To

Kiwi Property

From

Woods
Bidara Pathirage – Senior Associate Engineer
Shakti Singh – Engineer – 3 Waters

W-REF: P24-447 Drury Centre Stage
18 September 2025
Reviewer:
Pranil Wadan – Technical Director
Boniface Kinnear – Senior Associate Engineer

Road 25 Culvert Design Memorandum

Drury Centre Stage 2 - Fast Track

1. Introduction

Drury Centre Stage 2 is a proposed residential and commercial development in Drury, Auckland. This memorandum has been prepared as a response to the further information requested by Expert Panel under Section 67 of the Fast-track Approvals Act 2024, specifically for;

***"Item 7(a)** Drawing no. P24-447-01-3200DR shows the Stage 2 catchment boundary along the eastern side of Lot 42, however there is a blue arrow indicating runoff from a contributing catchment outside the Stage 2 area, flowing in a westerly direction towards Wetland 2-1. Please advise if the proposed stormwater pipes and any other parts of the proposed stormwater infrastructure in Stage 2 have been designed for flow originating from outside Stage 2 and how this is addressed with respect to future land use assumptions in assessing runoff and relevant consent conditions."*

This memorandum has been prepared in response to the request, providing parameters in relation to the design of the culvert and a discussion around future land use assumptions.

The following assessment confirms that proposed stormwater pipes and any other parts of the proposed stormwater infrastructure in Stage 2 have been designed for flow originating from outside Stage 2 with respect to future land use assumptions as per the SWCOP.

2. Background

Flows coming from the contributing catchment outside of Stage 2 flowing in a western direction discharge via a culvert under Road 25 to Stream A, as shown in Drawing No. P24-447-01-3200-DR.

Section 14.6 of the *Drury Centre Stage 2 Stormwater Assessment* (Woods, dated 22/08/25, Version 5) confirms that Stream A has adequate capacity to convey runoff generated from the upstream catchment. This memorandum has been prepared to assess the design of the proposed 900mm diameter culvert under Road 25. As the cross-sectional area of the culvert is less than 3.4m^2 (minor culvert), the design has been assessed in accordance with the Auckland Council's Stormwater Code of Practice, Version 4, July 2025 (SWCoP).

It is noted that there will be another structure located downstream of Stream A and under Road 6 (private road). The structure (proposed to be an arch culvert or bridge structure) will be private with design to be undertaken during the detailed design stage. Based on the current design information, the preliminary freeboard is approximately more than 4m between the maximum water level and proposed Road 6 level.

Figure 1 shows the location of the Culvert under Road 25.

It is noted that all levels provided in this assessment are in NZVD2016 vertical datum.

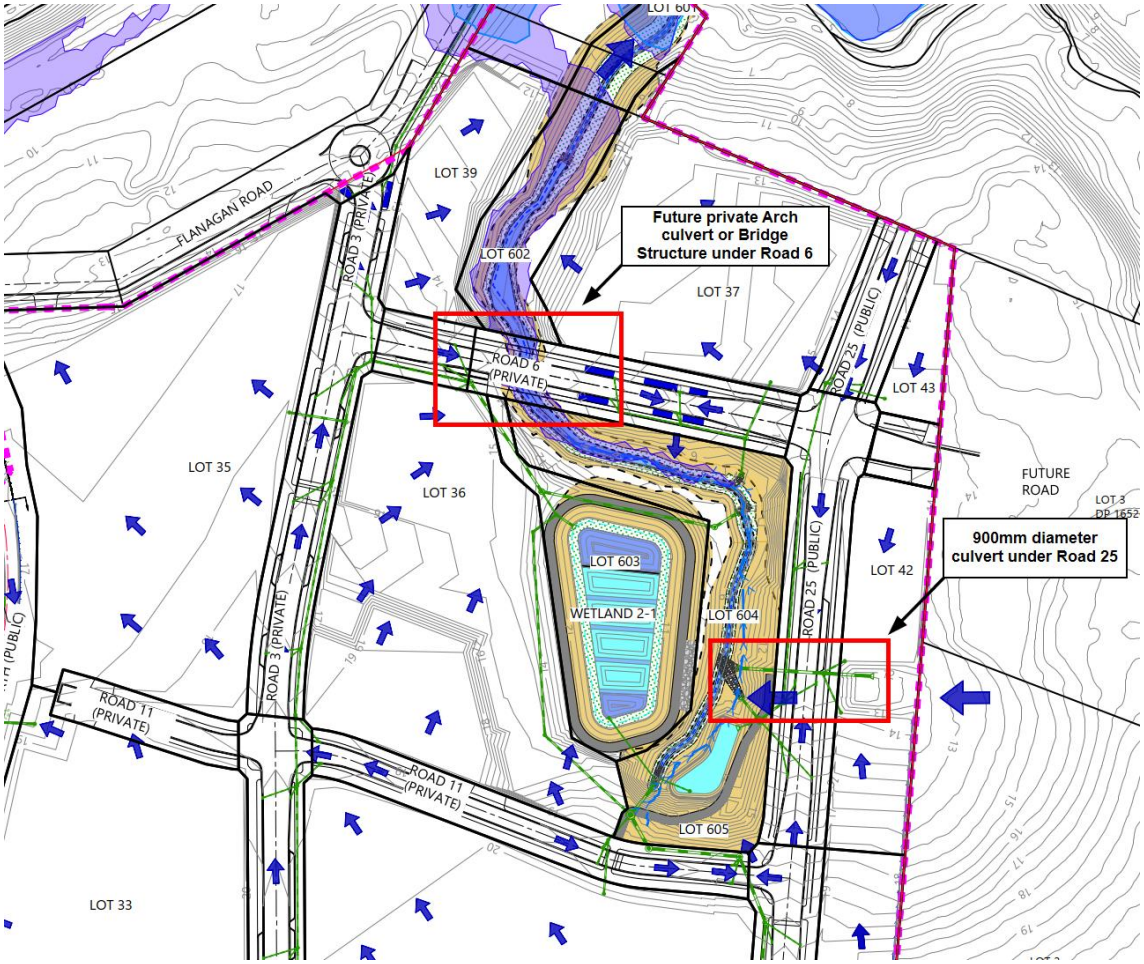


Figure 1: Location of proposed culvert under Road 25

3. Road 25 Culvert design

The proposed development incorporates a 900mm diameter culvert under Road 25 to convey runoff discharging from the upstream contributing area (inclusive of area outside of the site).

3.1. Peak flow calculation

Based on the design surface and existing landform information, a total area of 2.76 ha has been identified as contributing runoff to the culvert. This comprises 2.06 ha from outside the Stage 2 boundary (consistent with Auckland Council GeoMaps) and 0.7 ha from Lots 41 and 42. While a portion of the lot area will drain directly to Road 25, the full lot area has been conservatively included in the calculation. For the external catchment, a Maximum Probable Development (MPD) impervious coverage of 70% has been assumed (in line with Auckland Council GeoMaps), while for Lots 41 and 42, an impervious coverage of 100% has been applied.

Rainfall-runoff methodology as stated in the TP108 (published by Auckland Council, 1999) has been used to calculate the peak flow. The hydrological parameters assumed are in line with the *Overland flow path assessment memorandum* (prepared by Woods, dated 14 July 2025), included as Appendix I to the *Stormwater Assessment Report V5.*

The peak flow associated with the subcatchments for 2-year, 10-year and 100-year ARI storm event with consideration for maximum Probable Development (MPD) and allowance for future temperature increase of 3.8°C by 2110 are given in Table 1.

Table 1: Peak flows reaching culvert for 2-year, 10-year and 100-year ARI storm event (with allowance for 3.8ºC future climate change)

Storm event (+3.8°C)	**Peak Flow (m^3/s)**
2-year ARI	0.30
10-year ARI	0.65
100-year ARI	1.11

Attachment 1 contains the hydrological parameters and the TP108 peak flow calculation.

3.2. Culvert design

This section details the design details of the proposed culvert. Table 2 provide a summary of the proposed culvert design.

Table 2: Culvert design details

Diameter	900mm
Culvert type	Single broken-back
Upstream invert level	11.53 m RL (NZVD16)
Downstream invert level	9.44 m RL (NZVD16)
Break invert level	10.54 m RL (NZVD16)
Downstream channel invert	8.6 m RL (NZVD16)
Inlet and outlet configuration	Installed with headwalls

In addition to the above, there is a swale located at the inlet of the culvert (see Figure 1), with approximate dimensions as 25m top length, 21m tope width and 2.25m depth. The purpose of the swale is to capture the runoff as it flows from the upstream area before being conveyed by the culvert.

As previously noted, the culvert discharges to Stream A which receives runoff from a wider catchment. The design of the culvert thus considers the tailwater level in Stream A. The tailwater data was extracted from the *Fitzgerald Stream Local Catchment Model* (prepared by Woods) as noted in Table 13 of the *Drury Centre Stage 2 Stormwater Assessment*. The maximum tailwater at the location of the outlet is noted to be 10.22 m RL NZVD46.

3.3. Culvert performance assessment

HY-8 (software from Federal Highway Administration, build June 2, 2021) has been used to assess the performance of the proposed culvert.

Figure 2 shows the analysed crossing and culvert summary table as outputted from HY-8.

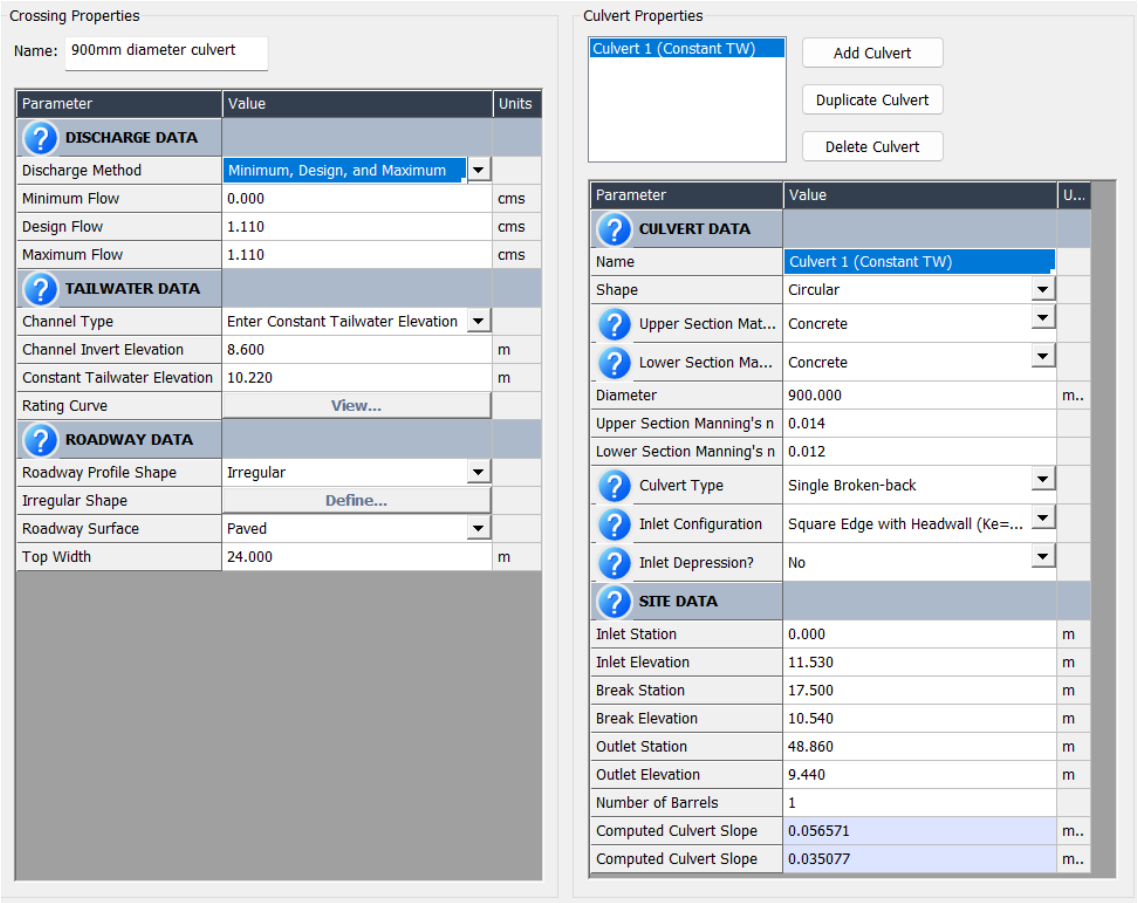


Figure 2: HY-8 input details

The results from the culvert summary table confirm that:

a. For peak flow associated with 100-year ARI storm event.

- The maximum headwater elevation is 12.52m RL while the road embankment level is appx. 13.4m RL. This results in approximately 0.88m of freeboard from the maximum water level to the road embankment level with appx. 1m headwater depth. This is noted to be in line with the requirements of the SWCoP.
- Using the equation $Q = v * A\ (where\ Q\ is\ flow, v\ is\ velocity, and\ A\ is\ area\ of\ flow)$,the maximum velocity of flow in the culvert during 100-year ARI storm event is appx. 4.7m/s. This is noted to be less than the maximum allowable velocity of 6.0m/s and in line with the requirements of the SWCoP.

Figure 3 shows the long section of the culvert for 100-year ARI storm event.

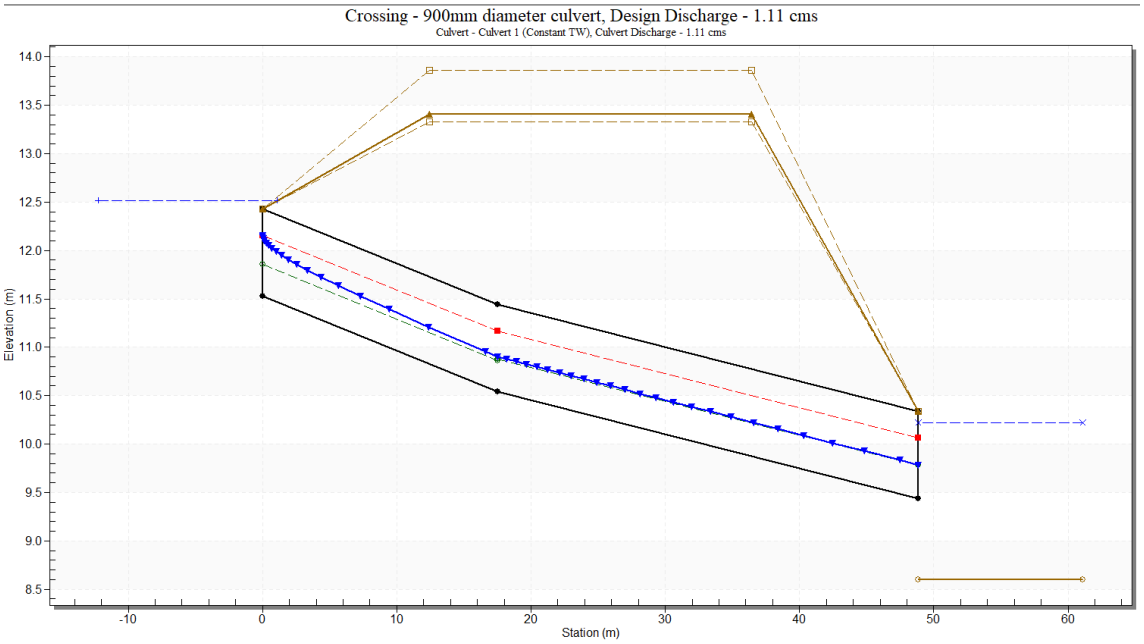


Figure 3: Culvert long section during 100-year ARI storm event

b. For peak flow associated with 10-year ARI storm event.

- The maximum headwater elevation is 12.21m RL (~0.68m headwater depth), while the soffit level of the culvert is appx. 12.43m RL. The results show that headwater depth is not higher than the soffit of the culvert. This is noted to be in line with the requirements of the SWCoP.

Figure 4 shows the long section of the culvert for 10-year ARI storm event.

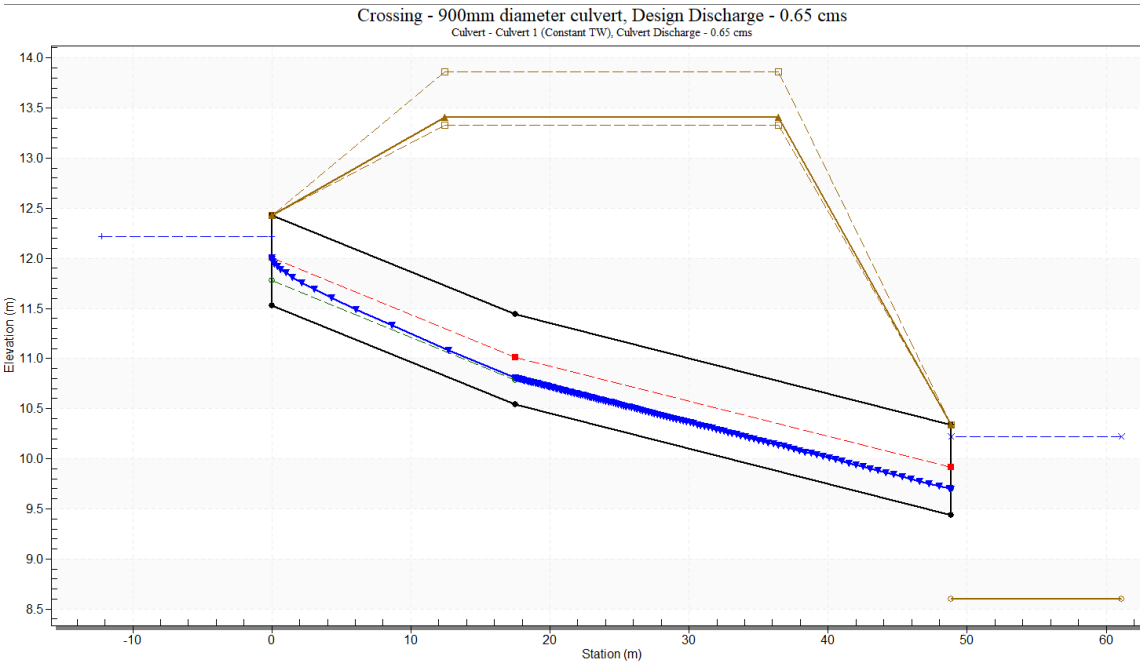


Figure 4: Culvert long section during 10-year ARI storm event

c. For peak flow associated with 2-year ARI storm event.

- Using equation $Q = v * A$ the velocity of flow in the culvert is appx. 3.31m/s which more than the required absolute minimum of 0.6m/s and in line with the requirements of SWCOP.

Figure 5 shows the long section of the culvert for 2-year ARI storm event.

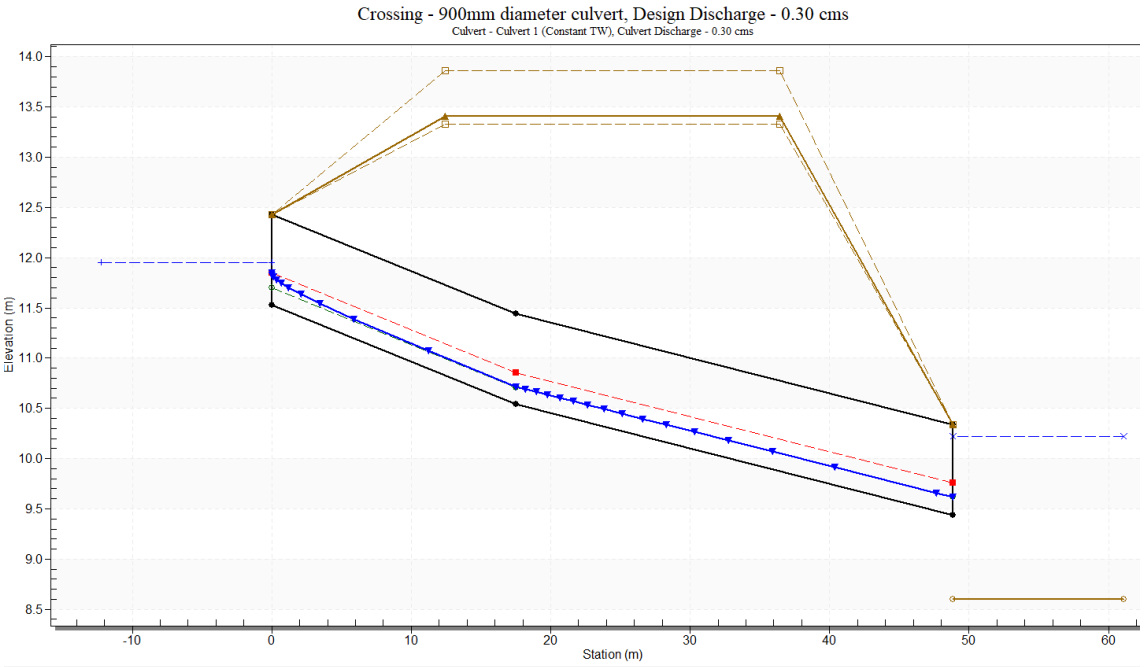


Figure 5: Culvert long section during 2-year ARI storm event

3.3.1. Blockage assessment

As per the SWCOP, any culvert less than 1500mm diameter needs to be assessed with 100% blockage factor. In line with the requirements, a sensitivity scenario has been analysed where the proposed culvert has been fully blocked.

Hydraulic Toolbox (from Federal Highways Administration, Version 5.3) has been used to calculate the maximum overtopping depth on Road 25 for a peak flow of 1.11m^3/s at the location of the road embankment (in a scenario where the runoff reaches the road noting the potential for the water to pond).

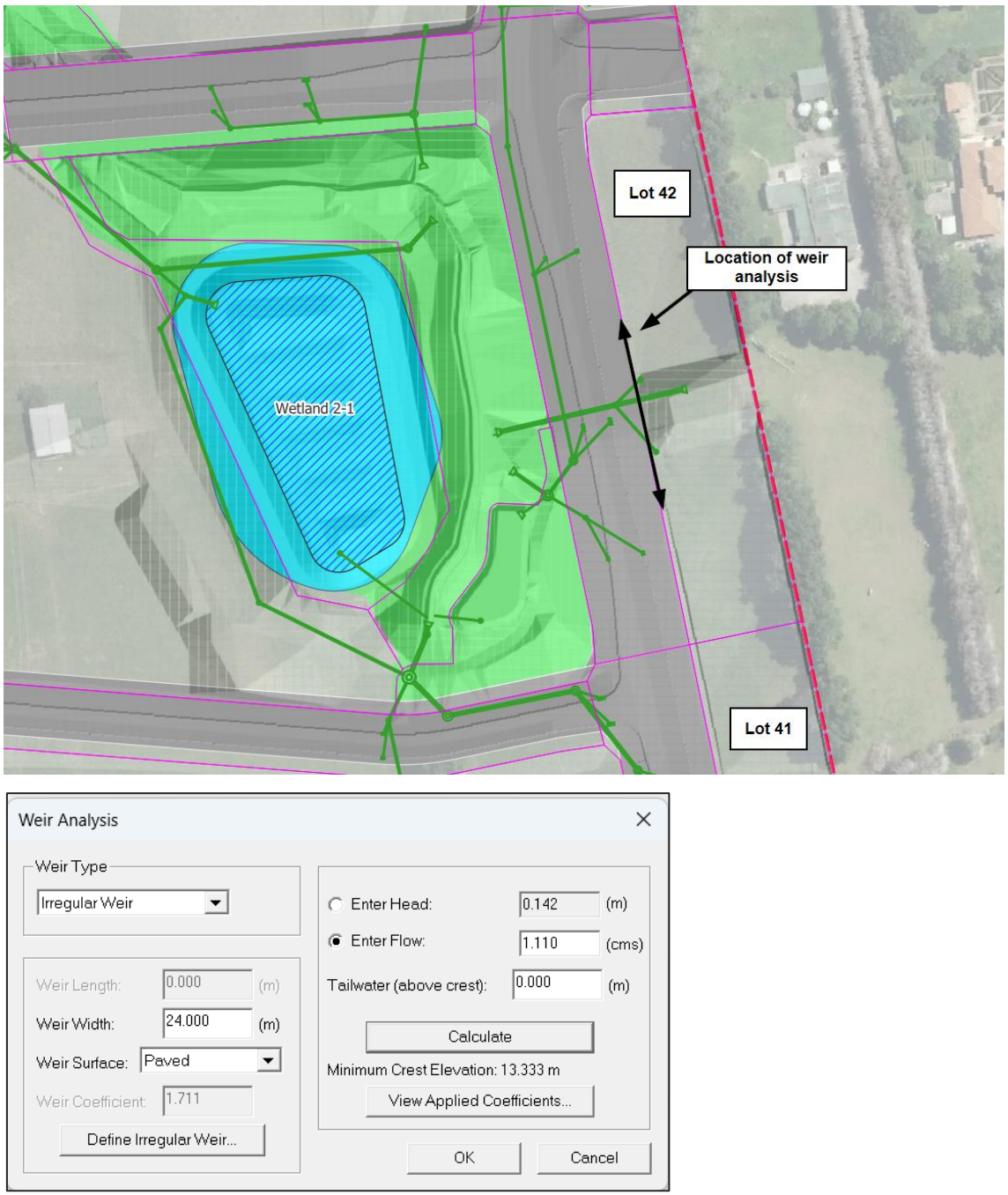
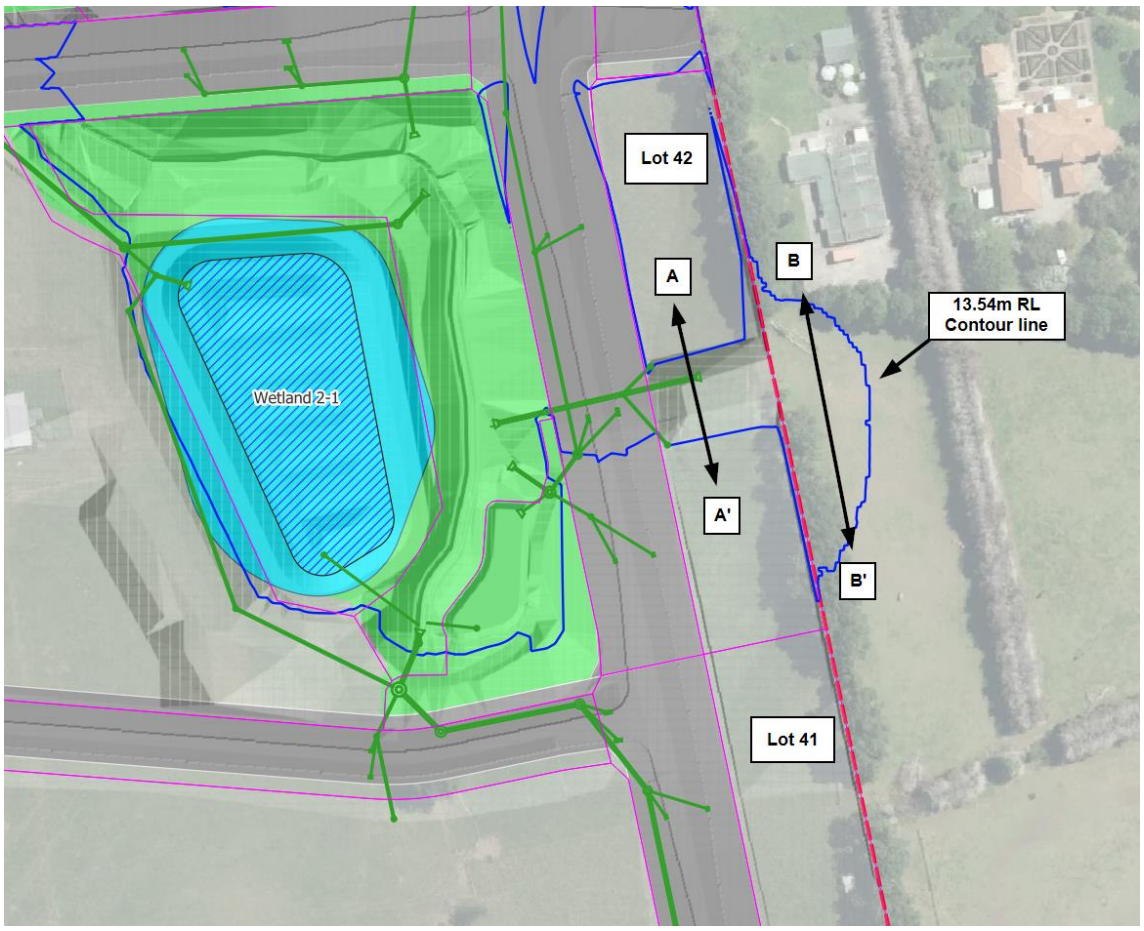


Figure 6: Weir overtopping analysis

As shown in Figure 6, the results from Hydraulic Toolbox indicate an overtopping depth of 142mm, which results in a maximum Water Level of 13.54 m RL [13.4 m RL (road embankment) + 0.142m].

The maximum water level as computed above has been superimposed on two cross sections, at the swale inlet location and outside the Stage 2 boundary.

Figure 7 shows the location of the cross sections and the water level cross sections.



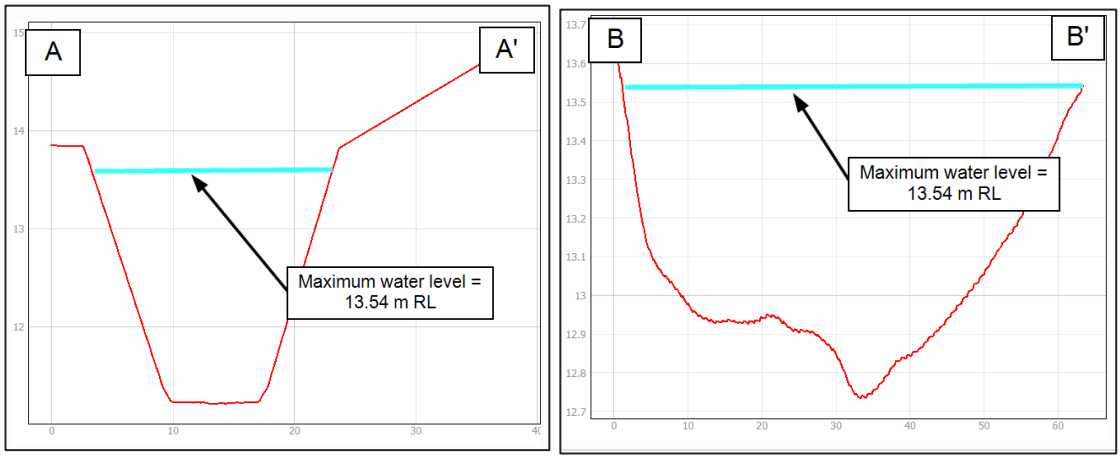


Figure 7: Location of cross section and maximum water level

Based on results presented in Figure 7, it is concluded that:

- The water level will overtop the culvert embankment and traverse downstream to Road 25. However, the runoff will not extend laterally onto Lot 41 and 42 as shown at Cross-section A-A'. During detailed design stage, consideration will be given to the maximum water level on Road 25 (inclusive of scenario when culvert is blocked and runoff overtops onto the road), when finalising the finished floor levels of the buildings located within the lots.
- No existing habitable floor levels located outside the development are deemed to be impacted by flooding as shown in Cross-section B-B'.

3.3.1.1. Road safety assessment

The *Overland Flow Path Assessment* memorandum includes a road safety assessment for the entire road network within Stage 2 (inclusive of Road 25) with consideration of MPD impervious coverage during the 100-year ARI storm event (with allowance for 3.8°C future climate change). The assessment considers the runoff generated from the catchment area outside of Stage 2 boundary.

The assessment confirms that surface water design of Road 25 meets the vehicle and pedestrian safety requirement as stated in Table 3 of *Road Drainage* (Version 1.2) of AT TDM.

4. Dam review assessment

The proposed culvert has been assessed in line with the requirements stated in Section 4.3.9.8 of SWCoP. In addition to the several requirements as stated in the document, the following has also been assessed;

"If the culvert embankment can be considered a dam under the Building Act 2004 or the Building (Dam Safety) Regulations 2022, the more stringent requirements of the Act and/or Regulations shall prevail and take precedence over those stated here."

According to the Building Act 2004, Section 7(1), a dam

1. Means an artificial barrier, and its appurtenant structures that
    1. is constructed to hold back water or other fluid under constant pressure so as to form a reservoir and
    2. is used for the storage, control or diversion of water or other fluid
2. Includes
    1. a flood control dam; and
    2. a natural feature that has been significantly modified to function as a dam; and
    3. a canal; but
3. does not include a stop bank design to control floodwaters

The embankment structure constructed to accommodate the 900mm diameter culvert does not meet the statutory definition of a dam under the Building Act for the following reasons:

1. No retention or reservoir formation
    - The structure is a conveyance asset. Water is not held back under constant pressure, and no reservoir is formed.
2. Not used for storage
    - The structure does not store water; it solely conveys water beneath a road alignment.
3. Control function incidental, not primary
    - While the culvert provides a controlled pathway for water under the road (a form of hydraulic control), the intent and design are conveyance, not retention or impoundment.
4. Not captured by inclusions
    - The structure is not a flood control dam, a modified natural feature acting as a dam, or a canal.

While it can be argued that the structure serves a control function (conveying water under a road) the intent of the design/construction is not holding back water/storage thus the definition is not considered to apply i.e., the embankment plus the open bottom nature of the culvert does not meet the Act's definition of a dam.

The Building (Dam Safety) Regulations 2022 applies only to *classifiable dams*. Since the proposed culvert/embankment structure is not a dam under the Building Act definition, it cannot be a classifiable dam and therefore does not fall within the scope of the Regulations.

Additionally, as per Building (Dam Safety) Regulations 2022, *A dam is classifiable if it has a height of 4 or more metres and stores 20,000 or more cubic metres volume of water or other fluid*. In this case, the volume to the road embankment is less than 1300 m^3 which is much lower than the requirement of 20,000 m^3.

Therefore, the relevant requirements to assess the proposal against are those outlined in the SWCoP.

5. Conclusion

Woods have prepared a memorandum as a response to the further information requested by Expert Panel under section 67 of the Fast-track Approvals Act 2024 for the proposed Drury Centre Stage 2 development.

*"**Item 7 a**) Drawing no. P24-447-01-3200DR shows the Stage 2 catchment boundary along the eastern side of Lot 42, however there is a blue arrow indicating runoff from a contributing catchment outside the Stage 2 area, flowing in a westerly direction towards Wetland 2-1. Please advise if the proposed stormwater pipes and any other parts of the proposed stormwater infrastructure in Stage 2 have been designed for flow originating from outside Stage 2 and how this is addressed with respect to future land use assumptions in assessing runoff and relevant consent conditions."*

- Three proposed structures/infrastructure are identified as receiving flows from areas outside of Stage 2: culvert under Road 25, Stream A, and culvert under Road 6.
- The *Drury Stormwater Assessment* report demonstrates that all structures/ infrastructure identified have sufficient capacity to convey flows from the upstream catchment. The culvert under Road 6 will be privately owned for which the design will be undertaken during the detailed design stage. The impervious coverages used has allowed for a maximum impervious of 70% (based on MPD as per AUP) for the catchment outside of Stage 2 and impervious coverage of 100% for Lot 41 and 42.
- This memorandum reports on the design assessment of the proposed 900mm diameter culvert under Road 25 in line with the requirements of the SWCoP. The design of the proposed culvert was assessed using HY-8 where the including 2-year, 10-year and 100-year ARI storm events (with allowance for 3.8°C future climate change). The results from the assessment demonstrate compliance with the requirements of the SWCoP for all storm events.
- A blockage assessment was also carried out, confirming that runoff from the upstream catchment does not adversely affect the buildings within Lots 41 and 42, nor any existing habitable floor levels outside the development area
- Additionally, a dam review has been undertaken where the design of the road embankment has been assessed against the Building Act 2004, Section 7(1) and Building (Dam Safety) Regulations 2022. The assessment confirms that the structure and the road embankment does not meet the requirements of dam as per the regulations. This confirms that the relevant requirements are those outlined in the SWCoP.
- A separate *Overland Flowpath Assessment* memorandum has been prepared where the pedestrian and vehicle safety for major events has been assessed (including Road 25). The assessment confirms that surface water design of Road 25 meets the vehicle and pedestrian safety requirement as stated in Table 3 of *Road Drainage* (Version 1.2) of AT TDM.
- The assessment further confirms that proposed stormwater pipes and any other parts of the proposed stormwater infrastructure in Stage 2 have been designed for flow originating from outside Stage 2 with respect to future land use assumptions as per the SWCOP.

Attachment 1

	Paste values here
	Do not make any changes

Notes		
	1	ToC adjusted to a minimum of 10mins (0.17hrs) (TP108, 1999)
	2	Check for lag times greater than 0.3 (may be because of slope)
	3	Also check slopes < 1% (may want to assume a minimum of 1% in agreement with your Client)
	4	Once hydrology has been finalised, make a copy and paste as values (filters are not dynamic due to HLOOKUP's)

NOTE: Different coloured cells are NOT dynamic - area is = 0 ha.

instructions:	from overland flow paths generated	length of overland flowpath to site location	(upstream level - downstream level)/length	assume 100% impervious	assume 100% impervious	Assume 0mm	From TP108 contours	assume 0	do not change anything here	do not change anything here	do not change anything here	do not change anything here	do not change anything here	do not change anything here	do not change anything here	do not change anything here	do not change anything here	do not change anything here	do not change anything here	do not change anything here
	Area	Catchment Length	Catchment Slope	Impervious Area (CN - 98)	Pervious Area (CN - 98)	Initial Abstraction	24hr Rainfall depth	Channelsiation factor	Curve Number	Time of concentration	Lag Time	Soil storage parameter	Runoff depth	Runoff index	Column reference from TP108 table	Specific Peak flow	Peak flow rate	Runoff volume	Catchment Discharge
TP108 notation	A	L	Sc	A	A	IA	P_{24}	C	CN	Tc	Lt	S	Q_{24}	c*		q*	q_p	$V_{pervious}$	
Units	ha	km	m/m	%	%	mm	mm			Hrs	Hrs	mm	mm			$m^3/s/(km^2 mm)$	m^3/s	m^3	$m^3/s/km^2$
MPD - CULVERT Road 25 - imp (100yr)	2.14	Tc assumed to be 10 mins		100%	0%	0	251	0.6	98.00	0.17	0.11	5.18	245.92	0.96	93.00	0.17	0.90	5267.63	41.83
MPD - CULVERT Road 25 - perv (100yr)	0.62			0%	100%	5	251	0.6	74.00	0.17	0.11	89.24	180.51	0.57	54.00	0.14	0.21	1115.57	34.16
																	1.11	6383.21	
MPD - CULVERT Road 25 - imp (10yr)	2.14	Tc assumed to be 10 mins		100%	0%	0	152.32	0.6	98.00	0.17	0.11	5.18	147.31	0.94	90.00	0.17	0.54	3155.31	25.24
MPD - CULVERT Road 25 - perv (10yr)	0.62			0%	100%	5	152.32	0.6	74.00	0.17	0.11	89.24	91.74	0.44	41.00	0.12	0.11	566.98	17.56
																	0.65		
MPD - CULVERT Road 25 - imp (2yr)	2.14	Tc assumed to be 10 mins		100%	0%	0	74.63	0.6	98.00	0.17	0.11	5.18	69.78	0.88	84.00	0.16	0.26	1494.75	12.22
MPD - CULVERT Road 25 - perv (2yr)	0.62			0%	100%	5	74.63	0.6	74.00	0.17	0.11	89.24	30.52	0.27	23.00	0.08	0.03	188.60	5.63
										0.17							0.30		

	EXTERNAL	INTERNAL	
IMP	1.44	0.70	2.14
PER	0.62	0.00	0.62
TOTAL	2.06	0.70	2.76