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Technical Note: Feeder Row, Cwmcarn

Document Control

Project	Feeder Row Canal Abstraction Calculation
Client	NRW
EPG Reference	TH460-U

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01	05/08/2024	Draft for internal approval
02	XX/XX/XXXX	Issued

Location Plan

1.1 Site location displayed in the red line boundary.

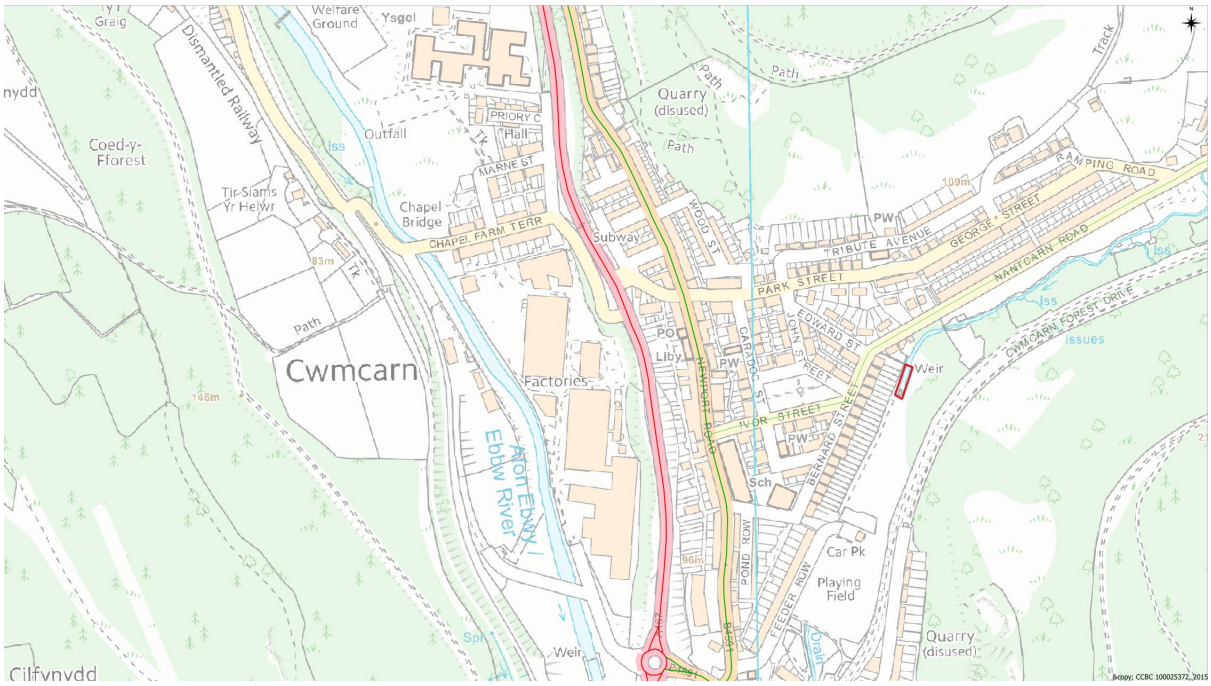


Figure 1: Location plan OS mapping. Easting: 322197, Northing: 193515

Figure 2: Location plan Aerial mapping. Easting: 322197, Northing: 193515

Instruction

2.1 Caerphilly County Borough Council's (CCBC) Engineering Projects Group (EPG) were instructed by Natural Resources Wales (NRW) to undertake a Hydrological assessment of the Nant Carn. The assessment's aim was to unearth the Q75 flow level within the Nant Carn.

2.2 NRW instructed EPG to find the Q75 flow level in the Nant Carn as this is the nominated level in which water abstraction can take place in the Watershed of the River Ebbw.

Background

3.1 The Nant Carn flows downstream to a 1.8m diameter concrete culvert, adjacent to a 450mm inlet with brick headwall (Image 1). Both structures are defended by a large steel debris screen.

Image 1: 1.8M Culvert adjacent to 450mm inlet with brick headwall

3.2 The 450mm inlet pipe feeds the Monmouthshire Canal. The inlet pipe leads to a chamber in front of the Nant Carn which houses a penstock valve to allow the water flows to

be switched on and off. At current time, the invert of the 450mm abstraction pipe inlet is 55mm above bed level.

3.3 At the time of the inspection the inlet was not freely flowing, as the penstock valve was closed (Image 2).

Image 2: Penstock downstream of inlet

3.4 As part of the South East Wales Valleys Abstraction strategy (ALS), assessment points (AP) are located within different river catchments. At each AP, water availability is calculated in megalitres per day. AP10 is the closest AP to the Nant Carn situated within the

River Ebbw and instructed by NRW for use. The ALS confirms that 11 megalitres per day can be abstracted from the Nany Carn.

Calculation of Q75 flow

4.1 Q75 is defined as (the 25-percentile flow): The flow in cubic metres per second which was equalled or exceeded for 75% of the flow record.

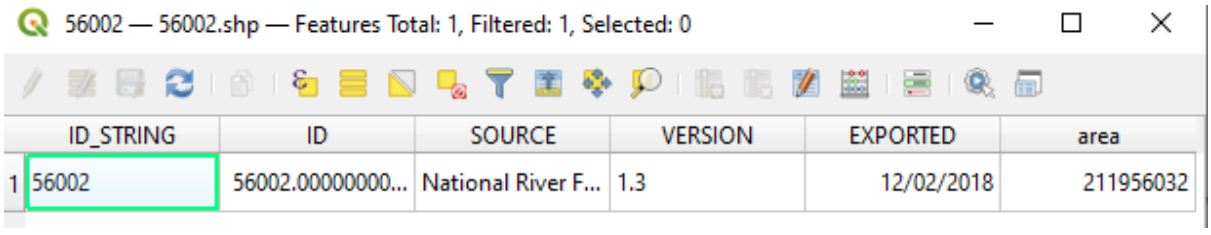
4.2 The Nant Carn is an ungauged Watercourse and as such, no site-specific flow record was available to utilise in the estimation of the Q75 flow rate.

4.3 In accordance with the latest EA/NRW guidance for estimating hydrographs for small catchments (22 March 2024), the single closest donor flow gauging station was utilised for flow estimation. This methodology is appropriate as it will give a good degree of accuracy due to similar catchment characteristics.

4.4 Q75 flow was derived from the below method:

1. Ebbw gauge station daily flow data downloaded from 1957-2022 (22,681 days).
2. Daily flow data sorted from smallest to largest.
3. Q75 expressed as a decimal = 0.25.
4. (0.25*(22,681+1)) =5670.5 value in the daily flow dataset.
5. 5671 value in Ebbw daily flow sorted dataset = 2.623m3/s
6. Q75 flow for the Ebbw catchment= **2.623m3/s.**

4.5 The catchment area for the Ebbw flow station Catchment is 211,956,032m2. This value was found by downloading the catchment area shapefile from the NRFA website and using the find area function of QGIS (Figure 3).



	ID_STRING	ID	SOURCE	VERSION	EXPORTED	area
1	56002	56002.00000000...	National River F...	1.3	12/02/2018	211956032

Figure 3: Area calculation for the River Ebbw- Taken from QGIS

4.6 The catchment area for the Nant Carn is 7,618,750m2. This value was found by downloading the catchment boundary from the FEH webservice and then the area function of QGIS.

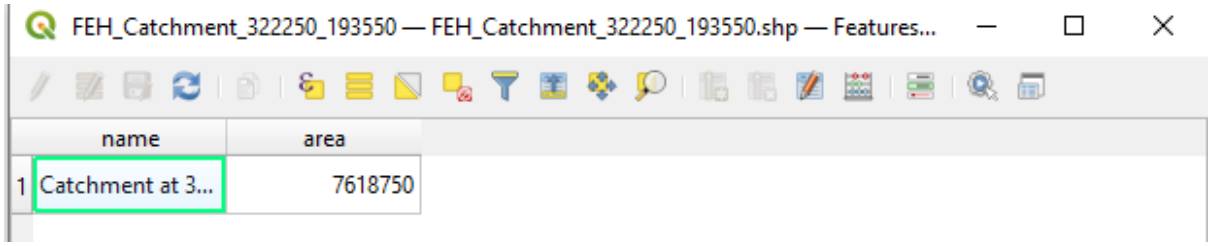


Figure 4: Area calculation for the Nant Carn- Taken from QGIS

4.7 The ratio between the River Ebbw catchment and the Nant Carn must be found to unearth what value the Q75 flow must be scaled by. The ratio is calculated as follows:

211956032/7618750=27.82

Catchment ratio between Ebbw and Feeder row= 27.82:1

4.8 Appendix A presents the Ebbw and Nant Carn catchment areas.

4.9 The Q75 flow rate can be calculated for the Nant Carn by dividing the Q75 flow rate for the River Ebbw by the catchment area ratio. The calculation is as follows:

Feeder row catchment ratio =2.623/27.8= 0.094m3/s

Feeder row Q75 Scaled from Ebbw catchment =0.094m3/s

4.10 The Q75 flow rate in ML/Day is 8.12. The calculation is as follows:

0.094x86.4= 8.12

Q75 flow =8.12 Ml/day

Calculation of Q75 Level

5.1 In order to calculate the level of the Q75 flow within the Nant Carn a 1D Flood Modeller model was built for the final 190m of the Nant Carn.

5.2 The 1.8 diameter culvert was represented as a 1.8m orifice to aid in model stability as well as to represent the raised sill level prior to the culvert inlet.

5.3 The Brick Headwall and 450mm inlet was not input into the model as the model aimed to find the water level at the cross-section directly in front of the headwall not within the structure itself.

5.4 Watercourse cross-sections were produced by topographical survey data taken on site.

5.5 Downstream cross-sections were not represented as a culvert, instead interpolated river sections from the upstream, to aid in model stability and simplicity. The length of the culvert bares no upstream influence on the model as the structure is oversized with a steep slope.

5.6 The 1D model inflow was the Q75 flow found in section 4.9, 0.094m3/s. As the Q75 flow is a constant value the 1D model was run as a steady state flow simulation.

5.7 The model build and extent is presented below (Figure 5).

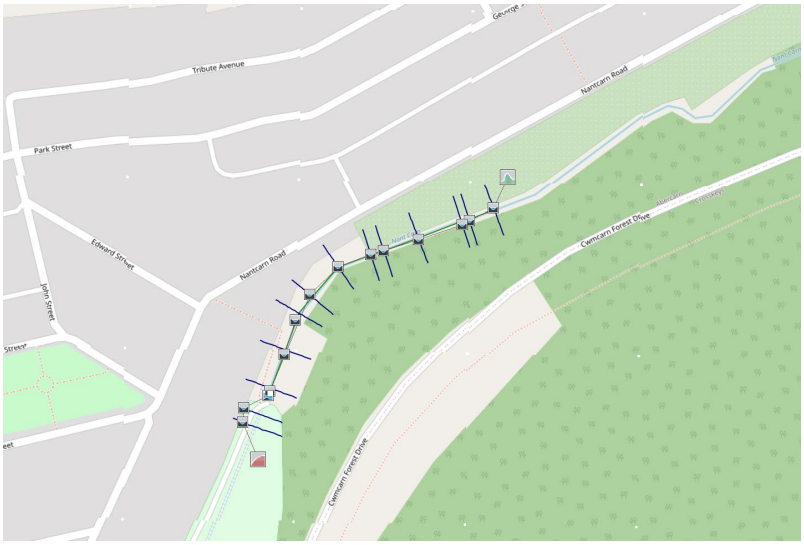


Figure 5: 1D model build extent

5.8 The 1D model produced the max stage of the river at each cross section during the Q75 flow.

5.9 Cross section FRS_010 was surveyed directly Infront of the Brick Headwall structure.

5.10 FRS_010 max stage during the Q75 flow was 88.613m AOD- **184mm Above bed level**.

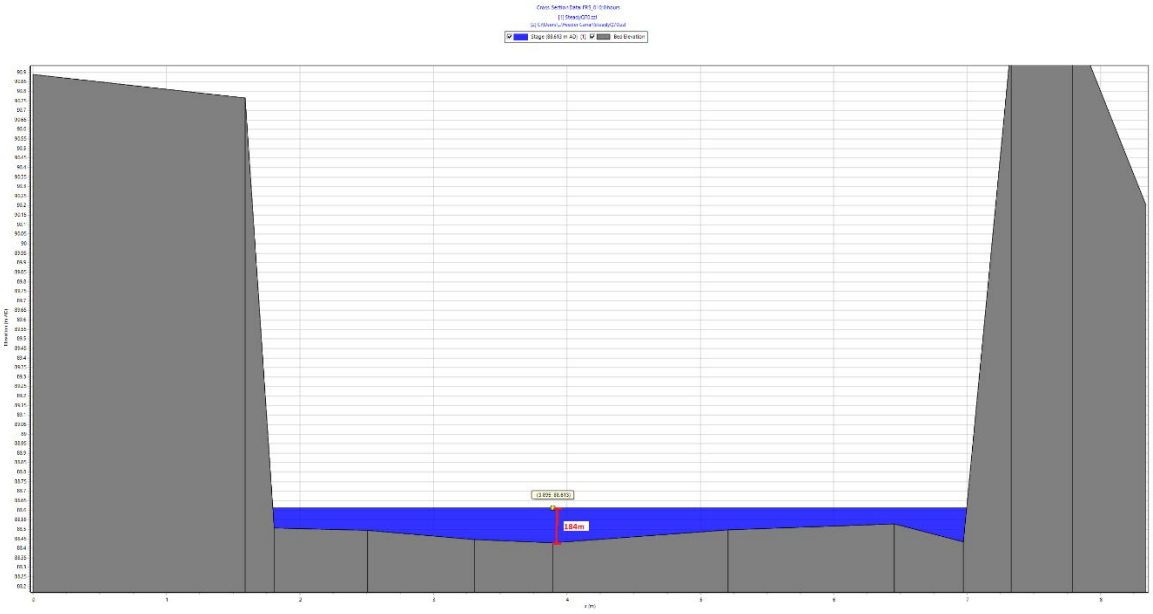


Figure 6:FRS_010 max stage during Q75 flow- Taken from flood modeller

5.11 The Q75 level within the Nant Carn is 184mm Above bed level directly Infront of the canal intake structure.

Calculation of Maximum Canal Feeder Pipe Capacity

6.1 The invert of the upstream inlet 450mm pipe is 87.920m AOD

The invert of the downstream 450mm outlet is 80.929m AOD

The length of the run between inlet and outfall is 496m.

The calculation of slope is as follows:

Sgrade(%) = (100 %) y / x

where

Sgrade(%) = grade (%)

x = horizontal run (m, ft ..)

y = vertical rise (m, ft ...)

Sgrade(%)= (100%) 6.991/496

Grade = 1.41%

6.2 Pipe capacity can be calculated using the Colebrook equation. The input parameters are as below. Roughness value derived from typical roughness of concrete culverts.

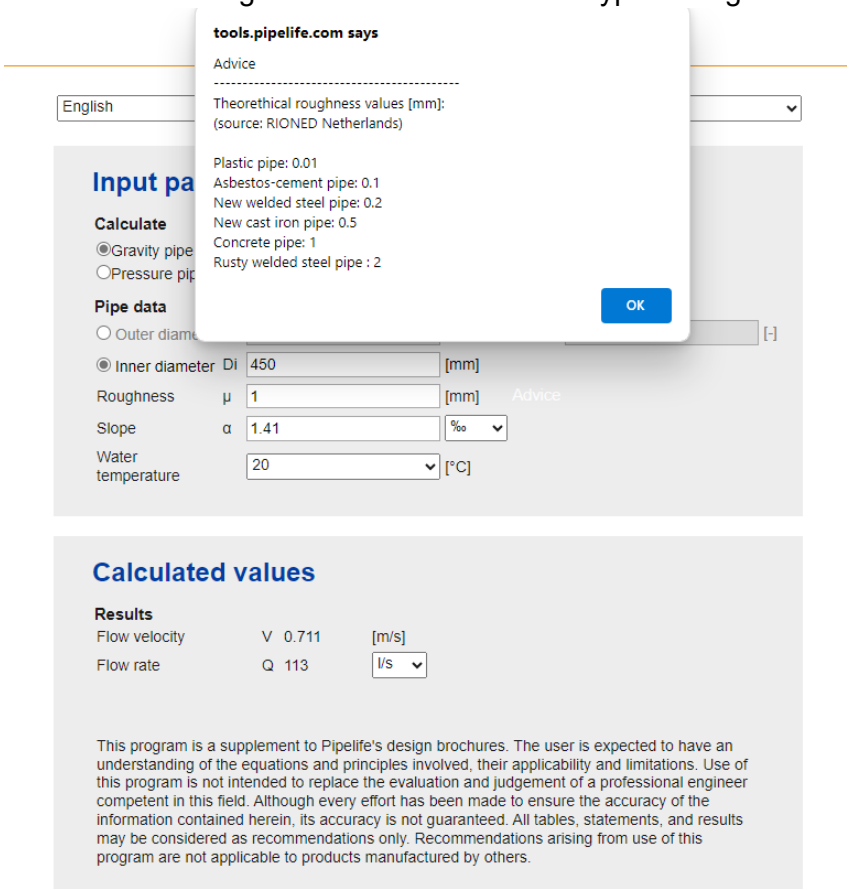


Figure 7: Colebrook Calculation

6.3 The canal feeder pipe maximum capacity is 113l/s.

6.4 The canal feeder pipe maximum daily flow capacity is 9.76ML/ Day.

Conversion base: 1 l/s = 0.0864 ML/day

6.5 The canal feeder pipe would be compliant with ALS AP10 abstraction restriction of 11ML/day, as the current system cannot physically outfall more than 9.76ML/Day.

Proposal

7.1 It is understood that the abstraction to the canal cannot take place outside of Q75 flows. Although the penstock valve is closed, in theory abstraction to the canal can take place below the Q75 level as the invert of the inlet is 55mm above bed level.

7.2 The Riverbed in front of the Brick Headwall is described by the surveyors as soft with gravel debris.

7.3 It is proposed to dig down the Riverbed in front of the Headwall to a level of 184mm, to ensure abstraction does not take place unless during Q75 flows.

7.4 This level would be measured and remediated when necessary, as part of regular culvert maintenance/ inspections.

Summary

8.1 The Q75 level in the Nant Carn directly Infront of the canal intake is 184mm.

8.2 To ensure water abstraction does not take place below the Q75 level, it is proposed the river bed level is dropped to 184mm below the intake invert.

8.3 The canal feeder pipe system has a maximum capacity of 9.76ML/ Day and is already complaint with ALS AP10 abstraction restriction of 11 ML/Day.

8.4 To ensure abstraction remains compliant with NRW request, regular inspections and remediation will take place throughout the year in regular intervals.