Summary – Rocky Point Stormwater Management evidence.

Introduction and Expertise:

My name is Bronwyn Patricia Rhynd, I am a Director and an environmental engineer at CKL NZ Ltd. I have a New Zealand Certificate in Civil Engineering, a Bachelor of Engineering, and a Masters in Environmental Engineering Science. I am a Fellow of Engineering New Zealand, a Chartered Professional Engineer registered with both Engineering New Zealand and the International Professional Engineers.

My professional expertise lies in water resource management, particularly stormwater treatment, disposal, management, and flood and flow regulation, spanning over 20 years. I have substantial experience working on projects across New Zealand for land development, local government and private sector clients.

Scope of evidence and Stakeholder Concerns:

My evidence addresses the critical aspects of stormwater management and flood risk, considering the site's unique characteristics and potential effects on the receiving environment.

Several stakeholders, including Iwi, the Department of Conservation, Waka Kotahi, and other individuals, have expressed concerns about the project's potential environmental impact. These concerns primarily relate to the potential effects on water quality, indigenous vegetation, and the overall character of the landscape.

Stormwater management – summary:

A comprehensive Stormwater Management Plan (SMP) has been developed for the Rocky Point subdivision to address and mitigate potential adverse effects. This plan is based on detailed hydrological analysis and hydraulic modelling.

The SMP outlines strategies for managing both primary flow (the initial runoff from a rainfall event) and secondary flow conveyance (the management of stormwater after it has been collected or treated).

Although the development is considered low contaminant generating, the SMP includes measures like using non-contaminant building materials and incorporating swales, which are shallow, vegetated channels designed to manage stormwater runoff and improve water quality.

Flood Risk Assessment and Mitigation -Summary:

The flood assessment identified five existing overland flow paths (OLFPS) traversing the site. These OLFPs can be accommodated within the development layout. However, one OLFP, associated with an existing watercourse adjacent to Bendigo Loop Road, requires slight modification to accommodate building platforms on lots 27-30.

This modification involves maintaining the existing entry and exit points of the watercourse to ensure no upstream or downstream impacts on flow conveyance. This means that the modified watercourse will continue to carry water in the same way as it did before, preventing any changes to flooding patterns in adjacent areas. The watercourse modification will include culverts for road and driveway crossings, allowing for the safe passage of vehicles while still enabling water flow.

Flood modelling demonstrates that the proposed development will result in minimal changes in flood levels downstream and will not impact the operation of the State Highway or adjacent land uses.

Addressing Specific Stakeholder Concerns:

The SMP is developed to provide best practicable options for the site to be developed in a way to ensure that effects on water quality and quantity are minimized, helping to preserve the mauri of the surface water. To achieve this, the SMP incorporates various measures, including, but not limited to;

- Strategic placement of structures to reduce water velocities and prevent soil erosion.
- Use of inert materials to minimize contamination.
- Provision of swales for treating runoff before discharge.

Stakeholder concerns about potential stormwater runoff onto the state highway are addressed by the flood assessment, which provides assurance that the highway will not experience increased flood risk due to the development. Additionally, the necessary intersection upgrade will adhere to the SMP's principles, further minimizing any potential impact.

The Section 42A report, raised concerns about potential changes in stormwater runoff patterns that could affect saline areas, particularly lots 23 and 25. While the SMP outlines general mitigation measures, the location and design of discharge points will be carefully determined during the detailed design phase. This stage will address the concern of changes in runoff patterns by ensuring that runoff from impervious surfaces, such as roofs and roads, is discharged effectively while protecting the sensitive saline areas.

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Appendix 2 Calculation Summary

- Watercourse updates: Summary of Rock Point Modelling – Hydraulic analysis
- Upper catchment 1&2: Flood assessment Lots 19-21

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CALCULATION SHEET					
Project:	Rocky Point, Central Otago	Job No:	A23205	Sheet:	1
Description:	Flood assessment for lot 19-21	Designed:	pp		
Date:	18-Jul-24	Checked:	JR		

A flood assessment for Lot 19-21

A.1 Catchment Information

Reference *Coterra, Lidar 1m DEM, 2024, Ground, Lindas Peak 2000, NZVD2016.*

A.2 Rainfall (HIRDS Version 4, RCP 8.5, Intensity, mm/hr)

- Rainfall intensities (mm/hr) :: RCP8.5 for the period 2081-2100

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h
10	0.1	46.8	32.8	26.9	19.3	13.6	7.41	4.81	2.96
100	0.01	91	62	50	34.8	23.9	12.5	7.86	4.7

A.3 Peak Flow

Catchment #2

Scenario	A (m^2)	C	CA	I_{10} (mm)	I_{100} (mm)	Q_{10} (m^3/s)	Q_{100} (m^3/s)	Tc	Suface
Pre	73186	0.300	21955.8	32.8	62.0	0.200	0.378	20	

A.4 Modelling Results

CALCULATION SHEET

Project:	Rocky Point, Central Otago	Job No:	A23205	Sheet:	2
Description:	Flood assessment for lot 19-21	Designed:	pp		
Date:	18-Jul-24	Checked:	JR		

A.4 Modelling Results

Depth

Velocity

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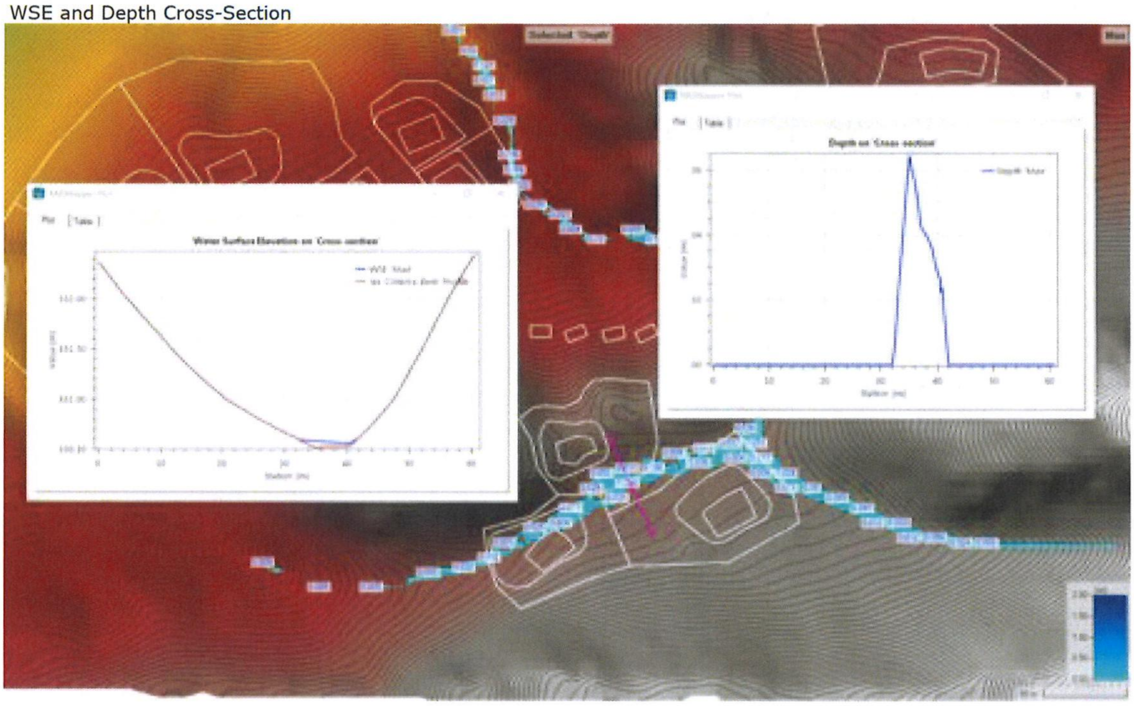
CALCULATION SHEET					
Project:	Rocky Point, Central Otago	Job No:	A23205	Sheet:	3
Description:	Flood assessment for lot 19-21	Designed:	pp		
Date:	18-Jul-24	Checked:	JR		

A.4 Modelling Results

WSE

WSE and Depth Cross-Section



CKL

CALCULATION SHEET

Project:	Rocky Point, Central Otago	Job No:	A23205	Sheet:	4
Address:	Flood assessment for lot 19-21	Designed:	pp		
Env Court Ref:	18-Jul-24	Checked:	JR		

C.7 Discharge Distribution for 24 hours

Peak Discharge (CMS)

Station	10year	100year
	0.20	0.38

	10year	100year
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01Jan2000, 01:10	0.0001	0.0002
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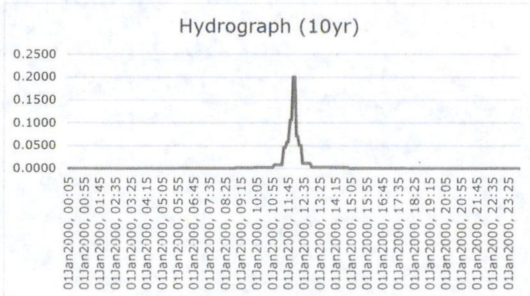

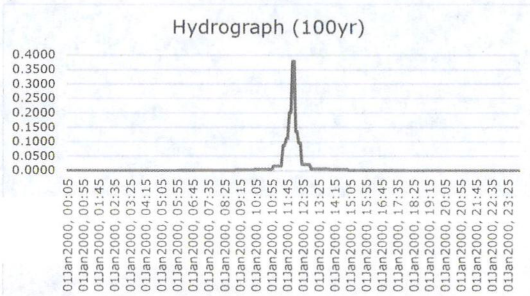

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Job number:	A23205		
Job description:	Hydraulic modelling summary-Version 1		
Calculations by:	PP	**Date:**	02/02/2024
Checked by: JR		**Date:**	02/02/2024

1 Aim

- Waterways Delineation on project site by Rain-Grid method of HEC-RAS.
- Clutha River conveyance and flow capacity assessment adjacent to the Lot 31~33 for checking flood risk.

2 Resources/Reference (Internal Use Only)

2.1 HEC RAS model

Synergy12d://CKL-AZU-SYN-1?Folder=632176_faf44865_fd66_4cc2_9a3d_4cfbcb0666c6

2.2 GIS Data

Synergy12d://CKL-AZU-SYN-1?File=6231332_faf44865_fd66_4cc2_9a3d_4cfbcb0666c6

2.3 Excel File

Synergy12d://CKL-AZU-SYN-1?File=6231598_faf44865_fd66_4cc2_9a3d_4cfbcb0666c6

3 Hydraulic model build

HEC RAS (version 6.4.1) is used for hydraulic modeling. The model build is summarized in following sections.

3.1 Scenarios

The following four scenarios are modelled:

#1 Waterways Delineation scenario:

- Rain-Grid modelling with LINZ 2012 (8m grid) for Pre-development.
- Drop the rainfall (24-hour) on each grid cell, the distribution based on TP108.
-

Clutha River conveyance and flow capacity check scenario:

- For checking flood risk adjacent to low project lots site (Lot 31-33)
- Using hydrograph data from Otago Regional Council's Environmental Portal for upstream and downstream stations.
- Making test HEC-RAS modelling with Flood waring discharge (1,000 CMS, Clyde Point) conservatively.
- Assessed flow conveyance by HEC-RAS model and Manning equation about Clutha River's main channel for checking flood risks around project site.

The model build files of the four scenarios are given in Table 1.

TABLE 1: MODEL SCENARIOS FOR WATERWAYS DELINEATION AND CLUTHA RIVER CONVEYANCE AND CAPACITY CHECK)

Model files	Scenario #1	Scenario #2
Model plan\result	Raingrid test	Flood 1000 CMS
Geometry	New Geometry	Clutha River runoff

Flow file	Raingrid	Clutha Flood Warning 1000 CMS
Manning	0.04 (Grassland)	0.06 (Emergent Herbaceous Wetlands)
Terrain model	LINZ, Lidar 8m DEM, 2012, Bendigo, Lindas Peak 2000, NZVD2016.	LINZ, Lidar 8m DEM, 2012, Bendigo, Lindas Peak 2000, NZVD2016.

3.2 Terrain model

Terrain model was created from following resources:

- **<u>All scenarios:</u>** LINZ, Lidar 8m DEM, 2012, Bendigo, Lindas Peak 2000, NZVD2016. Datum;

3.3 Geometry

- Cell size for 2D flow area is 8 m x 8 m for area of interest (The terrain cell size is 8 m).
- Components within 2D flow area for Scenario #1:
    - External flow boundary condition lines: low points of project site
    - Internal flow lines: None (Used Precipitation)
    - Downstream boundary condition line: Normal Depth (friction slope=0.115)
    - Manning = 0.04
- Model geometry and modified terrain model for scenario is shown in Figure 1.

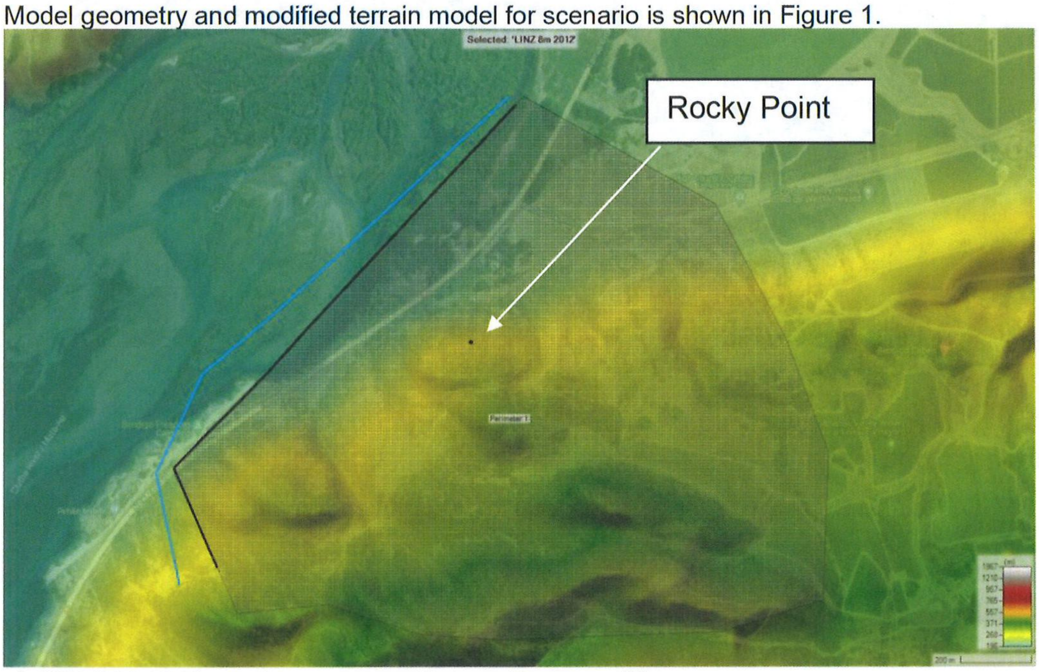


FIGURE 1: HEC RAS 2D MODEL GEOMETRY WITH TERRAIN (SCENARIO #1)

- Components within 2D flow area for Scenario #2:
  - External flow boundary condition lines: downstream
  - Internal flow lines: upstream
  - Downstream boundary condition line: Normal Depth (friction slope=0.00075)
  - Manning = 0.06
- Model geometry and modified terrain model for scenario is shown in Figure 2.

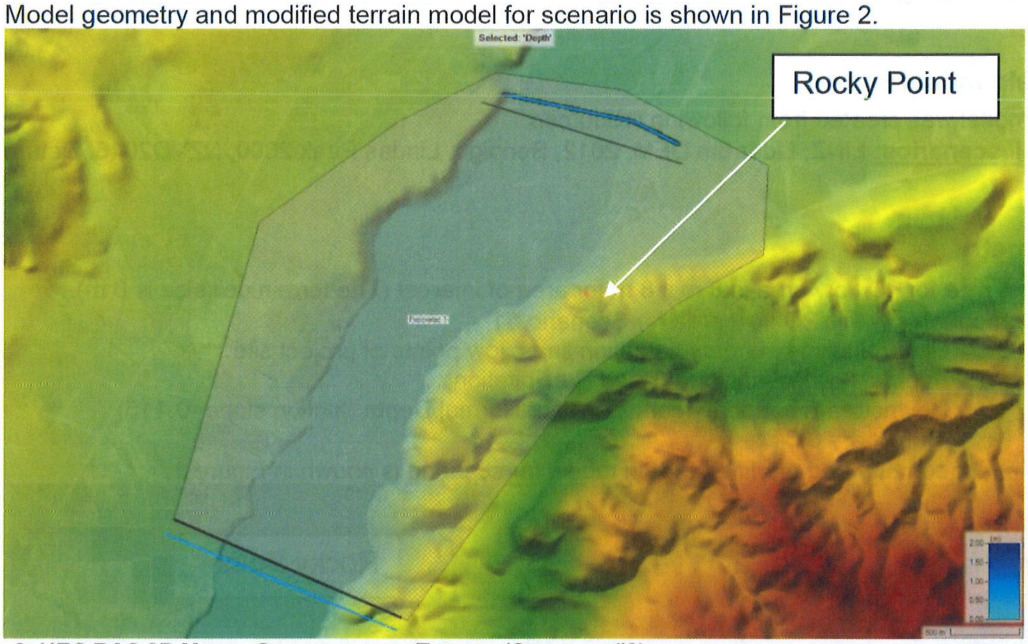


FIGURE 2: HEC RAS 2D MODEL GEOMETRY WITH TERRAIN (SCENARIO #2)

3.4 Energy loss

The following manning's n value were 0.04 (Grassland) for Scenario #1 and 0.06 (Emergent Herbaceous Wetland, conservatively) for Scenario #2.

3.5 Boundary Condition

- NIWA Rainfall Depth (RCP 8.5 for the period 2081-2100) and runoff data (1000 m^3/s, flood waring) of Clyde point used for the internal boundary condition lines.
- Normal Depth (Friction slope =0.001 and Friction slope=0.00075 respectively) for downstream boundary condition.

3.6 Simulation

- Computation Interval time step: 1.0 sec
- Simulation time: 24 hrs

4 Model result

The flood maps with a focus on waterways delineation from On-site for 100yr ARI (after climate change scenario) are provided in following.

4.1 Result of scenario #1

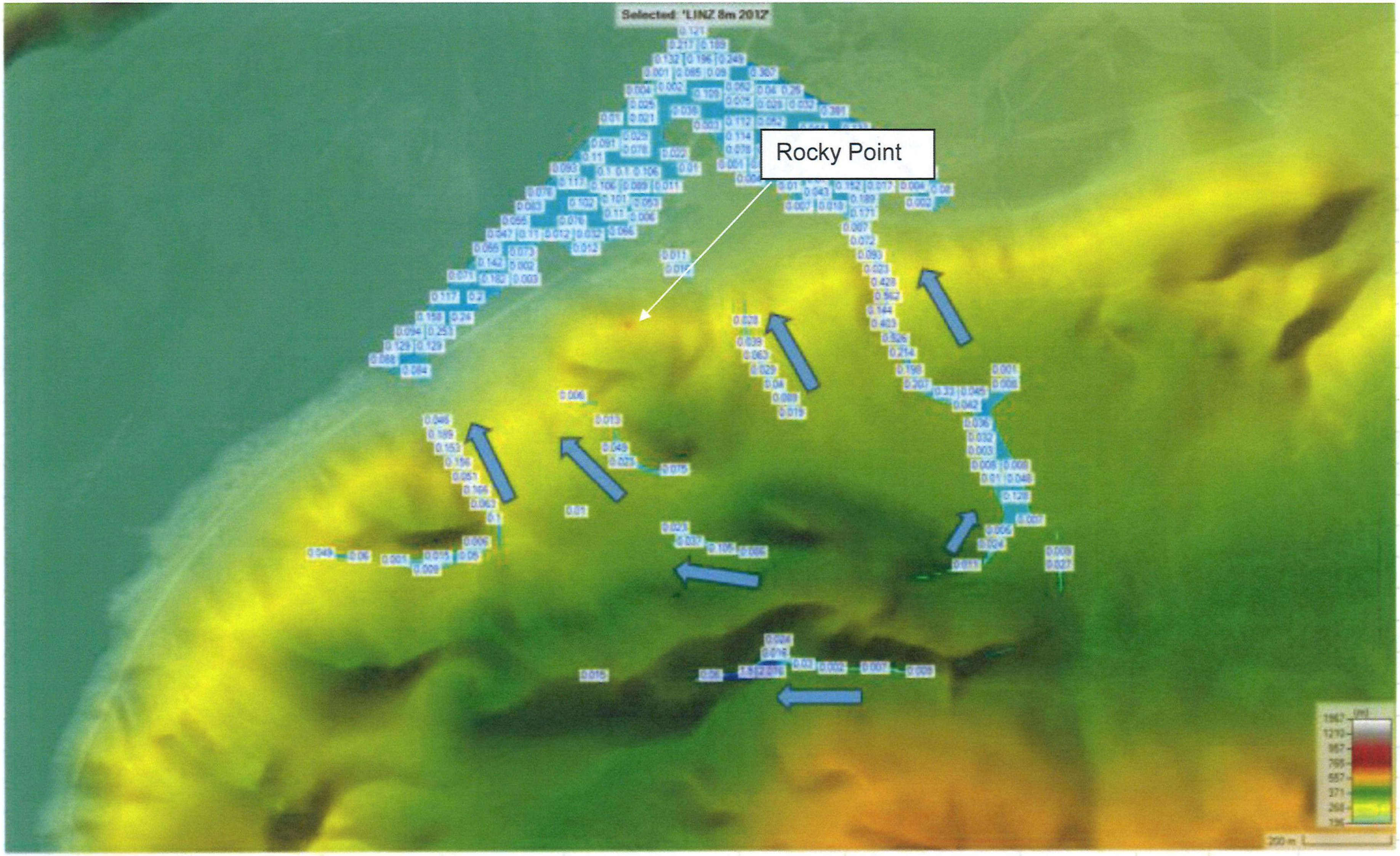


FIGURE 3: MAXIMUM FLOOD DEPTH FOR SCENARIO #1 -100YR CLIMATE CHANGE

4.2 Results of Scenario #2

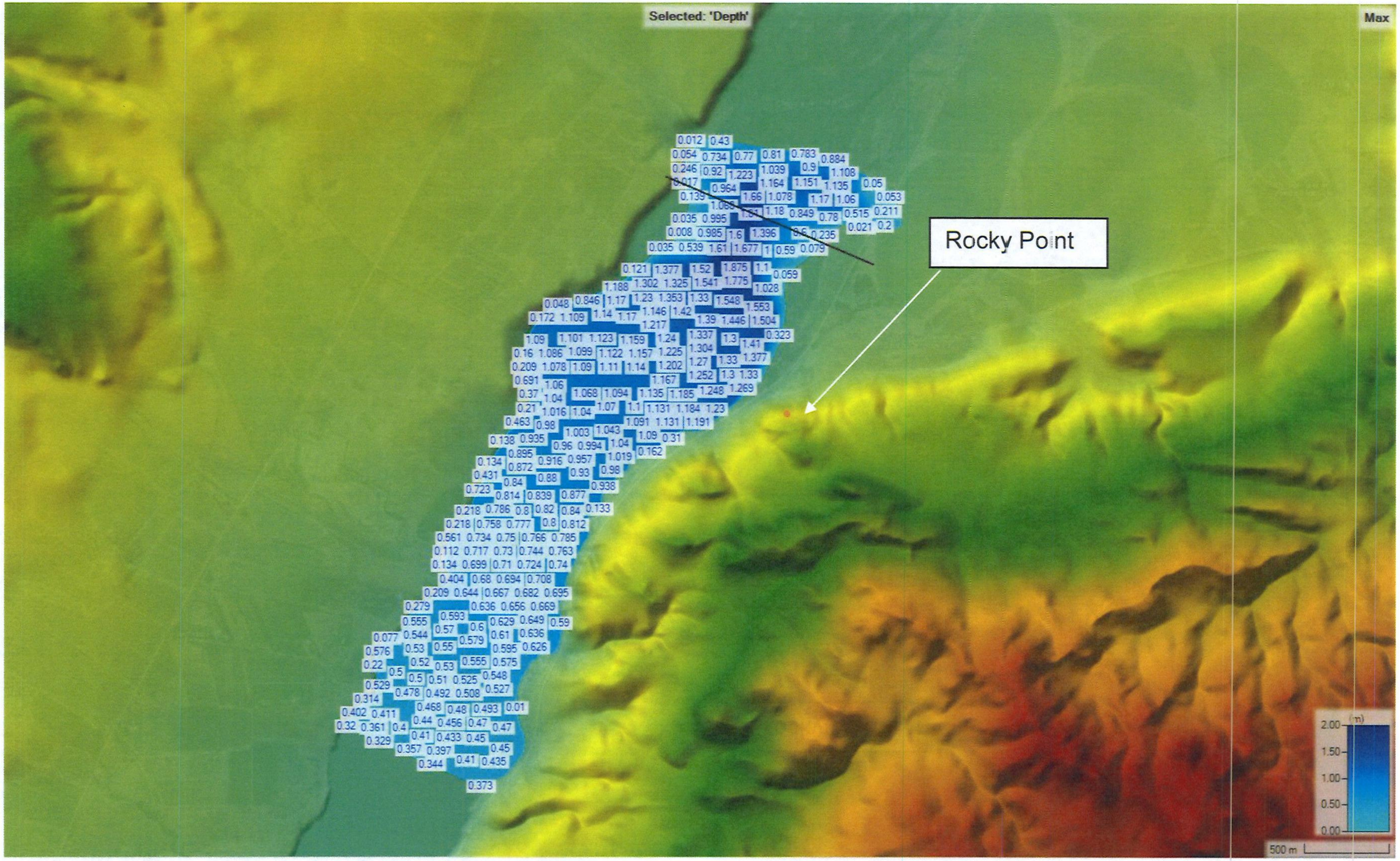


FIGURE 4: MAXIMUM FLOOD DEPTH FOR SCENARIO #2 -DISCHARGE 1000 M^3/S.

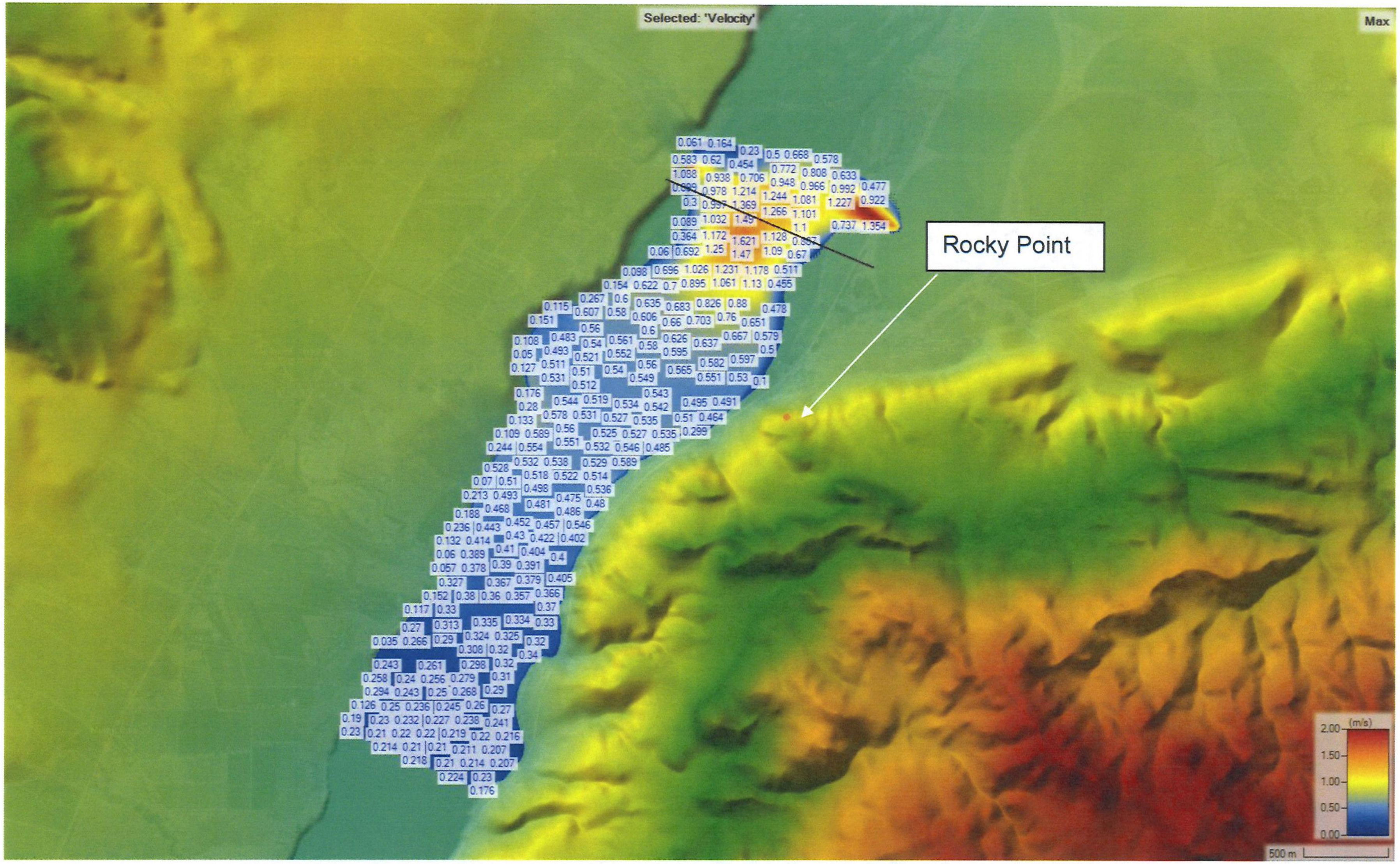


FIGURE 5: MAXIMUM FLOOD VELOCITY FOR SCENARIO #2 -DISCHARGE 1000 m^3/s

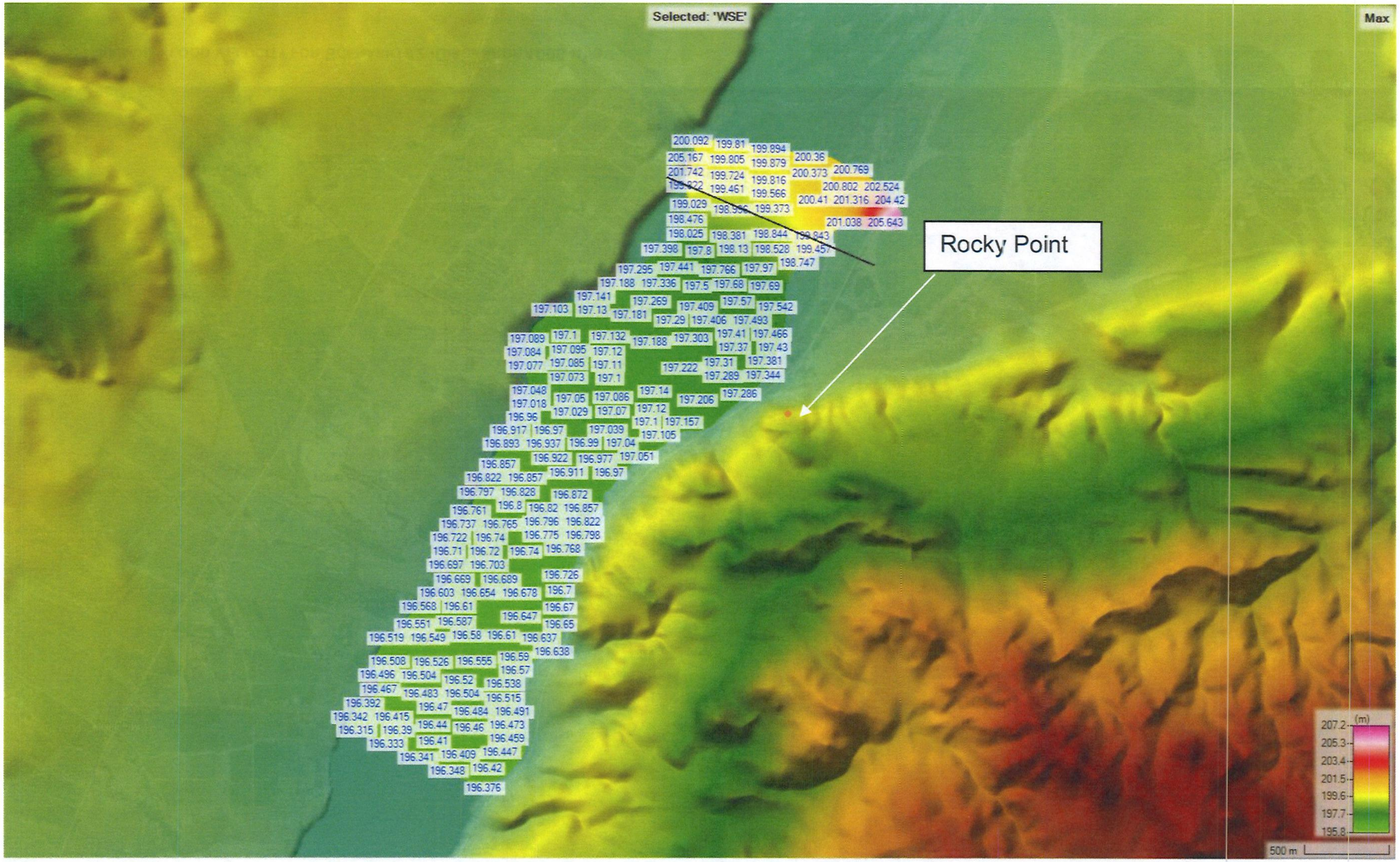
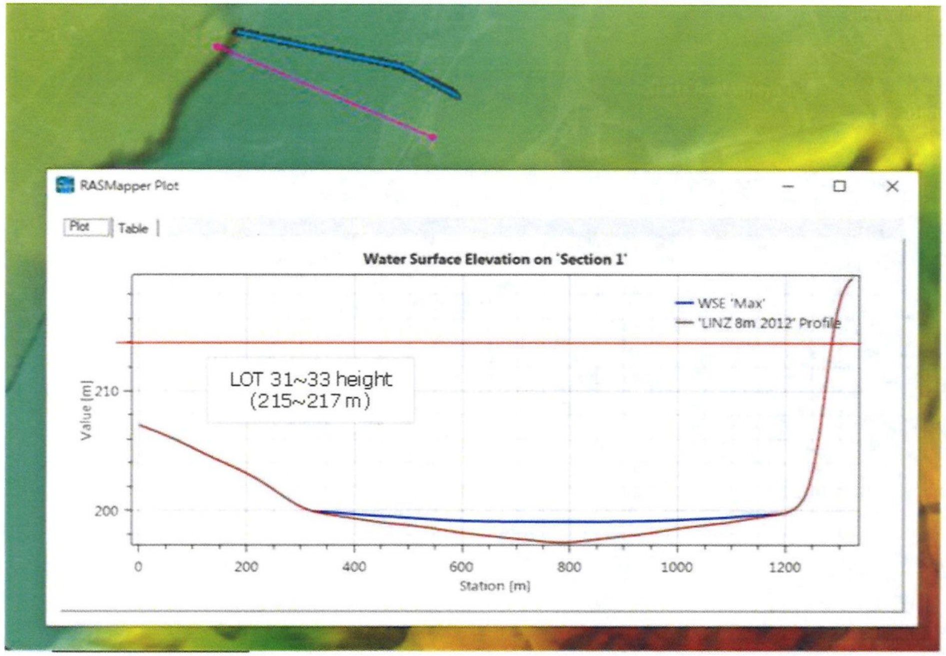


FIGURE 6: MAXIMUM FLOOD WSE FOR SCENARIO #2 -DISCHARGE 1000 M^3/S



Low point of Site: 215-217m (Lot 31, 32, 33)

Case #1

W(m)	1200		Assumed: Simplize (Rectangle) roughly
H(m)	10		
A(m2)	12000		
V(m/s)	2.10		
n	0.06		
R(m)	9.84	A/P	
S	0.00075	m/m	
Q	25,144.42	m3/s	

Case #2 for modelling

W(m)	884		Assumed: Simplize (triangle) roughly
H(m)	3		
A(m2)	1326		
V(m/s)	0.72		
n	0.05		
R(m)	1.50	A/P	
S	0.00075	m/m	
Q(m3/s	951.68		OK

$$Q = VA = \left(\frac{1.00}{n}\right) A R^{\frac{2}{3}} \sqrt{S} \quad [SI]$$

Where:

- Q = Flow Rate, (ft^3/s)
- v = Velocity, (ft/s)
- A = Flow Area, (ft^2)
- n = Manning's Roughness Coefficient
- R = Hydraulic Radius, (ft)
- S = Channel Slope, (ft/ft)

FIGURE 7: CLUTHA RIVER FLOW CAPACITY CHECK BY MANNING EQUATION.

5 Model updates - 25 October 2024

The surface within Lots 27-30 was updated in the HECRAS model with a new right of way, culvert, and channel to guide the upstream flows around proposed building sites. The channel depth ranges 0.3m-0.8m with a total top width ranging from 4m-7m. The modelled showed localized ponding on the building platforms however this is simply spill over from upstream areas that have not drained away due to the flat grade of the platforms. The cross sections shown in the following figures were taken through the centroid of each platform to show the clearances from the top water levels to the platforms levels.

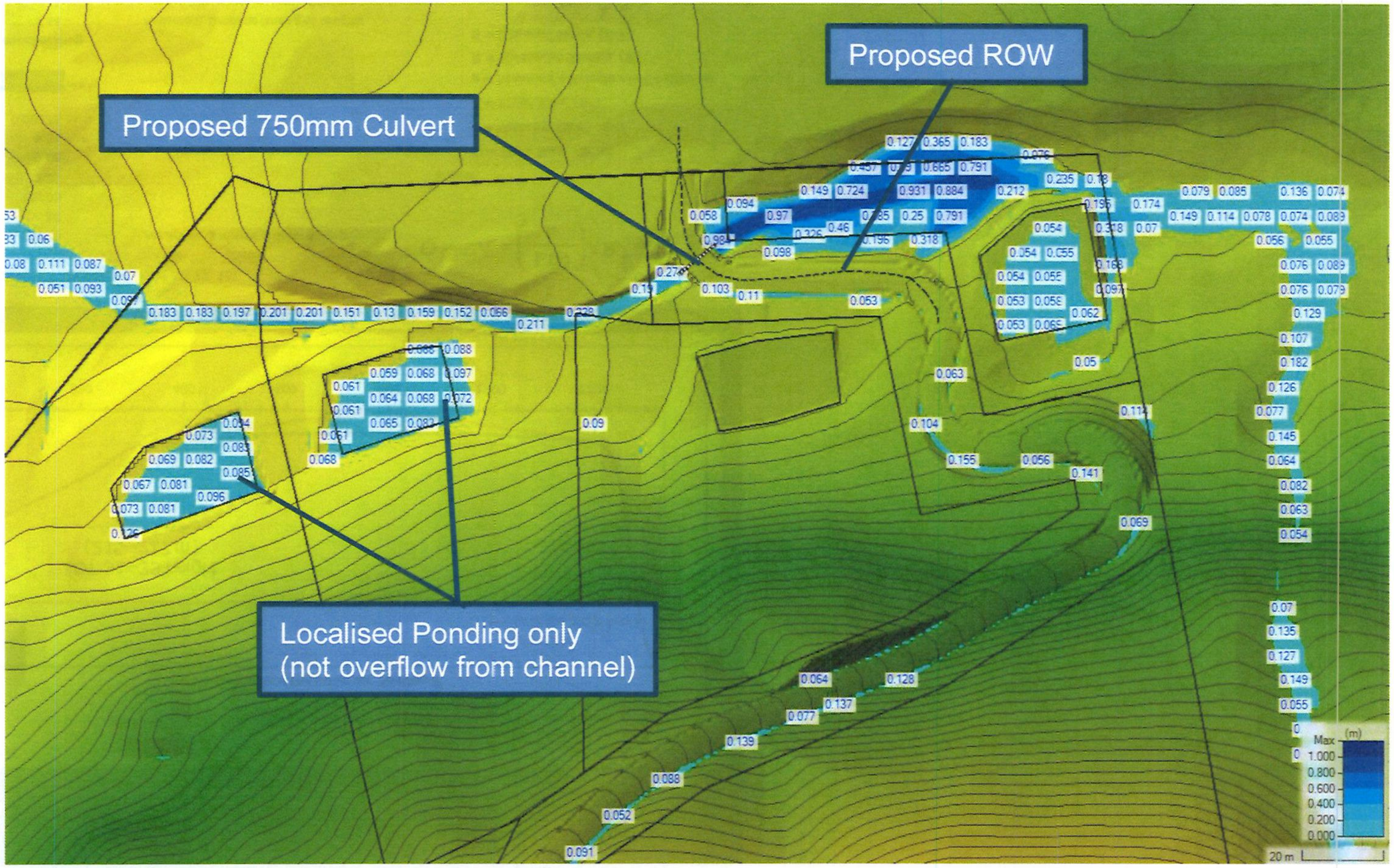


FIGURE 8: MAXIMUM 100YR FLOOD DEPTHS IN LOTS 27-30

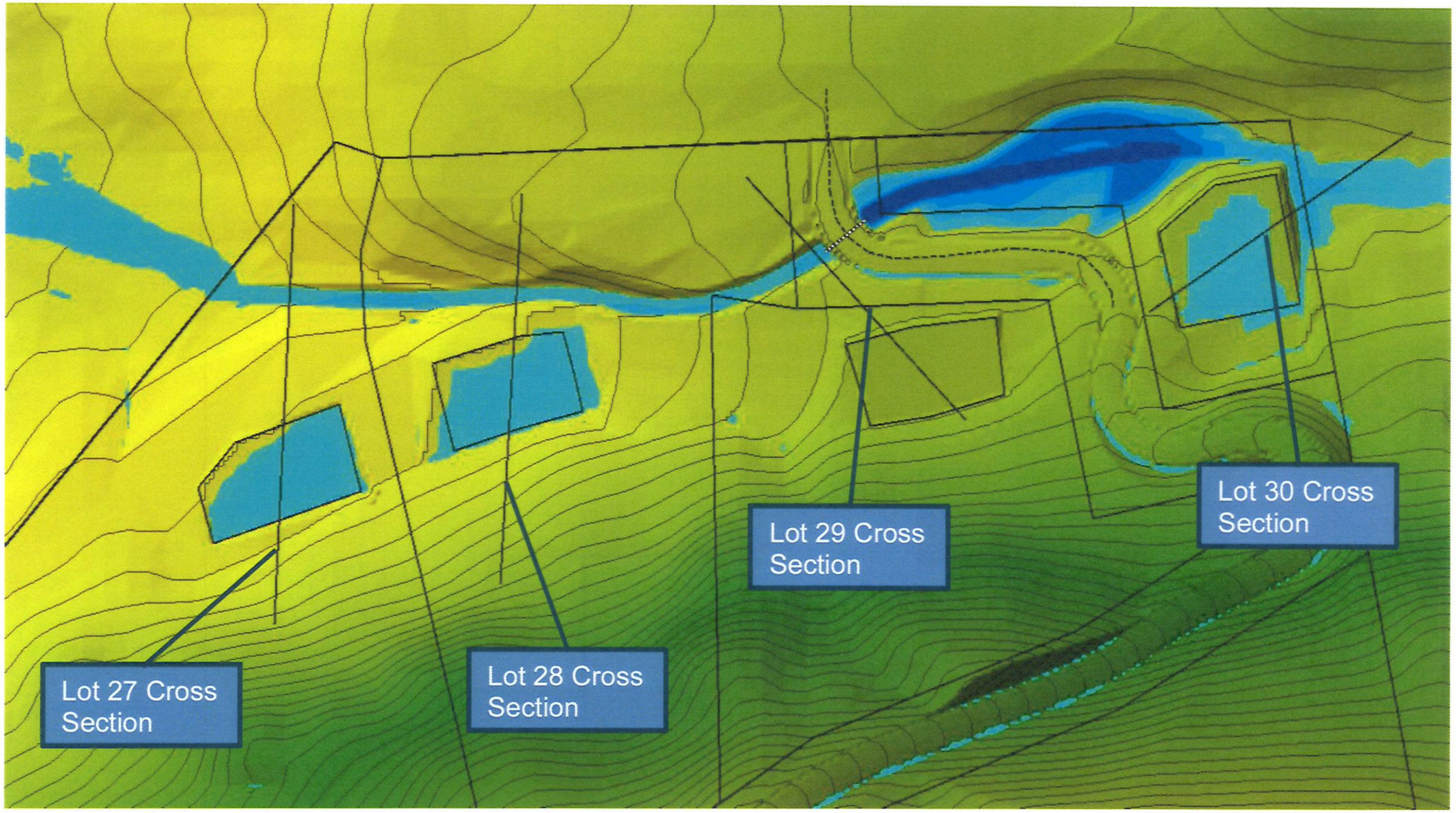


Figure 9: Cross Section locations

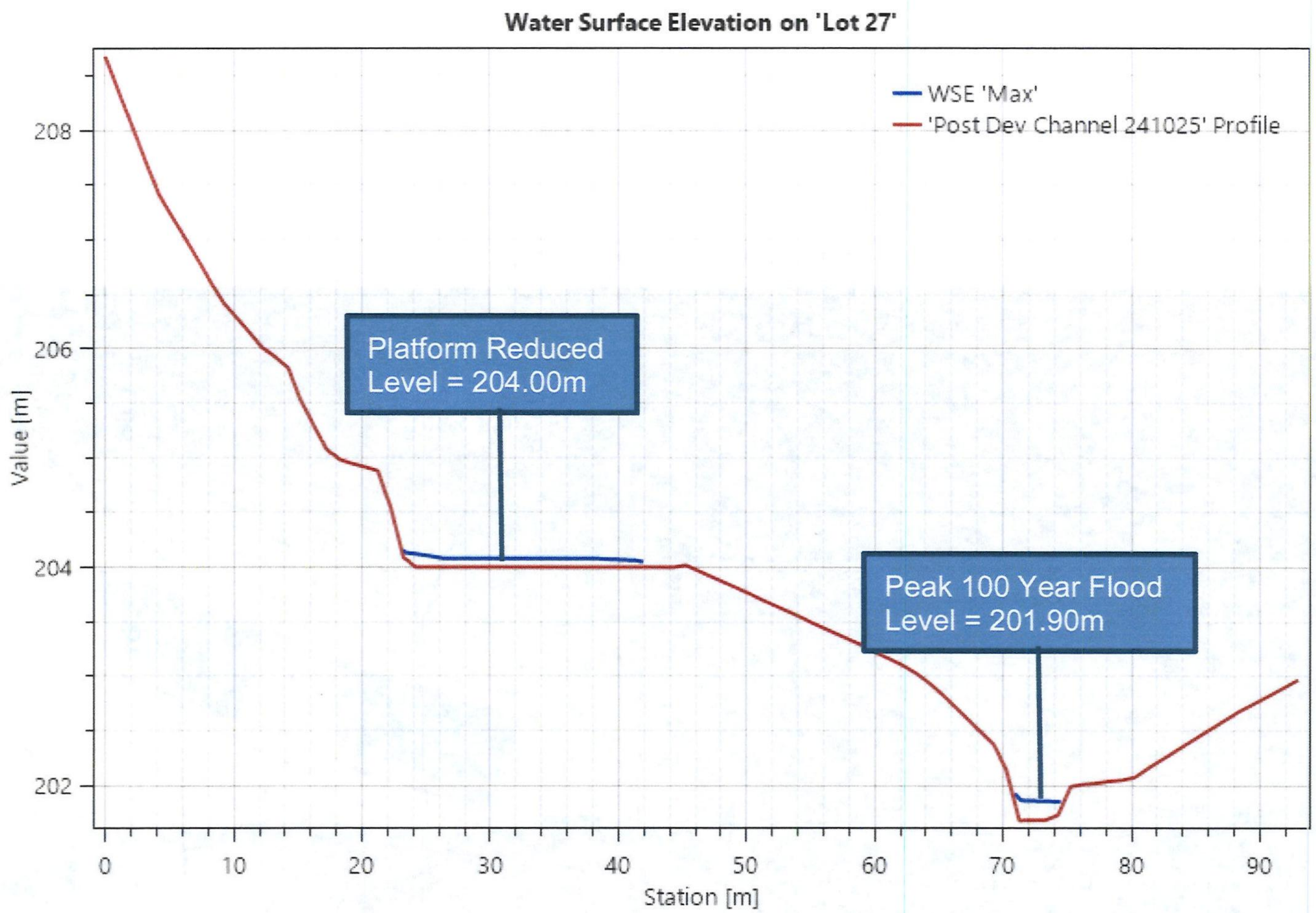


FIGURE 10: LOT 27 CROSS SECTION

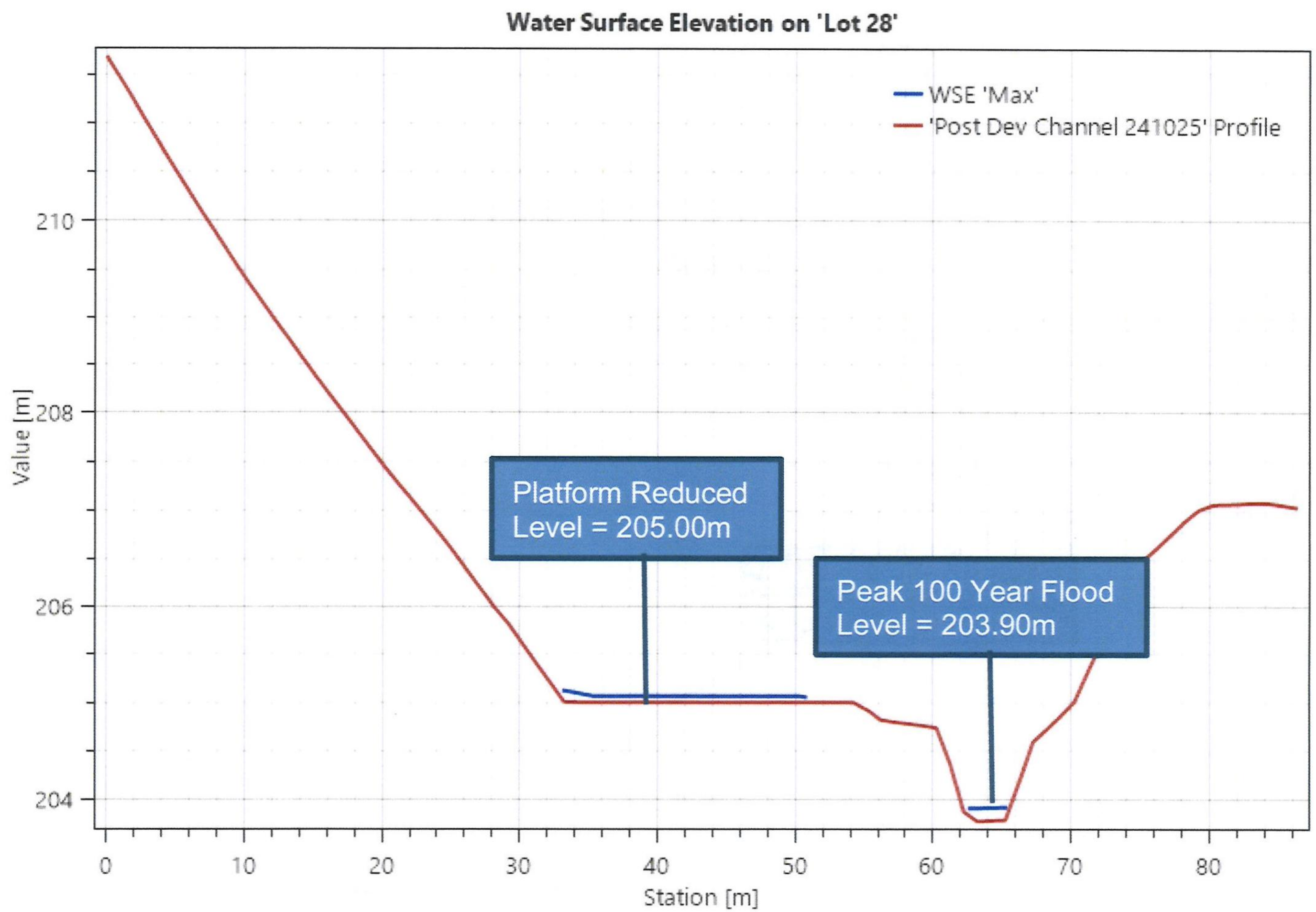


FIGURE 11: LOT 28 CROSS SECTION

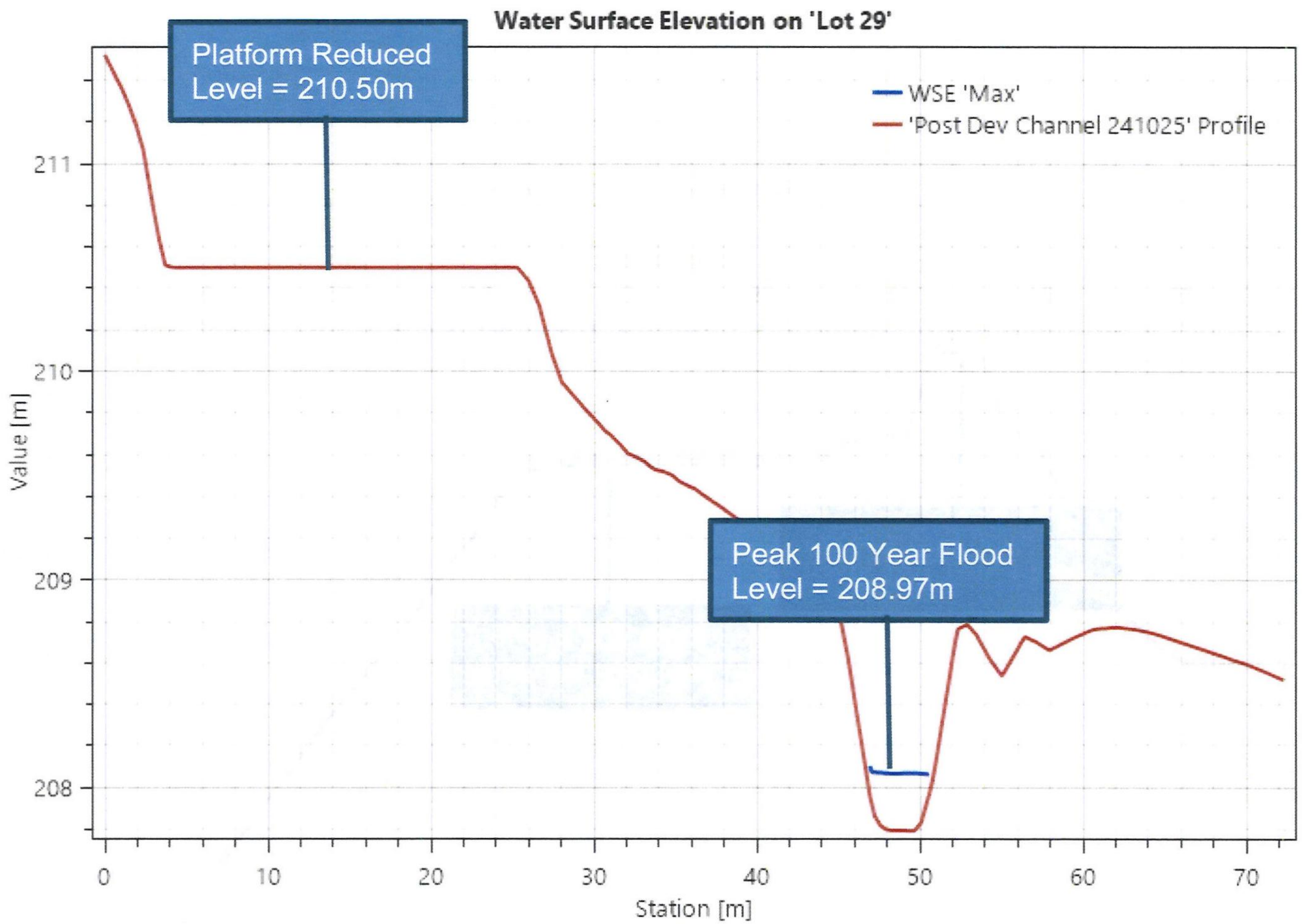


FIGURE 12: LOT 29 CROSS SECTION

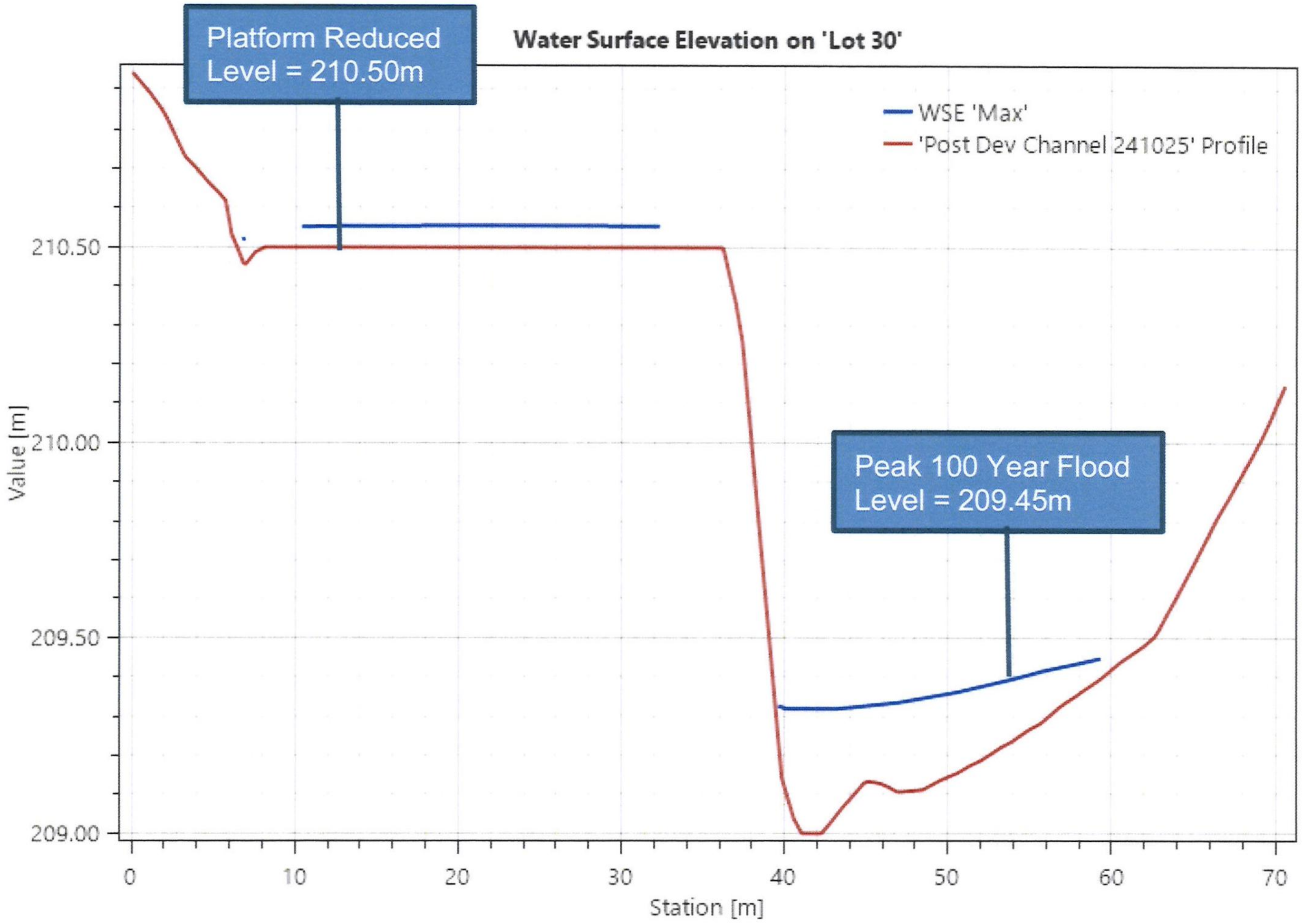


FIGURE 13: LOT 30 CROSS SECTION