

Appendix 4: Culvert hydraulics

Includes:

- 1) Workings for design of culvert sizes and assessment effects
 - a) assessment of physical existing situation
 - b) assessment of physical proposed situation
 - c) diagrammatic long-sections (existing and proposed)
 - d) HY-8 inputs and outputs.
 - e) culvert schedule

Waterway Crossing Summary – Preliminary design stage

Waterway crossing	Dist. (m)	Catchment area (ha)	Catchment Q100 flow ¹ (m ³ /s)	Fish passage ²	Cross-section (m)	Culvert grade (%)	Culvert length (m)	Stream Diversion (m)	Disturbed waterway length ³ (m)	Comments ⁴
Greenwood Culvert	0,394	162	13.3	Yes	4 x 2 (est.)	0.8	25	-	55	Culvert size still to be confirmed following changes in design philosophy for Otaki to Levin section of expressway
Coopers Culvert	0,715	Secondary flow path	NA	No	3 x 0.450 dia.	2.25	40	-	-	Culvert size still to be confirmed following detailed 2-d modelling of Waitohu Stream floodplain. This culvert is a dry culvert, so no stream is disturbed in its construction.
Waitohu Bridge	0,825	1920	217	Yes	~ 75m span	-	-	-	-	Bridge span matches GWRC fairway width for stream channel – allows for potential lateral migration of the channel over time due to geomorphologic instability induced by change in stream slope and gravel deposition
Waitohu Tributary Culvert	0,935	Secondary flow path	NA	Yes	5 x 1 (est.)	0.125	40	-	60	Culvert size still to be confirmed following detailed 2-d modelling of Waitohu Stream floodplain
Te Manuoa Culvert	1,650	37	3.2	No	0.450 dia.	1.0	5 (est.)	-	10	Minor culvert extension. This refers to the existing 450mm dia. pipe that goes under the existing SH1. A small drainage network is upstream of this pipe (rather than a stream). The existing pipe will need to be extended slightly to allow for the alteration of the local road at this point. Both 450mm pipe and any overland flow discharge into the railway wetland remnant. This eventually discharges to the Mangapouri stream, on the upstream side of the expressway.
Remnant Railway Wetland Outlet Culvert	~ 1,700	NA	NA	Yes ⁵	1.0 dia.	1.73	75	-	95	Hydraulic control for attenuation provided in Railway Wetland (see Technical Report No 9)
Kennedy Wetland Outlet Culvert	~ 1,940	NA	NA	Yes ⁵	1.0 dia.	11	15	-	20	Hydraulic control for attenuation provided in Kennedy Wetland (see Technical Report No 9). The proposed grade of this culvert may need to be refined to allow passage of eels.
Mangapouri Culvert ⁶ (Expressway)	1,940	237	~ 5	Yes	3 x 3	0.5	60	-	100	see Technical Report No 9 for details
Mangapouri Culvert (relocated NIMT railway)	NA	237	~ 5	Yes	3 x 3	0.1	20	-	60	see Technical Report No 9 for details
Rahui Road Overbridge Culvert	NA	NA	NA	No	10 x 2	0.0	~ 20	-	-	see Technical Report No 9 for details
Rahui Road flood relief Culvert	NA	NA	NA	No	1.5 x 0.5	0.87	115	-	-	see Technical Report No 9 for details
Racecourse Culvert	2,195	17	1.8	No	1.5 dia. or 1.35 dia. ⁷	0.5	~ 100	120	210	Proposed capacity to match existing - following discussions with KCDC (Matt Aitchison). This is to retain any hydraulic constriction and attenuation that the current culvert (currently a 1.25m by 1.25m box) is providing. This is important as this channel ends in a formalised soakage area behind a school. see Technical Report No 9 for details – update pending following results of 2-d modelling
Te Roto Culvert	2,620	12	1.0	No	0.525 dia.	0.8	40	-	65	Currently this drainage channel ends in a natural looking soakage bowl. The expressway is proposed to be over this soakage area. In order to replicate the existing conditions, we have included a soakage trench (20m long) to dispose of the water. We have also included an overflow culvert (under the proposed expressway) as is prudent when designing significant soakaways. The minimum project culvert size has been used as the overflow.

¹ Including Climate change to 2090 as mid-range of MfE recommendations.

² Technical Report No 12 (Aquatic Ecology) describes fish passage as required where the stream has a defined channel and has a tributary network, this guidance has been applied here.

³ The disturbed waterway length includes the preliminary design length of the culvert and any stream diversion, plus an allowance for headwall apron lengths and riprap. This is an estimate only; headwall and riprap detail will need to be specifically designed at detail stage.

⁴ Comments on design assumptions, expected details, effects or any other information deemed pertinent.

⁵ Fish passage required for eel species only.

⁶ Currently the proposed culvert under the expressway and the relocated NIMT railway are separate culvert however there is scope to combine these together. This would increase the potential size of the Taylor Basin.

⁷ Depending on alignment of culvert. If perpendicular to expressway, the culvert will be shorter and needs to be 1.35m diameter, or if the culvert is at 45 degrees to the expressway (reducing the length of new stream channel) it will be longer and needs to be 1.5m diameter to provide the same hydraulic throttle as existing.

Project - 5-C1814.00 Peka Peka to North Otaki 440PN
Element - SW - Culvert preliminary design summary

Waterway crossing	Dist. (m)	Catchment area (ha)	Catchment Q100 flow ¹ (m ³ /s)	Fish passage ²	Cross-section (m)	Culvert grade (%)	Culvert length (m)	Stream Diversion (m)	Disturbed waterway length ³ (m)	Comments ⁴
Andrews Culvert/Otaki Overflow Culvert	2950	secondary flow path	stop bank overflow	No	40 x 1.5	at grade	40	-	-	see Technical Report No 9 for details. A small culvert was original proposed for the small catchment behind the stop bank however the need for a large flood diversion culvert (in the event of the stop bank overtoping) removes the need for the small culvert for the local catchment. *
Grahams Culvert	3,300	1	Nominal	No	0.525 dia.	1.0	52	-	56	Minimum project culvert size used.
Otaki Bridge	3,600	> 30600	2,120	Yes	~ 320m span	-	-	-	-	see Technical Report No 9 for details
Mangaone link road (east) Culvert	NA	2495	85.2	Yes	10 x 2 (est.)	1.2	16	-	35	see Technical Report No 9 for details – update pending following results of 2-d modelling
Mangaone Culvert - Expressway	7,250	2495	85.2	Yes	5 x 2 (est.)	2.1	50	-	80	see Technical Report No 9 for details – update pending following results of 2-d modelling
Mangaone link road (west) bridge	NA	2495	85.2	Yes	Single span bridge	-	-	-	-	see Technical Report No 9 for details – update pending following results of 2-d modelling
Lucinsky overflow culvert – link road (west)	NA	Secondary flow path	NA	No	10 x 1 (est.)	0.63	16	-	-	see Technical Report No 9 for details – update pending following results of 2-d modelling
Mangaone Overflow Culvert - local link road (east)	NA	Secondary flow path	NA	No	Not known	at grade	16	-	-	see Technical Report No 9 for details – update pending following results of 2-d modelling
Mangaone Overflow Culvert – Expressway	7,430	Secondary flow path	NA	No	8 x 1.5 (est.)	0.76	50	-	-	see Technical Report No 9 for details – update pending following results of 2-d modelling
School Rd Culvert – link road (east)	NA	NA	NA	No	Not known	at grade	16	400	420	see Technical Report No 9 for details – update pending following results of 2-d modelling
Gear Road Culvert	NA	176	11.0	Yes	3.5 x 2	0.40	20	120	150	Designed for the Q10 flow (6.6m ³ /s) as this is the project level of serve for connecting roads. The road will over top in a Q100 event. Constraining factor is keeping 300mm freeboard in the Q10 event and reducing upstream effects. This culvert has been embedded by 500mm to allow for artificial substrate (increased roughness and low flow channel formation) to facilitate fish passage.
Gear Expressway Culvert	8,610	176	11.0	Yes	5 x 2	0.37	40	40	90	These culverts operate within a common flood zone; have a common tail water condition controlled by water flowing through and over the rail and SH1 culverts. Constraining factor is reducing upstream effects.
Settlement Heights Culvert	8,910	308	21.1	Yes	10 x 2	0.26	40	110	170	The new culverts under the expressway have been sized utilising a 300mm differential between upstream and downstream. This is compromise between keeping the increase in upstream flooding levels to a minimum whilst being aware of the culvert size required to achieve this. These culverts have been embedded by 500mm to allow for artificial substrate (increased roughness and low flow channel formation) to facilitate fish passage.
Coolen Culvert	8,980	6	0.9	No	0.6 dia.	1.0	40	-	44	These culverts do not have defined channels draining to them, nor are they at low points. Any water that bypasses them will drain down to the low point at the Settlement Heights Culvert. As such these culverts have been nominally sized to match the rail culverts immediately downstream. This maintains the existing situation and low flows for ecological use. Flow that bypasses these culverts has been allowed for in the sizing of the Settlement Heights Culvert.
Avatar Culvert	9,370	66	5.7	No	1.2 dia.	3.0	60	-	64	These culverts have not been embedded as fish passage is not expected to be required
Edwin Culvert	9,950	Nominal	Nominal	Yes	1.2 dia.	2.0	100	95	200	The culvert is very close to the much larger Jewell Culvert, and shares the same Q100 head pond. The catchment for this culvert has not been assessed separately from the Jewell catchment. Its purpose is to provide continued ecological flows to the land, stream and proposed wetland immediately down stream. Any flood capacity the culvert provides is incidental. This culvert has been nominally sized as slightly larger than the existing SH1 culvert immediately upstream. It is slightly larger to allow the culvert to have an embedded invert.

Waterway crossing	Dist. (m)	Catchment area (ha)	Catchment Q100 flow ¹ (m ³ /s)	Fish passage ²	Cross-section (m)	Culvert grade (%)	Culvert length (m)	Stream Diversion (m)	Disturbed waterway length ³ (m)	Comments ⁴
Jewell Culvert	10,020	360	21.8	Yes	Twin 3.5 x2.5	1.6	120	-	140	The constraint is the heading up level that the water can be, before it starts to affect the flow of water (and heading up level) through/over the upstream existing rail and SH1 culverts and the level at which water will start to flow onto the adjacent catchment. Our assessment shows that the governing constraint is the level of the LHS swale high point at chainage 10400, which is 22.2m. With the heading up restricted to this level there is no effect on the flood water level upstream of SH1 (or the railway). This culvert has been embedded by 500mm to allow for artificial substrate (increased roughness and low flow channel formation) to facilitate fish passage.
Cavallo Culvert	10,590	21	2.2	Yes	1.5 dia.	1.0	80	160 + 70	320	Assuming 100% of cording catchment also goes to Cavallo culvert – so designed for 3.6m ³ /s. This allows for the Cording Culvert to be deleted from the design. Constraint is the heading up level is lower than 0.5m below the level of the existing SH1. This is so we do not affect the flow of water (and heading up level) through/over the upstream existing SH1 culverts. This culvert has been embedded by 250mm to allow for artificial substrate (increased roughness and low flow channel formation) to facilitate fish passage.
Cording Culvert	10,930	12	1.4	No	0.450 dia.	1.0	70	-	75	Possibly this culvert is not needed if the existing 450mm dia. culvert under the SH1 can be shortened and discharged in to a channel flowing north, along the east side of the expressway. However this culvert is included until this can be confirmed at detail design stage.
Awatea Culvert	11,335	223	13.7	Yes	Twin 1.8 dia.	1.2	68	-	90	The Expressway culvert will replace the existing SH1 culvert. The new culvert will be bigger than the existing (to achieve levels of service). A possible effect will be an increase in flows being allowed downstream. Our assessment shows that the upstream railway culvert acts as the controlling throttle, as such the change in level of the Q100 storage behind the rail embankment remains largely unchanged. One of these twin culverts has been embedded by 350mm to allow for concrete baffles (to create ramps and pools within the culvert) to facilitate fish passage.
Kumototo Culvert	11,630	64	6.4	Yes	Twin 1.5 dia.	1.8	88	-	115	The Expressway culvert will replace the existing SH1 culvert. The new culvert will be bigger than the existing (to achieve levels of service). A possible effect will be an increase in flows being allowed downstream. Our assessment shows that the upstream railway culvert does not act as the controlling throttle, and the level of the Q100 storage behind the rail embankment reduces. However the total amount of storage behind the railway embankment is extremely small and will not have any effect on downstream flood levels. One of these twin culverts has been embedded by 350mm to allow for concrete baffles (to create ramps and pools within the culvert) to facilitate fish passage. Also an inlet drop structure is required to get sufficient cover to the culverts under the expressway; fish ramps and pools will need to be integrated in to this drop structure.

Introduction

This appendix documents the information gathered and used to assess the existing hydraulic situation and to size the proposed culvert sizes.

Where YH-8 has been used the inputs and outputs have been captured.

Key design parameters

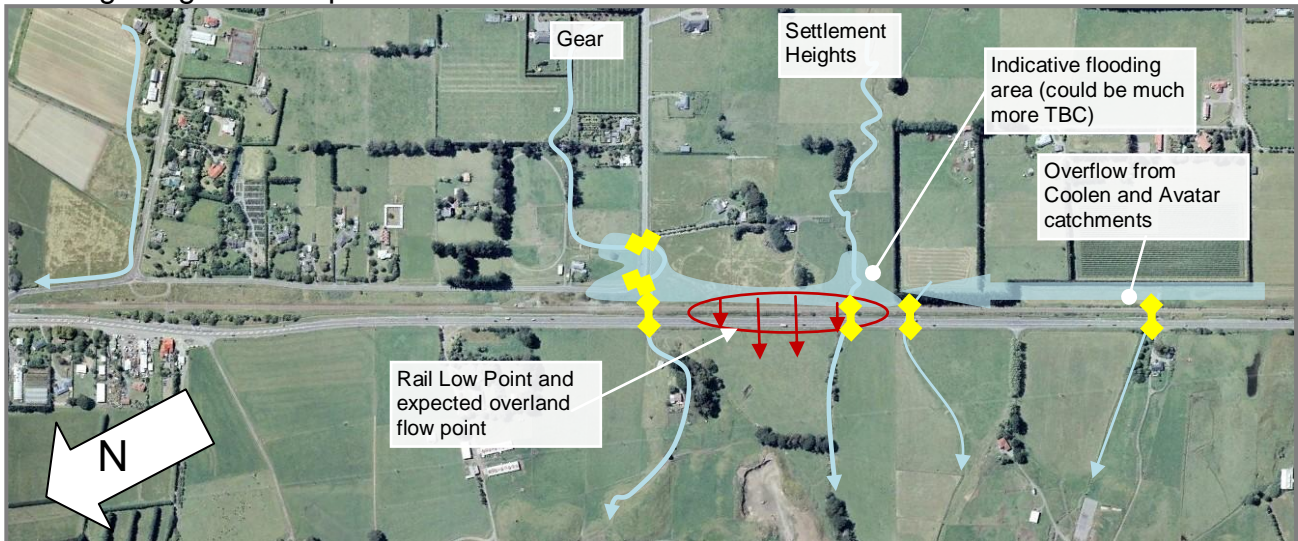
- All flows to include climate change to 2090.
- Q10 flows not to surcharge above culvert soffit.
- Q100 flows not to come within 500mm of road level (300mm at insensitive locations and local roads) and to have a maximum heading up depth of 2m above the soffit.
- Fish passage to be provided where needed (culvert invert embedded).
- Extreme event Q100 + CC+50%

Exceptions

- Due to downstream constraints, in Q10 flow, Gear and Settlement Heights culvert surcharge above soffit. And during Q100 flow have 300mm freeboard
- In extreme event, depending on exact height of bund in LHS swale, the some water from the Jewell catchment may spill over in to the Cavallo catchment. The amount of water will be very small compared to the extreme flows (max 200mm depth over 4m width)

GEAR AND SETTLEMENT HEIGHTS DOWN-STREAM CONDITIONS

Existing Image - conceptual



Commentary

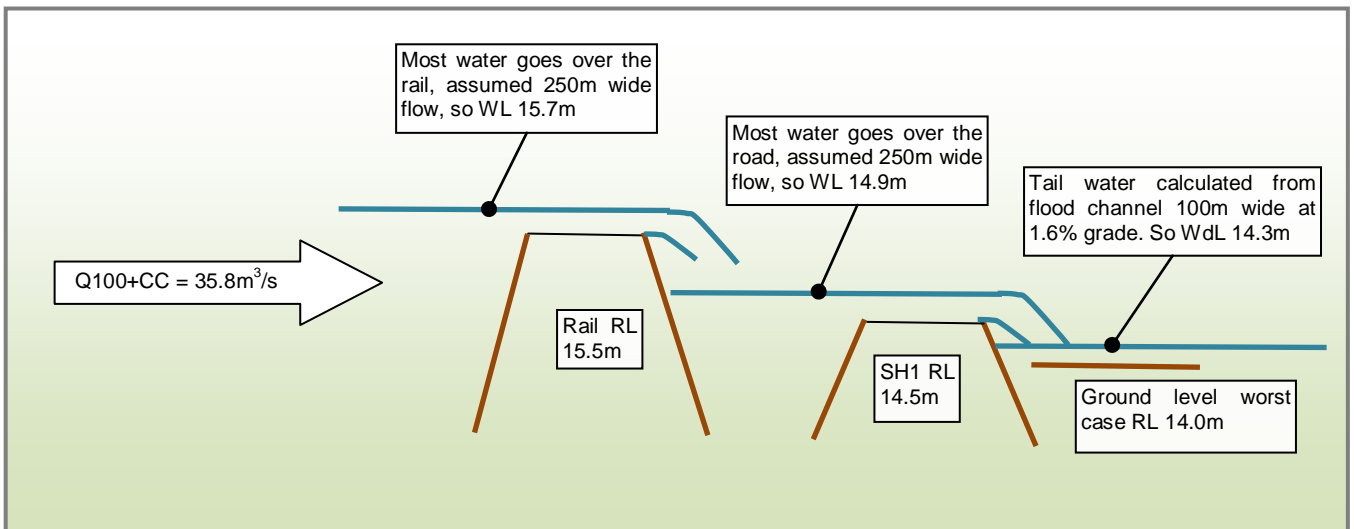
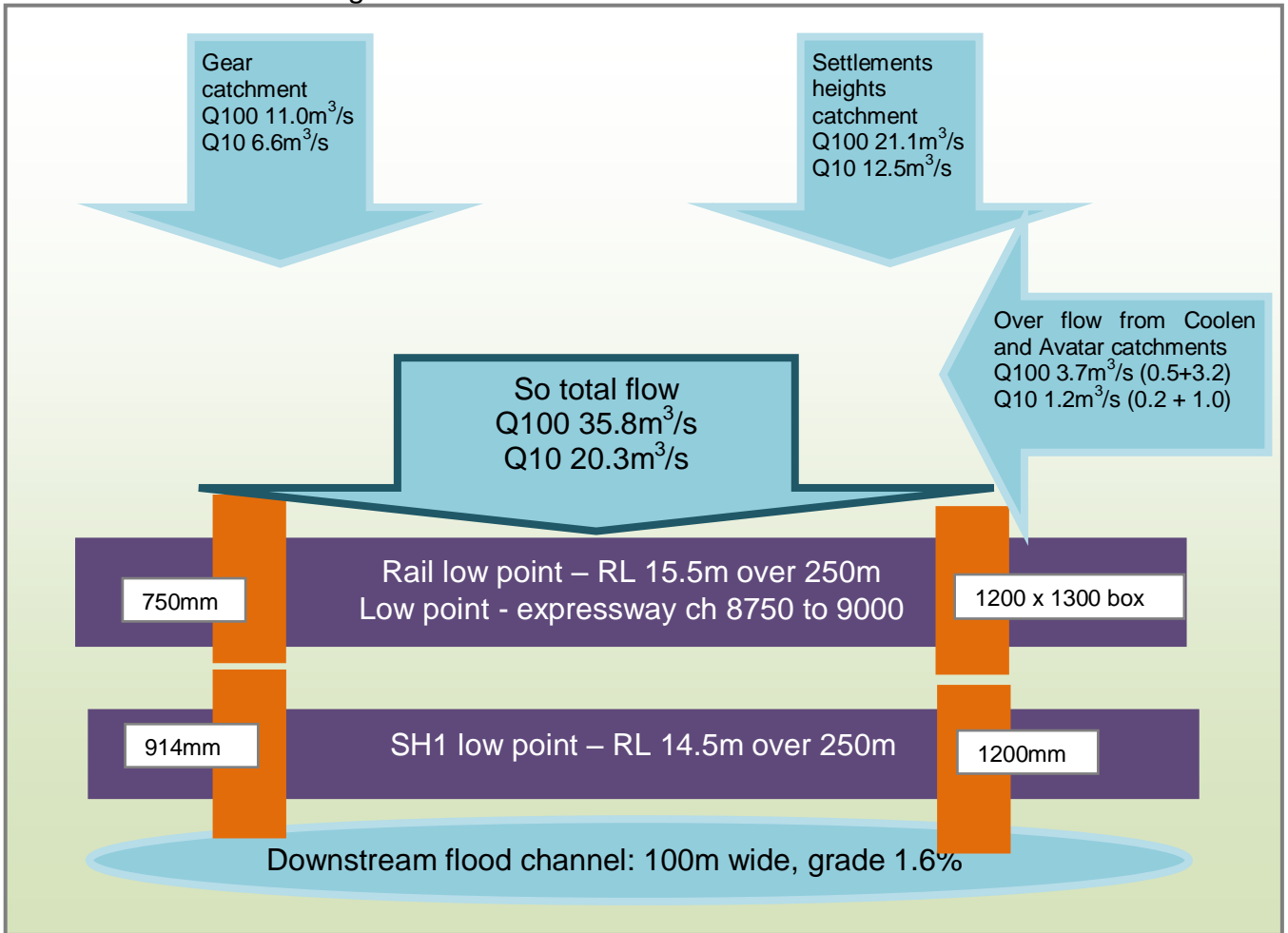
Gear, Settlement heights, Coolen and Avatar catchment work together in an integrated manner. This may not always have been the case but they do now due to the rail embankment. Medium

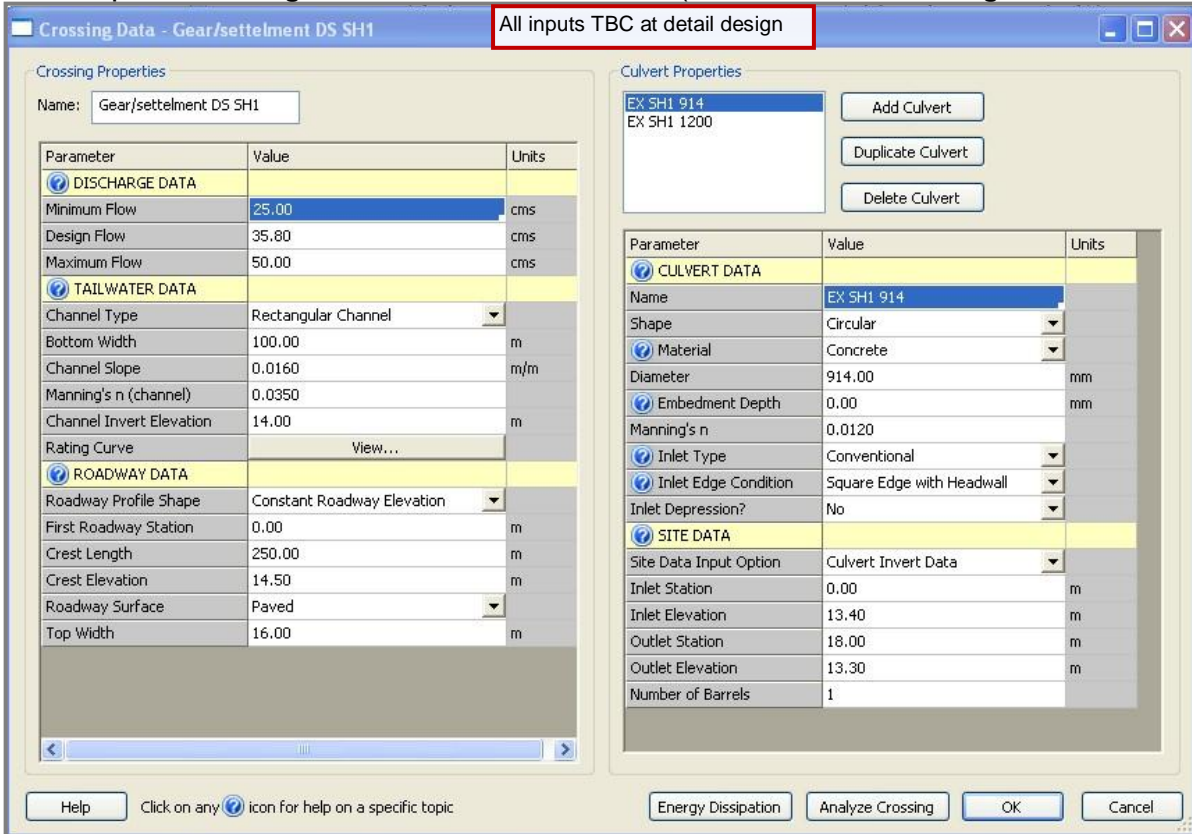
First: Coolen and Avatar culvert were assessed to propose culvert sizes. As the existing situation, the proposed culverts (for these two catchments) are undersized for the Q100 flow (sized to match the existing culvert capacity). The excess flow by-passes them and flows down to the Settlement heights culvert.

Secondly: we considered the downstream tail water level for both the Gear and Settlement heights culverts. The existing Rail culverts are undersized, so the Q100 flows overtop the rail embankment. The rail embankment low point is over about 250m between the Gear and Settlement heights culverts. As such we used a combined flow over the rail embankment (and through the two culvert) to assess the tail water level.

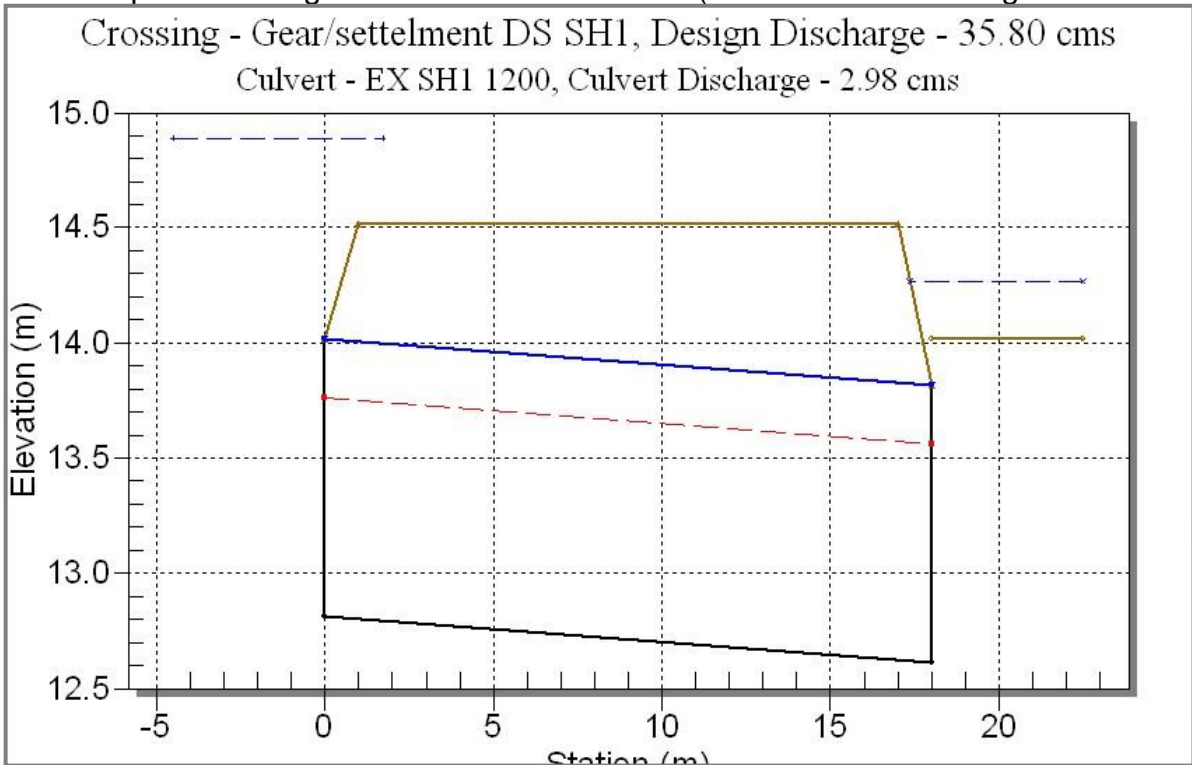
Thirdly: we calculated the size of the Gear and Settlement heights culverts (using the Gear catchment flow for the Gear culvert, and the Settlement heights catchment flow plus the overflow from the Coolen and Avatar catchment for the Settlement heights culvert)

Fourthly: we fed back into the road design team to set a minimum road level in this area.





HY-8 outputs: Existing Road culvert: Q100 + CC (Gear/ Settlement heights road culverts)



HY-8 inputs: Existing rail culvert: Q100 + CC (Gear/ Settlement heights rail culvert)

All inputs TBC at detail design

Crossing Properties

Name: Gear/settlement DS rail

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	20.00	cms
Design Flow	35.80	cms
Maximum Flow	70.00	cms
TAILWATER DATA		
Channel Type	Enter Constant Tailwater Elevation	
Channel Invert Elevation	13.30	m
Constant Tailwater Elevation	14.90	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	250.00	m
Crest Elevation	15.50	m
Roadway Surface	Gravel	
Top Width	12.00	m

Culvert Properties

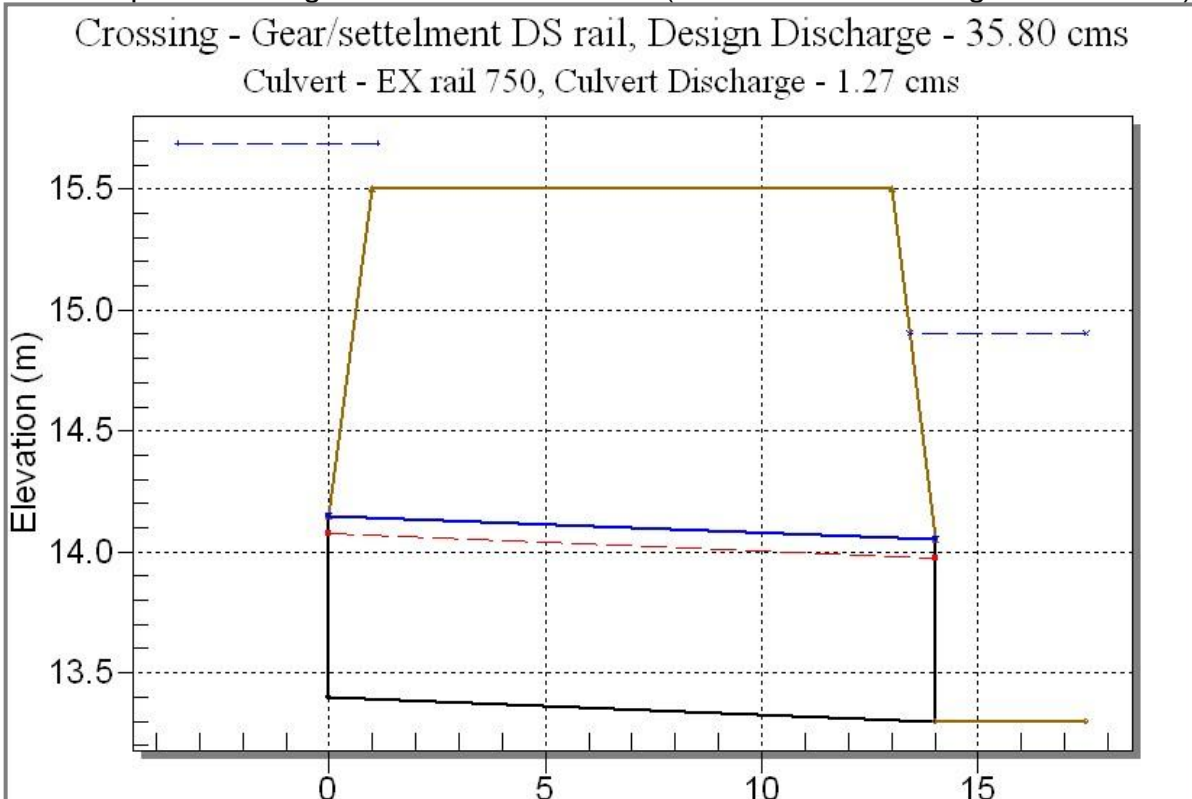
EX rail 750
 Ex rail 1.2x1.3

Add Culvert
 Duplicate Culvert
 Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	EX rail 750	
Shape	Circular	
Material	Concrete	
Diameter	750.00	mm
Embedment Depth	0.00	mm
Manning's n	0.0120	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	13.40	m
Outlet Station	14.00	m
Outlet Elevation	13.30	m
Number of Barrels	1	

Help Click on any icon for help on a specific topic Energy Dissipation Analyze Crossing OK Cancel

HY-8 outputs: Existing rail culvert: Q100 + CC (Gear/ Settlement heights rail culvert)



HY-8 inputs: Existing Rail culvert: Q100 + CC + 50% (Gear/Settlement heights rail culvert)

Crossing Data - Gear/settlement DS rail All inputs TBC at detail design

Crossing Properties
 Name: Gear/settlement DS rail

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	20.00	cms
Design Flow	53.70	cms
Maximum Flow	70.00	cms
TAILWATER DATA		
Channel Type	Enter Constant Tailwater Elevation	
Channel Invert Elevation	13.30	m
Constant Tailwater Elevation	14.90	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	250.00	m
Crest Elevation	15.50	m
Roadway Surface	Paved	
Top Width	12.00	m

Culvert Properties

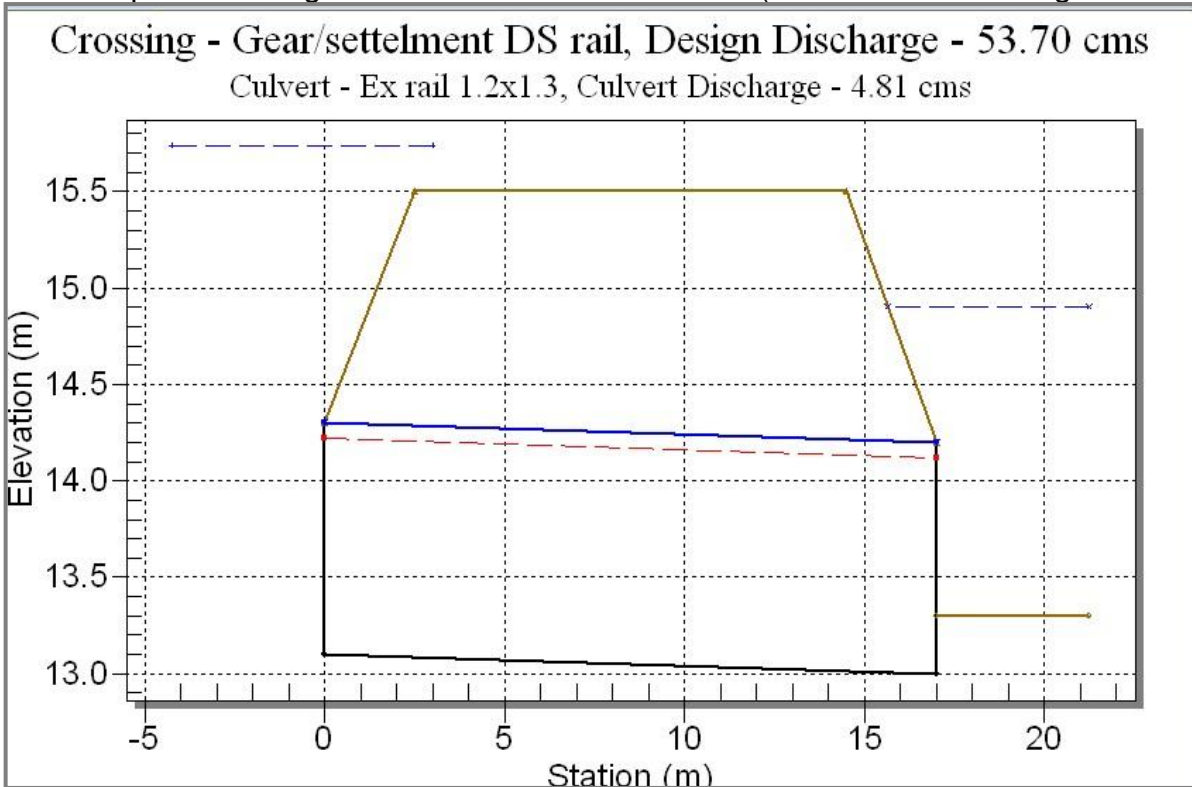
EX rail 750
 Ex rail 1.2x1.3

Add Culvert
 Duplicate Culvert
 Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Ex rail 1.2x1.3	
Shape	Concrete Box	
Material	Concrete	
Span	1300.00	mm
Rise	1200.00	mm
Embedment Depth	0.00	mm
Manning's n	0.0120	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge (90°) Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	13.10	m
Outlet Station	17.00	m
Outlet Elevation	13.00	m
Number of Barrels	1	

Help Click on any icon for help on a specific topic Energy Dissipation Analyze Crossing OK Cancel

HY-8 outputs: Existing Rail culvert: Q100+CC + 50% (Gear/Settlement heights rail culvert)



HY-8 inputs: Existing Rail culvert: Q10 + CC (Gear/Settlement heights rail culvert)

All inputs TBC at detail design

Crossing Properties

Name: Gear/settlement DS rail

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	20.00	cms
Design Flow	20.30	cms
Maximum Flow	70.00	cms
TAILWATER DATA		
Channel Type	Enter Constant Tailwater Elevation	
Channel Invert Elevation	13.30	m
Constant Tailwater Elevation	14.90	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	250.00	m
Crest Elevation	15.50	m
Roadway Surface	Gravel	
Top Width	12.00	m

Culvert Properties

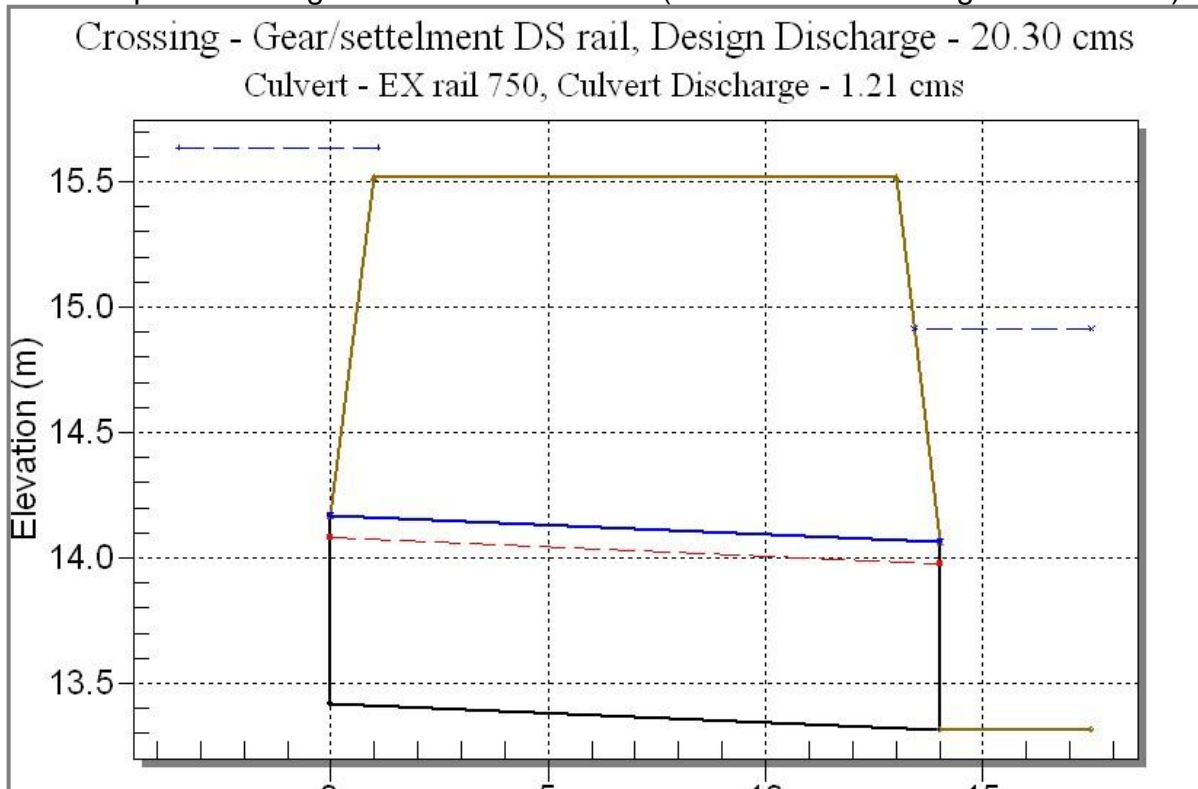
EX rail 750
 Ex rail 1.2x1.3

Add Culvert
 Duplicate Culvert
 Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	EX rail 750	
Shape	Circular	
Material	Concrete	
Diameter	750.00	mm
Embedment Depth	0.00	mm
Manning's n	0.0120	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	13.40	m
Outlet Station	14.00	m
Outlet Elevation	13.30	m
Number of Barrels	1	

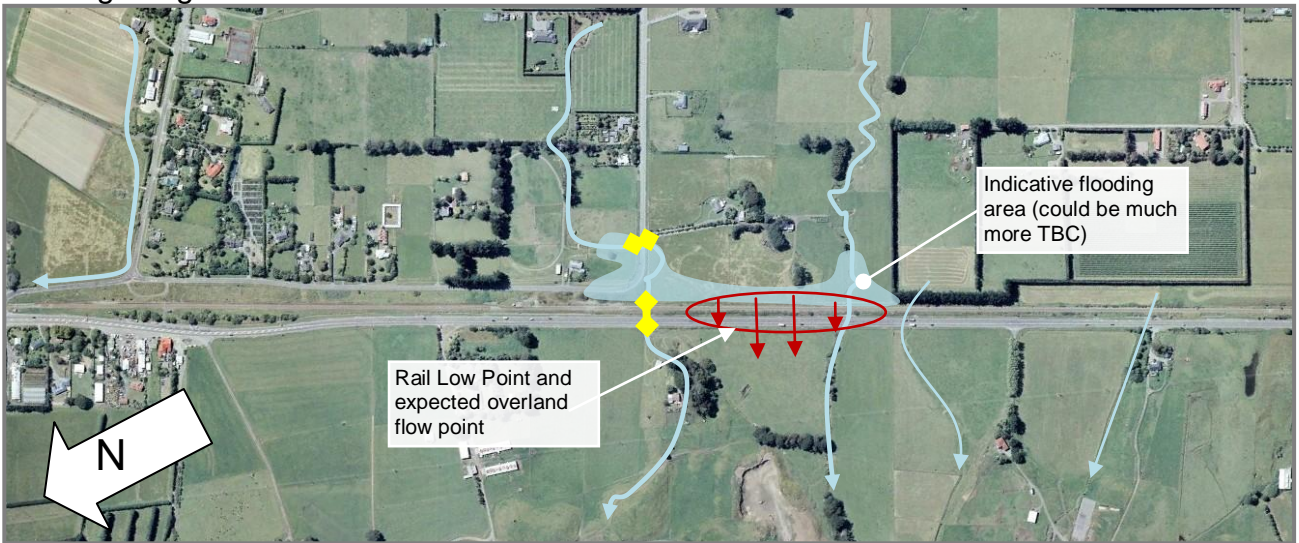
Help Click on any icon for help on a specific topic Energy Dissipation Analyze Crossing OK Cancel

HY-8 outputs: Existing Rail culvert: Q10 + CC (Gear/Settlement heights rail culvert)

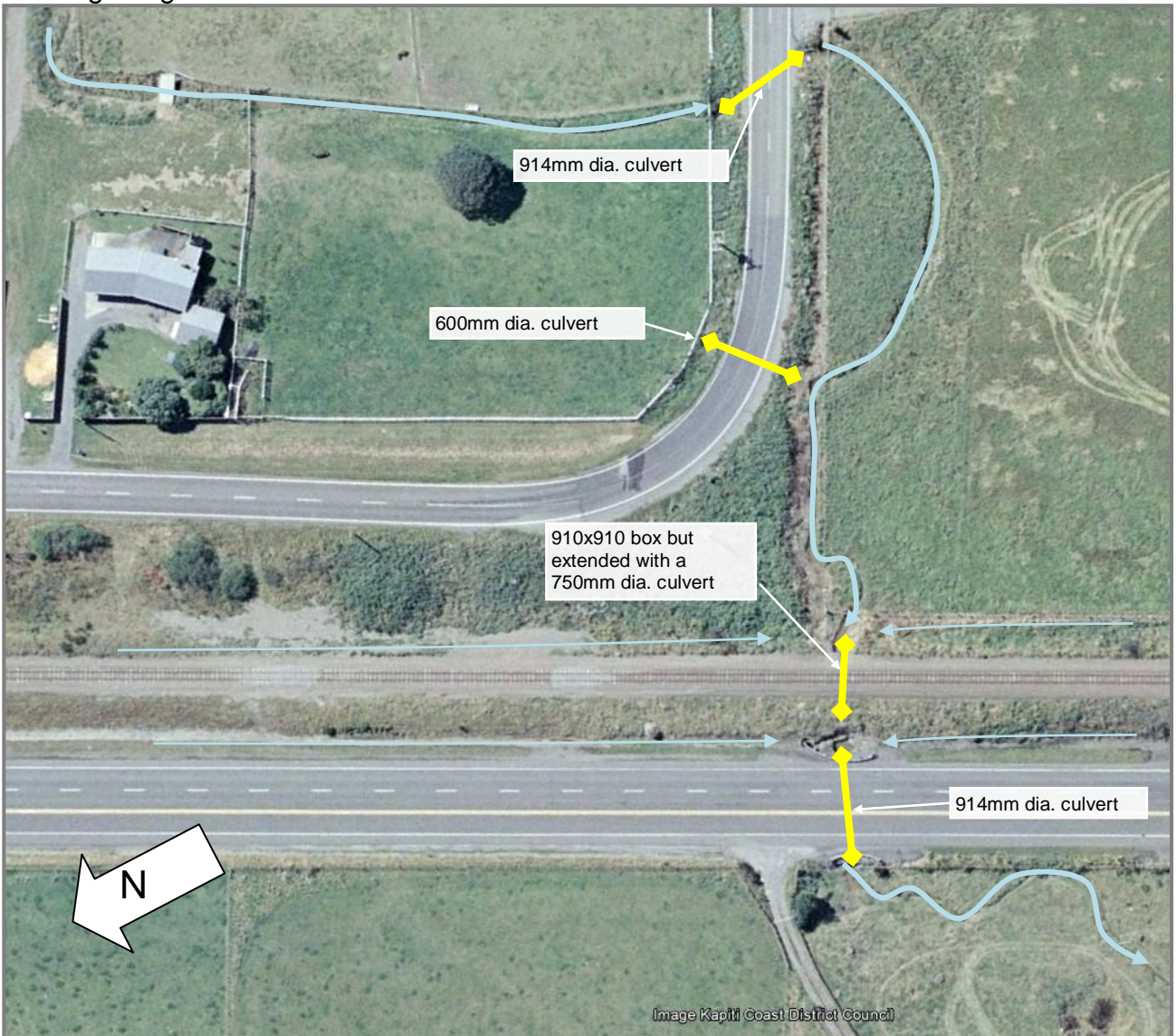


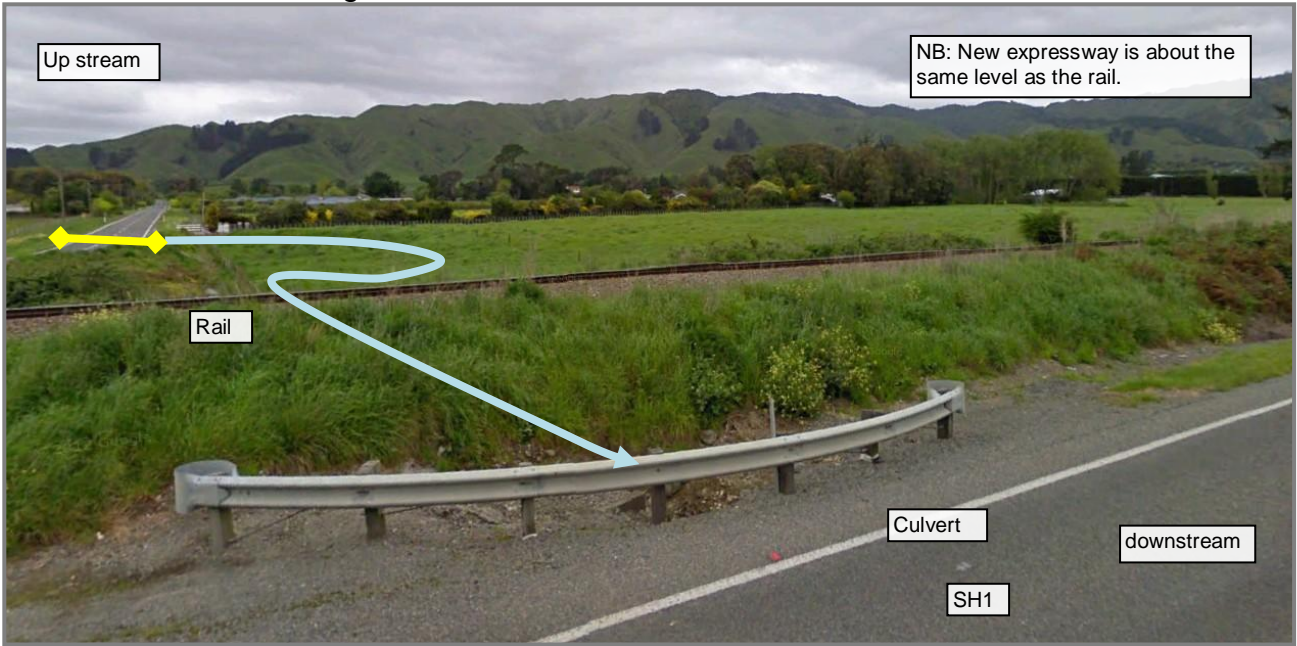
GEAR CULVERT(S)

Existing Image

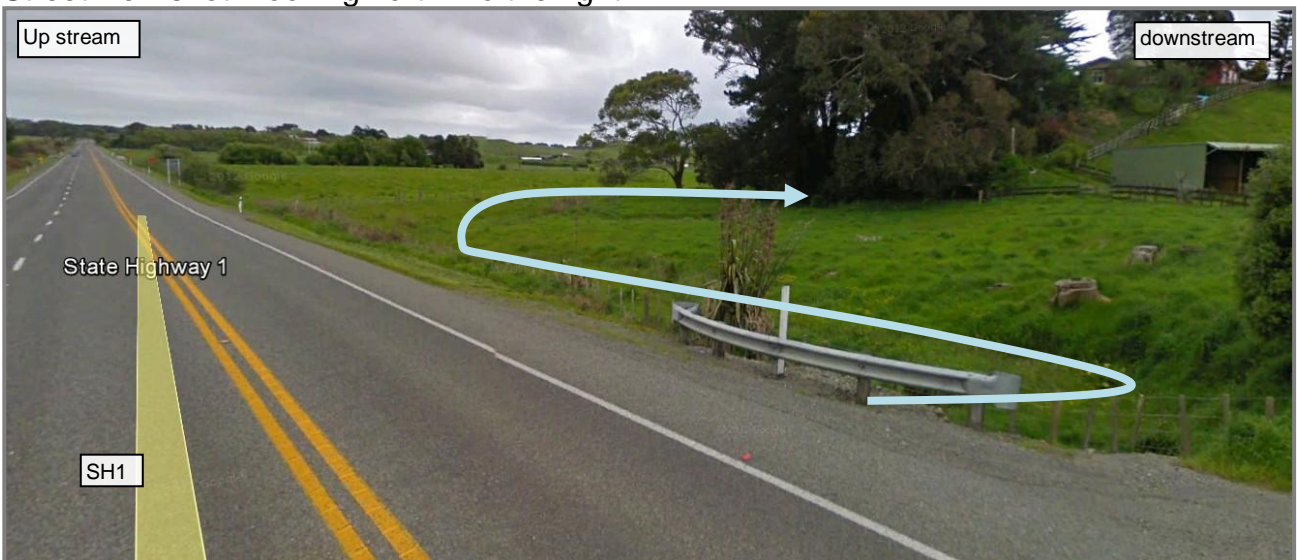


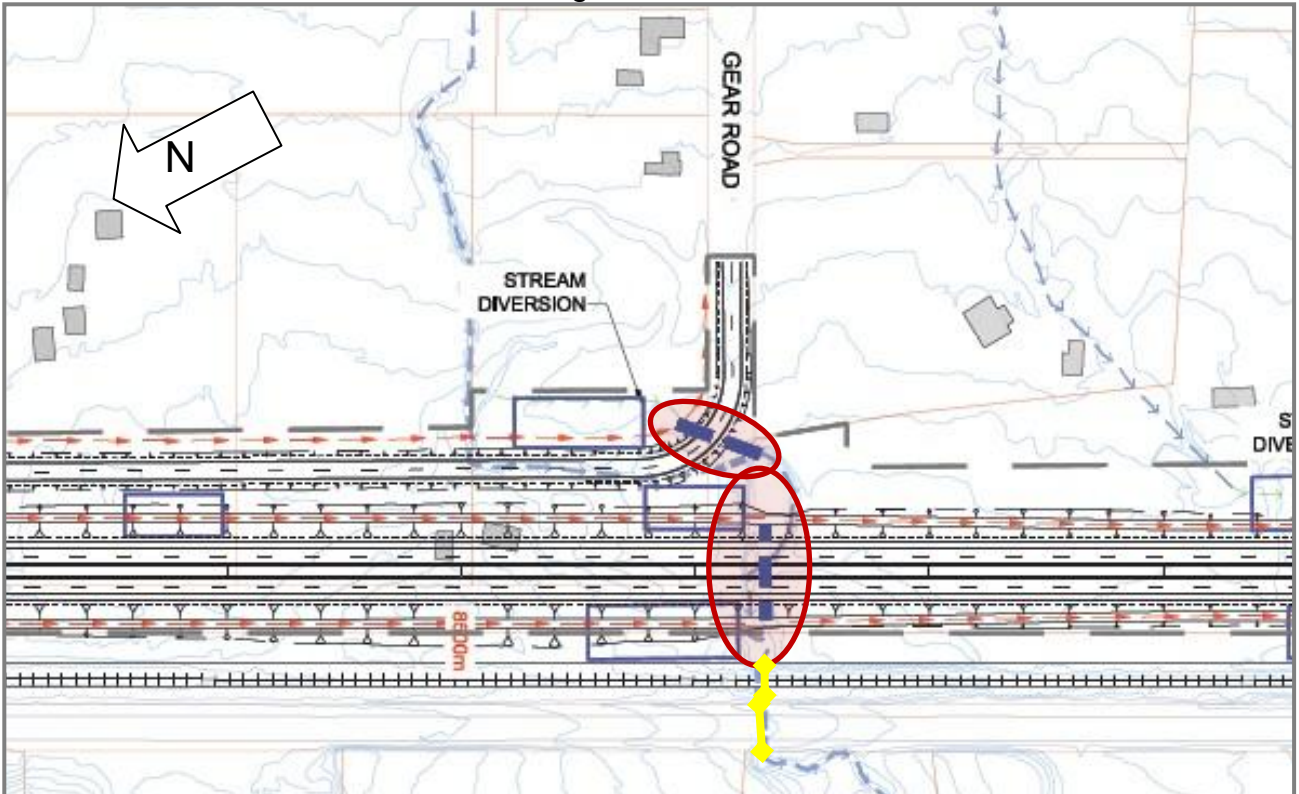
Existing Image



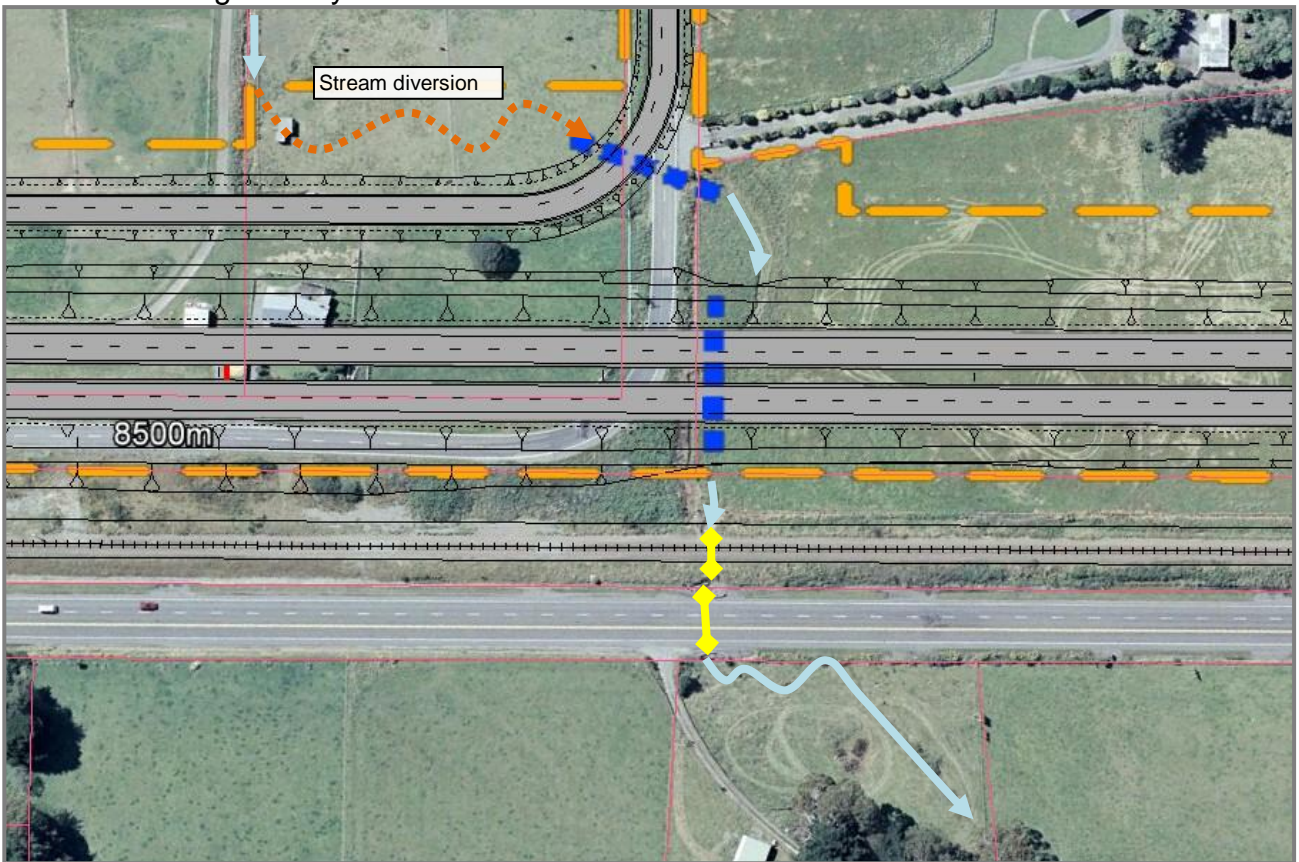


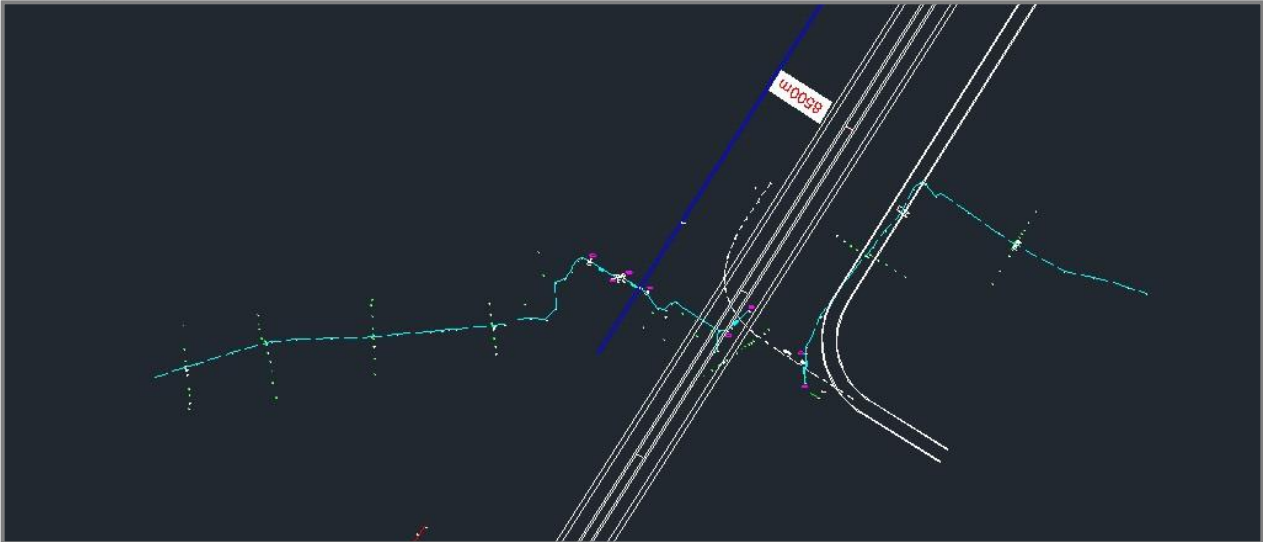
Street view shot. Looking north. To the right.



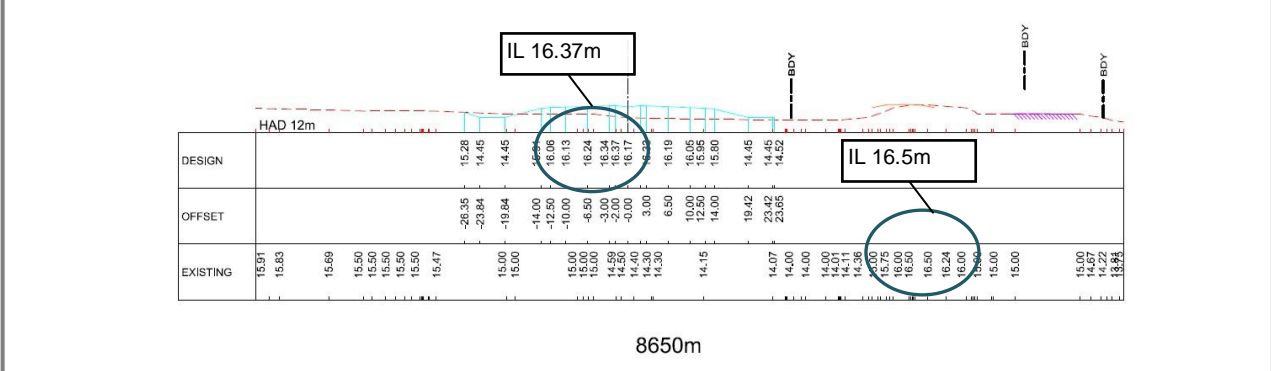
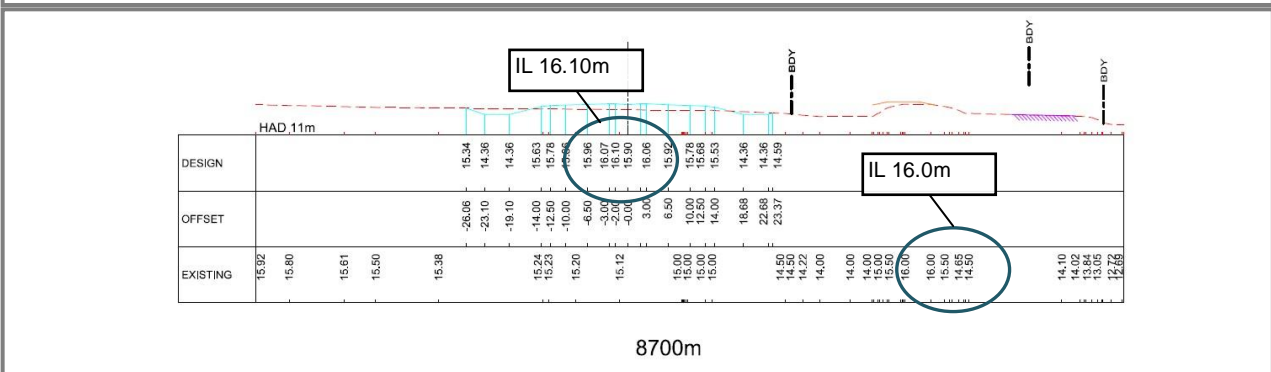
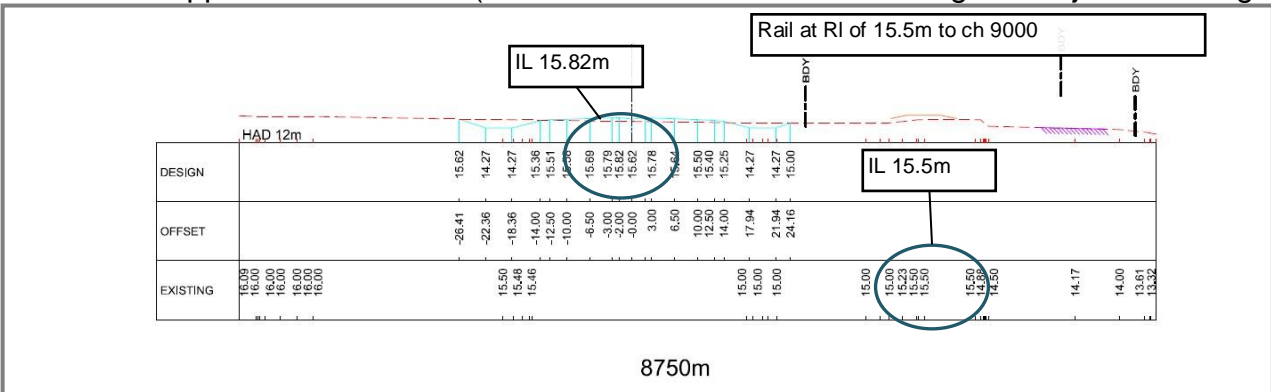


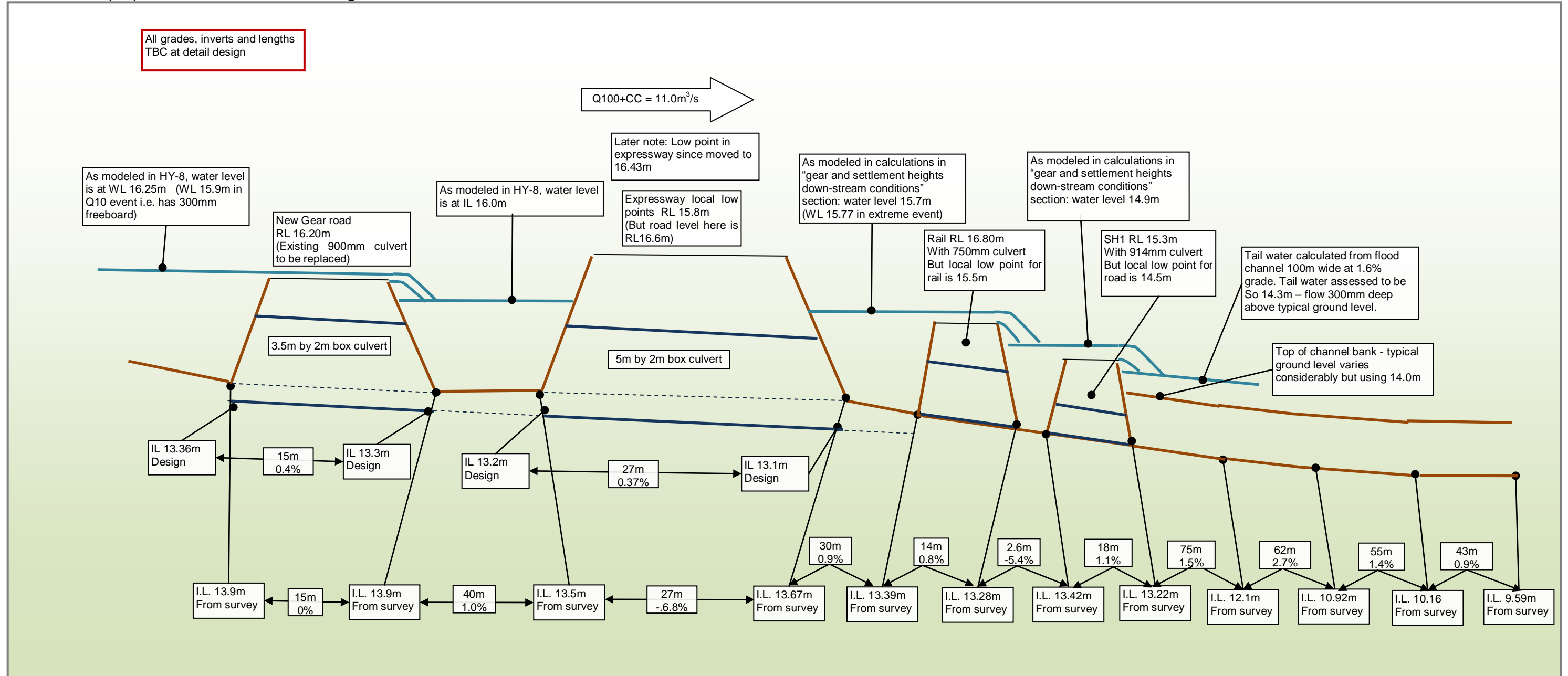
Aerial with road geometry





Sections at approximate location (from scheme assessment drawings – subject to change)





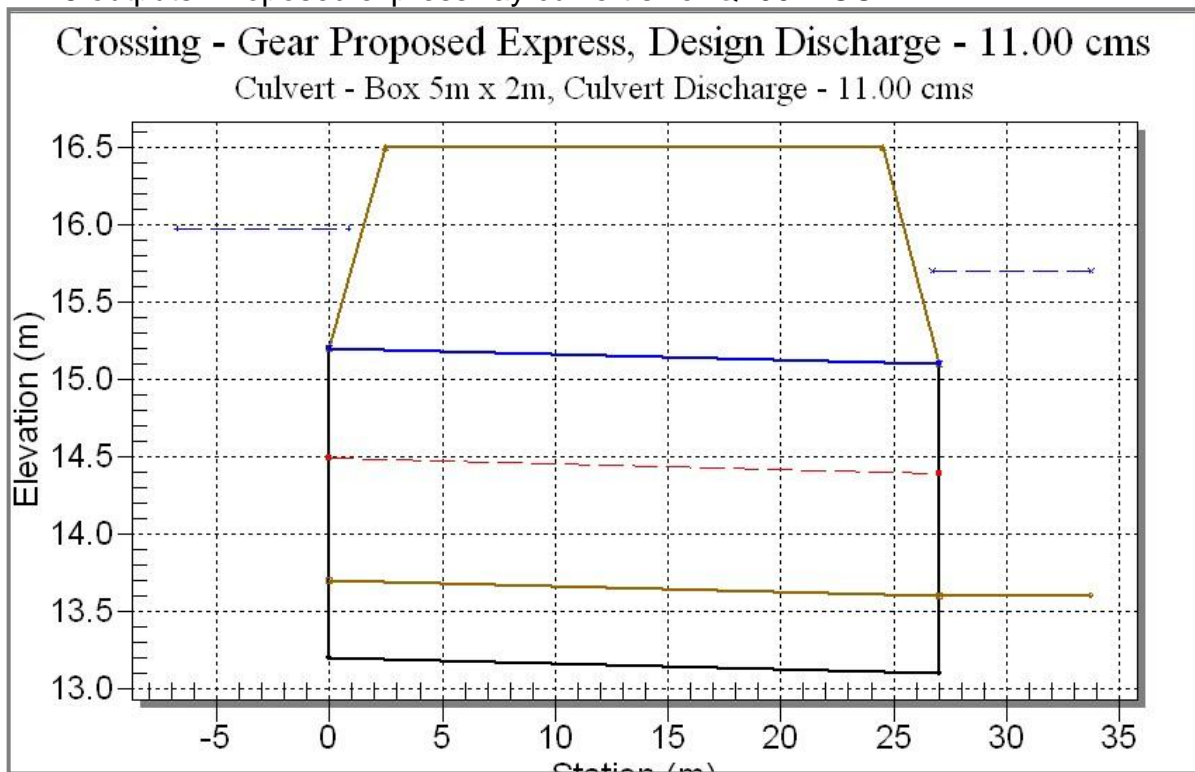
HY-8 inputs: Proposed expressway culvert size: Q100 + CC

All inputs TBC at detail design

Crossing Properties		
Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	8.00	cms
Design Flow	11.00	cms
Maximum Flow	20.00	cms
TAILWATER DATA		
Channel Type	Enter Constant Tailwater Elevation	
Channel Invert Elevation	13.60	m
Constant Tailwater Elevation	15.70	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	50.00	m
Crest Elevation	16.50	m
Roadway Surface	Paved	
Top Width	22.00	m

Culvert Properties		
Parameter	Value	Units
CULVERT DATA		
Name	Box 5m x 2m	
Shape	Concrete Box	
Material	Concrete	
Span	5000.00	mm
Rise	2000.00	mm
Embedment Depth	500.00	mm
Manning's n (Top/Sides)	0.0120	
Manning's n (Bottom)	0.0350	
Inlet Type	Conventional	
Inlet Edge Condition	Thin Edge Projecting	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	13.20	m
Outlet Station	27.00	m
Outlet Elevation	13.10	m
Number of Barrels	1	

HY-8 outputs: Proposed expressway culvert size: Q100 + CC



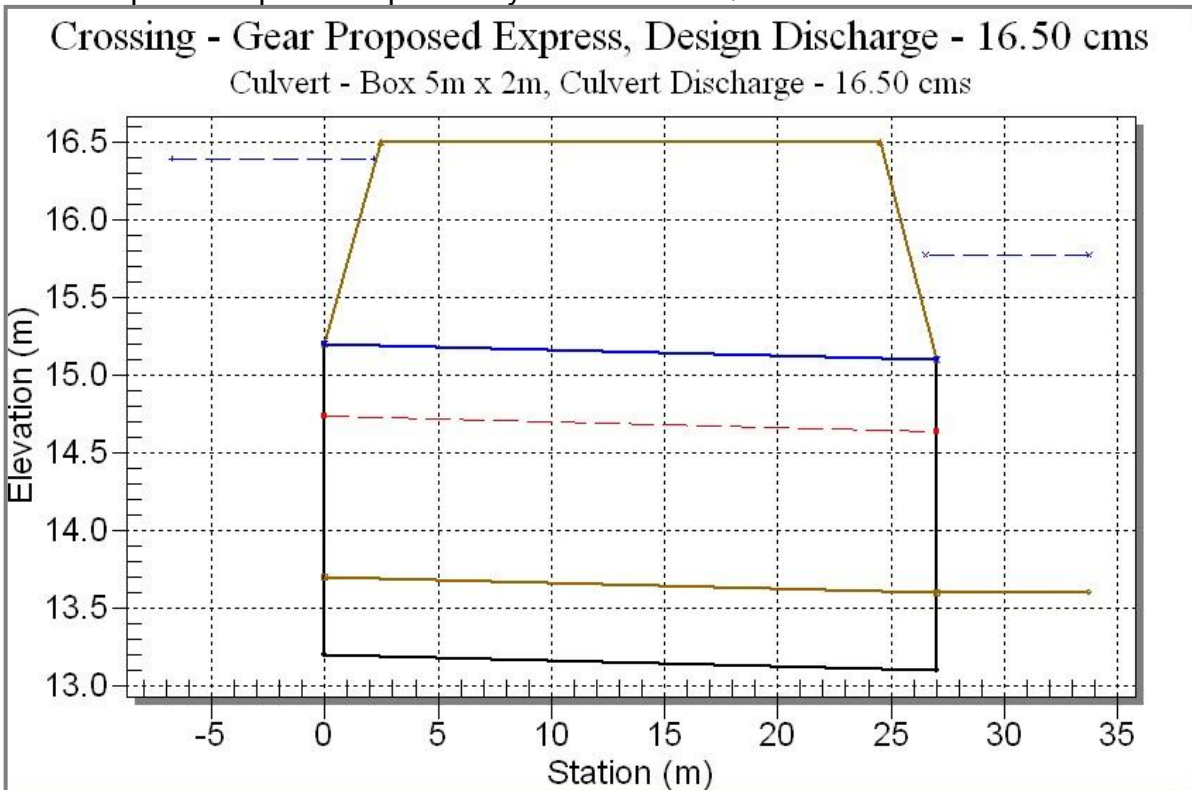
HY-8 inputs: Proposed expressway culvert size: Q100 + CC + 50%

All inputs TBC at detail design

Crossing Properties		
Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	8.00	cms
Design Flow	16.50	cms
Maximum Flow	20.00	cms
TAILWATER DATA		
Channel Type	Enter Constant Tailwater Elevation	
Channel Invert Elevation	13.60	m
Constant Tailwater Elevation	15.77	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	50.00	m
Crest Elevation	16.50	m
Roadway Surface	Paved	
Top Width	22.00	m

Culvert Properties		
Parameter	Value	Units
CULVERT DATA		
Name	Box 5m x 2m	
Shape	Concrete Box	
Material	Concrete	
Span	5000.00	mm
Rise	2000.00	mm
Embedment Depth	500.00	mm
Manning's n (Top/Sides)	0.0120	
Manning's n (Bottom)	0.0350	
Inlet Type	Conventional	
Inlet Edge Condition	Thin Edge Projecting	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	13.20	m
Outlet Station	27.00	m
Outlet Elevation	13.10	m
Number of Barrels	1	

HY-8 outputs: Proposed expressway culvert size: Q100 + CC + 50%



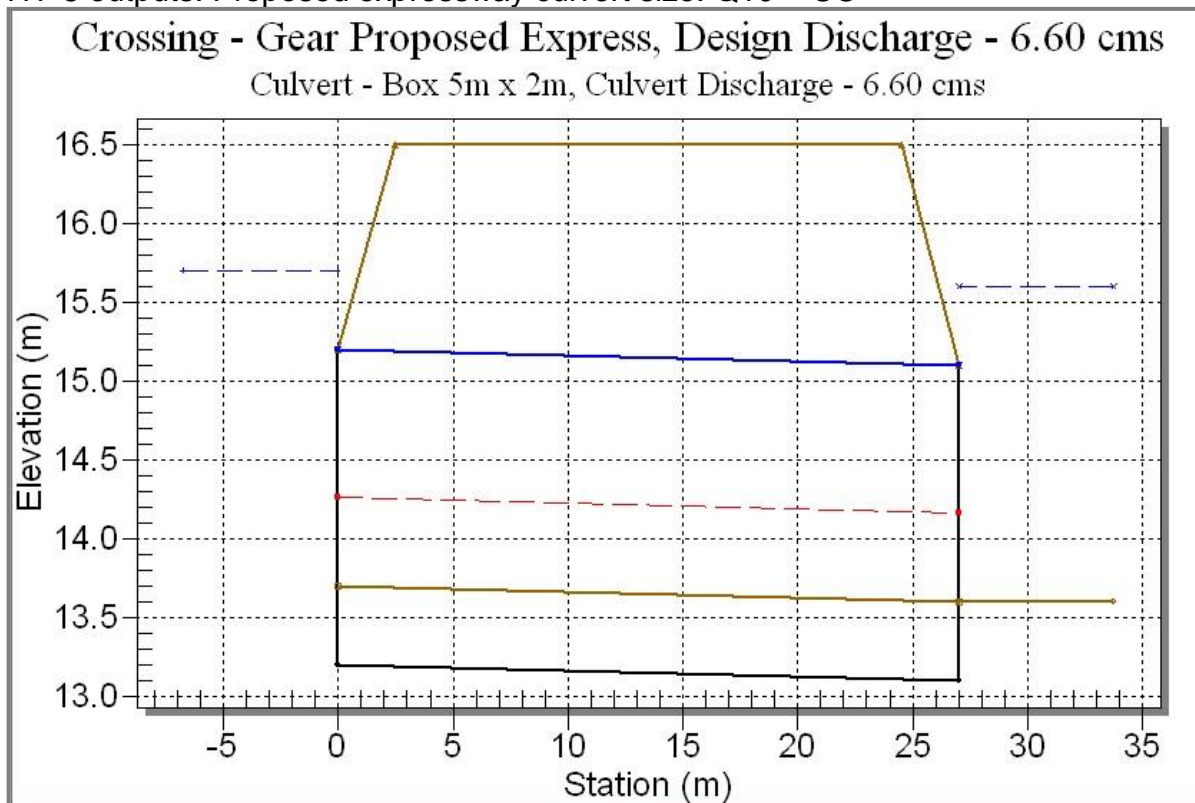
HY-8 inputs: Proposed expressway culvert size: Q10 + CC

All inputs TBC at detail design

Crossing Properties		
Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	6.00	cms
Design Flow	6.60	cms
Maximum Flow	20.00	cms
TAILWATER DATA		
Channel Type	Enter Constant Tailwater Elevation	
Channel Invert Elevation	13.60	m
Constant Tailwater Elevation	15.60	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	50.00	m
Crest Elevation	16.50	m
Roadway Surface	Paved	
Top Width	22.00	m

Culvert Properties		
Parameter	Value	Units
CULVERT DATA		
Name	Box 5m x 2m	
Shape	Concrete Box	
Material	Concrete	
Span	5000.00	mm
Rise	2000.00	mm
Embedment Depth	500.00	mm
Manning's n (Top/Sides)	0.0120	
Manning's n (Bottom)	0.0350	
Inlet Type	Conventional	
Inlet Edge Condition	Thin Edge Projecting	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	13.20	m
Outlet Station	27.00	m
Outlet Elevation	13.10	m
Number of Barrels	1	

HY-8 outputs: Proposed expressway culvert size: Q10 + CC



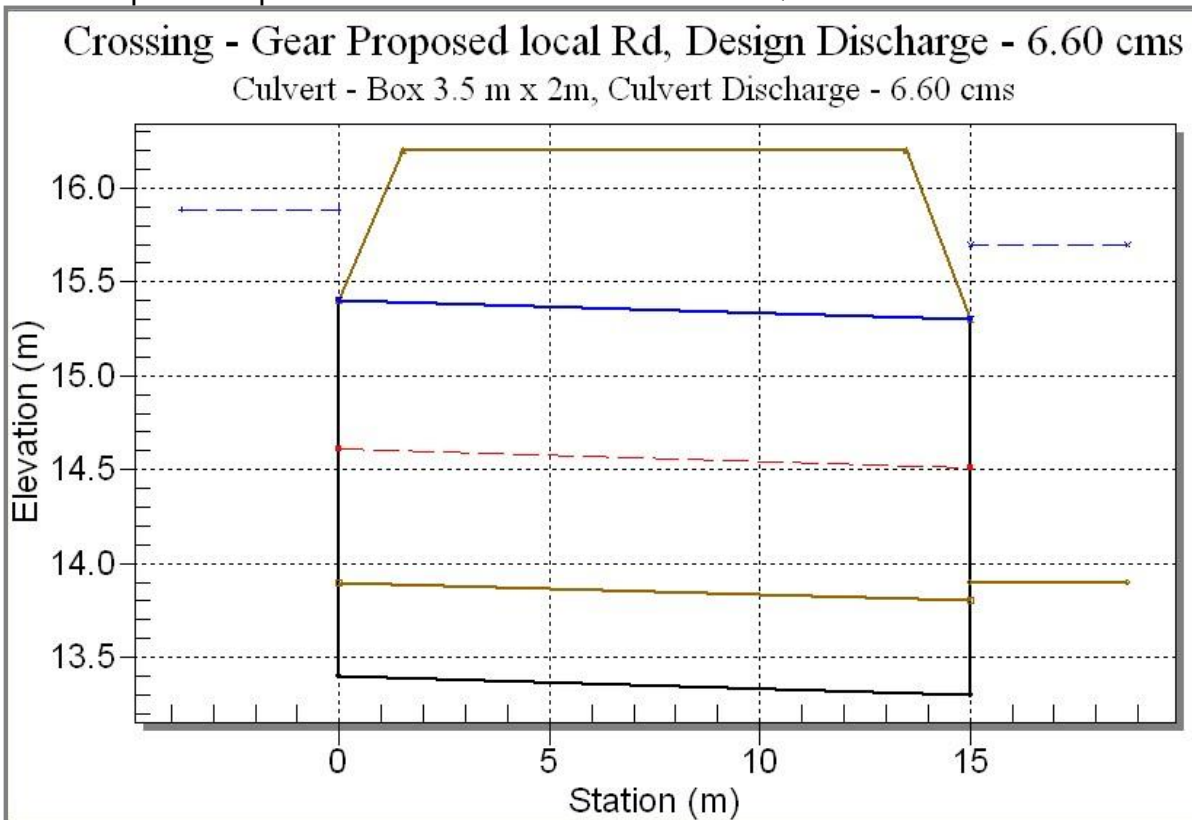
HY-8 inputs: Proposed local Gear road culvert size: Q10 + CC

All inputs TBC at detail design

Crossing Properties		
Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	6.00	cms
Design Flow	6.60	cms
Maximum Flow	20.00	cms
TAILWATER DATA		
Channel Type	Enter Constant Tailwater Elevation	
Channel Invert Elevation	13.90	m
Constant Tailwater Elevation	15.70	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	30.00	m
Crest Elevation	16.20	m
Roadway Surface	Paved	
Top Width	12.00	m

Culvert Properties		
Parameter	Value	Units
CULVERT DATA		
Name	Box 3.5 m x 2m	
Shape	Concrete Box	
Material	Concrete	
Span	3500.00	mm
Rise	2000.00	mm
Embedment Depth	500.00	mm
Manning's n (Top/Sides)	0.0120	
Manning's n (Bottom)	0.0350	
Inlet Type	Conventional	
Inlet Edge Condition	Thin Edge Projecting	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	13.40	m
Outlet Station	15.00	m
Outlet Elevation	13.30	m
Number of Barrels	1	

HY-8 outputs: Proposed local Gear road culvert size: Q10 + CC



GEAR CULVERT(s)

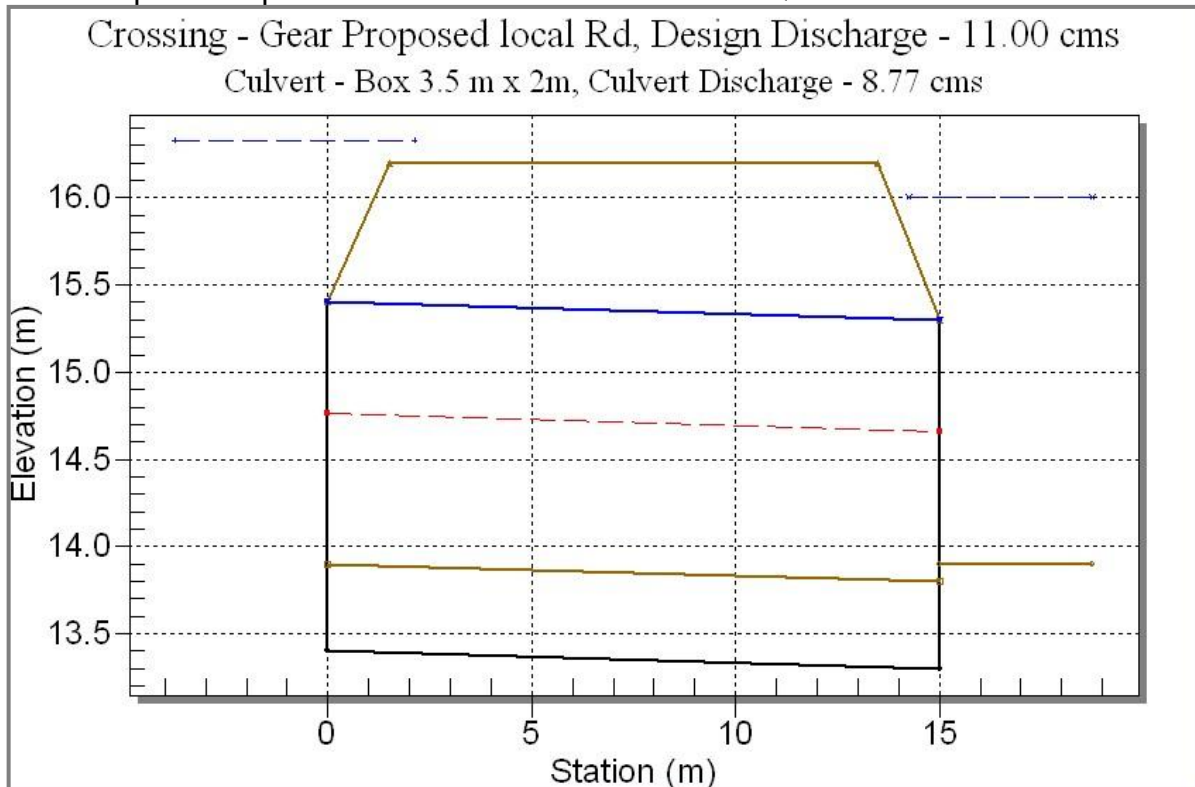
HY-8 inputs: Proposed local Gear road culvert size: Q100 + CC%

All inputs TBC at detail design

Crossing Properties		
Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	6.00	cms
Design Flow	11.00	cms
Maximum Flow	20.00	cms
TAILWATER DATA		
Channel Type	Enter Constant Tailwater Elevation	
Channel Invert Elevation	13.90	m
Constant Tailwater Elevation	16.00	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	30.00	m
Crest Elevation	16.20	m
Roadway Surface	Paved	
Top Width	12.00	m

Culvert Properties		
Parameter	Value	Units
CULVERT DATA		
Name	Box 3.5 m x 2m	
Shape	Concrete Box	
Material	Concrete	
Span	3500.00	mm
Rise	2000.00	mm
Embedment Depth	500.00	mm
Manning's n (Top/Sides)	0.0120	
Manning's n (Bottom)	0.0350	
Inlet Type	Conventional	
Inlet Edge Condition	Thin Edge Projecting	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	13.40	m
Outlet Station	15.00	m
Outlet Elevation	13.30	m
Number of Barrels	1	

HY-8 outputs: Proposed local Gear road culvert size: Q100 + CC%



GEAR CULVERT(S)

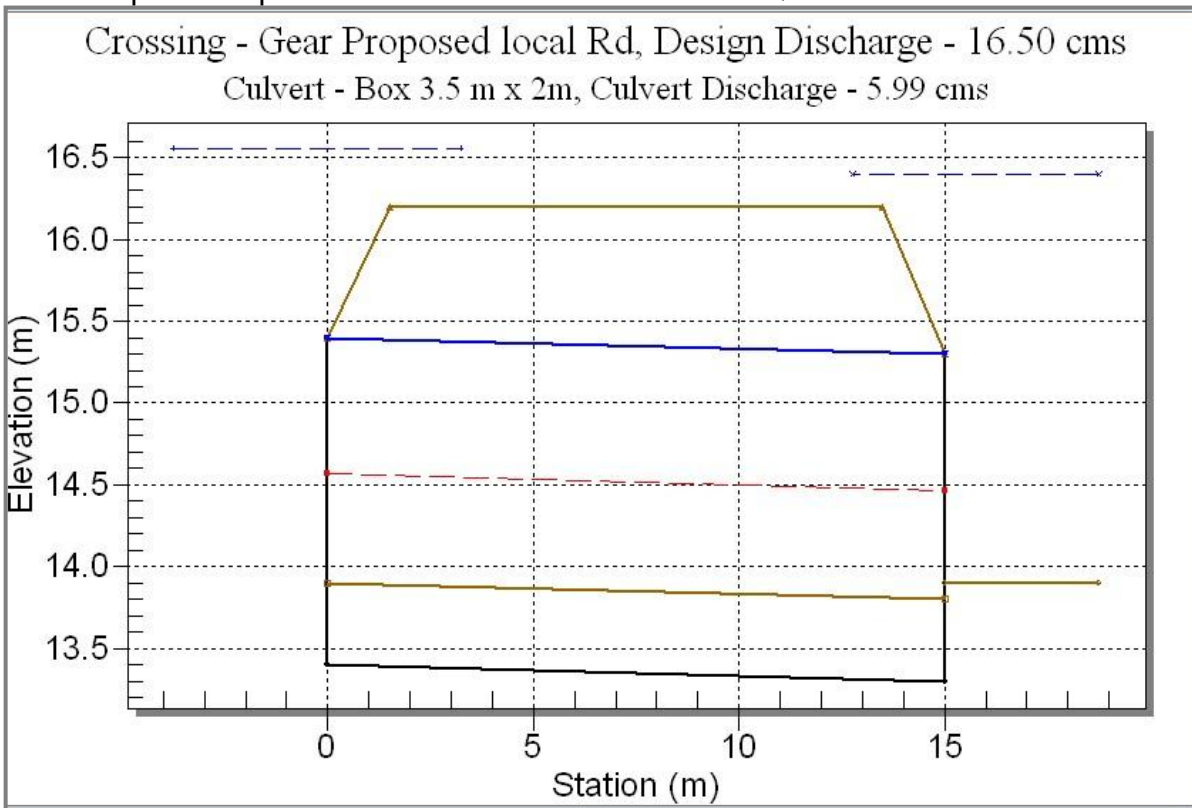
HY-8 inputs: Proposed local Gear road culvert size: Q100 + CC + 50%

All inputs TBC at detail design

Crossing Properties		
Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	6.00	cms
Design Flow	16.50	cms
Maximum Flow	20.00	cms
TAILWATER DATA		
Channel Type	Enter Constant Tailwater Elevation	
Channel Invert Elevation	13.90	m
Constant Tailwater Elevation	16.40	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	30.00	m
Crest Elevation	16.20	m
Roadway Surface	Paved	
Top Width	12.00	m

Culvert Properties		
Parameter	Value	Units
CULVERT DATA		
Name	Box 3.5 m x 2m	
Shape	Concrete Box	
Material	Concrete	
Span	3500.00	mm
Rise	2000.00	mm
Embedment Depth	500.00	mm
Manning's n (Top/Sides)	0.0120	
Manning's n (Bottom)	0.0350	
Inlet Type	Conventional	
Inlet Edge Condition	Thin Edge Projecting	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	13.40	m
Outlet Station	15.00	m
Outlet Elevation	13.30	m
Number of Barrels	1	

HY-8 outputs: Proposed local Gear road culvert size: Q100 + CC + 50%

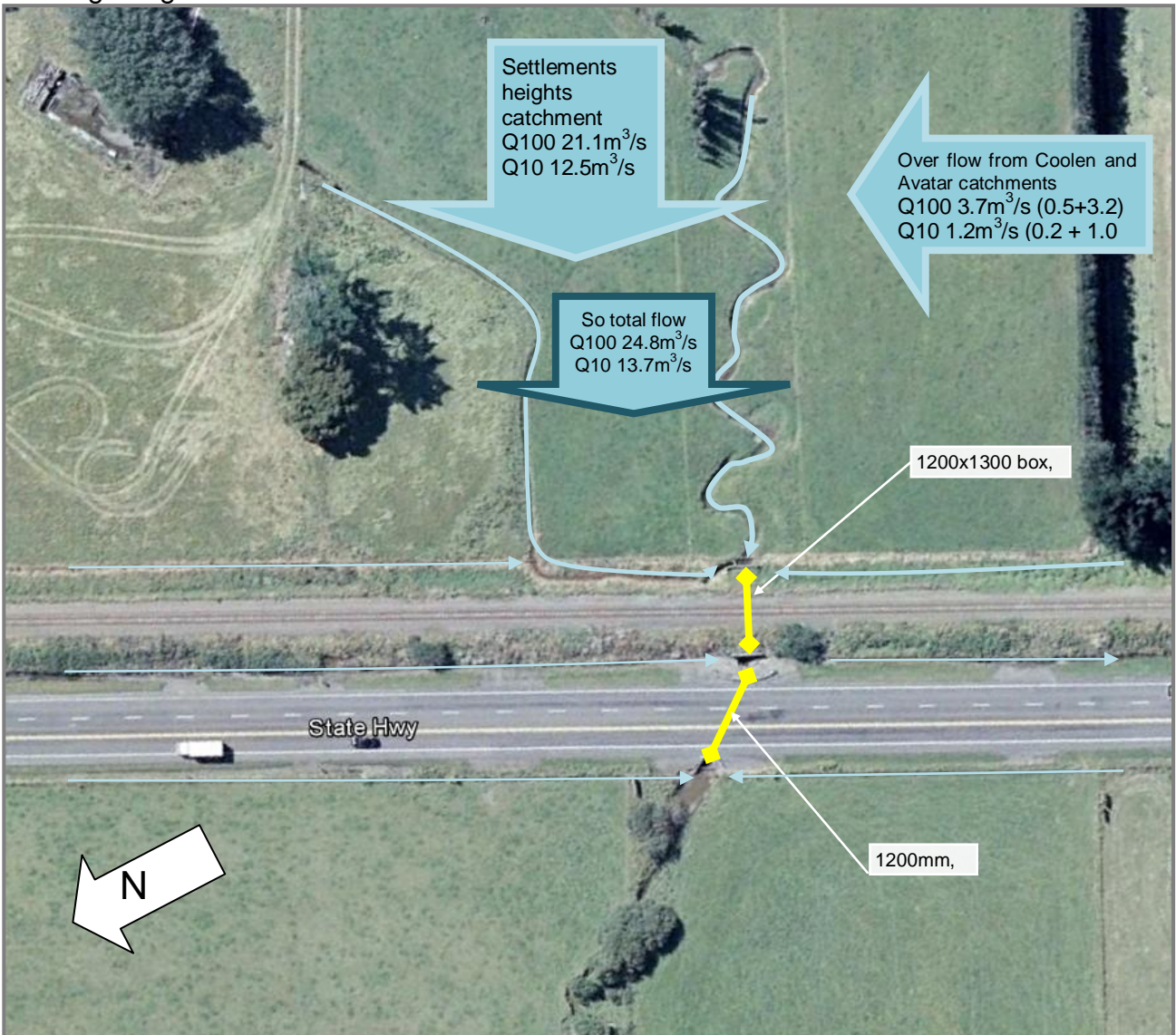


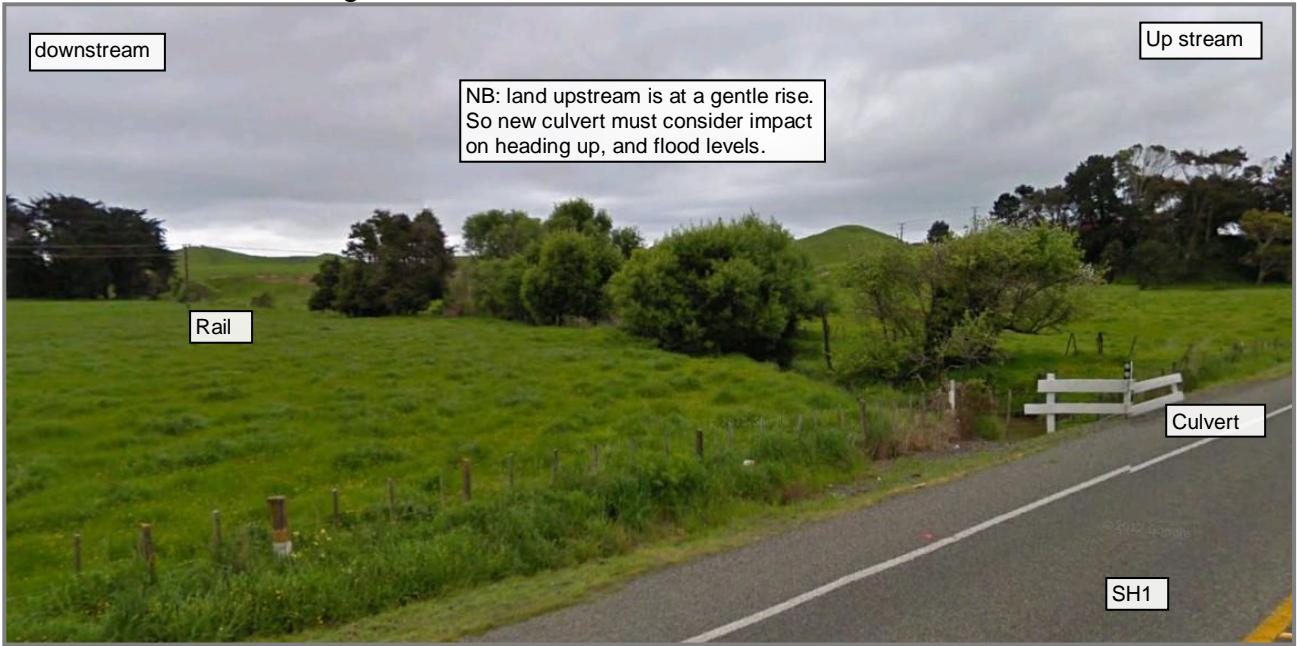
SETTLEMENTS HEIGHTS CULVERT

Existing Image



Existing Image

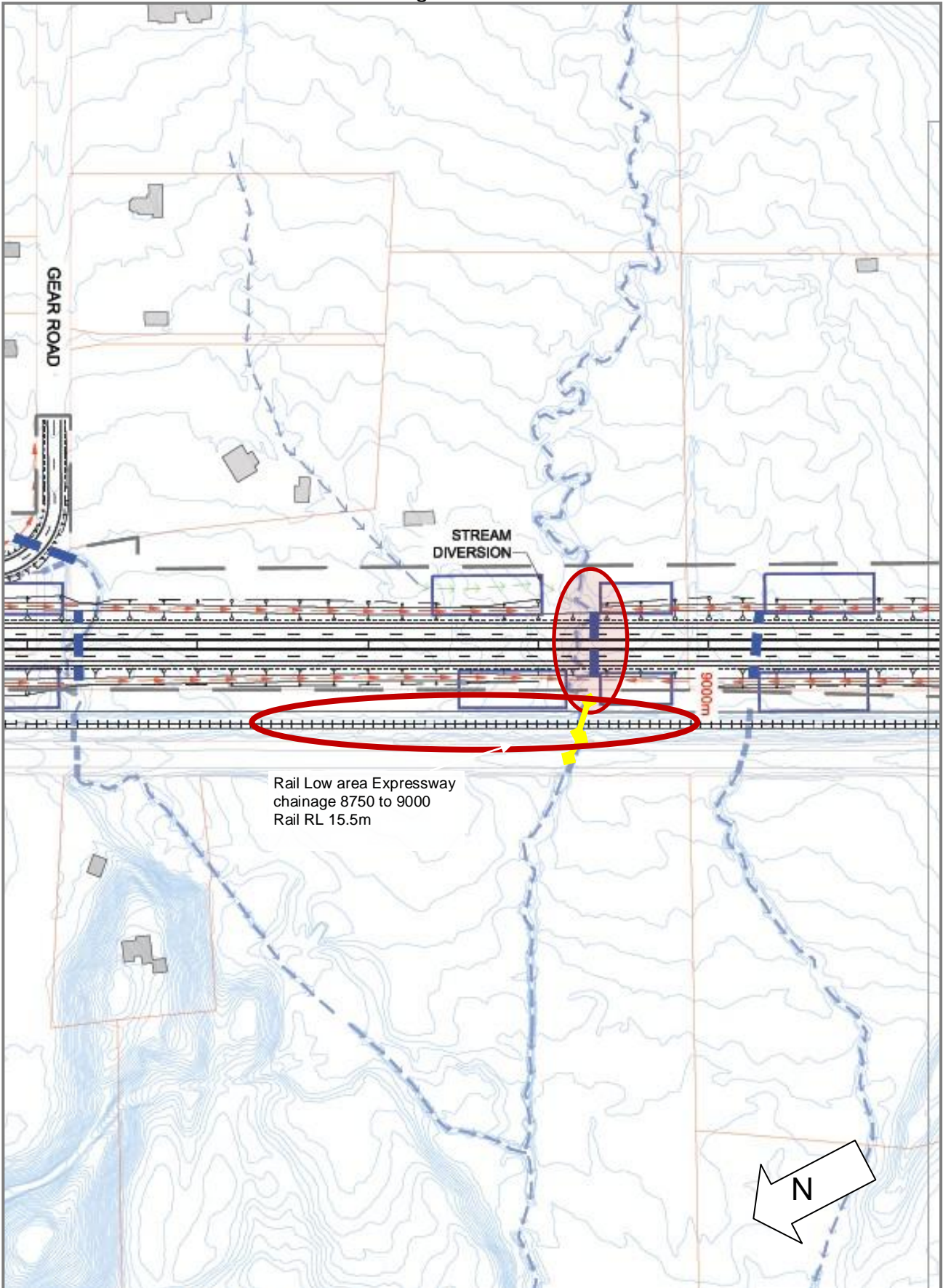




Street view shot. Looking north. To the right.

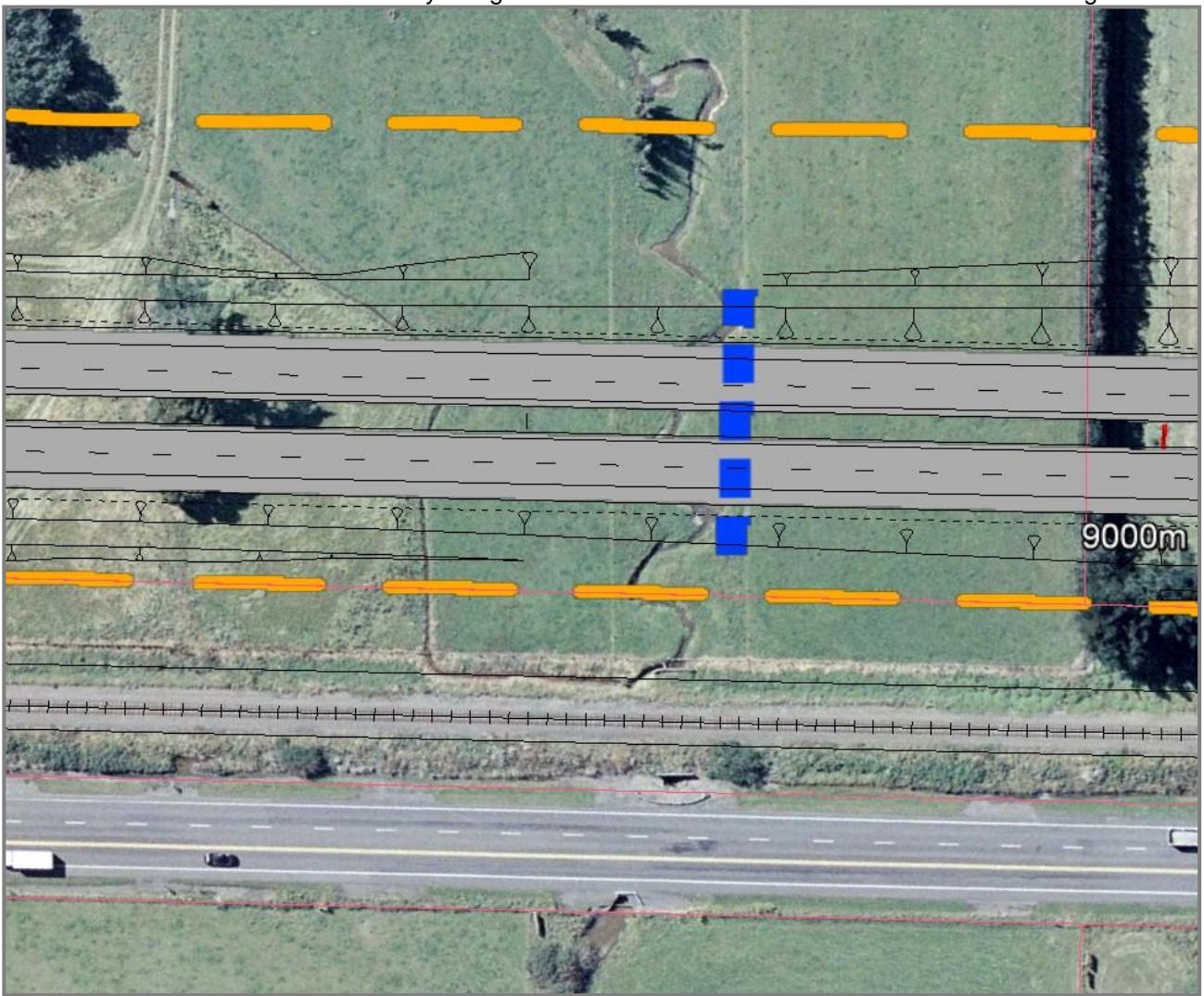


Location on scheme assessment drawing



Aerial with road geometry

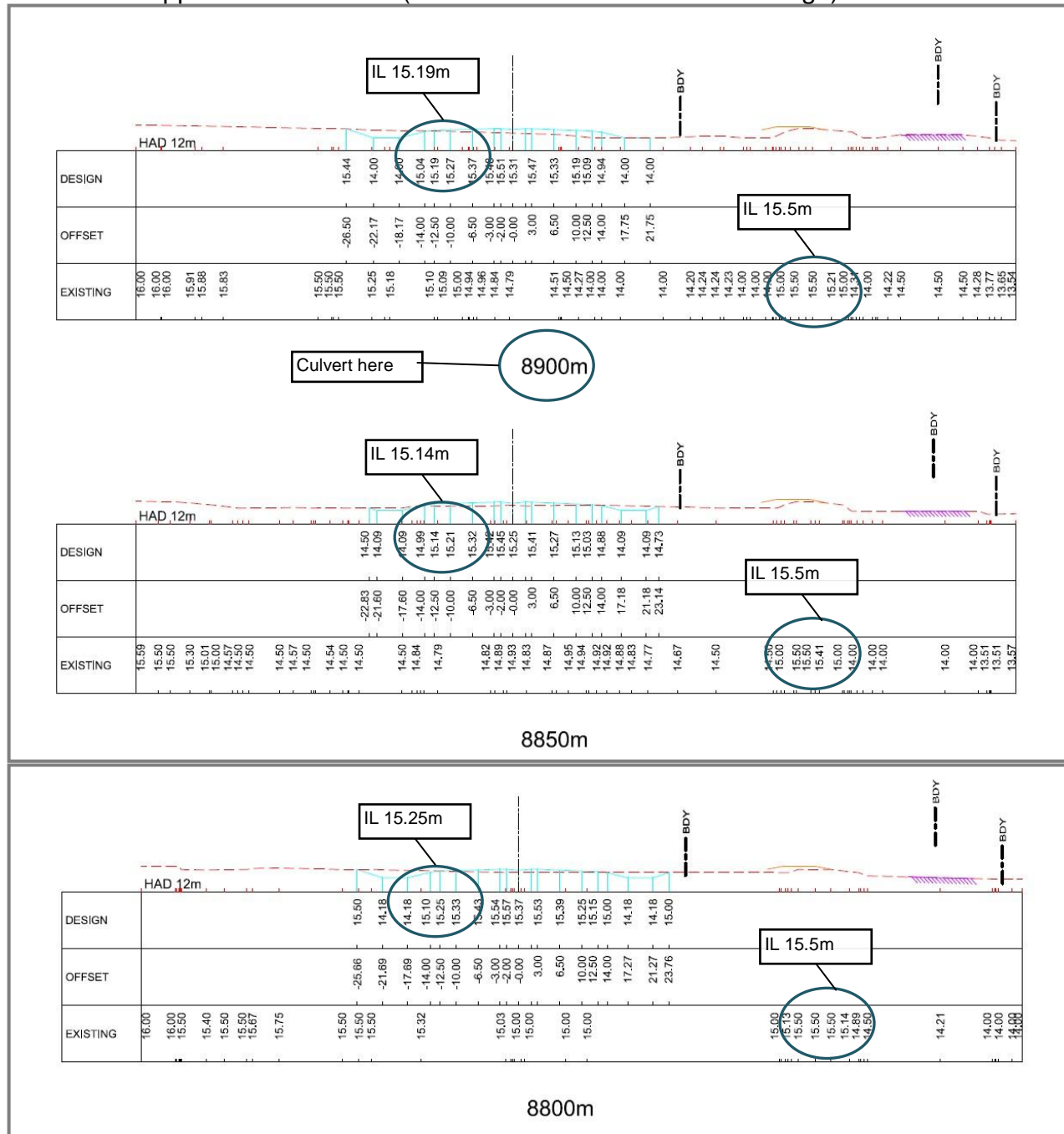
SETTLEMENTS HEIGHTS CULVERT

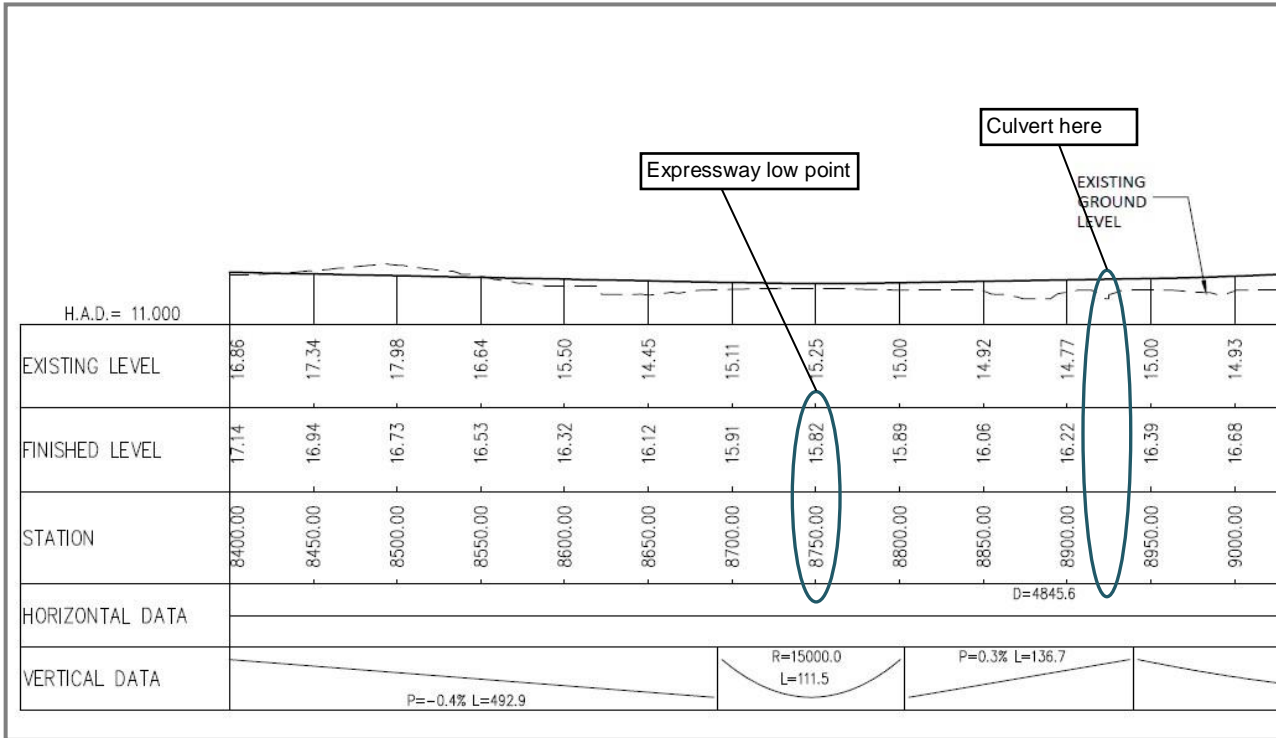


SETTLEMENTS HEIGHTS CULVERT

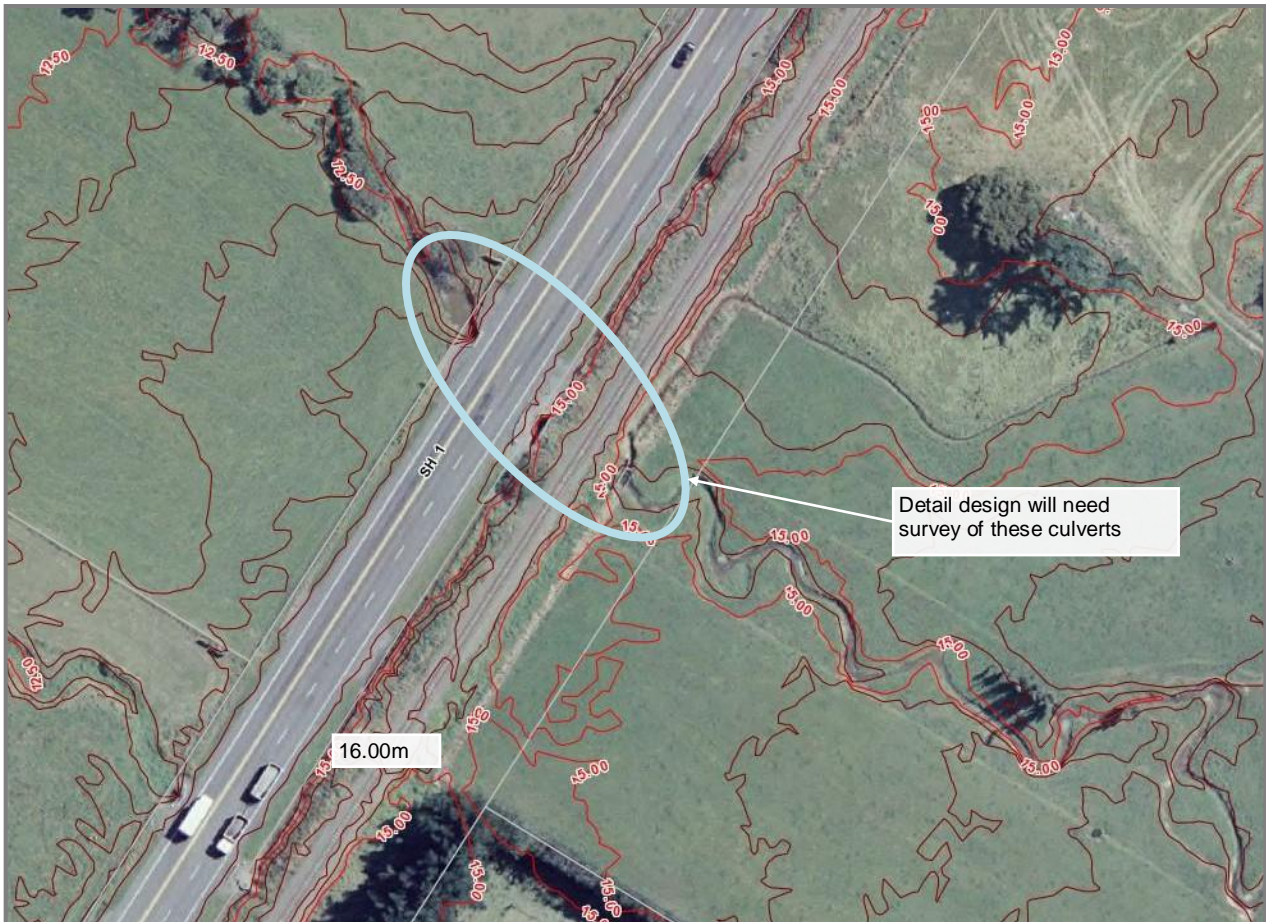
No survey in this area. Existing culvert inverts and stream bed levels all estimated from KCDC and Project specific contour information.
 All Levels (existing and proposed) to be confirmed at detail design stage.

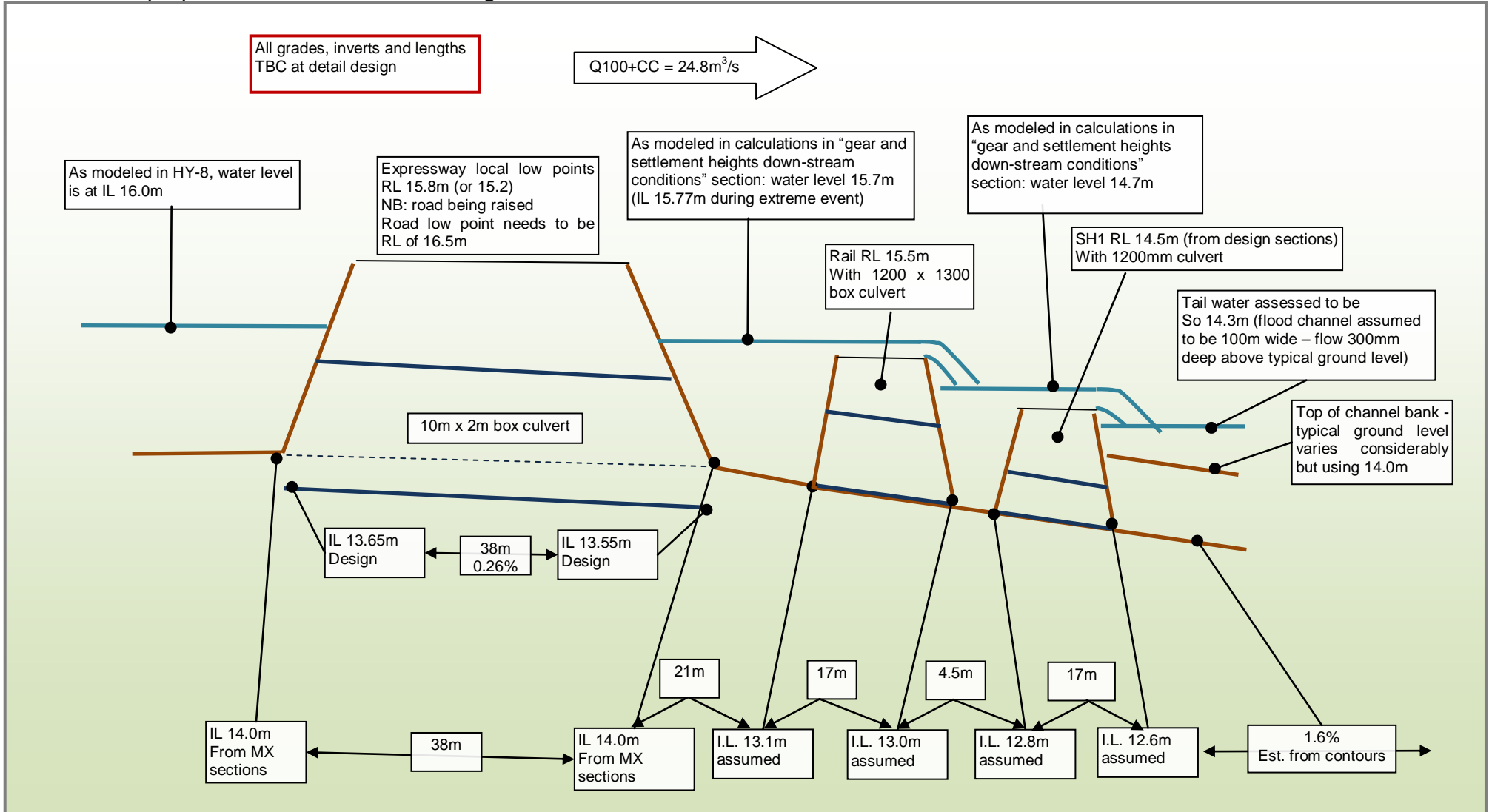
Sections at approximate location (from scheme assessment drawings)





Contours from KCDC GIS





SETTLEMENTS HEIGHTS CULVERT

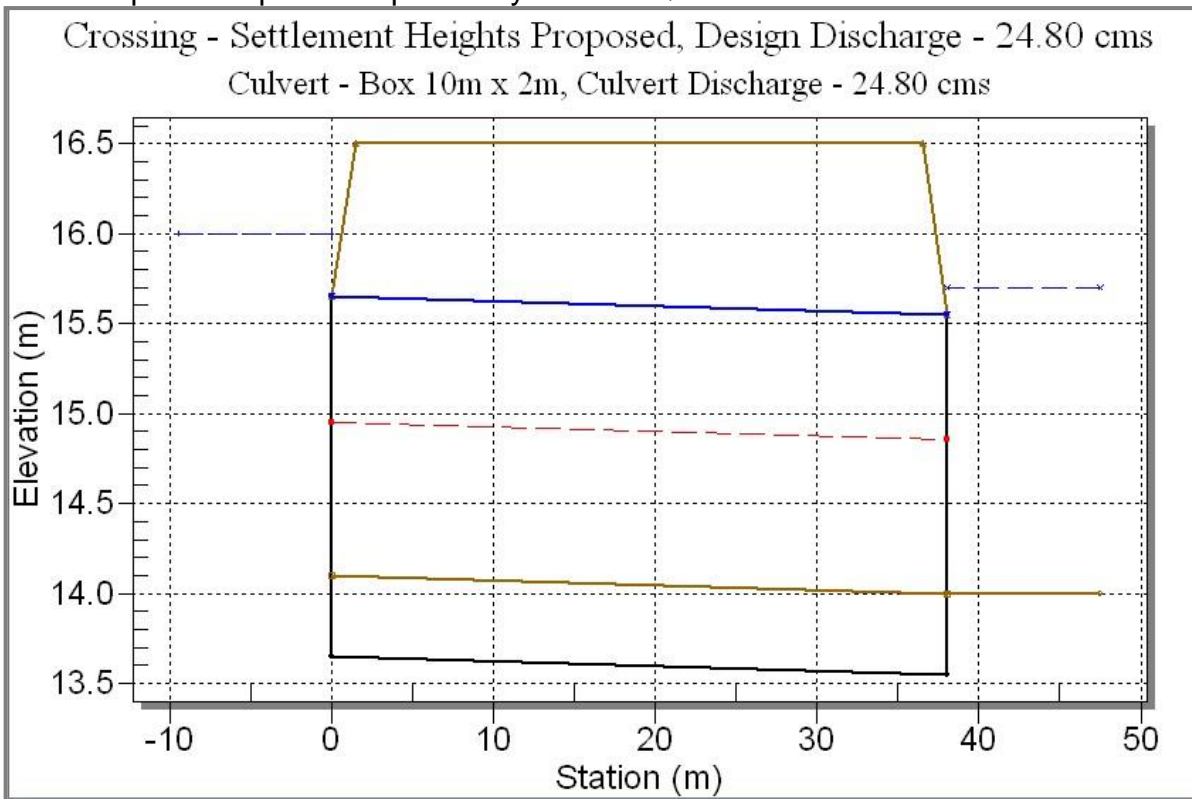
HY-8 inputs: Proposed Expressway culvert: Q100 + CC

All inputs TBC at detail design

Crossing Properties		
Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	20.00	cms
Design Flow	24.80	cms
Maximum Flow	50.00	cms
TAILWATER DATA		
Channel Type	Enter Constant Tailwater Elevation	
Channel Invert Elevation	14.00	m
Constant Tailwater Elevation	15.70	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	20.00	m
Crest Elevation	16.50	m
Roadway Surface	Paved	
Top Width	35.00	m

Culvert Properties		
Parameter	Value	Units
CULVERT DATA		
Name	Box 10m x 2m	
Shape	Concrete Box	
Material	Concrete	
Span	10000.00	mm
Rise	2000.00	mm
Embedment Depth	450.00	mm
Manning's n (Top/Sides)	0.0120	
Manning's n (Bottom)	0.0350	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	13.65	m
Outlet Station	38.00	m
Outlet Elevation	13.55	m
Number of Barrels	1	

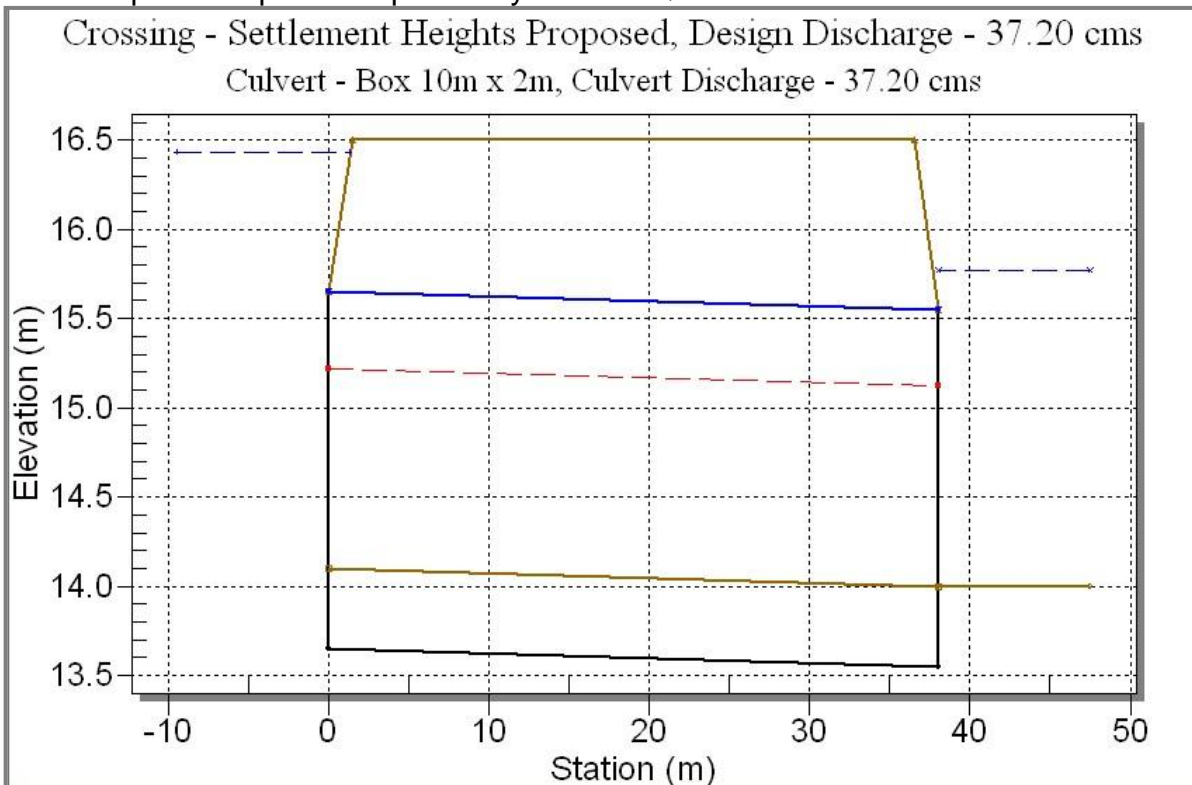
HY-8 outputs: Proposed Expressway culvert: Q100 + CC



HY-8 inputs: Proposed Expressway culvert: Q100 + CC +50%

All inputs TBC at detail design

HY-8 outputs: Proposed Expressway culvert: Q100 + CC +50%



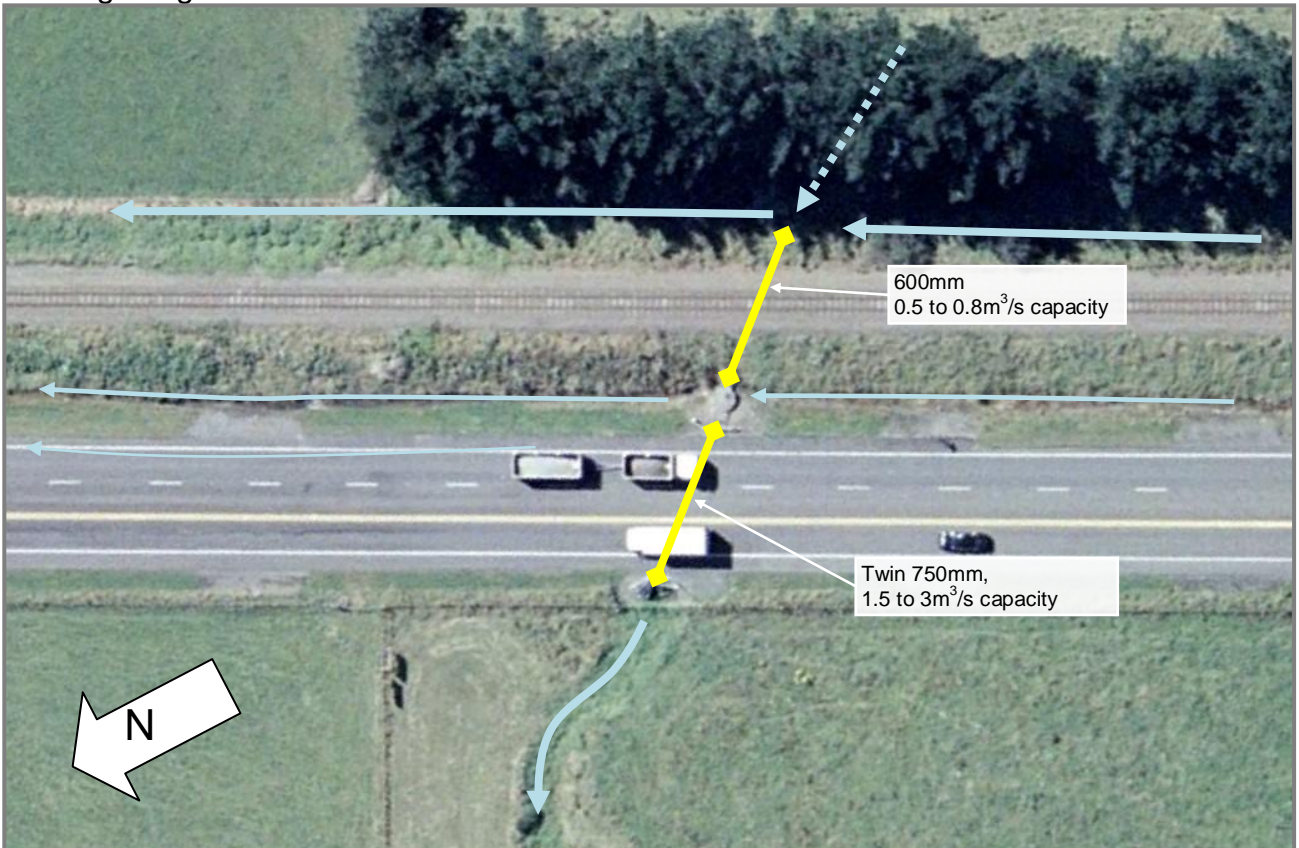
SETTLEMENTS HEIGHTS CULVERT

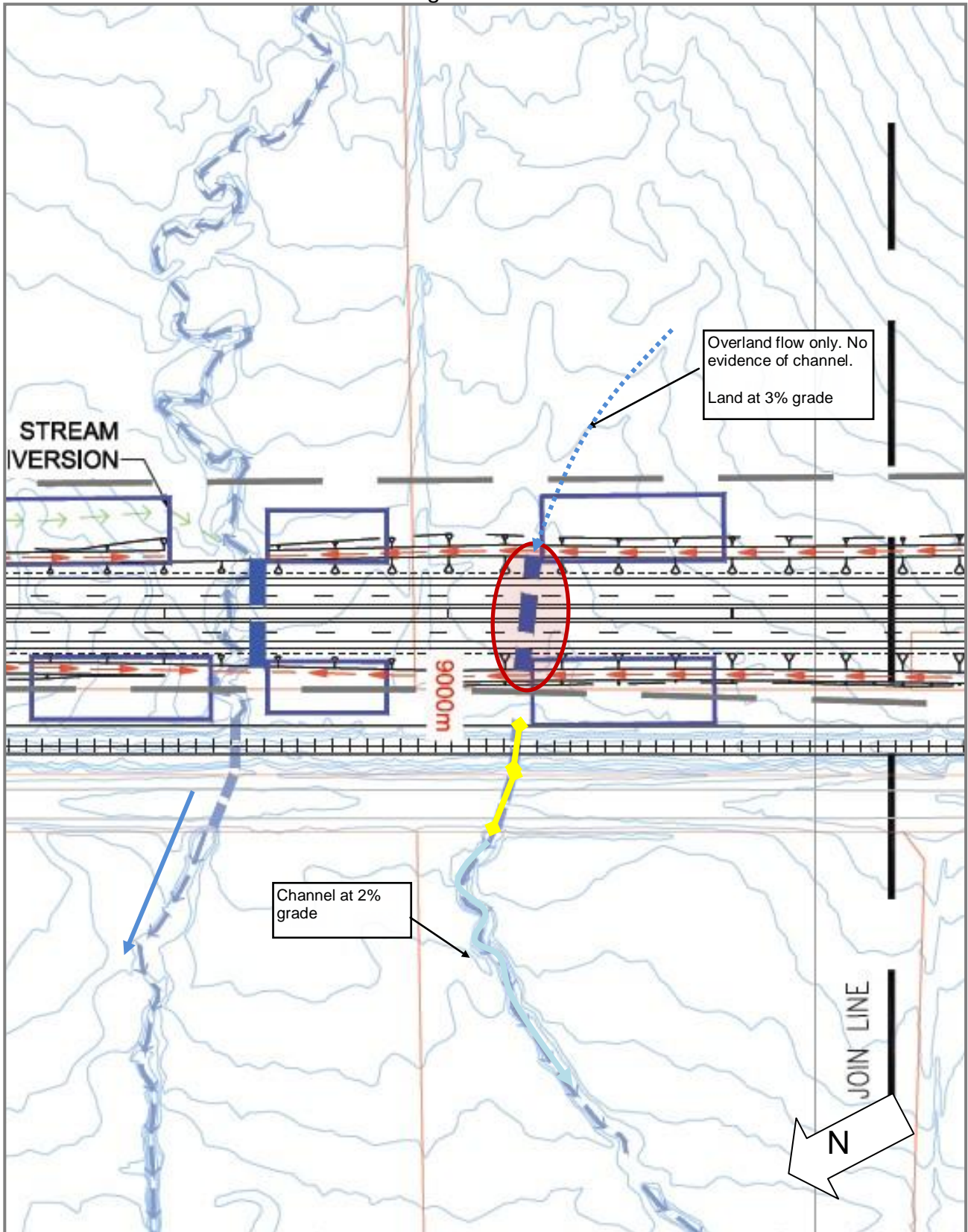
COOLEN CULVERT

Existing Image



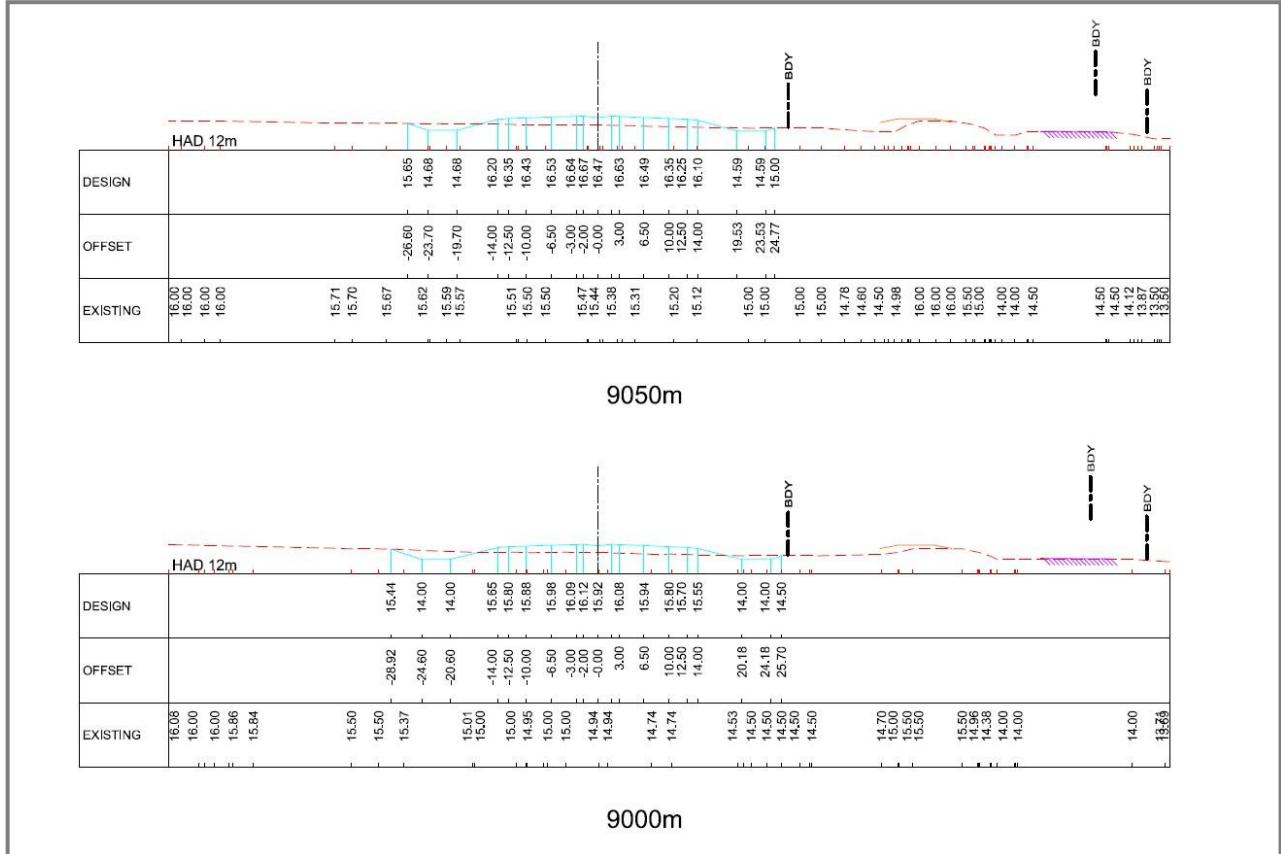
Existing Image



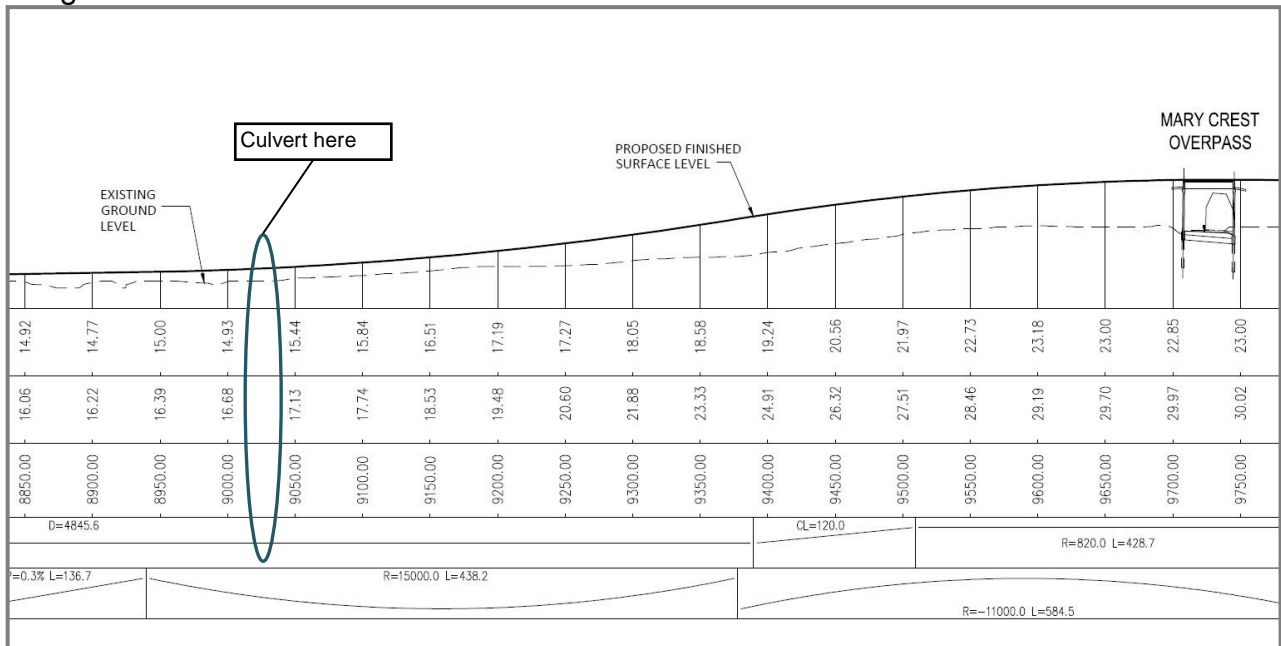


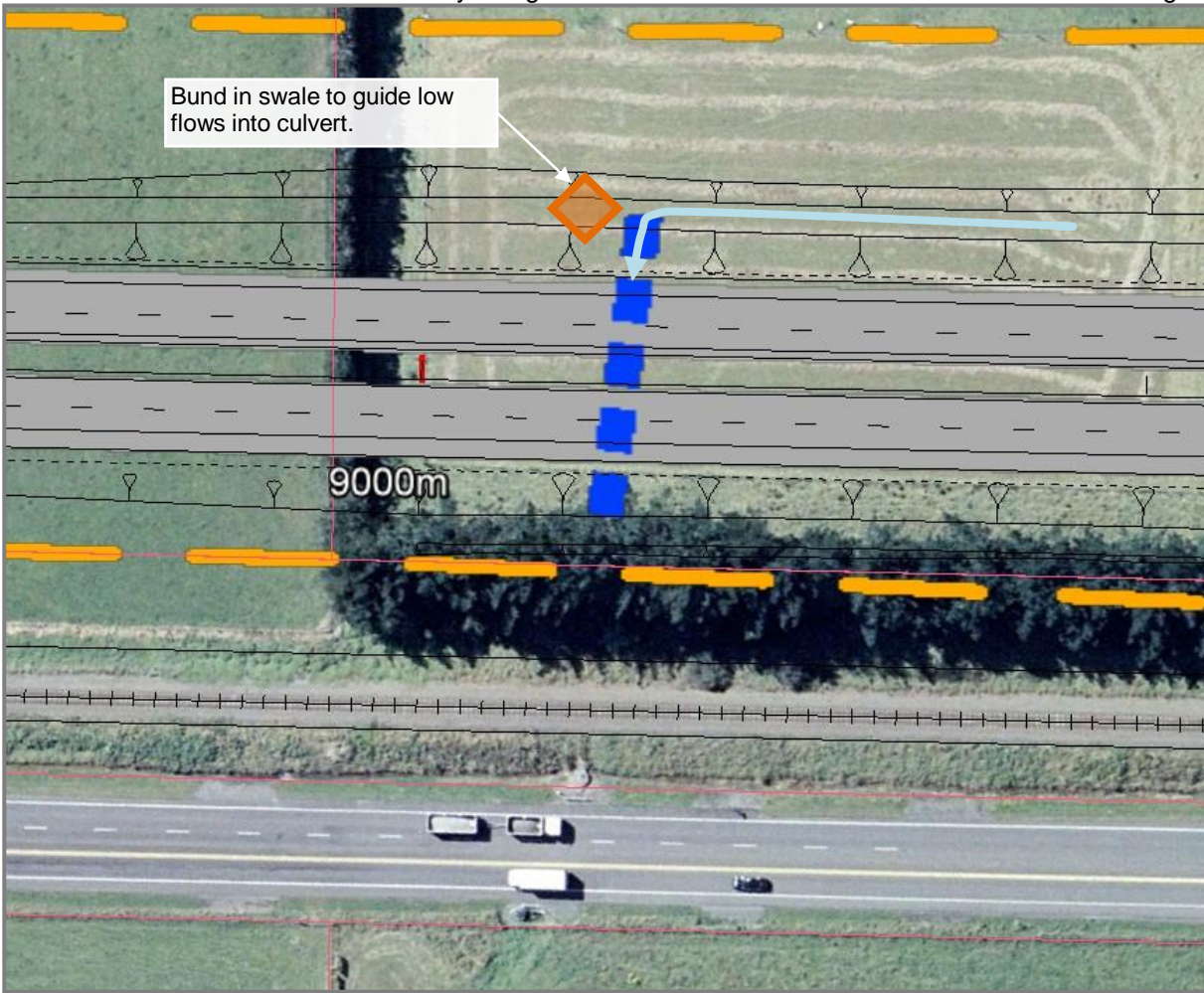
No survey in this area. Existing culvert inverts and stream bed levels all estimated from KCDC and Project specific contour information.
 All Levels (existing and proposed) to be confirmed at detail design stage.

Sections at approximate location (from scheme assessment drawings)

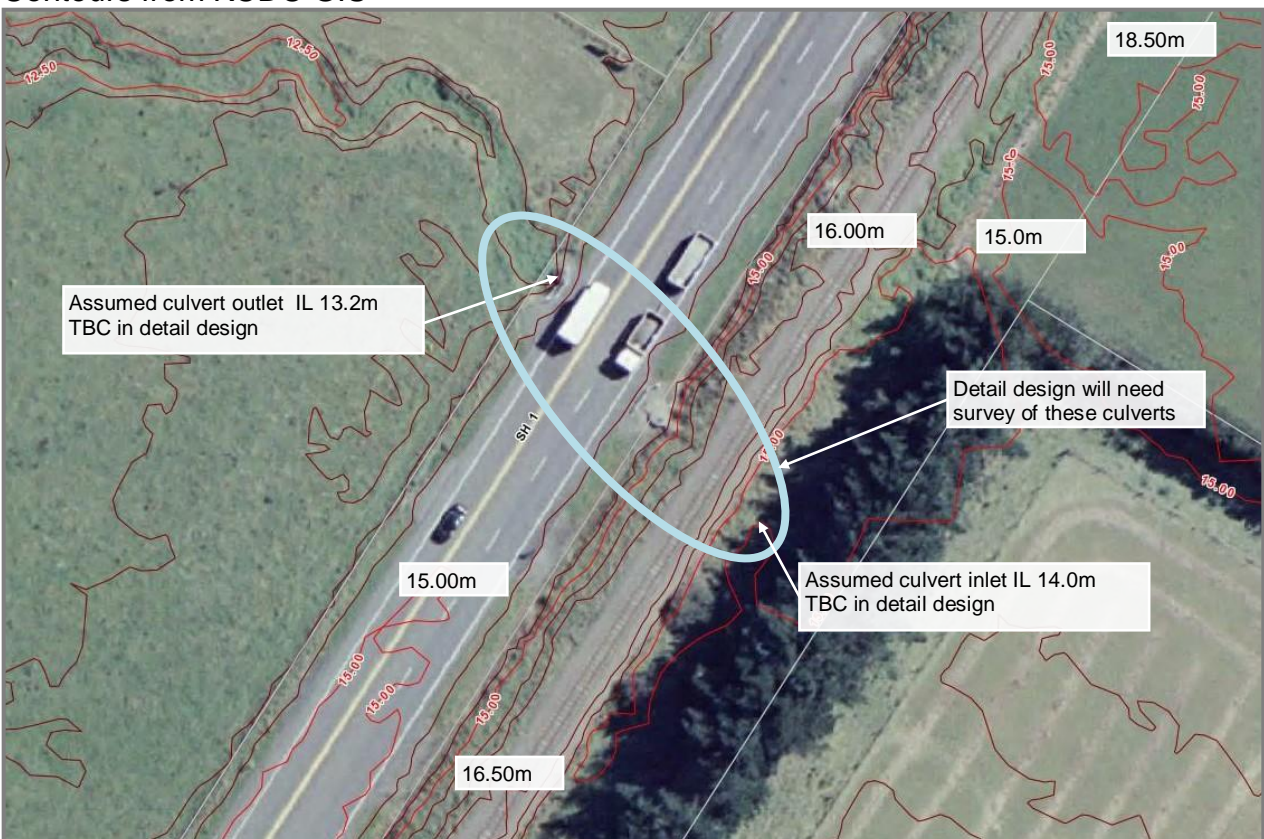


Long Section





Contours from KCDC GIS



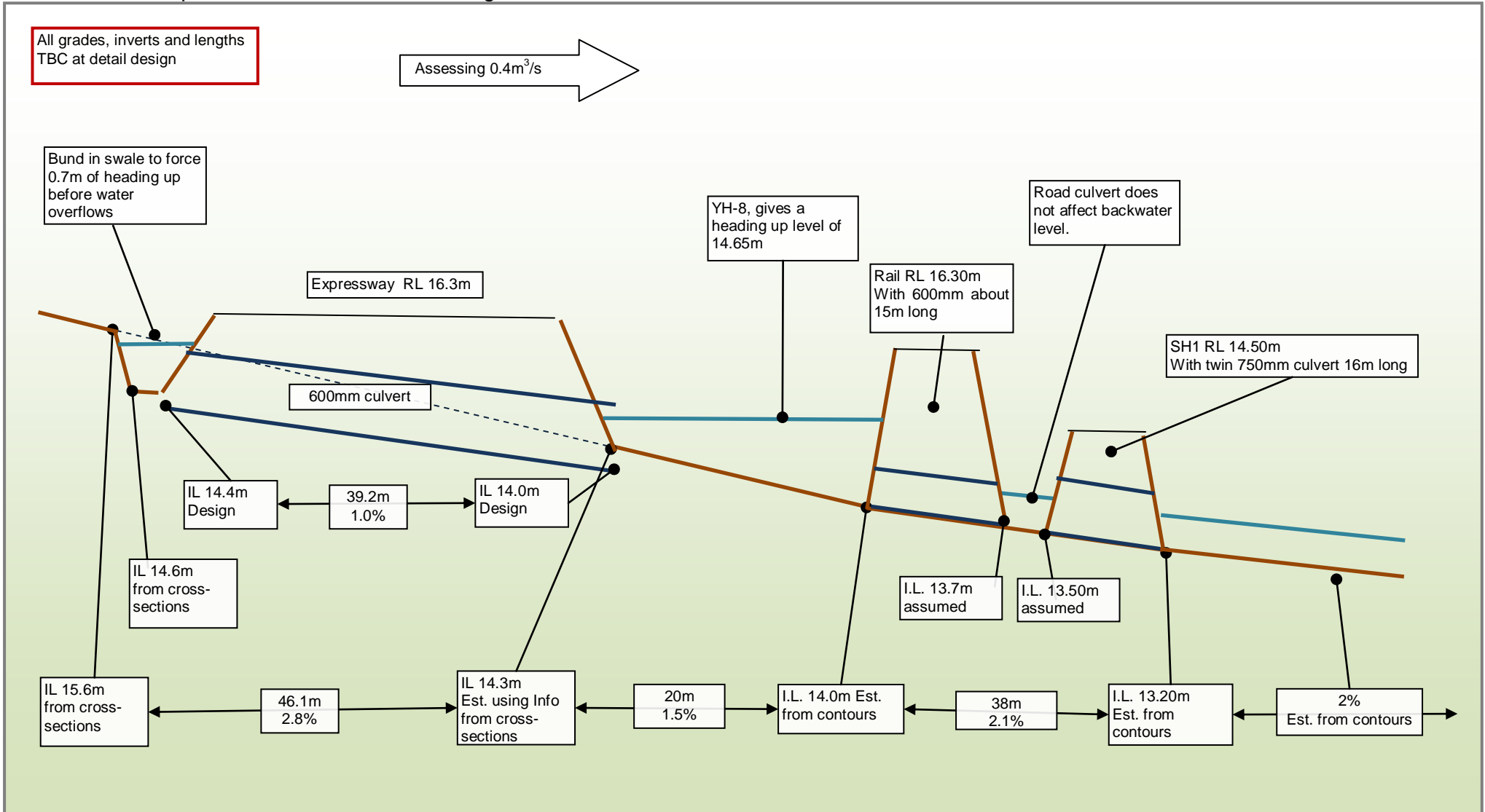
In the event of a storm event, the flow generated by the catchment will be much larger than the capacity of the rail culvert. Because of the topography, the water will not pond and over top the rail way, instead the water will run downhill (north) along the rail embankment.

So we proposed that a 600mm diameter culvert is used under the expressway at this location. If the culvert is any smaller:

- Less water will be available downstream for ecological use;
- More water will be diverted to the low area, where it will cause more heading up (and possible over topping) at the rail culvert in this area.

If the culvert is bigger: more water will pass through it (but not through the rail culvert) and over flow along the rail embankment as the existing situation. So there is no benefit.

The water that overflows to the low area will be dealt with at that location.



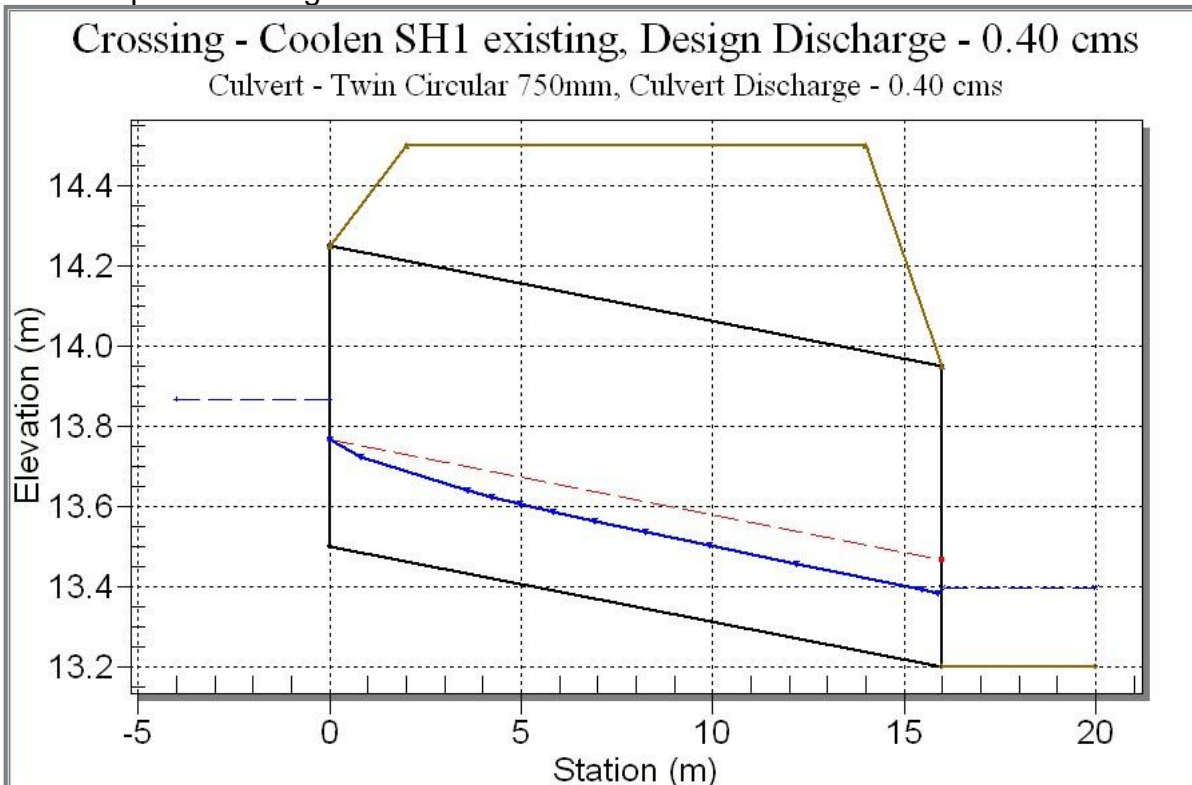
HY-8 inputs: Existing SH1 culvert

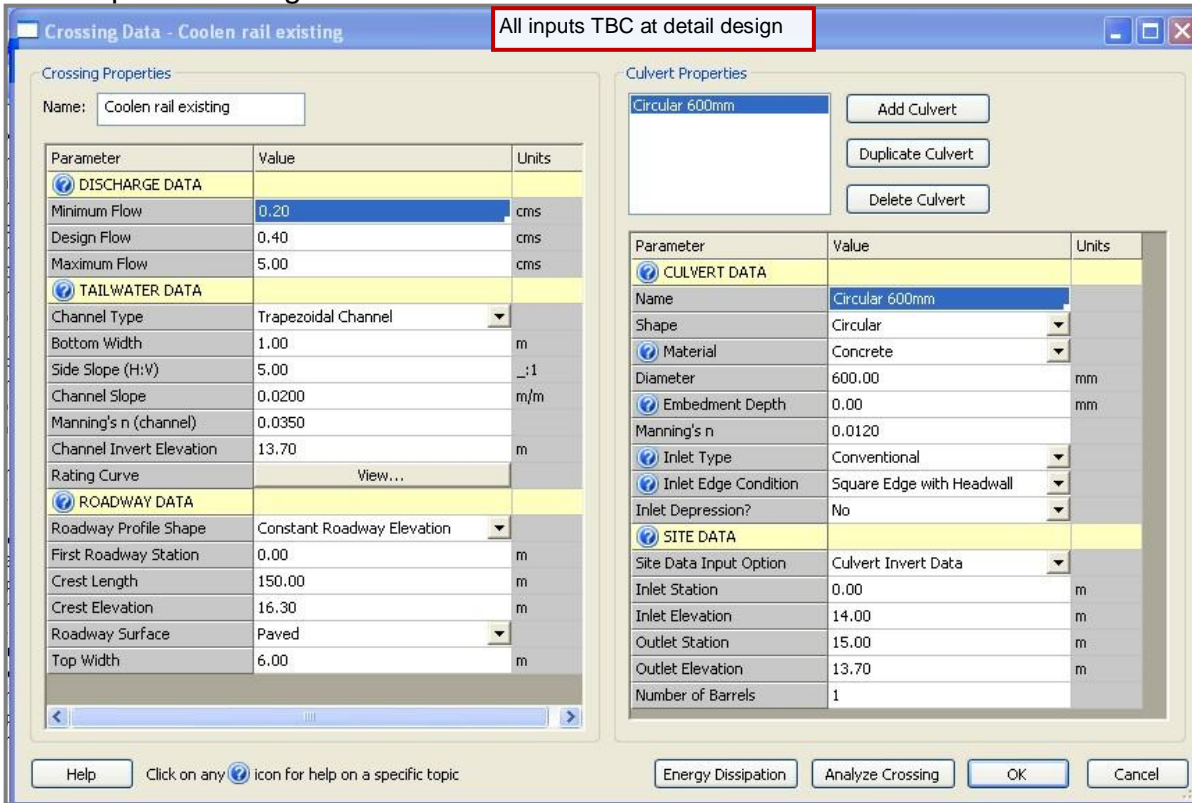
All inputs TBC at detail design

Crossing Properties		
Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	0.20	cms
Design Flow	0.40	cms
Maximum Flow	1.00	cms
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	1.00	m
Side Slope (H:V)	5.00	_:1
Channel Slope	0.0200	m/m
Manning's n (channel)	0.0350	
Channel Invert Elevation	13.20	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	150.00	m
Crest Elevation	14.50	m
Roadway Surface	Paved	
Top Width	12.00	m

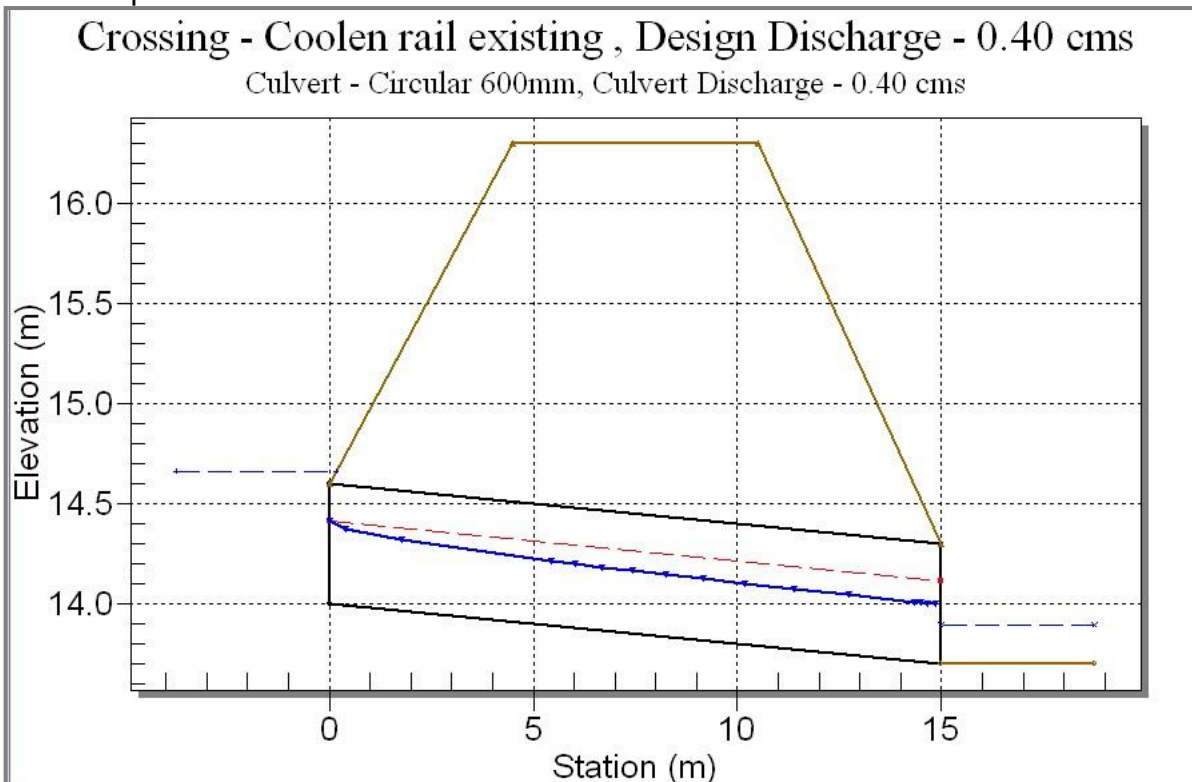
Culvert Properties		
Parameter	Value	Units
CULVERT DATA		
Name	Twin Circular 750mm	
Shape	Circular	
Material	Concrete	
Diameter	750.00	mm
Embedment Depth	0.00	mm
Manning's n	0.0120	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	13.50	m
Outlet Station	16.00	m
Outlet Elevation	13.20	m
Number of Barrels	2	

HY-8 outputs: Existing SH1 culvert





HY-8 outputs: SH1 culvert with increased tail water



HY-8 inputs: Proposed pipe size

All inputs TBC at detail design

Crossing Data - Crossing 19

Crossing Properties
 Name: coolen Proposed

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	0.20	cms
Design Flow	0.40	cms
Maximum Flow	5.00	cms
TAILWATER DATA		
Channel Type	Enter Constant Tailwater Elevation	
Channel Invert Elevation	14.00	m
Constant Tailwater Elevation	14.65	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	150.00	m
Crest Elevation	16.30	m
Roadway Surface	Paved	
Top Width	30.00	m

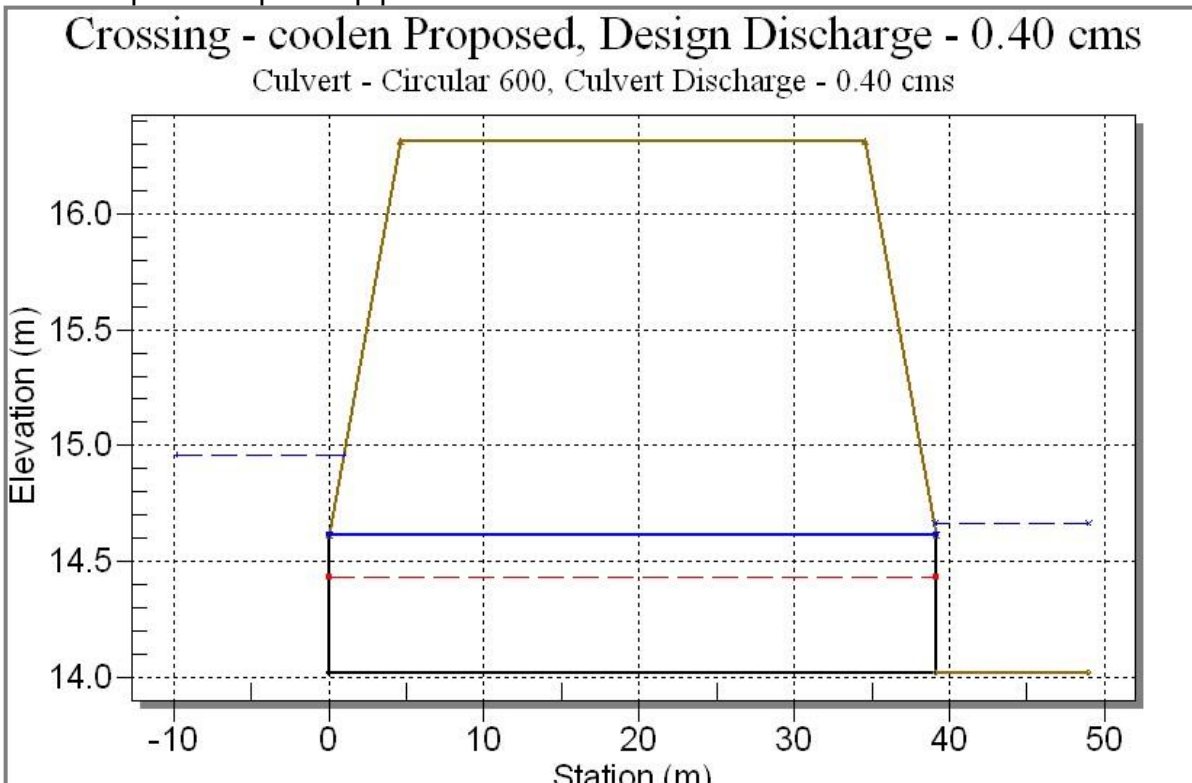
Culvert Properties
 Circular 600

Add Culvert
 Duplicate Culvert
 Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Circular 600	
Shape	Circular	
Material	Concrete	
Diameter	600.00	mm
Embedment Depth	0.00	mm
Manning's n	0.0120	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	14.00	m
Outlet Station	39.20	m
Outlet Elevation	14.00	m
Number of Barrels	1	

Help Click on any icon for help on a specific topic Energy Dissipation Analyze Crossing OK Cancel

HY-8 outputs: Proposed pipe size

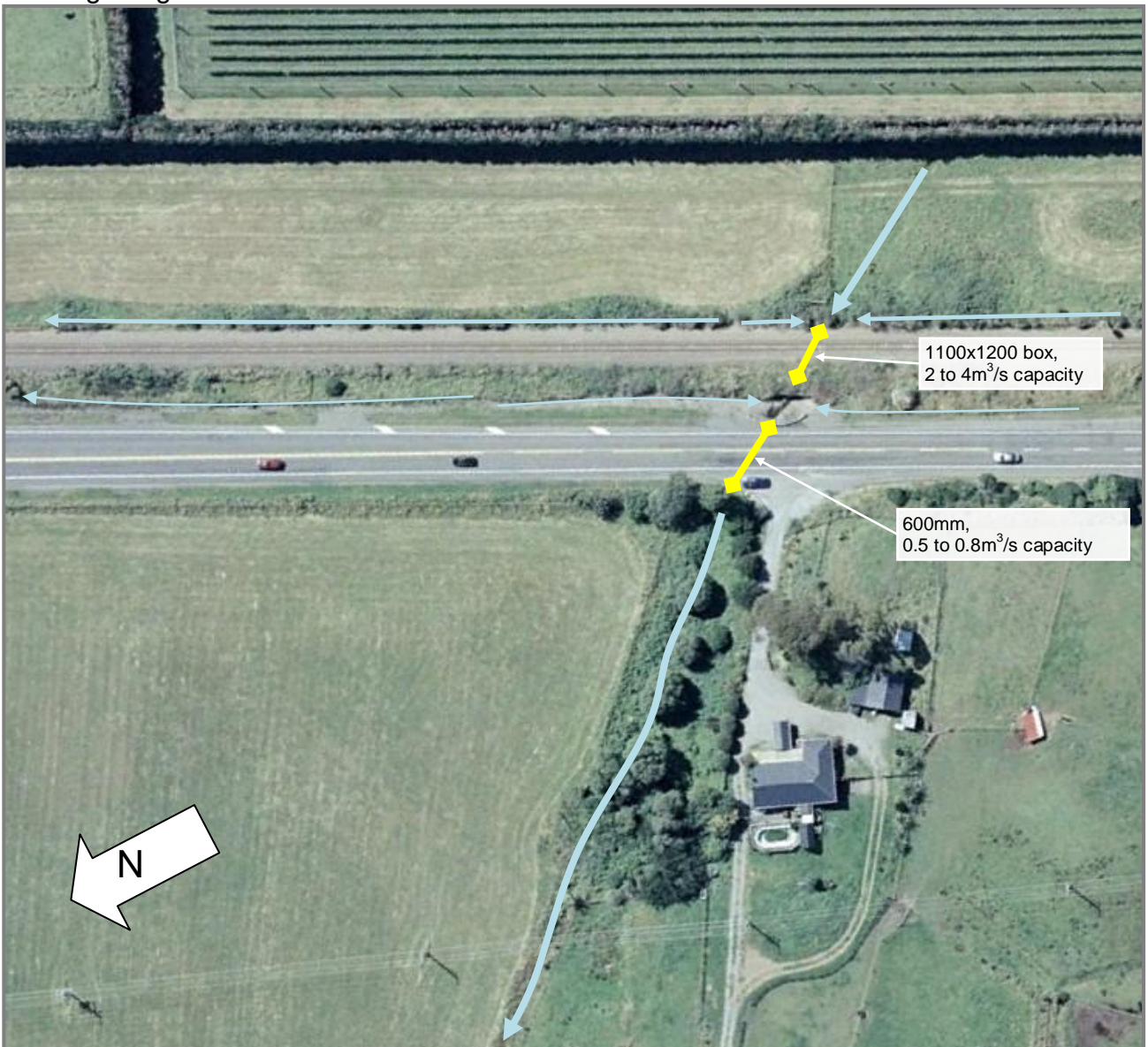


AVATAR CULVERT Part 1

Existing Image



Existing Image

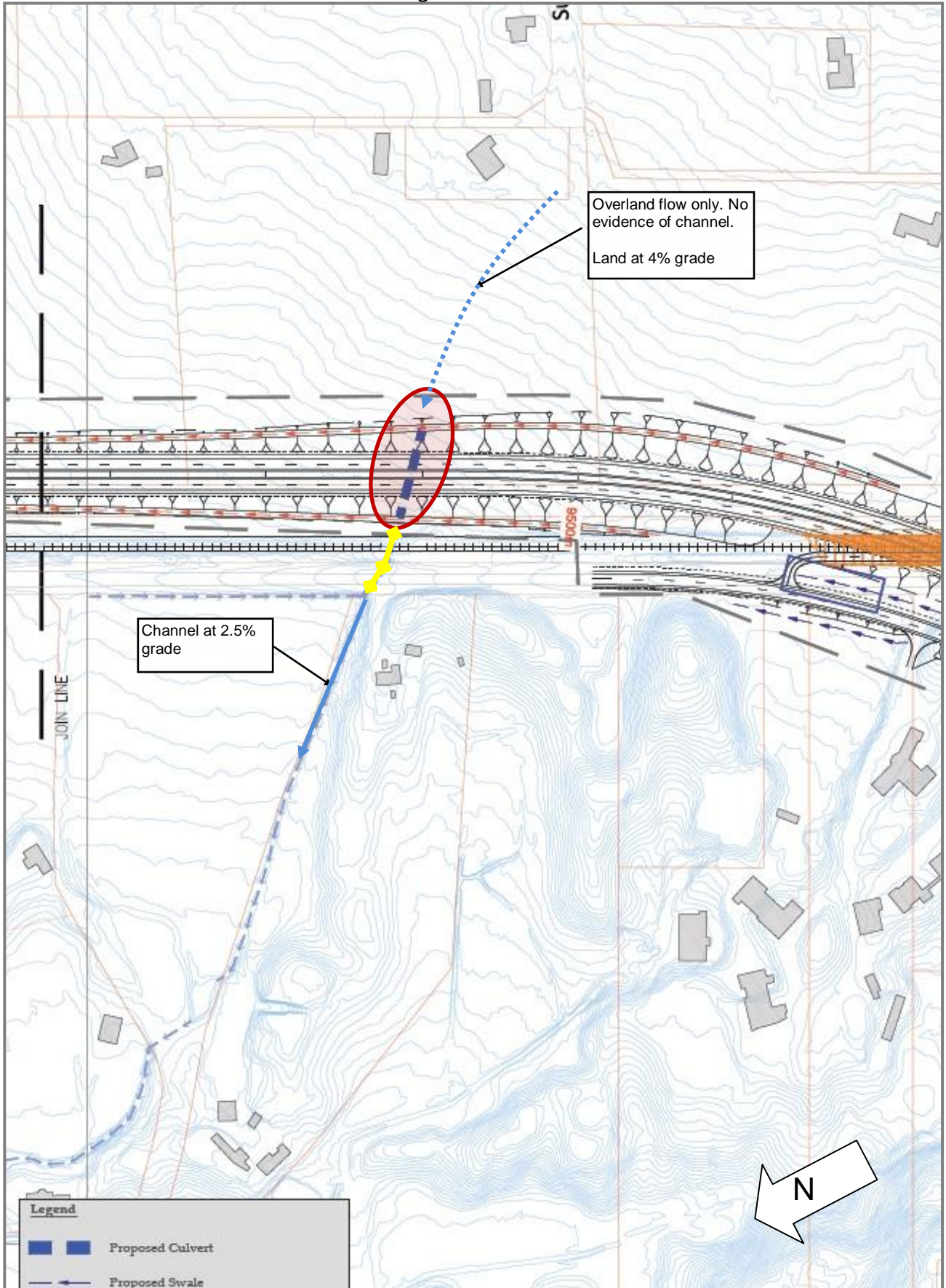




Street view shot. Looking south. To the right.



Location on scheme assessment drawing

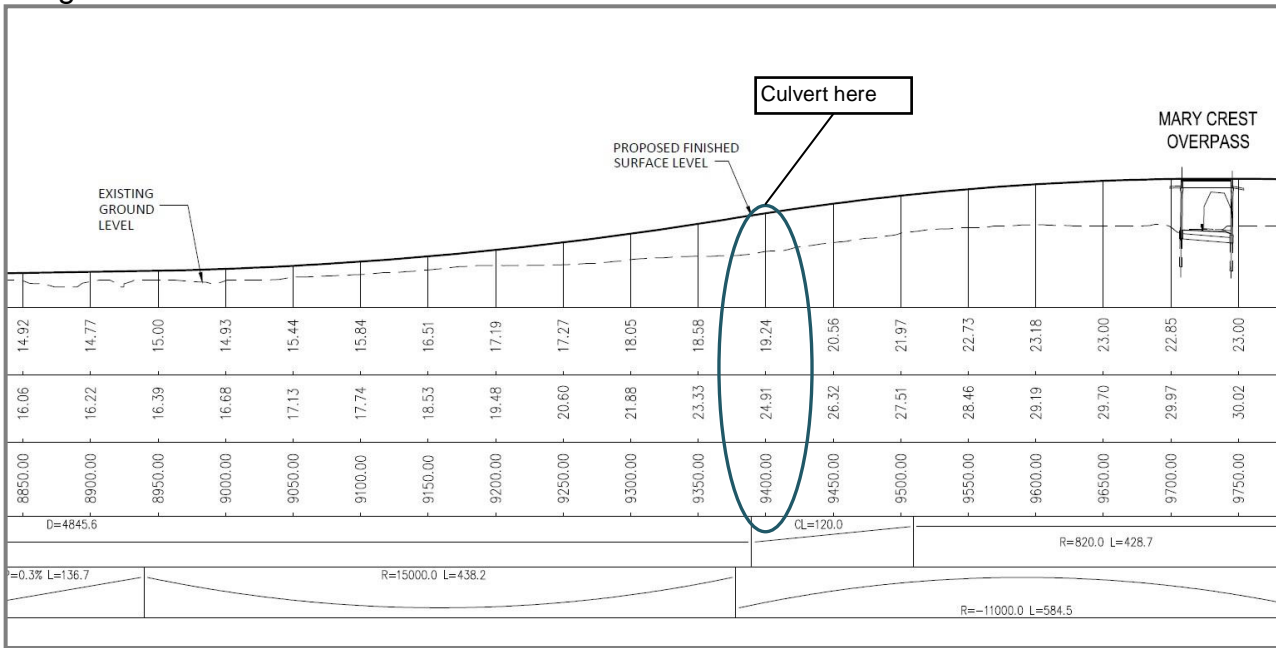


AVATAR CULVERT

No survey in this area. Existing culvert inverts and stream bed levels all estimated from KCDC and Project specific contour information.
 All Levels (existing and proposed) to be confirmed at detail design stage.

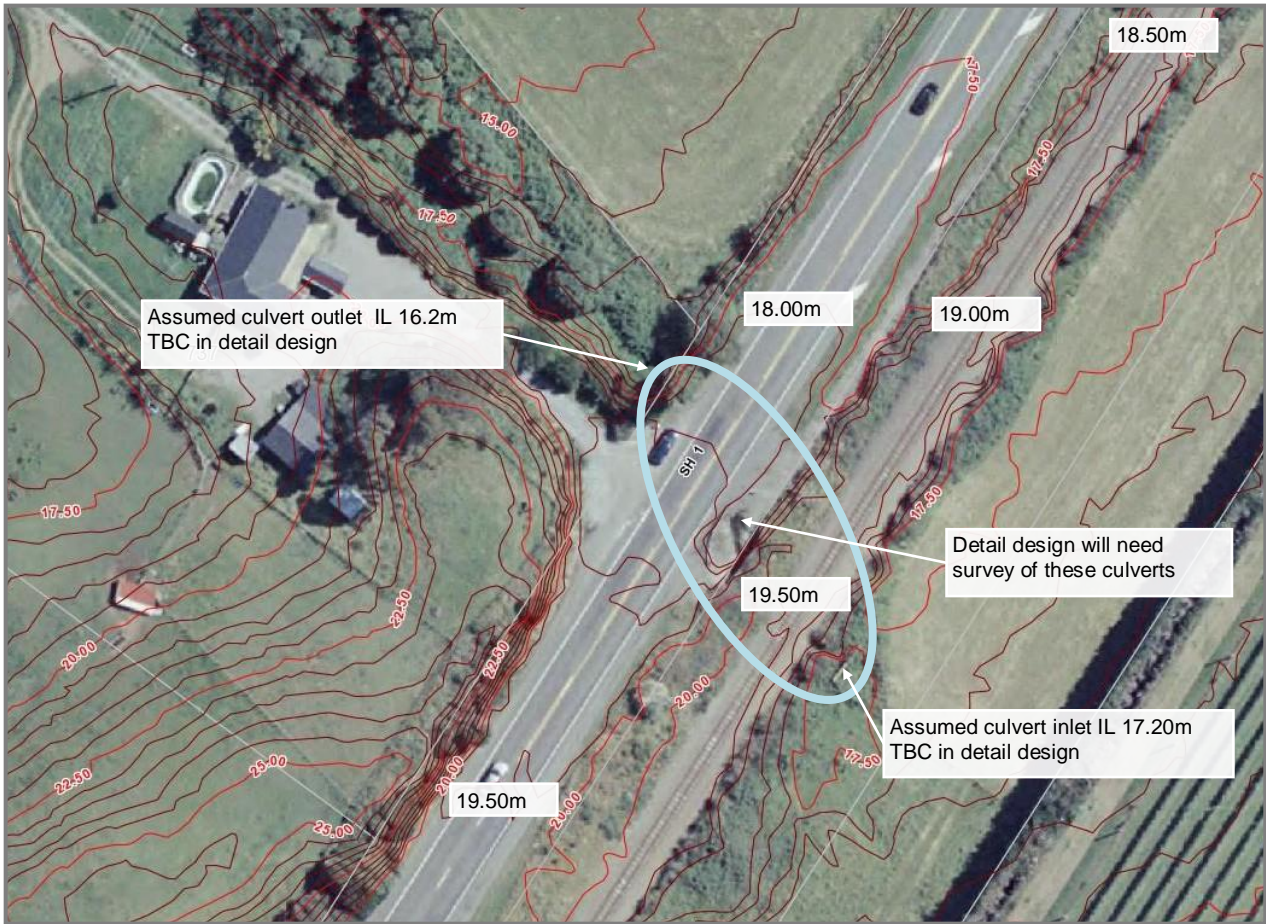
Sections at approximate location (from scheme assessment drawings)



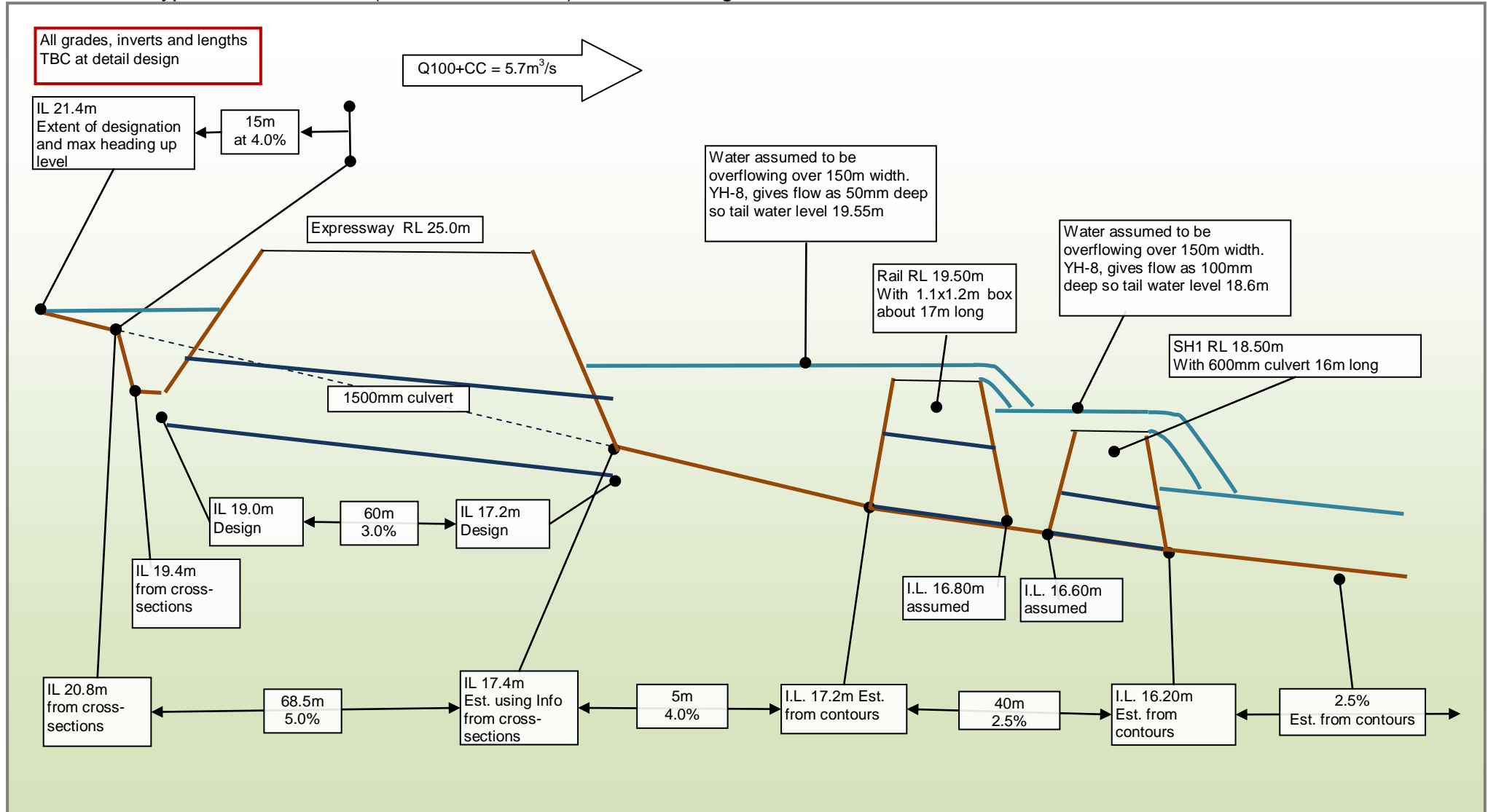


Aerial with road geometry





Schematic of hypothetical situation (NOT PROPOSED) – Levels and grades



HY-8 inputs: Existing SH1 culvert: Q100 + CC

Crossing Data - Avatar SH1 existing All inputs TBC at detail design

Crossing Properties
 Name: Avatar SH1 existing

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	1.00	cms
Design Flow	5.70	cms
Maximum Flow	14.00	cms
TAILWATER DATA		
Channel Type	Triangular Channel	
Side Slope (H:V)	5.00	:1
Channel Slope	0.0250	m/m
Manning's n (channel)	0.0350	
Channel Invert Elevation	16.20	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	150.00	m
Crest Elevation	18.50	m
Roadway Surface	Paved	
Top Width	10.00	m

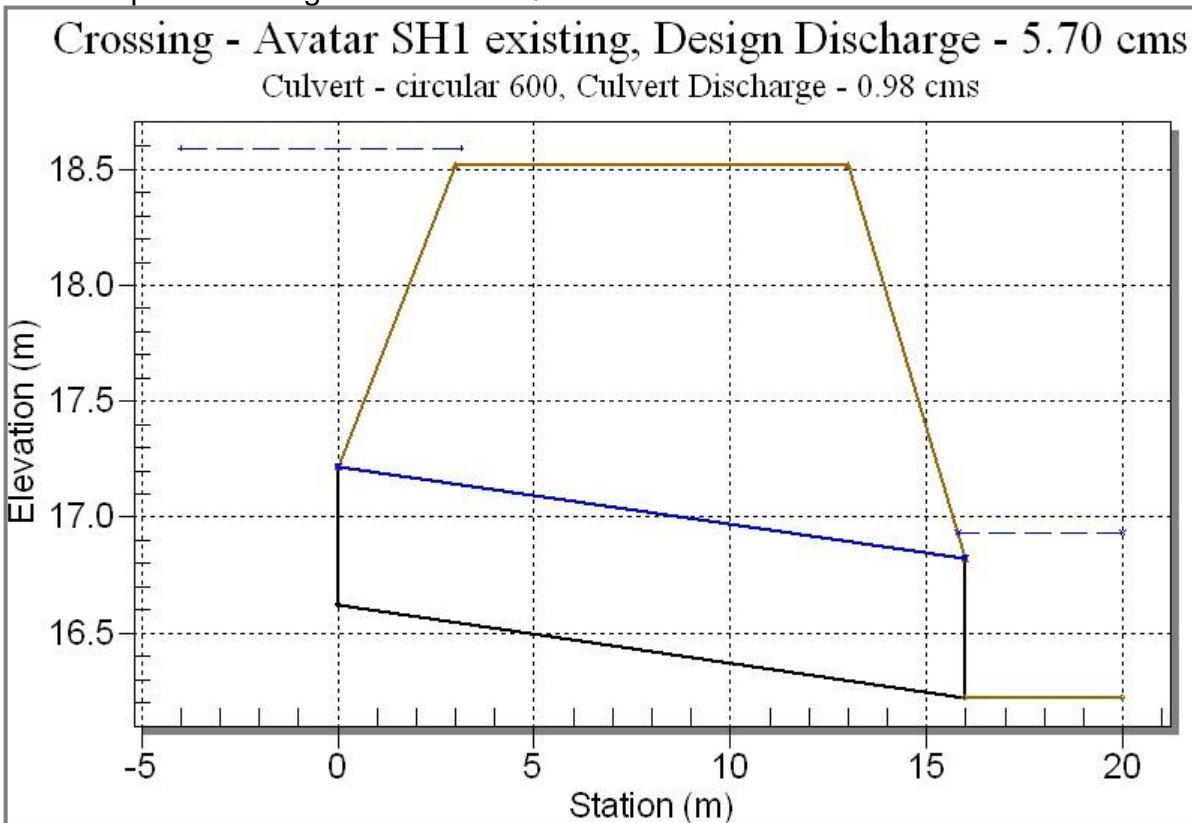
Culvert Properties

circular 600 Add Culvert
Duplicate Culvert
Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	circular 600	
Shape	Circular	
Material	Concrete	
Diameter	600.00	mm
Embedment Depth	0.00	mm
Manning's n	0.0120	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	16.60	m
Outlet Station	16.00	m
Outlet Elevation	16.20	m
Number of Barrels	1	

Help Click on any icon for help on a specific topic Energy Dissipation Analyze Crossing OK Cancel

HY-8 outputs: Existing SH1 culvert: Q100 + CC



Crossing Data - Avatar rail existing All inputs TBC at detail design

Crossing Properties
 Name: Avatar rail existing

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	1.00	cms
Design Flow	5.70	cms
Maximum Flow	14.00	cms
TAILWATER DATA		
Channel Type	Enter Constant Tailwater Elevation	
Channel Invert Elevation	16.80	m
Constant Tailwater Elevation	18.55	m
Rating Curve	view...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	150.00	m
Crest Elevation	19.50	m
Roadway Surface	Gravel	
Top Width	6.00	m

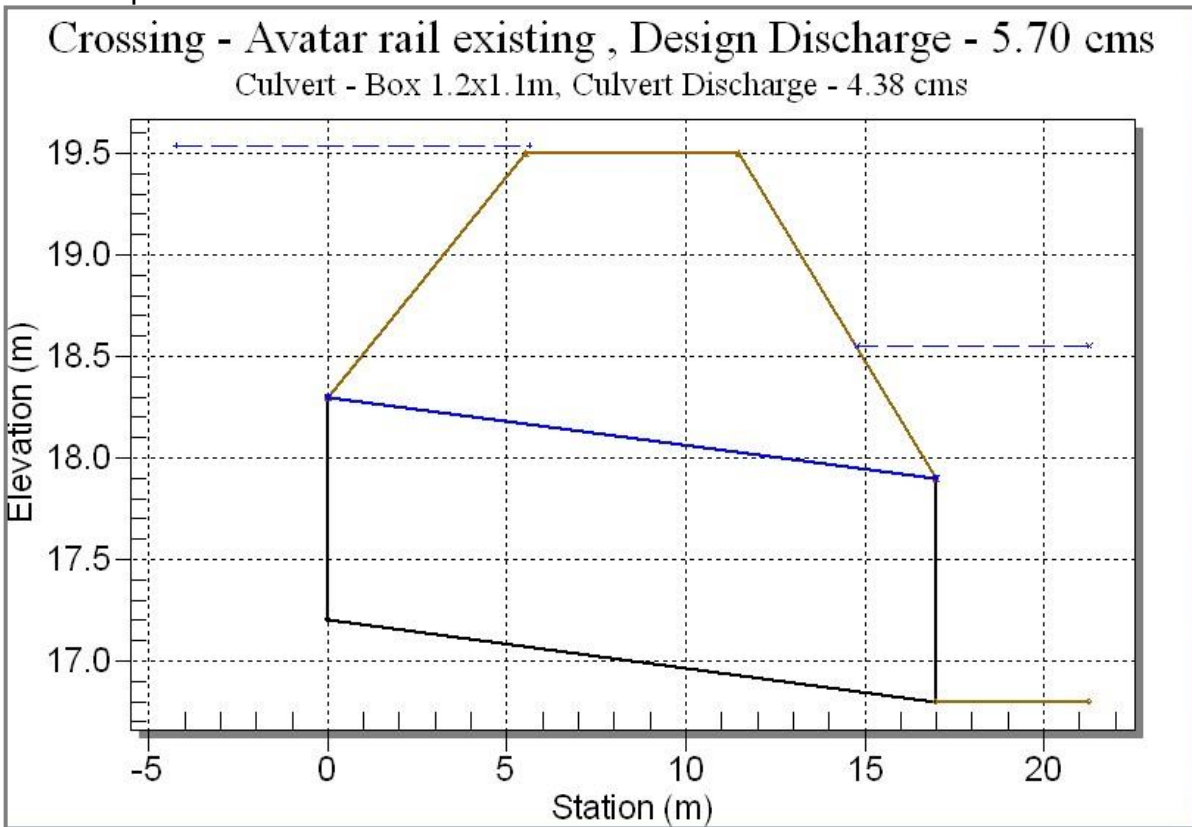
Culvert Properties

Box 1.2x1.1m Add Culvert
Duplicate Culvert
Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Box 1.2x1.1m	
Shape	Concrete Box	
Material	Concrete	
Span	1200.00	mm
Rise	1100.00	mm
Embedment Depth	0.00	mm
Manning's n	0.0120	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge (90°) Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	17.20	m
Outlet Station	17.00	m
Outlet Elevation	16.80	m
Number of Barrels	1	

Help Click on any icon for help on a specific topic Energy Dissipation Analyze Crossing OK Cancel

HY-8 outputs: SH1 culvert with increased tail water:: Q100 + CC



HY-8 inputs: Proposed pipe size: Q100 + CC

Crossing Data - Avatar proposed All inputs TBC at detail design

Crossing Properties
 Name: Avatar proposed

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	1.00	cms
Design Flow	5.70	cms
Maximum Flow	14.00	cms
TAILWATER DATA		
Channel Type	Enter Constant Tailwater Elevation	
Channel Invert Elevation	17.40	m
Constant Tailwater Elevation	19.55	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	150.00	m
Crest Elevation	25.00	m
Roadway Surface	Paved	
Top Width	27.00	m

Culvert Properties
 Circular 1500

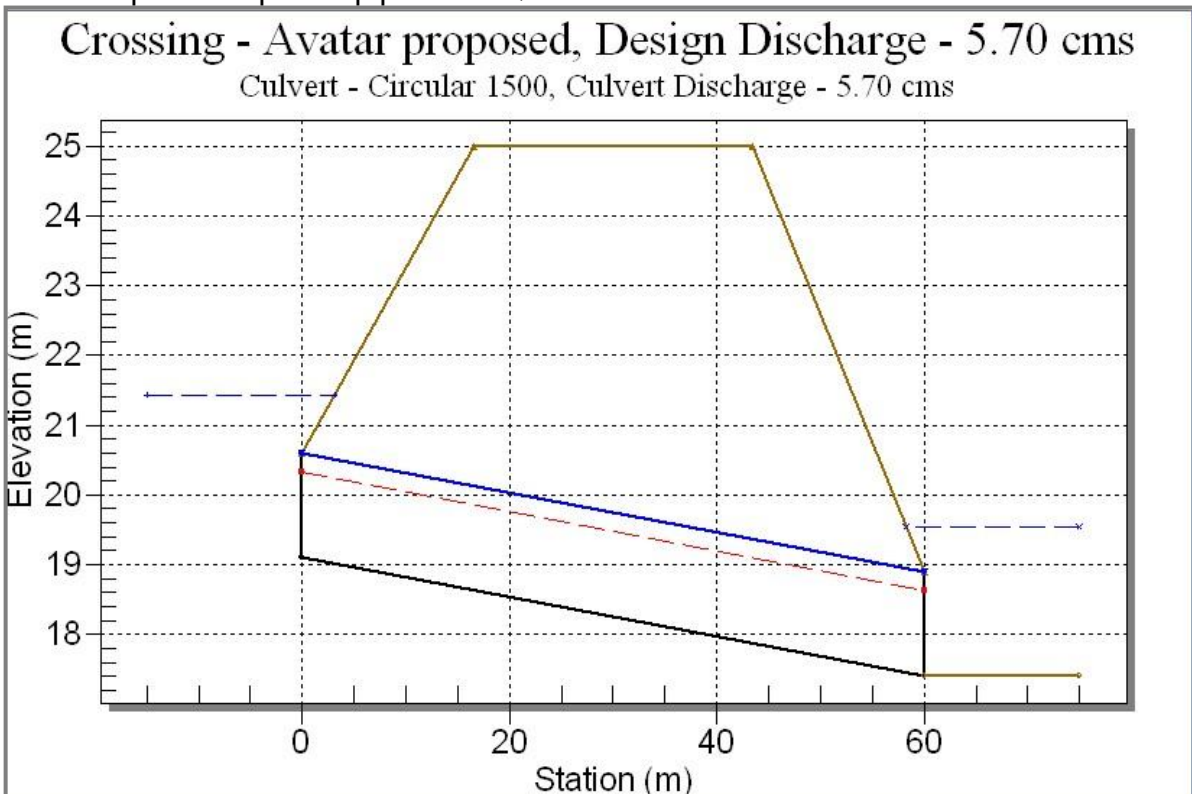
Add Culvert
 Duplicate Culvert
 Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Circular 1500	
Shape	Circular	
Material	Concrete	
Diameter	1500.00	mm
Embedment Depth	0.00	mm
Manning's n	0.0120	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	19.10	m
Outlet Station	60.00	m
Outlet Elevation	17.40	m
Number of Barrels	1	

Help Click on any icon for help on a specific topic

Energy Dissipation Analyze Crossing OK Cancel

HY-8 outputs: Proposed pipe size: Q100 + CC



AVATAR CULVERT Part 2



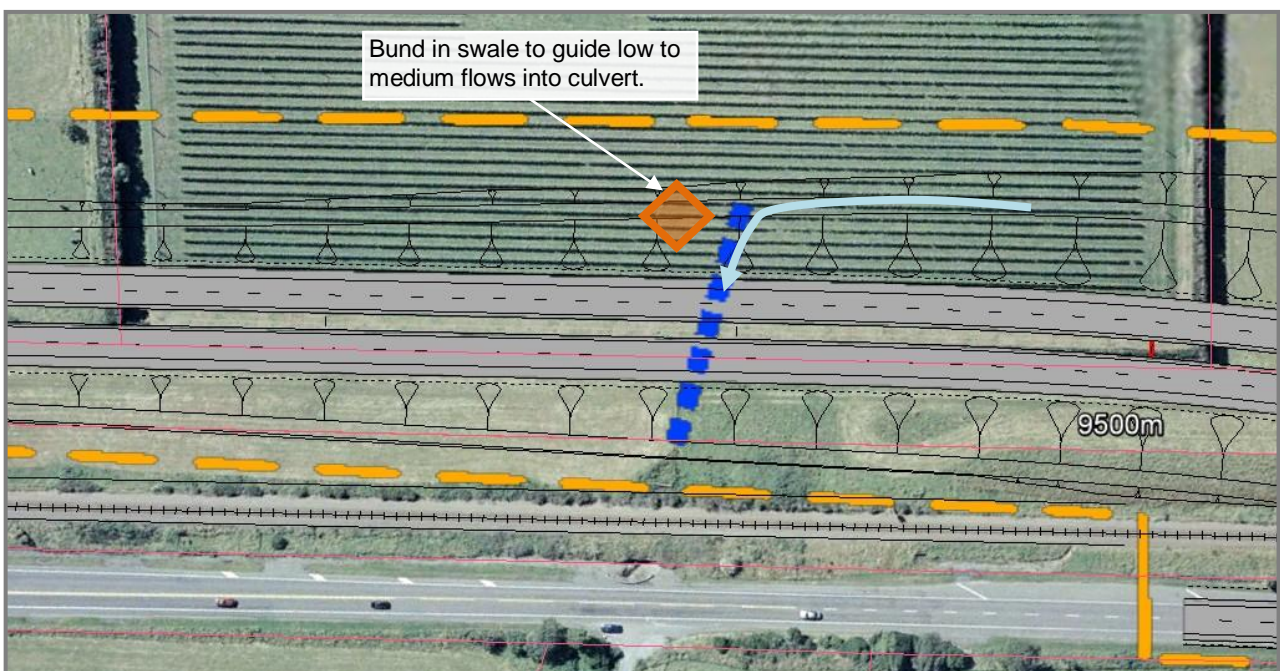
In the event of a storm event, the flow generated by the catchment will be much larger than the capacity of the rail culvert. Because of the topography, the water will not pond and over top the rail way, instead the water will run downhill (north) along the rail embankment.

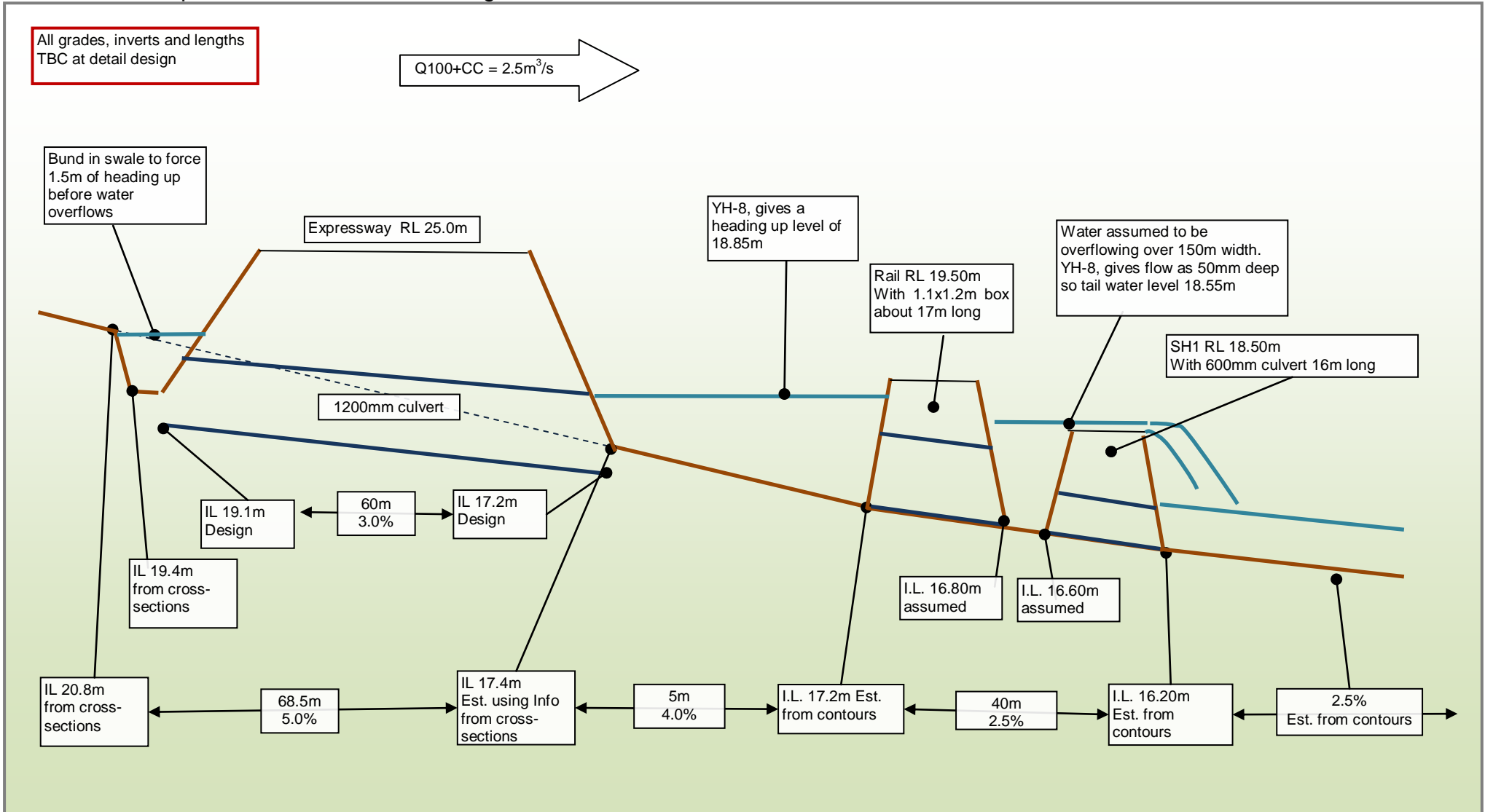
So we proposed that a 1200mm diameter culvert is used under the expressway at this location. If the culvert is any smaller:

- Less water will be available downstream for ecological use;
- More water will be diverted to the low area, where it will cause more heading up (and possible over topping) at the rail culvert in this area.

If the culvert is bigger: more water will pass through it (but not through the rail culvert) and overflow along the rail embankment as the existing situation. So there is no benefit.

The water that overflows to the low area will be dealt with at that location.





HY-8 inputs: Existing SH1 culvert

Crossing Data - Avatar SH1 existing
 All inputs TBC at detail design

Crossing Properties

Name: Avatar SH1 existing

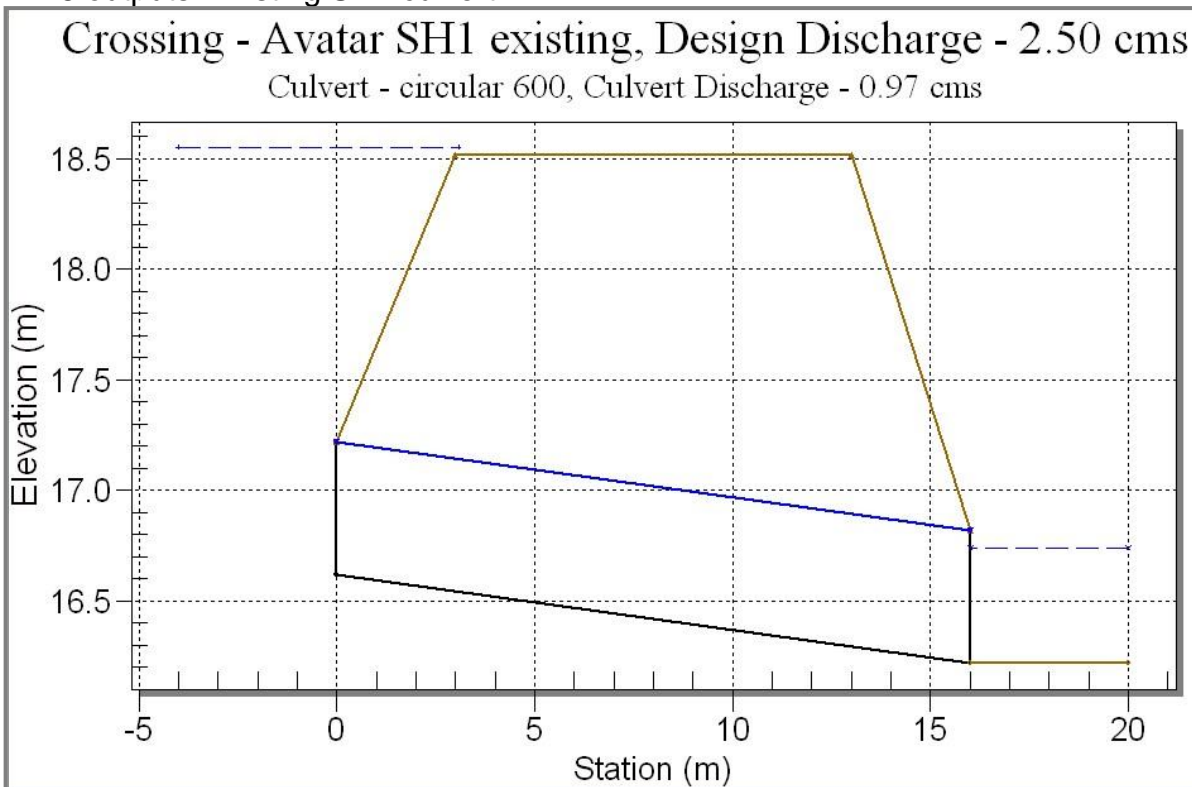
Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	1.00	cms
Design Flow	2.50	cms
Maximum Flow	14.00	cms
TAILWATER DATA		
Channel Type	Triangular Channel	
Side Slope (H:V)	5.00	_:1
Channel Slope	0.0250	m/m
Manning's n (channel)	0.0350	
Channel Invert Elevation	16.20	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	150.00	m
Crest Elevation	18.50	m
Roadway Surface	Paved	
Top Width	10.00	m

Culvert Properties

circular 600

Parameter	Value	Units
CULVERT DATA		
Name	circular 600	
Shape	Circular	
Material	Concrete	
Diameter	600.00	mm
Embedment Depth	0.00	mm
Manning's n	0.0120	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	16.60	m
Outlet Station	16.00	m
Outlet Elevation	16.20	m
Number of Barrels	1	

HY-8 outputs: Existing SH1 culvert

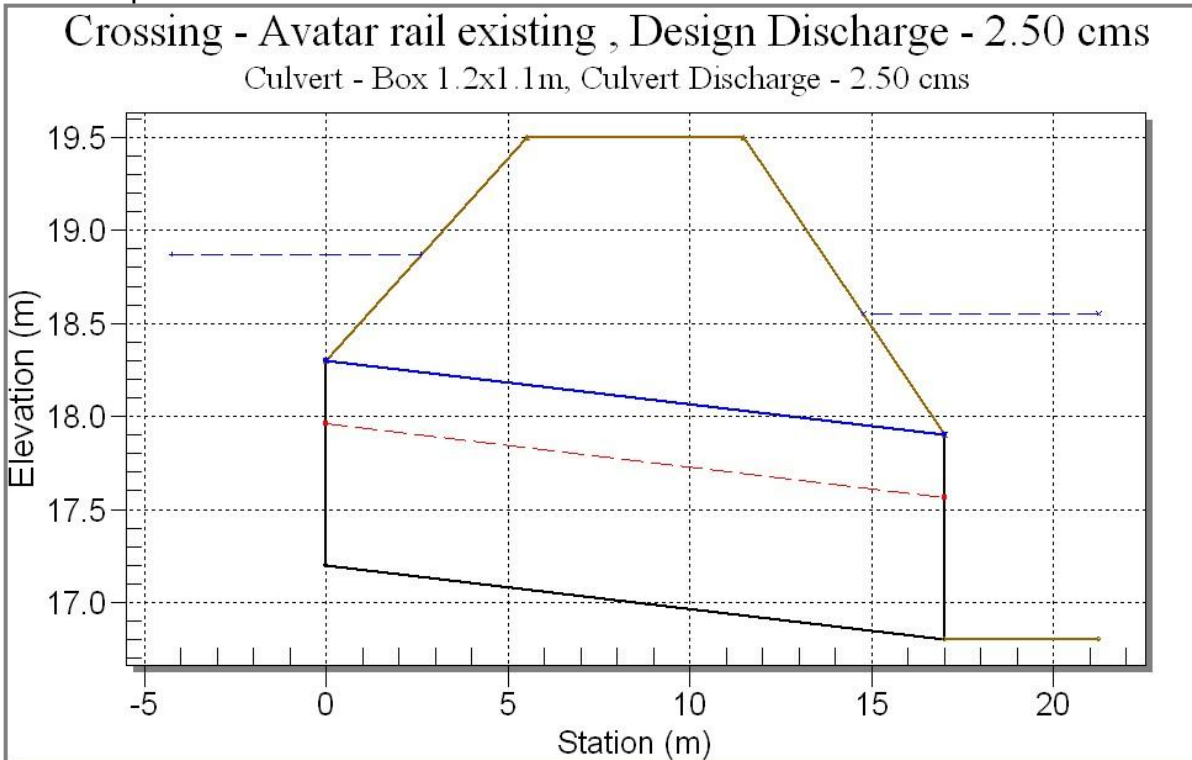


All inputs TBC at detail design

Crossing Properties		
Name: Avatar rail existing		
DISCHARGE DATA		
Minimum Flow	1.00	cms
Design Flow	2.50	cms
Maximum Flow	14.00	cms
TAILWATER DATA		
Channel Type	Enter Constant Tailwater Elevation	
Channel Invert Elevation	16.80	m
Constant Tailwater Elevation	18.55	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	150.00	m
Crest Elevation	19.50	m
Roadway Surface	Gravel	
Top Width	6.00	m

Culvert Properties		
Box 1.2x1.1m		
Add Culvert		
Duplicate Culvert		
Delete Culvert		
CULVERT DATA		
Name	Box 1.2x1.1m	
Shape	Concrete Box	
Material	Concrete	
Span	1200.00	mm
Rise	1100.00	mm
Embedment Depth	0.00	mm
Manning's n	0.0120	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge (90°) Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	17.20	m
Outlet Station	17.00	m
Outlet Elevation	16.80	m
Number of Barrels	1	

HY-8 outputs: SH1 culvert with increased tail water



HY-8 inputs: Proposed pipe size

Crossing Data - Avatar proposed
 All inputs TBC at detail design

Crossing Properties

Name: Avatar proposed

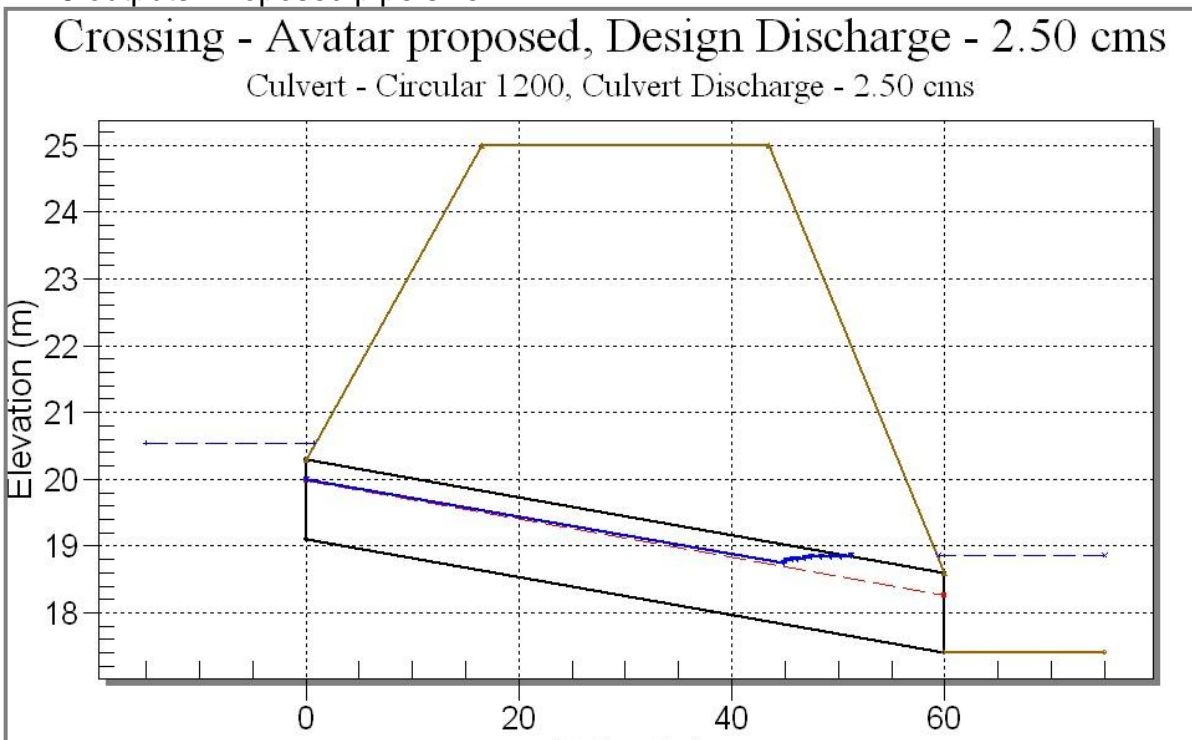
Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	1.00	cms
Design Flow	2.50	cms
Maximum Flow	14.00	cms
TAILWATER DATA		
Channel Type	Enter Constant Tailwater Elevation	
Channel Invert Elevation	17.40	m
Constant Tailwater Elevation	18.85	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	150.00	m
Crest Elevation	25.00	m
Roadway Surface	Paved	
Top Width	27.00	m

Culvert Properties

Circular 1200

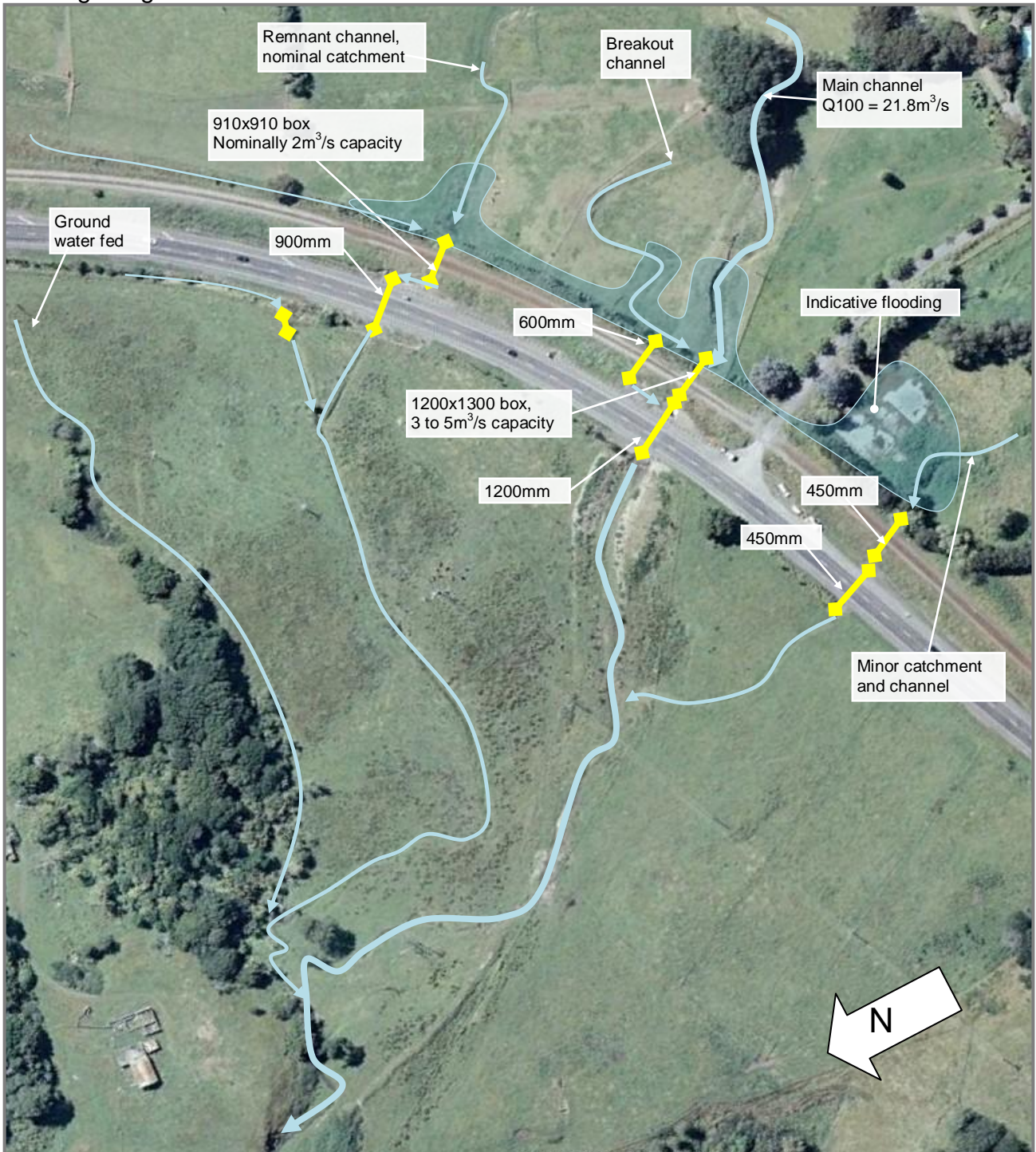
Parameter	Value	Units
CULVERT DATA		
Name	Circular 1200	
Shape	Circular	
Material	Concrete	
Diameter	1200.00	mm
Embedment Depth	0.00	mm
Manning's n	0.0120	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	19.10	m
Outlet Station	60.00	m
Outlet Elevation	17.40	m
Number of Barrels	1	

HY-8 outputs: Proposed pipe size



JEWELL CULVERT(S)

Existing Image



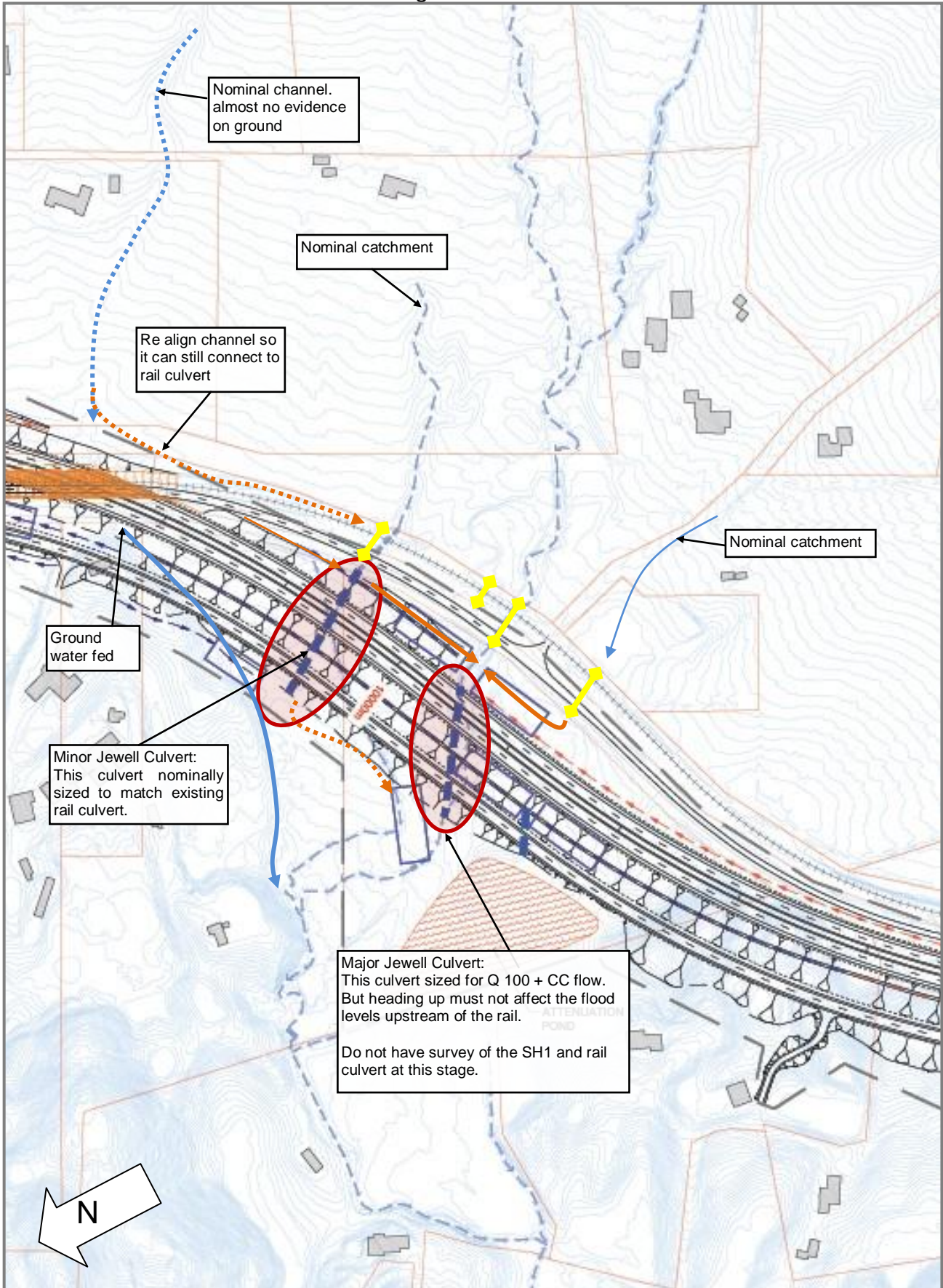
Street view shot. Looking north. To the left.



Street view shot. Looking north. To the right.



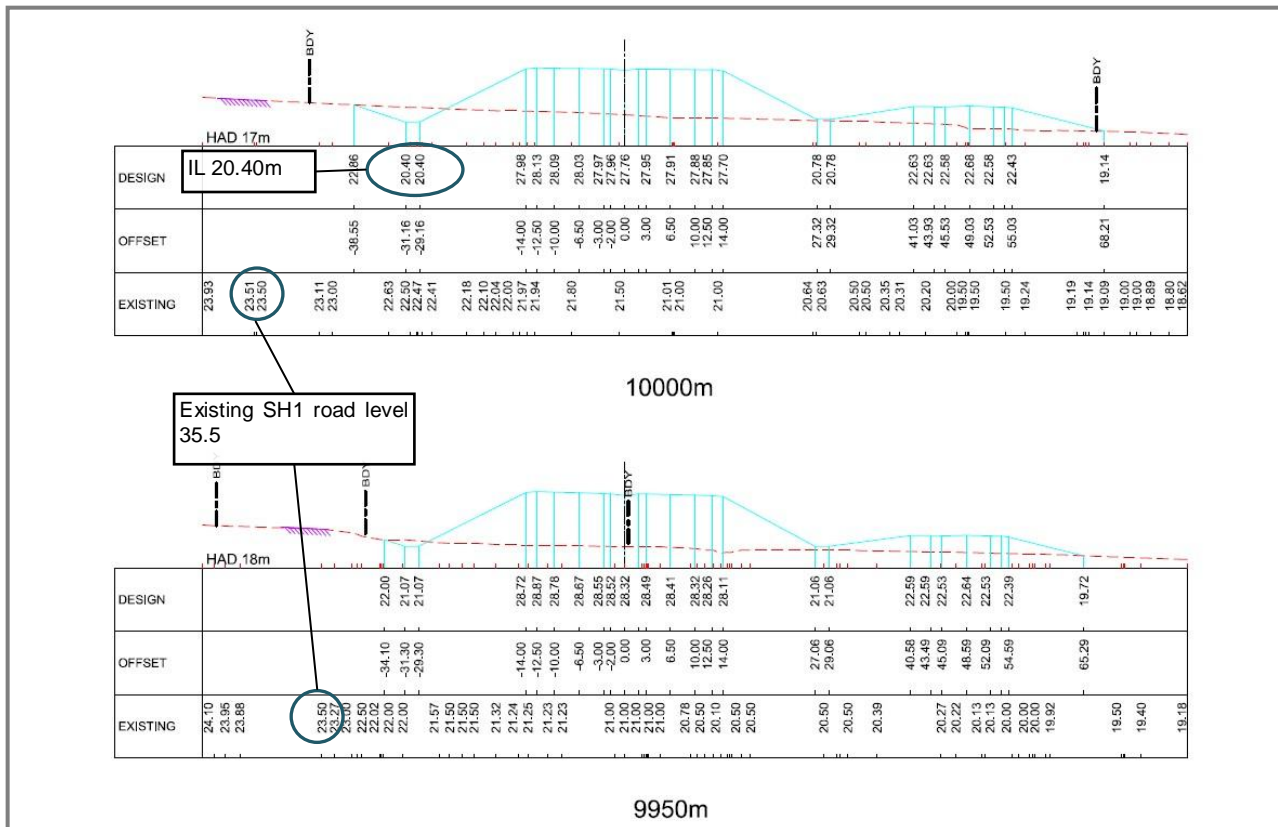
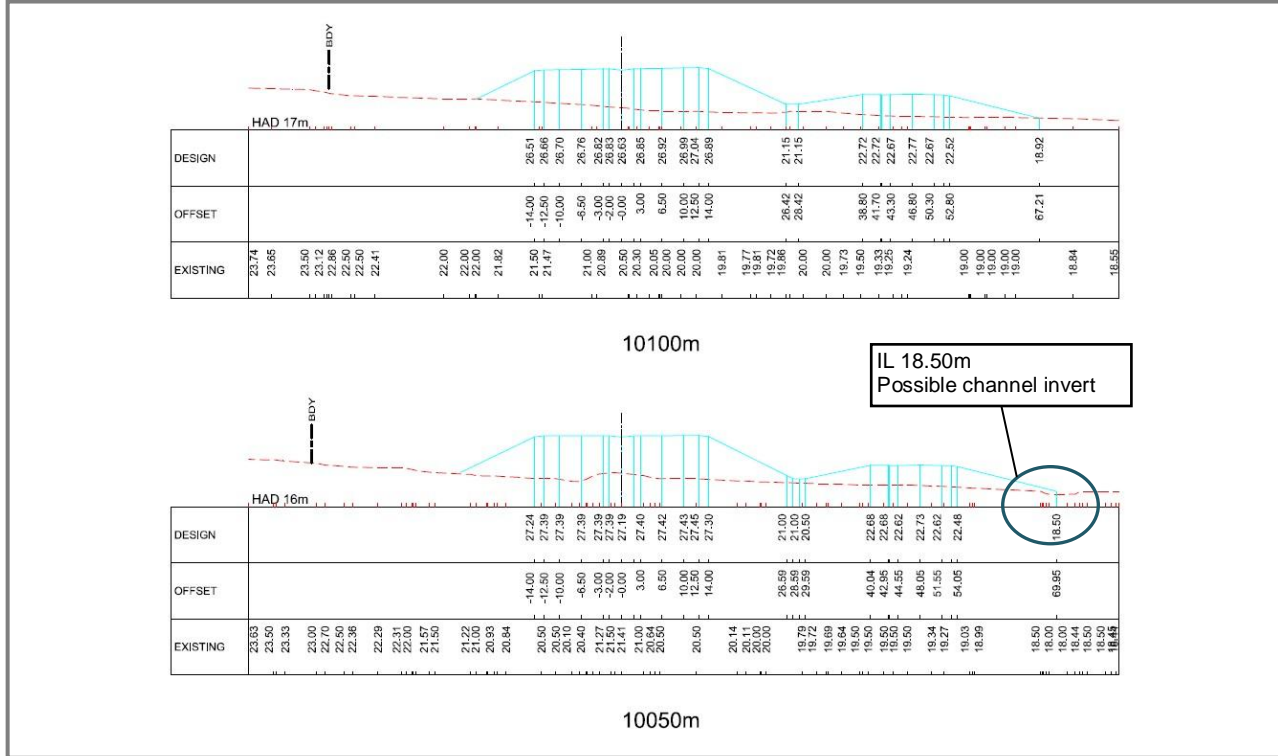
Location on scheme assessment drawing



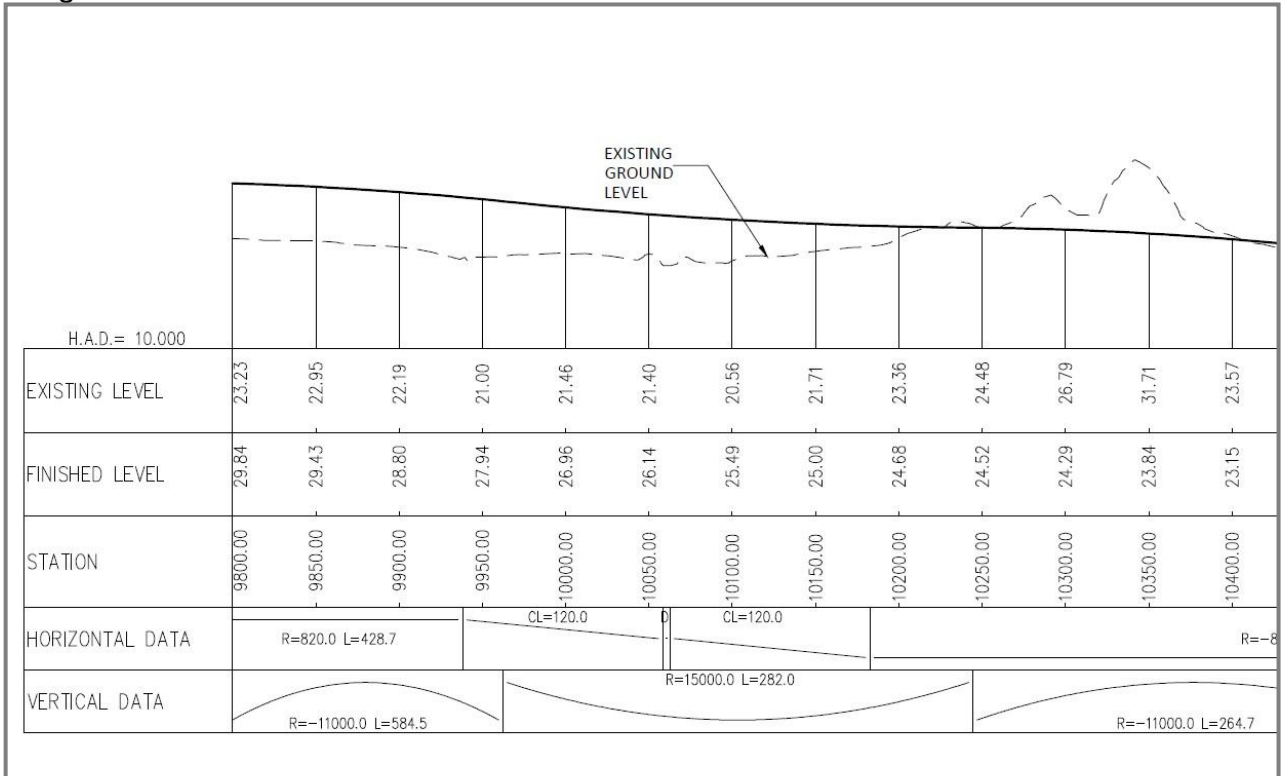
JEWELL CULVERT(S)

No survey in this area. Existing culvert inverts and stream bed levels all estimated from KCDC and Project specific contour information.
 All Levels (existing and proposed) to be confirmed at detail design stage.

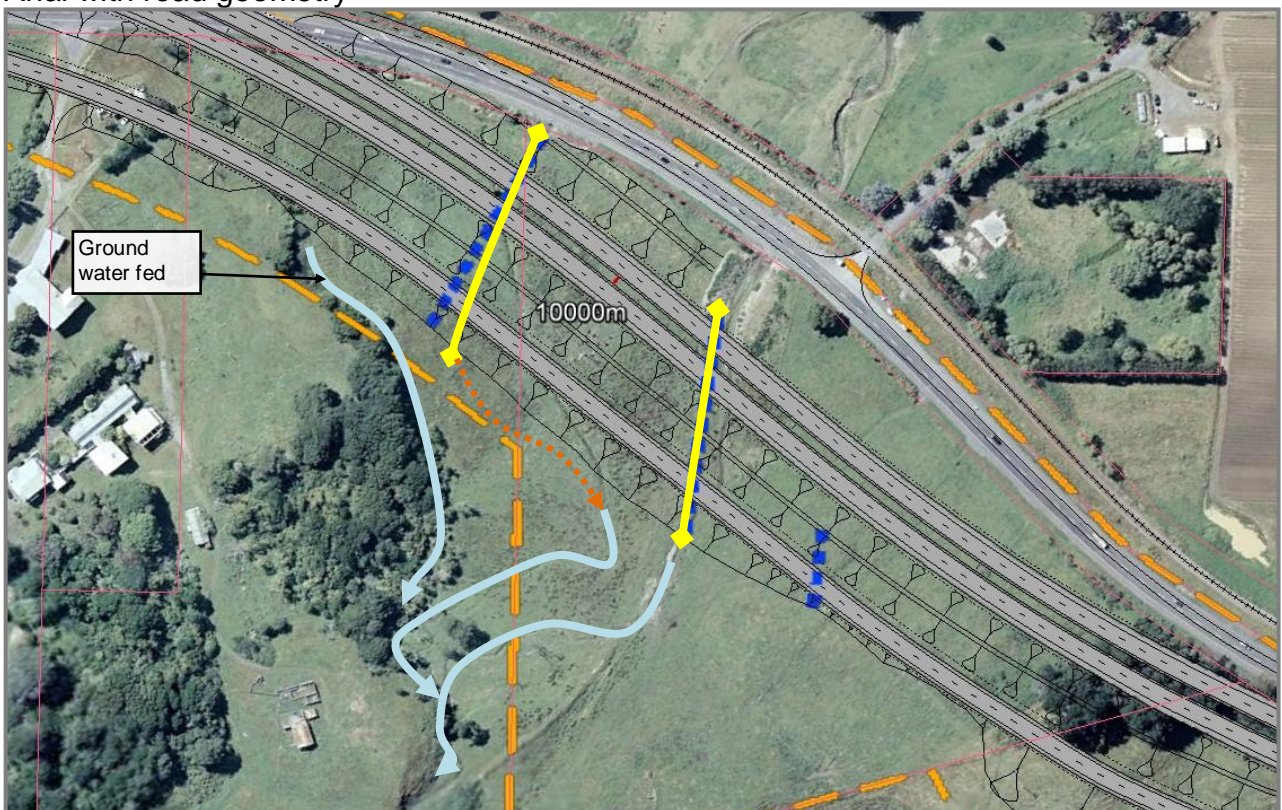
Sections at approximate location (from scheme assessment drawings)



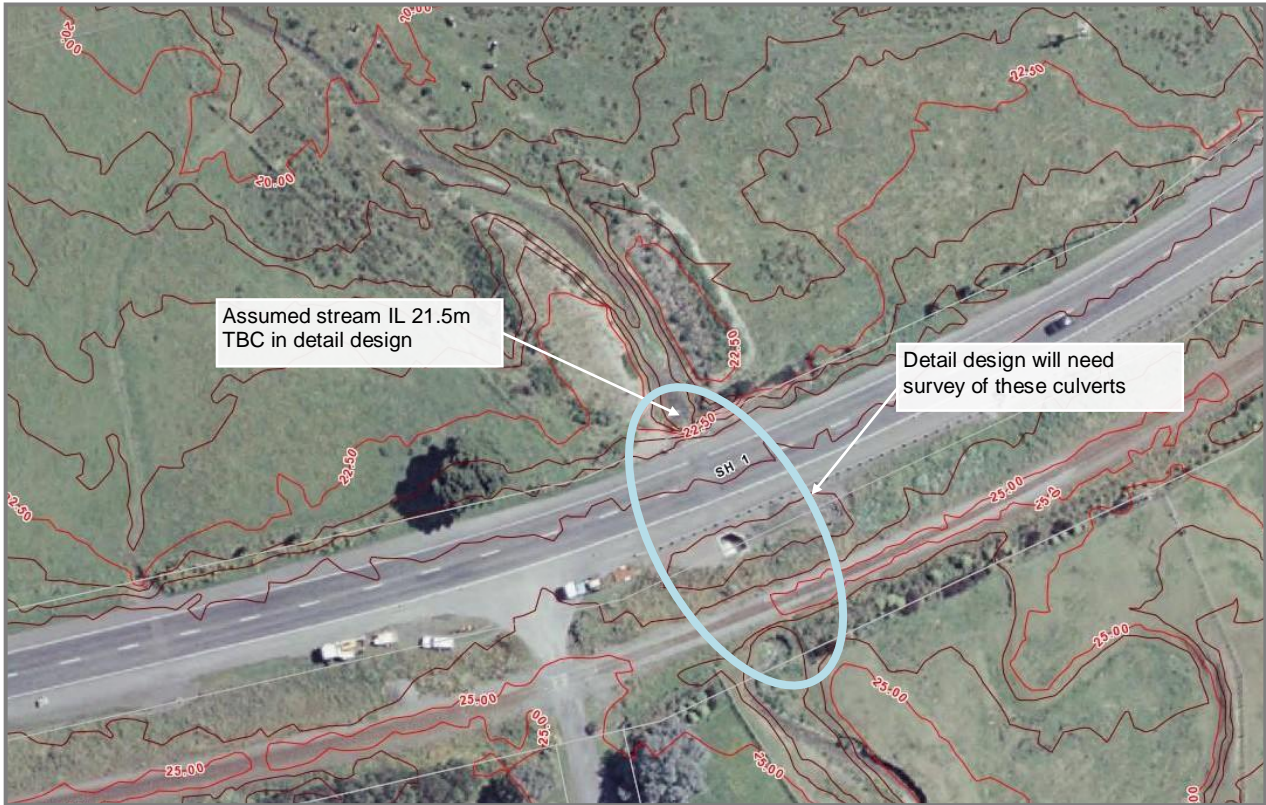
Long Section



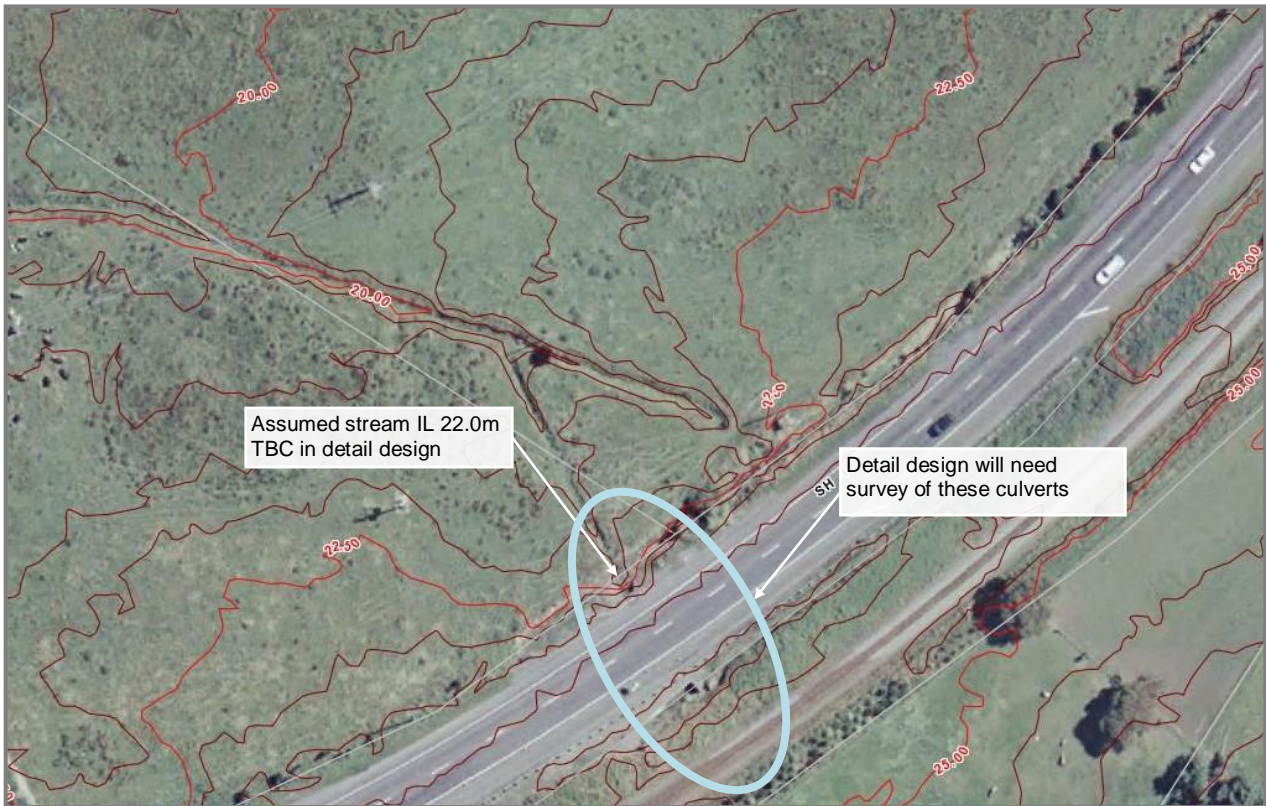
Arial with road geometry



Contours from KCDC GIS



Contours from KCDC GIS



Minor Jewell (Edwin) Culvert:

Assume sized to be nominally the same size as the culverts directly up stream.
Slight increase in size to reduce heading up, and reduction in flow through upstream culverts.

In flood event, any flow that over tops road can be diverted to the Major Jewell Culvert.

Existing culvert inverts (and proposed culvert inverts) need to be confirmed at detail design.

Minor Jewell Culvert = 1200mm

Nominally sized as slightly bigger than the upstream culvert. Excess flow is designed to go under the expressway at the main Jewell Culvert.

Jewell Culvert:

Assume 100% of Jewell catchment flow goes through this culvert. Size culvert to have minimal affect on water level downstream of existing culvert.

From scheme assessment drawing

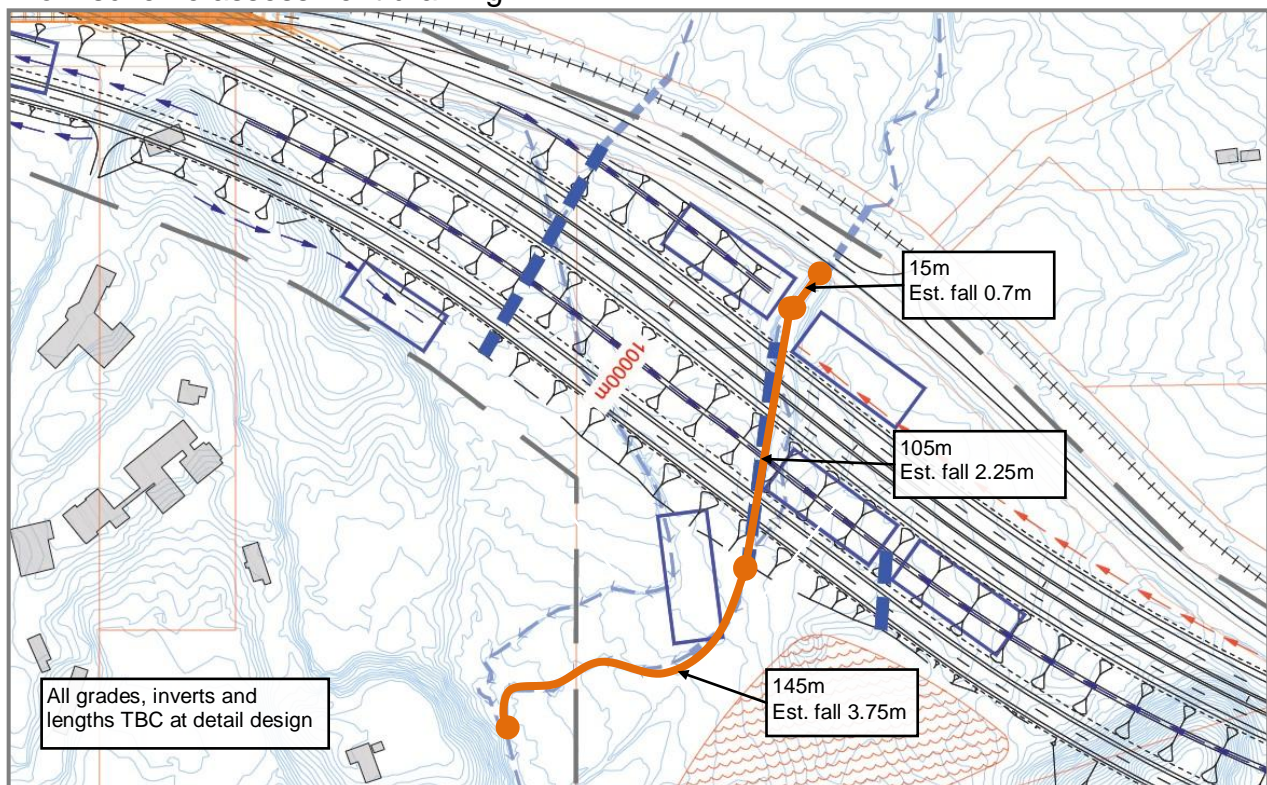
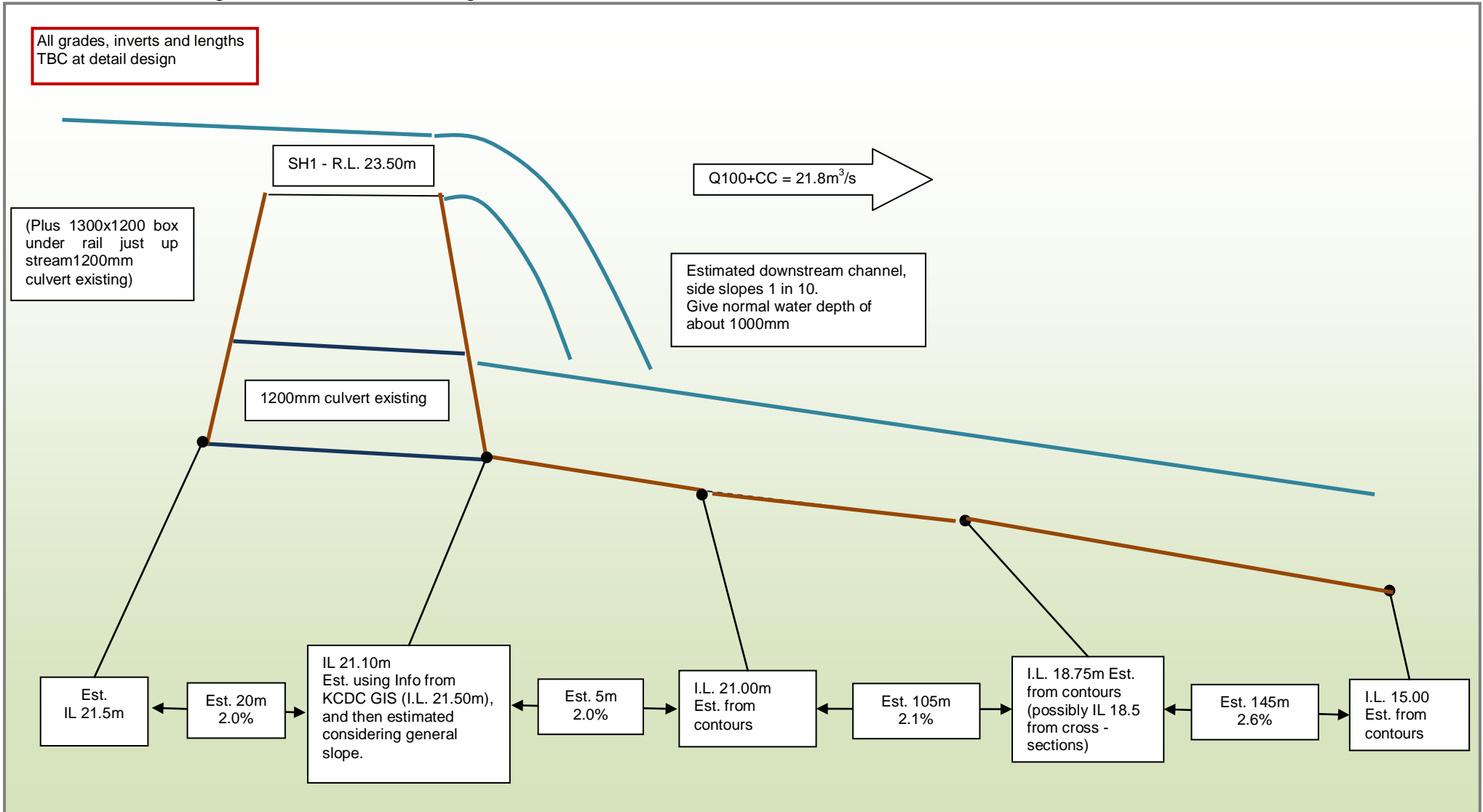
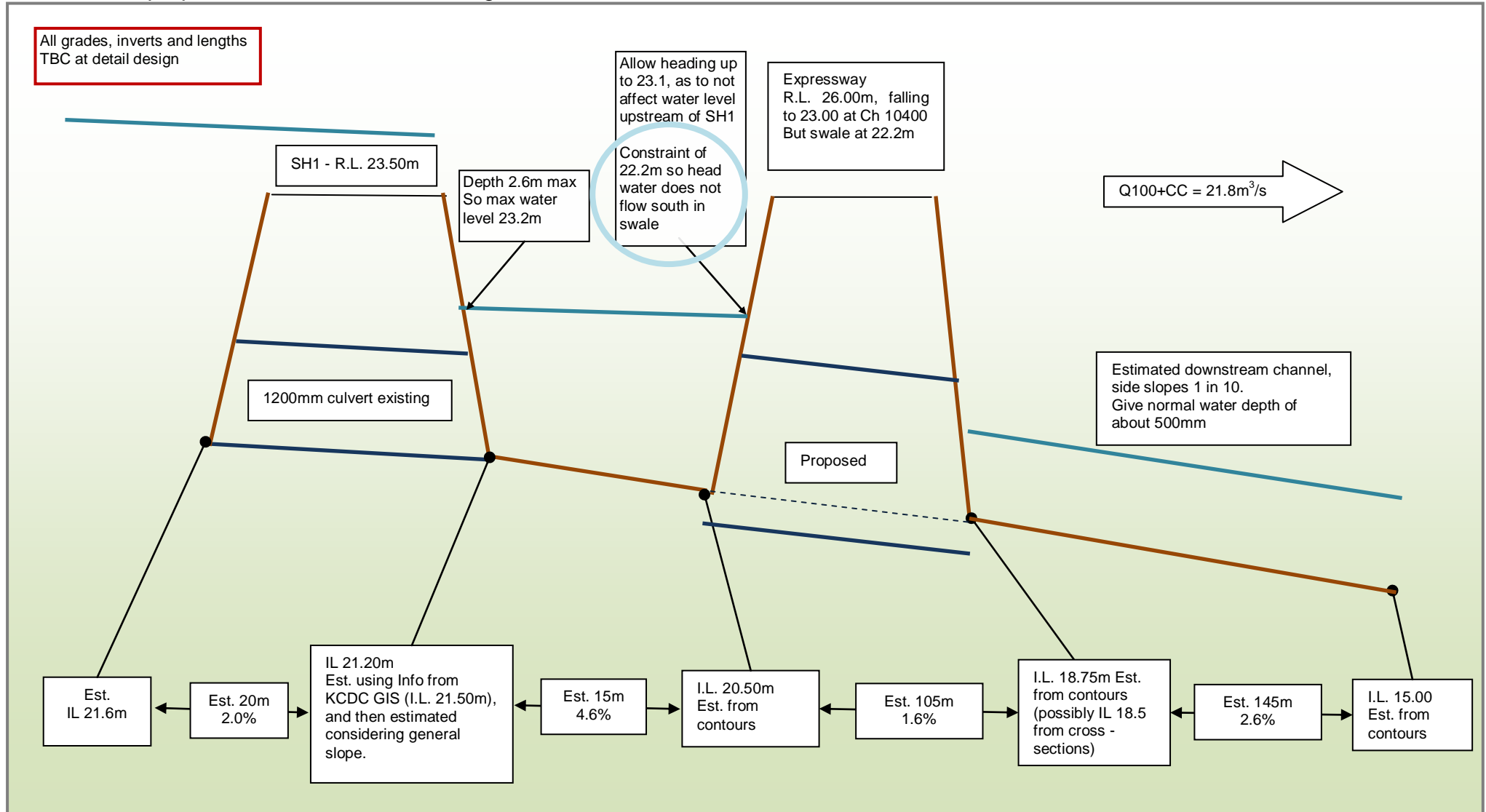


Photo of Major stream during low flow – est. 200 to 300l/s – which is 2 orders of magnitude less than Q100 flow (which is to be expected).

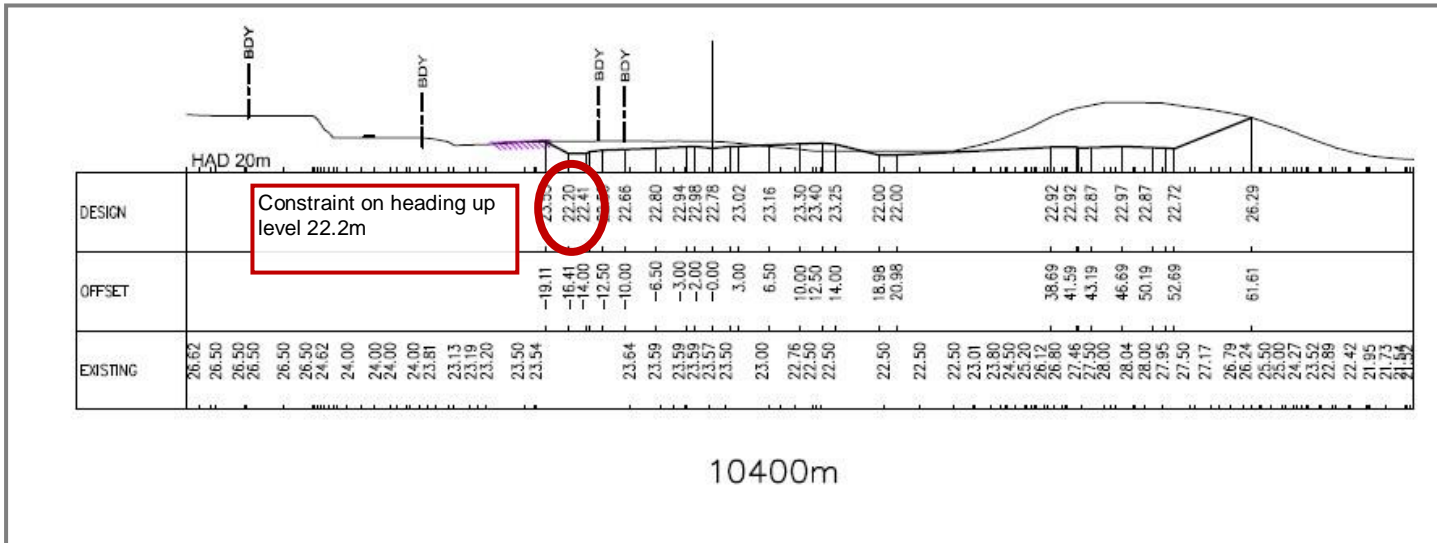
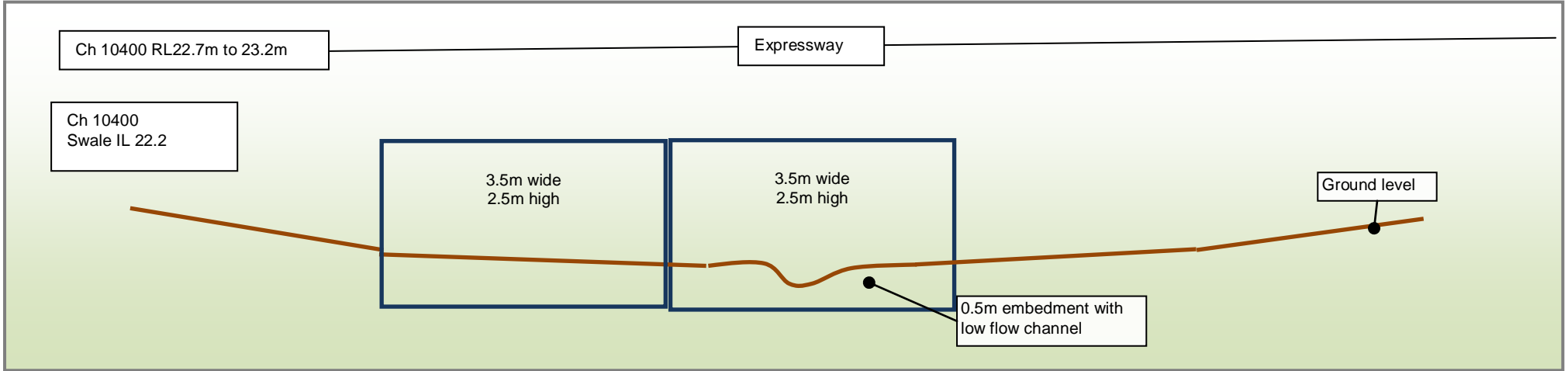




JEWELL CULVERT(S)



Schematic of proposed solution – view of box culvert, from upstream, looking down stream



HY-8 inputs: Existing SH1 upstream culvert: Q100 + CC

Crossing Data - Jewell existing Est. All inputs TBC at detail design

Crossing Properties
 Name: Jewell existing Est.

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	20.00	cms
Design Flow	21.80	cms
Maximum Flow	32.00	cms
TAILWATER DATA		
Channel Type	Triangular Channel	
Side Slope (H:V)	10.00	:1
Channel Slope	0.0210	m/m
Manning's n (channel)	0.0350	
Channel Invert Elevation	21.20	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	60.00	m
Crest Elevation	23.50	m
Roadway Surface	Paved	
Top Width	18.00	m

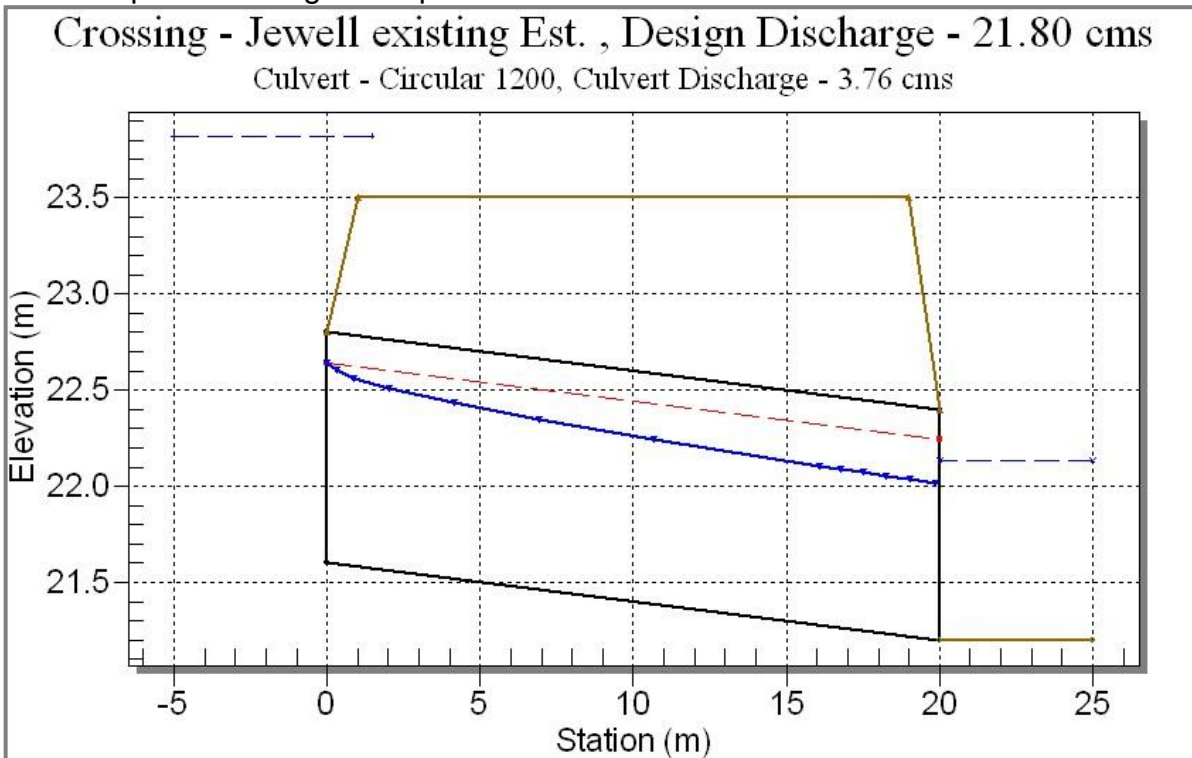
Culvert Properties
 Circular 1200

Add Culvert
 Duplicate Culvert
 Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Circular 1200	
Shape	Circular	
Material	Concrete	
Diameter	1200.00	mm
Embedment Depth	0.00	mm
Manning's n	0.0120	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	21.60	m
Outlet Station	20.00	m
Outlet Elevation	21.20	m
Number of Barrels	1	

Help Click on any icon for help on a specific topic Energy Dissipation Analyze Crossing OK Cancel

HY-8 outputs: Existing SH1 upstream culvert: Q100 + CC



JEWELL CULVERT(S)

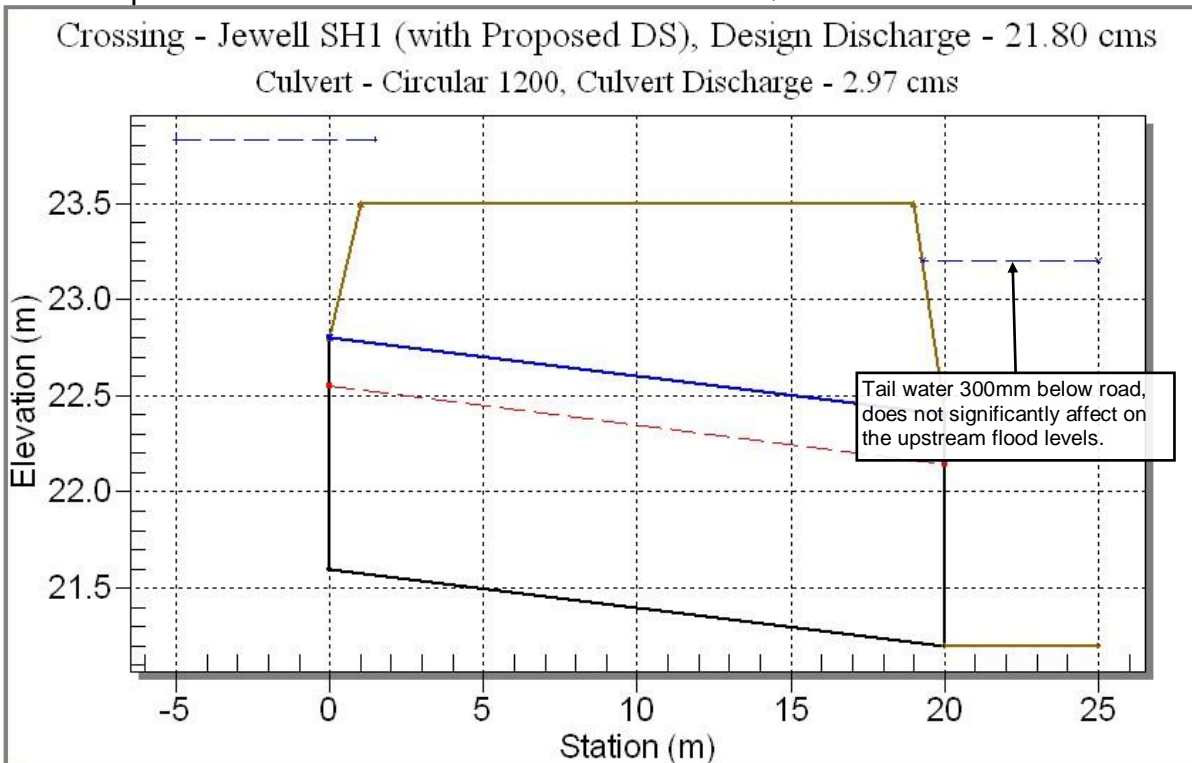
HY-8 inputs: SH1 culvert with increased tail water: Q100 + CC

All inputs TBC at detail design

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	20.00	cms
Design Flow	21.80	cms
Maximum Flow	32.00	cms
TAILWATER DATA		
Channel Type	Enter Constant Tailwater Elevation	
Channel Invert Elevation	21.20	m
Constant Tailwater Elevation	23.20	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	60.00	m
Crest Elevation	23.50	m
Roadway Surface	Paved	
Top Width	18.00	m

Parameter	Value	Units
CULVERT DATA		
Name	Circular 1200	
Shape	Circular	
Material	Concrete	
Diameter	1200.00	mm
Embedment Depth	0.00	mm
Manning's n	0.0120	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	21.60	m
Outlet Station	20.00	m
Outlet Elevation	21.20	m
Number of Barrels	1	

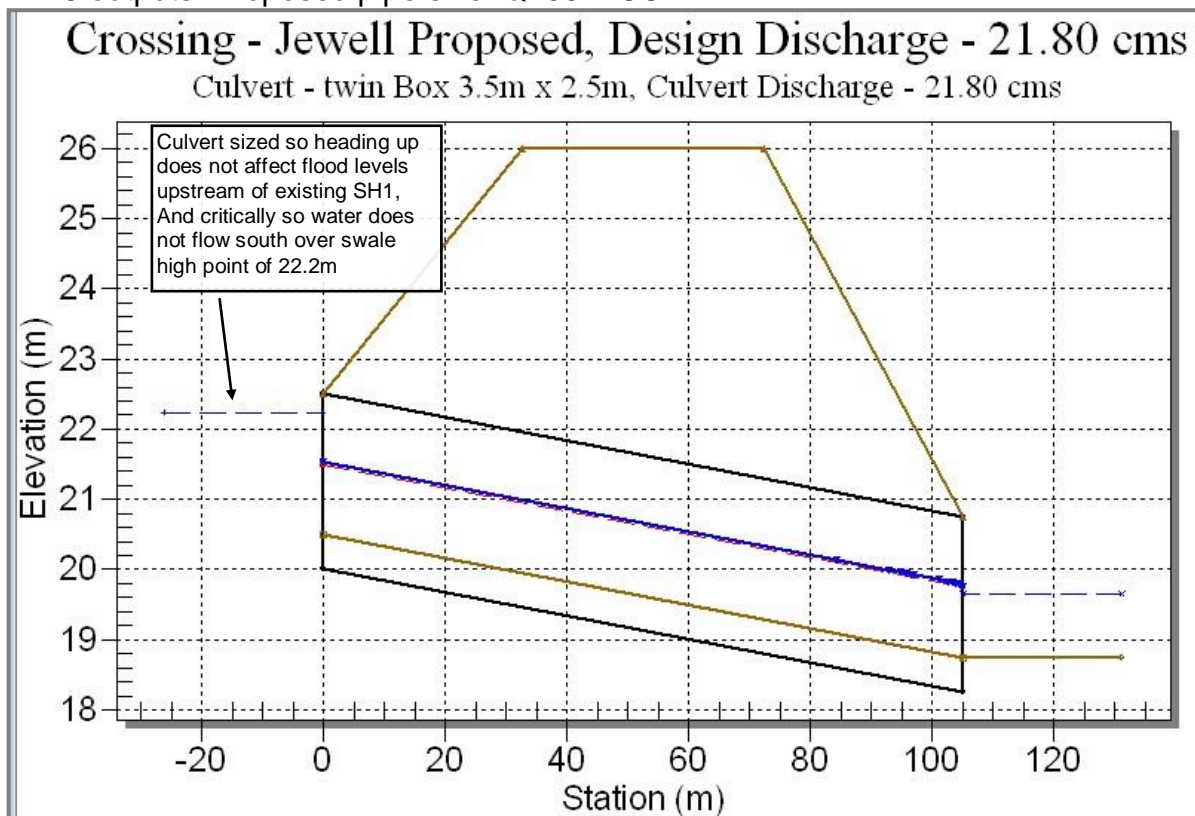
HY-8 outputs: SH1 culvert with increased tail water:: Q100 + CC



HY-8 inputs: Proposed pipe size: Q100 + CC

All inputs TBC at detail design

HY-8 outputs: Proposed pipe size: Q100 + CC



HY-8 inputs: Proposed pipe size: Extreme event $[(Q100 + CC) \times 1.5]$

Crossing Data - Jewell Proposed

Crossing Properties
 Name: Jewell Proposed

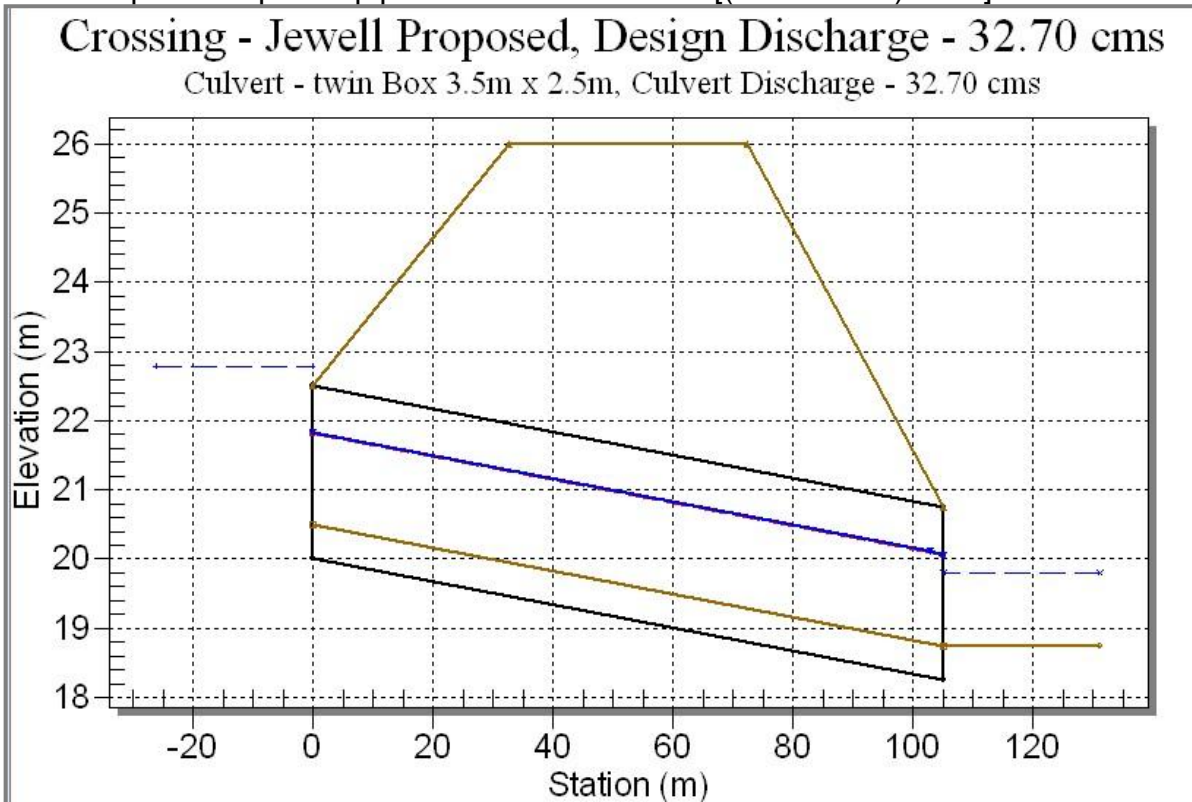
Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	20.00	cms
Design Flow	32.70	cms
Maximum Flow	40.00	cms
TAILWATER DATA		
Channel Type	Triangular Channel	
Side Slope (H:V)	10.00	:1
Channel Slope	0.0260	m/m
Manning's n (channel)	0.0350	
Channel Invert Elevation	18.75	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	90.00	m
Crest Elevation	26.00	m
Roadway Surface	Paved	
Top Width	40.00	m

Culvert Properties
 twin Box 3.5m x 2.5m

Add Culvert
 Duplicate Culvert
 Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	twin Box 3.5m x 2.5m	
Shape	Concrete Box	
Material	Concrete	
Span	3500.00	mm
Rise	2500.00	mm
Embedment Depth	500.00	mm
Manning's n (Top/Sides)	0.0120	
Manning's n (Bottom)	0.0350	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	20.00	m
Outlet Station	105.00	m
Outlet Elevation	18.25	m
Number of Barrels	2	

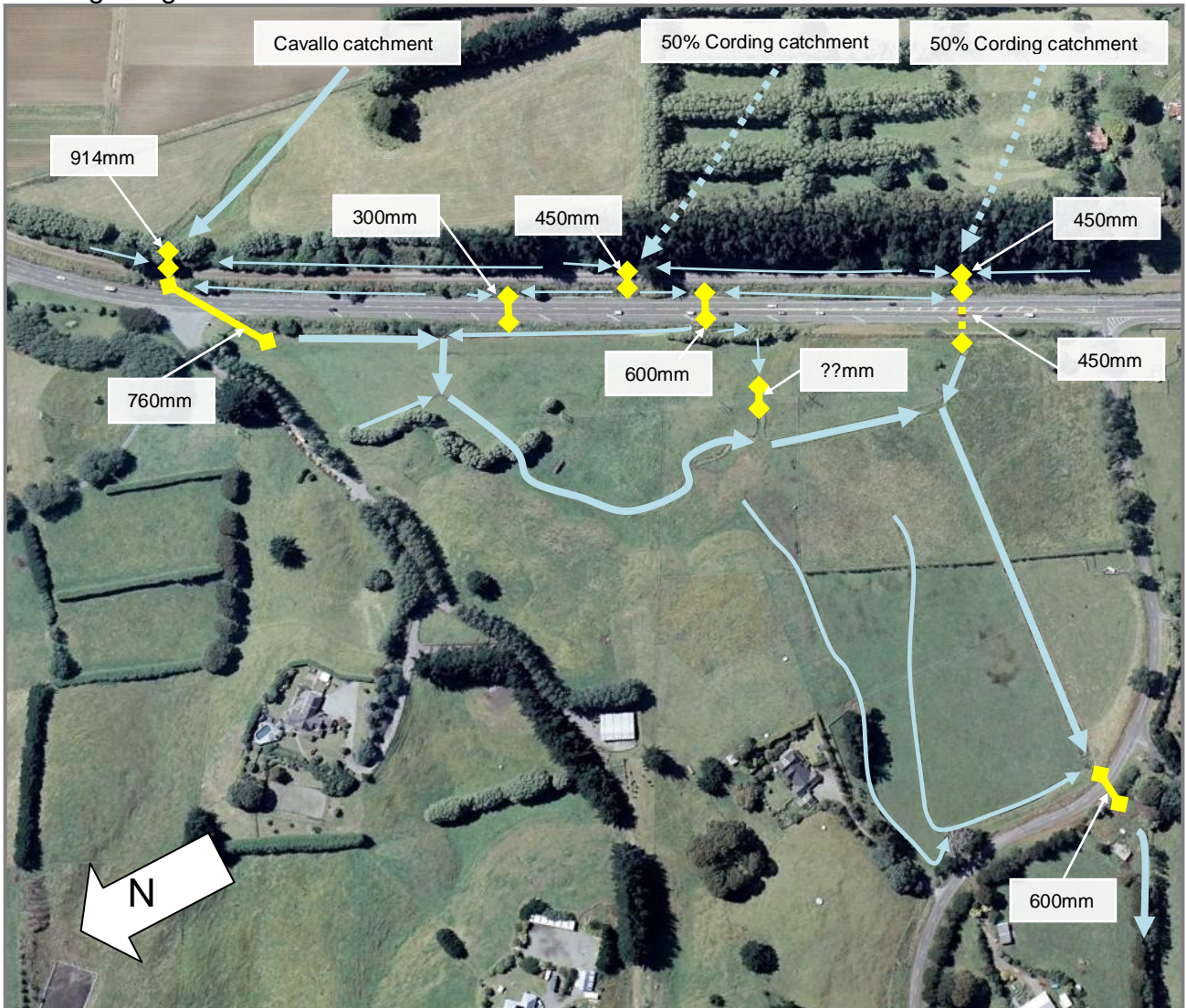
HY-8 outputs: Proposed pipe size: Extreme event $[(Q100 + CC) \times 1.5]$



JEWELL CULVERT(S)

CORDING AND CAVALLO CULVERT(S)

Existing Image

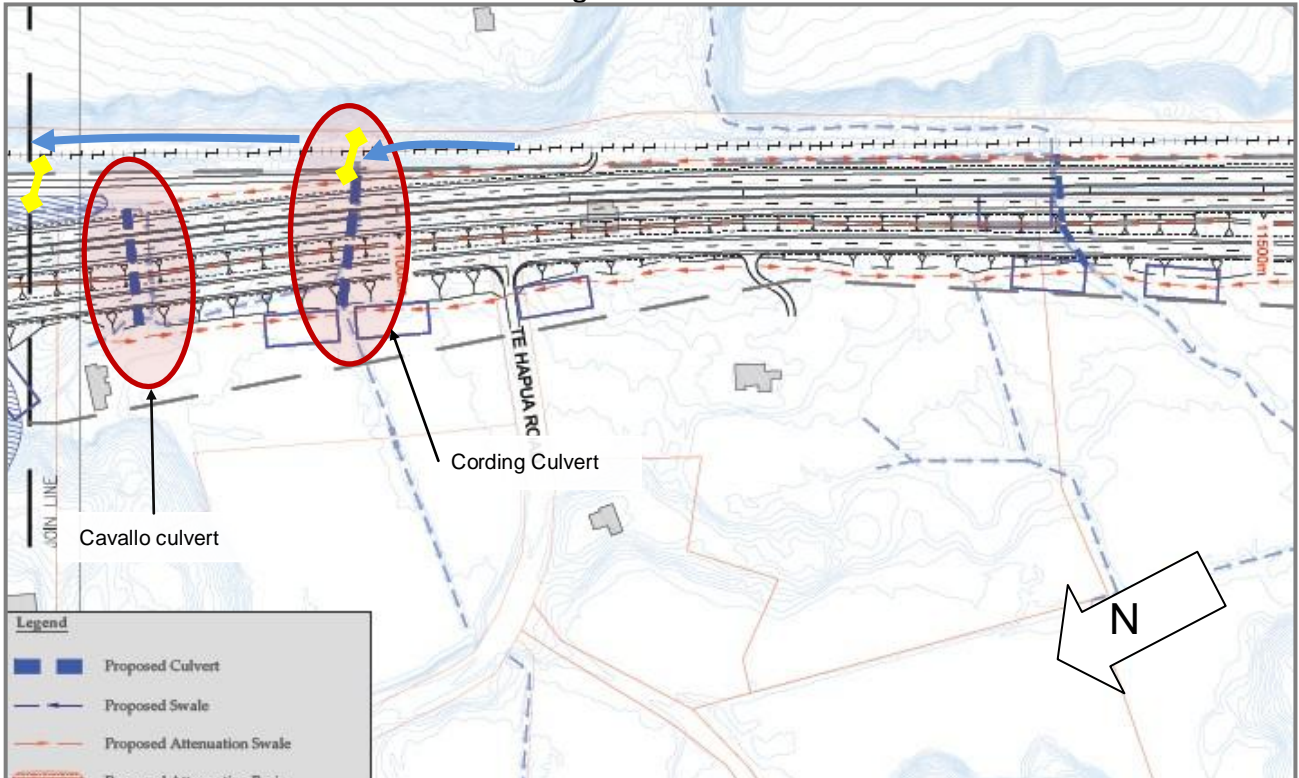


NB: No discernable channels up stream of railway

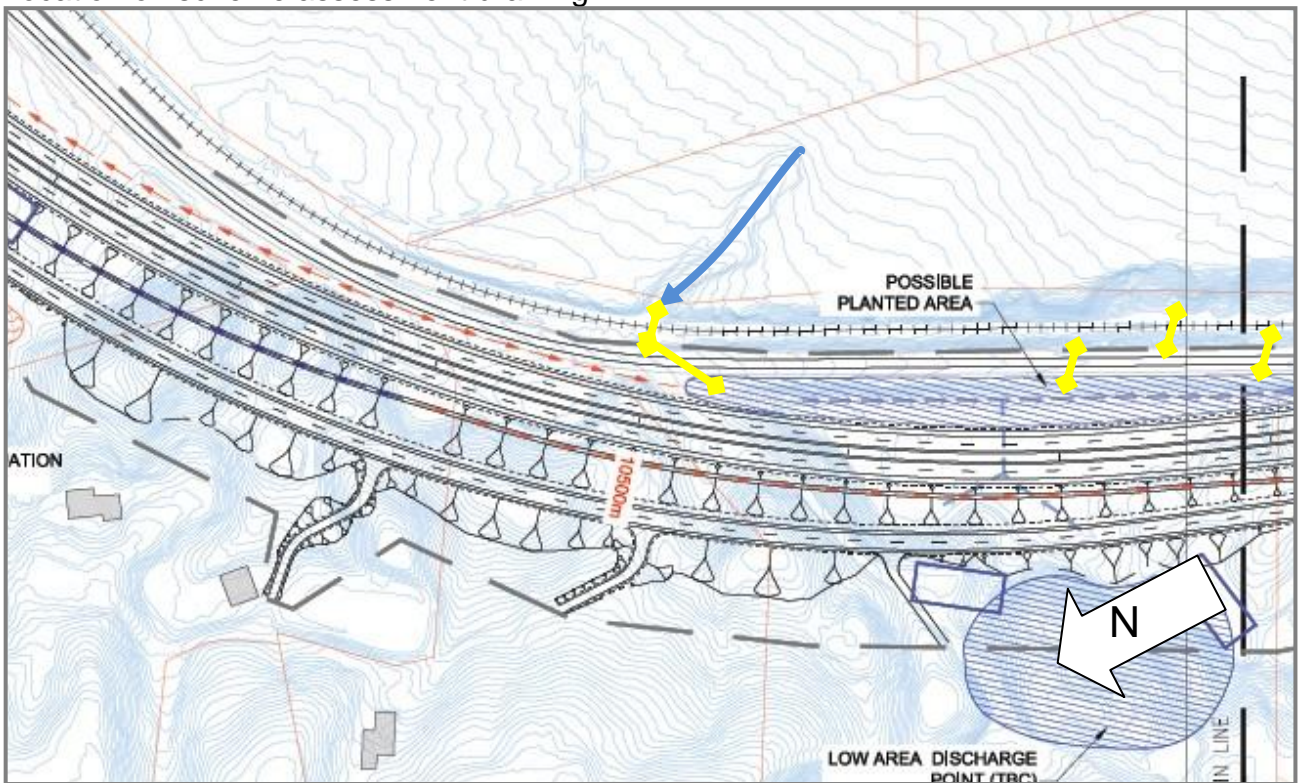
Street view shot. Looking north.



Location on scheme assessment drawing



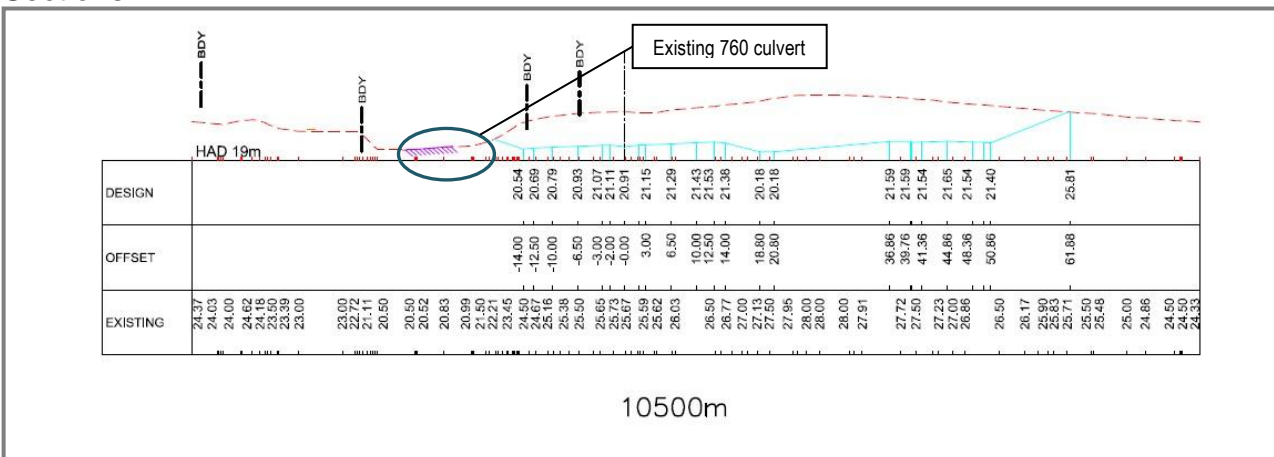
Location on scheme assessment drawing



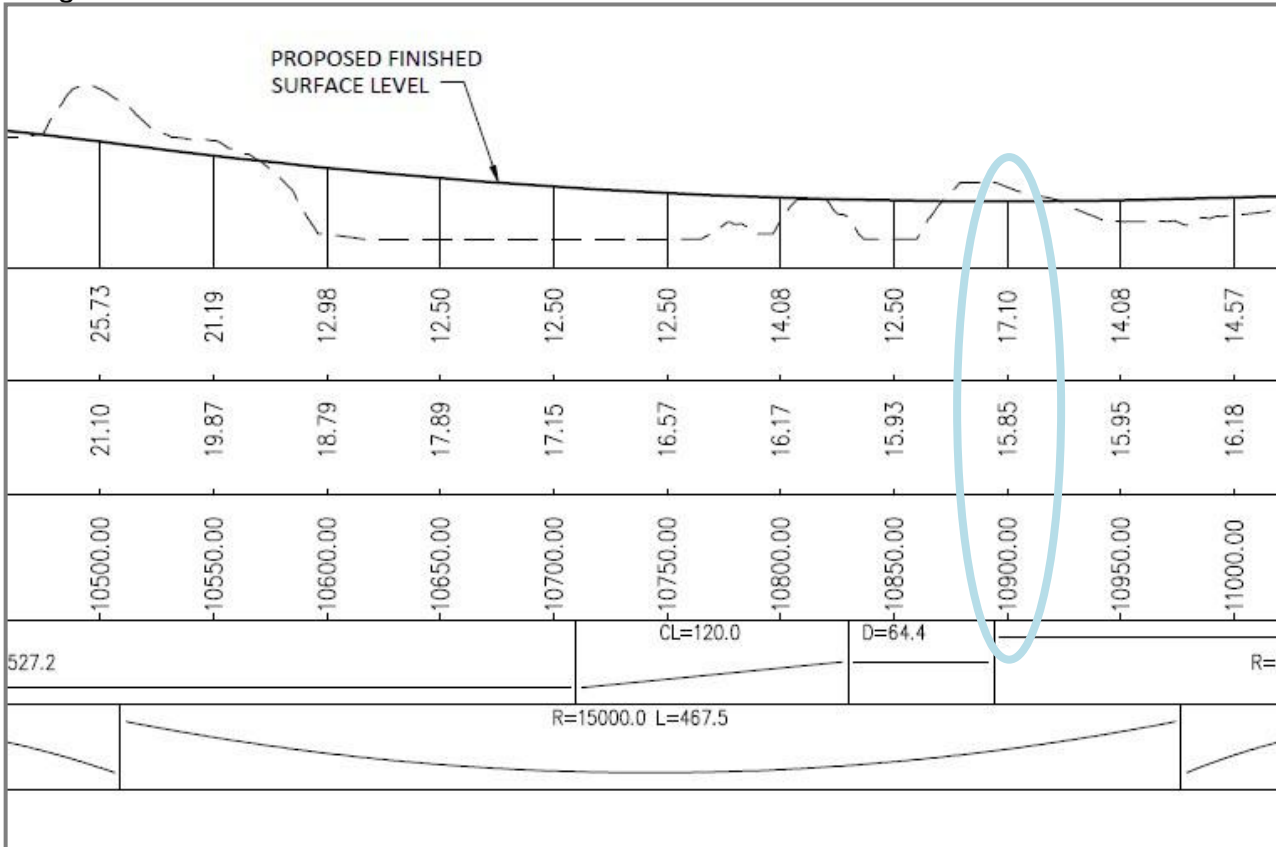
Existing Survey (with proposed road show)



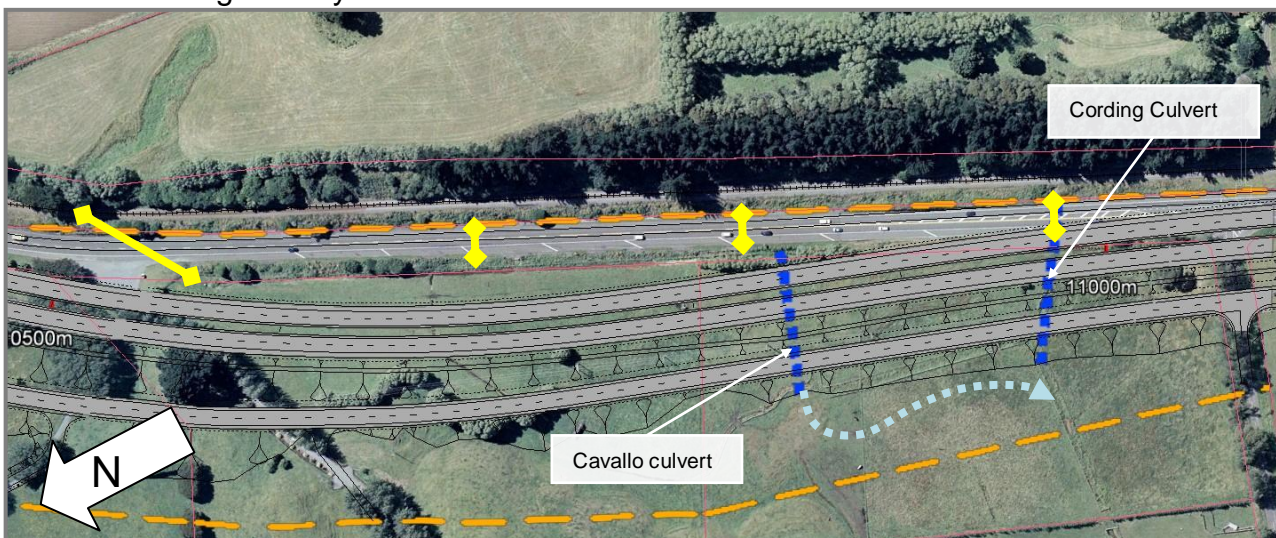
Sections



Long Section



Aerial with road geometry



Cording Culvert

This culvert may be needed to extend the existing SH1 culvert under the expressway. If the existing SH1 culvert can be reconfigured (shortened) than it can probably discharge north to the upstream end of the Cavallo culvert.

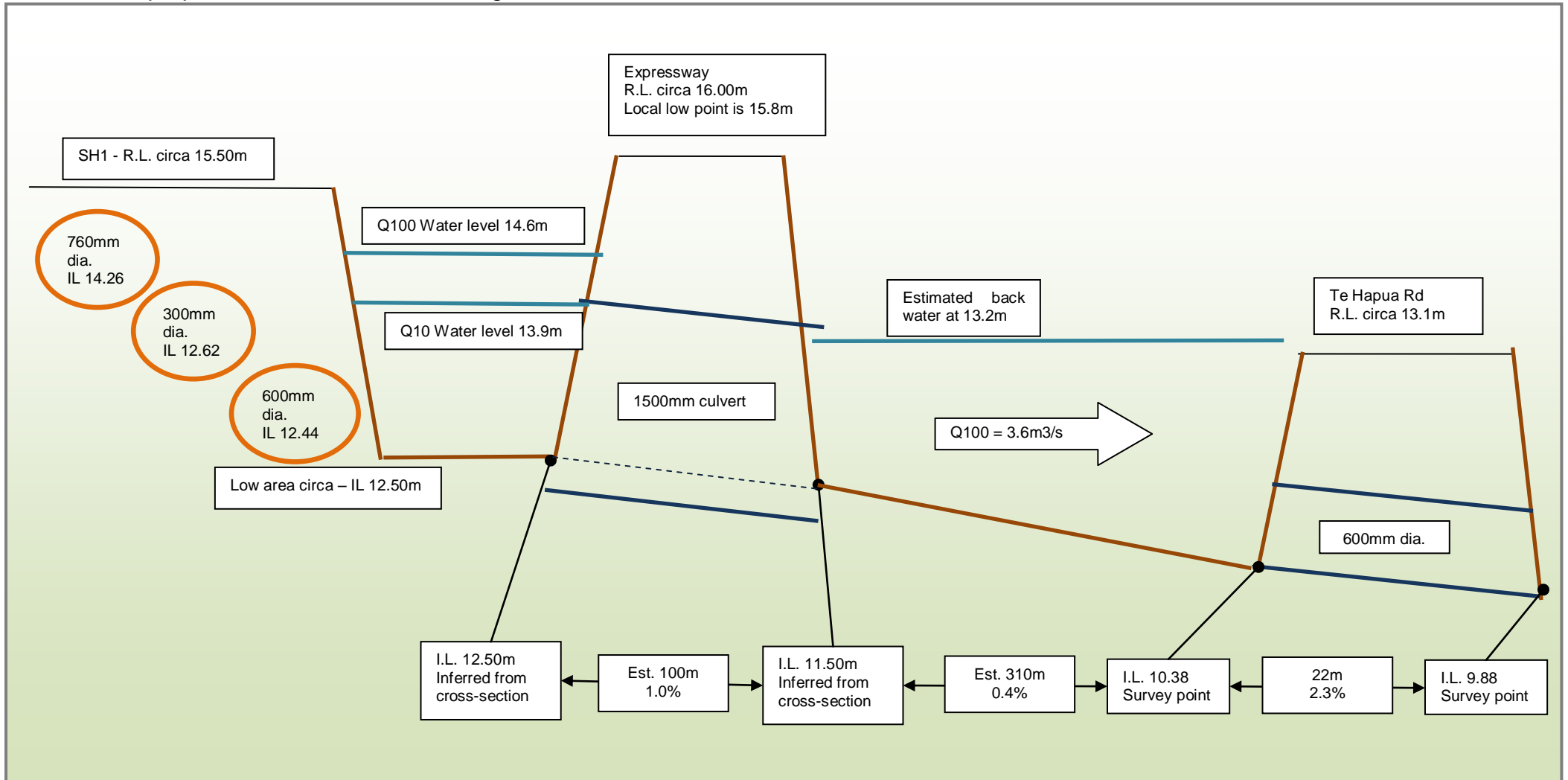
Cording Culvert = 450mm

Cavallo culvert

Assume 100% of Cavallo catchment flow and 100% of the Cording catchment could potentially drain to the Cavallo culvert.

Design for $3.6\text{m}^3/\text{s}$ (1.4+2.2)

Schematic of proposed situation – Levels and grades



HY-8 inputs: Proposed pipe size: Q100 + CC

Crossing Data - Cavallo Proposed

Crossing Properties
 Name: Cavallo Proposed

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	2.00	cms
Design Flow	3.60	cms
Maximum Flow	7.00	cms
TAILWATER DATA		
Channel Type	Enter Constant Tailwater Elevation	
Channel Invert Elevation	11.50	m
Constant Tailwater Elevation	13.20	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	20.00	m
Crest Elevation	16.00	m
Roadway Surface	Paved	
Top Width	50.00	m

Culvert Properties

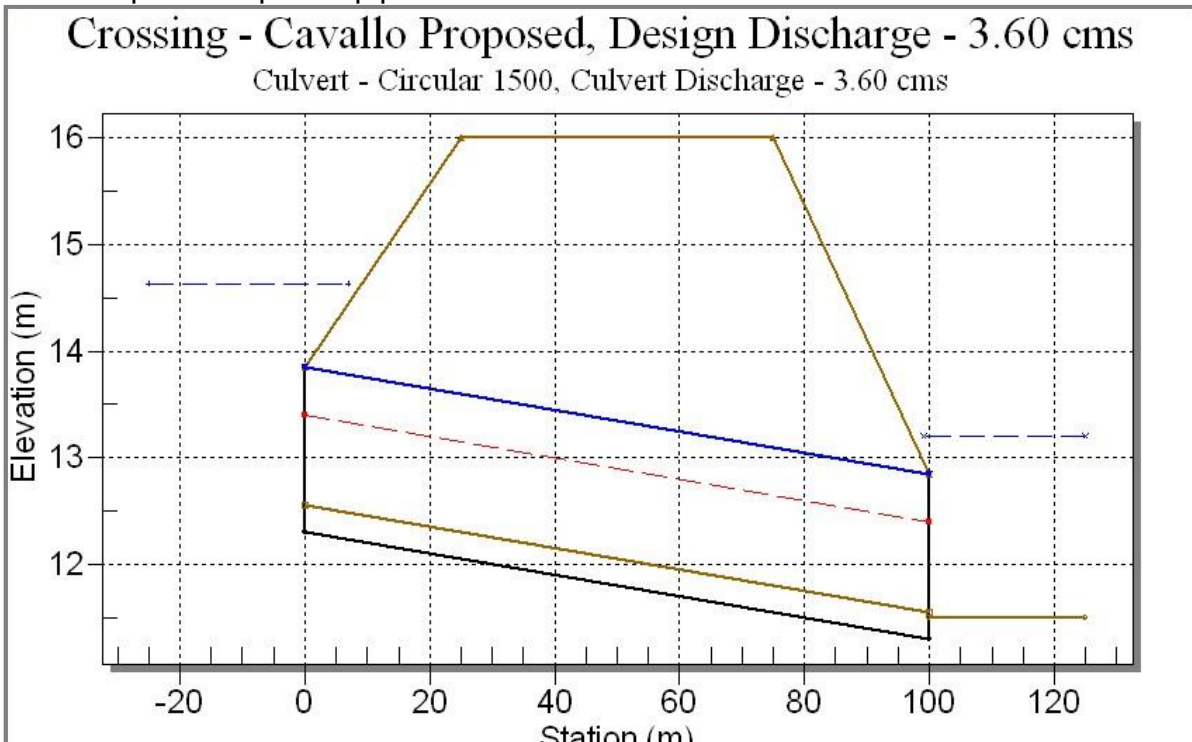
Circular 1500

Add Culvert
 Duplicate Culvert
 Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Circular 1500	
Shape	Circular	
Material	Concrete	
Diameter	1550.00	mm
Embedment Depth	250.00	mm
Manning's n (Top/Sides)	0.0120	
Manning's n (Bottom)	0.0350	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	12.30	m
Outlet Station	100.00	m
Outlet Elevation	11.30	m
Number of Barrels	1	

Help Click on any icon for help on a specific topic Energy Dissipation Analyze Crossing OK Cancel

HY-8 outputs: Proposed pipe size: Q100 + CC



HY-8 inputs: Proposed pipe size: Q10 + CC

Crossing Data - Cavallo Proposed

Crossing Properties
 Name: Cavallo Proposed

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	2.00	cms
Design Flow	2.20	cms
Maximum Flow	7.00	cms
TAILWATER DATA		
Channel Type	Enter Constant Tailwater Elevation	
Channel Invert Elevation	11.50	m
Constant Tailwater Elevation	13.20	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	20.00	m
Crest Elevation	16.00	m
Roadway Surface	Paved	
Top Width	50.00	m

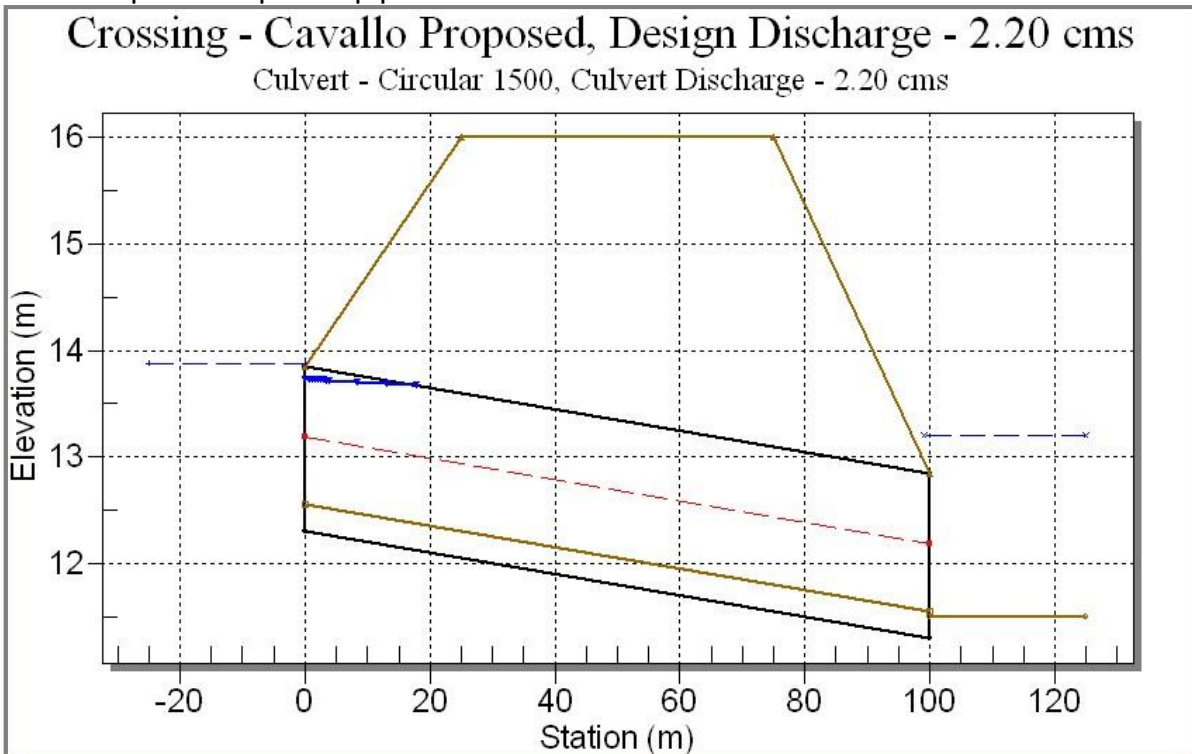
Culvert Properties
 Circular 1500

Add Culvert
 Duplicate Culvert
 Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Circular 1500	
Shape	Circular	
Material	Concrete	
Diameter	1550.00	mm
Embedment Depth	250.00	mm
Manning's n (Top/Sides)	0.0120	
Manning's n (Bottom)	0.0350	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	12.30	m
Outlet Station	100.00	m
Outlet Elevation	11.30	m
Number of Barrels	1	

Help Click on any icon for help on a specific topic Energy Dissipation Analyze Crossing OK Cancel

HY-8 outputs: Proposed pipe size: Q10 + CC



HY-8 inputs: Proposed pipe size: Extreme event $[(Q100 + CC) \times 1.5]$

Crossing Data - Cavallo Proposed

Name: Cavallo Proposed

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	2.00	cms
Design Flow	5.40	cms
Maximum Flow	7.00	cms
TAILWATER DATA		
Channel Type	Enter Constant Tailwater Elevation	
Channel Invert Elevation	11.50	m
Constant Tailwater Elevation	13.20	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	20.00	m
Crest Elevation	16.00	m
Roadway Surface	Paved	
Top Width	50.00	m

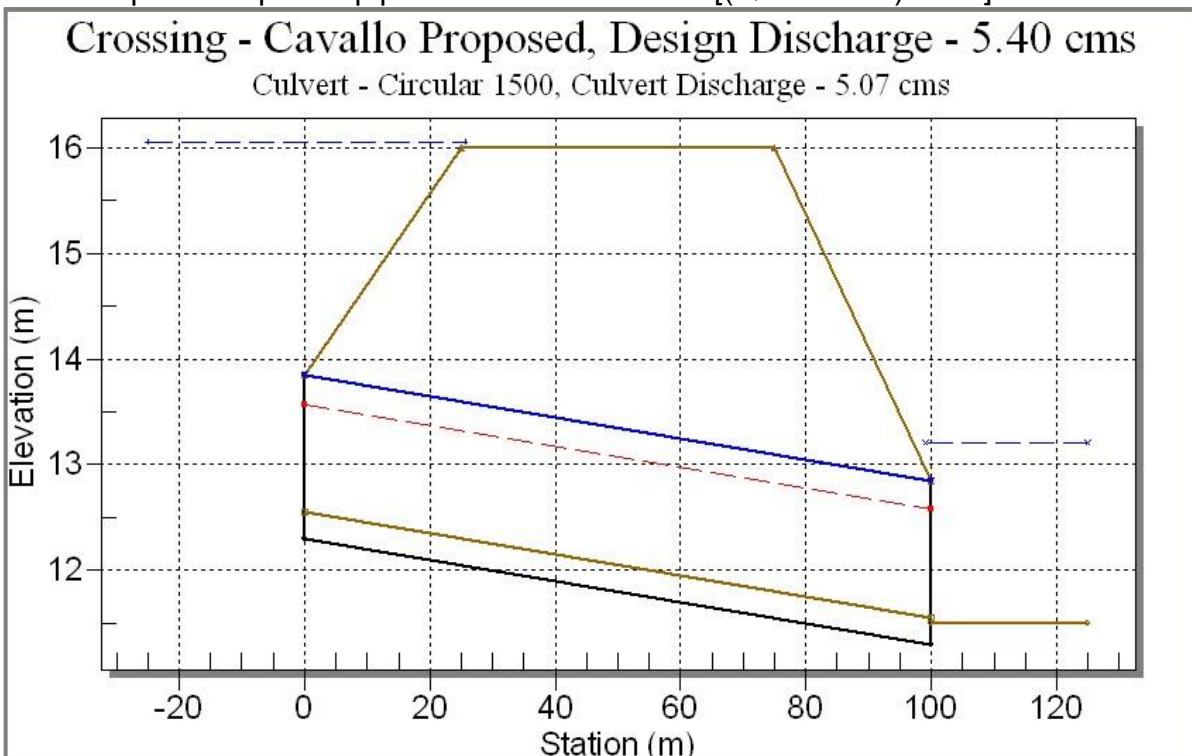
Culvert Properties

Circular 1500

Add Culvert
 Duplicate Culvert
 Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Circular 1500	
Shape	Circular	
Material	Concrete	
Diameter	1550.00	mm
Embedment Depth	250.00	mm
Manning's n (Top/Sides)	0.0120	
Manning's n (Bottom)	0.0350	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	12.30	m
Outlet Station	100.00	m
Outlet Elevation	11.30	m
Number of Barrels	1	

HY-8 outputs: Proposed pipe size: Extreme event $[(Q100 + CC) \times 1.5]$

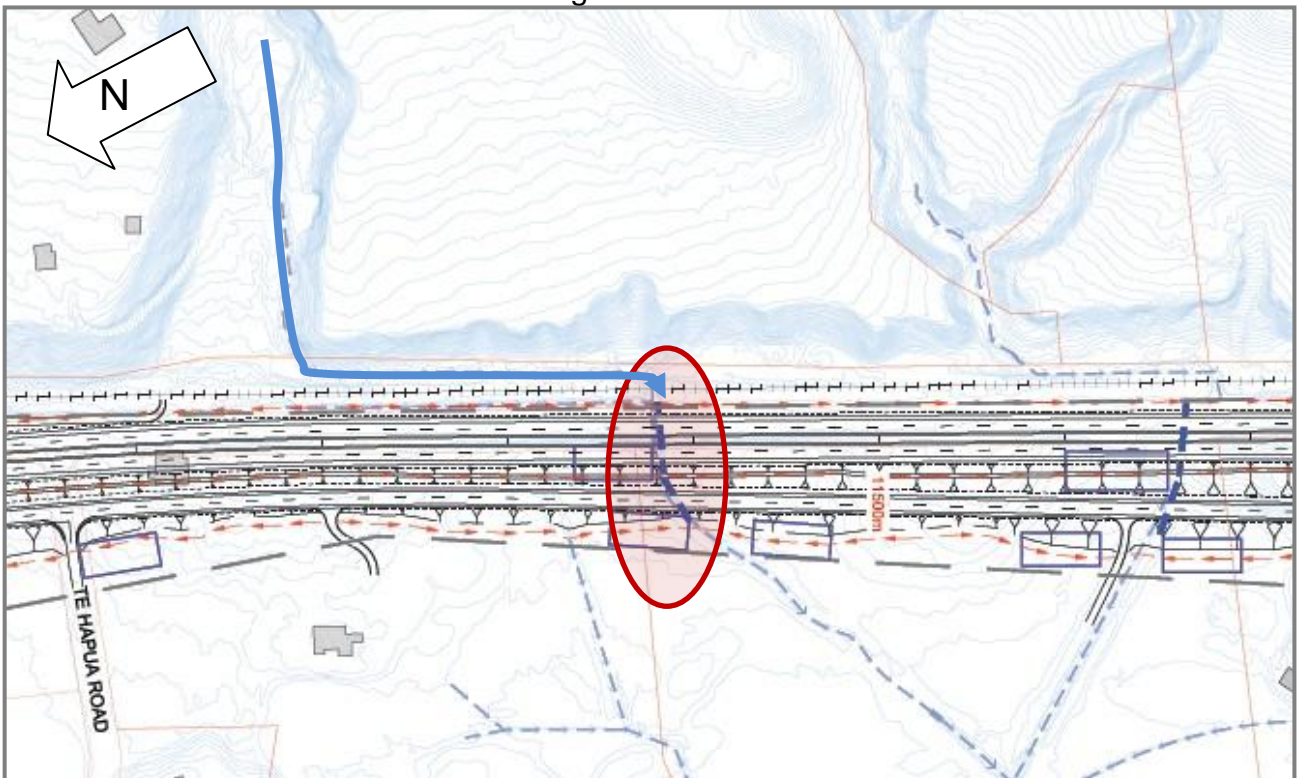


AWATEA CULVERT

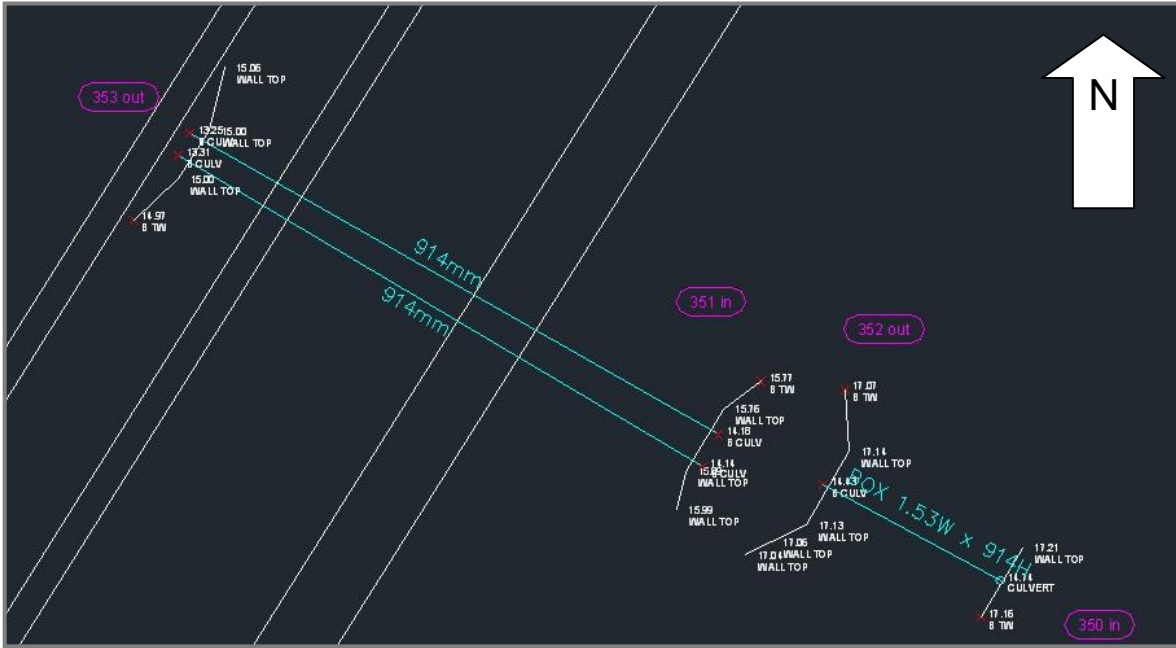
Existing Image



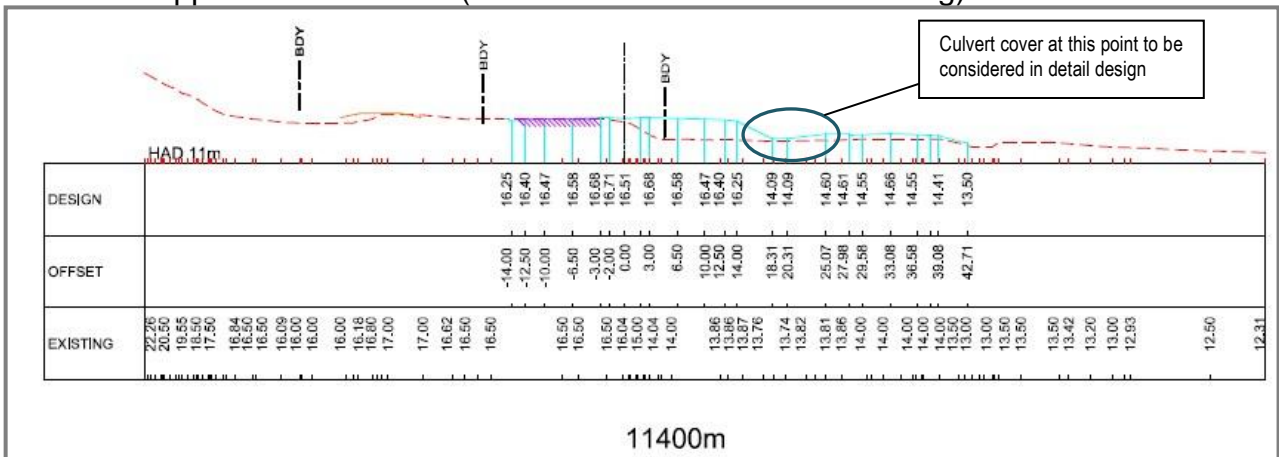
Location on scheme assessment drawing



Existing Survey (with proposed road show)



Section at approximate location (from scheme assessment drawing)



Aerial with road geometry

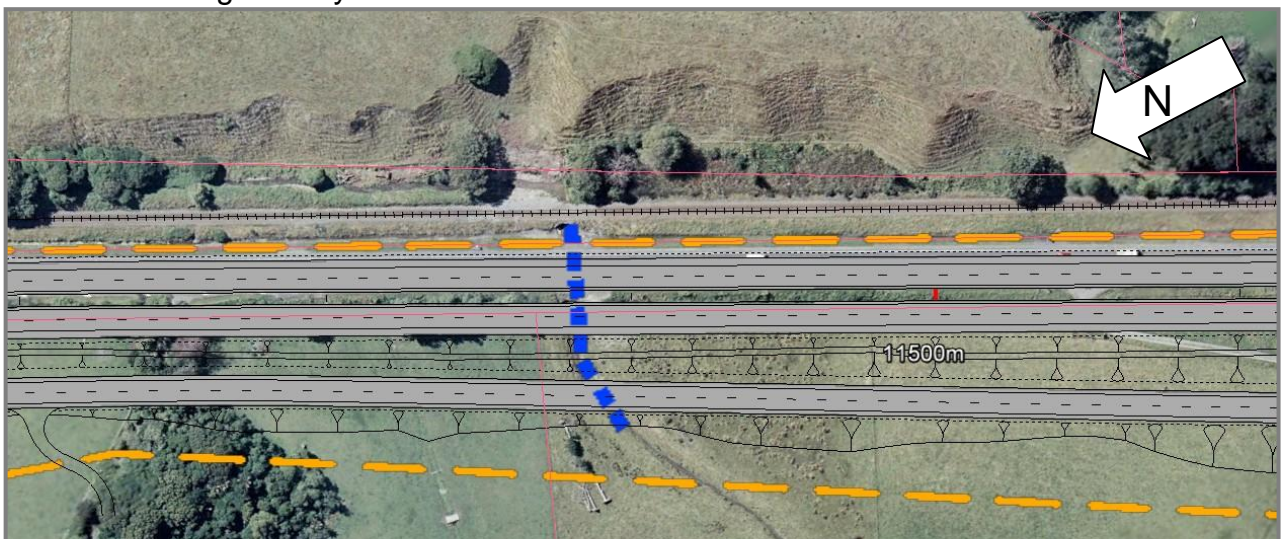


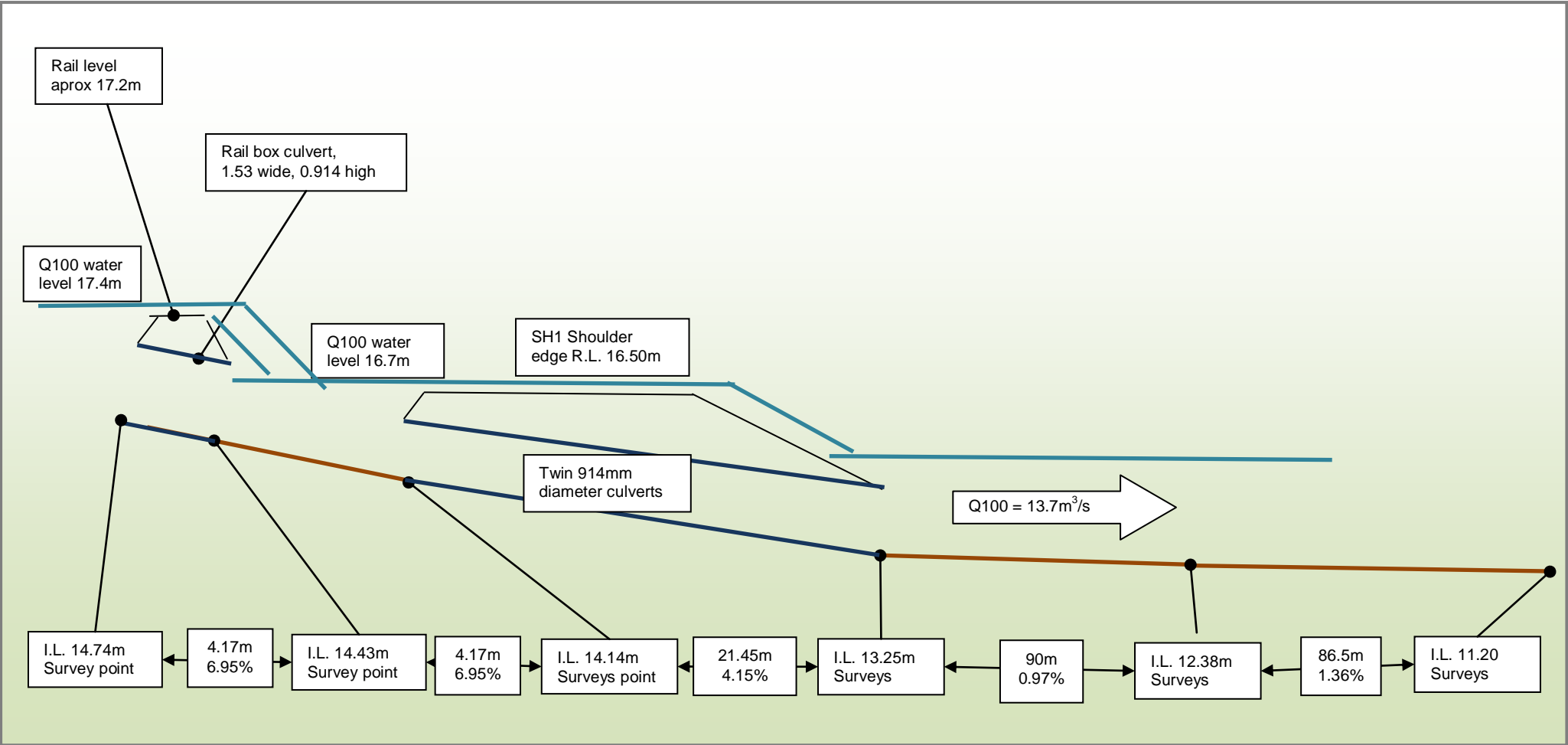
Photo of existing inlet



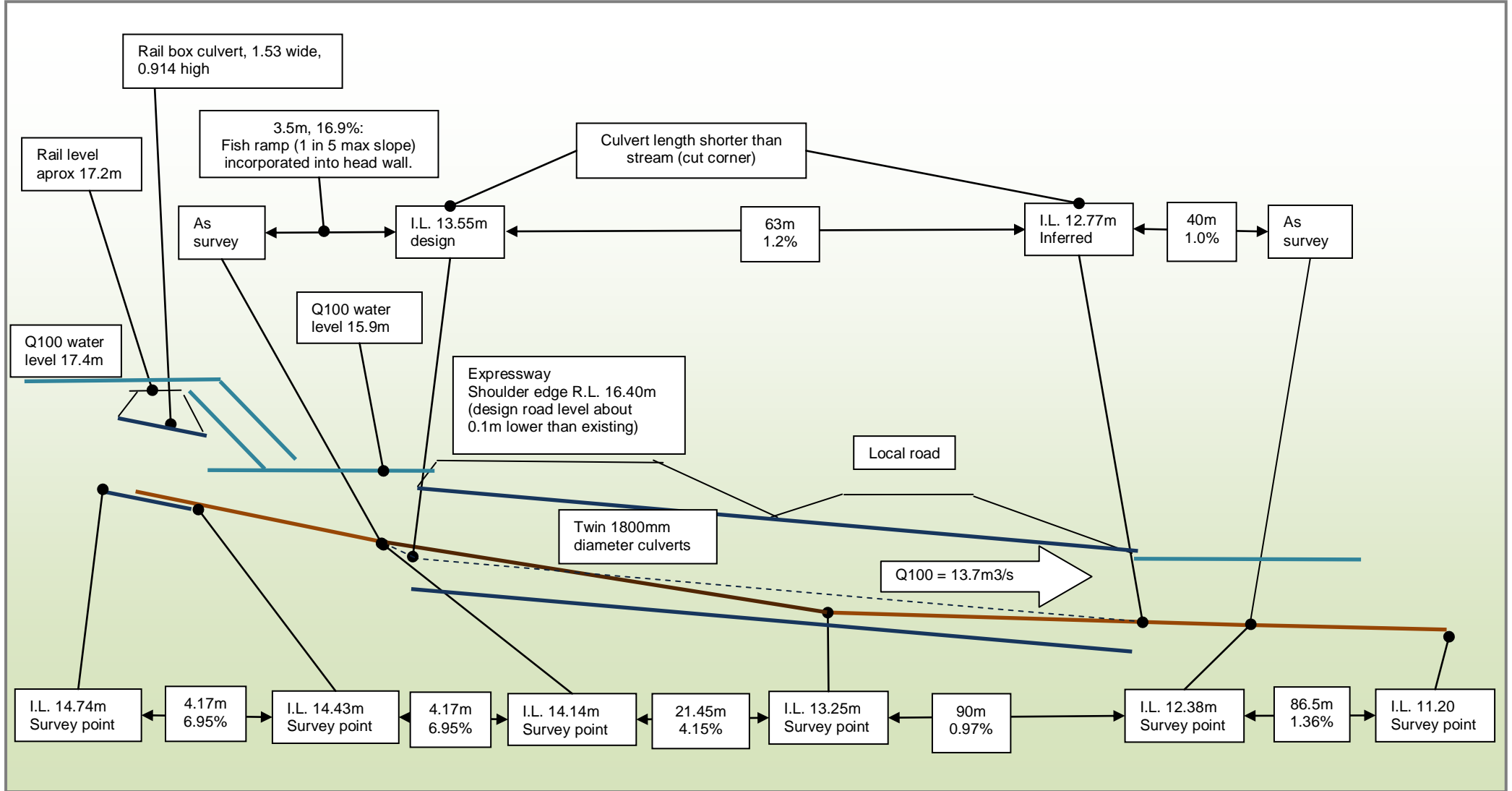
Photo of existing outlet



schematic of existing situation – Levels and grades



schematic of proposed situation – Levels and grades



AWATEA CULVERT

HY-8 inputs: existing road: Q100 + CC

Crossing Data - Awatea Existing

Crossing Properties
 Name: Awatea Existing

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	10.00	cms
Design Flow	13.70	cms
Maximum Flow	25.00	cms
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	1.50	m
Side Slope (H:V)	3.00	:1
Channel Slope	0.0097	m/m
Manning's n (channel)	0.0500	
Channel Invert Elevation	13.25	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	60.00	m
Crest Elevation	16.50	m
Roadway Surface	Paved	
Top Width	15.00	m

Culvert Properties
 Twin circular 914

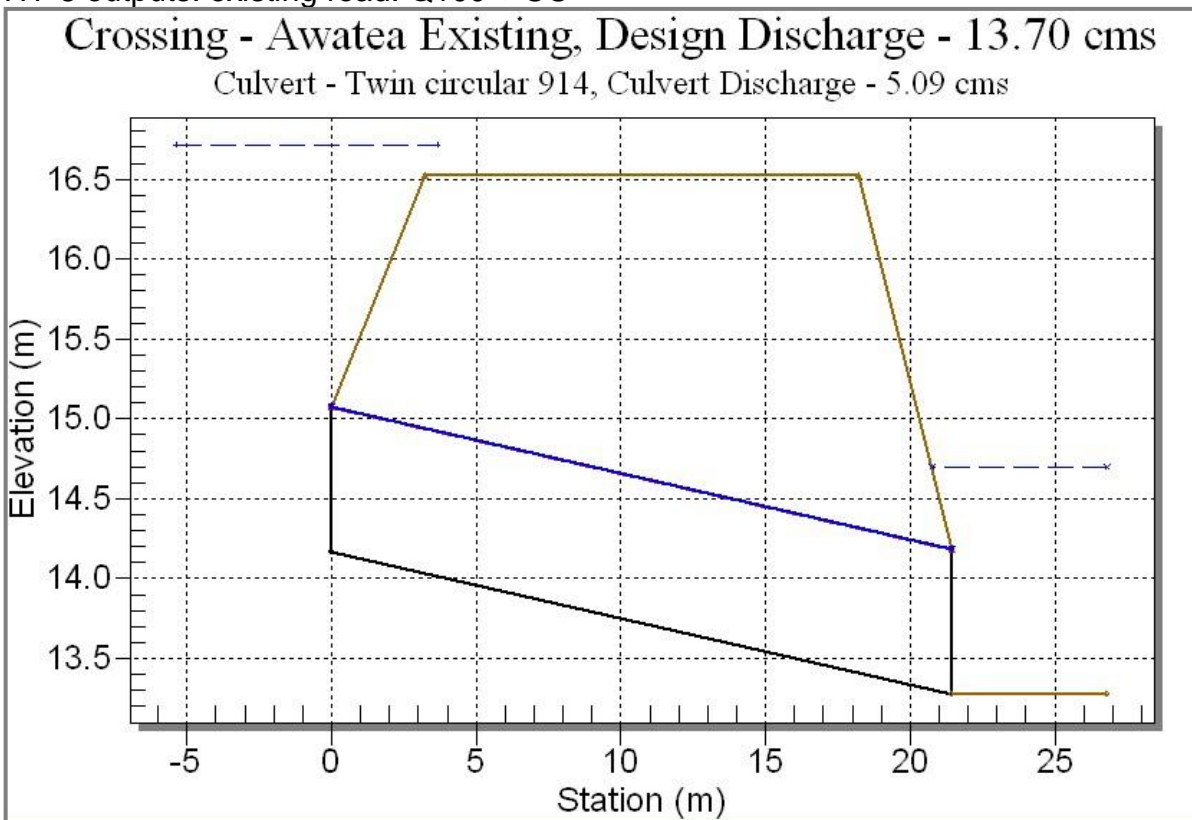
Add Culvert
 Duplicate Culvert
 Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Twin circular 914	
Shape	Circular	
Material	Concrete	
Diameter	914.00	mm
Embedment Depth	0.00	mm
Manning's n	0.0120	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	14.14	m
Outlet Station	21.45	m
Outlet Elevation	13.25	m
Number of Barrels	2	

Help Click on any icon for help on a specific topic

Energy Dissipation Analyze Crossing OK Cancel

HY-8 outputs: existing road: Q100 + CC



AWATEA CULVERT

HY-8 inputs: Proposed pipe size: Q100 + CC

Crossing Data - Awatea Proposed

Crossing Properties
 Name: Awatea Proposed

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	8.00	cms
Design Flow	13.70	cms
Maximum Flow	25.00	cms
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	1.50	m
Side Slope (H:V)	3.00	:1
Channel Slope	0.0097	m/m
Manning's n (channel)	0.0500	
Channel Invert Elevation	12.77	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	20.00	m
Crest Elevation	16.40	m
Roadway Surface	Paved	
Top Width	15.00	m

Culvert Properties

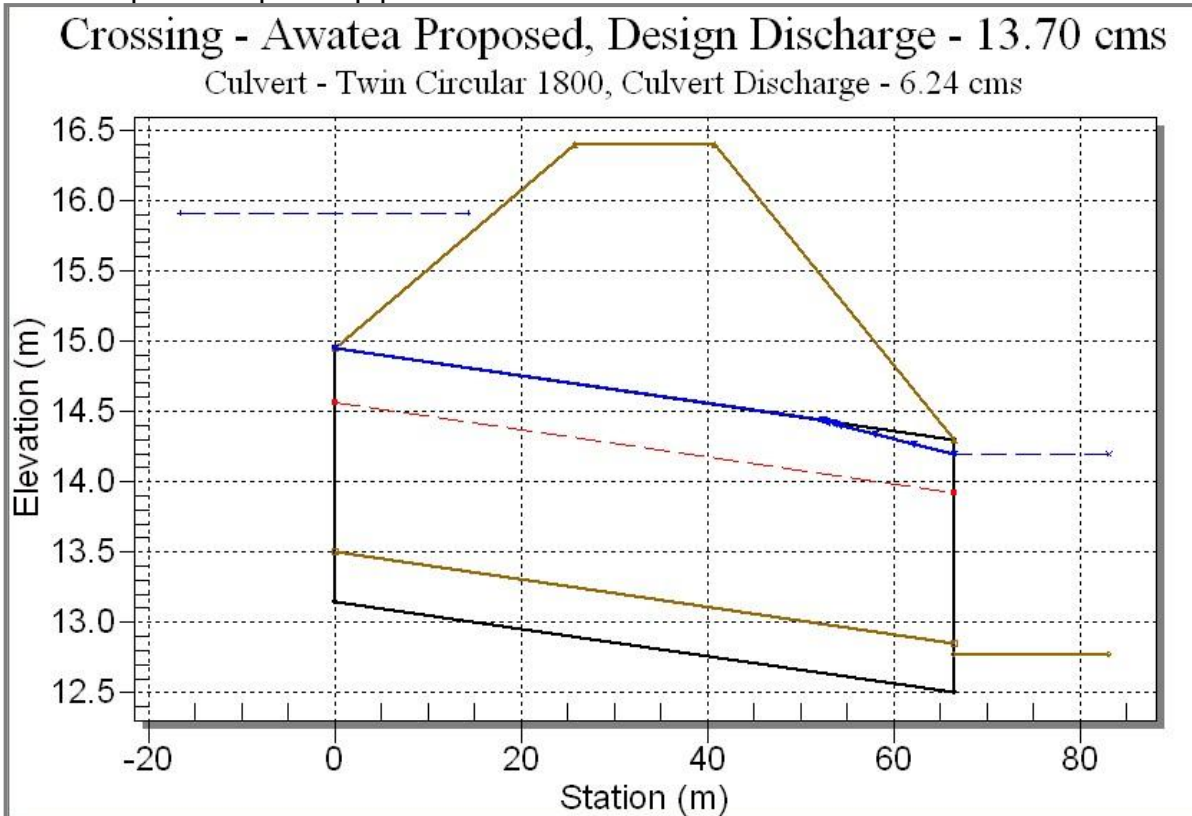
Twin Circular 1800
 Second 1800 (no embedment)

Add Culvert
 Duplicate Culvert
 Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Twin Circular 1800	
Shape	Circular	
Material	Concrete	
Diameter	1800.00	mm
Embedment Depth	350.00	mm
Manning's n (Top/Sides)	0.0120	
Manning's n (Bottom)	0.0350	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	13.15	m
Outlet Station	66.50	m
Outlet Elevation	12.50	m
Number of Barrels	1	

Help Click on any icon for help on a specific topic Energy Dissipation Analyze Crossing OK Cancel

HY-8 outputs: Proposed pipe size: Q100 + CC



HY-8 inputs: Proposed pipe size: Q10 + CC

Crossing Data - Awatea Proposed

Crossing Properties
 Name: Awatea Proposed

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	8.00	cms
Design Flow	8.20	cms
Maximum Flow	25.00	cms
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	1.50	m
Side Slope (H:V)	3.00	:1
Channel Slope	0.0097	m/m
Manning's n (channel)	0.0500	
Channel Invert Elevation	12.77	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	20.00	m
Crest Elevation	16.40	m
Roadway Surface	Paved	
Top Width	15.00	m

Culvert Properties

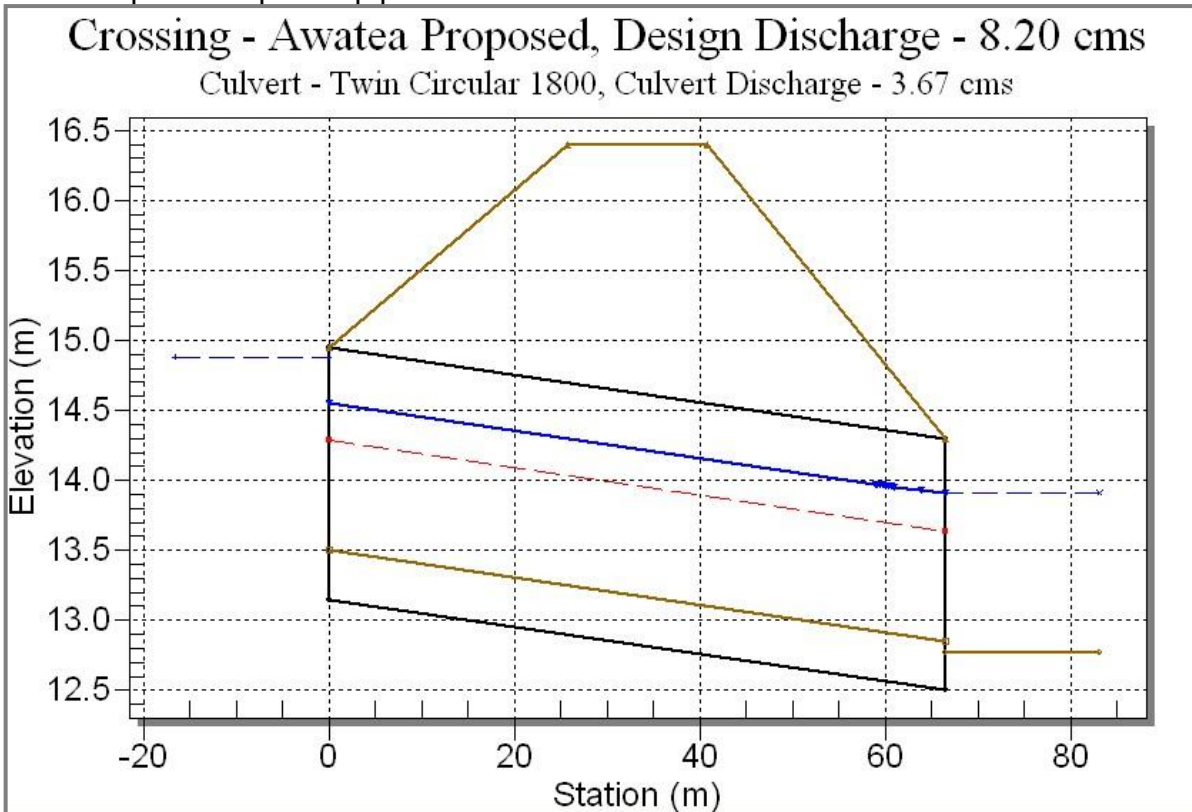
Twin Circular 1800
 Second 1800 (no embedment)

Add Culvert
 Duplicate Culvert
 Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Twin Circular 1800	
Shape	Circular	
Material	Concrete	
Diameter	1800.00	mm
Embedment Depth	350.00	mm
Manning's n (Top/Sides)	0.0120	
Manning's n (Bottom)	0.0350	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	13.15	m
Outlet Station	66.50	m
Outlet Elevation	12.50	m
Number of Barrels	1	

Help Click on any icon for help on a specific topic Energy Dissipation Analyze Crossing OK Cancel

HY-8 outputs: Proposed pipe size: Q10 + CC



HY-8 inputs: Proposed Alternative, Q100 + CC

Crossing Data - Awatea Proposed

Crossing Properties
 Name: Awatea Proposed

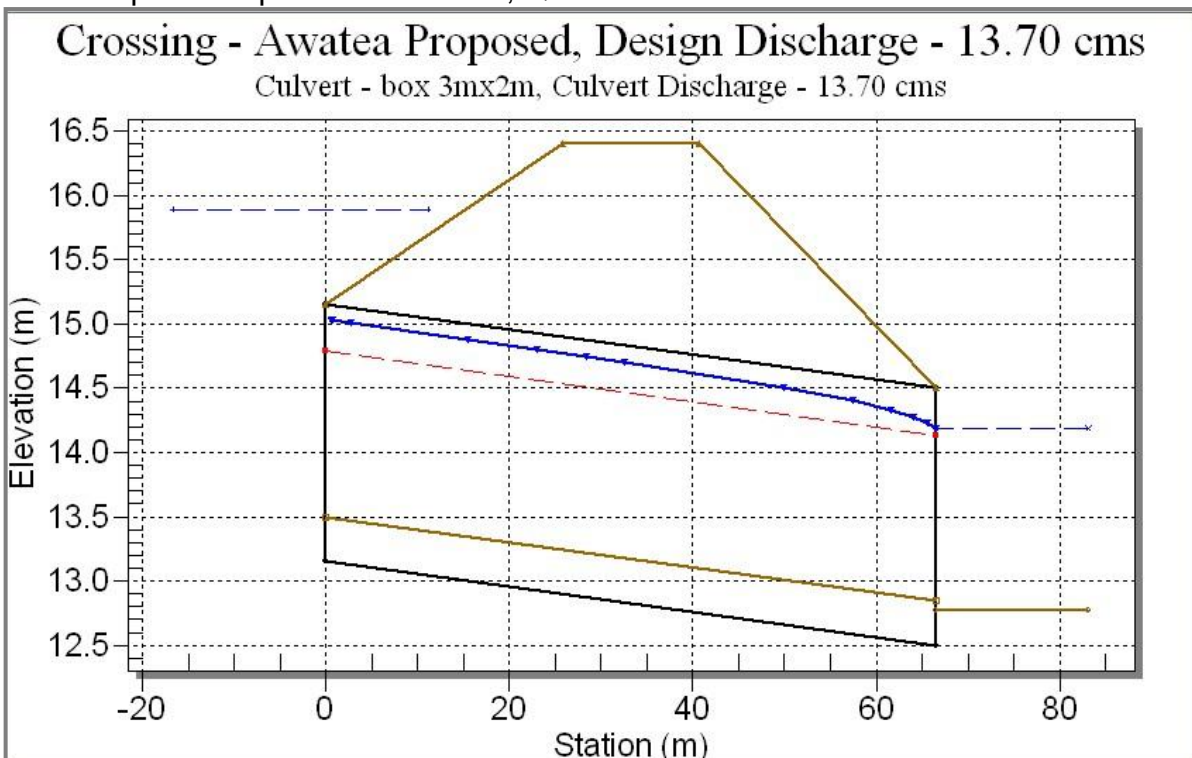
Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	8.00	cms
Design Flow	13.70	cms
Maximum Flow	25.00	cms
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	1.50	m
Side Slope (H:V)	3.00	:1
Channel Slope	0.0097	m/m
Manning's n (channel)	0.0500	
Channel Invert Elevation	12.77	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	20.00	m
Crest Elevation	16.40	m
Roadway Surface	Paved	
Top Width	15.00	m

Culvert Properties
 box 3m x 2m

Add Culvert
 Duplicate Culvert
 Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	box 3m x 2m	
Shape	Concrete Box	
Material	Concrete	
Span	3000.00	mm
Rise	2000.00	mm
Embedment Depth	350.00	mm
Manning's n (Top/Sides)	0.0120	
Manning's n (Bottom)	0.0350	
Inlet Type	Conventional	
Inlet Edge Condition	Thin Edge Projecting	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	13.15	m
Outlet Station	66.50	m
Outlet Elevation	12.50	m
Number of Barrels	1	

HY-8 outputs: Proposed Alternative, Q100 + CC



HY-8 inputs: Proposed pipe size: Extreme event [(Q100 + CC) x 1.5]

Crossing Data - Awatea Proposed

Crossing Properties
 Name: Awatea Proposed

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	8.00	cms
Design Flow	20.55	cms
Maximum Flow	25.00	cms
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	1.50	m
Side Slope (H:V)	3.00	:1
Channel Slope	0.0097	m/m
Manning's n (channel)	0.0500	
Channel Invert Elevation	12.77	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	20.00	m
Crest Elevation	16.40	m
Roadway Surface	Paved	
Top Width	15.00	m

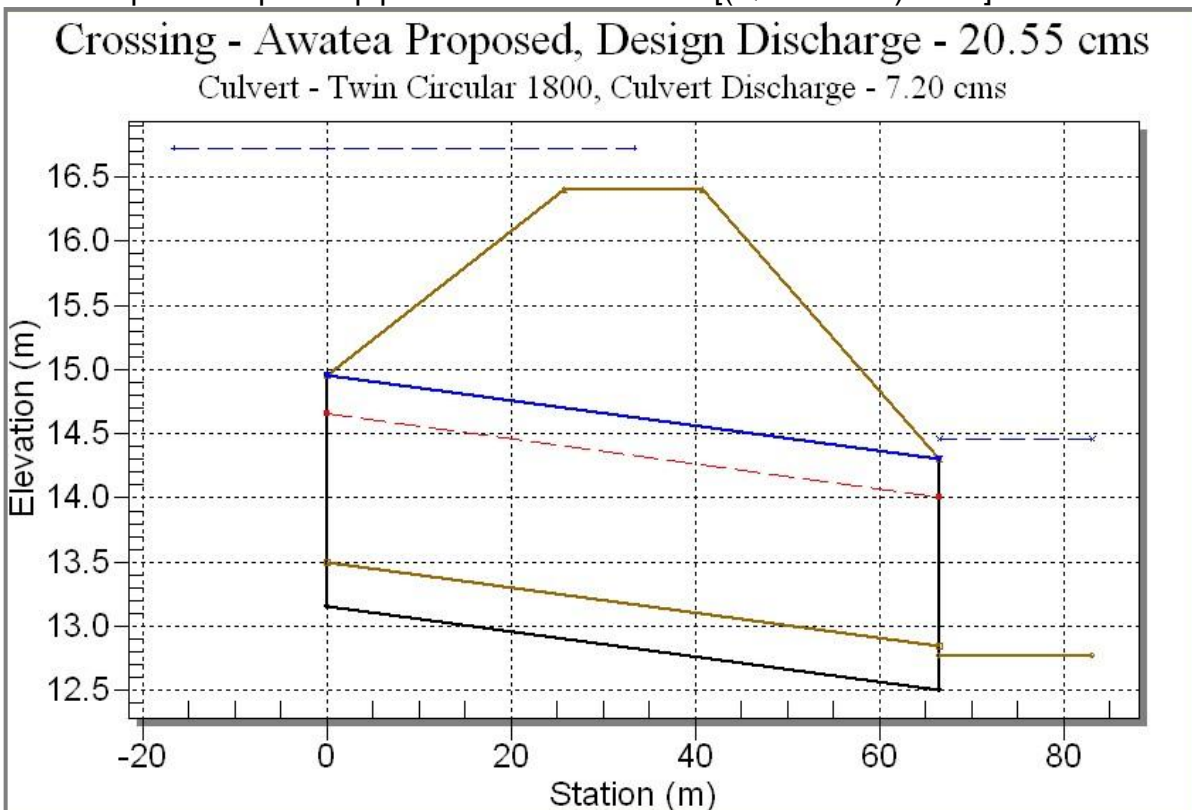
Culvert Properties

Twin Circular 1800
 Second 1800 (no embedment)

Add Culvert
 Duplicate Culvert
 Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Twin Circular 1800	
Shape	Circular	
Material	Concrete	
Diameter	1800.00	mm
Embedment Depth	350.00	mm
Manning's n (Top/Sides)	0.0120	
Manning's n (Bottom)	0.0350	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	13.15	m
Outlet Station	66.50	m
Outlet Elevation	12.50	m
Number of Barrels	1	

HY-8 outputs: Proposed pipe size: Extreme event [(Q100 + CC) x 1.5]



HY-8 inputs: Existing rail box with existing road culverts: Q100 + CC

Crossing Data - Awatea Existing Rail

DISCHARGE DATA
 Minimum Flow: 10.00 cms
 Design Flow: 13.70 cms
 Maximum Flow: 25.00 cms

TAILWATER DATA
 Channel Type: Enter Constant Tailwater Elevation
 Channel Invert Elevation: 14.43 m
 Constant Tailwater Elevation: 16.70 m
 Rating Curve: View...

ROADWAY DATA
 Roadway Profile Shape: Constant Roadway Elevation
 First Roadway Station: 0.00 m
 Crest Length: 60.00 m
 Crest Elevation: 17.20 m
 Roadway Surface: Paved
 Top Width: 4.00 m

Culvert Properties

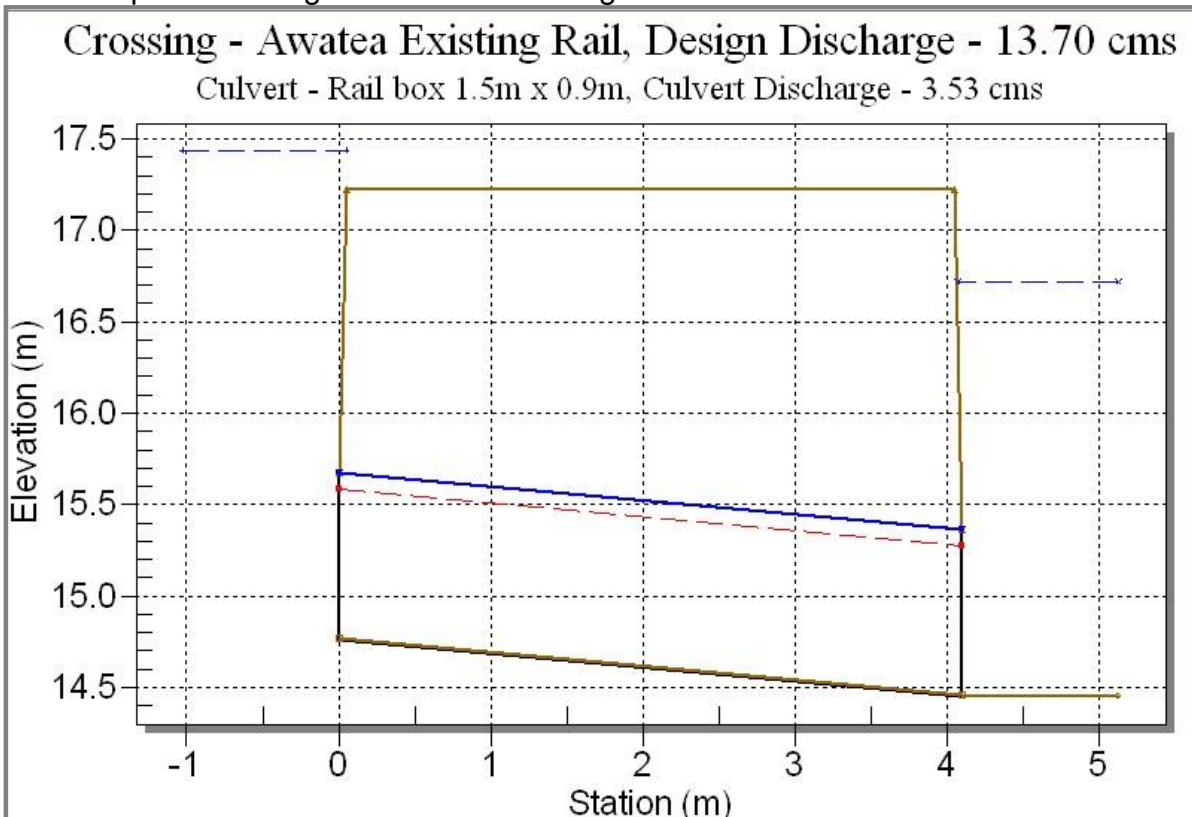
CULVERT DATA
 Name: Rail box 1.5m x 0.9m
 Shape: Concrete Box
 Material: Concrete
 Span: 1530.00 mm
 Rise: 914.00 mm
 Embedment Depth: 10.00 mm
 Manning's n (Top/Sides): 0.0120
 Manning's n (Bottom): 0.0350
 Inlet Type: Conventional
 Inlet Edge Condition: Thin Edge Projecting
 Inlet Depression?: No

SITE DATA

Site Data Input Option: Culvert Invert Data
 Inlet Station: 0.00 m
 Inlet Elevation: 14.74 m
 Outlet Station: 4.10 m
 Outlet Elevation: 14.43 m
 Number of Barrels: 1

Buttons: Help, Click on any icon for help on a specific topic, Energy Dissipation, Analyze Crossing, OK, Cancel

HY-8 outputs: Existing rail box with existing road culverts: Q100 + CC



HY-8 inputs: Existing rail box with proposed road culverts: Q100 + CC

Crossing Data - Awatea Existing Rail

Crossing Properties
 Name: Awatea Existing Rail

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	10.00	cms
Design Flow	13.70	cms
Maximum Flow	25.00	cms
TAILWATER DATA		
Channel Type	Enter Constant Tailwater Elevation	
Channel Invert Elevation	14.43	m
Constant Tailwater Elevation	15.90	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	60.00	m
Crest Elevation	17.20	m
Roadway Surface	Paved	
Top Width	4.00	m

Culvert Properties

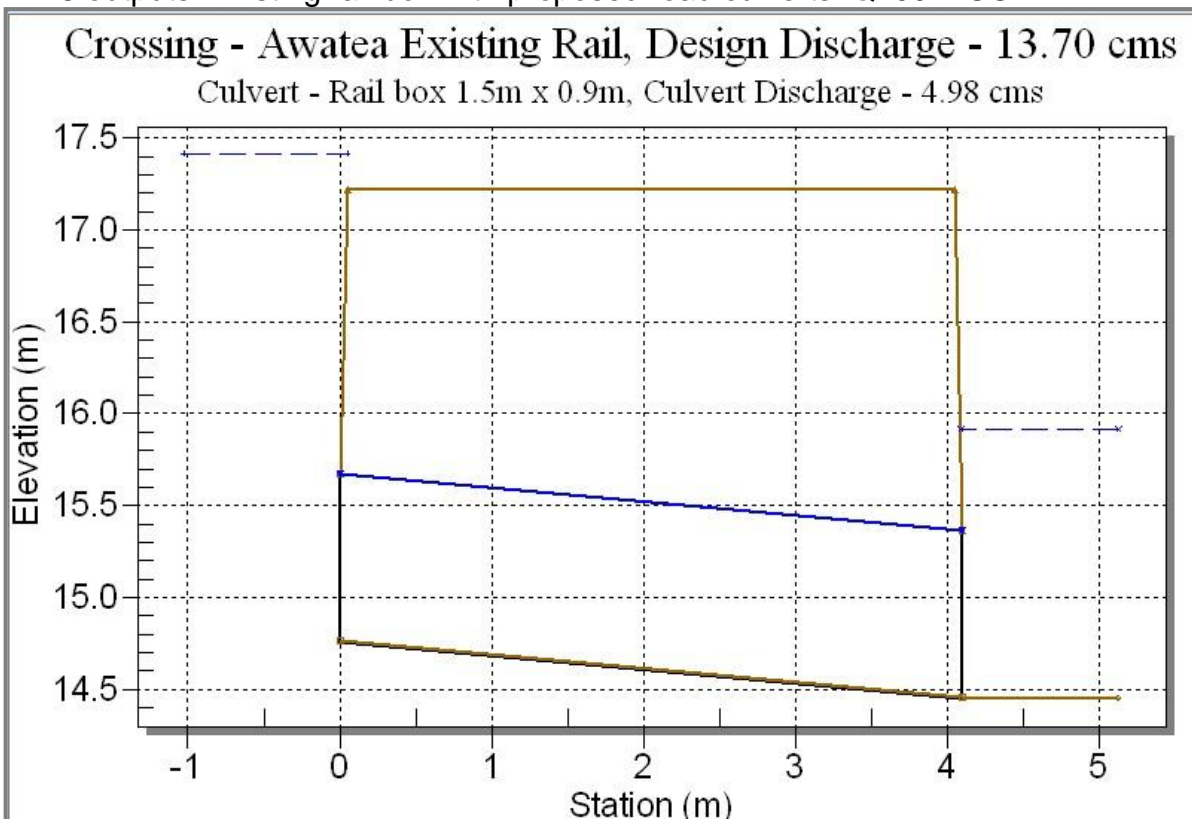
Rail box 1.5m x 0.9m

Buttons: Add Culvert, Duplicate Culvert, Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Rail box 1.5m x 0.9m	
Shape	Concrete Box	
Material	Concrete	
Span	1530.00	mm
Rise	914.00	mm
Embedment Depth	10.00	mm
Manning's n (Top/Sides)	0.0120	
Manning's n (Bottom)	0.0350	
Inlet Type	Conventional	
Inlet Edge Condition	Thin Edge Projecting	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	14.74	m
Outlet Station	4.10	m
Outlet Elevation	14.43	m
Number of Barrels	1	

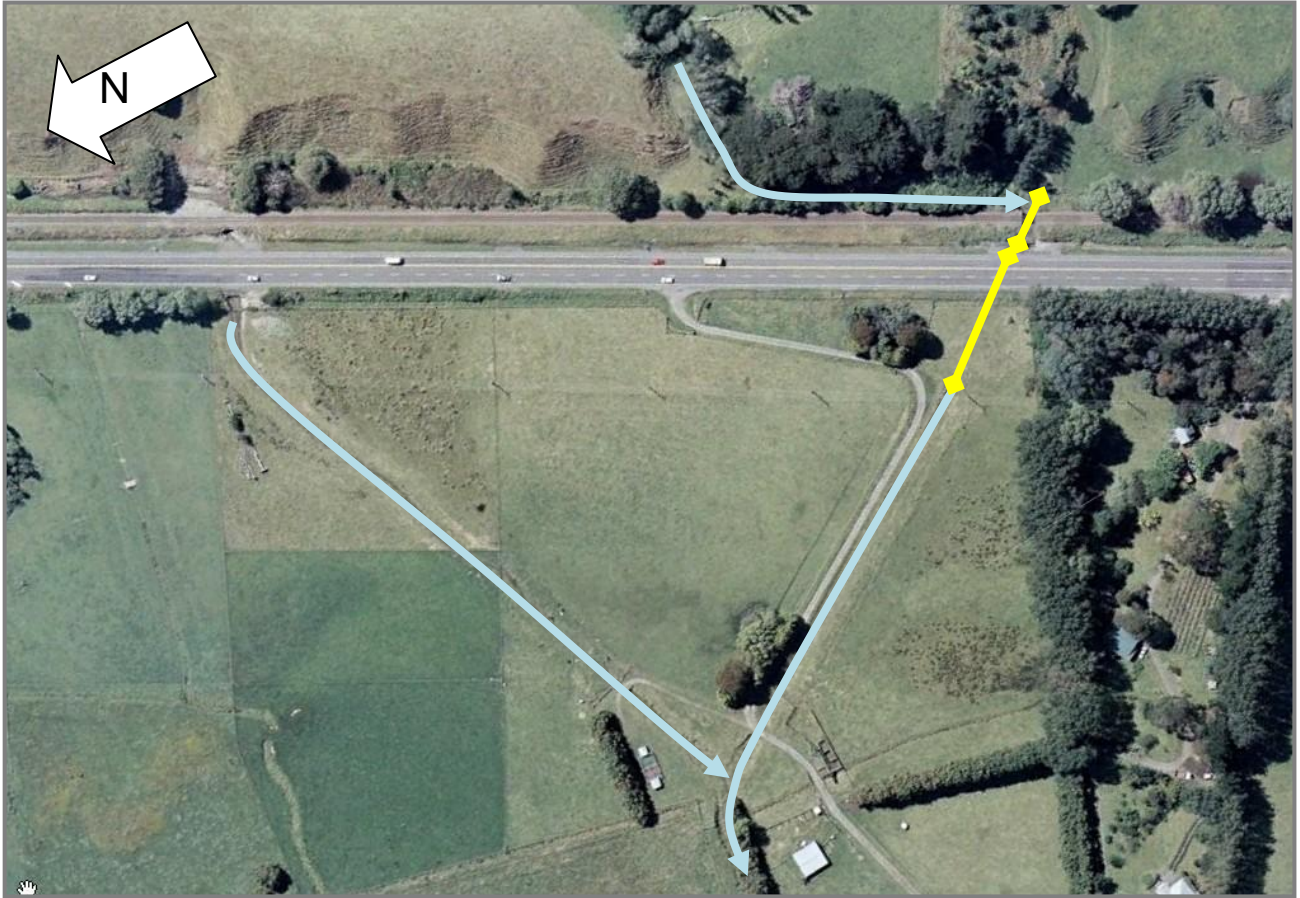
Buttons: Help, Energy Dissipation, Analyze Crossing, OK, Cancel

HY-8 outputs: Existing rail box with proposed road culverts: Q100 + CC

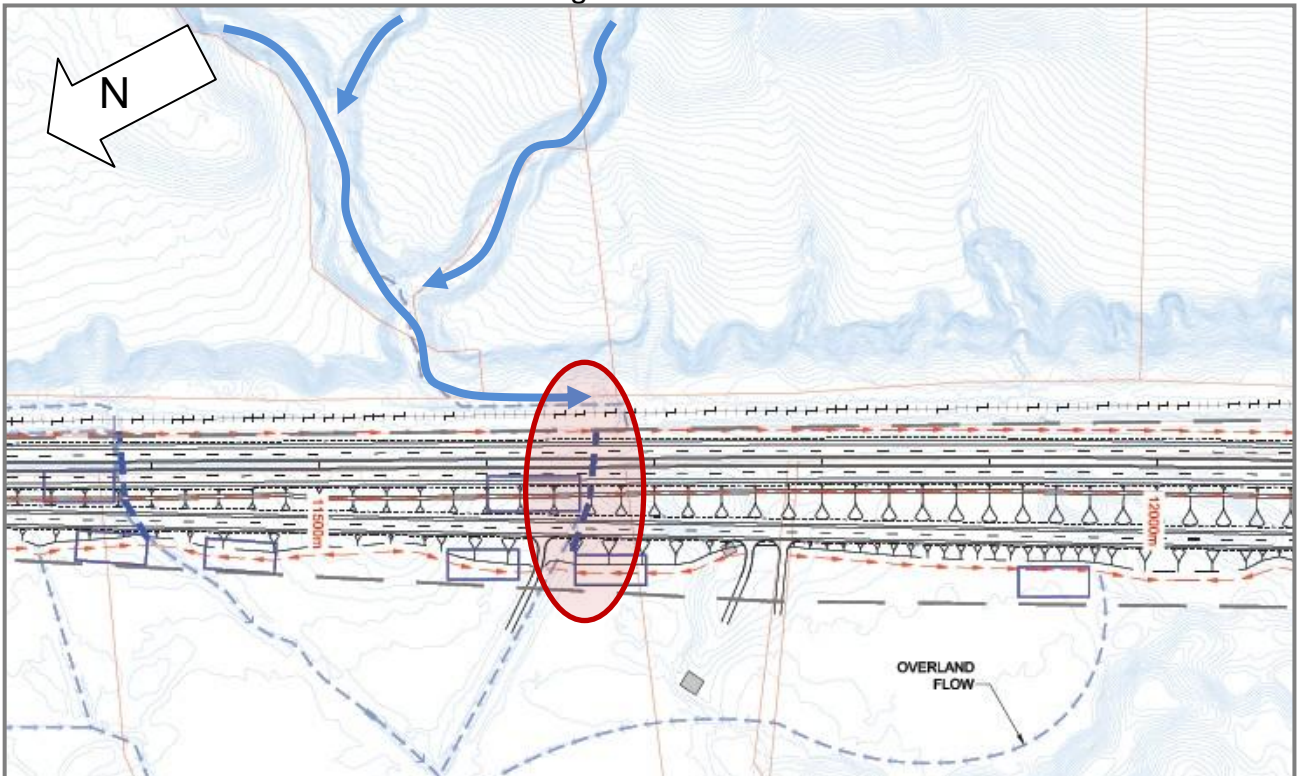


KUMOTOTO CULVERT

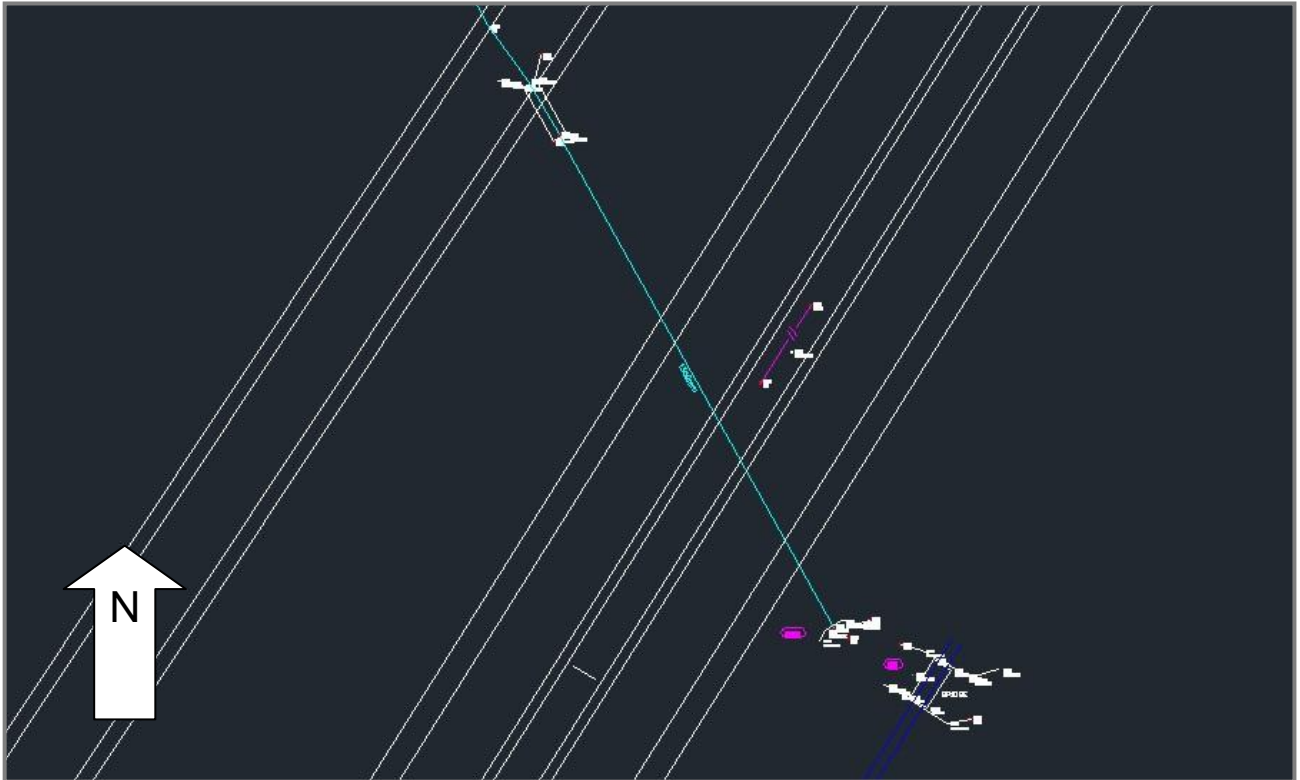
Existing Image



Location on schem assessment drawing



Existing Survey (with proposed road show)



Existing inlet

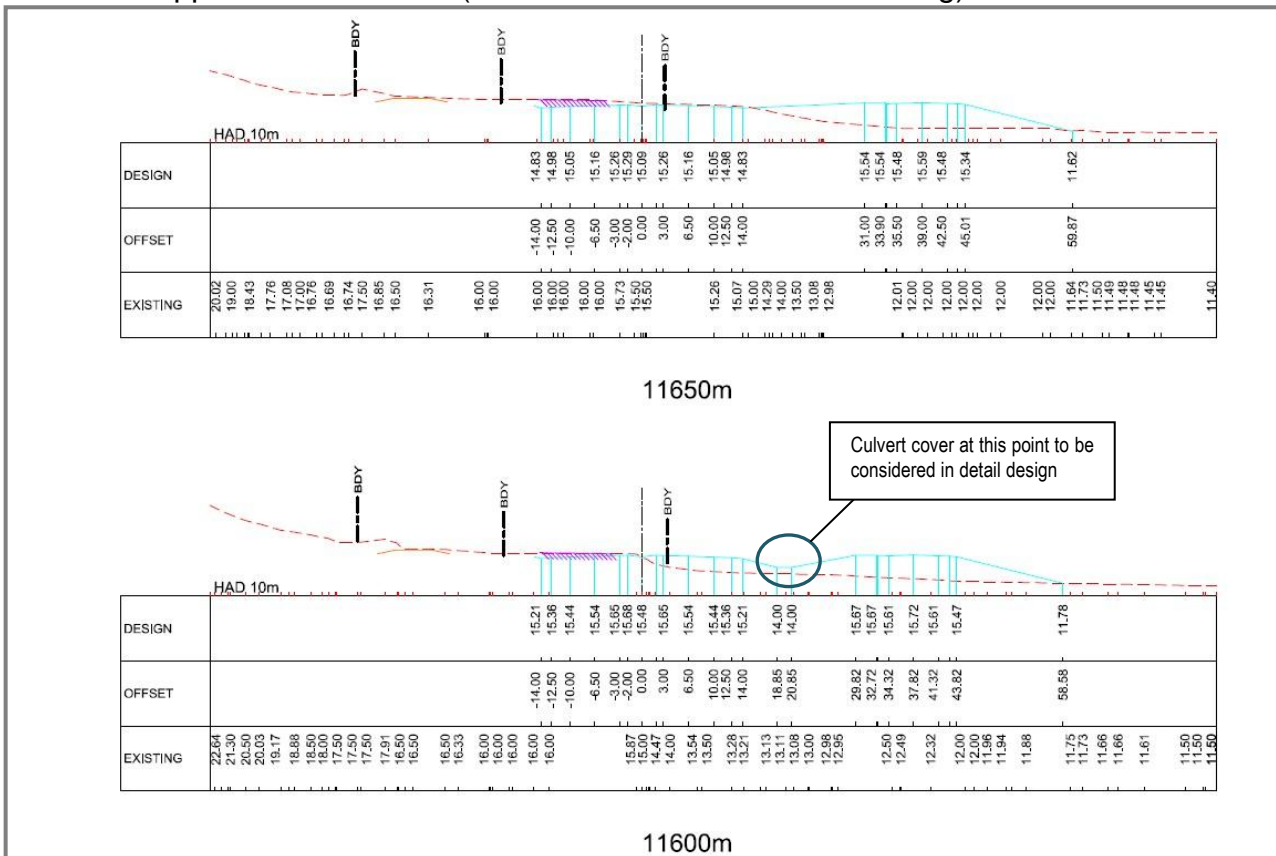


KUMOTOTO CULVERT

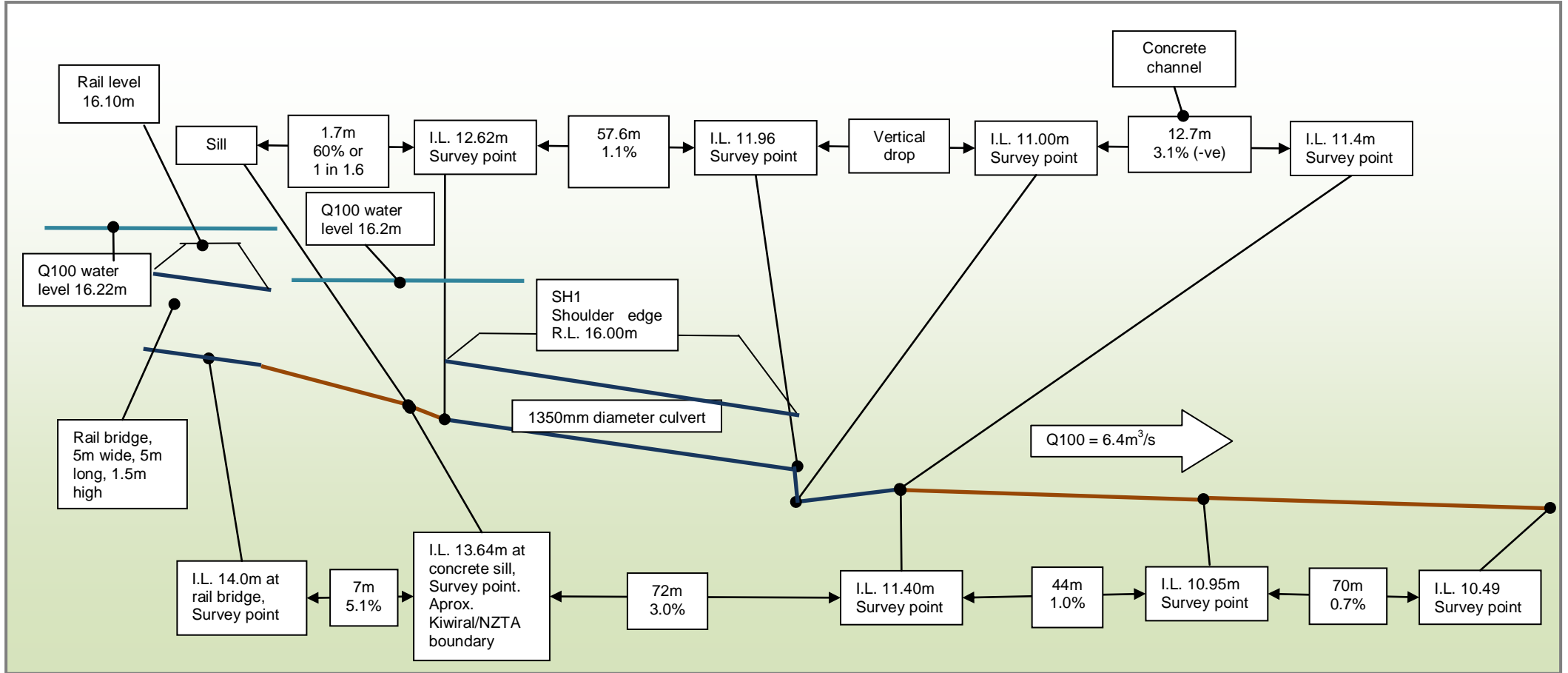
Existing upstream rail



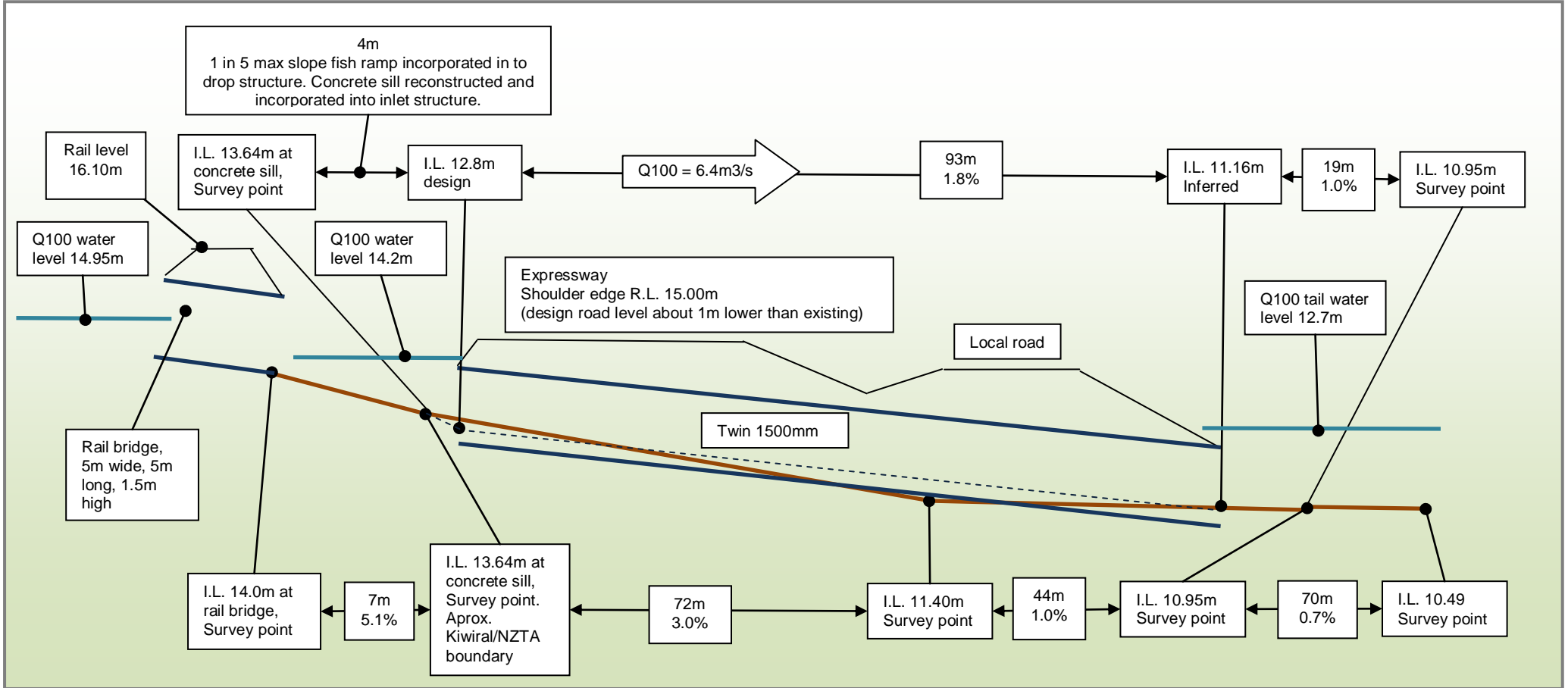
Section at approximate location (from scheme assessment drawing)



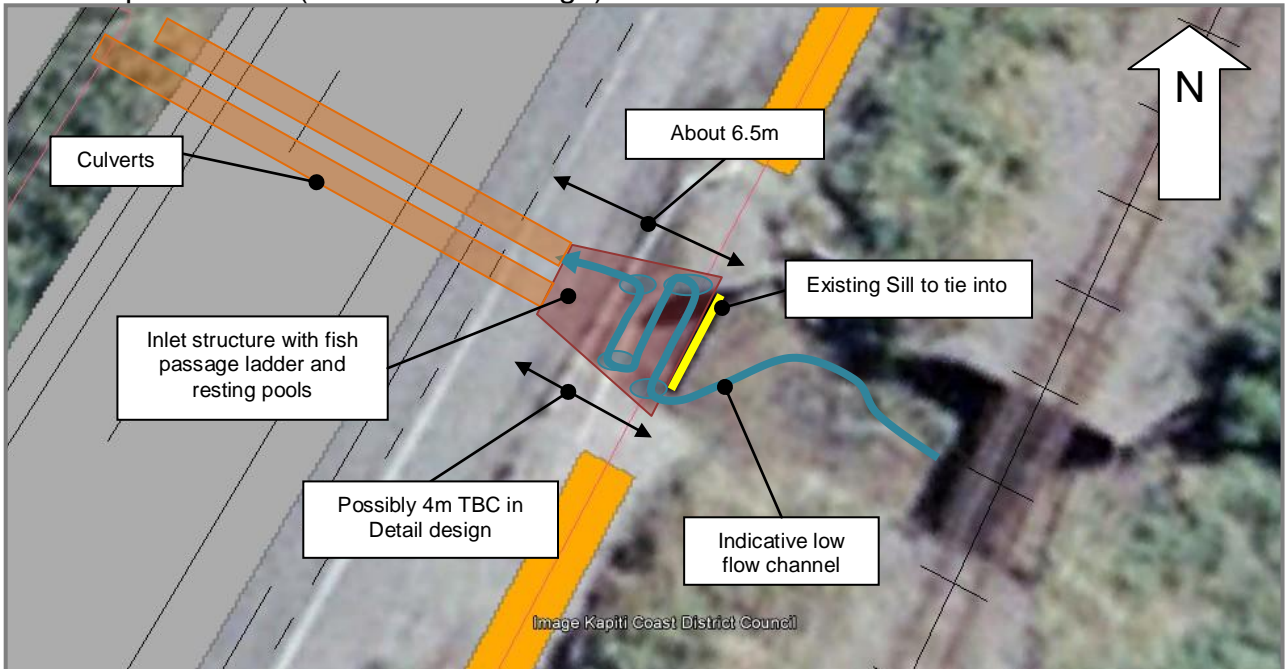
Schematic of existing situation – Levels and grades



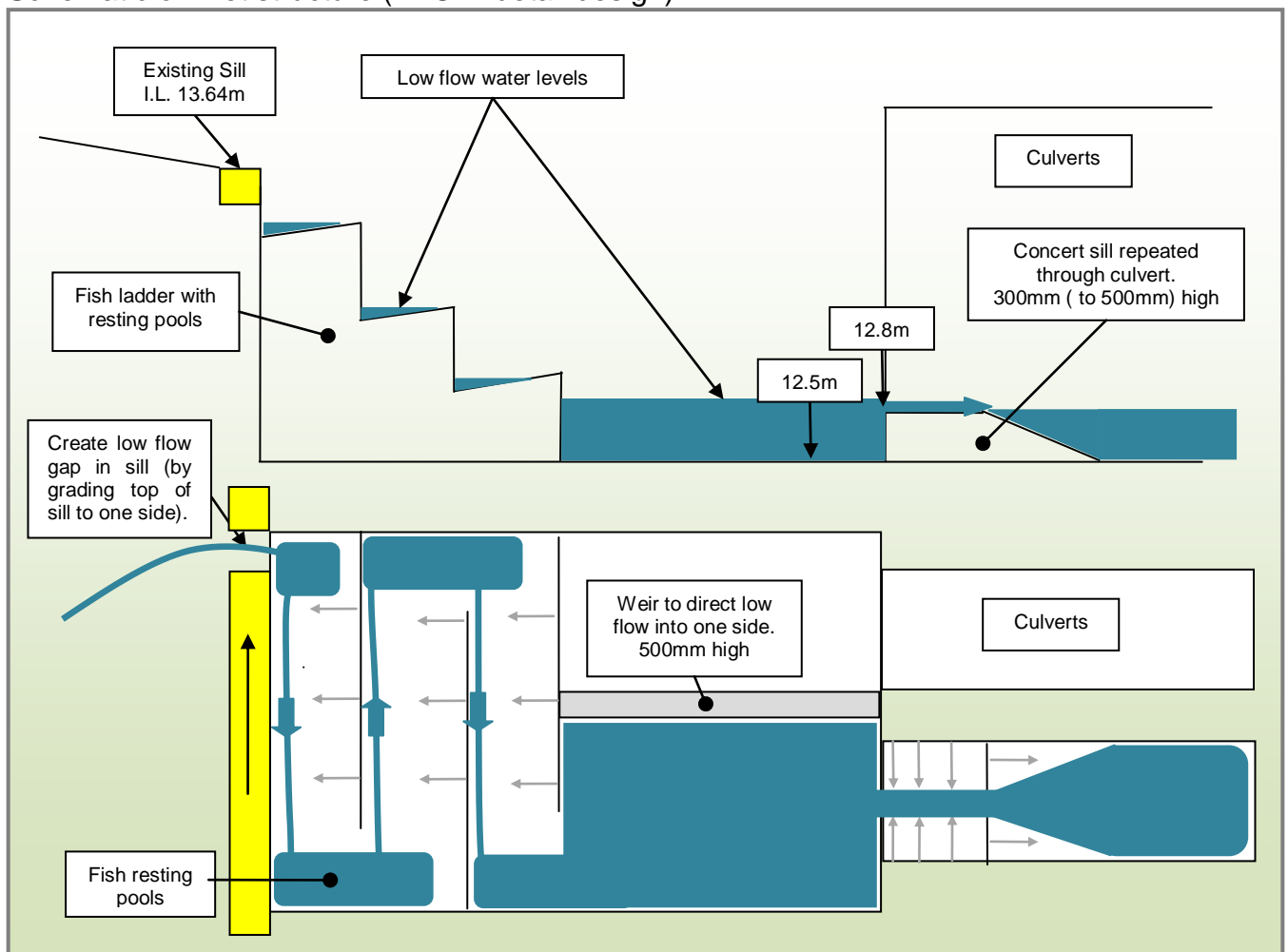
Schematic of proposed situation – Levels and grades



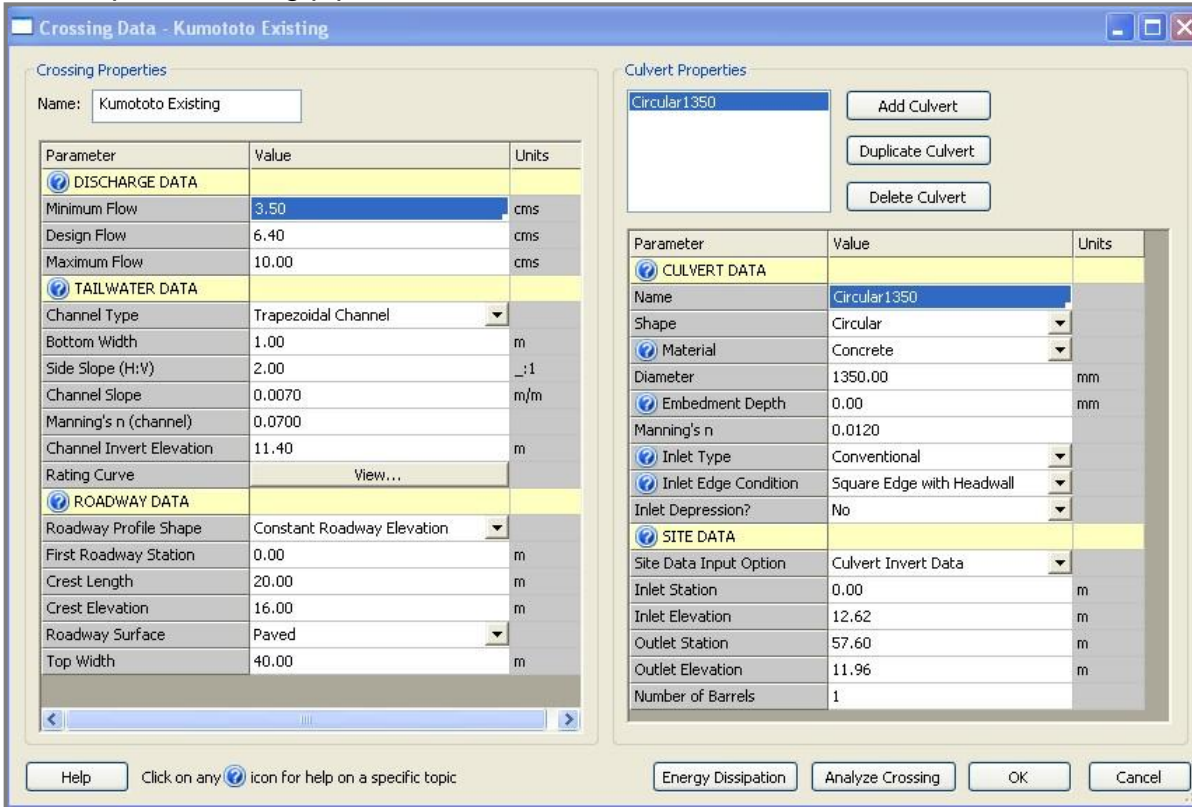
General plan of inlet (TBC in detail design)



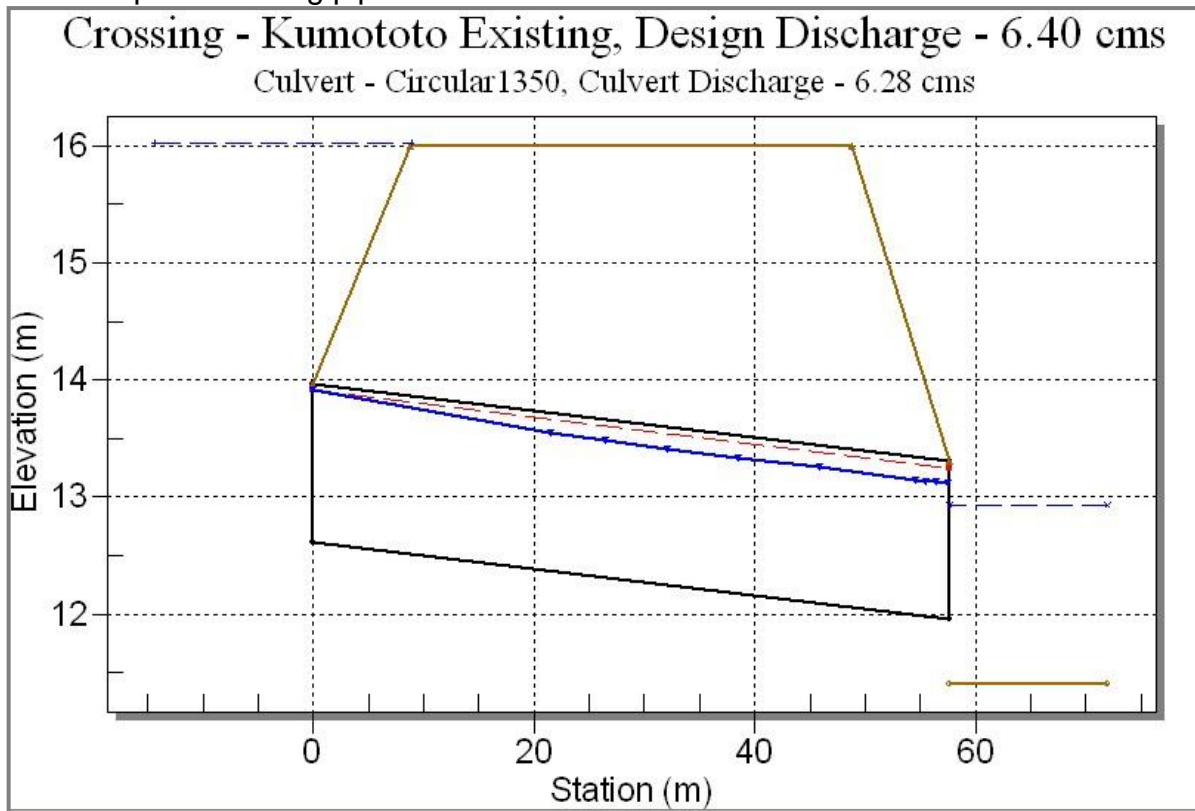
Schematic of inlet structure (TBC in detail design)



HY-8 inputs: Existing pipe size: Q100 + CC



HY-8 outputs: Existing pipe size: Q100 + CC



HY-8 inputs: Proposed pipe size: Q100 + CC

Crossing Data - Kumototo Proposed

Crossing Properties
 Name: Kumototo Proposed

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	3.50	cms
Design Flow	6.40	cms
Maximum Flow	10.00	cms
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	1.00	m
Side Slope (H:V)	2.00	:1
Channel Slope	0.0070	m/m
Manning's n (channel)	0.0700	
Channel Invert Elevation	11.16	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	20.00	m
Crest Elevation	15.00	m
Roadway Surface	Paved	
Top Width	60.00	m

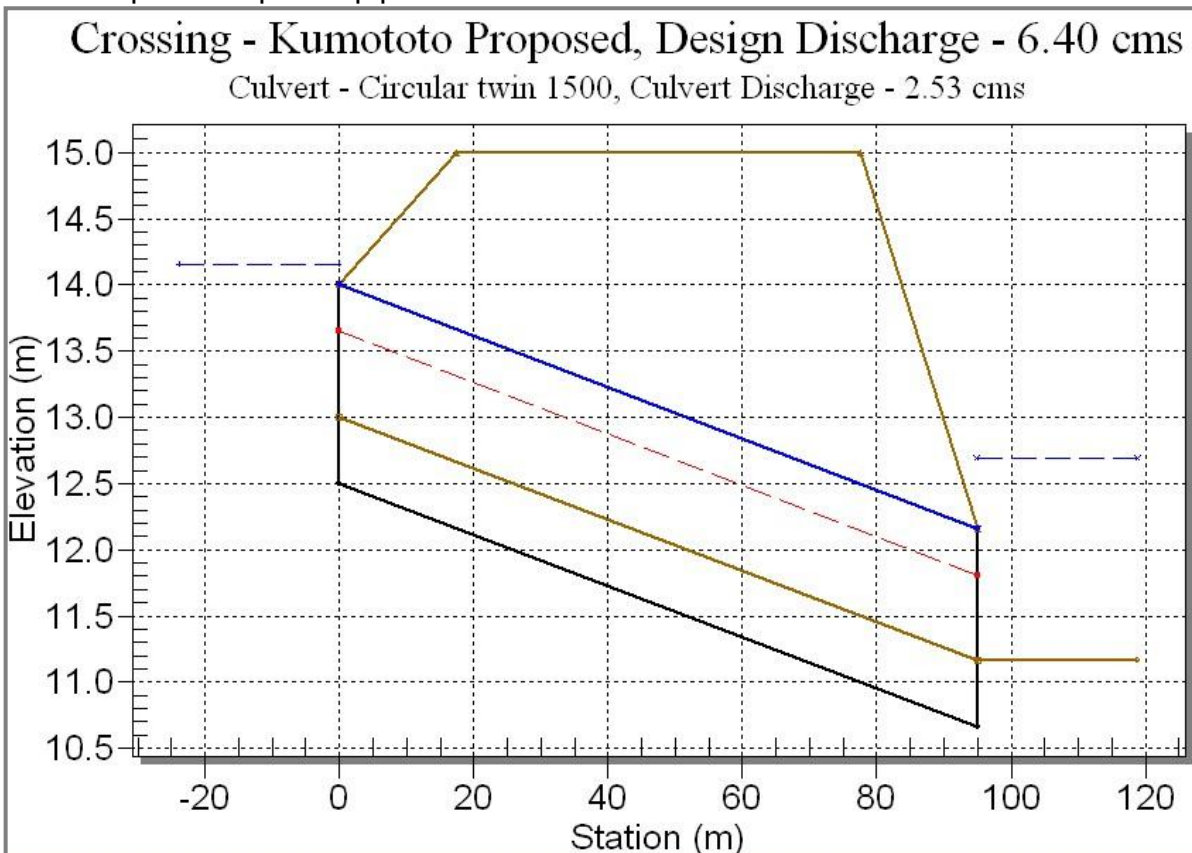
Culvert Properties

Circular twin 1500
 Second 1500 (no embedment)

Add Culvert
 Duplicate Culvert
 Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Circular twin 1500	
Shape	Circular	
Material	Concrete	
Diameter	1500.00	mm
Embedment Depth	500.00	mm
Manning's n (Top/Sides)	0.0120	
Manning's n (Bottom)	0.0350	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	12.50	m
Outlet Station	95.00	m
Outlet Elevation	10.66	m
Number of Barrels	1	

HY-8 outputs: Proposed pipe size: Q100 + CC



HY-8 inputs: Proposed pipe size: Extreme event $[(Q100 + CC) \times 1.5]$

Crossing Data - Kumototo Proposed

Crossing Properties
 Name: Kumototo Proposed

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	3.50	cms
Design Flow	9.60	cms
Maximum Flow	10.00	cms
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	1.00	m
Side Slope (H:V)	2.00	:1
Channel Slope	0.0070	m/m
Manning's n (channel)	0.0700	
Channel Invert Elevation	11.16	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	20.00	m
Crest Elevation	15.00	m
Roadway Surface	Paved	
Top Width	60.00	m

Culvert Properties

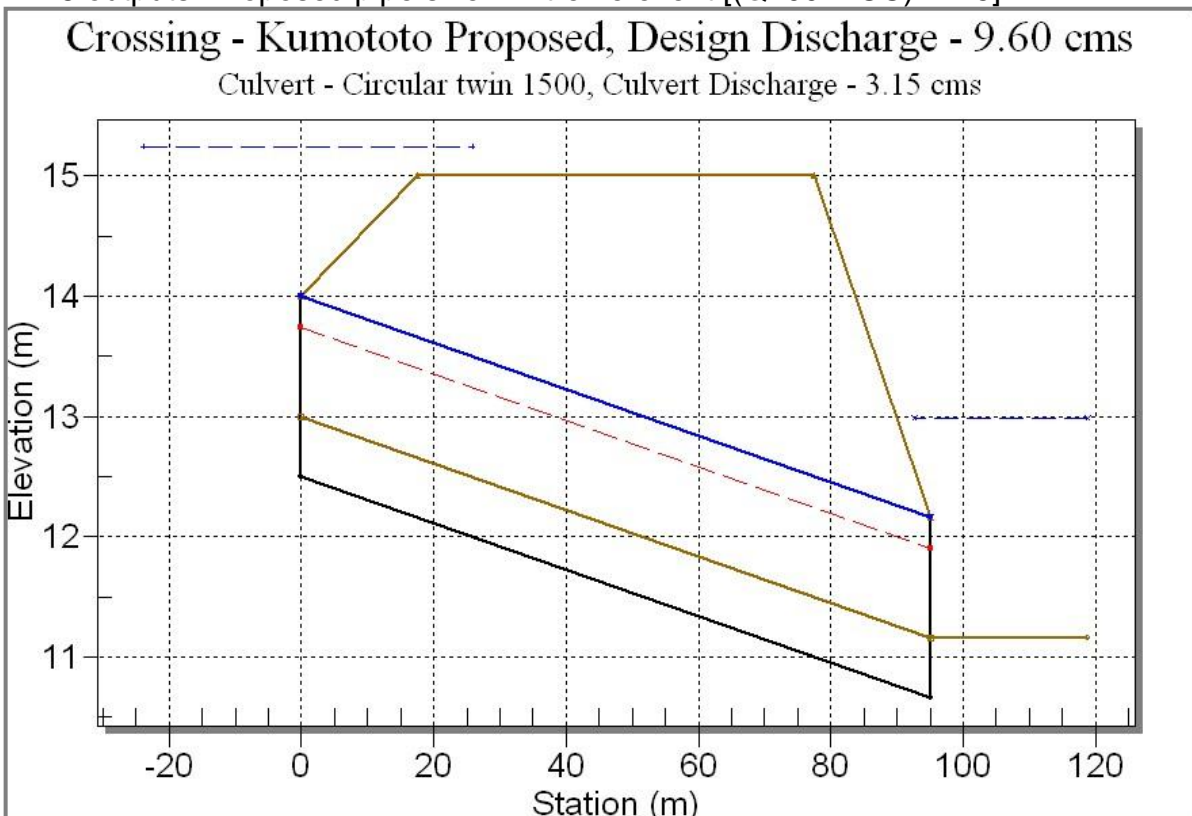
Circular twin 1500
 Second 1500 (no embedment)

Add Culvert
 Duplicate Culvert
 Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Circular twin 1500	
Shape	Circular	
Material	Concrete	
Diameter	1500.00	mm
Embedment Depth	500.00	mm
Manning's n (Top/Sides)	0.0120	
Manning's n (Bottom)	0.0350	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	12.50	m
Outlet Station	95.00	m
Outlet Elevation	10.66	m
Number of Barrels	1	

Help Click on any icon for help on a specific topic Energy Dissipation Analyze Crossing OK Cancel

HY-8 outputs: Proposed pipe size: Extreme event $[(Q100 + CC) \times 1.5]$



KUMOTOTO CULVERT

HY-8 inputs: Existing Rail box with existing road culvert: Q100 + CC

Crossing Data - Kumototo Existing Rail

Crossing Properties
 Name:

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	3.50	cms
Design Flow	6.40	cms
Maximum Flow	10.00	cms
TAILWATER DATA		
Channel Type	Enter Constant Tailwater Elevation	
Channel Invert Elevation	13.90	m
Constant Tailwater Elevation	16.05	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	60.00	m
Crest Elevation	16.10	m
Roadway Surface	Gravel	
Top Width	4.00	m

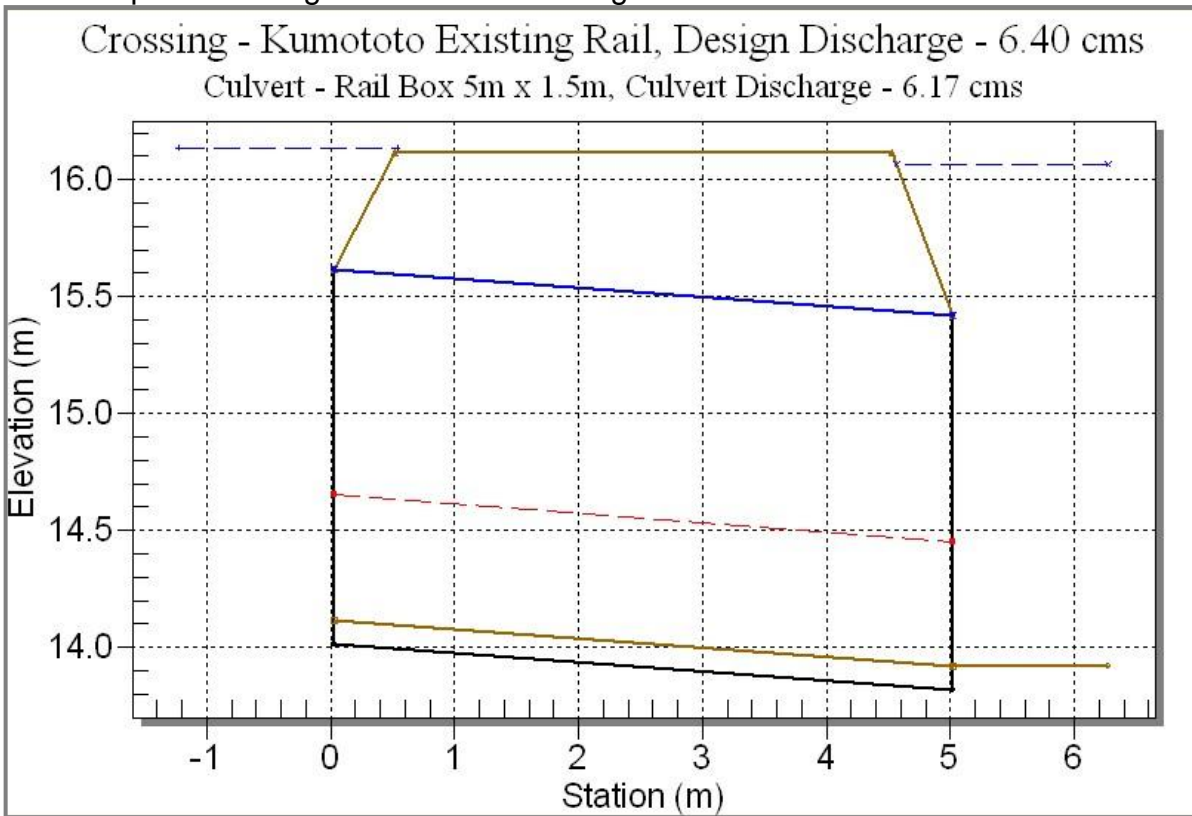
Culvert Properties
 Rail Box 5m x 1.5m

Add Culvert
 Duplicate Culvert
 Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Rail Box 5m x 1.5m	
Shape	Concrete Box	
Material	Concrete	
Span	5000.00	mm
Rise	1600.00	mm
Embedment Depth	100.00	mm
Manning's n (Top/Sides)	0.0120	
Manning's n (Bottom)	0.0350	
Inlet Type	Conventional	
Inlet Edge Condition	Thin Edge Projecting	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	14.00	m
Outlet Station	5.00	m
Outlet Elevation	13.80	m
Number of Barrels	1	

Help Click on any icon for help on a specific topic Energy Dissipation Analyze Crossing OK Cancel

HY-8 outputs: Existing Rail box with existing road culvert: Q100 + CC



HY-8 inputs: Existing Rail box with proposed road culvert: Q100 + CC

Crossing Data - Kumototo Existing Rail

Crossing Properties
 Name: Kumototo Existing Rail

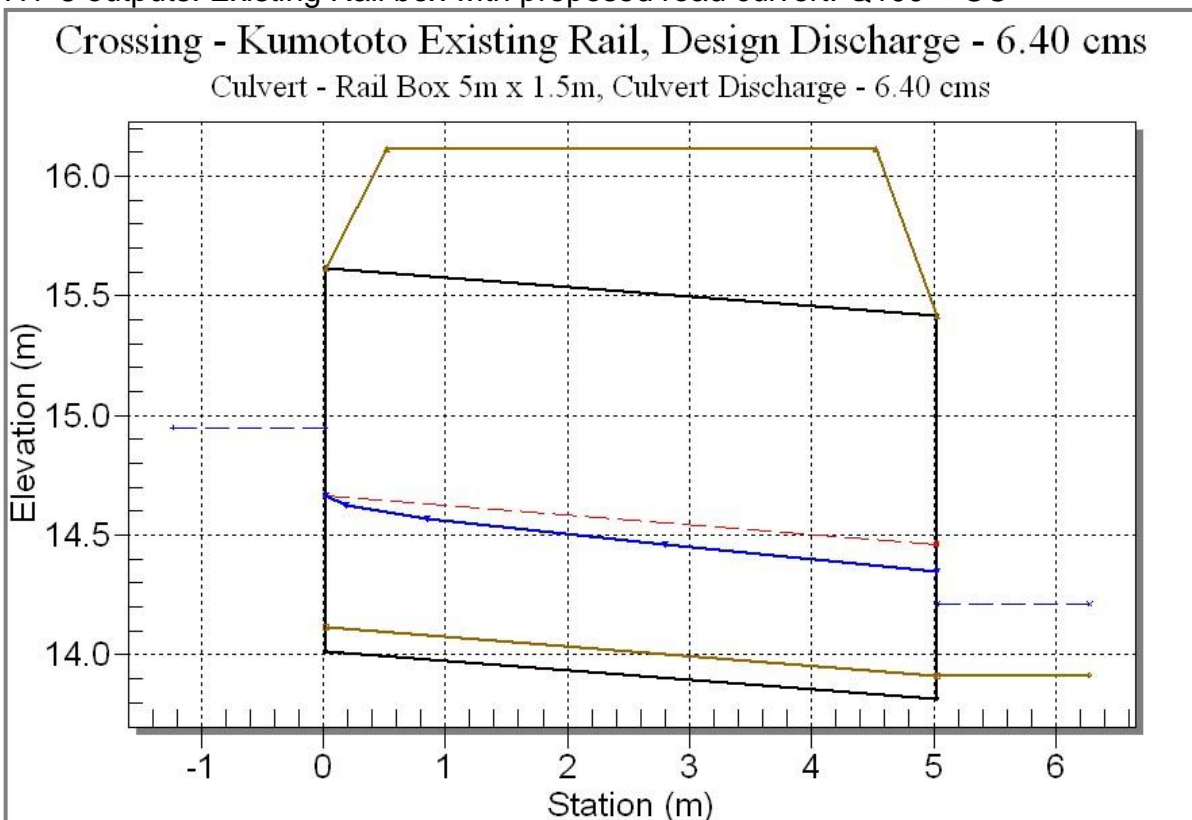
Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	3.50	cms
Design Flow	6.40	cms
Maximum Flow	10.00	cms
TAILWATER DATA		
Channel Type	Enter Constant Tailwater Elevation	
Channel Invert Elevation	13.90	m
Constant Tailwater Elevation	14.20	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.00	m
Crest Length	60.00	m
Crest Elevation	16.10	m
Roadway Surface	Paved	
Top Width	4.00	m

Culvert Properties
 Rail Box 5m x 1.5m

Add Culvert
 Duplicate Culvert
 Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Rail Box 5m x 1.5m	
Shape	Concrete Box	
Material	Concrete	
Span	5000.00	mm
Rise	1600.00	mm
Embedment Depth	100.00	mm
Manning's n (Top/Sides)	0.0120	
Manning's n (Bottom)	0.0350	
Inlet Type	Conventional	
Inlet Edge Condition	Thin Edge Projecting	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	m
Inlet Elevation	14.00	m
Outlet Station	5.00	m
Outlet Elevation	13.80	m
Number of Barrels	1	

HY-8 outputs: Existing Rail box with proposed road culvert: Q100 + CC



KUMOTOTO CULVERT