The Dell, Prestatyn

Flood Consequence Assessment and Outline Drainage Strategy
For Denbighshire County Council
May 2018

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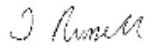

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1. Introduction

1.1. Commission

Opus International Consultants Ltd (OPUS) were appointed by Denbighshire County Council (DCC) to undertake A Flood Consequence Assessment (FCA) and Outline Drainage Strategy (DS) to support the proposed development at The Dell, Prestatyn.

This FRA focuses on assessing the flood risk issues at the site and includes the following:

- Liaison with the Natural Resources Wales, Denbighshire County Council and Welsh Water to obtain information relating to local flood risk issues for the site.
- Assessment of the existing consequences of flooding at the site and the potential impact of the proposals.
- Identification of all the potential sources of flooding at the site (i.e. fluvial, tidal, highways, groundwater, reservoir, sewers, canal, surface water).
- Consideration of the flood consequence implications, taking into account the potential allowance for climate change over the lifetime of the development and the identification of the measures to mitigate flood risk, if required.
- Foul drainage and surface water runoff management for the proposed development.

1.2. Policy Content

This FCA and DS has been prepared in accordance with the relevant national, regional and local requirements and guidance of the following publications and organisations:

- Technical Advice Note (TAN) 15: Development and Flood Risk dated October 2004 issued by Welsh Government
- Denbighshire County Council
- Building Regulations 2010 (Part H3)
- Sewers for Adoption 7th Edition
- Planning Policy Wales (Edition 9, November 2016) issued by Welsh Government
- Denbighshire County Council, Strategic Flood Consequence Assessment (SFCA) Version 1.1, JBA July 2014.
- Denbighshire County Council, Local Flood Risk Management Strategy (LFRMS), Version 2 June 2014.
- Welsh Ministers Standards for Foul Sewers and Lateral Drains
- The new Sustainable Drainage Systems (SuDs) Manual C753, CIRIA
- RainScape - Dwr Cymru Welsh Water
- SuDs Wales

To complete this FCA, the following stakeholders have been consulted:

- Natural Resources Wales (NRW).
- Dwr Cymru Welsh Water (DCWW).
- Denbighshire County Council (DCC) as Lead Local Flood Authority (LLFA).

1.3. Planning Policy Wales Vulnerability testing and Technical Advice Note 15

The general approach of the Planning Policy Wales (PPW), supported by the Technical Advice Note 15 (TAN15) is to follow a precautionary framework approach when determining the suitability of land for development in flood risk areas, with the intention of steering development away from areas of high risk of flooding to the lowest flood risk areas.

Where development has to be considered in high risk areas (zone C) only those developments which can be justified on the basis of the tests outlined in section 6 and section 7 of the TAN15 guidance are to be located within such areas.

Table 2 of TAN15 guidance confirms the 'Flood risk vulnerability classification' of a site, depending on the proposed usage. This classification is subsequently applied to Development Advice Map (DAM) containing three zones (A, B and C with subdivision into C1 and C2) to determine whether:

- The proposed development is suitable for the zone in which it is located.
- The appropriate planning tests that need to be demonstrated in relation to the proposed development.

1.4. Limitations

The findings and opinions conveyed via this report are based on information obtained from a variety of sources, as detailed, which OPUS believes are reliable. Nevertheless, OPUS cannot and does not guarantee the authenticity or reliability of the information it has relied upon from these sources.

This report has been written on behalf of the Client and no responsibility is accepted to any Third Party for all or any part. This report should not be relied upon or transferred to any or other parties without the express written authorisation of OPUS. If any unauthorised third party comes into possession of this report, they rely on it at their own risk and the authors owe them no duty of care or skill. OPUS disclaims any responsibility to the Client and others in respect of any matters outside the scope of the above contract.

This report has been prepared by OPUS with all reasonable skill and care within the terms of the Contract with the Client and taking into account of the information made available by the Client, as the manpower and resources devoted to it by agreement with the Client.

It should be noted that the insurance market applies different tests to properties in relation to both determining premiums and, more fundamentally, determining the insurability of properties for flood risk. Those undertaking development in areas which may be at risk of flooding are advised to contact their insurers or the Association of British Insurance (ABI) to seek further guidance prior to commencing development.

The findings of this FCA have been based on data available at the time of the study and on the review of available information that has been undertaken to date. They relate to the current development proposals as outlined in **Appendix 6.1**. OPUS do not warrant that the advice in this report will guarantee the availability of flood insurance either now or in the future.

2. Existing Site and Development Proposals

2.1. Site Location

The proposed re-development site is located to the south of Ffordd Isa and to the east of the residential street known as The Dell in Prestatyn. The site has an approximate area of 0.335ha, of which 0.046ha is impermeable area and is centred within National Grid Reference 306525E, 382327N.

The site is irregular in shape and is bounded to the north by Ffordd Isa, to the east by an abandoned railway line and to the south and west by residential properties and the associated access road The Dell respectively. The existing site location plan is shown in **Figure 1.0** below.

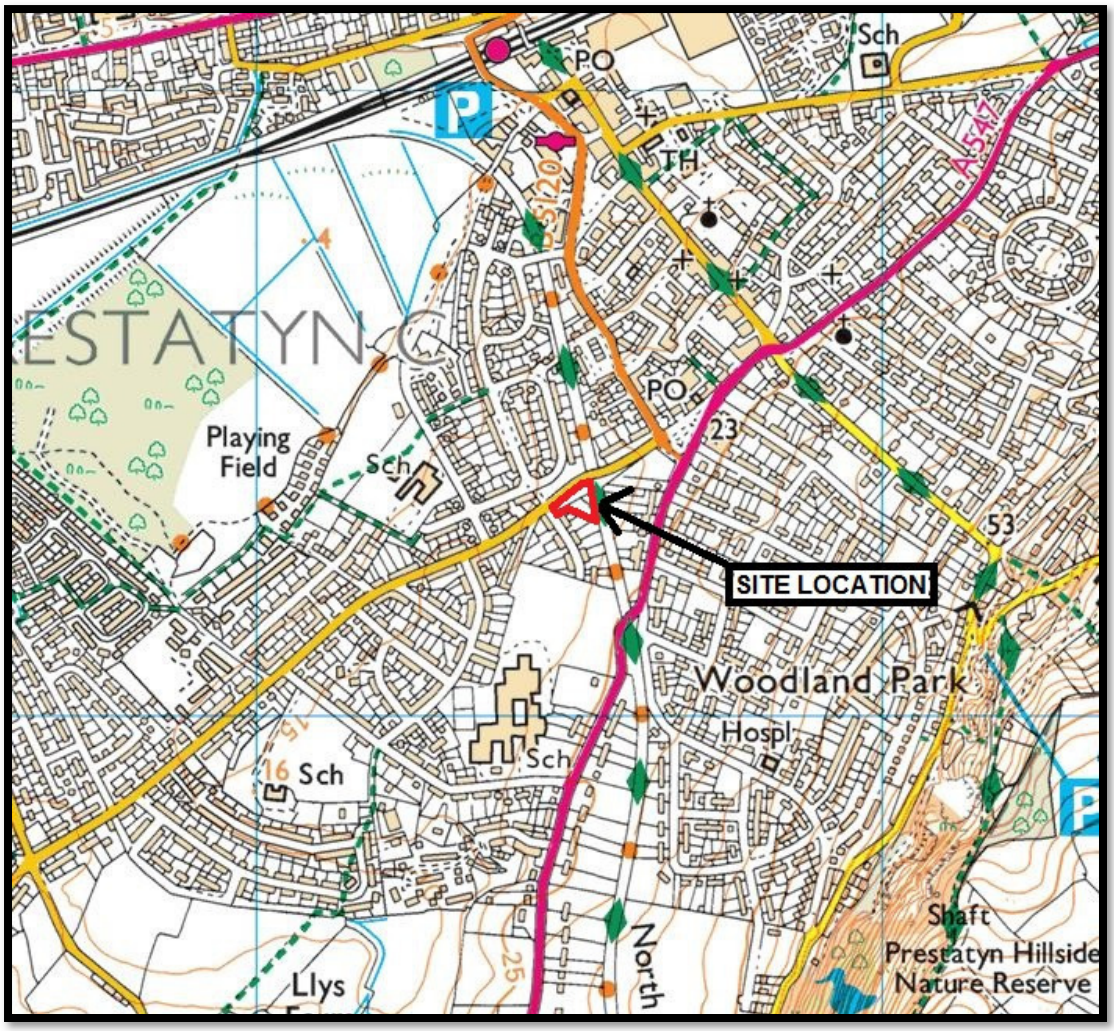


Figure 1.0: Site Location Plan (Source: Ordnance Survey Map Licence number WL1005152)

2.2. Site Description

A topographical survey provided by the Client has been reviewed as part of this assessment and is included in **Appendix 6.2** of this report. The survey indicates that the site has a high point at the top of the northern embankment adjacent to Ffordd Isa of 21.760m AOD and a low point in the south west corner of 15.880m AOD with levels of 17.350m AOD and 18.140m AOD in the north west and south east respectively. The northern boundary to the site includes trees, a fence line and an embankment which increases in height approximately 1.5m to 5m from west to east above existing ground levels. Adjacent to the embankment is an existing public footpath which connects The Dell with the local public footpath network. There is an existing residential property: no.1 The Dell, which is included within the proposed site

boundary and is located to the west of the site and has an access from The Dell. Much of the site is occupied by shrubs and numerous trees.

2.3. Proposed Development

The scheme consists of the demolition of the existing residential property No. 1 The Dell and then the construction of a block of 15 no. apartments with associated car parking on site. The ground floor level of the proposed development is to be set at 15.500m AOD.

Based upon latest development plans the approximate impermeable area generated by the proposals will be within the region of 0.182Ha which represents an increase of 0.141Ha in impermeable area, as shown on the impermeable area plan included on drawing **V-R6516.00-100-01** in **Appendix 6.3**.

The development proposals are shown on the Architects plans enclosed within **Appendix 6.1**.

2.4. Geology and Hydrogeology

The geology of the site has been reviewed from the following report:

- The Dell, Prestatyn – Phase 1 & 2 Geotechnical assessment for Denbighshire County Council, Smith Grant Environmental Consultancy, November 2017.

The borehole logs from the above report can be found within **Appendix 6.4**. The trial pits within the report summarised the geology and hydrogeology of the site as follows:

- *Topsoil within TP01-05, from the surface to depths between 0.3m to 0.4m bgl composed of blackish / dark brown slightly clayey silty sandy topsoil with roots.*
- *Made ground within TP06, from the surface to a depth of 1.3m bgl composed of blackish dark grey slightly clayey gravelly sand with roots, wood and occasional concrete sleepers. Gravel is angular brick and concrete.*
- *The underlying natural soil within TP01-02 and 05 to a depth of between 1.7m – 3.1 bgl when the trial pits were terminated composed of firm reddish brown slightly sandy slightly gravelly silty clay with lenses of light grey sand. Gravel is fine to course subrounded limestone (Glacial Till).*
- *The underlying natural soil within TP03 to a depth of 1.4m bgl composed of light brown slightly clayey silty sand. Gravel is fine to course subrounded limestone (Glacial Till).*
- *The underlying natural soil within TP03-04 and 06 to a depth of between 3.1m to 3.3m bgl when the trial pits were terminated composed of firm locally very stiff reddish brown slightly gravelly sandy to very sandy clay with partings of sand. Gravel is fine to course subrounded limestone (Glacial Till).*
- *The underlying natural soil within TP05 to a depth of 3.3m bgl when the trial pit was terminated composed of reddish brown silty sand. Gravel is fine to course subrounded limestone (Glacial Till).*
- *The underlying natural soil within TP06 to a depth of 2.2m bgl comprised of grey slightly clayey gravelly sand. Gravel is fine to course subrounded limestone (Glacial Till).*
- *Groundwater was encountered at a depth of 2.4m bgl within TP01 and TP02, at a depth of 3m bgl within TP03, a depth of 3.1m bgl within TP04, a depth of 3.2m bgl within TP05 and at a depth of 2.1m in TP06.*
- *Contamination Assessment – The results of the soil and groundwater chemical analysis have been compared to generic assessment criteria and applied to the development site based on the proposed end use. No exceedances of chemical determinants within the topsoil and subsoil were reported; and similarly, no exceedances of environmental quality standards were reported within the single groundwater sample obtained*

The above report concluded that the site is effectively uncontaminated and no specific contamination remediation would be required, however, encapsulation will be required in any areas of soft landscaping

Solid geology – Pennine coal measures – sedimentary rock cycles, coal measure type. Sedimentary bedrock formed between 319 and 308 million years ago during the carboniferous period.

Drift geology - site is mapped as underlain by Devensian age Glacial Till – Diamicton which consists of poorly sorted outwashes of sand and gravel suspended in a clay mud matrix. Alluvial deposits of gravels, sands, silts and clays are mapped to the north-east along the river and may be present on the site.

Information reviewed on the Soilscapes website (www.landis.org.uk/soilscapes/) noted that the underlying soil classification at the site is "slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils".

Permeability Testing – Soil infiltration testing was undertaken by Smith Grant Environmental Consultancy LLP, on the 18th December 2017, as per guidance detailed in BRE 365. The testing was undertaken in two locations on site. The two locations were selected as they provided the required distance of 5m from a building that is required for an infiltration based system to be utilised. The results of the testing are enclosed within **Appendix 6.5**. It is noted in the report that the testing was undertaken with the ground saturated from previous snow melt followed by rain and as such shallow groundwater was encountered in both test pits at a depth of 1.7m. Test pit SA1 produced a soil infiltration rate of 8.88 x10-7m/s and test pit SA2 produced a soil infiltration rate of 2.06 x10-6m/s. The subsequent design using the worst-case value of 8.88 x10-7m/s fails the minimum criteria specified for the half drain down time of the proposed infiltration system.

Based on this soil infiltration information and the local geology reviewed, it has therefore been concluded that full ground infiltration techniques will not be viable for the surface water drainage and management at this site.

2.5. Hydrology

There are no open watercourses on the site and the nearest adjacent watercourses are the drains to the north of the site that appear to discharge to Prestatyn Gutter. These are located approximately 500m from the northern boundary of the site adjacent to Dawson Drive. There may be unidentified culverted watercourses within the site boundary, however, we have no information regarding this.

Anecdotal evidence suggested there may be a well located on-site. A Geophysical Survey was undertaken to attempt to locate it and any other sub-surface anomalies. The processed GPR data shows an anomaly within an area on site which could be the well. An extract from the Geophysical Survey showing the approximate location of the well can be found within **Appendix 6.6.**

The anecdotal information indicated that the well could be an abstraction point. There may be issues with the legality of using it as a discharge point, therefore all other methods of surface water discharge should be assessed prior to considering this option further. Further investigations into the suitability of the well as a discharge point would be required if this is the only available option but we would suggest that this is carried out in more detail at a later point if required.

2.6. Existing Drainage

2.6.1. Public Sewers

A copy of Dwr Cymru Welsh Water's (DCWW) sewer records has been reviewed as part of this assessment and is included in **Appendix 6.7** of this report. There is an existing 225mm diameter public surface water sewer and an existing 150mm diameter public foul sewer which both flow in a northerly direction along The Dell and then north westerly behind the existing shop (located approximately 13m to the west of the site) and then into an existing manhole within the footway adjacent to Ffordd Isa and Maes Tegid (located approximately 35m from the site).

2.6.2. *Existing Site Drainage Arrangements*

As much of the site is greenfield there was expected to be no existing drainage infrastructure within it. This was confirmed by a topographical survey of the site and a site visit undertaken by OPUS on the 24th November 2017 which showed no visible evidence of any existing drainage infrastructure. The proposed section of the site that is currently the residential property No.1 The Dell has both a foul and surface water connection that appears to discharge to the existing public sewers within the residential street The Dell.

2.7. Consultation with Authorities

2.7.1. *Consultation with Denbighshire County Council (DCC)*

The Lead Local Flood Authority (LLFA) of DCC has been consulted as part of this assessment. They have requested that that the drainage strategy is carried out in accordance with the hierarchy stated within Building Regulations 2010 H3 which stipulates that rainwater from roofs and paved areas is carried away from the surface to discharge to one of the following, listed in order of hierarchy.

- Discharge to the ground
- Discharge to a surface water body
- Discharge to a surface water sewer
- To a combined sewer where there are absolutely no other options and only where agreed in advance with the relevant sewerage undertaker.

2.7.2. *Consultation with Natural Resources Wales (NRW)*

Consultation has been undertaken with NRW and their response in included within **Appendix 6.8.** NRW advised that the area is at a very low risk of flooding from rivers and the sea, that they have no record of flooding in the area and have no flood defences protecting the area.

NRW have stated that the site is in an area where the likelihood of flooding from both rivers and the sea has been assessed as less than 1 in 1,000 (0,1%) chance in any given year.

Therefore, the likelihood of flooding is estimated as ‘very low’ - less than 1 in 1,000 (0.1%) chance in any given year.

2.7.3. *Consultation with Dwr Cymru Welsh Water (DCWW)*

Initial consultations with DCWW has been undertaken to ascertain details of existing drainage infrastructure assets and any flooding history (**see Appendix 6.8**). The response received from DCWW is as follows:

- *There are no known sewers crossing the site so there no records of flooding within the development boundary.*
- *There are instances of flooding on the public sewer network as a result of hydraulic overload within the vicinity of the site. This flooding will likely have been caused as a result of storm water entering the foul sewers.*
- *There are no plans in place to undertake improvement works on this part of the catchment.*

The pre-planning advice received from DCWW can be found in **Appendix 6.8**, in which DCWW stated the following:

- *The foul flows only from the proposed development can be accommodated within the public sewerage system. We advise that the flows should be communicated with to the foul sewer at or beyond manhole SJ06824301. This manhole chamber is positioned to the West of the site within the road known as The Dell.*
- *You are required to fully exhaust all technical options outlined under Sections 3.2 and 3.4 of Part H of the publication 'Building Regulations 2000; Disposal should be made through the hierarchical approach, preferring infiltration and, where infiltration is not possible, disposal to watercourses in liaison with the Land Drainage Authority and/or Natural Resources Wales. Please be advised that the surface water flows from this*

development will not be permitted to discharge to the public foul or combined sewer systems. You are required to find an alternative means of draining surface water drainage.

- *In addition, please note that no highway or land drainage run-off will be permitted to discharge directly or indirectly into the public sewerage system.*
- *No problems are envisaged with the Waste Water Treatment Works for the treatment of domestic discharges from this site.*

3. Assessment of Flood Risk

3.1. Flooding History

Natural Resources Wales, Denbighshire County Council as the Lead Local Flood Authority and Dwr Cymru Welsh Water have been consulted regarding the flooding in this area. NRW confirmed that they have no record of flooding within in the area. The LLFA have provided no formal response with regard to flood information. DCWW have no records of flooding within the development boundary, however, they confirmed that there have been instances of flooding on the public sewer network as a result of hydraulic overload within the vicinity of the site and that his flooding will have been caused as a result of storm water entering the foul sewers.

3.2. Fluvial Flood Risk

Natural Resources Wales online flood risk map indicates that the site is at a very low risk of flooding from rivers and the sea. NRW have stated that the site is in an area where the likelihood of flooding from both rivers and the sea has been assessed as less than 1 in 1,000 (0,1%) chance in any given year. Therefore, the likelihood of flooding is estimated as 'very low' - less than 1 in 1,000 (0.1%) chance in any given year. **Figure 2.0** below shows an extract of the NRW's fluvial flood map.

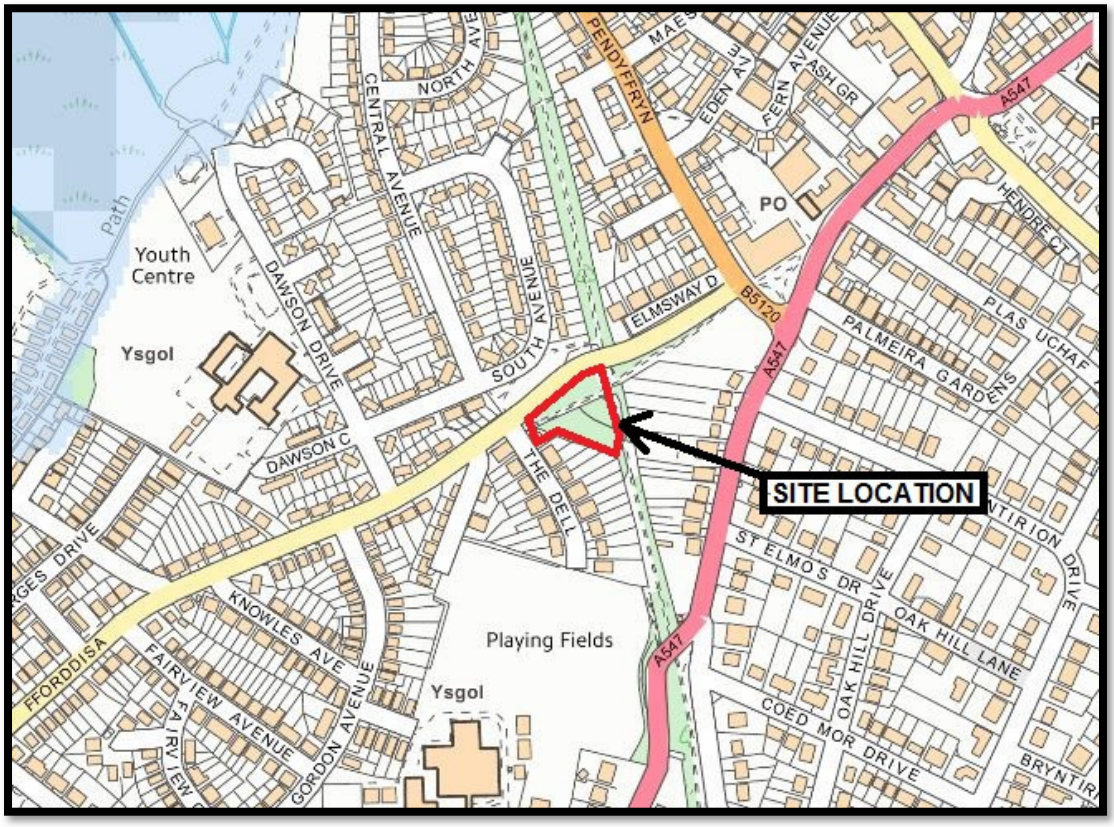


Figure 2.0: Fluvial Flooding Map (Source: Natural Resources Wales Floodmap March 2018)

3.3. Surface Water Flooding

Surface water flooding happens when rainwater does not drain away through the normal drainage systems or infiltrate into the ground, but lies on or flows over the ground instead. **Figure 2.1** below shows the NRW surface water flood map.

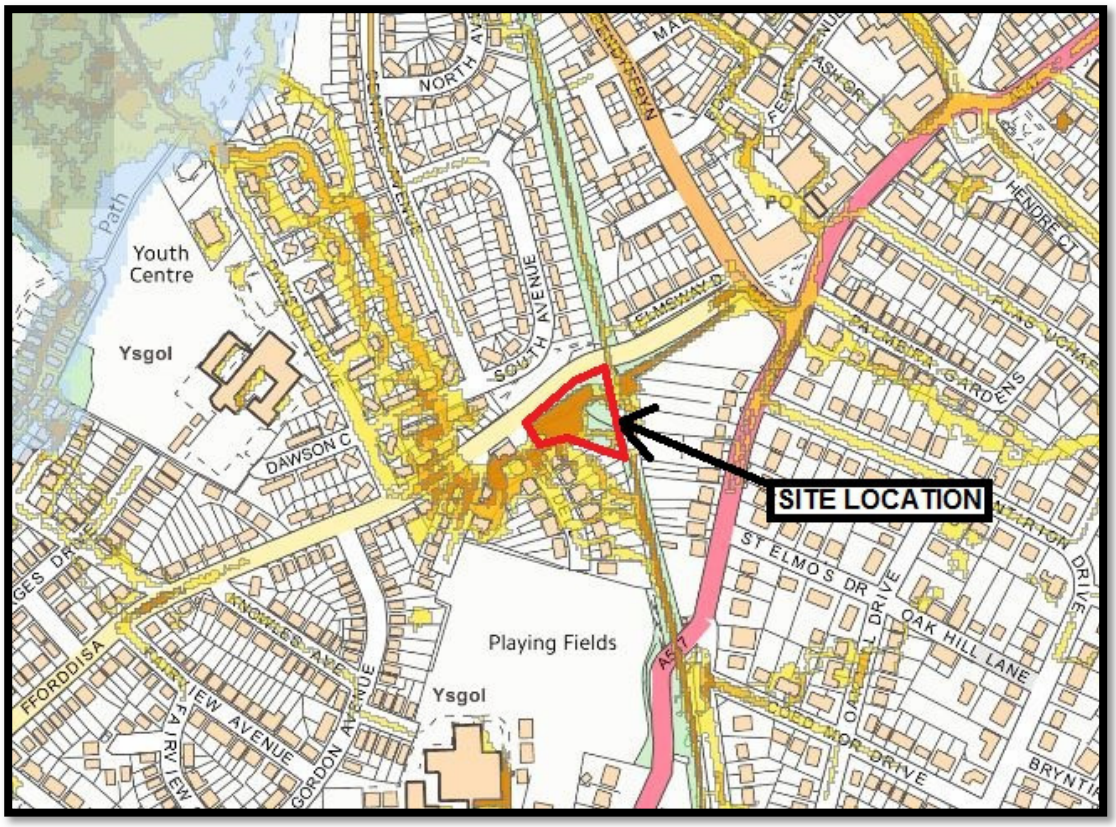


Figure 2.1: Surface Water Flooding Map (Source: Natural Resources Wales Floodmap March 2018)

The above information indicates that approximately 60% of the site is currently at a "High" risk of surface water flooding from overland flows caused by intense rainfall. NRW define "High" surface water flood risk as:

- "High" risk means that each year, the area has a chance of flooding of greater than 1 in 30 (3.3%).

It is likely that the "High" risk classification of the site shown within **Figure 2.1** is due to the existing ground levels of the site and the lack of a positive drainage system within the site.

Following a review of the existing ground levels of the development area during the site visit undertaken by OPUS on the 24th November 2017, it was noted that the surface water flooding shown in **Figure 2.1** is not a true representation of what would actually occur during a peak storm event. Owing to the existing ground levels it is likely surface water flows from Ffordd Isa and The Dell would be contained within the curtilages of the adjacent highway and flow south westerly along Ffordd Isa and southerly along The Dell, following the longitudinal gradients of the local highways away from the proposed site.

The proposed development will include a positive drainage system to serve the site with appropriate on site attenuation. This will ensure that surface water is managed on site so that there is no flood risk to the development or elsewhere. This is discussed in more detail in **Section 4.1** of this report.

3.4. Flooding from the Sea

As shown in **Figures 2.0 and 2.1** the site is located outside the extent of risk from flooding from rivers and the sea. On this basis, the risk of coastal or tidal flooding to the proposed development is considered to be "very low".

3.5. Flooding from Canal

There are no canals within the vicinity of the site. On this basis, the risk of canal flooding to the proposed development is considered to be “negligible”.

3.6. Groundwater Emergence and Flooding

In accordance with the Phase 1 & 2 Geotechnical assessment groundwater was encountered in the exploratory holes throughout the site, at a maximum depth of 3.2m bgl in TP05 and a minimum depth of 2.2m bgl in TP02 and during permeability testing was encountered at a level of 1.7m bgl. On this basis, the risk of the groundwater emergence from the underlying aquifer is considered to be “negligible”.

3.7. Flooding from Reservoirs

The NRW reservoir flooding map indicated that the site does not lie within a reservoir flooding outline. On this basis, the risk of reservoir flooding to the proposed site is “negligible”.

3.8. Flooding from Sewers

Consultation has been undertaken with Dwr Cymru Welsh Water regarding the sewer flood risk and their response is included in **Appendix 6.8**. DCWW have stated that

“There are instances of flooding on the public sewer network as a result of hydraulic overload within the vicinity of the site. This flooding will have been caused as a result of storm water entering the foul sewers.”

As the majority of the site is greenfield and does not have a positive drainage system and it is proposed to construct a positive drainage system to serve the proposed development with appropriate on-site attenuation, the risk of flooding from surface water should be reduced. The proposed surface water drainage system can also be fitted with a non-return valve to ensure that the proposed development is not affected by any surcharge in the local sewers. Indicative proposals of the foul and surface water drainage strategy are shown on drawing **V-R6516.00-500-01** enclosed within **Appendix 6.9**.

3.9. Flooding from Highway

The topographic survey provided by the client indicated that the site ground levels are lower than the adjacent highways of Ffordd Isa and The Dell. The survey also indicated that both Ffordd Isa and The Dell are both served by road gullies and as previously mentioned we would expect the existing longitudinal gradients of Ffordd Isa and The Dell to contain surface water flows within the curtilages of the respected highways and flow south westerly along Ffordd Isa and southerly along The Dell. On this basis, the site is considered to be at a low risk of flooding from the local highway.

4. Drainage Proposals

4.1. Foul Drainage

The foul drainage disposal is proposed to be in compliance with the requirements of Building Regulations 2010 Part H (2015 Edition), Drainage and Waste Disposal and Sewers for Adoption 7th Edition.
Part H1 of the above document contains the following requirements:
"An adequate system of drainage shall be provided to carry foul water from appliances within the building on to the following, listed in order of priority."

a. A public sewer or where that is not reasonably practicable
b. A private sewer communicating with a public sewer, or where that is not reasonably practicable,
c. Either a septic tank which has appropriate form of secondary treatment or another wastewater treatment system; or, where that is not reasonably practicable,
d. A cesspool

4.1.1. Connection to Public Sewer

The proposed peak foul discharge generated by the development has been calculated based upon an occupancy rate of 1.25 persons per 1 bedroom apartment and 2 persons per 2 bedroom apartment which equates to approximately 23.25 persons and allowing a conservative usage of 200 l/person/activity/day over a 24 hour day with a peaking factor of 6, which generates a peak flow in the region of 0.32l/s.

The existing peak foul discharge for the site can be calculated based upon 1 property and allowing a typical usage of 4000 l/dwelling/day over a 24 hour day, which generates a peak flow in the region of 0.05l/s, which represents an increase in peak foul flow of 0.27l/s.

A pre-development enquiry response has been received from DCWW, who advocated that foul flows only from the proposed development can be accommodated within the public sewerage system. DCWW advised that the flows should be communicated with the foul sewer at or beyond manhole SJ06824301 which is located within the highway of The Dell.

In light of the above, we would advocate a separate foul drainage system is designed to serve the proposed development, in accordance with all statutory requirements. The proposed development will also require a non-return valve to prevent flooding from the existing sewers to the site. Indicative proposals of the foul drainage are shown on drawing **V-R6516.00-500-01** enclosed within **Appendix 6.9**.

4.1. Surface Water Drainage

4.1.1. Surface Water Drainage Guidance and Policy

The **Welsh Government Planning Policy Wales** guidance states the following "*flood risk is a material planning consideration*" and the **Technical Advice Note 15: Development and Flood Risk (TAN15,2004)** also states that "*surface water is a material consideration and explains that development should not create additional runoff compared with the undeveloped situation and re-development schemes should also aim to reduce run-off where possible*."

The aim of a surface water drainage strategy is to focus on the capture and management of surface water within the site boundary and ensure compliance with the requirements and guidance of the following publications and organisations:

- The LLFA of Denbighshire County Council
- Building Regulations 2010 (Part H3)
- Sewers for Adoption 7th Edition
- Welsh Ministers Standards for Foul Sewers and Lateral Drains
- The new Sustainable Drainage Systems (SuDS) Manual C753, CIRIA
- Technical Advice Note 15 (TAN15, Welsh Government)
- RainScape – Dwr Cymru Welsh Water
- SuDs Wales

In accordance with the above, surface water drainage systems are required to consider quantity, quality, amenity and biodiversity whilst preventing any likelihood of flooding to the site or adjacent sites. Part H3 of the Buidling Regulations 2010 guidance recommends that surface water runoff shall discharge to one of the following, listed in order of priority:

- Discharge to the ground
- Discharge to a surface water body
- Discharge to a surface water sewer
- To a combined sewer where there are absolutely no other options and only where agreed in advance with the relevant sewerage undertaker.

It is necessary to identify the most appropriate method of controlling and discharging surface water. The design should seek to improve the local run-off profile by using systems that can either attenuate run-off and reduce peak flow rates or positively impact on the existing flood profile.

4.1.2. Discharge to the Ground

As previously referenced in section 2 of this report, soil infiltration testing was undertaken by Smith Grant Environmental Consultancy LLP, on the 18th December 2017, as per guidance detailed in BRE 365. The results of the testing are enclosed within **Appendix 6.5**. Based on this information it has therefore been concluded that full ground infiltration techniques will not be viable for surface water drainage and management on this site. This option has therefore been discounted.

4.1.3. Discharge to a Surface Water Body

As previously referenced in section 2 of this report, there are no open watercourses on the site and the nearest adjacent watercourses are the drains to the north of the site that appear to discharge to Prestatyn Gutter. These are located approximately 500m from the northern boundary of the site adjacent to Dawson Drive. On this basis, this option has therefore been discounted.

4.1.4. Discharge to a Surface Water Sewer

As previously referenced in section 2 of this report, the public sewer plan provided by DCWW shows that there is an existing 225mm diameter public surface water sewer which flows in a northerly direction along The Dell and then north westerly behind the existing shop and then

into an existing manhole within the footway adjacent to Ffordd Isa and Maes Tegid. (See DCWW sewer records in **Appendix 6.7).**

As infiltration drainage systems will be unsuitable for the discharge of surface water run-off from the proposed development, we would advocate a connection to the public surface water drainage system at EX MH SJ06824283 to the rear of the shop at the junction between The Dell and Ffordd Isa is pursued. Discussions with DCWW have confirmed that this point of connection is acceptable, evidence of this correspondence can be found within **Appendix 6.8**.

4.1.4.1. Existing Greenfield Run-off Rate

It is proposed that the surface water drainage system for the proposed development will discharge to the existing public surface water sewer manhole EX MH SJ06824283 to the rear of the shop at the junction between The Dell and Ffordd Isa at a maximum agreed discharge rate with DCWW.

The existing Greenfield run-off rates for the site have been calculated using the ICP SuDS method in Microdrainage Windes these are summarised in the table below and are also attached within **Appendix 6.10**.

EXISTING GREENFIELD DISCHARGE RATES	
Return Period	**Existing Discharge Rates (l/s)**
Q_{bar}	**0.6**
1 in 30 year	**1.1**
1 in 100 year	**1.4**

Table 4.0: Summary of Existing Greenfield Discharge Rates

4.1.4.2. Proposed Discharge Rate

In order to reduce the impact of developments on existing surface water drainage infrastructure, run-off rates for all brownfield sites, should be as close as practically possible to the greenfield run-off rate, which in this instance is 0.6l/s.

- To achieve a discharge rate of 0.6 l/s the orifice diameter will be less than 60mm for any vortex flow control device with a design head greater than 0.6m, this would greatly increase the risk of blockage and flood risk. To reduce the blockage risk, we would expect the diameter to be in excess of 75mm.
- Given the proposed development is situated within a built-up area, we would not advocate installing a drainage system which has any potential to increase flood risk elsewhere.
- Additionally, HR Wallingford Civil Engineering and Environmental Hydraulics Organisation states that: "*Where flow rates are less than 5 l/s consents are usually set at 5l/s if blockages from vegetation and other materials is possible*".

In light of the above, we would advocate that a discharge rate of 5l/s is proposed for the development site, which has been agreed with DCWW, evidence of this correspondence can be found within **Appendix 6.8**.

4.1.4.3. Scheme Proposals

In light of the above, we would advocate a surface water drainage system with an outfall to EX MH SJ06824283 designed in accordance with all statutory standards. DCWW have advised that the maximum permissible discharge of surface water drainage from the development site to the public sewer will be 5l/s.

Based upon a maximum permissible discharge rate of 5l/s the attenuation required on-site to cater for storm events up to and including the 1 in 100 year plus 30% climate change event would be in the order of 41m³ based upon storage calculations using MicroDrainage. It is

envisaged that the storm volume will be accommodated within the underground attenuation, either tanks or oversized pipework. It is acknowledged that as part of the detailed design, anti-siltation catch pits and measures will need to be incorporated upstream of the attenuation and flow control device.

Ground levels within the vicinity of the building may or may not need to be raised to allow for a gravity connection to the public sewer to comply with the minimum depth of cover requirements stated within Sewers for Adoption 7th edition. This will be informed at detail design stage, following more detailed discussions with DCWW.

The design criteria and assumptions are in compliance with the planning criteria of DCC and Building Regulations 2010 Part H with indicative proposals shown on drawings **V-R6516.00-500-01** in **Appendix 6**.9 and the calculations shown in **Appendix 6.11**. The proposed surface water system may require a non-return valve to prevent any flooding from the DCWW sewers entering the proposed development.

4.1.5. Water Quality

The new SuDS Manual (CIRIA C753, November 2015) introduced a slightly different approach compared to the previous version for the water quality management of surface water. The Manual describes risks posed by the surface water runoff to the receiving environment as a function of:

- The pollution hazard at a particular site (i.e. the pollution source).
- The effectiveness of SuDS treatment components in reducing levels of pollutants to environmentally acceptable levels (i.e. the pollutant pathway).
- The sensitivity of the receiving environment (the environment receptor).

The proposed land uses requiring surface water drainage for this site are as follows:

- Roof areas – surface water discharge to roof sump gulleys before discharging to the existing public sewer adjacent to The Dell.
- Car parking area – surface water discharge to linear drainage channel with sump before discharging to the existing public sewer adjacent to The Dell.

Table 26.2 of the SuDS Manual C753 assigns pollution hazard indices for different land use classification. The roof water and car parking areas pollution have hazard levels ranging from very low to low, with low levels of contamination. The proposed sump gullies and catch pit manholes are deemed to be sufficient to remove the suspended sediments from the roof and car park surface water for a development of this size and nature.

4.1.6. Residual Risks and Exceedance Flows and Runoff in Excess of Design Criteria

The outline surface water drainage scheme for this development is proposed to comply with the requirements of Sewers for Adoption, i.e. no surcharge in the 1 in 1 year event and no flooding in the 1 in 30 year event.

It is difficult to completely guard against flooding since extreme events greater than the design standard event are always possible. It is practicable to minimise the risk by careful design of the layout of the development such that internal flooding is avoided. Areas of hardstanding can be laid to fall away from buildings with flows directed to areas where damage and disruption to buildings, assets and operations will be minimized. For example, these could include the soft landscaped area to the east of the site.

The amenity and landscaped areas could also be used to accommodate residual flows beyond the design 1 in 100 year plus climate change event, without causing flooding elsewhere.

4.1.7. General Maintenance Regimes

The surface water drainage proposals for this site should include the following maintenance measures:

- Cleaning the sump of the road gullies, linear drainage channels and roof sump gullies to improve the quality of the water.
- Cleaning the sump of the roof sump gullies to improve the quality of water.

- Cleaning and maintenance of flow control device and its sump to maintain effective drainage.
- Inspection, cleaning and maintenance of the below ground attenuation systems to remove any silt and debris in accordance with the manufacturers instructions.

The frequency of the cleaning and maintenance inspections will be agreed with the site owner/operators maintenance team.

5. Conclusions & Recommendations

5.1. Conclusion

The proposed site was not found to be at fluvial flood risk and is situated on land identified on the TAN15 Development map as Flood Zone A.

Due to the location of the site, the risk of flooding from canals, reservoirs and tidal waters is considered to be negligible.

It has been agreed with DCWW that the maximum permissible discharge of surface water drainage from the development site to the public sewer will be 5l/s.

Based on all the above the proposed development will not cause flood risk elsewhere and is not expected to be affected by general objections in respect to draining the site. There will also be suitable conditions imposed to ensure that the drainage proposals are designed and constructed in accordance with relevant statutory requirements, including Building Regulations 2010 and the requirements of Denbighshire County Council's surface water management guidance.

5.2. Recommendations

Before the detailed design stage, it is recommended that a full CCTV survey inspection of the existing public sewer network within The Dell and Ffordd Isa is undertaken to confirm the viability of the sewers as points of discharge for the proposed development.

6. Appendices

FFORDD ISA

PUBLIC FOOTPATH

THE DELL

1

3

5

7

Attenuation Tank- Location TBA and subject to engineers design and specification

Land transfer to adjoining property (3, The Dell) subject to agreement- Exact details TBA

Party fence wall boundary treatment, exact details TBA- subject to agreement

Access for adjacent property 7 & 9 The Dell exact details TBA- subject to agreement

Schedule of Accommodation

15No Units : Comprising of : (approx. areas)

2No 2 Bed CAT 3 - Wheelchair User Apartments	80-88m2*
3No 1 Bed CAT 3 - Wheelchair User Apartments	62-70m2*
4No 2 Bed CAT 2 - Accessible & Adaptable Apartments	80-95m2*
6No 1 Bed CAT 2 - Accessible & Adaptable Apartments	62-70 m2*

* All apartments feature covered external 'private' space/ balcony 6-8m2

Scooter storage points (exact location TBA)

External Bin Store (exact location TBA)

On site Parking

5No Disabled Bays 3600 x 6000mm

13No standard parking bays 2400 x 4800mm

Attenuation Tank

Location TBA subject to engineers design and specification

Scooter Store Units

A	18:10:17	Schedule of Accommodation omitted
B	14:12:17	Schedule of Accommodation added
C	29:01:18	Location of Building Footprint Amended
D	07:02:18	Drainage Omitted Notes added regarding boundary etc
E	26:02:18	Levels Existing & Proposed added
F	23:04:18	Root Protection Area added (RPA)
G	03:05:18	Location of Building Footprint Amended Car parking layout amended Scooter units added

Cyngor sir ddinbych denbighshire County Council

Cyfleusterau, Asedau a Tai
Facilities, Assets & Housing

Project_Name :
The Dell, Prestatyn.

Project_Number :
P7_17_706

Drawing Stage:
RIBA STAGE 3

Drawn By: Reviewed By:

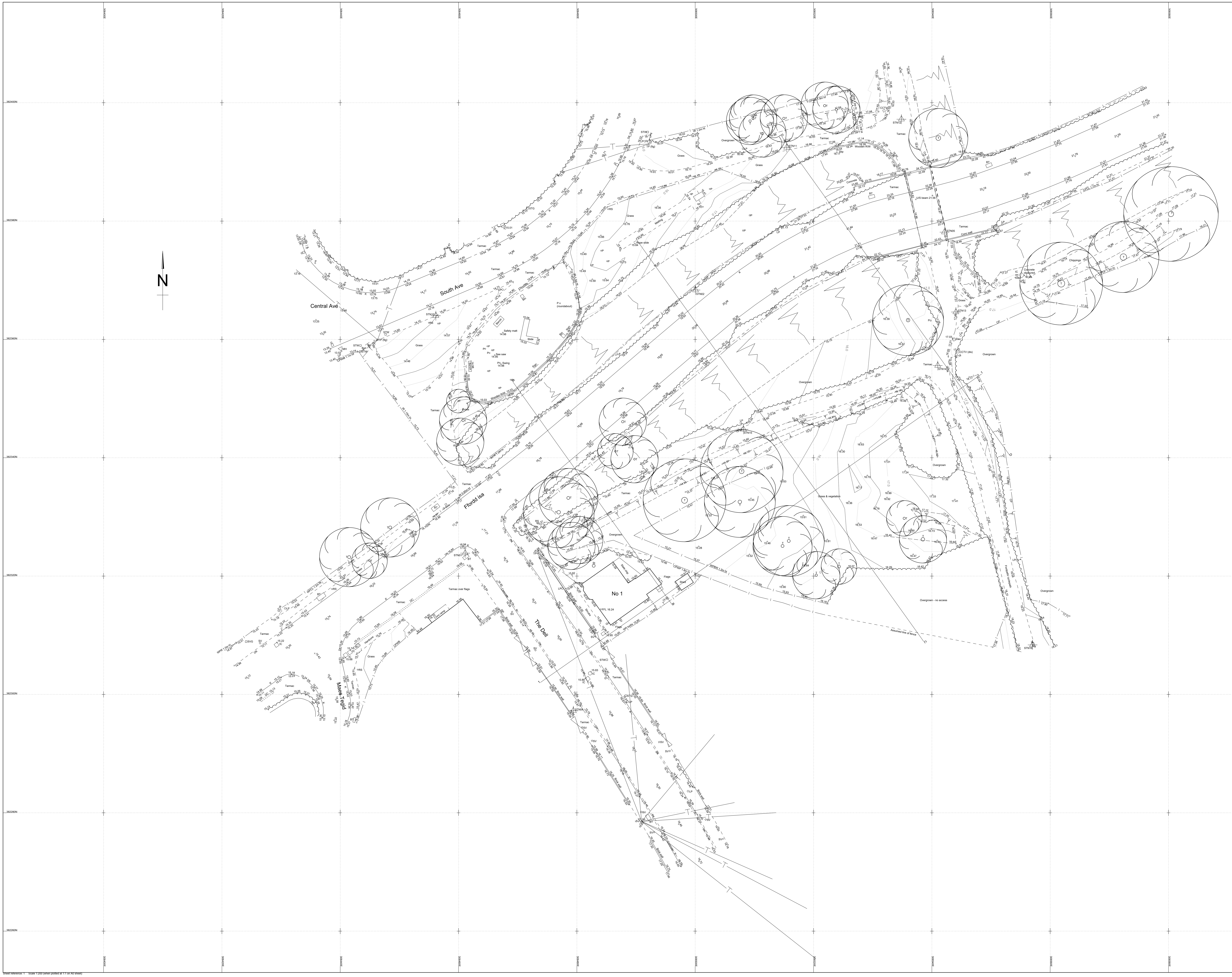
Date:
16:10:17

Scale:
1:200 @A1

Drawing Name:
Proposed Site Plan.

Drawing Number:
AL(0)110

Revision:
G



Revision	Description	Date
A	Section locations added	01.08.17

Station	Easting	Northing	Level	Station description
STN01	306461.12	382323.88	16.94	Road nail
STN02	306500.04	382368.35	20.26	Hilti nail
STN03	306481.27	382329.46	15.93	Road nail
STN04	306479.40	382297.23	15.93	Road nail
STN05	306542.13	382378.12	22.39	Road nail
STN10	306456.16	382364.01	14.26	Road nail
STN11	306515.47	382392.45	16.74	Hilti nail
STN12	306534.85	382397.21	16.61	Hilti nail
STN13	306544.07	382364.62	17.04	Hilti nail
STN14	306540.99	382355.58	16.89	Hilti nail
STN15	306508.16	382344.80	15.57	Hilti nail
STN16	306557.02	382308.37	18.36	Hilti nail

PROJECT

TOPOGRAPHIC SURVEY THE DELL PRESTATYN

CLIENT

DENBIGHSHIRE COUNTY COUNCIL
FINANCE & PERFORMANCE
CALEDFRYN
SMITHFIELD ROAD
DENBIGH LL16 3RJ

ORIGINAL SURVEY BY

Co - Surveys Ltd

Survey House
Unit 7 Parc Caer Seion
CONWY
LL32 8FA
Tel (01492) 593367
mail@co-surv.com

Surveyors : GD & DRP

August 2017

NOTES

GRID - Related to OSGB36 (UK National Grid) via GPS and OSTN15

LEVELS - Related to OS Datum via GPS and OSGM15

SCALES

HORIZONTAL 1:200
VERTICAL N/A

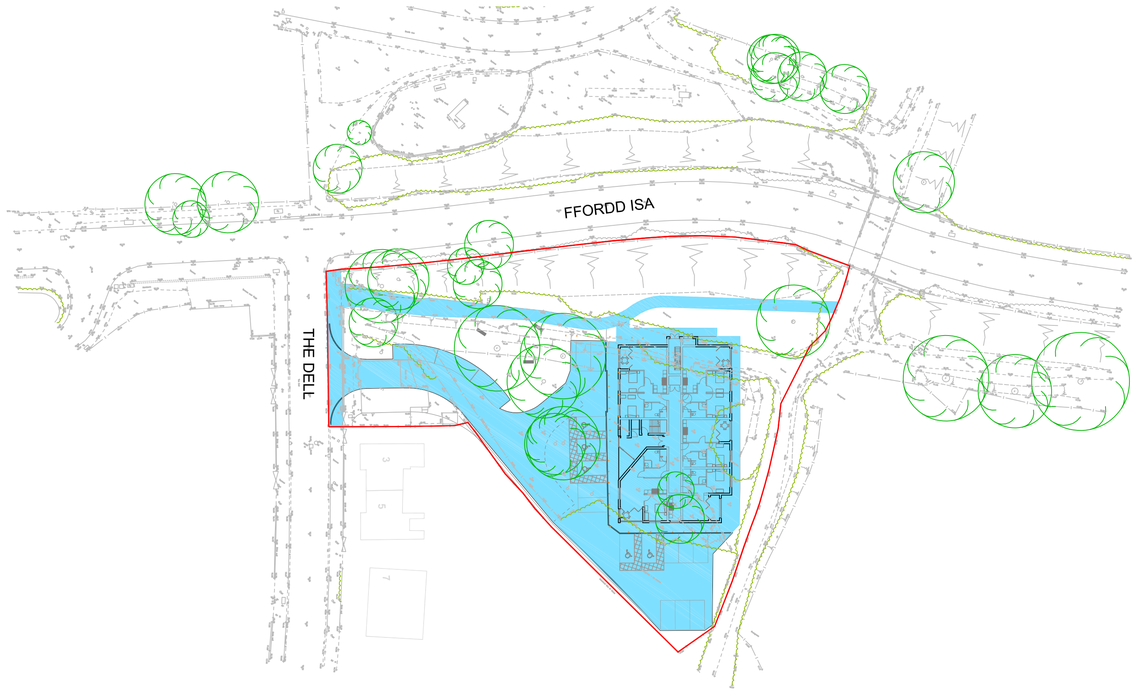
DRAWING REFERENCE

9765 / 1A (sheet 1 of 1)

EXISTING SITE (3,350 SQ M)

IMPERMEABLE AREA = 465 SQ M
(BUILDINGS AND PAVED AREAS)

PERMEABLE AREA = 2,885 SQ M
(LANDSCAPED AREAS)



PROPOSED SITE

IMPERMEABLE AREA = 1,765 SQ M

300 mm
200
100
50
10 mm
0

1:500 @ A1
0 5 10 15 20 25 30 35 40 45 50 m

Revision	Amendment	Approved	Revision Date
A1	AMENDED FOLLOWING DCC COMMENTS	JR/MW	22/05/18

Cyngor sir ddinbych denbighshire County Council
Cyfleusterau, Asedau a Tai
Facilities, Assets & Housing

OPUS
Wrexham Office
+44 1978 368100
Opus House, Yale Business Village
Wrexham Technology Park,
Wrexham LL13 7YL

Drawn	Designed	Approved	Revision Date
JR	JR	GNT	12/03/18

Project No.: V-R6516.00
Scale: 1:500 @ A1

Project
PROPOSED RESIDENTIAL DEVELOPMENT
THE DELL
PRESTATYN

Sheet
PROPOSED FOUL & SURFACE WATER
EXISTING & PROPOSED IMPERMEABLE AREAS

Drawing No.: V-R6516.00/100
Sheet. No.: 01
Revision: A1

Original Sheet Size A1 [841x594] Plot Date 17 May 2018 @ 4:00 PM Path G:\live\v-r6500s\v-r6516.00-the-dell-prestatyn\04-project-delivery\cde01-wip\Drainage\V-R6516.00-100-01-A - Existing and Proposed Impermeable area.dwg 500-01

SHEET:	LOCATION:	PROJECT:	ENGINEER:	JOB NO.	TRIAL PIT NO.
1 of 1	See Plan	The Dell Prestatyn	CS	R2485	TP01
		EXCAVATED BY: JCB 3cx backhoe excavator	CLIENT: Denbighshire County Council	DATE: 29 November 2017	

DEPTH (m)	SAMPLES	Field Records	DEPTH (m)	DESCRIPTION OF STRATA	LEGEND
			0	Dark brown slightly clayey silty sandy TOPSOIL with roots.	
0.2	ES1		0.3	Firm reddish brown slightly sandy slightly gravelly silty CLAY with lenses of light grey sand. Gravel is fine to coarse subrounded limestone (GLACIAL TILL).	
0.8	B	P.P. = 1.5kg/cm2			
2	D1	P.P. = 1.5kg/cm2			
		P.P. = 2kg/cm2			
				Terminated at 2.7m. Trial pit collapsing below groundwater level.	

SMITH GRANT Environmental Consultancy LLP

Smith Grant LLP
Station House, Station Road,
Ruabon, Wrexham LL146DL

Tel: 01978822367
Fax: 019788247182

www.smithgrant.co.uk
email: consult@smithgrant.co.uk

GROUND WATER:

Groundwater inflow at 2.4m

REMARKS:

Sidewalls collapsing below groundwater level.
Time: 11:00-11:25 am

ES: jar sample
D: small disturbed sample
B: bulk disturbed sample
P.P. - pocket penetrometer

SCALE:	LOGGED BY:	FIGURE NO.
1:250	CS	1

SHEET:	LOCATION:	PROJECT:	ENGINEER:	JOB NO.	TRIAL PIT NO.
1 of 1	See Plan	The Dell Prestatyn	CS	R2485	TP02
		EXCAVATED BY: JCB 3cx backhoe excavator	CLIENT: Denbighshire County Council	DATE: 29 November 2017	

DEPTH (m)	SAMPLES	Field Records	DEPTH (m)	DESCRIPTION OF STRATA	LEGEND
			0	Blackish dark brown slightly clayey silty sandy TOPSOIL with roots.	
0.3	ES1		0.4	Reddish brown locally light grey slightly gravelly slightly clayey silty SAND with lenses of silty clay and occasional subrounded cobbles of limestone. Gravel is fine to coarse subrounded limestone (GLACIAL TILL).	
0.6	D1				
0.7	B				
				Terminated at 3.1m. Trial pit collapsing below 1.5m.	

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GROUND WATER:

Groundwater seepage at 2.4m. Groundwater inflow at 2.8m.

REMARKS:

Sidewalls collapsing from 1.5m.
Time: 11:30-12:00

ES: jar sample
D: small disturbed sample
B: bulk disturbed sample
P.P. - pocket penetrometer

SCALE:	LOGGED BY:	FIGURE NO.
1:250	CS	1

SHEET:	LOCATION:	PROJECT:	ENGINEER:	JOB NO.	TRIAL PIT NO.
1 of 1	See Plan	The Dell Prestatyn	CS	R2485	TP03
		EXCAVATED BY: JCB 3cx backhoe excavator	CLIENT: Denbighshire County Council	DATE: 29 November 2017	

DEPTH (m)	SAMPLES	Field Records	DEPTH (m)	DESCRIPTION OF STRATA	LEGEND
			0	Dark brown slightly clayey silty sandy TOPSOIL with roots.	
1	D1		0.4	Light brown slightly clayey silty SAND with occasional fine to coarse subrounded gravel of limestone (GLACIAL TILL).	
			1.4	Reddish brown slightly gravelly slightly clayey silty SAND with lenses of clay. Gravel is fine to coarse subrounded limestone (GLACIAL TILL).	
			1.7	Stiff reddish brown slightly gravelly slightly sandy CLAY with partings of sand. Gravel is fine to coarse subrounded limestone (GLACIAL TILL).	
				Terminated at 3.1m. Trial pit collapsing below 2.4m.	

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GROUND WATER:

Grounwater seepage at 3m.

REMARKS:

Sidewalls collapsing from 2.4m.
Time: 12:00-12:15 pm

ES: jar sample
D: small disturbed sample
B: bulk disturbed sample
P.P. - pocket penetrometer

SCALE:	LOGGED BY:	FIGURE NO.
1:250	CS	1

SHEET:	LOCATION:	PROJECT:	ENGINEER:	JOB NO.	TRIAL PIT NO.
1 of 1	See Plan	The Dell Prestatyn	CS	R2485	TP04
		EXCAVATED BY: JCB 3cx backhoe excavator	CLIENT: Denbighshire County Council	DATE: 29 November 2017	

DEPTH (m)	SAMPLES	Field Records	DEPTH (m)	DESCRIPTION OF STRATA	LEGEND
			0	Blackish dark brown slightly clayey silty sandy TOPSOIL with roots.	
0.6	ES1		0.4	Light brown slightly clayey silty SAND with lenses of clay and with occasional fine to coarse subrounded gravel of limestone (GLACIAL TILL).	
1.9	D1	P.P. = 1kg/cm2	2	Firm locally very stiff reddish brown slightly gravelly sandy to very sandy CLAY with partings of sand. Gravel is fine to coarse subrounded limestone (GLACIAL TILL).	
2.5	D2	P.P. = 1.5kg/cm2		Terminated at 3.2m.	
		P.P. = 4kg/cm2			

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GROUND WATER:

Grounwater inflow at 3.1m.

REMARKS:

Sidewalls collapsing below groundwater level.
Time: 12:15-12:40 pm

ES: jar sample
D: small disturbed sample
B: bulk disturbed sample
P.P. - pocket penetrometer

SCALE:	LOGGED BY:	FIGURE NO.
1:250	CS	1

SHEET:	LOCATION:	PROJECT:	ENGINEER:	JOB NO.	TRIAL PIT NO.
1 of 1	See Plan	The Dell Prestatyn	CS	R2485	TP05
		EXCAVATED BY: JCB 3cx backhoe excavator	CLIENT: Denbighshire County Council	DATE: 29 November 2017	

DEPTH (m)	SAMPLES	Field Records	DEPTH (m)	DESCRIPTION OF STRATA	LEGEND
			0	Blackish dark brown slightly clayey silty sandy TOPSOIL with roots.	
0.4	ES1		0.4	Light brown locally light grey sandy to very sandy slightly gravelly CLAY withe lenses of sand. Gravel is fine to coarse subrounded limestone (GLACIAL TILL).	
			1.7	Reddish brown silty SAND with lenses of light grey sandy GRAVEL of fine to coarse subrounded limestone and sandstone (GLACIAL TILL).	
				Terminated at 3.3m. Trial pit collapsing below 1.1m.	

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GROUND WATER:

Grounwater seepage at 3.2m.

REMARKS:

Sidewalls collapsing from 1.1m.
Time: 12:40-13:00 pm

ES: jar sample
D: small disturbed sample
B: bulk disturbed sample
P.P. - pocket penetrometer

SCALE:	LOGGED BY:	FIGURE NO.
1:250	CS	1

SHEET:	LOCATION:	PROJECT:	ENGINEER:	JOB NO.	TRIAL PIT NO.
1 of 1	See Plan	The Dell Prestatyn	CS	R2485	TP06
		EXCAVATED BY: JCB 3cx backhoe excavator	CLIENT: Denbighshire County Council	DATE: 29 November 2017	

DEPTH (m)	SAMPLES	Field Records	DEPTH (m)	DESCRIPTION OF STRATA	LEGEND
			0	MADE GROUND: Blackish dark grey slightly clayey gravelly sand with roots, wood and occasional concrete sleepers. Gravel is angular brick and concrete.	
			1.3	Grey slightly clayey gravelly SAND.	
1.9	ES1				
			2.2	Very stiff reddish brown CLAY with occasional medium to coarse subrounded gravel of limestone (GLACIAL TILL).	
2.6	D2	P.P. = 3.5kg/cm2 P.P. = 4kg/cm2			
				Terminated at 3.3m.	

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GROUND WATER:

Grounwater seepage from 2.1m.

REMARKS:

Sidewalls unstable below groundwater level.
Time: 13:00-13:30 pm

ES: jar sample
D: small disturbed sample
B: bulk disturbed sample
P.P. - pocket penetrometer

SCALE:	LOGGED BY:	FIGURE NO.
1:250	CS	1

Contaminated Land
Air Quality
Environmental Audit

SMITH GRANT Environmental Consultancy LLP

Partnership No: OC 300776

Our ref: R2485-L20171218
Your ref: Soil Infiltration (Soakaway) Calculations

Mr David Whieldon
Facilities, Assets & Housing
Denbighshire County Council

18th December 2017

By e-mail: david.whieldon@denbighshire.gov.uk

Dear David,

Proposed Development at The Dell, Prestatyn
Soil Infiltration Testing

SGP were instructed to carry out soakaway trial-pits to determine a soil infiltration rate to allow assist determination in assessing the feasibility of soakaways and their design at the above site.

Prior to the commencement of intrusive works, SGP were advised of 2 potential locations in which soakaways may be located if determined suitable and recommendations were made on excavation depths of 2.2m and 2.9m or to the point at which groundwater was encountered. The locations of the test-pits are provided on the attached drawing (L20171218-D01) with works carried out in accordance with BRE 365[1].

Ground conditions were typical to those observed during the previous site investigation with entries SA1 and SA2 recording a surface cover of topsoil underlain by clayey silty sand with occasional gravel (Glacial Till outwash) within both locations. Shallow groundwater was encountered during the excavation with a slight seep noted at 1.7m bgl and trial pit collapsing below the seepage level within SA2. SGP consulted with the on-site engineer from Opus who agreed that the excavations should not extend beyond 1.7m bgl. The total depth of SA2 was 2m bgl following excavation but effective depth of 1.7m was considered for the purpose of deriving soil infiltration rates.

It is noted that the soakaway testing was completed following a period of snowmelt and during heavy to light rainfall which is considered to provide a 'worse case' scenario in terms of ground degree of saturation.

Soakaway tests were carried out within each test-pit on a single occasion due to slow infiltration rates with monitoring conducted over a test period of 4hrs. Soil infiltration rates were calculated by the methodology detailed in BRE 365, copies of the worksheets are provided with soil infiltration rates summarised in the table below:

Table 1.1 Soil infiltration rates

Test-Pit	Soil Infiltration Rate (ms^{-1})
SA1	8.88×10^{-7}
SA2	2.06×10^{-6}

[1] Building Research Establishment; Soakaway Design. Digest 365

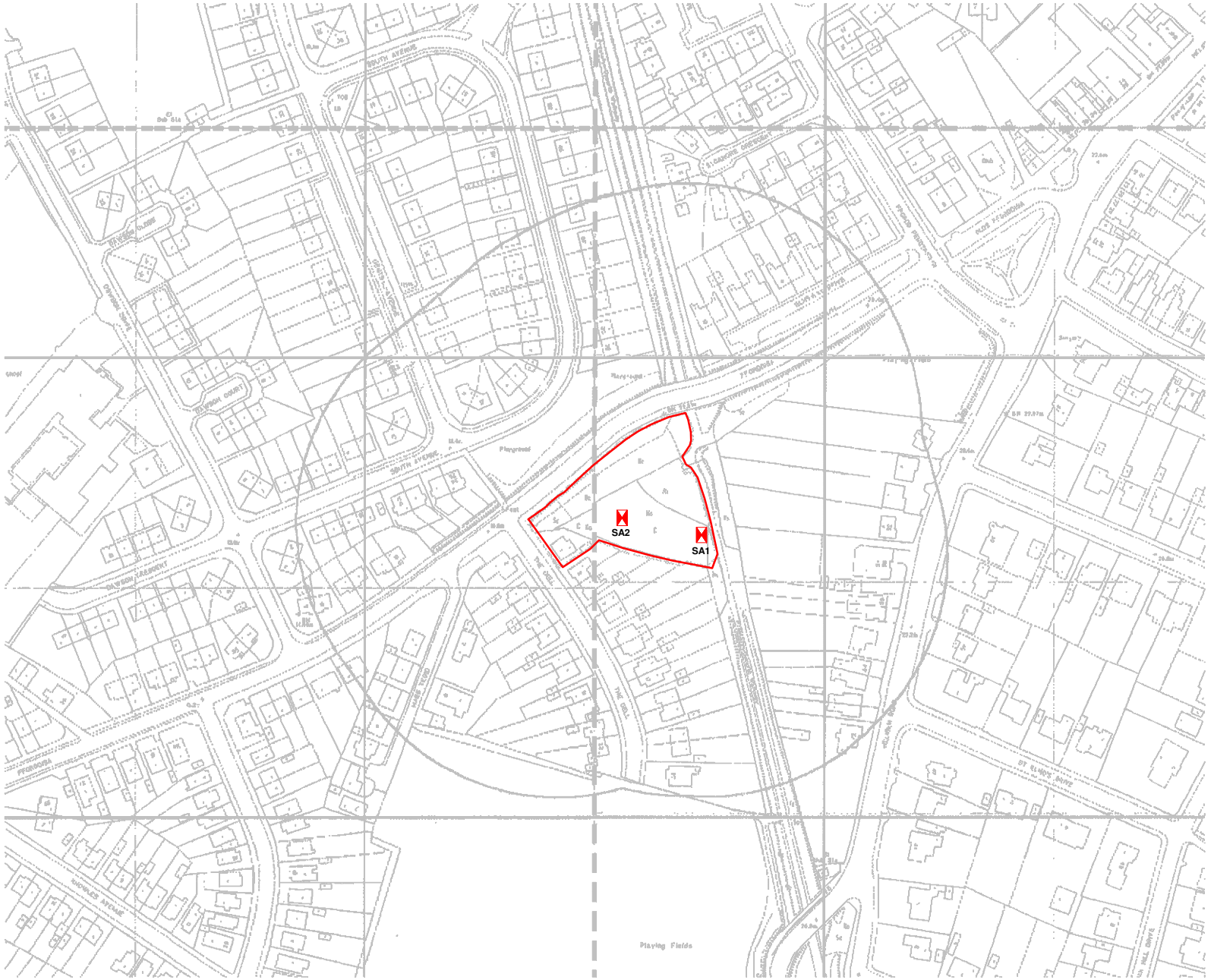
Soil infiltration rates ranged between 2.06 x 10^{-6} and 8.88 x 10^{-7} and are classed as 'poor drainage' which is typical for very fine sands, silts and clay silt laminate[2] as were recorded during the trial-pit excavation.

The results should be provided to a specialist drainage engineer who can determine the suitability of soakaways on the site, however based on the results provided and the findings of the site investigation, the suitability of soakaways is considered unlikely.

Yours sincerely
for: Smith Grant LLP

Dan Wayland
Senior Consultant

[2] BS8004: Code of Practice for Foundations



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email: info@smithgrant.co.uk

Project:
The Dell, Prestatyn

Drawing:
Soakaway Test-Pit
Location Plan

Drawn:	Checked:
SM	DW
Date: 18.12.17	Scale: 1:2,500 @ A4
Job No: R2485	Drg No: L20181218-L01-D01

BRE Digest 365, 2007

Trial Pit Soakage Calculation Sheet

Date: 13.12.17

Site: The Dell, Prestatyn

R2485

Trial Pit SA2

Weather conditions: cloudy, constant light rain with heavy rain intervals
Ground conditions: saturated, previous snow meltdown followed by rain

Trial pit dimensions (m)	
Length	1.60
Width	0.50
Depth	1.70
Trial pit fill	none
Initial water volume (m^3)	0.432

assumed drain invert at 0.2m bgl

effective depth (ed)	1.500	m
75% ed	0.575	m
25% ed	1.325	m

Fall from 25%-75% full depth not achieved during test; effective depth change adopted infiltration rate therefore estimated from 25-75% actual depth change:

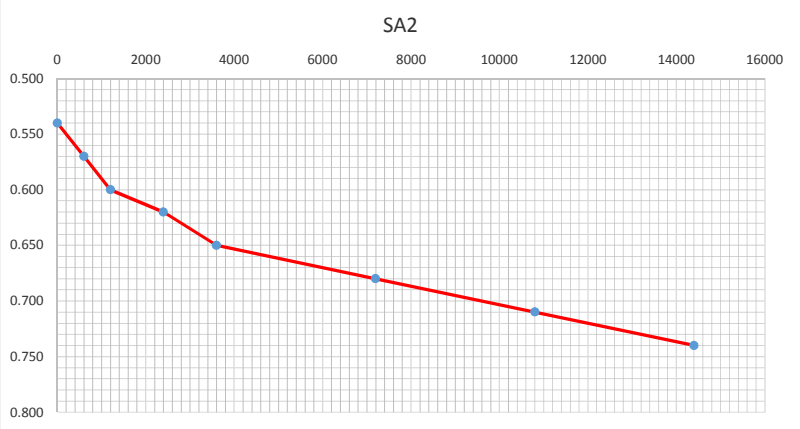
Drainage times

Run 1		Run2	
elapsed time (s)	depth to water (m)	elapsed time (s)	depth to water (m)
0	0.540		
600	0.570		
1200	0.600		
2400	0.620		
3600	0.650		
7200	0.680		
10800	0.710		
14400	0.740		
0	0.000		
0	0.000		
0	0.000		
0	0.000		
0	0.000		
0	0.000		
0	0.000		
0	0.000		
0	0.000		
0	0.000		
0	0.000		
0	0.000		

Calculations

	Run 1	
level at start (0%)	0.540	m
level at end (100%)	0.740	m
25% level	0.59	m
75% level	0.69	m
level change (75-25%)	0.1	m
volume drained (75-25%)	0.08	m^3
surface area drained (75-25%)	5.252	m^2
time at 25% level	1000	s
time at 75% level	8400	s
soil infiltration rate (75-25% actual), f =	**2.06E-06**	**ms^{-1}**

Note:
Trial pit depth - 2m bgl
Groundwater seepage at 1.7m bgl
Effective depth for calculations - 1.7m bgl



Pit profile

GL	Blackish dark brown slightly clayey silty sandy TOPSOIL with roots.
0.4m	
GW 1.7m	Reddish brown locally light grey slightly gravelly slightly clayey silty SAND with lenses of silty clay and occasional subrounded cobbles of limestone. Gravel is fine to coarse subrounded limestone (GLACIAL TILL).
2m	


Trial pit


Start of test


End of test

BRE Digest 365, 2007

Trial Pit Soakage Calculation Sheet

Date: 13.12.17

Site: The Dell, Prestatyn

R2485

Trial Pit SA1

Weather conditions: cloudy, constant light rain with heavy rain intervals
Ground conditions: saturated, previous snow meltdown followed by rain

Trial pit dimensions (m)	
Length	1.60
Width	0.50
Depth	1.70
Trial pit fill	none
Initial water volume (m^3)	0.408

assumed drain invert at 0.2m bgl

effective depth (ed)	1.500	m
75% ed	0.575	m
25% ed	1.325	m

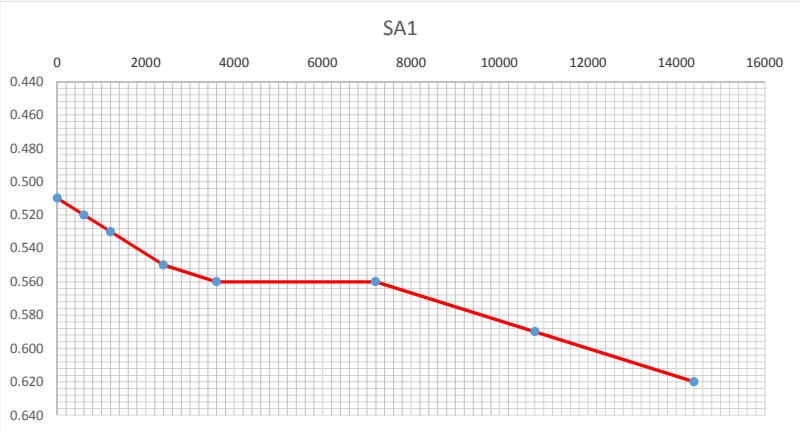
Fall from 25%-75% full depth not achieved during test; effective depth change adopted infiltration rate therefore estimated from 25-75% actual depth change:

Drainage times

Run 1		Run2	
elapsed time (s)	depth to water (m)	elapsed time (s)	depth to water (m)
0	0.510		
600	0.520		
1200	0.530		
2400	0.550		
3600	0.560		
7200	0.560		
10800	0.590		
14400	0.620		
0	0.000		
0	0.000		
0	0.000		
0	0.000		
0	0.000		
0	0.000		
0	0.000		
0	0.000		
0	0.000		
0	0.000		
0	0.000		
0	0.000		

Calculations

	Run 1	
level at start (0%)	0.510	m
level at end (100%)	0.620	m
25% level	0.5375	m
75% level	0.5925	m
level change (75-25%)	0.055	m
volume drained (75-25%)	0.044	m^3
surface area drained (75-25%)	5.567	m^2
time at 25% level	1900	s
time at 75% level	10800	s
soil infiltration rate (75-25% actual), f =	**8.88E-07**	**ms^{-1}**

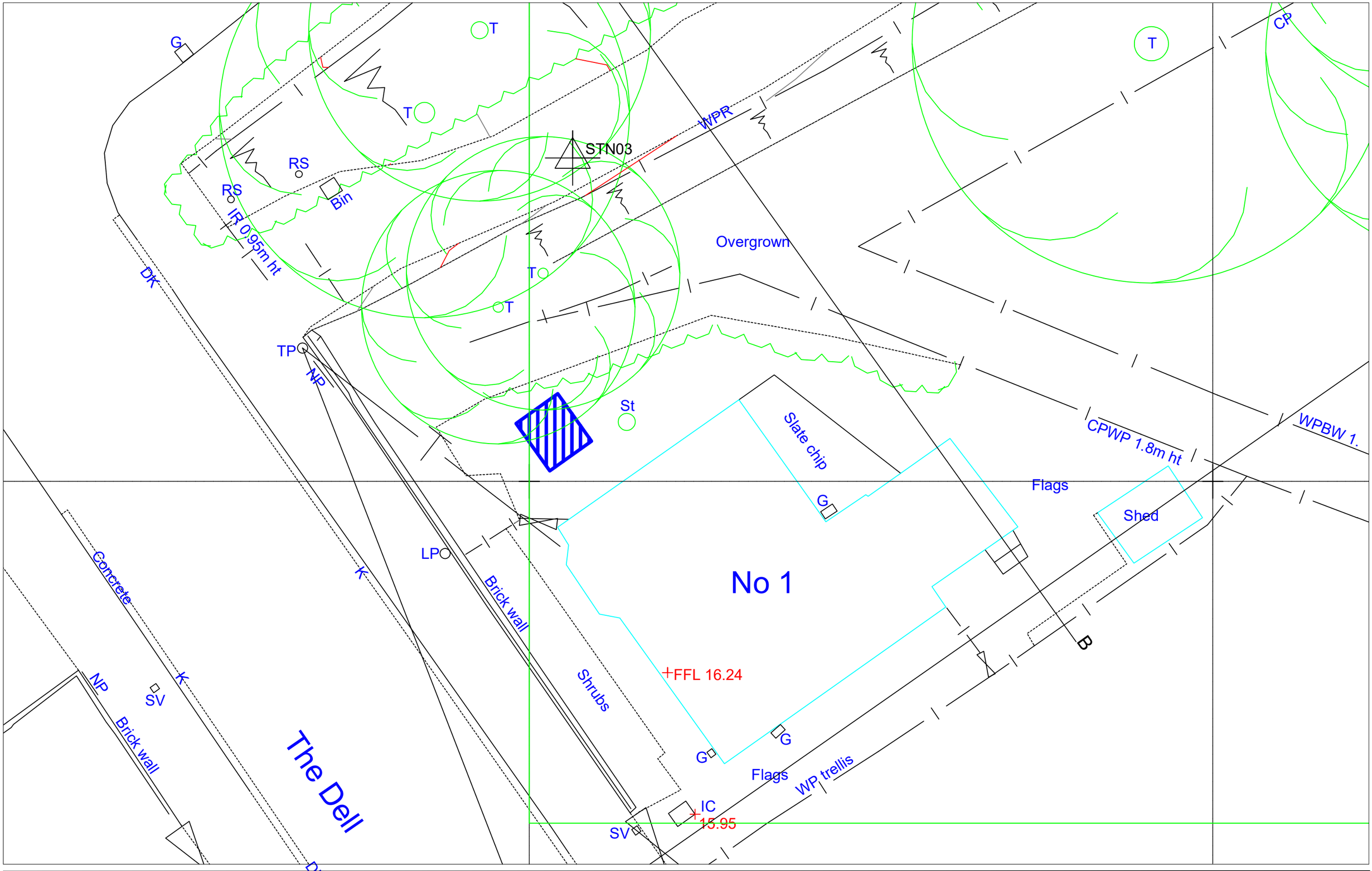


Pit profile

GL	Blackish dark brown slightly clayey silty sandy TOPSOIL with roots.
0.4m	Light brown slightly clayey silty SAND with lenses of clay and with occasional fine to coarse subrounded gravel of limestone (GLACIAL TILL).
1.7m	

Beginning of test

End of test



Bentham Geoconsulting
Environmental & Engineering Geophysical Services & Consultancy
6 Nether View, Wennington, Lancashire, LA2 8NP. UK
Tel +44 (0) 1524 222122
e-mail: info@benthamgeoconsulting.co.uk
web: www.benthamgeoconsulting.co.uk.

N

GPR anomaly suggestive of well. Coincides with slight depression in ground surface and area indicated by historic mapping.

Figure 3: Likely location of the well based upon GPR survey data.
Site: The Dell, Prestatyn
Client: Denbighshire County Council
Survey Date: 3rd January 2018

Scale 1:100 @ A3

Dŵr Cymru
Welsh Water

PPA0002643 Sewer Plan

N
W E
S

LEGEND(Representative of most common features)

Waste network:

- Foul chamber
- Surface water chamber
- Combined chamber
- Combined sewer overflow
- Special purpose chamber
- Treatment works
- Pumping station
- Outfall
- Lamphole
- Storm Overflow
- Rising main
- Gravity sewer
- Private sewer
- Private sewer subject to Sect. 104 adoption agreement
- Private Sewer Transfer
- Lateral Drain
- Inspection Chamber

NB: Sewer symbol colour indicates the type.
RED - Combined
GREEN - Surface Water
BROWN - Foul
Purple - Former S24 sewers (for indicative purposes only)

Notes:

Whilst every reasonable effort has been taken to correctly record the pipe material of DCWW assets, there is a possibility that in some cases pipe material (other than Asbestos Cement or Pitch Fibre) may be found to be asbestos cement (AC) or Pitch Fibre (PF) . It is therefore advisable that the possible presence of AC or PF pipes be anticipated and considered as part of any risk assessment prior to excavation

Dwr Cymru Cyf gives this information as to the position of its underground apparatus by way of general guidance only on the strict understanding that it is based on the best information available and no warranty as to its correctness is relied upon in the event of excavations or other works made in the vicinity of the Company's apparatus and any onus of locating the apparatus before carrying out any excavations rests entirely on you. It must be understood that the furnishing of the information is entirely without prejudice to the provision of the New Roads and Streetworks Act 1991 and of the Company's right to be compensated for any damage to its apparatus.

Service pipes are not generally shown but their presence should be anticipated.

EXACT LOCATIONS OF ALL APPARATUS TO BE DETERMINED ON SITE.

Map Ref:	306518,382338
Map scale:	1:1250
Printed by:	Trower Chris
Printed on:	01 Dec 2017

Jason Russell

From: Walker Graham <Graham.Walker@dwrcymru.com>
Sent: 20 March 2018 13:39
To: Jason Russell
Cc: Jones Alaw
Subject: RE: Further Enquiry pre-planning report reference number PPA0002643

Jason,

We would use the SFA 7th Edition for guidance and design details for minimum ground cover for soffit connections, please refer to page 9. SFA.

In regards to Attenuation, we would use page 56 in SFA 7th Edition for guidance on storage design. Please note that DCWW approve Storm Cell Hydro International for Cellular storage systems and they will provide you with guidance on design.

Thank you

Graham Walker
Project Engineer | **Developer Services** | **Wholesale Business Services** | **Dwr Cymru Welsh Water**
Linea | Cardiff | CF3 0LT | T: 0800 917 2652| www.dwrcymru.com

---

From: Jones Alaw
Sent: 19 March 2018 16:09
To: Walker Graham <Graham.Walker@dwrcymru.com>
Subject: FW: Further Enquiry pre-planning report reference number PPA0002643

Hi Graham,

I've received the e-mail below from Jason at Opus regarding a surface water connection to the surface water sewer at The Dell, Prestatyn, LL18 8SS. We've agreed in principle to accept surface water at a rate not exceeding 5 l/s.

Could you help Jason with his query regarding S104 please? (I've highlighted in yellow on the e-mail below)

Many thanks,

Alaw

From: Jason Russell [mailto:jason.russell@opusinternational.co.uk]
Sent: 13 March 2018 16:14
To: Jones Alaw <Alaw.Jones@dwrcymru.com>
Subject: RE: Further Enquiry pre-planning report reference number PPA0002643

******** External Mail ********
Hi Alaw,

The local highways authority (Denbighshire County Council) have no information on highway drainage details within the vicinity of the site and as previously mentioned when a walkover of the site was undertaken, the only drainage identified as being within the curtilage of Ffordd Isa was the DCWW public surface water manhole SJ06824307 and two road gullies on the approach to the bridge, therefore, the public surface water manhole previously identified (SJ06824283) is the only viable method of surface water discharge for the proposed development.

As you have confirmed that the site will be subject to a section 104 agreement can you confirm what the minimum cover from ground level to pipe soffit required is and if a cellular attenuations system could feasibly be used on site and adopted.

Can we now please also establish a discharge rate from the site into the public surface water sewer?

Given that the proposed site is comprised of two existing curtilages:-

- The existing residential property of No.1 The Dell which has both a foul and surface water connection that discharges to the existing public sewers within the residential street The Dell with an impermeable area of approx. 200m2.
- Open undeveloped shrub land with numerous trees and no existing drainage infrastructure.

In this instance 0.02 Ha of impermeable area currently contributes surface water flows to the public surface water drainage system situated within The Dell.
Therefore, it is possible to estimate the run-off generated by the existing site area for events up to 1 in 100 year years by using the Lloyd-Davies method thus;

$Q = 2.78.A.i.C_vC_r$ Where A = Area (ha)
I = Design rainfall intensity (mm/hr)
C_vC_r = Run off & routing coefficient ~ 1.0

Allowing for a rainfall intensity of 50mm/hr (1 in 1 Year Storm) and based upon a site impermeable area of 0.046 ha, the peak flow generated would be:

$Q = 2.78.A.i.C_vC_r$
$Q = 2.78 \times 0.02 \times 50 \times 1$
$Q = 2.8$ l/s

Therefore, given that the sewer we are proposing to discharge is to a designated public surface water sewer, we would suggest that a discharge rate to the sewer is based upon a combination of the existing brownfield runoff from the existing area of the residential property No.1 The Dell (2.8l/s) and the greenfield runoff from the adjacent undeveloped land (5l/s) is used, which would equate to a discharge rate of approx. 7.8l/s. to the existing public surface water sewer.

If you have any queries or wish to discuss further please do not hesitate to contact me.

Kind regards,
Jason

OPUS
WSP | OPUS
Jason Russell
Assistant Engineer
Opus International Consultants (UK) Ltd, Opus House Yale Business Village, Wrexham Technology Park, Wrexham

Opus International Consultants is now part of WSP

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****
_____ Dwr Cymru Welsh Water is firmly committed to water conservation and promoting water efficiency. Please log on to our website www.dwrcymru.com/waterefficiency to find out how you can become water wise. Mae Dwr Cymru Welsh Water wedi ymrwymo i warchod adnoddau dwr a hyrwyddo defnydd dwr effeithiol. Mae cyngor i' ch helpu i ddefnyddio dwr yn ddoeth yn www.dwrcymru.com/waterefficiency

_____
********** This email and any file attached is confidential. If you are not a named recipient or believe you may have received this email in error please delete from your system and promptly inform the sender. Dwr Cymru Cyf (trading as Welsh Water) is a company registered in England and Wales, number 02366777, registered office Pentwyn Road, Nelson, Treharris, Mid Glamorgan CF46 6LY. Mae'r neges e-bost yma ac unrhyw ffeil sydd ynghlwm wrthi'n gyfrinachol. Os nad chi yw'r derbynnydd a enwir, neu os ydych chi'n credu eich bod wedi derbyn y neges yma ar gam, dylech ei dileu o'ch system ar unwaith a hysbysu'r anfonwr. Cwmni sydd wedi ei gofrestru yng Nghymru yw Dŵr Cymru Cyf (yn masnachu fel Dŵr Cymru), ei rif cofrestredig yw 02366777, ac mae ei swyddfa gofrestredig yn Heol Pentwyn, Nelson, Treharris, Morgannwg Ganol CF46 6LY. **********

Dŵr Cymru
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E.bost: developer.services@dwrcymru.com

Mr Jason Russell
Opus International Consultants
Opus House
Yale Business Village
Wrexham
Wrexham
LL13 7YL

Date: 30/11/2017
Our Ref: PPA0002643

Dear Mr Russell

Grid Ref: 306517 382338
Site Address: The Dell, Ffordd Isa, Prestatyn, Denbighshire, LL18 8SS
Development: 15 apartment, The Dell, Ffordd Isa, Denbighshire

I refer to the pre planning enquiry received on the 28th November 2017 and would offer the following observations in relation to the residential development.

SEWERAGE

The foul flows only from the proposed development can be accommodated within the public sewerage system. We advise that the flows should be communicated with to the foul sewer at or beyond manhole SJ06824301. This manhole chamber is positioned to the West of the site within the road known as The Dell.

Should a planning application be submitted for this development we will seek to control these points of communication via appropriate planning conditions and therefore recommend that any drainage layout or strategy submitted as part of your application takes this into account.

However, should you wish for an alternative connection point to be considered please provide further information to us in the form of a drainage strategy, preferably in advance of a planning application being submitted.

SURFACE WATER DRAINAGE

You are required to fully exhaust all technical options outlined under Sections 3.2 and 3.4 of Part H of the publication 'Building Regulations 2000; Disposal should be made through the hierarchical approach, preferring infiltration and, where infiltration is not possible, disposal to watercourses in liaison with the Land Drainage Authority and/or Natural Resources Wales. Please be advised that the surface water flows from this development will not be permitted to discharge to the public foul or combined sewer systems. You are required to find an alternative means of draining surface water drainage.

In addition, please note that no highway or land drainage run-off will be permitted to discharge directly or indirectly into the public sewerage system.

Advisory

You may need to apply to Dwr Cymru Welsh Water for any connection to the public sewer under Section 106 of the Water industry Act 1991. However, if the connection to the public sewer network is either via a lateral drain (i.e. a drain which extends beyond the connecting property boundary) or via a new sewer (i.e. serves more than one property), it is now a mandatory requirement to first enter into a Section 104 Adoption Agreement (Water Industry Act 1991). The design of the sewers and lateral drains must also conform to the Welsh Ministers Standards for Foul Sewers and Lateral Drains, and conform with the publication "Sewers for Adoption"- 7th Edition. Further information can be obtained via the Developer Services pages of www.dwrcymru.com

You are also advised that some public sewers and lateral drains may not be recorded on our maps of public sewers because they were originally privately owned and were transferred into public ownership by nature of the Water Industry (Schemes for Adoption of Private Sewers) Regulations 2011. The presence of such assets may affect the proposal. In order to assist you may contact Dwr Cymru Welsh Water on 0800 085 3968 to establish the location and status of the apparatus in and around your site.

SEWERAGE TREATMENT

No problems are envisaged with the Waste Water Treatment Works for the treatment of domestic discharges from this site.

WATER SUPPLY

A water supply can be made available to service this proposed development. Initial indications are that a connection can be made from the '90mm' diameter watermain in 'Grid 306464,382322' location. The

cost of providing new on-site watermains can be calculated upon the receipt of detailed site layout plans which should be sent to the above address.

I trust the above information is helpful and will assist you in forming water and drainage strategies that should accompany any future planning application. I also attach copies of our water and sewer extract plans for the area, and a copy of our Planning Guidance Note which provides further information on our approach to the planning process, making connections to our systems and ensuring any existing public assets or infrastructure located within new development sites are protected.

Please note that our response is based on the information provided in your enquiry and should the information change we reserve the right to make a new representation. Should you have any queries or wish to discuss any aspect of our response please do not hesitate to contact our dedicated team of planning officers, either on 0800 917 2652 or via email at **developer.services@dwrcymru.com**

Please quote our reference number in all communications and correspondence.

Yours faithfully,

Owain George
Planning Liaison Manager
Developer Services

<u>Please Note</u> that demands upon the water and sewerage systems change continually; consequently the information given above should be regarded as reliable for a maximum period of 12 months from the date of this letter.

Jason Russell

From: Jones-Hughes Henry <Henry.Jones-Hughes@dwrcymru.com>
Sent: 07 December 2017 09:50
To: Jason Russell
Subject: RE: Flood Information Request - Proposed The Dell, Prestatyn

Hi Jason

Thanks for your further enquiry.

There are no known sewers crossing the site so we have no record of flooding within the development boundary. There are instances of flooding on the public sewer network as a result of hydraulic overload within the vicinity of the site. This flooding will have been caused as a result of storm water entering the foul sewers.

We have no plans in place to undertake improvement works on this part of the catchment

Regards
Henry

Henry Jones-Hughes
Project Engineer | Developer Services | Wholesale Business Services | Services Dwr Cymru Welsh Water
Linea | Cardiff | CF3 0LT | T: 0800 917 2652| www.dwrcymru.com

---

From: Jason Russell [mailto:jason.russell@opusinternational.co.uk]
Sent: 07 December 2017 09:41
To: sewerage.services@dwrcyrmu.com; services developer <developer.services@dwrcymru.com>
Cc: Jones-Hughes Henry <Henry.Jones-Hughes@dwrcymru.com>
Subject: Flood Information Request - Proposed The Dell, Prestatyn

******** External Mail ********
Dear Sirs,

We are currently undertaking a drainage strategy and flood consequence assessment for a proposed social housing development site located at The Dell, Prestatyn, LL11 8SS E-306525, N-382327, with an approximate area of 0.335Ha. Please see attached site location plan.

We have requested and received a pre-planning advice report from yourselves regarding the development.

We would like to request the following information:

- Any sewer flooding history from the site or surrounding area
- Any surface water management issues in this area
- Any flood alleviation schemes planned for this area

We would be very grateful if you could advise us on the above and the timescale for the provision of the above information.

Kind regards
Jason

Jason Russell
Assistant Engineer

Opus International Consultants (UK) Ltd, Opus House Yale Business Village, Wrexham Technology Park, Wrexham LL13 7YL, United Kingdom

+44 1978 368100 jason.russell@opusinternational.co.uk

www.opusinternational.co.uk

Registered in England & Wales Company Reg. No: 2847568
Reg Office: Willow House Brotherswood Court Great Park Road Bristol BS32 4QW

Cyfoeth Naturiol Cymru
Natural Resources Wales

Ein cyf/Our ref: ATI 14103a

By email:

Jason.russell@opusinternational.co.uk

Ebost/Email:
datadistribution@cyfoethnaturiolcymru.gov.uk

Ffôn/Phone: 0300 065 3568

Date: 6th December 2017

Dear Jason

Risk of flooding from rivers and the sea information for – The Dell, Prestatyn, LL22 8SS

Thank you for your recent request for information on the risk of flooding from rivers and the sea that Natural Resouces Wales holds. I can confirm that the above site is located in an area where the likelihood of flooding from both rivers and the sea has been assessed as less than 1 in 1,000 (0.1%) chance in any given year.

Therefore the likelihood of flooding is estimated as 'very low' - less than 1 in 1,000 (0.1%) chance in any given year**.**

This information may be helpful in discussions with your insurer, along with any other information that you may have providing evidence of a particular level of risk at your property. Insurance companies use a range of data sources in including 'flood maps' and information from Natural Resources Wales, as well as other maps purchased from the private sector and their own claims history when issuing insurance quotes. Insurers will then use this information to make an assessment as to whether they can provide insurance cover and under what terms. It is always a good idea to shop around to find the most suitable cover for your needs.

Water causing flooding can come from other sources, for example from blocked structures such as bridges, surface water, overflowing or backing up of sewers, drainage systems which have been overwhelmed, or from groundwater flooding.

I attach two documents:

- *Flooding Information Sheet – Your Questions Answered*, a document jointly produced with the Association of British Insurers.
- *Open Government Licence (OGL)* - which is a simple set of terms and conditions that facilitates the re-use of this information we have provided you. Please ensure that your use of this information complies with the OGL terms.

Yours sincerely

KMBanner

Kathleen Banner
Swyddog Cysylltiadau Allanol /**External Relations Officer**
Cyfoeth Naturiol Cymru/**Natural Resources Wales**

KEY

- SWS — EXISTING PUBLIC SURFACE WATER SEWER
- FWS — EXISTING PUBLIC FOUL SEWER
- PROPOSED FOUL DRAIN
- PROPOSED SURFACE WATER DRAIN
- LINEAR DRAINAGE CHANNEL
- PROPOSED ATTENUATION CRATES
- RG — TRAPPED ROAD GULLY

41m3 OF ATTENUATION PROVIDING SUFFICIENT CAPACITY TO CATER FOR THE 100 YEAR STORM EVENT WITH A 30% ALLOWANCE FOR CLIMATIC CHANGE

EX MH SJ06824283
CL 15.960 (ASSUMED)
IL 14.320 (ASSUMED)

CONTRACTOR TO DETERMINE EXACT INVERT LEVEL OF EXISTING MANHOLE PRIOR TO THE COMMENCEMENT OF THE WORKS AND REPORT FINDINGS TO THE ENGINEER

BREAK INTO EXISTING MANHOLE TO FACILITATE NEW INCOMING 150Ø SURFACE WATER CONNECTION. MAKE GOOD ALL BENCHING
IL 14.395

150Ø @1:100

FLOW CONTROL DEVICE TO LIMIT FORWARD FLOW TO 5 l/s AT 1m HEAD

INDICATIVE LOCATION OF ATTENUATION TANKS

ACO

RG

100Ø @1:80

EX MH SJ06824308
CL 15.830 (APPROX)
IL 14.590 (APPROX)

EX MH SJ06824281
CL 15.960 (ASSUMED)
IL 14.165 (ASSUMED)

CONTRACTOR TO DETERMINE EXACT INVERT LEVEL OF EXISTING MANHOLE PRIOR TO THE COMMENCEMENT OF THE WORKS AND REPORT FINDINGS TO THE ENGINEER

BREAK INTO EXISTING MANHOLE TO FACILITATE NEW INCOMING 150Ø FOUL CONNECTION. MAKE GOOD ALL BENCHING

EX MH SJ06824301
CL 15.880 (APPROX)
IL 14.400 (APPROX)

SWS 225Ø @1:65
FWS 150Ø @ 1:70

PRELIMINARY

Revision	Amendment	Approved	Revision Date
A1	AMENDED FOLLOWING DCC COMMENTS	JR/MW	22/05/18

Cyngor sir ddinbych denbighshire County Council
Cyfleusterau, Asedau a Tai
Facilities, Assets & Housing

OPUS
Wrexham Office
+44 1978 368100
Opus House, Yale Business Village
Wrexham Technology Park,
Wrexham LL13 7YL

Drawn	Designed	Approved	Revision Date
JR	JR	VM	29/03/18

Project
PROPOSED RESIDENTIAL DEVELOPMENT
THE DELL
PRESTATYN

Sheet
PROPOSED FOUL & SURFACE WATER INDICATIVE DRAINAGE LAYOUT

Project No.	Scale	Drawing No.	Sheet. No.	Revision
V-R6516.00	1:150 @ A1	V-R6516.00/100	01	A1

Original Sheet Size A1 [841x594] Plot Date 17 May 2018 @ 3:54 PM Path G:\live\v-r6500s\v-r6516.00-the-dell-prestatyn\04-project-delivery\cde01-wip\Drainage\V-R6516.00-500-01-A - Drainage.dwg 500-01

ICP SUDS Mean Annual Flood

Input

Return Period (years) 100 SAAR (mm) 700 Urban 0.000
Area (ha) 0.144 Soil 0.450 Region Number Region 9

Results l/s

QBAR Rural 0.6
QBAR Urban 0.6

Q100 years 1.4

Q1 year 0.6
Q30 years 1.1
Q100 years 1.4

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 76 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	15.035	0.385	0.0	5.0	5.0	22.4	O K
30 min Summer	15.145	0.495	0.0	5.0	5.0	28.9	O K
60 min Summer	15.213	0.563	0.0	5.0	5.0	32.9	O K
120 min Summer	15.210	0.560	0.0	5.0	5.0	32.7	O K
180 min Summer	15.183	0.533	0.0	5.0	5.0	31.1	O K
240 min Summer	15.146	0.496	0.0	5.0	5.0	28.9	O K
360 min Summer	15.060	0.410	0.0	5.0	5.0	23.9	O K
480 min Summer	14.981	0.331	0.0	5.0	5.0	19.3	O K
600 min Summer	14.914	0.264	0.0	5.0	5.0	15.3	O K
720 min Summer	14.856	0.206	0.0	5.0	5.0	12.0	O K
960 min Summer	14.773	0.123	0.0	4.9	4.9	7.1	O K
1440 min Summer	14.692	0.042	0.0	4.6	4.6	2.5	O K
2160 min Summer	14.662	0.012	0.0	3.5	3.5	0.7	O K
2880 min Summer	14.650	0.000	0.0	2.9	2.9	0.0	O K
4320 min Summer	14.650	0.000	0.0	2.1	2.1	0.0	O K
5760 min Summer	14.650	0.000	0.0	1.7	1.7	0.0	O K
7200 min Summer	14.650	0.000	0.0	1.4	1.4	0.0	O K
8640 min Summer	14.650	0.000	0.0	1.2	1.2	0.0	O K
10080 min Summer	14.650	0.000	0.0	1.1	1.1	0.0	O K
15 min Winter	15.093	0.443	0.0	5.0	5.0	25.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	105.586	0.0	28.5	23
30 min Summer	70.456	0.0	38.1	36
60 min Summer	44.962	0.0	48.5	62
120 min Summer	27.814	0.0	60.0	98
180 min Summer	20.750	0.0	67.0	132
240 min Summer	16.765	0.0	72.5	166
360 min Summer	12.311	0.0	79.7	230
480 min Summer	9.851	0.0	85.1	294
600 min Summer	8.294	0.0	89.5	354
720 min Summer	7.204	0.0	93.3	412
960 min Summer	5.762	0.0	99.6	526
1440 min Summer	4.199	0.0	108.8	746
2160 min Summer	3.054	0.0	118.7	1104
2880 min Summer	2.434	0.0	126.2	0
4320 min Summer	1.765	0.0	137.3	0
5760 min Summer	1.403	0.0	145.5	0
7200 min Summer	1.174	0.0	152.2	0
8640 min Summer	1.014	0.0	157.8	0
10080 min Summer	0.896	0.0	162.6	0
15 min Winter	105.586	0.0	31.9	23

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	15.223	0.573	0.0	5.0	5.0	33.4	O K
60 min Winter	15.307	0.657	0.0	5.0	5.0	38.4	O K
120 min Winter	15.306	0.656	0.0	5.0	5.0	38.3	O K
180 min Winter	15.266	0.616	0.0	5.0	5.0	36.0	O K
240 min Winter	15.215	0.565	0.0	5.0	5.0	33.0	O K
360 min Winter	15.078	0.428	0.0	5.0	5.0	24.9	O K
480 min Winter	14.954	0.304	0.0	5.0	5.0	17.7	O K
600 min Winter	14.856	0.206	0.0	5.0	5.0	11.9	O K
720 min Winter	14.783	0.133	0.0	5.0	5.0	7.7	O K
960 min Winter	14.700	0.050	0.0	4.6	4.6	2.9	O K
1440 min Winter	14.662	0.012	0.0	3.5	3.5	0.7	O K
2160 min Winter	14.650	0.000	0.0	2.6	2.6	0.0	O K
2880 min Winter	14.650	0.000	0.0	2.1	2.1	0.0	O K
4320 min Winter	14.650	0.000	0.0	1.5	1.5	0.0	O K
5760 min Winter	14.650	0.000	0.0	1.2	1.2	0.0	O K
7200 min Winter	14.650	0.000	0.0	1.0	1.0	0.0	O K
8640 min Winter	14.650	0.000	0.0	0.9	0.9	0.0	O K
10080 min Winter	14.650	0.000	0.0	0.8	0.8	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	70.456	0.0	42.6	36
60 min Winter	44.962	0.0	54.3	62
120 min Winter	27.814	0.0	67.1	102
180 min Winter	20.750	0.0	75.3	140
240 min Winter	16.765	0.0	81.1	180
360 min Winter	12.311	0.0	89.5	250
480 min Winter	9.851	0.0	95.4	312
600 min Winter	8.294	0.0	100.2	368
720 min Winter	7.204	0.0	104.5	422
960 min Winter	5.762	0.0	111.5	520
1440 min Winter	4.199	0.0	121.9	742
2160 min Winter	3.054	0.0	133.0	0
2880 min Winter	2.434	0.0	141.3	0
4320 min Winter	1.765	0.0	153.7	0
5760 min Winter	1.403	0.0	163.0	0
7200 min Winter	1.174	0.0	170.4	0
8640 min Winter	1.014	0.0	176.7	0
10080 min Winter	0.896	0.0	182.1	0

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	17.200	Shortest Storm (mins)	15
Ratio R	0.368	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.144

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.048	4	8	0.048	8	12	0.048

Model Details

Storage is Online Cover Level (m) 16.100

Cellular Storage Structure

Invert Level (m) 14.650 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	61.0	0.0	0.661	0.0	0.0
0.660	62.0	0.0			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0107-5000-0900-5000
Design Head (m)	0.900
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	107
Invert Level (m)	14.565
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.900	5.0
Flush-Flo™	0.271	5.0
Kick-Flo®	0.590	4.1
Mean Flow over Head Range	-	4.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.6	1.200	5.7	3.000	8.8	7.000	13.1
0.200	4.9	1.400	6.1	3.500	9.4	7.500	13.6
0.300	5.0	1.600	6.5	4.000	10.1	8.000	14.0
0.400	4.9	1.800	6.9	4.500	10.6	8.500	14.4
0.500	4.6	2.000	7.2	5.000	11.2	9.000	14.8
0.600	4.1	2.200	7.6	5.500	11.7	9.500	15.2
0.800	4.7	2.400	7.9	6.000	12.2		
1.000	5.2	2.600	8.2	6.500	12.7		

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