Technical Memorandum

Title	**Maroochydore City Centre** **Flooding and Stormwater Management Considerations for Stage 1**		
Client	Suncentral Maroochydore	Project No	249402
Date	26 August 2015	Status	Preliminary
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FLOODING AND STORMWATER MANAGEMENT

1. Summary

Stage 1 of the Maroochydore City Centre (MCC) development is PDA Precinct 3, which is the Core Business District area located to the north of Maud Canal. As part of Stage 1 works Maud Drain will realigned and constructed as a canal with increased flood conveyance capacity. The channel will be relocated further north at the eastern end of the site and further south at the western end of the site, so that the canal has a straighter configuration. The canal will be deepened to RL -2.0m AHD and will have a minimum width of 20 metres. From RL -2.0 to -0.5m AHD, 1 in 3 side slopes will be adopted. Above this level the canal will have vertical walls, and/or terraced walls, dependent on the landscape design and access. The typical surface levels adjacent to the canal will be around RL 3.3m AHD. The normal water surface level in the canal will typically vary between RL -0.33m AHD (MLWS) and RL 0.47m AHD (MHWS). A typical cross-section of the proposed canal is attached.

The current drain has a minimum level of RL -0.5m AHD at the eastern end of the site to around RL -1.2 mAHD at the western end. It has a bed width of around 10 metres and side slopes ranging from 1 in 3 to 1 in 5.

The current site where Stage 1 works are to take place consists of former golf course, club house and associated car parking. The majority of the existing Stage 1 area currently drains towards the north, where a stormwater inlet in the car park drains to an 825mm RCP. This connects northward to the underground stormwater drainage, which discharges to Cornmeal Creek at the end of Cornmeal Parade. The limited capacity of this stormwater drainage network has created urban flooding issues in the past. The MCC design will reduce the area that drains towards the north so that there is no increase in flows as a result of development. The current area of the site that drains towards the north is around 7.9 hectares, of which about 1.1 hectares is impervious. The ultimate design of Stage 1 will have around 0.55 hectares continuing to drain towards the north. This decrease in flows directed towards the north will result in a reduction of local flooding to the north of the site.

The *Cornmeal Creek Flood Study* (Cardno, 2013) was undertaken for Sunshine Coast Regional Council (SCRC) to inform the master planning for the site. In this study it was assumed that the majority of the Stage 1 area drainage would be re-directed towards Maud Canal. The increased capacity of the canal proposed as part of the MCC development ensured that there were no adverse flood impacts on adjacent properties. The results of the flood study showed that the MCC development resulted in reduction in peak water levels at Maud Street by up to 169mm.

Additional flood modelling has been conducted for the Stage 1 earthworks, to ensure that temporary diversion works and redirection of flows do not have an unacceptable impact on adjacent properties. The results of this analysis are provided in this Technical Note.

2. Flood Behaviour of Existing Site

In the existing case, flows from the urban catchment to the east of the site are conveyed west through Maud Drain and discharge into Cornmeal Creek downstream of Plaza Parade. Flood flows from south of Dalton Drive are conveyed in two directions: north into the golf course lake, and west beneath Maroochy Boulevard into Sunshine Cove Lake. Flood flows that enter the golf course eventually discharge via a swale along the north western boundary of the golf course, into Maud Drain near Plaza Parade, or they flow south-west to go back under Dalton Drive (near the intersection with Maroochy Boulevard), which then flows to the Sunshine Cove Lake. The majority of flood flows from the south do not overtop into Maud Drain, except for a small section at the eastern end of the site. This is due to the high southern bank, which is at levels of around RL 2.3 to 3.0m AHD, which is shown in Image 1 below. Flood flows in Maud Drain do not overtop the northern bank and therefore do not flow into the area that will be developed as part of Stage 1 works.

Image 1 Location of Existing Southern Bank

3. Flood Impacts during Stage 1 Works

The construction of Maud Canal during Stage 1 works will be conducted in a way that will ensure that flows from the east and south are not obstructed during construction. The existing channel will be retained while a temporary diversion channel is excavated and stabilised. A 15 metre wide overland flow path at RL 1.60m AHD will also be provided on the southern side of the temporary diversion drain, to direct flows from the south to existing low points in the north-west. A plan showing the proposed temporary diversion channel is attached. Once the temporary diversion drain is stabilised, works within the existing Maud Drain will be able to proceed. Stockpiling of excavation material will occur in existing flood free areas identified on the site.

The existing case TUFLOW flood model of the site set up for the *Cornmeal Creek Flood Study* (Cardno, 2013) was modified to take into account the temporary works required for Stage 1. For the flood

modelling it has been assumed that the section of Maud Drain undergoing excavation would not contribute to flood storage. The results of the analysis are attached. The TUFLOW analysis was able to demonstrate that Stage 1 temporary works can proceed with minimal flood impacts. There is a minor increase of around 30mm in the 1% and 39% Annual Exceedance Probability (AEP) peak water levels within the creek through Sunshine Plaza. No residential areas are affected. Given the temporary nature of these works, these impacts are considered acceptable. As shown in Figures 1 to 6, the residential area upstream of Maud Street will experience a reduction in peak flood levels for all AEP events.

The 1% AEP flood impact plot is also shown in Image 2. This image highlights areas that were dry and now are wet, or vice versa, in the 1% AEP event, with the temporary Stage 1 works in place. As shown by this image, the temporary works improve flooding for properties to the west and also for properties around Maud Street. The increase in inundation area around Sunshine Plaza is minimal. The difference in peak water levels in the 1% AEP event are shown in Figure 6.

In the 39% AEP event the flood extent around Sunshine Plaza is contained within the channels, so a minor increase is peak water level does not increase the area being inundated.

In the 1% AEP flood event none of the surrounding road crossings are overtopped, therefore the flood immunity of the roads is not reduced as part of Stage 1 works.

Image 2 1% AEP Stage 1 Temporary Works Flood Impact

4. Local Stormwater Drainage

A 675mm RCP runs along the eastern boundary of the site and drains into Maud Canal. The stormwater line drains local stormwater from Maud Street. This drainage line will be retained and a swale will be

constructed to convey any overland flow from this area, around Stage 1 works and towards Maud Canal. Similarly the existing stormwater drainage lines along the northern boundary of the site, that connect stormwater flows from Golf Street and Maud Street to the Cornmeal Parade drainage line will be retained.

For Stage 1, the internal stormwater network has been designed to have 5% AEP capacity. This is greater than the capacity required by the *Queensland Urban Drainage Manual* (QUDM), which specifies 10% AEP for commercial areas. Allowance for climate change has been made in the internal drainage design. The assumed tailwater level is the 5% AEP climate change storm tide level of RL 2.2m AHD. A 20 percent increase in rainfall intensity has also been allowed for in the design. In localised areas where overland flow paths are not able to be provided, the underground drainage network will be designed to have 1% AEP capacity. A duplicate 1% AEP capacity network will also be provided in these localised areas to account for the potential impact of blockage. This satisfies the requirements of QUDM, which stipulates that 100 percent blockage should be considered in severe events.

5. Flood Levels

The flood levels that have been used to define the minimum floor levels for the Stage 1 area are taken from the *Cornmeal Creek Flood Study* (Cardno, 2013), and are summarised below. They are based on *Planning Scheme Policy No.15: Maroochydore Principal Activity Centre Structure Plan*:

- 1% AEP Storm Surge level of RL 2.5m AHD + 819mm allowance for Mean Sea Level rise, i.e. RL 3.32m AHD. This is inclusive of 400mm of freeboard.
- 1% AEP Flood Level, including allowances for Climate Change (in 2100) + 400mm freeboard for residential, commercial and industrial buildings = RL 3.07m AHD. This is based on the 1% AEP climate change flood level in Maud Canal of RL 2.67m AHD.

The minimum floor level for the development within Stage 1 is therefore RL 3.32m AHD. However, to be consistent with future stages of the MCC development, **a minimum floor level of RL 3.5m AHD has been adopted.**

STORMWATER QUALITY

1. Summary

As part of Stage 1 works it is necessary to demonstrate that the stormwater quality objectives for the site, for this stage of works, can be achieved.

The overall stormwater quality strategy for the site is to use a combination of stormwater harvesting for irrigation, centralised treatment of upstream catchments entering the site and localised treatment of internal catchments. At Dalton Drive, approximately 291 hectares of urbanised area drains to the existing waterbody on the southern side of Dalton Drive and into Dalton Lake located within the site. By treating and reusing this water, significant reductions in pollutant loads can be achieved. As a weir at RL 1.4m AHD will ultimately be installed downstream of Dalton Drive this section of the lake will always contain freshwater. It is therefore suitable for use as irrigation water. The benefits of treating this external inflow and using it for stormwater harvesting include:

- Pollutant loads entering the Dalton Lake will be reduced, which will decrease the risk of algal blooms within the lake.
- Stormwater will be reused for irrigation, reducing the potable water demand of the site. It is proposed to use stormwater to irrigate open space areas proposed within Stage 3 works. The estimated irrigation demand for this area is 23 ML/year.
- By targeting external stormwater pollutant loads, less reduction of internal pollutant loads is required in order to meet the stormwater pollutant load reduction targets. This will allow for more flexibility within the urban design.

The stormwater treatment measures being considered within the public realm areas of the site include:

- Litter baskets in stormwater field inlets.

- End of line gross pollutant traps (GPTs) for areas where the installation of litter baskets is problematic.
- Porous pavement where suitable.
- Bio-retention street trees.
- Passively irrigated landscape areas.
- Bio-retention gardens or swales where suitable, such as in the median strip.
- Floating wetlands within the lake.

Litter baskets target the removal of gross pollutants, sediment, oil and grease. They also remove the nutrient load that is associated with these pollutants. Litter baskets are considered to be the most suitable method of removing gross pollutants within Stage 1. As the internal stormwater drainage network will be permanently backwatered from tidal inflows from Maud Canal, the design of an in-ground GPT would need to take these conditions into consideration for operation and maintenance. Due to the future infrastructure requirements for light rail, the area that is available for the installation of an in-ground GPT is limited at the downstream end of some of the stormwater drainage lines.

Litter baskets are able to be cleaned in-situ by vacuum hose attached to vacuum street sweeper trucks. They do not require confined space entry. As the litter baskets store the captured pollutants above standing water level, they reduce the potential breakdown of captured organic material. This reduces the potential for odour issues and the leaching of pollutants.

The design of the internal stormwater drainage will ensure that sufficient overflow capacity is provided if the litter basket is full.

2. Stage 1 Works

Stormwater harvesting is not proposed to commence during Stage 1 works. In order to meet the stormwater pollutant removal targets for this stage it is proposed to:

- Improve the treatment provided by the existing waterbody around Dalton Drive by installing floating wetlands. Installation of floating wetlands in this area would not require any modification during future stages. As a weir at RL 1.4m AHD will ultimately be installed downstream of Dalton Drive, this waterbody will always contain freshwater. Floating wetlands are currently being tested on local urban developments by the University of the Sunshine Coast.
- Provide litter baskets on all field inlets within the public realm.

Although not included in the MUSIC modelling (so as to allow flexibility within the landscape design), the following stormwater treatment measures will also be considered within Stage 1:

- Porous pavement where suitable.
- Passively irrigated trees and landscape areas.

Internal lots within Stage 1 will be responsible for providing their own stormwater treatment. It is expected that this will be provided via a combination of rainwater or stormwater harvesting (for example passive irrigation of vertical gardens) and proprietary treatment devices.

3. Stage 1 MUSIC Modelling

The Stage 1 works were modelled using MUSIC Version 6.10. The Stage 1 MUSIC source nodes included:

- Stage 1 Roads – 6.8 hectares, 80% impervious Commercial Road
- Stage 1 Open Space - 1.75 hectares, 60% impervious Commercial Road
- External Urban Catchment - 291 hectares, 50% impervious Urban

No stormwater harvesting was assumed for this stage of the works. The internal lots within Stage 1 were also not included in the modelling.

Typical stormwater treatment MUSIC nodes were used for the analysis. The treatment assumed for the litter baskets was 40 percent removal of Total Suspended Solids (TSS), 20 percent removal of Total Nitrogen (TN) and Total Phosphorus (TP) and 100 percent removal of Gross Pollutants (GP). Based on reported removal efficiencies from manufacturers, these removal rates are considered conservative. A high flow bypass of 11L/s for each litter basket was assumed, with one litter basket provided for every 0.25 hectares of catchment area. This was a conservative assumption as the preliminary number of litter baskets required is around 120.

As the existing waterbody provides treatment similar to a pond, this treatment node was included in the base case. The pond was modelled as having a 2.5ha surface area, storage volume of 50ML and extended detention depth of 0.3 metres. Only treatment in addition to that already provided by the pond would therefore be included in the developed case. The floating wetland was modelled as a wetland with a 50ML inlet pond. The storage surface area was conservatively modelled as the actual proposed area of floating macrophytes. The treatment efficiency of floating wetlands should be significantly greater due to the increased biological surface area in contact with water.

The treatment efficiency of floating wetlands is currently being tested. Once this testing is completed, specific MUSIC nodes will be made available from which the required treatment area can be verified. Using standard wetland treatment nodes it was found that floating wetland of 100m^2, coupled with the litter baskets could provide enough treatment to meet all of the stormwater quality pollutant reduction targets. However, preliminary site investigations have determined that a wetland area of around 300m^2 would be required to target all inflow points in the waterbody. It is therefore recommended that this larger area be installed during Stage 1 works. The installation of a solar powered recirculation pump is also recommended for the downstream section of the waterbody. The establishment time for floating wetlands is 6 to 12 months. The preliminary locations for the floating wetlands are attached.

If the litter baskets are not installed, then sufficient treatment is provided by the floating wetland for all pollutants with the exception of gross pollutants. Therefore the assumed treatment efficiency of litter baskets for the removal of TSS, TP and TN does not need to be relied upon in order to meet the pollutant reduction targets for Stage 1.

The MUSIC results are summarised in Table 1 below. The third column shows the pollutant loads relating to Stage 1 public realm areas. The fifth column shows the pollutant load removal targets for Stage 1 public realm areas. As shown by the last columns, as external loads are also being treated, more than 100 percent of Stage 1 pollutant loads are being removed for TSS and TP.

Table 1 Stage 1 MUSIC Model Results

Pollutant	Pollutant Load (kg/yr)		Total Pollutant Load After Treatment (kg/yr)	Pollutant Removal Required for Stage 1 (kg/yr)	Total Pollutant Removal Achieved Without Litter Baskets (kg/yr)	Total Pollutant Removal Achieved With Litter Baskets (kg/yr)
	External Catchment (After Pond Treatment)	Stage 1 Public Realm Areas (No Treatment)				
Total Suspended Solids	328000	**42300**	222500	**33840 (80%)**	133000 (>100%)	147800 (>100%)
Total Phosphorous	774	**72.3**	655	**43 (60%)**	179 (>100%)	191 (>100%)
Total Nitrogen	5130	**338**	5188	**152 (45%)**	220 (65%)	280 (83%)
Gross Pollutants	23.8	**2410**	114	**2169 (90%)**	0 (0%)	2319 (96%)

4. Future Stages

The treatment efficiency of the floating wetlands is currently being tested by the University of the Sunshine Coast. Preliminary results show that observed removal rates are significantly higher than those provided by standard wetland MUSIC nodes, which were adopted for this analysis. Using the specific MUSIC nodes that will be created as part of this work, the treatment provided for Stage 1 will be able to be verified.

If floating wetlands are found to be efficient, then they should be adopted for future stages. Additional floating wetlands could be installed in the existing waterbody as well as within areas of the proposed Dalton Lake. These floating wetlands would need to be planted with different vegetation that was able to tolerate brackish conditions. They would be positioned near stormwater culvert inlets into the lake. The depths of the lake in these areas would be limited to 1.6 metres, so that the treatment provided by the floating wetlands was maximised. An added benefit of having floating wetlands installed on the culvert inlets is that some treatment will also be provided for the lake re-circulation water that will be pumped into the lake. The floating wetlands will also provide for some fish habitat areas.

The expanded use of floating wetlands would remove the requirement to construct a wetland and bio-retention treatment system in the parkland area within Stage 3 works. If the floating wetlands are found not to be sufficiently effective, then a wetland and bio-retention treatment system within the Stage 3 parkland area will be required. This will need to be sized to also compensate for Stage 1 works.

The waterbody will also be used for stormwater harvesting, with the intake located upstream of the weir proposed to the north of Dalton Drive. The water used for irrigation will therefore be freshwater.

The waterbody has an area of 2.5 hectares, and a minimum level of RL -10m AHD. Preliminary water balance modelling in MUSIC was conducted using 50 years of daily rainfall data. This demonstrated that if a maximum drawdown of 300mm was allowed, then the waterbody could provide around 98 percent of the irrigation demand of 23 ML/year, which is the approximate irrigation demand for Stage 3. Therefore there is potential to use this waterbody to provide for additional non-potable demands. A reliability of around 87 percent can be achieved for a demand of 100 ML/year.

Additional preliminary MUSIC modelling has been conducted to take into account all future development of public realm areas, including Stage 1 works. The additional MUSIC nodes included:

- Stage 2 Entertainment Facility – 3.4 hectares, 100% impervious Commercial Roof
- Stage 3 Open Space – 5.3 hectares, 20% impervious, Commercial Ground
- Stage 3 Roads – 1.8 hectares, 80% impervious, Commercial Road
- Future Open Space – 1.3 hectares, 20% impervious Urban Ground
- Future Roads – 7.5 hectares, 80% impervious, Urban Road

Runoff from all areas, with the exception of open space, was assumed to be treated via litter baskets on all field inlets. For the purposes of MUSIC modelling, each litter basket was assumed to treat 0.25 hectares. The open space areas were assumed to be treated by grassed swales. The storage surface area of the wetland was increased and a re-use of 23ML/year was assumed.

The results of MUSIC modelling found that pollutant removal targets could be achieved if:

- The floating wetland area for external catchment treatment is maintained as per Stage 1 requirements.
- Floating wetland area of at least 200m^2 is provided within Dalton Lake near culvert inlets into the lake.
- Stormwater harvesting is used to irrigate Stage 3 open space, i.e. 23 ML/year.
- Litter baskets are installed on all field inlets.

It should be noted that although not included in the MUSIC modelling, additional stormwater treatment will be provided within public realm areas, as outlined in Section 1.

The results of the MUSIC modelling are summarised in Table 2. The removal targets are achieved for all pollutants with the proposed stormwater treatment strategy in place.

Table 2 Future Stages Preliminary MUSIC Model Results

Pollutant	Pollutant Load IN (kg/yr)		Total Pollutant Load After Treatment (kg/yr)	Pollutant Removal Required for All Public Realm Areas (kg/yr)	Pollutant Removal Achieved (kg/yr)
	External Catchment (After Pond Treatment)	All Public Realm Areas (No Treatment)			
Total Suspended Solids	326000	**100000**	255500	**80000 (80%)**	170500 (>100%)
Total Phosphorous	777	**184**	738	**110 (60%)**	228 (>100%)
Total Nitrogen	5130	**933**	5595	**420 (45%)**	468 (50%)
Gross Pollutants	23.8	**6960**	113.8	**6264 (90%)**	6870 (99%)

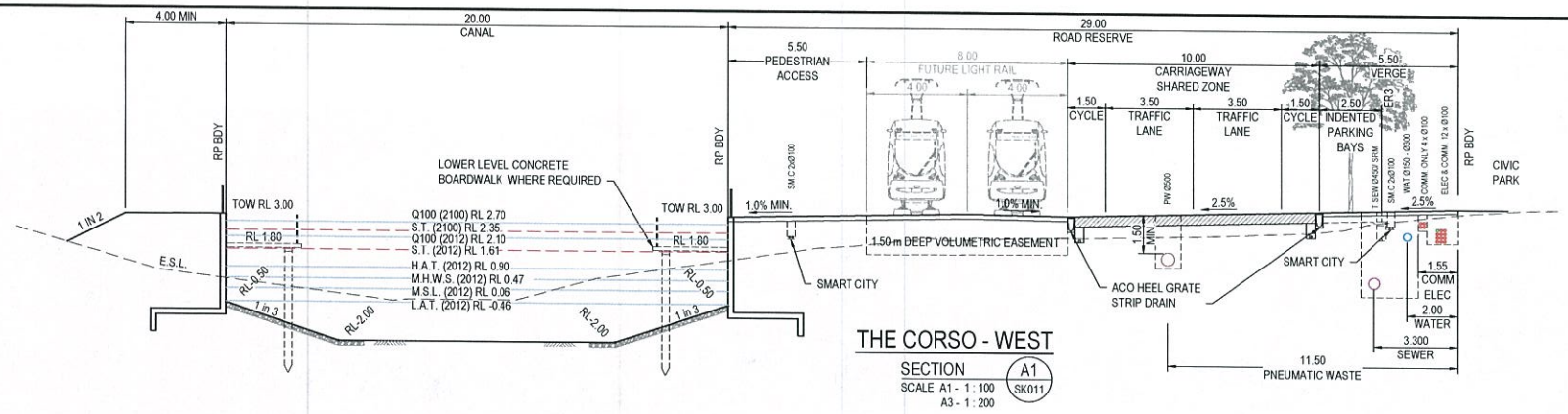
It should be noted that additional MUSIC modelling will be completed for future stages to verify the required floating wetland areas, once a specific MUSIC node becomes available.

There is potential to further increase the removal of stormwater pollutants from the public realm. This could be achieved through:

- Increased stormwater harvesting for non-potable uses throughout the site.
- Increased floating wetlands installed in the upstream waterbody.
- Rainwater harvesting for toilet flushing for the Entertainment and Convention Centre.
- Inclusion in MUSIC of the treatment that will be provided by landscape stormwater treatment measures.

5. Treatment of Internal Lots

It has been assumed that internal lots for Stage 1 and all future stages will be responsible for providing their own stormwater treatment. It is expected that this will be provided via a combination of rainwater or stormwater harvesting and proprietary treatment devices.



THE CORSO - WEST

SECTION A1 (SK011)

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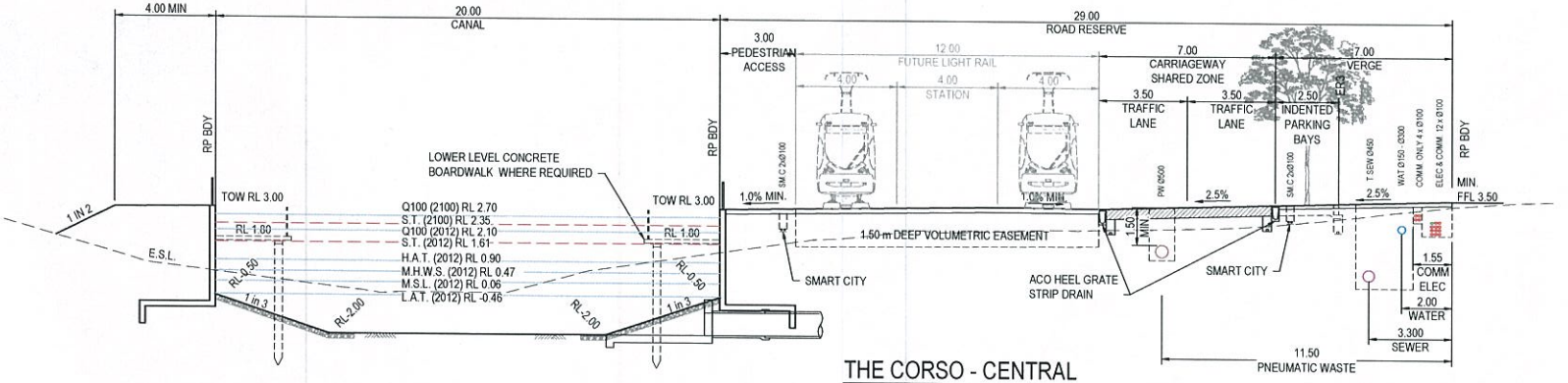
A3 - 1 : 200



THE CORSO - CENTRAL

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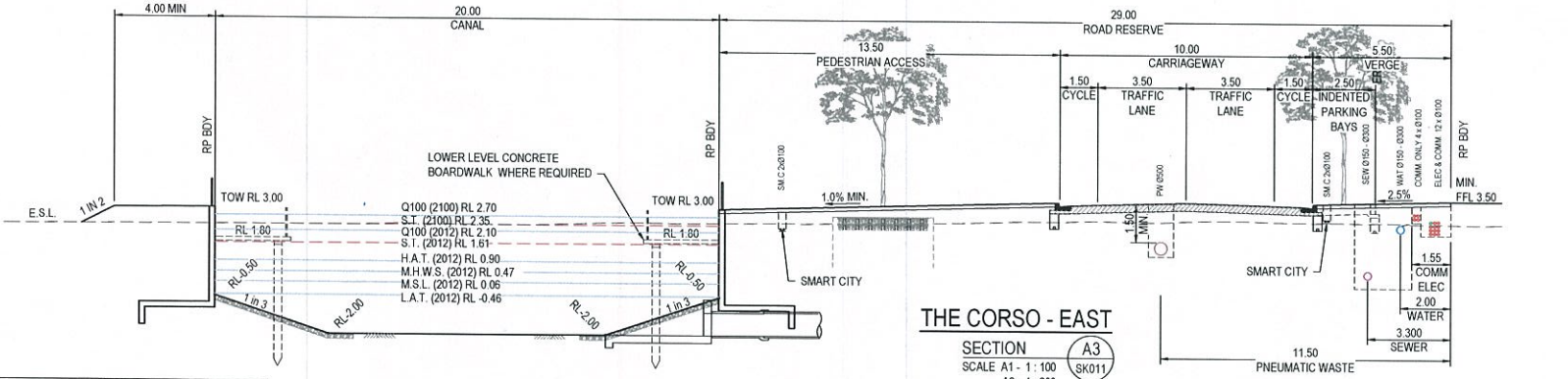

THE CORSO - EAST

SECTION A3 (SK011)

SCALE A1 - 1 : 100
A3 - 1 : 200

TYPICAL CROSS SECTIONS

SCALE A1 - 1 : 100
A3 - 1 : 200

1 0 1 2 3 4 5m

Scale 1:100

LEGEND	
TIDE	DESCRIPTION
S.T.	STORM TIDE
H.A.T.	HIGHEST ASTRONOMICAL TIDE
M.H.W.S.	MEAN HIGH WATER SPRINGS
M.S.L.	MEAN SEA LEVEL
S.W.L.	STANDING WATER LEVEL
L.A.T.	LOWEST ASTRONOMICAL TIDE

WORK IN PROGRESS
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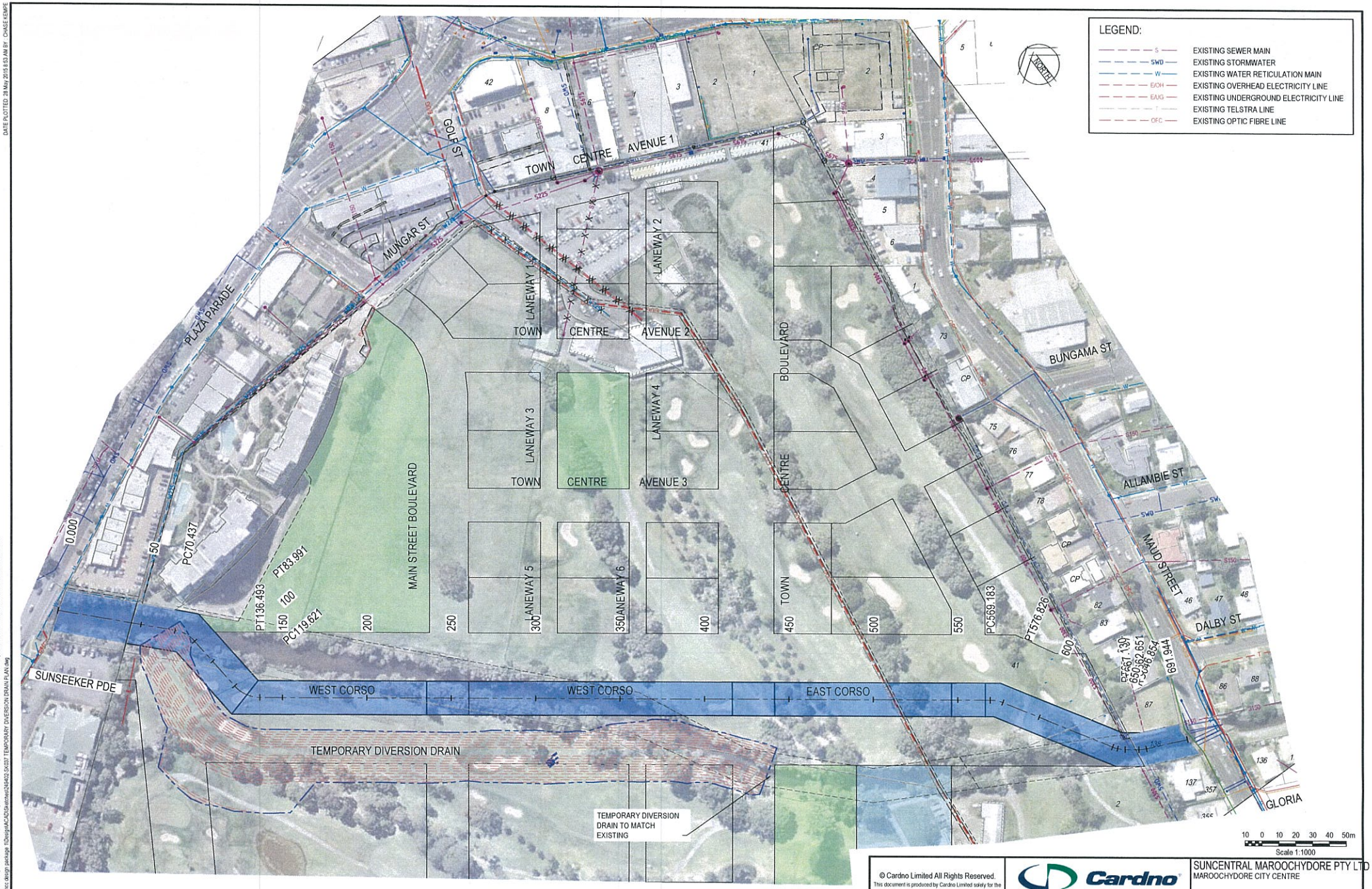
MAROOCHYDORE CITY CENTRE

ROADWORKS TYPICAL SECTIONS - SHEET 1

DATUM	Date	Scale	Size
AHD	22/07/2015	AS SHOWN	A1

Drawing Number: 249402-SK012
Revision: -



PLAN
SCALE A1 - 1 : 1000
A3 - 1 : 2000

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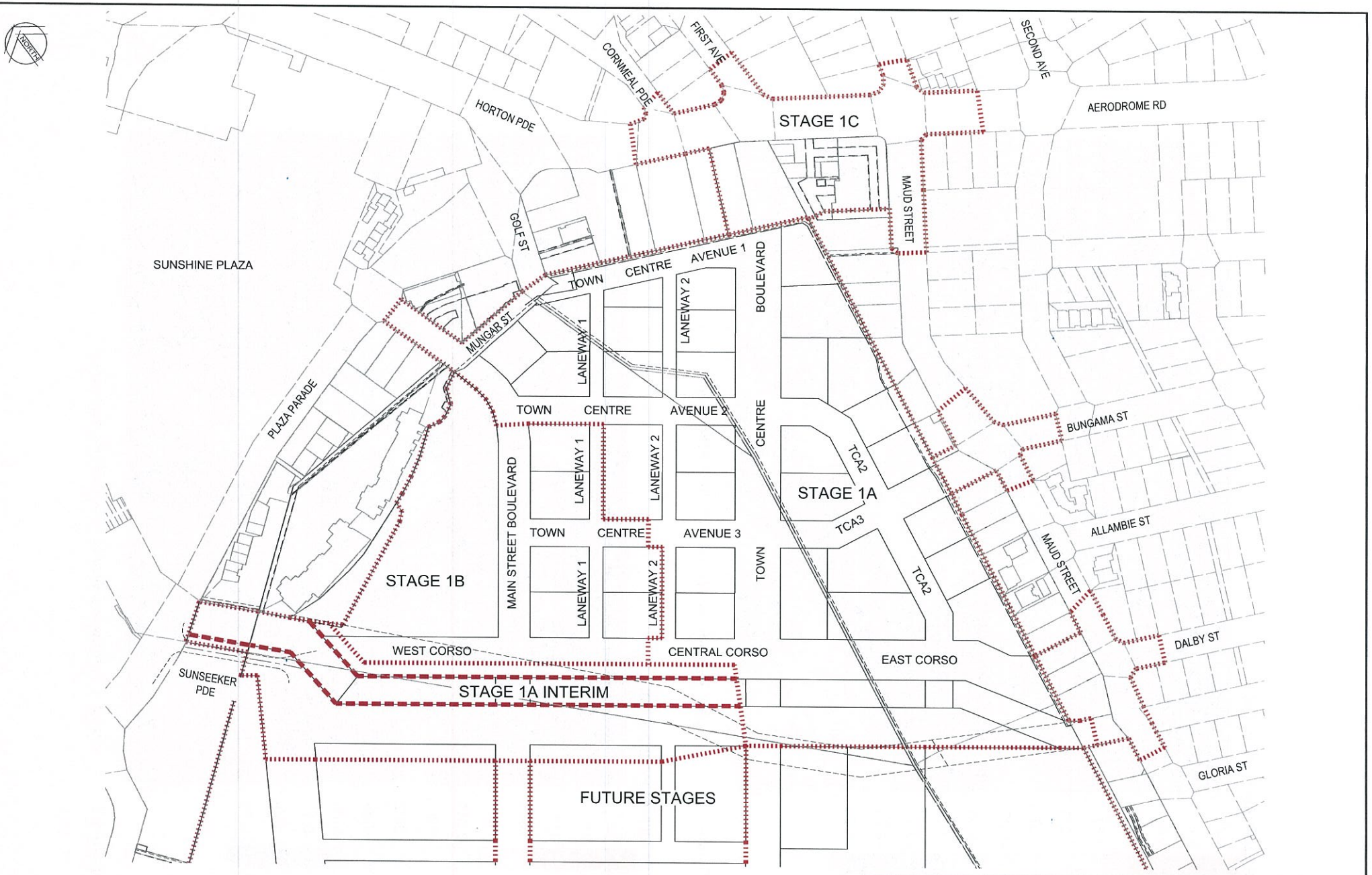
TEMPORARY DIVERSION DRAIN PLAN

DATUM	Date	Scale	Size
AHD	28/05/2015	AS SHOWN	A1

Drawing Number: 249402-SKSK037
Revision: -



LEGEND:

STAGE BOUNDARY

PLAN

SCALE A1 - 1 : 1250
A3 - 1 : 2500

12.5 0 12.5 25 37.5 50 62.5m
Scale 1:1250

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STAGING PLAN

DATUM	Date	Scale	Size
AHD	29/07/2015	AS SHOWN	A1

Drawing Number: 249402-SK150
Revision: 1

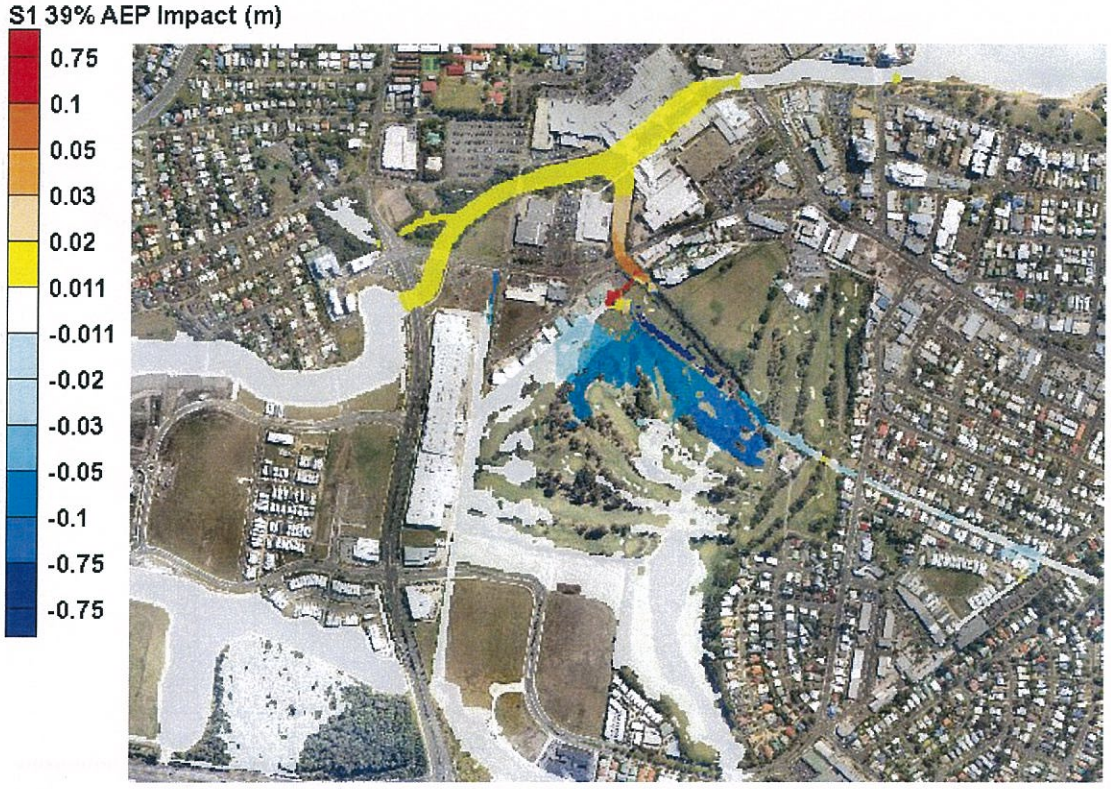


Figure 1 Stage 1 Temporary Works 39% AEP Flood Impact

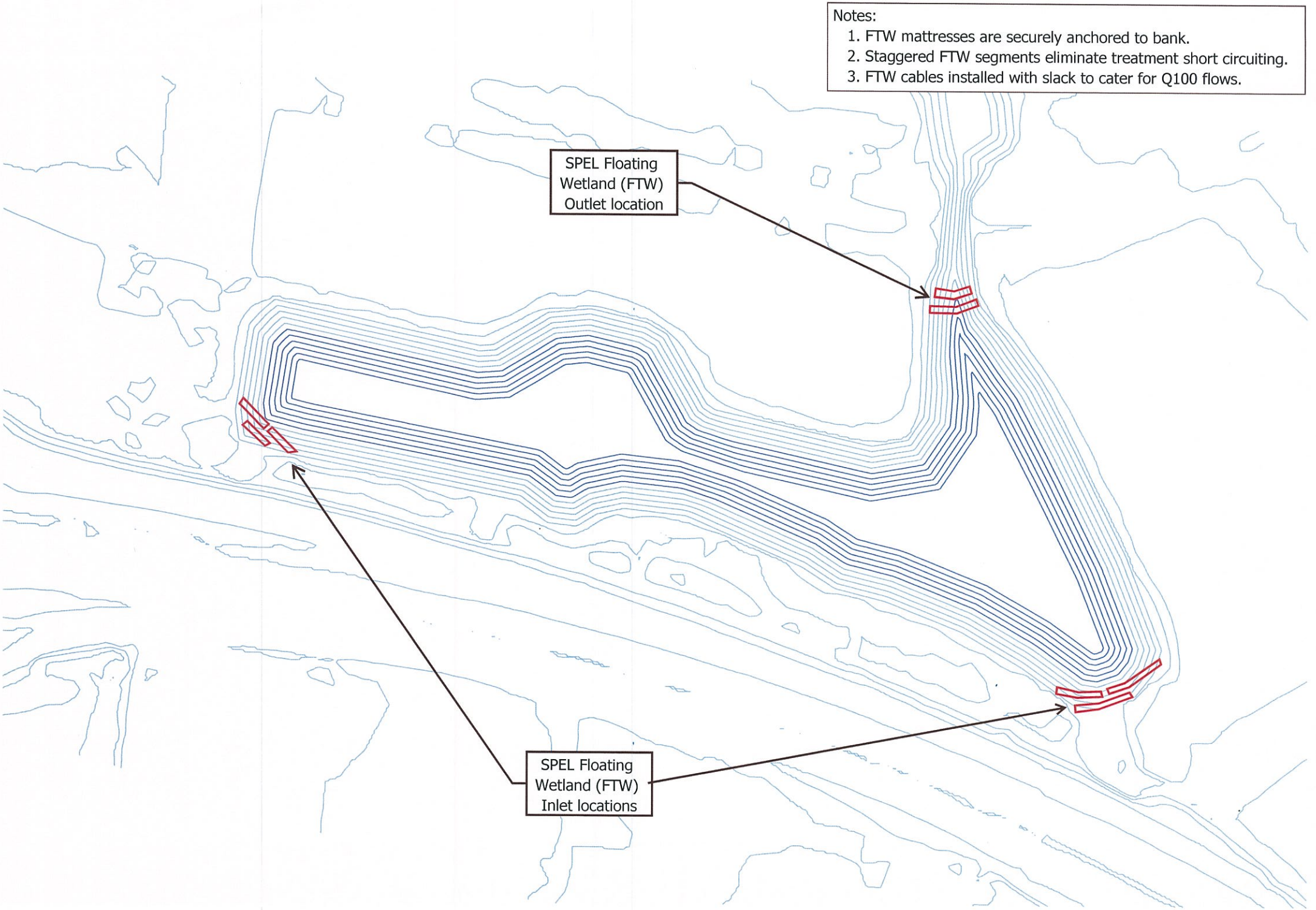
Figure 2 Stage 1 Temporary Works 18% AEP Flood Impact

Figure 3 Stage 1 Temporary Works 10% AEP Flood Impact

Figure 4 Stage 1 Temporary Works 5% AEP Flood Impact

Figure 5 Stage 1 Temporary Works 2% AEP Flood Impact

Figure 6 Stage 1 Temporary Works 1% AEP Flood Impact


Notes:
1. FTW mattresses are securely anchored to bank.
2. Staggered FTW segments eliminate treatment short circuiting.
3. FTW cables installed with slack to cater for Q100 flows.
SPEL Floating Wetland (FTW) Outlet location
SPEL Floating Wetland (FTW) Inlet locations