

Ballyfeeny Green Energy Project



Environmental Impact Assessment Report Volume III

Appendix 8.1 - Flood Risk Assessment

Date: 11/06/2025

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Executive Summary

Project Objective

The principal objective of this assessment was to determine the appropriateness of the proposed development at Ballyfeeny, Co. Roscommon for the construction of a wind turbine development from a flood risk perspective. Accordingly, the following assessment has been carried out in line with *'The Planning System and Flood Risk Management Guidelines for Planning Authorities'* (DoEHLG, 2009).

Summary of Conclusions

Following the completion of a hydrological / hydraulic modelling assessment of the Culliagh Stream to the east of the proposed wind farm site, it can be concluded that under the 1 in 100-year (+ climate change allowance) and 1 in 1000-year flood events, a marginal amount of right of bank flooding (i.e. same side as the proposed development) is predicted to occur. However, these flood extents are not modelled to impinge upon any proposed development area within confines of the applicant's site. Hence, the proposed development areas are located within a Flood Zone C. A Justification Test has been completed for the development which outlines how each criteria is passed.

Statement of Authority

Patrick McCabe holds a BSc in Applied Environmental Science and an MSc focusing on catchment science, surface water hydrology and ecology. He has over 10 years' experience in environmental consultancy where he has authored numerous flood risk assessments for projects within the agricultural, commercial, industrial and residential sectors.

Section 1 Introduction

1.1 Project Background & Context

It is understood that Ballyfeeny Green Energy Limited, intends to apply to Roscommon County Council for planning permission to construct a wind farm development at a site at Ballyfeeny and Tully, Strokestown, Co. Roscommon. Consequently, Hydrec Environmental Consulting were engaged by Rowan Engineering Consultants on behalf of the applicant to complete a Site-Specific Flood Risk Assessment (FRA) for the proposed Project. It is understood that an Environmental Impact Assessment Report (EIAR) is being prepared to accompany the planning application and that findings of this FRA have been utilised to form part of that assessment. This document contains the details of said FRA and is structured in the following format:

- Section 2 outlines the planning and flood risk guidelines adhered too;
- Section 3 describes the site setting and existing environment;
- Sections 4 – 6 works through a staged approach to the flood risk assessment;
- Section 7 describes the outcome of the detailed flood risk assessment / hydraulic modelling outputs;
- Section 8 assesses the requirement for a justification test; and
- Section 9 concludes on the findings of the assessment.

Section 2 The Planning System & Flood Risk Management Guidelines

The following assessment has been carried out in accordance with '*The Planning System and Flood Risk Management Guidelines for Planning Authorities*' (DoEHLG, 2009). This document is referred to as the 'Guidelines' throughout the remainder of the report.

These guidelines recommend a staged approach to flood risk assessment that covers both the likelihood of flooding and the potential consequences. The stages of appraisal and assessment are:

- **Stage 1 Flood Risk Identification** – to identify whether there may be any flooding or surface water management issues related to either the area of regional planning guidelines, development plans and LAP's or a proposed development site that may warrant further investigation at the appropriate lower level plan or planning application levels;
- **Stage 2 Initial flood risk assessment** – to confirm sources of flooding that may affect a plan area or proposed development site, to appraise the adequacy of existing information and to scope the extent of the risk of flooding which may involve preparing indicative flood zone maps. Where hydraulic models exist the potential impact of a development on flooding elsewhere and of the scope of possible mitigation measures can be assessed. In addition, the requirements of the detailed assessment should be scoped; and
- **Stage 3 Detailed flood risk assessment** – to assess flood risk issues in sufficient detail and to provide a quantitative appraisal of potential flood risk to a proposed or existing development or land to be zoned, of its potential impact on flood risk elsewhere and of the effectiveness of any proposed mitigation measures.

With reference to flood zones, flood zones are geographical areas within which the likelihood of flooding is in a particular range. There are three types or levels of flood zones defined for the purposes of these Guidelines:

- **Flood Zone A** – where the probability of flooding from rivers and the sea is highest (greater than 1% or 1 in 100 for river flooding or 0.5% or 1 in 200 for coastal flooding);
- **Flood Zone B** – where the probability of flooding from rivers and the sea is moderate (between 0.1% or 1 in 1000 and 1% or 1 in 100 for river flooding and between 0.1% or 1 in 1000 year and 0.5% or 1 in 200 for coastal flooding); and

- **Flood Zone C** – where the probability of flooding from rivers and the sea is low (less than 0.1% or 1 in 1000 for both river and coastal flooding). Flood Zone C covers all areas of the plan which are not in zones A or B.

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Section 3 Existing Environment

3.1 Site Description & Proposed Development

The proposed Project includes six no. turbines and all associated infrastructure including Turbine Foundations, Turbine Hardstands, Site Access Tracks, Wind Farm Internal Cabling, Grid Connection Route (GCR), Relay Tower, Onsite Substation and works required along the public road network for the two Turbine Delivery Route (TDR) options to facilitate the delivery of turbine components. A full description of the proposed Project is provided in **Chapter 2 - Project Description**.

The Applicant is in receipt of a notification of opinion by the Local Authority on design flexibility. The notification is provided in **Appendix 1.6 DFR-25-1 Notification of Opinion by LA**. This opinion from the Local Authority confirmed that it was *'appropriate that the proposed application be made and decided before the prospective applicant has confirmed certain details of the application'*.

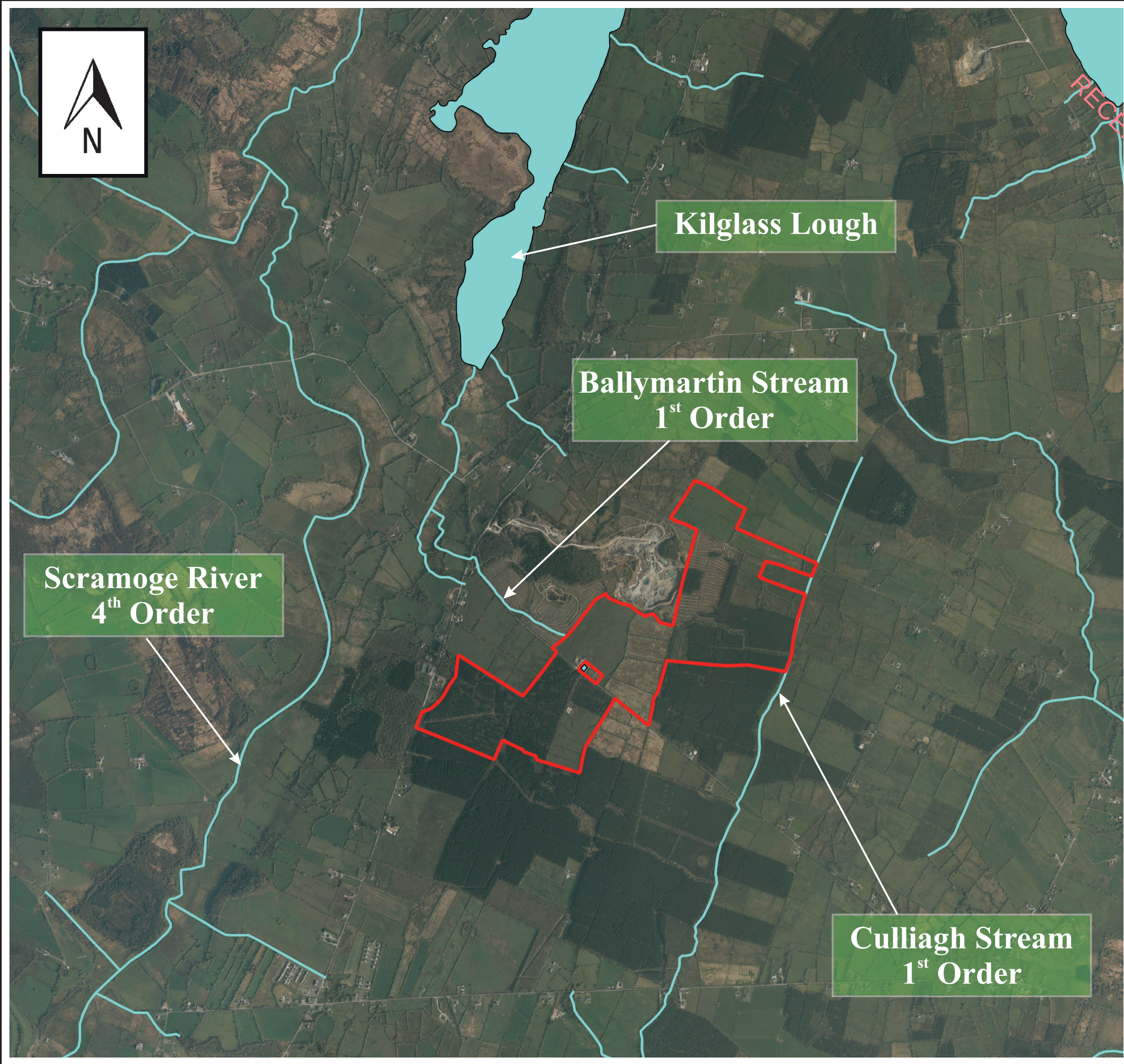
Chapter 1 – Introduction, Section 1.6 Approach to Design Flexibility, outlines with respect to the notification of opinion by the Local Authority, the Applicant in this EIAR, proposes to assess three distinct Technology Options within the range outlined by the Local Authority and in accordance with the design flexibility parameters sought

3.2 Hydrology

With the publication of Ireland's second River Basin Management Plan (RBMP), the RBMP 2018 – 2021 defines the entirety of the island of Ireland as a single River Basin District (RBD). This single RBD has been broken down into 46 catchment management units. These units are mainly based on the hydrometric areas in use by the local authorities. Each of the 46 catchment management units have been further broken down into 583 sub-catchments. The proposed Project is located within the Upper Shannon Hydrometric Area (No.26C) and WFD Catchment (No.26C). Additionally, the majority of the site is located within the Shannon (Upper)_SC_70 WFD Sub-catchment with some western parts of the site situated within the Shannon (Upper)_SC_40 or Scramoge_SC_010 WFD sub-catchment.

The local hydrology includes the Culliagh Stream (first order stream) which runs adjacent to the Site's eastern boundary and approximately 153m from turbine T03. The Culliagh Stream flows south and turns east to join the Feorish River (second order river) (and also referred to as the Tammonbary) before joining the Shannon Upper River (third order river).

The Ballymartin Stream (first order stream) is also located directly adjacent to the wind farm Site's western boundary and approximately 60m from the proposed Onsite Substation and



LEGEND



Site Boundary



Stream / River



Lough



Drainage Channel



PROJECT:
Site Specific Flood Risk Assessment.
- Ballyfeeny Green Energy

TITLE:
Hydrological features in the vicinity of
the site

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Communications Relay Tower. The Ballymartin Stream flows west before turning north to flow into Kilglass Lough. There are no EPA mapped watercourse crossings within the proposed wind farm Site boundary.

The GCR runs east of the Gortlustia Stream (first order stream), which flows into the Scramoge River (second order river). The Scramoge River then continues into the Mountain West River (third order river) and ultimately reaches Kilglass Lough.

The GCR also transects the Bellmount or Cloggernagh Stream (first order stream) further south, just before it turns west to join the existing Sliabh Bawn 110kV Substation. There are two watercourse crossings over EPA mapped waterbodies along the GCR to the existing Sliabh Bawn 110kV substation.

3.3 Soils & Geology

According to the Teagasc and EPA soils map, AminPD - Acid Deep Poorly Drained Mineral soils belonging to the Surface water / Groundwater Gleys soil group exist within the majority of the site. Whereas AlluvMin – mineral alluvium soils of variable texture are found to flank the Culliagh Stream with pockets found within the site.

In Ireland, the parent material underlying the majority of the country is comprised of quaternary sediments with the remainder composed of bedrock outcrop. These quaternary sediments have resulted from glacial movement, melting and deposition. The Teagasc and EPA subsoil maps identify that TLPDSs – Sandstone till subsoil of predominately sandy texture underlies the AminPD topsoils onsite. Where mineral alluvium soils border the Culliagh Stream, alluvium subsoils are also present. Whereas shallow bedrock is mapped to occur underneath the alluvial soils found within the centre of the site.

Based on the GSI's 1:100k bedrock formation mapping, the eastern / southern portions of the site are underlain by the Fearnaght Formation which is comprised of pale conglomerate & red sandstone. The Finnlaghta Formation which predominately comprises of blue-grey greywacke & black argillite underlies the western and northern areas.

According to the GSI's national karst database, no karst features are mapped to occur within the boundaries or in close proximity of the site. The closest mapped features (i.e. enclosed depression) are found c. 3.35km to the north-west. It should be noted however, that the GSI's map is not a complete dataset.

Section 4 Stage 1 Assessment (Screening Stage)

4.1 Review of Available Data Sets & Potential Sources of Flooding

Fluvial Flooding – Preliminary Flood Risk Assessment (PFRA)

River flooding or fluvial flooding occurs when the capacity of a watercourse is exceeded due to extreme rainfall resulting in excess waters spilling out onto low-lying areas. The Preliminary Flood Risk Assessment (PFRA) was a national screening exercise undertaken in 2011 to identify areas at potential flood risk. The country was divided into 420 map tiles for the purposes of disseminating the output of the assessment. These maps indicate the extent of the predicted 0.5% annual exceedance probability (AEP) for coastal flooding, the 0.1% AEP for fluvial flooding and the 1.0% AEP for pluvial flooding. Based on the PFRA mapping, no fluvial flooding from either the Scramoge River or Ballymartin Stream was predicated to encroach onto the proposed development site (see Plate 1). Conversely, fluvial flooding from the Culliagh Stream was mapped to marginally impinge onto the confines of the proposed Project.

It is also noted that no flooding from the PFRA dataset is mapped at any location along the GCR, or at any location along the TDR where temporary accommodation works are proposed.

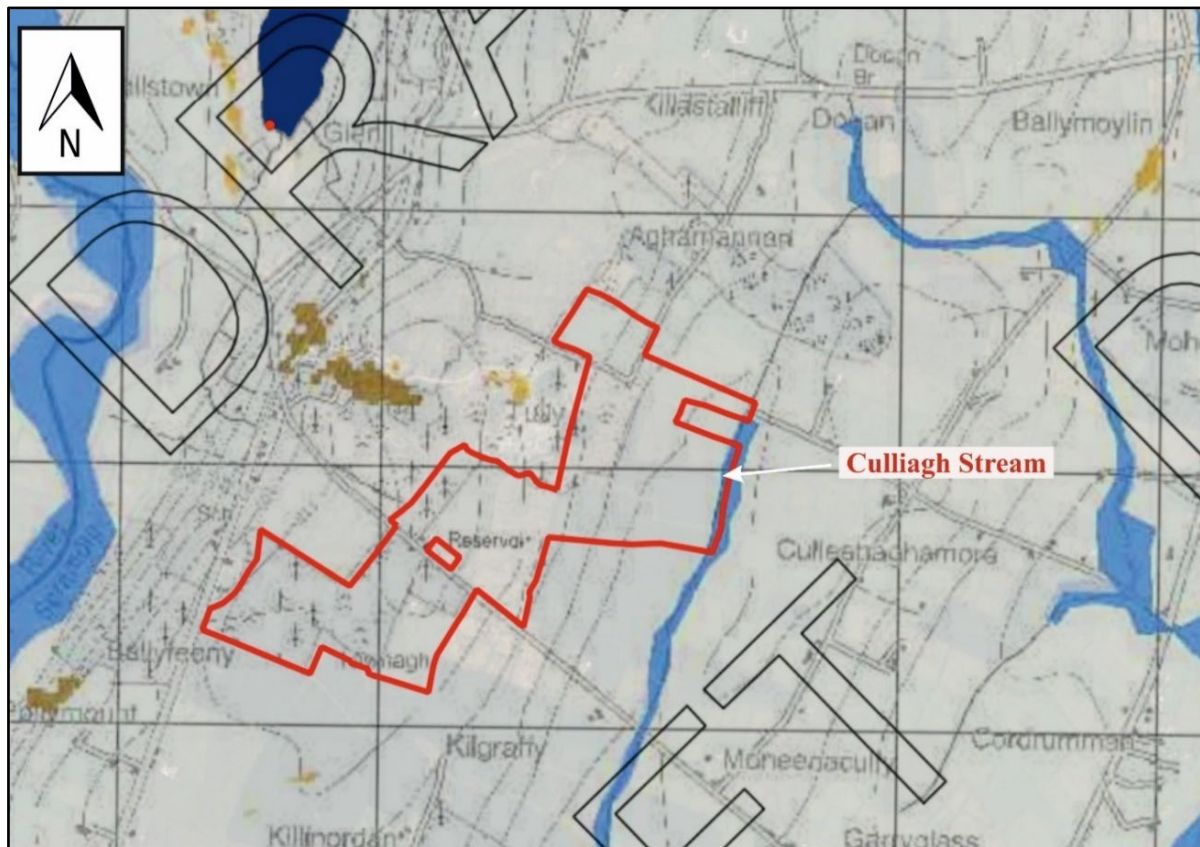


Plate 1. Extract from the Office of Public Works (OPW), Preliminary Flood Risk Assessment (PFRA) 2011 (Brown hatch represents pluvial flooding).

Fluvial Flooding – Catchment Flood Risk Assessment and Management (CFRAM)

Following the PFRA, the catchment flood risk assessment and management (CFRAM) programme identified 300 Areas for Further Assessment where flood risk was deemed to be potentially significant. The Scramoge River to the west of the proposed Project is included within the Shannon CFRAM hydraulic model domain extent (i.e. 1D Model). As can be seen from Plate 2., fluvial flooding under the 1 in 100-year event or 1 in 1000-year is not mapped to encroach upon the applicant's site or onto the R371 – Regional Road which accesses the site. Furthermore, Plate 3. Identifies that fluvial flooding from the Scramoge River is not an issue when a 20% allowance for climate change is factored in (i.e. Mid-Range Future Scenario). Neither the Culliagh Stream nor Ballymartin Stream were included in the Shannon CFRAM model. It is also noted that no flooding is identified in the CFRAM dataset at any location along the GCR, nor along the TDR where temporary accommodation works are proposed. Furthermore, the proposed works will not exacerbate flood risk along either route.



Plate 2. Map of flood extents emanating from the Scramoge River as modelled by the CFRAM project (Dark blue = 1 in 10-year flood extents, Mid blue = 1 in 100-year flood extents, Light blue = 1 in 1000-year flood extents).



Plate 3. Map of flood extents emanating from the Scramoge River as modelled by the CFRAM project (Dark blue = 1 in 10-year flood extents (+C.C), Mid blue = 1 in 100-year flood extents (+C.C), Light blue = 1 in 1000-year flood extents (+C.C)).

Fluvial Flooding – National Indicative Flood Mapping

The National Indicative Fluvial Maps (NIFM) is a project which was finalised in December 2020 which provides an indication of areas that may flood during a flood of an estimated probability of occurring. These indicative fluvial flood maps were developed using hydrodynamic modelling, based on calculated design river flows, Digital Terrain Models, and other relevant datasets (e.g. land use, data on past floods, etc.) for all subject watercourses with an upstream catchment area of greater than 5 km². It should be noted that the NIFM are not as accurate as the Flood Maps produced under the CFRAM Programme but could be regarded as advance from the PFRA dataset where available. Given the size of the Culliagh Stream and Ballymartin Stream sub-catchments (i.e. <5km²), flood modelling was not completed on that watercourse. As the Scramoge River was included in the CFRAM study it was not included for further assessment as part of the NIFM project.

It is also noted that no flooding from the NIFM dataset at any location along the GCR, nor along the TDR where temporary accommodation works are proposed. Furthermore, the proposed works will not exacerbate flood risk along either route.

Groundwater Flooding

Groundwater flooding occurs when the water stored beneath the ground (i.e. water table) rises above the land surface. Geological Survey Ireland have developed Groundwater Flood Maps for the Republic of Ireland. These maps were developed as part of the 2016-2019 GW Flood project in collaboration with Trinity College Dublin and the Institute of Technology Carlow, in response to the unprecedented groundwater floods of Winter 2015/2016.

The Groundwater Flood Probability Maps shows the probabilistic flood extent of groundwater flooding in limestone regions. These maps are focussed primarily (but not entirely) on flooding at seasonally flooded wetlands known as turloughs. The maps were created using groundwater levels measured in the field, satellite images and hydrological models with various precision levels. No groundwater flooding was predicated to occur within the site or in proximity to the site as part of the GW Flood project. The closest area identified as potentially susceptible to groundwater flooding occurs c.1.8km to the east (**Plate 4**).



Plate 4. Extract from GSI Winter Surface Water Flooding Map 2015/16 with GSI's maximum historic groundwater flooding included.

Additionally, a separate surface water flooding map (fluvial) was developed as a by-product of the project. This mapping shows flooding that actually occurred during the 2015/2016 winter period. The flood extents were made using remote sensing images (Copernicus Programme Sentinel-1), which covered any site in Ireland every 4-6 days. Thus, it is important to note that the true peak flood extents may not have been captured in all cases. Nevertheless, where flooding has been mapped as part of this dataset, valuable site-specific information can be utilised. This fluvial /pluvial flood map for the locality does not highlight the occurrence of any flooding during the winter 2015 / 2016 season within the proposed Project. **Plate 4** also identifies the areas whereby surface water flooding occurred during the 2015/2016 season. It should be noted that the areas which flooded coincide strongly with those areas modelled to flood as part of the CFRAM study.

It is also noted that no flooding from these datasets at any location along the GCR, nor along the TDR where temporary accommodation works are proposed. Furthermore, the proposed works will not exacerbate flood risk along either route.

Pluvial Flooding

Pluvial flooding occurs when extreme rainfall exceeds the soil infiltration capacity or drainage capacity causing excess rainwater to pond above ground at low points in the topography. The OPW's PFRA maps does not identify any part of the site as being susceptible to pluvial flooding (see Plate 1). Nor does it identify pluvial flooding at any location along the GCR, or at any location along the TDR where temporary accommodation works are proposed.

Coastal Flooding

Coastal flooding is caused by higher sea levels than normal, largely as a result of storm surges, resulting in the sea overflowing onto land. The proposed Project is located approx. 59km from the coast and therefore coastal flooding is not deemed to be an issue at the site.

Historic Flood Records

On review of the historic flood event data obtained from the Office of Public Works (OPW) past flood event records (www.floodinfo.ie), it was revealed that no flood events have previously been recorded within the confines of the proposed development site or indeed within the Culliagh Stream and Ballymartin Stream sub-catchments.

The following historic flood events on the Scramoge River are the closest recorded on the OPW's www.floodinfo.ie database (**Appendix 1**):

- Scramoge Bridge on N5 – River Scramoge overflow its banks every winter and floods significant area. The N5 has been realigned and the NRA office in Roscommon town has significant data, photographs and reports on the flooding. Flood Id = 83; and
- Gillstown – River Scramoge overflows its banks every winter as it enters Killglass Lough. Significant stretch of river floods Flood Id = 103.

Both flood events correlate with areas where the CFRAM study has modelled and mapped the fluvial flood extents. To that end these floodplains are located c. 2.8km and 1.9km from the proposed Project.

No further flood records are found at any location along the GCR, or at any location along the TDR where temporary accommodation works are proposed.

4.2 Stage 1 Conclusion

Pluvial and coastal flooding are not anticipated to occur onsite and therefore no further assessment in terms of risk from either is required. Similarly, there is no evidence to suggest that fluvial flooding from the Ballymartin Stream or Scramoge River will encroach onto the proposed development area or R371 – Regional Road (i.e. access road). However, based on the PFRA mapping the potential for fluvial flooding from the Culliagh Stream at the site exists. It is therefore concluded that the assessment should proceed to Stage 2 (Scoping Stage) and concentrate on the potential of the site being subject to fluvial flooding from the Culliagh Stream watercourse.

Section 5 Stage 2 Assessment (Scoping Stage)

At this juncture the only available evidence to suggest that fluvial flooding may impinge upon the wind farm site, is the stream flood extents mapped as part of the PFRA dataset. These maps are indicative only and the OPW advises that these maps should not be used at a local level to assess flood risk on individual properties / roads. Consequently, the PFRA mapping is not deemed to be of sufficient strength to allow a definitive conclusion to be made at this stage of the assessment process. Therefore, the flood risk assessment should advance to a Stage 3 Detailed Site-Specific Flood Risk Assessment and include a hydraulic assessment of the Culliagh Stream.

Section 6 Stage 3 Assessment (Detailed Site Specific)

6.1 Site Survey

In April 2024, Patrick McCabe of Hydrec Environmental Consulting visited the Culliagh Stream and surrounding environs to assess the condition of the watercourse and to select the cross-section locations required to complete the hydraulic modelling aspect of the project. Stream/catchment conditions were considered when selecting the Manning's 'n-Values' to be applied to the hydraulic model. Given the relatively straight nature of the channel, it was determined that 14 topographical cross sections were required to construct an accurate model of the watercourse. The stream survey extent spanned c. 920m in total.

Hydrec Environmental Consulting engaged the services of Horizon Surveys Ltd. to carry out the topographical cross-section surveying works. All cross-section topographical surveying was also completed in April 2024. The location of the surveyed cross sections is included on Figure 2 with the cross-section profiles produced by Horizon Surveys included in Appendix 2. This topographical data offers concise and highly accurate details of ground levels adjacent to the stream, the top and bottom levels of the stream banks and the watercourse bed elevations.

6.2 Peak Flow Estimation

6.2.1 Flood Studies Update (FSU)

The Flood Studies Update (FSU) programme was undertaken by the Office of Public Works (OPW), to provide improved methods of extreme rainfall and flood estimation at both gauged and ungauged locations across the Republic of Ireland. The FSU web-based application portal facilitates the estimation of flood flows, extreme rainfall depths and other hydrological variables at river node points at 500m centres along the entire Irish river network.

At each node point, the Q_{med} value can be obtained from catchment descriptor data through the application of the following regression model:

$$Q_{med_{rural}} = 1.237 \times 10^{-5} \times AREA^{0.937} \times BFI_{soils}^{0.922} \times SAAR^{1.306} \times FARL^{2.21} \times DRAIN^{0.341} \times S1085^{0.185} \times (1 + ARTDRAIN2)^{0.408}$$

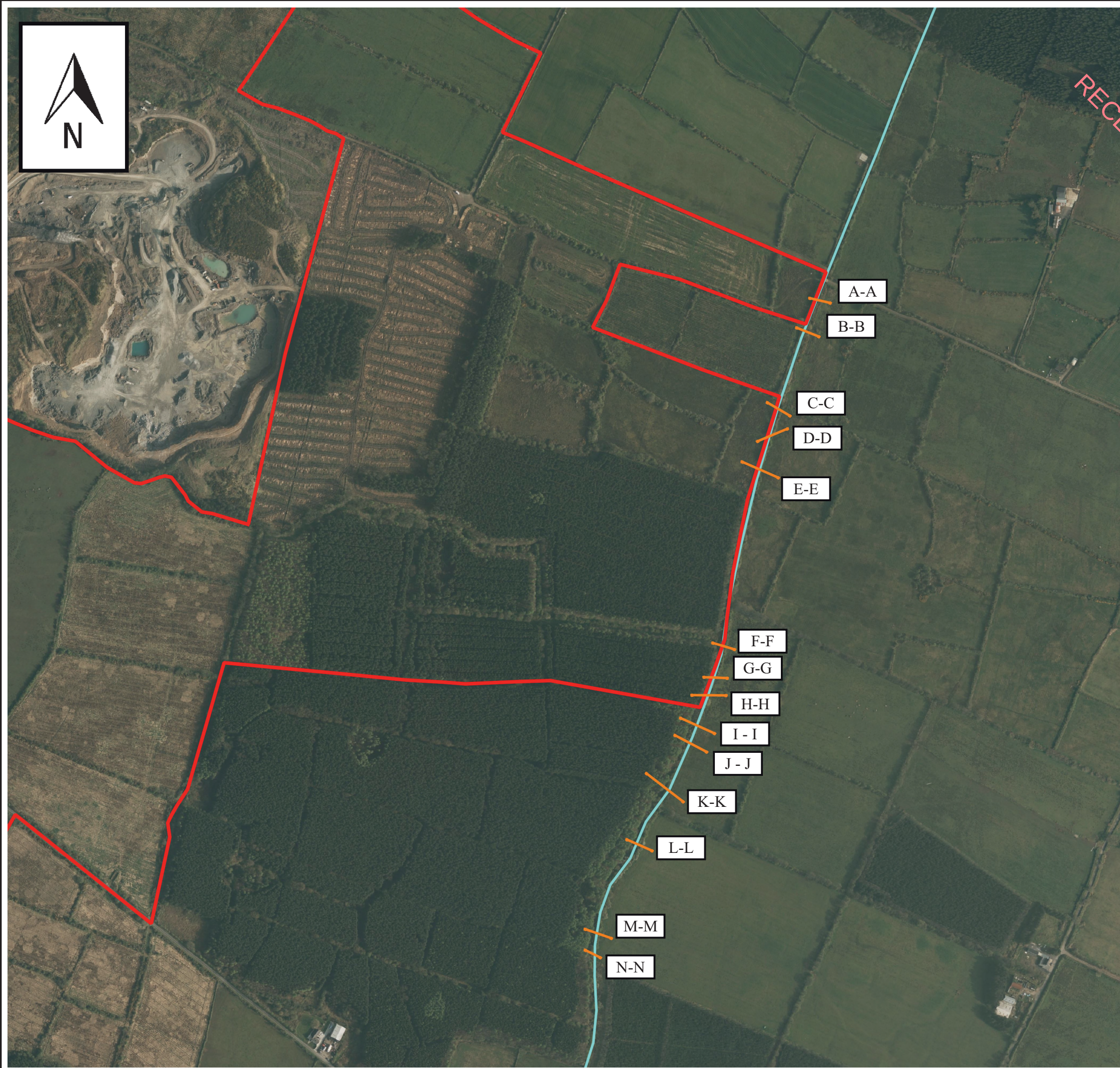
Where:

AREA = Catchment area (km²);

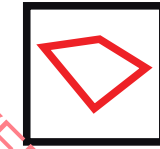
BFI_{soils} = Base flow index derived from soils data;

SAAR = Long term mean annual rainfall amount (mm);

FARL = Flood attenuation by reservoirs / lakes;



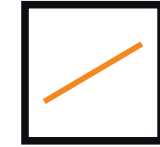
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Site Boundary



Stream / River



Cross Section Locations



PROJECT:

Site Specific Flood Risk Assessment.
- Ballyfeeny Green Energy

TITLE:

Topographical cross section locations
used in hydraulic modelling assessment

SCALE:

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DRAIND = Drainage density;

S1085 = Slope of the main channel between 10% and 85% of its length (m/km);

ARTDRAIN2 = Percentage of the catchment river network included in Drainage schemes.

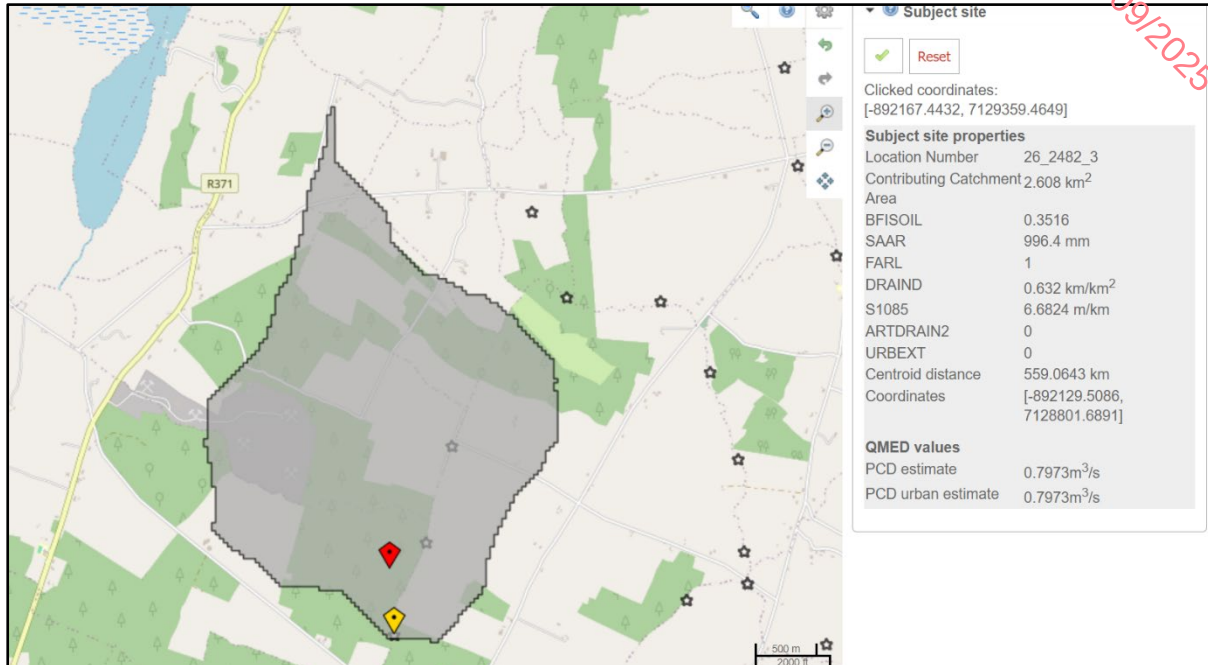


Plate 5. Output from the flood frequencies tool for gauged sites on the OPW FSU web portal.

The programme output for the subject site can be summarised as follows:

- Catchment Area: 2.608km²
- SAAR: 996.4mm
- S1085: 6.6824m/km
- Qmed: 0.7973m³/s

It is important to note that the use of the FSU Qmed is designed for catchments that are greater than 25km² in area. Therefore, the FSU method is not deemed appropriate for calculating design flows for the subject site, given that the upgradient catchment area equates to 2.608km². The application of more appropriate methodologies are outlined in the following sections. However, the FSU data can be used to supplement the following small catchment methodologies.

6.2.2 Flood Studies Report

In the absence of sufficient flow records, one of the most appropriate methods for estimating ungauged design flood flows in Ireland is based on the Flood Studies Report (FSR) and

subsequent modifications. The original FSR method with regression coefficient for Ireland is as follows:

$$Q_{\text{BAR}} = 0.0172 \times \text{AREA}^{0.94} \times \text{STMFRQ}^{0.27} \times \text{S1085}^{0.185} \times \text{SOIL}^{1.23} \times \text{RSMD}^{1.03} \times (1 + \text{Lake})^{-0.85}$$

Where:

STMFRQ = The number of stream junctions per km²;

SOIL = Soil infiltration index (determined from FSR WRAP maps);

RSMD = 1-day rainfall of 5-year return period minus Soil Moisture Deficit;

Lake = Catchment area draining through lakes.

Using the FSR soils winter rainfall acceptance potential (WRAP) maps, the SOIL value was calculated as follows:

$$\text{SOIL} = \frac{(0.15S_1 + 0.3S_2 + 0.4S_3 + 0.45S_4 + 0.5S_5)}{S_1 + S_2 + S_3 + S_4 + S_5}$$

Where S_1 to S_5 denote the proportions of the catchment covered by each soil class 1 to 5. Soil class 1 has the highest infiltration capacity and hence the lowest runoff potential, while soil class 5 has the lowest infiltration capacity and hence the highest runoff potential:

$$\text{SOIL} = \frac{(0.15(0) + 0.3(0) + 0.4(0) + 0.45(1) + 0.5(0))}{0.45} = 0.45$$

Using the FSR formula, the 1 in 1-year flow is as follows:

$$Q_{\text{BAR}} = 0.0172 \times 2.608^{0.94} \times 0.383^{0.27} \times 6.6824^{0.185} \times 0.45^{1.23} \times 38.28^{1.03} \times 1^{-0.85}$$

$$Q_{\text{BAR}} = 0.0172 \times 2.462 \times 0.771 \times 1.421 \times 0.374 \times 42.703 \times 1$$

$$Q_{\text{BAR}} = 0.741 \text{ m}^3/\text{s}$$

6.2.3 Flood Studies Supplementary Report 6

The original 1975 Flood Studies Report (FSR) equation when tested showed that floods on small catchments were less well predicated than on large ones. The Flood Studies Supplementary Report (FSSR) No. 6 was introduced to overcome the shortcomings in the estimation of mean annual floods from small catchments through the use of the FSR. A total

of 53 catchments with <20km² catchment area were used in the regression analysis during this study. The FSSR 6 Q_{BAR} equation for use on catchments of less than 20km² is:

$$Q_{BAR} = 0.00066 \times AREA^{0.92} \times SAAR^{1.22} \times SOIL^{2.0}$$

Using the FSSR 6 formula, the 1 in 1-year flow is as follows:

$$Q_{BAR} = 0.00066 \times 2.608^{0.92} \times 996.4^{1.22} \times 0.45^{2.0}$$

$$Q_{BAR} = 0.00066 \times 2.415 \times 4550.81 \times 0.2025$$

$$Q_{BAR} = 1.469 \text{ m}^3/\text{s}$$

6.2.4 Institute of Hydrology (IH) 124

In 1994 the Institute of Hydrology carried out further regression studies on small catchments (areas <25km²). A total of 87 catchments ranging from 0.9km² to 24.7km² were available. Seventy-one of these catchments were chosen as completely rural catchments having urban fractions of less than 0.025km². The following 3-variable equation was derived:

$$Q_{BAR} = 0.00108 \times AREA^{0.89} \times SAAR^{1.17} \times SOIL^{2.17}$$

This equation is widely used in Ireland to estimate flood flows and Greenfield runoff from small catchments (i.e. between 0.5km² and 25km²).

Using the IH124 formula, the 1 in 1-year flow is as follows:

$$Q_{BAR} = 0.00108 \times 2.608^{0.89} \times 996.4^{1.17} \times 0.45^{2.17}$$

$$Q_{BAR} = 0.00108 \times 2.347 \times 3222.31 \times 0.176$$

$$Q_{BAR} = 1.438 \text{ m}^3/\text{s}$$

6.3 Flood Frequency Growth Curve for Ireland

It is possible using standard growth factors, as set out in the Flood Studies Report, to determine the flood flow in the Culliagh Stream for the 1 in 100-year (1.0% AER) and 1 in 1000-year (0.1% AEP) flood events using the calculated QMED / QBAR values as set out on **Table 1**.

Table 1. Determination of flood flows for selected return periods

Peak Flow Estimation Method	QMED / Q_{BAR} Value (m^3/s)	Growth Factor (1 in 100 Years)	Growth Factor (1 in 1000 Years)	1 in 100 Year Predicted Flow (m^3/s)	1 in 1000 Year Predicted Flow (m^3/s)
FSR	0.741	1.96	2.6	1.45	1.93
FSSR 6	1.469	1.96	2.6	2.88	3.82
IH 124	1.438	1.96	2.6	2.82	3.74

6.4 Climate Change Allowance

It is proposed to apply a further growth factor of 1.2 to these estimated design year flows, in order to allow provision for predicted increased rainfall and associated run-off volumes over the coming century. The design flood flows (with allowance for climate change) are outlined in **Table 2** below.

Table 2. Determination of flood flows for selected return periods

Peak Flow Estimation Method	1 in 100 Year Predicted Flow (m^3/s)	1 in 1000 Year Predicted Flow (m^3/s)	Growth Factor (Climate Change Allowance)	Plus Climate Change Allowance	
				1 in 100 Year Predicted Flow (m^3/s)	1 in 1000 Year Predicted Flow (m^3/s)
FSR	1.45	1.93	1.2	1.74	2.32
FSSR 6	2.88	3.82	1.2	3.46	4.58
IH 124	2.82	3.74	1.2	3.38	4.49

6.5 Recommended Design Flow

As mentioned previously the FSU methodology is not suitable for small catchments and thus was discounted. Design flows estimated using the FSR formula were consistent with the FSU and thus have also been discounted. Thereafter there was a relatively strong agreement between each of the methods assessed. The most robust 1 in 100-year and 1 in 1000-year design flows were estimated using the FSSR 6 methodology. Therefore, these more stringent design flows were used in the hydraulic model¹.

6.6 Hydraulic Modelling Assessment

In order to assess the extent of fluvial flooding in relation to the 1 in 100-year and 1 in 1000-year (+ climate change allowance) flood events, a 1-Dimensional (1D) steady flow hydraulic model of the stream in question was constructed using the HEC-RAS hydraulic modelling software (latest version 6.3.1). The models were used to simulate the water level at different points along the stream under different flow regimes (see model outputs in Appendices 3-4). The model was constructed using the cross-sections surveyed in April 2024.

When constructing a 1D Steady Flow Hydraulic Model using HEC-RAS software, a number of user defined parameters are required to complete the computational procedure. This includes Manning's 'n-Values' (i.e. roughness coefficient) of the stream banks and channel at each cross-section. Contraction and expansion coefficients are also required to evaluate the amount of energy loss that occurs because of a flow contraction or expansion at each cross-section. The values used in the model are detailed in Table 3. The downgradient boundary condition of the model was determined using the 'Normal Depth' application of the software, whereby the channel slope was defined as 0.01 m/m. The 'Critical Depth' function was selected to model the upgradient boundary condition.

Table 3. Summary of roughness, contraction and expansion coefficients used in the hydraulic model for the Culliagh Stream

Cross Section No.	Roughness Coefficient (Manning's n Value)	Contraction Coefficient	Expansion Coefficient
Cross Section 1 (A-A) (RS = 215)	Left overbank – 0.030	0.1	0.3
	River channel – 0.025		
	Right overbank – 0.030		
Cross Section 2 (B-B)	Left overbank – 0.030	0.1	0.3

¹ A factorial standard error has been included in the calculation.

(RS = 214)	River channel – 0.025	0.1	0.3
	Right overbank – 0.030		
Cross Section 3 (C-C) (RS = 213)	Left overbank – 0.030	0.1	0.3
	River channel – 0.025		
	Right overbank – 0.030		
Cross Section 4 (D-D) (RS = 212)	Left overbank – 0.030	0.1	0.3
	River channel – 0.025		
	Right overbank – 0.030		
Cross Section 5 (E-E) (RS = 211)	Left overbank – 0.030	0.1	0.3
	River channel – 0.025		
	Right overbank – 0.030		
Cross Section 6 (F-F) (RS = 210)	Left overbank – 0.030	0.1	0.3
	River channel – 0.025		
	Right overbank – 0.030		
Cross Section 7 (G-G) (RS = 209)	Left overbank – 0.030	0.1	0.3
	River channel – 0.025		
	Right overbank – 0.080		
Cross Section 8 (H-H) (RS = 208)	Left overbank – 0.030	0.1	0.3
	River channel – 0.025		
	Right overbank – 0.080		

Note: Manning's 'n-Values' derived from Chow, V.T., 1959 Open Channel Hydraulics, Mc Graw – Hill Book Company, N.Y

Table 3 (Continued). Summary of roughness, contraction and expansion coefficients used in the hydraulic model for the Culligh Stream

Cross Section No.	Roughness Coefficient (Manning's n Value)	Contraction Coefficient	Expansion Coefficient
Cross Section 9 (I-I) (RS = 207)	Left overbank – 0.030	0.1	0.3
	River channel – 0.025		
	Right overbank – 0.080		
Cross Section 10 (J-J) (RS = 206)	Left overbank – 0.030	0.1	0.3
	River channel – 0.025		
	Right overbank – 0.080		
Cross Section 11 (K-K) (RS = 205)	Left overbank – 0.030	0.1	0.3
	River channel – 0.025		
	Right overbank – 0.080		
Cross Section 12 (L-L) (RS = 204)	Left overbank – 0.030	0.1	0.3
	River channel – 0.025		
	Right overbank – 0.080		
	Left overbank – 0.030	0.1	0.3

Cross Section 13 (M-M) (RS = 203)	River channel – 0.025		
	Right overbank – 0.080		
Cross Section 14 (N-N) (RS = 202)	Left overbank – 0.030	0.1	0.3
	River channel – 0.025		
	Right overbank – 0.080		

Note: Manning's 'n-Values' derived from Chow, V.T., 1959 Open Channel Hydraulics, Mc Graw – Hill Book Company, N.Y

Section 7 Model Results

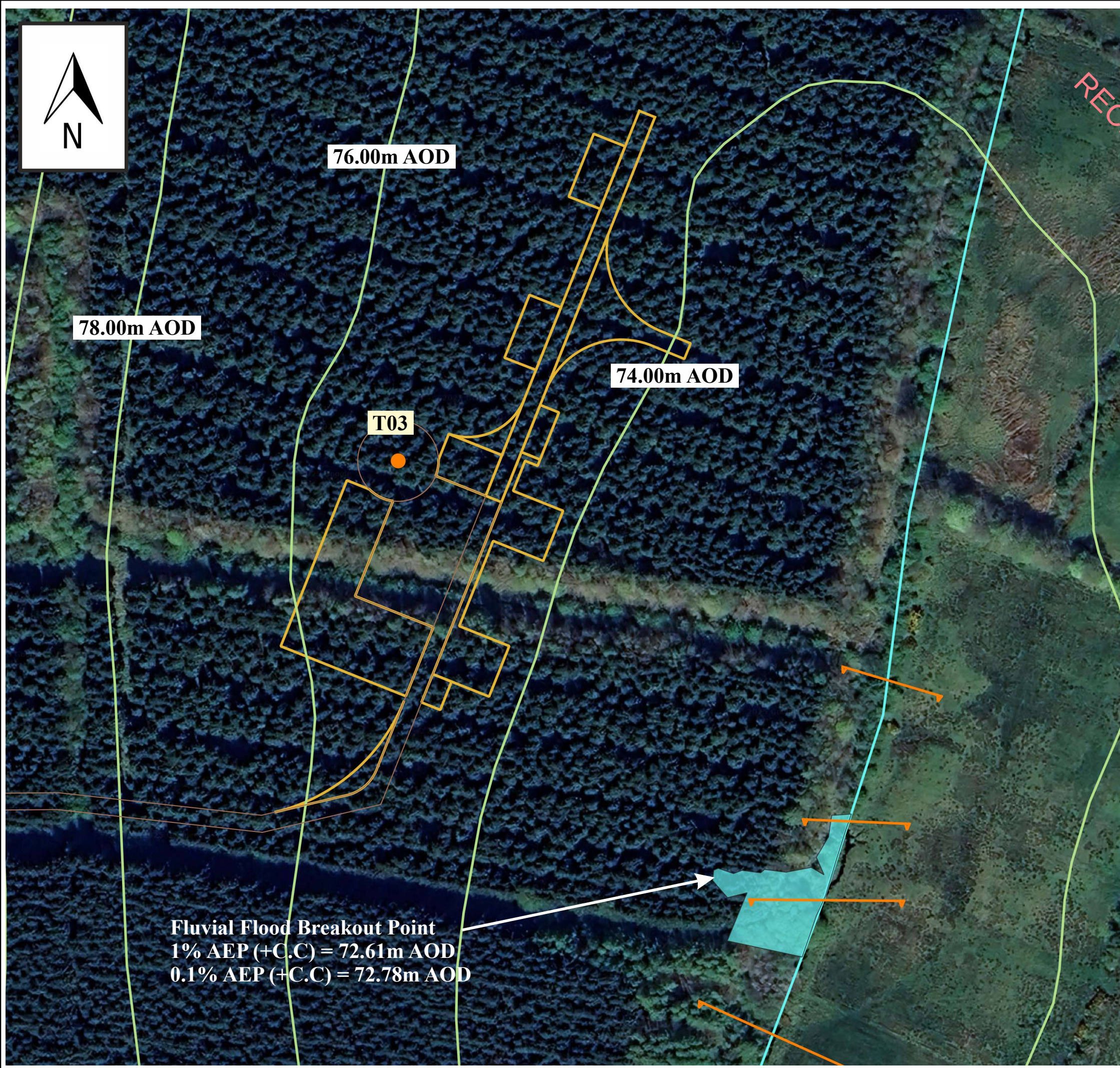
The conveyance capacity of each of the 14 surveyed watercourse cross sections were assessed for suitability to transmit the Q100 and Q1000 (+ climate change allowance) flood flows within the Culliagh Stream. Each of the cross-sectional profiles including Q100 and Q1000 flood levels are presented in **Appendix 3** with the model data outputs for both flood scenarios located in Appendix 4. Based on the hydraulic model produced for the watercourse, streambank overtopping for the 0.1% AEP scenario was predicated to occur right of bank (ROB) (i.e. same side as proposed Project) at Cross Section G with overspill modelled to occur under both the 1% AEP and 0.1% AEP scenarios at Cross Section H.

Table 4 details the water levels predicated for the 1 in 100-year and the 1 in 1000-year (+Climate. Change (C.C) allowance) for each of the modelled cross sections. Figure 3 highlights the extent of fluvial flooding under the 1 in 1000-year flood scenario (+ C.C allowance). As can be seen from Figure 3, the fluvial flood extents are not predicated to encroach on any proposed Project areas within the site. For instance, the closest wind turbine location (i.e. T03) is sufficiently elevated about the 0.1% AEP flood elevation (i.e. c. 1.2m above flood level).

Table 4. Water levels predicted for the Culliagh Stream

Cross Section No.	Water Level Predicted (1.0% AEP (plus C.C allowance))	Water Level Predicted (0.1% AEP) (plus C.C allowance))
CS 1	75.42m AOD	75.52m AOD
CS 2	75.14m AOD	75.25m AOD
CS 3	74.46m AOD	74.77m AOD
CS 4	74.42m AOD	74.51m AOD
CS 5	74.22m AOD	74.31m AOD
CS 6	73.05m AOD	73.11m AOD

CS 7	72.61m AOD	72.76m AOD
CS 8	72.66m AOD	72.72m AOD
CS 9	72.30m AOD	72.63m AOD
CS 10	72.07m AOD	72.24m AOD
CS 11	71.52m AOD	71.65m AOD
CS 12	70.68m AOD	70.79m AOD
CS 13	69.57m AOD	69.73m AOD
CS 14	68.94m AOD	69.06m AOD



LEGEND

- Site Boundary
- Stream / River
- Cross Section Locations
- Contour Lines
- Development Area
- 1 in 1000-year flood extents (+ C.C Allowance)



PROJECT:
Site Specific Flood Risk Assessment.
- Ballyfeeny Green Energy

TITLE:
Modelled flood levels & areas within
proposed development site

SCALE: 1:2,000@A3	DRAWN BY: PMcC
DRAWING NO: Figure 3.	REV. B

Section 8 Justification Test

Table 3.1 of the guidelines provides three vulnerability categories, based on the type of development that may be appropriate to each flood zone. In summary:

Zone A - High probability of flooding: Most types of development would be considered inappropriate in this zone. Development in this zone should be avoided and/or only considered in exceptional circumstances, such as in city and town centres, or in the case of essential infrastructure that cannot be located elsewhere, and where the Justification Test has been applied. Only water-compatible development, such as docks and marinas, dockside activities that require a waterside location, amenity open space, outdoor sports and recreation, would be considered appropriate in this zone;

Zone B - Moderate probability of flooding: Highly vulnerable development, such as hospitals, residential care homes, Garda, fire and ambulance stations, dwelling houses and primary strategic transport and utilities infrastructure, would generally be considered inappropriate in this zone, unless the requirements of the Justification Test can be met. Less vulnerable development, such as retail, commercial and industrial uses, sites used for short-let for caravans and camping and secondary strategic transport and utilities infrastructure, and water-compatible development might be considered appropriate in this zone;

Zone C - Low probability of flooding: Development in this zone is appropriate from a flood risk perspective (subject to assessment of flood hazard from sources other than rivers and the coast) but would need to meet the normal range of other proper planning and sustainable development considerations.

A Justification Test is an assessment of whether a development proposal within an area at risk of flooding meets specific criteria for proper planning and sustainable development and demonstrates that it will not be subject to unacceptable risk nor increase flood risk elsewhere. Table 3.2 of the guidelines illustrates those types of development that would be required to meet the Justification Test (**Plate 6**).

	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

Plate 6. Matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification Test (Extract from The Planning System and Flood Risk Management Guidelines)

On the basis that all lands proposed for development within the proposed Project will be located within a 'Flood Zone C', the project can be deemed appropriate from a flood risk perspective. Notwithstanding this, a Development Management Justification Test was carried out in respect of the proposed Project in accordance with Section 5.15 of the Flood Risk Management Guidelines. **Table 5** presents the results of this test which conclude that the proposed Project satisfies the criteria of the Justification test.

Table 5. Development Management Justification Test (Box 5.1 of the 'Guidelines')

Criterion	Response
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.	The proposed Project is not located within a 'Constrained Land Use' designation and has been zoned as a 'Most Favoured Area' for wind energy development in the County Development Plan (CDP).
5.1.2 (i) The development proposed will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk.	The Flood Risk Assessment shows that the development areas onsite will be positioned within a 'Flood Zone C'. Consequently, the proposed development will not displace flood water to adjoining lands under the 1% or 0.1% AEP scenarios and thus will not increase flood risk in the vicinity of the site or wider environment or through any works proposed on the GCR or TDR.

5.1.2 (ii) The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible.	The 1 in 1000-year (+C.C.) flood level has been modelled to be at a minimum 1.2m below the current ground levels onsite where development is scheduled. Thus, risk to people and property is low. Furthermore, contamination of the Culliagh Stream via a flood pathway is unlikely given that all development is proposed within a 'Flood Zone C'.
5.1.2 (iii) The development proposed 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 Project does not impact on any existing flood protection measures and will not prevent any potential future flood risk management measures being installed, given the setback distances between the development areas (i.e. T03) and the Culliagh Stream (95m of a buffer). No flooding at the proposed site entrance off the R371 – Regional Road is mapped or modelled to occur hence, emergency service access to the site will not be hindered from a flood risk perspective.
5.1.2 (iv) The development proposed 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.	The proposed Project, GCR and TDR is not located within a 'Constrained Land Use' designation.

Section 9 Conclusions & Recommendations

In consideration of the findings of this detailed site-specific flood risk assessment, the following conclusions and recommendations can be made:

- The 2011 PFRA mapping indicates that a small part of the applicant's site (i.e. along the eastern boundary) is potentially susceptible to fluvial flooding;
- These maps are however based on preliminary, non-definitive data and the OPW advises that these maps should not be used to assess risk to individual properties;

- Consequently, a hydraulic assessment of the Culliagh Stream was completed in order to predict the 1 in 100-year and 1 in 1000-year (+ climate change allowance) flood scenarios;
- Some channel overspill was modelled to occur under the 1% AEP and 0.1% AEP flood events. However, the associated flood extents were marginal in nature. This is in agreement with the marginal quantity of flooding mapped as part of the PFRA study;
- Furthermore, these flood extents are not predicted to encroach onto the confines of the proposed Project areas. Therefore, the development can be described as being located outside of 'Flood Zone A' or 'Flood Zone B' and thus deemed acceptable from a flood risk perspective;
- A minimum freeboard of 1.2m currently exists between the 1 in 1000-year (+C.C) flood level and proposed development locations;
- No flooding at the proposed site entrance off the R371 – Regional Road is mapped or modelled to occur hence, emergency service access to the site will not be restricted from a flood risk perspective (i.e. ground levels at site entrance at c. 104m AOD);
- In addition, no flooding from the PFRA, CFRAM, NIFM, GSI or OPW flood record datasets are mapped/recorded at any location along the offsite grid connection route or at any location where temporary accommodation works are proposed on the TDR;
- Consequently, the proposed project is deemed to have passed the criteria of the Justification Test; and
- **To conclude the development will not be at risk from flooding under the previously discussed scenarios nor will it exacerbate flooding in the immediate vicinity or wider area.**

Signed:

Patrick McCabe

Patrick McCabe B.Sc., M.Sc.

(P.I. available on request)

This document has been prepared as a Flood Risk Assessment for Ballyfeeny Green Energy Limited specifically for the associated site. Hydrec Environmental Consulting accepts no responsibility or liability for any use that is made of this document other than by the client for the purposes for which it was originally commissioned and prepared.

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Appendices

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Appendices

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APPENDIX 1

HISTORICAL FLOOD RECORDS

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MINUTES OF MEETING

Reference: P4D403A – F310 – 028 – 004-005 Page 1 of 3

Project No.: P4D403A

Project Title: OPW Flood Hazard Mapping – Phase 1

Purpose of Meeting: Roscommon County Council – Oral Report – Area Engineer – Strokestown

Participating: Area Engineer Roscommon County Council
Supervisors Roscommon County Council
Search Manager ESBI

Venue: Strokestown

Date of Meeting: 21/12/04

Copies to:

Compiled by: Search Manager ESBI

Status Draft

Approved for ESBI:

Approved for Roscommon County Council

Date:

Meeting with Area Engineer for Strokestown 21/12/04

The Area Engineer and his supervisors outlined 35 areas that are or were prone to flooding. These are: -

1. Tulsk – An area south of the town that floods after intense winter rainfall. The flood will last approximately 24 hrs and the road is liable to flooding
Flood Id = 78
2. Corbally/Tulsk – A significant area east of the town along the N5 floods every winter. This is a low-lying area
Flood Id = 823
3. Kilcooley/Clooncullaan – River over flows its banks every winter and floods significant area
Flood Id = 80
4. Ardakillin Lough – River flowing into lake overflows its banks or lake level rises and floods significant area.
Flood Id = 81
5. Sroove – River overflows its banks every winter
Flood Id = 82
6. Cloonconny – Cloonfinlack river overflows its banks every winter
Flood Id = 84
7. Farnmore along R368 – Low lying land floods every winter. Road is liable to flooding, council have raised road level.
Flood Id = 85
8. Scramoge Bridge on N5 – River Scramoge overflow its banks every winter and floods significant area. The N5 has been realigned and the NRA office in Roscommon town has significant data, photographs and reports on the flooding.
Flood Id = 83
9. N5 South east of Strokestown – Road and surrounding land is liable to flooding after intense rainfall when land is already saturated. This mostly occurs in winter.
Flood Id = 86
10. Mouth of Feorish River – Feorish River overflows its banks ever winter and floods a large area. This occurs every winter.
Flood Id = 87
11. River Shannon North of Lanesborough – The river overflows its banks
Flood Id = 88
12. Shannon Heights, Lanesborough – Land around the Shannon Heights development is liable to flooding. This could be due to the development and the existing drainage not able to cope with the runoff
Flood Id = 89
13. Carroward – Areas of low-lying land along road flood every year
Flood Id = 90
14. Scramoge River from Cloonboney to Ballymore – River Scamoge floods bank every winter and floods a significant area every winter.
Flood Id = 91
15. Kilbride River – River Kilbride overflows its banks ever winter and floods a large area.
Flood Id = 92

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16. Aghadangan – After heavy rainfall mountain stream rush down mountain side and cause damage. Road is damaged by the flood and debris is deposited on the road Flood Id = 93
17. Cloonybeirne – Lake level rises and floods significant land area every winter
Flood Id = 94
18. Cloonfree west of Strokestown either side of N5 – River overflow its banks every winter
Flood Id = 95
19. Killynagh – Lowlying area floods every winter
Flood Id = 96
20. Shankill Cross on N61. Flood occurs every winter in low-lying area just north of the cross road.
Flood Id = 97
21. Elphin, Back of Grammar School – Low lying land floods every winter (possible drainage issue)
Flood Id = 98
22. Clashaganey – Lowlying land floods every winter
Flood Id = 99
23. Carrowkell - Lowlying land floods every winter
Flood Id = 100
24. Elphin, Opposite Community Hall – Small area floods every winter after heavy rainfall. The flood last approximately 24 hrs
Flood Id = 101
25. Creggy – Turlough rises every year and floods significant area of land. Size of area is dependent on the rainfall.
Flood Id = 102
26. Gillstown – River Scramoge overflows its banks every winter as it enters Killglass Lough. Significant stretch of river floods
Flood Id = 103
27. Roosky – River Shannon overflow its banks
Flood Id = 104
28. Roosky – Lough Boderg level rises and floods significant area every winter
Flood Id = 105
29. Carrandoe/Rosky – Lake level rises and floods large area every winter
Flood Id = 106
30. Cloonflower – Road is liable to flooding
Flood Id = 107
31. Ballytoohey/Termonbarry – Lowlying land floods periodically every winter. The flood is of short duration
Flood Id = 108
32. Creeve – Low lying area floods every winter after intense rainfall
Flood Id = 109
33. Lugboy, junction of R368 - Low lying area floods every winter after intense rainfall
Flood Id = 110
34. Owenur River – Owenur river overflows its banks every winter
Flood Id = 111
35. Clooncosker - Low lying area floods every winter.
Flood Id = 112

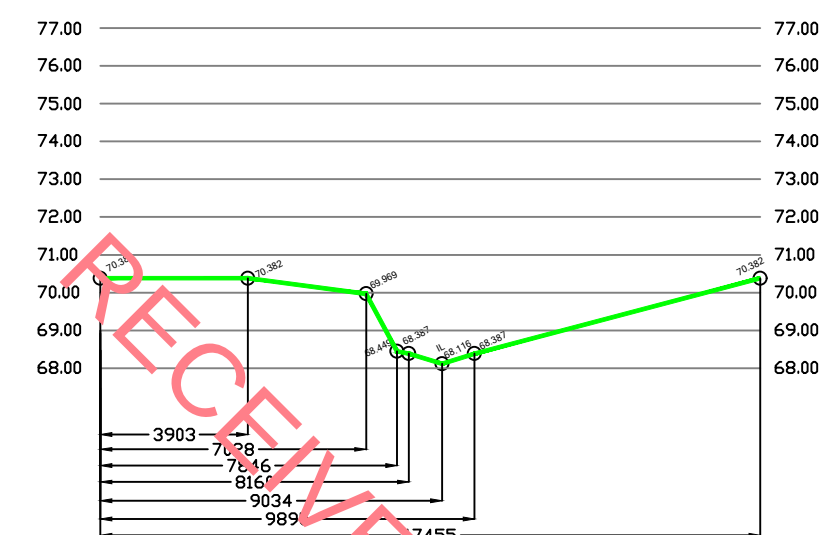
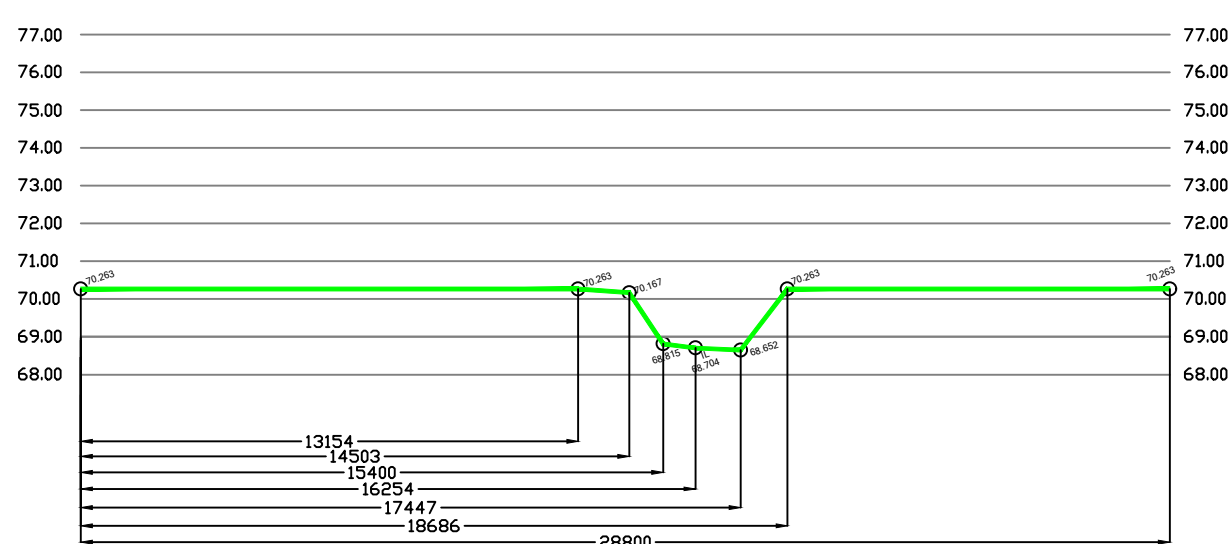
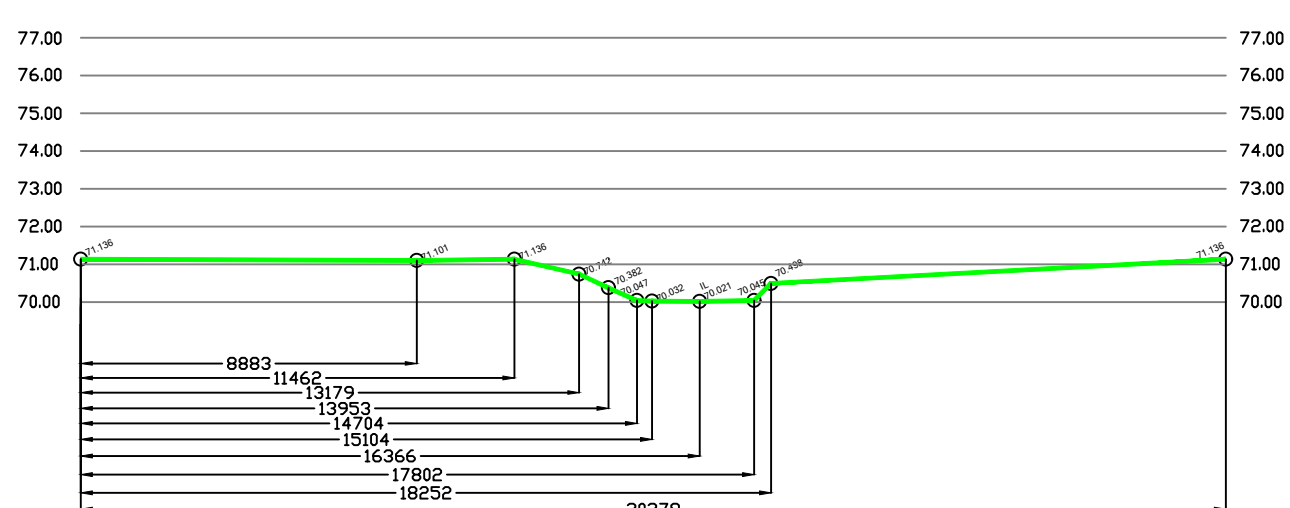
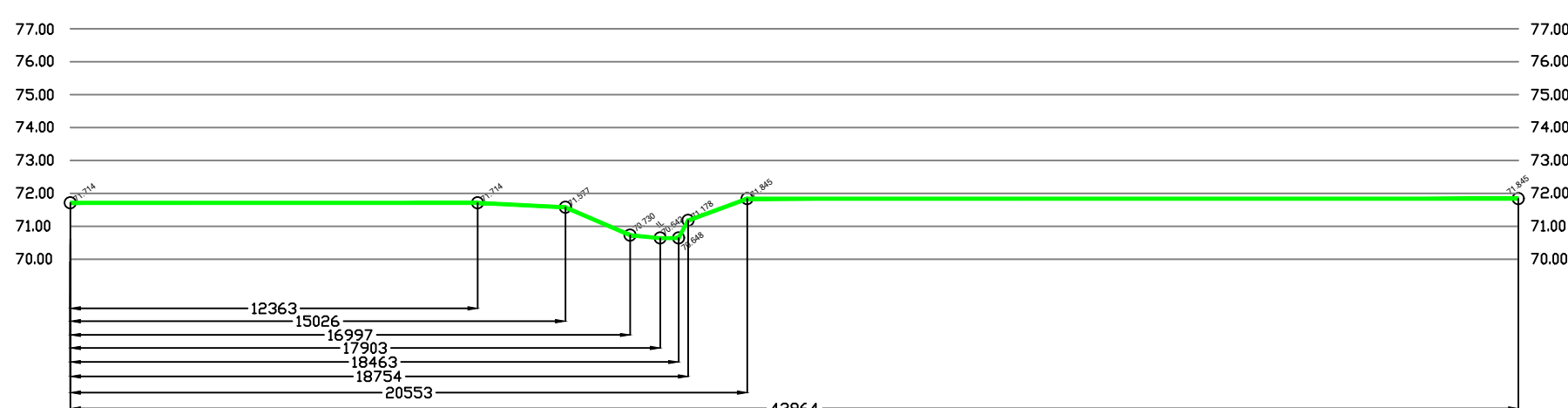
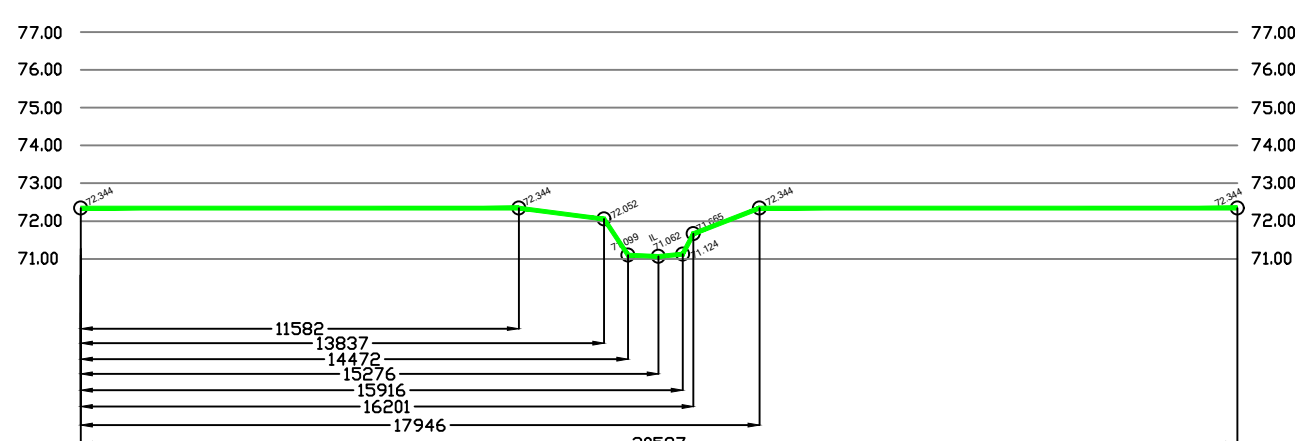
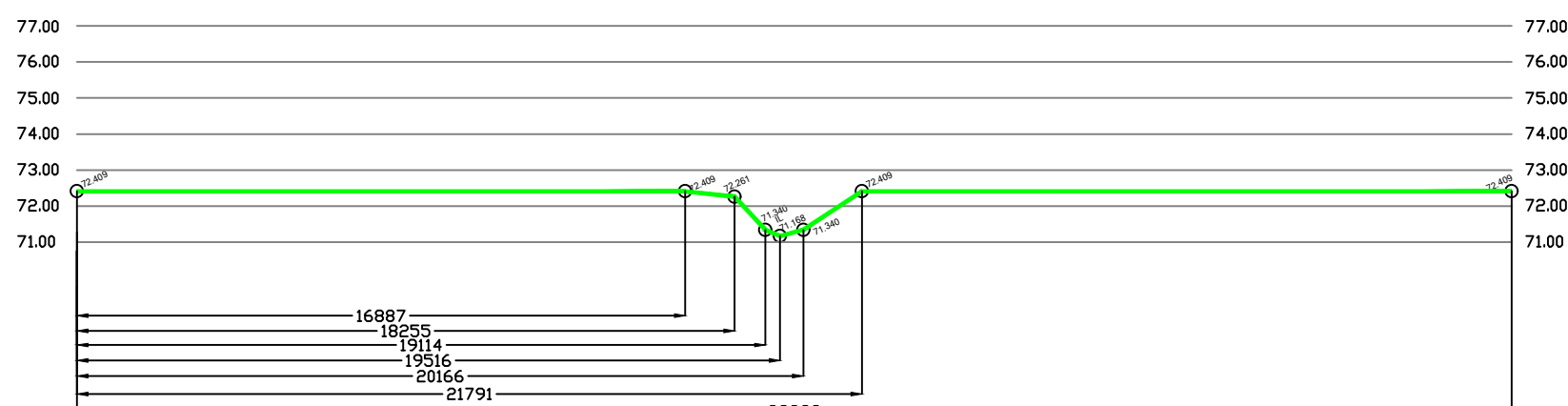
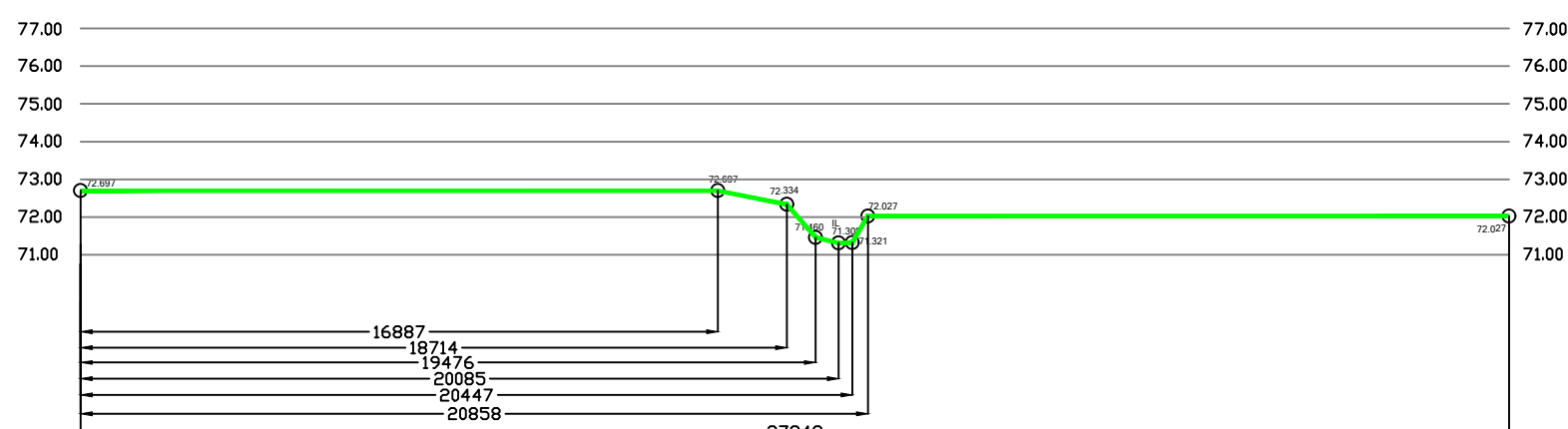
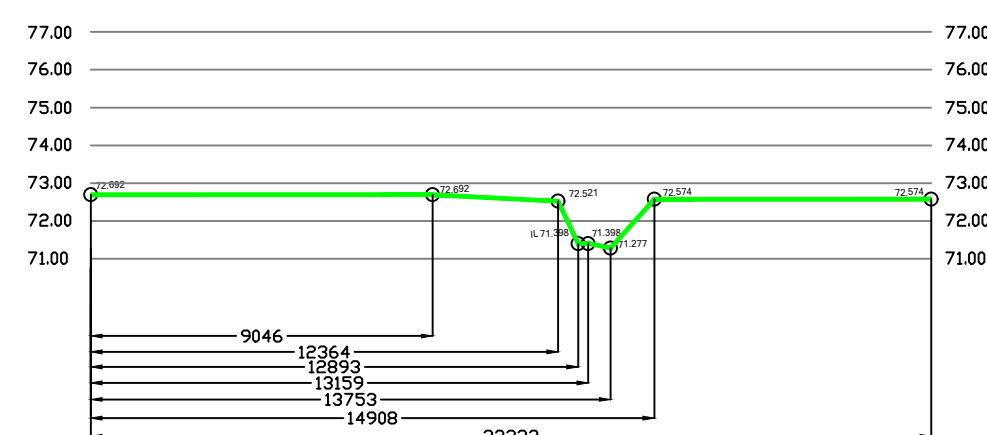
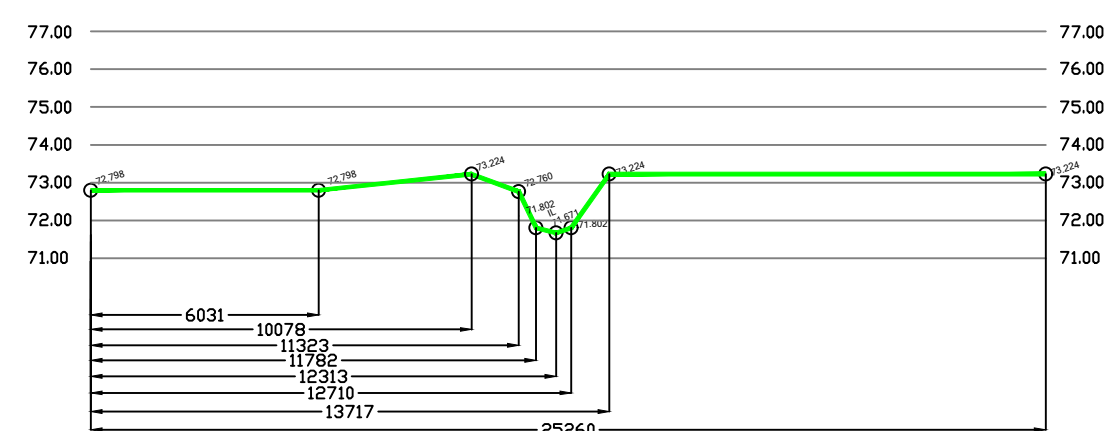
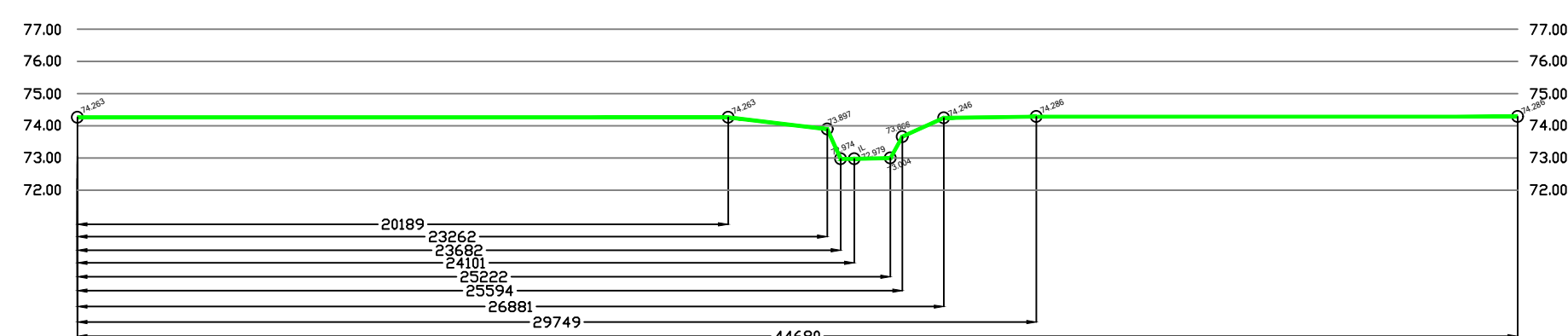
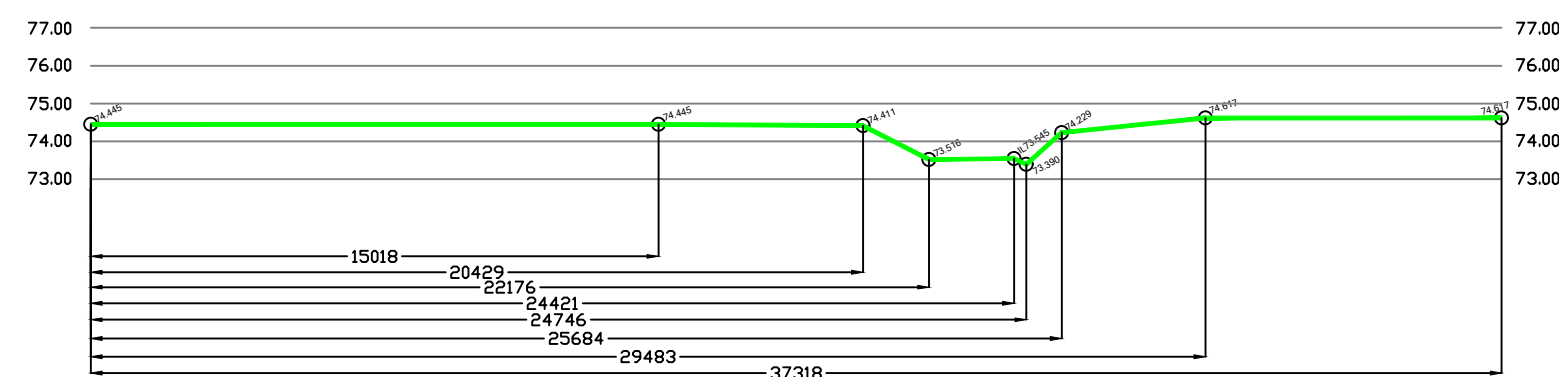
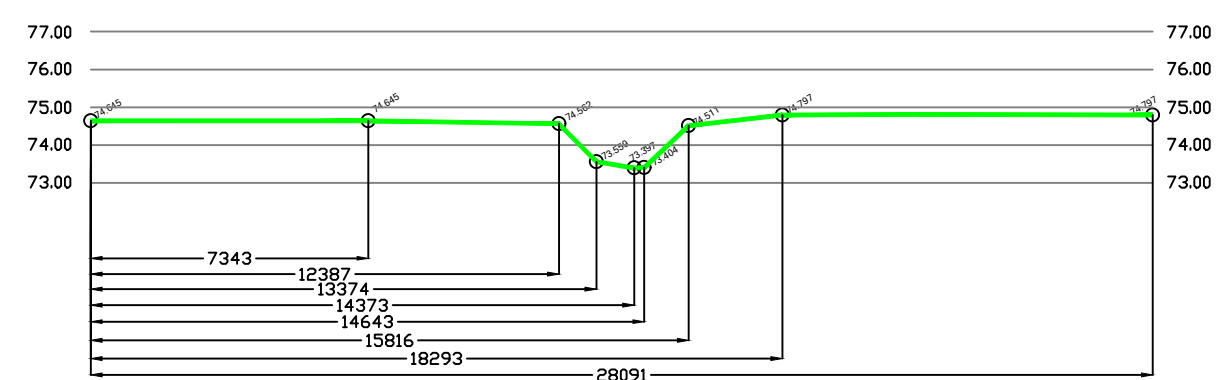
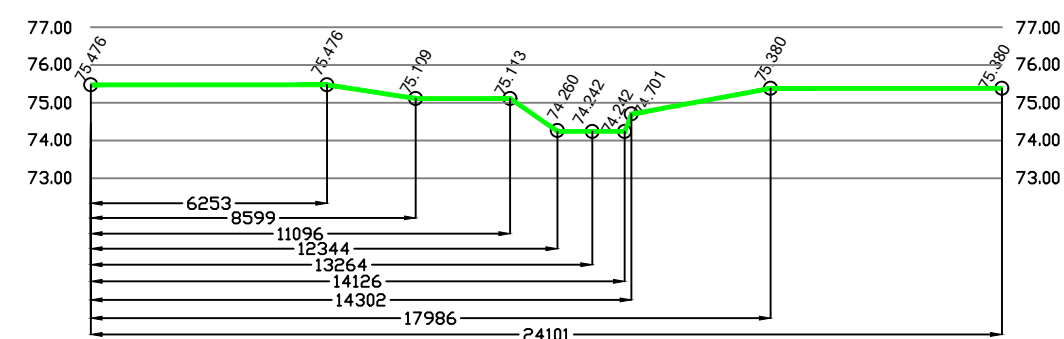
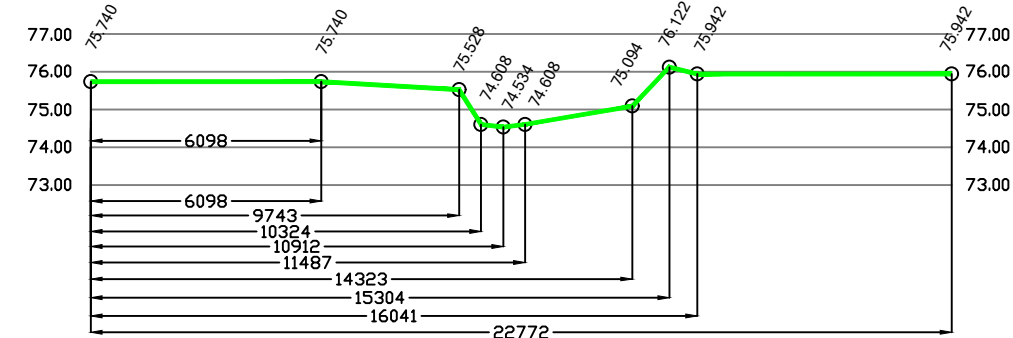
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APPENDIX 2

HORIZON SURVEYS – TOPOGRAPHICAL CROSS SECTIONS

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NOTES:

1. All levels are relative to Ordnance Datum Main Head
2. 50m sq grid relative to Irish Transverse Mercator Co-ordinate reference system
3. Contours are at .25m intervals

LINE TYPE LEGEND			
TRC	Box	55	Electricity Box
PIPE	Downpipe	55	
PIPE	Electricity Pole	55	Fire Hydrant
PIPE	Gate	55	Free Station
PIPE	Gate	55	Inspection Cover
PIPE	Gas Valve	55	Insert Level
PIPE	Gas Cover	55	Lamp Post
PIPE	Finished Floor Level	55	Manhole
PIPE	Electricity Cover	55	
PIPE	Manhole Cover	55	
PIPE	Ridge	55	Telegraph pole
PIPE	Spot Level	55	Telecom Cover
PIPE	Sign	55	Tree

LINE TYPE LEGEND			
	Boundary		Surface Change
	Building		Step
	Bank Top		Vegetation Line
	Bank Bottom		Verge
	Channel		Telecom Cover
	Fence		Wall
	Kerb		Railing
	Path		Verge
	Overhead Electricity Line		Road Edge

REVISIONS		
No.	Date	Description

Client:

Hydrec

Professional:

XX

Project Title:

River Survey

Drawn:	TD	Dwg No:	01/001
Scale:	As Shown	Date:	20/06/24

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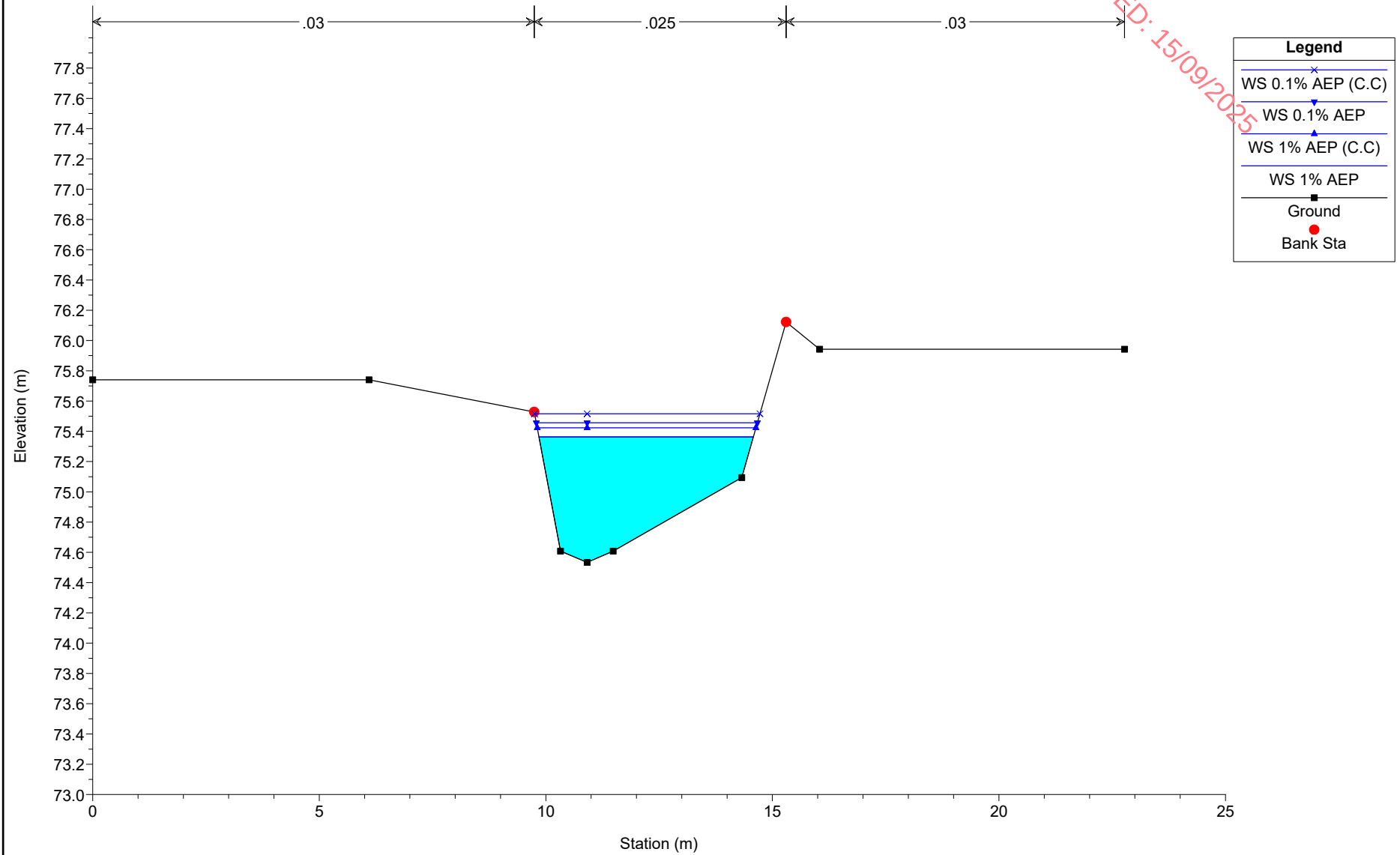
APPENDIX 3

HEC-RAS CROSS SECTION PROFILES

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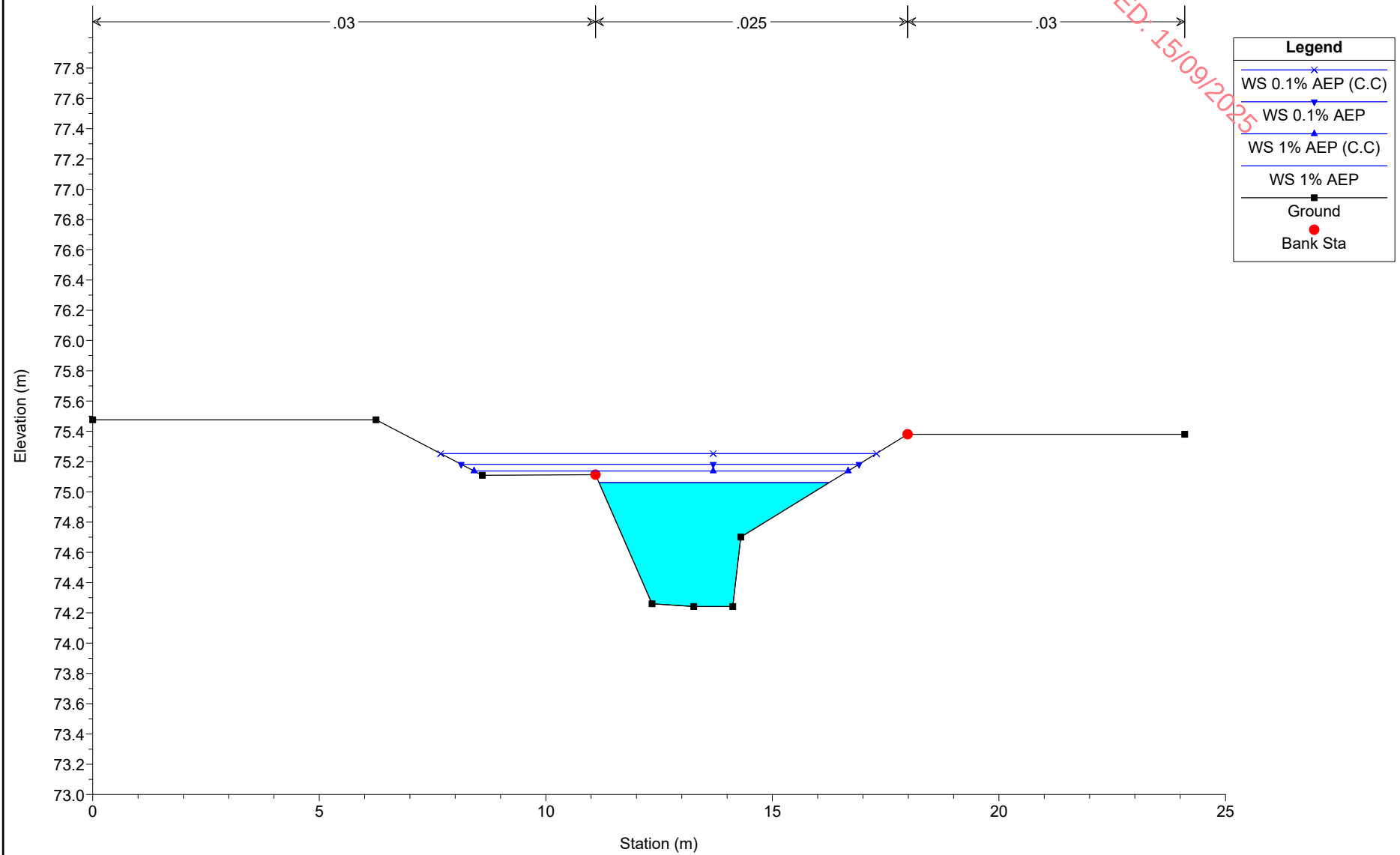
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Cross Section A



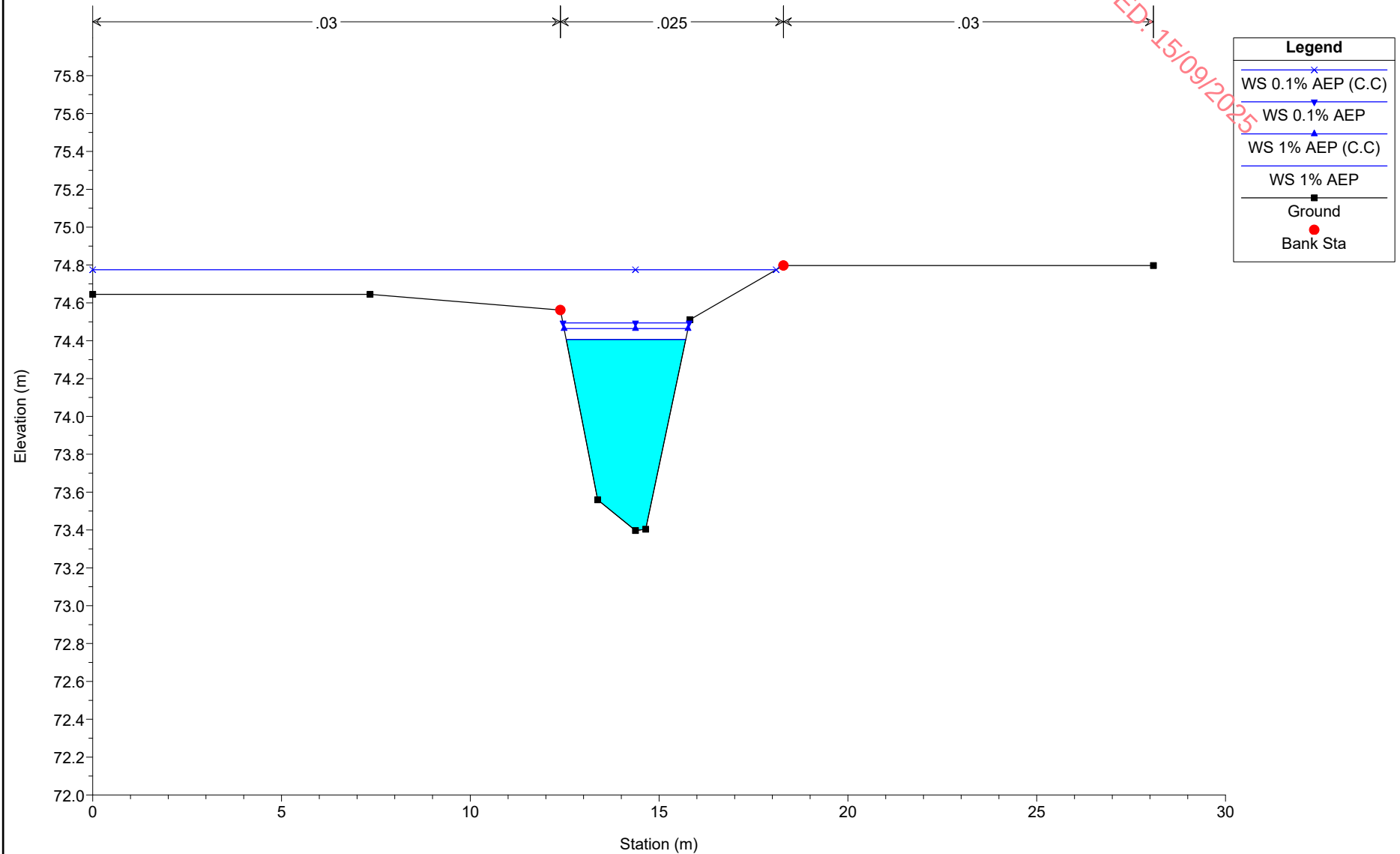
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Cross Section B



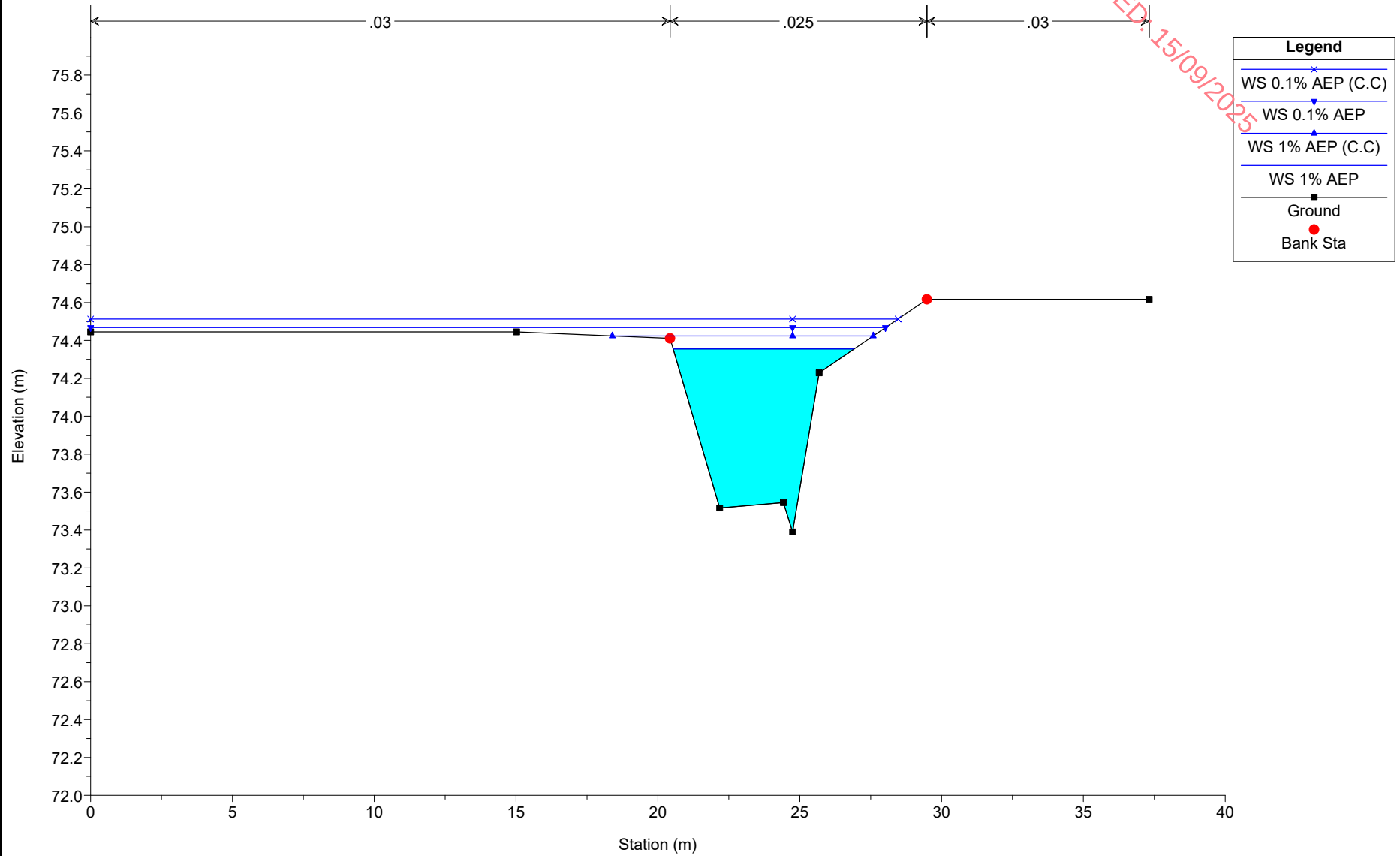
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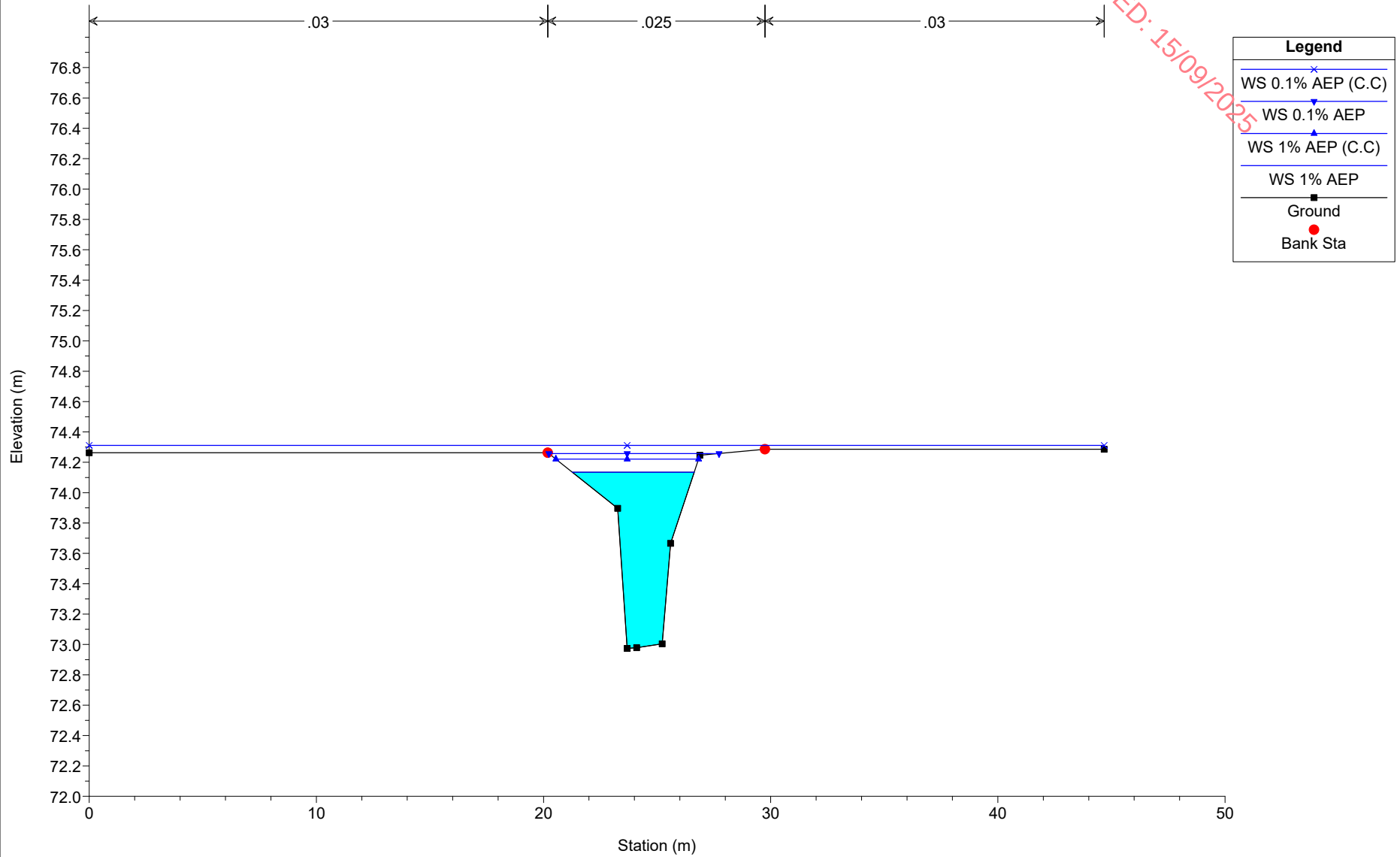
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Cross Section D



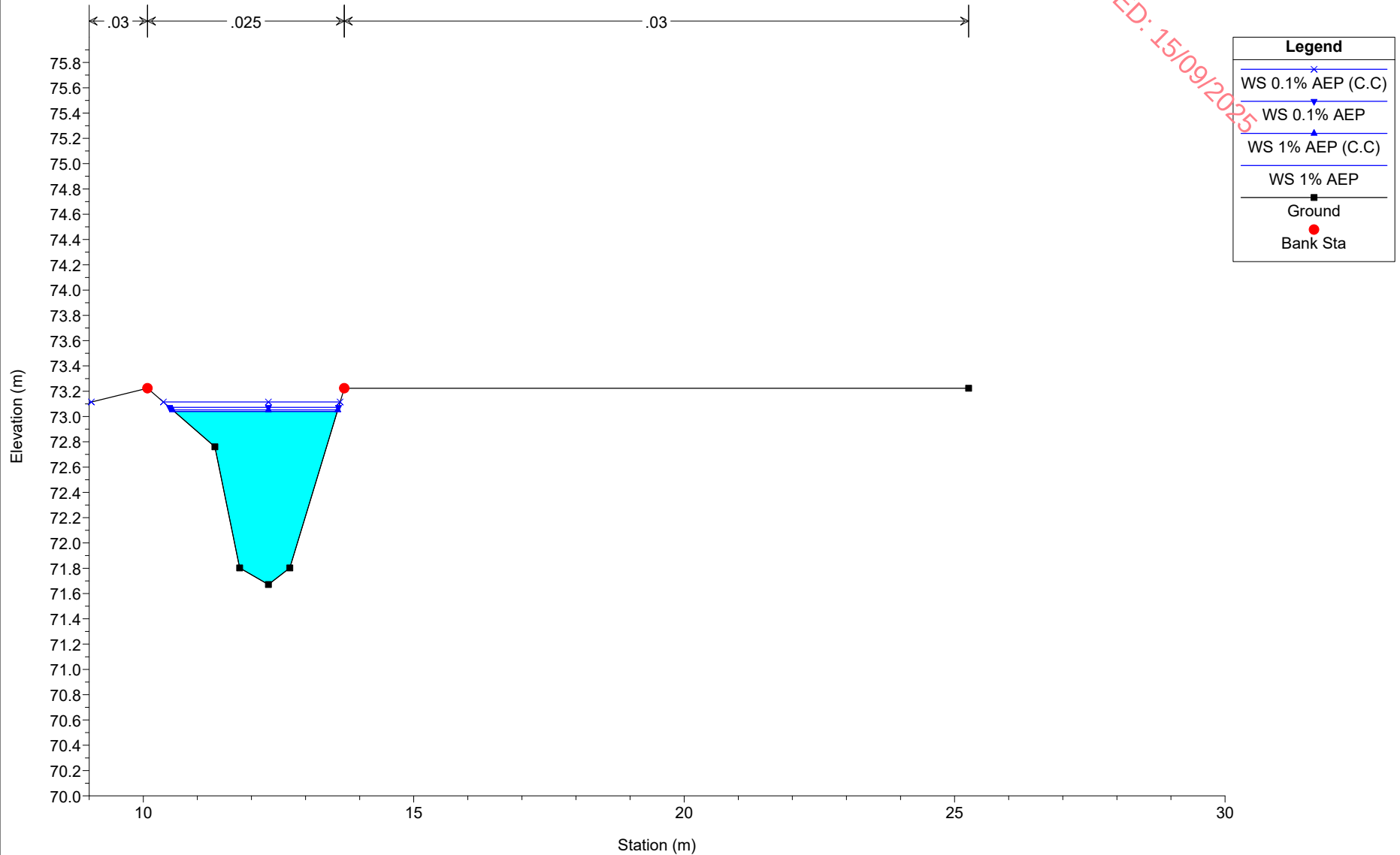
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Cross Section E



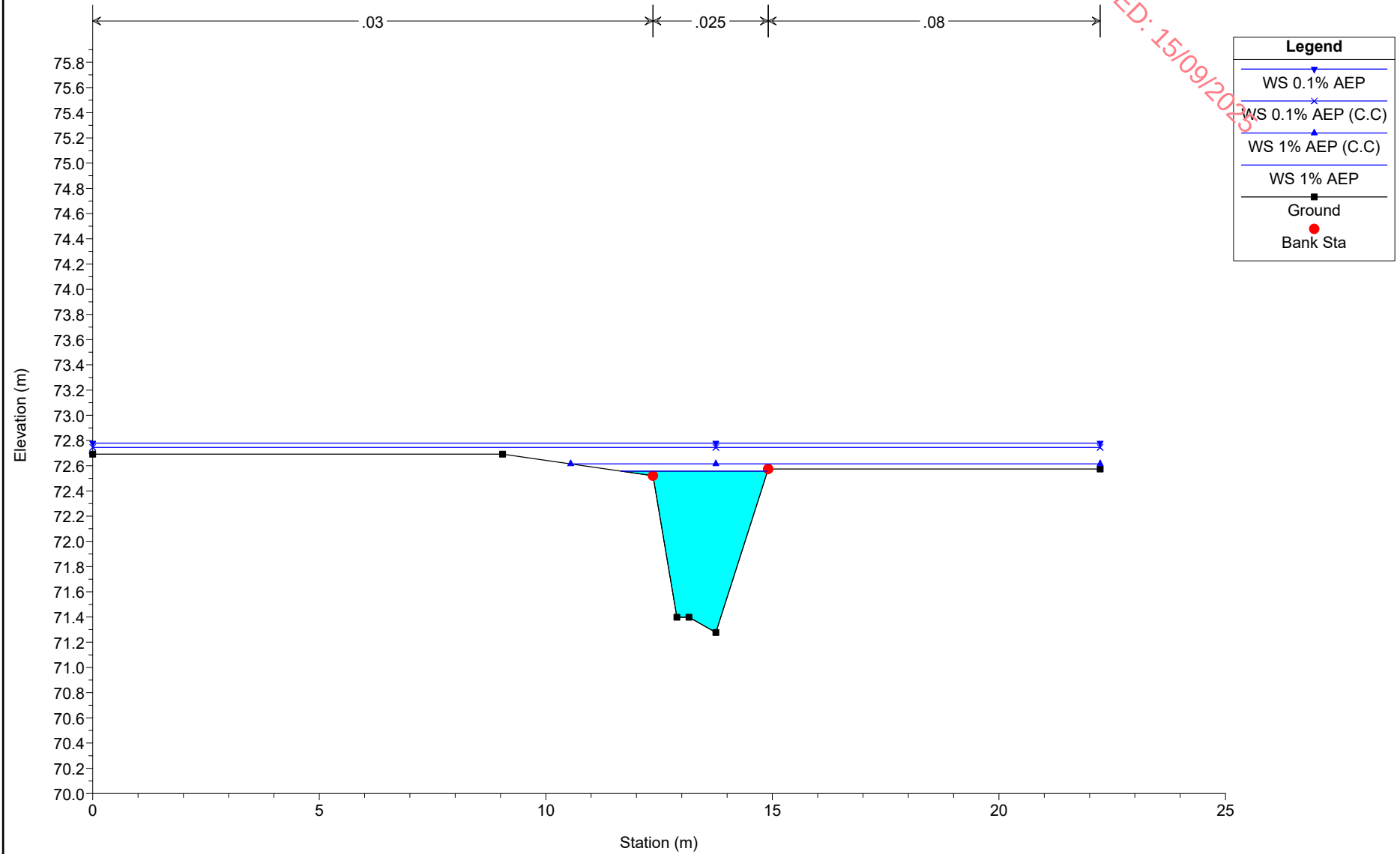
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Cross Section F



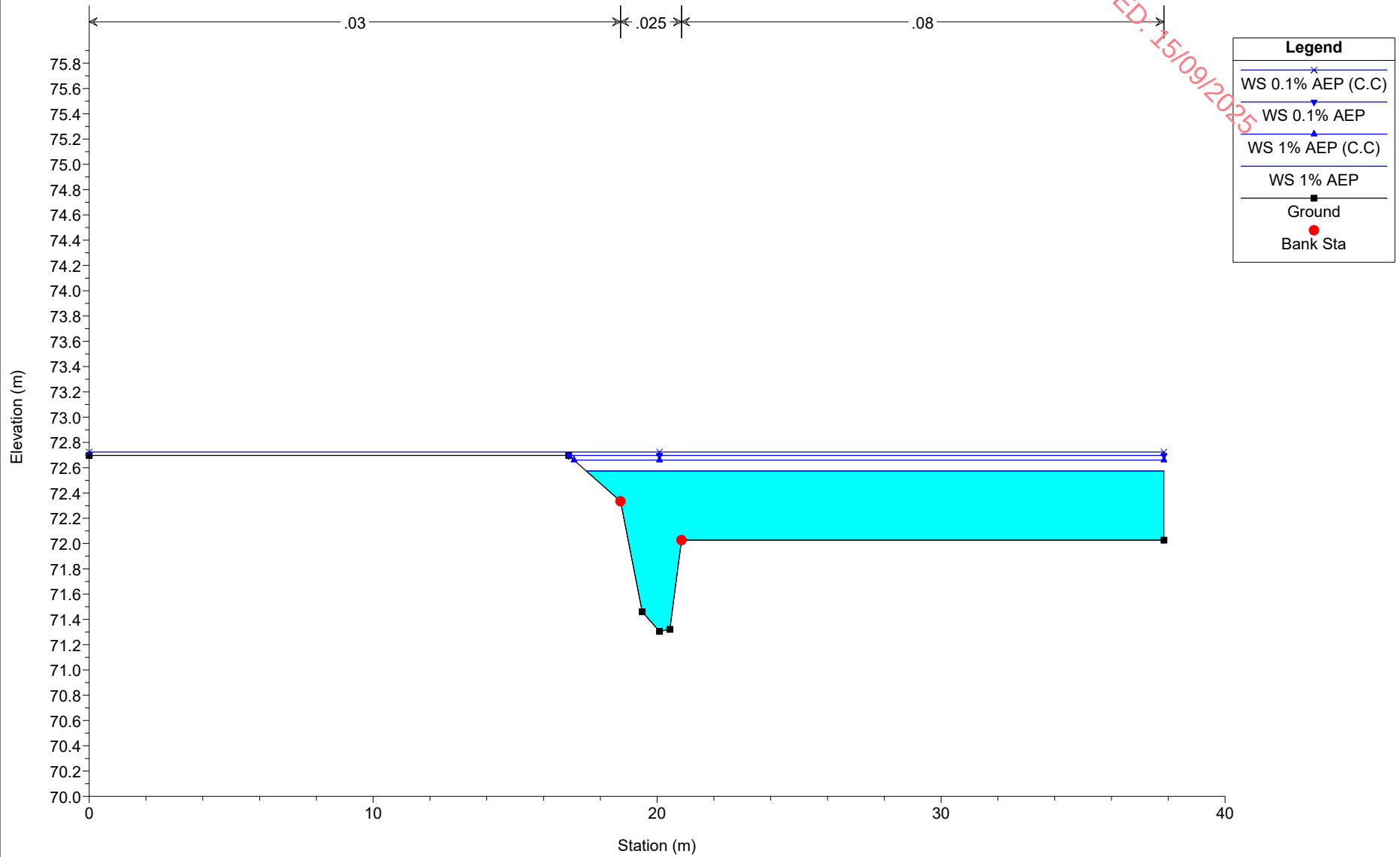
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Cross Section G



Ballyfeeny Green Energy Plan: Plan 01 02/07/2024

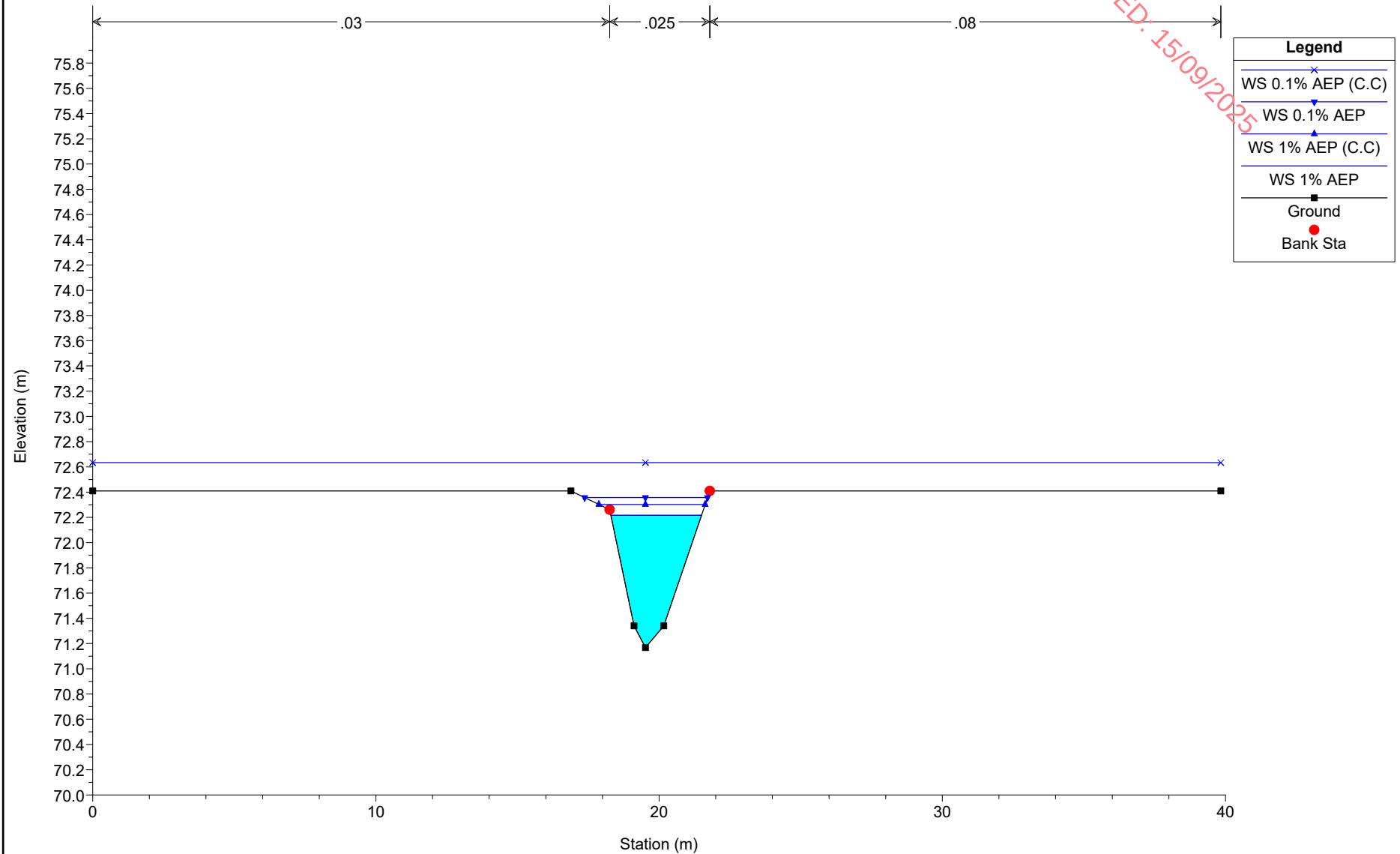
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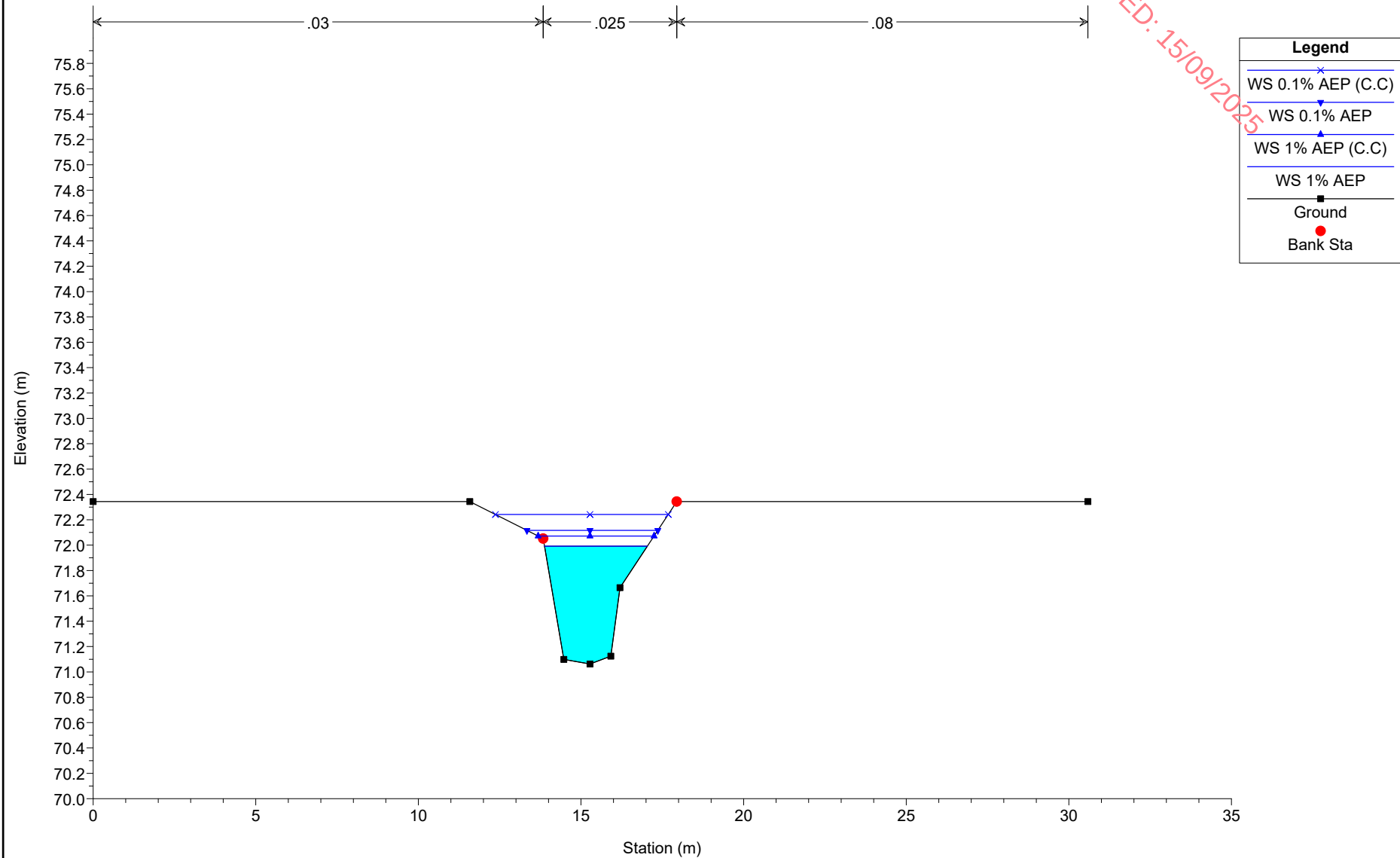
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Cross Section I



Ballyfeeny Green Energy Plan: Plan 01 02/07/2024

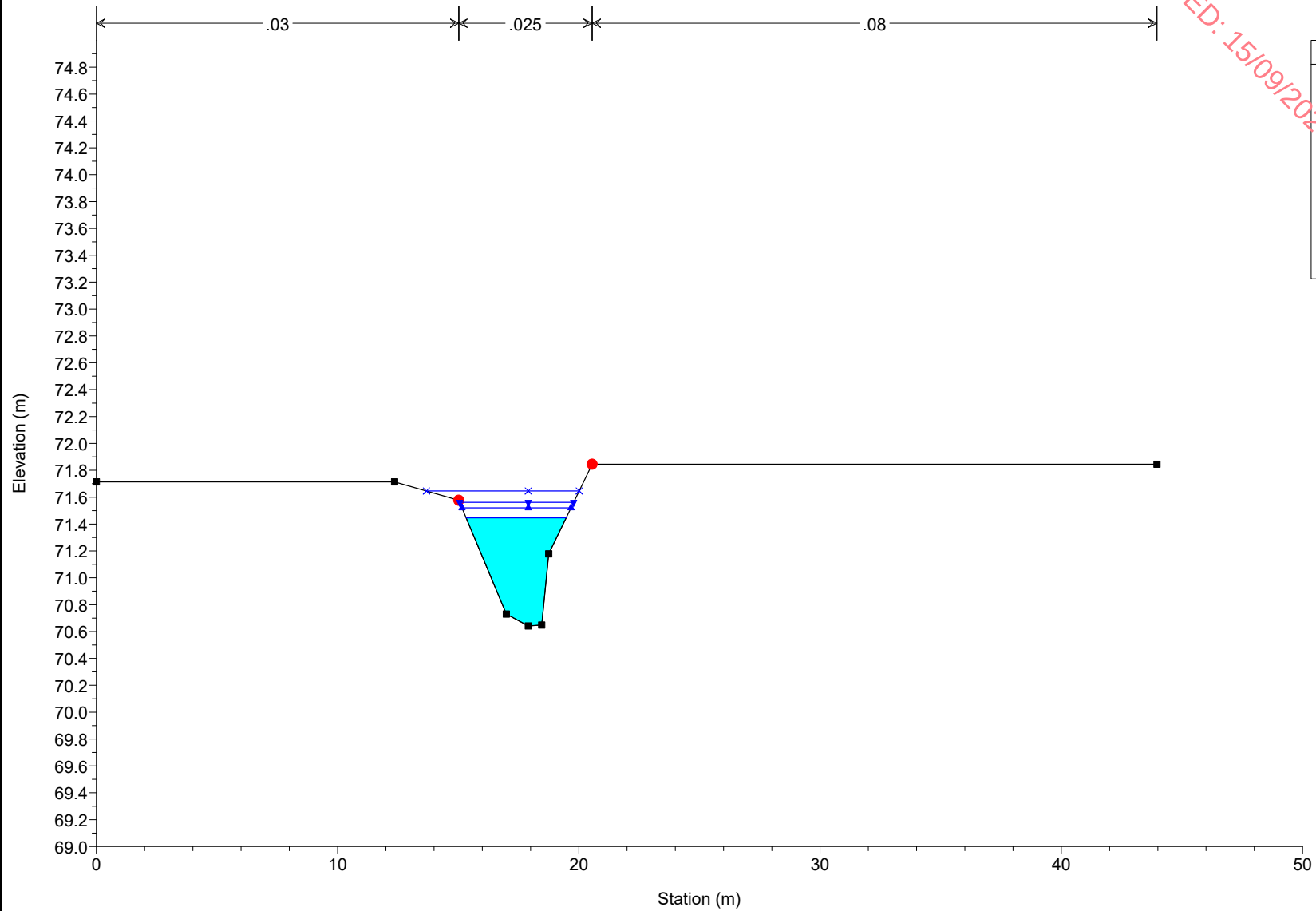
Cross Section J



Ballyfeeny Green Energy Plan: Plan 01 02/07/2024
Cross Section K

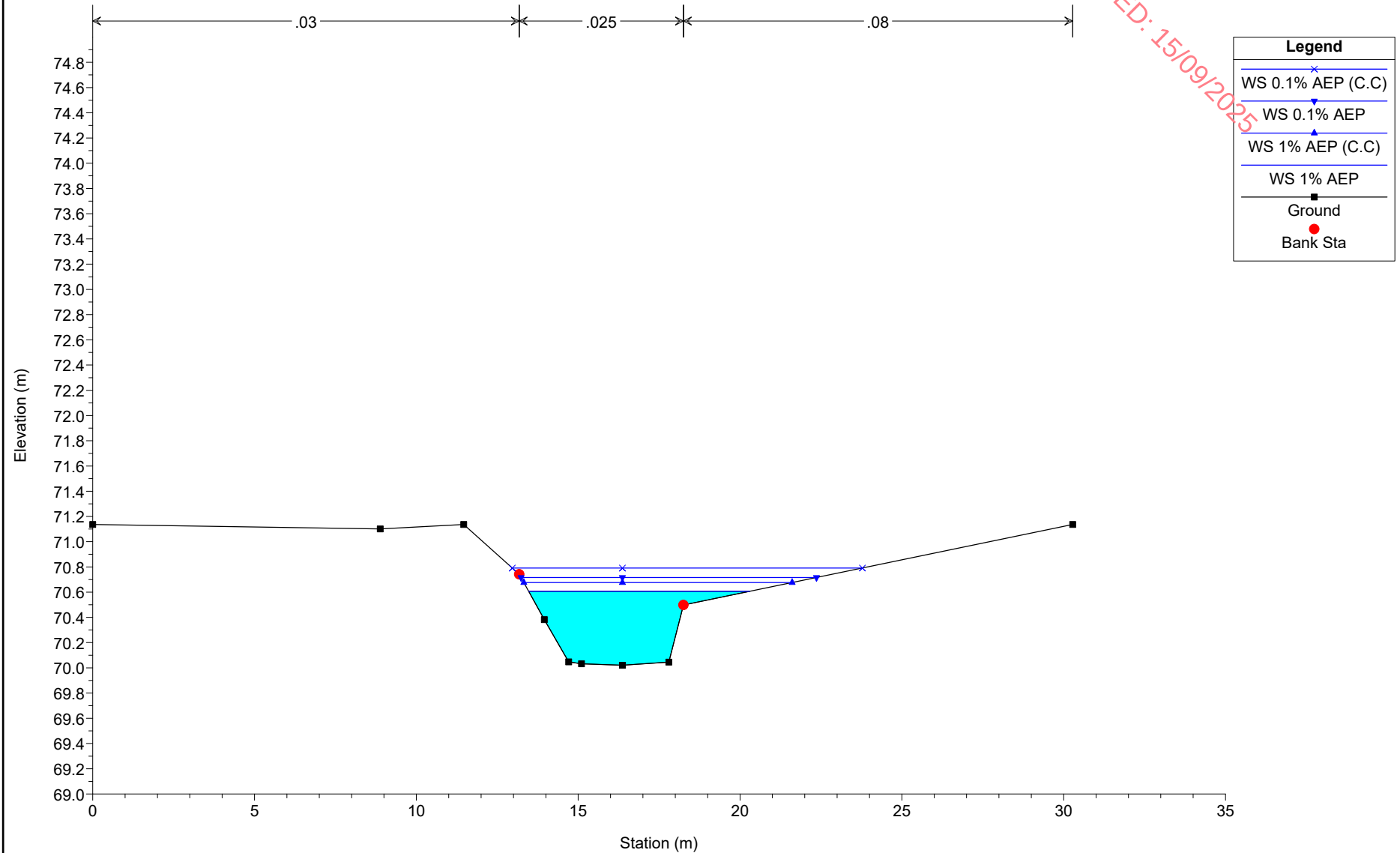
RECEIVED: 15/09/2025

Legend	
WS 0.1% AEP (C.C)	✕
WS 0.1% AEP	▼
WS 1% AEP (C.C)	▲
WS 1% AEP	—
Ground	■
Bank Sta	●



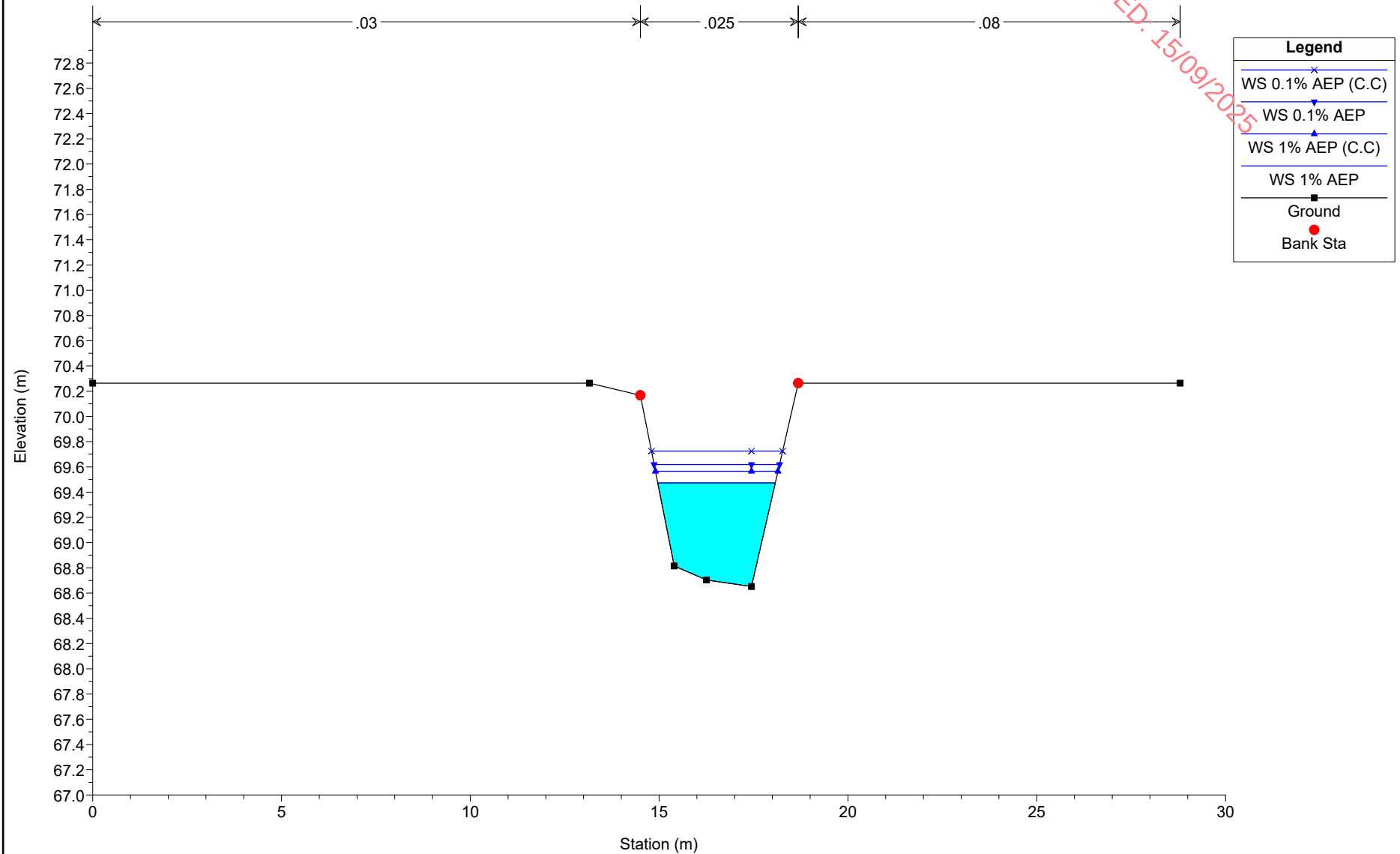
Ballyfeeny Green Energy Plan: Plan 01 02/07/2024

Cross Section L



Ballyfeeny Green Energy Plan: Plan 01 02/07/2024

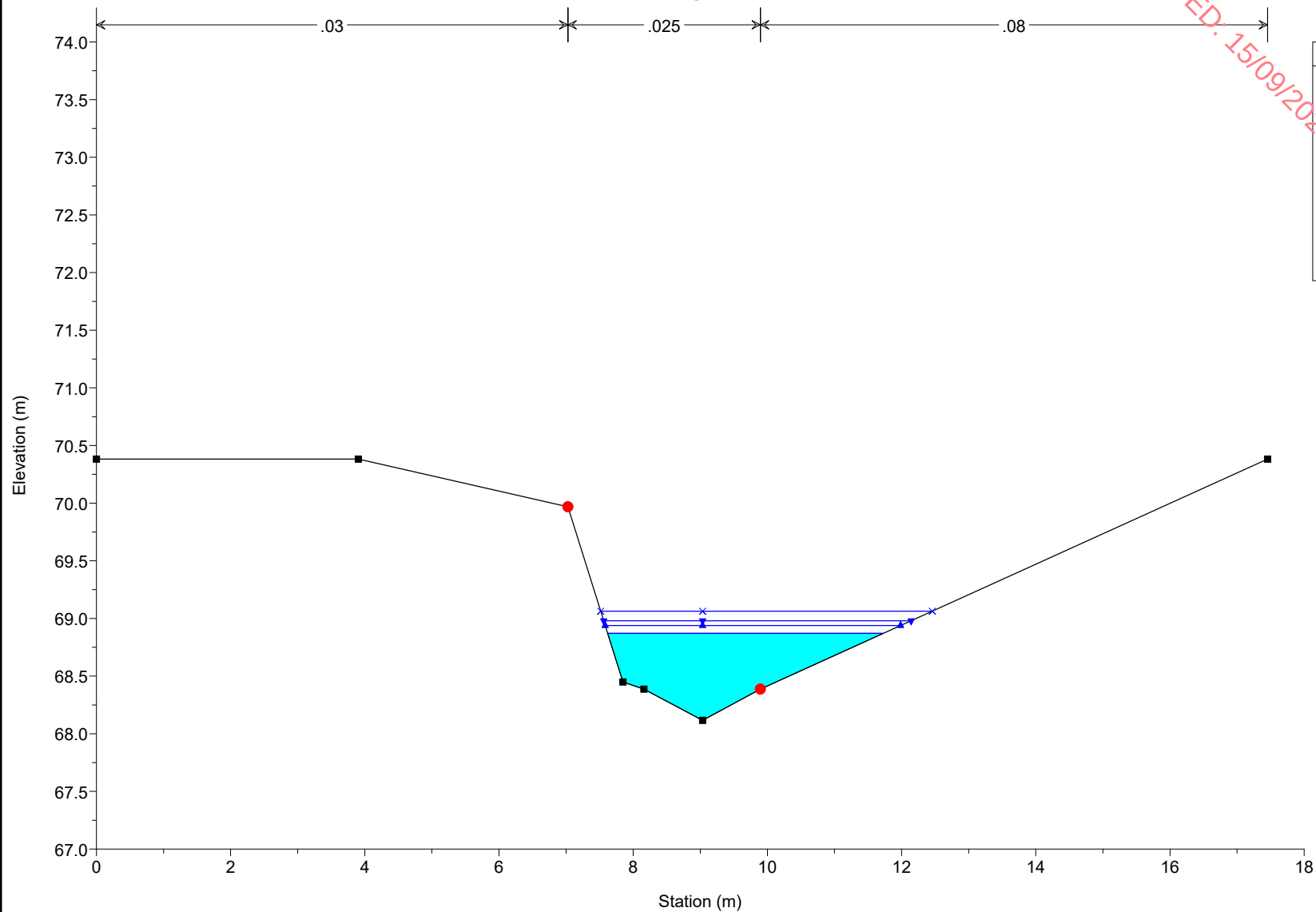
Cross Section M



Ballyfeeny Green Energy Plan: Plan 01 02/07/2024
Cross Section N

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Legend	
WS 0.1% AEP (C.C)	✕
WS 0.1% AEP	▼
WS 1% AEP (C.C)	▲
WS 1% AEP	—
Ground	■
Bank Sta	●



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APPENDIX 4

HEC-RAS HYDRAULIC MODEL OUTPUTS

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Plan: Plan 01 Culliagh Stream 1 RS: 215 Profile: 1% AEP

E.G. Elev (m)	75.51	Element	Left OB	Channel	Right OB
Vel Head (m)	0.14	Wt. n-Val.		0.025	
W.S. Elev (m)	75.36	Reach Len. (m)	4.00	4.00	4.00
Crit W.S. (m)	75.25	Flow Area (m2)		2.59	
E.G. Slope (m/m)	0.004599	Area (m2)		2.59	
Q Total (m3/s)	4.34	Flow (m3/s)		4.34	
Top Width (m)	4.73	Top Width (m)		4.73	
Vel Total (m/s)	1.68	Avg. Vel. (m/s)		1.68	
Max Chl Dpth (m)	0.83	Hydr. Depth (m)		0.55	
Conv. Total (m3/s)	64.0	Conv. (m3/s)		64.0	
Length Wtd. (m)	4.00	Wetted Per. (m)		5.31	
Min Ch El (m)	74.53	Shear (N/m2)		21.95	
Alpha	1.00	Stream Power (N/m s)		36.84	
Frctn Loss (m)	0.02	Cum Volume (1000 m3)	0.14	2.11	0.28
C & E Loss (m)	0.00	Cum SA (1000 m2)	1.49	3.69	0.93

Plan: Plan 01 Culliagh Stream 1 RS: 215 Profile: 1% AEP (C.C)

E.G. Elev (m)	75.59	Element	Left OB	Channel	Right OB
Vel Head (m)	0.17	Wt. n-Val.		0.025	
W.S. Elev (m)	75.42	Reach Len. (m)	4.00	4.00	4.00
Crit W.S. (m)	75.31	Flow Area (m2)		2.88	
E.G. Slope (m/m)	0.004853	Area (m2)		2.88	
Q Total (m3/s)	5.22	Flow (m3/s)		5.22	
Top Width (m)	4.83	Top Width (m)		4.83	
Vel Total (m/s)	1.82	Avg. Vel. (m/s)		1.82	
Max Chl Dpth (m)	0.89	Hydr. Depth (m)		0.60	
Conv. Total (m3/s)	74.9	Conv. (m3/s)		74.9	
Length Wtd. (m)	4.00	Wetted Per. (m)		5.47	
Min Ch El (m)	74.53	Shear (N/m2)		25.02	
Alpha	1.00	Stream Power (N/m s)		45.43	
Frctn Loss (m)	0.02	Cum Volume (1000 m3)	0.30	2.40	0.40
C & E Loss (m)	0.00	Cum SA (1000 m2)	3.09	3.94	1.33

Plan: Plan 01 Culliagh Stream 1 RS: 215 Profile: 0.1% AEP

E.G. Elev (m)	75.64	Element	Left OB	Channel	Right OB
Vel Head (m)	0.18	Wt. n-Val.		0.025	
W.S. Elev (m)	75.46	Reach Len. (m)	4.00	4.00	4.00
Crit W.S. (m)	75.34	Flow Area (m2)		3.04	
E.G. Slope (m/m)	0.005030	Area (m2)		3.04	
Q Total (m3/s)	5.76	Flow (m3/s)		5.76	
Top Width (m)	4.88	Top Width (m)		4.88	
Vel Total (m/s)	1.90	Avg. Vel. (m/s)		1.90	
Max Chl Dpth (m)	0.92	Hydr. Depth (m)		0.62	
Conv. Total (m3/s)	81.2	Conv. (m3/s)		81.2	
Length Wtd. (m)	4.00	Wetted Per. (m)		5.55	
Min Ch El (m)	74.53	Shear (N/m2)		26.97	
Alpha	1.00	Stream Power (N/m s)		51.16	
Frctn Loss (m)	0.02	Cum Volume (1000 m3)	0.49	2.57	0.49
C & E Loss (m)	0.00	Cum SA (1000 m2)	5.32	4.04	1.56

Plan: Plan 01 Culliagh Stream 1 RS: 215 Profile: 0.1% AEP (C.C)

E.G. Elev (m)	75.74	Element	Left OB	Channel	Right OB
Vel Head (m)	0.22	Wt. n-Val.		0.025	
W.S. Elev (m)	75.52	Reach Len. (m)	4.00	4.00	4.00
Crit W.S. (m)	75.42	Flow Area (m2)		3.33	
E.G. Slope (m/m)	0.005518	Area (m2)		3.33	
Q Total (m3/s)	6.91	Flow (m3/s)		6.91	

Plan: Plan 01 Culliagh Stream 1 RS: 215 Profile: 0.1% AEP (C.C) (Continued)

Top Width (m)	4.98	Top Width (m)		4.98	
Vel Total (m/s)	2.07	Avg. Vel. (m/s)		2.07	
Max Chl Dpth (m)	0.98	Hydr. Depth (m)		0.67	
Conv. Total (m3/s)	93.0	Conv. (m3/s)		93.0	
Length Wtd. (m)	4.00	Wetted Per. (m)		5.71	
Min Ch El (m)	74.53	Shear (N/m2)		31.58	
Alpha	1.00	Stream Power (N/m s)		65.52	
Frctn Loss (m)	0.02	Cum Volume (1000 m3)	0.86	2.84	0.61
C & E Loss (m)	0.00	Cum SA (1000 m2)	6.99	4.17	3.24

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Plan: Plan 01 Culliagh Stream 1 RS: 214 Profile: 1% AEP

E.G. Elev (m)	75.23	Element	Left OB	Channel	Right OB
Vel Head (m)	0.17	Wt. n-Val.		0.025	
W.S. Elev (m)	75.06	Reach Len. (m)	4.00	4.00	4.00
Crit W.S. (m)		Flow Area (m2)		2.37	
E.G. Slope (m/m)	0.006678	Area (m2)		2.37	
Q Total (m3/s)	4.34	Flow (m3/s)		4.34	
Top Width (m)	5.08	Top Width (m)		5.08	
Vel Total (m/s)	1.83	Avg. Vel. (m/s)		1.83	
Max Chl Dpth (m)	0.82	Hydr. Depth (m)		0.47	
Conv. Total (m3/s)	53.1	Conv. (m3/s)		53.1	
Length Wtd. (m)	4.00	Wetted Per. (m)		5.68	
Min Ch El (m)	74.24	Shear (N/m2)		27.39	
Alpha	1.00	Stream Power (N/m s)		50.07	
Frctn Loss (m)	0.03	Cum Volume (1000 m3)	0.14	2.00	0.28
C & E Loss (m)	0.00	Cum SA (1000 m2)	1.49	3.47	0.93

Plan: Plan 01 Culliagh Stream 1 RS: 214 Profile: 1% AEP (C.C)

E.G. Elev (m)	75.32	Element	Left OB	Channel	Right OB
Vel Head (m)	0.18	Wt. n-Val.	0.030	0.025	
W.S. Elev (m)	75.14	Reach Len. (m)	4.00	4.00	4.00
Crit W.S. (m)	75.07	Flow Area (m2)	0.07	2.79	
E.G. Slope (m/m)	0.006330	Area (m2)	0.07	2.79	
Q Total (m3/s)	5.22	Flow (m3/s)	0.02	5.20	
Top Width (m)	8.26	Top Width (m)	2.68	5.58	
Vel Total (m/s)	1.83	Avg. Vel. (m/s)	0.23	1.87	
Max Chl Dpth (m)	0.90	Hydr. Depth (m)	0.03	0.50	
Conv. Total (m3/s)	65.6	Conv. (m3/s)	0.2	65.4	
Length Wtd. (m)	4.00	Wetted Per. (m)	2.68	6.19	
Min Ch El (m)	74.24	Shear (N/m2)	1.60	27.92	
Alpha	1.04	Stream Power (N/m s)	0.37	52.15	
Frctn Loss (m)	0.03	Cum Volume (1000 m3)	0.30	2.28	0.40
C & E Loss (m)	0.00	Cum SA (1000 m2)	3.07	3.70	1.33

Plan: Plan 01 Culliagh Stream 1 RS: 214 Profile: 0.1% AEP

E.G. Elev (m)	75.36	Element	Left OB	Channel	Right OB
Vel Head (m)	0.18	Wt. n-Val.	0.030	0.025	
W.S. Elev (m)	75.18	Reach Len. (m)	4.00	4.00	4.00
Crit W.S. (m)	75.13	Flow Area (m2)	0.19	3.04	
E.G. Slope (m/m)	0.005947	Area (m2)	0.19	3.04	
Q Total (m3/s)	5.76	Flow (m3/s)	0.08	5.68	
Top Width (m)	8.78	Top Width (m)	2.96	5.82	
Vel Total (m/s)	1.78	Avg. Vel. (m/s)	0.42	1.87	
Max Chl Dpth (m)	0.94	Hydr. Depth (m)	0.07	0.52	
Conv. Total (m3/s)	74.7	Conv. (m3/s)	1.0	73.6	
Length Wtd. (m)	4.00	Wetted Per. (m)	2.97	6.44	
Min Ch El (m)	74.24	Shear (N/m2)	3.81	27.51	

Plan: Plan 01 Culliagh Stream 1 RS: 214 Profile: 0.1% AEP (Continued)

Alpha	1.09	Stream Power (N/m s)	1.59	51.44	
Frctn Loss (m)	0.02	Cum Volume (1000 m3)	0.49	2.44	0.49
C & E Loss (m)	0.00	Cum SA (1000 m2)	5.28	3.80	1.56

Plan: Plan 01 Culliagh Stream 1 RS: 214 Profile: 0.1% AEP (C.C)

E.G. Elev (m)	75.43	Element	Left OB	Channel	Right OB
Vel Head (m)	0.18	Wt. n-Val.	0.030	0.025	
W.S. Elev (m)	75.25	Reach Len. (m)	4.00	4.00	4.00
Crit W.S. (m)	75.21	Flow Area (m2)	0.42	3.46	
E.G. Slope (m/m)	0.005696	Area (m2)	0.42	3.46	
Q Total (m3/s)	6.91	Flow (m3/s)	0.26	6.65	
Top Width (m)	9.62	Top Width (m)	3.42	6.20	
Vel Total (m/s)	1.78	Avg. Vel. (m/s)	0.62	1.92	
Max Chl Dpth (m)	1.01	Hydr. Depth (m)	0.12	0.56	
Conv. Total (m3/s)	91.6	Conv. (m3/s)	3.5	88.1	
Length Wtd. (m)	4.00	Wetted Per. (m)	3.43	6.83	
Min Ch El (m)	74.24	Shear (N/m2)	6.85	28.33	
Alpha	1.12	Stream Power (N/m s)	4.25	54.39	
Frctn Loss (m)	0.02	Cum Volume (1000 m3)	0.85	2.69	0.61
C & E Loss (m)	0.00	Cum SA (1000 m2)	6.91	3.93	3.24

Plan: Plan 01 Culliagh Stream 1 RS: 213 Profile: 1% AEP

E.G. Elev (m)	74.63	Element	Left OB	Channel	Right OB
Vel Head (m)	0.22	Wt. n-Val.		0.025	
W.S. Elev (m)	74.41	Reach Len. (m)	3.80	3.80	3.80
Crit W.S. (m)		Flow Area (m2)		2.08	
E.G. Slope (m/m)	0.006310	Area (m2)		2.08	
Q Total (m3/s)	4.34	Flow (m3/s)		4.34	
Top Width (m)	3.17	Top Width (m)		3.17	
Vel Total (m/s)	2.08	Avg. Vel. (m/s)		2.08	
Max Chl Dpth (m)	1.01	Hydr. Depth (m)		0.66	
Conv. Total (m3/s)	54.6	Conv. (m3/s)		54.6	
Length Wtd. (m)	3.80	Wetted Per. (m)		3.93	
Min Ch El (m)	73.40	Shear (N/m2)		32.82	
Alpha	1.00	Stream Power (N/m s)		68.31	
Frctn Loss (m)	0.02	Cum Volume (1000 m3)	0.14	1.74	0.28
C & E Loss (m)	0.01	Cum SA (1000 m2)	1.49	3.00	0.93

Plan: Plan 01 Culliagh Stream 1 RS: 213 Profile: 1% AEP (C.C)

E.G. Elev (m)	74.73	Element	Left OB	Channel	Right OB
Vel Head (m)	0.27	Wt. n-Val.		0.025	
W.S. Elev (m)	74.46	Reach Len. (m)	3.80	3.80	3.80
Crit W.S. (m)	74.40	Flow Area (m2)		2.27	
E.G. Slope (m/m)	0.007246	Area (m2)		2.27	
Q Total (m3/s)	5.22	Flow (m3/s)		5.22	
Top Width (m)	3.28	Top Width (m)		3.28	
Vel Total (m/s)	2.30	Avg. Vel. (m/s)		2.30	
Max Chl Dpth (m)	1.07	Hydr. Depth (m)		0.69	
Conv. Total (m3/s)	61.3	Conv. (m3/s)		61.3	
Length Wtd. (m)	3.80	Wetted Per. (m)		4.10	
Min Ch El (m)	73.40	Shear (N/m2)		39.39	
Alpha	1.00	Stream Power (N/m s)		90.52	
Frctn Loss (m)	0.03	Cum Volume (1000 m3)	0.30	1.97	0.40
C & E Loss (m)	0.01	Cum SA (1000 m2)	3.01	3.19	1.32

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Plan: Plan 01 Culliagh Stream 1 RS: 213 Profile: 0.1% AEP

E.G. Elev (m)	74.80	Element	Left OB	Channel	Right OB
Vel Head (m)	0.30	Wt. n-Val.		0.025	
W.S. Elev (m)	74.49	Reach Len. (m)	3.80	3.80	3.80
Crit W.S. (m)	74.45	Flow Area (m2)		2.37	
E.G. Slope (m/m)	0.007880	Area (m2)		2.37	
Q Total (m3/s)	5.76	Flow (m3/s)		5.76	
Top Width (m)	3.34	Top Width (m)		3.34	
Vel Total (m/s)	2.43	Avg. Vel. (m/s)		2.43	
Max Chl Dpth (m)	1.10	Hydr. Depth (m)		0.71	
Conv. Total (m3/s)	64.9	Conv. (m3/s)		64.9	
Length Wtd. (m)	3.80	Wetted Per. (m)		4.18	
Min Ch El (m)	73.40	Shear (N/m2)		43.78	
Alpha	1.00	Stream Power (N/m s)		106.44	
Frctn Loss (m)	0.03	Cum Volume (1000 m3)	0.48	2.10	0.49
C & E Loss (m)	0.01	Cum SA (1000 m2)	4.97	3.27	1.55

Plan: Plan 01 Culliagh Stream 1 RS: 213 Profile: 0.1% AEP (C.C)

E.G. Elev (m)	74.91	Element	Left OB	Channel	Right OB
Vel Head (m)	0.14	Wt. n-Val.	0.030	0.025	0.030
W.S. Elev (m)	74.77	Reach Len. (m)	3.80	3.80	3.80
Crit W.S. (m)	74.55	Flow Area (m2)	1.82	3.33	0.30
E.G. Slope (m/m)	0.002756	Area (m2)	1.82	3.33	0.30
Q Total (m3/s)	6.91	Flow (m3/s)	0.88	5.90	0.14
Top Width (m)	18.10	Top Width (m)	12.39	3.43	2.28
Vel Total (m/s)	1.27	Avg. Vel. (m/s)	0.48	1.77	0.45
Max Chl Dpth (m)	1.38	Hydr. Depth (m)	0.15	0.97	0.13
Conv. Total (m3/s)	131.6	Conv. (m3/s)	16.7	112.3	2.6
Length Wtd. (m)	3.80	Wetted Per. (m)	12.52	4.30	2.30
Min Ch El (m)	73.40	Shear (N/m2)	3.92	20.92	3.54
Alpha	1.68	Stream Power (N/m s)	1.90	37.04	1.60
Frctn Loss (m)	0.02	Cum Volume (1000 m3)	0.79	2.31	0.60
C & E Loss (m)	0.02	Cum SA (1000 m2)	6.25	3.38	3.17

Plan: Plan 01 Culliagh Stream 1 RS: 212 Profile: 1% AEP

E.G. Elev (m)	74.44	Element	Left OB	Channel	Right OB
Vel Head (m)	0.09	Wt. n-Val.		0.025	0.030
W.S. Elev (m)	74.35	Reach Len. (m)	3.83	3.83	3.83
Crit W.S. (m)		Flow Area (m2)		3.34	0.08
E.G. Slope (m/m)	0.002139	Area (m2)		3.34	0.08
Q Total (m3/s)	4.34	Flow (m3/s)		4.32	0.02
Top Width (m)	6.38	Top Width (m)		5.15	1.23
Vel Total (m/s)	1.27	Avg. Vel. (m/s)		1.29	0.24
Max Chl Dpth (m)	0.96	Hydr. Depth (m)		0.65	0.06
Conv. Total (m3/s)	93.8	Conv. (m3/s)		93.4	0.4
Length Wtd. (m)	3.83	Wetted Per. (m)		5.70	1.24
Min Ch El (m)	73.39	Shear (N/m2)		12.28	1.32
Alpha	1.03	Stream Power (N/m s)		15.89	0.32
Frctn Loss (m)	0.01	Cum Volume (1000 m3)	0.14	1.64	0.28
C & E Loss (m)	0.00	Cum SA (1000 m2)	1.49	2.84	0.92

Plan: Plan 01 Culliagh Stream 1 RS: 212 Profile: 1% AEP (C.C)

E.G. Elev (m)	74.52	Element	Left OB	Channel	Right OB
Vel Head (m)	0.10	Wt. n-Val.	0.030	0.025	0.030
W.S. Elev (m)	74.42	Reach Len. (m)	3.83	3.83	3.83
Crit W.S. (m)		Flow Area (m2)	0.01	3.70	0.19
E.G. Slope (m/m)	0.002231	Area (m2)	0.01	3.70	0.19
Q Total (m3/s)	5.22	Flow (m3/s)	0.00	5.16	0.06

Plan: Plan 01 Culliagh Stream 1 RS: 212 Profile: 1% AEP (C.C) (Continued)

Top Width (m)	9.19	Top Width (m)	2.03	5.26	1.91
Vel Total (m/s)	1.34	Avg. Vel. (m/s)	0.05	1.40	0.33
Max Chl Dpth (m)	1.03	Hydr. Depth (m)	0.01	0.70	0.10
Conv. Total (m3/s)	110.5	Conv. (m3/s)	0.0	109.2	1.3
Length Wtd. (m)	3.83	Wetted Per. (m)	2.03	5.83	1.92
Min Ch El (m)	73.39	Shear (N/m2)	0.14	13.88	2.12
Alpha	1.07	Stream Power (N/m s)	0.01	19.37	0.71
Frctn Loss (m)	0.01	Cum Volume (1000 m3)	0.30	1.86	0.39
C & E Loss (m)	0.00	Cum SA (1000 m2)	3.01	3.03	1.30

Plan: Plan 01 Culliagh Stream 1 RS: 212 Profile: 0.1% AEP

E.G. Elev (m)	74.57	Element	Left OB	Channel	Right OB
Vel Head (m)	0.10	Wt. n-Val.	0.030	0.025	0.030
W.S. Elev (m)	74.47	Reach Len. (m)	3.83	3.83	3.83
Crit W.S. (m)	74.19	Flow Area (m2)	0.56	3.93	0.28
E.G. Slope (m/m)	0.002130	Area (m2)	0.56	3.93	0.28
Q Total (m3/s)	5.76	Flow (m3/s)	0.08	5.58	0.10
Top Width (m)	28.02	Top Width (m)	20.43	5.26	2.34
Vel Total (m/s)	1.21	Avg. Vel. (m/s)	0.14	1.42	0.37
Max Chl Dpth (m)	1.08	Hydr. Depth (m)	0.03	0.75	0.12
Conv. Total (m3/s)	124.8	Conv. (m3/s)	1.7	120.8	2.3
Length Wtd. (m)	3.83	Wetted Per. (m)	20.45	5.83	2.35
Min Ch El (m)	73.39	Shear (N/m2)	0.57	14.09	2.48
Alpha	1.34	Stream Power (N/m s)	0.08	20.00	0.92
Frctn Loss (m)	0.01	Cum Volume (1000 m3)	0.48	1.98	0.49
C & E Loss (m)	0.00	Cum SA (1000 m2)	4.84	3.11	1.51

Plan: Plan 01 Culliagh Stream 1 RS: 212 Profile: 0.1% AEP (C.C)

E.G. Elev (m)	74.62	Element	Left OB	Channel	Right OB
Vel Head (m)	0.11	Wt. n-Val.	0.030	0.025	0.030
W.S. Elev (m)	74.51	Reach Len. (m)	3.83	3.83	3.83
Crit W.S. (m)	74.27	Flow Area (m2)	1.48	4.17	0.40
E.G. Slope (m/m)	0.002257	Area (m2)	1.48	4.17	0.40
Q Total (m3/s)	6.91	Flow (m3/s)	0.41	6.33	0.17
Top Width (m)	28.47	Top Width (m)	20.43	5.26	2.78
Vel Total (m/s)	1.14	Avg. Vel. (m/s)	0.28	1.52	0.43
Max Chl Dpth (m)	1.12	Hydr. Depth (m)	0.07	0.79	0.14
Conv. Total (m3/s)	145.4	Conv. (m3/s)	8.6	133.3	3.6
Length Wtd. (m)	3.83	Wetted Per. (m)	20.50	5.83	2.80
Min Ch El (m)	73.39	Shear (N/m2)	1.60	15.83	3.13
Alpha	1.63	Stream Power (N/m s)	0.44	24.06	1.35
Frctn Loss (m)	0.01	Cum Volume (1000 m3)	0.78	2.19	0.60
C & E Loss (m)	0.00	Cum SA (1000 m2)	6.01	3.22	3.12

Plan: Plan 01 Culliagh Stream 1 RS: 211 Profile: 1% AEP

E.G. Elev (m)	74.25	Element	Left OB	Channel	Right OB
Vel Head (m)	0.12	Wt. n-Val.		0.025	
W.S. Elev (m)	74.13	Reach Len. (m)	3.97	3.97	3.97
Crit W.S. (m)		Flow Area (m2)		2.84	
E.G. Slope (m/m)	0.004372	Area (m2)		2.84	
Q Total (m3/s)	4.34	Flow (m3/s)		4.34	
Top Width (m)	5.37	Top Width (m)		5.37	
Vel Total (m/s)	1.53	Avg. Vel. (m/s)		1.53	
Max Chl Dpth (m)	1.16	Hydr. Depth (m)		0.53	
Conv. Total (m3/s)	65.6	Conv. (m3/s)		65.6	
Length Wtd. (m)	3.97	Wetted Per. (m)		6.47	
Min Ch El (m)	72.97	Shear (N/m2)		18.83	

Plan: Plan 01 Culliagh Stream 1 RS: 211 Profile: 1% AEP (Continued)

Alpha	1.00	Stream Power (N/m s)		28.77	
Frctn Loss (m)	0.02	Cum Volume (1000 m3)	0.14	1.50	0.28
C & E Loss (m)	0.00	Cum SA (1000 m2)	1.49	2.58	0.90

Plan: Plan 01 Culliagh Stream 1 RS: 211 Profile: 1% AEP (C.C)

E.G. Elev (m)	74.35	Element	Left OB	Channel	Right OB
Vel Head (m)	0.12	Wt. n-Val.		0.025	
W.S. Elev (m)	74.22	Reach Len. (m)	3.97	3.97	3.97
Crit W.S. (m)		Flow Area (m2)		3.34	
E.G. Slope (m/m)	0.004407	Area (m2)		3.34	
Q Total (m3/s)	5.22	Flow (m3/s)		5.22	
Top Width (m)	6.28	Top Width (m)		6.28	
Vel Total (m/s)	1.56	Avg. Vel. (m/s)		1.56	
Max Chl Dpth (m)	1.25	Hydr. Depth (m)		0.53	
Conv. Total (m3/s)	78.6	Conv. (m3/s)		78.6	
Length Wtd. (m)	3.97	Wetted Per. (m)		7.40	
Min Ch El (m)	72.97	Shear (N/m2)		19.51	
Alpha	1.00	Stream Power (N/m s)		30.48	
Frctn Loss (m)	0.02	Cum Volume (1000 m3)	0.30	1.70	0.39
C & E Loss (m)	0.00	Cum SA (1000 m2)	2.98	2.75	1.23

Plan: Plan 01 Culliagh Stream 1 RS: 211 Profile: 0.1% AEP

E.G. Elev (m)	74.39	Element	Left OB	Channel	Right OB
Vel Head (m)	0.13	Wt. n-Val.		0.025	0.030
W.S. Elev (m)	74.26	Reach Len. (m)	3.97	3.97	3.97
Crit W.S. (m)		Flow Area (m2)		3.58	0.01
E.G. Slope (m/m)	0.004549	Area (m2)		3.58	0.01
Q Total (m3/s)	5.76	Flow (m3/s)		5.76	0.00
Top Width (m)	7.50	Top Width (m)		6.65	0.85
Vel Total (m/s)	1.61	Avg. Vel. (m/s)		1.61	0.07
Max Chl Dpth (m)	1.28	Hydr. Depth (m)		0.54	0.01
Conv. Total (m3/s)	85.4	Conv. (m3/s)		85.4	0.0
Length Wtd. (m)	3.97	Wetted Per. (m)		7.78	0.85
Min Ch El (m)	72.97	Shear (N/m2)		20.54	0.26
Alpha	1.00	Stream Power (N/m s)		33.04	0.02
Frctn Loss (m)	0.02	Cum Volume (1000 m3)	0.46	1.82	0.48
C & E Loss (m)	0.00	Cum SA (1000 m2)	4.08	2.84	1.39

Plan: Plan 01 Culliagh Stream 1 RS: 211 Profile: 0.1% AEP (C.C)

E.G. Elev (m)	74.44	Element	Left OB	Channel	Right OB
Vel Head (m)	0.13	Wt. n-Val.	0.030	0.025	0.030
W.S. Elev (m)	74.31	Reach Len. (m)	3.97	3.97	3.97
Crit W.S. (m)	74.17	Flow Area (m2)	0.97	3.94	0.51
E.G. Slope (m/m)	0.004290	Area (m2)	0.97	3.94	0.51
Q Total (m3/s)	6.91	Flow (m3/s)	0.28	6.53	0.10
Top Width (m)	44.68	Top Width (m)	20.19	6.69	17.80
Vel Total (m/s)	1.28	Avg. Vel. (m/s)	0.29	1.66	0.20
Max Chl Dpth (m)	1.34	Hydr. Depth (m)	0.05	0.59	0.03
Conv. Total (m3/s)	105.5	Conv. (m3/s)	4.3	99.7	1.6
Length Wtd. (m)	3.97	Wetted Per. (m)	20.24	7.82	17.82
Min Ch El (m)	72.97	Shear (N/m2)	2.02	21.18	1.20
Alpha	1.60	Stream Power (N/m s)	0.58	35.12	0.24
Frctn Loss (m)	0.02	Cum Volume (1000 m3)	0.71	2.00	0.58
C & E Loss (m)	0.00	Cum SA (1000 m2)	5.07	2.94	2.77

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Plan: Plan 01 Culliagh Stream 1 RS: 210 Profile: 1% AEP

E.G. Elev (m)	73.13	Element	Left OB	Channel	Right OB
Vel Head (m)	0.08	Wt. n-Val.	0.030	0.025	
W.S. Elev (m)	73.04	Reach Len. (m)	3.95	3.95	3.95
Crit W.S. (m)		Flow Area (m2)	1.74	2.21	
E.G. Slope (m/m)	0.003253	Area (m2)	1.74	2.21	
Q Total (m3/s)	4.34	Flow (m3/s)	1.14	3.20	
Top Width (m)	11.35	Top Width (m)	8.33	3.02	
Vel Total (m/s)	1.10	Avg. Vel. (m/s)	0.66	1.45	
Max Chl Dpth (m)	1.37	Hydr. Depth (m)	0.21	0.73	
Conv. Total (m3/s)	76.1	Conv. (m3/s)	20.0	56.1	
Length Wtd. (m)	3.95	Wetted Per. (m)	8.58	4.35	
Min Ch El (m)	71.67	Shear (N/m2)	6.45	16.19	
Alpha	1.38	Stream Power (N/m s)	4.23	23.50	
Frctn Loss (m)	0.01	Cum Volume (1000 m3)	0.02	0.90	0.28
C & E Loss (m)	0.00	Cum SA (1000 m2)	0.15	1.60	0.90

Plan: Plan 01 Culliagh Stream 1 RS: 210 Profile: 1% AEP (C.C)

E.G. Elev (m)	73.17	Element	Left OB	Channel	Right OB
Vel Head (m)	0.11	Wt. n-Val.	0.030	0.025	
W.S. Elev (m)	73.05	Reach Len. (m)	3.95	3.95	3.95
Crit W.S. (m)		Flow Area (m2)	1.84	2.24	
E.G. Slope (m/m)	0.004372	Area (m2)	1.84	2.24	
Q Total (m3/s)	5.22	Flow (m3/s)	1.43	3.79	
Top Width (m)	11.50	Top Width (m)	8.44	3.06	
Vel Total (m/s)	1.28	Avg. Vel. (m/s)	0.78	1.69	
Max Chl Dpth (m)	1.38	Hydr. Depth (m)	0.22	0.73	
Conv. Total (m3/s)	78.9	Conv. (m3/s)	21.7	57.3	
Length Wtd. (m)	3.95	Wetted Per. (m)	8.71	4.39	
Min Ch El (m)	71.67	Shear (N/m2)	9.04	21.87	
Alpha	1.36	Stream Power (N/m s)	7.06	36.93	
Frctn Loss (m)	0.02	Cum Volume (1000 m3)	0.09	1.04	0.39
C & E Loss (m)	0.00	Cum SA (1000 m2)	0.82	1.68	1.23

Plan: Plan 01 Culliagh Stream 1 RS: 210 Profile: 0.1% AEP

E.G. Elev (m)	73.19	Element	Left OB	Channel	Right OB
Vel Head (m)	0.12	Wt. n-Val.	0.030	0.025	
W.S. Elev (m)	73.07	Reach Len. (m)	3.95	3.95	3.95
Crit W.S. (m)		Flow Area (m2)	2.01	2.31	
E.G. Slope (m/m)	0.004697	Area (m2)	2.01	2.31	
Q Total (m3/s)	5.76	Flow (m3/s)	1.70	4.06	
Top Width (m)	11.76	Top Width (m)	8.64	3.12	
Vel Total (m/s)	1.33	Avg. Vel. (m/s)	0.85	1.76	
Max Chl Dpth (m)	1.40	Hydr. Depth (m)	0.23	0.74	
Conv. Total (m3/s)	84.0	Conv. (m3/s)	24.8	59.2	
Length Wtd. (m)	3.95	Wetted Per. (m)	8.93	4.48	
Min Ch El (m)	71.67	Shear (N/m2)	10.38	23.71	
Alpha	1.35	Stream Power (N/m s)	8.78	41.74	
Frctn Loss (m)	0.02	Cum Volume (1000 m3)	0.17	1.12	0.48
C & E Loss (m)	0.00	Cum SA (1000 m2)	1.26	1.72	1.39

Plan: Plan 01 Culliagh Stream 1 RS: 210 Profile: 0.1% AEP (C.C)

E.G. Elev (m)	73.25	Element	Left OB	Channel	Right OB
Vel Head (m)	0.14	Wt. n-Val.	0.030	0.025	
W.S. Elev (m)	73.11	Reach Len. (m)	3.95	3.95	3.95
Crit W.S. (m)		Flow Area (m2)	2.39	2.44	
E.G. Slope (m/m)	0.005244	Area (m2)	2.39	2.44	
Q Total (m3/s)	6.91	Flow (m3/s)	2.31	4.60	

Plan: Plan 01 Culliagh Stream 1 RS: 210 Profile: 0.1% AEP (C.C) (Continued)

Top Width (m)	12.31	Top Width (m)	9.04	3.27	
Vel Total (m/s)	1.43	Avg. Vel. (m/s)	0.97	1.88	
Max Chl Dpth (m)	1.44	Hydr. Depth (m)	0.26	0.75	
Conv. Total (m3/s)	95.4	Conv. (m3/s)	31.9	63.5	
Length Wtd. (m)	3.95	Wetted Per. (m)	9.37	4.65	
Min Ch El (m)	71.67	Shear (N/m2)	13.09	26.98	
Alpha	1.31	Stream Power (N/m s)	12.69	50.84	
Frctn Loss (m)	0.02	Cum Volume (1000 m3)	0.25	1.25	0.56
C & E Loss (m)	0.00	Cum SA (1000 m2)	1.84	1.77	1.83

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Plan: Plan 01 Culliagh Stream 1 RS: 209 Profile: 1% AEP

E.G. Elev (m)	72.78	Element	Left OB	Channel	Right OB
Vel Head (m)	0.22	Wt. n-Val.	0.030	0.025	
W.S. Elev (m)	72.56	Reach Len. (m)	3.50	3.50	3.50
Crit W.S. (m)		Flow Area (m2)	0.01	2.08	
E.G. Slope (m/m)	0.006141	Area (m2)	0.01	2.08	
Q Total (m3/s)	4.34	Flow (m3/s)	0.00	4.34	
Top Width (m)	3.23	Top Width (m)	0.70	2.53	
Vel Total (m/s)	2.07	Avg. Vel. (m/s)	0.18	2.09	
Max Chl Dpth (m)	1.28	Hydr. Depth (m)	0.02	0.82	
Conv. Total (m3/s)	55.4	Conv. (m3/s)	0.0	55.4	
Length Wtd. (m)	3.50	Wetted Per. (m)	0.70	3.83	
Min Ch El (m)	71.28	Shear (N/m2)	1.09	32.70	
Alpha	1.01	Stream Power (N/m s)	0.20	68.24	
Frctn Loss (m)	0.02	Cum Volume (1000 m3)	0.01	0.82	0.28
C & E Loss (m)	0.00	Cum SA (1000 m2)	0.06	1.48	0.90

Plan: Plan 01 Culliagh Stream 1 RS: 209 Profile: 1% AEP (C.C)

E.G. Elev (m)	72.88	Element	Left OB	Channel	Right OB
Vel Head (m)	0.27	Wt. n-Val.	0.030	0.025	0.080
W.S. Elev (m)	72.61	Reach Len. (m)	3.50	3.50	3.50
Crit W.S. (m)	72.48	Flow Area (m2)	0.08	2.22	0.30
E.G. Slope (m/m)	0.006969	Area (m2)	0.08	2.22	0.30
Q Total (m3/s)	5.22	Flow (m3/s)	0.03	5.15	0.04
Top Width (m)	11.68	Top Width (m)	1.81	2.54	7.32
Vel Total (m/s)	2.00	Avg. Vel. (m/s)	0.36	2.32	0.12
Max Chl Dpth (m)	1.34	Hydr. Depth (m)	0.05	0.87	0.04
Conv. Total (m3/s)	62.5	Conv. (m3/s)	0.4	61.7	0.4
Length Wtd. (m)	3.50	Wetted Per. (m)	1.82	3.85	7.37
Min Ch El (m)	71.28	Shear (N/m2)	3.19	39.48	2.75
Alpha	1.32	Stream Power (N/m s)	1.15	91.45	0.34
Frctn Loss (m)	0.02	Cum Volume (1000 m3)	0.04	0.94	0.39
C & E Loss (m)	0.01	Cum SA (1000 m2)	0.57	1.55	1.11

Plan: Plan 01 Culliagh Stream 1 RS: 209 Profile: 0.1% AEP

E.G. Elev (m)	72.92	Element	Left OB	Channel	Right OB
Vel Head (m)	0.14	Wt. n-Val.	0.030	0.025	0.080
W.S. Elev (m)	72.78	Reach Len. (m)	3.50	3.50	3.50
Crit W.S. (m)	72.78	Flow Area (m2)	1.36	2.64	1.50
E.G. Slope (m/m)	0.003374	Area (m2)	1.36	2.64	1.50
Q Total (m3/s)	5.76	Flow (m3/s)	0.60	4.78	0.37
Top Width (m)	22.23	Top Width (m)	12.36	2.54	7.32
Vel Total (m/s)	1.04	Avg. Vel. (m/s)	0.44	1.81	0.25
Max Chl Dpth (m)	1.50	Hydr. Depth (m)	0.11	1.04	0.21
Conv. Total (m3/s)	99.2	Conv. (m3/s)	10.4	82.3	6.4
Length Wtd. (m)	3.50	Wetted Per. (m)	12.46	3.85	7.53
Min Ch El (m)	71.28	Shear (N/m2)	3.62	22.72	6.61

Plan: Plan 01 Culliagh Stream 1 RS: 209 Profile: 0.1% AEP (Continued)

Alpha	2.51	Stream Power (N/m s)	1.61	41.08	1.64
Frctn Loss (m)	0.02	Cum Volume (1000 m3)	0.09	1.00	0.45
C & E Loss (m)	0.01	Cum SA (1000 m2)	0.84	1.58	1.16

Plan: Plan 01 Culliagh Stream 1 RS: 209 Profile: 0.1% AEP (C.C)

E.G. Elev (m)	73.00	Element	Left OB	Channel	Right OB
Vel Head (m)	0.26	Wt. n-Val.	0.030	0.025	0.080
W.S. Elev (m)	72.75	Reach Len. (m)	3.50	3.50	3.50
Crit W.S. (m)	72.83	Flow Area (m2)	0.94	2.56	1.25
E.G. Slope (m/m)	0.006128	Area (m2)	0.94	2.56	1.25
Q Total (m3/s)	6.91	Flow (m3/s)	0.44	6.10	0.37
Top Width (m)	22.23	Top Width (m)	12.36	2.54	7.32
Vel Total (m/s)	1.45	Avg. Vel. (m/s)	0.47	2.38	0.30
Max Chl Dpth (m)	1.47	Hydr. Depth (m)	0.08	1.01	0.17
Conv. Total (m3/s)	88.3	Conv. (m3/s)	5.6	77.9	4.8
Length Wtd. (m)	3.50	Wetted Per. (m)	12.42	3.85	7.50
Min Ch El (m)	71.28	Shear (N/m2)	4.56	39.91	10.06
Alpha	2.38	Stream Power (N/m s)	2.13	95.14	2.99
Frctn Loss (m)	0.02	Cum Volume (1000 m3)	0.17	1.13	0.54
C & E Loss (m)	0.00	Cum SA (1000 m2)	1.36	1.64	1.57

Plan: Plan 01 Culliagh Stream 1 RS: 208 Profile: 1% AEP

E.G. Elev (m)	72.60	Element	Left OB	Channel	Right OB
Vel Head (m)	0.02	Wt. n-Val.	0.030	0.025	0.080
W.S. Elev (m)	72.57	Reach Len. (m)	3.86	3.86	3.86
Crit W.S. (m)		Flow Area (m2)	0.15	2.07	9.30
E.G. Slope (m/m)	0.000930	Area (m2)	0.15	2.07	9.30
Q Total (m3/s)	4.34	Flow (m3/s)	0.04	1.98	2.32
Top Width (m)	20.34	Top Width (m)	1.21	2.14	16.99
Vel Total (m/s)	0.38	Avg. Vel. (m/s)	0.24	0.96	0.25
Max Chl Dpth (m)	1.27	Hydr. Depth (m)	0.12	0.96	0.55
Conv. Total (m3/s)	142.3	Conv. (m3/s)	1.2	65.0	76.1
Length Wtd. (m)	3.86	Wetted Per. (m)	1.23	2.97	17.54
Min Ch El (m)	71.30	Shear (N/m2)	1.07	6.36	4.83
Alpha	3.19	Stream Power (N/m s)	0.26	6.09	1.21
Frctn Loss (m)	0.00	Cum Volume (1000 m3)	0.00	0.77	0.20
C & E Loss (m)	0.00	Cum SA (1000 m2)	0.04	1.42	0.61

Plan: Plan 01 Culliagh Stream 1 RS: 208 Profile: 1% AEP (C.C)

E.G. Elev (m)	72.68	Element	Left OB	Channel	Right OB
Vel Head (m)	0.02	Wt. n-Val.	0.030	0.025	0.080
W.S. Elev (m)	72.66	Reach Len. (m)	3.86	3.86	3.86
Crit W.S. (m)		Flow Area (m2)	0.27	2.25	10.76
E.G. Slope (m/m)	0.000895	Area (m2)	0.27	2.25	10.76
Q Total (m3/s)	5.22	Flow (m3/s)	0.08	2.24	2.90
Top Width (m)	20.78	Top Width (m)	1.64	2.14	16.99
Vel Total (m/s)	0.39	Avg. Vel. (m/s)	0.29	1.00	0.27
Max Chl Dpth (m)	1.36	Hydr. Depth (m)	0.16	1.05	0.63
Conv. Total (m3/s)	174.5	Conv. (m3/s)	2.6	75.0	96.8
Length Wtd. (m)	3.86	Wetted Per. (m)	1.68	2.97	17.62
Min Ch El (m)	71.30	Shear (N/m2)	1.41	6.67	5.36
Alpha	3.03	Stream Power (N/m s)	0.41	6.64	1.44
Frctn Loss (m)	0.00	Cum Volume (1000 m3)	0.04	0.88	0.28
C & E Loss (m)	0.00	Cum SA (1000 m2)	0.53	1.49	0.81

Plan: Plan 01 Culliagh Stream 1 RS: 208 Profile: 0.1% AEP

E.G. Elev (m)	72.72	Element	Left OB	Channel	Right OB
Vel Head (m)	0.03	Wt. n-Val.	0.030	0.025	0.050
W.S. Elev (m)	72.70	Reach Len. (m)	3.86	3.86	3.86
Crit W.S. (m)		Flow Area (m2)	0.33	2.33	11.38
E.G. Slope (m/m)	0.000928	Area (m2)	0.33	2.33	11.38
Q Total (m3/s)	5.76	Flow (m3/s)	0.11	2.42	3.23
Top Width (m)	20.96	Top Width (m)	1.83	2.14	16.99
Vel Total (m/s)	0.41	Avg. Vel. (m/s)	0.32	1.04	0.28
Max Chl Dpth (m)	1.39	Hydr. Depth (m)	0.18	1.09	0.67
Conv. Total (m3/s)	189.1	Conv. (m3/s)	3.5	79.4	106.2
Length Wtd. (m)	3.86	Wetted Per. (m)	1.86	2.97	17.66
Min Ch El (m)	71.30	Shear (N/m2)	1.62	7.15	5.87
Alpha	2.97	Stream Power (N/m s)	0.52	7.42	1.67
Frctn Loss (m)	0.00	Cum Volume (1000 m3)	0.09	0.95	0.33
C & E Loss (m)	0.00	Cum SA (1000 m2)	0.77	1.53	0.86

Plan: Plan 01 Culliagh Stream 1 RS: 208 Profile: 0.1% AEP (C.C)

E.G. Elev (m)	72.76	Element	Left OB	Channel	Right OB
Vel Head (m)	0.03	Wt. n-Val.	0.030	0.025	0.080
W.S. Elev (m)	72.72	Reach Len. (m)	3.86	3.86	3.86
Crit W.S. (m)		Flow Area (m2)	0.84	2.39	11.85
E.G. Slope (m/m)	0.001198	Area (m2)	0.84	2.39	11.85
Q Total (m3/s)	6.91	Flow (m3/s)	0.12	2.86	3.92
Top Width (m)	37.85	Top Width (m)	18.71	2.14	16.99
Vel Total (m/s)	0.46	Avg. Vel. (m/s)	0.15	1.20	0.33
Max Chl Dpth (m)	1.42	Hydr. Depth (m)	0.04	1.11	0.70
Conv. Total (m3/s)	199.6	Conv. (m3/s)	3.5	82.7	113.3
Length Wtd. (m)	3.86	Wetted Per. (m)	18.78	2.97	17.69
Min Ch El (m)	71.30	Shear (N/m2)	0.53	9.47	7.87
Alpha	3.13	Stream Power (N/m s)	0.08	11.35	2.61
Frctn Loss (m)	0.00	Cum Volume (1000 m3)	0.16	1.08	0.42
C & E Loss (m)	0.00	Cum SA (1000 m2)	1.12	1.58	1.27

Plan: Plan 01 Culliagh Stream 1 RS: 207 Profile: 1% AEP

E.G. Elev (m)	72.47	Element	Left OB	Channel	Right OB
Vel Head (m)	0.25	Wt. n-Val.		0.025	
W.S. Elev (m)	72.22	Reach Len. (m)	3.64	3.64	3.64
Crit W.S. (m)	72.17	Flow Area (m2)		1.95	
E.G. Slope (m/m)	0.007753	Area (m2)		1.95	
Q Total (m3/s)	4.34	Flow (m3/s)		4.34	
Top Width (m)	3.20	Top Width (m)		3.20	
Vel Total (m/s)	2.22	Avg. Vel. (m/s)		2.22	
Max Chl Dpth (m)	1.05	Hydr. Depth (m)		0.61	
Conv. Total (m3/s)	49.3	Conv. (m3/s)		49.3	
Length Wtd. (m)	3.64	Wetted Per. (m)		3.90	
Min Ch El (m)	71.17	Shear (N/m2)		38.07	
Alpha	1.00	Stream Power (N/m s)		84.55	
Frctn Loss (m)	0.03	Cum Volume (1000 m3)		0.67	0.00
C & E Loss (m)	0.00	Cum SA (1000 m2)		1.31	0.04

Plan: Plan 01 Culliagh Stream 1 RS: 207 Profile: 1% AEP (C.C)

E.G. Elev (m)	72.58	Element	Left OB	Channel	Right OB
Vel Head (m)	0.28	Wt. n-Val.	0.030	0.025	
W.S. Elev (m)	72.30	Reach Len. (m)	3.64	3.64	3.64
Crit W.S. (m)	72.25	Flow Area (m2)	0.01	2.24	
E.G. Slope (m/m)	0.007677	Area (m2)	0.01	2.24	
Q Total (m3/s)	5.22	Flow (m3/s)	0.00	5.22	

Plan: Plan 01 Culliagh Stream 1 RS: 207 Profile: 1% AEP (C.C) (Continued)

Top Width (m)	3.75	Top Width (m)	0.38	3.37	
Vel Total (m/s)	2.33	Avg. Vel. (m/s)	0.22	2.33	
Max Chl Dpth (m)	1.13	Hydr. Depth (m)	0.02	0.66	
Conv. Total (m3/s)	59.6	Conv. (m3/s)	0.0	59.6	
Length Wtd. (m)	3.64	Wetted Per. (m)	0.38	4.12	
Min Ch El (m)	71.17	Shear (N/m2)	1.54	40.88	
Alpha	1.01	Stream Power (N/m s)	0.33	95.37	
Frctn Loss (m)	0.03	Cum Volume (1000 m3)	0.00	0.77	0.01
C & E Loss (m)	0.00	Cum SA (1000 m2)	0.01	1.37	0.10

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Plan: Plan 01 Culliagh Stream 1 RS: 207 Profile: 0.1% AEP

E.G. Elev (m)	72.64	Element	Left OB	Channel	Right OB
Vel Head (m)	0.29	Wt. n-Val.	0.030	0.025	
W.S. Elev (m)	72.36	Reach Len. (m)	3.64	3.64	3.64
Crit W.S. (m)	72.31	Flow Area (m2)	0.04	2.42	
E.G. Slope (m/m)	0.007358	Area (m2)	0.04	2.42	
Q Total (m3/s)	5.76	Flow (m3/s)	0.02	5.74	
Top Width (m)	4.34	Top Width (m)	0.88	3.46	
Vel Total (m/s)	2.34	Avg. Vel. (m/s)	0.37	2.37	
Max Chl Dpth (m)	1.19	Hydr. Depth (m)	0.05	0.70	
Conv. Total (m3/s)	67.1	Conv. (m3/s)	0.2	67.0	
Length Wtd. (m)	3.64	Wetted Per. (m)	0.89	4.22	
Min Ch El (m)	71.17	Shear (N/m2)	3.43	41.44	
Alpha	1.03	Stream Power (N/m s)	1.28	98.25	
Frctn Loss (m)	0.03	Cum Volume (1000 m3)	0.00	0.83	0.01
C & E Loss (m)	0.00	Cum SA (1000 m2)	0.05	1.41	0.15

Plan: Plan 01 Culliagh Stream 1 RS: 207 Profile: 0.1% AEP (C.C)

E.G. Elev (m)	72.69	Element	Left OB	Channel	Right OB
Vel Head (m)	0.05	Wt. n-Val.	0.030	0.025	0.080
W.S. Elev (m)	72.63	Reach Len. (m)	3.64	3.64	3.64
Crit W.S. (m)		Flow Area (m2)	4.20	3.40	4.05
E.G. Slope (m/m)	0.001369	Area (m2)	4.20	3.40	4.05
Q Total (m3/s)	6.91	Flow (m3/s)	1.93	4.29	0.69
Top Width (m)	39.83	Top Width (m)	18.26	3.54	18.04
Vel Total (m/s)	0.59	Avg. Vel. (m/s)	0.46	1.26	0.17
Max Chl Dpth (m)	1.47	Hydr. Depth (m)	0.23	0.96	0.22
Conv. Total (m3/s)	186.8	Conv. (m3/s)	52.2	116.1	18.6
Length Wtd. (m)	3.64	Wetted Per. (m)	18.49	4.31	18.27
Min Ch El (m)	71.17	Shear (N/m2)	3.05	10.58	2.98
Alpha	2.99	Stream Power (N/m s)	1.40	13.36	0.50
Frctn Loss (m)	0.00	Cum Volume (1000 m3)	0.06	0.95	0.08
C & E Loss (m)	0.00	Cum SA (1000 m2)	0.33	1.46	0.53

Plan: Plan 01 Culliagh Stream 1 RS: 206 Profile: 1% AEP

E.G. Elev (m)	72.26	Element	Left OB	Channel	Right OB
Vel Head (m)	0.27	Wt. n-Val.		0.025	
W.S. Elev (m)	71.99	Reach Len. (m)	3.81	3.81	3.81
Crit W.S. (m)	71.97	Flow Area (m2)		1.88	
E.G. Slope (m/m)	0.009212	Area (m2)		1.88	
Q Total (m3/s)	4.34	Flow (m3/s)		4.34	
Top Width (m)	3.16	Top Width (m)		3.16	
Vel Total (m/s)	2.31	Avg. Vel. (m/s)		2.31	
Max Chl Dpth (m)	0.93	Hydr. Depth (m)		0.59	
Conv. Total (m3/s)	45.2	Conv. (m3/s)		45.2	
Length Wtd. (m)	3.81	Wetted Per. (m)		4.03	
Min Ch El (m)	71.06	Shear (N/m2)		42.12	

Plan: Plan 01 Culliagh Stream 1 RS: 206 Profile: 1% AEP (Continued)

Alpha	1.00	Stream Power (N/m s)		97.23	
Frctn Loss (m)	0.03	Cum Volume (1000 m3)		0.62	0.00
C & E Loss (m)	0.00	Cum SA (1000 m2)		1.22	0.04

Plan: Plan 01 Culliagh Stream 1 RS: 206 Profile: 1% AEP (C.C)

E.G. Elev (m)	72.37	Element	Left OB	Channel	Right OB
Vel Head (m)	0.30	Wt. n-Val.	0.030	0.025	
W.S. Elev (m)	72.07	Reach Len. (m)	3.81	3.81	3.81
Crit W.S. (m)	72.06	Flow Area (m2)	0.00	2.14	
E.G. Slope (m/m)	0.009433	Area (m2)	0.00	2.14	
Q Total (m3/s)	5.22	Flow (m3/s)	0.00	5.22	
Top Width (m)	3.56	Top Width (m)	0.15	3.41	
Vel Total (m/s)	2.43	Avg. Vel. (m/s)	0.15	2.43	
Max Chl Dpth (m)	1.01	Hydr. Depth (m)	0.01	0.63	
Conv. Total (m3/s)	53.7	Conv. (m3/s)	0.0	53.7	
Length Wtd. (m)	3.81	Wetted Per. (m)	0.16	4.33	
Min Ch El (m)	71.06	Shear (N/m2)	0.91	45.86	
Alpha	1.00	Stream Power (N/m s)	0.14	111.60	
Frctn Loss (m)	0.04	Cum Volume (1000 m3)	0.00	0.71	0.01
C & E Loss (m)	0.00	Cum SA (1000 m2)	0.00	1.28	0.10

Plan: Plan 01 Culliagh Stream 1 RS: 206 Profile: 0.1% AEP

E.G. Elev (m)	72.44	Element	Left OB	Channel	Right OB
Vel Head (m)	0.32	Wt. n-Val.	0.030	0.025	
W.S. Elev (m)	72.12	Reach Len. (m)	3.81	3.81	3.81
Crit W.S. (m)	72.12	Flow Area (m2)	0.02	2.30	
E.G. Slope (m/m)	0.009442	Area (m2)	0.02	2.30	
Q Total (m3/s)	5.76	Flow (m3/s)	0.01	5.75	
Top Width (m)	4.02	Top Width (m)	0.50	3.52	
Vel Total (m/s)	2.49	Avg. Vel. (m/s)	0.33	2.50	
Max Chl Dpth (m)	1.05	Hydr. Depth (m)	0.03	0.65	
Conv. Total (m3/s)	59.3	Conv. (m3/s)	0.1	59.2	
Length Wtd. (m)	3.81	Wetted Per. (m)	0.50	4.45	
Min Ch El (m)	71.06	Shear (N/m2)	2.96	47.84	
Alpha	1.01	Stream Power (N/m s)	0.96	119.75	
Frctn Loss (m)	0.04	Cum Volume (1000 m3)	0.00	0.76	0.01
C & E Loss (m)	0.00	Cum SA (1000 m2)	0.02	1.31	0.15

Plan: Plan 01 Culliagh Stream 1 RS: 206 Profile: 0.1% AEP (C.C)

E.G. Elev (m)	72.55	Element	Left OB	Channel	Right OB
Vel Head (m)	0.31	Wt. n-Val.	0.030	0.025	
W.S. Elev (m)	72.24	Reach Len. (m)	3.81	3.81	3.81
Crit W.S. (m)	72.24	Flow Area (m2)	0.14	2.76	
E.G. Slope (m/m)	0.007966	Area (m2)	0.14	2.76	
Q Total (m3/s)	6.91	Flow (m3/s)	0.09	6.82	
Top Width (m)	5.31	Top Width (m)	1.47	3.85	
Vel Total (m/s)	2.38	Avg. Vel. (m/s)	0.62	2.47	
Max Chl Dpth (m)	1.18	Hydr. Depth (m)	0.09	0.72	
Conv. Total (m3/s)	77.4	Conv. (m3/s)	1.0	76.5	
Length Wtd. (m)	3.81	Wetted Per. (m)	1.48	4.80	
Min Ch El (m)	71.06	Shear (N/m2)	7.36	44.98	
Alpha	1.06	Stream Power (N/m s)	4.53	111.16	
Frctn Loss (m)	0.03	Cum Volume (1000 m3)	0.00	0.87	0.03
C & E Loss (m)	0.00	Cum SA (1000 m2)	0.09	1.37	0.31

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Plan: Plan 01 Culliagh Stream 1 RS: 205 Profile: 1% AEP

E.G. Elev (m)	71.69	Element	Left OB	Channel	Right OB
Vel Head (m)	0.24	Wt. n-Val.		0.025	
W.S. Elev (m)	71.45	Reach Len. (m)	3.91	3.91	3.91
Crit W.S. (m)	71.45	Flow Area (m2)		1.99	
E.G. Slope (m/m)	0.009286	Area (m2)		1.99	
Q Total (m3/s)	4.34	Flow (m3/s)		4.34	
Top Width (m)	4.15	Top Width (m)		4.15	
Vel Total (m/s)	2.18	Avg. Vel. (m/s)		2.18	
Max Chl Dpth (m)	0.80	Hydr. Depth (m)		0.48	
Conv. Total (m3/s)	45.0	Conv. (m3/s)		45.0	
Length Wtd. (m)	3.91	Wetted Per. (m)		4.66	
Min Ch El (m)	70.64	Shear (N/m2)		38.83	
Alpha	1.00	Stream Power (N/m s)		84.78	
Frctn Loss (m)	0.04	Cum Volume (1000 m3)		0.48	0.00
C & E Loss (m)	0.00	Cum SA (1000 m2)		0.96	0.04

Plan: Plan 01 Culliagh Stream 1 RS: 205 Profile: 1% AEP (C.C)

E.G. Elev (m)	71.78	Element	Left OB	Channel	Right OB
Vel Head (m)	0.26	Wt. n-Val.		0.025	
W.S. Elev (m)	71.52	Reach Len. (m)	3.91	3.91	3.91
Crit W.S. (m)	71.52	Flow Area (m2)		2.31	
E.G. Slope (m/m)	0.009101	Area (m2)		2.31	
Q Total (m3/s)	5.22	Flow (m3/s)		5.22	
Top Width (m)	4.52	Top Width (m)		4.52	
Vel Total (m/s)	2.26	Avg. Vel. (m/s)		2.26	
Max Chl Dpth (m)	0.88	Hydr. Depth (m)		0.51	
Conv. Total (m3/s)	54.7	Conv. (m3/s)		54.7	
Length Wtd. (m)	3.91	Wetted Per. (m)		5.06	
Min Ch El (m)	70.64	Shear (N/m2)		40.70	
Alpha	1.00	Stream Power (N/m s)		92.02	
Frctn Loss (m)	0.04	Cum Volume (1000 m3)		0.55	0.01
C & E Loss (m)	0.00	Cum SA (1000 m2)		1.01	0.10

Plan: Plan 01 Culliagh Stream 1 RS: 205 Profile: 0.1% AEP

E.G. Elev (m)	71.83	Element	Left OB	Channel	Right OB
Vel Head (m)	0.27	Wt. n-Val.		0.025	
W.S. Elev (m)	71.56	Reach Len. (m)	3.91	3.91	3.91
Crit W.S. (m)	71.56	Flow Area (m2)		2.50	
E.G. Slope (m/m)	0.009039	Area (m2)		2.50	
Q Total (m3/s)	5.76	Flow (m3/s)		5.76	
Top Width (m)	4.72	Top Width (m)		4.72	
Vel Total (m/s)	2.31	Avg. Vel. (m/s)		2.31	
Max Chl Dpth (m)	0.92	Hydr. Depth (m)		0.53	
Conv. Total (m3/s)	60.6	Conv. (m3/s)		60.6	
Length Wtd. (m)	3.91	Wetted Per. (m)		5.28	
Min Ch El (m)	70.64	Shear (N/m2)		41.89	
Alpha	1.00	Stream Power (N/m s)		96.66	
Frctn Loss (m)	0.04	Cum Volume (1000 m3)		0.59	0.01
C & E Loss (m)	0.00	Cum SA (1000 m2)		1.03	0.15

Plan: Plan 01 Culliagh Stream 1 RS: 205 Profile: 0.1% AEP (C.C)

E.G. Elev (m)	71.93	Element	Left OB	Channel	Right OB
Vel Head (m)	0.29	Wt. n-Val.	0.030	0.025	
W.S. Elev (m)	71.65	Reach Len. (m)	3.91	3.91	3.91
Crit W.S. (m)	71.65	Flow Area (m2)	0.05	2.91	
E.G. Slope (m/m)	0.008328	Area (m2)	0.05	2.91	
Q Total (m3/s)	6.91	Flow (m3/s)	0.01	6.90	

Plan: Plan 01 Culliagh Stream 1 RS: 205 Profile: 0.1% AEP (C.C) (Continued)

Top Width (m)	6.34	Top Width (m)	1.34	4.99	
Vel Total (m/s)	2.34	Avg. Vel. (m/s)	0.32	2.37	
Max Chl Dpth (m)	1.00	Hydr. Depth (m)	0.03	0.58	
Conv. Total (m3/s)	75.7	Conv. (m3/s)	0.2	75.6	
Length Wtd. (m)	3.91	Wetted Per. (m)	1.35	5.57	
Min Ch El (m)	70.64	Shear (N/m2)	2.82	42.70	
Alpha	1.03	Stream Power (N/m s)	0.91	101.16	
Frctn Loss (m)	0.04	Cum Volume (1000 m3)	0.00	0.68	0.03
C & E Loss (m)	0.00	Cum SA (1000 m2)	0.02	1.07	0.31

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Plan: Plan 01 Culliagh Stream 1 RS: 204 Profile: 1% AEP

E.G. Elev (m)	70.79	Element	Left OB	Channel	Right OB
Vel Head (m)	0.18	Wt. n-Val.		0.025	0.080
W.S. Elev (m)	70.61	Reach Len. (m)	3.91	3.91	3.91
Crit W.S. (m)	70.57	Flow Area (m2)		2.28	0.11
E.G. Slope (m/m)	0.006546	Area (m2)		2.28	0.11
Q Total (m3/s)	4.34	Flow (m3/s)		4.32	0.02
Top Width (m)	6.83	Top Width (m)		4.78	2.04
Vel Total (m/s)	1.81	Avg. Vel. (m/s)		1.90	0.14
Max Chl Dpth (m)	0.59	Hydr. Depth (m)		0.48	0.05
Conv. Total (m3/s)	53.6	Conv. (m3/s)		53.4	0.2
Length Wtd. (m)	3.91	Wetted Per. (m)		5.09	2.05
Min Ch El (m)	70.02	Shear (N/m2)		28.76	3.47
Alpha	1.09	Stream Power (N/m s)		54.51	0.50
Frctn Loss (m)	0.03	Cum Volume (1000 m3)		0.31	0.00
C & E Loss (m)	0.00	Cum SA (1000 m2)		0.59	0.03

Plan: Plan 01 Culliagh Stream 1 RS: 204 Profile: 1% AEP (C.C)

E.G. Elev (m)	70.87	Element	Left OB	Channel	Right OB
Vel Head (m)	0.20	Wt. n-Val.		0.025	0.080
W.S. Elev (m)	70.68	Reach Len. (m)	3.91	3.91	3.91
Crit W.S. (m)	70.63	Flow Area (m2)		2.62	0.30
E.G. Slope (m/m)	0.006138	Area (m2)		2.62	0.30
Q Total (m3/s)	5.22	Flow (m3/s)		5.16	0.06
Top Width (m)	8.29	Top Width (m)		4.93	3.36
Vel Total (m/s)	1.79	Avg. Vel. (m/s)		1.97	0.20
Max Chl Dpth (m)	0.66	Hydr. Depth (m)		0.53	0.09
Conv. Total (m3/s)	66.6	Conv. (m3/s)		65.9	0.7
Length Wtd. (m)	3.91	Wetted Per. (m)		5.26	3.36
Min Ch El (m)	70.02	Shear (N/m2)		30.00	5.35
Alpha	1.20	Stream Power (N/m s)		59.10	1.04
Frctn Loss (m)	0.02	Cum Volume (1000 m3)		0.36	0.01
C & E Loss (m)	0.00	Cum SA (1000 m2)		0.61	0.07

Plan: Plan 01 Culliagh Stream 1 RS: 204 Profile: 0.1% AEP

E.G. Elev (m)	70.92	Element	Left OB	Channel	Right OB
Vel Head (m)	0.20	Wt. n-Val.		0.025	0.080
W.S. Elev (m)	70.72	Reach Len. (m)	3.91	3.91	3.91
Crit W.S. (m)	70.67	Flow Area (m2)		2.82	0.45
E.G. Slope (m/m)	0.005932	Area (m2)		2.82	0.45
Q Total (m3/s)	5.76	Flow (m3/s)		5.66	0.10
Top Width (m)	9.13	Top Width (m)		5.02	4.11
Vel Total (m/s)	1.76	Avg. Vel. (m/s)		2.01	0.22
Max Chl Dpth (m)	0.69	Hydr. Depth (m)		0.56	0.11
Conv. Total (m3/s)	74.8	Conv. (m3/s)		73.5	1.3
Length Wtd. (m)	3.91	Wetted Per. (m)		5.35	4.11
Min Ch El (m)	70.02	Shear (N/m2)		30.63	6.33

Plan: Plan 01 Culliagh Stream 1 RS: 204 Profile: 0.1% AEP (Continued)

Alpha	1.28	Stream Power (N/m s)		61.54	1.39
Frctn Loss (m)	0.02	Cum Volume (1000 m3)		0.39	0.71
C & E Loss (m)	0.00	Cum SA (1000 m2)		0.62	0.10

Plan: Plan 01 Culliagh Stream 1 RS: 204 Profile: 0.1% AEP (C.C)

E.G. Elev (m)	71.01	Element	Left OB	Channel	Right OB
Vel Head (m)	0.22	Wt. n-Val.	0.030	0.025	0.080
W.S. Elev (m)	70.79	Reach Len. (m)	3.91	3.91	3.91
Crit W.S. (m)	70.75	Flow Area (m2)	0.01	3.20	0.81
E.G. Slope (m/m)	0.005527	Area (m2)	0.01	3.20	0.81
Q Total (m3/s)	6.91	Flow (m3/s)	0.00	6.70	0.21
Top Width (m)	10.81	Top Width (m)	0.21	5.07	5.53
Vel Total (m/s)	1.72	Avg. Vel. (m/s)	0.21	2.09	0.26
Max Chl Dpth (m)	0.77	Hydr. Depth (m)	0.02	0.63	0.15
Conv. Total (m3/s)	92.9	Conv. (m3/s)	0.0	90.1	2.8
Length Wtd. (m)	3.91	Wetted Per. (m)	0.22	5.41	5.53
Min Ch El (m)	70.02	Shear (N/m2)	1.30	32.03	7.93
Alpha	1.44	Stream Power (N/m s)	0.27	67.09	2.05
Frctn Loss (m)	0.02	Cum Volume (1000 m3)	0.00	0.45	0.02
C & E Loss (m)	0.00	Cum SA (1000 m2)	0.00	0.65	0.19

Plan: Plan 01 Culliagh Stream 1 RS: 203 Profile: 1% AEP

E.G. Elev (m)	69.72	Element	Left OB	Channel	Right OB
Vel Head (m)	0.25	Wt. n-Val.		0.025	
W.S. Elev (m)	69.47	Reach Len. (m)	3.62	3.62	3.62
Crit W.S. (m)	69.42	Flow Area (m2)		1.96	
E.G. Slope (m/m)	0.007603	Area (m2)		1.96	
Q Total (m3/s)	4.34	Flow (m3/s)		4.34	
Top Width (m)	3.12	Top Width (m)		3.12	
Vel Total (m/s)	2.21	Avg. Vel. (m/s)		2.21	
Max Chl Dpth (m)	0.82	Hydr. Depth (m)		0.63	
Conv. Total (m3/s)	49.8	Conv. (m3/s)		49.8	
Length Wtd. (m)	3.62	Wetted Per. (m)		3.88	
Min Ch El (m)	68.65	Shear (N/m2)		37.68	
Alpha	1.00	Stream Power (N/m s)		83.36	
Frctn Loss (m)	0.03	Cum Volume (1000 m3)		0.05	0.00
C & E Loss (m)	0.00	Cum SA (1000 m2)		0.08	0.02

Plan: Plan 01 Culliagh Stream 1 RS: 203 Profile: 1% AEP (C.C)

E.G. Elev (m)	69.84	Element	Left OB	Channel	Right OB
Vel Head (m)	0.27	Wt. n-Val.		0.025	
W.S. Elev (m)	69.57	Reach Len. (m)	3.62	3.62	3.62
Crit W.S. (m)	69.50	Flow Area (m2)		2.25	
E.G. Slope (m/m)	0.007454	Area (m2)		2.25	
Q Total (m3/s)	5.22	Flow (m3/s)		5.22	
Top Width (m)	3.25	Top Width (m)		3.25	
Vel Total (m/s)	2.31	Avg. Vel. (m/s)		2.31	
Max Chl Dpth (m)	0.91	Hydr. Depth (m)		0.69	
Conv. Total (m3/s)	60.5	Conv. (m3/s)		60.5	
Length Wtd. (m)	3.62	Wetted Per. (m)		4.11	
Min Ch El (m)	68.65	Shear (N/m2)		40.12	
Alpha	1.00	Stream Power (N/m s)		92.87	
Frctn Loss (m)	0.03	Cum Volume (1000 m3)		0.06	0.00
C & E Loss (m)	0.00	Cum SA (1000 m2)		0.08	0.02

Plan: Plan 01 Culliagh Stream 1 RS: 203 Profile: 0.1% AEP

E.G. Elev (m)	69.91	Element	Left OB	Channel	Right OB
Vel Head (m)	0.29	Wt. n-Val.		0.025	
W.S. Elev (m)	69.62	Reach Len. (m)	3.62	3.62	3.62
Crit W.S. (m)	69.55	Flow Area (m2)		2.43	
E.G. Slope (m/m)	0.007379	Area (m2)		2.43	
Q Total (m3/s)	5.76	Flow (m3/s)		5.76	
Top Width (m)	3.32	Top Width (m)		3.32	
Vel Total (m/s)	2.37	Avg. Vel. (m/s)		2.37	
Max Chl Dpth (m)	0.97	Hydr. Depth (m)		0.73	
Conv. Total (m3/s)	67.1	Conv. (m3/s)		67.1	
Length Wtd. (m)	3.62	Wetted Per. (m)		4.24	
Min Ch El (m)	68.65	Shear (N/m2)		41.47	
Alpha	1.00	Stream Power (N/m s)		98.32	
Frctn Loss (m)	0.03	Cum Volume (1000 m3)		0.06	0.00
C & E Loss (m)	0.00	Cum SA (1000 m2)		0.09	0.02

Plan: Plan 01 Culliagh Stream 1 RS: 203 Profile: 0.1% AEP (C.C)

E.G. Elev (m)	70.04	Element	Left OB	Channel	Right OB
Vel Head (m)	0.31	Wt. n-Val.		0.025	
W.S. Elev (m)	69.73	Reach Len. (m)	3.62	3.62	3.62
Crit W.S. (m)	69.65	Flow Area (m2)		2.79	
E.G. Slope (m/m)	0.007232	Area (m2)		2.79	
Q Total (m3/s)	6.91	Flow (m3/s)		6.91	
Top Width (m)	3.48	Top Width (m)		3.48	
Vel Total (m/s)	2.47	Avg. Vel. (m/s)		2.47	
Max Chl Dpth (m)	1.07	Hydr. Depth (m)		0.80	
Conv. Total (m3/s)	81.3	Conv. (m3/s)		81.3	
Length Wtd. (m)	3.62	Wetted Per. (m)		4.50	
Min Ch El (m)	68.65	Shear (N/m2)		43.99	
Alpha	1.00	Stream Power (N/m s)		108.85	
Frctn Loss (m)	0.03	Cum Volume (1000 m3)		0.07	0.01
C & E Loss (m)	0.00	Cum SA (1000 m2)		0.09	0.03

Plan: Plan 01 Culliagh Stream 1 RS: 202 Profile: 1% AEP

E.G. Elev (m)	69.37	Element	Left OB	Channel	Right OB
Vel Head (m)	0.50	Wt. n-Val.		0.025	0.080
W.S. Elev (m)	68.87	Reach Len. (m)			
Crit W.S. (m)	69.01	Flow Area (m2)		1.26	0.44
E.G. Slope (m/m)	0.017044	Area (m2)		1.26	0.44
Q Total (m3/s)	4.34	Flow (m3/s)		4.07	0.27
Top Width (m)	4.11	Top Width (m)		2.28	1.83
Vel Total (m/s)	2.54	Avg. Vel. (m/s)		3.22	0.62
Max Chl Dpth (m)	0.75	Hydr. Depth (m)		0.56	0.24
Conv. Total (m3/s)	33.2	Conv. (m3/s)		31.1	2.1
Length Wtd. (m)		Wetted Per. (m)		2.62	1.90
Min Ch El (m)	68.12	Shear (N/m2)		80.76	39.08
Alpha	1.50	Stream Power (N/m s)		259.67	24.21
Frctn Loss (m)		Cum Volume (1000 m3)			
C & E Loss (m)		Cum SA (1000 m2)			

Plan: Plan 01 Culliagh Stream 1 RS: 202 Profile: 1% AEP (C.C)

E.G. Elev (m)	69.49	Element	Left OB	Channel	Right OB
Vel Head (m)	0.55	Wt. n-Val.		0.025	0.080
W.S. Elev (m)	68.94	Reach Len. (m)			
Crit W.S. (m)	69.10	Flow Area (m2)		1.42	0.58
E.G. Slope (m/m)	0.016993	Area (m2)		1.42	0.58
Q Total (m3/s)	5.22	Flow (m3/s)		4.83	0.39

Plan: Plan 01 Culliagh Stream 1 RS: 202 Profile: 1% AEP (C.C) (Continued)

Top Width (m)	4.40	Top Width (m)		2.31	2.09
Vel Total (m/s)	2.62	Avg. Vel. (m/s)		3.40	0.67
Max Chl Dpth (m)	0.82	Hydr. Depth (m)		0.61	0.28
Conv. Total (m3/s)	40.0	Conv. (m3/s)		37.1	3.0
Length Wtd. (m)		Wetted Per. (m)		2.69	2.16
Min Ch El (m)	68.12	Shear (N/m2)		87.83	44.43
Alpha	1.57	Stream Power (N/m s)		298.84	29.99
Frctn Loss (m)		Cum Volume (1000 m3)			
C & E Loss (m)		Cum SA (1000 m2)			

Plan: Plan 01 Culliagh Stream 1 RS: 202 Profile: 0.1% AEP

E.G. Elev (m)	69.55	Element	Left OB	Channel	Right OB
Vel Head (m)	0.57	Wt. n-Val.		0.025	0.080
W.S. Elev (m)	68.98	Reach Len. (m)			
Crit W.S. (m)	69.15	Flow Area (m2)		1.52	0.67
E.G. Slope (m/m)	0.016760	Area (m2)		1.52	0.67
Q Total (m3/s)	5.76	Flow (m3/s)		5.29	0.47
Top Width (m)	4.58	Top Width (m)		2.33	2.25
Vel Total (m/s)	2.64	Avg. Vel. (m/s)		3.49	0.70
Max Chl Dpth (m)	0.86	Hydr. Depth (m)		0.65	0.30
Conv. Total (m3/s)	44.5	Conv. (m3/s)		40.9	3.6
Length Wtd. (m)		Wetted Per. (m)		2.74	2.32
Min Ch El (m)	68.12	Shear (N/m2)		90.92	47.12
Alpha	1.61	Stream Power (N/m s)		317.28	33.15
Frctn Loss (m)		Cum Volume (1000 m3)			
C & E Loss (m)		Cum SA (1000 m2)			

Plan: Plan 01 Culliagh Stream 1 RS: 202 Profile: 0.1% AEP (C.C)

E.G. Elev (m)	69.68	Element	Left OB	Channel	Right OB
Vel Head (m)	0.62	Wt. n-Val.		0.025	0.080
W.S. Elev (m)	69.06	Reach Len. (m)			
Crit W.S. (m)	69.24	Flow Area (m2)		1.71	0.87
E.G. Slope (m/m)	0.016323	Area (m2)		1.71	0.87
Q Total (m3/s)	6.91	Flow (m3/s)		6.25	0.66
Top Width (m)	4.94	Top Width (m)		2.38	2.56
Vel Total (m/s)	2.68	Avg. Vel. (m/s)		3.65	0.76
Max Chl Dpth (m)	0.95	Hydr. Depth (m)		0.72	0.34
Conv. Total (m3/s)	54.1	Conv. (m3/s)		48.9	5.1
Length Wtd. (m)		Wetted Per. (m)		2.84	2.65
Min Ch El (m)	68.12	Shear (N/m2)		96.68	52.33
Alpha	1.69	Stream Power (N/m s)		353.01	39.66
Frctn Loss (m)		Cum Volume (1000 m3)			
C & E Loss (m)		Cum SA (1000 m2)			

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