low Risk. Raised Waterways: NA – covered within flood defence breach analysis. Flood Defence Breach / Failure: At Risk. The property is located within an area benefitting from the presence of flood defences, the breach or failure of which could lead to flooding, with further assessment required.
Overland Flow (surface water from off-site sources)	No. EA Flood Maps indicate the house to be at **Very Low** risk of SW flooding.
Sewers	No. The property is remote from public sewer networks.
Surface Water Drainage (on-site)	Yes. An uplift in impervious surface will arise from the proposals. Full surface water management is proposed in line with best practice for new development.

Table 009: Flood Risk Screening Opinion

4.1.2 Flood screening indicates the principal flood risk to arise from tidal and fluvial sources, which have been duly assessed. Residual risks associated with infrastructure failure, specifically flood defence breach, also require consideration. The results are summarised below.

4.2 Tidal Flooding

4.2.1 According to EA mapping and supplied data the property is indicated to be defended from tidal flooding, with the risk to the development from tidal flooding anticipated to be **Very Low** during a 200 year tidal flood event, Figure 012.

4.2.2 The SFRA and CFMP note a policy of maintaining the current standard of protection from flooding over time, with the proposed facility indicated to remain defended from tidal flooding. This is strengthened by the Local Plan land allocations for the Ince Marsh area, which include employment and mixed uses.

4.2.3 The following factors serve to increase the lead time for flood warning and reduce the flood hazard:

- The tidal nature of flooding provides an element of predictability for those extreme storm events which may lead to elevated water levels within the River Mersey / Manchester Ship Canal;
- Given the tidal nature of flooding it is anticipated that maximum water levels would be restricted to the peak around the high tide, with flood water receding quickly in the period between high waters;
- The River Mersey / MSC and their tributaries are subject to significant artificial control by pumps and sluices, with a substantial monitoring regime likely to be in place, which would strengthen the passage of information via the flood warning system in this locale;

- The facility is remote (1.25km) from the tidal flood defences, with the Manchester Ship Canal providing flood alleviation in the event of a breach of the River Mersey defences;
- The principal flood mechanism is indicated to be overtopping of the defences. It is anticipated that areas of lower ground present to the north would flood first, providing significant flood storage, with a low speed of inundation and low velocity of floodwater anticipated at the property; and
- Availability of Environment Agency Flood Warning.

4.2.4 Accounting for the above factors, the actual risk posed to the development by tidal flooding is concluded to be **Low**. Residual risks associated with flood defence failure are discussed below.

Figure 012: Environment Agency Flood Map – Long Term Risk of Fluvial / Tidal Flooding

4.3 Fluvial Flooding

4.3.1 Comparison of EA supplied detailed fluvial flood data with topographical survey indicates the application area to be unaffected by fluvial flooding, now or in the future, accounting for the presence of flood defences, the crest levels of which are located between 4.77m AOD and 5.12m AOD adjacent to the site.

4.3.2 This assertion is based on topographical analysis which indicates minimum on-site ground levels (4.2m AOD) to be located some 200mm above the maximum defended fluvial flood level (3.99m AOD) for return period events up to and including 100 years accounting for climate change. Further, the flood defences exhibit a minimum freeboard of 770mm above the defended flood level.

4.3.3 The risk posed to the development by fluvial flooding is therefore concluded to be **Low**. Residual risks associated with flood defence failure are discussed below.

4.4 Residual Flood Risk

Flood Zone 2 - 1000 Year Fluvial Flood Outline

4.4.1 In accordance with the requirements of the NPPF it is necessary to consider the risks associated with more extreme flooding, to inform the flood management measures required. The NPPF regards the 1000 year storm to be representative of an extreme event and this has been duly assessed.

4.4.2 The probability of extreme flooding occurring is considered to be low, which reduces the flood risk.

4.4.3 According to the detailed data supplied by the EA the property is defended from flooding during a 1000 year fluvial flood. The crest level of the flood defences being located between 4.77m AOD and 5.12m AOD in this locale, with a freeboard >610mm above the maximum defended fluvial flood level (4.16m AOD) and with a **Low** associated flood risk.

Flood Zone 2 - 1000 Year Fluvial Flood Outline

4.4.4 The EA data indicates 1000 year tidal flood level is the same as the 200 year tidal flood level. It is therefore considered that the facility will be at **Low** risk from flooding during a 1000 year return period tidal flood event owing to the presence of flood defences. The residual risk associated with flood defence failure are discussed below.

Infrastructure Failure – Breach of Flood Defences

4.4.5 Even when flood defences are in place, there is always the potential that these could be overtopped in an extreme storm event or that they could fail or breach. The property benefits from the presence of raised flood defences on the River Mersey and more locally on the West Central Drain adjacent to the eastern boundary, the failure of which could lead to flooding of the Ince Marsh area and potentially the power facility.

4.4.6 In the event of a beach or failure of the Mersey flood defences, there would be little or no flood warning with a significant associated flood hazard. Flow velocities would be greatest close to the defences, reducing with distance as waters spread across the floodplain (spreading loss). The property is located some 1.25km from the defences and is therefore likely to experience low flow velocities. During a breach event the facility could experience maximum flood depths up to 7.57m AOD (accounting for climate change), and water depths of up to 3.40m, with a **Significant** associated flood hazard.

4.4.7 In the event of a breach of the fluvial flood defences to the east, the facility could experience maximum flood depths up to 6.23m AOD (accounting for undefended flooding with climate change), and water depths of up to 2.03m, elevated flow velocities and a **Significant** associated flood hazard.

4.4.8 In this instance, it is considered that the flood mitigation and management measures outlined for the facility would provide a suitable lead time for flood warning to allow remote shut down and isolation of critical infrastructure until such time as the flood defences have been repaired. Plant operators should be prepared for flooding across a minimum of two tidal cycles.

4.4.9 Whilst the risks associated with flood defence failure would be significant, accounting for the low probability of this occurring, coupled with the nature of use (*Essential Infrastructure*) and outlined flood mitigation and management measures (including remote operation, shut down and isolation procedures, and with no personnel present who could be placed at risk), it is considered that the residual risks posed to the installation by flooding arising from a breach of the coastal or fluvial defences can be reduced to an acceptable level.

Infrastructure Failure – Failure of Pumped Drainage Networks

4.4.10 The Ash Road area benefits from a strategically managed pumped drainage network serving the Ince and Frodsham Marshes. The potential consequence of failure of these networks on the flood risk to the facility must therefore be assessed.

4.4.11 The Environment Agency has previously consulted on switching off the pumped networks and allowing the marshes to flood. In this instance it is estimated that the western and central parts of the marshes would become water logged with this leading to surface water flooding during periods of elevated rainfall. It is understood that the Environment Agency has been duly diligent in ensuring no undue increase in flood risk to the industrial area at the former Ince Power Station would arise from these proposals.

4.4.12 Furthermore, the property is remote from both marshland areas with flood defences present in the intervening land, e.g. on the western banks of the West Central Drain, which are considered to protect the wider locale from fluvial flooding. Given this factor and the **Very Low** indicative risk of surface water flooding, it is concluded that the facility would be unaffected by flooding arising from failure / planned removal of the pumps serving the Ince and Frodsham Marshes.

4.4.13 Accounting for the above considerations and the flood mitigation and management measures outlined within the design, the residual flood risk to the facility in the event of failure / closure of the pumped networks serving the area is concluded to be **Low**.

4.5 Flood Mitigation & Management

4.5.1 The property is indicated to be protected from fluvial flooding for return period events up to and including 1000 years, and from tidal flooding for return period events up to and including 200 years, with that standard of protection indicated to be maintained over time. The 1000 year tidal flood level is indicated as equal to the 200 year flood level in this locale.

4.5.2 Based on the above and coupled with the potential maximum flood level (200 yr. tidal flood level = 7.22m AOD – 7.57m AOD) should a breach of tidal flood defences occur, it is considered prohibitive to protect the facility entirely from undefended tidal flooding.

4.5.3 It is therefore proposed to incorporate the following flood mitigation and management measures to increase the lead time for flooding and to minimise any disruption in this event:

- Raising of all on-site controls and critical infrastructure by 600mm above the surrounding ground level to ensure that any disruption caused by flooding is kept to a minimum;
- Incorporation of flood resistant and resilient construction techniques within the design of the facility (particularly any elements which have not been raised), to minimise water ingress in the event of flooding. This should be suited to salt water environments;
- Preparation of a Flood Management Plan outlining the procedures to be followed in the event of flooding;
- Signing up to the EA flood warning system to alert personnel to the potential for flooding and allow safe evacuation and execution of the Flood Management Plan;
- The plant will be subject to remote operation with no staff present who could be placed at risk; and
- In the event of flooding the plant will be subject to remote shut down / isolation.

4.5.4 Whilst the flood mechanism (pump / defence failure) is unpredictable, the presence of significant intervening flood storage between the downstream outfalls from the West Central Drain 1 and the facility will allow a degree of flood warning, reducing the flood risk. The raising of all critical infrastructure to 0.6m above existing minimum ground levels will increase the lead time for flood warning.

4.5.5 Given the above factors and accounting for the nature of use proposed, it is felt that with the outlined flood mitigation and management measures in place the residual risks posed to personnel and the plant by flooding, can be reduced to an acceptable level.

Safe Access

4.5.6 In the instance that maximum flood depths were realised at the property, safe access exists onto Ash Road c.150m west, which is elevated (5.6m AOD to 8.4m AOD) and which is indicated to be unaffected by flooding south of the railway line / Hapsford Lane (420m south west) throughout all return period flood events, now and in the future.

4.5.7 The risks posed to site users will be minimised through remote operation, with personnel highly unlikely to be present during day to day operations.

4.6 Summary of Flood Risk

4.6.1 In accordance with the requirements of the NPPF, all potential flood risks posed to / by the facility have been assessed. The principal flood risks are identified to arise from fluvial and tidal flooding, with the property currently indicated to be at **Low** risk for design return period flood events, accounting for climate change and the presence of flood defences.

4.6.2 Local Policy proposes flood defence improvements to ensure that the existing standard of protection is maintained over time. The proposed operational measures, which include remote operation and shut down / isolation, further reduce the flood hazard to site users.

4.6.3 Residual risks associated with overtopping and breach / failure of the flood defences and pumped drainage networks serving the area have also been assessed. It has been demonstrated that with the outlined flood mitigation and management measures in place, the identified residual flood risks can be reduced to an acceptable level throughout the development lifetime. It is also demonstrated that the proposals will not detrimentally impact flood risk elsewhere.

4.6.4 The proposals are therefore considered appropriate within the context of the Local Planning Policy documents and paragraph 167 of the NPPF:

- *Within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;*
- *The development is appropriately flood resistant and resilient such that, in the event of a flood it could be quickly brought back into use without significant refurbishment;*
- *It incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;*
- *Any residual risk can be safely managed; and*
- *Safe access and escape routes are included, where appropriate, as part of an agreed emergency plan.*

4.6.5 Potential impacts to flood risk arising from surface water generated within the development are addressed in Section 5.0.

5.0 SURFACE WATER

5.1 Introduction

5.1.1 An application is to be submitted for a 49.5MW Gas Powered Standby Electricity Generation Plant, along with associated infrastructure and access within a 0.99ha plot of land, including a 0.183ha access road, at Ash Road, Ellesmere Port, CH2 4LB.

5.1.2 The study area comprises a brownfield plot which currently drains unattenuated via infiltration into the underlying soils, with excess runoff discharged to local drainage networks and watercourses via overland flow.

5.1.3 The NPPF and its PPG require that existing runoff rates be maintained, taking account of climate change and that, wherever possible, a degree of betterment is provided.

5.1.4 An uplift in the runoff coefficient will arise from development proposals which, without mitigation, would have a consequent detrimental impact on the rate and volume of surface water runoff generated. This would be further compounded by climate change impacts over time.

5.1.5 In accordance with the NPPF new development must incorporate flood attenuation measures sized to accommodate flows from impervious surfaces for return period pluvial flood events up to and including 100 years, taking account of climate change and with discharges restricted to greenfield rates. Water quality treatment is also required to mitigate potential detrimental impacts to downstream receptors, including groundwater and local watercourses.

5.1.6 Sustainable Drainage Systems (SuDS) must be incorporated within the design, wherever practicable.

5.2 Land Use

	Existing		Proposed	
Land Use	**Area (ha)**	**Runoff Coefficient**	**Area (ha)**	**Runoff Coefficient**
Soft Landscaping	1.108	0.45	0.155	0.45
Gravel Chippings	0.00	0.70	0.437	0.70
Impermeable (roads / hardstanding / built)	0.00	0.90	0.516	0.90
Total	**1.108**	**0. 45**	**1.108**	**0.76**

Table 010: Summary of Land Use

5.3 SuDS Options for Surface Water Disposal

5.3.1 Desk based investigation indicates the presence of underlying clay geology with limited potential for the disposal of site generated runoff using infiltration.

5.3.2 A network of land drains is present in this locale, which is laterally extensive and into which a gravitational connection could be established for the discharge of attenuated runoff.

5.3.3 The surface water attenuation measures have therefore been sized based on discharge to local watercourses at *greenfield* rates. SuDS measures are proposed to maximise infiltration at source.

5.3.4 This conforms with the discharge hierarchy as outlined within Section 3.2.3 of the SuDS Manual, as follows:

SuDS Discharge Hierarchy:

- Infiltration.
- Discharge to surface waters.
- Discharge to surface water sewer.
- Discharge to combined sewer (Last Resort).

5.4 Greenfield Runoff Rates

5.4.1 Greenfield runoff rates have been estimated using the WinDes Micro drainage ICPSUDS function, with input data from the Flood Estimation Handbook web service and based on linear interpolation from a 50ha catchment, in accordance with SUDS manual guidance. Table 011 summarises the results of this analysis. Full copies of these calculations are located at Appendix II: *Workings*.

Return Period (yrs.)	Runoff Rate (l/s/ha)	Runoff Rate (l/s)* Main Compound	Runoff Rate (l/s)* Access Road
Q_{BAR}	5.412	4.169	0.988
30	8.924	6.875	1.629
100	10.674	8.223	1.948

Table 011: Greenfield Runoff Rates

*Based on a 0.77ha u/s impermeable area & *0.183ha area

5.5 Attenuation and Controlled Discharge

5.5.1 The WinDes Micro Drainage software package has been used to estimate the surface water attenuation requirements. Storm scenarios were run for both winter and summer profiles, for a range of durations (15-10,080 minutes), taking account of land use data, greenfield runoff rates and climate change, respectively. Full copies of these calculations are contained within Appendix II: *Workings*, with a summary provided in Table 012.

5.5.2 The WinDes Micro Drainage package assumes all land surface to be impermeable. Therefore, where the runoff coefficient differs (e.g. gravel / stone chipping) the total contributing area has been multiplied by the runoff coefficient to establish an '*Effective Impermeable Area*' (EIA) for assessment. Impermeable surfaces are accounted for at 100%.

Results

Return Period Rainfall Event (Yrs.)	Storage Requirement (m^3) Main Compound	Storage Requirement (m^3) Access Road
$Q_{BAR\ Urban}$	115	28
30	226	64
100	315	90

Table 012: Surface Water Attenuation Requirements

5.6 Drainage Layout

5.6.1 A maximum rainwater storage requirement of 315m^3 has been estimated for the main compound and 90m^3 for the access road. This will be provided as follows.

Main Compound

5.6.2 The main compound will be served by an attenuation pond situated on the western boundary and sized to accommodate runoff for return period rainfall events up to and including the 100 year storm, without surcharge and accounting for climate change at 25% (based on a development lifetime of 25 years). Refer to Drawing H8497-001: *Conceptual Drainage Layout*, for a graphical representation of the proposed drainage layout. The following design considerations have been assumed:

- Depth: 0.7m
- Area (top of bank): 971m^2 (28.4m x 34.2m); (base): 726m^2 (24.2m x 30.0m)
- Bank Slope: 1:3
- Max. Water Level (Q100+25%CC): 0.396m
- Freeboard: >300mm
- Invert: 0.7m bgl / <3.5m AOD
- Volume: 315m^3

Access Road

5.6.3 The access road will drain to a swale situated on one side of the road and sized to accommodate runoff for return period rainfall events up to and including the 100 year storm, without surcharge and accounting for climate change at 25% (based on a development lifetime of 25 years). Refer to Drawing H8497-001 for a graphical representation of the proposed drainage layout. The following design considerations have been assumed:

- Depth: 0.7m
- Length: 275m
- Width (top of bank): 4.6m; (base): 0.4m
- Bank Slope: 1:3
- Max. Water Level: 0.398m
- Freeboard: >0.3m
- Invert: 0.7m bgl / <3.5m AOD
- Volume: 90m^3

5.6.4 Both surface water storage facilities will discharge to the surrounding land drainage network at controlled rates. A dual outfall arrangement is proposed, with a low level outfall to maintain flows within local watercourses under standard conditions, and a high level offtake to allow discharge at higher rates under flood conditions. Discharge from both outfalls / storage areas will be controlled by a Hydrobrake / restricted orifice fitted with a flow control slot and / or flap valve, to ensure existing (*greenfield*) runoff rates are maintained and to reduce the likelihood of blockage leading to surcharge.

5.6.5 This configuration will promote infiltration to ground, where practicable, with excess water discharged via gravity to local drainage channels at controlled (*greenfield*) rates. It is recommended that the discharge point be fitted with a non-return valve to prevent backflow where elevated water levels occur downstream.

5.6.6 Topographical survey data indicates minimum ground levels of c.4.20m AOD in the area of the attenuation pond (western boundary), with invert levels on the downstream drainage channel likely to be c.1.0m bgl (3.20m AOD) and downslope of the application area, with gravitational discharge deemed feasible. Where necessary, the existing land drain could be excavated to match the depth of the deeper land drain situated on the northern boundary to enable free discharge from the attenuation facility(ies).

5.7 Network Capacity

5.7.1 Roof water (where present) will drain to the attenuation facility via a piped network sized to convey surface water for rainfall events of up to 100 years, including climate change and without surcharge.

5.7.2 Runoff from hardstanding areas will be directed to the storage facilities via perimeter filter drains with underlying permeable pipework. It is recommended that all filter drains / permeable pipes be lined / sleeved with a geotextile membrane to reduce sediment ingress / clogging, with a silt trap fitted at the downstream end to prevent sedimentation of the storage facility(ies).

5.7.3 The piped networks are sized to convey runoff for return period storms up to and including 100 years, accounting climate change, without surcharge, and with capacity present for short duration (high intensity) rainfall events, e.g. the 15 minute storm. Where practicable the fall on the piped networks has been designed to promote self-cleansing. Minor ground reprofiling may be necessary to facilitate pipe protection and gravitational discharge into the storage areas / land drains.

5.7.4 Surface contouring will be used to direct runoff into the piped networks, with exceedance pathways incorporated within the design to convey runoff to the attenuation facility(ies) via overland flow in the event of pipe blockage / surcharge. The access track will be contoured to incorporate a side hang which will also direct runoff into the swale via overland flows.

5.7.5 The attenuation facility(ies) is / are designed to be dry under normal conditions becoming operational only following intense rainfall or sustained storm activity. Capacity is present to accommodate rainfall events up to and including the 100 year storm, accounting for climate change and without surcharge. It is recommended that a 0.5m wide section of bank above the outfalls of the storage facilities be lowered by 50mm – 100mm to provide a preferential flowpath / overflow which would function where blockage or surcharge of the outfall occurs, ensuring continued controlled discharge in this event.

5.7.6 Safety factors are incorporated within the surface water storage calculations to allow for successive rainfall, fluctuations in flow and flood levels, climate change sensitivity and losses in efficiency associated with siltation.

5.7.7 Intercept drainage, including filter drains, will be placed at the facility perimeter to direct runoff back into the on-site surface water management systems and to prevent the uncontrolled discharge of runoff to off-site areas.

5.7.8 Owing to the underlying clay geology, it is anticipated that the attenuation facility(ies) will not suffer impacts to efficiency arising from groundwater ingress. Nevertheless, where groundwater is encountered during construction clay liners should be incorporated within the design.

First Flush Areas

5.7.9 In line with best practise, first flush storage is required to accept the first 5mm of rainfall from impervious surfaces and infiltrate it into the surrounding topsoil. This to reduce off-site surface water discharges during minor rainfall events.

5.7.10 A total first flush storage requirement of 41.10m^3 is calculated based on an *Effective Impermeable Area* of 8,220m^2. It is anticipated that this would be easily accommodated within the on-site SuDS measures, which include filter drains, a swale and an attenuation pond. These will promote the interception and infiltration of runoff at source, limiting off-site discharges under general / low flow conditions.

5.8 Health and Safety

5.8.1 The banks of the flood storage areas have been designed with slopes of 1:3 to allow safe '*crawl out'* in the event of accidental fall-in (where water is present).

5.8.2 The attenuation facilities are located within an industrial setting with public access restricted by the presence of security fencing at the perimeter of the wider compound. The pond and swale should also fenced to limit accidental fall in, with life buoys present which could be thrown to personnel in this event.

5.8.3 It is recommended that a risk assessment be completed for '*working near water*' with this shared with all personnel who will be visiting the property.

5.9 Water Quality

5.9.1 The surface water management system incorporates a number of SuDS elements which have been designed in accordance with the SuDS Manual (CIRIA report no. C753) to provide on-site water quality treatment. These measures account for the Pollution Hazard and Mitigation Indices outlined within Tables 26.2 and 26.3 of the SuDS Manual, respectively; with these summarised in Tables 013 and 014 of this report.

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
General industrial (Energy Facility)	High	0.8	0.8	0.9
Low traffic roads (e.g. general access) with <300 vehicle movements / day.	Low	0.5	0.4	0.4

Table 013: Excerpt from CIRIA 753 Table 26.2 Pollution Hazard Indices for Different Land Use Classifications

5.9.2 Review of the SuDS Manual Table 26.2 indicates there to be no hazard classification which applies specifically to the nature of development proposed. However, as the proposals are industrial in nature a ***High Hazard*** has been assumed.

		SuDS Mitigation Indices		
SuDS Component	**Area Served**	**Total Suspended Solids**	**Metals**	**Hydrocarbons**
Filter Strip	All areas	0.4	0.4	0.5
Filter Drain	Main Compound only	0.4	0.4	0.4
Swale	Access Road only	0.5	0.6	0.6
Detention Basin	Main Compound only	0.5	0.5	0.6
Adjusted SuDS Mitigation Index[1]	**Main Compound**	**0.85**	**0.85**	**1.00**
Adjusted SuDS Mitigation Index[1]	**Access Road**	**0.65**	**0.70**	**0.80**

[1] Applies where the Mitigation Index of individual SuDS component is insufficient to treat runoff in isolation and where 2 SuDS components (or more) are required in series

Table 014: Excerpt from CIRIA 753 Table 26.3 SuDS Mitigation Indices for Discharges to Surface Waters

Access Road

5.9.3 Review of the above data indicates the Mitigation Index for the proposed swale (considered in isolation) to be above the identified Pollution Hazard Index for contaminants present within runoff generated by ***Low Hazard*** Level sites, with no requirement for further water quality treatment.

Main Compound

5.9.4 Review of the above data indicates the Mitigation Index for each of the SuDS Components (considered in isolation) to be below the identified Pollution Hazard Index for contaminants present within runoff generated by ***High Hazard*** Level sites.

5.9.5 The guidance notes within CIRIA 753, P.568 state that where the Mitigation Index of an individual SuDS component is insufficient to perform water treatment in isolation, two SuDS components (or more) in series will be required, where:

$$\textbf{Total SuDS Mitigation Index} = \textbf{Mitigation Index}_1 + 0.5\,(\textbf{Mitigation Index}_2)$$

5.9.6 A factor of 0.5 is used to account for the reduced performance of secondary or tertiary components associated with already reduced inflow concentrations. For example, the adjustment for TSS would be calculated as follows:

Total SuDS Mitigation Index (TSS) = 0.4 + (0.5 * 0.4) = 0.60

5.9.7 The adjusted SuDS Mitigation Indices are presented in the bottom row of Table 014. Based on this adjusted data, it is concluded that the proposed SuDS Mitigation measures outlined above and expanded on below, are sufficient to mitigate potential contaminants present within the runoff from the proposed facility when considered in combination, with no requirement for further water quality treatment.

5.9.8 Nevertheless, an oil interceptor could be installed where required. This would be sized in accordance with the manufacturer's specification for oil separators within an industrial setting and accounting for the upstream drainage area.

5.9.9 The main access road will drain via filter strips to a swale with this considered to provide adequate water quality treatment, and with no requirement for discharge via the petrol interceptor.

Water Quality Treatment

5.9.10 Based on the above analysis the following water quality treatment measures will be interspersed throughout the development and will service the different built elements as outlined below:

- Roof drainage (where present), to pass to the attenuation area via filter drains with no further treatment aside from silt traps located at the upstream end of all pipe runs to remove silts and sediments upstream of the SW storage facility;
- Potentially contaminated runoff from the plant, roads and hardstanding (main compound) will discharge to the attenuation facility via the following water quality treatment, designed in accordance with the requirements of the SuDS Manual section 4 (Table 4.3) and Section 26 (Tables 26.2 and 26.3):
    - **Filter Strips – serving access road & main compound:** 1m wide grass / crushed stone strips present between facility / car parks / roads / filter drains to slow runoff and encourage sediment deposition;
    - **Filter Drains – serving main compound:** Situated at the perimeter of the main compound and designed to convey runoff into the attenuation area(s) via underlying permeable pipework. Permeable pipework to be wrapped in membrane to prevent sediment ingress;
    - **Swale – serving access road only:** Planted with reeds / sedges to encourage silt / sediment deposition and to further aid water quality polishing upstream of the discharge point; and
    - **Attenuation Pond – serving main compound only**: Planted with reeds / sedges to encourage silt / sediment deposition and to further aid water quality polishing upstream of the discharge point.

5.9.11 The inclusion of the above measures will encourage the settlement and retention of sediments, preventing blockage of the inlet(s) / outfall(s) and the discharge of sediment laden water to local watercourses and associated scour, and will ensure that only clean water is discharged.

5.10 SuDS Management and Maintenance Plan

Element	Frequency	Notes
Gulleys / Gulley Pots / Drainage grates	Quarterly / following storm activity	▪ Remove grill and check for debris / blockage. ▪ Remove accumulated debris to prevent blockage of below ground pipework. ▪ Rod / jet where required. Silt traps to be cleansed before **and** after rodding.
Manholes / Inspection Covers / pipework	Quarterly / following storm activity	▪ Visual inspection – remove cover, shine torch into manhole. ▪ Check every orifice for blockage / siltation. ▪ Pour water into each to verify through flow. ▪ Remove debris /silt and rod / jet where required.
Silt Traps	Quarterly / following storm activity	▪ Visual inspection, removal of accumulated silt. ▪ Where rodding of manholes is proposed silt traps should be cleansed before and after to prevent silt bypassing the traps.
Filter Strips	Quarterly / following storm activity	▪ Regular mowing and maintenance will be key to ensuring the continued efficiency of the filter strips. ▪ Reseeding or turfing should be undertaken where bald patches or die back occur.
Filter Drains	Quarterly / following storm activity	▪ Visual inspection for accumulated silt / vegetation (at surface). ▪ Check for surface clogging / ponding. Remove vegetation / silt. ▪ Remove siltation / blockage from the stone sub-base and/or underlying pipework serving the drainage blanket.
Attenuation Areas / Swales	Annually Twice annually (Mar. / Sept.) / following storm activity	▪ Visual inspection for accumulated silt. Where significant siltation is seen, remedial works should be undertaken. ▪ Visual inspection / removal of accumulated, debris, blockage.
Inlets / Outfalls	Quarterly / following storm activity	▪ Visual inspection for accumulated debris or blockage, at both upstream and downstream faces. ▪ Check every orifice / inlet / outlet / structure for blockage or siltation, pour water into each to verify through flow. ▪ Remove any debris and rod where required.
Vegetation	Quarterly (ensure cutting / strimming is undertaken at least twice during peak growing seasons e.g. Mar. / Sept.)	▪ Regular grass cutting and maintenance of shrubs / trees will be key in reducing the presence of debris which could block the drainage network or cause eutrophication of water bodies. ▪ Grass should be cut quarterly, with focus on the growing season (Mar. – Oct.) and leaves / debris cleared from landscaped areas. ▪ During the winter shrubs and trees should be pruned to reduce accumulated vegetation within the site / detention facilities. ▪ All mowings / cuttings to be removed from vicinity of SW storage areas to prevent eutrophication.
Oil Separator (where present)	In accordance with manufacturers' specification.	▪ NA

Table 015: Drainage Inspection and Maintenance Schedule

5.10.1 **Forsa Energy Gas Holdings Limited**, or its successor, will be responsible for ensuring the ongoing management and maintenance of the surface water management systems serving the application area, either directly or via an appointed contractor.

5.10.2 The responsibility for management and maintenance will pass to the lessee, where the facility is operated by a third party, and to the purchaser where the site is subject to sale.

Inspection and Maintenance Schedule

5.10.3 It is proposed that a programme of inspection and maintenance be executed for the surface water management systems by the facilities manager, or appointed drainage contractor. This should be undertaken in accordance with the schedule outlined below and following significant rainfall events and / or storm activity.

5.10.4 A photographic record of inspections should be undertaken to pick up long term changes that may not be apparent within a single inspection. Inspections should comply with all relevant Health and Safety legislation.

5.10.5 This management and maintenance schedule applies for the lifetime of the development.

Notes

5.10.6 The facilities manager, or similar appointed personnel, should be contacted where pollution or blockage are identified.

5.10.7 Where silt removal is proposed, this should be undertaken in an environmentally sensitive manner. For example, reeds should be removed and replaced to encourage rapid recovery of habitats which may have become reliant on the drainage feature.

5.10.8 All waste arisings should be collected by an approved contractor and should be subject to appropriate treatment and disposal.

6.0 CONCLUSIONS

6.0.1 Amber Planning Ltd. has been appointed by Forsa Energy Gas Holdings to prepare a National Planning Policy Framework (NPPF) compliant Flood Risk Assessment in support of an application for a 49.5 MW Gas Powered Standby Electricity Generation Plant to provide backup power for the National Grid. This comprises a 0.99ha plot with 0.118ha access and associated infrastructure on land at Ash Road, Ellesmere Port, CH2 4LB. The Ellesmere Port area falls within the administrative remit of Cheshire West and Chester Council.

6.0.2 Planning was originally granted for this facility in 2016 (Ref. 16/03516/FUL & 17/01912/S73) which has now expired. Flood Risk and Drainage comments were provided within Conditions 10, 12, 19, & 20 which were reviewed as input to a revised Flood Risk Assessment prepared in 2021. This Flood Risk Assessment has been prepared to inform a fresh application and accounts for a revised development layout.

6.0.3 This Flood Risk Assessment has been completed in accordance with the guidance set out in the NPPF, Section 14, and its accompanying PPG, for '*Essential Infrastructure'* within defended Flood Zone 3a. The requirements of Local Planning Policy, as well as the SFRA, have been accounted for within the assessment of flood risk.

6.0.4 A scoping exercise has been completed which considers all potential flood risks, each of which have been fully assessed as part of this study, with flood mitigation measures proposed to ensure that identified flood risks can be reduced to an acceptable level throughout the development lifetime, accounting for climate change predictions.

6.0.5 Residual risks associated with flood defence failure and extreme return period storm events have been assessed, with the flood risk concluded to be practicably low throughout the anticipated development lifetime, accounting for on-site flood mitigation and management measures. This would be further ameliorated by strategic flood defence improvements, proposed as part of local planning policy to ensure the current standard of protection is maintained over time.

6.0.6 The surface water attenuation requirements for the facility have been assessed using the WinDes Micro Drainage software package for return period rainfall events up to and including 100 years, taking account of existing runoff rates and climate change consideration at 25% and with a total storage of 405m^3 proposed. Gravitational discharge to local watercourses is proposed at controlled (*greenfield*) rates.

6.0.7 All drainage networks have been designed to account for industry best practice with regards system capacity, with safety factors accounted for within the surface water storage calculations to allow for successive rainfall events, fluctuations in flow and flood level, climate change sensitivity and losses in efficiency associated with siltation.

6.0.8 It is duly presented that the provision of a formal surface water management system, which incorporates on-site attenuation and water quality treatment, will ensure that potential detrimental impacts to flood risk and water quality are suitably mitigated throughout the anticipated development lifetime, in accordance with the National Planning Policy Framework and its accompanying Planning Practice Guidance. The requirements of Local Planning Policy and Technical studies have also been accounted for within this assessment.

6.0.9 **Forsa Energy Gas Holdings Limited**, or its successor, will be responsible for the ongoing management and maintenance of the surface water management system, throughout its lifetime, either directly or via an appointed contractor. The responsibility for management and maintenance will pass to the lessee, where the site is operated by a third party, and to the purchaser where the site is subject to sale.

6.0.10 The mitigation solutions noted within this report are subject to agreement with the Environment Agency and Cheshire West and Chester Council in their respective capacities within the Lead Local Flood Authority and as part of the application process.

6.0.11 It is duly presented that the application is appropriate within the context of the NPPF (Section 14) and Local Planning Policy.

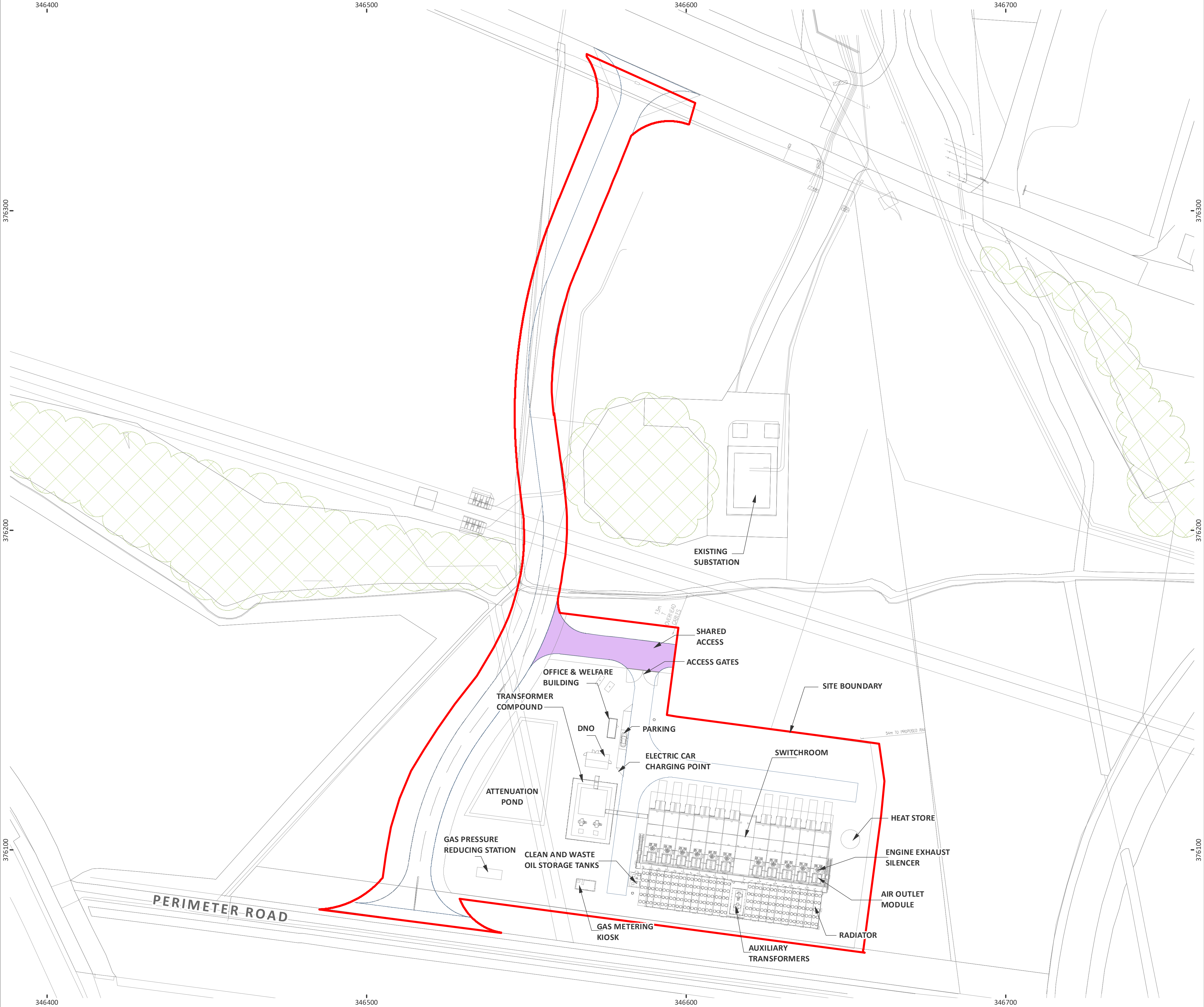
7.0 CLOSURE

7.0.1 This report has been prepared by Amber Planning Ltd with all reasonable skill, care and diligence, and taking account of the manpower and resources devoted to it by agreement with The Client. Information reported herein is based on the interpretation of data collected and has been accepted in good faith as being accurate and valid.

7.0.2 Reliance has been placed on factual and anecdotal data obtained from the sources identified. Amber Planning Ltd cannot be held responsible for the scope of work, or any omissions, misrepresentation, errors or inaccuracies within the supplied information. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part in the event of delay between the writing of the report and its consideration by The Client, with particular regard to submission of a planning application.

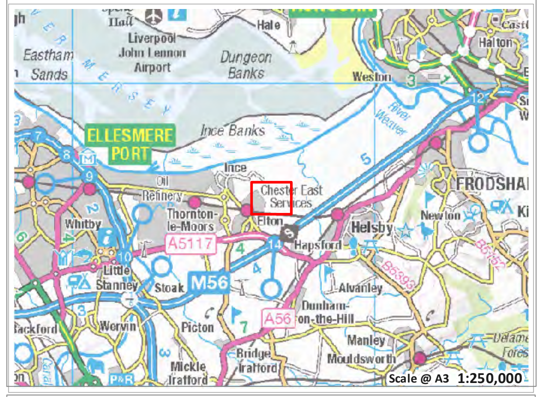
7.0.3 This report is for the exclusive use of The Client; no warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from Amber Planning.

7.0.4 Amber Planning disclaims any responsibility to The Client and others in respect of any matters outside the agreed scope of the work.



Site Boundary

Shared Access



FORSA ENERGY

Site Layout

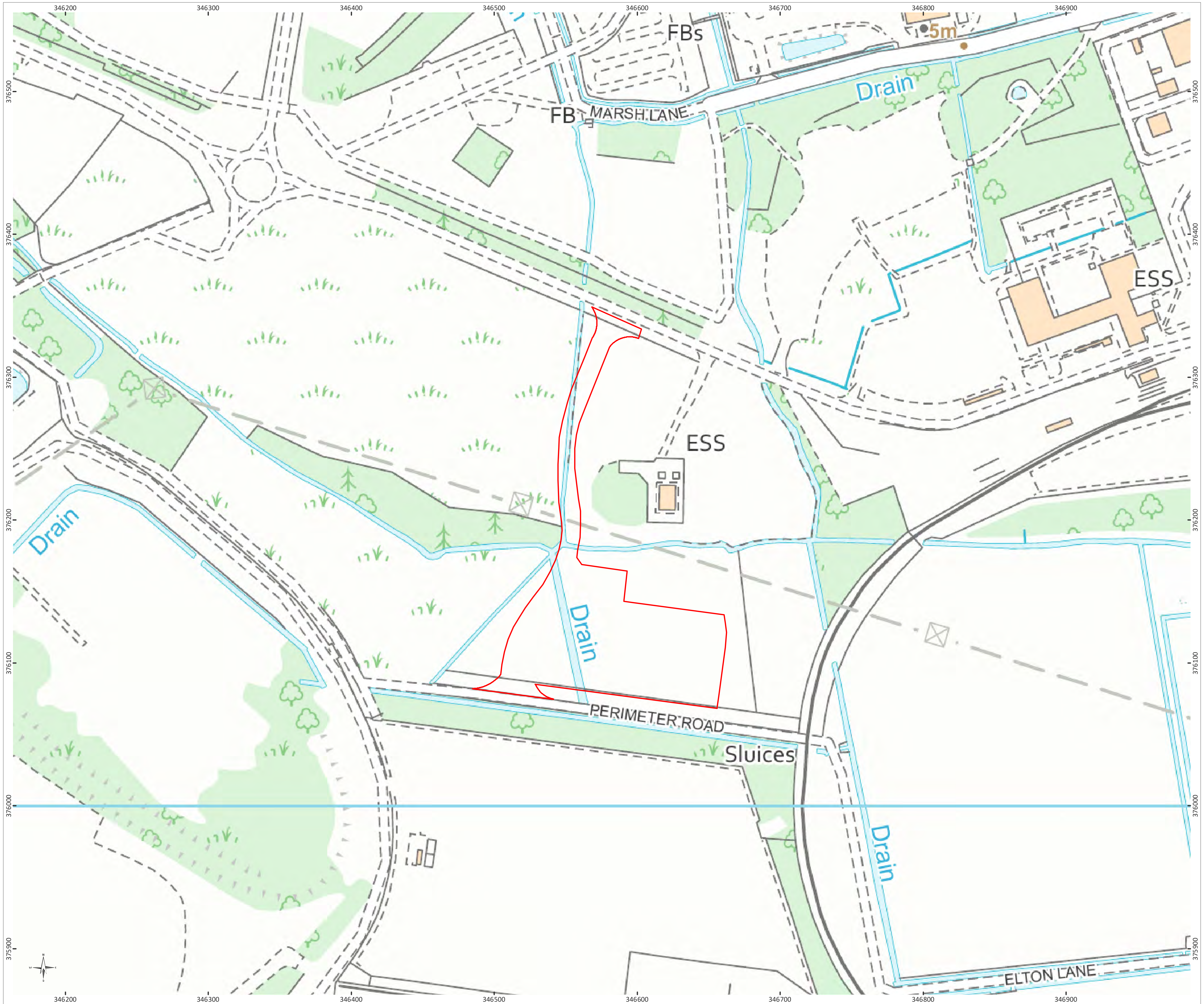
Gas Energy Generating Site Protos, Ince Marshes, Chester

NOTE:

Ref: FE/017/486
Date: 09/12/2022

Produced: VM
Approved: RW

Scale @ A3
1:1,125



Planning Boundary
Total Area = 1.37Ha

FORSA ENERGY

Site Location

Gas Energy Generating Site
Protos, Ince Marshes, Chester

NOTE:

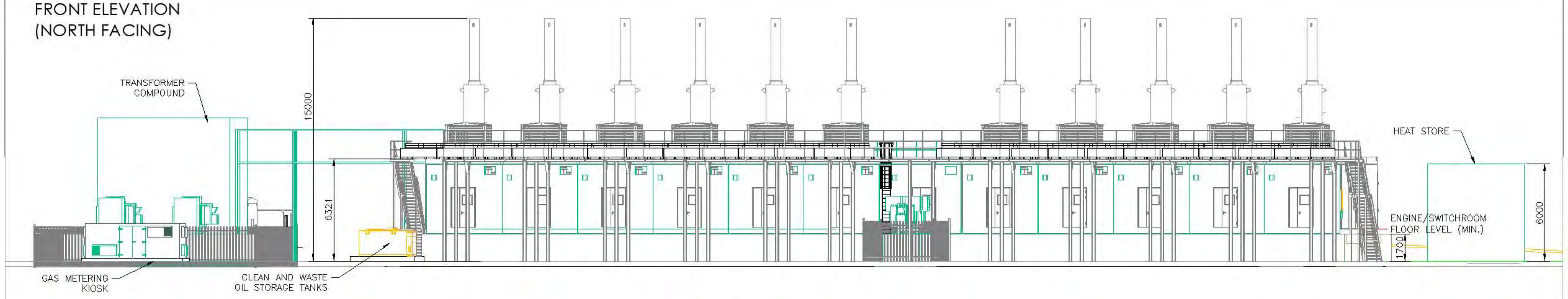
Ref: FE/017/487
Date: 09/12/2022

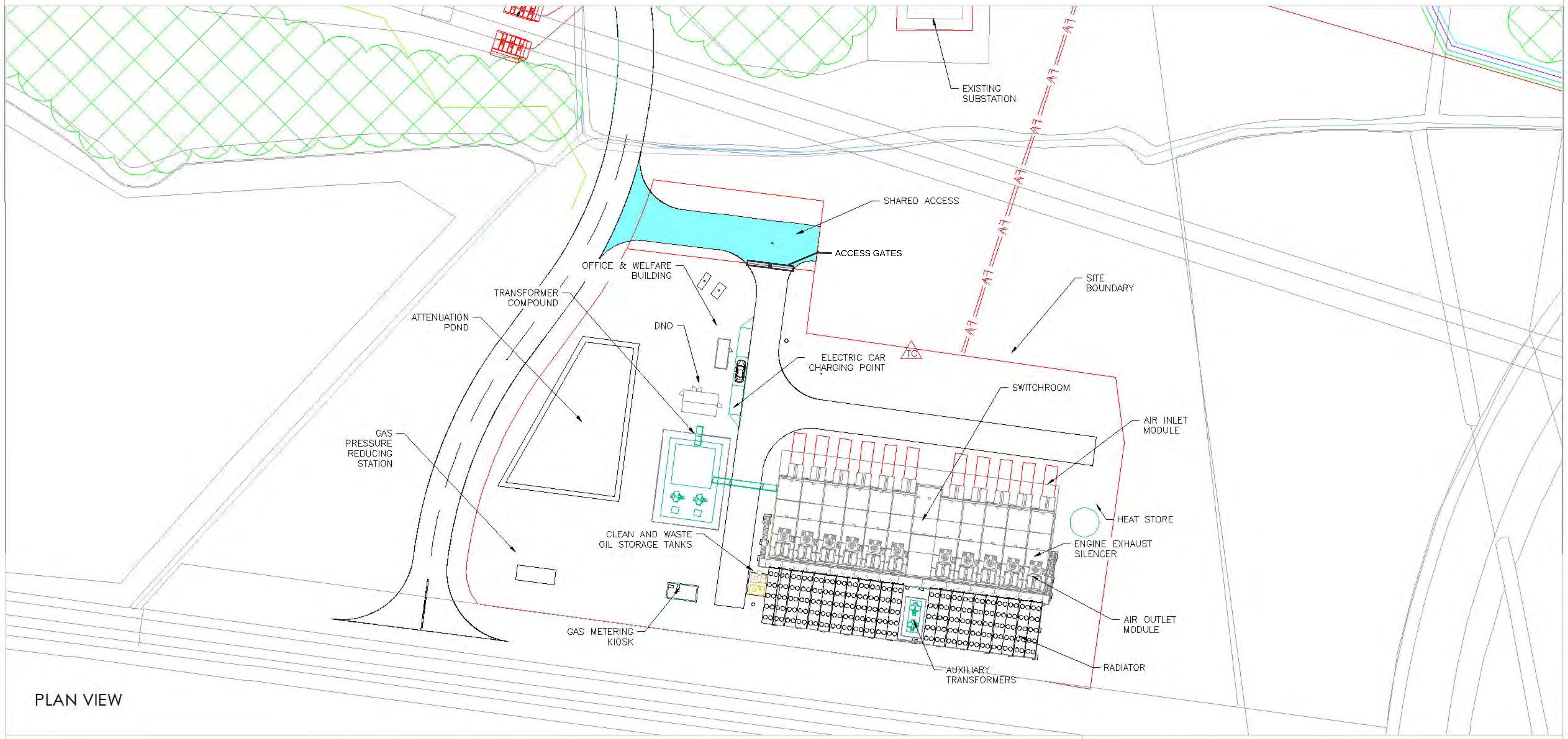
Produced: VM
Approved: RW

Scale @ A3
1:2,500

0 25 50 100 metres
0 25 50 100 yards

FRONT ELEVATION (NORTH FACING)





PLAN VIEW

GAS KIOSK

WELFARE BUILDING

HV/LV SWITCHGEAR CONTAINER

CONTAINERISED ENGINE UNIT

SIDE ELEVATIONS

NOTES:

1. NOT TO SCALE
2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS SPECIFIED OTHERWISE
3. THIS DRAWING IS FOR INDICATIVE PURPOSES ONLY AND SHOULD NOT BE USED FOR CONSTRUCTION

NOTES:

FIGURE REF:	FE/017/488
DATE OF ISSUE:	08/12/22
A3	DRAWN: VM
	ISSUED: RW

FORSA ENERGY

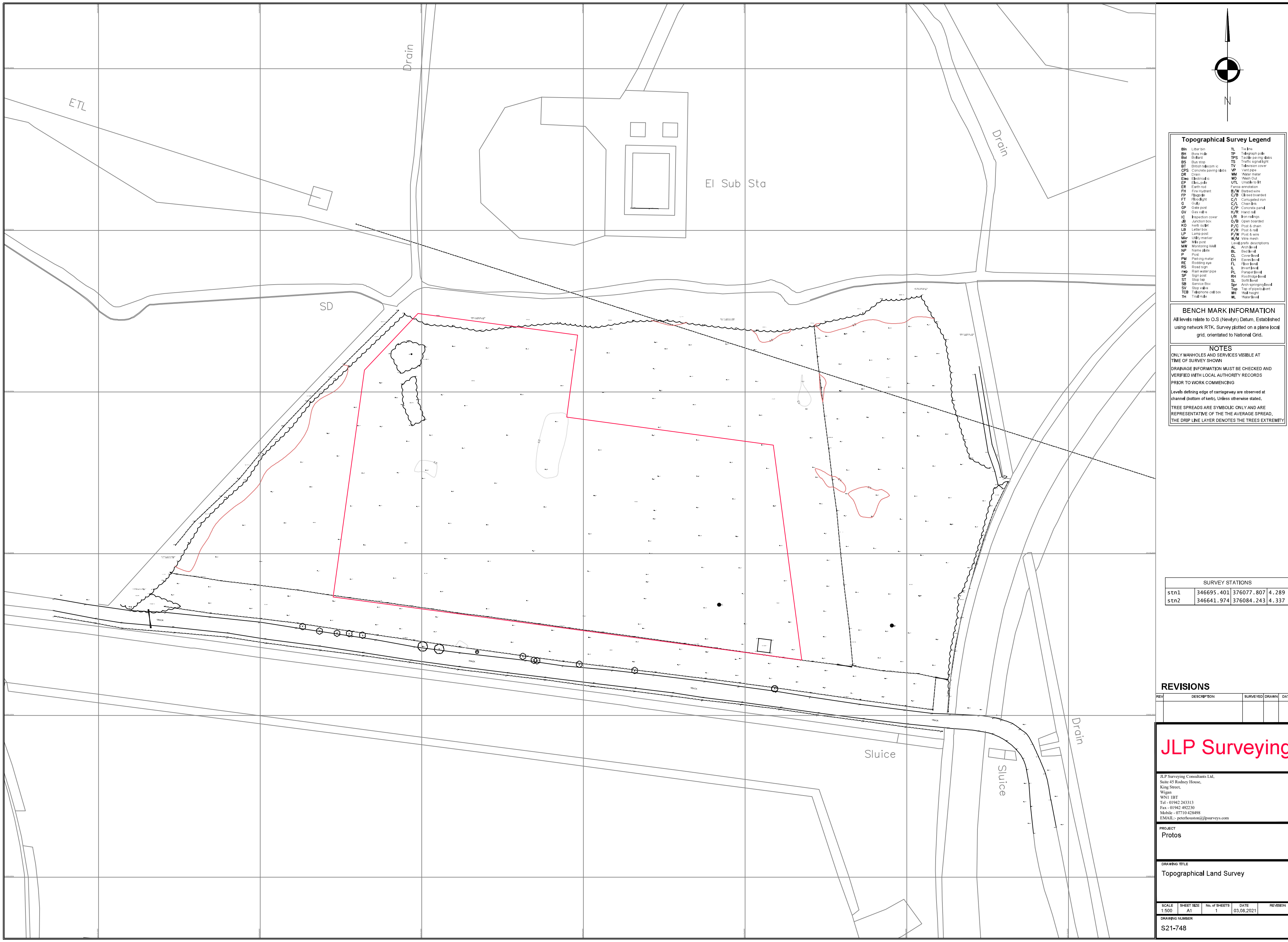
FIGURE

Plan and Elevations

PROJECT

Gas Energy Generating Site
Protos, Ince Marshes, Chester

British National Grid projection
OSGB36 coordinate reference system
(Ordnance Survey Great Britain 1936)



Topographical Survey Legend

Bin	Litter bin	TL	Tie line
BH	Bore Hole	TP	Telegraph pole
Bol	Bollard	TPS	Tactile paving slabs
BS	Bus stop	TS	Traffic signal light
BT	British telecom ic	TV	Television cover
CPS	Concrete paving slabs	VP	Vent pipe
DR	Drain	WM	Water meter
Elec	Electrical ic	WO	Wash Out
EP	Elec. pole	UTL	Unable to lift
ER	Earth rod	Fence annotation	
FH	Fire Hydrant	B/W	Barbed wire
FP	Flagpole	C/B	Closed boarded
FT	Floodlight	C/I	Corrugated iron
G	Gully	C/L	Chain link
GP	Gate post	C/P	Concrete panel
GV	Gas valve	H/R	Hand rail
IC	Inspection cover	I/R	Iron railings
JB	Junction box	O/B	Open boarded
KO	Kerb outlet	P/C	Post & chain
LB	Letter box	P/R	Post & rail
LP	Lamp post	P/W	Post & wire
Mkr	Utility marker	W/M	Wire mesh
MP	Mile post	Level prefix descriptions	
MW	Monitoring Well	AL	Arch level
NP	Name plate	BL	Bed level
P	Post	CL	Cover level
PM	Parking meter	EH	Eaves level
RE	Rodding eye	FL	Floor level
RS	Road sign	IL	Invert level
rwp	Rain water pipe	PL	Parapet level
SP	Sign post	RH	Roof/ridge level
ST	Stop tap	SL	Soffit level
SB	Service Box	Spr	Arch springing level
SV	Stop valve	Top	Top of pipe/culvert
TCB	Telephone call box	WH	Wall height
TH	Trial Hole	WL	Water level

BENCH MARK INFORMATION

All levels relate to O.S (Newlyn) Datum, Established using network RTK. Survey plotted on a plane local grid, orientated to National Grid.

NOTES

ONLY MANHOLES AND SERVICES VISIBLE AT TIME OF SURVEY SHOWN

DRAINAGE INFORMATION MUST BE CHECKED AND VERIFIED WITH LOCAL AUTHORITY RECORDS PRIOR TO WORK COMMENCING

Levels defining edge of carriageway are observed at channel (bottom of kerb). Unless otherwise stated.

TREE SPREADS ARE SYMBOLIC ONLY AND ARE REPRESENTATIVE OF THE THE AVERAGE SPREAD. THE DRIP LINE LAYER DENOTES THE TREES EXTREMITY

SURVEY STATIONS			
stn1	346695.401	376077.807	4.289
stn2	346641.974	376084.243	4.337

REVISIONS

REV	DESCRIPTION	SURVEYED	DRAWN	DATE

JLP Surveying

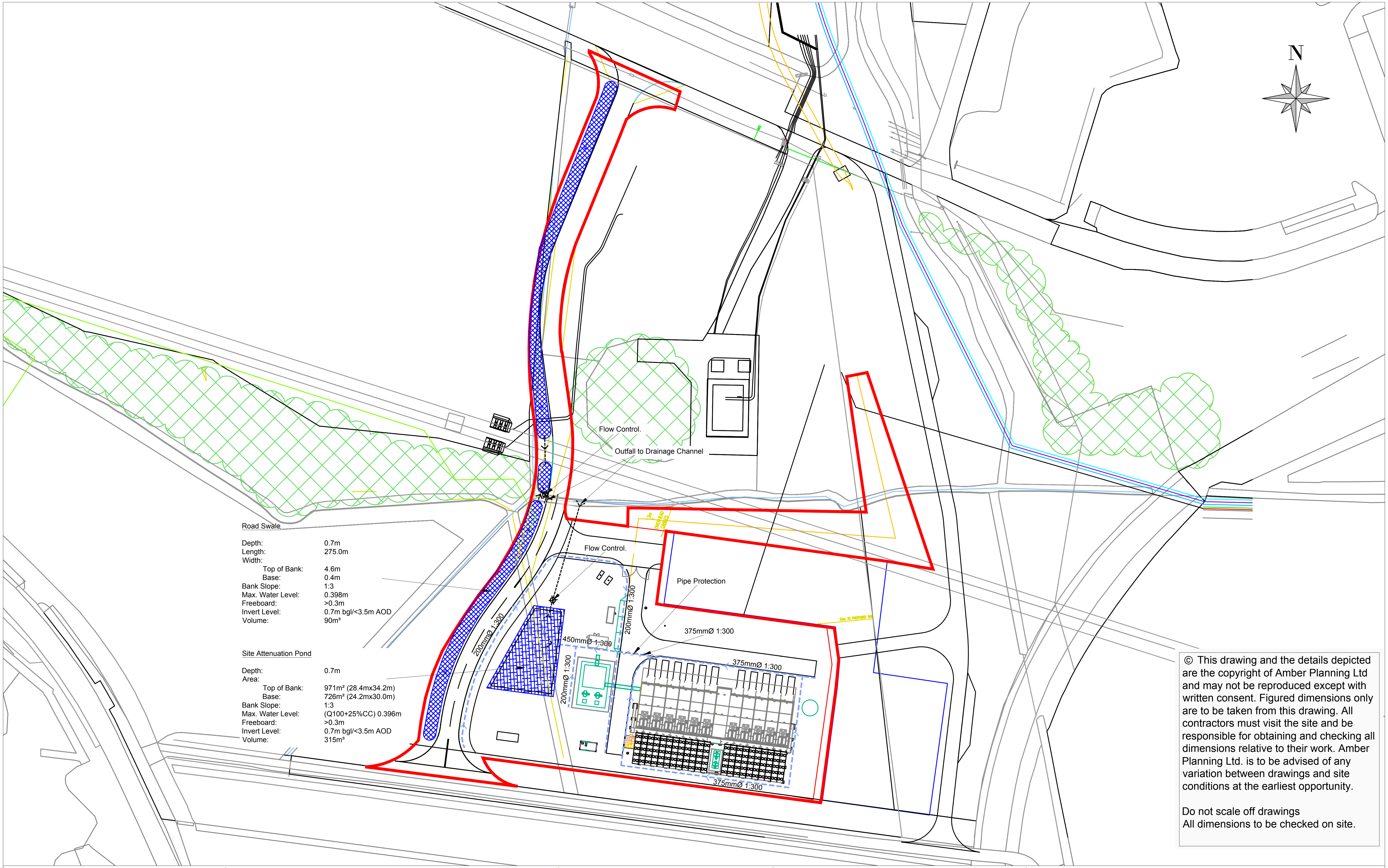
JLP Surveying Consultants Ltd,
Suite 45 Rodney House,
King Street,
Wigan
WN1 1BT
Tel - 01942 243313
Fax - 01942 492230
Mobile - 07710 428498
EMAIL:- peterhouston@jlpsurveys.com

PROJECT
Protos

DRAWING TITLE
Topographical Land Survey

SCALE	SHEET SIZE	No. of SHEETS	DATE	REVISION
1:500	A1	1	03.08.2021	

DRAWING NUMBER
S21-748



Do not scale off drawings
All dimensions to be checked on site.

Amber Planning Ltd
www.amberplanning.co.uk
Tel. 07930 877447

KEY
- Road Swale
- Site Attenuation Pond
- Permeable Pipe in Filter Drain

NOTES:

SCALE: 1:1,250 @ A3	PROJECT NO.: H8497	PROJECT: Ash Road, Protos
DATE: May 2023	DRAWING NO.: H8497-001	DRAWING TITLE: Conceptual Drainage Layout
DRAWN: KR	CHECKED: KdS	CLIENT: FORSA ENERGY

RECORD OF WELL

For Institute use only Licence No.

N .... SJ 47 NE / 20

SJ47/61 4656 7604

At INCE 'B' PRODUCTION BH 1

Town or Village ....

County ....

97

EXACT SITE OF WELL

Six-inch National Grid sheet and reference SJ 4656 7604

For C.E.G.B.

State whether owner, tenant, builder, contractor, consultant, etc.: ....

Address (if different from above) ....

Level of ground surface above sea level (O.D.) .... ft (........ m)

*DELETE AS NECESSARY

If well top is not at ground level state how far above:* below: .... ft (........ m)

SHAFT .... ft (........ m); diameter .... ft (........ m);

HEADINGS (please attach details—dimensions and directions)

BORE .... ft (86.0 m); diameter: at top .... in (305 mm);

at bottom .... in (........ mm)

Full details of permanent lining tubes (position, length, inner and outer diameters, plain slotted etc.):

24m x 340mm of steel from surface

86m x 203mm of terrafitter from surface

Water struck at depths of .... ft (........ m) below well top

TEST CONDITIONS

Rest level of water .... ft (1.10 m) ~~above~~* below well top. Suction at .... ft (........ m)

Yield on .... hours'* days' test pumping at .... galls per .... (........ l/s) with depression to .... ft (........ m) below well top. Recovery to rest level in .... mins* hours

Capacity of pump .... g.p.h. (........ l/s)

Date of measurements 28.9.84

NORMAL CONDITIONS

DESCRIPTION OF PERMANENT PUMPING EQUIPMENT:

Make and/or type .... Motive power ....

Capacity .... galls (........ m^3) per hour. Suction at .... ft (........ m) below well top. Amount pumped .... galls (........ m^3) per day. Estimated consumption .... galls (........ m^3) per week

Well made by DRILLING & GEO SERVICES Date of sinking ....

ADDITIONAL NOTES ANALYSIS (please attach copy if available)

LOG OF STRATA OVERLEAF

EMERGENCY ABSTRACTION BH

PUMP INSTALLED 28.9.84

METHANE VALUE IN H_2O - <0.10mg/L

Received from NWWA

Date 4.3.85

Observation well ....

Recorder ....

SJ 4 / NE / 60
4656
7604.

Institute use only

[GEO]LOGICAL [CLA]SSIFICATION	NATURE OF STRATA *If measurements start below ground surface, state how far.*	Thickness Feet	Thickness Inches	Thickness Metres	Depth Feet	Depth Inches	Depth Metres
Alluvium	CLAY			2.20			2.20
Peat	PEAT			1.60			3.80
Till or alluvium	GREY SOFT CLAY			3.20			7.00
Glacial Till	BOULDER CLAY			10.00			17.00
Weathered Sst / Fluvial sands	SAND			1.50			18.50
Triassic sandstones & conglomerates	HARD RED SANDSTONE			45.50			64.0
	'SAND + GRAVEL' ?			13.0			77.0
	HARD RED SANDSTONE			9.00			86.0

At INCE 'B' PRODUCTION BH.1

Town or Village ....

County ....

SJ47/61

97 SJ47NE

EXACT SITE OF WELL

Six-inch National Grid sheet and reference SJ 4656 7604

For C.E.G.B

State whether owner, tenant, builder, contractor, consultant, etc.: ....

Address (if different from above) ....

Level of ground surface above sea level (O.D.) .... ft (.... m)

*DELETE AS NECESSARY

If well top is not at ground level state how far above:* below: .... ft (.... m)

SHAFT .... ft (.... m); diameter .... ft (.... m);

HEADINGS (please attach details—dimensions and directions)

BORE .... ft (86.0 m); diameter: at top .... in (305 mm);
at bottom .... in (.... mm)

Full details of permanent lining tubes (position, length, inner and outer diameters, plain slotted etc.):
24m x 340mm of steel from surface
86m x 203mm of terrafitter from surface

Water struck at depths of .... ft (.... m) below well top

TEST CONDITIONS

Rest level of water .... ft (1.10 m) ~~above*~~ below well top. Suction at .... ft (.... m)

Yield on .... hours'* days' test pumping at .... galls per .... (.... l/s) with depression to .... ft (.... m) below well top. Recovery to rest level in .... mins* hours

Capacity of pump .... g.p.h. (.... l/s)

Date of measurements 28.9.84

NORMAL CONDITIONS

DESCRIPTION OF PERMANENT PUMPING EQUIPMENT:

Make and/or type .... Motive power ....

Capacity .... galls (.... m³) per hour. Suction at .... ft (.... m) below well top. Amount pumped .... galls (.... m³) per day. Estimated consumption .... galls (.... m³) per week

Well made by DRILLING & GEO SERVICES Date of sinking ....

ADDITIONAL NOTES ANALYSIS (please attach copy if available)

LOG OF STRATA OVERLEAF

EMERGENCY ABSTRACTION BH
PUMP INSTALLED 28.9.84
METHANE VALUE IN H_2O = <0.10mg/L

Received from NWWA

Date 4.3.85

Observation well ....

Recorder ....

ER log ....

Site marked on
1" map ....
6" map—Grid Sheet ....
(use symbol)

Copy to ....

INSTITUTE OF GEOLOGICAL SCIENCES
HYDROGEOLOGY UNIT
EXHIBITION ROAD
LONDON SW7 2DE

RECORD OF WELL

For Institute use only Licence No.

N ....

SJ 47 NE / 21

SJ47/62

4660
7603

At CEGB INCE 'B' PRODUCTION
BH 2

Town or Village ....

County ....

97

EXACT SITE OF WELL

Six-inch National Grid sheet and reference SJ 4660 7603

For ....

State whether owner, tenant, builder, contractor, consultant, etc.: ....

Address (if different from above) ....

....

Level of ground surface above sea level (O.D.) ....ft (..........m)

*DELETE AS NECESSARY

If well top is not at ground level state how far above:* below: ....ft (..........m)

SHAFT..........ft (..........m); diameter..........ft (..........m);

HEADINGS (please attach details—dimensions and directions)

BORE..........ft (85 m); diameter: at top..........in (305 mm);

at bottom..........in (..........mm)

Full details of permanent lining tubes (position, length, inner and outer diameters, plain slotted etc.):

20m x 340mm of steel from surface

....

Water struck at depths of ....ft (..........m) below well top

TEST CONDITIONS

Rest level of water..........ft (0.90 m) ~~above~~* below well top. Suction at..........ft (..........m)

Yield on..........hours'* days' test pumping at..........galls per .... (..........l/s) with

depression to..........ft (..........m) below well top. Recovery to rest level in .... mins* hours

Capacity of pump..........g.p.h. (..........l/s)

Date of measurements 28.9.84

NORMAL CONDITIONS

DESCRIPTION OF PERMANENT PUMPING EQUIPMENT:

Make and/or type .... Motive power..........

Capacity..........galls (..........m³) per hour. Suction at ....ft (..........m)

below well top. Amount pumped..........galls (..........m³) per day. Estimated

consumption ....galls (..........m³) per week

Well made by DRILLING & GEO SERVICES Date of sinking..........

ADDITIONAL NOTES ANALYSIS (please attach copy if available)

LOG OF STRATA OVERLEAF

EMERGENCY ABSTRACTION BH
PUMP INSTALLED 28.9.84
METHANE VALUES IN H_2O = <0.10 mg/l

Received from NWWA

Date 4.3.85

Observation well..........

Recorder..........

SJ 47 NE / 21
4669
7603.

For Institute use only

GEOLOGICAL CLASSIFICATION	NATURE OF STRATA *If measurements start below ground surface, state how far.*	THICKNESS Feet	Inches	Metres	DEPTH Feet	Inches	Metres
	GRAVEL FILL			1·0			1·0
Alluvium	SILTY CLAY			2·0			3·0
Peat	PEAT			2·0			5·0
"Stoneless Clay" Glacial Till	SOFT GREY CLAY			4·0			9·0
or Alluvium.	RED / BROWN SILTY CLAY			9·5			18·5
Triassic sandstone.	SANDSTONE			66·5			85·0

At CEGB INCE 'B' PRODUCTION BH2

Town or Village ....

County ....

SJ47/62

97 SJ47NE

EXACT SITE OF WELL

Six-inch National Grid sheet and reference SJ 4660 7603

For ....

State whether owner, tenant, builder, contractor, consultant, etc.: ....

Address (if different from above) ....

Level of ground surface above sea level (O.D.) ....ft (........m)

*DELETE AS NECESSARY

If well top is not at ground level state how far above:* below: ....ft (........m)

SHAFT........ft (........m); diameter........ft (........m);

HEADINGS (please attach details—dimensions and directions)

BORE........ft (85........m); diameter: at top........in (305........mm); at bottom........in (........mm)

Full details of permanent lining tubes (position, length, inner and outer diameters, plain slotted etc.):

20m x 340mm of steel from surface

Water struck at depths of ....ft (........m) below well top

TEST CONDITIONS

Rest level of water........ft (0.90 m) ~~above~~* below well top. Suction at........ ft (........m)

Yield on........ hours'* days' test pumping at........galls per .... (........ l/s) with depression to........ft (........m) below well top. Recovery to rest level in .... mins* hours

Capacity of pump........g.p.h. (........l/s)

Date of measurements 28.9.84

NORMAL CONDITIONS

DESCRIPTION OF PERMANENT PUMPING EQUIPMENT:

Make and/or type .... Motive power........

Capacity........galls (........m^3) per hour. Suction at .... ft (........m) below well top. Amount pumped........galls (........m^3) per day. Estimated consumption ....galls (........m^3) per week

Well made by DRILLING & GEO SERVICES Date of sinking........

ADDITIONAL NOTES ANALYSIS (please attach copy if available)

LOG OF STRATA OVERLEAF

EMERGENCY ABSTRACTION BH
PUMP INSTALLED 28.9.84
METHANE VALUES IN H_2O = < 0.10 mg/l

Received from NWWA ....

Date 4.3.85

Observation well........

Recorder........

ER log ....

Site marked on
1" map ....
6" map—Grid Sheet........
(use symbol)

Copy to........

INSTITUTE OF GEOLOGICAL SCIENCES
HYDROGEOLOGY UNIT
EXHIBITION ROAD
LONDON SW7 2DE

Kirsten de Savary

From: GMMC Info Requests <Inforequests.gmmc@environment-agency.gov.uk>
Sent: 15 May 2017 14:05
To: info@amberplanning.co.uk
Subject: GMMC16147AB (July 2016)

Dear Kirsten,

Our officer has advised that the information is still the most up to date data we have.

Kind regards,

Anne

Anne Ball
Customer and Engagement
Greater Manchester, Merseyside and Cheshire
Direct: **Inforequests.GMMC@environment-agency.gov.uk**
Office address: Richard Fairclough House, Knutsford Road, Latchford, Warrington, WA4 1HT
External: 020 302 51232
Internal: 51232

From: Kirsten de Savary [mailto:info@amberplanning.co.uk]
Sent: 08 May 2017 17:23
To: Enquiries, Unit <enquiries@environment-agency.gov.uk>
Subject: 170511/MS02 gmmc Information Request - Data Currency: CH2 4LB; GMMC16147AB (July 2016)

Dear Enquiries,

I am contacting you to confirm whether the attached data remains current. Feel free to contact me with any queries.

Kind Regards

Kirsten de Savary BSc Hons C.WEM CEnv
07930 877447

AMBER PLANNING
Flood Risk and Hydrology
www.amberplanning.co.uk
@amberplanning

1 Low Moor Road, Lincoln, LN6 3JY

From: GMMC Info Requests
To: Lucy Raven
Subject: GMMC16147AB Response attached from the Environment Agency
Date: 14 July 2016 10:13:49
Attachments: Defences.pdf
Map.pdf
Water Levels and Flows1.pdf
Visual condition grading of FCRM assets - Feb 13.pdf

Dear Lucy,

Thank you for your enquiry which was received on 22/6/18.

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

I enclose the information you have requested. We have no record of flooding affecting this site. However, this does not mean flooding has not occurred in the past or that it will not flood in future. We recommend that you also contact United Utilities and Cheshire West and Chester Council who may hold additional information (the former especially in relation to sewer flooding).
Please refer to the Open Government Licence which explains the permitted use of this information.

Please get in touch if you have any further queries or contact us within two months if you'd like us to review the information we have sent.

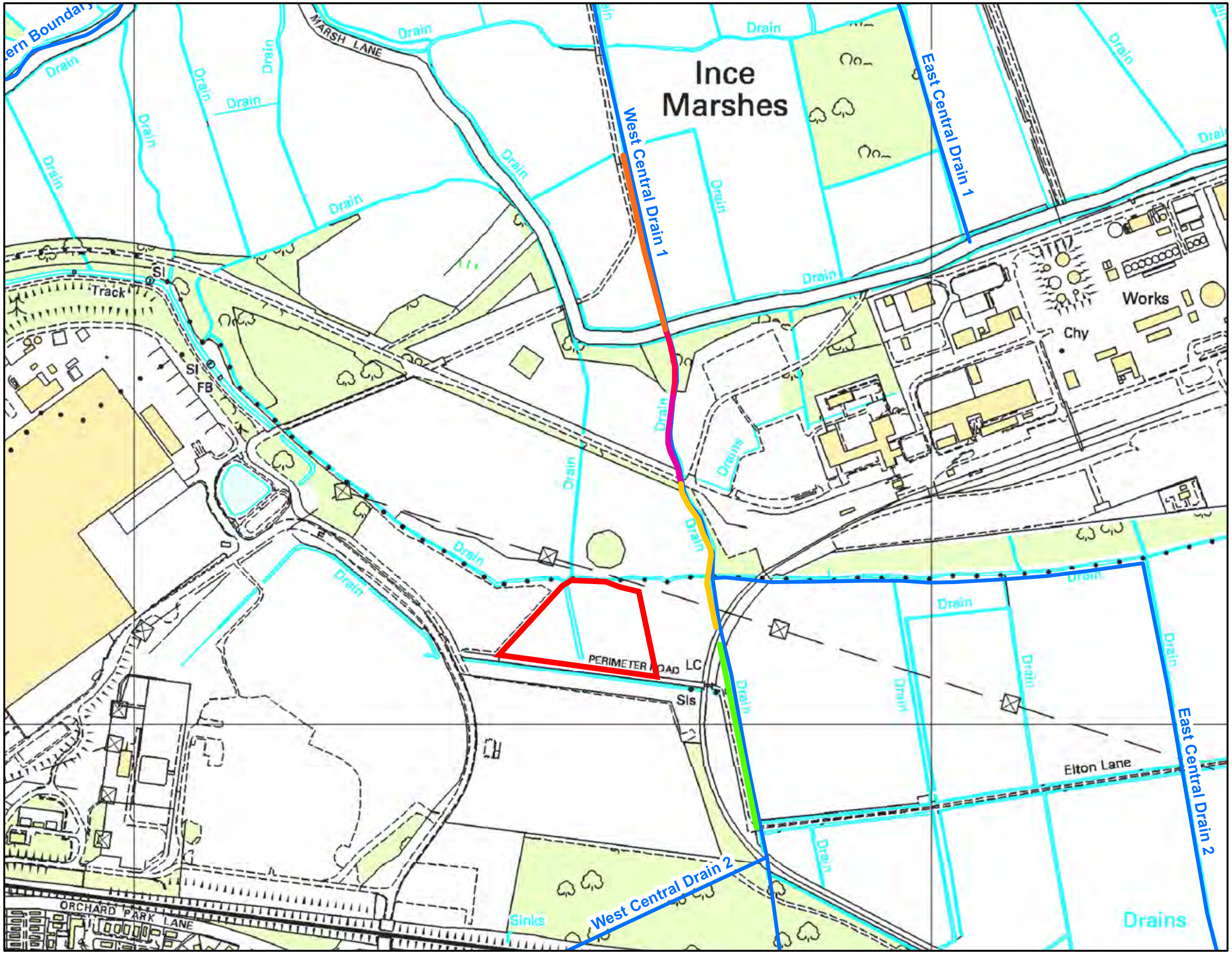
We are committed to providing a professional customer service. Please help us understand more about what is important to you by completing our survey.
http://www.smartsurvey.co.uk/s/EnvironmentAgencyCustomerSurvey/?a=GMMC

Kind regards,

Anne Ball
Customer and Engagement Officer
Greater Manchester, Merseyside and Cheshire
Internal: 721 2937
External: 020 302 51232
Email: Inforequests.gmmc@environment-agency.gov.uk

APPENDIX C:	Flood Defences Locations

Defences centred on Site near Ash Road, Ince CH2 4LB GMMC16147AB created 11/07/2016



Environment Agency

1:7,000

N

Legend

Defences

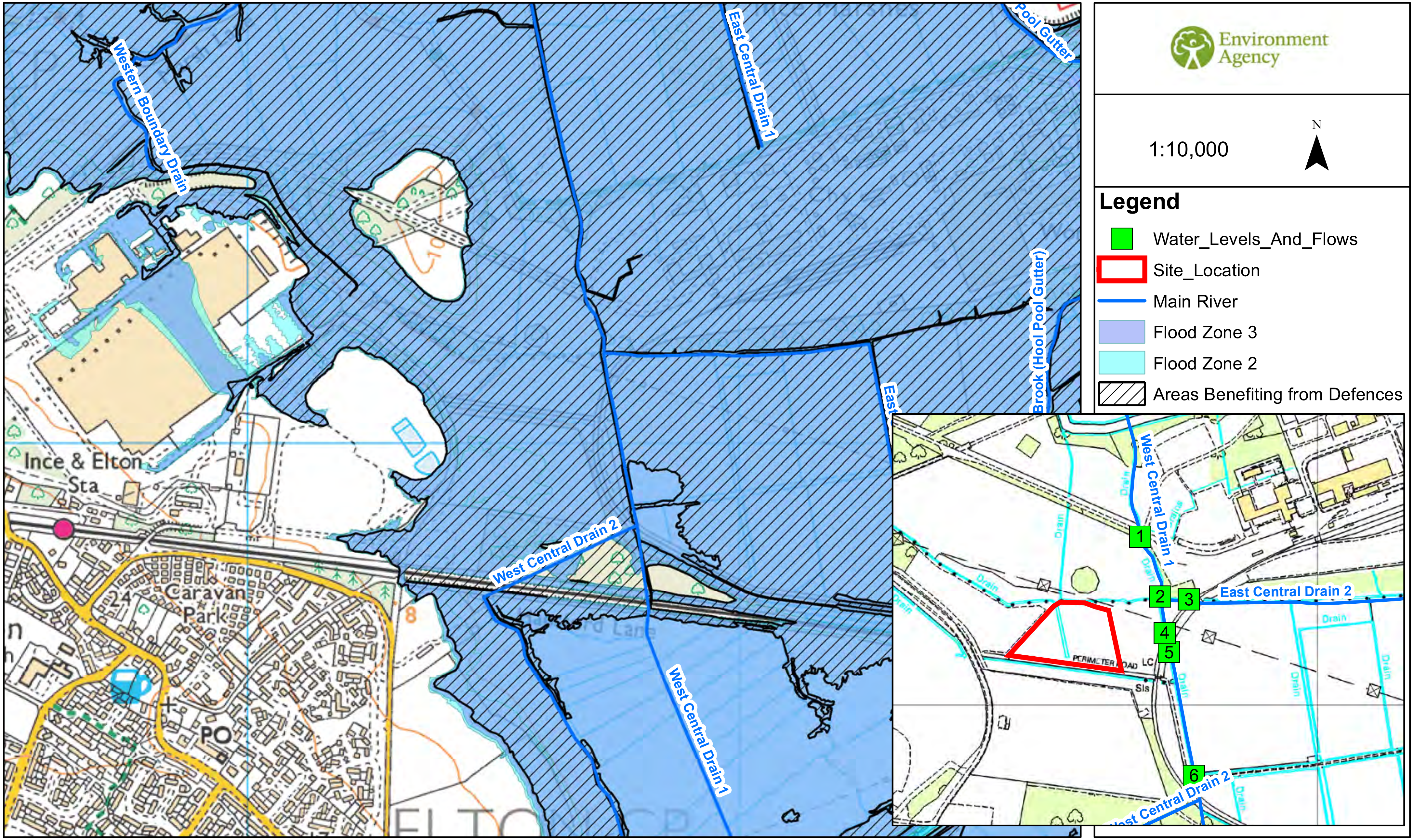
ASSET_ID

- 34291
- 34292
- 184581
- 184582
- 185538
- Main River
- Site Location

Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 08708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

APPENDIX D:	Model Node Locations and Water Levels

Detailed Map centred on Site near Ash Road, Ince CH2 4LB GMMC16147AB created 11/07/2016



Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 08708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

					Tidal									
Map Reference	Model Node Reference	Easting	Northing	Data	50 % AEP (1 in 2 year)	20 % AEP (1 in 5 year)	10 % AEP (1 in 10 year)	4 % AEP (1 in 25 year)	2 % AEP (1 in 50 year)	1.33 % AEP (1 in 75 year)	1 % AEP (1 in 100 year)	1 % AEP (1 in 100 year) + Climate Change*	0.5 % AEP (1 in 200 year)	0.1 % AEP (1 in 1000 year)
1	ea013_Model_WCDR01_00014	3E+05	376296	Modelled Water Level (m aod)	5.99	6.34	6.56	6.81	6.93	7.01	7.07	7.93	7.22	7.22
				Modelled Flow (cumecs)	0	0	0	0	0	0	0	0	0	0
2	ea013_Model_WCDR01_00019	3E+05	375875	Modelled Water Level (m aod)	5.87	6.29	6.51	6.74	6.84	6.92	6.96	7.81	7.11	7.11
				Modelled Flow (cumecs)	0	0	0	0	0	0	0	0	0	0
3	ea013_Model_WCDR01_00018	3E+05	376093	Modelled Water Level (m aod)	5.89	6.3	6.52	6.76	6.87	6.94	6.99	7.84	7.14	7.14
				Modelled Flow (cumecs)	0	0	0	0	0	0	0	0	0	0
4	ea013_Model_WCDR01_00017	3E+05	376126	Modelled Water Level (m aod)	5.89	6.3	6.52	6.76	6.87	6.94	6.99	7.84	7.14	7.14
				Modelled Flow (cumecs)	0	0	0	0	0	0	0	0	0	0
5	ea013_Model_ECD201_00002	3E+05	376185	Modelled Water Level (m aod)	5.91	6.31	6.53	6.78	6.89	6.97	7.02	7.87	7.17	7.17
				Modelled Flow (cumecs)	0	0	0	0	0	0	0	0	0	0
6	ea013_Model_WCDR01_00015	3E+05	376190	Modelled Water Level (m aod)	5.95	6.33	6.55	6.8	6.92	7	7.05	7.91	7.21	7.21
				Modelled Flow (cumecs)	0	0	0	0	0	0	0	0	0	0

					Fluvial Defended									
Map Reference	Model Node Reference	Easting	Northing	Data	50 % AEP (1 in 2 year)	20 % AEP (1 in 5 year)	10 % AEP (1 in 10 year)	4 % AEP (1 in 25 year)	2 % AEP (1 in 50 year)	1.33 % AEP (1 in 75 year)	1 % AEP (1 in 100 year)	1 % AEP (1 in 100 year) + Climate Change*	0.5 % AEP (1 in 200 year)	0.1 % AEP (1 in 1000 year)
1	ea013_Model_WCDR01_00014	3E+05	376296	Modelled Water Level (m aod)	3.54	3.6	3.64	3.67	3.69	3.71	3.72	3.84	3.76	3.95
				Modelled Flow (cumecs)	0.36	0.39	0.42	0.44	0.47	0.49	0.5	0.55	0.54	0.71
2	ea013_Model_WCDR01_00019	3E+05	375875	Modelled Water Level (m aod)	3.8	3.83	3.85	3.88	3.91	3.92	3.93	3.99	3.97	4.16
				Modelled Flow (cumecs)	0.31	0.32	0.32	0.35	0.36	0.38	0.39	0.38	0.37	0.44
3	ea013_Model_WCDR01_00018	3E+05	376093	Modelled Water Level (m aod)	3.64	3.69	3.72	3.75	3.77	3.78	3.79	3.89	3.83	4.04
				Modelled Flow (cumecs)	0.27	0.28	0.29	0.31	0.33	0.34	0.35	0.38	0.37	0.49
4	ea013_Model_WCDR01_00017	3E+05	376126	Modelled Water Level (m aod)	3.64	3.69	3.72	3.75	3.76	3.78	3.79	3.89	3.82	4.03
				Modelled Flow (cumecs)	0.27	0.28	0.29	0.31	0.33	0.34	0.35	0.38	0.37	0.49
5	ea013_Model_ECD201_00002	3E+05	376185	Modelled Water Level (m aod)	3.6	3.66	3.7	3.73	3.75	3.76	3.77	3.87	3.81	4
				Modelled Flow (cumecs)	0.11	0.12	0.13	0.14	0.15	0.15	0.16	0.17	0.17	0.22
6	ea013_Model_WCDR01_00015	3E+05	376190	Modelled Water Level (m aod)	3.58	3.64	3.67	3.7	3.72	3.74	3.75	3.86	3.79	3.98
				Modelled Flow (cumecs)	0.36	0.4	0.42	0.45	0.48	0.49	0.5	0.55	0.54	0.71

					Fluvial Undefended									
Map Reference	Model Node Reference	Easting	Northing	Data	50 % AEP (1 in 2 year)	20 % AEP (1 in 5 year)	10 % AEP (1 in 10 year)	4 % AEP (1 in 25 year)	2 % AEP (1 in 50 year)	1.33 % AEP (1 in 75 year)	1 % AEP (1 in 100 year)	1 % AEP (1 in 100 year) + Climate Change*	0.5 % AEP (1 in 200 year)	0.1 % AEP (1 in 1000 year)
1	ea013_Model_WCDR01_00014	3E+05	376296	Modelled Water Level (m aod)	5.68	5.68	5.68	5.68	5.68	5.68	5.69	6.23	5.69	7.26
				Modelled Flow (cumecs)	0	0	0	0	0	0	0	0	0	0
2	ea013_Model_WCDR01_00019	3E+05	375875	Modelled Water Level (m aod)	5.49	5.49	5.5	5.5	5.51	5.51	5.54	6.2	5.54	7.14
				Modelled Flow (cumecs)	0	0	0	0	0	0	0	0	0	0
3	ea013_Model_WCDR01_00018	3E+05	376093	Modelled Water Level (m aod)	5.53	5.53	5.54	5.54	5.54	5.55	5.57	6.21	5.57	7.17
				Modelled Flow (cumecs)	0	0	0	0	0	0	0	0	0	0
4	ea013_Model_WCDR01_00017	3E+05	376126	Modelled Water Level (m aod)	5.54	5.54	5.54	5.54	5.55	5.55	5.57	6.21	5.57	7.17
				Modelled Flow (cumecs)	0	0	0	0	0	0	0	0	0	0
5	ea013_Model_ECD201_00002	3E+05	376185	Modelled Water Level (m aod)	5.58	5.59	5.59	5.59	5.59	5.59	5.61	6.22	5.61	7.2
				Modelled Flow (cumecs)	0	0	0	0	0	0	0	0	0	0
6	ea013_Model_WCDR01_00015	3E+05	376190	Modelled Water Level (m aod)	5.65	5.65	5.65	5.65	5.65	5.65	5.66	6.23	5.66	7.25
				Modelled Flow (cumecs)	0	0	0	0	0	0	0	0	0	0

Defences

Date built	Asset ID	Standard of Protection	Overall Condition Grade^	Upstream Actual Crest Level (m aodN)	Downstream Actual Crest Level (m aodN)
Not Available	34291	5	3	3.84	3.12
Not Available	34292	5	3	3.12	4.77
Not Available	184581	5	3	4.77	4.02
Not Available	184582	100	3	3.04	3.84
Not Available	185538	100	3	4.61	5.12

Model data taken from Ince and Frodsham Marshes Strategic Study 2011
Notes:
AEP - Annual Exceedence Probability
m aod - metres above ordnance datum
cumecs - cubic metres per second
*Climate Change Scenario based on the previous guidance - 20% increase in flow.
The new climate change guidance is available at
https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances
The location of the site and the type (vulnerablility) of development determine the climate change allowances to consider in any flood risk assessment.
^ Refer to condition grade document

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.450
Area (ha)	50.000	Urban	0.113
SAAR (mm)	715	Region Number	Region 10

Results	**l/s**
QBAR Rural	225.2
QBAR Urban	270.6
Q100 years	533.7
Q1 year	235.5
Q30 years	446.2
Q100 years	533.7

Summary of Results for 2 year Return Period (+25%)

Half Drain Time : 247 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.192	0.192	0.0	0.9	0.0	0.9	14.4	O K
30 min Summer	0.206	0.206	0.0	0.9	0.0	0.9	17.3	O K
60 min Summer	0.220	0.220	0.0	0.9	0.0	0.9	20.3	O K
120 min Summer	0.230	0.230	0.0	1.0	0.0	1.0	22.8	O K
180 min Summer	0.233	0.233	0.0	1.0	0.0	1.0	23.6	O K
240 min Summer	0.234	0.234	0.0	1.0	0.0	1.0	23.7	O K
360 min Summer	0.233	0.233	0.0	1.0	0.0	1.0	23.5	O K
480 min Summer	0.231	0.231	0.0	1.0	0.0	1.0	23.1	O K
600 min Summer	0.230	0.230	0.0	1.0	0.0	1.0	22.6	O K
720 min Summer	0.227	0.227	0.0	1.0	0.0	1.0	22.1	O K
960 min Summer	0.224	0.224	0.0	0.9	0.0	0.9	21.2	O K
1440 min Summer	0.215	0.215	0.0	0.9	0.0	0.9	19.1	O K
2160 min Summer	0.199	0.199	0.0	0.9	0.0	0.9	15.7	O K
2880 min Summer	0.181	0.181	0.0	0.9	0.0	0.9	12.5	O K
4320 min Summer	0.142	0.142	0.0	0.9	0.0	0.9	6.9	O K
5760 min Summer	0.108	0.108	0.0	0.9	0.0	0.9	3.6	O K
7200 min Summer	0.085	0.085	0.0	0.9	0.0	0.9	2.1	O K
8640 min Summer	0.071	0.071	0.0	0.8	0.0	0.8	1.4	O K
10080 min Summer	0.062	0.062	0.0	0.7	0.0	0.7	1.0	O K
15 min Winter	0.201	0.201	0.0	0.9	0.0	0.9	16.3	O K
30 min Winter	0.217	0.217	0.0	0.9	0.0	0.9	19.6	O K
60 min Winter	0.232	0.232	0.0	1.0	0.0	1.0	23.2	O K

Storm Event	Rain (mm/hr)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	46.329	0.0	32
30 min Summer	28.388	0.0	45
60 min Summer	17.395	0.0	72
120 min Summer	10.658	0.0	126
180 min Summer	8.003	0.0	182
240 min Summer	6.531	0.0	220
360 min Summer	4.904	0.0	284
480 min Summer	4.002	0.0	350
600 min Summer	3.418	0.0	420
720 min Summer	3.005	0.0	490
960 min Summer	2.475	0.0	628
1440 min Summer	1.884	0.0	900
2160 min Summer	1.434	0.0	1296
2880 min Summer	1.181	0.0	1676
4320 min Summer	0.892	0.0	2376
5760 min Summer	0.731	0.0	3016
7200 min Summer	0.627	0.0	3688
8640 min Summer	0.552	0.0	4408
10080 min Summer	0.497	0.0	5136
15 min Winter	46.329	0.0	32
30 min Winter	28.388	0.0	45
60 min Winter	17.395	0.0	72

Summary of Results for 2 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
120 min Winter	0.244	0.244	0.0	1.0	0.0	1.0	26.4	O K
180 min Winter	0.248	0.248	0.0	1.0	0.0	1.0	27.6	O K
240 min Winter	0.249	0.249	0.0	1.0	0.0	1.0	28.0	O K
360 min Winter	0.248	0.248	0.0	1.0	0.0	1.0	27.6	O K
480 min Winter	0.246	0.246	0.0	1.0	0.0	1.0	27.0	O K
600 min Winter	0.243	0.243	0.0	1.0	0.0	1.0	26.2	O K
720 min Winter	0.240	0.240	0.0	1.0	0.0	1.0	25.3	O K
960 min Winter	0.234	0.234	0.0	1.0	0.0	1.0	23.6	O K
1440 min Winter	0.218	0.218	0.0	0.9	0.0	0.9	19.9	O K
2160 min Winter	0.191	0.191	0.0	0.9	0.0	0.9	14.2	O K
2880 min Winter	0.159	0.159	0.0	0.9	0.0	0.9	9.1	O K
4320 min Winter	0.095	0.095	0.0	0.9	0.0	0.9	2.7	O K
5760 min Winter	0.067	0.067	0.0	0.8	0.0	0.8	1.2	O K
7200 min Winter	0.056	0.056	0.0	0.7	0.0	0.7	0.8	O K
8640 min Winter	0.050	0.050	0.0	0.6	0.0	0.6	0.6	O K
10080 min Winter	0.045	0.045	0.0	0.5	0.0	0.5	0.5	O K

Storm Event	Rain (mm/hr)	Overflow Volume (m³)	Time-Peak (mins)
120 min Winter	10.658	0.0	126
180 min Winter	8.003	0.0	182
240 min Winter	6.531	0.0	236
360 min Winter	4.904	0.0	304
480 min Winter	4.002	0.0	378
600 min Winter	3.418	0.0	456
720 min Winter	3.005	0.0	532
960 min Winter	2.475	0.0	684
1440 min Winter	1.884	0.0	972
2160 min Winter	1.434	0.0	1376
2880 min Winter	1.181	0.0	1740
4320 min Winter	0.892	0.0	2332
5760 min Winter	0.731	0.0	2944
7200 min Winter	0.627	0.0	3672
8640 min Winter	0.552	0.0	4376
10080 min Winter	0.497	0.0	5112

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.325	Cv (Winter)	0.840
Return Period (years)	2	E (1km)	0.290	Shortest Storm (mins)	15
Site Location		F (1km)	2.432	Longest Storm (mins)	10080
C (1km)	-0.024	Summer Storms	Yes	Climate Change %	+25
D1 (1km)	0.310	Winter Storms	Yes		
D2 (1km)	0.343	Cv (Summer)	0.750		

Time / Area Diagram

Total Area (ha) 0.183

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.037	4-8	0.037	8-12	0.037	12-16	0.036	16-20	0.036

Model Details

Storage is Online Cover Level (m) 0.700

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	275.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	1000.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.4		

Hydro-Brake® Outflow Control

Design Head (m) 0.249 Hydro-Brake® Type Md5 SW Only Invert Level (m) 0.000
Design Flow (l/s) 1.0 Diameter (mm) 56

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	0.9	1.200	2.1	3.000	3.3	7.000	5.0
0.200	0.9	1.400	2.2	3.500	3.5	7.500	5.2
0.300	1.0	1.600	2.4	4.000	3.8	8.000	5.3
0.400	1.2	1.800	2.5	4.500	4.0	8.500	5.5
0.500	1.3	2.000	2.7	5.000	4.2	9.000	5.7
0.600	1.5	2.200	2.8	5.500	4.4	9.500	5.8
0.800	1.7	2.400	2.9	6.000	4.6		
1.000	1.9	2.600	3.0	6.500	4.8		

Orifice Overflow Control

Diameter (m) 0.035 Discharge Coefficient 0.600 Invert Level (m) 0.285

Summary of Results for 30 year Return Period (+25%)

Half Drain Time : 518 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.276	0.276	0.0	1.0	0.0	1.0	36.2	O K
30 min Summer	0.292	0.292	0.0	1.0	0.0	1.1	42.0	O K
60 min Summer	0.308	0.308	0.0	1.1	0.1	1.2	47.9	O K
120 min Summer	0.321	0.321	0.0	1.1	0.3	1.4	53.0	O K
180 min Summer	0.326	0.326	0.0	1.1	0.3	1.4	55.1	O K
240 min Summer	0.327	0.327	0.0	1.1	0.4	1.5	55.7	O K
360 min Summer	0.326	0.326	0.0	1.1	0.3	1.4	55.2	O K
480 min Summer	0.324	0.324	0.0	1.1	0.3	1.4	54.4	O K
600 min Summer	0.322	0.322	0.0	1.1	0.3	1.4	53.5	O K
720 min Summer	0.319	0.319	0.0	1.1	0.3	1.3	52.5	O K
960 min Summer	0.316	0.316	0.0	1.1	0.2	1.3	51.3	O K
1440 min Summer	0.310	0.310	0.0	1.1	0.2	1.2	48.7	O K
2160 min Summer	0.300	0.300	0.0	1.0	0.1	1.1	44.7	O K
2880 min Summer	0.288	0.288	0.0	1.0	0.0	1.0	40.4	O K
4320 min Summer	0.261	0.261	0.0	1.0	0.0	1.0	31.3	O K
5760 min Summer	0.233	0.233	0.0	1.0	0.0	1.0	23.4	O K
7200 min Summer	0.204	0.204	0.0	0.9	0.0	0.9	16.8	O K
8640 min Summer	0.174	0.174	0.0	0.9	0.0	0.9	11.4	O K
10080 min Summer	0.144	0.144	0.0	0.9	0.0	0.9	7.1	O K
15 min Winter	0.289	0.289	0.0	1.0	0.0	1.0	40.7	O K
30 min Winter	0.306	0.306	0.0	1.1	0.1	1.2	47.2	O K
60 min Winter	0.323	0.323	0.0	1.1	0.3	1.4	53.9	O K

Storm Event	Rain (mm/hr)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	110.579	0.0	34
30 min Summer	64.791	0.0	47
60 min Summer	37.962	0.5	76
120 min Summer	22.243	1.8	130
180 min Summer	16.270	2.9	186
240 min Summer	13.033	3.6	242
360 min Summer	9.533	4.4	320
480 min Summer	7.636	4.7	384
600 min Summer	6.429	4.6	452
720 min Summer	5.585	4.3	520
960 min Summer	4.517	3.8	662
1440 min Summer	3.348	2.4	944
2160 min Summer	2.482	0.7	1372
2880 min Summer	2.007	0.0	1788
4320 min Summer	1.477	0.0	2560
5760 min Summer	1.188	0.0	3304
7200 min Summer	1.004	0.0	4040
8640 min Summer	0.875	0.0	4688
10080 min Summer	0.778	0.0	5352
15 min Winter	110.579	0.0	34
30 min Winter	64.791	0.4	47
60 min Winter	37.962	1.8	74

Summary of Results for 30 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
120 min Winter	0.337	0.337	0.0	1.1	0.5	1.6	60.0	O K
180 min Winter	0.343	0.343	0.0	1.1	0.5	1.6	62.6	O K
240 min Winter	0.345	0.345	0.0	1.1	0.5	1.6	63.6	O K
360 min Winter	0.345	0.345	0.0	1.1	0.5	1.6	63.5	O K
480 min Winter	0.343	0.343	0.0	1.1	0.5	1.6	62.5	O K
600 min Winter	0.340	0.340	0.0	1.1	0.5	1.6	61.4	O K
720 min Winter	0.337	0.337	0.0	1.1	0.5	1.6	60.2	O K
960 min Winter	0.333	0.333	0.0	1.1	0.4	1.5	58.2	O K
1440 min Winter	0.323	0.323	0.0	1.1	0.3	1.4	54.1	O K
2160 min Winter	0.309	0.309	0.0	1.1	0.1	1.2	48.2	O K
2880 min Winter	0.293	0.293	0.0	1.0	0.0	1.1	42.2	O K
4320 min Winter	0.251	0.251	0.0	1.0	0.0	1.0	28.4	O K
5760 min Winter	0.205	0.205	0.0	0.9	0.0	0.9	17.0	O K
7200 min Winter	0.148	0.148	0.0	0.9	0.0	0.9	7.6	O K
8640 min Winter	0.097	0.097	0.0	0.9	0.0	0.9	2.8	O K
10080 min Winter	0.075	0.075	0.0	0.8	0.0	0.8	1.6	O K

Storm Event	Rain (mm/hr)	Overflow Volume (m³)	Time-Peak (mins)
120 min Winter	22.243	4.1	128
180 min Winter	16.270	5.7	184
240 min Winter	13.033	6.8	238
360 min Winter	9.533	8.2	344
480 min Winter	7.636	8.9	390
600 min Winter	6.429	9.2	466
720 min Winter	5.585	9.1	544
960 min Winter	4.517	8.7	700
1440 min Winter	3.348	6.6	1008
2160 min Winter	2.482	2.8	1460
2880 min Winter	2.007	0.2	1916
4320 min Winter	1.477	0.0	2728
5760 min Winter	1.188	0.0	3464
7200 min Winter	1.004	0.0	4104
8640 min Winter	0.875	0.0	4576
10080 min Winter	0.778	0.0	5152

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.325	Cv (Winter)	0.840
Return Period (years)	30	E (1km)	0.290	Shortest Storm (mins)	15
Site Location		F (1km)	2.432	Longest Storm (mins)	10080
C (1km)	-0.024	Summer Storms	Yes	Climate Change %	+25
D1 (1km)	0.310	Winter Storms	Yes		
D2 (1km)	0.343	Cv (Summer)	0.750		

Time / Area Diagram

Total Area (ha) 0.183

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**	**Time (mins)**	**Area (ha)**	**Time (mins)**	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.037	4-8	0.037	8-12	0.037	12-16	0.036	16-20	0.036

Model Details

Storage is Online Cover Level (m) 0.700

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	275.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	1000.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.4		

Hydro-Brake® Outflow Control

Design Head (m) 0.249 Hydro-Brake® Type Md5 SW Only Invert Level (m) 0.000
Design Flow (l/s) 1.0 Diameter (mm) 56

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.9	1.200	2.1	3.000	3.3	7.000	5.0
0.200	0.9	1.400	2.2	3.500	3.5	7.500	5.2
0.300	1.0	1.600	2.4	4.000	3.8	8.000	5.3
0.400	1.2	1.800	2.5	4.500	4.0	8.500	5.5
0.500	1.3	2.000	2.7	5.000	4.2	9.000	5.7
0.600	1.5	2.200	2.8	5.500	4.4	9.500	5.8
0.800	1.7	2.400	2.9	6.000	4.6		
1.000	1.9	2.600	3.0	6.500	4.8		

Orifice Overflow Control

Diameter (m) 0.035 Discharge Coefficient 0.600 Invert Level (m) 0.285

Summary of Results for 100 year Return Period (+25%)

Half Drain Time : 685 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.324	0.324	0.0	1.1	0.3	1.4	54.2	O K
30 min Summer	0.340	0.340	0.0	1.1	0.5	1.6	61.4	O K
60 min Summer	0.356	0.356	0.0	1.1	0.6	1.7	68.8	O K
120 min Summer	0.370	0.370	0.0	1.2	0.7	1.8	75.2	O K
180 min Summer	0.375	0.375	0.0	1.2	0.7	1.8	77.7	O K
240 min Summer	0.376	0.376	0.0	1.2	0.7	1.9	78.5	O K
360 min Summer	0.375	0.375	0.0	1.2	0.7	1.8	77.7	O K
480 min Summer	0.372	0.372	0.0	1.2	0.7	1.8	76.3	O K
600 min Summer	0.369	0.369	0.0	1.1	0.7	1.8	74.8	O K
720 min Summer	0.366	0.366	0.0	1.1	0.6	1.8	73.2	O K
960 min Summer	0.361	0.361	0.0	1.1	0.6	1.8	70.9	O K
1440 min Summer	0.352	0.352	0.0	1.1	0.6	1.7	66.6	O K
2160 min Summer	0.340	0.340	0.0	1.1	0.5	1.6	61.1	O K
2880 min Summer	0.329	0.329	0.0	1.1	0.4	1.5	56.6	O K
4320 min Summer	0.309	0.309	0.0	1.1	0.2	1.2	48.4	O K
5760 min Summer	0.288	0.288	0.0	1.0	0.0	1.0	40.3	O K
7200 min Summer	0.263	0.263	0.0	1.0	0.0	1.0	31.9	O K
8640 min Summer	0.238	0.238	0.0	1.0	0.0	1.0	24.7	O K
10080 min Summer	0.212	0.212	0.0	0.9	0.0	0.9	18.6	O K
15 min Winter	0.339	0.339	0.0	1.1	0.5	1.6	60.8	O K
30 min Winter	0.357	0.357	0.0	1.1	0.6	1.7	69.1	O K
60 min Winter	0.374	0.374	0.0	1.2	0.7	1.8	77.5	O K

Storm Event	Rain (mm/hr)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	163.822	1.6	34
30 min Summer	94.065	3.9	47
60 min Summer	54.011	6.9	76
120 min Summer	31.012	10.3	130
180 min Summer	22.418	12.3	188
240 min Summer	17.807	13.8	244
360 min Summer	12.872	15.6	330
480 min Summer	10.225	16.6	390
600 min Summer	8.552	17.1	452
720 min Summer	7.391	17.3	520
960 min Summer	5.927	17.8	658
1440 min Summer	4.342	16.9	936
2160 min Summer	3.181	13.5	1344
2880 min Summer	2.551	10.0	1748
4320 min Summer	1.855	3.4	2568
5760 min Summer	1.480	0.0	3400
7200 min Summer	1.242	0.0	4120
8640 min Summer	1.076	0.0	4856
10080 min Summer	0.954	0.0	5560
15 min Winter	163.822	3.5	33
30 min Winter	94.065	6.5	47
60 min Winter	54.011	10.2	74

Summary of Results for 100 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
120 min Winter	0.389	0.389	0.0	1.2	0.8	1.9	85.2	O K
180 min Winter	0.396	0.396	0.0	1.2	0.8	2.0	88.6	O K
240 min Winter	0.398	0.398	0.0	1.2	0.8	2.0	90.0	O K
360 min Winter	0.398	0.398	0.0	1.2	0.8	2.0	89.9	O K
480 min Winter	0.395	0.395	0.0	1.2	0.8	2.0	88.0	O K
600 min Winter	0.392	0.392	0.0	1.2	0.8	1.9	86.4	O K
720 min Winter	0.388	0.388	0.0	1.2	0.7	1.9	84.6	O K
960 min Winter	0.382	0.382	0.0	1.2	0.7	1.9	81.4	O K
1440 min Winter	0.369	0.369	0.0	1.1	0.7	1.8	74.7	O K
2160 min Winter	0.351	0.351	0.0	1.1	0.6	1.7	66.1	O K
2880 min Winter	0.335	0.335	0.0	1.1	0.5	1.6	59.2	O K
4320 min Winter	0.309	0.309	0.0	1.1	0.1	1.2	48.2	O K
5760 min Winter	0.276	0.276	0.0	1.0	0.0	1.0	36.2	O K
7200 min Winter	0.237	0.237	0.0	1.0	0.0	1.0	24.5	O K
8640 min Winter	0.192	0.192	0.0	0.9	0.0	0.9	14.5	O K
10080 min Winter	0.136	0.136	0.0	0.9	0.0	0.9	6.3	O K

Storm Event	Rain (mm/hr)	Overflow Volume (m³)	Time-Peak (mins)
120 min Winter	31.012	14.3	130
180 min Winter	22.418	16.9	184
240 min Winter	17.807	18.7	240
360 min Winter	12.872	21.0	348
480 min Winter	10.225	22.5	410
600 min Winter	8.552	23.4	476
720 min Winter	7.391	23.8	552
960 min Winter	5.927	24.7	708
1440 min Winter	4.342	24.5	1008
2160 min Winter	3.181	20.7	1436
2880 min Winter	2.551	15.4	1852
4320 min Winter	1.855	4.1	2732
5760 min Winter	1.480	0.0	3584
7200 min Winter	1.242	0.0	4336
8640 min Winter	1.076	0.0	5024
10080 min Winter	0.954	0.0	5552

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.325	Cv (Winter)	0.840
Return Period (years)	100	E (1km)	0.290	Shortest Storm (mins)	15
Site Location		F (1km)	2.432	Longest Storm (mins)	10080
C (1km)	-0.024	Summer Storms	Yes	Climate Change %	+25
D1 (1km)	0.310	Winter Storms	Yes		
D2 (1km)	0.343	Cv (Summer)	0.750		

Time / Area Diagram

Total Area (ha) 0.183

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.037	4-8	0.037	8-12	0.037	12-16	0.036	16-20	0.036

Model Details

Storage is Online Cover Level (m) 0.700

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	275.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	1000.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.4		

Hydro-Brake® Outflow Control

Design Head (m) 0.249 Hydro-Brake® Type Md5 SW Only Invert Level (m) 0.000
Design Flow (l/s) 1.0 Diameter (mm) 56

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.9	1.200	2.1	3.000	3.3	7.000	5.0
0.200	0.9	1.400	2.2	3.500	3.5	7.500	5.2
0.300	1.0	1.600	2.4	4.000	3.8	8.000	5.3
0.400	1.2	1.800	2.5	4.500	4.0	8.500	5.5
0.500	1.3	2.000	2.7	5.000	4.2	9.000	5.7
0.600	1.5	2.200	2.8	5.500	4.4	9.500	5.8
0.800	1.7	2.400	2.9	6.000	4.6		
1.000	1.9	2.600	3.0	6.500	4.8		

Orifice Overflow Control

Diameter (m) 0.035 Discharge Coefficient 0.600 Invert Level (m) 0.285

Summary of Results for 2 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.073	0.073	2.2	0.0	2.2	53.6	O K
30 min Summer	0.087	0.087	2.7	0.0	2.7	64.5	O K
60 min Summer	0.103	0.103	3.2	0.0	3.2	76.6	O K
120 min Summer	0.118	0.118	3.6	0.0	3.6	88.2	O K
180 min Summer	0.125	0.125	3.8	0.0	3.8	93.5	O K
240 min Summer	0.129	0.129	3.8	0.0	3.8	96.7	O K
360 min Summer	0.135	0.135	3.9	0.0	3.9	101.0	O K
480 min Summer	0.138	0.138	4.0	0.0	4.0	103.3	O K
600 min Summer	0.139	0.139	4.0	0.0	4.0	104.5	O K
720 min Summer	0.140	0.140	4.0	0.0	4.0	104.8	O K
960 min Summer	0.140	0.140	4.0	0.0	4.0	105.0	O K
1440 min Summer	0.136	0.136	3.9	0.0	3.9	102.2	O K
2160 min Summer	0.128	0.128	3.8	0.0	3.8	95.4	O K
2880 min Summer	0.119	0.119	3.6	0.0	3.6	88.8	O K
4320 min Summer	0.104	0.104	3.2	0.0	3.2	77.7	O K
5760 min Summer	0.094	0.094	2.9	0.0	2.9	69.7	O K
7200 min Summer	0.086	0.086	2.7	0.0	2.7	63.8	O K
8640 min Summer	0.080	0.080	2.4	0.0	2.4	59.0	O K
10080 min Summer	0.075	0.075	2.2	0.0	2.2	55.4	O K
15 min Winter	0.081	0.081	2.5	0.0	2.5	59.9	O K
30 min Winter	0.097	0.097	3.0	0.0	3.0	72.3	O K
60 min Winter	0.115	0.115	3.5	0.0	3.5	85.9	O K
120 min Winter	0.133	0.133	3.9	0.0	3.9	99.4	O K

Storm Event	Rain (mm/hr)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	46.329	0.0	33
30 min Summer	28.388	0.0	46
60 min Summer	17.395	0.0	72
120 min Summer	10.658	0.0	126
180 min Summer	8.003	0.0	178
240 min Summer	6.531	0.0	206
360 min Summer	4.904	0.0	270
480 min Summer	4.002	0.0	338
600 min Summer	3.418	0.0	406
720 min Summer	3.005	0.0	474
960 min Summer	2.475	0.0	612
1440 min Summer	1.884	0.0	878
2160 min Summer	1.434	0.0	1260
2880 min Summer	1.181	0.0	1632
4320 min Summer	0.892	0.0	2376
5760 min Summer	0.731	0.0	3112
7200 min Summer	0.627	0.0	3824
8640 min Summer	0.552	0.0	4520
10080 min Summer	0.497	0.0	5256
15 min Winter	46.329	0.0	33
30 min Winter	28.388	0.0	46
60 min Winter	17.395	0.0	72
120 min Winter	10.658	0.0	126

Summary of Results for 2 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	0.141	0.141	4.0	0.0	4.0	105.9	O K
240 min Winter	0.145	0.145	4.1	0.0	4.1	109.2	O K
360 min Winter	0.150	0.150	4.1	0.0	4.1	113.0	O K
480 min Winter	0.152	0.152	4.2	0.0	4.2	114.6	O K
600 min Winter	0.152	0.152	4.2	0.0	4.2	114.7	O K
720 min Winter	0.151	0.151	4.1	0.0	4.1	113.8	O K
960 min Winter	0.149	0.149	4.1	0.0	4.1	111.7	O K
1440 min Winter	0.139	0.139	4.0	0.0	4.0	104.5	O K
2160 min Winter	0.124	0.124	3.7	0.0	3.7	93.1	O K
2880 min Winter	0.112	0.112	3.5	0.0	3.5	83.6	O K
4320 min Winter	0.094	0.094	2.9	0.0	2.9	69.8	O K
5760 min Winter	0.082	0.082	2.5	0.0	2.5	60.8	O K
7200 min Winter	0.074	0.074	2.2	0.0	2.2	54.6	O K
8640 min Winter	0.068	0.068	2.0	0.0	2.0	49.9	O K
10080 min Winter	0.063	0.063	1.8	0.0	1.8	46.4	O K

Storm Event	Rain (mm/hr)	Overflow Volume (m³)	Time-Peak (mins)
180 min Winter	8.003	0.0	178
240 min Winter	6.531	0.0	228
360 min Winter	4.904	0.0	286
480 min Winter	4.002	0.0	364
600 min Winter	3.418	0.0	440
720 min Winter	3.005	0.0	514
960 min Winter	2.475	0.0	658
1440 min Winter	1.884	0.0	934
2160 min Winter	1.434	0.0	1324
2880 min Winter	1.181	0.0	1700
4320 min Winter	0.892	0.0	2432
5760 min Winter	0.731	0.0	3168
7200 min Winter	0.627	0.0	3896
8640 min Winter	0.552	0.0	4592
10080 min Winter	0.497	0.0	5352

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.325	Cv (Winter)	0.840
Return Period (years)	2	E (1km)	0.290	Shortest Storm (mins)	15
Site Location		F (1km)	2.432	Longest Storm (mins)	10080
C (1km)	-0.024	Summer Storms	Yes	Climate Change %	+25
D1 (1km)	0.310	Winter Storms	Yes		
D2 (1km)	0.343	Cv (Summer)	0.750		

Time / Area Diagram

Total Area (ha) 0.639

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.128	4-8	0.128	8-12	0.128	12-16	0.128	16-20	0.127

Model Details

Storage is Online Cover Level (m) 0.700

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	726.0	0.700	971.0

Hydro-Brake® Outflow Control

Design Head (m) 0.152 Hydro-Brake® Type Md5 SW Only Invert Level (m) 0.000
Design Flow (l/s) 4.2 Diameter (mm) 105

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.1	1.200	7.3	3.000	11.5	7.000	17.6
0.200	4.5	1.400	7.9	3.500	12.4	7.500	18.2
0.300	4.4	1.600	8.4	4.000	13.3	8.000	18.8
0.400	4.5	1.800	8.9	4.500	14.1	8.500	19.3
0.500	4.8	2.000	9.4	5.000	14.8	9.000	19.9
0.600	5.2	2.200	9.8	5.500	15.6	9.500	20.5
0.800	5.9	2.400	10.3	6.000	16.3		
1.000	6.6	2.600	10.7	6.500	16.9		

Orifice Overflow Control

Diameter (m) 0.062 Discharge Coefficient 0.600 Invert Level (m) 0.165

Summary of Results for 30 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.169	0.169	4.3	0.0	4.3	127.8	O K
30 min Summer	0.195	0.195	4.4	0.3	4.8	148.0	O K
60 min Summer	0.221	0.221	4.5	1.0	5.5	169.1	O K
120 min Summer	0.245	0.245	4.5	1.7	6.1	188.0	O K
180 min Summer	0.254	0.254	4.5	1.9	6.4	195.6	O K
240 min Summer	0.257	0.257	4.5	2.0	6.4	198.4	O K
360 min Summer	0.261	0.261	4.5	2.0	6.5	201.3	O K
480 min Summer	0.262	0.262	4.5	2.1	6.5	202.2	O K
600 min Summer	0.261	0.261	4.5	2.0	6.5	201.8	O K
720 min Summer	0.260	0.260	4.5	2.0	6.5	200.4	O K
960 min Summer	0.257	0.257	4.5	2.0	6.4	198.1	O K
1440 min Summer	0.247	0.247	4.5	1.7	6.2	189.8	O K
2160 min Summer	0.229	0.229	4.5	1.2	5.7	175.7	O K
2880 min Summer	0.213	0.213	4.5	0.7	5.2	162.4	O K
4320 min Summer	0.182	0.182	4.4	0.1	4.5	137.9	O K
5760 min Summer	0.155	0.155	4.2	0.0	4.2	117.1	O K
7200 min Summer	0.136	0.136	3.9	0.0	3.9	101.8	O K
8640 min Summer	0.122	0.122	3.7	0.0	3.7	91.0	O K
10080 min Summer	0.111	0.111	3.4	0.0	3.4	82.9	O K
15 min Winter	0.189	0.189	4.4	0.2	4.6	143.3	O K
30 min Winter	0.217	0.217	4.5	0.9	5.3	166.0	O K
60 min Winter	0.247	0.247	4.5	1.7	6.2	189.7	O K
120 min Winter	0.273	0.273	4.5	2.2	6.7	211.5	O K

Storm Event	Rain (mm/hr)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	110.579	0.0	33
30 min Summer	64.791	0.8	47
60 min Summer	37.962	4.4	74
120 min Summer	22.243	11.7	128
180 min Summer	16.270	17.4	182
240 min Summer	13.033	21.7	226
360 min Summer	9.533	27.7	284
480 min Summer	7.636	31.3	348
600 min Summer	6.429	33.4	418
720 min Summer	5.585	34.2	486
960 min Summer	4.517	34.9	622
1440 min Summer	3.348	30.9	894
2160 min Summer	2.482	22.3	1292
2880 min Summer	2.007	13.8	1684
4320 min Summer	1.477	1.5	2440
5760 min Summer	1.188	0.0	3176
7200 min Summer	1.004	0.0	3888
8640 min Summer	0.875	0.0	4584
10080 min Summer	0.778	0.0	5264
15 min Winter	110.579	0.4	33
30 min Winter	64.791	3.3	47
60 min Winter	37.962	10.2	74
120 min Winter	22.243	20.6	128

Summary of Results for 30 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	0.285	0.285	4.5	2.4	6.8	221.1	O K
240 min Winter	0.290	0.290	4.5	2.5	6.9	225.1	O K
360 min Winter	0.291	0.291	4.5	2.5	6.9	226.4	O K
480 min Winter	0.291	0.291	4.5	2.5	6.9	226.2	O K
600 min Winter	0.289	0.289	4.5	2.4	6.9	224.1	O K
720 min Winter	0.284	0.284	4.5	2.4	6.8	220.7	O K
960 min Winter	0.277	0.277	4.5	2.3	6.7	214.4	O K
1440 min Winter	0.258	0.258	4.5	2.0	6.5	198.8	O K
2160 min Winter	0.231	0.231	4.5	1.3	5.7	177.4	O K
2880 min Winter	0.208	0.208	4.5	0.6	5.1	158.6	O K
4320 min Winter	0.165	0.165	4.3	0.0	4.3	124.2	O K
5760 min Winter	0.132	0.132	3.9	0.0	3.9	99.0	O K
7200 min Winter	0.113	0.113	3.5	0.0	3.5	84.2	O K
8640 min Winter	0.100	0.100	3.1	0.0	3.1	74.4	O K
10080 min Winter	0.091	0.091	2.8	0.0	2.8	67.4	O K

Storm Event	Rain (mm/hr)	Overflow Volume (m³)	Time-Peak (mins)
180 min Winter	16.270	27.7	182
240 min Winter	13.033	32.9	236
360 min Winter	9.533	40.2	298
480 min Winter	7.636	44.9	372
600 min Winter	6.429	47.9	450
720 min Winter	5.585	49.6	524
960 min Winter	4.517	51.4	672
1440 min Winter	3.348	45.9	954
2160 min Winter	2.482	29.9	1368
2880 min Winter	2.007	14.7	1772
4320 min Winter	1.477	0.0	2556
5760 min Winter	1.188	0.0	3240
7200 min Winter	1.004	0.0	3960
8640 min Winter	0.875	0.0	4664
10080 min Winter	0.778	0.0	5352

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.325	Cv (Winter)	0.840
Return Period (years)	30	E (1km)	0.290	Shortest Storm (mins)	15
Site Location		F (1km)	2.432	Longest Storm (mins)	10080
C (1km)	-0.024	Summer Storms	Yes	Climate Change %	+25
D1 (1km)	0.310	Winter Storms	Yes		
D2 (1km)	0.343	Cv (Summer)	0.750		

Time / Area Diagram

Total Area (ha) 0.639

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**	**Time (mins)**	**Area (ha)**	**Time (mins)**	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.128	4-8	0.128	8-12	0.128	12-16	0.128	16-20	0.127

Model Details

Storage is Online Cover Level (m) 0.700

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	726.0	0.700	971.0

Hydro-Brake® Outflow Control

Design Head (m) 0.152 Hydro-Brake® Type Md5 SW Only Invert Level (m) 0.000
Design Flow (l/s) 4.2 Diameter (mm) 105

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.1	1.200	7.3	3.000	11.5	7.000	17.6
0.200	4.5	1.400	7.9	3.500	12.4	7.500	18.2
0.300	4.4	1.600	8.4	4.000	13.3	8.000	18.8
0.400	4.5	1.800	8.9	4.500	14.1	8.500	19.3
0.500	4.8	2.000	9.4	5.000	14.8	9.000	19.9
0.600	5.2	2.200	9.8	5.500	15.6	9.500	20.5
0.800	5.9	2.400	10.3	6.000	16.3		
1.000	6.6	2.600	10.7	6.500	16.9		

Orifice Overflow Control

Diameter (m) 0.062 Discharge Coefficient 0.600 Invert Level (m) 0.165

Summary of Results for 100 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.247	0.247	4.5	1.7	6.2	189.7	O K
30 min Summer	0.278	0.278	4.5	2.3	6.7	215.3	O K
60 min Summer	0.310	0.310	4.5	2.7	7.1	241.5	O K
120 min Summer	0.337	0.337	4.5	3.0	7.4	264.7	O K
180 min Summer	0.348	0.348	4.5	3.1	7.6	274.0	O K
240 min Summer	0.352	0.352	4.5	3.2	7.6	277.1	O K
360 min Summer	0.352	0.352	4.5	3.2	7.6	277.3	O K
480 min Summer	0.351	0.351	4.5	3.2	7.6	276.2	O K
600 min Summer	0.348	0.348	4.5	3.1	7.6	274.0	O K
720 min Summer	0.345	0.345	4.5	3.1	7.5	270.9	O K
960 min Summer	0.339	0.339	4.5	3.0	7.5	266.0	O K
1440 min Summer	0.322	0.322	4.5	2.8	7.3	251.8	O K
2160 min Summer	0.295	0.295	4.5	2.5	6.9	229.0	O K
2880 min Summer	0.270	0.270	4.5	2.2	6.6	208.7	O K
4320 min Summer	0.232	0.232	4.5	1.3	5.8	177.9	O K
5760 min Summer	0.203	0.203	4.5	0.5	5.0	155.0	O K
7200 min Summer	0.179	0.179	4.4	0.1	4.5	135.6	O K
8640 min Summer	0.157	0.157	4.2	0.0	4.2	118.0	O K
10080 min Summer	0.139	0.139	4.0	0.0	4.0	104.6	O K
15 min Winter	0.275	0.275	4.5	2.3	6.7	212.7	O K
30 min Winter	0.310	0.310	4.5	2.7	7.1	241.7	O K
60 min Winter	0.345	0.345	4.5	3.1	7.5	271.6	O K
120 min Winter	0.377	0.377	4.5	3.4	7.9	298.7	O K

Storm Event	Rain (mm/hr)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	163.822	8.8	33
30 min Summer	94.065	18.2	47
60 min Summer	54.011	30.2	74
120 min Summer	31.012	44.5	130
180 min Summer	22.418	53.7	186
240 min Summer	17.807	60.4	242
360 min Summer	12.872	69.7	302
480 min Summer	10.225	75.8	364
600 min Summer	8.552	80.0	430
720 min Summer	7.391	82.9	498
960 min Summer	5.927	87.8	634
1440 min Summer	4.342	87.4	908
2160 min Summer	3.181	75.8	1304
2880 min Summer	2.551	63.2	1684
4320 min Summer	1.855	34.5	2432
5760 min Summer	1.480	12.8	3184
7200 min Summer	1.242	1.2	3960
8640 min Summer	1.076	0.0	4672
10080 min Summer	0.954	0.0	5352
15 min Winter	163.822	16.5	33
30 min Winter	94.065	28.3	47
60 min Winter	54.011	42.9	74
120 min Winter	31.012	59.9	128

Summary of Results for 100 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	0.391	0.391	4.5	3.5	8.0	310.3	O K
240 min Winter	0.396	0.396	4.5	3.6	8.1	314.9	O K
360 min Winter	0.395	0.395	4.5	3.6	8.1	314.1	O K
480 min Winter	0.392	0.392	4.5	3.5	8.1	311.1	O K
600 min Winter	0.387	0.387	4.5	3.5	8.0	306.9	O K
720 min Winter	0.380	0.380	4.5	3.4	7.9	301.5	O K
960 min Winter	0.369	0.369	4.5	3.3	7.8	291.8	O K
1440 min Winter	0.341	0.341	4.5	3.1	7.5	268.1	O K
2160 min Winter	0.300	0.300	4.5	2.6	7.0	233.5	O K
2880 min Winter	0.265	0.265	4.5	2.1	6.6	205.1	O K
4320 min Winter	0.218	0.218	4.5	0.9	5.4	166.8	O K
5760 min Winter	0.181	0.181	4.4	0.1	4.5	137.0	O K
7200 min Winter	0.147	0.147	4.1	0.0	4.1	110.3	O K
8640 min Winter	0.125	0.125	3.7	0.0	3.7	93.2	O K
10080 min Winter	0.110	0.110	3.4	0.0	3.4	82.3	O K

Storm Event	Rain (mm/hr)	Overflow Volume (m³)	Time-Peak (mins)
180 min Winter	22.418	70.7	184
240 min Winter	17.807	78.6	238
360 min Winter	12.872	89.6	340
480 min Winter	10.225	97.0	384
600 min Winter	8.552	102.1	460
720 min Winter	7.391	105.6	536
960 min Winter	5.927	111.9	686
1440 min Winter	4.342	114.3	974
2160 min Winter	3.181	98.4	1384
2880 min Winter	2.551	77.3	1768
4320 min Winter	1.855	29.8	2556
5760 min Winter	1.480	2.1	3352
7200 min Winter	1.242	0.0	4040
8640 min Winter	1.076	0.0	4680
10080 min Winter	0.954	0.0	5368

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.325	Cv (Winter)	0.840
Return Period (years)	100	E (1km)	0.290	Shortest Storm (mins)	15
Site Location		F (1km)	2.432	Longest Storm (mins)	10080
C (1km)	-0.024	Summer Storms	Yes	Climate Change %	+25
D1 (1km)	0.310	Winter Storms	Yes		
D2 (1km)	0.343	Cv (Summer)	0.750		

Time / Area Diagram

Total Area (ha) 0.639

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**	**Time (mins)**	**Area (ha)**	**Time (mins)**	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.128	4-8	0.128	8-12	0.128	12-16	0.128	16-20	0.127

Model Details

Storage is Online Cover Level (m) 0.700

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	726.0	0.700	971.0

Hydro-Brake® Outflow Control

Design Head (m) 0.152 Hydro-Brake® Type Md5 SW Only Invert Level (m) 0.000
Design Flow (l/s) 4.2 Diameter (mm) 105

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.1	1.200	7.3	3.000	11.5	7.000	17.6
0.200	4.5	1.400	7.9	3.500	12.4	7.500	18.2
0.300	4.4	1.600	8.4	4.000	13.3	8.000	18.8
0.400	4.5	1.800	8.9	4.500	14.1	8.500	19.3
0.500	4.8	2.000	9.4	5.000	14.8	9.000	19.9
0.600	5.2	2.200	9.8	5.500	15.6	9.500	20.5
0.800	5.9	2.400	10.3	6.000	16.3		
1.000	6.6	2.600	10.7	6.500	16.9		

Orifice Overflow Control

Diameter (m) 0.062 Discharge Coefficient 0.600 Invert Level (m) 0.165