APPENDIX I – Optioneering Technical Note

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Project: Comrie and Dalginross Flood Study

Technical Note on Hydraulic Model Option Results

Produced for

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1.0 Introduction

This technical note summarises the results of the various baseline and option model runs and includes eight appendices containing detailed results of various model runs. Extent of the hydraulic model is shown in Appendix 1.

The options to be modelled are tabulated below and the results are given in this note.

Table 1 - Option considered for modelling

Item Number	Description	Status
01	Baseline model/flow finalization (10, 25, 50, 75, 100, 200 and 200+CC years and 4 additional models for sensitivity scenarios) PLUS Qmed in all three watercourses	Complete
02	Sensitivity with d/s boundary (200 years)	Complete
03	Model with bank stabilisation (reinforcement) along Water of Ruchill (200 year)	Complete
04	Traditional Wall and Embankment Option model (200, and other 4 sensitivity scenarios plus 200+CC, 100, 75, 50, 25 and 10 years)	Complete
04a	Removal / replacement of weir downstream of Bridge (200 and 200+CC)	Complete
04b	Improved conveyance at the bridge (200 year only)	Not progressed
04c	Maximise flood storage on local flood plains (200 and 200+CC only)	Complete
04d	Dredging of river channels (200 and 200+CC only)	Complete
04e	Natural Flood Management Techniques (200 and 200+CC only)	Complete
05	Upstream storage – (200 only)	Complete
06a	Traditional Wall & Embankment PLUS Upstream storage on Water of Ruchill (200 and 200+CC)	Complete
06b	Traditional Wall & Embankment PLUS Upstream storage on River Earn (200 and 200+CC)	Complete
06c	Traditional Wall & Embankment PLUS Upstream storage on River Lednock (200 year only)	Complete
06d	Traditional Wall & Embankment PLUS Upstream storage on combinations of watercourses (200 year only)	Not progressed
07	Preferred option model run for all return periods	Not progressed

Locations of the 28 cross-sections selected for results comparison is shown in **Figure 1**. For the ease of result comparison, these 28 cross-sections were divided into four reaches as below:

- Ruchill Water – cross-sections 1 to 8;
- Upper Earn – cross-sections 9 to 17;
- Earn – cross-sections 18 to 22; and
- Lednock – cross-sections 23 to 28.

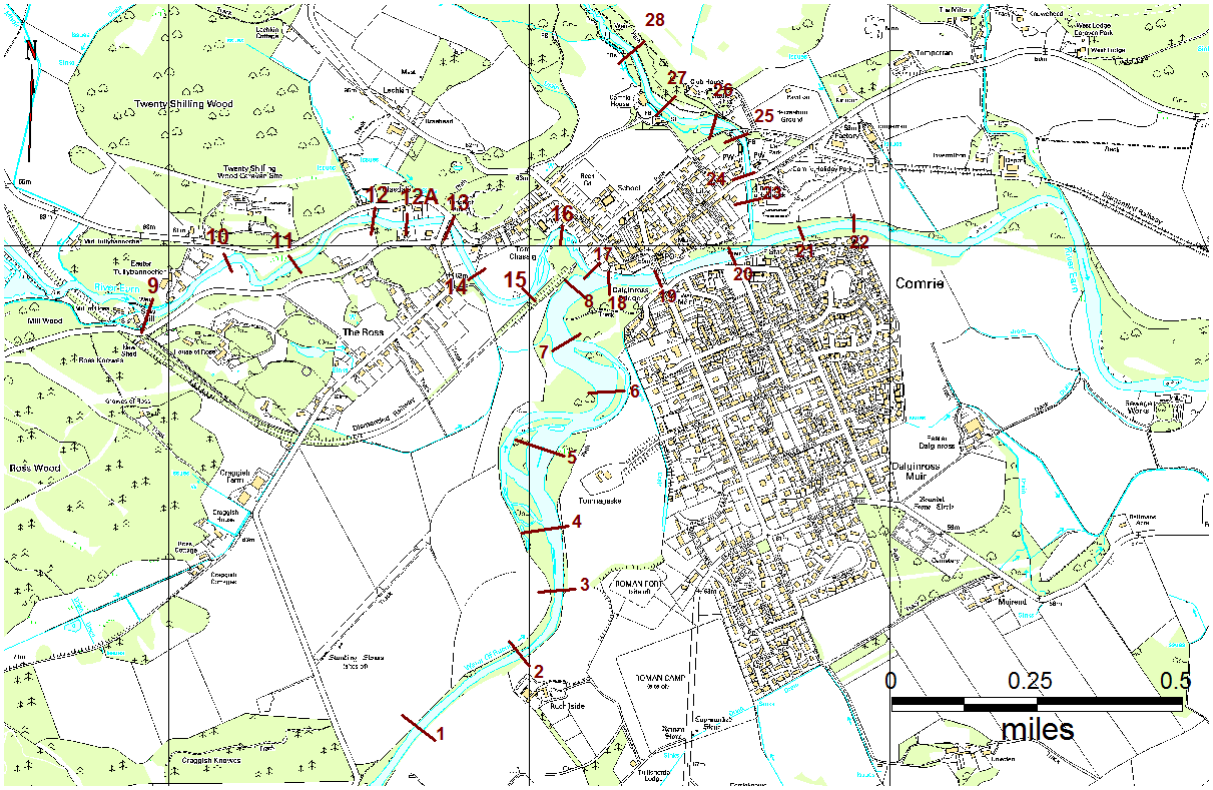


Figure 1 – Location of cross-sections selected for result comparison

2.0 Options 01 and 02: Baseline Model Results and Sensitivity

Baseline models have been run for 1 in 25, 50, 75, 100 and 200 year return periods both with and without climate change allowance. An excel spreadsheet showing the model results in terms of peak water levels in the selected 28 cross-sections for each of these return periods are presented in Appendix 2A. Appendix 2A also includes flood extent maps for each of these return periods.

The results show that flooding occurs in the town of Comrie with all the above considered return periods.

A model run has also been carried out with Qmed [1] (median of the annual maximum flow) in all three water courses. The results show that few properties along the left bank of River Earn are at potential risks of flooding with the Qmed flow in all three water courses. A flood extent map with Qmed flow in all three water courses is presented in Appendix 2A and a snapshot of the maximum flood extent for this scenario is presented in **Figure 2.**

[1] Qmed is equivalent to about 2 year return period

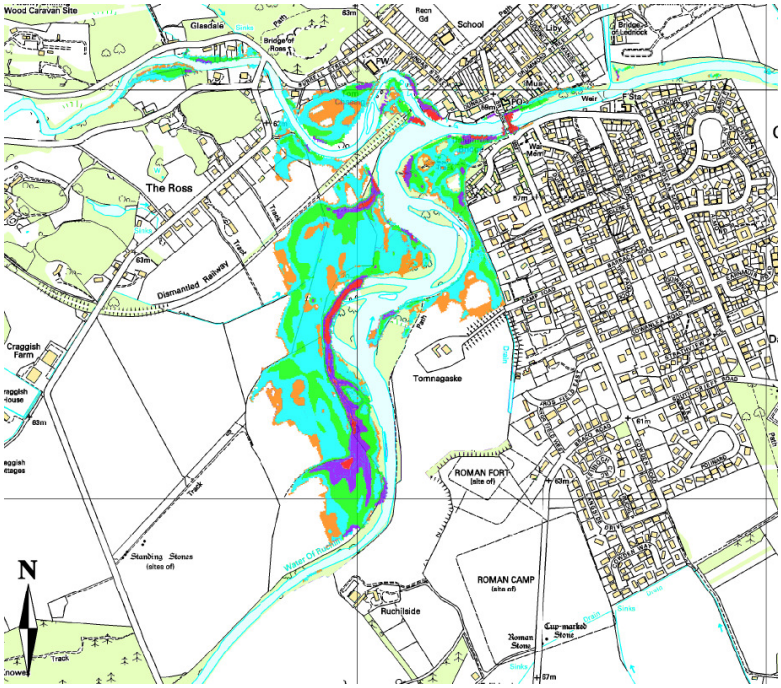


Figure 2 – Flood extent map with Qmed in all three watercourses

3.0 Option 03: Bank Stabilisation

Both banks along the reach of the Ruchill Water upstream of the confluence are susceptible to erosion. Therefore, it is proposed that right bank (approximately 1280 m) and left bank (approximately 1050 m) along the Ruchill Water be reinforced with rock armour. Manning's roughness value was increased from 0.040 to 0.045 to replicate the change from natural channel to Rock Armour. The model run with the bank reinforcement has been carried out for 200 year return period. The approximate extent of the bank reinforcement is shown by brown line in **Figure 3**.

The results in terms of comparison of water levels with and without bank reinforcement in the selected 28 cross-sections is presented in Appendix 2B.

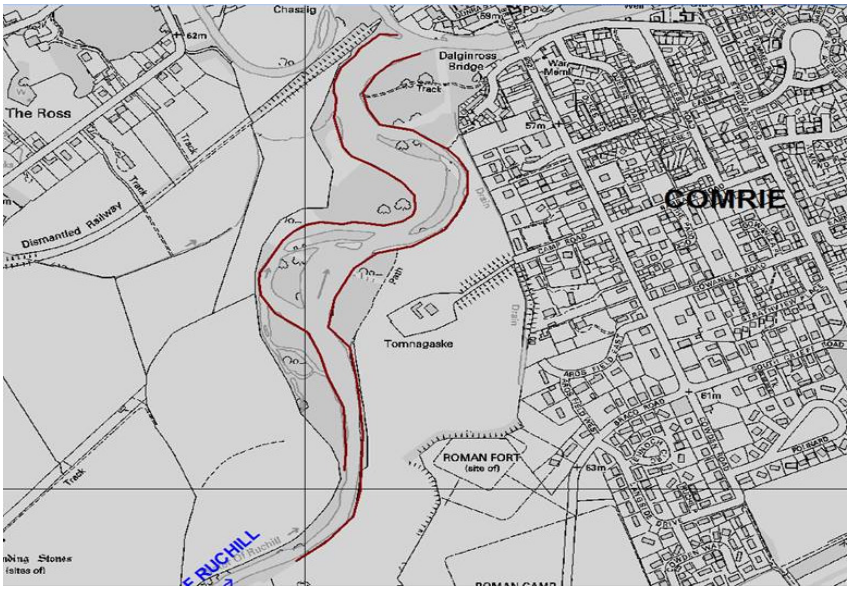


Figure 3 – Extent of bank reinforcement

The results show that while the stabilisation is required it will have a negligible impact on maximum water levels. When comparing the maximum 1 in 200 year water levels before and after the bank reinforcement, the maximum rise in water levels is 13 mm approximately 650 m upstream of the confluence with the Earn.

4.0 Option 04: Traditional Walls and Embankments Option

Model runs with the wall and embankment option have been carried out for 25, 50, 75, and 100, 200 and 200+ CC return periods. The extent of flood walls and embankments as included in the model is shown in **Figure 4**.

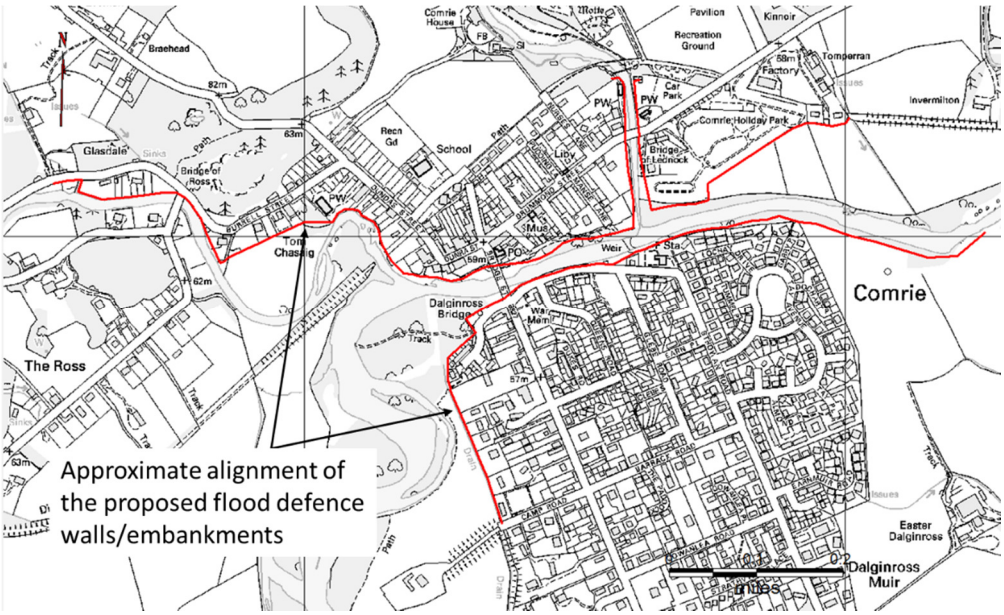


Figure 4 – Extent of the proposed flood defence walls/embankments

The wall and embankments are included in the model as vertical "glass" walls to simulate the theoretical effect on water level. At this stage in the assessment the viability of the structures are not taken into account. Results of water levels with and without the option, approximate height of the walls and required flood defence levels in the selected 28 cross-sections for each of the return periods are presented in Appendix 3A. Appendix 3A also includes flood extent maps for each of these return periods. Points to consider when referring to Appendix 3A are as follows;

- Freeboard is calculated using EA guidanced[2] is likely to be revised following a review by the Council.
- The approximate height of the wall is based on the average ground level near the proposed wall alignment. The ground levels have been derived from the LiDAR data
- The detail of how the defence would accommodate structures and tied to higher ground has not been included.
- The height of the wall shown on the spreadsheet for the Ruchill Water is relative to the top of the existing wall/embankment of Camp Road Flood Alleviation Scheme.

The summary of the results is presented below:

- Increase in water levels due to inclusion of the proposed defence for 200 year return period ranges from 0 to 440 mm depending upon the location.
- The maximum increase in water level occurs upstream of Dalginross Bridge for each of the return periods. The maximum increase in water level for the 200 year return period is 400 mm. The Bridge, however, is not surcharged.
- For 200 year return period, the height of the wall/embankment, including current freeboard allowances, ranges from 0.47 – 0.77; 1.2 – 3.77; 0.77 – 2.72 and 0.45 – 1.42 m above the ground respectively in Ruchill Water, Upper Earn, Earn and Lednock. These heights are based on a freeboard calculated using the EA guidance[3] which are likely to be revised through discussion with the Council. In particular, the wall/embankment height for the Upper Earn will be reduced.
- This option leads to additional flood risk to some properties around the depot in the Invermilton. The 1 in 200 year water levels increase by 110 to 140 mm compared to the baseline model as shown in Figure 5. Localized flood protection measures (bund or wall) would be required for these properties.
- Gardens of some properties are still flooded by the Ruchill Water in the Ross and also upstream of the Bridge of Ross along the right bank of the River Earn. The threshold levels of these properties needs to be checked before the model is refined further.

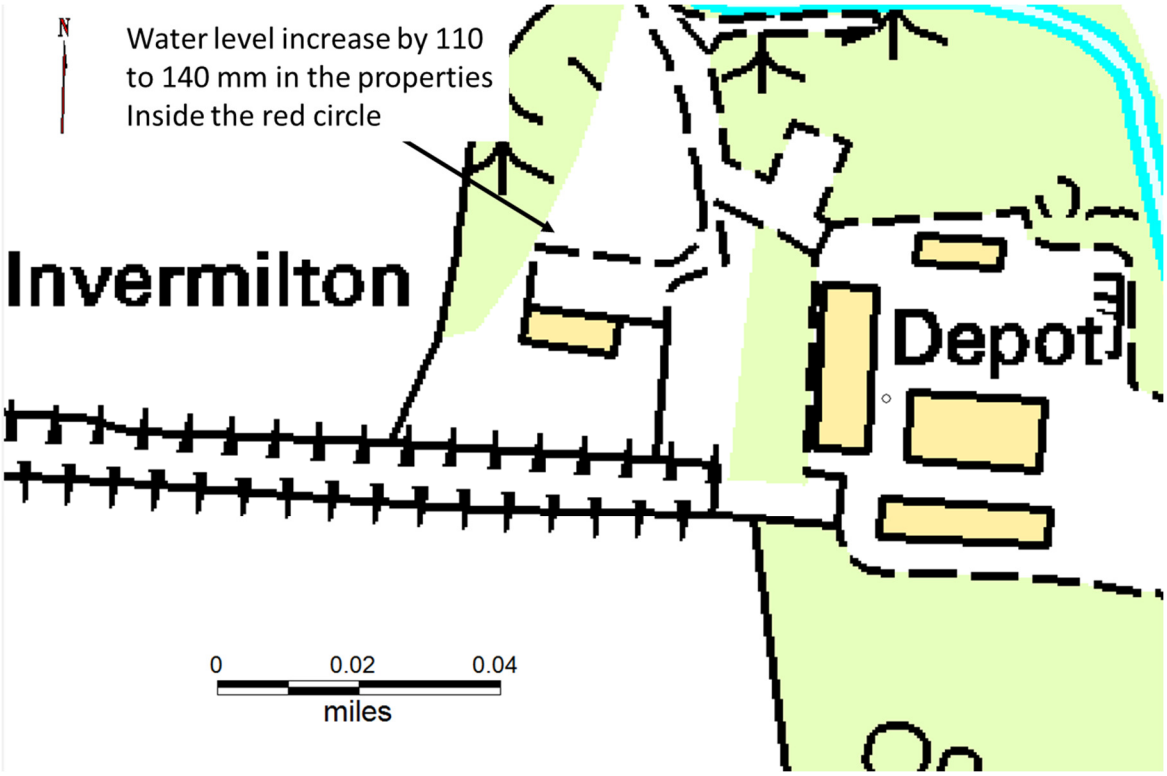


Figure 5 – Location of the properties with additional flood risk

[2 & 3] Fluvial Freeboard Guidance Note. R&D Technical Note W187. Environment Agency (2000)

4.1 Option 04: Sensitivity runs with alternate 200 year scenarios

In order to allow for the various combinations of peak flows in each river the following scenarios were also assessed:

i) Simplified Joint Probability Scenario (JP scenario)
ii) 200 year in Ruchill Water and 10 year in River Earn and Lednock (200-10-10 scenario)
iii) 200 year in River Earn and 10 year in Ruchill Water and Lednock (10-200-10 scenario)
iv) 200 year in Lednock and 10 year in Ruchill Water and Lednock (10-10-200 scenario)

The wall/embankment model runs have been carried out with each of these scenarios and wall heights have been compared at 28 selected cross-sections. The conclusions of the results are summarised below:

- Wall heights are higher at all locations when all three water courses have 200 year return period flows (200 year all scenario) compared to the above mentioned four sensitivity scenarios;
- The heights of the wall are lowest along the Ruchill Water and Upper Earn with sub-option iv) compared to other scenarios
- The heights of the wall are lowest in most of the cross-sections along the Earn with sub-scenario i) except for the reach immediately upstream of the Dalginross Bridge, where iv) gives lowest wall heights.
- The height of the walls are lowest along the Lednock with sub-scenario a) compared to other scenarios.

Detailed results are presented in Appendix 3B.

As expected the scenario that uses the 200 year flow in each river gives the highest water levels. This scenario will be used for future work to refine the options. However, the sub-scenarios a) to d) can be brought back into the assessment should there be a need to consider different levels of protection for areas at risk.

5.0 Option 04: Secondary Options

Four secondary options were tested with the hydraulic models. The model runs were carried out for 200 and 200+CC return periods.

a) Removal / replacement of weir downstream of Bridge
b) Improved conveyance at the bridge (200 year only)
c) Maximise flood storage on local flood plains
d) Dredging
e) Natural Flood Management Techniques

Option 04b was not progressed as the head loss at the bridge is already small (11 cm for the 200 year) and would therefore not provide any significant improvement in conveyance.

Results in terms of comparison of water levels before and after the options at the selected 28 cross-sections are presented in Appendix 4. Appendix 4 also includes flood extent maps for each of the secondary options. The modelling approach and summary of the results for each of the secondary options are presented in section 5.1 to 5.4.

5.1 Option 04a: Weir replacement removal and land regarding

To test this option, the weir downstream of the Dalginross Bridge was removed from the baseline model and the bed of the River Earn has been regraded for about 250 m upstream and 200m downstream of the weir. Figure 2 shows existing bed profiles of the River Earn (extracted directly from ISIS model) from the location of the Dalginross Bridge to approximately 275 m downstream of the weir. The proposed bed levels after regarding, as included in the model, are shown by brown line in **Figure 6**.

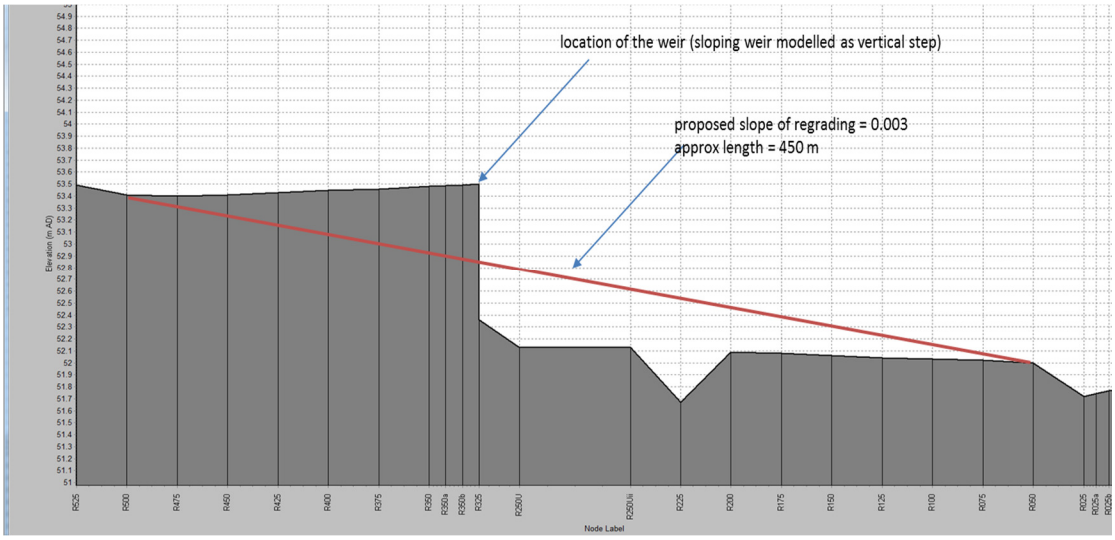


Figure 6 – Proposed land regarding after weir removal

The results show that with this option, the water levels decrease locally from Dalginross Bridge to the location of the weir in the range of 110 - 280 mm and 80 - 200 mm respectively for 1 in 200 and 200+CC return periods. Upstream of the bridge, the reduction in water levels is limited to 10 to 50 mm depending upon the return period.

5.2 Option 04c: Maximise flood storage on local flood plains

This option has been tested with the hydraulic model by lowering ground levels by 750 mm for an area of approximately 0.58 km^2 adjacent to the Ruchill Water. The extent of the storage is shown by the red polygon in **Figure 7** below:

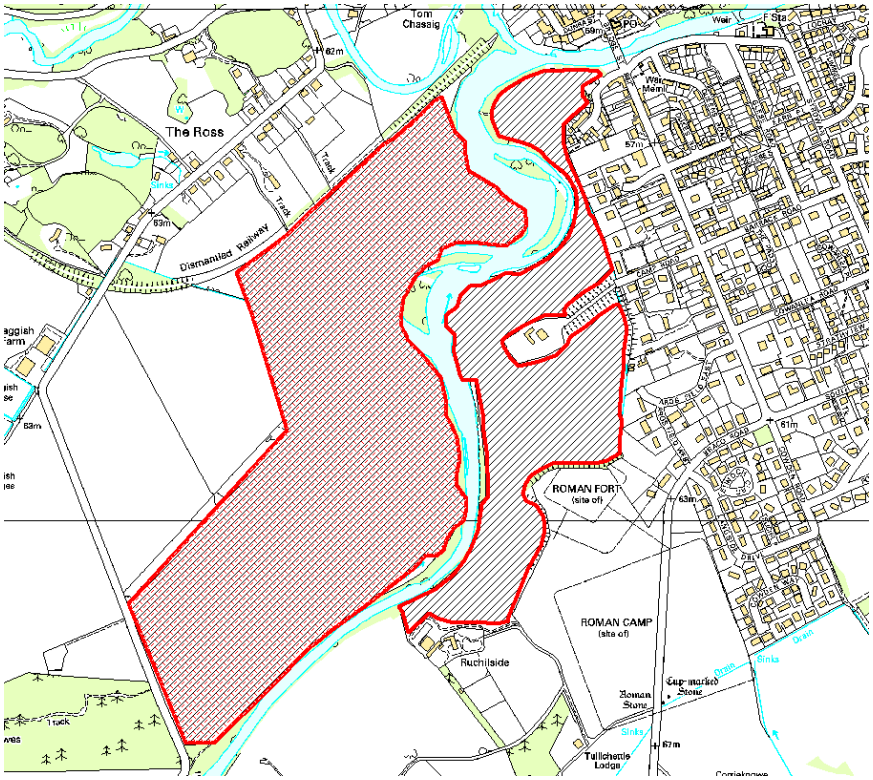


Figure 7 – Proposed extent of local storage

The results show that with this option, the water levels decrease in the Ruchill Water in the range from 30 - 510 mm and 0.0 - 520 mm respectively with 200 and 200+CC return periods. The decrease in water levels is higher in upstream reach (upstream of the extent of the proposed wall) of the Ruchill Water compared to downstream reach near the confluence.

Water levels also slightly increase in the River Earn near the confluence with Ruchill Water.

5.3 Options 04d: Dredging

Two scenarios of dredging have been tested with the hydraulic model for 1 in 200 year return period both with and without climate change allowance. The model has been used to determine the theoretical impact on water levels with no consideration given to viability.

Scenario 1

This option has been tested with the hydraulic model by lowering the bed levels by approximately 1 m for 2.2 km of the model reach. The red line in **Figure 8** shows extent of the dredging. The weir levels have also been lowered by approximately 1 m.

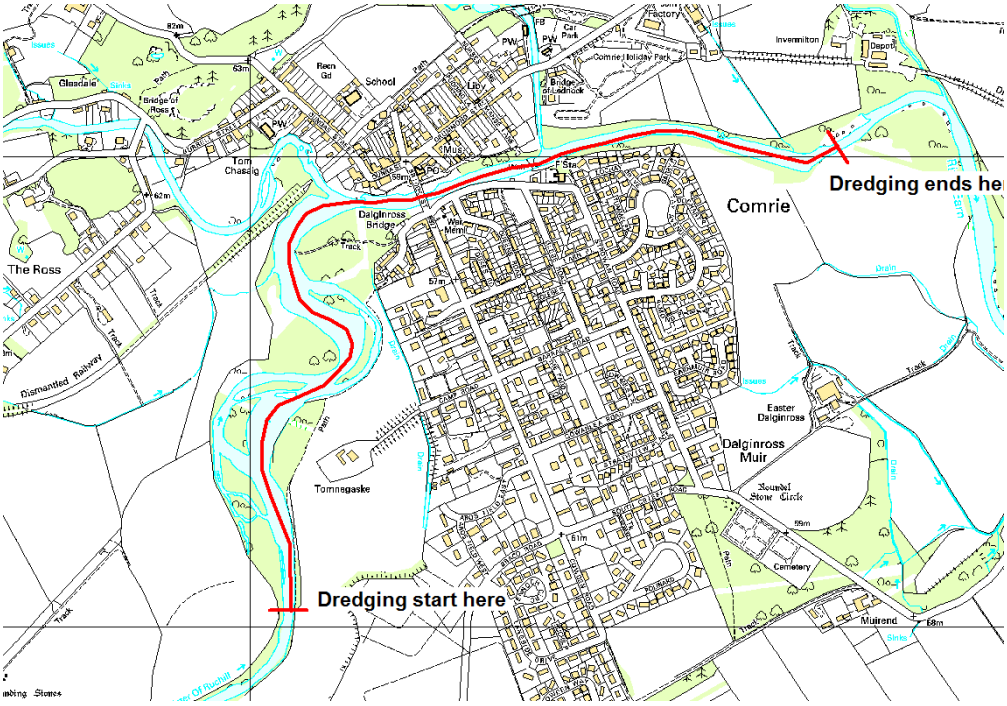


Figure 8 – Proposed extent of dredging

The results show that when dredging is carried out, the water levels decrease in the range of 0 – 375 mm, 4 – 404 mm, 97 – 408 mm and 0-186 mm respectively in Ruchill Water, Upper Earn, Earn and Lednock for 1 in 200 year return period depending upon the locations. Similarly, the water levels decrease in the range of 0 – 300 mm, 10 – 360 mm, 40 – 380 mm and 0 – 110 mm respectively in Ruchill Water, Upper Earn, Earn and Lednock for 1 in 200+CC depending upon the locations.

Scenario 2

The aim of this model run was to investigate approximate depth and extent of the dredging to entirely alleviate the risk of flooding in the Comrie town. The scenario has been included to illustrate the scale of dredging required with no consideration of viability. Following approach were applied in the hydraulic model to test this option:

- Bed levels of the Ruchill Water at the start of the dredging (see Figure 4) have been lowered by 5m and the bed levels of all other downstream sections have been dredged to maintain constant longitudinal slope of 0.0035 throughout the dredging reach shown by red line in Figure 6.
- Where the Ruchill bifurcates both channel have been dredged.
- Further dredging were carried out to ensure a smooth transition between dredged and non-dredged reaches. These reaches are shown in Figure 6. In Water of Ruchill (upstream of the original start of the dredging shown by green line in Figure 6), River Earn (upstream of the confluence with Ruchill Water shown by blue line in Figure 6) and Lednock (upstream of the confluence with River Earn shown by yellow line in Figure 6).

- All the dredged channel were assumed to have trapezoidal cross-sections with 1:1 bank slopes. **Figure 9** shows a cross-section before and after dredging at the location approximately 200 m downstream of the start of dredging.
- The weir downstream of the Dalginross Bridge has been removed from the model.

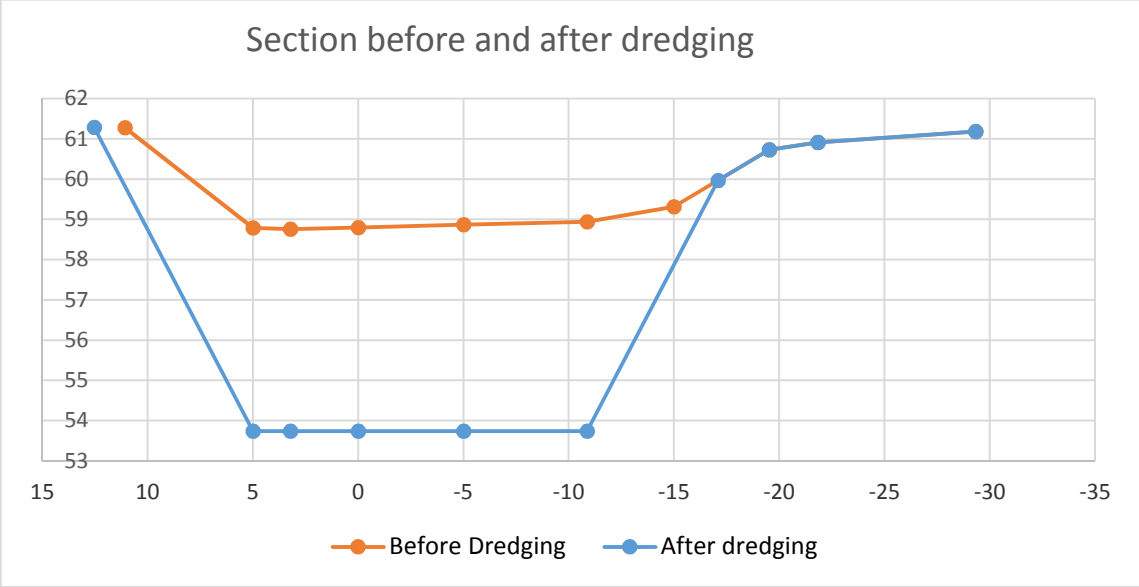


Figure 9 – Cross-section before and after dredging

Table 2 shows the original and additional dredged length, slope and range of dredged depth in each of the original and additional dredged extent.

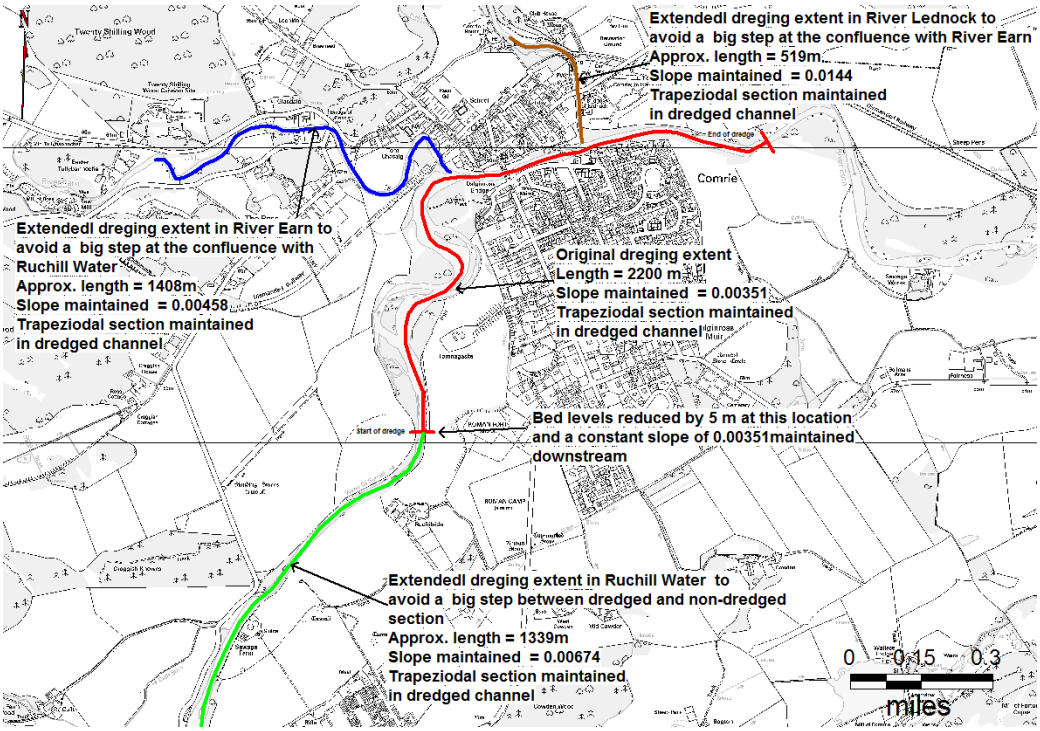


Figure 10 – Original and extended dredging extent

Table 2 – Length, slope and dredging depth

	Approximate Length, m	Slope of the dredged channel, m/m
Original extent	2200	0.00351
Extended extent_Ruchill Water	1339	0.00674
Extended extent_River Earn	1408	0.00458
Extended extent_Ruchill Water	519	0.0144
Total length	**5466**	

The model results show that the water levels in the selected 28 cross-sections decrease in the range 1940 mm – 3680 mm; 500 mm – 2780 mm; 1090 mm – 2670 mm, 170 mm – 1780 mm respectively in Ruchill Water, Upper Earn, Earn and Lednock. As expected, this option would entirely mitigate the flooding issue in the Comrie town for the 200 years return period both with and without climate change. **Figure 11** shows the 1 in 200 year flood extent map with this option.

Figure 11 – 1 in 200 year maximum flood xtent ap with 5m (average) redging

5.4 Option 04e: Natural Flood Management (NFM)

The approach to undertake the natural flood management has been issued to the client as a separate technical note[4]. This option has been tested for 1 in 200 year return period both with and without climate change allowance.

The model results are summarised below:

- 1 in 200 year peak flows at the Cultybraggan and Aberuchill gauges decrease approximately by 6.7 and 6.9% respectively.

[4] Fluvial Freeboard Guidance Note.[5] R&D Technical Note W187. Environment Agency (2000)

- With the NFM option the 1 in 200 years return period water levels in the selected 28 cross-sections decrease in the range 30 – 130 mm; 110 – 190 mm; 40 – 140 mm, 0 – 70 mm respectively in Ruchill Water, Upper Earn, Earn and Lednock.

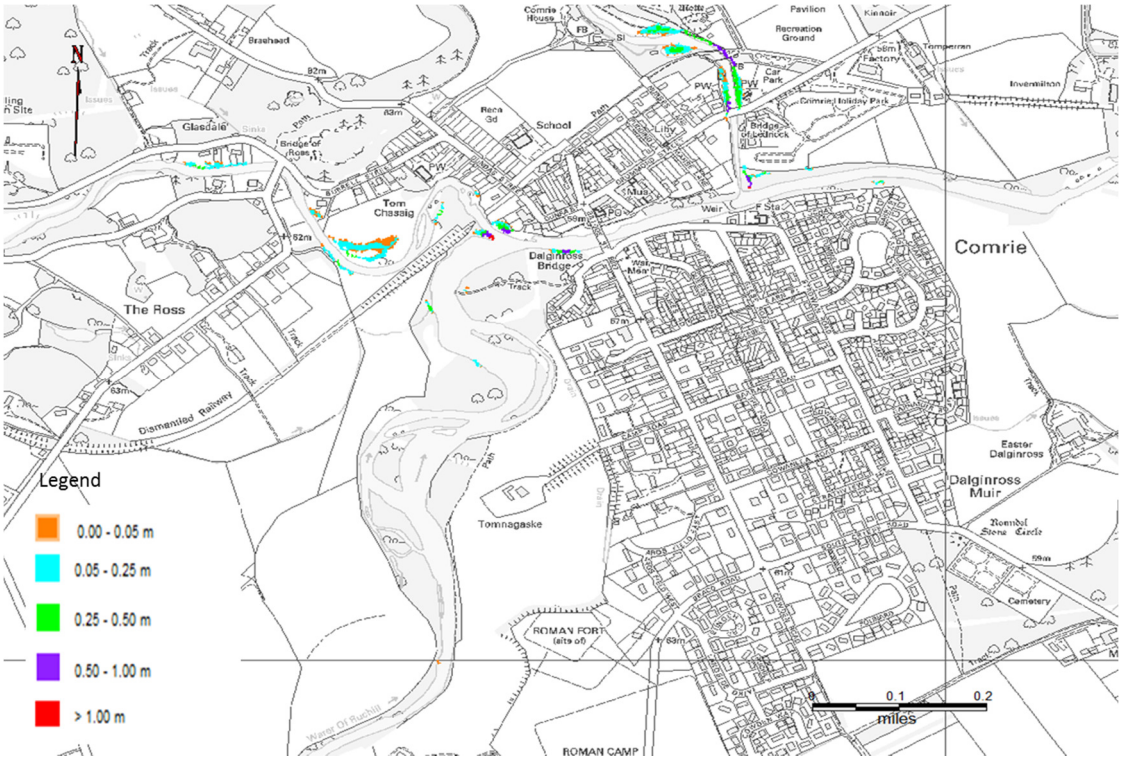
6.0 Option 05: Upstream Storage

Potential locations of the storage in the upstream catchments of each of the three watercourses is shown in a map in Appendix 5.

This option has been tested with 1 in 200 years return period and without flood walls/embankments in the Comrie. The aim of this model run was to store enough volume in the Ruchill Water and River Earn catchment such that flow would contain within the banks of Ruchill Water and River Earn along the reach of Comrie. For the modelling purpose, an ISIS sluice gate unit has been used to represent the impounding dam.

A sketch showing key parameters of the reservoirs (length, height, volume of storage and flow released downstream) and the flood extent map are presented in Appendix 5.

The model results show that over-bank flow is negligible[5] in the reach of the Ruchill Water and River Earn through Comrie when approximately 10.6 and 4.0 million m^3 of water is stored in Ruchill Water and River Earn catchment respectively. **Figure 12** shows the flood extent map with this option.



[5] R&D Technical Note W187. Environment Agency (2000)
he River Earn floodplain immediately adjacent to the bank. This out of bank spill is nominal and localized and would not flood any properties.

Figure 12 – 1 in 200 year maximum flood extent map with upstream storage on the Waters of Ruchill and River Earn

The key parameters of the reservoir under this option are presented in **Table 3.**

Table 3 – Key parameters of reservoir with upstream storage option

	Approx. Volume of storage require, mln m^3	Approx. height of the Dam (H), m	Approx. length of the reservoir (L), km	Flow released d/s of dam, m3/s
Water of Ruchill	10.6	30.3	2.8	44.6
River Earn	4.0	20.1	3.2	39.4

7.0 Option 06: Upstream Storage in combination with traditional walls/embankments

With the view of assessing potential reduction in the heights of the proposed flood defence walls/embankments along Comrie, Mouchel has carried out following model runs:

a) Storage in Ruchill Water in combination with traditional walls/embankments in Comrie;
b) Storage in River Earn in combination with traditional walls/embankments in Comrie; and
c) Storage in Lednock in combination with traditional walls /embankments Comrie.

For the modelling purpose, ISIS sluice gate unit has been incorporated at the location of the dam.

Results in terms of comparison of water levels with and without the option, approximate height of the walls and required flood defence levels in the selected 28 cross-sections for each of the these options are presented in Appendix 6. Sketches showing key parameters of the reservoirs (length, height, volume of storage and flow released downstream) and the flood maps are also presented in Appendix 6. Key results in terms of volume of storage, height of dam and reservoir length for 1 in 200 year return period are summarised in **Table 7**. More detailed information and results of each of these options are described in section 7.1 to 7.3.

7.1 Option 06a: Storage in Ruchill Water in combination with walls

This option has been tested for 200 years return period both with and without climate change allowance. Reduction in the wall heights in the Comrie with the storage in Ruchill Water has been assessed for two different sets of storage volume.

The channel sections in the storage area (upstream of the dam) have not been regraded or re-profiled and the walls/embankments are as given in section 4.0.

The summary of the results for 1 in 200 years return period is presented in **Table 4.**

Table 4 – 1 in 200 year model results with upstream storage in Ruchill Water and traditional walls/embankment in Comrie

Reach	Volume of storage = 2.5 million m^3			Volume of storage = 4.1 million m^3		
	Decrease in water levels compared to baseline model, m	Range of wall height including freeboard, m	Reduction in wall heights compared to "traditional walls" option, m	Decrease in water levels compared to baseline model, m	Range of wall height including freeboard, m	Reduction in wall heights compared to "traditional walls" option, m
Ruchill Water	0.31 - 0.97	0.07	0.40 – 0.89	0.69 – 1.78	NA	0.93 – 1.53
Upper Earn	0.01 - 0.66	1.16 – 3.08	0.05 – 0.69	0.02 – 1.12	1.14 – 2.74	0.06 - 1.15
Earn	0.20 - 0.70	0.19 – 1.79	0.42 – 0.92	0.38 – 1.17	0.48 – 1.35	0.71 – 1.5
Lednock	0.00 - 0.26	0.15 – 1.22	0.20 – 0.31	0.00-0.35	0.04 - 1.16	0.26 – 0.41

- The results show that wall heights in the selected 28 cross-sections decrease in the range 0.05-0.89 and 0.06–1.53 m compared to the "traditional walls/embankments" option when respectively 2.5 and 4.1 million m^3 of volume is stored in the Water of Ruchill in 1 in 200 years return period.
- While the scenario is designed to reduce wall heights along the Ruchill heights are also reduced in the Upper Earn upstream of the confluence and the Earn downstream of the confluence. There is small reduction in the lower reach of the Lednock.
- A 24m high dam and 2.1 km long reservoir is required to store approximately 2.5 million m^3 of volume in Ruchill Water.
- A 28m high dam and 2.6 km long reservoir is required to store approximately 4.1 million m^3 of volume in Ruchill Water.

7.2 Option 06b: Storage in River Earn in combination with walls

This option has been tested for 200 year return period both with and without climate change allowance. Reduction in the wall heights in Comrie with the storage in River Earn has been assessed for two different storage volume.

The summary of the results for 1 in 200 year return period is presented in **Table 5**

Table 5 – 1 in 200 years model results with upstream storage in River Earn and traditional walls/embankment in Comrie

Reach	Volume of storage = 0.4 million m^3			Volume of storage = 2.9 million m^3		
	Decrease in water levels compared to baseline model, m	Range of wall height including freeboard, m	Reduction in wall heights compared to "traditional walls" option, m	Decrease in water levels compared to baseline model, m	Range of wall height including freeboard, m	Reduction in wall heights compared to "traditional walls" option, m
Ruchill Water	0.13 – 0.17	0.43 – 0.58	0.05 – 0.20	0.22 – 0.32	0.35 – 0.40	0.08 – 0.40
Upper Earn	0.21- 0.76	0.38 – 3.50	0.27 – 0.83	0.38 – 1.63	0.00 - 3.21	0.56 – 1.81
Earn	0.03 – 0.19	0.61 – 2.43	0.13 – 0.28	0.08 – 0.37	0.51 – 2.24	0.19 – 0.49
Lednock	0.00 – 0.09	0.35 – 1.39	0.04 – 0.11	0.01 – 0.15	0.27 – 1.34	0.09 – 0.18

- The results show that wall heights in the selected 28 cross-sections decrease in the range 0.04–0.83 and 0.08–1.81 m compared to the "traditional walls/embankments" option when respectively 0.4 and 2.9million m^3 of volume is stored in the River Earn.
- The reduction in the wall heights compared to the "traditional walls/embankments" option is naturally more in the Upper Earn resulting in reductions in the Earn and lower reaches of the Ruchill and Lednock.
- An approximately 15 m high dam and 2.2 km long reservoir is required to store approximately 0.4 million m^3 of volume in River Earn.
- An approximately 18.4 m high dam and 2.7 km long reservoir is required to store approximately 2.9 million m^3 of volume in River Earn.

7.3 Option 06c: Storage in River Lednock in combination with walls

This option has been tested for 200 year return period. The summary of the results is presented in **Table 6**

Table 6 – 1 in 200 years model results with upstream storage in River Lednock and traditional walls/embankments in Comrie

Reach	Volume of storage = 1.2 million m^3		
	Decrease in water levels compared to baseline model, m	Range of wall height including freeboard, m	Reduction in wall heights compared to "traditional walls" option, m
Ruchill Water	0.00 – 0.03	0.47 – 0.73	0.01 – 0.04
Upper Earn	0.00 – 0.03	1.20 – 3.72	0.00 – 0.05
Earn	0.04 – 0.18	0.64 – 2.67	0.05 – 0.19
Lednock	0.01 – 0.74	0.36 – 1.06	0.09 – 0.36

- The results show that wall heights in the selected 28 cross-sections decrease in the range 0.00 – 0.36 m compared to the "traditional walls/embankment" option when 1.2 million m^3 of volume is stored in the River Lednock.
- The reduction in the wall heights compared to the "traditional walls/embankments" option is naturally more in the Lednock with only a small reduction in the Earn.
- The reduction in wall heights is quite localized in the Lednock and in the Earn near the confluence with Lednock.
- An approximately 16.4 m high dam is required to store approximately 1.2 million m^3 of volume in Lednock. The length of the reservoir will be approximately 1.4 km.

Key model results related to proposed reservoir is summarized in **Table 7.**

Table 7 – Key parameters of reservoir with upstream storage and traditional walls

	Approx. Volume of storage require, mln m^3	Approx. height of the Dam (H), m	Approx. length of the reservoir (L), km	Flow released d/s of dam, m3/s
Water of Ruchill				
	2.5	23.5	2.1	145
	4.1	28.0	2.6	75
River Earn				
	0.4	15.1	2.2	139
	2.9	18.4	2.7	75.4
Lednock				
	1.2	16.4	1.4	75.2

8.0 Discussion

8.1 Option 04: Traditional walls/embankments option

A summary of the wall heights for Option 04 (walls/embankments only) for different return periods is given in Appendix 8. It is evident that wall/embankment heights for the 200 year flows are significant, particularly along the Upper Earn upstream of the Bridge of Ross and in the Earn through Comrie. The freeboard allowances are subject to review, but even a reduction to 600mm for embankments and 300mm for walls will not reduce the walls to acceptable heights.

The increase in accuracy that would result from using a topographic survey rather than LiDAR is not likely to be significant.

This option includes local measures to protect five properties near Invermilton.

8.2 Secondary Options

Option 04b: Weir replacement removal and land regrading

This option shows only a local reduction in the water levels between the weir and Dalginross Bridge. Implementing this option would involve river diversion and large scale earthworks in river bed and is therefore unlikely to be cost effective.

Option 04c: Maximize flood storage in local flood plain

This option reduces the water levels in the Ruchill upstream of the existing prevention works where walls/embankments are not required. The water level reduction in the lower reaches of the river, upstream of the confluence, is limited to 30 to 110 mm.

Option 04d: Dredging

The modelling has demonstrated that a significant increase in the hydraulic capacity of the channels through dredging will reduce water levels to the extent that no out-of bank flows would occur.

However, this option involves dredging approximately 5.5 km of channel to a depth of up to 5 m. The Bridge of Dalginross would have to be removed or re-built and the weir would be removed. There would be significant implications for the stability of structures adjacent to the river as well as the practical consideration of removing the dredged material. The capital cost of this option would be significant.

In addition, a costly maintenance regime would be required to maintain the capacity of the channel.

Option 04e: Natural Flood Management

The approach taken to assess the impact of NFM measures is relatively high level at this time due to the difficulty in quantifying the impact of measures at the catchment scale. A reduction in runoff of 6% over about 45% of the catchment combined with an increase in the time to peak of 10% is a reasonable approach to test for sensitivity. The maximum reduction in water level occurs in the Upper Earn where the 1 in 200 year water level decreases by up to 190 mm.

Upstream storage is included in the list of options and has not been treated as a NFM measure.

NFM measures can give wider benefits including enhancement of biodiversity, improving recreational value and long term sustainability. However, the establishment of carefully monitored NFM trials are needed to quantify the effect of specific NFM options.

The study and implementation of NFM would be a long term project relying on collaboration with other stakeholders including SEPA and land owners.

8.3 Option 05: Upstream Storage

Significant volumes of storage would be required to fully protect Comrie against the 1 in 200 year flood. Reservoir capacities of 10.6 and 4.0 million m^3 are required in the Ruchill Water and River Earn catchments. Additional volumes would be required to allow for the high volume of sediment transported by these rivers (particularly the Ruchill Water).

The Ruchill Water has great potential to store the water naturally due to the valley shape of the upstream catchment. However, this option requires a high dam (or a series of dams) to retain the required volume of water, be high cost and involve numerous stakeholders.

Unlike Ruchill Water, River Earn has limited natural storage capacity. The cost of implementing a control at the outlet to Loch Earn is not likely to be cost effective and the area required for a storage of 4 million m^3 is not likely to be available.

Storage is not a solution in itself and should be combined with walls and embankments.

8.4 Option 06: Upstream Storage in combination with traditional walls/embankment

There is a direct link between the volume of upstream storage and the required wall/embankment height. The balance between storage and wall/embankments ultimately is determined by benefit-cost.

The modelling to date has considered two storage options. The full storage option as presented in option 05 and a reduced storage option that uses 2.5 million m^3 in the Ruchill and 0.4 million m^3 in the Upper Earn. The latter has been used to test the sensitivity of the wall/embankment heights to upstream storage. Further options will be included guided by the benefit-cost and broader feasibility study.

The benefit of storage in the Upper Earn is reduction of wall heights with the storage in the River Earn is limited mainly to the Upper Earn.

The wall/embankment height reduces by up to 1.5 m in some locations by storing 4.1 million m^3 of water in Ruchill Water. The maximum height of the wall reduces from 3.8 m to 2.7 m. The reduction in water levels in the Upper Earn is greater than when storage in the Upper Earn only is considered.

Loch Lednock already provides storage within the catchment of the Lednock. Rather than consider additional storage, which is almost certainly not viable, the operator of the reservoir (SSE) have been approached to establish if there is merit in considering modifying the discharges from the reservoir prior to and during flood events.

9.0 Conclusion and Recommendations

9.1 Conclusions and Recommendations Tabulated

The conclusions and recommendations of the hydraulic modelling is tabulated below:

Option	Description	Comment	Recommendation
04	Traditional walls/embankment	Wall height through the town would range from 2.1m to 0.15m plus freeboard. Wall height along the left bank of the Upper Earn exceeds 3m upstream of the confluence.	Progress
04a	Removal of weir downstream of the Dalginross Bridge	Water levels decrease locally from the Dalginross Bridge to the location of the weir in the range of 110 - 280 mm and 80 - 200 mm respectively for 1 in 200 and 200+CC compared to the baseline scenario. Upstream of the bridge, the reduction in water levels is limited to 10 to 50 mm depending upon return period.	Hold
04b	Improved conveyance at the bridge (200 year only)	Water level decrease of 110 mm but very localised (upstream of bridge).	Hold
04c	Maximise flood storage on local flood plains (200 and 200+CC only)	The water levels in the Ruchill within the extent of the proposed wall are reduced by 3 to 320 mm.	Hold
04d	Dredging of river channels (200 and 200+CC only)	When average 1 m of dredging is carried out, the water levels decrease in the range of 0 - 375, 4 - 404, 97 - 408 and 0-186 mm respectively in Ruchill Water, Upper Earn, Earn and Lednock for 1 in 200 year return period. A 5 m reduction in bed level over a reach of 5.5km is required to entirely mitigate the risk of flooding in the Comrie Town.	Hold

04e	Natural Flood Management (NFM)	A reduction in runoff of 6% over 45% of the catchment combined with an increase in the time to peak of 10% gives a maximum reduction in water level of 190 mm. This occurs in the Upper Earn upstream of the confluence. The option gives a reduction of about 50 mm through the town.	Hold
05	Upstream storage	Approximately 10.6 and 4.0 million m^3 of water would have to be stored in Ruchill Water and Upper Earn catchments to alleviate the flooding issue in the Comrie without any flood defence walls embankment.	Do not progress
06a,b and c	Traditional Wall & Embankment PLUS Upstream storage	Wall/embankment heights are reduced as the volume of upstream storage is increased. The model results show that providing upstream storage in the Ruchill is the most effective way of reducing water levels through Comrie. For example, wall heights decrease in the range 0.05-0.89 when 2.5 million m^3 of volume is stored in the Water of Ruchill for the 200 year flood. However, a 24m high dam and 2.1 km long reservoir is required to store approximately 2.5 million m^3.	Progress

9.2 Conclusions and Recommendations Summary

- The preferred option will include traditional walls and embankments
- The freeboard allowance should be agreed. It is expected to be 300mm for walls and 600mm for earth embankments
- The viability of upstream storage needs to be assessed further
- All secondary options have been put on hold but may well be re-introduced to refine a preferred option
- Natural Flood Management is not a short term option but could increase the resilience of the scheme over time as well as giving multiple benefits

APPENDIX 1 : MODEL EXTENTS

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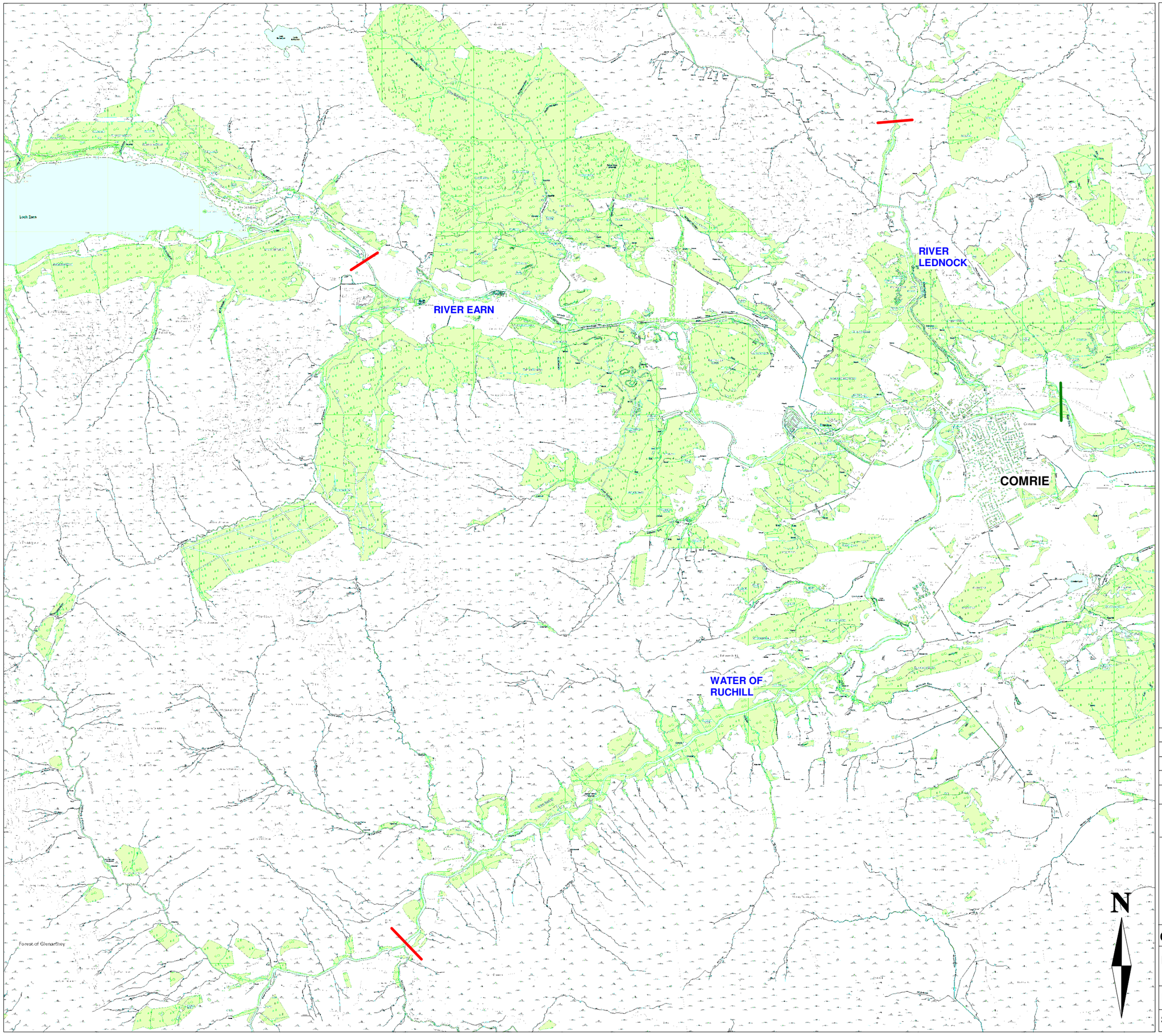

NOTES

UPSTREAM BOUNDARY

DOWNSTREAM BOUNDARY

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PERTH & KINROSS COUNCIL

No Window

Comrie and Dalginross Flood Study

Extents of hydraulic model

Date of Issue: June 2015

Scale at A3: Not to Scale

APPENDIX 2A : BASELINE RESULTS & FLOOD MAPS

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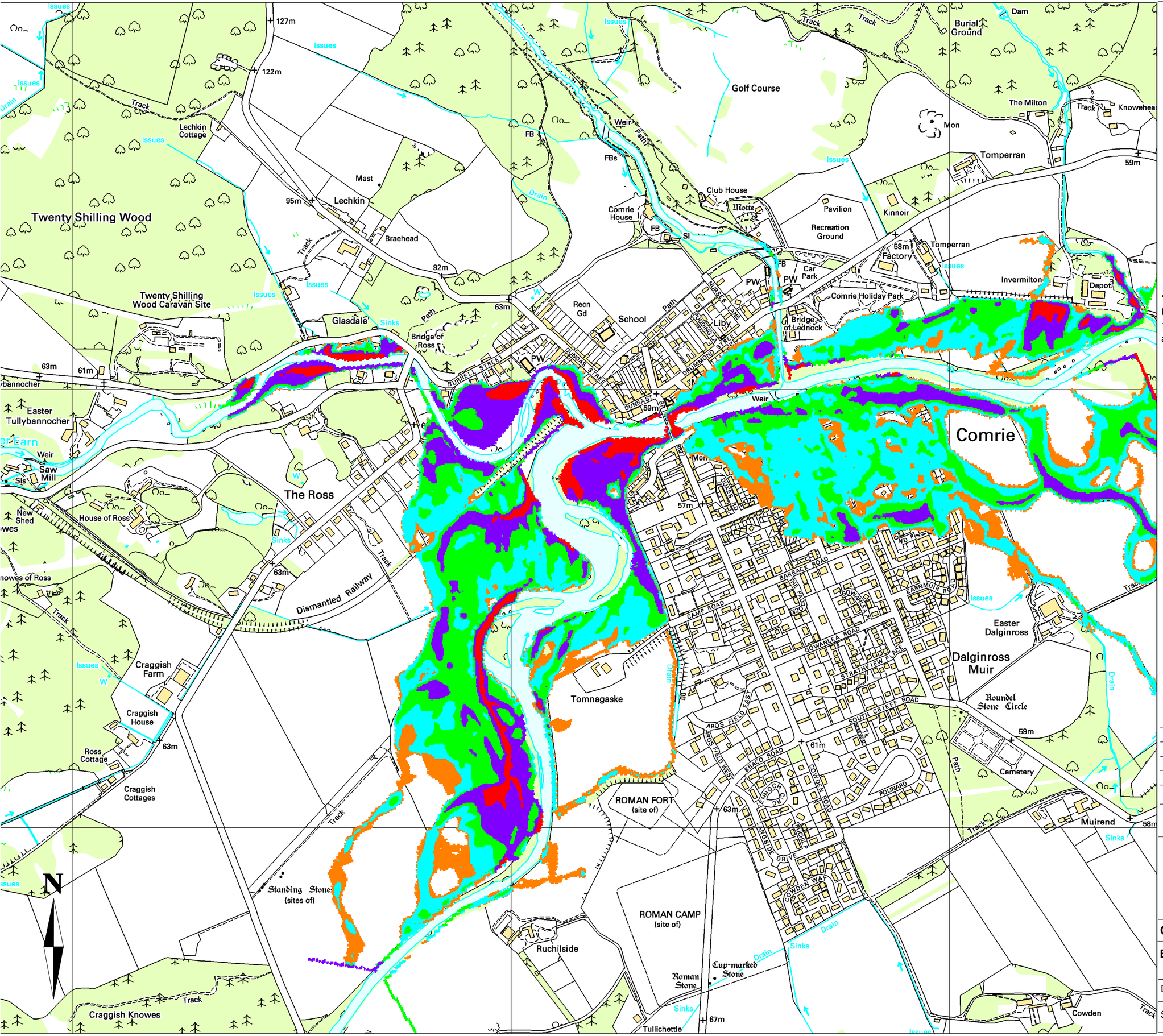
TABLE 1A: BASELINE MODEL WATER LEVELS RESULTS

Section reference	Model Node Reference	1 IN 25 YEAR	1 IN 50 YEAR	1 IN 75 YEAR	1 IN 100 YEAR	1 IN 200 YEAR	1 IN 200+CC
A. RUCHILL WATER							
1	R2415	64.20	64.30	64.35	64.38	64.44	64.58
2	R2073	62.37	62.41	62.43	62.45	62.48	62.58
3	R1850	61.64	61.68	61.71	61.73	61.77	61.87
4	R1675	61.12	61.18	61.21	61.23	61.28	61.38
5	R1450	59.77	59.81	59.83	59.84	59.87	59.94
6	R1200	58.67	58.75	58.80	58.85	58.97	59.28
7	R1000	58.48	58.61	58.69	58.75	58.91	59.24
8	R800	58.40	58.55	58.63	58.70	58.87	59.21
B. UPPER EARN							
9	E1700_ND	60.50	60.71	60.83	60.94	61.19	61.57
10	E1407_N	60.32	60.56	60.70	60.82	61.11	61.57
11	E1185_N	59.98	60.20	60.32	60.44	60.72	61.17
12	E916_N	59.71	59.99	60.14	60.27	60.61	61.10
12A	E916b	59.52	59.81	59.97	60.12	60.48	60.99
13	E712_N	59.04	59.18	59.26	59.34	59.53	59.78
14	E538	58.52	58.67	58.76	58.84	59.01	59.32
15	E360	58.45	58.63	58.72	58.81	58.99	59.31
16	E157	58.27	58.46	58.56	58.65	58.85	59.20
17	E000	58.24	58.40	58.49	58.57	58.76	59.11
C. EARN							
18	R700	58.07	58.24	58.33	58.41	58.59	58.95
19	R575U	57.59	57.69	57.74	57.78	57.88	58.07
20	R350	57.17	57.26	57.31	57.35	57.43	57.55
21	R150	56.11	56.17	56.21	56.24	56.31	56.45
22	R000	55.71	55.83	55.89	55.93	56.02	56.16
D. LEDNOCK							
23	L108	56.35	56.45	56.50	56.55	56.70	56.97
24	L176	56.63	56.79	56.89	56.96	57.19	57.44
25	L289	57.15	57.36	57.42	57.46	57.58	57.74
26	L372	57.65	57.85	57.95	58.01	58.19	58.42
27	L519	58.75	58.91	58.99	59.04	59.18	59.35
28	L703	60.73	60.90	60.99	61.06	61.24	61.50



NOTES

Users should notethat the floodplain extents were mapped at 1:10,000 scale, as appropriate to the level of investigation and are based on the information available at the time of survey.

FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

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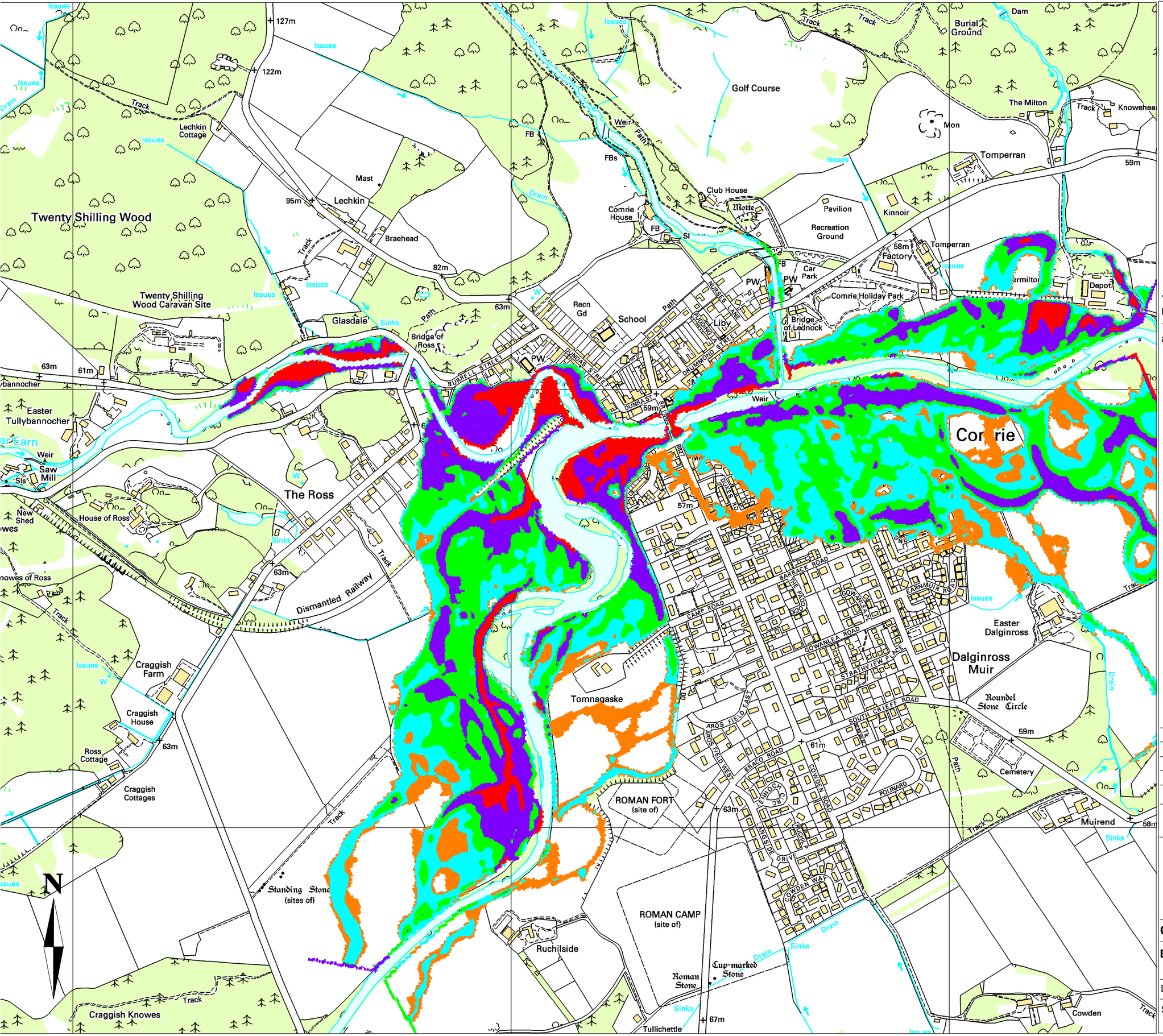
Comrie and Dalginross Flood Study

Baseline flood outline for a 1 in 25 year flood event

Date of Issue: April 2015

Scale at A3: Not to Scale



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FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

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Baseline flood outline for a 1 in 50 year floor event

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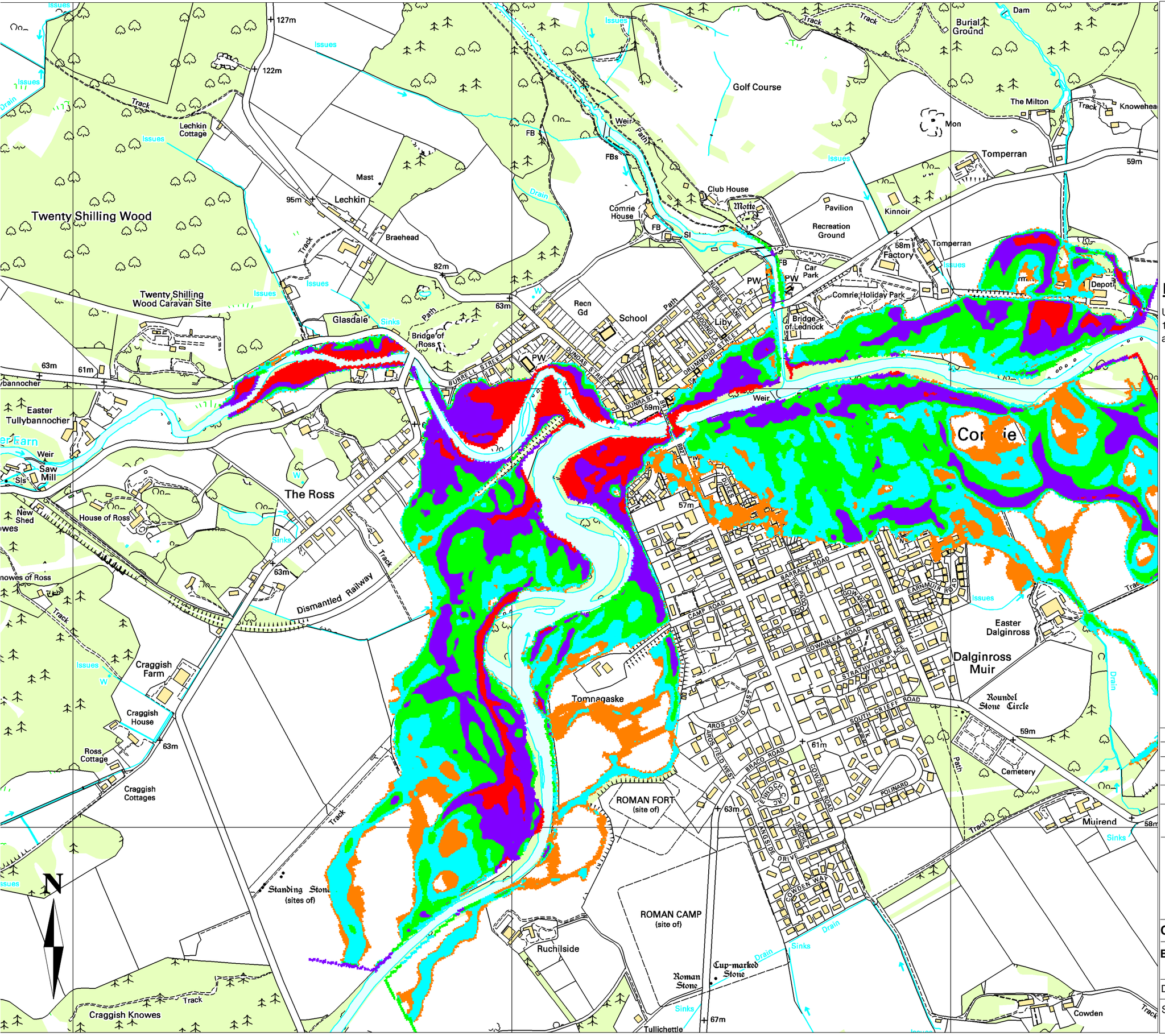

NOTES

Users should notethat the floodplain extents were mapped at 1:10,000 scale, as appropriate to the level of investigation and are based on the information available at the time of survey.

FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

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Comrie and Dalginross Flood Study

Baseline flood outline for a 1 in 75 year flood event

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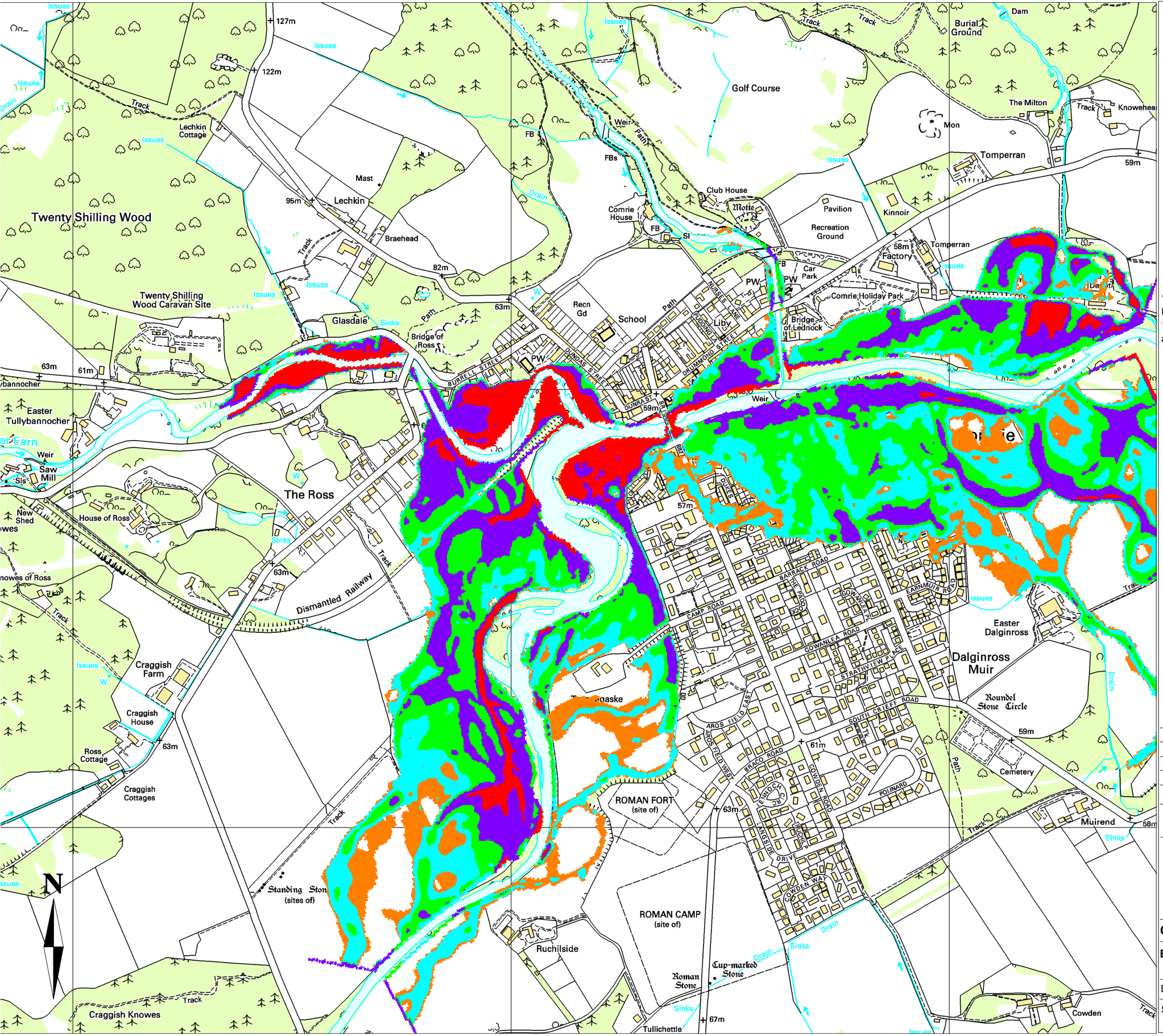

NOTES

Users should notethat the floodplain extents were mapped at 1:10,000 scale, as appropriate to the level of investigation and are based on the information available at the time of survey.

FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

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Baseline flood outline for a 1 in 100 year flood event

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FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

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Comrie and Dalginross Flood Study

Baseline flood outline for a 1 in 200 year flood event

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FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

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Baseline flood outline for a 1 in 200 year + cc flood event

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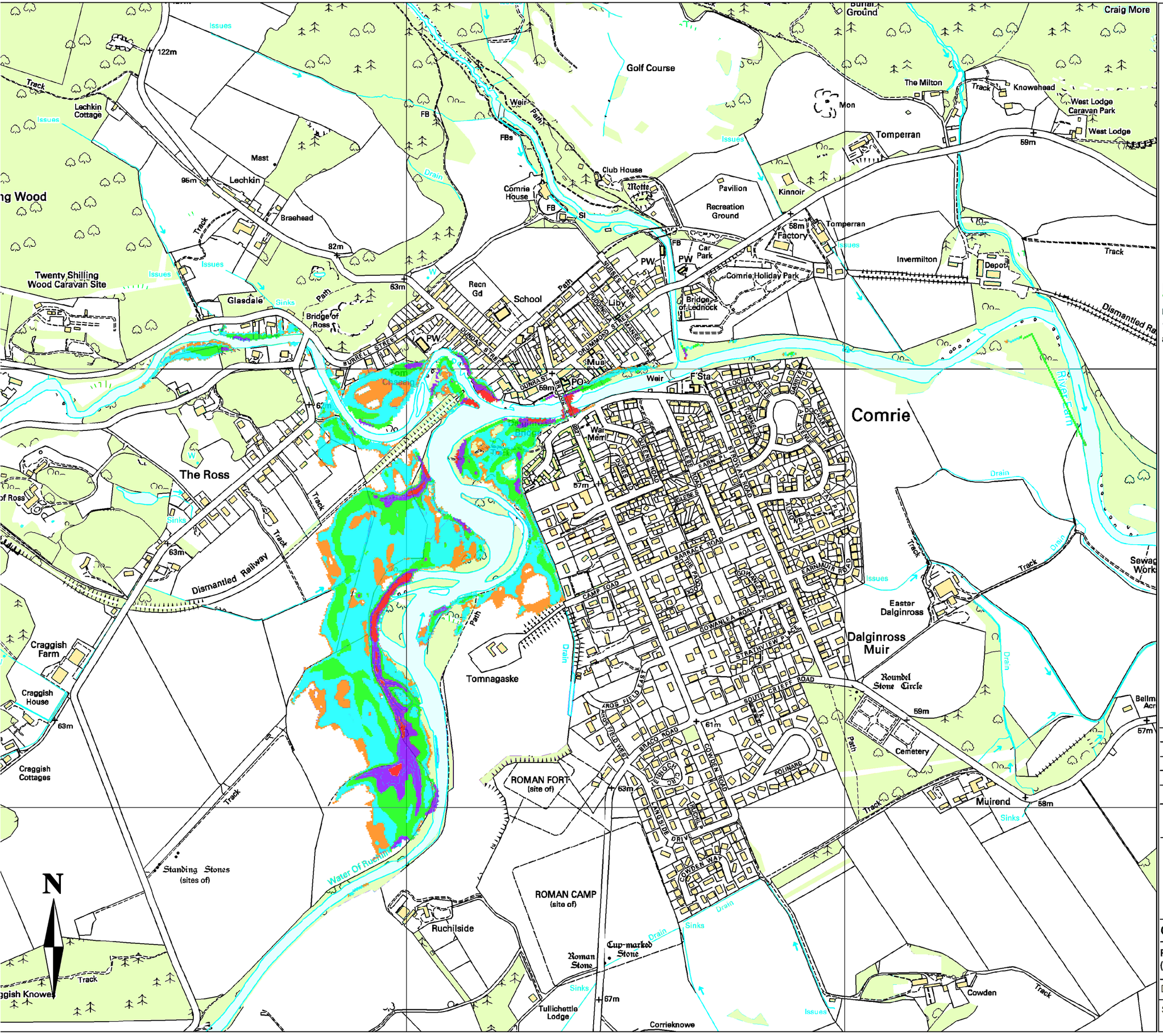

NOTES

Users should notethat the floodplain extents were mapped at 1:10,000 scale, as appropriate to the level of investigation and are based on the information available at the time of survey.

FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

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Comrie and Dalginross Flood Study

Flood outline for a baseline event with Annual Median Flow (QMED) on all three watercourses.

Date of Issue: June 2015

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APPENDIX 2B : BANK REINFORCEMENT RESULTS

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TABLE 2B: COMPARISON OF MODELLED WATER LEVEL RESULTS WITH AND WITHOUT BANK REINFORCEMENT ALONG WATER OF RUCHILL

Section reference	Model Node Reference	Baseline water levels, mAOD	Water levels with bank reinforcement on Ruchill Water (see sketch below for the extent of bank reinforcement), mAOD	Difference in water level with and without bank reinforcement, m
A. RUCHILL WATER				
1	R2415	64.44	64.44	0.000
2	R2073	62.48	62.48	0.000
3	R1850	61.77	61.77	-0.001
4	R1675	61.28	61.28	0.004
5	R1450	59.87	59.88	0.013
6	R1200	58.97	58.97	0.005
7	R1000	58.91	58.91	0.001
8	R800	58.87	58.87	0.002
B. UPPER EARN				
9	E1700_ND	61.19	61.19	-0.002
10	E1407_N	61.11	61.11	-0.001
11	E1185_N	60.72	60.72	0.002
12	E916_N	60.61	60.61	-0.003
12A	E916b	60.48	60.48	0.002
13	E712_N	59.53	59.53	-0.002
14	E538	59.01	59.01	-0.002
15	E360	58.99	58.99	-0.001
16	E157	58.85	58.85	0.000
17	E000	58.76	58.76	0.001
C. EARN				
18	R700	58.59	58.60	0.001
19	R575U	57.88	57.88	0.000
20	R350	57.43	57.43	0.000
21	R150	56.31	56.31	0.000
22	R000	56.02	56.02	0.000
D. LEDNOCK				
23	L108	56.70	56.70	0.000
24	L176	57.19	57.19	0.000
25	L289	57.58	57.58	0.000
26	L372	58.19	58.19	0.000
27	L519	59.18	59.18	0.000
28	L708	61.24	61.24	0.000

Conclusion: Proposed bank reinforcement along the Ruchill Water has negligible impact on water levels in the selected cross-sections

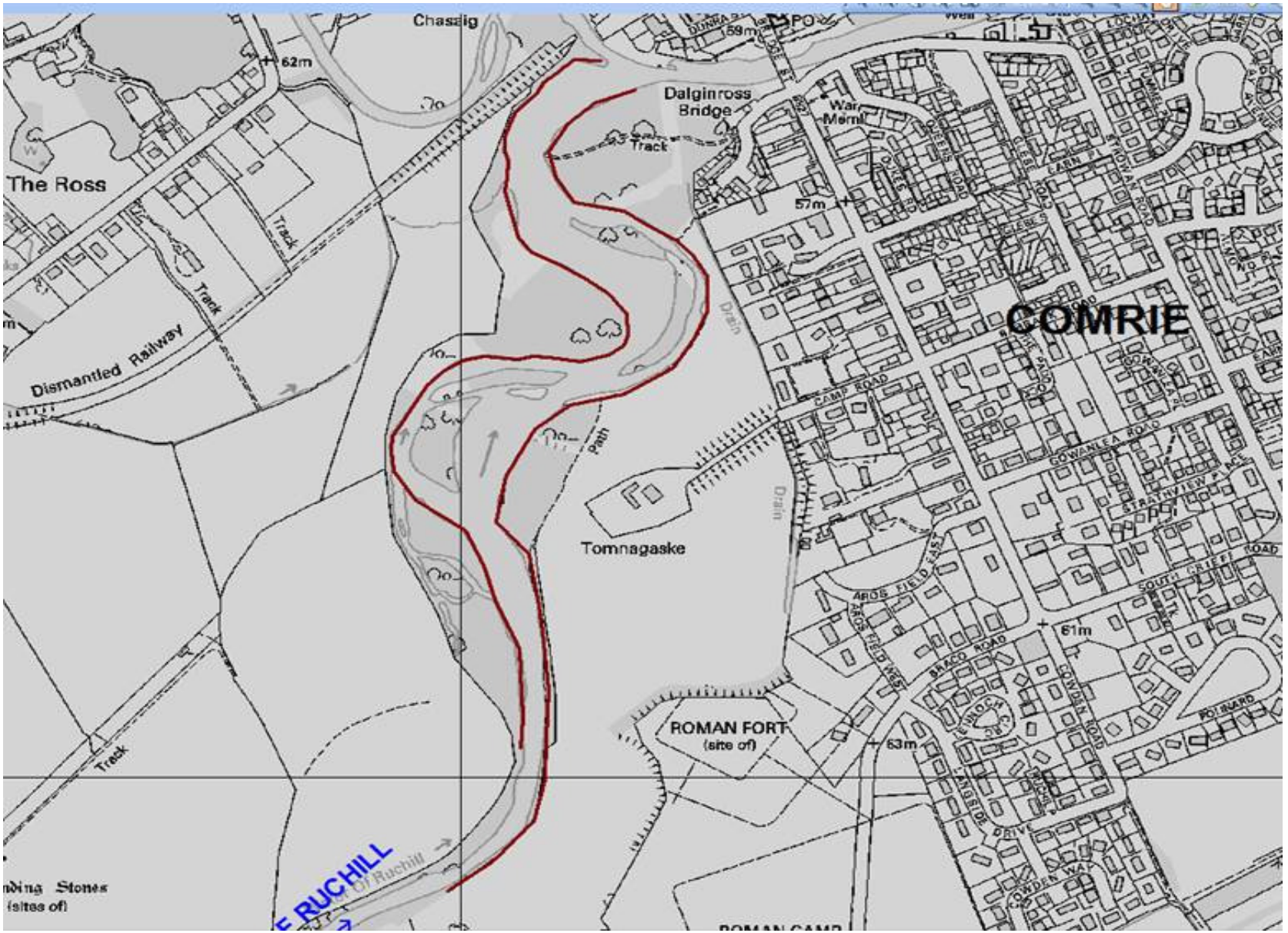

FIGURE 1B: EXTENT OF BANK REINFORCEMENT ALONG RUCHILL WATER

APPENDIX 3A : WALL OPTION RESULTS & FLOOD MAPS

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TABLE 3A: DEFENCE HEIGHTS AND WATER LEVELS WITH AND WITHOUT PROPOSED FLOOD DEFENCE FOR VARIOUS RETURN PERIODS

Section reference (see sketch below for locations of the sections)	Model Node Reference	1 IN 25 YEAR							1 IN 50 YEAR							1 IN 75 YEAR							1 IN 100 YEAR				
		Water level with baseline model, mAOD	Water level with proposed flood defence, mAOD	Difference, m	Calculated Freeboard, m	Required Flood Defence Level, mAOD	Approx height of wall including freeboard, mAOD		Water level with baseline model, mAOD	Water level with proposed flood defence, mAOD	Difference, m	Calculated Freeboard, m	Required Flood Defence Level, mAOD	Approx height of wall including freeboard, mAOD		Water level with baseline model, mAOD	Water level with proposed flood defence, mAOD	Difference, m	Calculated Freeboard, m	Required Flood Defence Level, mAOD	Approx height of wall including freeboard, mAOD		Water level with baseline model, mAOD	Water level with proposed flood defence, mAOD	Difference, m	Calculated Freeboard, m	Required Flood Defence Level, mAOD
							left	right						left	right						left	right					
A. RUCHILL WATER																											
1	R2415	64.20	64.20	0.00	NA	NA	NA	NA	64.30	64.30	0.00	NA	NA	NA	NA	64.35	64.35	0.00	NA	NA	NA	NA	64.38	64.38	0.00	NA	NA
2	R2073	62.37	62.38	0.00	NA	NA	NA	NA	62.41	62.42	0.00	NA	NA	NA	NA	62.43	62.44	0.00	NA	NA	NA	NA	62.45	62.45	0.00	NA	NA
3	R1850	61.64	61.62	-0.01	NA	NA	NA	NA	61.68	61.67	-0.01	NA	NA	NA	NA	61.71	61.70	-0.01	NA	NA	NA	NA	61.73	61.72	-0.01	NA	NA
4	R1675	61.12	61.11	0.00	NA	NA	NA	NA	61.18	61.18	0.00	NA	NA	NA	NA	61.21	61.21	0.00	NA	NA	NA	NA	61.23	61.23	0.00	NA	NA
5	R1450	59.77	59.79	0.01	0.248	60.03	NA	0.23	59.81	59.82	0.01	0.291	60.11	NA	0.31	59.83	59.84	0.01	0.306	60.14	NA	0.34	59.84	59.85	0.01	0.331	60.18
6	R1200	58.67	58.70	0.03	0.248	58.95	NA	NA	58.75	58.80	0.04	0.291	59.09	NA	NA	58.80	58.86	0.06	0.306	59.17	NA	NA	58.85	58.92	0.08	0.331	59.26
7	R1000	58.48	58.53	0.05	0.346	58.87	NA	0.07	58.61	58.69	0.07	0.399	59.08	NA	0.28	58.69	58.77	0.09	0.428	59.20	NA	0.40	58.75	58.86	0.11	0.457	59.31
8	R800	58.40	58.46	0.06	0.346	58.81	NA	0.01	58.55	58.64	0.09	0.399	59.03	NA	0.23	58.63	58.73	0.10	0.428	59.16	NA	0.36	58.70	58.82	0.12	0.457	59.28
B. UPPER EARN																											
9	E1700_ND	60.50	60.52	0.02	NA	NA	NA	NA	60.71	60.75	0.03	NA	NA	NA	NA	60.83	60.88	0.04	NA	NA	NA	NA	60.94	61.00	0.06	NA	NA
10	E1407_N	60.32	60.35	0.03	NA	NA	NA	NA	60.56	60.61	0.05	NA	NA	NA	NA	60.70	60.76	0.06	NA	NA	NA	NA	60.82	60.89	0.07	NA	NA
11	E1185_N	59.98	60.02	0.04	NA	NA	NA	NA	60.20	60.27	0.07	NA	NA	NA	NA	60.32	60.41	0.09	NA	NA	NA	NA	60.44	60.54	0.10	NA	NA
12	E916_N	59.71	59.79	0.09	0.452	60.25	NA	NA	59.99	60.10	0.11	0.542	60.65	0.35	NA	60.14	60.27	0.14	0.590	60.86	0.56	NA	60.27	60.43	0.16	0.632	61.06
12A	E916b	59.52	59.47	-0.05	0.452	59.92	1.62	NA	59.81	59.75	-0.06	0.542	60.29	1.99	NA	59.97	59.90	-0.07	0.590	60.49	2.19	NA	60.12	60.05	-0.07	0.632	60.68
13	E712_N	59.04	59.07	0.03	0.452	59.52	NA	NA	59.18	59.24	0.06	0.542	59.78	NA	NA	59.26	59.34	0.08	0.590	59.93	NA	NA	59.34	59.45	0.12	0.632	60.09
14	E538	58.52	58.56	0.04	0.452	59.01	1.01	NA	58.67	58.75	0.08	0.542	59.29	1.29	NA	58.76	58.85	0.09	0.590	59.44	1.44	NA	58.84	58.94	0.11	0.632	59.58
15	E360	58.45	58.51	0.06	0.452	58.96	1.36	NA	58.63	58.72	0.10	0.542	59.26	1.66	NA	58.72	58.83	0.11	0.590	59.42	1.82	NA	58.81	58.93	0.12	0.632	59.56
16	E157	58.27	58.38	0.10	0.452	58.83	1.33	NA	58.46	58.60	0.14	0.542	59.14	1.64	NA	58.56	58.73	0.17	0.590	59.32	1.82	NA	58.65	58.83	0.18	0.632	59.46
17	E000	58.24	58.31	0.08	0.452	58.77	2.87	NA	58.40	58.51	0.11	0.542	59.05	3.15	NA	58.49	58.62	0.13	0.590	59.21	3.31	NA	58.57	58.72	0.15	0.632	59.35
C. EARN																											
18	R700	58.07	58.15	0.08	0.414	58.57	1.87	NA	58.24	58.36	0.12	0.489	58.84	2.14	NA	58.33	58.47	0.14	0.530	59.00	2.30	NA	58.41	58.56	0.16	0.565	59.13
19	R575U	57.59	57.75	0.16	0.414	58.17	0.42	0.27	57.69	57.93	0.24	0.489	58.42	0.67	0.52	57.74	58.02	0.29	0.530	58.55	0.80	0.65	57.78	58.10	0.32	0.565	58.67
20	R350	57.17	57.12	-0.05	0.414	57.54	1.74	1.14	57.26	57.26	-0.01	0.489	57.75	1.95	1.35	57.31	57.33	0.02	0.530	57.86	2.06	1.46	57.35	57.39	0.05	0.565	57.96
21	R150	56.11	56.16	0.06	0.414	56.58	0.78	1.68	56.17	56.24	0.07	0.489	56.73	0.93	1.83	56.21	56.28	0.07	0.530	56.81	1.01	1.91	56.24	56.31	0.07	0.565	56.88
22	R000	55.71	55.78	0.06	0.414	56.19	0.19	0.69	55.83	55.91	0.08	0.489	56.40	0.40	0.90	55.89	55.98	0.09	0.530	56.51	0.51	1.01	55.93	56.04	0.10	0.565	56.60
D. LEDNOCK																											
23	L108	56.35	56.36	0.00	0.325	56.68	NA	0.33	56.45	56.45	0.00	0.383	56.84	0.14	0.49	56.50	56.50	0.00	0.413	56.92	0.22	0.57	56.55	56.55	0.00	0.437	56.99
24	L176	56.63	56.61	-0.02	0.325	56.93	0.83	0.13	56.79	56.75	-0.03	0.383	57.14	1.04	0.34	56.89	56.83	-0.06	0.413	57.24	1.14	0.44	56.96	56.89	-0.08	0.437	57.32
25	L289	57.15	57.16	0.00	NA	NA	NA	NA	57.36	57.36	0.01	NA	NA	NA	NA	57.42	57.43	0.01	NA	NA	NA	NA	57.46	57.48	0.02	NA	NA
26	L372	57.65	57.65	0.00	NA	NA	NA	NA	57.85	57.86	0.00	NA	NA	NA	NA	57.95	57.95	0.00	NA	NA	NA	NA	58.01	58.02	0.01	NA	NA
27	L519	58.75	58.75	0.00	NA	NA	NA	NA	58.91	58.91	0.00	NA	NA	NA	NA	58.99	58.99	0.00	NA	NA	NA	NA	59.04	59.04	0.00	NA	NA
28	L703	60.73	60.74	0.00	NA	NA	NA	NA	60.90	60.90	0.00	NA	NA	NA	NA	60.99	60.99	0.00	NA	NA	NA	NA	61.06	61.06	0.00	NA	NA

Note: The approximate height of the wall is based on the avregae ground level near the proposed wall alignment. The ground levels have been derived from the LiDAR data/NEXT map
The proposed alignment is approximate and subject to change based on site conditions. Currently, the defence have not been tied to the higher ground or structures at the upstream end and at the location of the structures
Gardens of some properties seems to be flooded in the Ross towards left bank of the Ruchill and also upstream of the Bridge of Ross in the right bank of the River Earn.The threshold levels of these properties needs to be checked against the water levels.

TABLE 3A: DEFENCE HEIGHTS AND WATER LEVELS WITH AND WITHOUT PROPOSED FLOOD DEFENCE FOR VARIOUS RETURN PERIODS

Section reference (see sketch below for locations of the sections)	Model Node Reference	1 IN 200 YEAR							Approx height of wall including freeboard, mAOD		1 IN 200+CC YEAR					Approx height of wall including freeboard, mAOD		Approx ground level from LiDAR/model, mAOD		Comments
		Approx height of wall including freeboard, mAOD		Water level with baseline model, mAOD	Water level with proposed flood defence, mAOD	Difference, m	Calculated Freeboard, m	Required Flood Defence Level, mAOD			Water level with baseline model, mAOD	Water level with proposed flood defence, mAOD	Difference, m	Calculated Freeboard, m	Required Flood Defence Level, mAOD					
		left	right						left	right						left	right	left	right	
A. RUCHILL WATER																				
1	R2415	NA	NA	64.44	64.44	0.00	NA	NA	NA	NA	64.58	64.58	0.00	NA	NA	NA	NA	NA	NA	
2	R2073	NA	NA	62.48	62.49	0.00	NA	NA	NA	NA	62.58	62.58	0.00	NA	NA	NA	NA	NA	NA	
3	R1850	NA	NA	61.77	61.76	0.00	NA	NA	NA	NA	61.87	61.87	0.00	NA	NA	NA	NA	NA	NA	
4	R1675	NA	NA	61.28	61.28	0.00	NA	NA	NA	NA	61.38	61.39	0.00	NA	NA	NA	NA	NA	NA	
5	R1450	NA	0.38	59.88	59.88	0.00	0.393	60.27	NA	0.47	59.94	59.96	0.03	0.523	60.49	NA	0.69	NA	59.80	The height of the wall is on the top of the existing wall
6	R1200	NA	NA	58.97	59.11	0.13	0.393	59.50	NA	0.00	59.28	59.56	0.27	0.523	60.08	NA	0.58	NA	59.50	The height of the wall is on the top of the existing wall
7	R1000	NA	0.51	58.91	59.06	0.16	0.508	59.57	NA	0.77	59.24	59.53	0.30	0.656	60.19	NA	1.39	NA	58.80	The height of the wall is on the top of the existing wall
8	R800	NA	0.48	58.87	59.03	0.17	0.508	59.54	NA	0.74	59.21	59.52	0.31	0.656	60.17	NA	1.37	NA	58.80	The height of the wall is on the top of the existing wall
B. UPPER EARN																				
9	E1700_ND	NA	NA	61.19	61.27	0.07	NA	NA	NA	NA	61.57	61.69	0.13	NA	NA	NA	NA	NA	NA	
10	E1407_N	NA	NA	61.11	61.21	0.10	NA	NA	NA	NA	61.57	61.70	0.13	NA	NA	NA	NA	NA	NA	
11	E1185_N	NA	NA	60.72	60.85	0.13	NA	NA	NA	NA	61.17	61.34	0.17	NA	NA	NA	NA	NA	NA	
12	E916_N	0.76	NA	60.61	60.78	0.17	0.724	61.50	1.20	NA	61.10	61.31	0.21	0.905	62.22	1.92	NA	60.30	NA	Level taken at the edge of the road. Defence may be required at the right bank(TBC)
12A	E916b	2.38	NA	60.48	60.40	-0.08	0.724	61.12	2.82	NA	60.99	60.94	-0.05	0.905	61.84	3.54	NA	58.30	NA	Defence may be required at right bank (TBC)
13	E712_N	NA	NA	59.53	59.65	0.12	0.724	60.37	NA	NA	59.78	60.01	0.23	0.905	60.92	NA	NA	61.64	NA	Defence may be required at right bank (TBC)
14	E538	1.58	NA	59.01	59.15	0.14	0.724	59.87	1.87	NA	59.32	59.59	0.27	0.905	60.49	2.49	NA	58.00	NA	
15	E360	1.96	NA	58.99	59.14	0.15	0.724	59.87	2.27	NA	59.31	59.58	0.27	0.905	60.49	2.89	NA	57.60	NA	
16	E157	1.96	NA	58.85	59.07	0.22	0.724	59.79	2.29	NA	59.20	59.55	0.35	0.905	60.46	2.96	NA	57.50	NA	
17	E000	3.45	NA	58.76	58.95	0.19	0.724	59.67	3.77	NA	59.11	59.44	0.33	0.905	60.35	4.45	NA	55.90	NA	
C. EARN																				
18	R700	2.43	NA	58.60	58.79	0.20	0.622	59.42	2.72	NA	58.95	59.31	0.36	0.801	60.11	3.41	NA	56.70	NA	
19	R575U	0.92	0.77	57.88	58.28	0.40	0.622	58.90	1.15	1.00	58.07	58.71	0.65	0.801	59.51	1.76	1.61	57.75	57.90	Ground level at the left is from the bottom of the existing wall along the cymmetry
20	R350	2.16	1.56	57.43	57.53	0.11	0.622	58.15	2.35	1.75	57.55	57.89	0.34	0.801	58.69	2.89	2.29	55.80	56.40	Ground level at the right is at the edge of the cymmetry
21	R150	1.08	1.98	56.31	56.37	0.06	0.622	56.99	1.19	2.09	56.45	56.52	0.07	0.801	57.32	1.52	2.42	55.80	54.90	
22	R000	0.60	1.10	56.02	56.15	0.13	0.622	56.77	0.77	1.27	56.16	56.34	0.18	0.801	57.14	1.14	1.64	56.00	55.50	Ground level is steep at the left wall alignment. 56.0 Maod is an average level
D. LEDNOCK																				
23	L108	0.29	0.64	56.70	56.66	-0.05	0.496	57.15	0.45	0.80	56.97	56.86	-0.11	0.591	57.45	0.75	1.10	56.70	56.35	
24	L176	1.22	0.52	57.19	57.03	-0.16	0.496	57.53	1.43	0.73	57.44	57.26	-0.18	0.591	57.85	1.75	1.05	56.10	56.80	
25	L289	NA	NA	57.58	57.63	0.05	NA	NA	NA	NA	57.74	57.83	0.09	0.591	58.42	NA	NA	NA	NA	
26	L372	NA	NA	58.19	58.21	0.02	NA	NA	NA	NA	58.42	58.49	0.08	0.591	59.08	NA	NA	NA	NA	
27	L519	NA	NA	59.18	59.18	0.00	NA	NA	NA	NA	59.35	59.33	-0.02	0.591	59.92	NA	NA	NA	NA	
28	L703	NA	NA	61.24	61.24	0.00	NA	NA	NA	NA	61.50	61.50	0.00	0.591	62.09	NA	NA	NA	NA	

NOTES

Users should notethat the floodplain extents were mapped at 1:10,000 scale, as appropriate to the level of investigation and are based on the information available at the time of survey.

FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m
- Extent of flood defence

REV	DATE	REMARKS
1	07/04/2015	Draft

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Comrie and Dalginross Flood Study

Flood outline for a 1 in 25 year flood event with proposed flood defence.

Date of Issue: April 2015

Scale at A3: Not to Scale

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FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m
- Extent of flood defence

REV	DATE	REMARKS
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Flood outline for a 1 in 50 year flood event with proposed flood defence.

Date of Issue: April 2015

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FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m
- Extent of flood defence

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Flood outline for a 1 in 75 year flood event with proposed flood defence.

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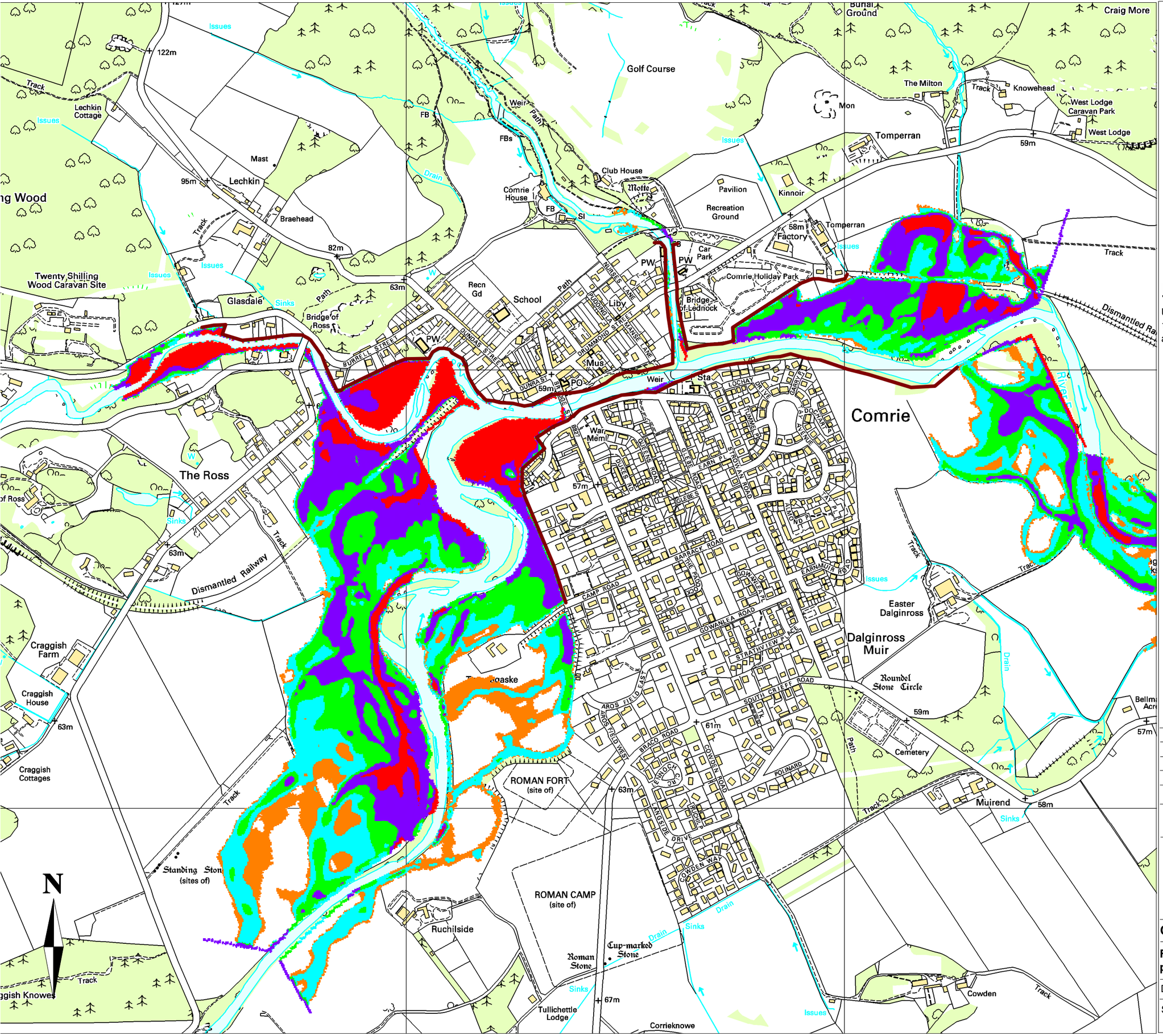

NOTES

Users should notethat the floodplain extents were mapped at 1:10,000 scale, as appropriate to the level of investigation and are based on the information available at the time of survey.

FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m
- Extent of flood defence

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Flood outline for a 1 in 100 year flood event with proposed flood defence.

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FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m
- Extent of flood defence

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FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m
- Extent of flood defence

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Flood outline for a 1 in 200 year +cc flood event with proposed flood defence.

Date of Issue: April 2015

Scale at A3: Not to Scale

NOTES

Users should notethat the floodplain extents were mapped at 1:10,000 scale, as appropriate to the level of investigation and are based on the information available at the time of survey.

FLOOD DEPTHS

- Baseline flood extent
- Wall option flood extent
- Extent of flood defence

Users should notethat the floodplain extents were mapped at 1:10,000 scale, as appropriate to the level of investigation and are based on the information available at the time of survey.

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Comrie and Dalginross Flood Study

Comparison of flood outlines: 200 year return period baseline and 200 year return period wall option

Date of Issue: May 2015

Scale at A3: Not to Scale

NOTES

Users should notethat the floodplain extents were mapped at 1:10,000 scale, as appropriate to the level of investigation and are based on the information available at the time of survey.

FLOOD DEPTHS

- Baseline flood extent
- Wall option flood extent
- Extent of flood defence

Users should notethat the floodplain extents were mapped at 1:10,000 scale, as appropriate to the level of investigation and are based on the information available at the time of survey.

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Comparison of flood outlines: 200 year +cc return period baseline and 200 year +cc return period wall option

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APPENDIX 3B : RESULTS OF SENSITIVITY RUNS ON WALL OPTION

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TABLE 3B : REQUIRED FLOOD DEFENCE HEIGHTS WITH ALTERNATIVE 1 IN 200 YEAR RETURN PERIOD FLOOD EVENT

Section reference	Model Node Reference	Approx ground level		Freeboard for 1 in 200 RP(calculated based on Fluvial Freeboard Guidance), m	200 year RP in all watercourse (Base defence scenario)			JP FLOW (with wall option)			WR:RE:LE = 200:10:10 (with wall option)			WR:RE:LE = 10:200:10 (with wall option)			WR:RE:LE = 10:10:200 (with wall option)			Comments
						Wall heigth, m			Wall heigth, m			Wall heigth, m			Wall heigth, m			Wall heigth, m			
		left	right		Water levels, mAOD	left	right	Water levels, mAOD	left	right	Water levels, mAOD	left	right	Water levels, mAOD	left	right	Water levels, mAOD	left	right	
A. RUCHILL WATER																				
1	R2415	NA	NA	NA	64.44	NA	NA	64.36	NA	NA	64.44	NA	NA	64.03	NA	NA	64.03	NA	NA	
2	R2073	NA	NA	NA	62.49	NA	NA	62.44	NA	NA	62.48	NA	NA	62.30	NA	NA	62.30	NA	NA	
3	R1850	NA	NA	NA	61.76	NA	NA	61.71	NA	NA	61.77	NA	NA	61.54	NA	NA	61.55	NA	NA	
4	R1675	NA	NA	NA	61.28	NA	NA	61.22	NA	NA	61.28	NA	NA	61.01	NA	NA	61.02	NA	NA	
5	R1450	NA	59.80	0.393	59.88	NA	0.47	59.84	NA	0.44	59.88	NA	0.47	59.74	NA	0.33	59.74	NA	0.33	The height of the wall is on the top of the existing wall
6	R1200	NA	59.50	0.393	59.11	NA	0.00	58.80	NA	NA	58.88	NA	NA	58.68	NA	NA	58.61	NA	NA	The height of the wall is on the top of the existing wall
7	R1000	NA	58.80	0.508	59.06	NA	0.77	58.67	NA	0.38	58.77	NA	0.48	58.57	NA	0.28	58.35	NA	0.06	The height of the wall is on the top of the existing wall
8	R800	NA	58.80	0.508	59.03	NA	0.74	58.61	NA	0.32	58.71	NA	0.42	58.53	NA	0.24	58.27	NA	NA	The height of the wall is on the top of the existing wall
B. UPPER EARN																				
9	E1700_ND	NA	NA	NA	61.27	NA	NA	60.52	NA	NA	60.28	NA	NA	61.26	NA	NA	60.31	NA	NA	
10	E1407_N	NA	NA	NA	61.21	NA	NA	60.35	NA	NA	60.06	NA	NA	61.20	NA	NA	60.06	NA	NA	
11	E1185_N	NA	NA	NA	60.85	NA	NA	60.03	NA	NA	59.77	NA	NA	60.83	NA	NA	59.77	NA	NA	Defence may be required at this location (TBC)
12	E916_N	60.30	NA	0.724	60.78	1.20	NA	59.80	0.23	NA	59.46	NA	NA	60.76	1.19	NA	59.45	NA	NA	Level taken at the edge of the road. Defence may be required at the right bank(TBC)
12A	E916b	58.30	NA	0.724	60.40	2.82	NA	59.48	1.91	NA	59.21	1.64	NA	60.36	2.78	NA	59.17	1.47	NA	Defence may be required at right bank (TBC)
13	E712_N	61.64	NA	0.724	59.65	NA	NA	59.08	NA	NA	58.97	NA	NA	59.61	-1.31	NA	58.88	NA	NA	At the edge of the road from survey data (The road level is high. Need to tie the proposed defence here.. Defence may be required at right bank (TBC)
14	E538	58.00	NA	0.724	59.15	1.87	NA	58.67	1.40	NA	58.72	1.44	NA	58.81	1.54	NA	58.40	1.00	NA	
15	E360	57.60	NA	0.724	59.14	2.27	NA	58.64	1.77	NA	58.69	1.82	NA	58.78	1.90	NA	58.29	1.29	NA	
16	E157	57.50	NA	0.724	59.07	2.29	NA	58.53	1.75	NA	58.62	1.84	NA	58.59	1.81	NA	58.14	1.24	NA	
17	E000	55.90	NA	0.724	58.95	3.77	NA	58.46	3.29	NA	58.55	3.38	NA	58.44	3.27	NA	58.10	2.80	NA	
C. EARN																				
18	R700	56.70	NA	0.622	58.79	NA	NA	58.30	2.22	NA	58.40	2.33	NA	58.27	2.19	NA	57.95	1.85	NA	
19	R575U	57.75	57.90	0.622	58.28	1.15	1.00	57.83	0.70	0.55	57.92	0.79	0.64	57.86	0.73	0.58	57.63	0.48	0.35	Ground level at the left is from the bottom of the existing wall along the cymmetry
20	R350	55.80	56.40	0.622	57.53	2.35	1.75	56.99	1.81	1.21	57.15	1.97	1.37	57.14	1.97	1.37	57.15	1.95	1.37	Ground level at the right is at the edge of the cymmetry
21	R150	55.80	54.90	0.622	56.37	1.19	2.09	56.15	0.97	1.87	56.21	1.03	1.93	56.18	1.00	1.90	56.17	0.97	1.90	
22	R000	56.00	55.50	0.622	56.15	0.77	1.27	55.76	0.38	0.88	55.86	0.48	0.98	55.79	0.42	0.92	55.79	0.39	0.91	Ground level is steep at the left wall alignment. 56.0 Maod is an average level
D. LEDNOCK																				
23	L108	56.70	56.35	0.496	56.66	0.45	0.80	56.41	0.21	0.56	56.47	0.27	0.62	56.42	0.22	0.57	56.42	0.32	0.56	
24	L176	56.10	56.80	0.496	57.03	1.43	0.73	56.48	0.87	0.17	56.60	0.99	0.29	56.55	0.95	0.25	56.90	1.40	0.59	
25	L289	NA	NA	NA	57.63	NA	NA	56.68	NA	NA	56.94	NA	NA	56.93	NA	NA	57.62	NA	NA	
26	L372	NA	NA	NA	58.21	NA	NA	57.12	NA	NA	57.41	NA	NA	57.43	NA	NA	58.21	NA	NA	
27	L519	NA	NA	NA	59.18	NA	NA	58.21	NA	NA	58.53	NA	NA	58.55	NA	NA	59.19	NA	NA	
28	L703	NA	NA	NA	61.24	NA	NA	60.31	NA	NA	60.53	NA	NA	60.57	NA	NA	61.25	NA	NA	

Note: The approximate height of the wall is based on the avregae ground level near the proposed wall alignment. The ground levels have been derived from the LiDAR data

The proposed alignment is approximate and subject to change based on site conditions. Currently, the defence have not been tied to the higher ground or structures at the upstream end and at the location of the structures

Some properties seems to be flooded immediately upstream of the current alignment of the walls. This needs to be confirmed and wall needs to be extended further upstream, if needed.

0.6 m freeboard assumed along the entire reach of the flood defence

APPENDIX 4 : SECONDARY OPTIONS RESULTS & FLOOD MAPS

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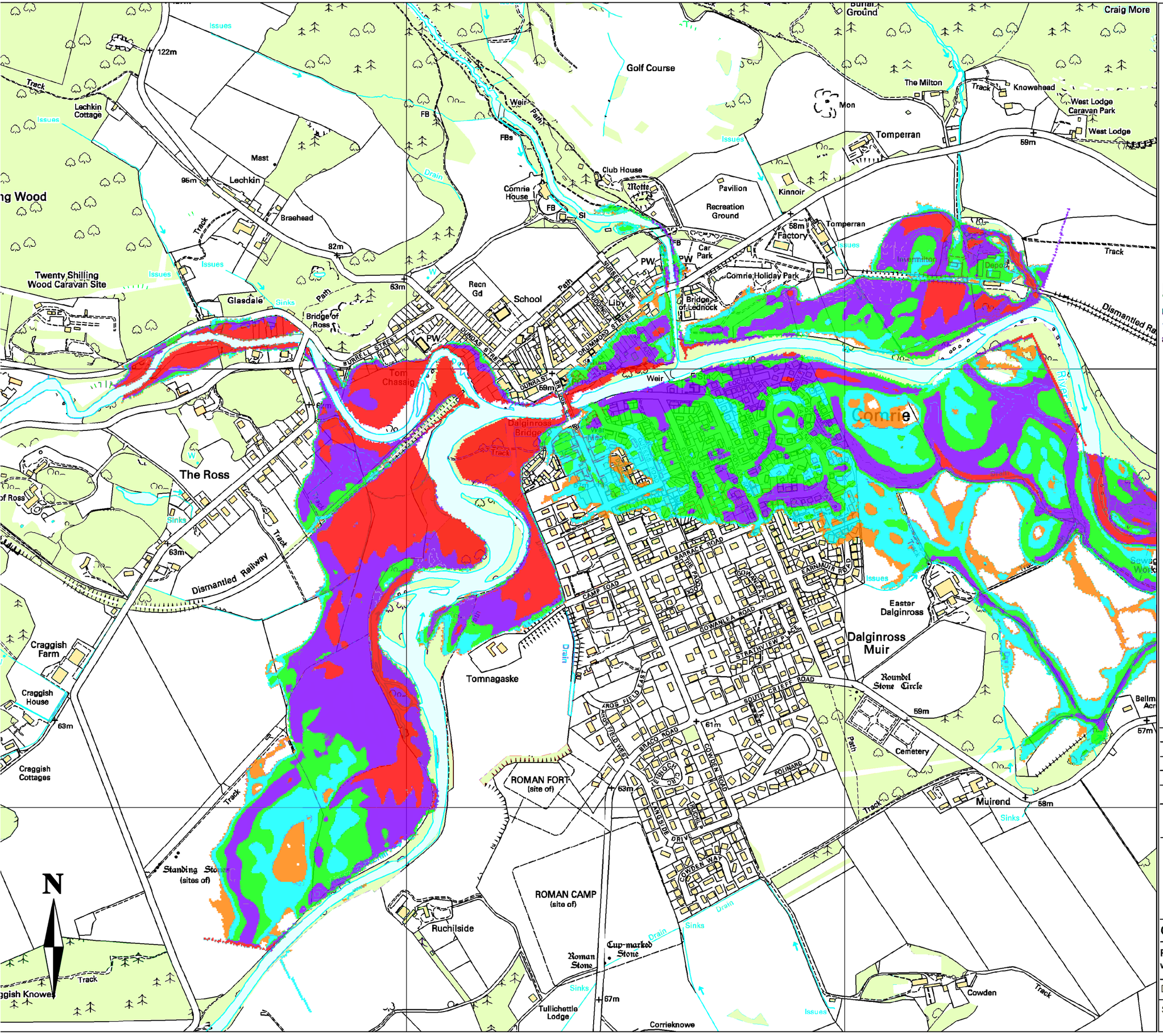
TABLE 4A : DEFENCE HEIGHTS AND WATER LEVELS WITH AND WITHOUT PROPOSED FLOOD DEFENCES FOR VARIOUS RETURN PERIODS

Section reference (see sketch below for locations of the sections)	Model Node Reference	1 IN 200 YEAR WATER LEVELS, mAOD											1 IN 200 + cc YEAR WATER LEVELS, mAOD									
		Baseline model water level mAOD	Secondary option with weir removal and river bed regading		Secondary option with local storage		Secondary option with average 1 m dredging		Secondary option with 5 m dredging - uniform bed gradient + trapezoidal channel		Secondary option with natural flood management		Baseline model water level mAOD	Secondary option with weir removal and river bed regading		Secondary option with local storage		Secondary option with average 1 m dredging		Secondary option with 5 m dredging - uniform bed gradient + trapezoidal channel		Secondary option with natural flood management	
			Water level mAOD	Difference with baseline model, m	Water level mAOD	Difference with baseline model, m	Water level mAOD	Difference with baseline model, m	Water level, mAOD	Difference with baseline model, m	Water level mAOD	Difference with baseline model, m		Water level mAOD	Difference with baseline model, m	Water level mAOD	Difference with baseline model, m	Water level mAOD	Difference with baseline model, m	Water level, mAOD	Difference with baseline model, m	Water level mAOD	Difference with baseline model, m
A. RUCHILL WATER																						
1	R2415	64.44	64.44	0.00	64.11	-0.33	64.44	0.000	61.36	-3.08	64.38	-0.06	64.58	64.58	0.00	64.25	-0.33	64.58	0.00	61.85	-2.73	64.53	-0.05
2	R2073	62.48	62.48	0.00	62.02	-0.47	62.48	-0.003	60.31	-2.18	62.45	-0.03	62.58	62.58	0.00	62.08	-0.50	62.58	0.00	60.88	-1.70	62.55	-0.03
3	R1850	61.77	61.76	0.00	61.26	-0.51	61.57	-0.198	58.40	-3.36	61.72	-0.04	61.87	61.87	0.00	61.36	-0.52	61.71	-0.16	58.87	-3.00	61.83	-0.04
4	R1675	61.28	61.28	0.00	60.78	-0.50	60.91	-0.375	57.60	-3.68	61.24	-0.05	61.38	61.39	0.00	60.90	-0.49	61.12	-0.27	58.09	-3.29	61.35	-0.04
5	R1450	59.88	59.88	0.00	59.56	-0.32	59.65	-0.232	57.16	-2.73	59.85	-0.03	59.94	59.95	0.01	59.63	-0.31	59.79	-0.15	57.71	-2.23	59.92	-0.01
6	R1200	58.97	58.95	-0.02	58.86	-0.11	58.76	-0.215	57.03	-1.94	58.87	-0.10	59.28	59.27	-0.01	59.20	-0.08	59.01	-0.28	57.59	-1.69	59.17	-0.11
7	R1000	58.91	58.88	-0.03	58.87	-0.04	58.60	-0.306	56.55	-2.36	58.78	-0.12	59.24	59.22	-0.01	59.20	-0.04	58.93	-0.31	57.13	-2.11	59.12	-0.12
8	R800	58.87	58.83	-0.03	58.84	-0.03	58.56	-0.309	56.56	-2.31	58.74	-0.13	59.21	59.20	-0.01	59.21	0.00	58.91	-0.30	57.14	-2.07	59.09	-0.12
B. UPPER EARN																						
9	E1700_ND	61.19	61.19	0.00	61.19	0.00	61.187	-0.004	60.69	-0.50	61.06	-0.13	61.57	61.57	0.00	61.57	0.01	61.56	-0.01	60.92	-0.64	61.41	-0.16
10	E1407_N	61.11	61.11	0.00	61.11	0.00	61.106	-0.006	59.90	-1.21	60.95	-0.16	61.57	61.57	0.00	61.57	0.01	61.56	-0.01	60.32	-1.25	61.37	-0.19
11	E1185_N	60.72	60.72	0.00	60.72	0.00	60.708	-0.010	59.04	-1.68	60.56	-0.15	61.17	61.17	0.00	61.17	0.00	61.15	-0.02	59.48	-1.69	60.97	-0.20
12	E916_N	60.61	60.60	0.00	60.61	0.00	60.596	-0.010	58.26	-2.35	60.43	-0.18	61.10	61.10	0.00	61.10	0.00	61.09	-0.02	58.75	-2.36	60.89	-0.21
12A	E916b	60.48	60.47	-0.01	60.48	0.00	60.462	-0.017	57.92	-2.56	60.29	-0.19	60.99	60.99	0.00	61.00	0.01	60.97	-0.02	58.41	-2.58	60.77	-0.22
13	E712_N	59.53	59.52	0.00	59.53	0.00	59.479	-0.048	56.94	-2.59	59.42	-0.11	59.78	59.78	0.00	59.78	0.00	59.74	-0.05	57.35	-2.43	59.63	-0.15
14	E538	59.01	58.99	-0.02	58.99	-0.03	58.755	-0.256	56.56	-2.45	58.89	-0.12	59.32	59.31	-0.01	59.32	0.00	59.05	-0.27	57.08	-2.24	59.21	-0.11
15	E360	58.99	58.96	-0.03	58.97	-0.02	58.700	-0.289	56.25	-2.74	58.86	-0.13	59.31	59.30	-0.01	59.32	0.01	59.02	-0.29	56.81	-2.50	59.19	-0.12
16	E157	58.85	58.81	-0.04	58.86	0.01	58.446	-0.404	56.08	-2.78	58.71	-0.14	59.20	59.19	-0.02	59.24	0.04	58.84	-0.36	56.63	-2.57	59.08	-0.13
17	E000	58.76	58.72	-0.04	58.79	0.03	58.379	-0.382	56.09	-2.67	58.62	-0.14	59.11	59.09	-0.02	59.18	0.07	58.75	-0.36	56.65	-2.46	58.98	-0.13
C. EARN																						
18	R700	58.60	58.55	-0.05	58.70	0.10	58.188	-0.408	55.93	-2.67	58.46	-0.14	58.95	58.93	-0.02	59.10	0.15	58.56	-0.38	56.46	-2.49	58.82	-0.13
19	R575U	57.88	57.77	-0.11	57.89	0.01	57.708	-0.175	55.76	-2.12	57.81	-0.07	58.07	57.99	-0.08	58.10	0.03	57.91	-0.16	56.28	-1.78	58.00	-0.07
20	R350	57.43	57.15	-0.28	57.43	0.01	57.329	-0.097	55.44	-1.99	57.37	-0.05	57.55	57.35	-0.20	57.57	0.02	57.51	-0.04	55.86	-1.69	57.51	-0.04
21	R150	56.31	56.28	-0.04	56.32	0.01	56.206	-0.108	55.19	-1.13	56.27	-0.04	56.45	56.40	-0.05	56.49	0.04	56.35	-0.10	55.55	-0.90	56.40	-0.05
22	R000	56.02	56.04	0.02	56.03	0.01	55.918	-0.105	54.94	-1.09	55.97	-0.05	56.16	56.17	0.01	56.19	0.03	56.10	-0.06	55.24	-0.92	56.11	-0.05
D. LEDNOCK																						
23	L108	56.70	56.53	-0.17	56.71	0.01	56.515	-0.186	55.46	-1.25	56.63	-0.07	56.97	56.78	-0.20	57.01	0.04	56.86	-0.11	55.82	-1.15	56.89	-0.08
24	L176	57.19	57.04	-0.15	57.19	0.00	57.035	-0.153	55.47	-1.72	57.13	-0.06	57.44	57.33	-0.11	57.45	0.01	57.39	-0.05	55.84	-1.60	57.41	-0.03
25	L289	57.58	57.58	0.00	57.58	0.00	57.583	0.002	55.83	-1.75	57.58	0.00	57.74	57.73	-0.01	57.74	0.00	57.74	0.00	56.22	-1.52	57.74	0.00
26	L372	58.19	58.19	0.00	58.19	0.00	58.190	0.001	56.41	-1.78	58.19	0.00	58.42	58.41	-0.01	58.42	0.00	58.42	0.00	56.74	-1.68	58.42	0.00
27	L519	59.18	59.18	0.00	59.18	0.00	59.183	0.000	58.60	-0.58	59.18	0.00	59.35	59.35	0.00	59.35	0.00	59.35	0.00	58.87	-0.48	59.35	0.00
28	L703	61.24	61.24	0.00	61.24	0.00	61.244	0.000	61.08	-0.17	61.24	0.00	61.50	61.50	0.00	61.50	0.00	61.50	0.00	61.34	-0.16	61.50	0.00



NOTES

Users should notethat the floodplain extents were mapped at 1:10,000 scale, as appropriate to the level of investigation and are based on the information available at the time of survey.

FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

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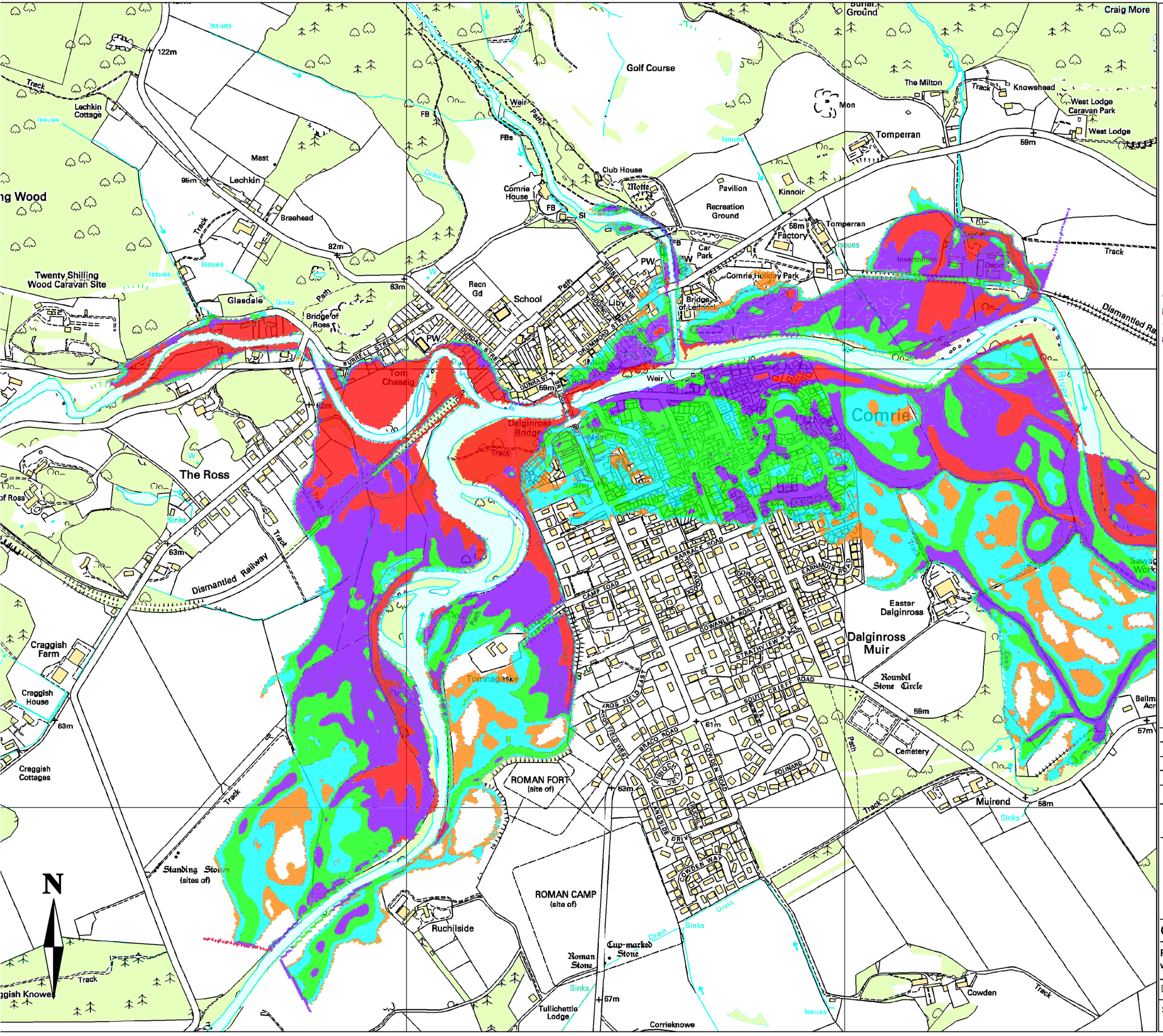
Comrie and Dalginross Flood Study

Flood outline for a 1 in 200 year return period event with weir removal and channel regrading.

Date of Issue: June 2015

Scale at A3: Not to Scale



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FLOOD DEPTHS

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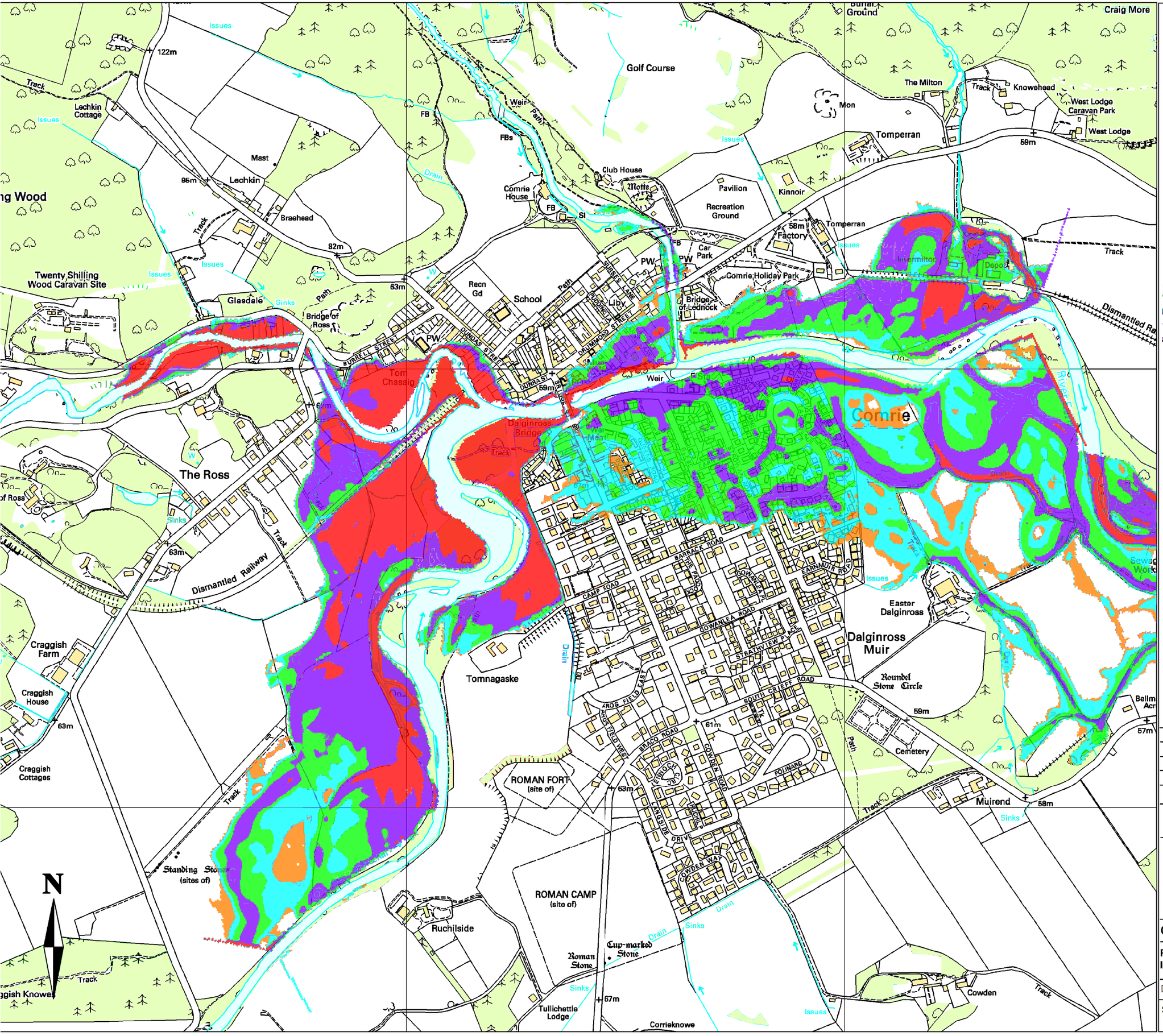

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FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

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Flood outline for a 1 in 200 year return period event local storage.

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FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

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Flood outline for a 1 in 200 year + CC return period event with local storage

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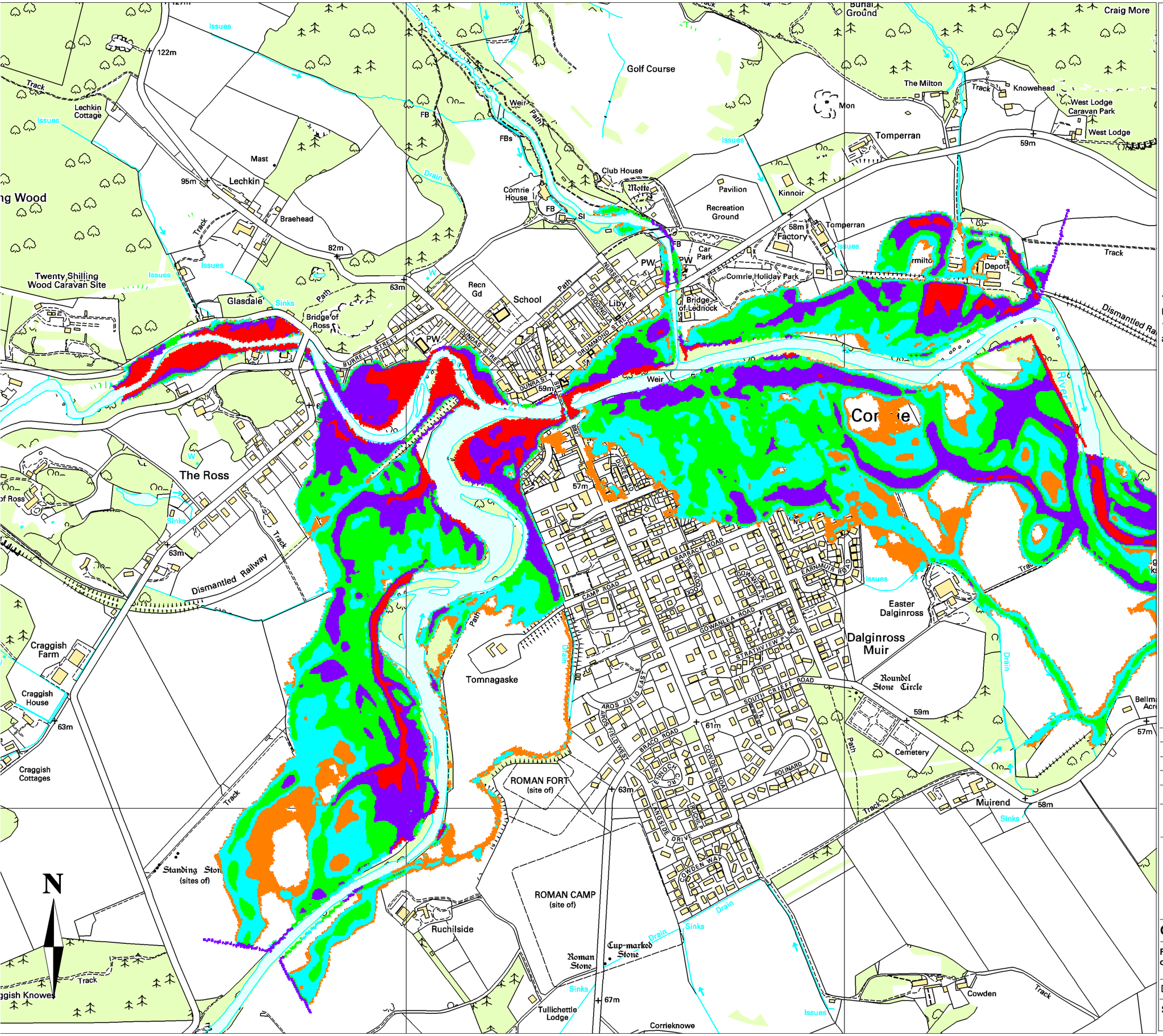

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FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

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Flood outline for a 1 in 200 year return period with average dredging of 1.0 metres.

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FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

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Flood outline for a 1 in 200 year return period with 5 metres of average dredging on the Water of Ruchill

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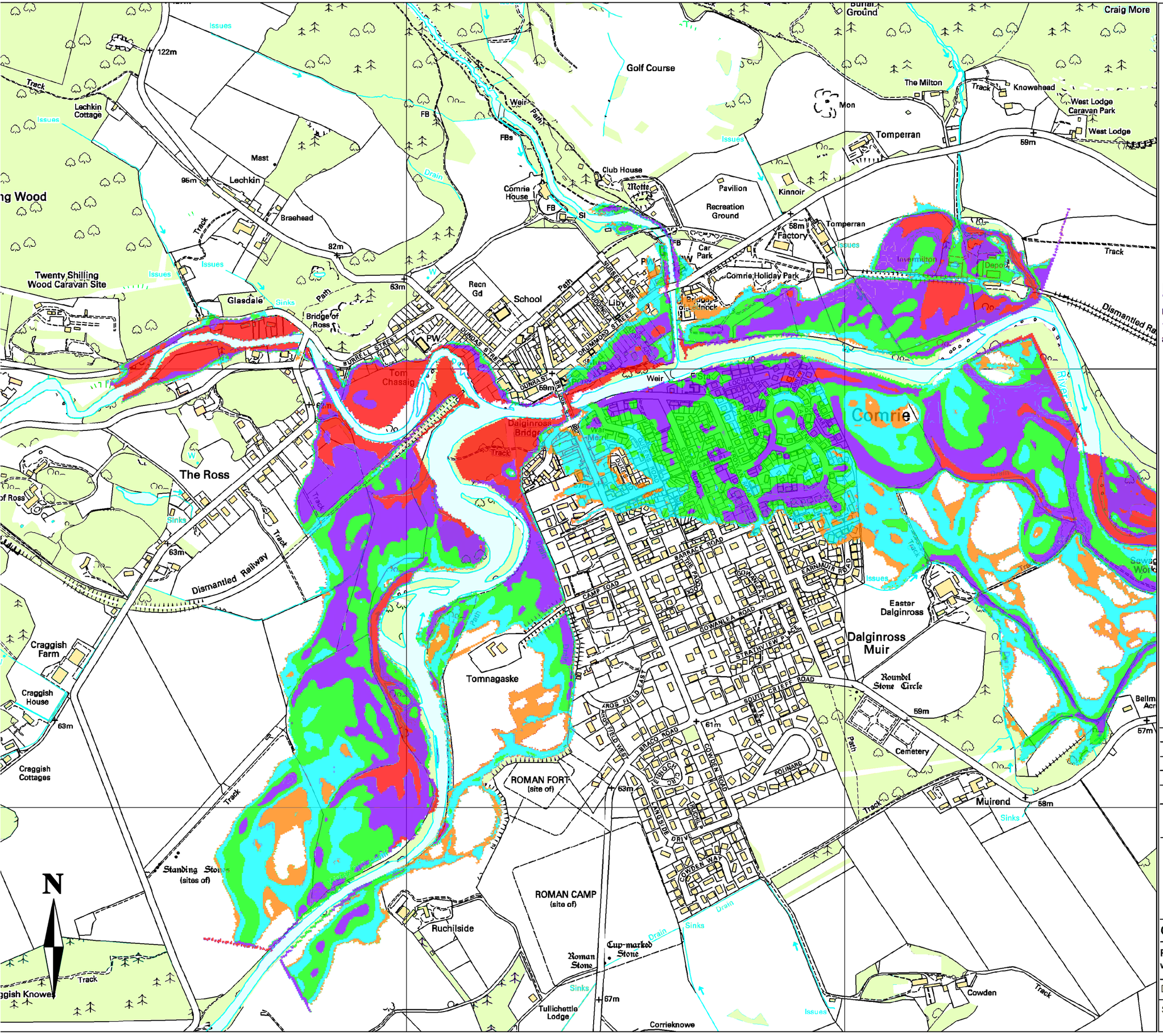

NOTES

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FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

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Flood outline for a 1 in 200 year + CC return period event with 1m average dredging.

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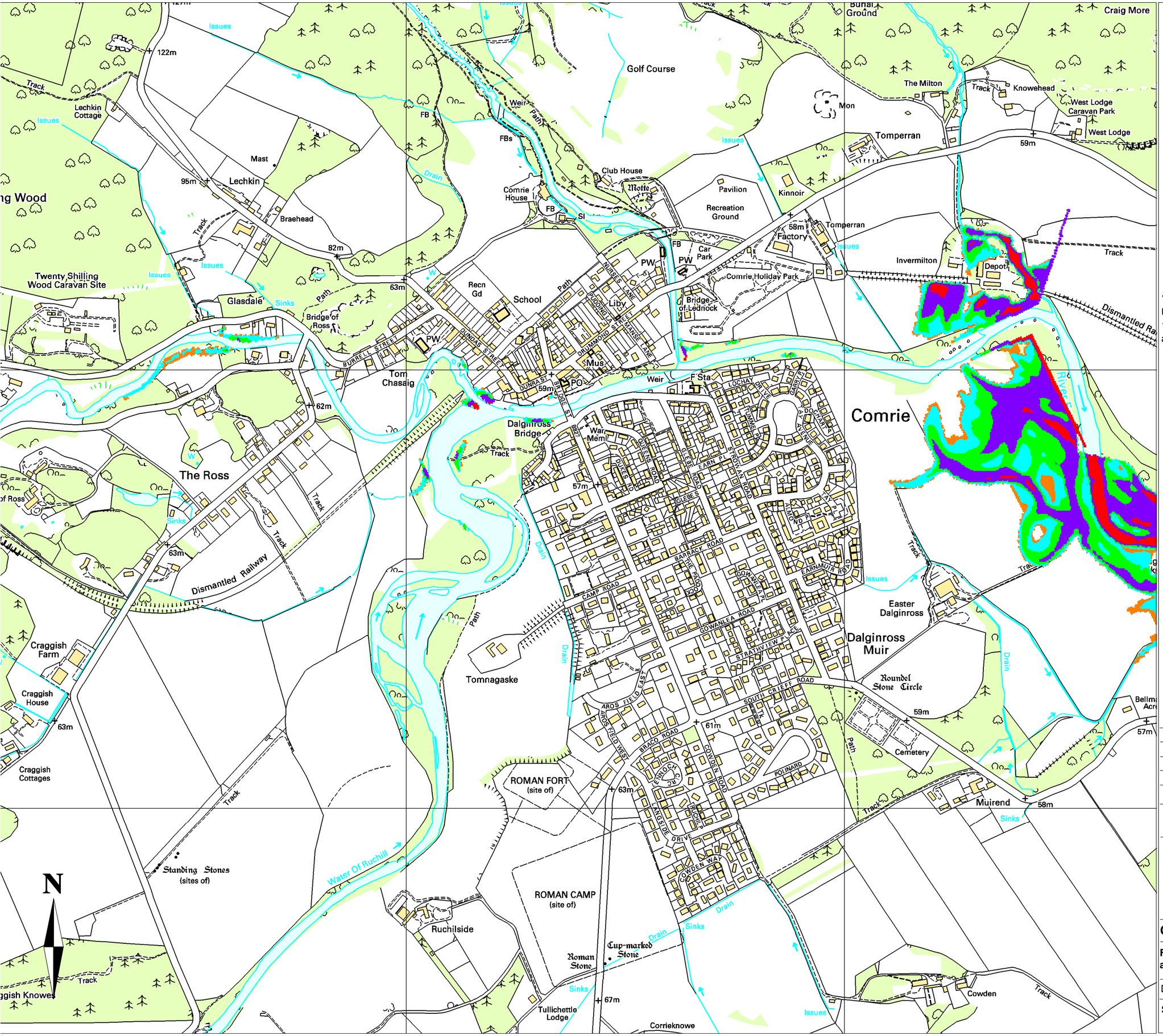

NOTES

Users should notethat the floodplain extents were mapped at 1:10,000 scale, as appropriate to the level of investigation and are based on the information available at the time of survey.

FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

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Flood outline- 1 in 200 year + CC return period with 5m average dredging on Water of Ruchill

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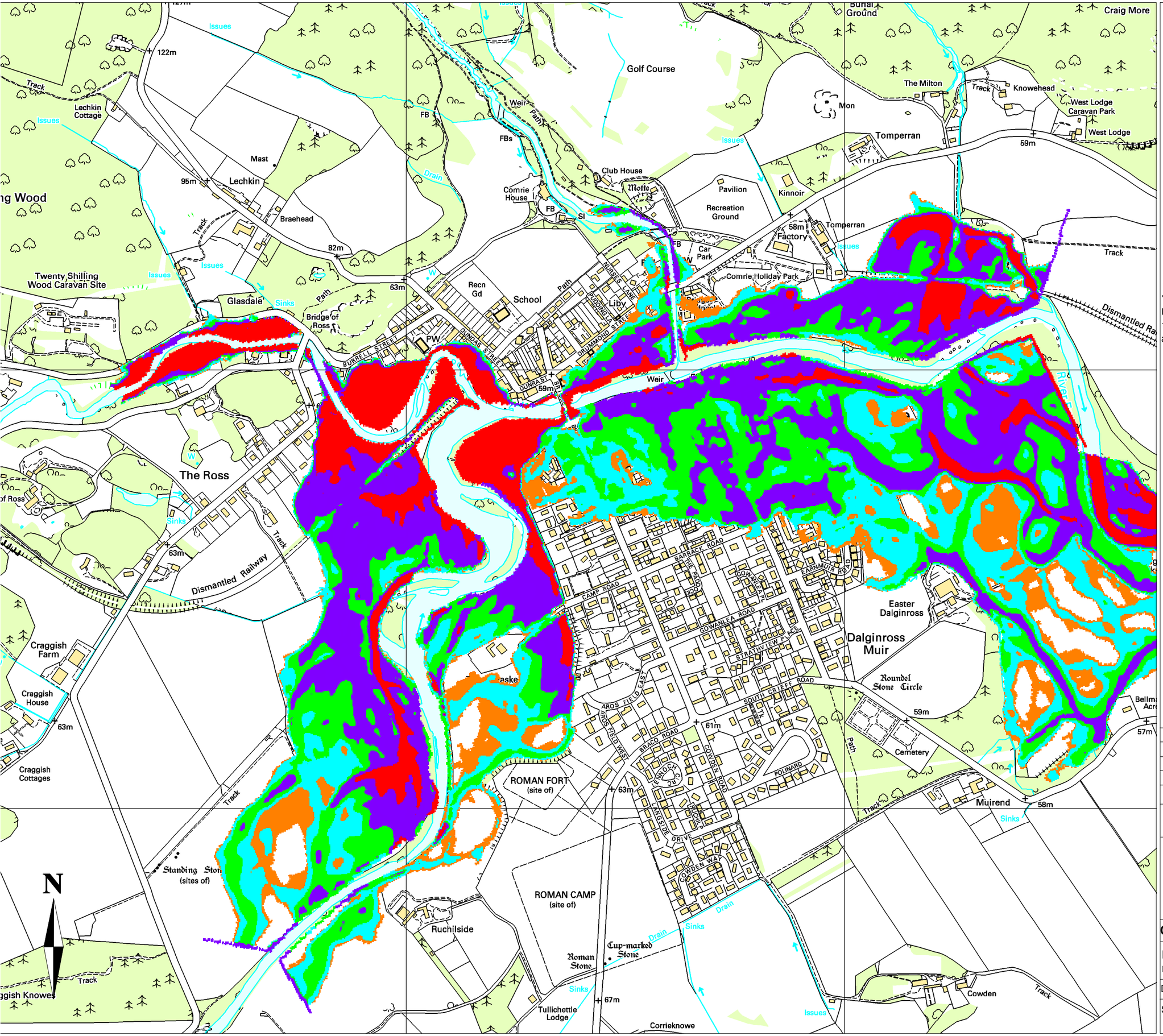
Scale at A3: Not to Scale



NOTES

Users should notethat the floodplain extents were mapped at 1:10,000 scale, as appropriate to the level of investigation and are based on the information available at the time of survey.

FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

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Flood outline for a 1 in 200 year + cc return period with natural flood management

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NOTES

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FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

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Flood outline for a 1 in 200 year return period with natural flood management

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APPENDIX 5 : UPSTREAM STORAGE – KEY PARAMETERS, STORAGE LOCATIONS AND FLOOD MAP

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Figure 5A: ISIS Long Profile through Storage Area in Water of Ruchill with upstream storage option

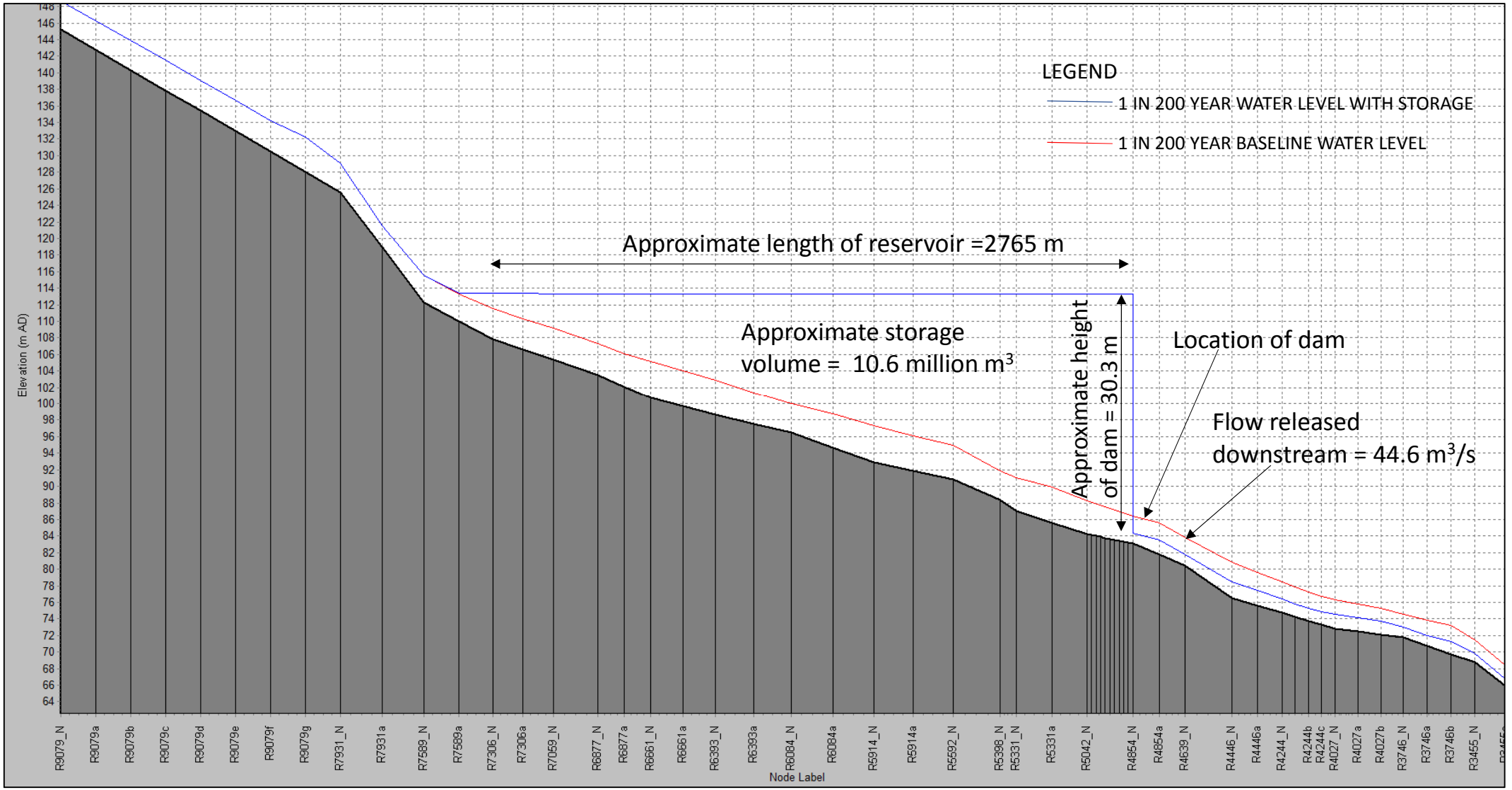
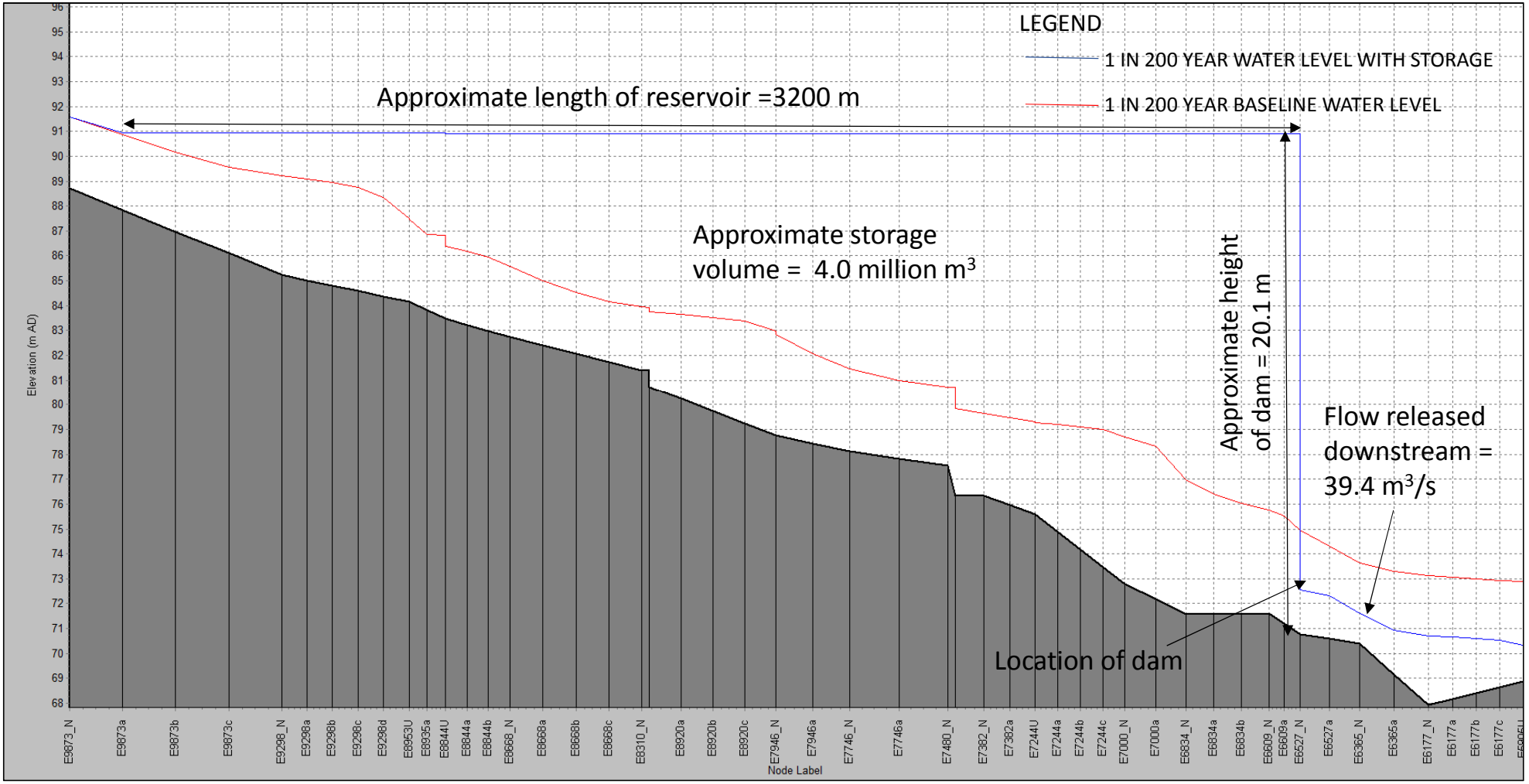
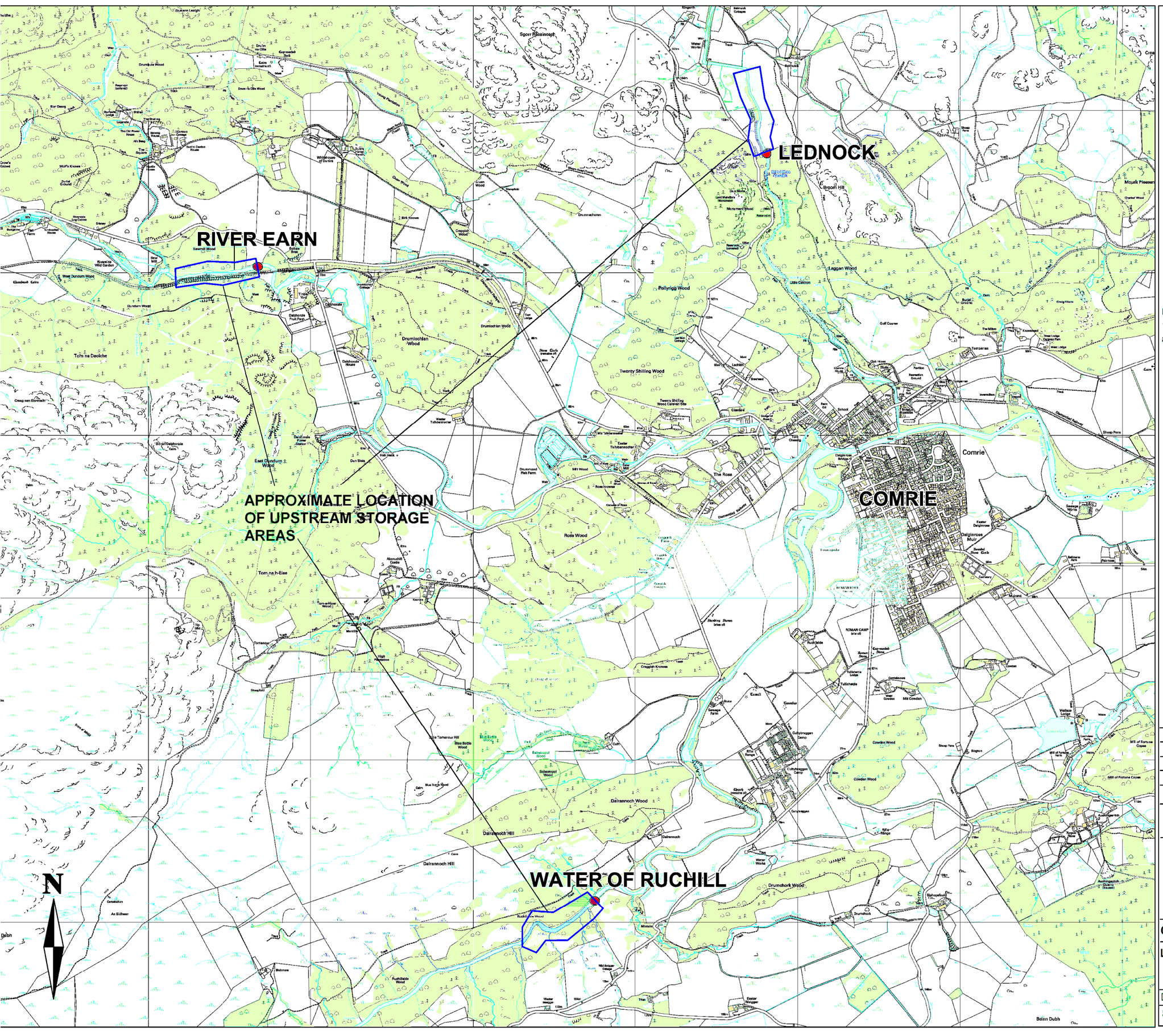


Figure 5B: ISIS Long Profile through Storage Area in River Earn with upstream storage option





NOTES

Users should notethat the floodplain extents were mapped at 1:10,000 scale, as appropriate to the level of investigation and are based on the information available at the time of survey.

Areas suitable for upstream storage

1	06/05/2015	Draft
REV	**DATE**	**REMARKS**

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Comrie and Dalginross Flood Study

Location of areas suitable for upstream storage

Date of Issue: May 2015

Scale at A3: Not to Scale

NOTES

Users should notethat the floodplain extents were mapped at 1:10,000 scale, as appropriate to the level of investigation and are based on the information available at the time of survey.

FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

REV	DATE	REMARKS
1	04/06/2015	Draft

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Comrie and Dalginross Flood Study

Flood outline for a 1 in 200 year return period event with upstream storage and flood wall on the Upper Earn and Water of Ruchill. Volume stored = 4.0 million m3.

Date of Issue: June 2015

Scale at A3: Not to Scale

APPENDIX 6: COMBINED OPTION – FLOOD WALL WITH UPSTREAM STORAGE – KEY PARAMETERS, WATER LEVEL RESULTS, FLOOD MAPS AND STORAGE LOCATIONS.

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Table 6A: Defence heights and water levels with proposed flood defence walls and storage (Water of Ruchill) option

Section reference (see sketch below for locations of the sections)	Model Node Reference	200 year RP (Volume of Storage = 4.1 million m3)							200 year RP (Volume of Storage = 2.5million m3)							200 +CC RP (Volume of Storage = 5.7 million m3)							200 +CC RP (Volume of Storage = 3.5 million m3)								Comments
		Water level with proposed flood defence but without storage, mAOD	Water level with proposed flood defence with storage, mAOD	Difference, m	Calculated Freeboard, m	Required Flood Defence Level, mAOD	Approx height of wall including freeboard, mAOD		level with proposed flood defence but without storage,	level with proposed flood defence with storage, mAOD	Difference, m	Calculated Freeboard, m	Required Flood Defence Level, mAOD	Approx height of wall including freeboard, mAOD		level with proposed flood defence but without storage,	level with proposed flood defence with storage, mAOD	Difference, m	Calculated Freeboard, m	Required Flood Defence Level, mAOD	Approx height of wall including freeboard, mAOD		level with proposed flood defence but without storage,	level with proposed flood defence with storage, mAOD	Difference, m	Calculated Freeboard, m	Required Flood Defence Level, mAOD	Approx height of wall including freeboard, mAOD		Approx ground level from LiDAR/model, mAOD		
							left	right						left	right						left	right						left	right	
A. RUCHILL WATER																														
1.00	R2415	64.44	62.66	-1.78	NA	NA	NA	NA	64.44	63.47	-0.97	NA	NA	NA	NA	64.58	62.72	-1.85	NA	NA	NA	NA	64.58	63.55	-1.02	NA	NA	NA	NA	NA	NA	
2.00	R2073	62.49	61.65	-0.84	NA	NA	NA	NA	62.49	62.11	-0.38	NA	NA	NA	NA	62.58	61.70	-0.88	NA	NA	NA	NA	62.58	62.14	-0.45	NA	NA	NA	NA	NA	NA	
3.00	R1850	61.76	60.89	-0.87	NA	NA	NA	NA	61.76	61.23	-0.53	NA	NA	NA	NA	61.87	60.94	-0.93	NA	NA	NA	NA	61.87	61.27	-0.60	NA	NA	NA	NA	NA	NA	
4.00	R1675	61.28	60.22	-1.06	NA	NA	NA	NA	61.28	60.70	-0.58	NA	NA	NA	NA	61.39	60.26	-1.13	NA	NA	NA	NA	61.39	60.75	-0.63	NA	NA	NA	NA	NA	NA	
5.00	R1450	59.88	59.19	-0.69	0.150	59.34	NA	-0.46	59.88	59.57	-0.31	0.302	59.87	NA	0.07	59.96	59.23	-0.74	0.240	59.47	NA	-0.33	59.96	59.60	-0.37	0.247	59.84	NA	0.04	NA	59.80	The height of the wall is on the top of the existing wall
6.00	R1200	59.11	58.12	-0.98	0.150	58.27	NA	-1.23	59.11	58.50	-0.60	0.302	58.81	NA	-0.69	59.56	58.27	-1.29	0.240	58.51	NA	-0.99	59.56	58.68	-0.87	0.247	58.93	NA	-0.57	NA	59.50	The height of the wall is on the top of the existing wall
7.00	R1000	59.06	57.89	-1.17	0.150	58.04	NA	-0.76	59.06	58.38	-0.69	0.302	58.68	NA	-0.12	59.53	58.15	-1.39	0.240	58.39	NA	-0.41	59.53	58.63	-0.91	0.374	59.00	NA	0.20	NA	58.80	The height of the wall is on the top of the existing wall
8.00	R800	59.03	57.87	-1.16	0.150	58.02	NA	-0.78	59.03	58.35	-0.69	0.302	58.65	NA	-0.15	59.52	58.14	-1.38	0.240	58.38	NA	-0.42	59.52	58.61	-0.91	0.374	58.98	NA	0.18	NA	58.80	The height of the wall is on the top of the existing wall
B. UPPER EARN																																
9.00	E1700_ND	61.27	61.24	-0.02	NA	NA	NA	NA	61.27	61.25	-0.01	NA	NA	NA	NA	61.69	61.65	-0.04	NA	NA	NA	NA	61.69	61.66	-0.03	NA	NA	NA	NA	NA	NA	
10.00	E1407_N	61.21	61.18	-0.02	NA	NA	NA	NA	61.21	61.19	-0.02	NA	NA	NA	NA	61.70	61.66	-0.04	NA	NA	NA	NA	61.70	61.67	-0.03	NA	NA	NA	NA	NA	NA	
11.00	E1185_N	60.85	60.81	-0.04	NA	NA	NA	NA	60.85	60.83	-0.03	NA	NA	NA	NA	61.34	61.28	-0.07	NA	NA	NA	NA	61.34	61.30	-0.05	NA	NA	NA	NA	NA	NA	
12.00	E916_N	60.78	60.75	-0.04	0.695	61.44	1.14	NA	60.78	60.76	-0.02	0.699	61.46	1.16	NA	61.31	61.24	-0.07	0.868	62.11	1.81	NA	61.31	61.26	-0.05	0.876	62.14	1.84	NA	60.30	NA	Level taken at the edge of the road. Defence may be required at the right
12A	E916b	60.40	60.34	-0.05	0.695	61.04	2.74	NA	60.40	60.36	-0.04	0.699	61.06	2.76	NA	60.94	60.83	-0.11	0.868	61.70	3.40	NA	60.94	60.86	-0.08	0.876	61.74	3.44	NA	58.30	NA	Defence may be required at right bank (TBC)
13.00	E712_N	59.65	59.56	-0.09	0.695	60.26	NA	NA	59.65	59.60	-0.05	0.699	60.30	NA	NA	60.01	59.81	-0.20	0.868	60.68	NA	NA	60.01	59.86	-0.16	0.876	60.73	NA	NA	61.64	NA	At the edge of the road from survey data (The road level is high. Need to tie the proposed defence here.. Defence may be required at right bank (TBC)
14.00	E538	59.15	58.67	-0.47	0.695	59.37	1.37	NA	59.15	58.78	-0.37	0.699	59.48	1.48	NA	59.59	58.85	-0.74	0.868	59.71	1.71	NA	59.59	58.97	-0.62	0.876	59.85	1.85	NA	58.00	NA	
15.00	E360	59.14	58.59	-0.55	0.695	59.29	1.69	NA	59.14	58.74	-0.40	0.699	59.44	1.84	NA	59.58	58.80	-0.79	0.868	59.67	2.07	NA	59.58	58.95	-0.63	0.876	59.83	2.23	NA	57.60	NA	
16.00	E157	59.07	58.03	-1.03	0.695	58.73	1.23	NA	59.07	58.47	-0.60	0.699	59.17	1.67	NA	59.55	58.41	-1.14	0.868	59.28	1.78	NA	59.55	58.77	-0.78	0.876	59.65	2.15	NA	57.50	NA	
17.00	E000	58.95	57.83	-1.12	0.695	58.52	2.62	NA	58.95	58.28	-0.66	0.699	58.98	3.08	NA	59.44	58.11	-1.33	0.868	58.98	3.08	NA	59.44	58.56	-0.89	0.876	59.43	3.53	NA	55.90	NA	
C. EARN																																
18.00	R700	58.79	57.63	-1.17	0.285	57.91	1.21	NA	58.79	58.09	-0.70	0.400	58.49	1.79	NA	59.31	57.91	-1.40	0.373	58.28	1.58	NA	59.31	58.37	-0.94	0.500	58.87	2.17	NA	56.70	NA	
19.00	R575U	58.28	57.37	-0.91	0.285	57.66	-0.09	-0.24	58.28	57.74	-0.54	0.400	58.14	0.39	0.24	58.71	57.64	-1.07	0.373	58.01	0.26	0.11	58.71	57.98	-0.74	0.500	58.48	0.73	0.58	57.75	57.90	Ground level at the left is from the bottom of the existing wall along the cymmetry
20.00	R350	57.53	56.86	-0.67	0.285	57.15	1.35	0.75	57.53	57.19	-0.34	0.400	57.59	1.79	1.19	57.89	57.11	-0.77	0.373	57.49	1.69	1.09	57.89	57.39	-0.49	0.500	57.89	2.09	1.49	55.80	56.40	Ground level at the right is at the edge of the cymmetry
21.00	R150	56.37	55.99	-0.38	0.285	56.28	0.48	1.38	56.37	56.17	-0.20	0.400	56.57	0.77	1.67	56.52	56.16	-0.36	0.373	56.53	0.73	1.63	56.52	56.28	-0.24	0.500	56.78	0.98	1.88	55.80	54.90	
22.00	R000	56.15	55.52	-0.63	0.285	55.81	-0.19	0.31	56.15	55.79	-0.36	0.400	56.19	0.19	0.69	56.34	55.77	-0.57	0.373	56.14	0.14	0.64	56.34	55.97	-0.37	0.500	56.47	0.47	0.97	56.00	55.50	Ground level is steep at the left wall alignment. 56.0 Maod is an average level
D. LEDNOCK																																
23.00	L108	56.66	56.30	-0.35	0.442	56.74	0.04	0.39	56.66	56.39	-0.26	0.451	56.85	0.15	0.50	56.86	56.55	-0.31	0.522	57.07	0.37	0.72	56.86	56.60	-0.26	0.527	57.13	0.43	0.78	56.70	56.35	
24.00	L176	57.03	56.82	-0.21	0.442	57.26	1.16	0.46	57.03	56.87	-0.16	0.451	57.32	1.22	0.52	57.26	57.04	-0.22	0.522	57.57	1.47	0.77	57.26	57.07	-0.19	0.527	57.59	1.49	0.79	56.10	56.80	
25.00	L289	57.63	57.60	-0.03	NA	NA	NA	NA	57.63	57.61	-0.02	NA	NA	NA	NA	57.83	57.80	-0.03	0.522	58.33	NA	NA	57.83	57.81	-0.02	0.527	58.34	NA	NA	NA	NA	
26.00	L372	58.21	58.20	-0.01	NA	NA	NA	NA	58.21	58.20	-0.01	NA	NA	NA	NA	58.49	58.47	-0.03	0.522	58.99	NA	NA	58.49	58.47	-0.02	0.527	59.00	NA	NA	NA	NA	
27.00	L519	59.18	59.18	0.00	NA	NA	NA	NA	59.18	59.18	0.00	NA	NA	NA	NA	59.33	59.34	0.01	0.522	59.86	NA	NA	59.33	59.34	0.01	0.527	59.86	NA	NA	NA	NA	
28.00	L703	61.24	61.24	0.00	NA	NA	NA	NA	61.24	61.24	0.00	NA	NA	NA	NA	61.50	61.50	0.00	0.522	62.02	NA	NA	61.50	61.50	0.00	0.527	62.02	NA	NA	NA	NA	

Note: The approximate height of the wall is based on the avregae ground level near the proposed wall alignment. The ground levels have been derived from the LiDAR data/NEXT map

The proposed alignment is approximate and subject to change based on site conditions. Currently, the defence have not been tied to the higher ground or structures at the upstream end and at the location of the structures

Gardens of some properties seems to be flooded in the Ross towards left bank of the Ruchill and also upstream of the Bridge of Ross in the right bank of the River Earn.The threshold levels of these properties needs to be checked against the water levels.

Table 6B: Defence heights and water levels with proposed flood defence walls and storage (River Earn) option

Section reference (see sketch below for locations of the sections)	Model Node Reference	200 year RP (Volume of Storage = 2.9 mln m3)							200 year RP (Volume of Storage = 0.4 million m3)							200 +CC RP (Volume of Storage = 3.9 million m3)							200 +CC RP (Volume of Storage = 2.2 million m3)									Comments
		Water level with proposed flood defence but without storage, mAOD	Water level with proposed flood defence with storage, mAOD	Difference, m	Calculated Freeboard, m	Required Flood Defence Level, mAOD	Approx height of wall including freeboard, mAOD		level with proposed flood defence but without storage,	level with proposed flood defence with storage, mAOD	Difference, m	Calculated Freeboard, m	Required Flood Defence Level, mAOD	Approx height of wall including freeboard, mAOD		level with proposed flood defence but without storage,	level with proposed flood defence with storage, mAOD	Difference, m	Calculated Freeboard, m	Required Flood Defence Level, mAOD	Approx height of wall including freeboard, mAOD		level with proposed flood defence but without storage,	level with proposed flood defence with storage, mAOD	Difference, m	Calculated Freeboard, m	Required Flood Defence Level, mAOD	Approx height of wall including freeboard, mAOD		Approx ground level from LiDAR/model, mAOD		
							left	right						left	right						left	right						left	right	left	right	
A. RUCHILL WATER																																
1.00	R2415	64.44	64.44	0.00	NA	NA	NA	NA	64.44	64.44	0.00	NA	NA	NA	NA	64.58	64.58	0.00	NA	NA	NA	NA	64.58	64.58	0.00	NA	NA	NA	NA	NA	NA	
2.00	R2073	62.49	62.49	0.00	NA	NA	NA	NA	62.49	62.49	0.00	NA	NA	NA	NA	62.58	62.58	0.00	NA	NA	NA	NA	62.58	62.58	0.00	NA	NA	NA	NA	NA	NA	
3.00	R1850	61.76	61.76	0.00	NA	NA	NA	NA	61.76	61.76	0.00	NA	NA	NA	NA	61.87	61.87	0.00	NA	NA	NA	NA	61.87	61.86	0.00	NA	NA	NA	NA	NA	NA	
4.00	R1675	61.28	61.28	0.00	NA	NA	NA	NA	61.28	61.28	0.00	NA	NA	NA	NA	61.39	61.39	0.00	NA	NA	NA	NA	61.39	61.39	0.00	NA	NA	NA	NA	NA	NA	
5.00	R1450	59.88	59.88	0.00	0.314	60.20	NA	0.40	59.88	59.88	0.00	0.347	60.23	NA	0.43	59.96	59.95	-0.01	0.406	60.36	NA	0.56	59.96	59.95	-0.01	0.460	60.41	NA	0.61	NA	59.80	The height of the wall is on the top of the existing wall
6.00	R1200	59.11	58.89	-0.22	0.314	59.20	NA	-0.30	59.11	58.98	-0.13	0.347	59.32	NA	-0.18	59.56	59.16	-0.39	0.406	59.57	NA	0.07	59.56	59.32	-0.24	0.460	59.78	NA	0.28	NA	59.50	The height of the wall is on the top of the existing wall
7.00	R1000	59.06	58.78	-0.28	0.431	59.21	NA	0.41	59.06	58.90	-0.16	0.473	59.38	NA	0.58	59.53	59.08	-0.45	0.513	59.60	NA	0.80	59.53	59.27	-0.27	0.570	59.84	NA	1.04	NA	58.80	The height of the wall is on the top of the existing wall
8.00	R800	59.03	58.72	-0.32	0.431	59.15	NA	0.35	59.03	58.87	-0.17	0.473	59.34	NA	0.54	59.52	59.05	-0.47	0.513	59.56	NA	0.76	59.52	59.25	-0.27	0.570	59.82	NA	1.02	NA	58.80	The height of the wall is on the top of the existing wall
B. UPPER EARN																																
9.00	E1700_ND	61.27	60.03	-1.24	NA	NA	NA	NA	61.27	60.69	-0.57	NA	NA	NA	NA	61.69	60.09	-1.60	NA	NA	NA	NA	61.69	60.77	-0.92	NA	NA	NA	NA	NA	NA	
10.00	E1407_N	61.21	59.75	-1.45	NA	NA	NA	NA	61.21	60.55	-0.66	NA	NA	NA	NA	61.70	59.84	-1.86	NA	NA	NA	NA	61.70	60.63	-1.07	NA	NA	NA	NA	NA	NA	
11.00	E1185_N	60.85	59.50	-1.36	NA	NA	NA	NA	60.85	60.20	-0.65	NA	NA	NA	NA	61.34	59.63	-1.71	NA	NA	NA	NA	61.34	60.28	-1.06	NA	NA	NA	NA	NA	NA	
12.00	E916_N	60.78	59.15	-1.63	0.545	59.69	-0.61	NA	60.78	60.02	-0.76	0.652	60.68	0.38	NA	61.31	59.42	-1.89	0.689	60.11	-0.19	NA	61.31	60.12	-1.19	0.797	60.92	0.62	NA	60.30	NA	Level taken at the edge of the road. Defence may be required at the right bank(TBC)
12A	E916b	60.40	59.00	-1.40	0.545	59.54	1.24	NA	60.40	59.67	-0.73	0.652	60.32	2.02	NA	60.94	59.29	-1.65	0.689	59.98	1.68	NA	60.94	59.83	-1.11	0.797	60.62	2.32	NA	58.30	NA	Defence may be required at right bank (TBC)
13.00	E712_N	59.65	58.86	-0.79	0.545	59.40	NA	NA	59.65	59.23	-0.42	0.652	59.88	NA	NA	60.01	59.16	-0.85	0.689	59.85	NA	NA	60.01	59.50	-0.51	0.797	60.30	NA	NA	61.64	NA	At the edge of the road from survey data (The road level is high. Need to tie the proposed defence here.. Defence may be required at right bank (TBC)
14.00	E538	59.15	58.70	-0.45	0.545	59.24	1.24	NA	59.15	58.94	-0.21	0.652	59.60	1.60	NA	59.59	59.06	-0.53	0.689	59.75	1.75	NA	59.59	59.31	-0.28	0.797	60.10	2.10	NA	58.00	NA	
15.00	E360	59.14	58.67	-0.47	0.545	59.22	1.62	NA	59.14	58.93	-0.22	0.652	59.58	1.98	NA	59.58	59.05	-0.54	0.689	59.73	2.13	NA	59.58	59.29	-0.29	0.797	60.09	2.49	NA	57.60	NA	
16.00	E157	59.07	58.61	-0.46	0.545	59.15	1.65	NA	59.07	58.85	-0.22	0.652	59.50	2.00	NA	59.55	58.99	-0.56	0.689	59.68	2.18	NA	59.55	59.24	-0.31	0.797	60.04	2.54	NA	57.50	NA	
17.00	E000	58.95	58.56	-0.38	0.545	59.11	3.21	NA	58.95	58.75	-0.19	0.652	59.40	3.50	NA	59.44	58.92	-0.52	0.689	59.61	3.71	NA	59.44	59.15	-0.30	0.797	59.94	4.04	NA	55.90	NA	
C. EARN																																
18.00	R700	58.79	58.43	-0.37	0.512	58.94	2.24	NA	58.79	58.61	-0.19	0.528	59.13	2.43	NA	59.31	58.79	-0.52	0.619	59.41	2.71	NA	59.31	59.01	-0.30	0.695	59.70	3.00	NA	56.70	NA	
19.00	R575U	58.28	58.00	-0.28	0.512	58.51	0.76	0.61	58.28	58.14	-0.14	0.528	58.66	0.91	0.76	58.71	58.29	-0.42	0.619	58.91	1.16	1.01	58.71	58.46	-0.25	0.695	59.15	1.40	1.25	57.75	57.90	Ground level at the left is from the bottom of the existing wall along the cymmetry
20.00	R350	57.53	57.44	-0.09	0.512	57.95	2.15	1.55	57.53	57.47	-0.06	0.528	58.00	2.20	1.60	57.89	59.54	1.65	0.619	60.16	4.36	3.76	57.89	59.54	1.65	0.695	60.24	4.44	3.84	55.80	56.40	Ground level at the right is at the edge of the cymmetry
21.00	R150	56.37	56.29	-0.08	0.512	56.80	1.00	1.90	56.37	56.34	-0.03	0.528	56.86	1.06	1.96	56.52	56.39	-0.13	0.619	57.01	1.21	2.11	56.52	56.42	-0.10	0.695	57.12	1.32	2.22	55.80	54.90	
22.00	R000	56.15	56.00	-0.15	0.512	56.51	0.51	1.01	56.15	56.08	-0.07	0.528	56.61	0.61	1.11	56.34	56.19	-0.14	0.619	56.81	0.81	1.31	56.34	56.26	-0.07	0.695	56.96	0.96	1.46	56.00	55.50	Ground level is steep at the left wall alignment. 56.0 Maod is an average level
D. LEDNOCK																																
23.00	L108	56.66	56.50	-0.15	0.469	56.97	0.27	0.62	56.66	56.56	-0.09	0.485	57.05	0.35	0.70	56.86	56.74	-0.12	0.560	57.30	0.60	0.95	56.86	56.87	0.01	0.576	57.44	0.74	1.09	56.70	56.35	
24.00	L176	57.03	56.97	-0.06	0.469	57.44	1.34	0.64	57.03	57.00	-0.03	0.485	57.49	1.39	0.69	57.26	57.18	-0.08	0.560	57.74	1.64	0.94	57.26	57.22	-0.04	0.576	57.80	1.70	1.00	56.10	56.80	
25.00	L289	57.63	57.62	-0.01	NA	NA	NA	NA	57.63	57.63	0.00	NA	NA	NA	NA	57.83	57.85	0.02	0.560	58.41	NA	NA	57.83	57.82	-0.01	0.576	58.40	NA	NA	NA	NA	
26.00	L372	58.21	58.19	-0.01	NA	NA	NA	NA	58.21	58.20	0.00	NA	NA	NA	NA	58.49	58.50	0.00	0.560	59.06	NA	NA	58.49	58.49	-0.01	0.576	59.06	NA	NA	NA	NA	
27.00	L519	59.18	59.17	-0.01	NA	NA	NA	NA	59.18	59.18	0.00	NA	NA	NA	NA	59.33	59.39	0.06	0.560	59.95	NA	NA	59.33	59.33	0.00	0.576	59.90	NA	NA	NA	NA	
28.00	L703	61.24	61.24	-0.01	NA	NA	NA	NA	61.24	61.24	0.00	NA	NA	NA	NA	61.50	61.50	0.00	0.560	62.06	NA	NA	61.50	61.49	-0.01	0.576	62.07	NA	NA	NA	NA	

Note: The approximate height of the wall is based on the avregae ground level near the proposed wall alignment. The ground levels have been derived from the LiDAR data/NEXT map
The proposed alignment is approximate and subject to change based on site conditions. Currently, the defence have not been tied to the higher ground or structures at the upstream end and at the location of the structure
Gardens of some properties seems to be flooded in the Ross towards left bank of the Ruchill and also upstream of the Bridge of Ross in the right bank of the River Earn.The threshold levels of these properties needs to be checked against the water levels

Table 6C: Defence heights and water levels with proposed flood defence walls and storage (River Lednock) option

Section reference (see sketch below for locations of the sections)	Model Node Reference	200 year RP (Volume of Storage = 1.2 mln m3)					Approx height of wall including freeboard, mAOD		Approx ground level from LiDAR/model, mAOD		Comments
		Water level with proposed flood defence but without storage, mAOD	Water level with proposed flood defence with storage, mAOD	Difference, m	Calculated Freeboard, m	Required Flood Defence Level, mAOD	left	right	left	right	
A.RUCHILL WATER											
1.00	R2415	64.44	64.44	0.00	NA	NA	NA	NA	NA	NA	
2.00	R2073	62.49	62.49	0.00	NA	NA	NA	NA	NA	NA	
3.00	R1850	61.76	61.76	0.00	NA	NA	NA	NA	NA	NA	
4.00	R1675	61.28	61.28	0.00	NA	NA	NA	NA	NA	NA	
5.00	R1450	59.88	59.88	0.00	0.384	60.27	NA	0.47	NA	59.80	The height of the wall is on the top of the existing wall
6.00	R1200	59.11	59.08	-0.03	0.384	59.46	NA	-0.04	NA	59.50	The height of the wall is on the top of the existing wall
7.00	R1000	59.06	59.03	-0.03	0.497	59.53	NA	0.73	NA	58.80	The height of the wall is on the top of the existing wall
8.00	R800	59.03	59.00	-0.03	0.50	59.50	NA	0.70	NA	58.80	The height of the wall is on the top of the existing wall
B.UPPER EARN											
9.00	E1700_ND	61.27	61.27	0.01	NA	NA	NA	NA	NA	NA	
10.00	E1407_N	61.21	61.21	0.00	NA	NA	NA	NA	NA	NA	
11.00	E1185_N	60.85	60.86	0.01	NA	NA	NA	NA	NA	NA	
12.00	E916_N	60.78	60.79	0.01	0.711	61.50	1.20	NA	60.30	NA	Level taken at the edge of the road. Defence may be required at the right bank(TBC)
12A	E916b	60.40	60.40	0.00	0.711	61.11	2.81	NA	58.30	NA	Defence may be required at right bank (TBC)
13.00	E712_N	59.65	59.67	0.02	0.711	60.38	NA	NA	61.64	NA	At the edge of the road from survey data (The road level is high. Need to tie the proposed defence here.. Defence may be required at right bank (TBC)
14.00	E538	59.15	59.13	-0.02	0.711	59.84	1.84	NA	58.00	NA	
15.00	E360	59.14	59.12	-0.02	0.71	59.83	2.23	NA	57.60	NA	
16.00	E157	59.07	59.04	-0.03	0.71	59.75	2.25	NA	57.50	NA	
17.00	E000	58.95	58.91	-0.03	0.71	59.62	3.72	NA	55.90	NA	
C.EARN											
18.00	R700	58.79	58.76	-0.04	0.608	59.37	2.67	NA	56.70	NA	
19.00	R575U	58.28	58.23	-0.05	0.608	58.84	1.09	0.94	57.75	57.90	Ground level at the left is from the bottom of the existing wall along the cymmetry
20.00	R350	57.53	57.36	-0.18	0.61	57.96	2.16	1.56	55.80	56.40	Ground level at the right is at the edge of the cymmetry
21.00	R150	56.37	56.31	-0.062	0.61	56.92	1.12	2.02	55.80	54.90	
22.00	R000	56.15	56.03	-0.121	0.61	56.64	0.64	1.14	56.00	55.50	Ground level is steep at the left wall alignment. 56.0 Maod is an average level
D. LEDNOCK											
23.00	L108	56.66	56.64	-0.01	0.422	57.06	0.36	0.71	56.70	56.35	
24.00	L176	57.03	56.74	-0.29	0.422	57.16	1.06	0.36	56.10	56.80	
25.00	L289	57.63	56.98	-0.65	NA	NA	NA	NA	NA	NA	
26.00	L372	58.21	57.39	-0.82	NA	NA	NA	NA	NA	NA	
27.00	L519	59.18	58.50	-0.69	NA	NA	NA	NA	NA	NA	
28.00	L703	61.24	60.51	-0.74	NA	NA	NA	NA	NA	NA	

Note: The approximate height of the wall is based on the avregae ground level near the proposed wall alignment. The ground levels have been derived from the LiDAR data/NEXT map
The proposed alignment is approximate and subject to change based on site conditions. Currently, the defence have not been tied to the higher ground or structures at the upstream end and at the location of the structur
Gardens of some properties seems to be flooded in the Ross towards left bank of the Ruchill and also upstream of the Bridge of Ross in the right bank of the River Earn.The threshold levels of these properties needs to be checked against the water leve

Figure 6A: ISIS Long Profile through Storage Area in Water of Ruchill for 1 in 200 Year Return Period with Flood Defence Walls in Comrie

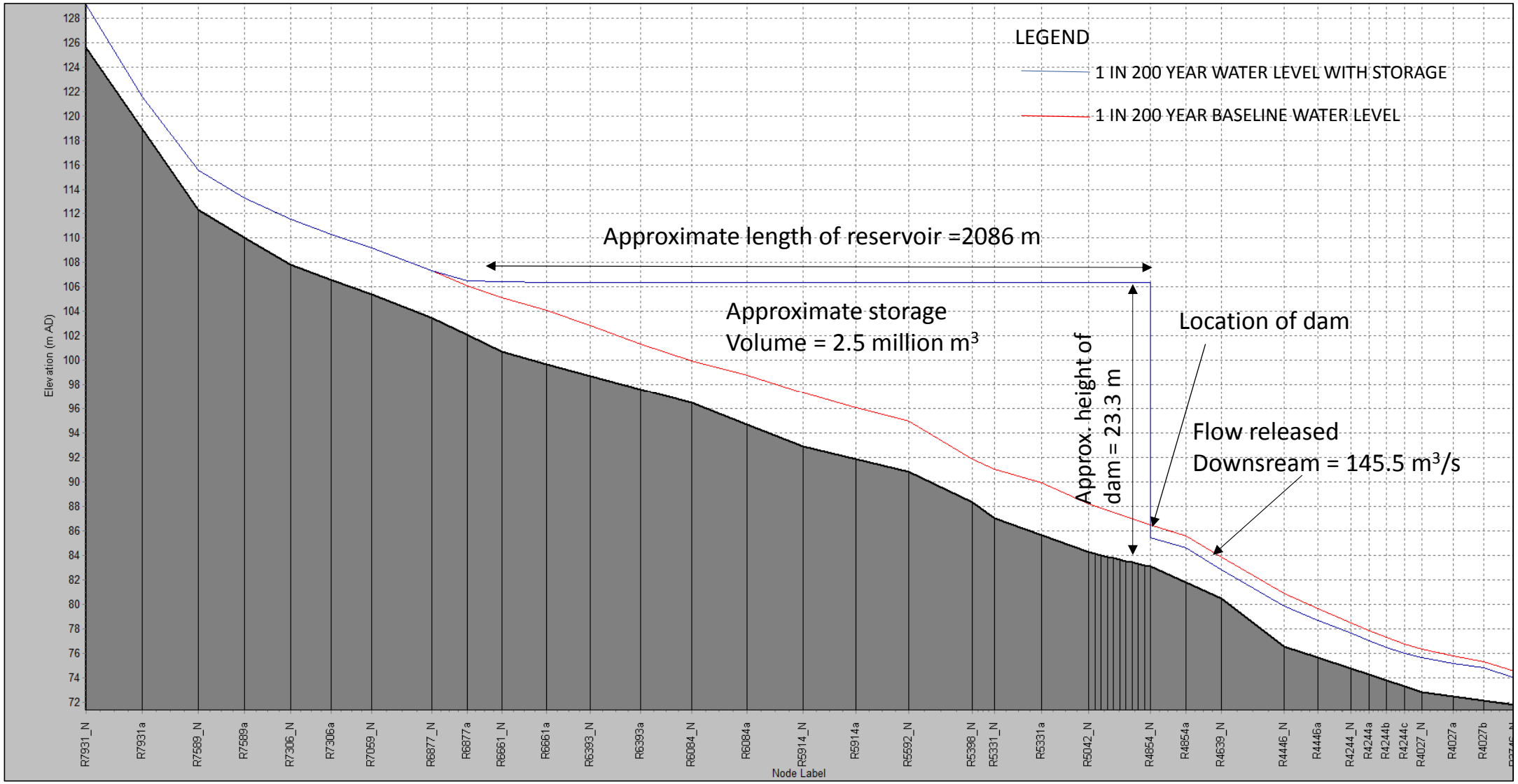


Figure 6B: ISIS Long Profile through Storage Area in Water of Ruchill for 1 in 200 Year Return Period with Flood Defence Walls in the Comrie

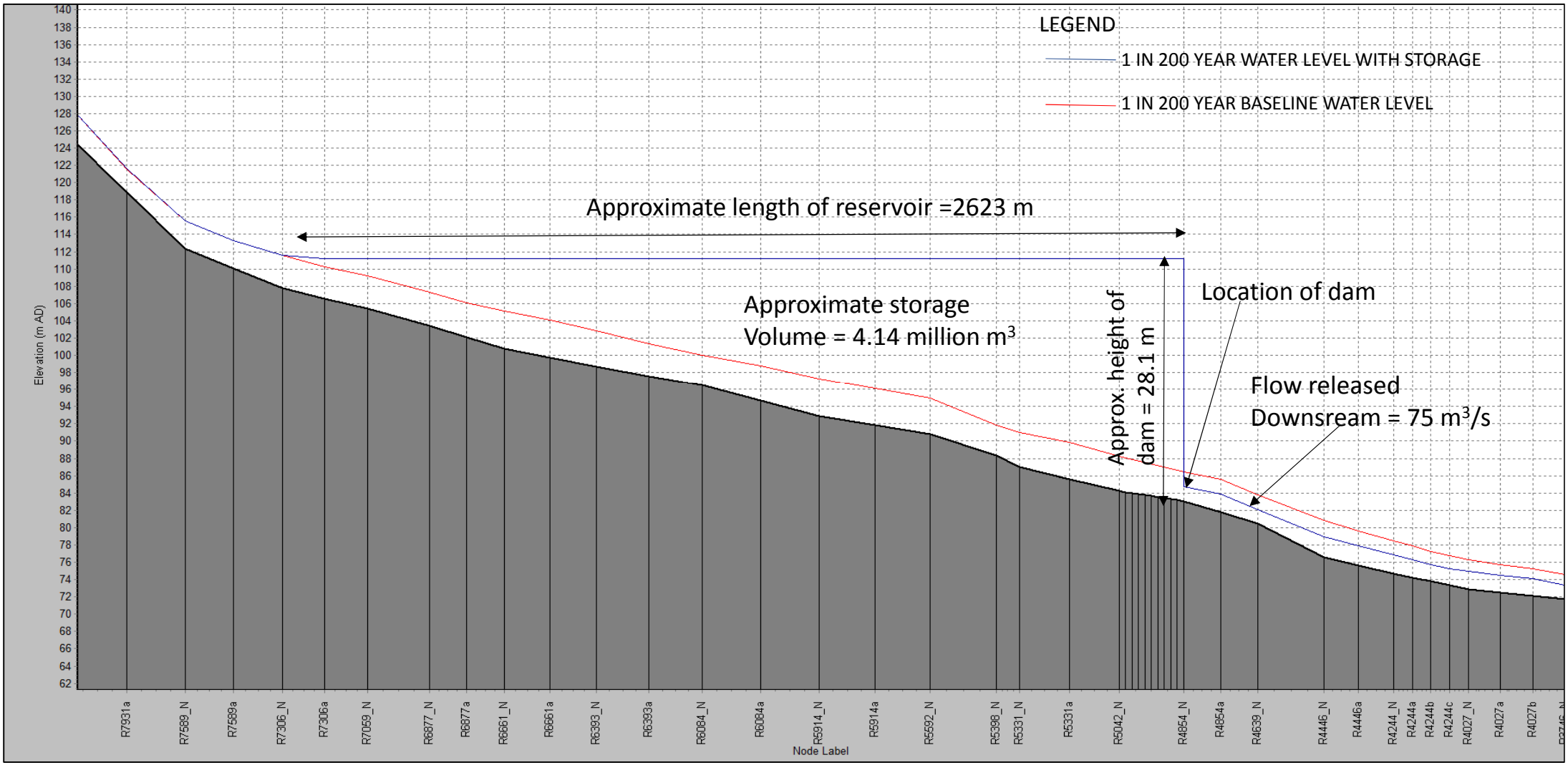


Figure 6C: ISIS Long Profile through Storage Area in Water of Ruchill for 1 in 200+CC Return Period with Flood Defence Walls in Comrie

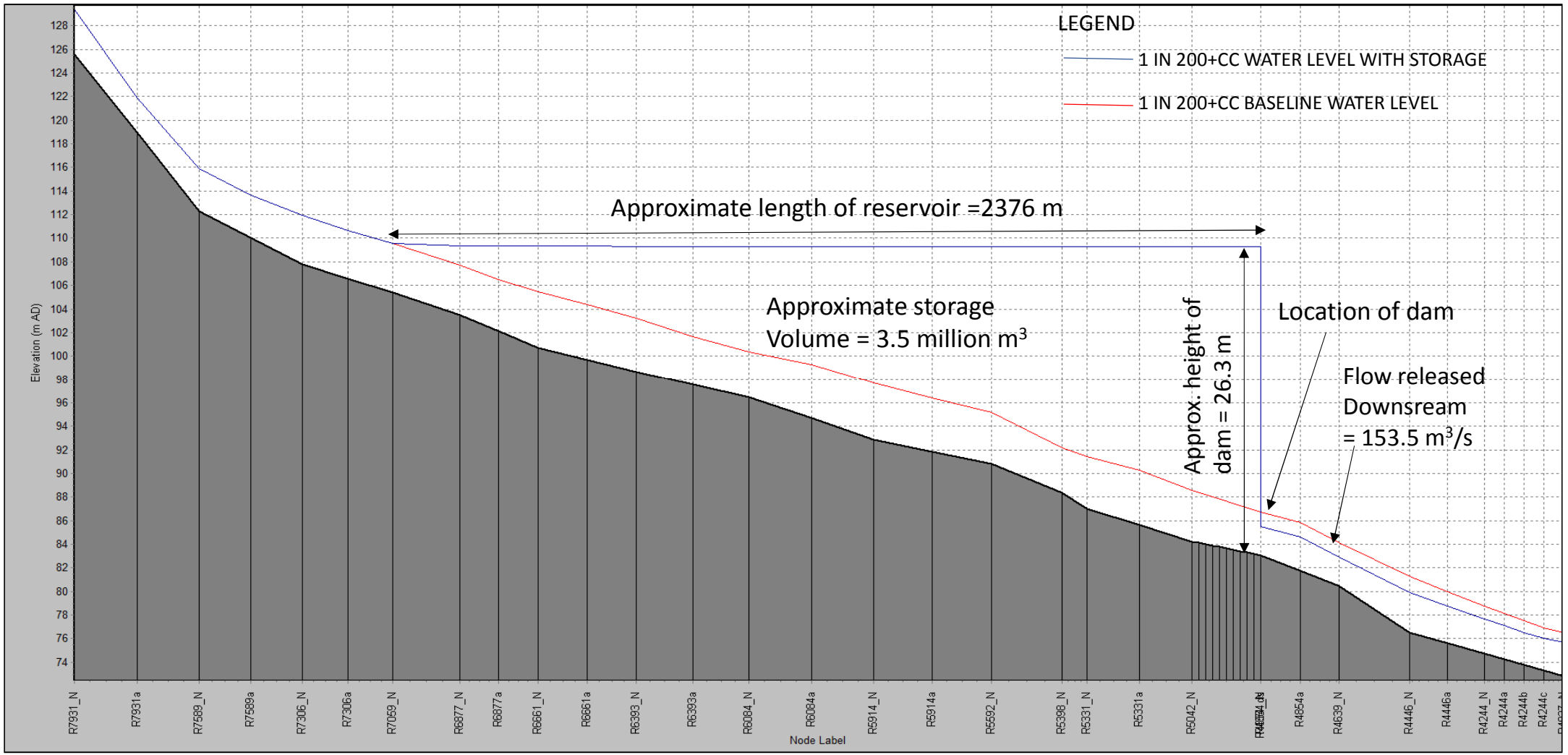


Figure 6D: ISIS Long Profile through Storage Area in Water of Ruchill for 1 in 200+CC Return Period with Flood Defence Walls in Comrie

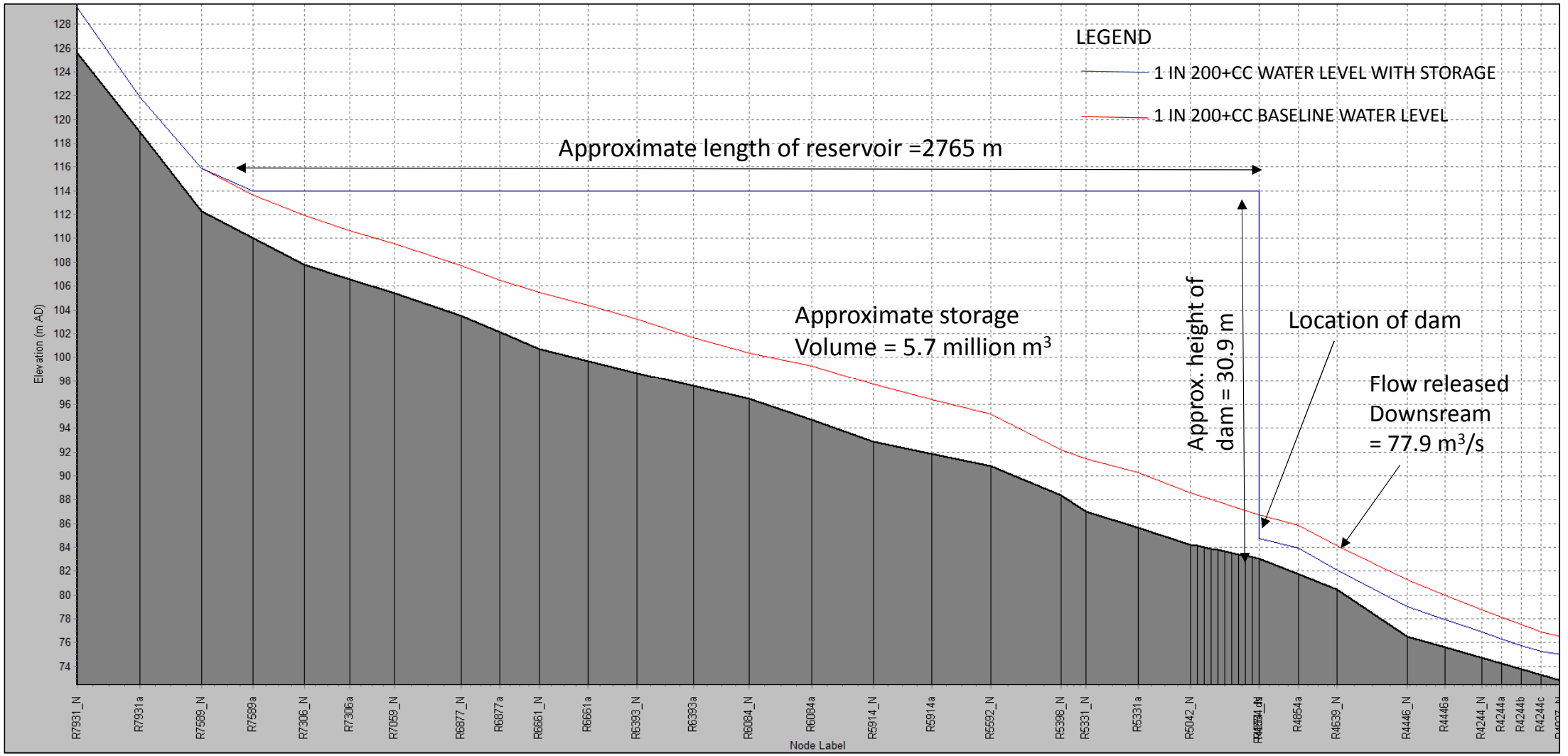


Figure 6E: ISIS Long Profile through Storage Area in River Earn for 1 in 200 Year Return Period with Flood Defence Walls in Comrie

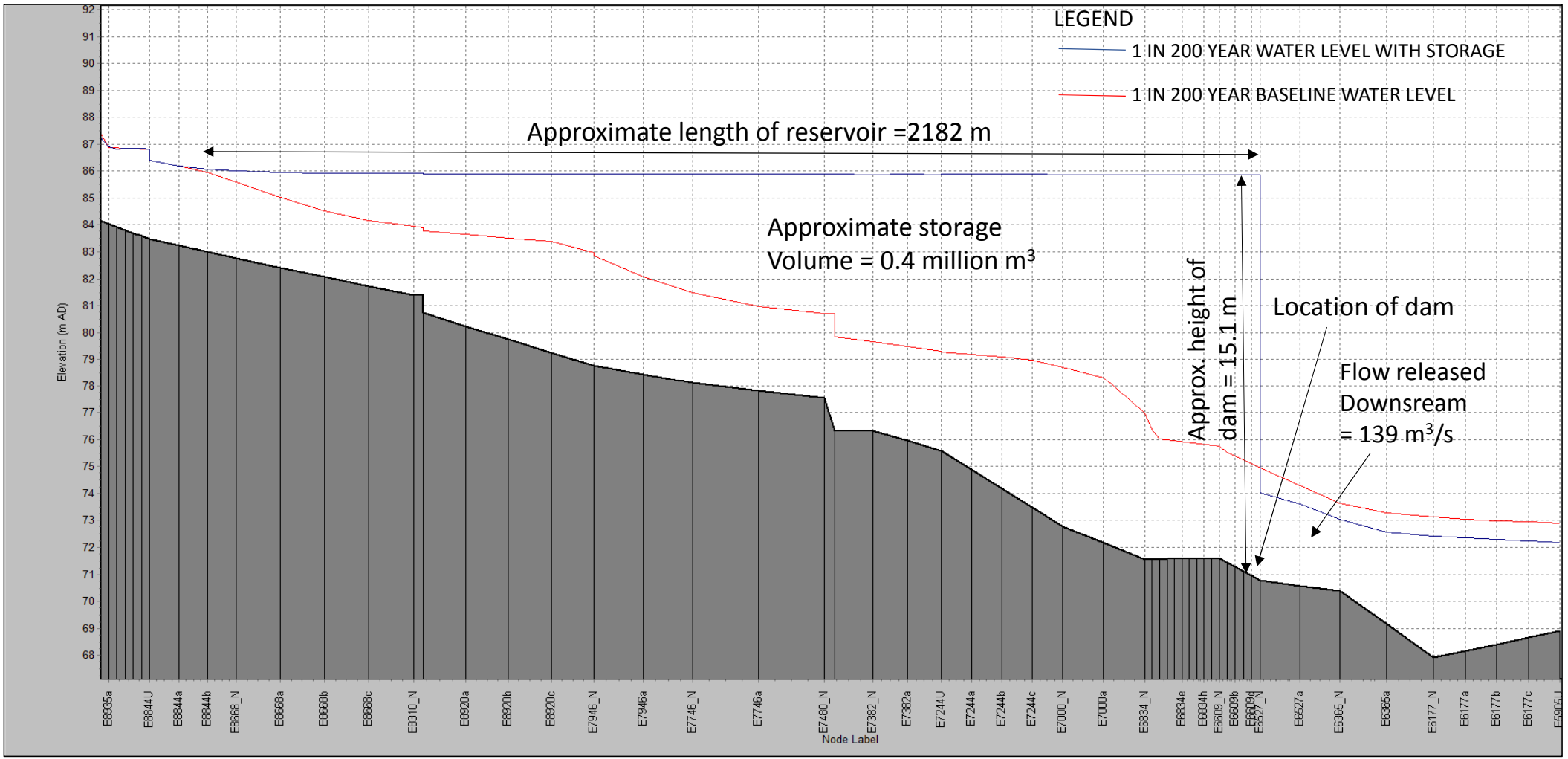


Figure 6F: ISIS Long Profile through Storage Area in River Earn for 1 in 200 Year Return Period with Flood Defence Walls in Comrie

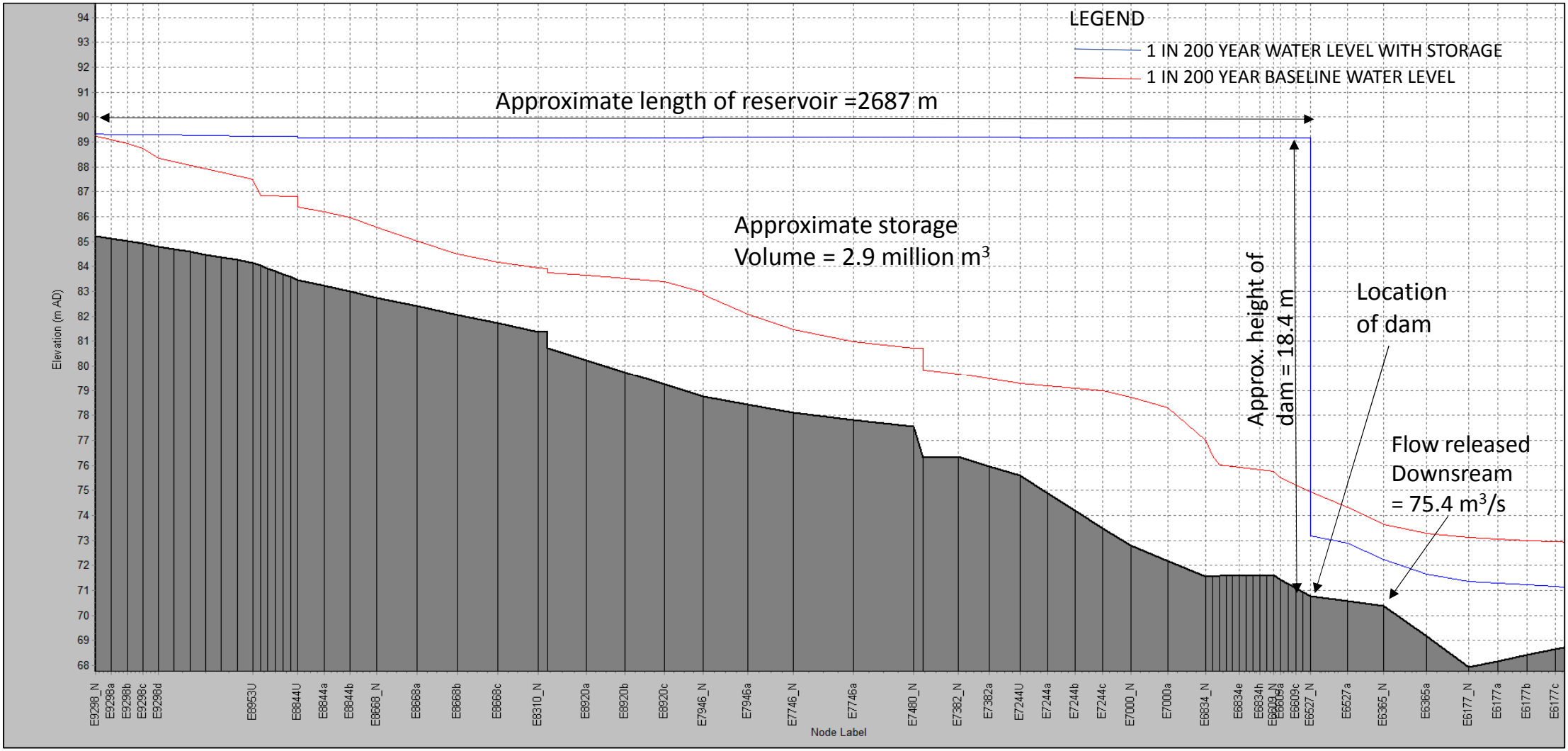


Figure 6G: ISIS Long Profile through Storage Area in River Earn for 1 in 200+CC with Flood Defence Walls in Comrie

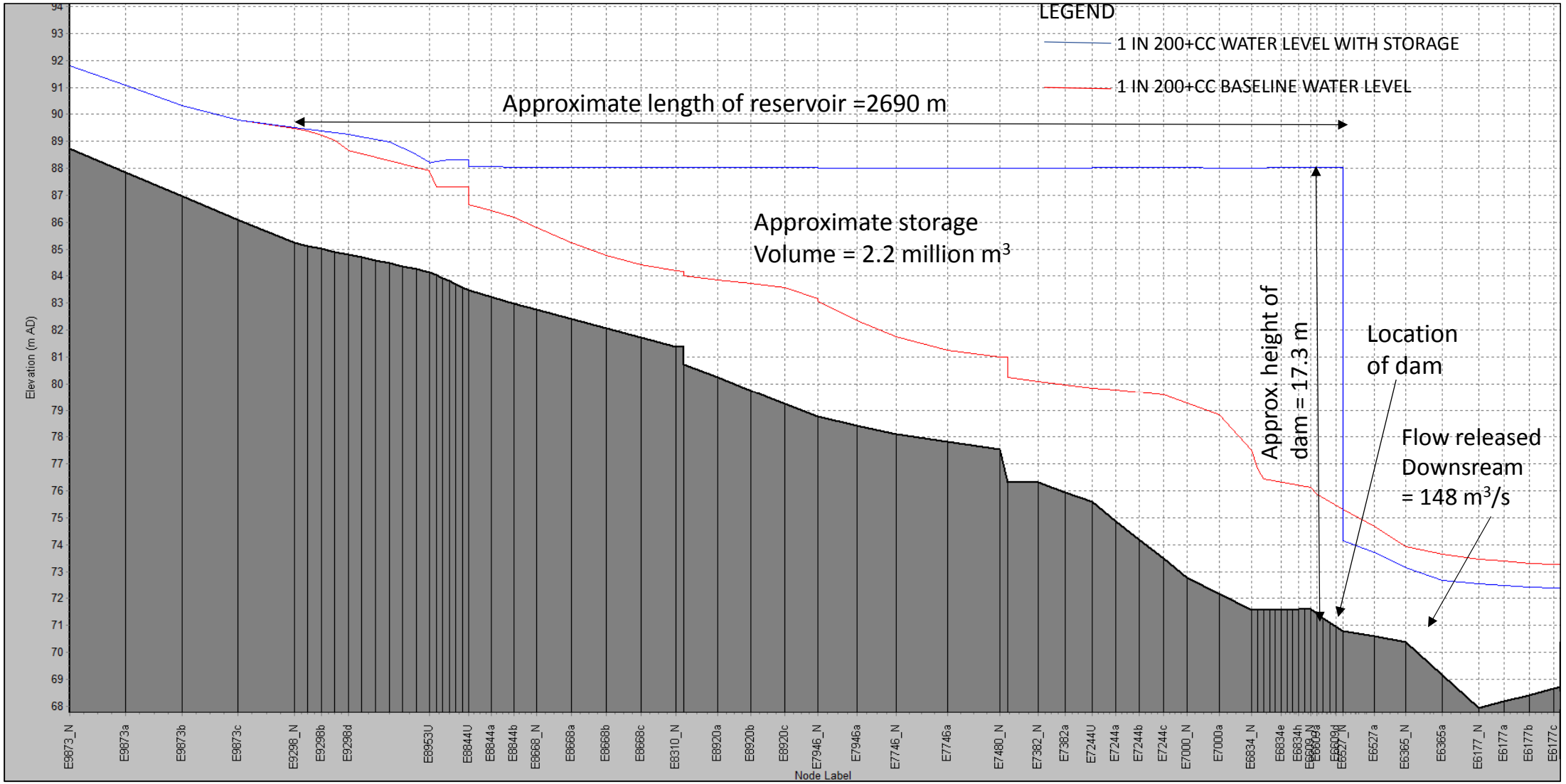


Figure 6H: ISIS Long Profile through Storage Area in River Earn for 1 in 200+CC with Flood Defence Walls in Comrie

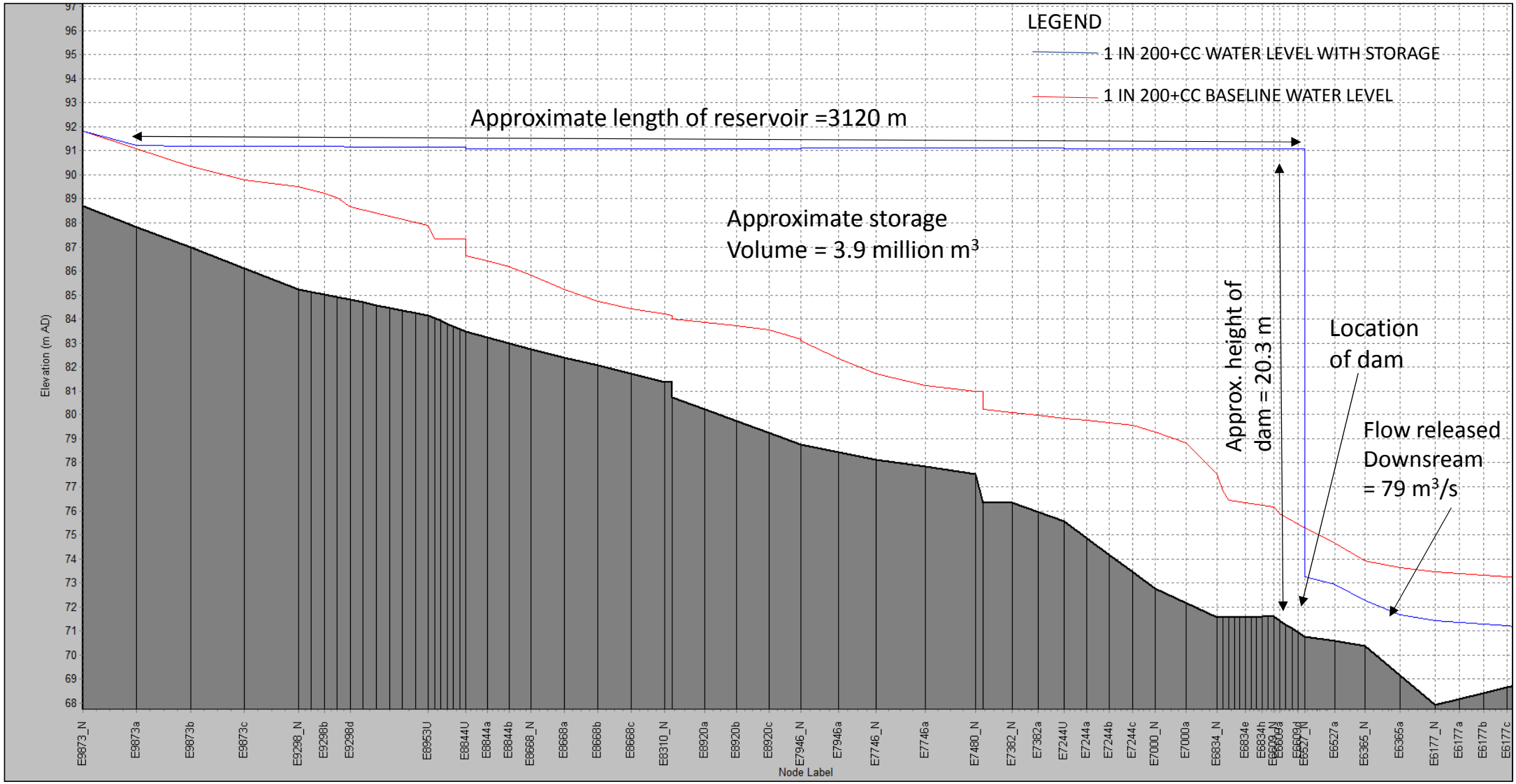
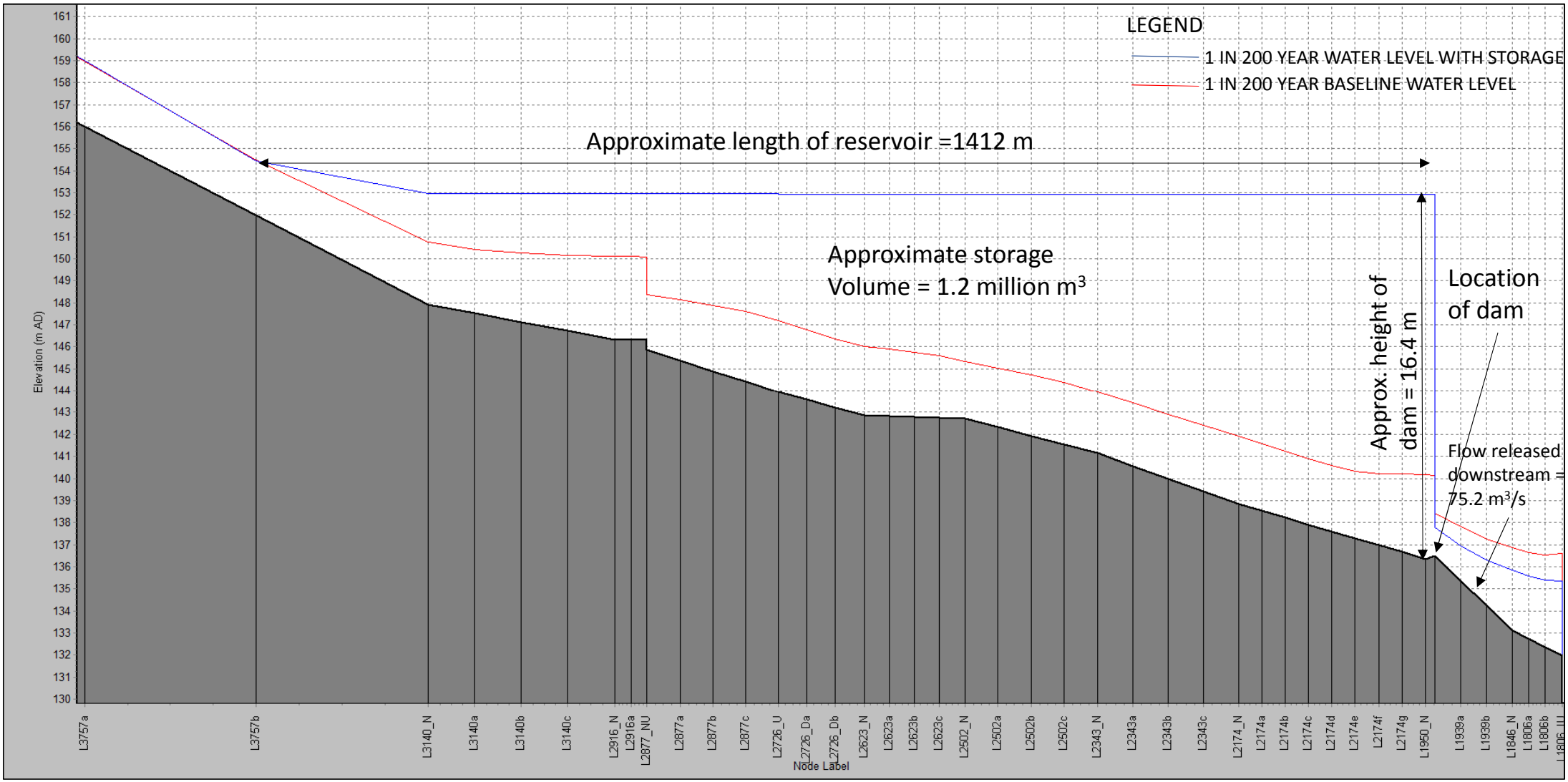
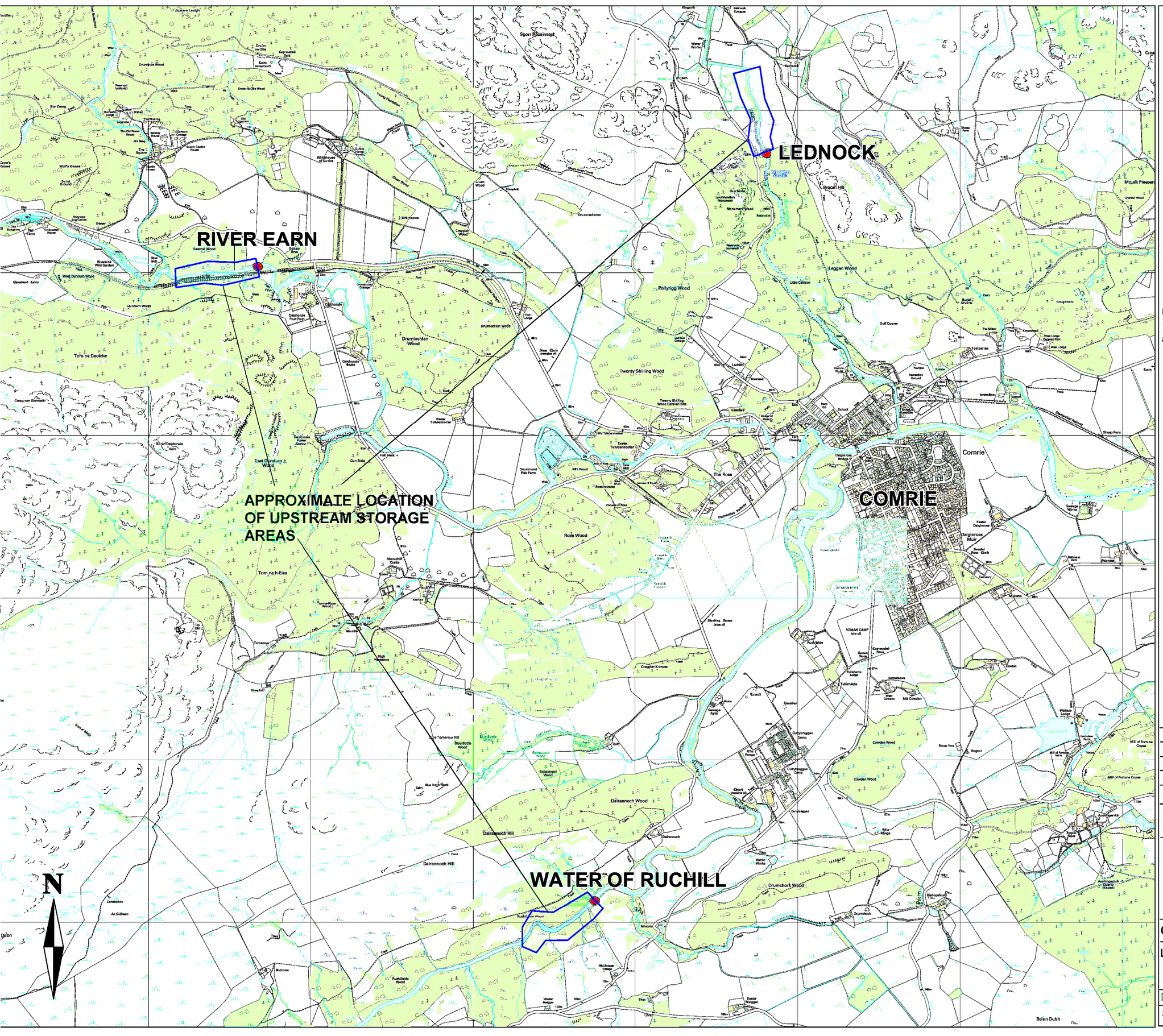


Figure 6I: ISIS Long Profile through Storage Area in Lednock for 1 in 200 Year Return Period with Flood Defence Walls in Comrie





NOTES

Users should notethat the floodplain extents were mapped at 1:10,000 scale, as appropriate to the level of investigation and are based on the information available at the time of survey.

Areas suitable for upstream storage

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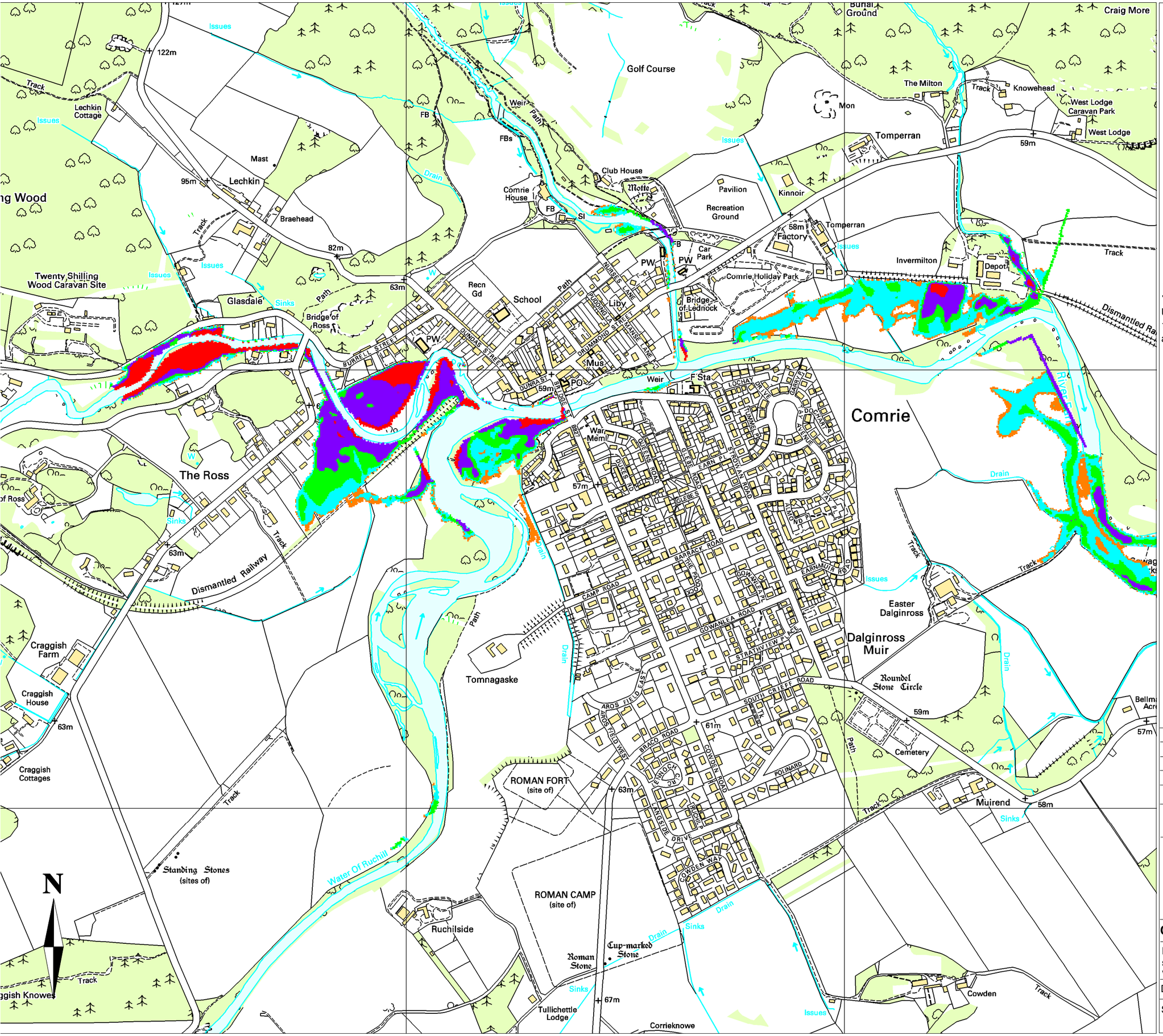
Comrie and Dalginross Flood Study

Location of areas suitable for upstream storage

Date of Issue: May 2015

Scale at A3: Not to Scale



NOTES

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FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

1	29/05/2015	Draft
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Comrie and Dalginross Flood Study

Flood outline for a 1 in 200 year flood event with upstream storage on Water of Ruchill with wall option
Volume stored= 4.1 million m3

Date of Issue: May 2015

Scale at A3: Not to Scale

NOTES

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FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m
- Extent of flood defence

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Comrie and Dalginross Flood Study

Flood outline- 1 in 200 year flood event with upstream storage on Water of Ruchill with wall option. Volume stored = 2.5 million m3

Date of Issue: May 2015

Scale at A3: Not to Scale

NOTES

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FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

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Comrie and Dalginross Flood Study

Flood outline for a 1 in 200 year return period event with upstream storage on the Upper Earn with wall option. Volume stored = 2.9 million m3.

Date of Issue: May 2015

Scale at A3: Not to Scale

NOTES

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FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

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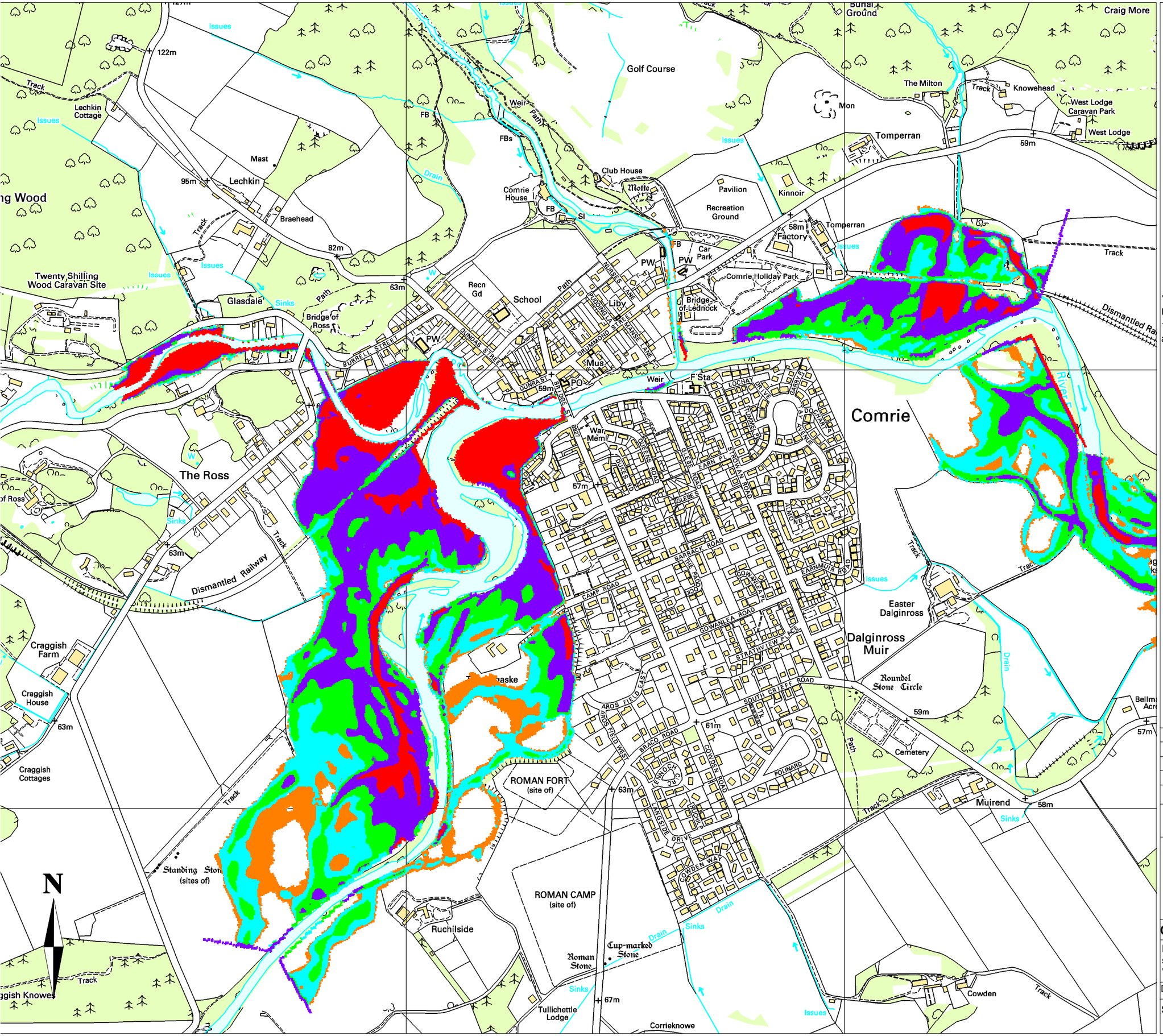
Flood outline for a 1 in 200 year return period event with upstream storage on the Upper Earn with wall option. Volume stored = 0.4 million m3

Date of Issue: June 2015

Scale at A3: Not to Scale



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FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

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Comrie and Dalginross Flood Study

Flood outline for a 1 in 200 year return period with upstream storage on R.Lednock with wall option.
Volume stored = 1.2 million m3

Date of Issue: May 2015

Scale at A3: Not to Scale

NOTES

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FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

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Flood outline for a 1 in 200 year + cc return period with upstream storage on Water of Ruchill and wall option
Volume stored = 5.7 million m3

Date of Issue: May 2015

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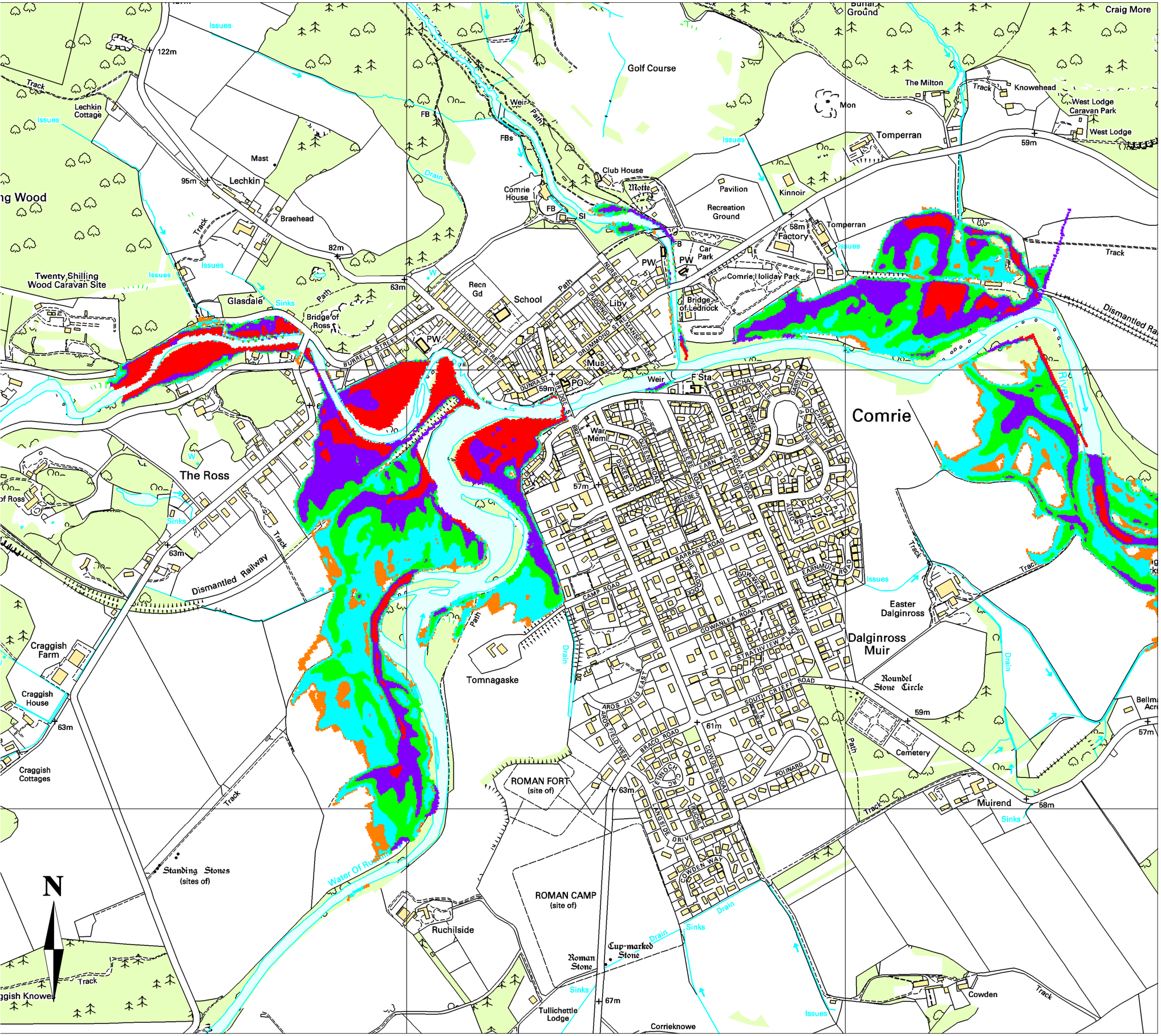

NOTES

Users should notethat the floodplain extents were mapped at 1:10,000 scale, as appropriate to the level of investigation and are based on the information available at the time of survey.

FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

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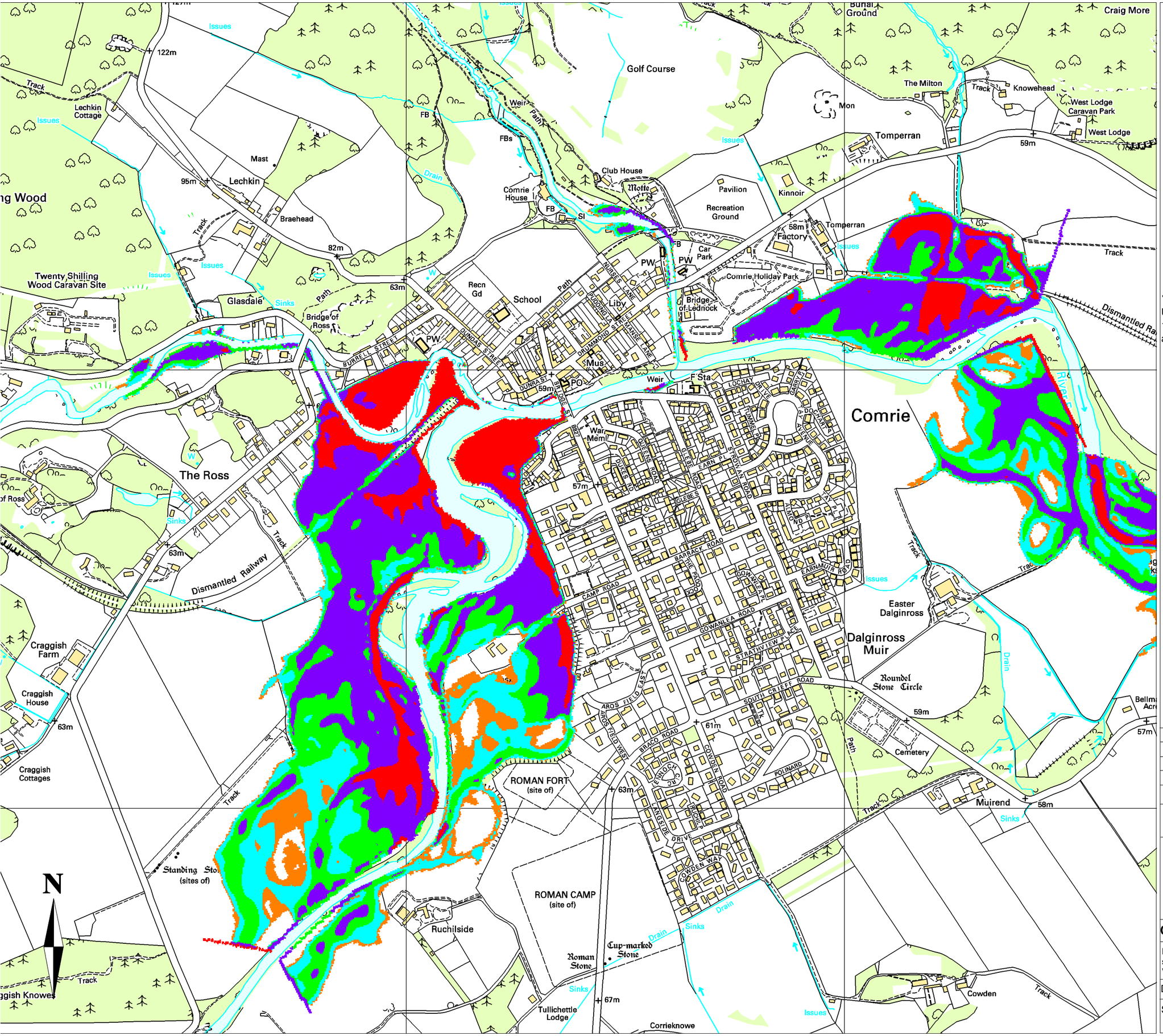
Comrie and Dalginross Flood Study

Flood outline for 1 in 200 year + cc return period with upstream storage on Water of Ruchill and wall option.
Volume stored = 3.5 million m3

Date of Issue: May 2015

Scale at A3: Not to Scale



NOTES

Users should notethat the floodplain extents were mapped at 1:10,000 scale, as appropriate to the level of investigation and are based on the information available at the time of survey.

FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

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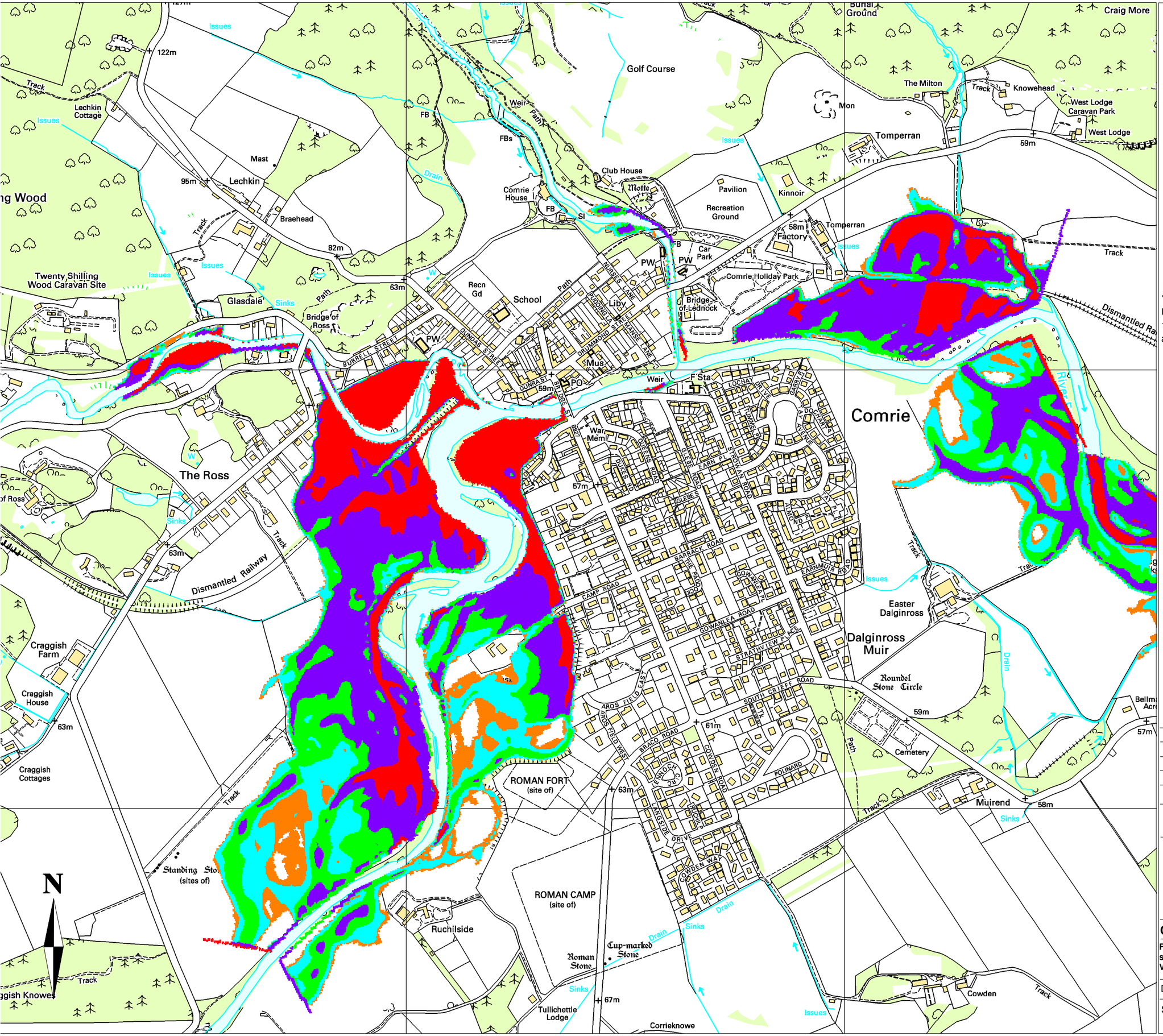
Comrie and Dalginross Flood Study

Flood outline for a 1 in 200 year + cc return period with upstream storage on the Upper Earn and wall option.
Volume stored = 3.9 million m3

Date of Issue: June 2015

Scale at A3: Not to Scale



NOTES

Users should notethat the floodplain extents were mapped at 1:10,000 scale, as appropriate to the level of investigation and are based on the information available at the time of survey.

FLOOD DEPTHS

- 0.00 - 0.05 m
- 0.05 - 0.25 m
- 0.25 - 0.50 m
- 0.50 - 1.00 m
- > 1.00 m

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Comrie and Dalginross Flood Study

Flood outline for a 1 in 200 year + cc flood event with upstream storage on the Upper Earn and wall option.
Volume stored = 2.2 million m3

Date of Issue: June 2015

Scale at A3: Not to Scale

APPENDIX 7 : FREEBOARD CALCULATIONS

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Table 7A - Freeboard Calculation - Comrie Flood Alleviation Scheme (1 in 25 years RP)

Cross-section reference	ISIS model nodes	Location of flood defence	Type of flood defence	1 in 25 year baseline water levels without flood defenmce, mAOD	1 in 25 year Flood water levels with flood defence, mAOD	Difference, m	Freeboard value (m)	Required flood defence levels, mAOD
Ruchill Water								
1	R1450	Right	wall	59.77	59.79	0.01	0.248	60.03
2	R1400	Right	wall	59.70	59.70	0.01	0.248	59.95
3	R1375	Right	wall	59.45	59.45	0.00	0.248	59.69
4	R1350	Right	wall	59.29	59.27	-0.02	0.248	59.52
5	R1300	Right	wall	59.13	59.15	0.01	0.248	59.39
6	R1250	Right	wall	58.81	58.83	0.01	0.248	59.08
7	R1200	Right	wall	58.67	58.70	0.03	0.248	58.95
8	R1150	Right	wall	58.65	58.68	0.03	0.248	58.93
9	R1100	Right	wall	58.59	58.62	0.03	0.248	58.87
10	R1050	Right	wall	58.35	58.40	0.05	0.346	58.75
11	R1000	Right	wall	58.48	58.53	0.05	0.346	58.87
12	R950	Right	wall	58.43	58.48	0.05	0.346	58.83
13	R900	Right	wall	58.39	58.45	0.05	0.346	58.79
14	R850	Right	wall	58.40	58.45	0.06	0.346	58.80
15	R800	Right	wall	58.40	58.46	0.06	0.346	58.81
Upper Earn								
16	E916_N	Left	wall	59.71	59.79	0.09	0.452	60.25
17	E712_US	Left	wall	59.24	59.27	0.03	0.452	59.72
18	E712_N	Left	wall	59.04	59.07	0.03	0.452	59.52
19	E538	Left	wall	58.52	58.56	0.04	0.452	59.01
20	E474	Left	wall	58.50	58.55	0.05	0.452	59.00
21	E360	Left	wall	58.45	58.51	0.06	0.452	58.96
22	E291	Left	wall	58.43	58.50	0.07	0.452	58.95
23	E232	Left	wall	58.36	58.44	0.08	0.452	58.89
24	E193	Left	wall	58.32	58.41	0.09	0.452	58.86
25	E157	Left	wall	58.27	58.38	0.10	0.452	58.83
26	E126	Left	wall	58.28	58.37	0.10	0.452	58.83
27	E111	Left	wall	58.28	58.37	0.10	0.452	58.83
28	E095	Left	wall	58.27	58.37	0.09	0.452	58.82
29	E077	Left	wall	58.26	58.35	0.08	0.452	58.80
30	E044	Left	wall	58.25	58.33	0.08	0.452	58.78
31	E000	Left	wall	58.24	58.31	0.08	0.452	58.77
Earn								
32	R700	both bank	wall	58.07	58.15	0.08	0.414	58.57
33	R675	both bank	wall	57.98	58.09	0.11	0.414	58.50
34	R650	both bank	wall	57.76	57.90	0.13	0.414	58.31
35	R600	both bank	wall	57.58	57.75	0.16	0.414	58.16
36	R575U	both bank	wall	57.59	57.75	0.16	0.414	58.17
37	R525	both bank	wall	57.52	57.70	0.18	0.414	58.12
38	R500	both bank	wall	57.44	57.58	0.14	0.414	58.00
39	R450	both bank	wall	57.24	57.42	0.17	0.414	57.83
40	R400	both bank	wall	57.33	57.49	0.16	0.414	57.91
41	R350	both bank	wall	57.17	57.12	-0.05	0.414	57.54
42	R325	both bank	wall	56.62	56.71	0.08	0.414	57.12
43	R300	both bank	wall	56.24	56.26	0.02	0.414	56.67
44	R200	both bank	wall	56.38	56.48	0.10	0.414	56.89
45	R150	both bank	wall	56.11	56.16	0.06	0.414	56.58
46	R100	both bank	wall	56.08	56.15	0.08	0.414	56.57
47	R050	both bank	wall	55.93	56.01	0.08	0.414	56.43
48	R000	both bank	wall	55.71	55.78	0.06	0.414	56.19
49	R-060	both bank	wall	55.52	55.56	0.04	0.414	55.97
50	R-173	both bank	wall	55.30	55.33	0.03	0.414	55.74
51	R-372	Right	wall	54.68	54.75	0.06	0.414	55.16
LEDNOCK								
52	L-108	both bank	wall	56.35	56.36	0.00	0.325	56.68
53	L-164	both bank	wall	56.59	56.57	-0.02	0.325	56.89
54	L-176	both bank	wall	56.63	56.61	-0.02	0.325	56.93
55	L-228	both bank	wall	56.75	56.76	0.01	0.325	57.08

it is assumed that flood wall will be placed throughout the entire reach of the flood defence

Table 7B - Freeboard Calculation - Comrie Flood Alleviation Scheme (1 in 50 years RP)

Cross-section reference	ISIS model nodes	Location of flood defence	Type of flood defence	1 in 50 year baseline water levels without flood defenmce, mAOD	1 in 50 year Flood water levels with flood defence, mAOD	Difference	Freeboard value (m)	Required flood defence levels, mAOD
Ruchill Water								
1	R1450	Right	wall	59.81	59.82	0.01	0.291	60.11
2	R1400	Right	wall	59.73	59.74	0.01	0.291	60.03
3	R1375	Right	wall	59.49	59.49	0.00	0.291	59.78
4	R1350	Right	wall	59.32	59.30	-0.01	0.291	59.60
5	R1300	Right	wall	59.18	59.20	0.02	0.291	59.49
6	R1250	Right	wall	58.86	58.88	0.02	0.291	59.17
7	R1200	Right	wall	58.75	58.80	0.04	0.291	59.09
8	R1150	Right	wall	58.75	58.80	0.05	0.291	59.09
9	R1100	Right	wall	58.69	58.74	0.06	0.291	59.03
10	R1050	Right	wall	58.50	58.58	0.08	0.399	58.98
11	R1000	Right	wall	58.61	58.69	0.07	0.399	59.08
12	R950	Right	wall	58.57	58.65	0.08	0.399	59.05
13	R900	Right	wall	58.54	58.62	0.08	0.399	59.02
14	R850	Right	wall	58.54	58.63	0.09	0.399	59.03
15	R800	Right	wall	58.55	58.64	0.09	0.399	59.03
Upper Earn								
16	E916_N	Left	wall	59.99	60.10	0.11	0.542	60.65
17	E712_US	Left	wall	59.48	59.53	0.05	0.542	60.07
18	E712_N	Left	wall	59.18	59.24	0.06	0.542	59.78
19	E538	Left	wall	58.67	58.75	0.08	0.542	59.29
20	E474	Left	wall	58.66	58.74	0.08	0.542	59.28
21	E360	Left	wall	58.63	58.72	0.10	0.542	59.26
22	E291	Left	wall	58.62	58.72	0.10	0.542	59.26
23	E232	Left	wall	58.54	58.66	0.12	0.542	59.20
24	E193	Left	wall	58.50	58.63	0.13	0.542	59.17
25	E157	Left	wall	58.46	58.60	0.14	0.542	59.14
26	E126	Left	wall	58.46	58.60	0.14	0.542	59.14
27	E111	Left	wall	58.46	58.59	0.14	0.542	59.14
28	E095	Left	wall	58.45	58.59	0.13	0.542	59.13
29	E077	Left	wall	58.44	58.56	0.12	0.542	59.10
30	E044	Left	wall	58.42	58.53	0.11	0.542	59.07
31	E000	Left	wall	58.40	58.51	0.11	0.542	59.05
Earn								
32	R700	both bank	wall	58.24	58.36	0.12	0.489	58.84
33	R675	both bank	wall	58.14	58.29	0.15	0.489	58.78
34	R650	both bank	wall	57.92	58.10	0.18	0.489	58.59
35	R600	both bank	wall	57.69	57.92	0.23	0.489	58.41
36	R575U	both bank	wall	57.69	57.93	0.24	0.489	58.42
37	R525	both bank	wall	57.61	57.87	0.26	0.489	58.36
38	R500	both bank	wall	57.52	57.74	0.22	0.489	58.23
39	R450	both bank	wall	57.30	57.56	0.26	0.489	58.04
40	R400	both bank	wall	57.41	57.66	0.25	0.489	58.15
41	R350	both bank	wall	57.26	57.26	-0.01	0.489	57.75
42	R325	both bank	wall	56.72	56.84	0.12	0.489	57.33
43	R300	both bank	wall	56.32	56.35	0.03	0.489	56.84
44	R200	both bank	wall	56.48	56.62	0.14	0.489	57.11
45	R150	both bank	wall	56.17	56.24	0.07	0.489	56.73
46	R100	both bank	wall	56.16	56.26	0.10	0.489	56.75
47	R050	both bank	wall	56.02	56.13	0.11	0.489	56.62
48	R000	both bank	wall	55.83	55.91	0.08	0.489	56.40
49	R-060	both bank	wall	55.63	55.67	0.04	0.489	56.16
50	R-173	both bank	wall	55.41	55.43	0.03	0.489	55.92
51	R-372	Right	wall	54.90	54.89	-0.01	0.489	55.38
Lednock								
52	L-108	both bank	wall	56.45	56.45	0.00	0.383	56.84
53	L-164	both bank	wall	56.76	56.72	-0.04	0.383	57.11
54	L-176	both bank	wall	56.79	56.75	-0.03	0.383	57.14
55	L-228	both bank	wall	57.03	57.02	-0.01	0.383	57.41

It is assumed that flood wall will be placed throughout the entire reach of the flood defence

Table 7C - Freeboard Calculation - Comrie Flood Alleviation Scheme (1 in 75 years RP)

Cross-section reference	ISIS model nodes	Location of flood defence	Type of flood defence	1 in 75 year baseline water levels without flood defenmce, mAOD	1 in 75 year Flood water levels with flood defence, mAOD	Difference	Freeboard value (m)	Required flood defence levels, mAOD
Ruchill Water								
1	R1450	Right	wall	59.83	59.84	0.01	0.306	60.15
2	R1400	Right	wall	59.75	59.76	0.01	0.306	60.07
3	R1375	Right	wall	59.50	59.51	0.00	0.306	59.81
4	R1350	Right	wall	59.33	59.32	-0.01	0.306	59.63
5	R1300	Right	wall	59.20	59.23	0.03	0.306	59.53
6	R1250	Right	wall	58.88	58.93	0.04	0.306	59.23
7	R1200	Right	wall	58.80	58.86	0.06	0.306	59.17
8	R1150	Right	wall	58.80	58.87	0.07	0.306	59.17
9	R1100	Right	wall	58.74	58.81	0.07	0.306	59.12
10	R1050	Right	wall	58.57	58.67	0.10	0.428	59.10
11	R1000	Right	wall	58.69	58.77	0.09	0.428	59.20
12	R950	Right	wall	58.65	58.74	0.10	0.428	59.17
13	R900	Right	wall	58.61	58.71	0.10	0.428	59.14
14	R850	Right	wall	58.62	58.73	0.10	0.428	59.15
15	R800	Right	wall	58.63	58.73	0.10	0.428	59.16
Upper Earn								
16	E916_N	Left	wall	60.14	60.27	0.14	0.590	60.86
17	E712_US	Left	wall	59.61	59.68	0.07	0.590	60.27
18	E712_N	Left	wall	59.26	59.34	0.08	0.590	59.93
19	E538	Left	wall	58.76	58.85	0.09	0.590	59.44
20	E474	Left	wall	58.75	58.85	0.10	0.590	59.44
21	E360	Left	wall	58.72	58.83	0.11	0.590	59.42
22	E291	Left	wall	58.71	58.83	0.12	0.590	59.42
23	E232	Left	wall	58.64	58.78	0.13	0.590	59.37
24	E193	Left	wall	58.60	58.75	0.15	0.590	59.34
25	E157	Left	wall	58.56	58.73	0.17	0.590	59.32
26	E126	Left	wall	58.56	58.72	0.16	0.590	59.31
27	E111	Left	wall	58.56	58.72	0.16	0.590	59.31
28	E095	Left	wall	58.55	58.71	0.15	0.590	59.30
29	E077	Left	wall	58.54	58.68	0.14	0.590	59.27
30	E044	Left	wall	58.52	58.65	0.13	0.590	59.24
31	E000	Left	wall	58.49	58.62	0.13	0.590	59.21
Earn								
32	R700	both bank	wall	58.33	58.47	0.14	0.530	59.00
33	R675	both bank	wall	58.22	58.40	0.18	0.530	58.93
34	R650	both bank	wall	58.00	58.21	0.21	0.530	58.74
35	R600	both bank	wall	57.74	58.01	0.28	0.530	58.54
36	R575U	both bank	wall	57.74	58.02	0.29	0.530	58.55
37	R525	both bank	wall	57.65	57.96	0.31	0.530	58.49
38	R500	both bank	wall	57.56	57.83	0.27	0.530	58.36
39	R450	both bank	wall	57.32	57.63	0.31	0.530	58.16
40	R400	both bank	wall	57.44	57.75	0.31	0.530	58.28
41	R350	both bank	wall	57.31	57.33	0.02	0.530	57.86
42	R325	both bank	wall	56.78	56.91	0.13	0.530	57.44
43	R300	both bank	wall	56.37	56.40	0.03	0.530	56.93
44	R200	both bank	wall	56.53	56.69	0.16	0.530	57.22
45	R150	both bank	wall	56.21	56.28	0.07	0.530	56.81
46	R100	both bank	wall	56.20	56.31	0.11	0.530	56.84
47	R050	both bank	wall	56.06	56.18	0.12	0.530	56.71
48	R000	both bank	wall	55.89	55.98	0.09	0.530	56.51
49	R-060	both bank	wall	55.68	55.73	0.04	0.530	56.26
50	R-173	both bank	wall	55.45	55.47	0.03	0.530	56.00
51	R-372	Right	wall	54.92	54.97	0.05	0.530	55.50
Lednock								
52	L-108	both bank	wall	56.50	56.50	0.00	0.413	56.92
53	L-164	both bank	wall	56.85	56.80	-0.05	0.413	57.21
54	L-176	both bank	wall	56.89	56.83	-0.06	0.413	57.24
55	L-228	both bank	wall	57.10	57.09	-0.01	0.413	57.50

it is assumed that flood wall will be placed throughout the entire reach of the flood defence

Table 7D - Freeboard Calculation - Comrie Flood Alleviation Scheme (1 in 100 years RP)

Cross-section reference	ISIS model nodes	Location of flood defence	Type of flood defence	1 in 100 year baseline water levels without flood defenmce, mAOD	1 in 100 year Flood water levels with flood defence, mAOD	Difference	Freeboard value (m)	Required flood defence levels, mAOD
Ruchill Water								
1	R1450	Right	wall	59.84	59.85	0.01	0.331	60.18
2	R1400	Right	wall	59.77	59.77	0.01	0.331	60.10
3	R1375	Right	wall	59.52	59.52	0.00	0.331	59.85
4	R1350	Right	wall	59.35	59.34	-0.01	0.331	59.67
5	R1300	Right	wall	59.22	59.25	0.03	0.331	59.58
6	R1250	Right	wall	58.92	58.98	0.06	0.331	59.31
7	R1200	Right	wall	58.85	58.92	0.08	0.331	59.26
8	R1150	Right	wall	58.85	58.93	0.08	0.331	59.26
9	R1100	Right	wall	58.79	58.89	0.09	0.331	59.22
10	R1050	Right	wall	58.64	58.76	0.12	0.457	59.22
11	R1000	Right	wall	58.75	58.86	0.11	0.457	59.31
12	R950	Right	wall	58.71	58.83	0.12	0.457	59.29
13	R900	Right	wall	58.68	58.80	0.12	0.457	59.26
14	R850	Right	wall	58.69	58.82	0.12	0.457	59.27
15	R800	Right	wall	58.70	58.82	0.12	0.457	59.28
Upper Earn								
16	E916_N	Left	wall	60.27	60.43	0.16	0.632	61.06
17	E712_US	Left	wall	59.74	59.82	0.09	0.632	60.46
18	E712_N	Left	wall	59.34	59.45	0.12	0.632	60.09
19	E538	Left	wall	58.84	58.94	0.11	0.632	59.58
20	E474	Left	wall	58.83	58.94	0.11	0.632	59.57
21	E360	Left	wall	58.81	58.93	0.12	0.632	59.56
22	E291	Left	wall	58.80	58.93	0.13	0.632	59.56
23	E232	Left	wall	58.73	58.88	0.15	0.632	59.51
24	E193	Left	wall	58.69	58.85	0.16	0.632	59.49
25	E157	Left	wall	58.65	58.83	0.18	0.632	59.46
26	E126	Left	wall	58.65	58.82	0.18	0.632	59.45
27	E111	Left	wall	58.65	58.82	0.18	0.632	59.45
28	E095	Left	wall	58.64	58.81	0.17	0.632	59.45
29	E077	Left	wall	58.62	58.78	0.16	0.632	59.41
30	E044	Left	wall	58.60	58.75	0.14	0.632	59.38
31	E000	Left	wall	58.57	58.72	0.15	0.632	59.35
Earn								
32	R700	both bank	wall	58.41	58.56	0.16	0.565	59.13
33	R675	both bank	wall	58.30	58.50	0.20	0.565	59.06
34	R650	both bank	wall	58.08	58.31	0.23	0.565	58.87
35	R600	both bank	wall	57.79	58.10	0.31	0.565	58.66
36	R575U	both bank	wall	57.78	58.10	0.32	0.565	58.67
37	R525	both bank	wall	57.69	58.04	0.35	0.565	58.61
38	R500	both bank	wall	57.59	57.90	0.31	0.565	58.47
39	R450	both bank	wall	57.35	57.70	0.35	0.565	58.26
40	R400	both bank	wall	57.48	57.83	0.36	0.565	58.40
41	R350	both bank	wall	57.35	57.39	0.05	0.565	57.96
42	R325	both bank	wall	56.82	56.97	0.15	0.565	57.53
43	R300	both bank	wall	56.40	56.43	0.03	0.565	57.00
44	R200	both bank	wall	56.57	56.75	0.19	0.565	57.32
45	R150	both bank	wall	56.24	56.31	0.07	0.565	56.88
46	R100	both bank	wall	56.23	56.35	0.12	0.565	56.92
47	R050	both bank	wall	56.10	56.23	0.13	0.565	56.79
48	R000	both bank	wall	55.93	56.04	0.10	0.565	56.60
49	R-060	both bank	wall	55.72	55.77	0.05	0.565	56.34
50	R-173	both bank	wall	55.46	55.50	0.04	0.565	56.07
51	R-372	Right	wall	54.99	55.05	0.06	0.565	55.62
LEDNOCK								
52	L-108	both bank	wall	56.55	56.55	0.00	0.437	56.99
53	L-164	both bank	wall	56.92	56.86	-0.06	0.437	57.30
54	L-176	both bank	wall	56.96	56.89	-0.08	0.437	57.32
55	L-228	both bank	wall	57.16	57.14	-0.02	0.437	57.58

it is assumed that flood wall will be placed throughout the entire reach of the flood defence

Table 7E - Freeboard Calculation - Comrie Flood Alleviation Scheme (1 in 200 years RP)

Cross-section reference	ISIS model nodes	Location of flood defence	Type of flood defence	1 in 200 year baseline water levels without flood defence, mAOD	1 in 200 year Flood water levels with flood defence, mAOD	Difference	Freeboard value (m)	Required flood defence levels, mAOD
Ruchill Water								
1	R1450	Right	wall	59.87	59.88	0.01	0.393	60.27
2	R1400	Right	wall	59.80	59.81	0.01	0.393	60.20
3	R1375	Right	wall	59.55	59.55	0.01	0.393	59.95
4	R1350	Right	wall	59.38	59.38	0.01	0.393	59.78
5	R1300	Right	wall	59.27	59.32	0.05	0.393	59.72
6	R1250	Right	wall	59.02	59.14	0.12	0.393	59.53
7	R1200	Right	wall	58.97	59.11	0.14	0.393	59.50
8	R1150	Right	wall	58.98	59.11	0.14	0.393	59.51
9	R1100	Right	wall	58.93	59.07	0.14	0.393	59.47
10	R1050	Right	wall	58.81	58.98	0.17	0.508	59.49
11	R1000	Right	wall	58.91	59.06	0.16	0.508	59.57
12	R950	Right	wall	58.88	59.04	0.16	0.508	59.55
13	R900	Right	wall	58.85	59.02	0.17	0.508	59.52
14	R850	Right	wall	58.86	59.03	0.16	0.508	59.53
15	R800	Right	wall	58.87	59.03	0.17	0.508	59.54
Upper Earn								
16	E916_N	Left	wall	60.61	60.78	0.17	0.724	61.50
17	E712_US	Left	wall	60.05	60.15	0.10	0.724	60.87
18	E712_N	Left	wall	59.53	59.65	0.12	0.724	60.37
19	E538	Left	wall	59.01	59.15	0.14	0.724	59.87
20	E474	Left	wall	59.01	59.15	0.14	0.724	59.87
21	E360	Left	wall	58.99	59.14	0.15	0.724	59.87
22	E291	Left	wall	58.99	59.14	0.16	0.724	59.87
23	E232	Left	wall	58.92	59.10	0.18	0.724	59.82
24	E193	Left	wall	58.89	59.08	0.20	0.724	59.81
25	E157	Left	wall	58.85	59.07	0.22	0.724	59.79
26	E126	Left	wall	58.85	59.06	0.21	0.724	59.78
27	E111	Left	wall	58.85	59.06	0.21	0.724	59.78
28	E095	Left	wall	58.84	59.05	0.21	0.724	59.78
29	E077	Left	wall	58.82	59.02	0.20	0.724	59.74
30	E044	Left	wall	58.80	58.98	0.18	0.724	59.70
31	E000	Left	wall	58.76	58.95	0.19	0.724	59.67
Earn								
32	R700	both bank	wall	58.59	58.79	0.20	0.622	59.42
33	R675	both bank	wall	58.48	58.73	0.24	0.622	59.35
34	R650	both bank	wall	58.26	58.53	0.27	0.622	59.15
35	R600	both bank	wall	57.90	58.28	0.38	0.622	58.90
36	R575U	both bank	wall	57.88	58.28	0.40	0.622	58.90
37	R525	both bank	wall	57.77	58.21	0.44	0.622	58.84
38	R500	both bank	wall	57.67	58.06	0.39	0.622	58.68
39	R450	both bank	wall	57.40	57.83	0.43	0.622	58.45
40	R400	both bank	wall	57.55	58.00	0.45	0.622	58.62
41	R350	both bank	wall	57.43	57.53	0.11	0.622	58.15
42	R325	both bank	wall	56.93	57.10	0.18	0.622	57.73
43	R300	both bank	wall	56.49	56.52	0.03	0.622	57.14
44	R200	both bank	wall	56.66	56.90	0.24	0.622	57.53
45	R150	both bank	wall	56.31	56.37	0.06	0.622	56.99
46	R100	both bank	wall	56.30	56.45	0.14	0.622	57.07
47	R050	both bank	wall	56.16	56.32	0.15	0.622	56.94
48	R000	both bank	wall	56.02	56.15	0.13	0.622	56.77
49	R-060	both bank	wall	55.81	55.86	0.05	0.622	56.48
50	R-173	both bank	wall	55.48	55.58	0.10	0.622	56.20
51	R-372	Right	wall	55.18	55.22	0.04	0.622	55.84
Lednock								
52	L-108	both bank	wall	56.70	56.66	-0.05	0.496	57.15
53	L-164	both bank	wall	57.12	57.02	-0.11	0.496	57.51
54	L-176	both bank	wall	57.19	57.03	-0.16	0.496	57.53
55	L-228	both bank	wall	57.33	57.28	-0.04	0.496	57.78

It is assumed that flood wall will be placed throughout the entire reach of the flood defence

Table 7F - Freeboard Calculation - Comrie Flood Alleviation Scheme (1 in 200+CC)

Cross-section reference	ISIS model nodes	Location of flood defence	Type of flood defence	1 in 200+cc baseline water levels without flood defence, mAOD	1 in 200+cc water levels with flood defence, mAOD	Difference	Freeboard value (m)	Required flood defence levels, mAOD
Ruchill Water								
1	R1450	Right	wall	59.94	59.96	0.03	0.523	60.49
2	R1400	Right	wall	59.87	59.90	0.03	0.523	60.42
3	R1375	Right	wall	59.62	59.69	0.08	0.523	60.22
4	R1350	Right	wall	59.48	59.62	0.13	0.523	60.14
5	R1300	Right	wall	59.45	59.64	0.19	0.523	60.16
6	R1250	Right	wall	59.32	59.58	0.25	0.523	60.10
7	R1200	Right	wall	59.28	59.56	0.27	0.523	60.08
8	R1150	Right	wall	59.28	59.55	0.27	0.523	60.08
9	R1100	Right	wall	59.24	59.53	0.29	0.523	60.05
10	R1050	Right	wall	59.16	59.48	0.32	0.656	60.13
11	R1000	Right	wall	59.24	59.53	0.30	0.656	60.19
12	R950	Right	wall	59.22	59.52	0.30	0.656	60.18
13	R900	Right	wall	59.19	59.50	0.31	0.656	60.15
14	R850	Right	wall	59.20	59.51	0.31	0.656	60.17
15	R800	Right	wall	59.21	59.52	0.31	0.656	60.17
Upper Earn								
16	E916_N	Left	wall	61.10	61.31	0.21	0.905	62.22
17	E712_US	Left	wall	60.50	60.66	0.16	0.905	61.57
18	E712_N	Left	wall	59.78	60.01	0.23	0.905	60.92
19	E538	Left	wall	59.32	59.59	0.27	0.905	60.49
20	E474	Left	wall	59.32	59.59	0.27	0.905	60.49
21	E360	Left	wall	59.31	59.58	0.27	0.905	60.49
22	E291	Left	wall	59.31	59.59	0.28	0.905	60.49
23	E232	Left	wall	59.25	59.56	0.31	0.905	60.47
24	E193	Left	wall	59.23	59.56	0.33	0.905	60.47
25	E157	Left	wall	59.20	59.55	0.35	0.905	60.46
26	E126	Left	wall	59.20	59.55	0.35	0.905	60.45
27	E111	Left	wall	59.20	59.55	0.35	0.905	60.45
28	E095	Left	wall	59.20	59.54	0.35	0.905	60.45
29	E077	Left	wall	59.17	59.52	0.34	0.905	60.42
30	E044	Left	wall	59.15	59.48	0.33	0.905	60.38
31	E000	Left	wall	59.11	59.44	0.33	0.905	60.35
Earn								
32	R700	both bank	wall	58.95	59.31	0.36	0.801	60.11
33	R675	both bank	wall	58.82	59.24	0.42	0.801	60.04
34	R650	both bank	wall	58.59	59.04	0.45	0.801	59.84
35	R600	both bank	wall	58.12	58.73	0.61	0.801	59.53
36	R575U	both bank	wall	58.07	58.71	0.65	0.801	59.51
37	R525	both bank	wall	57.92	58.63	0.71	0.801	59.43
38	R500	both bank	wall	57.81	58.45	0.64	0.801	59.25
39	R450	both bank	wall	57.51	58.17	0.66	0.801	58.97
40	R400	both bank	wall	57.66	58.43	0.76	0.801	59.23
41	R350	both bank	wall	57.55	57.89	0.34	0.801	58.69
42	R325	both bank	wall	57.12	57.46	0.34	0.801	58.26
43	R300	both bank	wall	56.64	56.76	0.12	0.801	57.56
44	R200	both bank	wall	56.82	57.18	0.37	0.801	57.99
45	R150	both bank	wall	56.45	56.52	0.07	0.801	57.32
46	R100	both bank	wall	56.44	56.62	0.18	0.801	57.42
47	R050	both bank	wall	56.29	56.48	0.19	0.801	57.28
48	R000	both bank	wall	56.16	56.34	0.18	0.801	57.14
49	R-060	both bank	wall	55.99	56.03	0.04	0.801	56.83
50	R-173	both bank	wall	55.49	55.72	0.23	0.801	56.52
51	R-372	Right	wall	55.48	55.49	0.01	0.801	56.29
Lednock								
52	L-108	both bank	wall	56.97	56.86	-0.11	0.591	57.45
53	L-164	both bank	wall	57.37	57.27	-0.11	0.591	57.86
54	L-176	both bank	wall	57.44	57.26	-0.18	0.591	57.85
55	L-228	both bank	wall	57.56	57.52	-0.04	0.591	58.11

it is assumed that flood wall will be placed throughout the entire reach of the flood defence

Table 7G- Freeboard Calculation - Comrie Flood Alleviation Scheme: 1 in 200 years RP with Flood Defence Walls and Storage in Ruchill Water(Volume of Storage = 4.1 million m^3)

Cross-section reference	ISIS model nodes	Location of flood defence	Type of flood defence	1 in 200 year baseline water levels without option, mAOD	1 in 200 year Flood water levels with option, mAOD	Difference	Freeboard value (m)	Required flood defence levels, mAOD
Ruchill Water								
1	R1450	Right	wall	59.87	59.19	-0.67	0.150	59.34
2	R1400	Right	wall	59.80	59.09	-0.70	0.150	59.24
3	R1375	Right	wall	59.55	58.96	-0.59	0.150	59.11
4	R1350	Right	wall	59.38	58.84	-0.54	0.150	58.99
5	R1300	Right	wall	59.27	58.52	-0.75	0.150	58.67
6	R1250	Right	wall	59.02	58.25	-0.77	0.150	58.40
7	R1200	Right	wall	58.97	58.12	-0.85	0.150	58.27
8	R1150	Right	wall	58.98	58.05	-0.93	0.150	58.20
9	R1100	Right	wall	58.93	58.01	-0.92	0.150	58.16
10	R1050	Right	wall	58.81	57.84	-0.97	0.150	57.99
11	R1000	Right	wall	58.91	57.89	-1.01	0.150	58.04
12	R950	Right	wall	58.88	57.88	-1.00	0.150	58.03
13	R900	Right	wall	58.85	57.87	-0.98	0.150	58.02
14	R850	Right	wall	58.86	57.87	-0.99	0.150	58.02
15	R800	Right	wall	58.87	57.87	-0.99	0.150	58.02
Upper Earn								
16	E916_N	Left	wall	60.61	60.75	0.14	0.695	61.44
17	E712_US	Left	wall	60.05	60.08	0.03	0.695	60.78
18	E712_N	Left	wall	59.53	59.56	0.03	0.695	60.26
19	E538	Left	wall	59.01	58.67	-0.34	0.695	59.37
20	E474	Left	wall	59.01	58.64	-0.36	0.695	59.34
21	E360	Left	wall	58.99	58.59	-0.40	0.695	59.29
22	E291	Left	wall	58.99	58.57	-0.41	0.695	59.27
23	E232	Left	wall	58.92	58.40	-0.52	0.695	59.09
24	E193	Left	wall	58.89	58.24	-0.65	0.695	58.93
25	E157	Left	wall	58.85	58.03	-0.82	0.695	58.73
26	E126	Left	wall	58.85	58.06	-0.79	0.695	58.75
27	E111	Left	wall	58.85	58.05	-0.80	0.695	58.74
28	E095	Left	wall	58.84	58.01	-0.83	0.695	58.71
29	E077	Left	wall	58.82	57.94	-0.88	0.695	58.63
30	E044	Left	wall	58.80	57.85	-0.95	0.695	58.54
31	E000	Left	wall	58.76	57.83	-0.93	0.695	58.52
Earn								
32	R700	both bank	wall	58.59	57.63	-0.97	0.285	57.91
33	R675	both bank	wall	58.48	57.58	-0.90	0.285	57.86
34	R650	both bank	wall	58.26	57.41	-0.85	0.285	57.69
35	R600	both bank	wall	57.90	57.36	-0.53	0.285	57.65
36	R575U	both bank	wall	57.88	57.37	-0.51	0.285	57.66
37	R525	both bank	wall	57.77	57.33	-0.44	0.285	57.62
38	R500	both bank	wall	57.67	57.24	-0.43	0.285	57.53
39	R450	both bank	wall	57.40	57.12	-0.28	0.285	57.40
40	R400	both bank	wall	57.55	57.13	-0.41	0.285	57.42
41	R350	both bank	wall	57.43	56.86	-0.56	0.285	57.15
42	R325	both bank	wall	56.93	56.44	-0.49	0.285	56.72
43	R300	both bank	wall	56.49	56.15	-0.34	0.285	56.43
44	R200	both bank	wall	56.66	56.25	-0.41	0.285	56.54
45	R150	both bank	wall	56.31	55.99	-0.32	0.285	56.28
46	R100	both bank	wall	56.30	55.94	-0.36	0.285	56.23
47	R050	both bank	wall	56.16	55.78	-0.38	0.285	56.06
48	R000	both bank	wall	56.02	55.52	-0.50	0.285	55.81
49	R-060	both bank	wall	55.81	55.33	-0.49	0.285	55.61
50	R-173	both bank	wall	55.48	55.10	-0.38	0.285	55.38
51	R-372	Right	wall	55.18	54.53	-0.65	0.285	54.82
Lednock								
52	L-108	both bank	wall	56.70	56.30	-0.40	0.442	56.74
53	L-164	both bank	wall	57.12	56.75	-0.37	0.442	57.19
54	L-176	both bank	wall	57.19	56.82	-0.37	0.442	57.26
55	L-228	both bank	wall	57.33	57.19	-0.14	0.442	57.63

it is assumed that flood wall will be placed throughout the entire reach of the flood defence

Table 7H - Freeboard Calculation - Comrie Flood Alleviation Scheme: 1 in 200 years RP with Flood Defence Walls and Storage in Ruchill Water(Volume of Storage = 2.5 million m^3)

Cross-section reference	ISIS model nodes	Location of flood defence	Type of flood defence	1 in 200 year baseline water levels without option, mAOD	1 in 200 year Flood water levels with option, mAOD	Difference	Freeboard value (m)	Required flood defence levels, mAOD
Ruchill Water								
1	R1450	Right	wall	59.87	59.57	-0.30	0.302	59.87
2	R1400	Right	wall	59.80	59.44	-0.36	0.302	59.74
3	R1375	Right	wall	59.55	59.22	-0.32	0.302	59.53
4	R1350	Right	wall	59.38	59.09	-0.28	0.302	59.40
5	R1300	Right	wall	59.27	58.90	-0.38	0.302	59.20
6	R1250	Right	wall	59.02	58.61	-0.41	0.302	58.91
7	R1200	Right	wall	58.97	58.50	-0.47	0.302	58.81
8	R1150	Right	wall	58.98	58.49	-0.49	0.302	58.79
9	R1100	Right	wall	58.93	58.45	-0.48	0.302	58.75
10	R1050	Right	wall	58.81	58.30	-0.51	0.302	58.61
11	R1000	Right	wall	58.91	58.38	-0.53	0.302	58.68
12	R950	Right	wall	58.88	58.36	-0.53	0.302	58.66
13	R900	Right	wall	58.85	58.34	-0.51	0.302	58.64
14	R850	Right	wall	58.86	58.35	-0.52	0.302	58.65
15	R800	Right	wall	58.87	58.35	-0.52	0.302	58.65
Upper Earn								
16	E916_N	Left	wall	60.61	60.76	0.15	0.699	61.46
17	E712_US	Left	wall	60.05	60.10	0.06	0.699	60.80
18	E712_N	Left	wall	59.53	59.60	0.07	0.699	60.30
19	E538	Left	wall	59.01	58.78	-0.24	0.699	59.48
20	E474	Left	wall	59.01	58.76	-0.25	0.699	59.46
21	E360	Left	wall	58.99	58.74	-0.25	0.699	59.44
22	E291	Left	wall	58.99	58.73	-0.25	0.699	59.43
23	E232	Left	wall	58.92	58.62	-0.30	0.699	59.32
24	E193	Left	wall	58.89	58.55	-0.34	0.699	59.25
25	E157	Left	wall	58.85	58.47	-0.38	0.699	59.17
26	E126	Left	wall	58.85	58.46	-0.39	0.699	59.16
27	E111	Left	wall	58.85	58.46	-0.39	0.699	59.16
28	E095	Left	wall	58.84	58.44	-0.41	0.699	59.14
29	E077	Left	wall	58.82	58.38	-0.44	0.699	59.08
30	E044	Left	wall	58.80	58.31	-0.49	0.699	59.01
31	E000	Left	wall	58.76	58.28	-0.48	0.699	58.98
Earn								
32	R700	both bank	wall	58.59	58.09	-0.50	0.400	58.49
33	R675	both bank	wall	58.48	58.04	-0.44	0.400	58.44
34	R650	both bank	wall	58.26	57.86	-0.40	0.400	58.26
35	R600	both bank	wall	57.90	57.73	-0.17	0.400	58.13
36	R575U	both bank	wall	57.88	57.74	-0.14	0.400	58.15
37	R525	both bank	wall	57.77	57.70	-0.08	0.400	58.10
38	R500	both bank	wall	57.67	57.59	-0.08	0.400	57.99
39	R450	both bank	wall	57.40	57.43	0.03	0.400	57.84
40	R400	both bank	wall	57.55	57.50	-0.04	0.400	57.90
41	R350	both bank	wall	57.43	57.19	-0.23	0.400	57.59
42	R325	both bank	wall	56.93	56.71	-0.21	0.400	57.11
43	R300	both bank	wall	56.49	56.32	-0.16	0.400	56.72
44	R200	both bank	wall	56.66	56.50	-0.16	0.400	56.90
45	R150	both bank	wall	56.31	56.17	-0.14	0.400	56.57
46	R100	both bank	wall	56.30	56.17	-0.14	0.400	56.57
47	R050	both bank	wall	56.16	56.03	-0.14	0.400	56.43
48	R000	both bank	wall	56.02	55.79	-0.23	0.400	56.19
49	R-060	both bank	wall	55.81	55.57	-0.24	0.400	55.98
50	R-173	both bank	wall	55.48	55.34	-0.13	0.400	55.75
51	R-372	Right	wall	55.18	54.76	-0.42	0.400	55.17
Lednock								
52	L-108	both bank	wall	56.70	56.39	-0.31	0.451	56.85
53	L-164	both bank	wall	57.12	56.82	-0.30	0.451	57.28
54	L-176	both bank	wall	57.19	56.87	-0.32	0.451	57.32
55	L-228	both bank	wall	57.33	57.21	-0.12	0.451	57.66

it is assumed that flood wall will be placed throughout the entire reach of the flood defence

Table 7I - Freeboard Calculation - Comrie Flood Alleviation Scheme: 1 in 200 Year RP with Flood Defence Walls and Storage in River Earn(Volume of Storage = 2.9 million m^3)

Cross-section reference	ISIS model nodes	Location of flood defence	Type of flood defence	1 in 200 year baseline water levels without option, mAOD	1 in 200 year flood water levels with option, mAOD	Difference	Freeboard value (m)	Required flood defence levels, mAOD
Ruchill Water								
1	R1450	Right	wall	59.87	59.88	0.01	0.314	60.20
2	R1400	Right	wall	59.80	59.80	0.01	0.314	60.12
3	R1375	Right	wall	59.55	59.55	0.00	0.314	59.86
4	R1350	Right	wall	59.38	59.36	-0.02	0.314	59.67
5	R1300	Right	wall	59.27	59.28	0.00	0.314	59.59
6	R1250	Right	wall	59.02	58.97	-0.06	0.314	59.28
7	R1200	Right	wall	58.97	58.89	-0.08	0.314	59.20
8	R1150	Right	wall	58.98	58.89	-0.08	0.314	59.21
9	R1100	Right	wall	58.93	58.83	-0.10	0.314	59.15
10	R1050	Right	wall	58.81	58.66	-0.15	0.431	59.09
11	R1000	Right	wall	58.91	58.78	-0.13	0.431	59.21
12	R950	Right	wall	58.88	58.74	-0.14	0.431	59.17
13	R900	Right	wall	58.85	58.70	-0.15	0.431	59.13
14	R850	Right	wall	58.86	58.71	-0.15	0.431	59.14
15	R800	Right	wall	58.87	58.72	-0.15	0.431	59.15
Upper Earn								
16	E916_N	Left	wall	60.61	59.15	-1.46	0.545	59.69
17	E712_US	Left	wall	60.05	58.90	-1.15	0.545	59.45
18	E712_N	Left	wall	59.53	58.86	-0.67	0.545	59.40
19	E538	Left	wall	59.01	58.70	-0.32	0.545	59.24
20	E474	Left	wall	59.01	58.69	-0.31	0.545	59.24
21	E360	Left	wall	58.99	58.67	-0.32	0.545	59.22
22	E291	Left	wall	58.99	58.67	-0.32	0.545	59.21
23	E232	Left	wall	58.92	58.64	-0.28	0.545	59.18
24	E193	Left	wall	58.89	58.62	-0.26	0.545	59.17
25	E157	Left	wall	58.85	58.61	-0.24	0.545	59.15
26	E126	Left	wall	58.85	58.61	-0.24	0.545	59.15
27	E111	Left	wall	58.85	58.61	-0.24	0.545	59.15
28	E095	Left	wall	58.84	58.60	-0.24	0.545	59.15
29	E077	Left	wall	58.82	58.59	-0.23	0.545	59.14
30	E044	Left	wall	58.80	58.58	-0.22	0.545	59.12
31	E000	Left	wall	58.76	58.56	-0.20	0.545	59.11
Earn								
32	R700	both bank	wall	58.59	58.43	-0.17	0.512	58.94
33	R675	both bank	wall	58.48	58.36	-0.12	0.512	58.87
34	R650	both bank	wall	58.26	58.18	-0.08	0.512	58.69
35	R600	both bank	wall	57.90	58.00	0.10	0.512	58.51
36	R575U	both bank	wall	57.88	58.00	0.12	0.512	58.51
37	R525	both bank	wall	57.77	57.95	0.18	0.512	58.47
38	R500	both bank	wall	57.67	57.84	0.17	0.512	58.35
39	R450	both bank	wall	57.40	57.67	0.27	0.512	58.18
40	R400	both bank	wall	57.55	57.77	0.23	0.512	58.28
41	R350	both bank	wall	57.43	57.44	0.01	0.512	57.95
42	R325	both bank	wall	56.93	56.92	0.00	0.512	57.44
43	R300	both bank	wall	56.49	56.47	-0.02	0.512	56.98
44	R200	both bank	wall	56.66	56.71	0.05	0.512	57.22
45	R150	both bank	wall	56.31	56.29	-0.02	0.512	56.80
46	R100	both bank	wall	56.30	56.33	0.02	0.512	56.84
47	R050	both bank	wall	56.16	56.20	0.03	0.512	56.71
48	R000	both bank	wall	56.02	56.00	-0.02	0.512	56.51
49	R-060	both bank	wall	55.81	55.74	-0.07	0.512	56.26
50	R-173	both bank	wall	55.48	55.48	0.01	0.512	56.00
51	R-372	Right	wall	55.18	55.00	-0.18	0.512	55.51
Lednock								
52	L-108	both bank	wall	56.70	56.50	-0.20	0.469	56.97
53	L-164	both bank	wall	57.12	56.95	-0.18	0.469	57.42
54	L-176	both bank	wall	57.19	56.97	-0.22	0.469	57.44
55	L-228	both bank	wall	57.33	57.25	-0.08	0.469	57.72

It is assumed that flood wall will be placed throughout the entire reach of the flood defence

Table 7J- Freeboard Calculation - Comrie Flood Alleviation Scheme: 1 in 200+CC RP with Flood Defence Walls and Storage in River Earn(Volume of Storage = 0.4 million m^3)

Cross-section reference	ISIS model nodes	Location of flood defence	Type of flood defence	1 in 200+CC baseline water levels without option, mAOD	1 in 200+CC Flood water levels with option, mAOD	Difference	Freeboard value (m)	Required flood defence levels, mAOD
Ruchill Water								
1	R1450	Right	wall	59.94	59.95	0.01	0.460	60.41
2	R1400	Right	wall	59.87	59.88	0.01	0.460	60.34
3	R1375	Right	wall	59.62	59.63	0.01	0.460	60.09
4	R1350	Right	wall	59.48	59.49	0.01	0.460	59.95
5	R1300	Right	wall	59.45	59.48	0.03	0.460	59.94
6	R1250	Right	wall	59.32	59.36	0.04	0.460	59.82
7	R1200	Right	wall	59.28	59.32	0.04	0.460	59.78
8	R1150	Right	wall	59.28	59.31	0.04	0.460	59.78
9	R1100	Right	wall	59.24	59.27	0.03	0.460	59.73
10	R1050	Right	wall	59.16	59.18	0.03	0.570	59.75
11	R1000	Right	wall	59.24	59.27	0.03	0.570	59.84
12	R950	Right	wall	59.22	59.25	0.03	0.570	59.82
13	R900	Right	wall	59.19	59.22	0.04	0.570	59.79
14	R850	Right	wall	59.20	59.24	0.04	0.570	59.81
15	R800	Right	wall	59.21	59.25	0.04	0.570	59.82
Upper Earn								
16	E916_N	Left	wall	61.10	60.12	-0.98	0.797	60.92
17	E712_US	Left	wall	60.50	59.68	-0.82	0.797	60.47
18	E712_N	Left	wall	59.78	59.50	-0.28	0.797	60.30
19	E538	Left	wall	59.32	59.31	-0.01	0.797	60.10
20	E474	Left	wall	59.32	59.31	-0.01	0.797	60.10
21	E360	Left	wall	59.31	59.29	-0.02	0.797	60.09
22	E291	Left	wall	59.31	59.30	-0.01	0.797	60.09
23	E232	Left	wall	59.25	59.27	0.02	0.797	60.07
24	E193	Left	wall	59.23	59.25	0.02	0.797	60.05
25	E157	Left	wall	59.20	59.24	0.04	0.797	60.04
26	E126	Left	wall	59.20	59.24	0.04	0.797	60.04
27	E111	Left	wall	59.20	59.24	0.04	0.797	60.03
28	E095	Left	wall	59.20	59.23	0.03	0.797	60.02
29	E077	Left	wall	59.17	59.20	0.03	0.797	60.00
30	E044	Left	wall	59.15	59.17	0.02	0.797	59.97
31	E000	Left	wall	59.11	59.15	0.04	0.797	59.94
Earn								
32	R700	both bank	wall	58.95	59.01	0.06	0.695	59.70
33	R675	both bank	wall	58.82	58.94	0.12	0.695	59.63
34	R650	both bank	wall	58.59	58.74	0.15	0.695	59.44
35	R600	both bank	wall	58.12	58.47	0.35	0.695	59.16
36	R575U	both bank	wall	58.07	58.46	0.39	0.695	59.15
37	R525	both bank	wall	57.92	58.39	0.47	0.695	59.09
38	R500	both bank	wall	57.81	58.23	0.42	0.695	58.93
39	R450	both bank	wall	57.51	57.99	0.48	0.695	58.68
40	R400	both bank	wall	57.66	58.19	0.53	0.695	58.88
41	R350	both bank	wall	57.55	57.71	0.16	0.695	58.41
42	R325	both bank	wall	57.12	57.27	0.14	0.695	57.96
43	R300	both bank	wall	56.64	56.65	0.01	0.695	57.35
44	R200	both bank	wall	56.82	57.08	0.26	0.695	57.77
45	R150	both bank	wall	56.45	56.42	-0.03	0.695	57.12
46	R100	both bank	wall	56.44	56.55	0.11	0.695	57.24
47	R050	both bank	wall	56.29	56.41	0.12	0.695	57.11
48	R000	both bank	wall	56.16	56.26	0.10	0.695	56.96
49	R-060	both bank	wall	55.99	55.95	-0.04	0.695	56.64
50	R-173	both bank	wall	55.49	55.66	0.17	0.695	56.35
51	R-372	Right	wall	55.48	55.37	-0.10	0.695	56.07
Lednock								
52	L-108	both bank	wall	56.97	56.87	-0.10	0.576	57.44
53	L-164	both bank	wall	57.37	57.23	-0.15	0.576	57.80
54	L-176	both bank	wall	57.44	57.22	-0.22	0.576	57.80
55	L-228	both bank	wall	57.56	57.49	-0.07	0.576	58.07

it is assumed that flood wall will be placed throughout the entire reach of the flood defence

Table 7K- Freeboard Calculation - Comrie Flood Alleviation Scheme: 1 in 200 Year RP with Flood Defence Walls and Storage in River Lednock(Volume of Storage = 1.2 million m^3)

Cross-section reference	ISIS model nodes	Location of flood defence	Type of flood defence	1 in 200 year baseline water levels without option, mAOD	1 in 200 year flood water levels with option, mAOD	Difference	Freeboard value (m)	Required flood defence levels, mAOD
Ruchill Water								
1	R1450	Right	wall	59.87	59.88	0.01	0.384	60.27
2	R1400	Right	wall	59.80	59.80	0.01	0.384	60.19
3	R1375	Right	wall	59.55	59.55	0.00	0.384	59.93
4	R1350	Right	wall	59.38	59.37	0.00	0.384	59.76
5	R1300	Right	wall	59.27	59.31	0.03	0.384	59.69
6	R1250	Right	wall	59.02	59.11	0.09	0.384	59.50
7	R1200	Right	wall	58.97	59.08	0.11	0.384	59.46
8	R1150	Right	wall	58.98	59.09	0.11	0.384	59.47
9	R1100	Right	wall	58.93	59.04	0.12	0.384	59.43
10	R1050	Right	wall	58.81	58.95	0.14	0.497	59.45
11	R1000	Right	wall	58.91	59.03	0.13	0.497	59.53
12	R950	Right	wall	58.88	59.01	0.13	0.497	59.51
13	R900	Right	wall	58.85	58.99	0.14	0.497	59.48
14	R850	Right	wall	58.86	59.00	0.14	0.497	59.50
15	R800	Right	wall	58.87	59.00	0.14	0.497	59.50
Upper Earn								
16	E916_N	Left	wall	60.61	60.79	0.18	0.711	61.50
17	E712_US	Left	wall	60.05	60.16	0.11	0.711	60.87
18	E712_N	Left	wall	59.53	59.67	0.14	0.711	60.38
19	E538	Left	wall	59.01	59.13	0.11	0.711	59.84
20	E474	Left	wall	59.01	59.12	0.12	0.711	59.83
21	E360	Left	wall	58.99	59.12	0.13	0.711	59.83
22	E291	Left	wall	58.99	59.12	0.13	0.711	59.83
23	E232	Left	wall	58.92	59.07	0.15	0.711	59.79
24	E193	Left	wall	58.89	59.06	0.17	0.711	59.77
25	E157	Left	wall	58.85	59.04	0.19	0.711	59.75
26	E126	Left	wall	58.85	59.03	0.18	0.711	59.74
27	E111	Left	wall	58.85	59.03	0.18	0.711	59.74
28	E095	Left	wall	58.84	59.02	0.18	0.711	59.73
29	E077	Left	wall	58.82	58.99	0.17	0.711	59.70
30	E044	Left	wall	58.80	58.95	0.15	0.711	59.66
31	E000	Left	wall	58.76	58.91	0.15	0.711	59.63
Earn								
32	R700	both bank	wall	58.59	58.76	0.16	0.608	59.37
33	R675	both bank	wall	58.48	58.69	0.21	0.608	59.30
34	R650	both bank	wall	58.26	58.49	0.23	0.608	59.09
35	R600	both bank	wall	57.90	58.23	0.34	0.608	58.84
36	R575U	both bank	wall	57.88	58.23	0.35	0.608	58.84
37	R525	both bank	wall	57.77	58.16	0.39	0.608	58.77
38	R500	both bank	wall	57.67	58.00	0.33	0.608	58.61
39	R450	both bank	wall	57.40	57.75	0.35	0.608	58.36
40	R400	both bank	wall	57.55	57.93	0.38	0.608	58.53
41	R350	both bank	wall	57.43	57.36	-0.07	0.608	57.96
42	R325	both bank	wall	56.93	57.05	0.12	0.608	57.65
43	R300	both bank	wall	56.49	56.41	-0.08	0.608	57.02
44	R200	both bank	wall	56.66	56.75	0.09	0.608	57.36
45	R150	both bank	wall	56.31	56.31	-0.01	0.608	56.92
46	R100	both bank	wall	56.30	56.35	0.05	0.608	56.96
47	R050	both bank	wall	56.16	56.22	0.06	0.608	56.83
48	R000	both bank	wall	56.02	56.03	0.01	0.608	56.64
49	R-060	both bank	wall	55.81	55.77	-0.04	0.608	56.38
50	R-173	both bank	wall	55.48	55.50	0.02	0.608	56.11
51	R-372	Right	wall	55.18	55.04	-0.14	0.608	55.65
LEDNOCK								
52	L-108	both bank	wall	56.70	56.64	-0.06	0.422	57.06
53	L-164	both bank	wall	57.12	56.73	-0.39	0.422	57.15
54	L-176	both bank	wall	57.19	56.74	-0.45	0.422	57.16
55	L-228	both bank	wall	57.33	56.76	-0.57	0.422	57.18

It is assumed that flood wall will be placed throughout the entire reach of the flood defence

Table 7L - Freeboard Calculation - Comrie Flood Alleviation Scheme: 1 in 200+CC RP with Flood Defence Walls and Storage in Ruchill Water(Volume of Storage = 5.7 million m^3)

Cross-section reference	ISIS model nodes	Location of flood defence	Type of flood defence	1 in 200+CC baseline water levels without option, mAOD	1 in 200+CC flood water levels with option, mAOD	Difference	Freeboard value (m)	Required flood defence levels, mAOD
Ruchill Water								
1	R1450	Right	wall	59.94	59.23	-0.71	0.240	59.47
2	R1400	Right	wall	59.87	59.12	-0.74	0.240	59.36
3	R1375	Right	wall	59.62	58.98	-0.63	0.240	59.22
4	R1350	Right	wall	59.48	58.86	-0.62	0.240	59.10
5	R1300	Right	wall	59.45	58.57	-0.89	0.240	58.81
6	R1250	Right	wall	59.32	58.33	-0.99	0.240	58.57
7	R1200	Right	wall	59.28	58.27	-1.01	0.240	58.51
8	R1150	Right	wall	59.28	58.24	-1.04	0.240	58.48
9	R1100	Right	wall	59.24	58.21	-1.03	0.240	58.45
10	R1050	Right	wall	59.16	58.11	-1.05	0.240	58.35
11	R1000	Right	wall	59.24	58.15	-1.09	0.240	58.39
12	R950	Right	wall	59.22	58.14	-1.08	0.240	58.38
13	R900	Right	wall	59.19	58.13	-1.05	0.240	58.37
14	R850	Right	wall	59.20	58.14	-1.06	0.240	58.38
15	R800	Right	wall	59.21	58.14	-1.07	0.240	58.38
Upper Earn								
16	E916_N	Left	wall	61.10	61.24	0.14	0.868	62.11
17	E712_US	Left	wall	60.50	60.54	0.04	0.868	61.41
18	E712_N	Left	wall	59.78	59.81	0.03	0.868	60.68
19	E538	Left	wall	59.32	58.85	-0.47	0.868	59.71
20	E474	Left	wall	59.32	58.82	-0.50	0.868	59.69
21	E360	Left	wall	59.31	58.80	-0.51	0.868	59.67
22	E291	Left	wall	59.31	58.79	-0.52	0.868	59.66
23	E232	Left	wall	59.25	58.64	-0.62	0.868	59.51
24	E193	Left	wall	59.23	58.53	-0.70	0.868	59.40
25	E157	Left	wall	59.20	58.41	-0.80	0.868	59.28
26	E126	Left	wall	59.20	58.39	-0.81	0.868	59.26
27	E111	Left	wall	59.20	58.38	-0.81	0.868	59.25
28	E095	Left	wall	59.20	58.35	-0.85	0.868	59.22
29	E077	Left	wall	59.17	58.25	-0.92	0.868	59.12
30	E044	Left	wall	59.15	58.14	-1.01	0.868	59.01
31	E000	Left	wall	59.11	58.11	-1.00	0.868	58.98
Earn								
32	R700	both bank	wall	58.95	57.91	-1.03	0.373	58.29
33	R675	both bank	wall	58.82	57.87	-0.95	0.373	58.24
34	R650	both bank	wall	58.59	57.70	-0.89	0.373	58.08
35	R600	both bank	wall	58.12	57.62	-0.50	0.373	57.99
36	R575U	both bank	wall	58.07	57.64	-0.43	0.373	58.01
37	R525	both bank	wall	57.92	57.59	-0.33	0.373	57.97
38	R500	both bank	wall	57.81	57.49	-0.32	0.373	57.86
39	R450	both bank	wall	57.51	57.35	-0.16	0.373	57.72
40	R400	both bank	wall	57.66	57.41	-0.26	0.373	57.78
41	R350	both bank	wall	57.55	57.11	-0.44	0.373	57.49
42	R325	both bank	wall	57.12	56.66	-0.47	0.373	57.03
43	R300	both bank	wall	56.64	56.34	-0.30	0.373	56.71
44	R200	both bank	wall	56.82	56.47	-0.35	0.373	56.84
45	R150	both bank	wall	56.45	56.16	-0.30	0.373	56.53
46	R100	both bank	wall	56.44	56.14	-0.30	0.373	56.52
47	R050	both bank	wall	56.29	56.00	-0.29	0.373	56.38
48	R000	both bank	wall	56.16	55.77	-0.40	0.373	56.14
49	R-060	both bank	wall	55.99	55.55	-0.43	0.373	55.93
50	R-173	both bank	wall	55.49	55.32	-0.16	0.373	55.69
51	R-372	Right	wall	55.48	54.74	-0.74	0.373	55.11
Lednock								
52	L-108	both bank	wall	56.97	56.55	-0.42	0.522	57.07
53	L-164	both bank	wall	57.37	56.99	-0.38	0.522	57.51
54	L-176	both bank	wall	57.44	57.04	-0.40	0.522	57.56
55	L-228	both bank	wall	57.56	57.39	-0.16	0.522	57.92

It is assumed that flood wall will be placed throughout the entire reach of the flood defence

Table 7M - Freeboard Calculation - Comrie Flood Alleviation Scheme: 1 in 200+CC RP with Flood Defence Walls and Storage in Ruchill Water(Volume of Storage = 3.5 million m^3)

Cross-section reference	ISIS model nodes	Location of flood defence	Type of flood defence	1 in 200+CC baseline water levels without option, mAOD	1 in 200+CC Flood water levels with option, mAOD	Difference	Freeboard value (m)	Required flood defence levels, mAOD
Ruchill Water								
1	R1450	Right	wall	59.94	59.60	-0.34	0.247	59.84
2	R1400	Right	wall	59.87	59.47	-0.40	0.247	59.72
3	R1375	Right	wall	59.62	59.25	-0.36	0.247	59.50
4	R1350	Right	wall	59.48	59.12	-0.36	0.247	59.37
5	R1300	Right	wall	59.45	58.95	-0.50	0.247	59.20
6	R1250	Right	wall	59.32	58.73	-0.60	0.247	58.97
7	R1200	Right	wall	59.28	58.68	-0.60	0.247	58.93
8	R1150	Right	wall	59.28	58.68	-0.59	0.247	58.93
9	R1100	Right	wall	59.24	58.65	-0.59	0.247	58.90
10	R1050	Right	wall	59.16	58.58	-0.58	0.374	58.95
11	R1000	Right	wall	59.24	58.63	-0.61	0.374	59.00
12	R950	Right	wall	59.22	58.61	-0.61	0.374	58.99
13	R900	Right	wall	59.19	58.60	-0.59	0.374	58.97
14	R850	Right	wall	59.20	58.60	-0.60	0.374	58.98
15	R800	Right	wall	59.21	58.61	-0.60	0.374	58.98
Upper Earn								
16	E916_N	Left	wall	61.10	61.26	0.16	0.876	62.14
17	E712_US	Left	wall	60.50	60.58	0.08	0.876	61.45
18	E712_N	Left	wall	59.78	59.86	0.07	0.876	60.73
19	E538	Left	wall	59.32	58.97	-0.35	0.876	59.85
20	E474	Left	wall	59.32	58.95	-0.36	0.876	59.83
21	E360	Left	wall	59.31	58.95	-0.36	0.876	59.83
22	E291	Left	wall	59.31	58.95	-0.36	0.876	59.83
23	E232	Left	wall	59.25	58.86	-0.40	0.876	59.73
24	E193	Left	wall	59.23	58.82	-0.41	0.876	59.69
25	E157	Left	wall	59.20	58.77	-0.43	0.876	59.64
26	E126	Left	wall	59.20	58.75	-0.45	0.876	59.63
27	E111	Left	wall	59.20	58.75	-0.45	0.876	59.63
28	E095	Left	wall	59.20	58.73	-0.46	0.876	59.61
29	E077	Left	wall	59.17	58.67	-0.51	0.876	59.54
30	E044	Left	wall	59.15	58.59	-0.56	0.876	59.47
31	E000	Left	wall	59.11	58.56	-0.55	0.876	59.43
Earn								
32	R700	both bank	wall	58.95	58.37	-0.57	0.500	58.87
33	R675	both bank	wall	58.82	58.32	-0.50	0.500	58.82
34	R650	both bank	wall	58.59	58.13	-0.46	0.500	58.63
35	R600	both bank	wall	58.12	57.96	-0.15	0.500	58.46
36	R575U	both bank	wall	58.07	57.98	-0.09	0.500	58.48
37	R525	both bank	wall	57.92	57.92	-0.01	0.500	58.42
38	R500	both bank	wall	57.81	57.79	-0.02	0.500	58.29
39	R450	both bank	wall	57.51	57.63	0.11	0.500	58.12
40	R400	both bank	wall	57.66	57.72	0.06	0.500	58.22
41	R350	both bank	wall	57.55	57.39	-0.16	0.500	57.89
42	R325	both bank	wall	57.12	56.89	-0.23	0.500	57.39
43	R300	both bank	wall	56.64	56.46	-0.18	0.500	56.96
44	R200	both bank	wall	56.82	56.68	-0.14	0.500	57.18
45	R150	both bank	wall	56.45	56.28	-0.18	0.500	56.78
46	R100	both bank	wall	56.44	56.30	-0.14	0.500	56.80
47	R050	both bank	wall	56.29	56.18	-0.11	0.500	56.68
48	R000	both bank	wall	56.16	55.97	-0.19	0.500	56.47
49	R-060	both bank	wall	55.99	55.72	-0.27	0.500	56.22
50	R-173	both bank	wall	55.49	55.47	-0.02	0.500	55.97
51	R-372	Right	wall	55.48	54.97	-0.50	0.500	55.47
LEDNOCK								
52	L-108	both bank	wall	56.97	56.60	-0.37	0.527	57.13
53	L-164	both bank	wall	57.37	57.03	-0.34	0.527	57.56
54	L-176	both bank	wall	57.44	57.07	-0.37	0.527	57.59
55	L-228	both bank	wall	57.56	57.41	-0.15	0.527	57.94

It is assumed that flood wall will be placed throughout the entire reach of the flood defence

Table 7N - Freeboard Calculation - Comrie Flood Alleviation Scheme: 1 in 200+CC RP with Flood Defence Walls and Storage in River Earn(Volume of Storage = 3.9 million m^3)

Cross-section reference	ISIS model nodes	Location of flood defence	Type of flood defence	1 in 200+CC baseline water levels without option, mAOD	1 in 200+CC Flood water levels with option, mAOD	Difference	Freeboard value (m)	Required flood defence levels, mAOD
Ruchill Water								
1	R1450	Right	wall	59.94	59.95	0.01	0.406	60.36
2	R1400	Right	wall	59.87	59.87	0.01	0.406	60.28
3	R1375	Right	wall	59.62	59.61	0.00	0.406	60.02
4	R1350	Right	wall	59.48	59.45	-0.03	0.406	59.85
5	R1300	Right	wall	59.45	59.41	-0.04	0.406	59.82
6	R1250	Right	wall	59.32	59.23	-0.10	0.406	59.63
7	R1200	Right	wall	59.28	59.16	-0.12	0.406	59.57
8	R1150	Right	wall	59.28	59.16	-0.12	0.406	59.56
9	R1100	Right	wall	59.24	59.11	-0.13	0.406	59.51
10	R1050	Right	wall	59.16	58.98	-0.18	0.513	59.49
11	R1000	Right	wall	59.24	59.08	-0.16	0.513	59.60
12	R950	Right	wall	59.22	59.06	-0.16	0.513	59.58
13	R900	Right	wall	59.19	59.02	-0.16	0.513	59.54
14	R850	Right	wall	59.20	59.04	-0.16	0.513	59.55
15	R800	Right	wall	59.21	59.05	-0.16	0.513	59.56
Upper Earn								
16	E916_N	Left	wall	61.10	59.42	-1.68	0.689	60.11
17	E712_US	Left	wall	60.50	59.22	-1.28	0.689	59.91
18	E712_N	Left	wall	59.78	59.16	-0.62	0.689	59.85
19	E538	Left	wall	59.32	59.06	-0.26	0.689	59.75
20	E474	Left	wall	59.32	59.06	-0.25	0.689	59.75
21	E360	Left	wall	59.31	59.05	-0.27	0.689	59.73
22	E291	Left	wall	59.31	59.04	-0.27	0.689	59.73
23	E232	Left	wall	59.25	59.02	-0.24	0.689	59.71
24	E193	Left	wall	59.23	59.00	-0.23	0.689	59.69
25	E157	Left	wall	59.20	58.99	-0.21	0.689	59.68
26	E126	Left	wall	59.20	58.99	-0.21	0.689	59.68
27	E111	Left	wall	59.20	58.99	-0.21	0.689	59.68
28	E095	Left	wall	59.20	58.98	-0.21	0.689	59.67
29	E077	Left	wall	59.17	58.96	-0.21	0.689	59.65
30	E044	Left	wall	59.15	58.95	-0.20	0.689	59.63
31	E000	Left	wall	59.11	58.92	-0.19	0.689	59.61
Earn								
32	R700	both bank	wall	58.95	58.79	-0.16	0.619	59.41
33	R675	both bank	wall	58.82	58.72	-0.10	0.619	59.34
34	R650	both bank	wall	58.59	58.54	-0.06	0.619	59.15
35	R600	both bank	wall	58.12	58.30	0.18	0.619	58.91
36	R575U	both bank	wall	58.07	58.29	0.23	0.619	58.91
37	R525	both bank	wall	57.92	58.24	0.31	0.619	58.86
38	R500	both bank	wall	57.81	58.10	0.29	0.619	58.72
39	R450	both bank	wall	57.51	57.90	0.39	0.619	58.51
40	R400	both bank	wall	57.66	58.05	0.39	0.619	58.67
41	R350	both bank	wall	57.55	57.67	0.12	0.619	58.29
42	R325	both bank	wall	57.12	57.16	0.04	0.619	57.78
43	R300	both bank	wall	56.64	56.62	-0.02	0.619	57.24
44	R200	both bank	wall	56.82	56.96	0.15	0.619	57.58
45	R150	both bank	wall	56.45	56.39	-0.06	0.619	57.01
46	R100	both bank	wall	56.44	56.48	0.04	0.619	57.10
47	R050	both bank	wall	56.29	56.35	0.06	0.619	56.97
48	R000	both bank	wall	56.16	56.19	0.03	0.619	56.81
49	R-060	both bank	wall	55.99	55.89	-0.09	0.619	56.51
50	R-173	both bank	wall	55.49	55.60	0.12	0.619	56.22
51	R-372	Right	wall	55.48	55.27	-0.21	0.619	55.89
Lednock								
52	L-108	both bank	wall	56.97	56.74	-0.23	0.560	57.30
53	L-164	both bank	wall	57.37	57.18	-0.19	0.560	57.74
54	L-176	both bank	wall	57.44	57.18	-0.26	0.560	57.74
55	L-228	both bank	wall	57.56	57.49	-0.06	0.560	58.05

It is assumed that flood wall will be placed throughout the entire reach of the flood defence

Table 7O - Freeboard Calculation - Comrie Flood Alleviation Scheme: 1 in 200+CC RP with Flood Defence Walls and Storage in River Earn(Volume of Storage = 2.2 million m^3)

Cross-section reference	ISIS model nodes	Location of flood defence	Type of flood defence	1 in 200+CC baseline water levels without option, mAOD	1 in 200+CC Flood water levels with option, mAOD	Difference	Freeboard value (m)	Required flood defence levels, mAOD
Ruchill Water								
1	R1450	Right	wall	59.94	59.95	0.01	0.460	60.41
2	R1400	Right	wall	59.87	59.88	0.01	0.460	60.34
3	R1375	Right	wall	59.62	59.63	0.01	0.460	60.09
4	R1350	Right	wall	59.48	59.49	0.01	0.460	59.95
5	R1300	Right	wall	59.45	59.48	0.03	0.460	59.94
6	R1250	Right	wall	59.32	59.36	0.04	0.460	59.82
7	R1200	Right	wall	59.28	59.32	0.04	0.460	59.78
8	R1150	Right	wall	59.28	59.31	0.04	0.460	59.78
9	R1100	Right	wall	59.24	59.27	0.03	0.460	59.73
10	R1050	Right	wall	59.16	59.18	0.03	0.570	59.75
11	R1000	Right	wall	59.24	59.27	0.03	0.570	59.84
12	R950	Right	wall	59.22	59.25	0.03	0.570	59.82
13	R900	Right	wall	59.19	59.22	0.04	0.570	59.79
14	R850	Right	wall	59.20	59.24	0.04	0.570	59.81
15	R800	Right	wall	59.21	59.25	0.04	0.570	59.82
Upper Earn								
16	E916_N	Left	wall	61.10	60.12	-0.98	0.797	60.92
17	E712_US	Left	wall	60.50	59.68	-0.82	0.797	60.47
18	E712_N	Left	wall	59.78	59.50	-0.28	0.797	60.30
19	E538	Left	wall	59.32	59.31	-0.01	0.797	60.10
20	E474	Left	wall	59.32	59.31	-0.01	0.797	60.10
21	E360	Left	wall	59.31	59.29	-0.02	0.797	60.09
22	E291	Left	wall	59.31	59.30	-0.01	0.797	60.09
23	E232	Left	wall	59.25	59.27	0.02	0.797	60.07
24	E193	Left	wall	59.23	59.25	0.02	0.797	60.05
25	E157	Left	wall	59.20	59.24	0.04	0.797	60.04
26	E126	Left	wall	59.20	59.24	0.04	0.797	60.04
27	E111	Left	wall	59.20	59.24	0.04	0.797	60.03
28	E095	Left	wall	59.20	59.23	0.03	0.797	60.02
29	E077	Left	wall	59.17	59.20	0.03	0.797	60.00
30	E044	Left	wall	59.15	59.17	0.02	0.797	59.97
31	E000	Left	wall	59.11	59.15	0.04	0.797	59.94
Earn								
32	R700	both bank	wall	58.95	59.01	0.06	0.695	59.70
33	R675	both bank	wall	58.82	58.94	0.12	0.695	59.63
34	R650	both bank	wall	58.59	58.74	0.15	0.695	59.44
35	R600	both bank	wall	58.12	58.47	0.35	0.695	59.16
36	R575U	both bank	wall	58.07	58.46	0.39	0.695	59.15
37	R525	both bank	wall	57.92	58.39	0.47	0.695	59.09
38	R500	both bank	wall	57.81	58.23	0.42	0.695	58.93
39	R450	both bank	wall	57.51	57.99	0.48	0.695	58.68
40	R400	both bank	wall	57.66	58.19	0.53	0.695	58.88
41	R350	both bank	wall	57.55	57.71	0.16	0.695	58.41
42	R325	both bank	wall	57.12	57.27	0.14	0.695	57.96
43	R300	both bank	wall	56.64	56.65	0.01	0.695	57.35
44	R200	both bank	wall	56.82	57.08	0.26	0.695	57.77
45	R150	both bank	wall	56.45	56.42	-0.03	0.695	57.12
46	R100	both bank	wall	56.44	56.55	0.11	0.695	57.24
47	R050	both bank	wall	56.29	56.41	0.12	0.695	57.11
48	R000	both bank	wall	56.16	56.26	0.10	0.695	56.96
49	R-060	both bank	wall	55.99	55.95	-0.04	0.695	56.64
50	R-173	both bank	wall	55.49	55.66	0.17	0.695	56.35
51	R-372	Right	wall	55.48	55.37	-0.10	0.695	56.07
Lednock								
52	L-108	both bank	wall	56.97	56.87	-0.10	0.576	57.44
53	L-164	both bank	wall	57.37	57.23	-0.15	0.576	57.80
54	L-176	both bank	wall	57.44	57.22	-0.22	0.576	57.80
55	L-228	both bank	wall	57.56	57.49	-0.07	0.576	58.07

It is assumed that flood wall will be placed throughout the entire reach of the flood defence

APPENDIX 8 : WALL HEIGHTS

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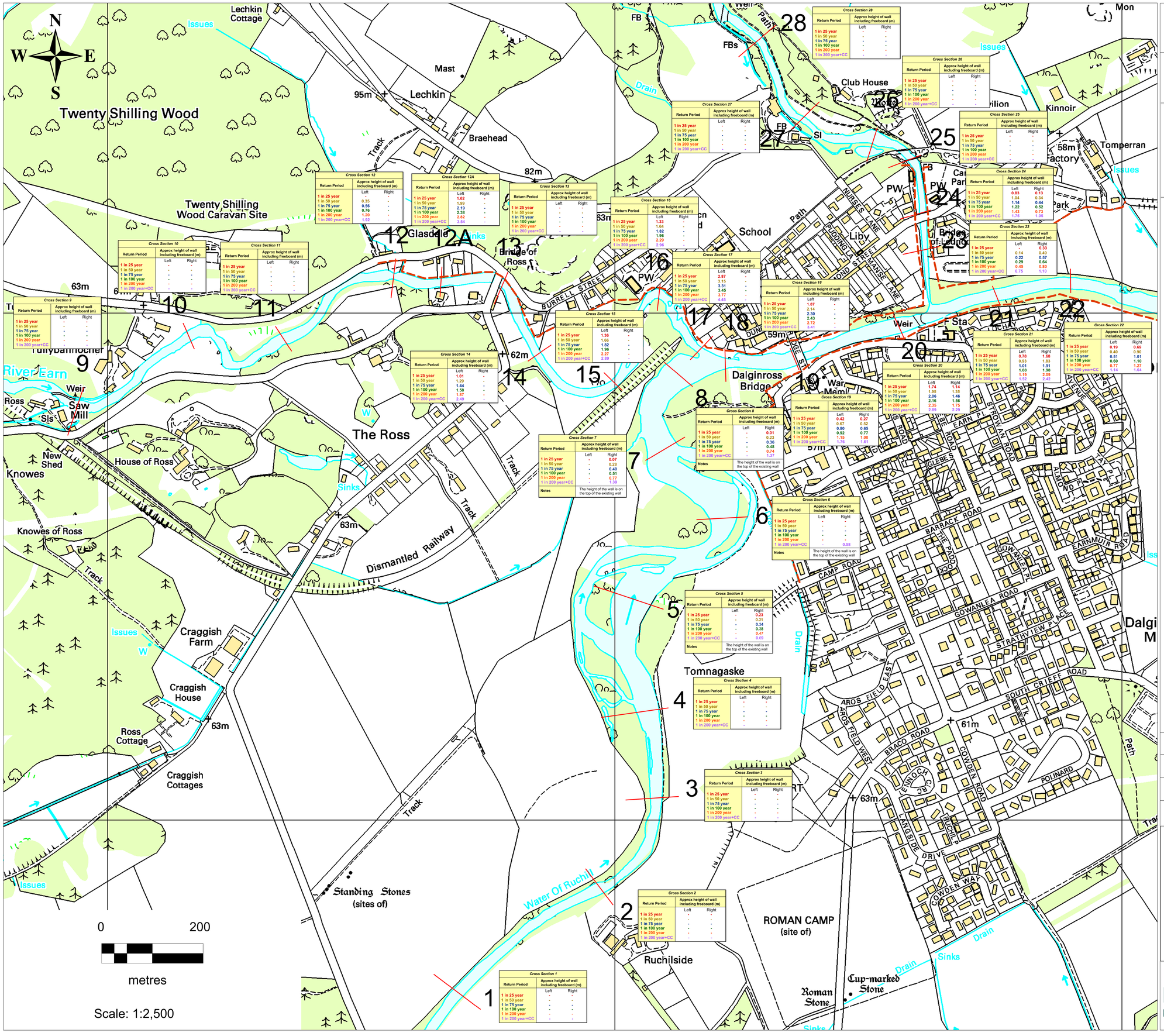

Cross Section 1

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	-	-
1 in 50 year	-	-
1 in 75 year	-	-
1 in 100 year	-	-
1 in 200 year	-	-
1 in 200 year+CC	-	-

Cross Section 2

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	-	-
1 in 50 year	-	-
1 in 75 year	-	-
1 in 100 year	-	-
1 in 200 year	-	-
1 in 200 year+CC	-	-

Cross Section 3

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	-	-
1 in 50 year	-	-
1 in 75 year	-	-
1 in 100 year	-	-
1 in 200 year	-	-
1 in 200 year+CC	-	-

Cross Section 4

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	-	-
1 in 50 year	-	-
1 in 75 year	-	-
1 in 100 year	-	-
1 in 200 year	-	-
1 in 200 year+CC	-	-

Cross Section 5

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	-	0.23
1 in 50 year	-	0.31
1 in 75 year	-	0.34
1 in 100 year	-	0.38
1 in 200 year	-	0.47
1 in 200 year+CC	-	0.69

Notes: The height of the wall is on the top of the existing wall

Cross Section 6

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	-	-
1 in 50 year	-	-
1 in 75 year	-	-
1 in 100 year	-	-
1 in 200 year	-	-
1 in 200 year+CC	-	0.58

Notes: The height of the wall is on the top of the existing wall

Cross Section 7

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	-	0.07
1 in 50 year	-	0.20
1 in 75 year	-	0.40
1 in 100 year	-	0.51
1 in 200 year	-	0.77
1 in 200 year+CC	-	1.39

Notes: The height of the wall is on the top of the existing wall

Cross Section 8

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	-	0.01
1 in 50 year	-	0.23
1 in 75 year	-	0.36
1 in 100 year	-	0.48
1 in 200 year	-	0.74
1 in 200 year+CC	-	1.37

Notes: The height of the wall is on the top of the existing wall

Cross Section 9

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	-	-
1 in 50 year	-	-
1 in 75 year	-	-
1 in 100 year	-	-
1 in 200 year	-	-
1 in 200 year+CC	-	-

Cross Section 10

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	-	-
1 in 50 year	-	-
1 in 75 year	-	-
1 in 100 year	-	-
1 in 200 year	-	-
1 in 200 year+CC	-	-

Cross Section 11

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	-	-
1 in 50 year	-	-
1 in 75 year	-	-
1 in 100 year	-	-
1 in 200 year	-	-
1 in 200 year+CC	-	-

Cross Section 12

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	-	-
1 in 50 year	0.35	-
1 in 75 year	0.56	-
1 in 100 year	0.76	-
1 in 200 year	1.29	-
1 in 200 year+CC	1.82	-

Cross Section 12A

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	1.62	-
1 in 50 year	1.99	-
1 in 75 year	2.19	-
1 in 100 year	2.38	-
1 in 200 year	2.82	-
1 in 200 year+CC	3.54	-

Cross Section 13

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	-	-
1 in 50 year	-	-
1 in 75 year	-	-
1 in 100 year	-	-
1 in 200 year	-	-
1 in 200 year+CC	-	-

Cross Section 14

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	1.01	-
1 in 50 year	1.29	-
1 in 75 year	1.44	-
1 in 100 year	1.58	-
1 in 200 year	1.97	-
1 in 200 year+CC	2.49	-

Cross Section 15

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	1.36	-
1 in 50 year	1.65	-
1 in 75 year	1.82	-
1 in 100 year	1.96	-
1 in 200 year	2.27	-
1 in 200 year+CC	2.69	-

Cross Section 16

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	1.33	-
1 in 50 year	1.64	-
1 in 75 year	1.82	-
1 in 100 year	1.96	-
1 in 200 year	2.29	-
1 in 200 year+CC	2.96	-

Cross Section 17

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	2.87	-
1 in 50 year	3.15	-
1 in 75 year	3.31	-
1 in 100 year	3.45	-
1 in 200 year	3.77	-
1 in 200 year+CC	4.45	-

Cross Section 18

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	1.87	-
1 in 50 year	2.14	-
1 in 75 year	2.30	-
1 in 100 year	2.43	-
1 in 200 year	2.72	-
1 in 200 year+CC	3.41	-

Cross Section 19

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	0.42	0.27
1 in 50 year	0.67	0.52
1 in 75 year	0.80	0.65
1 in 100 year	0.92	0.77
1 in 200 year	1.15	1.00
1 in 200 year+CC	1.76	1.61

Cross Section 20

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	1.74	1.14
1 in 50 year	1.95	1.35
1 in 75 year	2.06	1.46
1 in 100 year	2.16	1.56
1 in 200 year	2.35	1.75
1 in 200 year+CC	2.89	2.29

Cross Section 21

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	0.78	1.68
1 in 50 year	0.93	1.83
1 in 75 year	1.01	1.91
1 in 100 year	1.08	1.98
1 in 200 year	1.19	2.09
1 in 200 year+CC	1.52	2.42

Cross Section 22

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	0.19	0.69
1 in 50 year	0.40	0.90
1 in 75 year	0.51	1.01
1 in 100 year	0.60	1.10
1 in 200 year	0.77	1.27
1 in 200 year+CC	1.14	1.64

Cross Section 23

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	-	0.33
1 in 50 year	0.14	0.49
1 in 75 year	0.22	0.57
1 in 100 year	0.29	0.64
1 in 200 year	0.45	0.80
1 in 200 year+CC	0.75	1.10

Cross Section 24

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	0.83	0.13
1 in 50 year	1.04	0.34
1 in 75 year	1.14	0.44
1 in 100 year	1.22	0.52
1 in 200 year	1.43	0.73
1 in 200 year+CC	1.75	1.05

Cross Section 25

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	-	-
1 in 50 year	-	-
1 in 75 year	-	-
1 in 100 year	-	-
1 in 200 year	-	-
1 in 200 year+CC	-	-

Cross Section 26

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	-	-
1 in 50 year	-	-
1 in 75 year	-	-
1 in 100 year	-	-
1 in 200 year	-	-
1 in 200 year+CC	-	-

Cross Section 27

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	-	-
1 in 50 year	-	-
1 in 75 year	-	-
1 in 100 year	-	-
1 in 200 year	-	-
1 in 200 year+CC	-	-

Cross Section 28

Return Period	Approx height of wall including freeboard (m) Left	Right
1 in 25 year	-	-
1 in 50 year	-	-
1 in 75 year	-	-
1 in 100 year	-	-
1 in 200 year	-	-
1 in 200 year+CC	-	-

PROJECT TITLE

Comrie Flood Study

MAP TITLE

Comrie Optioneering - Proposed Wall defence (Approximate height)

LEGEND

- Proposed Defence Wall
- Cross Sections

NOTES

'Right' and 'left' is based on the flow direction (looking downstream).

The approximate height of the wall is based on the average ground level near the proposed wall alignment. The ground levels have been derived from the LiDAR data/NEXT map.

The proposed alignment is approximate and subject to change based on site conditions. Currently, the defence have not been tied to the higher ground or structures at the upstream end and at the location of the structures.

Gardens of some properties seems to be flooded in the Ross towards left bank of the Ruchill and also upstream of the Bridge of Ross in the right bank of the River Earn.The threshold levels of these properties needs to be checked against the water levels.

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