BUNGENDORE FLOOD RISK MANAGEMENT IMPLEMENTATION PLAN

DESIGN REPORT

REPORT NUMBER: ISR18157

DECEMBER 2018

Report Number: ISR18157

Document Control

Issue / Revision	Author	Reviewer	Approved for Issue	
			Name	Date
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Cover Image: Turallo Terrace Levee, Bungendore--

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Foreword

Public Works Advisory (PWA) has been commissioned by Queanbeyan-Palerang Regional Council to undertake the investigation of flooding issues and concept design of mitigation works for Bungendore in light of managing existing, future and residual risks in the Study Area.

PWA has extensive experience and knowledge in complex and challenging flood process evaluations and design of effective flood mitigation works in consideration of social, ecological and economic factors relating to flood risks.

Executive summary

This report presents the detailed design of flood mitigation works for Bungendore Flood Risk Management Implementation Plan. The project is being prepared for Queanbeyan-Palerang Regional Council in order to manage existing, future and residual flood risks in the Study Area.

The primary objective of the New South Wales Government's Flood Prone Land Policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods, utilising ecologically positive methods wherever possible. Queanbeyan-Palerang Regional Council is obligated to comply with the New South Wales Government's Flood Prone Land Policy. The *Floodplain Development Manual: the management of flood liable land* (NSW Government 2005) is provided to assist councils to meet their obligations through the preparation of floodplain risk management plans. The Manual also documents the process for plan preparation, implementation and review.

Following the completion of Bungendore Floodplain Risk Management Study(FRMS) and Floodplain Risk Management Plan (FRMP), Council has identified three Flood Modification Measures recommended for further investigation and design, those being:

- Removal of dense vegetation and creek re-shaping at the confluence of Turallo, Halfway and Millpost Creeks (referred to as Measure 1 in the FRMP).
- Upgrade of the existing Turallo Terrace levee (referred to as Measure 2 in the FRMP);
- Construction of an overflow channel across Tarago Road (referred to as Measure 3 in the FRMP),

These measures are part of the floodplain risk management strategy recommended for implementation in the Bungendore Floodplain Risk Management Plan. Following the recent completion of investigation and concept design of these measured, this project delivers developed detail design plans for implementation as the final phase of the process.

Detail design drawings showing the general layout and arrangement for the flood mitigation works are provided at **Appendix A**.

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Abbreviations

Abbreviation	Description
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ARR	Australian Rainfall and Runoff
BOM	Bureau of Meteorology
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation

1 Introduction

1.1 General

This report documents the main aspects associated with the investigations and design work for the Bungendore Floodplain Risk Management Implementation Plan project, up to completion of the detailed design phase. The design was commissioned by Queanbeyan-Palerang Regional Council and prepared by Public Works Advisory.

Where considered necessary investigation and design aspects presented in the 2012 Concept Design Report (Public Works 2018) have been referenced, repeated, updated and/or extended in this report.

The principal purpose of this study is developing detail design, which leads into the final key stage of the Floodplain Management process for Bungendore, the implementation of flood mitigation options.

The prime project objectives include:

- Removal of dense vegetation and creek re-shaping at the confluence of Turallo, Halfway and Millpost Creeks (Measure 1);
- Upgrade of the existing Turallo Terrace levee (Measure 2);
- Construction of an overflow channel across Tarago Road (Measure 3).

1.2 Background & Study Area

Bungendore is located approximately 27 km north-east of Queanbeyan, in the Southern Tablelands Region of New South Wales, within the QPRC Local Government Area. All the investigations for the preferred Flood Mitigation Option have been undertaken within the locations of the three identified Flood Modification Measures which are as follows:

- The confluence of the Turallo and Halfway Creeks;
- Along the existing Turallo Terrace Levee;
- Along the proposed alignment of overflow channel, including the Tarago Road crossing.

1.2.1 Measure 1

This flood mitigation measure includes the removal of vegetation at the confluence of Turallo and Halfway Creeks and the reshaping of the creeks, which would enhance the capacity for floodwaters to escape more rapidly from the village reach of Turallo Creek. Excavation of overbank areas at the confluence would provide additional capacity when floodwaters exceed the channel capacity.

1.2.2 Measure 2

This flood mitigation measure includes upgrade of the existing Turallo Terrace levee to increase crest elevations above the peak 1% AEP flood level with 0.5 m freeboard. In the initial 120 m of the alignment, the natural surface levels are generally above flood levels, apart from a minor (approximately 15 m long) section between the railway and Turallo Terrace, where the levee bank upgrade was not proposed, following the Council's request.

Between Chainage 140 m to Chainage 280 m, the levee bank is located within private properties (No. 56 to 64 Turallo Terrace). The levee bank heights have been estimated to be about 0.8 m to

1.2 m, with crest levels in the order of RL 691.8 m to RL692.4 m. The crest and batters are typically grassed, with minor bare surface area where an access track traverses the levee bank (No. 60 property's backyard). Furthermore, there is a newly built fence along the levee crest within the grounds of the Bungendore Pre-school (No. 62-64).

At approximate Ch 280 m, the levee bank exits the private properties and generally runs parallel to the rear property fence lines up to Ch 590 m. Between Ch 280 m and Ch 540 m, the levee bank heights have been estimated to be about 0.7 m to 1.0 m, with crest levels in the order of RL 691.1 m to RL 691.8 m. From Ch 540 m, the levee bank heights gradually increase from 0.9 m to approximately 2.2 m near Ch 580 m, with crest levels in order of RL 691.3 to RL 692 m. In the remaining part of this section, between approximate chainages Ch 580 m and Ch 680 m, the natural surface levels are above design flood levels.

The levee batters are well grassed while the crest is typically sparsely grassed up to Ch 350 m and then becomes a bare surface where the levee bank is used as an access track. There are some ruts/depressions along the levee crest between Ch 350 m and Ch 590 m, where water can pond. These are interpreted to have been caused by vehicular traffic when the subgrade was softened.

There are lines of mature trees located on the inner and outer levee batters between approximate Ch 400 m and Ch 450 m. There are also other occasional individual trees along this section, a pedestrian footpath at approximate Ch 355 m and a drainage pipe at approximate Ch 550 m.

Between Chainage 720 m to Chainage 840 m the proposed levee alignment crosses a drainage channel. The existing channel bank heights are in the order of 3.6 m and 2.8 m, with the channel bed at RL 687.9 m and top of the banks at RL 691.5 m (eastern bank) and RL 690.7 m (western). The batters of the channel are steep to very steep (in order of 18° to 25°) and vegetated.

After the channel crossing, the existing levee bank (Chainage 720 m to Chainage 840 m) follows the Council's property fence line and exits just before its terminating point at the Molonglo Street Bridge abutment. The existing levee crest levels are in the order of RL 690.7 m to RL 691.3 m. The levee bank heights have been estimated to be similar for the majority of the alignment at about 1m or less. However, the topography descends towards the creek and therefore, the overall heights of the levee bank and natural slope are well in excess of 1 m. Along this section, the existing levee crest and batters are generally grassed with occasional mature trees on the inner (creek side) batter of the levee bank.

1.2.3 Measure 3

This measure, as a relief floodway, allows floodwaters to bypass the Tarrago Road bridge crossing of the creek during major events. The higher flows will be diverted across Tarago Road upstream of the bridge crossing so that they will re-enter the creek downstream of the confluence of Turallo and Halfway Creeks.

Generally, the channel is to be located within relatively flat paddocks to the north and north-east of the confluence of the Turallo and Halfway Creeks. The paddocks are separated by the Tarago Road. The paddock to the east of the road crossing is relatively flat and typically sparsely

grassed. The creek's bank and the western property fence are lined with occasional or stands of mature trees.

The paddock to the west of the road crossing is grassed and is also relatively flat, with a slightly elevated section between Ch 260 m and Ch 270 m. There are occasional mature trees immediately after the road crossing and along the creek's bank. The initial straight alignment of the proposed channel, as proposed in the Flood Risk Management Study, had been revised through this area following the property owner's objection that the channel should not be located through the middle of his paddock and preferably moved south towards the property's boundary.

1.3 Scope of Works

Public Works Advisory has carried out the detailed design and documentation for the project.

The design engagement involves the development and refinement of the concept design prepared in October 2018 into detailed design drawings and contract documentation for the implementation of flood mitigation works in Bungendore to meet current engineering standards.

1.4 Detail Design Drawings

Engineering drawings which show the key features, dimensions and extent of the Works are provided at Appendix A. The Drawings presented in this report are listed below.

Table 1-1 - Drawing List for Design Report (Appendix A)

Drawing No.	Drawing Title
C0000	Cover Sheet and Drawing Schedule
C0001	Drawing Schedule & Site Locality Plan
C0010	Overall Layout Plan
LEVEE	
C1001	Levee General Arrangement
C1101	Levee Longitudinal Section Sheet 1 of 3
C1102	Levee Longitudinal Section Sheet 2 of 3
C1103	Levee Longitudinal Section Sheet 3 of 3
C1104	Typical Levee Sections
C1201	Levee Design Cross Sections Sheet 1 of 3
C1202	Levee Design Cross Sections Sheet 2 of 3
C1203	Levee Design Cross Sections Sheet 3 of 3
C1210	Levee Retaining Wall General Arrangement Plan & Elevation
C1211	Typical Levee Retaining Wall Sections
C1220	Levee Culvert Plan & Longitudinal Section
C1221	Levee Culvert Elevation
CHANNEL	
C1301	Channel General Arrangement Plan & Longitudinal Section Sheet 1 of 2
C1302	Channel General Arrangement Plan & Longitudinal Section Sheet 2 of 2
C1303	Typical Channel Sections
C1311	Culvert Details Sheet 1 of 3
C1312	Culvert Details Sheet 2 of 3

Drawing No.	Drawing Title
C1313	Culvert Details Sheet 3 of 3
C1401	Channel Design Cross Sections Sheet 1 of 2
C1402	Channel Design Cross Sections Sheet 2 of 2
CONFLUENCE	
C1501	River Confluence Excavation General Arrangement Plan & Longitudinal Sections
C1502	Typical Confluence Cut Sections
C1601	River Confluence Excavation 1 Design Cross Sections
C1602	River Confluence Excavation 2 Design Cross Sections

2 Data Review & Supplementary Investigations

2.1 Review of Relevant Studies & Existing Digital Flood Models

The two current and most important studies considered relevant to this project have been reviewed and they are listed below:

- *Bungendore Floodplain Risk Management Study (*Worley Parsons, December 2014);
- *Bungendore Floodplain Risk Management Plan (*Worley Parsons, December 2014).

A summary of the hydrologic and hydraulics models used in the relevant flood studies is presented in **Table 2-1**.

Table 2-1: **Summary of previous flood models**

Catchment	Report	Model (Hydrologic / Hydraulic)
Bungendore (Flood Study)	Patterson Britton & Partners, 2002	XP_RAFTS RMA-2 2D model
Bungendore (Floodplain Risk Management Study & Plan)	Worley Parsons, 2014	XP_RAFTS Updated RMA-2 2D model

As part of the floodplain risk management study, the 2D RMA-2 hydrodynamic model developed as part of 'Bungendore Flood Study' (2002) by Patterson Britton & Partners was updated to incorporate topographic data acquired since 2002. The model was also updated to ensure it reflected current catchment conditions such as recent development of the floodplain and updates to hydraulic control structures.

The original XP_RAFTS hydrologic model that had been developed for the 2002 flood study was used as the basis for the updated RMA-2 model inflows.

All the flood modelling results for the three measures of the preferred Floodplain Risk Management option have been reviewed using the WaterRIDE package and utilised in the further investigation and modelling for the project.

2.2 Available Data

For the purpose of engineering assessment of the proposed Floodplain Risk Management option, PWA have been provided with the additional data by Council including:

- Additional topographic data and site survey plans and aerial photography;
- Location of existing underground and overhead services;
- Location and dimensions of drainage assets;
- Work As Executed (WAE) Tarrago Road Bridge Design Drawings including long section of the Tarrago Road centreline;
- Optic fibre location surveyed by QPRC in November 2018.

2.3 Channel Realignment

Following up on the updated Council's information regarding optic fibre location along the south fence adjacent to the proposed overflow channel and request for realigning the channel to avoid both the optic fibre and the existing electrical pole, the channel alignment was revised during the detail design phase.

2.4 PWA Geotechnical Investigation

A Geotechnical Investigation Report has been prepared by Public Works Advisory on behalf of Queanbeyan-Palerang Regional Council (Report Number ISR 17030).

This section of the report presents a summary of the conclusions identified in the Geotechnical Investigation Report for the Bungendore Flood Risk Management Plan Implementation project.

2.4.1 Measure 1 - Clearing and creek re-shaping at the confluence

Summary and Discussions

Within the Confluence 1 area, the depths of cuts will vary from negligible to up to approximately 3 m. The deeper cuts appear to be confined to the northern bank of Turallo Creek meander. Within the Confluence 2 area, the depths of cuts will vary from approximately 0.8 m to 1.9 m.

Generally, the drilling has revealed that excavations to the design invert levels will encounter a variety of alluvial sediments dominated by silty sands and sandy silts with varying clay contents and locally, silty and sandy clays. The sediments, due to high silt and fine sand contents, low plasticity properties and dispersive characteristics, are potentially highly erosive.

Excavations within alluvial sediments should readily be achievable by equipment such as hydraulic excavators using conventional earth moving.

2.4.2 Measure 2 - Upgrade of existing Turallo Terrace Levee

Summary and Discussions

Visual inspection of the existing levee banks did not detect any slope stability issues nor any batter erosion, with the levee bank batters being well vegetated.

The investigation revealed that dominantly the levee bank was constructed using imported fill materials, as evidenced by the presence of quartz and rock fragments and matrix containing higher clay contents than in-situ alluvial sediments. Generally, the permeability characteristics of the embankment fill are assessed to be in a practically impervious category. The levee bank fill, based on visual assessment and SPT test data, is assessed to be an engineered fill. This is supported by the performance of the banks during a number of flood events.

In conclusion, the existing levee bank can be incorporated into the proposed raised embankment. The new embankment fill may be placed directly onto the existing banks subject to the following subgrade preparation:

- Strip all unsuitable material from the crest and batters. This includes grass root affected fill;
- In areas where the fill is to be placed on the natural subgrade, topsoil and root affected materials should be stripped for the full depth. Following stripping, the subgrade should be

inspected for consistency. Any soft spots detected should be excavated out for a depth of at least 400 mm and replaced with engineered fill. The stripped subgrade should be scarified to a depth of 150 mm - 200 mm; moisture conditioned to within 2% of modified optimum moisture content and re-compacted to a minimum modified dry density ratio of 93%.

Investigation of proposed deviations of the levee alignment were not part of this geotechnical investigation and therefore, no boreholes were scheduled in these two areas. Nonetheless, the following general comments are provided based on current borehole data.

For the deviation around the private properties, the levee will comprise an earthen bank with a concrete retaining wall section where there is limited room between the property fence line and the creek. The other deviation will comprise an earthen bank.

The foundation conditions at both locations are not known; however, the subsurface profiles are likely to comprise alluvial sandy clayey silts overlying sands with varying concentrations of silt and locally, with some gravel. The alluvium is expected to be of stiff consistency. For the earthen banks it is envisaged that the foundation preparation will comprise stripping the topsoil, inspecting the subgrade for consistency and proof-rolling by typically 4-6 passes of a smooth drum roller (say,10 tonne static weight). Similar minimum treatment would be required for the concrete retaining wall section; however, for the detail design stage it is recommended that additional detail design investigation be carried to determine the foundation conditions and the extent of any subgrade treatment for the retaining wall designs.

The embankment fill for the proposed raising of the levee banks will be sourced from the excavations required for the new overflow channel and supplemented by materials stripped from the creek re-shaping at the confluence of the Turallo and Halfway Creeks.

Representative samples of the in-situ sediments were selected and tested from the proposed channel alignment and confluence re-shaping locations. The testing was carried out on two major soil groupings of sandy silts with varying clay contents, which were encountered in the upper parts of the profile, and sands, with varying contents of fines and locally gravel, which occur in the lower parts of the profiles.

The surficial deposits of dark grey brown to dark grey sandy silt with some clay, to an average depth of 0.5 m, are not considered to be suitable for use as engineered fill in the raising of the existing levee banks. The materials may be stockpiled for subsequent re-use as topsoil. The surficial sand deposits, encountered to a depth of 0.5 m in BH12, should also be stripped and put to spoil.

The mottled fine-grained alluvium underlying the surficial deposits may be considered for use as engineered fill. The sediments are dominantly slightly clayey sandy silts of low to medium plasticity (CL and CI), with lesser silty clays of medium or high plasticity (CI or CH) and clayey silty sands (SC).

The relatively clean gravelly sands and silty sands, which were encountered typically below 2m depth, are not considered to be suitable for raising the levee banks; consequently, careful borrow area management will be required to exclude these materials from the finer grained alluvium.

As indicated above, the clayey sandy silts are potentially highly erosive and all batters should be suitably top-soiled and grassed. The fill should be placed in loose layers not exceeding 150mm and compacted to a minimum modified dry density ratio of 95% at a moisture content in the range of 2% dry to 1% wet of the modified optimum moisture content.

2.4.3 Measure 3 - Overflow Channel

Summary and Discussions

The investigation revealed that the channel alignment is located within thick deposits of alluvial sediments which can be broadly grouped into fine grained cohesive and coarse-grained alluvium. Overall, there is potential for bed and toe scour erosion. Furthermore, during periods of inclement weather, the cut batters are expected to be subjected to rutting erosion due to rainfall runoff. To prevent formation of runnels and progressive slope degradation suitable remedial slope protection measures need to be provided. As a minimum, depending on flood velocities, the cut batters should be grassed.

The founding strata along the alignment of the culverts are expected to change from coarse grained sediments to fine grained sediments. For either strata, an allowable bearing pressure of 200 kPa may be adopted in design. However, the foundation conditions should be assessed at the time of construction to ascertain any need for foundation improvement. As a minimum, the subgrade should be proof-rolled by typically 4-6 passes of a smooth drum roller (10 tonne static weight). Any soft spots detected should be excavated out for a minimum depth of 400 mm and replaced with engineered fill. Nonetheless, to provide a uniform subgrade, consideration should be given to over-excavate the sediments for a depth of at least 400 mm and replace the sediments with road base type material.

Excavations to design invert level will be within alluvial sediments and should readily be achievable using conventional earth moving equipment such as hydraulic excavators.

2.5 PWA Environmental Investigation

The Review of Environmental Factors (REF) has been prepared by Public Works Advisory on behalf of Queanbeyan-Palerang Regional Council and is reported separately. This chapter presents only a summary of the conclusions identified in the Bungendore FRM Works REF, Report No. ISR18046.

The proposed flood management measures form an integral part of the FRM plan developed to provide an increased level of protection to Bungendore from damage due to flooding from future flood events. The proposal would potentially cause short term impacts such as increased noise and traffic and a reduction in community amenity for the nearby residents and users of local streets during the construction phase. However, these impacts are considered to be minor and temporary.

There would be a need to remove some vegetation for the proposed works. However, the proposal would be unlikely to significantly affect any listed threatened species, fauna populations or communities, provided appropriate mitigation measures are implemented.

An ACHAR of the proposal has identified two Aboriginal sites and has concluded that an AHIP from OEH will be required for the proposed overflow channel works.

No significant impacts to historic heritage are anticipated associated with the proposed works.

Bungendore FRM Works REF has been prepared in accordance with Sections 5.5 and 5.7 of the Environmental Planning and Assessment Act 1979 and Clause 228 of the Environmental Planning and Assessment Regulation 2000. It provides a true and fair assessment of the proposed activity in relation to its likely effects on the environment.

On the basis of the information presented in this REF it is concluded that:

(1) The proposed activity is not likely to have a significant impact on the environment and therefore an Environmental Impact Statement is not required;

(2) The proposed activity is not likely to significantly affect threatened species, populations, ecological communities, or critical habitat. Therefore, a Species Impact Statement (SIS) is not required;

(3) The proposed activity is not likely to affect any Commonwealth land, is not being carried out on Commonwealth land, or significantly affect any Matters of National Environmental Significance.

The proposed activity is recommended for approval subject to implementation of the measures to avoid, minimise or manage environmental impacts listed in the Bungendore FRM Works REF. For details refer to Report No. ISR18046.

3 12d Modelling & Detail Design

3.1 General

The “detail design of this project, as required by the project scope, is based on the concept design adopted by Council and the results indicated in the Flood Risk Management Study and Plan. The previous modelling results are assumed final to the satisfaction of Council and no further 2D hydraulic modelling has been undertaken to confirm the previously modelled flood characteristics.

The three-dimensional ground survey and hydraulic model were integrated with the 12d Model, where the recommended flood modification works were further assessed, modelled and optimised including alternative alignments for the proposed levee and overflow channel measures.

Further development of a 12d model has resulted in economic sizing of the proposed mitigation works which do not impact on existing services.

Utilising the 12d Model, PWA has delivered Detail Design Drawings, documenting the full extent of works including cadastral information and services. Modelling of the three proposed measures are detailed in the Sections below.

3.2 Measure 1 - Clearing and creek re-shaping at the confluence

12d software has been used for 3D modelling of clearing extent, re-shaping works and volumes at the confluence of Turallo and Halfway Creeks. The proposed locations of the creek’s confluence re-shaping are shown on **Figure 3-1**.

Generally, within the confluence of the two creeks, the work is divided into two sections, namely the northern side (Confluence 1) which encompasses the northern and eastern banks (meander) of the Turallo Creek and the western side/bank of Halfway Creek (Confluence 2). Confluence 1 is approximately 110 m in length while Confluence 2 is approximately 85 m in length.

The northern re-shaping area is located within a grassed paddock with some occasional shrubs and trees. The ground is relatively flat with typical slope of less than 5% towards the creek bank. The creek’s bank batter is heavily overgrown with blackberry bush, weeds and grasses.

The western re-shaping area is located within a terraced slope/creek bank. The accessible section of the area comprises a grassed and relatively flat paddock. The rest of the area (towards the creek) is moderately vegetated with trees and shrubs.

Re-shaping will involve stripping of all vegetation and re-grading the creeks banks. Within the Confluence 1 area, the depths of cuts will vary from negligible to up to approximately 3 m. The deeper cuts appear to be confined to the northern bank of Turallo Creek meander. Within the Confluence 2 area, the depths of cuts will vary from approximately 0.8 m to 1.9 m. Refer to **Figure 3-1**.

Considering the subsurface geotechnical profiles of the excavated areas and high velocities (almost 2 m/s within the Confluence 1 area) and to prevent future erosion of the excavated areas, 200 mm thick reinforced grass cover on top of the creek banks and 300 mm thick appropriate riprap layer along the creek bed, are proposed.

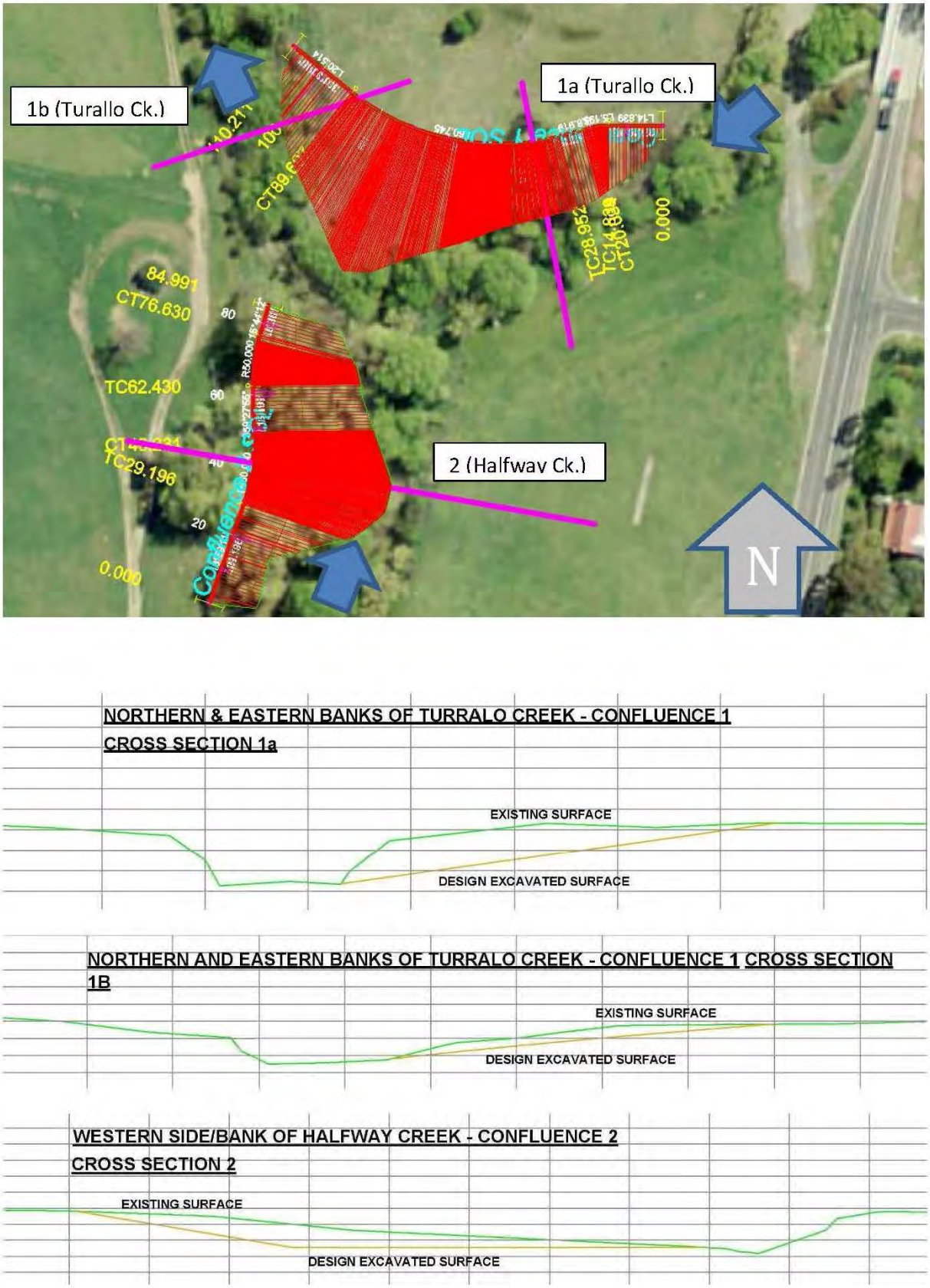

Figure 3-1 Clearing and creek's confluence re-shaping sketch (plan and sections)

For the detail design layout, typical sections and details of the proposed clearing and creek's confluence re-shaping option refer to Drawings C1501, C1502, C1601 and C1702.

3.3 Measure2 - Upgrade of existing Turallo Terrace Levee

3.3.1 Proposed Levee

12d software has been used for 3D modelling of the raised levee to increase crest elevations above the peak 1% AEP flood level with 0.5 m freeboard.

The proposed levee bank is approximately 840 m in length, commencing at the railway embankment (Ch 0 m) on the western side of Turallo Terrace and terminating at the bridge abutment in Molonglo Street (Ch 840.41 m).

The levee upgrade detail design drawings indicate a typical crest width of about 3 m with outer batter (properties side) of 1(V) : 3(H) and inner batter (creek's side) of 1(V) : 4(H). The proposed crest design level gradually reduces from RL 693.4 m (Ch 0 m) to RL 691 m (Ch 840 m).

The proposed levee bank upgrade will follow the existing levee alignment; however, there are sections of the levee where realignments were being considered. These are where the existing levee bank is located within private properties (approximate Ch 120 m to Ch 280 m) and where significant mature trees are located on the levee batters (approximate Ch 400 m to Ch4 50 m).

For the deviation around the private properties, the levee will comprise an earthen bank with a concrete retaining wall section where there is limited room between the property fence line and the creek. Following up on the survey results from the private properties owners and the community consultation meeting on 16 August 2018, the following amendments had been carried out to the proposed levee alignment adjacent to the private properties:

- the levee crest to be wholly outside the existing fence line;
- the 'town side' batter to be reduced from 1(V):3(H) to 1(V):4(H) where it is within the cadastral boundaries.

After Council had confirmed the revised levee/retaining wall realignment, this option was modelled further and progressed to the detail design. For retaining wall detail design refer to Drawings C1210 and C1211.

The alternative deviation of the existing levee alignment, where significant mature trees are located on the levee batters, comprises an earthen bank and this had been modelled for the detail design.

Where the proposed levee alignment crosses a drainage channel, flood gates with twin DN1200 stormwater pipes have been proposed. For culvert detail design refer to Drawings C1220 and C1221.

For the detail design layout, typical sections and details of the proposed levee option refer to Drawings C1001, C1101, C1102, C1103, C1104, C1201 C1202, C1203, C1210, C1211, C1220 and C1221.

3.4 Measure 3 - Overflow Channel

12d software has been used for 3D modelling of the proposed overflow channel to the 1% AEP design flood event. The trigger level for the diversion channel activation is the invert of the channel at RL 687.88.

The proposed grass lined channel will have a trapezoidal cross section, 4.5m wide floor and with cut batters of 1 (vertical) to 3 (horizontal). The proposed overflow channel passes under the existing Tarrago Road, where a culvert structure of twin culverts DN 2100 x 1500, 34 m long, has been proposed. The culvert structure has a critical impact on the channel design. The proposed invert level of the concrete box culverts will be at RL 687.4 m which means that the culverts will be founded approximately 2.5 m below existing surface levels. For the detail culvert design refer to Drawings C1311, C1312 and C1313.

Considering the existing surface levels, the batter offset from the channel centreline will locally reach 14 m (Ch 320 m). The excavation depths to the proposed invert levels of the channel floor are typically in the order of 2.3 m to 2.8 m between Ch 40 m and Ch 240 m, and approximately 3.4 m to 4.2 m between Ch 250 m and Ch 320 m.

For the detail design layout, typical sections and details of the proposed overflow channel option refer to Drawings C1301, C1302, C1303, C1311, C1312, C1313, C1401 and C1402.

3.4.1 Overflow Channel Hydraulic Modelling

HEC-RAS hydraulic software has been used for 1D hydraulic modelling to examine the channel's maximum hydraulic catering capacity and to enable design of a typical cross-section of the proposed channel and culvert structure across Tarago Road. Modelling methodology and results were presented in the PWA Concept Report (Report Number ISR18124).

For the purpose of detail design and confirming the velocities along the channel, further hydraulic modelling of the culverts using Culverts for Windows was undertaken. The modelling results showed maximum velocities around the culvert structure not exceeding 2 m/s just downstream of the culverts.

To prevent future erosion of the proposed channel and considering the subsurface geotechnical profiles of the excavated areas around both the intake and the offtake of the diversion channel out and back into the creek and the high velocities around the culverts, these areas will be reinforced with the appropriate riprap, detailed on the drawings.

4 Feasibility of the Preferred Flood Mitigation Option

4.1 General

Following the completion of Bungendore Floodplain Risk Management Study and Floodplain Risk Management Plan, Council identified the three Flood Modification Measures recommended for further investigation and design, which are as follows:

- Removal of dense vegetation and creek re-shaping at the confluence of the Turallo and Halfway Creeks (Measure 1);
- Upgrade of the existing Turallo Terrace levee (Measure 2);
- Construction of an overflow channel across Tarago Road (Measure 3).

The measures are part of the floodplain risk management strategy recommended for implementation, as the most cost-effective solution that will result in a reduction in existing flood damages in Bungendore.

This section details further review and investigation of the recommended flood mitigation works, addressing the following critical issues before delivering detail design plans for implementation:

- The design and any anticipated or proposed construction techniques have been focussed to minimise the risk of damage to environmentally sensitive areas including trees of significance, and any other infrastructure or services. Any required interfaces between such areas and proposed new works have been documented;
- The design has been undertaken in conjunction and with regards to the findings of the geotechnical and environmental investigations. This has been carefully coordinated not only to produce a quality design but also for the design to be completed efficiently without the need for an excessive rework.

4.2 Construction

The following provides a summary of the likely construction activities.

4.2.1 Construction Activities

Site Establishment:

- Construction compound and laydown areas;
- A separate access to thy Vegetation Clearing and Creek's Confluence Re-shaping work area, to the Turallo Terrace Levee work area and the Channel Overflow work area. An access to the work areas shall occur within existing cleared paths where possible, although some trimming or clearing of vegetation may be required. The works should be undertaken in manner that minimises disturbance;
- Erosion and sediment controls, including in stream controls.

Confluence and Channelisation works:

- Vegetation removal to progressively move along the confluence and the channel;
- All noxious and exotic weeds would be appropriately managed and removed for off-site

disposal;

- All debris such as plastic bags, bottles, foam containers and other litter shall be removed;
- Rehabilitation of the confluence area and the channel bed and banks using suitably qualified and experienced bush regeneration contractors.

Levee works:

The embankment fill for the proposed raising of the levee banks will be sourced from the excavations required for the new overflow channel and supplemented by materials stripped from the creek re-shaping at the confluence of the Turallo and Halfway Creeks.

The levee would be dressed with topsoil certified as weed free.

Site dis-establishment:

- Removal of all construction equipment;
- General site clean-up.

4.2.2 Construction Equipment

The following construction equipment is likely to be required to undertake the works:

- Hydraulic excavator for vegetation clearing, works within the confluence and channel areas;
- Small trucks carrying construction materials;
- Large trucks to transport imported material and excavated material to and from the site;
- Concrete mixer for culverts foundation;
- Backhoe / excavator equipment to construct levee;
- Passenger vehicles to transport construction workers.

4.2.3 Construction Issues

Construction Environmental Management Plan

The proposed works would be undertaken in accordance with a Construction Environmental Management Plan (CEMP) prepared by the construction contractor and approved by Queanbeyan-Palerang Regional Council prior to the commencement of works.

The CEMP would incorporate site specific management plans and would reflect all the mitigation measures identified in the Bungendore Flood Risk Management Implementation Plan REF, additional mitigation measures identified as a result of the contractor's risk assessment and construction methodology and any conditions of the project determination and other licences/approvals.

Construction site layout

The contractor would establish a compound area to accommodate construction facilities for the duration of the construction period. The compound area would accommodate the following facilities:

- Site Office
- Materials and equipment storage area

- Toilets
- Fuel storage

Construction timeframe

The construction works are predicted to take up to six months.

Working hours

The *Interim Construction Noise Guidelines* (DECC 2009) outlines recommended standard construction working hours as:

Monday to Friday 7am to 6pm
Saturdays 8am to 1pm
No work on Sundays or public holidays.
The construction would comply with these recommended hours.

4.3 Operational Issues

Maintenance of Turallo and Halfway Creeks confluence area, the Turallo Terrace levee and the overflow channel areas would form part of Queanbeyan-Palerang Regional Council's overall maintenance program within the LGA and in accordance with current Vegetation Management Plan.

Ongoing management procedures would include:

- Annual removal of foreign material such as plastic bags, bottles, foam containers and other litter (does not include leaf litter, branches or logs);
- Weed control undertaken at frequencies specified by the Vegetation Management Plan by an experienced and qualified Bush Regeneration Contractor or Bush Regeneration Staff. Weed control would occur using standard bush regeneration techniques such as hand weeding or use of Glyphosate based herbicides;
- Slashing of indigenous herbland or reedland by qualified Bush Regeneration Contractor or Bush Regeneration Staff. Slashing would be undertaken after the species has flowered and set seed. No herbicide shall be used in association with slashing to allow indigenous species to regenerate from root stock, rhizomes or seed. Slashing would occur using hand operated mechanical equipment. Organic debris material would be removed from site.

5 Estimation of Capital Costs

Detailed cost break down for all the three flood mitigation management measures has been refined as part of the Detail Design Report and outlined in **Table 5-1**

Bungendore FRM Measure 1 – Clearing & Creek Reshaping at the confluence

Date: December 2018

Item No.	Description	Quantity	Unit	Rate	Amount	Sub-total
1	**SITE ESTABLISHMENT**					**$ 45,000**
	Site establishment & disestablishment	1	Item	Lump Sum	$ 10,000	
	ENVIRONMENTAL MANAGEMENT					
	Erosion & sedimentation control measures during construction	1	Item	Lump Sum	$ 10,000	
	OH&S procedures	1	Item	Lump Sum	$ 5,000	
	Stormwater diversion and flood protection during construction	1	Item	Lump Sum	$ 5,000	
	Vegetation management / protection of trees	1	Item	Lump Sum	$ 10,000	
	SITE PREPARATION					
	Survey and site pegging out of works	1	Item	Lump Sum	$ 5,000	
2	**ACCESS ROAD WORKS**					**$ 7,200**
	Temporary Access Road (100mm NGS40)	30	cu.m	$ 140.00	$ 4,200	
	Compact Roadway Subgrade	300	sq.m	$ 10.00	$ 3,000	
3	**CONFLUENCE CLEARING AND CREEK RESHAPING CONSTRUCTION WORKS**					**$606,153**
	Clear site vegetation and cart away	13,360	sq.m	$ 0.50	$ 6,680	
	Strip and stockpile 150mm topsoil	5,290	sq.m	$ 5.25	$ 27,773	
	Reduce levels along overbank areas-comfluence cutting, incl. disposal	4,377	cu.m	$ 19.10	$ 83,601	
	Compaction of banks and channel base	5290	sq.m	$ 20.00	$105,800	
	Landscaping - Incl. Spread Topsoil and revegetate Surface	5,290	sq.m	$ 20.00	$105,800	
	Supply, delivery and placement of 200 mm thick reinforced grass protection	4,950	cu.m	$ 30.00	$148,500	
	Supply, delivery and placement of Rip-Rap rockfill protection upstream and downstream of culverts	480	cu.m	$ 200.00	$ 96,000	
	Supply, delivery and install Bidim A34 Geotextile layers	1,600	sq.m	$ 20.00	$ 32,000	
	DIRECT COST					***$658,353***
	DETAILED DESIGN & CONTINGENCY					
	Project supervision		% of direct cost	10		***$ 65,853***
	SID		% of direct cost	15		***$ 98,753***

	Contingency		% of direct cost	20		***$131,671***
	GST		% of direct cost	10		***$ 65,835***
	TOTAL ESTIMATED COST					***$ 1,020,447***

Table 1-2 Bungendore FRM Measure 3 – Overflow Channel

Date: December 2018

Item No.	Description	Quantity	Unit	Rate	Amount	Sub-total
1	**SITE ESTABLISHMENT**					**$ 45,000**
	Site establishment & disestablishment	1	Item	Lump Sum	$ 10,000	
	ENVIRONMENTAL MANAGEMENT					
	Erosion & sedimentation control measures during construction	1	Item	Lump Sum	$ 10,000	
	OH&S procedures	1	Item	Lump Sum	$ 5,000	
	Stormwater diversion and flood protection during construction	1	Item	Lump Sum	$ 5,000	
	Vegetation management / protection of trees	1	Item	Lump Sum	$ 10,000	
	SITE PREPARATION					
	Survey and site pegging out of works	1	Item	Lump Sum	$ 5,000	
2	**ACCESS ROAD WORKS**					**$ 4,800**
	Temporary Access Road (100mm NGS40)	20	cu.m	$ 140.00	$ 2,800	
	Compact Roadway Subgrade	200	sq.m	$ 10.00	$ 2,000	
3	**CHANNEL CONSTRUCTION WORKS**					**$ 902,849**
	Clear site vegetation and cart away	7,661	sq.m	$ 0.50	$3,830	
	Strip and stockpile 150mm topsoil	7,661	sq.m	$ 5.25	$40,219	
	Channel & overbank excavation to required levels, incl. disposal	12,260	cu.m	$ 19.10	$174,001	
	Compaction of banks and channel base	7,661	sq.m	$ 20.00	$24,898	
	Landscaping - Incl. Spread Topsoil and revegetate Surface	7,661	sq.m	$ 20.00	$153,216	
	Supply, delivery and placement of Rip-Rap rockfill protection at the channel intake and offtake	144	cu.m	$ 200.00	$ 28,800	
	Supply, delivery and install Bidim A34 Geotextile layers	480	sq.m	$ 20.00	$ 9,600	
	Fence relocation	78	m	$ 20	$ 1,560	
	Property gate relocation	1	Item	Lump Sum	$ 2,000	
	Optus cable relocation	1	Item	Lump Sum	$ 20,000	
	CULVERTS					

	New DN2100 x DN1500 stomwater box culverts under Tarrago Road (approx.30 m)	2	Item	$187,000.00	$374,000	
	Cast in situ reinforced concrete outlet headwall	2	Item	$ 1,200.00	$ 2,400	
	Supply, delivery and placement of Rip-Rap rockfill protection upstream and downstream of culverts	34	cu.m	$ 200	$ 6,800	
	Supply, delivery and install Bidim A49 Geotextile layers	68	sq.m	$ 20	$ 1,360	
	DIRECT COST					***$ 652,649***
	DETAILED DESIGN & CONTINGENCY					
	Project supervision		% of direct cost	10		***$ 92,265***
	SID		% of direct cost	15		***$ 142,897***
	Contingency		% of direct cost	20		***$ 190,530***
	GST		% of direct cost	10		***$ 95,265***
	TOTAL ESTIMATED COST					***$1,476,606***

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Table 5-1 Bungendore FRM Measure 1 – Clearing & Creek Reshaping at the confluence

Date: December 2018

Item No.	Description	Quantity	Unit	Rate	Amount	Sub-total
1	**SITE ESTABLISHMENT**					**$ 45,000**
	Site establishment & disestablishment	1	Item	Lump Sum	$ 10,000	
	ENVIRONMENTAL MANAGEMENT					
	Erosion & sedimentation control measures during construction	1	Item	Lump Sum	$ 10,000	
	OH&S procedures	1	Item	Lump Sum	$ 5,000	
	Stormwater diversion and flood protection during construction	1	Item	Lump Sum	$ 5,000	
	Vegetation management / protection of trees	1	Item	Lump Sum	$ 10,000	
	SITE PREPARATION					
	Survey and site pegging out of works	1	Item	Lump Sum	$ 5,000	
2	**ACCESS ROAD WORKS**					**$ 7,200**
	Temporary Access Road (100mm NGS40)	30	cu.m	$ 140.00	$ 4,200	
	Compact Roadway Subgrade	300	sq.m	$ 10.00	$ 3,000	
3	**CONFLUENCE CLEARING AND CREEK RESHAPING CONSTRUCTION WORKS**					**$606,153**
	Clear site vegetation and cart away	13,360	sq.m	$ 0.50	$ 6,680	
	Strip and stockpile 150mm topsoil	5,290	sq.m	$ 5.25	$ 27,773	

	Reduce levels along overbank areas-comfluence cutting, incl. disposal	4,377	cu.m	$ 19.10	$ 83,601	
	Compaction of banks and channel base	5290	sq.m	$ 20.00	$105,800	
	Landscaping - Incl. Spread Topsoil and revegetate Surface	5,290	sq.m	$ 20.00	$105,800	
	Supply, delivery and placement of 200 mm thick reinforced grass protection	4,950	cu.m	$ 30.00	$148,500	
	Supply, delivery and placement of Rip-Rap rockfill protection upstream and downstream of culverts	480	cu.m	$ 200.00	$ 96,000	
	Supply, delivery and install Bidim A34 Geotextile layers	1,600	sq.m	$ 20.00	$ 32,000	
	DIRECT COST					***$658,353***
	DETAILED DESIGN & CONTINGENCY					
	Project supervision		% of direct cost	10		***$ 65,853***
	SID		% of direct cost	15		***$ 98,753***
	Contingency		% of direct cost	20		***$131,671***
	GST		% of direct cost	10		***$ 65,835***
	TOTAL ESTIMATED COST					***$ 1,020,447***

Table 1-2 Bungendore FRM Measure 3 – Overflow Channel

Date: December 2018

Item No.	Description	Quantity	Unit	Rate	Amount	Sub-total
1	**SITE ESTABLISHMENT**					**$ 45,000**
	Site establishment & disestablishment	1	Item	Lump Sum	$ 10,000	
	ENVIRONMENTAL MANAGEMENT					
	Erosion & sedimentation control measures during construction	1	Item	Lump Sum	$ 10,000	
	OH&S procedures	1	Item	Lump Sum	$ 5,000	
	Stormwater diversion and flood protection during construction	1	Item	Lump Sum	$ 5,000	
	Vegetation management / protection of trees	1	Item	Lump Sum	$ 10,000	
	SITE PREPARATION					
	Survey and site pegging out of works	1	Item	Lump Sum	$ 5,000	
2	**ACCESS ROAD WORKS**					**$ 4,800**
	Temporary Access Road (100mm NGS40)	20	cu.m	$ 140.00	$ 2,800	
	Compact Roadway Subgrade	200	sq.m	$ 10.00	$ 2,000	
3	**CHANNEL CONSTRUCTION WORKS**					**$ 902,849**
	Clear site vegetation and cart away	7,661	sq.m	$ 0.50	$3,830	

	Strip and stockpile 150mm topsoil	7,661	sq.m	$ 5.25	$40,219	
	Channel & overbank excavation to required levels, incl. disposal	12,260	cu.m	$ 19.10	$174,001	
	Compaction of banks and channel base	7,661	sq.m	$ 20.00	$24,898	
	Landscaping - Incl. Spread Topsoil and revegetate Surface	7,661	sq.m	$ 20.00	$153,216	
	Supply, delivery and placement of Rip-Rap rockfill protection at the channel intake and offtake	144	cu.m	$ 200.00	$ 28,800	
	Supply, delivery and install Bidim A34 Geotextile layers	480	sq.m	$ 20.00	$ 9,600	
	Fence relocation	78	m	$ 20	$ 1,560	
	Property gate relocation	1	Item	Lump Sum	$ 2,000	
	Optus cable relocation	1	Item	Lump Sum	$ 20,000	
	CULVERTS					
	New DN2100 x DN1500 stomwater box culverts under Tarrago Road (approx.30 m)	2	Item	$187,000.00	$374,000	
	Cast in situ reinforced concrete outlet headwall	2	Item	$ 1,200.00	$ 2,400	
	Supply, delivery and placement of Rip-Rap rockfill protection upstream and downstream of culverts	34	cu.m	$ 200	$ 6,800	
	Supply, delivery and install Bidim A49 Geotextile layers	68	sq.m	$ 20	$ 1,360	
	DIRECT COST					***$ 652,649***
	DETAILED DESIGN & CONTINGENCY					
	Project supervision		% of direct cost	10		***$ 92,265***
	SID		% of direct cost	15		***$ 142,897***
	Contingency		% of direct cost	20		***$ 190,530***
	GST		% of direct cost	10		***$ 95,265***
	TOTAL ESTIMATED COST					***$1,476,606***

Table 1-3 Bungendore FRM Measure 2 – Levee

Date: December 2018

Item No.	Description	Quantity	Unit	Rate	Amount	Sub-total
1	**SITE ESTABLISHMENT**					**$ 45,000**
	Site establishment & disestablishment	1	Item	Lump Sum	$ 15,000	
	ENVIRONMENTAL MANAGEMENT					
	Erosion & sedimentation control measures during construction	1	Item	Lump Sum	$ 10,000	

	OH&S procedures	1	Item	Lump Sum	$ 5,000	
	Stormwater diversion and flood protection during construction	1	Item	Lump Sum	$ 5,000	
	Vegetation management / protection of trees	1	Item	Lump Sum	$ 10,000	
	SITE PREPARATION					
	Survey and site pegging out of works	1	Item	Lump Sum	$ 5,000	
2	**ACCESS ROAD WORKS**					**$ 4,800**
	Temporary Access Road (100mm NGS40)	20	cu.m	$ 140.00	$ 2,800	
	Compact Roadway Subgrade	200	sq.m	$ 10.00	$ 2,000	
3	**LEVEE CONSTRUCTION WORKS**					**$ 612,253**
	Clear site vegetation and cart away	9350	sq.m	$ 1.00	$ 4,675	
	Strip and stockpile 150mm topsoil for foundation and compact	9350	sq.m	$ 5.00	$ 49,088	
3a	**New Levee**					
	Excavate cutoff trench (3 m wide and 0.5 m deep)	427	cu.m	$ 15.00	$ 6,405	
	Construction of embankment from engineering fill material (approx. 280 m long, 1.8 m high, 1:3 and 1:4) incl. stockpile, trim and grade	4565	cu.m	$ 20.00	$ 91,300	
	Landscaping - Incl. Spread Topsoil and revegetate Surface	3562	sq.m	$ 20.00	$ 71,240	
	Construction of 3 m wide crest of DGB20, including geotextile	840	sq.m	$ 25.00	$ 21,000	
	Construction of v-drain from the town side (0.8 m x 0.1 m)	240	m	$ 3.00	$ 720	
	Reinforced concrete retaining Wall 69 m long	61	cu.m	$ 2,200.00	$ 134,200	
3b	**Raised Levee**					
	Construction of embankment from engineering fill material (approx. 443 m long, 1.4 m high, 1:3 and 1:4) incl. stockpile, trim and grade	5145	cu.m	$ 20.00	$ 102,900	
	Landscaping - Incl. Spread Topsoil and revegetate Surface	5314	sq.m	$ 20.00	$ 106,280	
	Construction of 3 m wide crest of DGB20, including geotextile	1329	sq.m	$ 25.00	$ 33,225	
	Construction of v-drain from the town side (0.8 m x 0.1 m)	740	m	$ 3.00	$ 2,220	
4	**DRAINAGE WORKS**					**$ 257,060**
	New DN1200 stromwater culverts under the levee including installation	2	No.	$ 108,000.00	$ 216,000	
	Cast in situ reinforced concrete outlet headwall	2	No.	$ 5,000.00	$ 10,000	
4a	**New Culvert Floodgates Accessories**					
	Supply, delivery and install Gabion wall cages	2	No.	$ 50.00	$ 100	
	Supply, delivery and placement of Gabion and Rip-Rap rockfill	3.6	cu.m	$ 200.00	$ 720	

	Supply, delivery and install Bidim A49 Geotextile layers	12	sq.m	$ 20.00	$ 240	
	New 1200DN Culvert Floodgates (supply, delivery and install top sealing penstock gate valves)	2	No.	$ 14,000.00	$ 28,000	
	DIRECT COST					***$ 933,113***
	DETAILED DESIGN & CONTINGENCY					
	Project supervision		% of direct cost	10		***$ 93,311***
	SID		% of direct cost	15		***$ 139,967***
	Contingency		% of direct cost	20		***$ 186,623***
	GST		% of direct cost	10		***$ 93,311***
	TOTAL ESTIMATED COST					***$1,446,324***

6 Conclusions and Recommendations

Detail design drawings showing layout, typical sections and details of the three proposed flood mitigation measures are provided at **Appendix A**.

It is considered that the design is sufficiently developed such that the tendering and construction phases of the project may commence subject to the design presented in this report meeting Council's requirements.

The design investigations indicate that there are no engineering factors which will impede the Bungendore Flood Mitigation Works. It is not expected that there will be any major environmental impediments to the project, however environmental assessments are required.

7 References

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Worley Parsons, *Bungendore Floodplain Risk Management Study Report*, December 2014

Worley Parsons, *Bungendore Floodplain Risk Management Plan Report*, December 2014

NSW Public Works Advisory, *Bungendore Floodplain Risk Management Plan Implementation-Geotechnical Investigation*, February 2018 (Report Number ISR 17030)

NSW Public Works Advisory, *Bungendore Floodplain Risk Management Plan Implementation-REF*, April 2018 (Report No. ISR18046)

NSW Public Works Advisory, *Bungendore Floodplain Risk Management Plan Implementation-Concept Design Report*, October 2018 (Report No. ISR18124)

Appendix A Detail Design Drawings

BUNGENDORE FLOOD MITIGATION WORKS
DETAILED DESIGN DRAWINGS (DRAFT)

LEVEE RAISING, NEW CHANNEL &
RIVER CONFLUENCE EXCAVATION AND CLEARING WORKS

PREPARED FOR

QPRC

DECEMBER 2018

DRAFT ONLY - ISSUED FOR REVIEW

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DRAWING SCHEDULE

DRAWING NO.	DRAWING TITLE
C0000	COVER SHEET
C0001	DRAWING SCHEDULE AND SITE LOCALITY PLANS
C0010	OVERALL LAYOUT PLAN
LEVEE	
C1001	LEVEE GENERAL ARRANGEMENT PLAN
C1101	LEVEE LONGITUDINAL SECTION SHEET 1 OF 3
C1102	LEVEE LONGITUDINAL SECTION SHEET 2 OF 3
C1103	LEVEE LONGITUDINAL SECTION SHEET 3 OF 3
C1104	TYPICAL LEVEE SECTIONS
C1201	LEVEE DESIGN CROSS SECTIONS SHEET 1 OF 3
C1202	LEVEE DESIGN CROSS SECTIONS SHEET 2 OF 3
C1203	LEVEE DESIGN CROSS SECTIONS SHEET 3 OF 3
C1210	LEVEE RETAINING WALL GENERAL ARRANGEMENT PLAN AND ELEVATION
C1211	TYPICAL LEVEE RETAINING WALL SECTIONS
C1220	LEVEE CULVERT PLAN AND LONGITUDINAL SECTION
C1221	LEVEE CULVERT ELEVATION
CHANNEL	
C1301	CHANNEL GENERAL ARRANGEMENT PLAN AND LONGITUDINAL SECTION - SHEET 1 OF 2
C1302	CHANNEL GENERAL ARRANGEMENT PLAN AND LONGITUDINAL SECTION - SHEET 2 OF 2
C1303	TYPICAL CHANNEL SECTIONS
C1311	CHANNEL CULVERT DETAILS SHEET 1 OF 3
C1312	CHANNEL CULVERT DETAILS SHEET 2 OF 3
C1313	CHANNEL CULVERT DETAILS SHEET 2 OF 3
C1401	CHANNEL DESIGN CROSS SECTIONS SHEET 1 OF 2
C1402	CHANNEL DESIGN CROSS SECTIONS SHEET 2 OF 2
CONFLUENCE	
C1313	CHANNEL CULVERT DETAILS SHEET 2 OF 3
C1401	CHANNEL DESIGN CROSS SECTIONS SHEET 1 OF 2
C1402	CHANNEL DESIGN CROSS SECTIONS SHEET 2 OF 2
C1501	RIVER CONFLUENCE EXCAVATION AND CLEARING GENERAL ARRANGEMENT PLAN AND LONGITUDINAL SECTIONS
C1502	TYPICAL CONFLUENCE CUT SECTIONS
C1601	RIVER CONFLUENCE EXCAVATION 1 DESIGN CROSS SECTIONS
C1602	RIVER CONFLUENCE EXCAVATION 2 DESIGN CROSS SECTIONS

SOURCE: GOOGLE MAPS 2018

STATE LOCALITY PLAN

LOCATION IN BUNGENDORE

DRAFT ONLY - ISSUED FOR REVIEW

ISS.	DATE	AMENDMENT / REVISION DETAILS
0	11/12/2018	DRAFT FOR REVIEW

1. NSW Public Works Advisory, a division of the Department of Finance, Services and Innovation (the Department) shall not be liable or responsible for any loss or damage arising out of the conversion of any electronic document, data or program to any other format or medium, or arising out of any modification or changes that occur in the handling or use of the electronic document, data or program.
2. The recipient or user of any electronic document, data or program is solely responsible for ascertaining its accuracy and its suitability for their purposes.
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DRAFTED T. PERUSCO
CHECKED S. CVETKOVIC
SENIOR ENGINEER G. SAMIOS

QUEANBEYAN-PALERANG REGIONAL COUNCIL
BUNGENDORE FLOOD MITIGATION WORKS
DETAILED DESIGN DRAWINGS

DRAWING SCHEDULE AND SITE LOCALITY PLANS

CONTRACT NO. T.B.C.
SCALE @ A1 N.T.S.
CADD ID. -
DRAWING NO. **C0001**
REV. 0
A1

CONFIRM SCALE 100mm ON ORIGINAL

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PLOT BY: Peruscot
PLOT DATE: 11/12/2018
PLOT TIME: 3:57:46 PM

OVERALL LAYOUT PLAN

SCALE 1:1500

1:1500 0 30 60 90 120 180m
20 10

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ISS.	DATE	AMENDMENT / REVISION DETAILS
0	11/12/2018	DRAFT FOR REVIEW

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QPRC

NSW GOVERNMENT Public Works Advisory

DESIGNED S. CVETKOVIC
DRAFTED T. PERUSCO
CHECKED S. CVETKOVIC
SENIOR ENGINEER G. SAMIOS

QUEANBEYAN-PALERANG REGIONAL COUNCIL
BUNGENDORE FLOOD MITIGATION WORKS
DETAILED DESIGN DRAWINGS

OVERALL LAYOUT PLAN

CONTRACT NO. T.B.C.
A1
SCALE @ A1 1:1500
CADD ID. -
DRAWING NO. **C0001**
REV. 0

CONFIRM SCALE 100mm ON ORIGINAL

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PLOT BY: Perusco
PLOT DATE: 11/12/2018
PLOT TIME: 3:38:02 PM

LEVEE - GENERAL ARRANGEMENT PLAN

SCALE 1:1000

1:1000 0 20 40 60 80 100m
20 10

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SENIOR ENGINEER G. SAMIOS

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BUNGENDORE FLOOD MITIGATION WORKS
DETAILED DESIGN DRAWINGS

LEVEE GENERAL ARRANGEMENT PLAN

CONTRACT NO. T.B.C.
SCALE @ A1 1:1000
CADD ID. -
DRAWING NO. **C1001**
REV. 0
A1

CONFIRM SCALE 100mm ON ORIGINAL

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PLOT DATE: 11/12/2018
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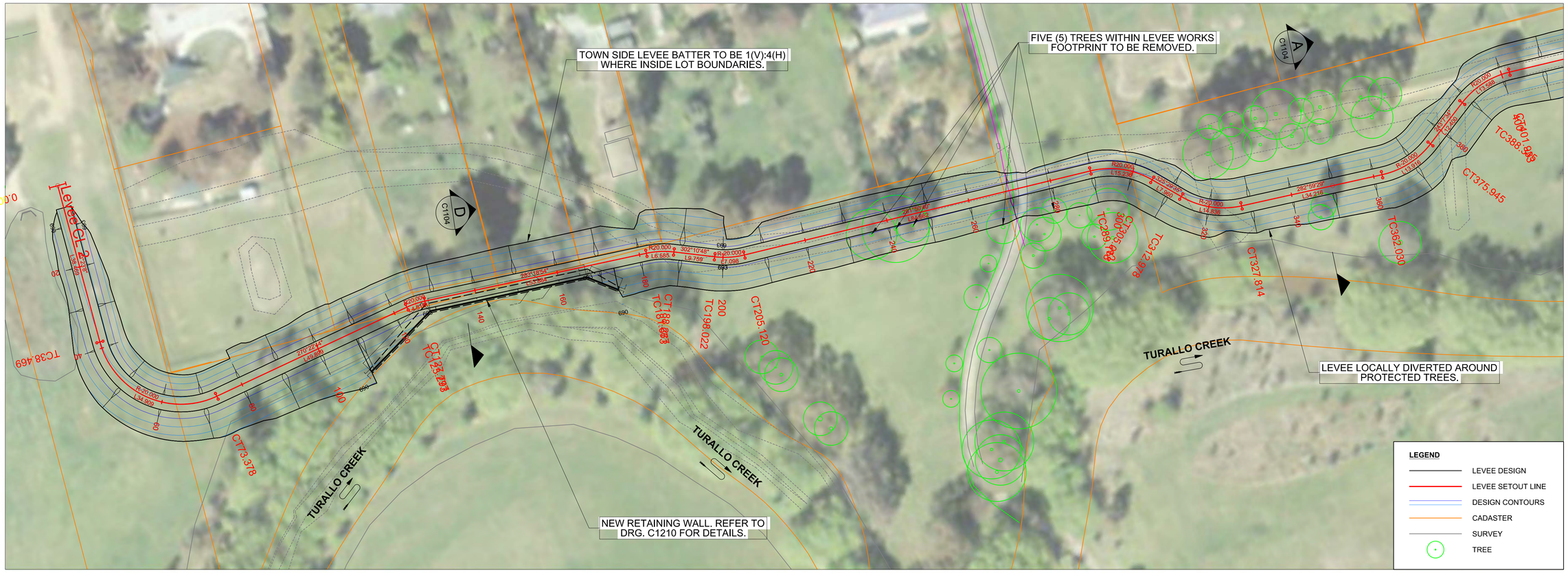
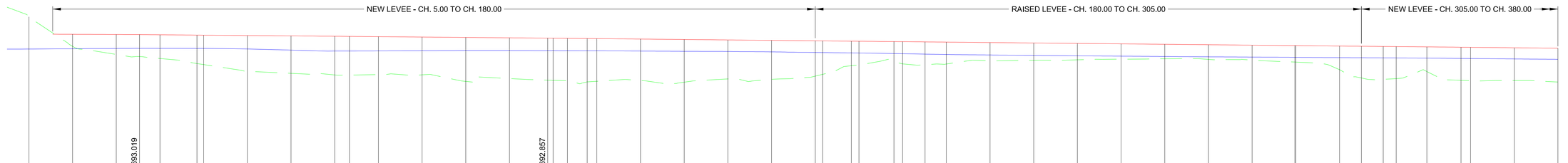


LEVEE - GENERAL ARRANGEMENT PLAN

SCALE 1:500



H.C.
V.C.
GRADE
DATUM R.L. 684.00

CHAINAGE	DESIGN LEVEL	1% AEP FLOOD	EXISTING LEVEL
0	693.84	692.36	693.84
10	693.03	692.37	692.48
20	693.02	692.38	692.11
25.33	693.02	692.39	692.01
30	693.01	692.39	691.92
38.47	693	692.38	691.69
40	692.99	692.38	691.65
50	692.98	692.36	691.33
60	692.96	692.31	691.24
70	692.94	692.26	691.17
73.38	692.94	692.27	691.16
80	692.92	692.27	691.18
90	692.91	692.28	691.17
100	692.89	692.29	690.87
110	692.87	692.29	691
118.76	692.86	692.28	690.93
120	692.85	692.28	690.92
123.28	692.85	692.28	690.9
127.79	692.84	692.28	690.85
130	692.83	692.28	690.88
140	692.81	692.26	690.91
150	692.79	692.25	690.84
160	692.77	692.24	690.99
170	692.75	692.23	690.97
180	692.73	692.2	691.11
181.68	692.73	692.2	691.2
188.26	692.72	692.18	691.59
190	692.71	692.18	691.63
198.02	692.7	692.15	691.77
200	692.69	692.14	691.67
205.12	692.68	692.12	691.63
210	692.67	692.11	691.67
220	692.65	692.08	691.82
230	692.64	692.07	691.84
240	692.62	692.05	691.86
250	692.6	692.03	691.89
260	692.58	692.01	691.91
270	692.56	692	691.88
280	692.54	691.99	691.85
289.78	692.52	691.98	691.76
290	692.52	691.98	691.76
300	692.5	691.96	691.41
305.02	692.49	691.96	691.03
310	692.48	691.95	690.97
312.98	692.47	691.95	691
320	692.46	691.94	691.32
327.81	692.44	691.93	690.92
330	692.44	691.92	690.9
340	692.42	691.9	690.91
350	692.4	691.88	690.84

LEVEE CL - LONGITUDINAL SECTION

HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100

1:500 — 0 10 20 30 40 50m — 10

1:100 — 0 2 4 6 8 10m — 2 1

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CLIENT: QPRC

NSW GOVERNMENT Public Works Advisory

DESIGNED: S. CVETKOVIC
DRAFTED: T. PERUSCO
CHECKED: S. CVETKOVIC
SENIOR ENGINEER: G. SAMIOS

QUEANBEYAN-PALERANG REGIONAL COUNCIL
BUNGENDORE FLOOD MITIGATION WORKS
DETAILED DESIGN DRAWINGS

LEVEE LONGITUDINAL SECTION
SHEET 1 OF 3

CONTRACT NO. T.B.C.
SIZE A1
SCALE @ A1 1:500, 1: 100
CADD ID. -
DRAWING NO. C1101
REV. 0

CONFIRM SCALE — 100mm ON ORIGINAL

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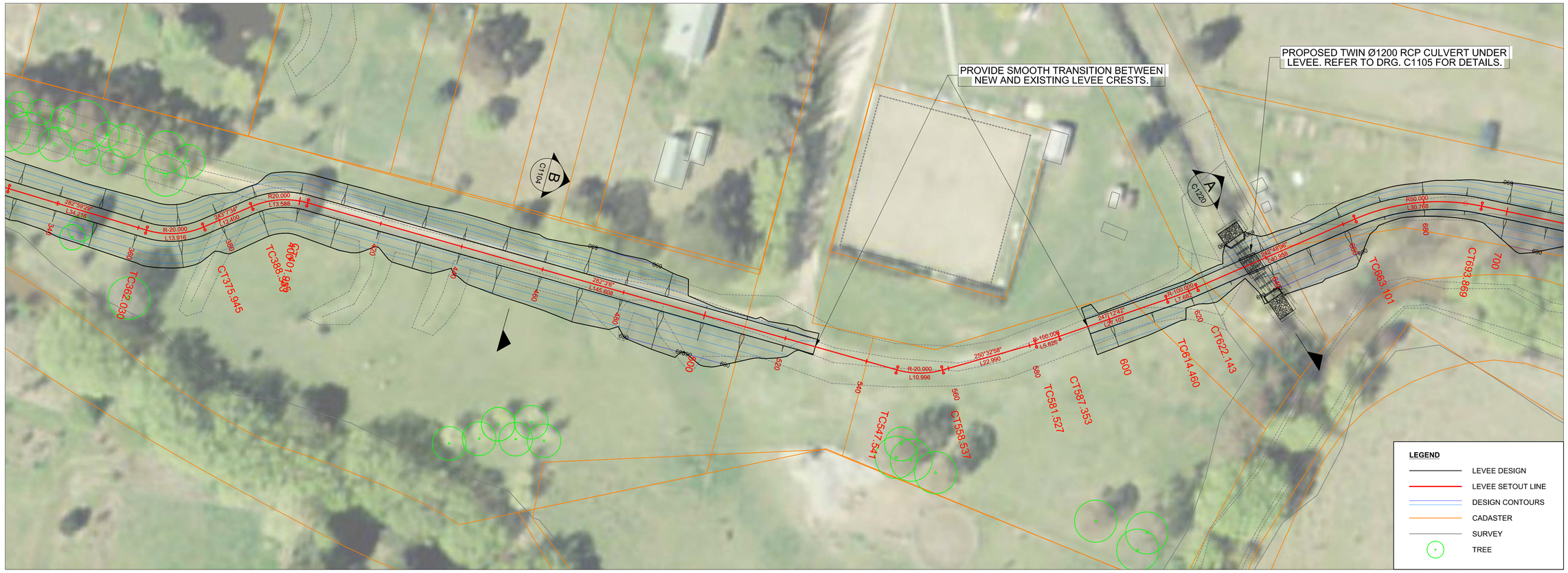
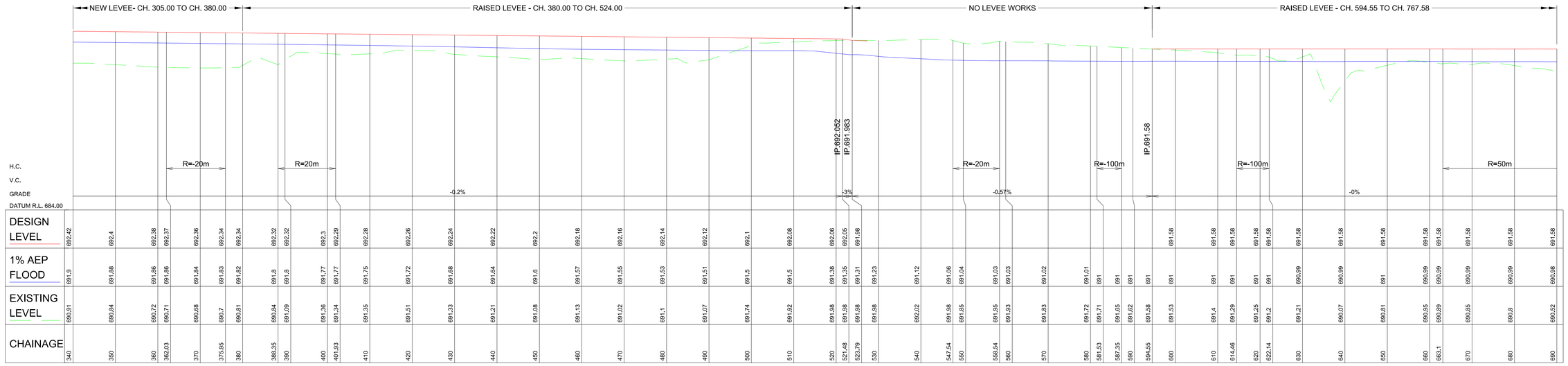
FILE LOCATION: G:\Watertec\Dams_civ\PROJ\Bungendore FRMP\DETAIL DESIGN\Drawings\3_DETAILED DESIGN\P_BUNGENDORE_C1101_LS_LEVEE1.dgn
PLOT BY: Peruscot
PLOT DATE: 11/12/2018
PLOT TIME: 3:38:11 PM



LEVEE - GENERAL ARRANGEMENT PLAN

SCALE 1:500



LEVEE CL - LONGITUDINAL SECTION

HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100

1:500 — 0 10 20 30 40 50m (10)

1:100 — 0 2 4 6 8 10m (2 1)

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NSW GOVERNMENT Public Works Advisory

DESIGNED: S. CVETKOVIC
DRAFTED: T. PERUSCO
CHECKED: S. CVETKOVIC
SENIOR ENGINEER: G. SAMIOS

QUEANBEYAN-PALERANG REGIONAL COUNCIL
BUNGENDORE FLOOD MITIGATION WORKS
DETAILED DESIGN DRAWINGS

LEVEE LONGITUDINAL SECTION
SHEET 2 OF 3

CONTRACT NO. T.B.C.
SCALE @ A1 1:500, 1: 100
DRAWING NO. **C1102**
REV. 0
CADD ID. -
A1

CONFIRM SCALE — 100mm ON ORIGINAL

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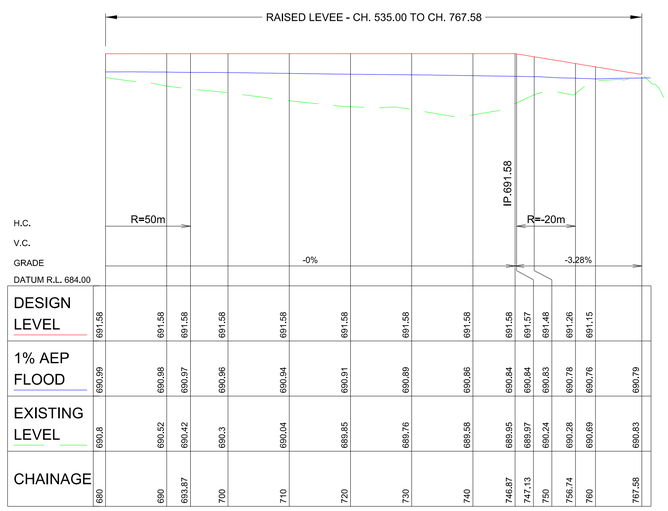
PLOT BY: Peruscot
PLOT DATE: 11/12/2018
PLOT TIME: 3:38:14 PM

LEVEE- GENERAL ARRANGEMENT PLAN

SCALE 1:500



CHAINAGE	DESIGN LEVEL	1% AEP FLOOD	EXISTING LEVEL
680	691.58	690.99	690.8
690	691.58	690.98	690.52
693.87	691.58	690.97	690.42
700	691.58	690.96	690.3
710	691.58	690.94	690.04
720	691.58	690.91	689.85
730	691.58	690.89	689.76
740	691.58	690.86	689.58
746.87	691.58	690.84	689.95
747.13	691.57	690.84	689.97
750	691.48	690.83	690.24
756.74	691.26	690.78	690.28
760	691.15	690.76	690.69
767.58		690.79	690.83

LEVEE CL - LONGITUDINAL SECTION

HORIZONTAL SCALE 1:500

VERTICAL SCALE 1:100

1:500 — 0 10 20 30 40 50m (10)

1:100 — 0 2 4 6 8 10m (2 1)

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CLIENT: QPRC

NSW GOVERNMENT Public Works Advisory

DESIGNED: S. CVETKOVIC
DRAFTED: T. PERUSCO
CHECKED: S. CVETKOVIC
SENIOR ENGINEER: G. SAMIOS

QUEANBEYAN-PALERANG REGIONAL COUNCIL
BUNGENDORE FLOOD MITIGATION WORKS
DETAILED DESIGN DRAWINGS

LEVEE LONGITUDINAL SECTION
SHEET 3 OF 3

CONTRACT NO. T.B.C.
SCALE @ A1 1:500, 1: 100
DRAWING NO. **C1103**
REV. 0
A1
CADD ID. -

CONFIRM SCALE — 100mm ON ORIGINAL

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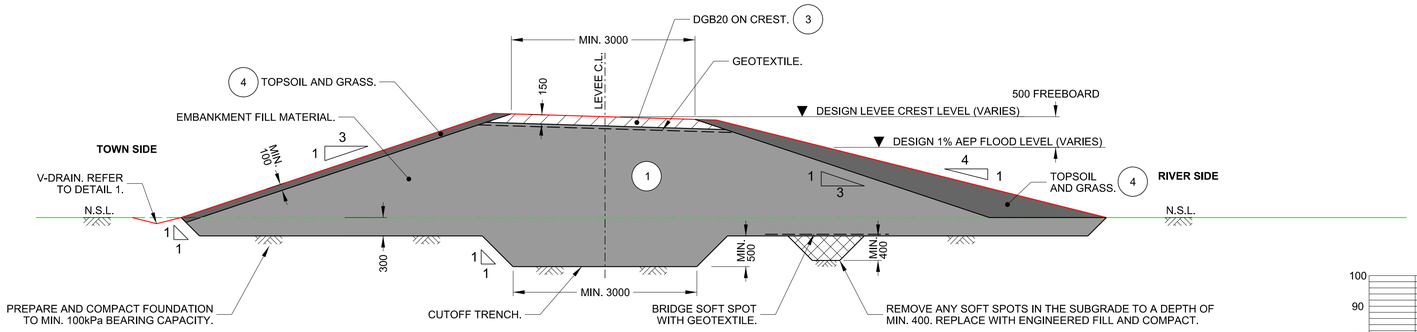
PLOT BY: Peruscot
PLOT DATE: 11/12/2018
PLOT TIME: 3:38:16 PM

EMBANKMENT AND PLACEMENT SPECIFICATIONS

(SUMMARY ONLY)

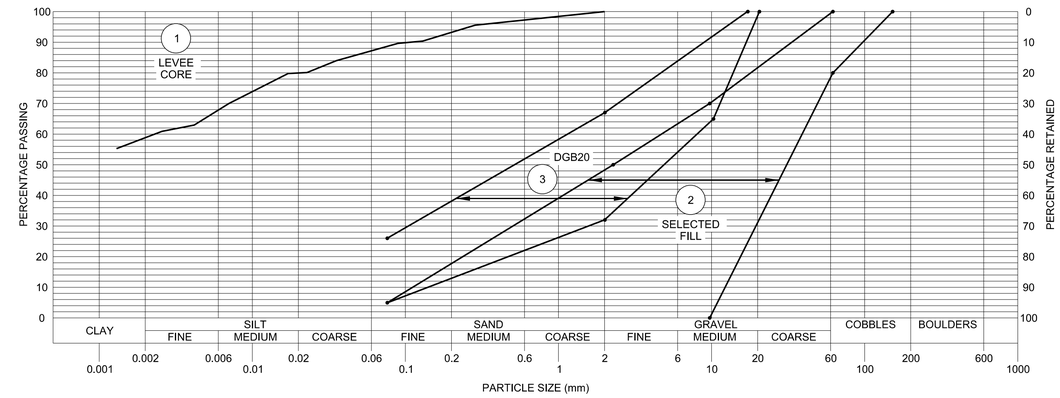
ZONE	DESCRIPTION	MATERIAL SPECIFICATION	PLACEMENT SPECIFICATION
1	LEVEE CORE	SELECTED IMPERVIOUS MATERIAL FROM APPROVED BORROW AREAS, OR REQUIRED IMPORTED MATERIAL THAT SATISFIES THE GRADING LIMITS SHOWN BELOW.	COMPACT IN LAYERS NOT EXCEEDING 150mm AFTER COMPACTION TO NOT LESS THAN 98% MAXIMUM DRY DENSITY AT MOISTURE CONTENT BETWEEN OMC -2% AND OMC +1%.
2	SELECTED FILL	SELECTED MATERIAL FROM APPROVED BORROW AREAS, OR REQUIRED IMPORTED MATERIAL THAT SATISFIES THE GRADING LIMITS SHOWN BELOW.	COMPACT IN LAYERS NOT EXCEEDING 150mm AFTER COMPACTION TO NOT LESS THAN 98% MAXIMUM DRY DENSITY AT MOISTURE CONTENT BETWEEN OMC -2% AND OMC +1%.
3	DGB	SELECTED ROCKFILL FROM APPROVED QUARRY TO GRADING LIMITS SHOWN BELOW.	PLACED TO THICKNESS AS SHOWN ON THE DRAWINGS.
4	TOPSOIL	SELECTED MATERIAL FROM APPROVED BORROW AREAS, OR REQUIRED IMPORTED MATERIAL THAT SATISFIES THE GRADING LIMITS SHOWN BELOW.	PLACED TO THICKNESS AS SHOWN ON THE DRAWINGS.



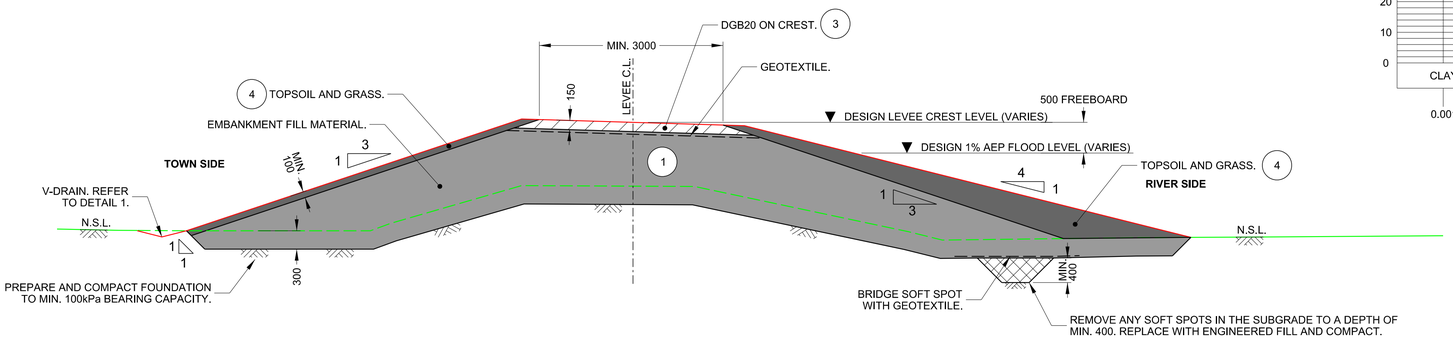
A C1101 NEW LEVEE - TYPICAL SECTION

SCALE 1:50

CH. 190 TO 300,
CH. 390 TO 527 AND
CH. 595 TO 767



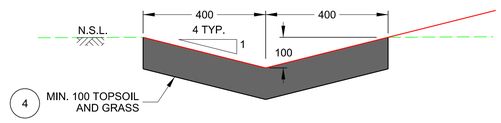
GRADING LIMITS



B C1102 RAISED LEVEE - TYPICAL SECTION

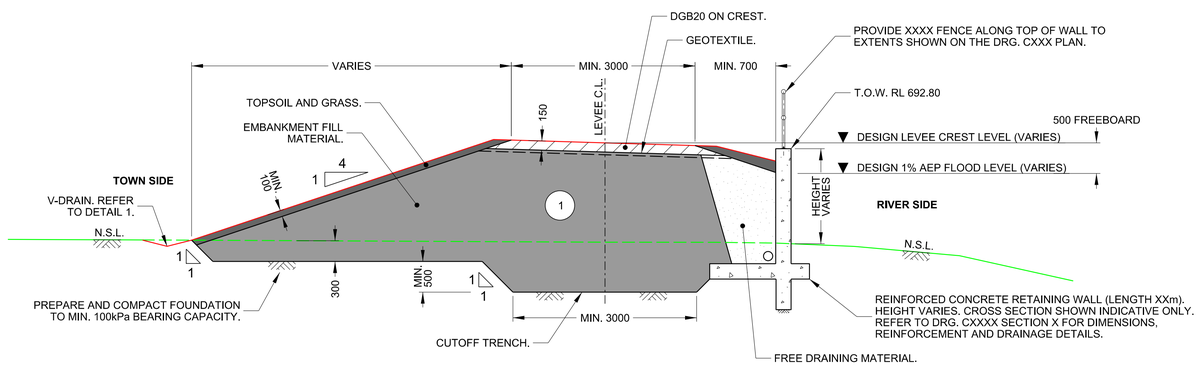
SCALE 1:50

CH. 0 TO 190 AND
CH. 300 TO 390



1 - V-DRAIN DETAIL

SCALE 1:10



D C1101 NEW LEVEE WITH RETAINING WALL - TYPICAL SECTION

SCALE 1:50

CH. 109 TO 173

1:10 0 200 400 600 800 1000mm (200 100)

1:50 0 1 2 3 4 5m (1)

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LEGEND

- EXISTING SURFACE LEVEL
- DESIGN SURFACE LEVEL

CLIENT: QPRC

NSW GOVERNMENT Public Works Advisory

DESIGNED S. CVETKOVIC
DRAFTED T. PERUSCO
CHECKED S. CVETKOVIC
SENIOR ENGINEER G. SAMIOS

QUEANBEYAN-PALERANG REGIONAL COUNCIL
BUNGENDORE FLOOD MITIGATION WORKS
DETAILED DESIGN DRAWINGS

TYPICAL LEVEE SECTIONS

CONTRACT NO. T.B.C.
SCALE @ A1 1:50, 1:10
A1
CADD ID. -
DRAWING NO. C1104
REV. 0

CONFIRM SCALE — 100mm ON ORIGINAL

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PLOT BY: Perusco
PLOT DATE: 11/12/2018
PLOT TIME: 3:38:17 PM

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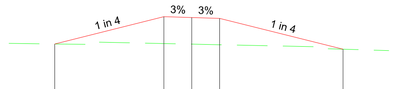
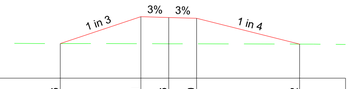


Datum RL 688.00

DESIGN LEVEL (mAHD)	691.20	692.98	692.92	692.87	690.85	
EXISTING LEVEL (mAHD)	691.20	691.22	691.18	691.15	690.85	
OFFSET (m)	-8.95	-1.82	0.00	1.82	9.89	

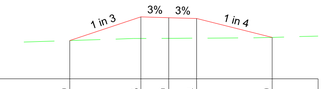
CH 80.00



Datum RL 689.00

DESIGN LEVEL (mAHD)	691.26	693.01	692.96	692.90	691.22	
EXISTING LEVEL (mAHD)	691.26	691.25	691.24	691.24	691.22	
OFFSET (m)	-7.09	-1.82	0.00	1.82	8.55	

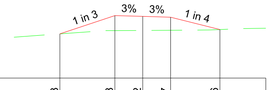
CH 60.00



Datum RL 689.00

DESIGN LEVEL (mAHD)	691.50	693.05	692.99	692.94	691.70	
EXISTING LEVEL (mAHD)	691.50	691.64	691.65	691.65	691.70	
OFFSET (m)	-6.46	-1.82	0.00	1.82	6.76	

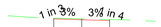
CH 40.00



Datum RL 689.00

DESIGN LEVEL (mAHD)	691.88	693.08	693.02	692.97	692.16	
EXISTING LEVEL (mAHD)	691.88	692.10	692.11	692.12	692.16	
OFFSET (m)	-5.41	-1.82	0.00	1.82	5.04	

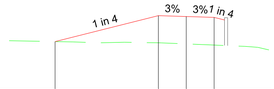
CH 20.00



Datum RL 690.00

DESIGN LEVEL (mAHD)	693.09	693.04	692.98			
EXISTING LEVEL (mAHD)	693.13	693.10	693.06			
OFFSET (m)	-1.82	0.00	1.82			

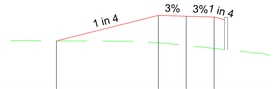
CH 5.44



Datum RL 688.00

DESIGN LEVEL (mAHD)	691.14	692.83	692.77	692.72		
EXISTING LEVEL (mAHD)	691.14	691.06	690.99	690.91		
OFFSET (m)	-8.57	-1.82	0.00	1.82		

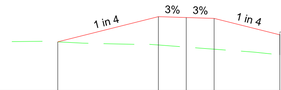
CH 160.00



Datum RL 688.00

DESIGN LEVEL (mAHD)	691.20	692.87	692.81	692.76		
EXISTING LEVEL (mAHD)	691.20	691.08	690.91	690.71		
OFFSET (m)	-8.48	-1.82	0.00	1.82		

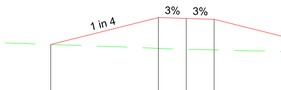
CH 140.00



Datum RL 688.00

DESIGN LEVEL (mAHD)	691.27	692.91	692.85	692.80	691.73	
EXISTING LEVEL (mAHD)	691.27	691.06	690.92	690.79	690.42	
OFFSET (m)	-8.39	-1.82	0.00	1.82	6.11	

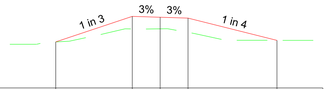
CH 120.00



Datum RL 688.00

DESIGN LEVEL (mAHD)	691.19	692.94	692.89	692.84	690.31	
EXISTING LEVEL (mAHD)	691.19	690.93	690.87	690.83	690.31	
OFFSET (m)	-8.85	-1.82	0.00	1.82	11.91	

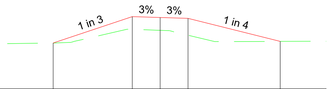
CH 100.00



Datum RL 688.00

DESIGN LEVEL (mAHD)	691.00	692.67	692.62	692.56	691.11	
EXISTING LEVEL (mAHD)	691.00	691.85	691.86	691.63	691.11	
OFFSET (m)	-6.82	-1.82	0.00	1.82	7.63	

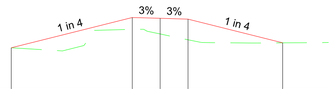
CH 240.00



Datum RL 688.00

DESIGN LEVEL (mAHD)	690.99	692.71	692.65	692.60	691.09	
EXISTING LEVEL (mAHD)	690.99	691.88	691.82	691.50	691.09	
OFFSET (m)	-6.99	-1.82	0.00	1.82	7.85	

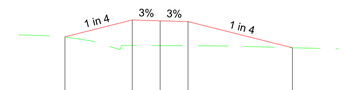
CH 220.00



Datum RL 688.00

DESIGN LEVEL (mAHD)	690.77	692.75	692.69	692.64	691.09	
EXISTING LEVEL (mAHD)	690.77	691.98	691.67	691.29	691.09	
OFFSET (m)	-9.72	-1.82	0.00	1.82	8.00	

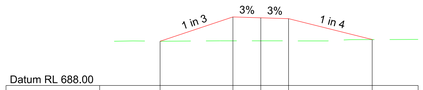
CH 200.00



Datum RL 688.00

DESIGN LEVEL (mAHD)	691.69	692.79	692.73	692.68	690.98	
EXISTING LEVEL (mAHD)	691.69	691.12	691.11	691.10	690.98	
OFFSET (m)	-6.22	-1.82	0.00	1.82	8.64	

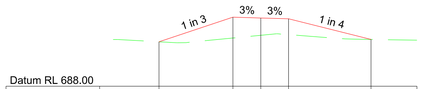
CH 180.00



Datum RL 688.00

DESIGN LEVEL (mAHD)	690.89	692.47	692.42	692.36	691.00	
EXISTING LEVEL (mAHD)	690.89	690.91	690.91	690.91	691.00	
OFFSET (m)	-6.57	-1.82	0.00	1.82	7.28	

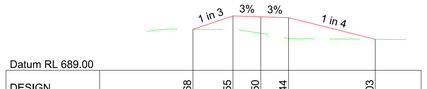
CH 340.00



Datum RL 688.00

DESIGN LEVEL (mAHD)	690.90	692.51	692.46	692.40	691.05	
EXISTING LEVEL (mAHD)	690.90	691.15	691.32	691.37	691.05	
OFFSET (m)	-6.64	-1.82	0.00	1.82	7.21	

CH 320.00



Datum RL 689.00

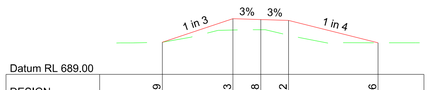
DESIGN LEVEL (mAHD)	691.68	692.55	692.50	692.44	691.03	
EXISTING LEVEL (mAHD)	691.68	691.66	691.41	691.09	691.03	
OFFSET (m)	-4.43	-1.82	0.00	1.82	7.48	

CH 300.00

Datum RL 689.00

DESIGN LEVEL (mAHD)	691.91	692.59	692.54	692.48	691.05	
EXISTING LEVEL (mAHD)	691.91	692.01	691.85	691.72	691.05	
OFFSET (m)	-3.87	-1.82	0.00	1.82	7.55	

CH 280.00



Datum RL 689.00

DESIGN LEVEL (mAHD)	691.09	692.63	692.58	692.52	691.06	
EXISTING LEVEL (mAHD)	691.09	691.89	691.91	691.55	691.06	
OFFSET (m)	-6.43	-1.82	0.00	1.82	7.66	

CH 260.00

1:200 0 4 8 12 16 20m
4 2

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0	11/12/2018	DRAFT FOR REVIEW

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EXISTING SURFACE LEVEL

DESIGN SURFACE LEVEL

CLIENT

QPRC

NSW GOVERNMENT Public Works Advisory

DESIGNED S. CVETKOVIC
DRAFTED T. PERUSCO
CHECKED S. CVETKOVIC
SENIOR ENGINEER G. SAMIOS

QUEANBEYAN-PALERANG REGIONAL COUNCIL
BUNGENDORE FLOOD MITIGATION WORKS
DETAILED DESIGN DRAWINGS

LEVEE DESIGN CROSS SECTIONS
SHEET 1 OF 3

CONTRACT NO. T.B.C.
A1
SCALE @ A1 1:200
CADD ID. -
DRAWING NO. C1201
REV. 0

CONFIRM SCALE 100mm ON ORIGINAL

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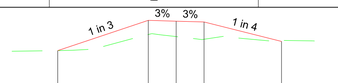
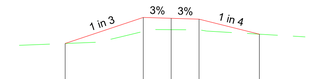


Datum RL 688.00

DESIGN LEVEL (mAHD)	690.30	692.27	692.22	692.16	690.90	
EXISTING LEVEL (mAHD)	690.30	691.34	691.21	691.03	690.90	
OFFSET (m)	-7.74	-1.82	0.00	1.82	6.88	

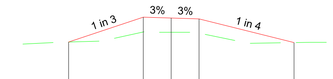
CH 440.00



Datum RL 688.00

DESIGN LEVEL (mAHD)	690.61	692.31	692.26	692.20	691.22	
EXISTING LEVEL (mAHD)	690.61	691.40	691.51	691.50	691.22	
OFFSET (m)	-6.93	-1.82	0.00	1.82	5.76	

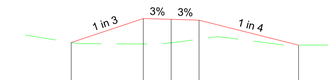
CH 420.00



Datum RL 688.00

DESIGN LEVEL (mAHD)	690.72	692.35	692.30	692.24	690.69	
EXISTING LEVEL (mAHD)	690.72	691.39	691.36	691.32	690.69	
OFFSET (m)	-6.70	-1.82	0.00	1.82	8.02	

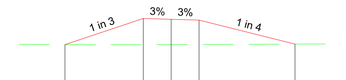
CH 400.00



Datum RL 688.00

DESIGN LEVEL (mAHD)	690.82	692.39	692.34	692.28	690.65	
EXISTING LEVEL (mAHD)	690.82	690.73	690.81	691.04	690.65	
OFFSET (m)	-6.53	-1.82	0.00	1.82	8.32	

CH 380.00



Datum RL 688.00

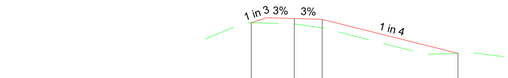
DESIGN LEVEL (mAHD)	690.72	692.43	692.38	692.32	690.75	
EXISTING LEVEL (mAHD)	690.72	690.72	690.72	690.73	690.75	
OFFSET (m)	-6.94	-1.82	0.00	1.82	8.09	

CH 360.00

Datum RL 688.00

DESIGN LEVEL (mAHD)	691.61	692.11	692.06	692.00	691.26	
EXISTING LEVEL (mAHD)	691.61	691.91	691.98	691.87	691.26	
OFFSET (m)	-3.32	-1.82	0.00	1.82	4.78	

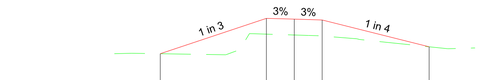
CH 520.00



Datum RL 687.00

DESIGN LEVEL (mAHD)	691.82	692.10	692.04		689.82	
EXISTING LEVEL (mAHD)	691.82	691.74	691.49		689.82	
OFFSET (m)	-2.81	0.00	1.82		10.69	

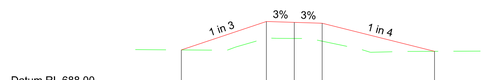
CH 500.00



Datum RL 687.00

DESIGN LEVEL (mAHD)	689.88	692.19	692.14	692.08	690.33	
EXISTING LEVEL (mAHD)	689.88	691.16	691.10	691.03	690.33	
OFFSET (m)	-8.75	-1.82	0.00	1.82	8.81	

CH 480.00



Datum RL 688.00

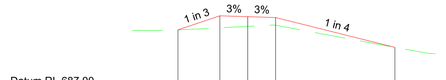
DESIGN LEVEL (mAHD)	690.38	692.23	692.18	692.12	690.29	
EXISTING LEVEL (mAHD)	690.38	691.14	691.13	690.95	690.29	
OFFSET (m)	-7.38	-1.82	0.00	1.82	9.16	

CH 460.00

Datum RL 688.00

DESIGN LEVEL (mAHD)	690.68	691.63	691.58	691.53	691.14	
EXISTING LEVEL (mAHD)	690.68	690.70	690.80	690.99	691.14	
OFFSET (m)	-4.70	-1.82	0.00	1.82	3.36	

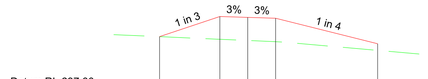
CH 680.00



Datum RL 687.00

DESIGN LEVEL (mAHD)	690.72	691.63	691.58	691.53	689.58	
EXISTING LEVEL (mAHD)	690.72	690.85	690.95	691.02	689.58	
OFFSET (m)	-4.56	-1.82	0.00	1.82	9.61	

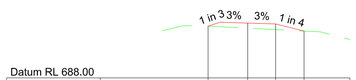
CH 660.00



Datum RL 687.00

DESIGN LEVEL (mAHD)	690.32	691.63	691.58	691.53	689.86	
EXISTING LEVEL (mAHD)	690.32	690.15	690.07	689.99	689.42	
OFFSET (m)	-5.76	-1.82	0.00	1.82	8.48	

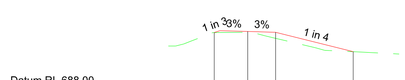
CH 640.00



Datum RL 688.00

DESIGN LEVEL (mAHD)	691.38	691.58	691.53	691.06		
EXISTING LEVEL (mAHD)	691.38	691.25	691.16	691.06		
OFFSET (m)	-2.59	0.00	1.82	3.68		

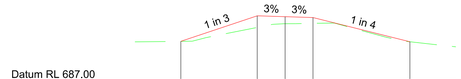
CH 620.00



Datum RL 688.00

DESIGN LEVEL (mAHD)	691.51	691.58	691.53	690.26		
EXISTING LEVEL (mAHD)	691.51	691.53	691.13	690.26		
OFFSET (m)	-2.19	0.00	1.82	6.88		

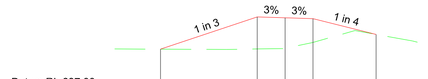
CH 600.00



Datum RL 687.00

DESIGN LEVEL (mAHD)	689.54	691.20	691.15	691.10	689.51	
EXISTING LEVEL (mAHD)	689.54	690.45	690.69	690.71	689.51	
OFFSET (m)	-6.81	-1.82	0.00	1.82	8.15	

CH 760.00



Datum RL 687.00

DESIGN LEVEL (mAHD)	689.53	691.63	691.58	691.53	690.49	
EXISTING LEVEL (mAHD)	689.53	689.54	689.58	689.97	690.49	
OFFSET (m)	-8.13	-1.82	0.00	1.82	5.95	

CH 740.00

Datum RL 687.00

DESIGN LEVEL (mAHD)	689.71	691.63	691.58	691.53	690.34	
EXISTING LEVEL (mAHD)	689.71	689.76	689.85	690.16	690.34	
OFFSET (m)	-7.60	-1.82	0.00	1.82	6.57	

CH 720.00

Datum RL 687.00

DESIGN LEVEL (mAHD)	689.94	691.63	691.58	691.53	690.32	
EXISTING LEVEL (mAHD)	689.94	689.97	690.30	690.62	690.32	
OFFSET (m)	-6.92	-1.82	0.00	1.82	6.65	

CH 700.00

1:200 0 4 8 12 16 20m
4 2

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LEGEND

EXISTING SURFACE LEVEL

DESIGN SURFACE LEVEL

CLIENT

QPRC

NSW GOVERNMENT Public Works Advisory

DESIGNED S. CVETKOVIC
DRAFTED T. PERUSCO
CHECKED S. CVETKOVIC
SENIOR ENGINEER G. SAMIOS

QUEANBEYAN-PALERANG REGIONAL COUNCIL
BUNGENDORE FLOOD MITIGATION WORKS
DETAILED DESIGN DRAWINGS

LEVEE DESIGN CROSS SECTIONS
SHEET 2 OF 3

CONTRACT NO. T.B.C.
SCALE @ A1 1:200
CADD ID. -
DRAWING NO. **C1202**
REV. 0
A1

CONFIRM SCALE 100mm ON ORIGINAL

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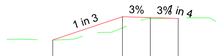

Datum RL 687.00

DESIGN LEVEL (mAHD)	689.44	690.96	690.90	690.85	
EXISTING LEVEL (mAHD)	689.44	690.23	690.83	690.87	
OFFSET (m)	-6.38	-1.82	0.00	1.82	

CH 767.58

1:200 0 4 8 12 16 20m
4 2

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LEGEND

EXISTING SURFACE LEVEL

DESIGN SURFACE LEVEL

CLIENT

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DESIGNED S. CVETKOVIC
DRAFTED T. PERUSCO
CHECKED S. CVETKOVIC
SENIOR ENGINEER G. SAMIOS

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BUNGENDORE FLOOD MITIGATION WORKS
DETAILED DESIGN DRAWINGS

LEVEE DESIGN CROSS SECTIONS
SHEET 3 OF 3

CONTRACT NO. T.B.C.
A1
SCALE @ A1 1:200
CADD ID. -
DRAWING NO. C1203
REV. 0

CONFIRM SCALE 100mm ON ORIGINAL

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FILE LOCATION: G:\Watertec\Dams_civ\PROJ\Bungendore FRMP\DETAIL DESIGN\Drawings\3_DETAILED DESIGN\P_BUNGENDORE_C1203_XSECT_LEVEE3.dgn
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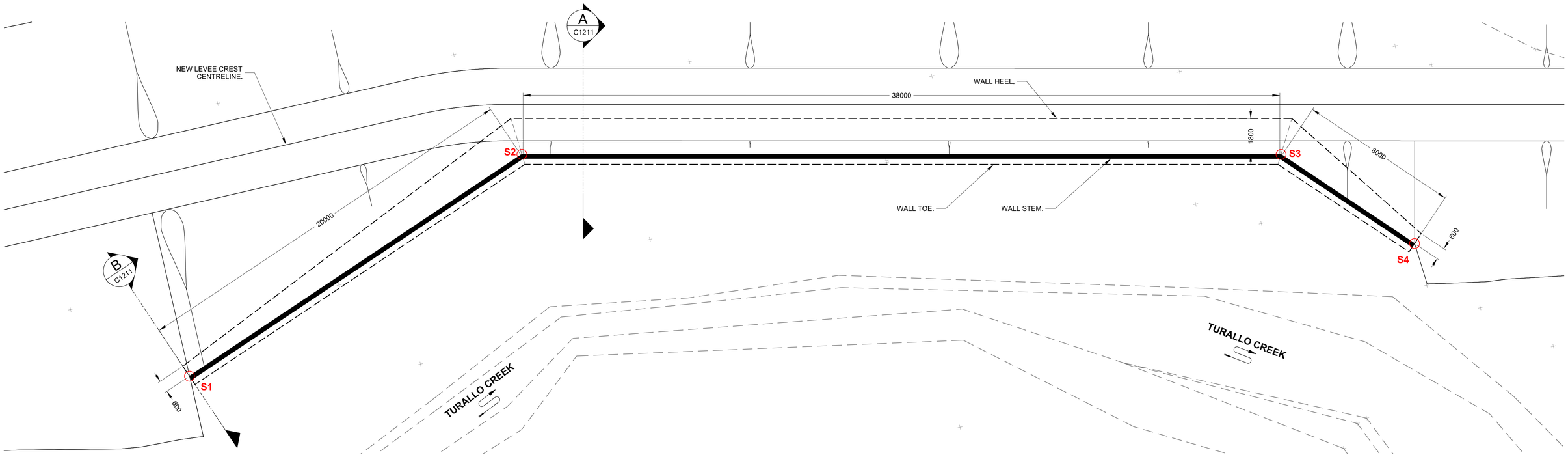
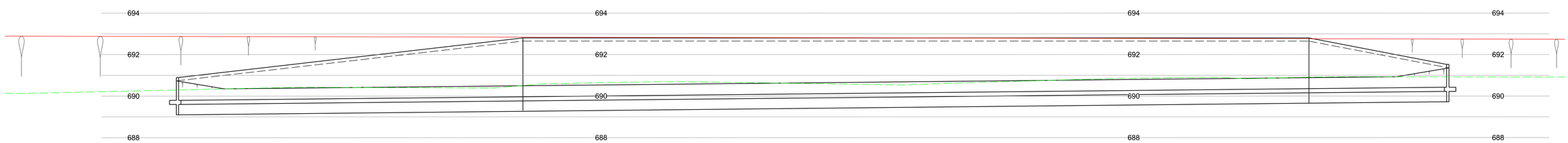
PLOT DATE: 11/12/2018
PLOT TIME: 3:38:20 PM



RETAINING WALL - GENERAL ARRANGEMENT PLAN

SCALE 1:100



RETAINING WALL - ELEVATION

SCALE 1:100

RETAINING WALL SETOUT TABLE

POINT	EASTING	NORTHING	R.L.
S1 (TOW BACK)	722525.346	6096312.667	690.90
S2 (TOW BACK)	722506.540	6096305.683	692.80
S3 (TOW BACK)	722469.444	6096314.462	692.80
S4 (TOW BACK)	722463.947	6096320.358	691.52

1:20 — 0, 400, 800, 1200, 1600, 2000mm; 400, 200

1:100 — 0, 2, 4, 6, 8, 10m; 2, 1

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NOTES:

1. FENCE ON TOP OF RETAINING WALL NOT SHOWN FOR CLARITY. REFER TO TYPICAL SECTION AND SPECIFICATION FOR FENCING DETAILS.

ISS.	DATE	AMENDMENT / REVISION DETAILS
0	11/12/2018	DRAFT FOR REVIEW

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DRAFTED: T. PERUSCO
CHECKED: S. CVETKOVIC
SENIOR ENGINEER: G. SAMIOS

QUEANBEYAN-PALERANG REGIONAL COUNCIL
BUNGENDORE FLOOD MITIGATION WORKS
DETAILED DESIGN DRAWINGS

LEVEE RETAINING WALL
GENERAL ARRANGEMENT PLAN AND ELEVATION

CONTRACT NO. T.B.C.
SCALE @ A1 1:100
CADD ID. -
DRAWING NO. **C1210**
REV. 0

CONFIRM SCALE — 100mm ON ORIGINAL

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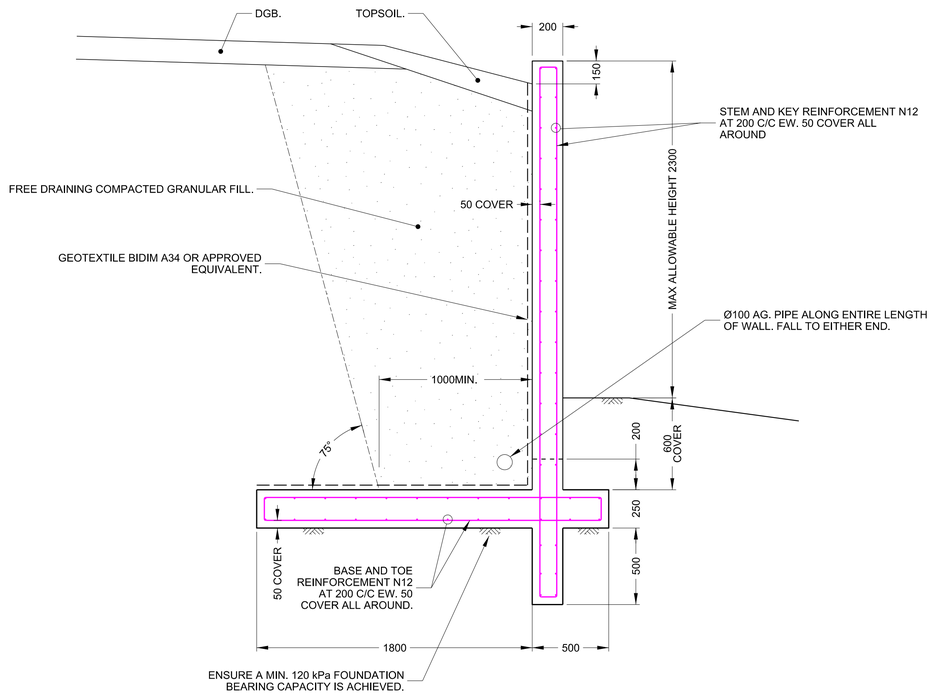
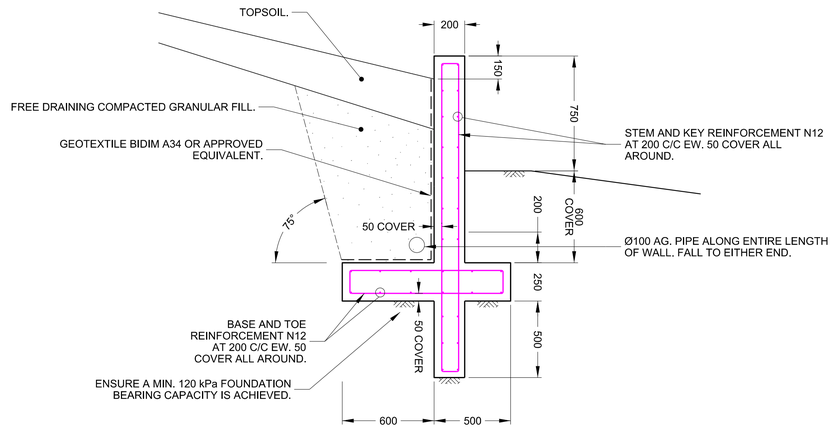
PLOT DATE: 11/12/2018
PLOT TIME: 3:38:28 PM



A C1210 TYPICAL RETAINING WALL SECTION
SCALE 1:20



B C1210 TYPICAL RETAINING WALL END SECTION
SCALE 1:20

1:20 0 400 800 1200 1600 2000mm
400 200

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BUNGENDORE FLOOD MITIGATION WORKS
DETAILED DESIGN DRAWINGS

TYPICAL LEVEE RETAINING WALL SECTIONS

CONTRACT NO. T.B.C.
A1
SCALE @ A1 1:20
CADD ID. -
DRAWING NO. C1211
REV. 0

CONFIRM SCALE 100mm ON ORIGINAL

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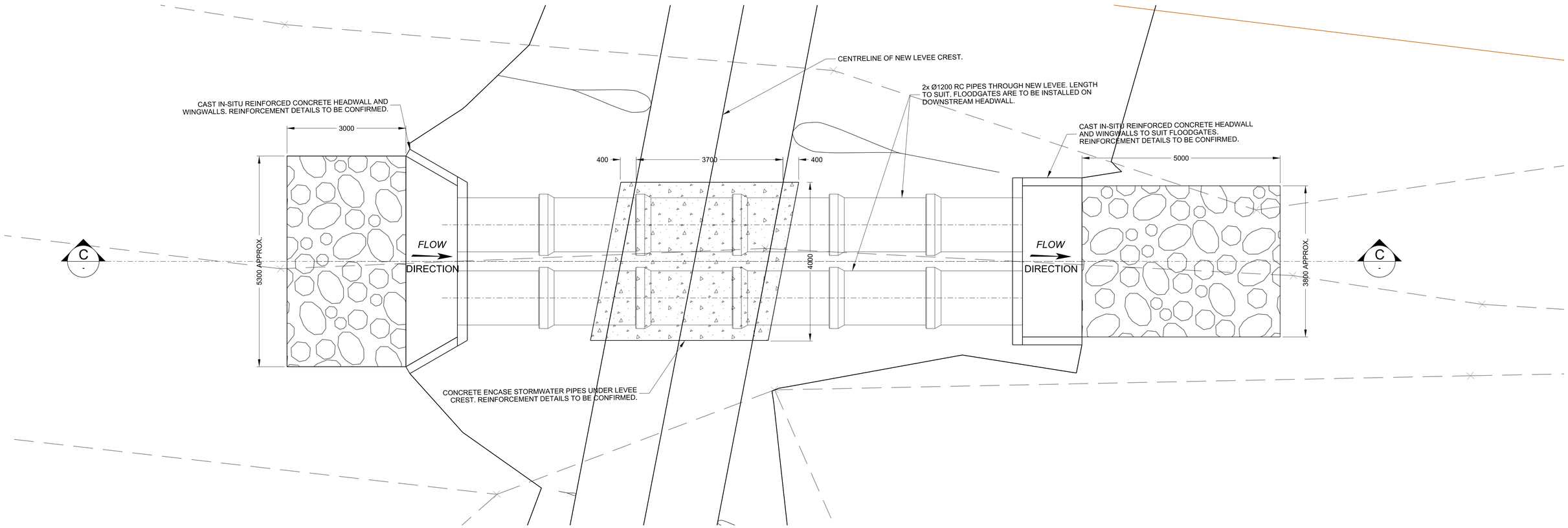
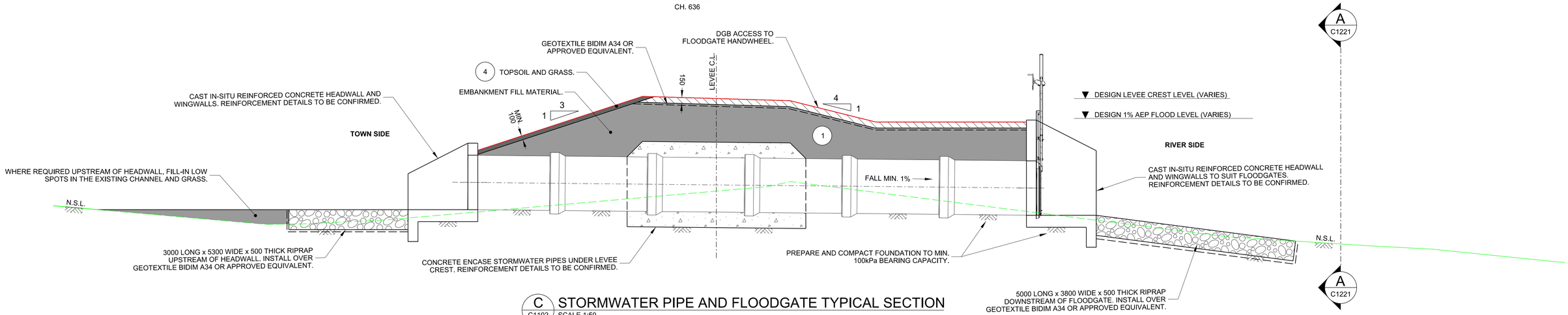


LEVEE CULVERT PLAN

SCALE 1:50

CH. 636



C / C1102 STORMWATER PIPE AND FLOODGATE TYPICAL SECTION

SCALE 1:50

CH. 636

1:50 0 1 2 3 4 5m

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CHECKED: S. CVETKOVIC
SENIOR ENGINEER: G. SAMIOS

QUEANBEYAN-PALERANG REGIONAL COUNCIL
BUNGENDORE FLOOD MITIGATION WORKS
DETAILED DESIGN DRAWINGS

LEVEE CULVERT PLAN AND LONGITUDINAL SECTION

CONTRACT NO. T.B.C.
A1
SCALE @ A1 1:50
CADD ID. -
DRAWING NO. **C1220**
REV. 0

CONFIRM SCALE — 100mm ON ORIGINAL

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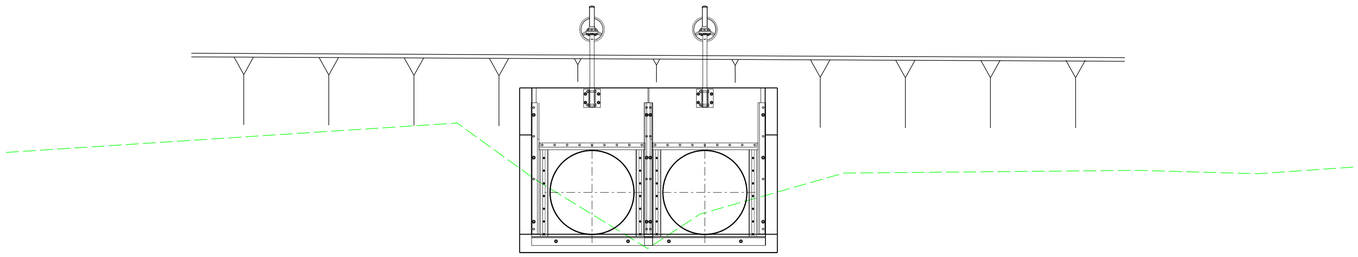

A C1220 STORMWATER PIPE AND FLOODGATE TYPICAL SECTION
SCALE 1:50

1:50 0 1 2 3 4 5m

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SENIOR ENGINEER G. SAMIOS

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DETAILED DESIGN DRAWINGS

LEVEE CULVERT ELEVATION

CONTRACT NO. T.B.C.
A1
SCALE @ A1 1:50
CADD ID. -
DRAWING NO. **C1221**
REV. 0

CONFIRM SCALE 100mm ON ORIGINAL

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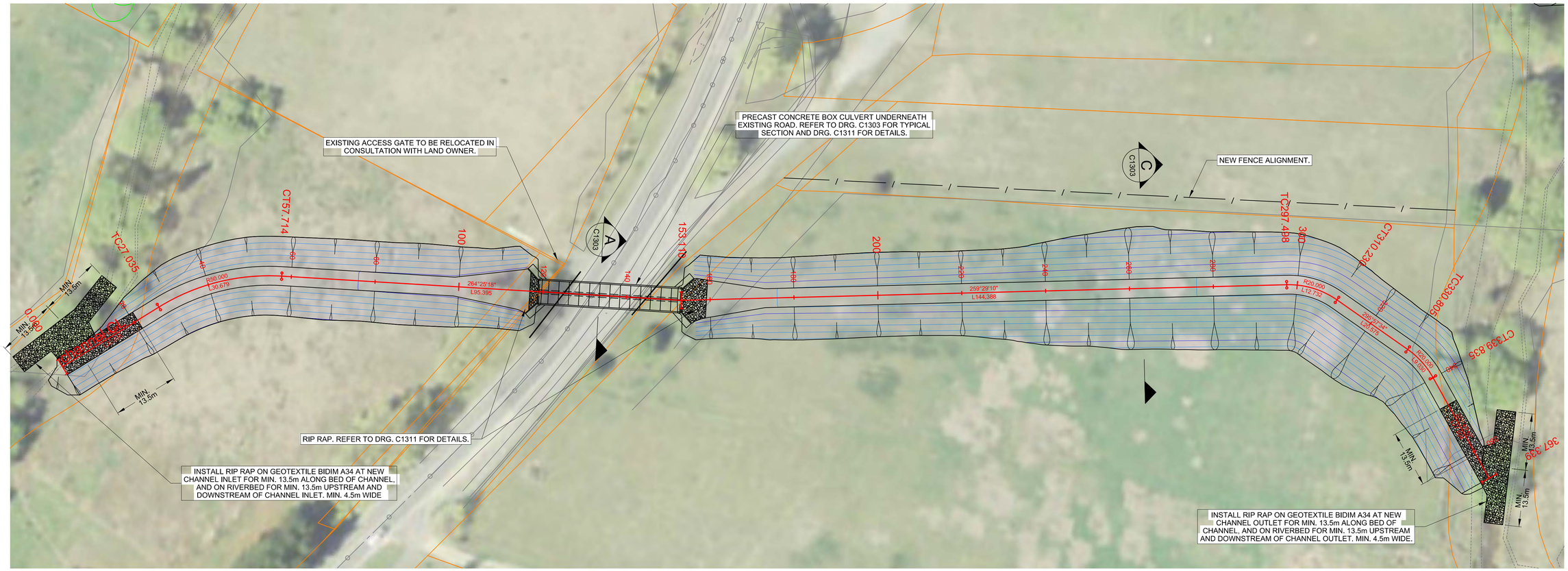
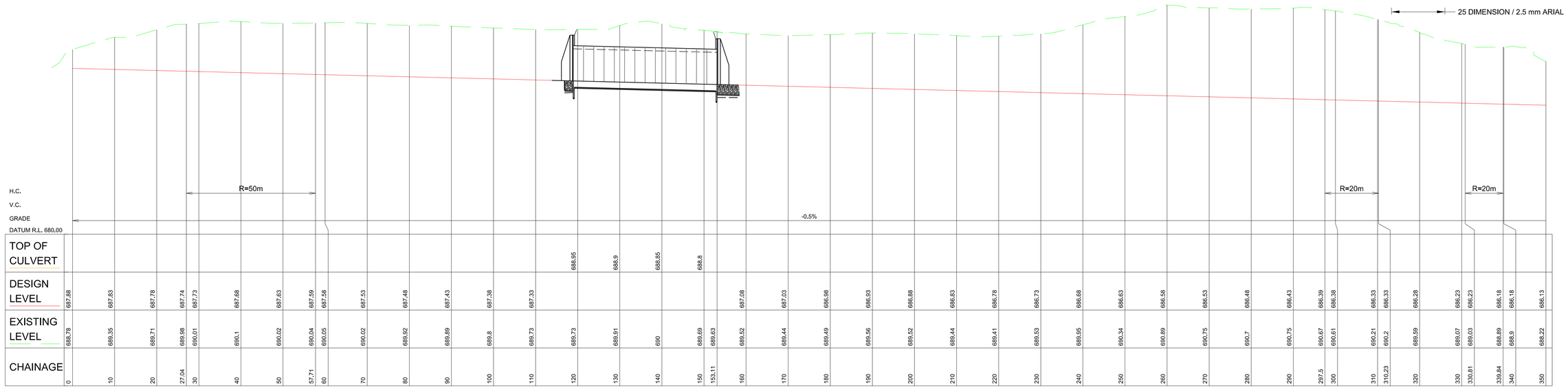
PLOT TIME: 3:38:32 PM



CHANNEL - GENERAL ARRANGEMENT PLAN

SCALE 1:500



CHANNEL CL - LONGITUDINAL SECTION

HORIZONTAL SCALE 1:500

VERTICAL SCALE 1:100

1:500 — 0 10 20 30 40 50m

1:100 — 0 2 4 6 8 10m

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LEGEND

RIP RAP

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BUNGENDORE FLOOD MITIGATION WORKS
DETAILED DESIGN DRAWINGS

CHANNEL GENERAL ARRANGEMENT PLAN AND LONGITUDINAL SECTION - SHEET 1 OF 2

CONTRACT NO. T.B.C.

SCALE @ A1 1:500, 1:100

CADD ID. -

DRAWING NO. **C1301**

REV. 0

A1

CONFIRM SCALE — 100mm ON ORIGINAL

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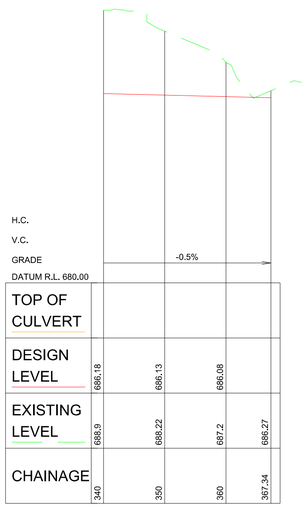
PLOT BY: Perusco

PLOT DATE: 11/12/2018

PLOT TIME: 3:38:35 PM

CHANNEL - GENERAL ARRANGEMENT PLAN

SCALE 1:500



CHANNEL CL - LONGITUDINAL SECTION

HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100

1:500 0 10 20 30 40 50m
10

1:100 0 2 4 6 8 10m
2 1

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LEGEND

REINFORCED GRASS

RIP RAP

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DETAILED DESIGN DRAWINGS

CHANNEL GENERAL ARRANGEMENT PLAN AND LONGITUDINAL SECTION - SHEET 2 OF 2

CONTRACT NO. T.B.C.
A1
SCALE @ A1 1:500, 1:100
CADD ID. -
DRAWING NO. **C1302**
REV. 0

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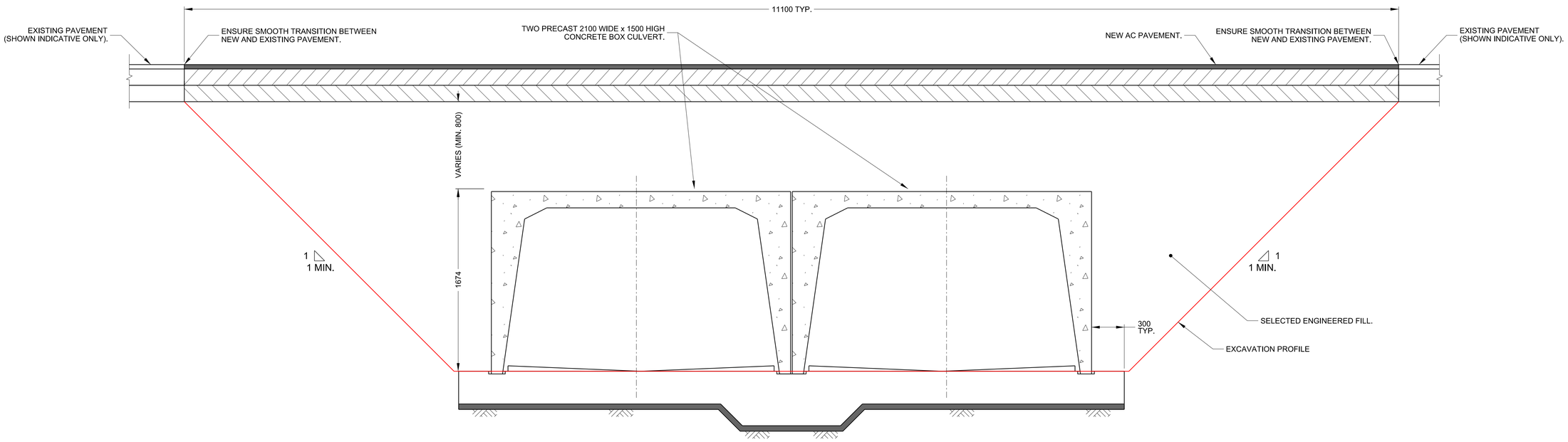
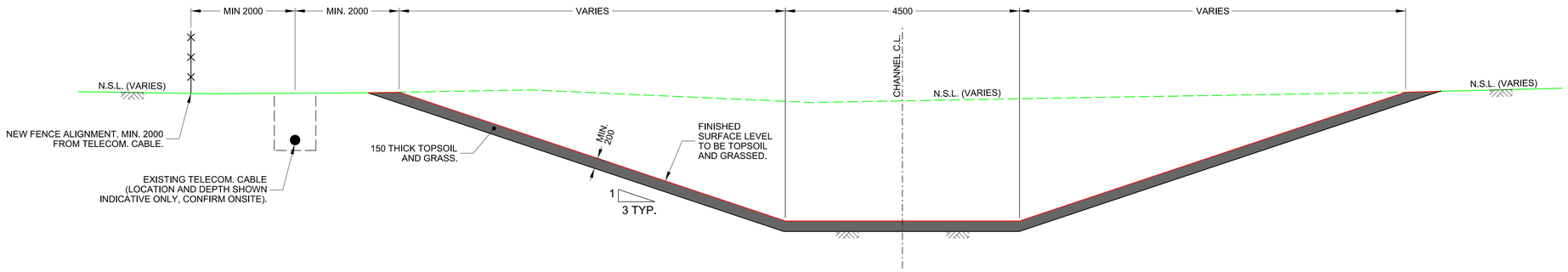
PLOT DATE: 11/12/2018
PLOT TIME: 3:38:38 PM



A C1301 TARAGO ROAD CULVERT - TYPICAL SECTION
SCALE 1:20



B C1301 CHANNEL - TYPICAL SECTION
SCALE 1:50

1:20 0 400 800 1200 1600 2000mm
400 200
1:50 0 1 2 3 4 5m
1

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LEGEND
- EXISTING SURFACE LEVEL
- DESIGN SURFACE LEVEL

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DETAILED DESIGN DRAWINGS

TYPICAL CHANNEL SECTIONS

CONTRACT NO. T.B.C.
A1
SCALE @ A1 1:50
CADD ID. -
DRAWING NO. C1303
REV. 0

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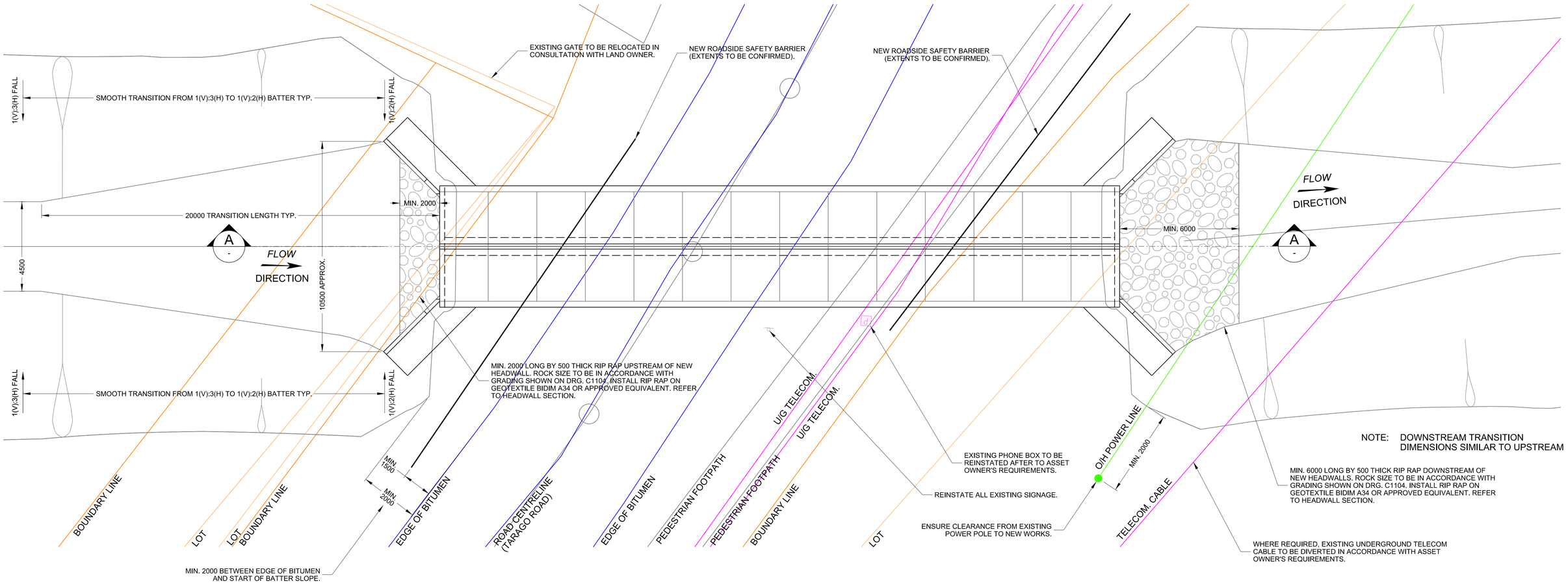
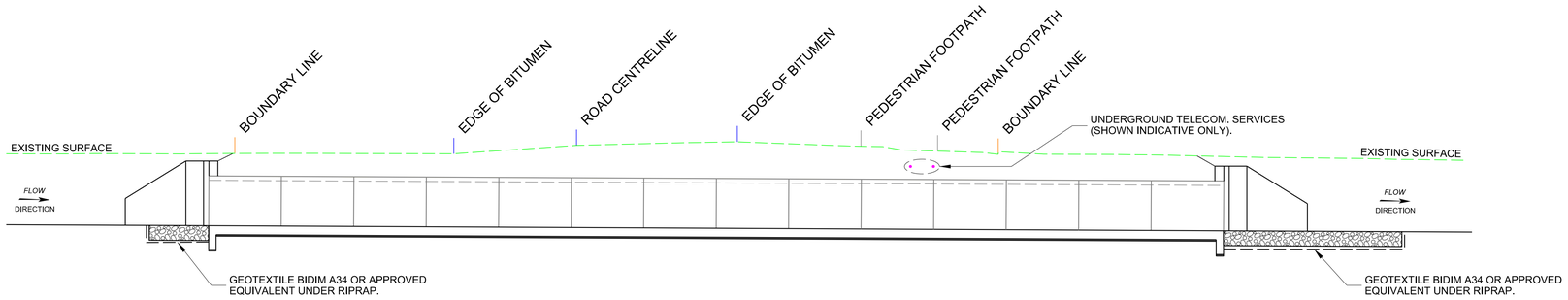
PLOT TIME: 3:38:39 PM



CULVERT GENERAL ARRANGEMENT PLAN WITH SURVEY

SCALE 1:100



A / - CULVERT LONGITUDINAL SECTION

SCALE 1:100

1:100 0 2 4 6 8 10m

2 1

NOTES:

1. BATTER SLOPES ON HEADWALLS AND WINGWALLS ARE SHOWN AT 1(V):2(H).
2. CHANNEL AND CULVERT LONGITUDINAL FALL TO BE MIN. 0.5%.
3. DOWNSTREAM CHANNEL TRANSITION DIMENSIONS ARE SIMILAR TO UPSTREAM DIMENSIONS SHOWN.

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DRAFTED: T. PERUSCO
CHECKED: S. CVETKOVIC
SENIOR ENGINEER: G. SAMIOS

QUEANBEYAN-PALERANG REGIONAL COUNCIL
BUNGENDORE FLOOD MITIGATION WORKS
DETAILED DESIGN DRAWINGS

CHANNEL CULVERT DETAILS
SHEET 1 OF 3

CONTRACT NO. T.B.C.
A1
SCALE @ A1 1:100
CADD ID. -
DRAWING NO. C1311
REV. 0

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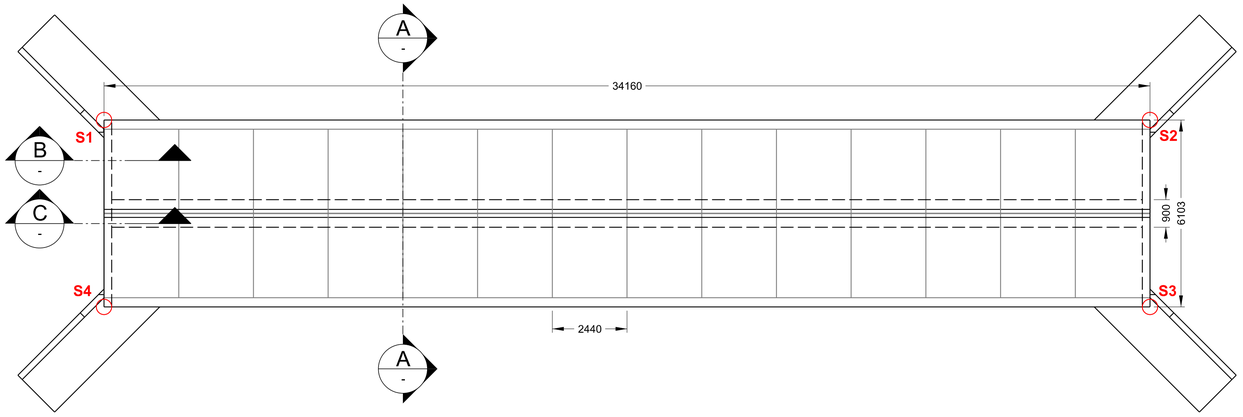
PLOT DATE: 11/12/2018
PLOT TIME: 3:38:41 PM

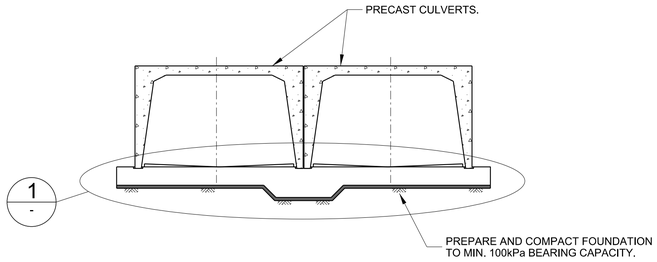


BASE SLAB SETOUT PLAN

SCALE 1:100

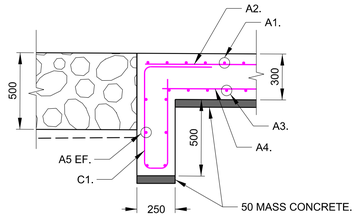
BASE SLAB SETOUT TABLE

POINT	EASTING	NORTHING	R.L.
S1	721937.383	6096483.805	687.29
S2	721903.385	6096480.484	687.12
S3	721902.792	6096486.558	687.12
S4	721936.790	6096489.879	687.29



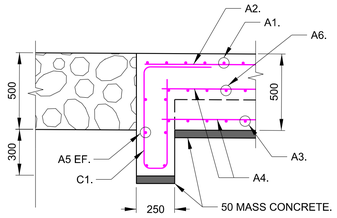
A TARAGO ROAD CULVERTS - SECTION A

SCALE 1:100



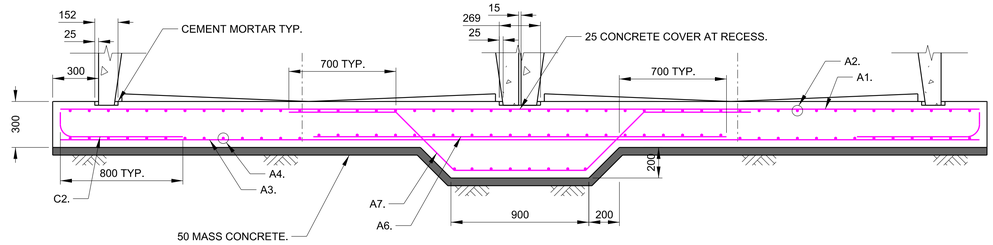
B CUTOFF DETAIL

SCALE 1:20



C CUTOFF DETAIL

SCALE 1:20



1 SLAB DETAIL

SCALE 1:20

BASE SLAB - STEEL LIST

NAME	BAR SIZE	SPACING / NO. BARS
A1	N16	125 C/C
A2	N16	125 C/C
A3	N16	125 C/C
A4	N16	125 C/C
A5	N16	3 OFF
A6	N20	125 C/C
A7	N20	125 C/C
C1	N12	125 C/C
C2	N20	125 C/C

1:20 0 400 800 1200 1600 2000mm (400 200)

1:100 0 2 4 6 8 10m (2 1)

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ISS.	DATE	AMENDMENT / REVISION DETAILS
0	11/12/2018	DRAFT FOR REVIEW

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NSW GOVERNMENT Public Works Advisory

DESIGNED S. CVETKOVIC
DRAFTED T. PERUSCO
CHECKED S. CVETKOVIC
SENIOR ENGINEER G. SAMIOS

QUEANBEYAN-PALERANG REGIONAL COUNCIL
BUNGENDORE FLOOD MITIGATION WORKS
DETAILED DESIGN DRAWINGS

CHANNEL CULVERT DETAILS
SHEET 2 OF 3

CONTRACT NO. T.B.C.
A1
SCALE @ A1 1:100, 1: 20
CADD ID. -
DRAWING NO. C1312
REV. 0

CONFIRM SCALE 100mm ON ORIGINAL

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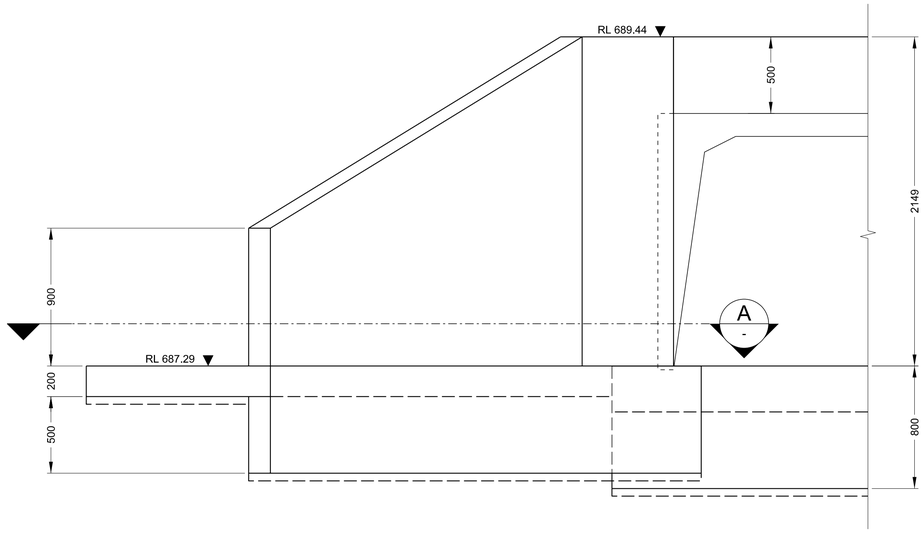
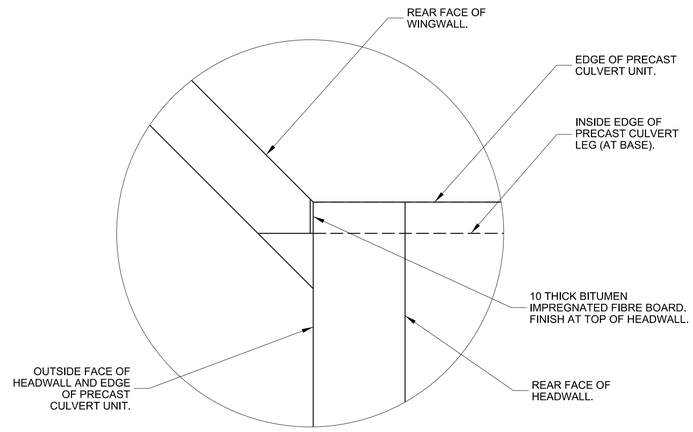
PLOT DATE: 11/12/2018
PLOT TIME: 3:38:47 PM



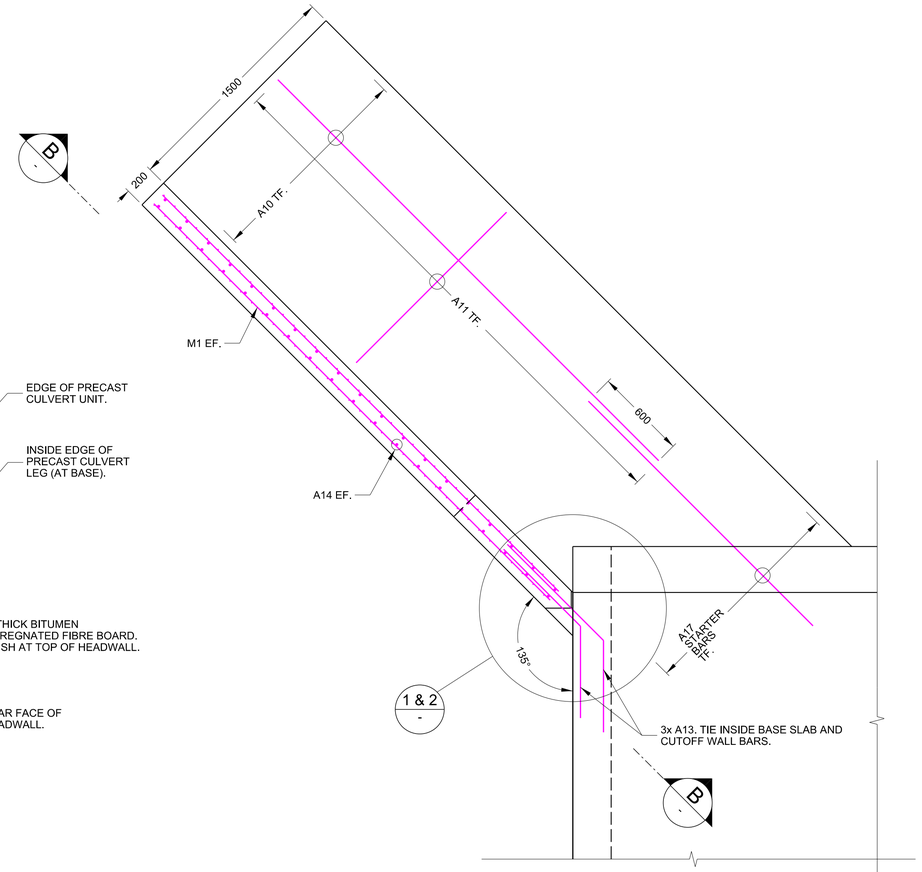
UPSTREAM WINGWALL ELEVATION
SCALE 1:20

WING WALLS - STEEL LIST

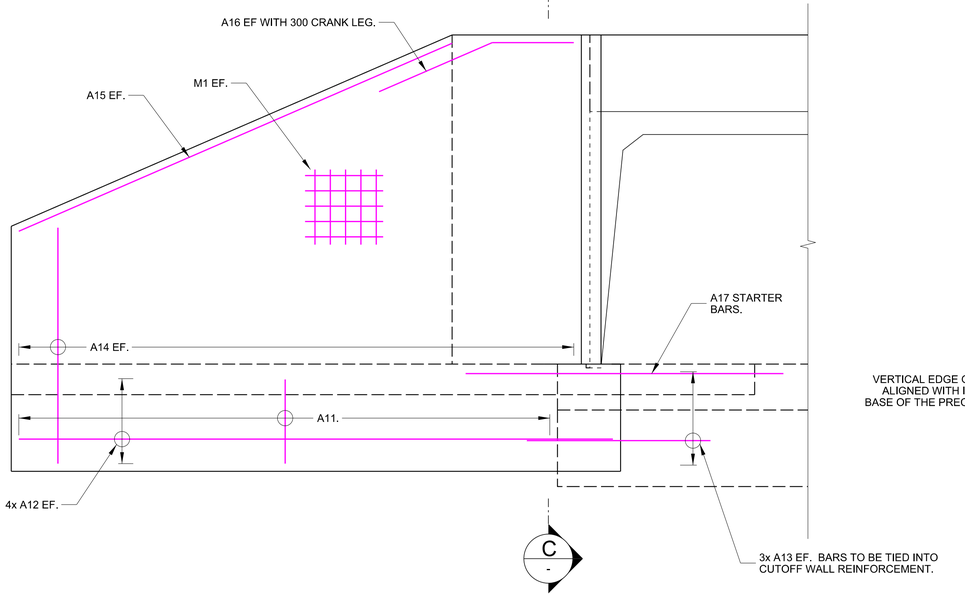
NAME	BAR SIZE	SPACING / NO. BARS
A10	N12	150 C/C
A11	N16	200 C/C
A12	N12	8 OFF
A13	N12	6 OFF
A14	N16	200 C/C
A15	N12	2 OFF
A16	N12	2 OFF
A17	N12	150 C/C
M1	SL81	-



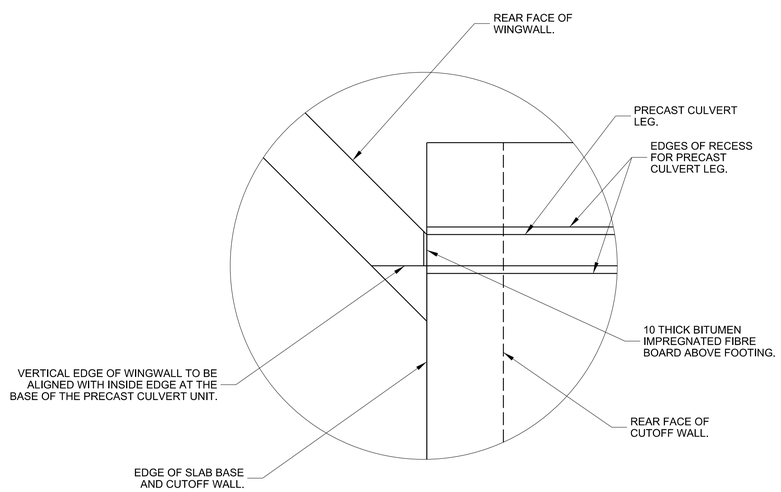
2 WINGWALL TO HEADWALL DETAIL
SCALE 1:10



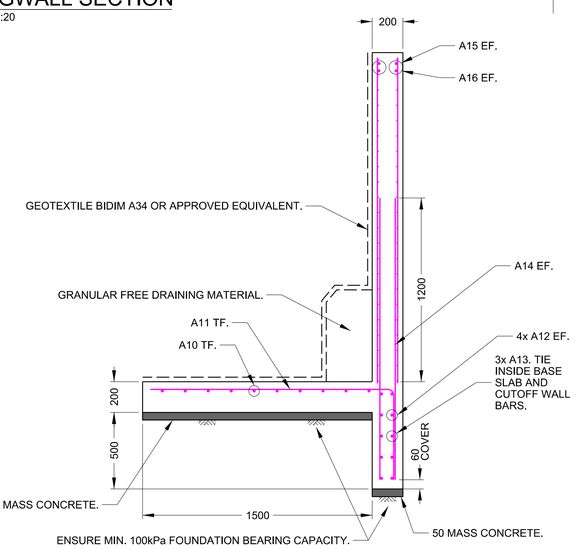
A WINGWALL SECTION
SCALE 1:20



B WINGWALL ELEVATION
SCALE 1:20



1 WINGWALL TO BASE SLAB DETAIL
SCALE 1:10



C WINGWALL SECTION
SCALE 1:20

1:10 — 0, 200, 400, 600, 800, 1000mm; 200, 100

1:20 — 0, 400, 800, 1200, 1600, 2000mm; 400, 200

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ISS.	DATE	AMENDMENT / REVISION DETAILS
0	11/12/2018	DRAFT FOR REVIEW

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DRAFTED: T. PERUSCO
CHECKED: S. CVETKOVIC
SENIOR ENGINEER: G. SAMIOS

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BUNGENDORE FLOOD MITIGATION WORKS
DETAILED DESIGN DRAWINGS

CHANNEL CULVERT DETAILS
SHEET 3 OF 3

CONTRACT NO. T.B.C.
A1
SCALE @ A1 1:20, 1: 10
CADD ID. -
DRAWING NO. C1313
REV. 0

CONFIRM SCALE — 100mm ON ORIGINAL

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PLOT DATE: 11/12/2018
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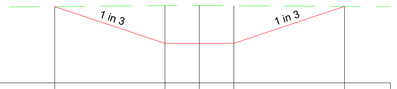
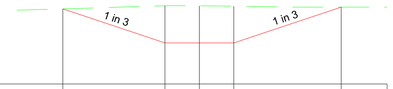


Datum RL 685.00

DESIGN LEVEL (mAHD)	689.98	687.58	687.58	687.58	689.99	
EXISTING LEVEL (mAHD)	689.98	690.04	690.05	690.03	689.99	
OFFSET (m)	-9.45	-2.25	0.00	2.25	9.48	

CH 60.00



Datum RL 685.00

DESIGN LEVEL (mAHD)	689.90	687.68	687.68	687.68	690.02	
EXISTING LEVEL (mAHD)	689.90	690.11	690.10	690.08	690.02	
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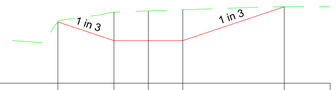
CH 40.00



Datum RL 685.00

DESIGN LEVEL (mAHD)	689.00	687.78	687.78	687.78	689.99	
EXISTING LEVEL (mAHD)	689.00	689.64	689.71	689.79	689.99	
OFFSET (m)	-5.91	-2.25	0.00	2.25	8.88	

CH 20.00

Datum RL 685.00

DESIGN LEVEL (mAHD)	687.95	687.88	687.88	687.88	689.77	
EXISTING LEVEL (mAHD)	687.95	688.78	689.35	689.77	689.77	
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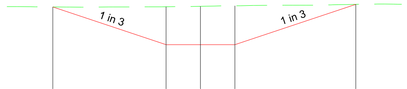
CH 0.00



Datum RL 684.00

DESIGN LEVEL (mAHD)	689.44	686.98	686.98	686.98	689.61	
EXISTING LEVEL (mAHD)	689.44	689.45	689.49	689.52	689.61	
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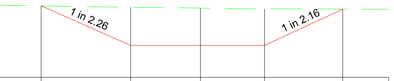
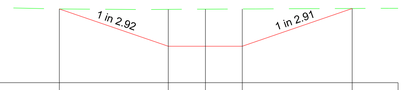
CH 180.00



Datum RL 685.00

DESIGN LEVEL (mAHD)	689.67	687.08	687.08	687.08	689.45	
EXISTING LEVEL (mAHD)	689.67	689.58	689.52	689.46	689.45	
OFFSET (m)	-10.40	-4.56	0.00	4.18	9.29	

CH 160.00



Datum RL 685.00

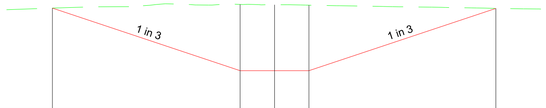
DESIGN LEVEL (mAHD)	689.81	687.38	687.38	687.38	689.84	
EXISTING LEVEL (mAHD)	689.81	689.79	689.80	689.81	689.84	
OFFSET (m)	-9.54	-2.43	0.00	2.40	9.58	

CH 100.00

Datum RL 685.00

DESIGN LEVEL (mAHD)	689.94	687.48	687.48	687.48	689.95	
EXISTING LEVEL (mAHD)	689.94	689.93	689.92	689.93	689.95	
OFFSET (m)	-9.63	-2.25	0.00	2.25	9.66	

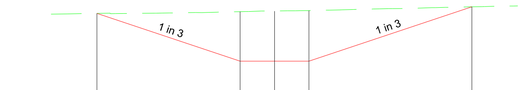
CH 80.00



Datum RL 684.00

DESIGN LEVEL (mAHD)	690.67	686.58	686.58	686.58	690.65	
EXISTING LEVEL (mAHD)	690.67	690.91	690.89	690.86	690.65	
OFFSET (m)	-14.51	-2.25	0.00	2.25	14.46	

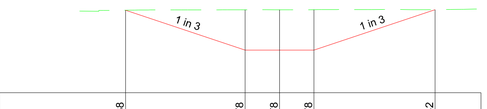
CH 260.00



Datum RL 684.00

DESIGN LEVEL (mAHD)	689.80	686.68	686.68	686.68	690.23	
EXISTING LEVEL (mAHD)	689.80	689.91	689.95	689.98	690.23	
OFFSET (m)	-11.60	-2.25	0.00	2.25	12.89	

CH 240.00



Datum RL 684.00

DESIGN LEVEL (mAHD)	689.38	686.78	686.78	686.78	689.42	
EXISTING LEVEL (mAHD)	689.38	689.41	689.41	689.42	689.42	
OFFSET (m)	-10.06	-2.25	0.00	2.25	10.16	

CH 220.00

Datum RL 684.00

DESIGN LEVEL (mAHD)	689.53	686.88	686.88	686.88	689.42	
EXISTING LEVEL (mAHD)	689.53	689.54	689.52	689.52	689.42	
OFFSET (m)	-10.20	-2.25	0.00	2.25	9.88	

CH 200.00

1:200 0 4 8 12 16 20m
4 2

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EXISTING SURFACE LEVEL

DESIGN SURFACE LEVEL

CLIENT

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DESIGNED S. CVETKOVIC
DRAFTED T. PERUSCO
CHECKED S. CVETKOVIC
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DETAILED DESIGN DRAWINGS

CHANNEL DESIGN CROSS SECTIONS
SHEET 1 OF 2

CONTRACT NO. T.B.C.
SCALE @ A1 1:200
CADD ID. -
DRAWING NO. **C1401**
REV. 0
A1

CONFIRM SCALE 100mm ON ORIGINAL

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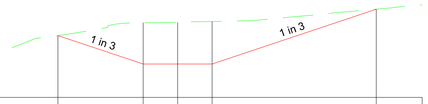
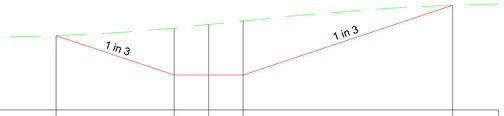
PLOT DATE: 11/12/2018
PLOT TIME: 3:38:49 PM



Datum RL 684.00

DESIGN LEVEL (mAHD)	688.04	686.18	686.18	686.18	689.75	
EXISTING LEVEL (mAHD)	688.04	688.88	688.90	688.95	689.75	
OFFSET (m)	-7.82	-2.25	0.00	2.25	12.97	

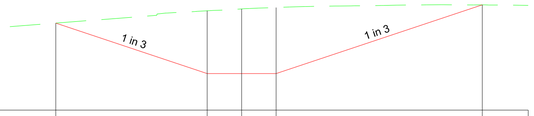
CH 340.00



Datum RL 684.00

DESIGN LEVEL (mAHD)	688.85	686.28	686.28	686.28	690.84	
EXISTING LEVEL (mAHD)	688.85	689.34	689.59	689.82	690.84	
OFFSET (m)	-9.97	-2.25	0.00	2.25	15.93	

CH 320.00



Datum RL 684.00

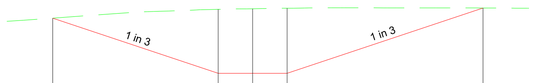
DESIGN LEVEL (mAHD)	689.68	686.38	686.38	686.38	690.87	
EXISTING LEVEL (mAHD)	689.68	690.48	690.61	690.69	690.87	
OFFSET (m)	-12.14	-2.25	0.00	2.25	15.71	

CH 300.00

Datum RL 684.00

DESIGN LEVEL (mAHD)	686.61	686.04	686.04	686.04	687.78	
EXISTING LEVEL (mAHD)	686.61	686.46	686.27	686.37	687.78	
OFFSET (m)	-3.95	-2.25	0.00	2.25	7.47	

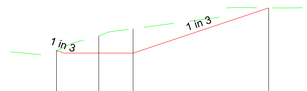
CH 367.34



Datum RL 684.00

DESIGN LEVEL (mAHD)	690.08	686.48	686.48	686.48	690.75	
EXISTING LEVEL (mAHD)	690.08	690.66	690.70	690.73	690.75	
OFFSET (m)	-13.06	-2.25	0.00	2.25	15.05	

CH 280.00



Datum RL 683.00

DESIGN LEVEL (mAHD)	686.25	686.08	686.08	686.08	689.03	
EXISTING LEVEL (mAHD)	686.25	687.20	687.67	687.67	689.03	
OFFSET (m)	-2.75	0.00	2.25	2.25	11.10	

CH 360.00

1:200 0 4 8 12 16 20m
4 2

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DESIGN SURFACE LEVEL

CLIENT

QPRC

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BUNGENDORE FLOOD MITIGATION WORKS
DETAILED DESIGN DRAWINGS

CHANNEL DESIGN CROSS SECTIONS
SHEET 2 OF 2

CONTRACT NO. T.B.C.
SCALE @ A1 1:200
CADD ID. -
DRAWING NO. **C1402**
REV. 0
A1

CONFIRM SCALE 100mm ON ORIGINAL

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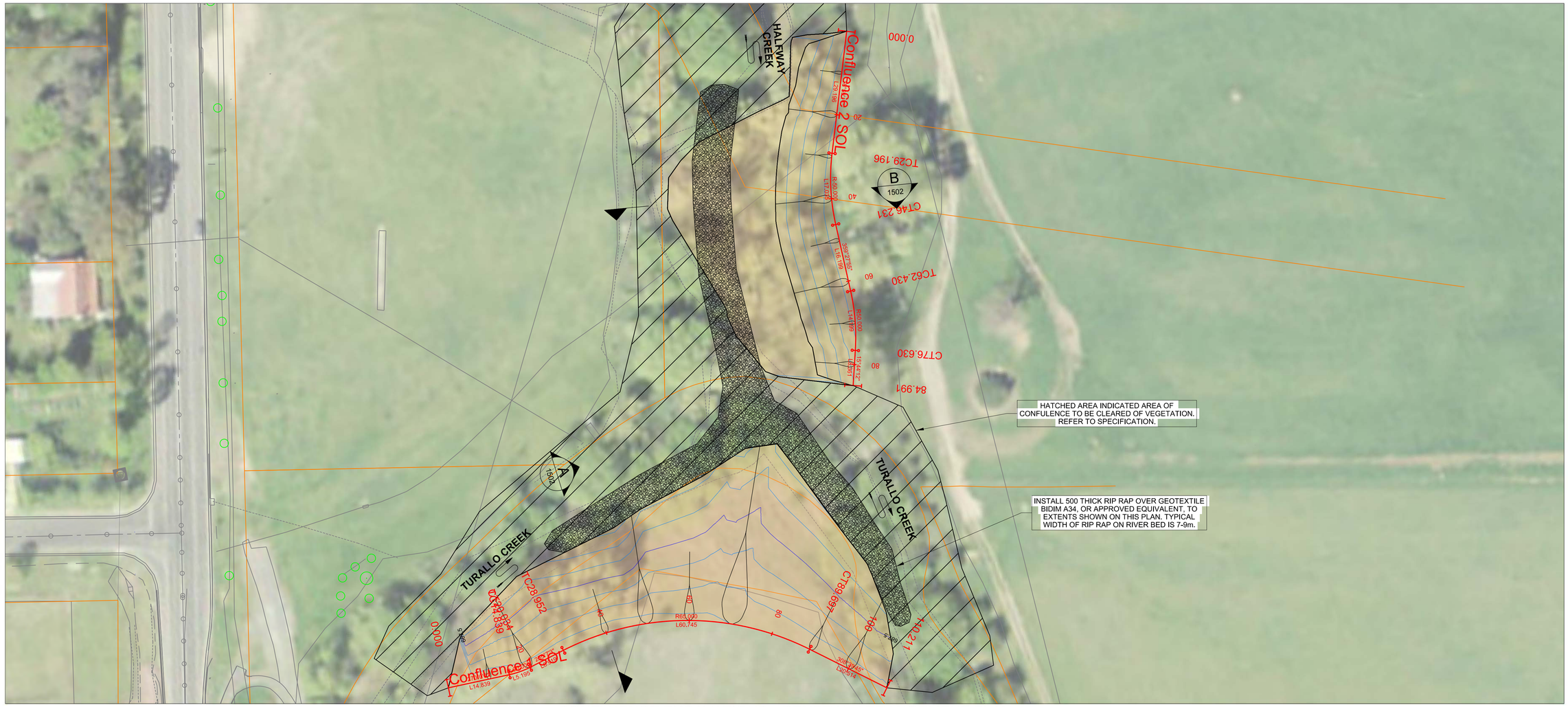
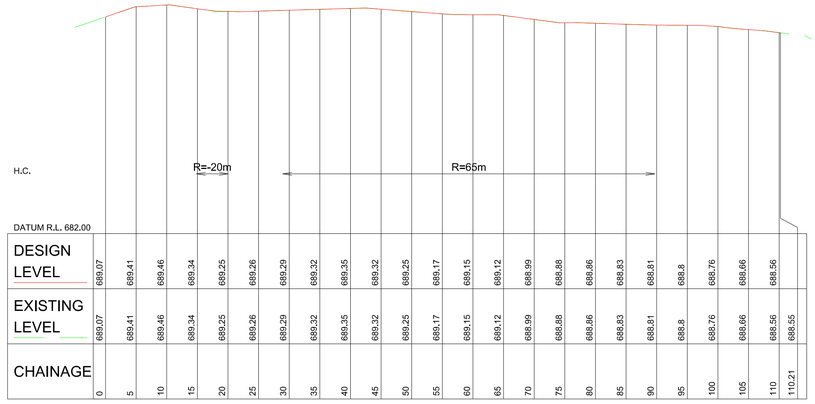


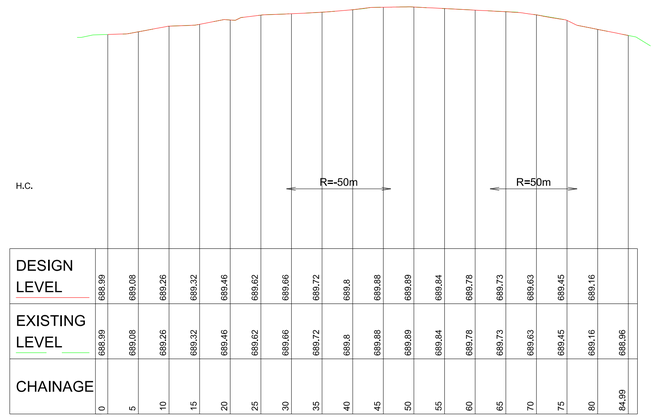
CONFLUENCE EXCAVATIONS - GENERAL ARRANGEMENT PLAN

SCALE 1:500



CONFLUENCE 1 SOL - LONGITUDINAL SECTION

HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100



CONFLUENCE 2 SOL - LONGITUDINAL SECTION

HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100

1:500 — 0 10 20 30 40 50m (10)
1:100 — 0 2 4 6 8 10m (2 1)

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CLIENT: QPRC

NSW GOVERNMENT Public Works Advisory

DESIGNED S. CVETKOVIC
DRAFTED T. PERUSCO
CHECKED S. CVETKOVIC
SENIOR ENGINEER G. SAMIOS

QUEANBEYAN-PALERANG REGIONAL COUNCIL
BUNGENDORE FLOOD MITIGATION WORKS
DETAILED DESIGN DRAWINGS

RIVER CONFLUENCE EXCAVATION AND CLEARING
GENERAL ARRANGEMENT PLAN AND LONGITUDINAL SECTIONS

CONTRACT NO. T.B.C. | A1
SCALE @ A1 1:500, 1:100 | CADD ID. -
DRAWING NO. **C1501** | REV. 0

CONFIRM SCALE — 100mm ON ORIGINAL

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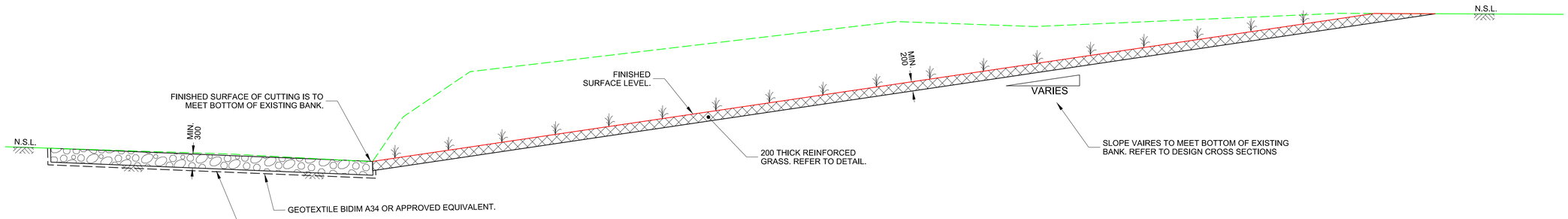
PLOT DATE: 11/12/2018
PLOT TIME: 3:38:56 PM



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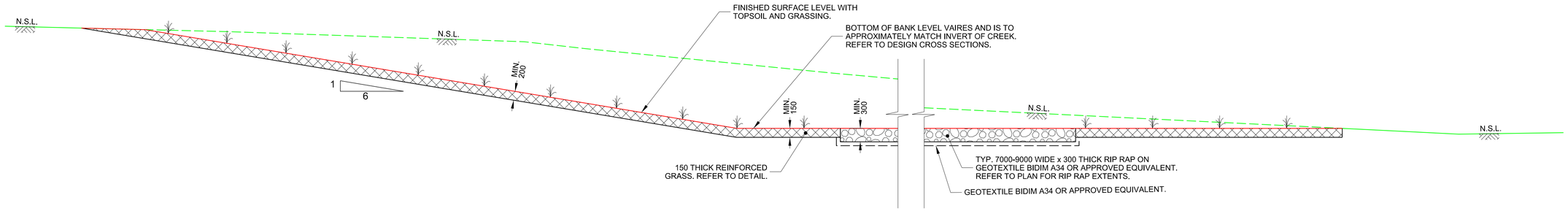
SCALE 1:50



B C1501 CONFLUENCE 2 CUTTING - TYPICAL SECTION
SCALE 1:50

1:50 0 1 2 3 4 5m

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LEGEND
- EXISTING SURFACE LEVEL
- DESIGN SURFACE LEVEL

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BUNGENDORE FLOOD MITIGATION WORKS
DETAILED DESIGN DRAWINGS

TYPICAL CONFLUENCE CUT SECTIONS

CONTRACT NO. T.B.C.
SCALE @ A1 1:50
CADD ID. -
DRAWING NO. **C1502**
REV. 0
A1

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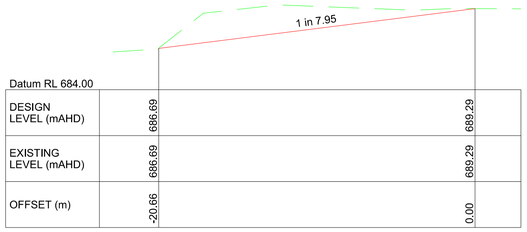

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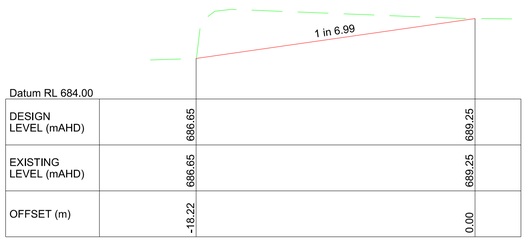

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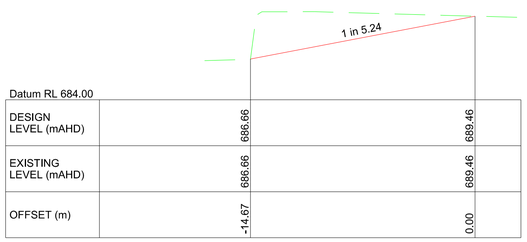
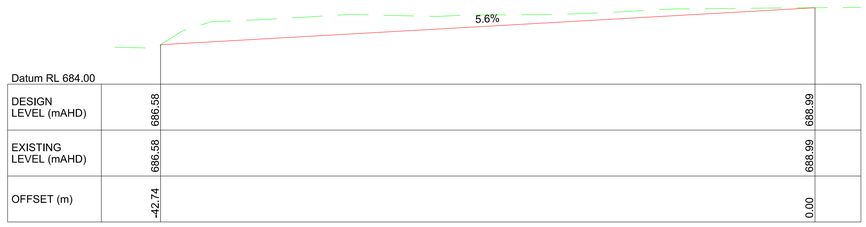


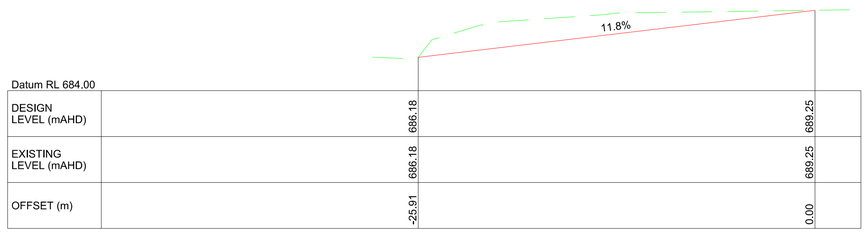
CH 10.00

CH 0.00



CH 70.00

CH 60.00



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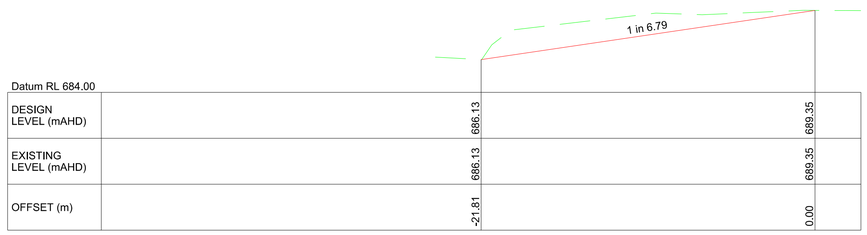

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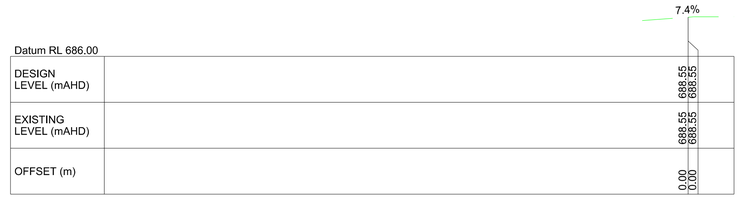
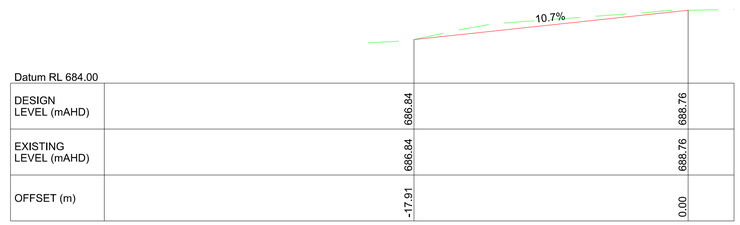


CH 110.21

CH 110.00



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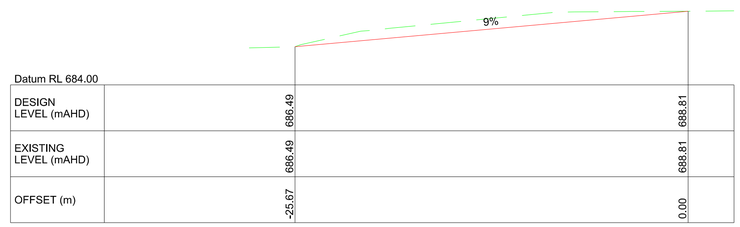

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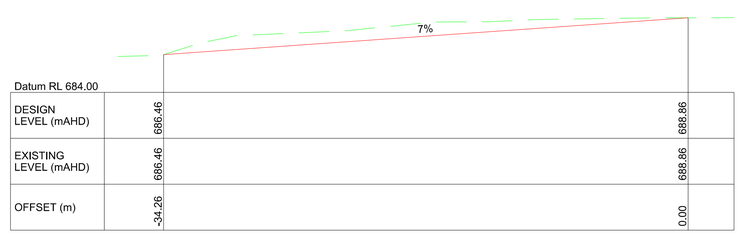

CH 80.00

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4 2

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EXISTING SURFACE LEVEL

DESIGN SURFACE LEVEL

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DRAFTED T. PERUSCO
CHECKED S. CVETKOVIC
SENIOR ENGINEER G. SAMIOS

QUEANBEYAN-PALERANG REGIONAL COUNCIL
BUNGENDORE FLOOD MITIGATION WORKS
DETAILED DESIGN DRAWINGS

RIVER CONFLUENCE EXCAVATION 1
DESIGN CROSS SECTIONS

CONTRACT NO. T.B.C.
A1
SCALE @ A1 1:200
CADD ID. -
DRAWING NO. C1601
REV. 0

CONFIRM SCALE 100mm ON ORIGINAL

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PLOT BY: Peruscot
PLOT DATE: 11/12/2018
PLOT TIME: 3:38:59 PM

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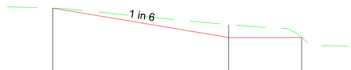

Datum RL 684.00

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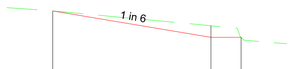
CH 20.00



Datum RL 685.00

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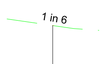
CH 10.00



Datum RL 686.00

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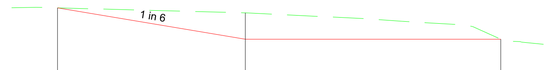
CH 0.00



Datum RL 685.00

DESIGN LEVEL (mAHD)	689.63	687.59	687.59
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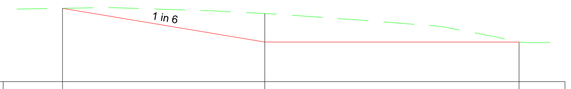
CH 70.00



Datum RL 685.00

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CH 60.00

Datum RL 685.00

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CH 50.00

Datum RL 686.00

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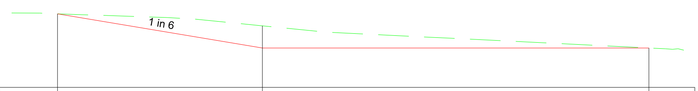
CH 84.99



Datum RL 685.00

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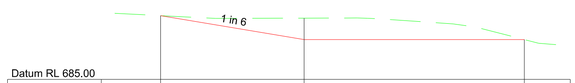

Datum RL 685.00

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OFFSET (m)	0.00	9.37	23.76

CH 80.00

1:200 0 4 8 12 16 20m
4 2

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DESIGN SURFACE LEVEL

CLIENT

QPRC

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SENIOR ENGINEER G. SAMIOS

QUEANBEYAN-PALERANG REGIONAL COUNCIL
BUNGENDORE FLOOD MITIGATION WORKS
DETAILED DESIGN DRAWINGS

RIVER CONFLUENCE EXCAVATION 2
DESIGN CROSS SECTIONS

CONTRACT NO. T.B.C.
A1
SCALE @ A1 1:200
CADD ID. -
DRAWING NO. C1602
REV. 0

CONFIRM SCALE 100mm ON ORIGINAL

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PLOT BY: Peruscot
PLOT DATE: 11/12/2018
PLOT TIME: 3:39:00 PM

Appendix B Safety in Design (SID) Report

PUBLIC WORKS ADVISORY (PWA) SAFETY IN DESIGN (SID) REPORT FOR STRUCTURE THAT HAS UNUSUAL OR ATYPICAL FEATURES

Client name:

Queanbeyan-Palerang Regional Council (QPRC)

Name and address of project:

Bungendore is located approximately 27 km north-east of Queanbeyan, in the Southern Tablelands Region of New South Wales, within the QPRC Local Government Area.

This project concentrates on the Bungendore Flood Risk Management Implementation and. comprises of the three (3) flood mitigation measures to be constructed. These being:

- Removal of dense vegetation and creek re-shaping at the confluence of Turallo, Halfway and Millpost Creeks (referred to as Measure 1 in the FRMP).
- Upgrade of the existing Turallo Terrace levee (referred to as Measure 2 in the FRMP);
- Construction of an overflow channel including construction of a roadway culvert across Tarago Road (referred to as Measure 3 in the FRMP).

Name / Signature of Designer:

Svetlana Cvetkovic | Engineer Civil Projects | PWA Infrastructure Services

Name / Signature of QA Witness:

Kenneth Casey | Manager WHS & Quality | PWA

Date provided to Owner of the Works / Project Manager:

11 December 2018 | Nicole Bailey, South Coast-Capital Snowy

Name / Signature of Representative of Owner of the Works:

Sadia Afrin| Project Engineer| Queanbeyan-Palerang Regional Council

NOTE: Owner = Owner of the Works and is interchangeable with 'Council' and where relevant, 'Client'.

This SID Report is provided in accordance with the requirements of the:

- NSW Work Health and Safety (WHS) Act 2011, Section 22, *Duties of persons conducting businesses or undertakings that design plant, substances or structures,*
- NSW WHS Regulations 2011 Clause 295, and
- WorkCover Code of Practice *Safe Design of Structures*.

The Report details the manageable risks, as a result of identified hazards, in relation to the foreseeable types of engineering handling of the abovementioned design that, as far as the Designer was able to identify during the detailed design phase, would create health and / or safety concerns to persons who are to be associated with the engineering handling lifecycle of the proposed works or structures to be constructed for the flood modification measures. For items beyond the direct control of the Designer, e.g. inherent operational hazards and risks of heavy machinery such as excavators, drilling rigs, cranes, compactors, etc., standard stormwater management plan (SWMP), standard environmental management plan (EMP), standard traffic control plan (TCP), work procedures, etc., it has been assumed that the Contractor / Operator / Owner have established Safe Work Method Statements / Procedures for their employees and the Client.

SFAIRP (so far as is reasonably practicable) and ALARP (as low as reasonably practical) principles have been applied to this report for the people, the environment, the asset(s) and other interfacing / nearby assets to address the identified hazards for the whole-of-asset-life costs and benefits of the structure(s).

This SID Report applies to design of structures that have unusual or atypical features which present risks during:

- ***Construction***
- ***Commissioning / Handover***
- ***Operation and Maintenance (O&M)***

phases that are unique to the particular design.

It is noted that in the process of designing heavy works engineering projects, it will not always be possible to clearly delineate who has responsibility, and in which circumstances, for the elimination and / or mitigation of risks associated with the various structural elements. The duties may be concurrent and overlapping for all parties involved with the engineering handling lifecycle of the structure(s).

It is further noted that the approaches and methodologies eventually adopted for particular elements of the structure(s) during its engineering handling lifecycle often differ to as foreseen during the detailed design phase due to:

- Preference of engineering handling techniques and / or materials;
- Availability of engineering resources;
- Alterations in the operation intents, patterns, output expectations, etc. originally designed for the structure's service;
- Advancement in engineering technologies;

- Design components under the responsibility of the Contractor (i.e. dewatering, flood protection, temporary works, etc., modifications to the original design at the time of construction, etc.);
- Future voluntary / involuntary adaptation of the structure(s) with its changing natural / artificial environment;
- negligence;
- etc.

Therefore, not all hazards and risks are evident at the design, detailed design or design and construct (D&C) documentation phases of the structure(s).

This SID Report <u>does not</u> provide an exhaustive list of every conceivable risk, as a consequence of the existence or eventual occurrence of any types of hazards, that may become evident during the engineering handling lifecycle of the structure(s). Moreover, this Report <u>does not</u> cover 'typical' hazards and risks already inherent within any equipment, procedures, events, etc. that are <u>beyond the direct knowledge / control</u> of the Designer such as standards and WHS requirements of working with heavy machinery, etc. However, for example, larger scale operation interferences such as a crane hitting power lines, an excavator damaging underground services, etc. would be identified and addressed in this Report.

Parties involved in all types of engineering handling in relation to the designed structure(s), as well as the Owner of the Works, have equal responsibility to identify and manage hazards and risks in parallel with the Designer, during and for periods beyond the detailed design phase. It is up to the end-users to be familiar with and evolve this report to assist with their own determination of safety requirements based on the circumstances of their interactions during the lifecycle of the structure(s). Therefore, the Contractor(s) and Owner are encouraged to use this SID Report to establish particular Safe Work Method Statements / Procedures for their employees, tailored to suit the specifics of this project.

SID GENERAL QUICK-TICK LIST

Design Items	Addressed in Design?			Remarks
	Yes	No	Not Applicable	
Geotechnical				
Latest available geotechnical assessment used for the design		✓		The Design has been based on the *Geotechnical Investigation report for Bungendore Floodplain Risk Management Plan Implementation- Report Number ISR 17030 dated February 2018,* prepared by NSW Public Works Advisory. The Contractor is to carry out own geotechnical investigation prior to start of construction works.
Approved earthen engineering materials sourcing location(s) (e.g. borrow area, quarry, etc.) have been identified		✓		The Contractor is to carry out his own investigation and testing of materials prior to start of and during the construction works. Refer to Technical Specifications
Survey				
Latest available site survey used for the design		✓		The Design has been based on survey data supplied by the Client, comprising of: • Areal Land Surveys (ALS) in 3D and site specific survey plans; • Location of existing underground and overhead services; • Location and dimensions of drainage assets; • Work As Executed (WAE) Tarrago Road Bridge Design Drawings including long section of the Tarrago Road centreline. There is no guarantee that the survey data provided would remain identical at the time of construction works. The Contractor is to carry out his own surveys prior to start of construction works.
Civil				
Design caters for the required flood / Owner requested etc. design capacity	✓			The Flood Risk Management consisting of flood mitigation structures like channels, levees, retaining walls, culverts, etc. have been designed to safely cater for the

Design Items	Addressed in Design?			Remarks
	Yes	No	Not Applicable	
				1% AEP design flood event as recommended in the latest available Flood Study.
Trip hazards (e.g. items with height from natural surface / design ground level < 900 mm besides a standard RMS 150 mm high kerb, etc.) have been eliminated from the design			✓	
Steps, stairs, step irons, ladders, etc. facilities have be designed in accordance with AS1657			✓	
Fall hazards (elevation differential of two (2) opened working surfaces > 300 mm) have been protected with min. 1,000 m high guardrails, etc. (refer to AS1657)	✓			Where space permits, the designed slopes have a minimum gradient of 1(V) to 3(H). Guard rail safety barriers along roadway to AS1657 Standards
Maximum engineering slopes designed in accordance with AS1657	✓			Temporary access road slope have been designed at a minimum of 1(V) to 8(H).
Standard access-way widths have been incorporated in the design	✓			Width of temporary access road need to be a minimum of 3m wide for construction traffic.
Standard Factor of Safety (FOS – sliding, overturning, shear, bending, etc.), design live / reduction factors, etc. have been used in the design of sections / structural members	✓			• Min. Factor of Safety (FOS) for existing collapsed river bank = 1.0. • Minimum FOS during construction with a 40 tonne excavator on the existing collapsed bank = 1.1 • Min. Factor of Safety (FOS) for steady state case for river bank stabilisation works = 1.5. • Min. Factor of Safety (FOS) for rapid drawdown case for river bank stabilisation works = 1.3
Bearing capacity of the design structure(s) have been verified	✓			A minimum of 100kPa bearing capacity is specified. Refer to Design Drawings
Mechanical				
Positioning of valve handwheel(s)			✓	
Rotating elements have safety guards			✓	
Access openings are user friendly for retrieval of personnel			✓	
Access ladders (vertical)			✓	
Fasteners for fixing of steelwork to be Min. Grade 8.8			✓	

Design Items	Addressed in Design?			Remarks
	Yes	No	Not Applicable	
Protective coating to be suitable for potable water and in accordance with WSA 201			✓	
All mechanical equipment can easily be accessed for maintenance with sufficient space around equipment			✓	
Electrical				
Switchroom containing switchboards longer than 3 m			✓	
Access clearance in front of switchboard			✓	
Positioning of Main Switch of the switchboard			✓	
Emergency switching including emergency stopping and suitable location of switch			✓	
Electrical pits			✓	
Electrical pit marking			✓	
Environmental				
Latest available environmental assessment used for the design	✓			Refer to the *Review of Environmental Factors (REF), Bungendore Floodplain Risk Management Plan Implementation, Report No. ISR18046 dated April 2018* prepared by NSW Public Works Advisory
Approval to eliminate identified sensitive environmental items to accommodate for the design has been received		✓		Identified sensitive items as per the REF must not be disturbed by the design and construction. A joint site inspection is specified in the technical specifications to identify: • Sensitive environmental items • mature trees to be retained before commencement of clearing operations
The design was carried out with the intention of preserving identified sensitive environmental items	✓			Where practical, the design intent of the proposed flood mitigation works is to preserve the identified sensitive environmental items.
General Safety				
Installation of appropriate warning signage specified in the design	✓			For the road culvert construction, appropriate signs and traffic management procedures will need to be implemented before start of construction. This may involve road

Design Items	Addressed in Design?			Remarks
	Yes	No	Not Applicable	
				closure or provision of temporary road diversion. “Authorised Personnel Only” and “Construction activities within Riverine environment” signages are to be installed at site entry. ‘Hazmat’ signage to be installed in the vicinity of works area. Refer to Technical specifications
Emergency evacuation routes / exits have been incorporated in the design		✓		The Contractor will need to obtain approval from Council for the emergency evacuation routes/exits.
Speed limit of vehicles have been incorporated in the design	✓			Comply with Local Council requirements. In general, a 10kph speed limit will need to be enforced on the construction site/s
Others				
Please see below				

NOTE: *Use the SID Risk Register to address in detail specific design items not listed above.*

CONSEQUENCE PROBABILITY MATRIX

	Probability (Likelihood)			
Consequence	**Very Likely** Could happen any time	**Likely** Could happen sometimes	**Unlikely** Could happen but very rarely	**Very Unlikely** Could happen but probably never will
Very Severe Kill or cause permanent disability or ill health; Complete destruction of the designed structure(s) and / or surrounding infrastructure / environment resulting in major long-term re-engineering works and severe legal penalties.	**1**	**1**	2	3
Severe Long term illness or serious injury; Substantial damages to the designed structure(s) and / or surrounding infrastructure / environment resulting in up to a year of re-engineering works and lengthy legal implications.	**1**	2	3	4
Moderate Medical attention and several days off work; Moderate damages / interruptions to the services offered by the designed structure(s) and / or surrounding infrastructure / environment requiring a mending timeframe of up to 6 months with some legal implications.	2	3	4	5
Minor First Aid needed; Minor damages / interruptions to services offered by the designed structure(s) and / or surrounding infrastructure / environment which could be mended by the Contractor with minimal legal implications.	3	4	5	6

Adapted from WorkCover NSW HAZPAK Worksheet

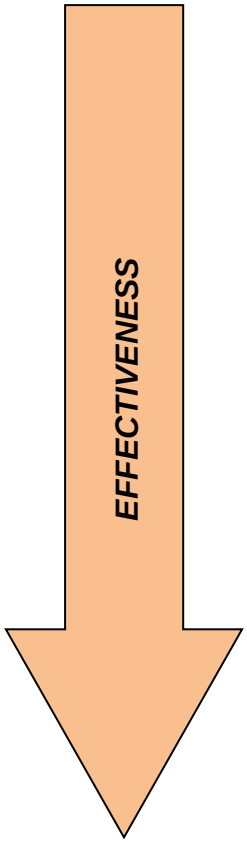
GENERAL DEFINITIONS

A **hazard** is generally defined as a dangerous situation / item, i.e. a source of danger, that has the potential to cause harm and / or damage to people / animals, operating equipment, associated infrastructure and the environment.

A **risk** is generally defined as the occurrence probability of harm and / or damage to the recipient(s) due to the existence of a hazard.

In the context of SID reporting, the risks of identified hazards are to be distinguished by the achievable level of outcome as a result of implementing safety measures, by application of the Hierarchy of Control, for a particular dangerous situation / item.

HIERARCHY OF CONTROL LEVELS



1. **Elimination** – Remove the source of danger so that it no longer exists to cause harm / damage.
   Example: Proposed structure located below existing overhead power lines – remove / relocate overhead power lines prior to construction.

2. **Avoidance** – Relocate the work so that the source of danger no longer exists to cause harm / damage.
   Example: Proposed structure located on flood-prone land – relocate structure to higher grounds outside of inundation area.

3. **Substitution** – Adoption of operation alternatives to carry out the work so that the probability and severity of harm / damage can be eliminated / minimised.
   Example: Conventional sheet pile installation with crane and hammer rig would hit existing overhead power lines – install using silent 'clamp' piler with water jetting in combination with on-site pile welding to satisfy vertical clearance requirements.

4. **Isolation** – Isolate the potential recipient from the source of danger by temporary relocation so that the probability and severity of harm / damage can be minimised.
   Example: Structure located on flood-prone land – evacuate the structure and / or prevent access to the structure during early phase of critical storm / flood events.

5. **Engineering** – Protect the potential recipient from the source of danger with engineering solutions so that the probability and severity of harm / damage can be minimised.
   Example: Structure located on flood-prone land – construct / install flood barriers to prevent inundation of structure.

6. **Administration** – Notify the potential recipient of the source of danger on-site so that the probability and severity of harm / damage can be minimised.
   Example: warning signage, flood meter, speed humps, bollards, buoys, lighting, etc.

7. **Personal Protection Equipment (PPE)** – Potential recipient to administer on-body protection so that the probability and severity of harm / damage can be minimised.
   Example: formal training, helmet, steel cap boots, safety vests, rope harness, hazmat suit, etc.

Therefore, for the purpose of preparing the SID Report:

- An *eliminated risk* is a hazard that can be **eliminated / avoided** by the implementation of safety measures such that its occurrence probability and resultant severity would subsequently become 'very unlikely' to 'no chance' (e.g. a permanent structure designed at a location where overhead power lines exist – possible safety measures: relocate overhead power lines; relocate structure; etc.).

  If a Hierarchy of Control Level of 1 or 2 ***can*** *be effectively applied, then the hazard would be classified as an eliminated risk, as the source of danger* ***can*** *be made absent.*

- A *residual risk* is a hazard that can only be **mitigated** by the implementation of safety measures such that its occurrence probability and resultant severity would subsequently be lowered following the ALARP principle (e.g. a permanent structure designed at a location where overhead power lines exist but both items cannot be relocated – possible safety measures: ensure overhead power lines are offline during construction / operation of the structure; ensure power lines are clearly marked and mobile machineries in association with the structure comply with safe working clearances as instructed by the service provider; etc.).

  If a Hierarchy of Control Level of 1 or 2 ***cannot*** *be effectively applied, then the hazard would be classified as a residual risk, as the source of danger* ***cannot*** *be made absent.*

It is possible that this SID Report does not identify any straight forward obvious hazards as the elimination and avoidance of sources of danger could already be inherent attributes of the original design intent.

SID RISK REGISTER

Situation ID	Description of Situation	Routine Situation during Lifecycle Phase? (Yes / No)	Consequence Probability Rating (prior to actioning of Safety Measure(s))	Hierarchy Control Level of implementable Safety Measures	Safety Measure(s) to be actioned	Consequence Probability Rating (post actioning of Safety Measure(s))	Lifecycle Phase of Action	Action implemented by	Action verified by	Action monitored / maintained by
1 – CONSTRUCTION PHASE										
1.1 – Eliminated Risks										
1.1.1	Contractor has extensive experience and expertise in the type of construction works. Sub-contractors have extensive experience and expertise in the type of construction works they are involved in.	Yes	1	1,2	The designer (NSW Public Works Advisory) assumes that the selected Contractor is fully qualified in terms of capability, capacity, skills, relevant experience and expertise etc. To be determined at tender stage: • Demonstrated capabilities in the construction of similar flood mitigation works including river bank stabilisation /restoration works especially in riverine and water environments; • Demonstrated capability of the works and a thorough understanding of the environmental management procedures required, eg erosion and sediment controls including provision of floating sediment boom fence in the river; • Demonstrated capability of demolition, earthworks, concrete construction and landscaping works; • Experience and past performance in comparable projects; • Ability and experience of key project personnel in comparable projects and proposed staff organisation; • Proposed construction program, Method Statements and methodologies; • Understanding of	6	Contractor selection	Designer, Owner, Project Manager	Designer, Owner, Project Manager	Project Manager

Situation ID	Description of Situation	Routine Situation during Lifecycle Phase? (Yes / No)	Consequence Probability Rating (prior to actioning of Safety Measure(s))	Hierarchy Control Level of implementable Safety Measures	Safety Measure(s) to be actioned	Consequence Probability Rating (post actioning of Safety Measure(s))	Lifecycle Phase of Action	Action implemented by	Action verified by	Action monitored / maintained by
					environmental management requirements. Ensuring the selected Contractor has the right mix of capabilities is critical to ensuring successful construction outcomes for the project and in terms of recognising and managing WHS risks.					
1.1.2	WHS Management (Construction of the Works by the Contractor)	Yes	1	2	All works and site areas. Contractor must comply with the *Specification* (General Conditions, Preliminaries and Technical Specifications). Contractor must comply with WHS Act 2011 (NSW), WHS Regulation 2011 (NSW), NSW Government "Occupational Health and Safety Management Systems Guidelines", all statutory requirements, relevant codes of practice and Australian Standards. Refer to the *Specification* for requirements. Contractor to submit Project WHS Work Management Plan to the Principal's Authorised Person for approval before start of construction.	6	Contractor	Contractor	Site Project Manager	Site Project Manager
1.1.3	Culture for management of the Contract	Yes	1	1,2	The parties (Principal and Contractor) must establish a culture of co-operation, effective communications and teamwork for the management and implementation of the Project; i.e. in accordance with the requirements and intent of the Contract.	6	Contractor/Site Project Manager	Designer, Owner, Project Manager	Contractor/Site Project Manager	Contractor/Site Project Manager
1.2	**Residual Risks**									
1.2.1	Staging of the works	Yes	1	1,2,5	The works will be carried out in stages, eg at any one time no accumulated length of river bank or channel longer than 30 lineal	5	Contractor/Site Project Manager	Contractor	Site Project Manager	Site Project Manager

Situation ID	Description of Situation	Routine Situation during Lifecycle Phase? (Yes / No)	Consequence Probability Rating (prior to actioning of Safety Measure(s))	Hierarchy Control Level of implementable Safety Measures	Safety Measure(s) to be actioned	Consequence Probability Rating (post actioning of Safety Measure(s))	Lifecycle Phase of Action	Action implemented by	Action verified by	Action monitored / maintained by
					metres is to be left stripped of topsoil and natural protective vegetation. For the culvert construction, it is anticipated that the work will be carried out in 2 stages, that is closing one side of the Tarago Road to construct the culvert. This will involve some traffic management and/or traffic diversion.					
1.2.2	Sequence of the river bank restoration, channel/levee construction, rock revetment and landscaping works	Yes	1	1,2,5	The flood mitigation works will involve carrying out earthworks to reshape the collapsed bank surfaces into a smooth gentle alignment along the river with stable banks. Construction of channels and levees including the required flood mitigation structures, eg retaining walls, culverts, as specified. Rock revetment will need to start by constructing the rock rip-rap located at the upstream end bed of the river, including installation of turf and reinforced grass on the banks	4	Contractor/Site Project Manager	Contractor	Site Project Manager	Site Project Manager
1.2.3	Temporary signs, fencing, barricades, site security and exclusion of the public	Yes	1	1,2,5	At each stage of construction, the Contractor is required to put up temporary signs, fencing and barricades to exclude public from the works area. Contractor is also required to provide site security. Refer to the Technical *Specification* for requirements.	5	Contractor/ Site Project Manager	Contractor	Site Project Manager	Site Project Manager
1.2.4	Existing site services, eg water, power, telecom, gas etc. which may obstruct the works or need to be relocated or diverted.	Yes	1	1,2,5	Before Construction activities are commenced, the Contractor is to contact Service Authorities responsible for services to ascertain location and status and requirements for continued	4	Contractor	Contractor	Site Project Manager	Site Project Manager

Situation ID	Description of Situation	Routine Situation during Lifecycle Phase? (Yes / No)	Consequence Probability Rating (prior to actioning of Safety Measure(s))	Hierarchy Control Level of implementable Safety Measures	Safety Measure(s) to be actioned	Consequence Probability Rating (post actioning of Safety Measure(s))	Lifecycle Phase of Action	Action implemented by	Action verified by	Action monitored / maintained by
					operation. If required, service relocations may be required. Refer to the Technical *Specification* for requirements.					
1.2.5	Site Access during construction and traffic management.	Yes	1	1,2,5	Contractor is to ensure: • traffic management procedures and controls are in place, • construction traffic accesses the site(s) by approved route(s). • provision of safe and temporary access for Heavy Road Vehicles during construction. • provision of traffic management along the local public roads, etc. during construction for normal traffic, construction truck movements and earthmoving plant/equipment. Refer to the Technical *Specification* for requirements. Contractor to submit Project Work Management Plans including Traffic Management Controls to the Principal's Authorised Person before start of works	5	Contractor	Contractor	Site Project Manager	Site Project Manager
1.2.6	Contractor fully aware of all obligations and accountabilities in respect of temporary works, carrying out design work and in providing appropriately detailed work plans and work method statements, which are acceptable to the Principal's Authorised Person	Yes	1	1,2	Contractor to undertake design of temporary works such as staging of works, dewatering & flood protection provisions, shoring of and/or safe batters in excavations, propping of existing structural elements etc. Contractor to submit Work Management Plans to the Principal's Authorised Person Refer to the Technical *Specification* and Drawings for	4	Contractor	Contractor	Site Project Manager	Site Project Manager

Situation ID	Description of Situation	Routine Situation during Lifecycle Phase? (Yes / No)	Consequence Probability Rating (prior to actioning of Safety Measure(s))	Hierarchy Control Level of implementable Safety Measures	Safety Measure(s) to be actioned	Consequence Probability Rating (post actioning of Safety Measure(s))	Lifecycle Phase of Action	Action implemented by	Action verified by	Action monitored / maintained by
					requirements.					
1.2.7	Contractor fully aware and cognisant with site conditions and site information.	Yes	1	1,2	Contractor to undertake own investigations to manage risks.eg weather especially large storm events, river water levels, embankment pore pressures, including heavy road vehicle/machinery loadings on the collapsed and "meta-stable" river banks including soft grounds during construction phase. Refer to the Technical *Specification* and Drawings and to the Site Information documents.	4	Contractor	Contractor	Site Project Manager	Site Project Manager
1.2.8	Contractor fully aware and cognisant with site services and site information.	Yes	1	1	Contractor to undertake own investigations to manage risks.eg contact Dial before you dig, carry out additional survey with services locator, etc. Refer to the Technical *Specification* and Drawings and to the Site Information documents	4	Contractor	Contractor	Site Project Manager	Site Project Manager
1.2.9	Environmental condition affecting persons – noise, air quality, dust management, delivery and storage of fuels and chemicals, handling and disposal of grey water, waste management, accidental chemical spillages and incident management etc.	Yes	1	1,2	Contractor to submit detailed Construction Environmental Management Plan (CEMP) to the Principal's Authorised Person before start of works. Refer to the Specification	5	Contractor	Contractor	Site Project Manager	Site Project Manager
1.2.10	Clearing of trees and vegetation – risk of trees falling on private property, persons, etc.	Yes	1	1,2,5	Contractor to submit detailed Construction Environmental Management Plan (CEMP) including the hiring of a tree specialist or Arborist. Refer to the *Specification*.	5	Contractor	Contractor	Site Project Manager	Site Project Manager
1.2.11	Hazardous Materials	Yes	1	1,2	Give notice immediately if hazardous materials or conditions are found, including the following: a) Asbestos or material	4	Contractor	Contractor	Site Project Manager	Site Project Manager

Situation ID	Description of Situation	Routine Situation during Lifecycle Phase? (Yes / No)	Consequence Probability Rating (prior to actioning of Safety Measure(s))	Hierarchy Control Level of implementable Safety Measures	Safety Measure(s) to be actioned	Consequence Probability Rating (post actioning of Safety Measure(s))	Lifecycle Phase of Action	Action implemented by	Action verified by	Action monitored / maintained by
					containing asbestos. b) Flammable or explosive liquids or gases. c) Toxic, infective or contaminated materials. d) Radiation or radioactive materials. e) Noxious or explosive chemicals. f) Tanks or other containers which have been used for storage of explosive, hydrocarbons, toxic, infective or contaminated substances. Refer to the *Specification*.					
1.2.12	Stability of the existing structures including buildings, river banks, existing services, trees to be preserved, etc. when carrying out the earthworks for the channel and levee construction. Stability issues could range from small localised slips and/or large scale slumps which could threaten the integrity of the nearby structures, river banks and levees.	Yes	1	1,2,5	Contractor to provide temporary protection works and shoring of the existing buildings and structures. Contractor to submit Project Work Method Statements or Management Plans to the Principal's Authorised Person before the start of works. Refer to the *Technical Specification* and Drawings.	5	Contractor	Contractor	Site Project Manager	Site Project Manager
1.2.13	Flood risk allocation (Contractor and Principal).	Yes	1	1,5	The Contractor is to: • take out flood insurance. Also, the Contractor will need to provide on-site: catch drains, pumps, etc., to divert storm and flood waters away from construction works areas, etc. • will need to monitor the weather conditions, river levels and flood forecast event/s • In the event of flooding Contractor is to take prompt action to remove persons, plant, materials and equipment from work areas	5	Contractor	Contractor	Site Project Manager	Site Project Manager

Situation ID	Description of Situation	Routine Situation during Lifecycle Phase? (Yes / No)	Consequence Probability Rating (prior to actioning of Safety Measure(s))	Hierarchy Control Level of implementable Safety Measures	Safety Measure(s) to be actioned	Consequence Probability Rating (post actioning of Safety Measure(s))	Lifecycle Phase of Action	Action implemented by	Action verified by	Action monitored / maintained by
					Contractor to submit Project Work Management Plans to the Principal. Refer to the *Technical Specification and Drawings* for sequencing the works, construction constraints risk allocation and other related requirements.					
1.2.14	Construction activities for the riverbank stabilisation works and levee works in close proximity to river – workers / equipment / materials falling into the river	Yes	1	3, 5, 6, 7	The Contractor is to: • Install temporary safety barriers shall be installed along river bank. • place stockpiles with a minimum of 10 m away from the nearest water course/channel/river. The stockpiles should be protected using silt fences, barriers and adequately covered / protected. • Install Danger / warning signage that are visible for all personnel. • Due to limited working space on river bank, select the appropriate plant and equipment for the construction works. Contractor and all personnel on the works site must wear PPE protective gear. If applicable, approved floatation equipment, rope and harness gear should be used when required to work on the river bank and levee slopes.	4	Contractor	Contractor	Site Project Manager	Site Project Manager/Safety officer

Situation ID	Description of Situation	Routine Situation during Lifecycle Phase? (Yes / No)	Consequence Probability Rating (prior to actioning of Safety Measure(s))	Hierarchy Control Level of implementable Safety Measures	Safety Measure(s) to be actioned	Consequence Probability Rating (post actioning of Safety Measure(s))	Lifecycle Phase of Action	Action implemented by	Action verified by	Action monitored / maintained by
1.2.15	Restoration works include: • site access roads • levees (if damaged) • general landscaping and re-grassing The restoration works requires the use of plant, equipment and power tools and other electrical operated equipment. There is a risk of electrocution and fire. Manual handling activities. Slip hazard. Jacking of structural steel. Preparation for and placement of large earthfill and free draining materials. Preparation for and placement of large rock boulders and concrete.	Yes	1	1,2	As per Specifications On grass cover or re-grassing, the Contractor is responsible for the proper establishment and continued watering, returfing, reseeding of bare patches where necessary and general maintenance of all grassed surfaces under the Contract Contractor to provide suitable, plant/equipment and on-site fire fighting equipment as there is a risk of fires, ignited by sparks from construction equipment. Contractor to provide effective safe work systems, procedures, communications and backup systems to warn all personnel on-site of the hazardous work activities. This includes informing all personnel of plant/equipment to be used onsite, materials supply like earthfill, rip rap, precast culverts, etc. to be delivered and storage areas onsite, concrete pour commencement ,etc). Contractor to submit Project Work Management Plans to the Principal's Authorised Person. Refer to the Technical *Specification* for requirements. See item "WHS Management (Construction of the Works by the Contractor)" above	5	Contractor	Contractor	Site Project Manager	Site Project Manager
2 – COMMISSIONING / HANDOVER										
2.1 – Eliminated Risks										
2.1.1	Nil									
2.2 - Residual Risks										
2.2.1	Nil									
3 – OPERATION AND MAINTENANCE PHASE (O&M)										

Situation ID	Description of Situation	Routine Situation during Lifecycle Phase? (Yes / No)	Consequence Probability Rating (prior to actioning of Safety Measure(s))	Hierarchy Control Level of implementable Safety Measures	Safety Measure(s) to be actioned	Consequence Probability Rating (post actioning of Safety Measure(s))	Lifecycle Phase of Action	Action implemented by	Action verified by	Action monitored / maintained by
3.1 – Eliminated Risks										
3.1.1	Open channels and Levees especially during floods or high water level river flows	Yes	3	1	Council to: • conduct safety programmes to educate local residents and school children about living close to the open channels/levees during floods. • install safety signs	5	Council	Council	Owner, Operator	Owner, Operator
3.1.2	Turf Grass and Reinforced grass	Yes	3	1	• Council to carry out watering and irrigation of turf grass and Reinforced grass until plants are established.	5	Council	Council	Owner, Operator	Owner, Operator
3.2 – Residual Risks										
3.2.1	Floods and Falling into river from riverbank and levees	Yes	2	5, 6, 7	• Install safety signs • Design safety rails with 'falling danger' sign on crest of structure. • Apply rope and harness gear, and appropriate PPE, to safety rails when working in near river or extreme weather conditions.	4	Council	Council	Owner	Owner with SWMS
3.2.2										
4 – DECOMMISSIONING, DEMOLITION AND DISPOSAL (DD&D)										
4.1 – Eliminated Risks										
4.1.1	Nil									
4.1.2										
4.2 – Residual Risks										
4.2.1	As above									

NOTE: *Do not delete any lifecycle phases in the above table that are considered not applicable to the designed structure(s). Provide explanation where considered not applicable to be addressed.*

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