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Capami Ltd.

Residential Development, Bohernabreena, Oldcourt, Ballycullen, Co. Dublin

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Report on Site-Specific Flood Risk Assessment

Capami Ltd.	**Document Ref. No.**	**Kilgallen & Partners** **Consulting Engineers** **Well Road,** **Portlaoise** **Co. Laois**
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1. INTRODUCTION

Capami Ltd. [‘the Applicant’] intends to apply for planning permission for residential development [‘the proposed development’] at Bohernabreena, Oldcourt, Ballycullen, Co. Dublin [‘the Site’].

The Applicant has appointed Kilgallen and Partners Consulting Engineers to carry out a Site-Specific Flood Risk Assessment [‘SSFRA’] of the proposed development in accordance with the document ‘Planning System and Flood Risk Management – Guidelines for Planning Authorities’ [‘The Guidelines’] published by the Office of Public Works [OPW].

This report presents the findings of the SSFRA.

2. PROCESS FOR SITE SPECIFIC FLOOD RISK ASSESSMENT

The core principle of The Guidelines is to adopt a risk based sequential approach to managing flood risk and to avoid development in areas that are at risk. The Guidelines recommend a precautionary approach to the consideration of flood risk management in the planning system.

The objective of SSFRA is to assess all types of flood risk to a development. It investigates potential sources of flood risk and includes for the effects of climate change. The assessment is required to examine the impact of the development and the effectiveness of flood mitigation and management procedures proposed. It also presents the residual risks that remain after those measures are put in place.

2.1 Potential Sources of Flood Risk

Potential flood risk mechanisms are summarised in Table 2-1.

Source	Mechanism
Fluvial:	Overtopping of Rivers and Streams
Pluvial:	The intensity of rainfall events is such that the ground cannot absorb rainfall run-off effectively or urban drainage systems cannot carry the run-off generated.
Groundwater:	Rising water table
Coastal:	Tidal levels and / or wave action
Infrastructure	Failure of flood protection or drainage infrastructure

Table 2-1 Flood Risk Mechanisms

As an inland site upstream of tidal influences and possible wave action, the Site is not subject to coastal flood risk and so this mechanism does not need to be considered further in this assessment.

The assessment will therefore consider the following mechanisms:
- Fluvial;
- Pluvial;
- Groundwater;
- Drainage Infrastructure (considered under Section 7 – Residual Flood Risk)

2.2 Flood Risk Indicators

Indicators of flood risk are identified using available data, most of which is historically derived. Typically, this data is not prescriptive in relation to flood return periods and, in many cases being historical, neither predictive nor inclusive of climate change analysis.

Flood risk indicators include:
- Records available on the OPW's National Flood Risk Website. As part of the National Flood Risk Management Policy, the OPW developed the www.floodinfo.ie web-based data set, which contains

information concerning historical flood data and displays related mapped information and provides tools to search for and display information about selected flood events;

- NIFM & CFRAM mapping produced by the OPW;
- The Strategic Flood Risk Assessment carried out to inform the making of the Local Area Plan;
- Geological Survey of Ireland (GSI) mapping - Hydrogeological mapping maintained by the GSI and made available through its website www.gsi.ie;
- Ordnance Survey mapping - Ordnance Survey maps include areas which are marked as being "Liable to Floods". Generally, these areas are only shown identified indicatively and suggest historical flooding, usually recurrent. In addition, the maps indicate areas of wet or hummocky ground, bog, marsh, springs, rises and wells as well as surface water features including rivers, streams, bridges, weirs and dams;
- Topographical survey information;
- Records of previous floods from other sources;
- Flood Studies, Reports and Flood Relief Schemes carried out in the vicinity of the Study Area;
- Site Walkover.

2.3 Identification of the Presence and Extent of Fluvial Flood Risk

Where the initial process of examining flood risk indicators demonstrates the existence of a risk of fluvial flooding, the study progresses to the next stage, which is a detailed flood risk assessment. This is based on field measurements and hydrological modelling and enables mapping of the zones of Flood Risk within the Site to be established.

The Guidelines categorise flood risk zones as follows:

Flood Zone A where the probability of flooding in any year is greater than 1% (i.e. Flood Zone in respect of a flood with a return period of 100years). Throughout this report this is referred to as the 1% AEP flood, where AEP stands for Annual Exceedance Probability.

Flood Zone B where the probability of flooding in any year is between 0.1% and 1% (i.e. Flood Zone in respect of a flood with a return period of between 100years and 1,000years). Throughout this report this is referred to as the 0.1% AEP flood.

Flood Zone C where the probability of flooding in any year is less than 0.1% (i.e. Flood Zone in respect of a flood with a return period of greater than 1,000years).

2.4 Identification of the Presence and Extent of Pluvial Flood Risk

Where the initial process of examining flood risk indicators demonstrates the existence of a risk of pluvial flooding, the study progresses to the next stage, which is a detailed assessment to establish the extent of pluvial flood risk at the Site.

2.5 Identification of the Presence and Extent of Groundwater Flood Risk

Where the initial process of examining flood risk indicators demonstrates the existence of a risk of flooding from groundwater, the assessment progresses to the next stage, which is a detailed assessment to establish the extent of groundwater flood risk at the Site.

2.6 Assessment of Proposed Development

As described in the previous paragraphs, the first stages of the assessment process are concerned with identifying whether the Site is at risk of pluvial, fluvial or groundwater flooding and establishing the extent of any such flood risks.

The next stage of the assessment process is concerned with the following:

- Determination of the impact that any of the identified flood risks will have on the proposed Development;
- Determination of any impact that the Development itself might have in terms of increasing the level of flood risk elsewhere outside the Site;
- Identification of mitigation measures in respect of any such impacts and identification of any residual risks after those mitigation measures are put in place.

Table 3.1 of The Guidelines classifies different types of development in terms of their vulnerability to flooding. Figure 2-1 contains an extract from this table which shows residential development classified as Highly Vulnerable.

Vulnerability class	Land uses and types of development which include*:
Highly vulnerable development (including essential infrastructure)	Garda, ambulance and fire stations and command centres required to be operational during flooding; Hospitals; Emergency access and egress points; Schools; Dwelling houses, student halls of residence and hostels; Residential institutions such as residential care homes, children's homes and social services homes; Caravans and mobile home parks; Dwelling houses designed, constructed or adapted for the elderly or, other people with impaired mobility; and Essential infrastructure, such as primary transport and utilities distribution, including electricity generating power stations and sub-stations, water and sewage treatment, and potential significant sources of pollution (SEVESO sites, IPPC sites, etc.) in the event of flooding.

Figure 2-1 Classification of development type by vulnerability to flooding

Table 3.2 of The Guidelines provides a matrix of development vulnerability versus Flood Zone which illustrates the appropriateness of a development type for each Flood Zone. This table is reproduced in Figure 2-2 and shows Highly Vulnerable development requiring the Justification Test for Sites in Flood Zones A and B.

	Flood Zone A	Flood Zone B	Flood Zone C
Highly vulnerable development (including essential infrastructure)	Justification Test	Justification Test	Appropriate
Less vulnerable development	Justification Test	Appropriate	Appropriate
Water-compatible development	Appropriate	Appropriate	Appropriate

Table 3.2: Matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification Test.

Figure 2-2 Matrix of vulnerability versus Flood Zone

2.7 Climate Change Adaption

This assessment's consideration of the effects of climate change is guided by the climate change adaption plan published by OPW ('*Flood Risk Management - Climate Change Sectoral Adaptation Plan*' Sep 2019).

For the purposes of the CFRAM Programme, the OPW adopted two indicative potential futures for flood risk assessment; the Mid-Range Future Scenario (MRFS) and the High-End Future Scenario (HEFS). These were selected to reflect, based on information available at the time, a future in the latter part of the century that would be:

(i). typical or near to the general average of the future climate projections (MRFS), and,

(ii). a more extreme future based on the upper end of the range of projections of future climatic conditions and the impacts such changes would have on the drivers of flood risk (HEFS).

Table 2-2 reproduces climate change adaption factors for each of these scenarios from Table 5-5 of the OPW plan. The OPW plan considers these factors acceptable as plausible futures for use in assessing potential requirements for climate adaption.

Parameter	MRFS	HEFS
Extreme Rainfall Depths	+ 20%	+ 30%
Peak Flood Flows	+ 20%	+ 30%
Land Movement	-0.5mm / year	-0.5mm / year
Urbanisation	No general allowance – review on a case-by-case basis	No general allowance – review on a case-by-case basis

Table 2-2 OPW climate adaption allowances in flood parameters for the Mid-Range and High-End Future Scenarios

This assessment will apply the MRFS factors in its general consideration of flood risk. The potential effects of the HRFS will be considered in terms of residual risk (Section 8).

3. SITE DESCRIPTION AND PROPOSED DEVELOPMENT

3.1. Site Description

The Site measures c.20.4 hectares and is primarily under agricultural use (there is a small commercial development at the west boundary).

The lands north and east of the Site are developed (primarily residential). The western boundary adjoins Bohernabreena Cemetery. The lands south of the Site are under agricultural use. Figure 3.1 provides a map showing the Site location.

The ground level rises steeply from north to south - there is a difference of approximately 19.0m in elevation between the north and south. The ground level continues this steep gradient south of the Site. The ground level falls away north of the Site but at a shallower gradient.

Two streams, both tributaries of the Dodder, flow through the Site. The first, Friarstown Upper (EPA Designation Code 09F11), flows in a northeasterly direction through the Site. The second, Oldcourt Stream (EPA Designation Code 09O12), flows along the eastern boundary of the Site. (https://gis/epa.ie/EPAMaps/Water).

The Site is divided into fields bounded by hedgerows, with drainage ditches adjacent to many of these hedgerows.

3.2. Land-Use Classification

Under the South Dublin County Council (SDCC) Development Plan, the Site's land-use is classified as 'Objective RES-N - To provide for new residential communities in accordance with approved area plans'.

3.3. Proposed Development

The proposed development is primarily residential with associated streets, footways, cycleways and other paved areas which, in combination with roof areas, will increase the impermeability of the Site.

The surface water drainage system for the proposed development was designed by Pinnacle Consulting Engineers. Appendix C lists drawings produced by Pinnacle Consulting Engineers which provide details of proposed finished levels and of the proposed surface water drainage system.

The surface water drainage system for the proposed development was designed by Pinnacle Consulting Engineers to comply with the Greater Dublin Regional Code of Practice, the GDSDS and CIRIA Report c753 "The SuDS Manual" 2015. It incorporates a Sustainable Urban Drainage (SUDS) regime which provides a sequence of management practices, control structures and strategies designed to efficiently and sustainably drain surface water, while minimising pollution and managing the impact on water quality of local water bodies.

Table 3-1 Drawings by Pinnacle Consulting Engineers

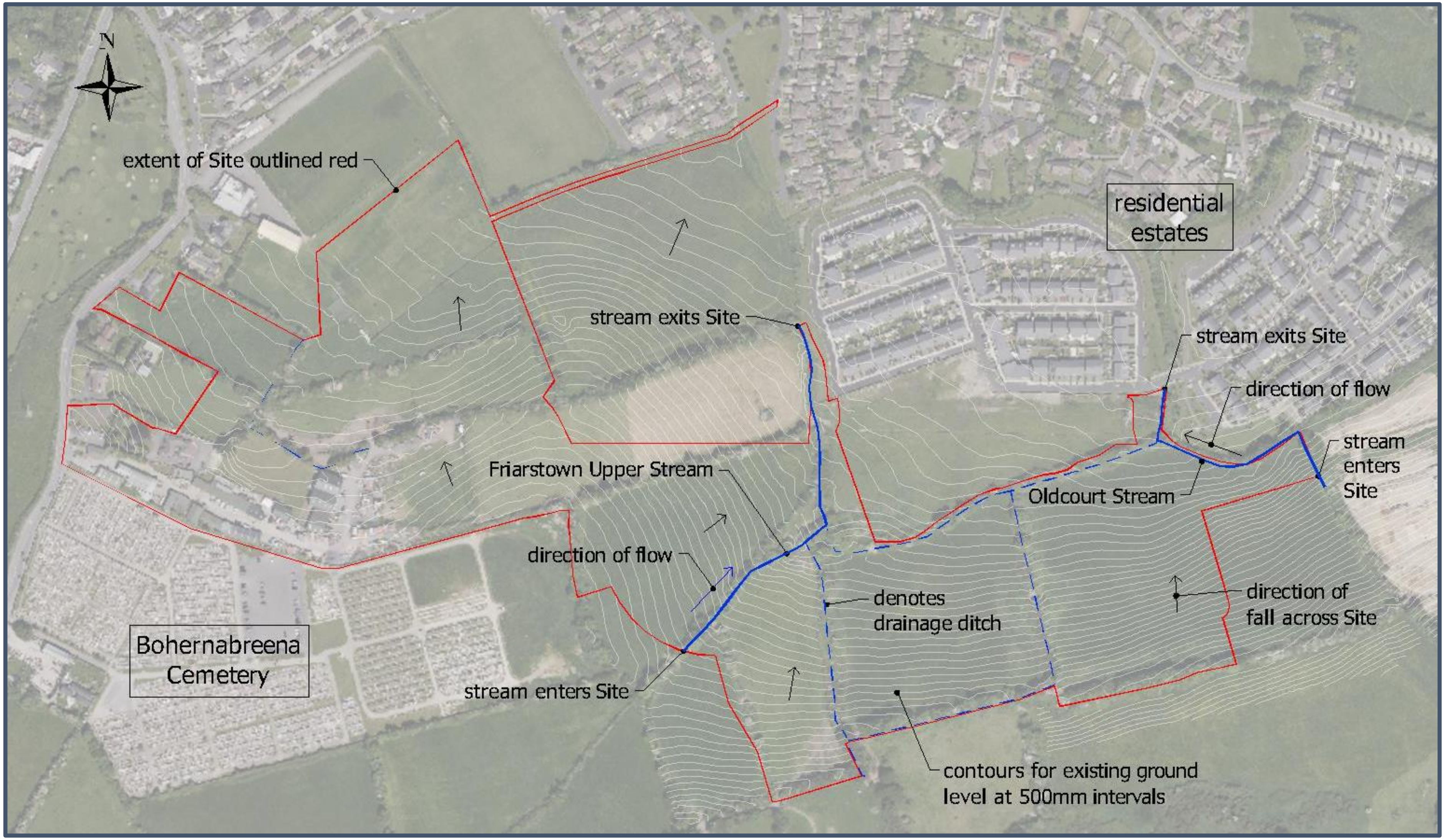


Figure 3.1 Existing Site

Figure 3.2 Proposed Development

Plate 3.1 View at western boundary looking east

Plate 3.2 View at southeastern boundary looking west

Plate 3.3 View at southern boundary looking northeast

4. FLUVIAL FLOOD RISK – INITIAL ASSESMENT

4.1 Flood Risk Indicators - Desktop

A number of datasets were interrogated for indicators of fluvial flood risk:

(i). <u>SFRA for South Dublin Development Plan 2022 – 2028</u>

The Strategic Flood Risk Assessment for the South Dublin Development Plan 2022 – 2028 does not show the Site to be affected by either 1% AEP or 0.1% AEP flood risk zones.

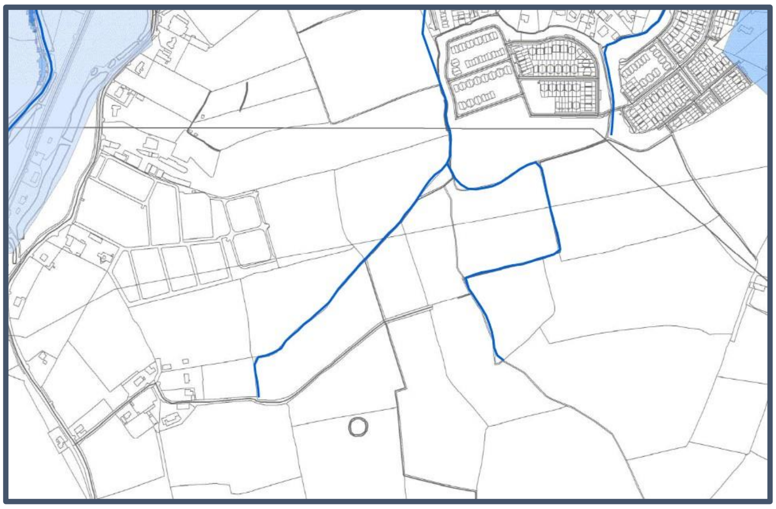


Figure 4.1 Extract from SFRA for County Development Plan 2022 – 2028

(ii). <u>OPW National Flood Hazard Mapping Website</u>

The OPW maintains the National Flood Hazard Mapping website (floodinfo.ie) which contains information about locations that may be at risk from flooding. The source of this information includes Local Authorities and other historic records such as newspaper articles and other documentation about reported floods. This source does not register any previous flood events associated with the streams at the Site. However, since the streams are located away from the public road, the absence of historic flood records is not a strong indicator that there is no flood risk.

(iii). <u>OPW National Indicative Fluvial Mapping (NIFM)</u>

NIFM mapping does not show fluvial flood risk at the Site.

(iv). <u>OPW Catchment Flood Risk Management (CFRAM)</u>

There are no CFRAM maps for the immediate vicinity of the Site.

(v). <u>Ordnance Survey Mapping</u>

Historic OS mapping for the Site and its immediate surroundings does not contain any indicators of fluvial flood risk.

(vi). <u>Proposed Surface Water Drainage</u>

The surface water drainage system for the proposed development was designed by Pinnacle Consulting Engineers to comply with the Greater Dublin Regional Code of Practice, the GDSDS and CIRIA Report c753 "The SuDS Manual" 2015. Compliance with these guidance documents ensures the proposed development will not give rise to fluvial flood risk elsewhere.

4.2 Flood Risk Indicators - Site Walkover

A Site walkover was carried out by the author of this report to allow a direct inspection of drainage features.

Fluvial drainage features are consistent with those shown on OS mapping, suggesting there have been no significant changes to the drainage regime in recent times.

The channels of both streams vary considerably as they flow through the Site; being shallow and ill-defined at some locations and relatively deep and well-defined at others. Field culverts appear undersized and in many cases are in poor repair. Both streams include heavy vegetation. Flows were observed to be low in both streams.

Many of the field boundaries have drainage ditches which connect to the streams.

Plate 4.1 Friarstown Upper stream at southwestern boundary

Plate 4.2 Friarstown Upper stream within Site

Plate 4.3 Oldcourt Stream at eastern boundary

Plate 4.4 Oldcourt Stream at northern boundary

4.3 Stream Channels

The condition of the streams observed during the Site walkover suggest the channels might not have sufficient hydraulic capacity to convey larger flows that that would occur during extreme rainfall events, leading to overtopping at locations where the channels are poorly defined, inadequately culverted or heavily vegetated.

The steep gradient through the Site eliminates the potential for floodplain storage within the Site; instead, overtopping water will continue downstream as overland flow before merging into the streams at a lower point. The result is that during extreme events, the lands adjoining the streams act as overflow channels. Figures 4.2 and 4.3 show profiles through the streams which demonstrate their steeply sloping nature. Figure 4.4 shows the resulting overtopping flow paths.

The risk from overtopping flow can be mitigated by maintaining the existing stream channels and, where these are of inadequate capacity, lowering the channel bed or raising the ground adjoining the channel locally to provide the additional hydraulic capacity. The determination of the required channel cross-sections is described in Section 4.4.

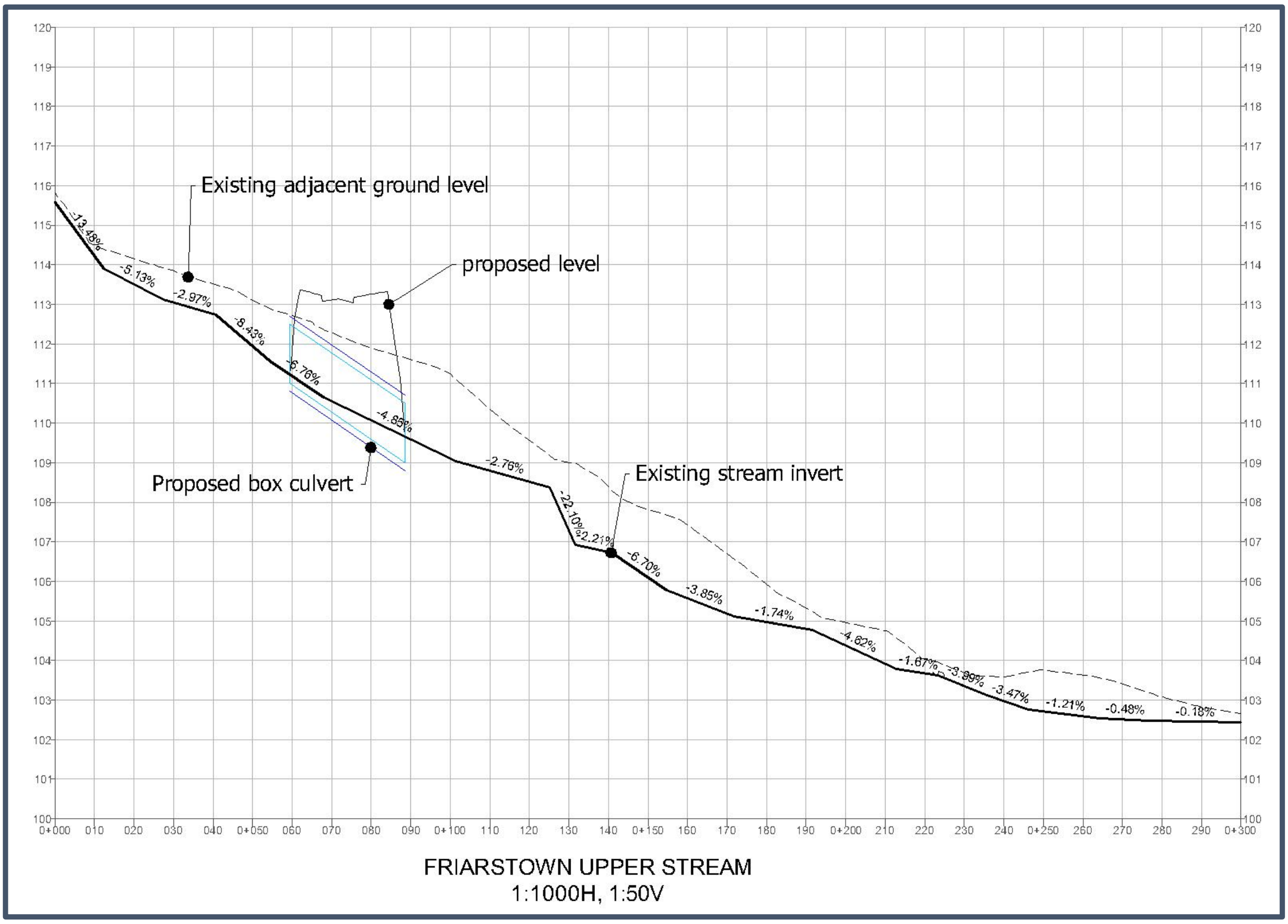


Figure 4.2 Friarstown Upper Stream Profile

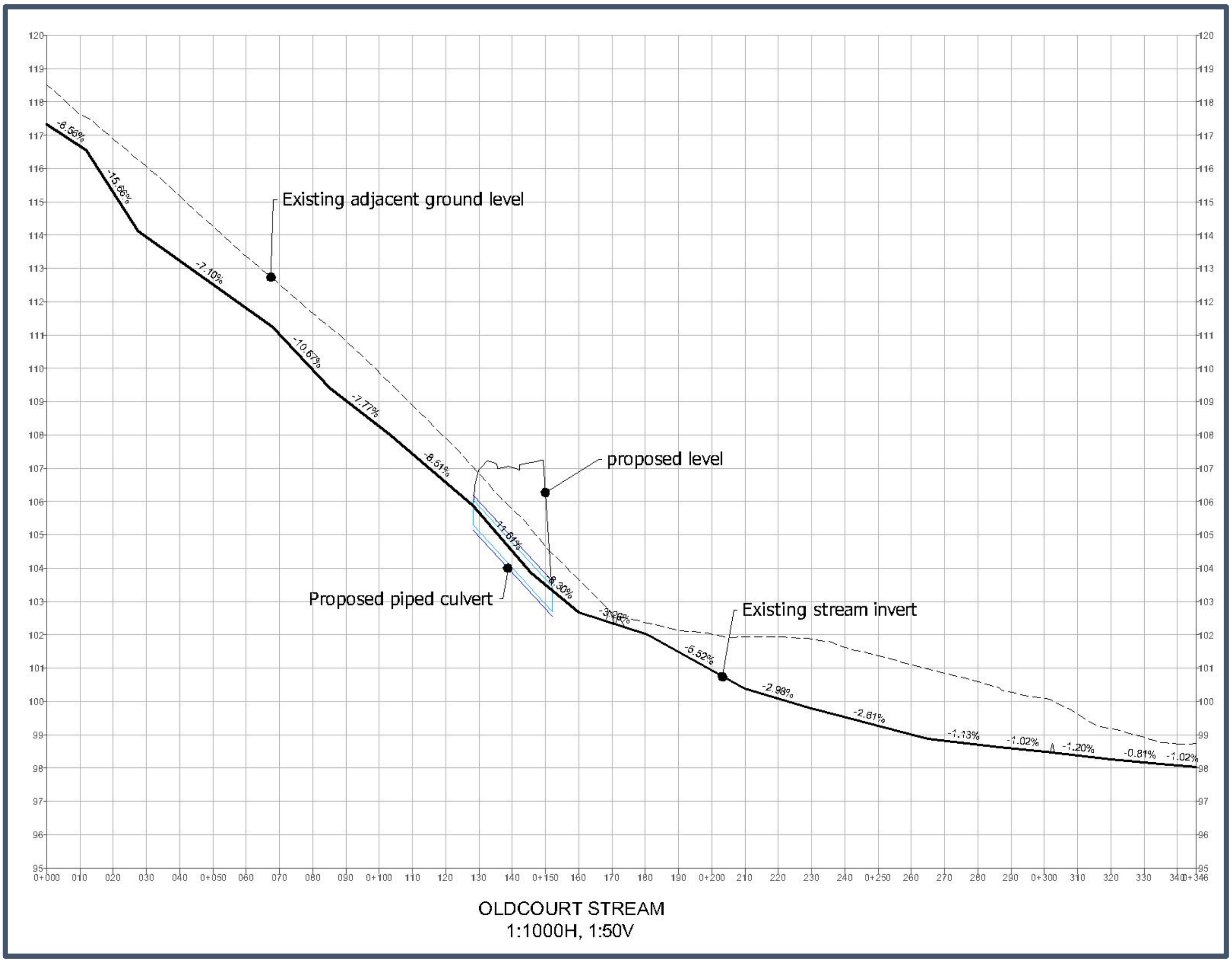


Figure 4.3 Oldcourt Stream Profile

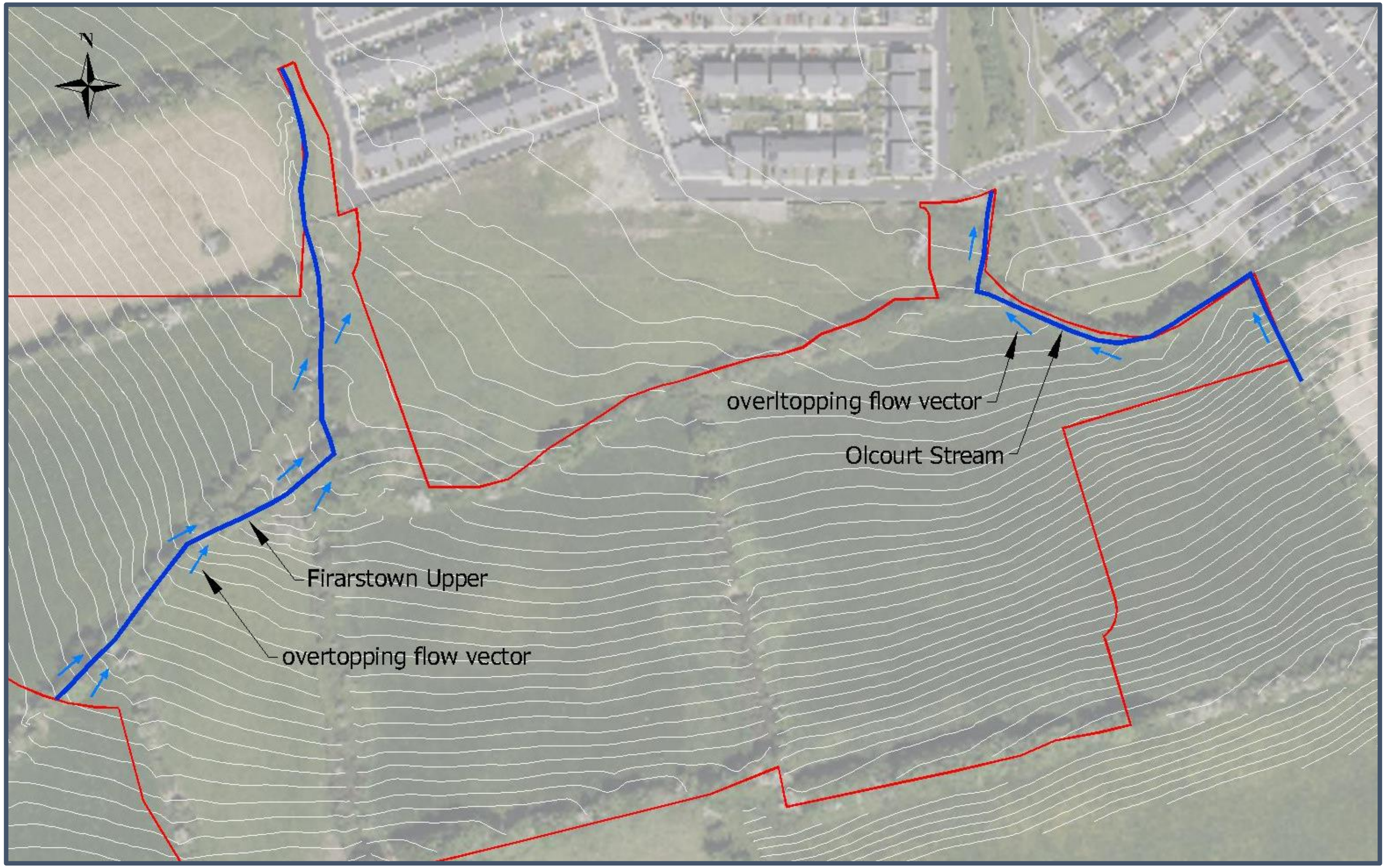


Figure 4.4 Overtopping Flow Paths

4.4 Mitigation

Peak Flows

The OPW provides a Web Portal for estimating peak flood flows in natural catchments (Flood Studies Update (FSU) Web Portal).

The portal identifies the catchment areas for the Friarstown Upper and Oldcourt Streams to be stream to be 3.55 km^2.

While the use of this portal is generally considered best practice for the estimation of flood flows, the portal advises 'particular caution' where peak flows are being estimated for catchments of less than 25km^2. Accordingly, peak flood flows were calculated using a range of alternative statistical methods; the results of these calculations are summarised in Table 4.1 and shown in detail in Appendix A.

Physical catchment descriptors used in the calculations were taken from the FSU Web Portal. All flow estimates include a climate change factor of 20% in accordance with the Mid-Range Future Scenario.

Method	Friarstown Upper		Olcourt Stream	
	1% AEP	**0.1% AEP**	**1% AEP**	**0.1% AEP**
	m^3/s	m^3/s	m3/s	m3/s
IH124	3.00	3.98	1.57	2.08
FSU Update	2.57	3.47	1.31	1.77
FSU-3V	0.43	0.58	0.23	0.31
FSU_7V	1.57	2.12	0.80	1.08
FEH-Statistical	1.07	1.44	0.60	0.81

Table 4.1 Summary of peak flows estimated by statistical methods

Peak flow estimates vary greatly across the various methodologies. IH124 estimates are significantly higher than other methods for both streams; this is not surprising as this method is generally considered to over-estimate peak flood flows *{WP4.2 Flood Estimation in Small and Urbanised Catchments – OPW 2012}*. Applying the precautionary principle, the IH124 flows will be used in this assessment, however it is likely that actual peak flows are smaller.

Table 4.2 shows the peak fluvial flows that will be used in the assessment.

Stream	1.0% AEP (m^3/s)	0.1% AEP (m^3/s)
Friarstown Upper	3.00	3.98
Oldcourt	1.57	2.08

Table 4.2 – Peak Fluvial Flows

Figures 4.5 and 4.6 show the channel cross-sections required to convey these flows (based on the lowest bed-gradient in each stream).

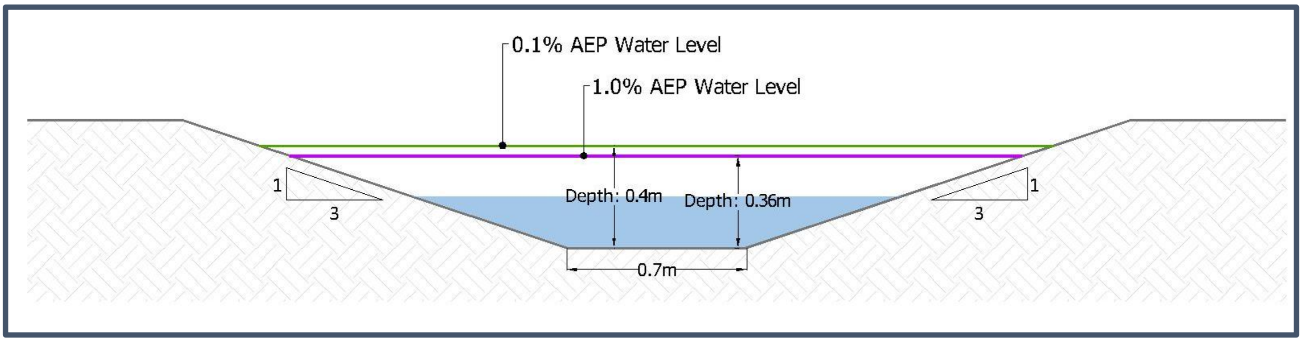


Figure 4.5 – Minimum channel cross-section for Friarstown Upper Stream

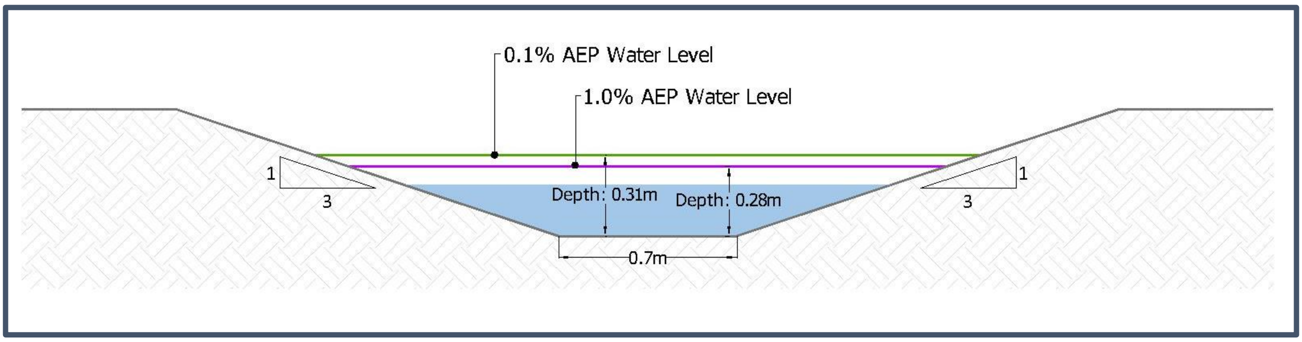


Figure 4.6 - Minimum channel cross-section for Oldcourt Stream

4.5 Proposed Culverts

The proposed development includes the installation of culverts on both streams and on several drainage ditches. The locations of these are shown in Figure 4.7.

Each culvert has been assessed and is of sufficient hydraulic capacity to convey peak flows. Calculations in this regard are provided in Appendix B.

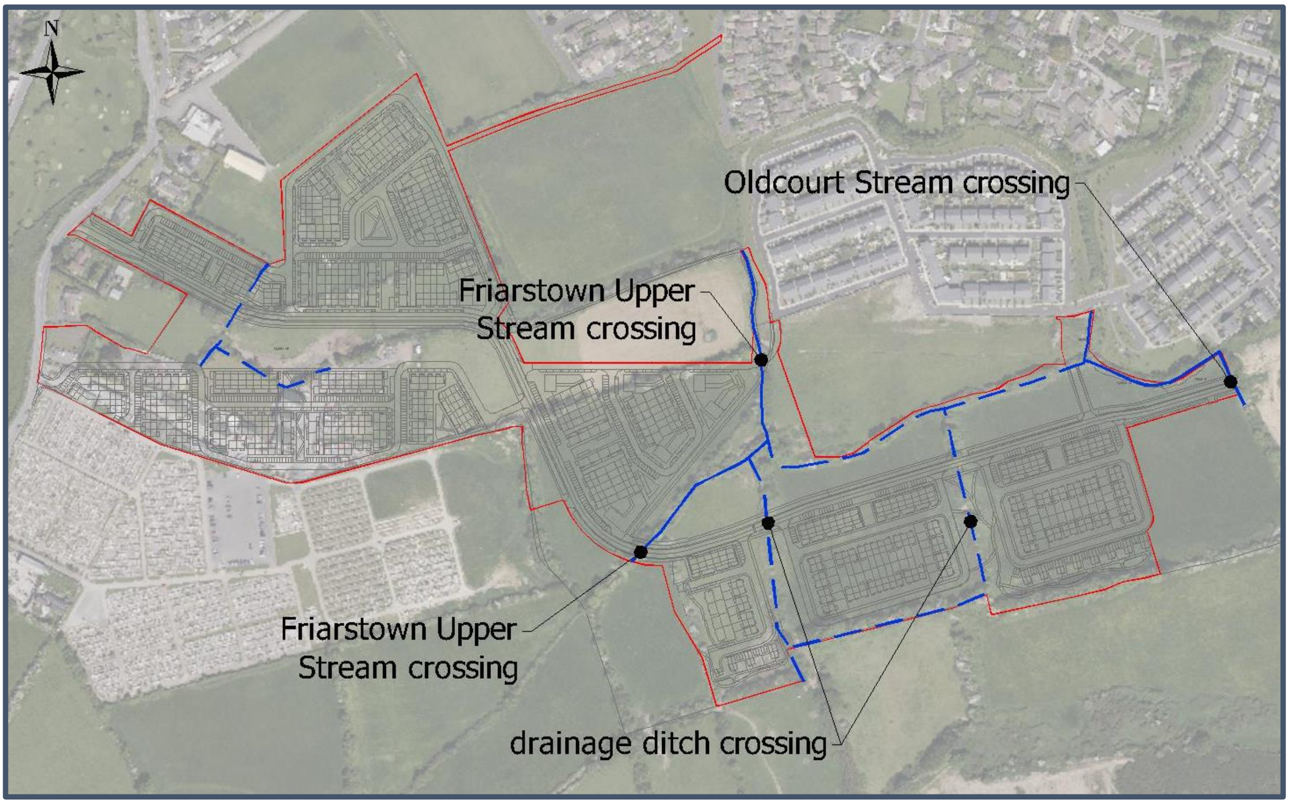


Figure 4.7 Stream Crossings

4.6 Assessment

Subject to the implementation of the mitigation measures described above, the development will not be at risk from fluvial flooding and will not increase fluvial flood risk elsewhere. Accordingly, the proposed development is considered appropriate from the fluvial flood-risk perspective.

5. FLOOD RISK FROM GROUNDWATER

5.1 Flood Risk Indicators - Desktop

A number of datasets were interrogated for indicators of flood risk from Ground Water. These comprised:

(i). OPW National Flood Hazard Mapping

Records from the National Flood Hazard Mapping website maintained by the OPW do not contain any evidence of flood events at the Site associated with fluctuations in groundwater level. However, as much of the Site is away from the public road, the absence of historic flood records is not a strong indicator that there is no flood risk.

(ii). Geological Survey of Ireland (GSI)

The GSI maintains a web portal which contains information on groundwater flooding. (https://www.gsi.ie). The portal does not show any groundwater flooding at the Site or its environs.

(iii). Historical Ordnance Survey Mapping

Historical OS maps do not contain any indicator of flood risk from ground water.

(iv). Topographical Survey

The Site slopes steeply from the southern to the northern boundary. This sloping topography eliminates the potential for significant localised groundwater ponding within the Site.

5.2 Flood Risk Indicators – Site Walkover

No indicators of groundwater flood risk were observed during a Site walkover.

5.3 Initial Assessment

The indicators described above do not provide any indication of flood risk from groundwater and so detailed assessment of flood risk from this mechanism is not required.

6. PLUVIAL FLOOD RISK

6.1 Flood Risk Indicators - Desktop

A number of datasets were interrogated for indicators of pluvial flood risk:

(i) SFRA South Dublin Development Plan 2022-2028

The Strategic Flood Risk Assessment for the South Dublin Development Plan 2022 – 2028 does not show any indicators of pluvial flood risk at the Site.

(ii) OPW National Flood Hazard Mapping Website

The OPW maintains the National Flood Hazard Mapping website (floodinfo.ie) which contains information about locations that may be at risk from flooding. The source of this information includes Local Authorities and other historic records such as newspaper articles and other documentation about reported floods. This source does not register any previous flood events associated with pluvial flood risk at the Site. However, as much of the Site is away from the public road, the absence of historic flood records is not a strong indicator that there is no flood risk.

(iii) Site Survey

The topographical survey of the Site shows the ground level to fall steeply from south to north. Steeply sloping sites typically give rise to greater overland flows than flatter sites.

(iv) Surface Water Drainage

The surface water drainage system for the proposed development was designed by Pinnacle Consulting Engineers to comply with the Greater Dublin Regional Code of Practice, the GDSDS and CIRIA Report c753 "The SuDS Manual" 2015. Compliance with these guidance documents ensures the proposed development will not give be at risk from pluvial flooding and will not give rise to pluvial flood risk elsewhere.

6.2 Flood Risk Indicators – Site Walkover

The Site is on steeply sloping ground and is vulnerable to overland flow entering the Site from the higher ground to the south.

No drainage pipes entering were observed.

6.3 Mitigation Measures

The steeply sloping ground will encourage higher rates of overland flow; there is a risk of overland flow entering the Site from higher ground to the south.

Overland flow volumes are typically much smaller than fluvial flows and dispersed across larger areas. Nevertheless, the following measures to mitigate pluvial flood risk should be incorporated into the proposed development:

- where the proposed development intercepts drainage ditches, the drainage paths should be diverted to an appropriate outfall (it is noted that the SUDS regime referred to in Section 3.3 achieves this by incorporating intercepted drainage ditches into swales);
- where water-vulnerable elements of the development adjoin higher ground (for example, boundary walls), intercepting drains (such as filter drains or swales) should be installed to intercept overland flow from the higher ground;
- intercepting drains should be installed along all sections of the Site boundary which adjoin higher ground (there are already drainage ditches along parts of the south boundary and the drainage paths these provide should be maintained).

6.4 Initial Assessment

Subject to the implementation of the mitigation measures described above, the development will not be at risk from pluvial flooding and will not increase pluvial flood risk elsewhere. Accordingly, detailed assessment is not required.

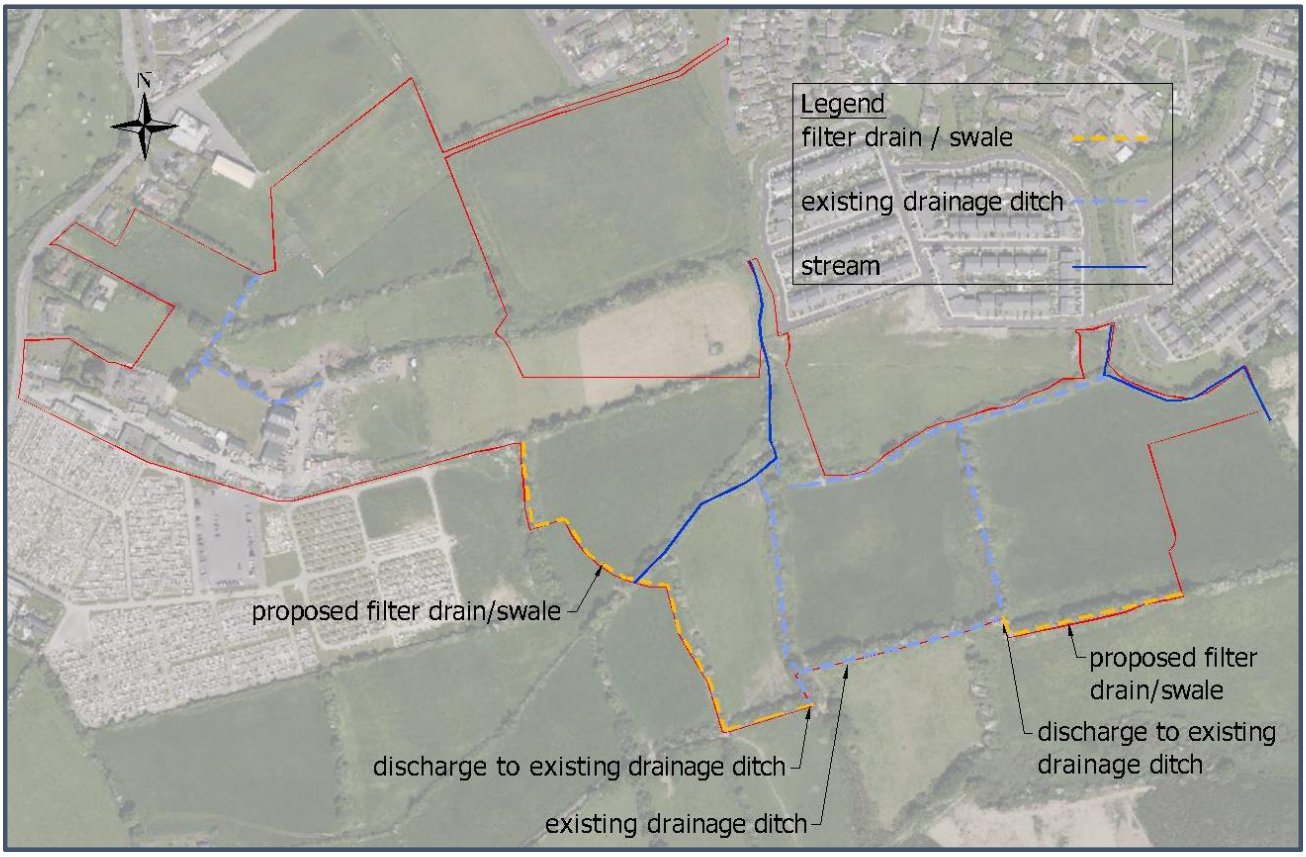


Figure 6.1 Drains at southern boundary

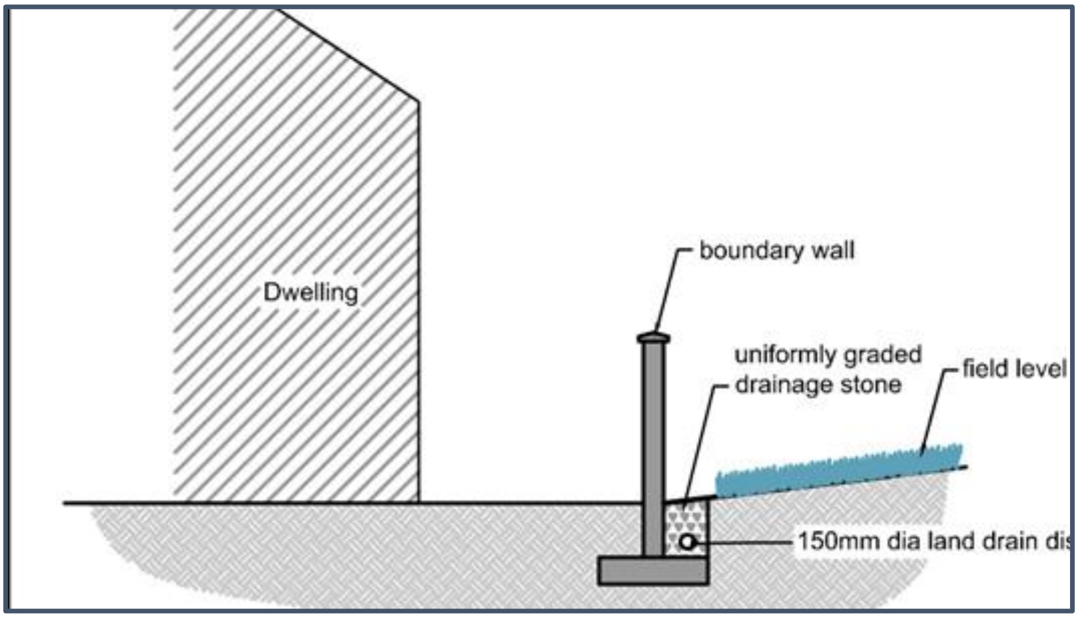


Figure 6.2 Typical Filter Drain cross-section

7. RESIDUAL FLOOD RISK

Residual risk is the risk that remains after all mitigation measures to reduce the frequency of flooding have been taken.

7.1 Climate Change

As described in Section 2.7, the assessment considered flood risk associated with the Mid-Range Future Scenario (MRFS).

The OPW has adopted a second indicative potential futures for flood risk assessment; the High-End Future Scenario (HEFS). The HEFS is based on a more extreme future based on the upper end of the range of projections of future climatic conditions and is considered as a residual flood risk.

Section 4.4 describes measures to ensure the stream channels are each of sufficient capacity to convey peak fluvial flows. The performances of these channels were analysed for peak flows in the 1% AEP scenario based on a 30% climate change factor. These analyses found that even in the HEFS, each channel has sufficient capacity to convey peak flows.

Section 4.5 describes the assessment of the various culverts proposed in the development. The performances of these culverts were also analysed for peak flows in the 1% AEP scenario based on a 30% climate change factor. These analyses found that even in the HEFS, each has sufficient capacity to convey peak flows.

7.2 Existing Drainage Infrastructure

Because of its steeply sloping terrain, the Site will not be at risk of flooding even in the event of flow in the watercourse downstream becoming obstructed during a significant rainfall event (for example if a culvert downstream of the Site became blocked). In such a scenario, water would overtop the channel and continue downstream and would not surcharge onto the proposed development.

7.3 Failure of surface water drainage system

The surface water drainage system has been designed to capture, store and discharge surface water run-off from rainfall events for all return periods up to and including 100 years (with an allowance for climate change).

Notwithstanding this, a blockage could occur in the surface water drainage system, leading to the risk of water rising in upstream manholes to the point where the manhole overtops and water overflows on to the surrounding ground.

The proposed development provides routes for the conveyance of such overflows which ensure that buildings would not be at risk of flooding in this scenario.

8. DEVELOPMENT MANAGEMENT JUSTIFICATION TEST

A Development Management Justification Test was carried out in respect of the proposed development in accordance with Section 5.15 of the Flood Risk Management Guidelines and incorporating the findings of the subject SSFRA. Table 8.1 presents the results of this test which conclude that the proposed development satisfies the criteria of the Justification test.

5.1.1	*The subject lands have been zoned or otherwise designated for the particular use or form of development in an operative development plan, which has been adopted or varied taking account of these Guidelines.*	
	Under the South Dublin County Council (SDCC) Development Plan, the Site is classified for the following land use (Objective RES-N) To provide for new residential communities in accordance with approved area plans.	
5.1.2	*The proposal has been subject to an appropriate flood risk assessment which demonstrates that :*	
	(i)	*the proposed development will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk;*
		The Site does not currently provide floodplain storage and so the proposed development will not displace floodplain storage. The surface water drainage system for the proposed development was designed by Pinnacle Consulting Engineers to comply with the Greater Dublin Regional Code of Practice, the GDSDS and CIRIA Report c753 "The SuDS Manual" 2015. Compliance with these guidance documents ensures the proposed development will not give be at risk from pluvial flooding and will not give rise to pluvial flood risk elsewhere.
	(ii)	*the proposed development includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible;*
		The surface water drainage system for the proposed development was designed by Pinnacle Consulting Engineers to comply with the Greater Dublin Regional Code of Practice, the GDSDS and CIRIA Report c753 "The SuDS Manual" 2015. It incorporates a Sustainable Urban Drainage (SUDS) regime which provides a sequence of management practices, control structures and strategies designed to efficiently and sustainably drain surface water, while minimising pollution and managing the impact on water quality of local water bodies.
	(iii)	*the proposed development includes measures to ensure that residual risks to the area and/or development can be managed to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding of any future flood risk management measures and provisions for emergency services access;*
		The proposed development does not impact on any existing flood protection measures and will not prevent possible future flood risk management measures.
	(iv)	*the proposed development addresses the above in a manner that is also compatible with the achievement of wider planning objectives in relation to development of good urban design and vibrant and active streetscapes.*
		Yes.

Table 8.1 Justification Test

9. SUMMARY AND CONCLUSION

9.1 Summary

This report presents the findings of a Site-specific flood risk assessment (SSFRA) carried out by Kilgallen and Partners in regard to a proposed residential development at Bohernabreena, Oldcourt, Ballycullen, Co. Dublin. The SSFRA was carried out in accordance with the document *'Planning System and Flood Risk Management – Guidelines for Planning Authorities (2009)'.*

As an inland site upstream of tidal influences and possible wave action, the Site is not subject to coastal flood risk and so this mechanism does not need to be considered further in this assessment.

The assessment therefore considered flood-risk from the following mechanisms:

- Fluvial;
- Pluvial;
- Groundwater;
- Drainage Infrastructure.

<u>Fluvial</u>

Desktop indicators gave no indication of flood-risk at the Site. Site inspection identified inadequacies in stream channels which could lead to overtopping during extreme rainfall events. The steep gradient through the Site eliminates the potential for floodplain storage within the Site; instead, overtopping water would continue downstream as overland flow before merging into the streams at a lower point. The result is that during extreme events, the lands adjoining the streams act as overflow channels. Mitigation measures were recommended, in this case ensuring a sufficient channel cross-section is provided through the proposed development for each stream. Subject to the implementation of these measures, the development was considered to not be at risk from fluvial flooding and to not give rise to an increase in fluvial flood risk elsewhere.

<u>Groundwater</u>

Initial assessment of existing flood risk indicators indicate the Site is not at risk from groundwater flooding.

<u>Pluvial</u>

The Site is on steeply sloping ground and is vulnerable to overland flow entering the Site from the higher ground to the south. Mitigation measures were recommended to maintain existing flow paths, intercept potential overland flow entering the Site from the south and to protect water-vulnerable elements of the proposed development. Subject to the implementation of these measures, the development was considered to not be at risk from pluvial flooding and to not give rise to an increase in pluvial flood risk elsewhere.

<u>Residual flood risk (including drainage infrastructure)</u>

Residual risk is the risk that remains after all mitigation measures to reduce the frequency of flooding have been taken. Residual risk was examined under three headings:

- climate change – the proposed development was found to be not at risk of flooding even in the HEFS for climate change.
- existing drainage infrastructure - the proposed development was found to be not at risk of flooding even in the event of blockages in the streams downstream of the Site;
- failure of proposed surface water drainage system - the proposed development provides routes for the conveyance of surcharging water which ensure that buildings would not be at risk of flooding in this scenario.

Justification Test

The proposed development was subject to and passed the Development Management Justification Test.

9.2 Conclusion

The proposed development is not at risk of flooding and will not increase flood risk elsewhere. The proposed development is therefore appropriate from a flood risk perspective.

Appendix A

Peak Fluvial Flows

Friarstown Upper

IH124 Estimation of Q_{100} and Q_{1000}			
$Q_{BAR\ RURAL} = 0.00108 \times AREA^{0.89} \times SAAR^{1.17} \times SOIL^{2.17}$			
Characteristic	**Value**	**Unit**	**Source**
Area (A)	1.7	km^2	FSU
Average Annual Rainfall (SAAR)	907	mm	FSU
G1 % =	0%	%	Fig I 4.18
G2 % =	40%	%	Fig I 4.18
G3 % =	0%	%	Fig I 4.18
G4 % =	0%	%	Fig I 4.18
G5 % =	60%	%	Fig I 4.18
Soil index (G) =	0.42	%	
$Q_{BAR\ RURAL}$ =	0.75	m3/sec	
CWI =	121		Fig I 6.62
CIND =	41.89		Eqn 7.2
NC =	0.70		Eqn 7.3
URBAN =	1%		FSU
$Q_{BAR\ URBAN} / Q_{BAR\ RURAL}$ =	1.025		Eqn 7.4
Q_{BAR} =	0.772	m3/sec	
Q_{100} / Q_{BAR} (Ireland)	1.96		FSR - Ireland
$Q_{1,000} / Q_{BAR}$ (Ireland)	2.6		FSR - Ireland
Q_{100} =	1.513	m3/sec	
$Q_{1,000}$ =	2.007	m3/sec	
Factorial Error Factor =	1.651		Page 37 IOH124
Climate Change Factor =	1.2		FRMG
Q_{100} =	**3.00**	**m3/sec**	
$Q_{1,000}$ =	**3.98**	**m3/sec**	

FSU Update estimation of Q_{100} & Q_{1000}			
Characteristic	**Value**	**Unit**	**Source**
Area	1.7	km^2	FSU Portal
SAAR	907	mm	FSU Portal
BFI_{soil}	0.728		FSU Portal
FARL	1.0		FSU Portal
S1085	74.19	m/km	FSU Portal
$QMED_{rural}$	0.76	m3/s	
URBEXT	0.01		FSU Portal
$QMED_{urban}$	0.77		
Climate Change Factor	1.2		OPW
Q_{100} / $QMED_{rural}$	2.77		FSU Portal
Q_{1000} / $QMED_{rural}$	3.74		FSU Portal
Q_{100}	**2.567**	**m3/sec**	
$Q_{1,000}$	**3.466**	**m3/sec**	

FSU-3V estimation of Q_{100} & Q_{1000}			
Characteristic	**Value**	**Unit**	**Source**
Area	1.7	km^2	FSU Portal
BFI_{soil}	0.728		FSU Portal
SAAR	907	mm	FSU Portal
QMED	0.129	m3/s	
Climate Change Factor	1.2		OPW
Q_{100} / QMED	2.77		
Q_{1000} / QMED	3.74		
Q_{100}	**0.429**	**m3/sec**	
$Q_{1,000}$	**0.579**	**m3/sec**	

FSU-7V estimation of Q_{100} & Q_{1000}			
Characteristic	**Value**	**Unit**	**Source**
Area	1.7	km^2	FSU Portal
BFI_{soil}	0.728		FSU Portal
SAAR	907	mm	FSU Portal
FARL	1.0		FSU Portal
DRAIND	1.20	km/km^2	
S1085	74.19	m/km	FSU Portal
ARTDRAIN	0.00		
$QMED_{rural}$	0.464	m3/s	
URBEXT	0.01		FSU Portal
$QMED_{urban}$	0.47		
Climate Change Factor	1.2		OPW
Q_{100} / $QMED_{rural}$	2.77		FSU Portal
Q_{1000} / $QMED_{rural}$	3.74		FSU Portal
Q_{100}	**1.572**	**m3/sec**	
$Q_{1,000}$	**2.122**	**m3/sec**	

FEH-Statistical estimation of Q_{100} & Q_{1000}			
Characteristic	**Value**	**Unit**	**Source**
Area	1.7	km^2	FSU Portal
SAAR	907	mm	FSU Portal
FARL	1.0		FSU Portal
BFI_{soil}	0.728		FSU Portal
QMED	0.32	m3/s	
Climate Change Factor	1.2		OPW
Q_{100} / QMED	2.77		FSU Portal
Q_{1000} / QMED	3.74		FSU Portal
Q_{100}	**1.067**	**m3/sec**	
$Q_{1,000}$	**1.440**	**m3/sec**	

Oldcourt Stream

IH124 Estimation of Q_{100} and Q_{1000}			
$Q_{BAR\,RURAL} = 0.00108 \times AREA^{0.89} \times SAAR^{1.17} \times SOIL^{2.17}$			
Characteristic	**Value**	**Unit**	**Source**
Area (A)	0.8	km^2	FSU
Average Annual Rainfall (SAAR)	950	mm	FSU
G1 % =	0%	%	Fig I 4.18
G2 % =	40%	%	Fig I 4.18
G3 % =	0%	%	Fig I 4.18
G4 % =	0%	%	Fig I 4.18
G5 % =	60%	%	Fig I 4.18
Soil index (G) =	0.42	%	
$Q_{BAR\,RURAL}$ =	0.39	m3/sec	
CWI =	125		Fig I 6.62
CIND =	43.01		Eqn 7.2
NC =	0.69		Eqn 7.3
URBAN =	1%		FSU
$Q_{BAR\,URBAN} / Q_{BAR\,RURAL}$ =	1.024		Eqn 7.4
Q_{BAR} =	0.404	m3/sec	
Q_{100} / Q_{BAR} (Ireland)	1.96		FSR - Ireland
$Q_{1,000} / Q_{BAR}$ (Ireland)	2.6		FSR - Ireland
Q_{100} =	0.791	m3/sec	
$Q_{1,000}$ =	1.050	m3/sec	
Factorial Error Factor =	1.651		Page 37 IOH124
Climate Change Factor =	1.2		FRMG
Q_{100} =	**1.57**	**m3/sec**	
$Q_{1,000}$ =	**2.08**	**m3/sec**	

FSU Update estimation of Q_{100} & Q_{1000}			
Characteristic	**Value**	**Unit**	**Source**
Area	0.8	km^2	FSU Portal
SAAR	950	mm	FSU Portal
BFI_{soil}	0.728		FSU Portal
FARL	1.0		FSU Portal
S1085	74.19	m/km	FSU Portal
$QMED_{rural}$	0.39	m3/s	
URBEXT	0.01		FSU Portal
$QMED_{urban}$	0.39		
Climate Change Factor	1.2		OPW
Q_{100} / $QMED_{rural}$	2.77		FSU Portal
Q_{1000} / $QMED_{rural}$	3.74		FSU Portal
Q_{100}	**1.313**	**m3/sec**	
$Q_{1,000}$	**1.773**	**m3/sec**	

FSU-3V estimation of Q_{100} & Q_{1000}			
Characteristic	**Value**	**Unit**	**Source**
Area	0.8	km^2	FSU Portal
BFI_{soil}	0.728		FSU Portal
SAAR	950	mm	FSU Portal
QMED	0.070	m3/s	
Climate Change Factor	1.2		OPW
Q_{100} / QMED	2.77		
Q_{1000} / QMED	3.74		
Q_{100}	**0.232**	**m3/sec**	
$Q_{1,000}$	**0.314**	**m3/sec**	

FSU-7V estimation of Q_{100} & Q_{1000}			
Characteristic	**Value**	**Unit**	**Source**
Area	0.8	km^2	FSU Portal
BFI_{soil}	0.728		FSU Portal
SAAR	950	mm	FSU Portal
FARL	1.0		FSU Portal
DRAIND	1.20	km/km^2	
S1085	74.19	m/km	FSU Portal
ARTDRAIN	0.00		
$QMED_{rural}$	0.235	m3/s	
URBEXT	0.01		FSU Portal
$QMED_{urban}$	0.24		
Climate Change Factor	1.2		OPW
Q_{100} / $QMED_{rural}$	2.77		FSU Portal
Q_{1000} / $QMED_{rural}$	3.74		FSU Portal
Q_{100}	**0.797**	**m3/sec**	
$Q_{1,000}$	**1.077**	**m3/sec**	

FEH-Statistical estimation of Q_{100} & Q_{1000}			
Characteristic	**Value**	**Unit**	**Source**
Area	0.8	km^2	FSU Portal
SAAR	950	mm	FSU Portal
FARL	1.0		FSU Portal
BFI_{soil}	0.728		FSU Portal
QMED	0.18	m3/s	
Climate Change Factor	1.2		OPW
Q_{100} / QMED	2.77		FSU Portal
Q_{1000} / QMED	3.74		FSU Portal
Q_{100}	**0.599**	**m3/sec**	
$Q_{1,000}$	**0.808**	**m3/sec**	

Appendix B

Culvert Capacities

Friarstown Upper

HY-8 Culvert Analysis Report

Table 1 - Project Headwater Table

Crossing Name	Culvert Name	Discharge Names	Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	HW / D (m)	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Outlet Velocity (m/s)
Friarstown Upper	Proposed Culvert 06	0.1% AEP	3.98	3.98	112.28	1.14	0.0*	0.29	0.51	0.74	0.51	3.91

* Full Flow Headwater elevation is below inlet invert.

Crossing Input: Friarstown Upper

Parameter	Value	Units
DISCHARGE DATA		
Discharge Method	User-Defined	
Discharge List	Define...	
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	0.700	m
Side Slope (H:V)	3.000	_:1
Channel Slope	0.2000	m/m
Manning's n (channel)	0.040	
Channel Invert Elevation	109.165	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	4.000	m
Crest Length	31.000	m
Crest Elevation	113.230	m
Roadway Surface	Paved	
Top Width	23.500	m

Culvert Input: Friarstown Upper

Parameter	Value	Units
CULVERT DATA		
Name	Proposed Culvert 06	
Shape	Concrete Box	

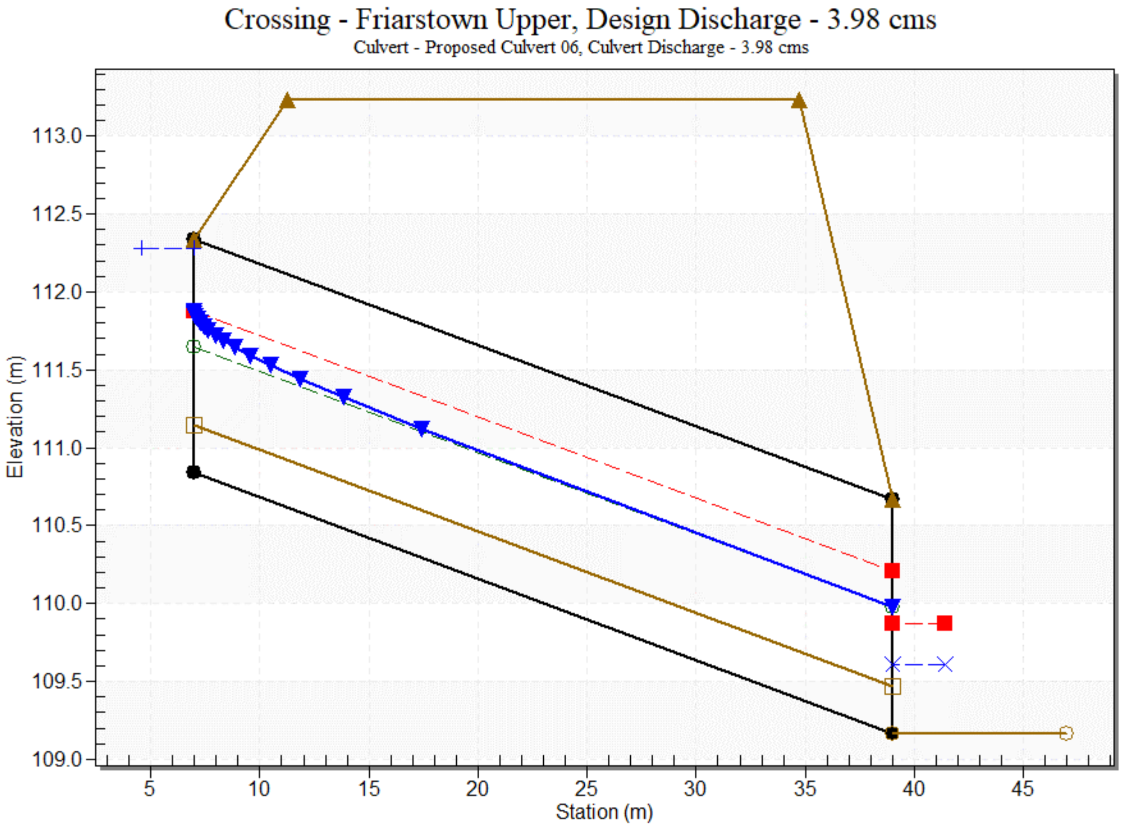
Material	Concrete	
Span	2000.000	mm
Rise	1500.000	mm
Embedment Depth	300.000	mm
Manning's n (Top/Sides)	0.012	
Manning's n (Bottom)	0.035	
Culvert Type	Straight	
Inlet Configuration	1:1 Bevel (45º flare) Wingwall (Ke=0.2)	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	7.000	m
Inlet Elevation	110.840	m
Outlet Station	39.000	m
Outlet Elevation	109.165	m
Number of Barrels	1	
Computed Culvert Slope	0.052344	m/m

Table 2 - Culvert Summary Table: Proposed Culvert 06

Discharge Names	Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	HW / D (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
1.0% AEP	3.00	3.00	112.06	0.92	0.0*	0.23	1-S2n	0.43	0.61	0.43	0.39	3.52	4.18
0.1% AEP	3.98	3.98	112.28	1.14	0.0*	0.29	1-S2n	0.51	0.74	0.51	0.44	3.91	4.49
Overtopping	9.95	8.27	113.34	2.20	0.842	0.56	5-S2n	0.81	1.20	0.82	0.66	5.06	5.67

* Full Flow Headwater elevation is below inlet invert.

Water Surface Profile Plot for Culvert: Proposed Culvert 06



Oldcourt Stream

HY-8 Culvert Analysis Report

Table 1 - Project Headwater Table

Crossing Name	Culvert Name	Discharge Names	Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	HW / D (m)	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Outlet Velocity (m/s)
Oldcourt	Proposed Culvert 01	0.1%	2.08	2.08	105.46	1.49	1.194	0.65	0.64	0.70	0.64	3.23

Crossing Input: Oldcourt

Parameter	Value	Units
DISCHARGE DATA		
Discharge Method	User-Defined	
Discharge List	Define...	
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	0.700	m
Side Slope (H:V)	3.000	_:1
Channel Slope	0.0500	m/m
Manning's n (channel)	0.040	
Channel Invert Elevation	102.990	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	14.000	m
Crest Length	20.000	m
Crest Elevation	107.010	m
Roadway Surface	Paved	
Top Width	18.000	m

Culvert Input: Oldcourt

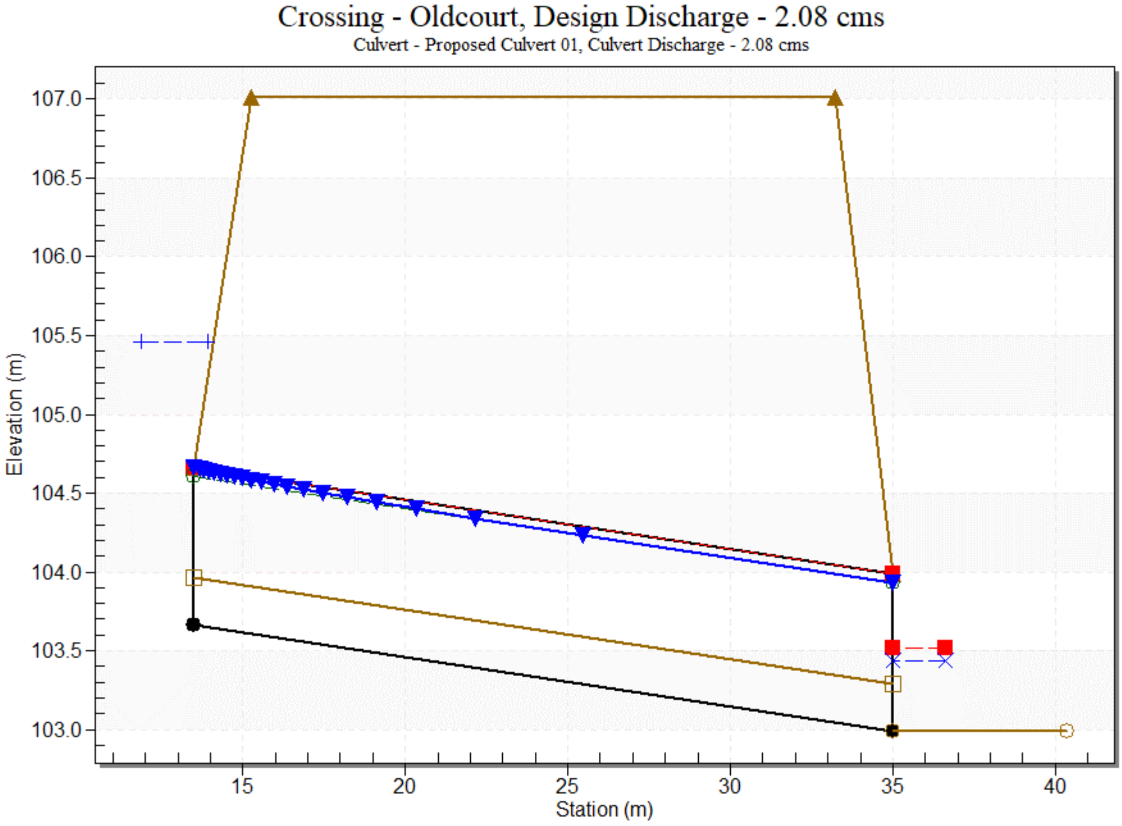
Parameter	Value	Units
CULVERT DATA		
Name	Proposed Culvert 01	
Shape	Concrete Box	

Material	Concrete	
Span	1000.000	mm
Rise	1000.000	mm
Embedment Depth	300.000	mm
Manning's n (Top/Sides)	0.012	
Manning's n (Bottom)	0.035	
Culvert Type	Straight	
Inlet Configuration	1:1 Bevel (45º flare) Wingwall (Ke=0.2)	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	13.500	m
Inlet Elevation	103.665	m
Outlet Station	35.000	m
Outlet Elevation	102.990	m
Number of Barrels	1	
Computed Culvert Slope	0.031395	m/m

Table 2 - Culvert Summary Table: Proposed Culvert 01

Discharge Names	Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	HW / D (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
1.0%	1.57	1.57	105.05	1.09	0.656	0.47	5-S2n	0.53	0.63	0.53	0.39	2.94	2.11
0.1%	2.08	2.08	105.46	1.49	1.194	0.65	5-S2n	0.64	0.70	0.64	0.45	3.23	2.27
Overtopping	4.16	3.43	107.18	3.22	3.209	1.40	6-FFc	0.70	0.70	0.70	0.61	4.91	2.71

Water Surface Profile Plot for Culvert: Proposed Culvert 01



Appendix C

Schedule of Drainage Drawings

Document	Ref No.	Title
Drawing	P211102-PIN-XX-XX-DR-C-00210-S2 Rev: P02	Surface Water Diversion Layout
Drawing	P211102-PIN-XX-XX-DR-C-00211-S2 Rev: P01	Surface Water Diversion Proposed Longsection
Drawing	P211102-PIN-XX-XX-DR-C-00220-S2 Rev: P01	Pre-Development Flow Route Analysis
Drawing	P211102-PIN-XX-XX-DR-C-00221-S2 Rev: P01	Post- Development Flow Route Analysis
Drawing	P211102-PIN-XX-XX-DR-C-00600-S2 Rev: P01	SUDS Drainage Overall Layout
Drawing	P211102-PIN-XX-XX-DR-C-00601-S2 Rev: P01	SUDS Drainage Layout Sheet 1 of 6
Drawing	P211102-PIN-XX-XX-DR-C-00602-S2 Rev: P01	SUDS Drainage Layout Sheet 2 of 6
Drawing	P211102-PIN-XX-XX-DR-C-00603-S2 Rev: P01	SUDS Drainage Layout Sheet 3 of 6
Drawing	P211102-PIN-XX-XX-DR-C-00604-S2 Rev: P01	SUDS Drainage Layout Sheet 4 of 6
Drawing	P211102-PIN-XX-XX-DR-C-00605-S2 Rev: P01	SUDS Drainage Layout Sheet 5 of 6
Drawing	P211102-PIN-XX-XX-DR-C-00606-S2 Rev: P01	SUDS Drainage Layout Sheet 6 of 6
Drawing	P211102-PIN-XX-XX-DR-C-00610-S2 Rev: P01	Surface Water Catchment Layout – Overall Layout
Drawing	P211102-PIN-XX-XX-DR-C-00630-S2 Rev: P01	Surface Water Manhole Schedule
Drawing	P211102-PIN-XX-XX-DR-C-00631-S2 Rev: P01	Surface Water Long Sections Sheet 1 of 6
Drawing	P211102-PIN-XX-XX-DR-C-00632-S2 Rev: P01	Surface Water Long Sections Sheet 2 of 6
Drawing	P211102-PIN-XX-XX-DR-C-00633-S2 Rev: P01	Surface Water Long Sections Sheet 3 of 6
Drawing	P211102-PIN-XX-XX-DR-C-00634-S2 Rev: P01	Surface Water Long Sections Sheet 4 of 6
Drawing	P211102-PIN-XX-XX-DR-C-00635-S2 Rev: P01	Surface Water Long Sections Sheet 5 of 6
Drawing	P211102-PIN-XX-XX-DR-C-00636-S2 Rev: P01	Surface Water Long Sections Sheet 6 of 6
Drawing	P211102-PIN-XX-XX-DR-C-00640-S2 Rev: P01	Surface Water Cross Section Sheet 1 of 9
Drawing	P211102-PIN-XX-XX-DR-C-00641-S2 Rev: P01	Surface Water Cross Section Sheet 2 of 9
Drawing	P211102-PIN-XX-XX-DR-C-00642-S2 Rev: P01	Surface Water Cross Section Sheet 3 of 9

Drawing	P211102-PIN-XX-XX-DR-C-00643-S2 Rev: P01	Surface Water Cross Section Sheet 4 of 9
Drawing	P211102-PIN-XX-XX-DR-C-00645-S2 Rev: P01	Surface Water Cross Section Sheet 5 of 9
Drawing	P211102-PIN-XX-XX-DR-C-00646-S2 Rev: P01	Surface Water Cross Section Sheet 6 of 9
Drawing	P211102-PIN-XX-XX-DR-C-00647-S2 Rev: P01	Surface Water Cross Section Sheet 7 of 9
Drawing	P211102-PIN-XX-XX-DR-C-00648-S2 Rev: P01	Surface Water Cross Section Sheet 9 of 9
Drawing	P211102-PIN-XX-XX-DR-C-01000-S2 Rev: P01	Storm Water Culvert Overall Layout
Drawing	P211102-PIN-XX-XX-DR-C-01001-S2 Rev: P01	Storm Water Culvert 01 Details
Drawing	P211102-PIN-XX-XX-DR-C-01002-S2 Rev: P01	Storm Water Culvert 02 Details
Drawing	P211102-PIN-XX-XX-DR-C-01003-S2 Rev: P01	Storm Water Culvert 03 Details
Drawing	P211102-PIN-XX-XX-DR-C-01004-S2 Rev: P01	Storm Water Culvert 04 Details
Drawing	P211102-PIN-XX-XX-DR-C-01005-S2 Rev: P01	Storm Water Culvert 05 Details
Drawing	P211102-PIN-XX-XX-DR-C-01006-S2 Rev: P01	Storm Water Culvert 06 Details
Drawing	P211102-PIN-XX-XX-DR-C-01007-S2 Rev: P01	Storm Water Culvert 07 Details
Drawing	P211102-PIN-XX-XX-DR-C-01008-S2 Rev: P01	Storm Water Culvert 08 Details