Report Number: P061-001

City of Windhoek

FLOOD EVALUATION ERF RE/77 KW

DRAFT REPORT

16 July 2020

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Title:	Flood Evaluation for Erf RE/77 KW
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Report status:	Draft
Report number:	P061 - 001
Date:	16 July 2020
Keywords:	Erf RE/77 KW, Hec Ras, Floodline, Hydraulic Model, Klein Windhoek River, Bassingthwaighte St

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Date:

City of Windhoek, Department: Urban Planning and Property Management, Division: Planning, Design and Traffic Flow

Approved for City of Windhoek

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Date

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1 INTRODUCTION

Chris Muir Consulting Engineer was appointed to undertake a flood evaluation of Erf RE/77 KW which is located off Bassingthwaighte St in Klein Windhoek.

The property is located on the left bank of the Klein Windhoek River. The location of the site is shown in **Figure 1.1**. A portion of the site is situated in the flood plain of the Klein Windhoek River, as illustrated by the yellow floodline. The yellow line is the latest 1 in 50 year floodline generated from a study done for the City of Windhoek in 2014 (Lithon).

Figure 1.1: Locality of Erf RE/77

This flood study will determine the effect that future plans for the development of the property will have on the 1 in 50 year flood levels and will indicate whether possible changes in the flood

levels will have a negative impact on any neighbouring properties or on properties located on the opposite side of the river.

This report will furthermore provide the approach to the study and the methodology used. The results of hydraulic modelling done of the relevant stretch of the river are presented, and recommendations are made based on the modelling results.

It should be noted that the City of Windhoek requires that the finished floor level of any new structure on the property be 250mm above the 1 in 100 year flood level.

2 DESCRIPTION OF THE SITE

Currently the lower section of the site cannot be fully utilised since it lies below the floodline. However, a boundary wall has been constructed along the cadastral boundary. The existing stormwater outlets are below the floodline and floodwaters can flow into the property. The section of the erf that currently cannot be developed is shown as the green shaded area in **Figure 2.1**.

Figure 2.1: Erf RE/77 showing the undeveloped area below the floodline

The owner would like to raise the portion of the erf that lies below the floodline to a level above the flood level. This will make it possible to utilise the full extent of the erf for development.

This report will analyse the impact that this raising will have on the flood level in the river and will request approval from the City of Windhoek to raise the low lying sections of the erf to above the 1 in 50 year flood level and to strengthen the existing boundary wall against erosion and flood damage.

3 HYDROLOGY

The hydrology of the Windhoek Rivers was revised in January 2014. The results of this hydrology study were used for the Lithon flood study of 2014. The same flows have been used in this study. The flows used are:

1 in 50 year 258 m^3/s
1 in 100 year 312 m^3/s.

4 SITE VISIT AND EVALUATION OF THE CURRENT CONDITION OF THE RIVER

A site visit was undertaken to check for any changes in the river environment since the previous study was done. Particular attention was given to ensuring that all control points are correctly modelled and that representative Manning's n-values are used to model the condition of the riverbed.

5 SURVEY

The Lidar survey flown in December 2014 was used to develop the hydraulic model.

6 HYDRAULIC MODELLING

The hydraulic modelling involves a backwater analysis using the HEC-RAS River Modelling Software. With this software, a one dimensional model is built by importing a series of cross sections at critical points along the river reach. Information such as distances between cross-sections, position of the river bank stations and Manning's roughness values (n) also forms part of the required inputs to the model.

The hydrology, and the resulting 1 in 50 year peak flow used for this evaluation, is the same as the flow used for the 2014 City of Windhoek study. This will ensure a consistent comparison of the flood levels for each of the scenarios, before and after the development is implemented.

6.1 MODELLING APPROACH

The modelling approach is to first model the river before the development under consideration in the floodplain is constructed. A second model will then be developed to model the condition after the construction of the development. This will include the raising of the erf that is currently below the 1 in 50 year flood level to above the flood level and the construction of a boundary wall that will protect the property against flooding. A comparison of the flood levels then gives an indication of how the flood level is affected by the development. Approval of the application is then based on the results of the modelling. One of the main aspects considered is

whether the development will have a negative impact on neighbouring properties or on properties located on the opposite side of the river.

6.2 SCENARIOS MODELLED

The following scenarios were modelled to evaluate the effect of development on Erf RE/77:

1. Model 1: The original 2014 (Lithon) model which was used as the base model ;
2. Model 2: The original 2014 model was adapted to include the raising of the erf to above the 1 in 50 year flood level and the construction of a boundary wall.

The following comparisons were made:

1. The difference in water levels between Models 1 and 2.

6.3 RIVER CROSS SECTIONS

The positions of the river cross sections, referred to as River Stations (RS) in the Hec Ras software, are shown in green in **Figure 6.1**. The cross sections are approximately 20 metres apart and are adequately spaced to model the effect of Erf RE/77.

A larger scale plan of the river cross sections is shown in **Appendix 1**.

Figure 6.1: Position of river cross sections

6.4 MODELLING RESULTS

Table 6.1 below presents a comparison of the 1 in 50 year flood water levels from the scenarios modelled. The flood levels are also illustrated in **Figure 6.3.**

Table 6.1: 1 in 50 Year Water Surface Elevation Differences between the models

POST DEVELOPMENT			PRE-DEVELOPMENT	LEVEL
River Station	Q Total (m^3/s)	W.S. Elev (m)	W.S. Elevation (m)	DIFFERENCE (cm)
1835	258	1673.66	1673.66	0
1832	258	1673.46	1673.46	0
1830	258	1673.32	1673.32	0
1829	258	1672.89	1672.89	0
1827	258	1672.42	1672.42	0
1825	258	1672.32	1672.32	0
1823	258	1672	1672.03	-0.03
1821	258	1671.69	1671.63	0.06
1819	258	1671.32	1671.36	-0.04
1817	258	1671.22	1671.24	-0.02
1815	258	1670.9	1670.9	0
1813	258	1670.97	1670.97	0
1811	258	1670.9	1670.9	0

Note: +ve values represent a rise in the flood level for the post-development case.
The highlighted rows in **Table 6.1** are the flood levels along the boundary wall of Erf RE/77.

Table 6.2: 1 in 100 Year Water Surface Elevation Differences

POST DEVELOPMENT			PRE-DEVELOPMENT	LEVEL
River Station	Q Total (m^3/s)	W.S. Elev (m)	W.S. Elev (m)	DIFFERENCE (cm)
1835	312	1673.86	1673.86	0
1832	312	1673.67	1673.67	0
1830	312	1673.55	1673.55	0
1829	312	1673.07	1673.07	0
1827	312	1672.66	1672.66	0
1825	312	1672.57	1672.58	-0.01
1823	312	1672.21	1672.24	-0.03
1821	312	1671.9	1671.83	0.07
1819	312	1671.54	1671.5	0.04
1817	312	1671.42	1671.46	-0.04
1815	312	1671.19	1671.19	0
1813	312	1671.28	1671.28	0
1811	312	1671.21	1671.21	0

Note: The purpose of providing the 1 in 100 year flood levels is because the floor levels of new buildings must be 250mm above the 1 in 100 year flood level.

6.5 FLOODLINE COMPARISON

At the time that the 2014 (Lithon) flood study was carried out the floodlines were generated by an ArcGis plug-in for Hec Ras, the river analysis software used for the hydraulic modelling. Since then Hec Ras has further developed their own software to include a GIS package, Ras Mapper, to generate the floodlines and inundation areas.

Figure 6.2 below shows the 1 in 50 year floodlines generated by the respective software packages using the same data, which are the water levels at each cross section. The yellow line was generated in ArcGis and shows a great deal more smoothing of the line. The more ragged blue line was generated by Ras Mapper. Both lines represent the 1 in 50 year floodline.

To see the impact that the proposed new boundary wall will have on the floodlines, before and after its construction, it is necessary to compare the two cases using the same software. Since the ArcGis software is not available to the author, the comparison was made using Ras Mapper.

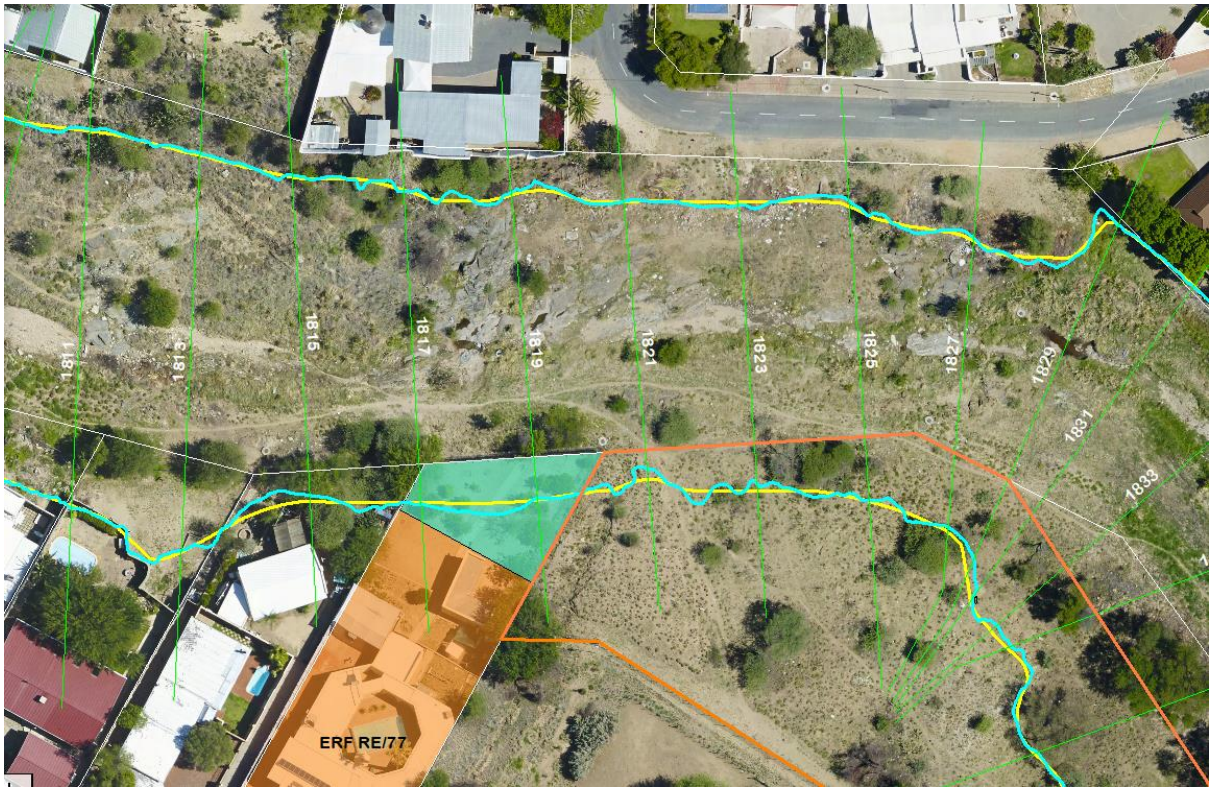

Figure 6.2: Comparison of floodlines generated by ArcGis and Ras Mapper

Figure 6.3: Comparison of the 1 in 50 year floodline, pre- and post-development

shows the comparison of the floodlines for the pre- and post-development cases. The blue line represents the pre-development case and the red line represents the post-development case. From the image there is almost no difference between the two. This is confirmed by the flood levels given in **Table 6.1** where the maximum rise in the flood level is only 6cm. It can also be seen that there is no negative impact on neighbouring properties or properties on the opposite side of the river.

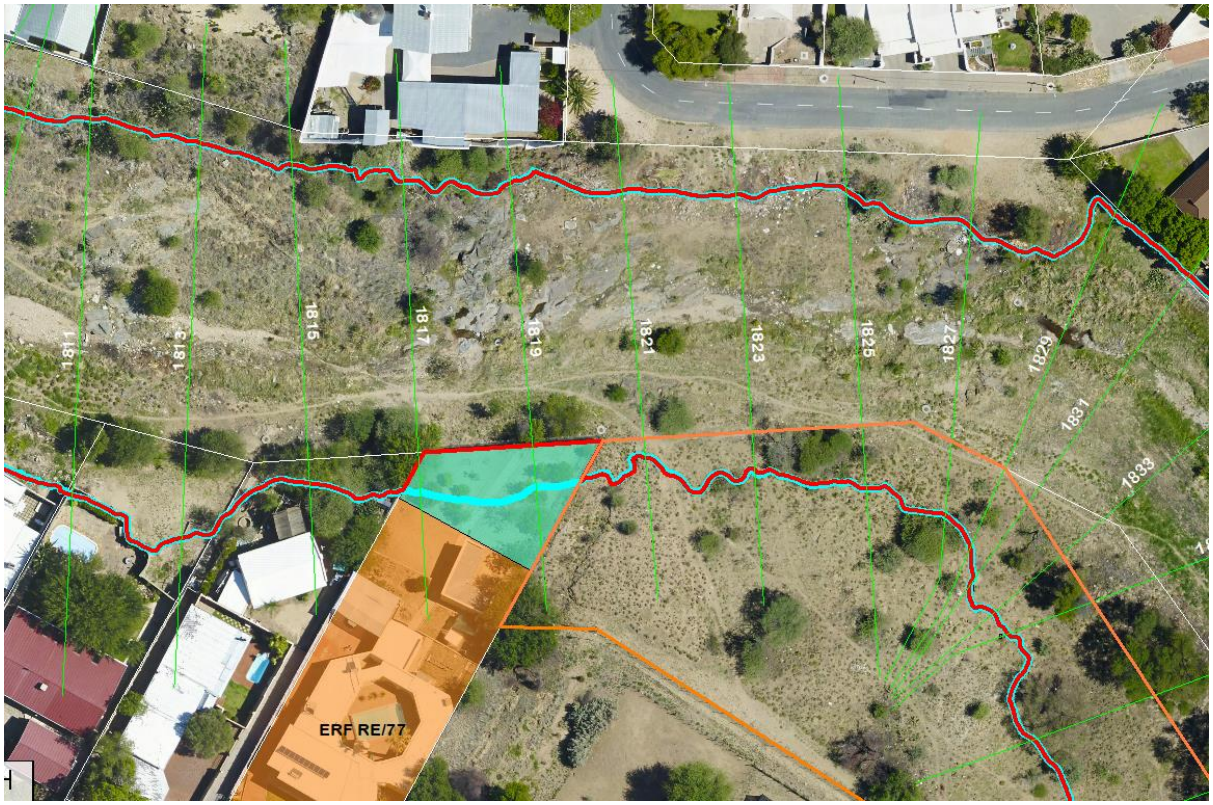

Figure 6.3: Comparison of the 1 in 50 year floodline, pre- and post-development

7 CONCLUSIONS

The following conclusions can be drawn from the study:

1. There is little difference in the flood levels of the pre-and post-development cases.
2. The construction of a boundary wall along the cadastral boundary of Erf RE/77 will not have a negative impact on any neighbouring properties or on properties situated on the opposite side of the river.

8 RECOMMENDATIONS

The following recommendations are made:

1. That the owner be allowed to raise the low lying areas of his property to at least the 1 in 50 year flood level (RL 1671.32).
2. That the boundary wall be designed by a Professional Engineer to protect it against erosion from possible flood water.
3. That the finished floor level of all new structures be at least 250 mm above the 1 in 100 year flood level (RL 1671.54).
4. That all stormwater or rainfall run-off generated on the site be discharged into the river at a level above the 1 in 50 year flood level.

Report compiled by:
A C Muir (PE 88100)
Chris Muir Consulting Engineer Date: 16 July 2020

APPENDIX 1

POSITION OF RIVER CROSS SECTIONS


1813
1815
1817
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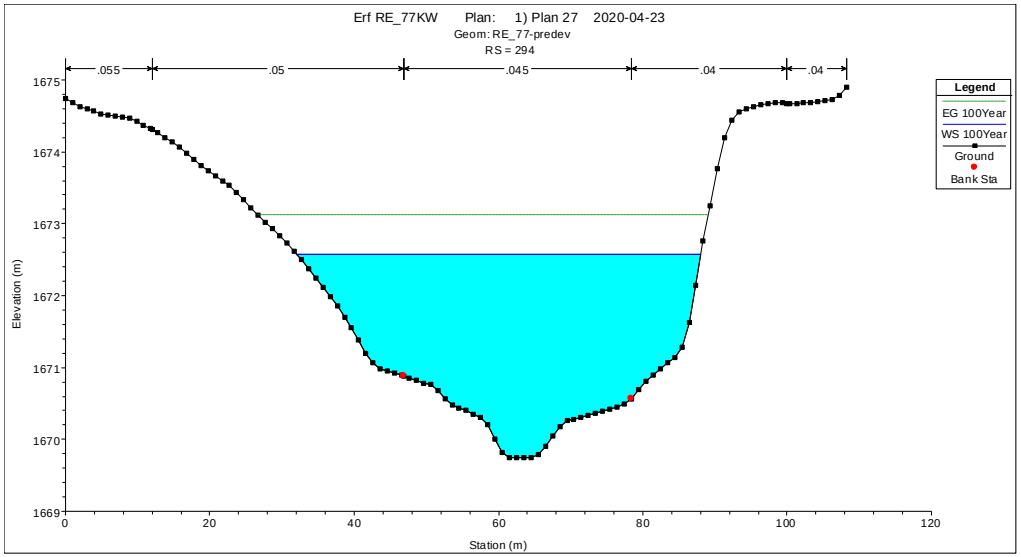
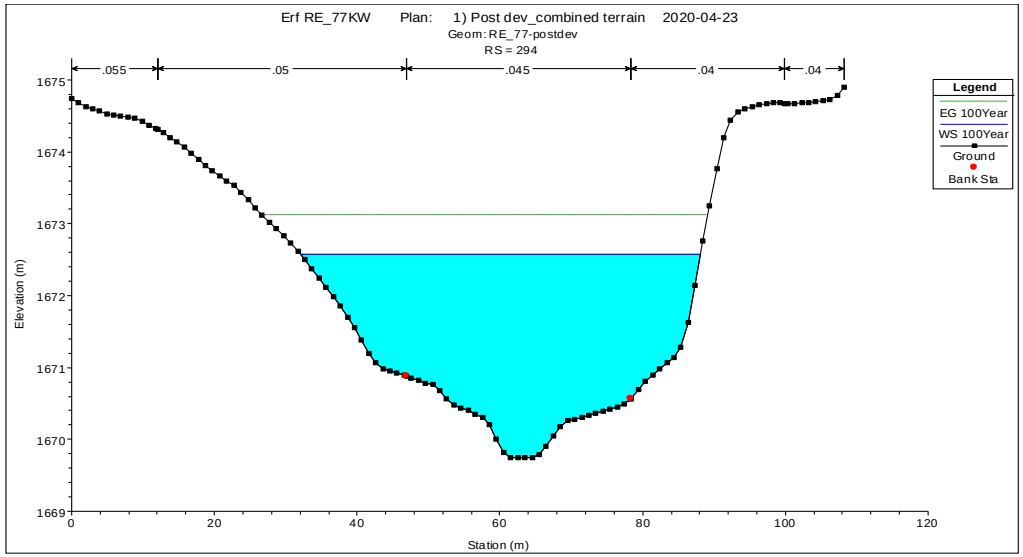
ERF RE/77

APPENDIX 2

RIVER CROSS SECTION PLOTS

PRE-DEVELOPMENT	POST-DEVELOPMENT
	
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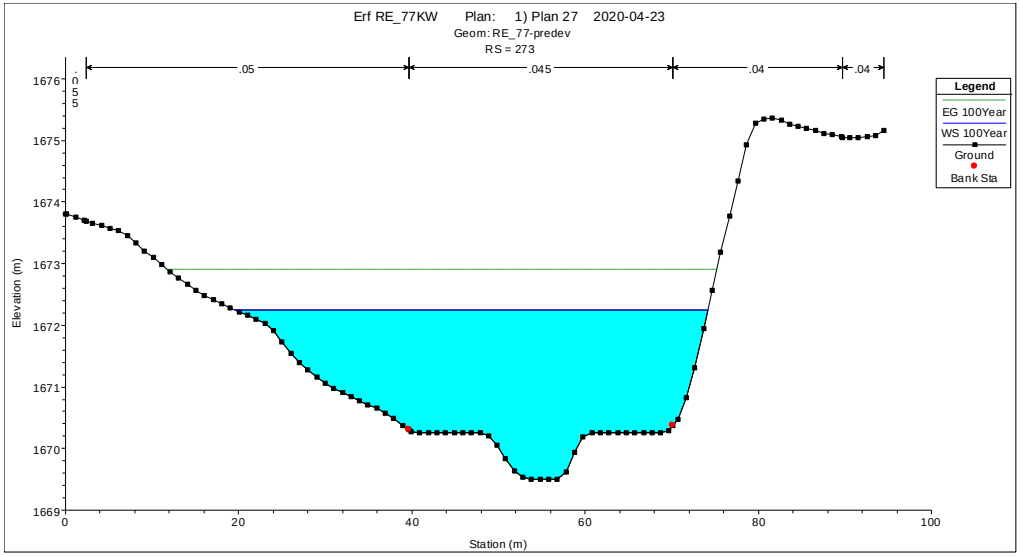	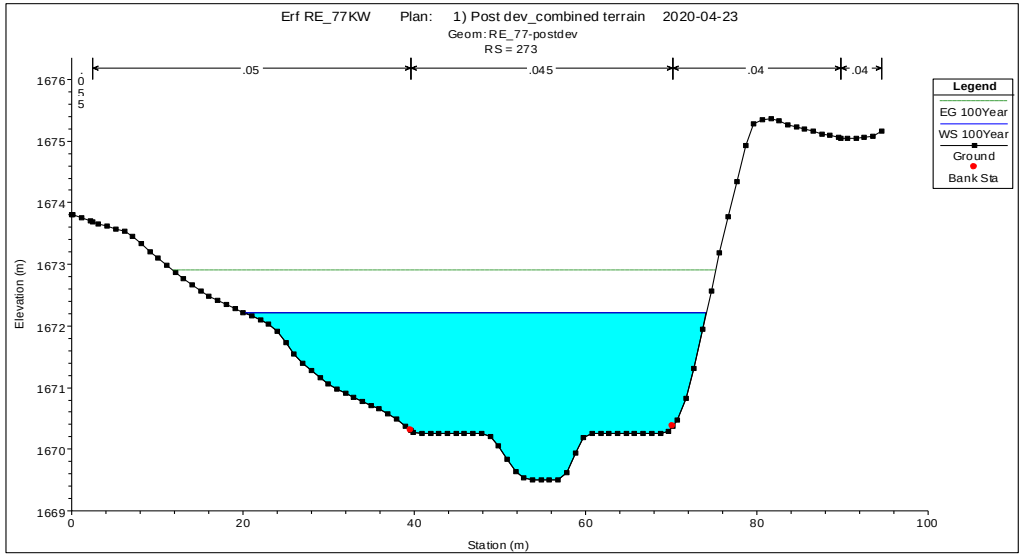
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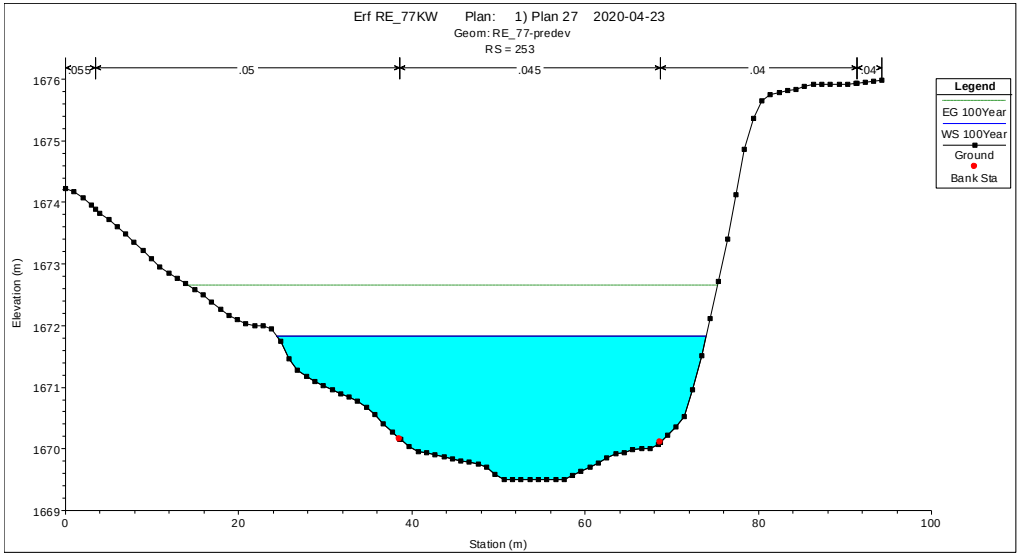

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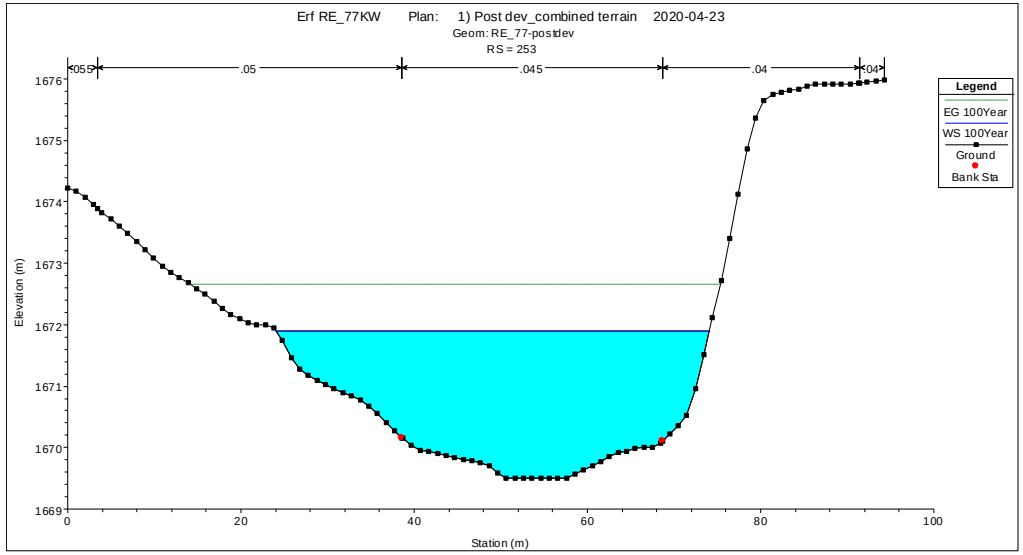

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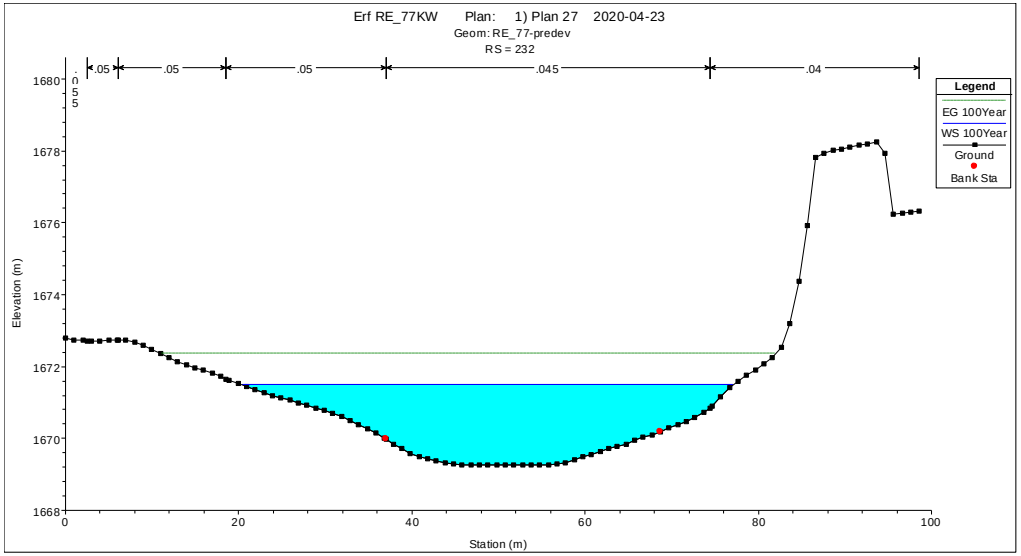

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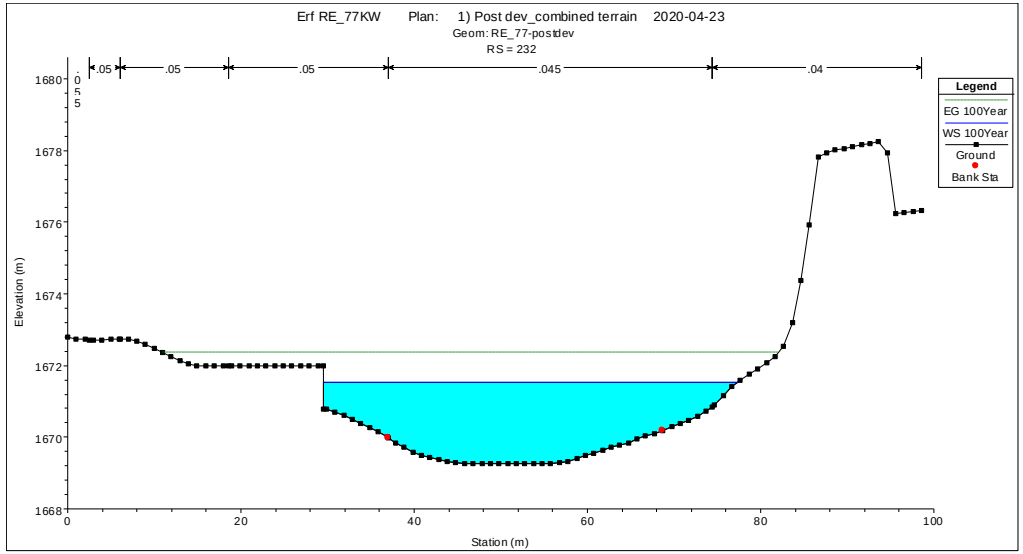

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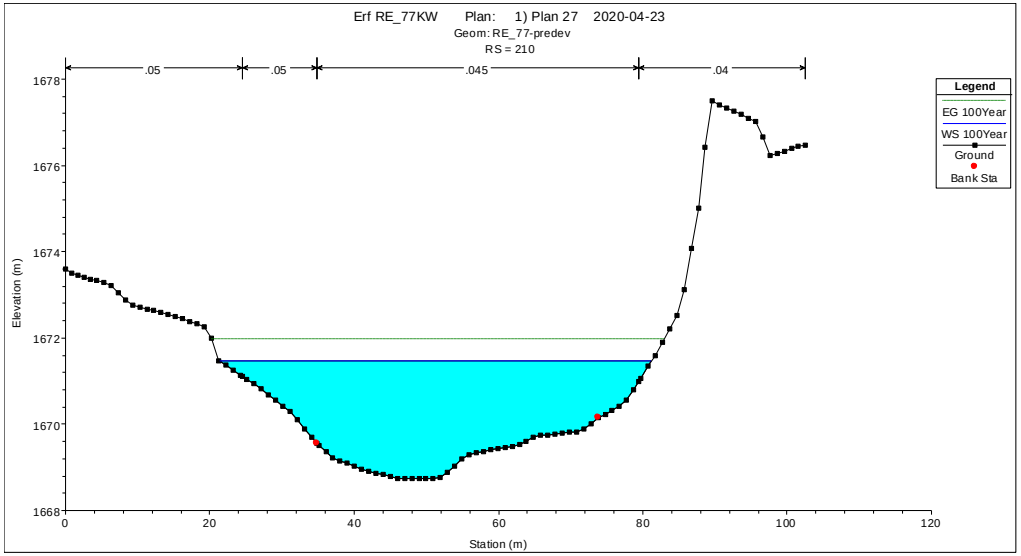

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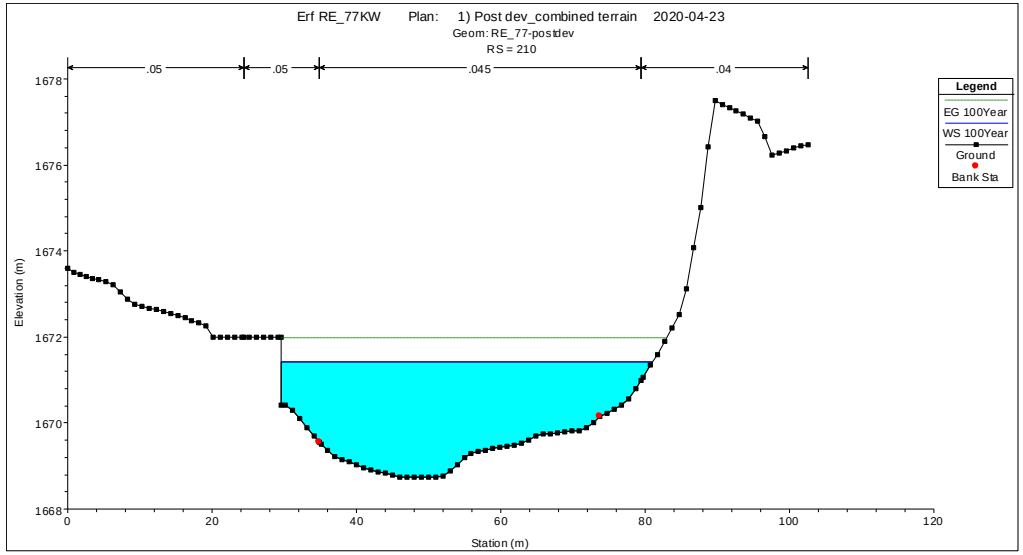

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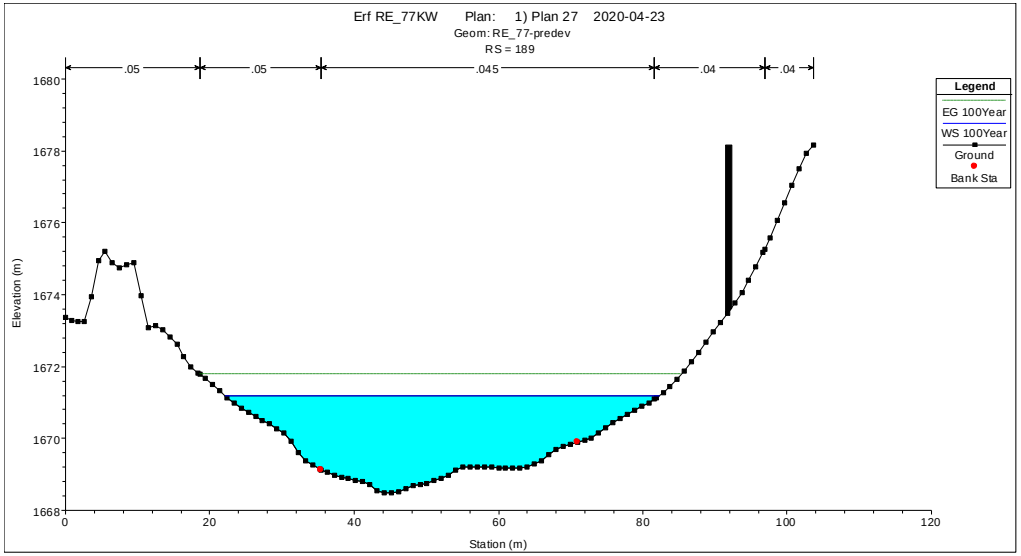

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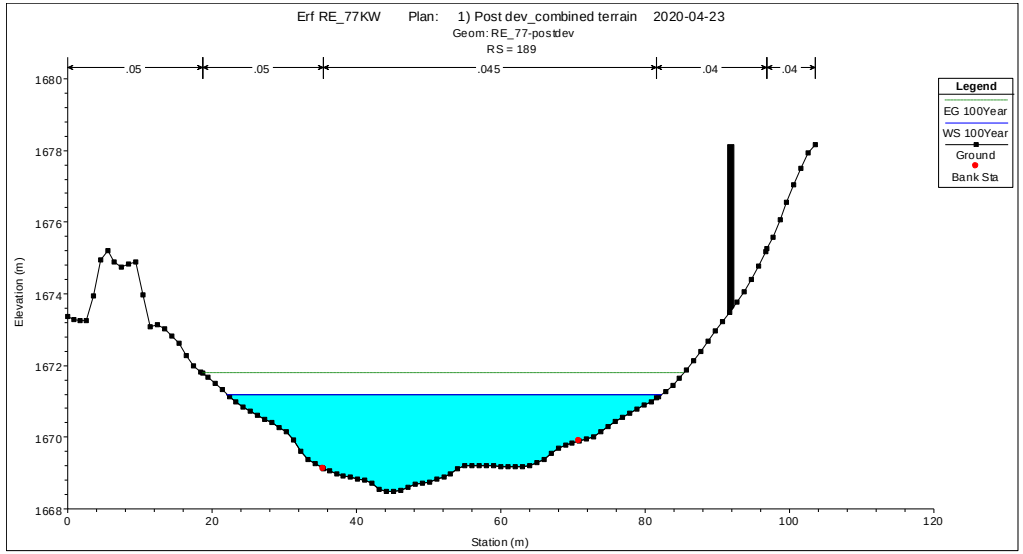

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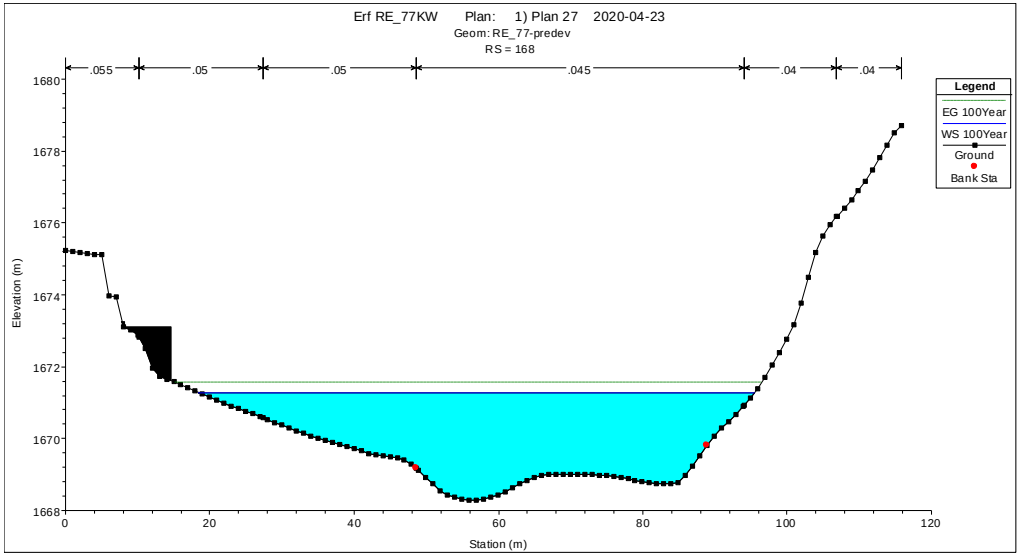

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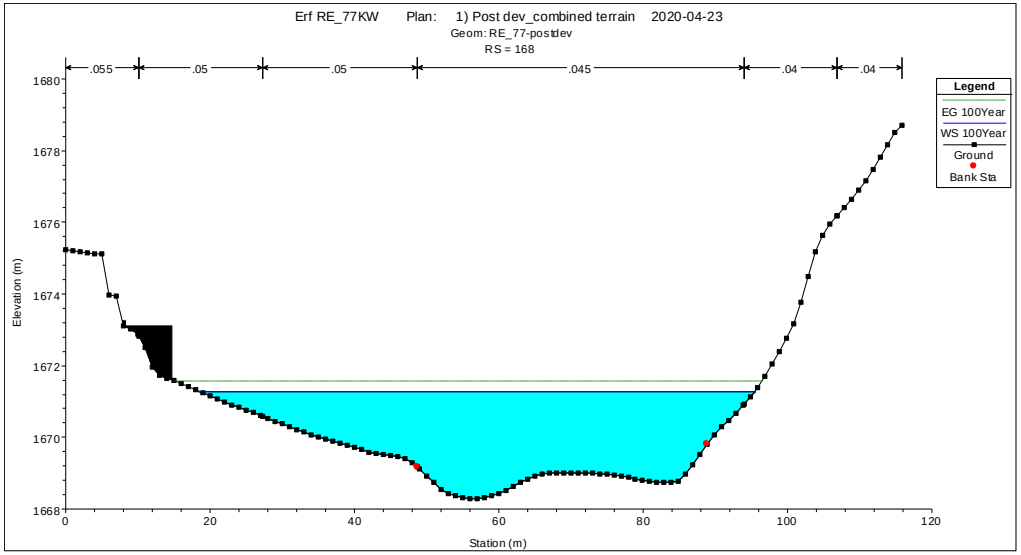

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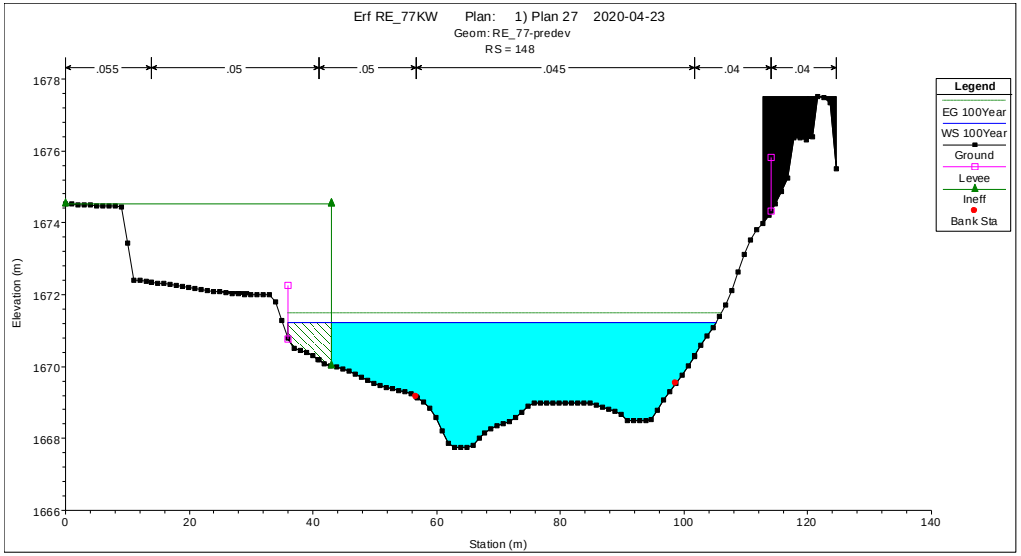

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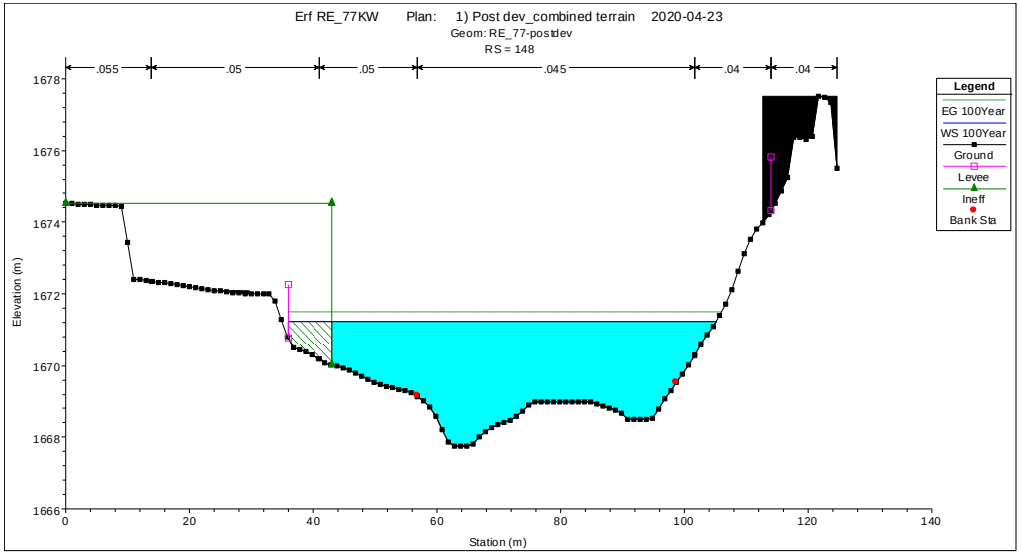

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