Table 1 RORB input details

	Unit	
Kc Factor		From Eqn 3.23, ARR, Weeks: Kc=0.88 x A^0.53
m		0.80
Initial Loss	mm	52.0 (Constant with AEP) (Geoscience Australia 2016)
Continuing loss	mm	1.7 (Constant with AEP) (Geoscience Australia 2016)
Temporal pattern		ARR2016 areal temporal patterns
Spatial pattern		Uniform
Areal Red. Fact		Based on ARR 2016 (Book 2 Chapter 4)
Fraction impervious		Ranged from 0 to 0.1
Channel type		Natural

2.3. Results

The RORB model produces a series of peak discharge estimates using an ensemble method. The rainfall event duration with the highest mean discharge was selected as the critical event, at each AEP (annual exceedance probability). The critical event duration differs between catchments, sub-catchments and AEP, reflecting the storage and attenuation differences throughout the catchment.

Three key results are provided from the model.

1. **Peak discharge:** The peak discharge is the maximum flow rate at the point of interest, shown as cubic metres per second.

2. **Peak event duration:** The peak event duration is the rainfall event which is predicted to result in the highest peak discharge.

3. **Time to peak:** The time to peak discharge is the length of time after the start of the rainfall event, that the peak discharge is experienced at the point of interest. This will vary based on the temporal pattern.

2.3.1. Peak Discharge Results

The range of peak discharge results at the outlet of the catchment (i.e., downstream of the ski park) for the critical duration 10%, 5%, 2%, 1%, 0.2% AEP events and the PMF are shown in Table 2. The selected critical hydrograph for each AEP is shown in Figure 3.

Table 2 Critical peak discharges – Proposed Ski Park

AEP	Pre Developed			
	Duration (min)	Average Q (m^3/s)	Median Q (m^3/s)	Critical Q (m^3/s)
PMF	1,440	6,735	6,762	**6,844**
0.2% AEP	1,440	1,587	1,595	**1,641**
1% AEP	1,440	1,149	1,131	**1,140**
2% AEP	1,440	929	898	**903**
5% AEP	1,440	669	632	**639**
10% AEP	1,440	478	461	**466**

2.3.2. Pre vs Post development conditions

The pre-developed conditions reflect the existing site land uses. The post-development hydrological RORB model was not altered as the ski park does not significantly increase the impervious area of the catchment and will therefore result in minimal change in volume or peak discharge. The potential impacts of the ski park will primarily be due to the change in flood plain configuration.

There is no contributing catchment to the ski park. The direct rainfall on the surface of the ski park will result in an increase in water level within the facility. Unless the direct rainfall results in the facility overtopping, this will not result in an increase in flood level at the points of interest.

2.4. Model Calibration and Validation

Model calibration is the optimisation of model variables to meet an observed output. Model validation is undertaken by independently modelling measured events (such as the 1990 flood) using the calibrated model, outside of the calibration period. Where the modelled and actual results are similar, the model is validated.

Due to the lack of available data within the study catchment, no direct calibration or validation of the hydrology model was carried out. Instead, comparisons were made with the results of a previous flood study – the Queensland Reconstruction Authority (QLDRA) Flood Hazard Mapping for Barcaldine (Atiquzzaman and Britton 2013) – and an alternative method, the Regional flood frequency estimation (RFFE).

2.4.1. Regional Flood Frequency Estimation

The RFFE is a tool produced through the Australian Rainfall and Runoff Guide (ARR) update project (Rahman and Haddad 2015), intended to provide an estimate of the peak discharge in large, ungauged catchments. Only events up to 1% AEP are estimated through the RFFE tool.

The results of this method Table 3 showed that whilst the modelled peak discharges were within the range of the RFFE results, the modelled results were much greater. For example, the 1% AEP modelled discharge was 1,140 m3/s. This is almost double the predicted discharge but less than half of the 95% confidence result. This is likely due to the location and characteristics of the catchment. Catchments with the following characteristics typically have a lower accuracy:

- Less than 0.5 km^2 or greater than 1,000 km^2 – not applicable, catchment area meets criteria.
- Located further than 300 km^2 from the nearest gauged catchment used in the RFFE calculations – not applicable, 243 km.
- Catchments in the arid zones - Barcaldine is classified as 'fringe arid / east coast' for the purposes of these calculations (Ball et al. 2016, bk. 3 ch 3 fig 3.3.2).

Table 3 Flow comparisons – ACS modelled vs Regional Flood Frequency Estimation

AEP (%)	RFFE Discharge (m^3/s)	Lower Confidence Limit (5%) (m^3/s)	Upper Confidence Limit (95%) (m^3/s)	Modelled Discharge (m^3/s)
10	269	71.3	1120	**466**
5	370	94.1	1590	**640**
2	478	119	2080	**900**
1	608	146	2710	**1,140**

2.4.2. Queensland Reconstruction Authority Model

Flood modelling was carried out by the Queensland Reconstruction Authority (QRA) in 2013 (Atiquzzaman and Britton 2013). The 1 % AEP peak discharge was estimated in that study, based on a flood frequency analysis downstream at the Alice River, to be 1,205 m3/s, similar to that estimated using the RORB model. The higher frequency events however, resulted in larger differences in flow, Table 4

The hydrology estimates made using RORB were accepted for use in the flood inundation modelling.

Table 4 Flow comparisons – ACS modelled vs QRA 2013 flood frequency analysis

AEP (%)	QRA Flood frequency analysis peak Discharge (m^3/s)	Modelled Discharge (m^3/s)
10	270	**466**
5	460	**640**
2	840	**900**
1	1,300	**1,140**
0.2	3,100	**1,641**

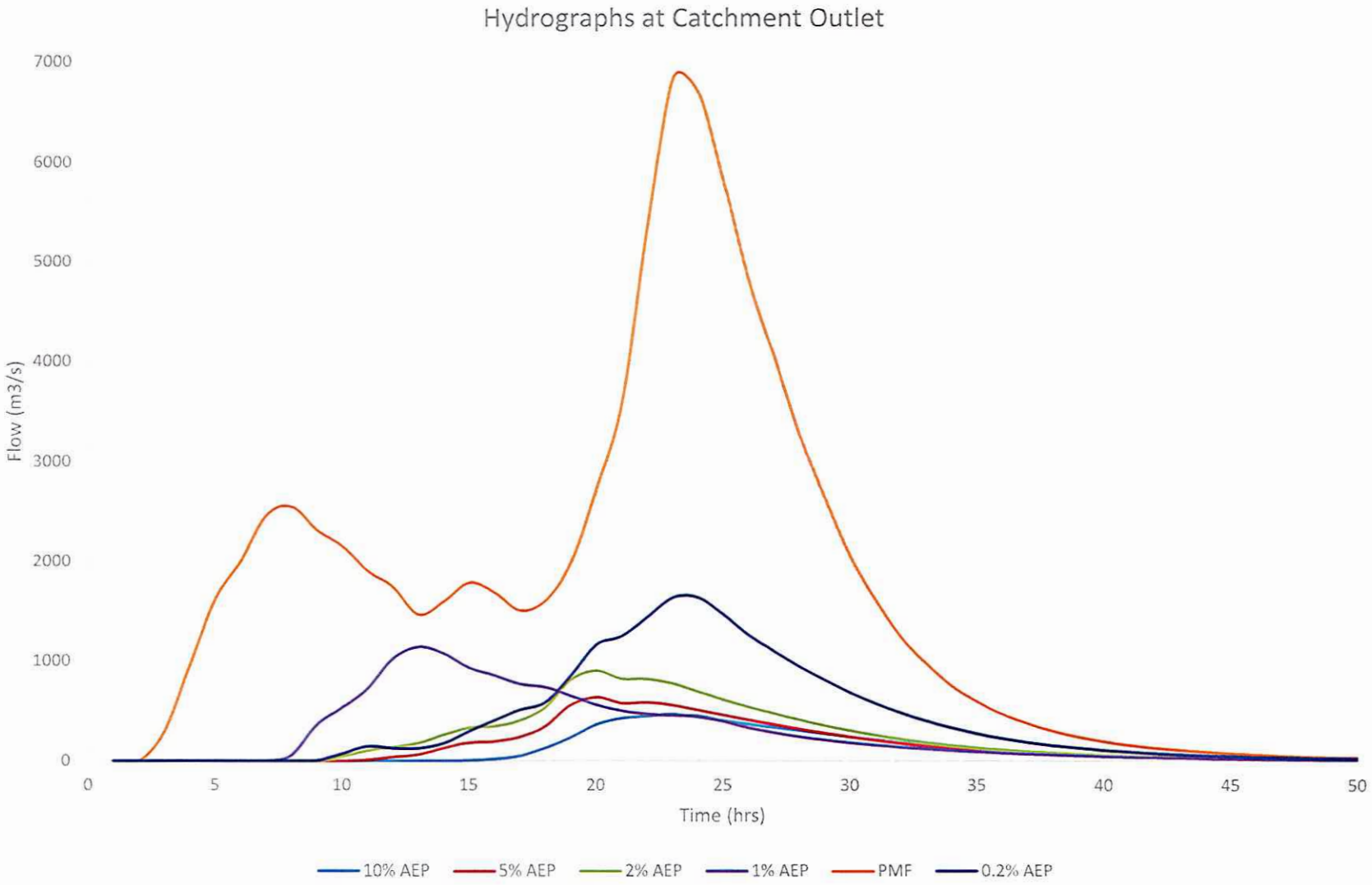

Figure 3 Peak Discharge Hydrographs, at the catchment outlet

3. Flood Inundation Modelling

A flood model was produced using HEC-RAS 2D (Version 5.0.3) (USACE 2016), to assess the potential change in flood impacts at the points of interest. The outputs of the flood inundation modelling included the depth at the points of interest and depth, velocity and flood hazard across the assessment area.

3.1. Scenarios

Following from the previous modelling undertaken and assessment of the results of that, two scenarios were chosen to be modelled within HEC-RAS to provide an understanding of the potential impacts from the detailed design of the development.

- Scenario 1 – Pre-developed, existing conditions with channel at the Landsborough Highway culverts
- Scenario 2 – Post-developed conditions, inclusive of SMK ski lake design and ACS Engineers spillway design, channel at the Landsborough Highway culverts and de-silted Lagoon Creek.

3.2. Inputs

The model inputs are included in Table 5 and a model was run for each of the events required (PMF, 0.2, 1, 2, 5, 10% and 50% AEP) for both scenarios.

Table 5 HEC-RAS 2D Model Inputs

Input Category	Data	
Mesh	10 metres	
Breakline cell Spacing	Varies (2 m – 12 m)	
Initial ramp up period	2 hour	
Computation interval	20 seconds	
Model Duration	100 hours Note: The duration of the model captured the inundation effects of the flood peak at the subject site. This duration did not model the full flood duration due to run time limitations (i.e., water level had not returned to zero during the modelled duration).	
Mannings / Landcover	Bare grasslands	0.03
	Racecourse / golf club	0.035
	Rural-res w/shrubs	0.037
	Shrubs	0.04
	Sparse	0.035
	Stream	0.04
	Urban area (semi-arid)	0.025

3.2.1. Model Geometry

LiDAR data was sourced through the Elevation Foundation Spatial Data (ELVIS) website, which provides free access to the Geoscience Australia and Queensland Government spatial data sets (ANZLIC 2017). The 1 m DEM data from Qld Government was selected and processed for use within QGIS and HEC-RAS.

The topography was input to HEC-RAS and a 2D mesh was created. The mesh was formed on a 10 m grid; however, each cell is able to be created with up to 8 sides. Roads, embankments, and other areas of significance were digitised as breaklines within the HEC-RAS model to force a refined 2D mesh in those zones.

The Landsborough Highway crossing is a series of culverts. The culverts were not modelled within HEC-RAS and instead the model used a channel in place of the culverts. This treatment is likely to reduce the backwater flooding effects upstream of the highway by allowing free flow through the crossing (potentially decreasing the estimated flood impacts upstream); however, this better estimates the flooding downstream.

3.2.2. Ski Park Design

The post-developed scenario modelled the ski park design by SMK and the subsequent spillway design prepared by ACS Engineers. The ski park has been designed by SMK to include an operating water level of 257.1 m AHD, a spillway level of 258.5 m AHD, and top of embankment level of 259.4 m AHD.

Appendix A and B include design details.

3.3. Results

The results of the model showed the flood inundation depths, velocity and the flood hazard across the assessment area. The post developed scenario is estimated to result in an increased flood inundation depth at all points of interest.

The flood inundation maps are provided on Figures 2 through to 40 (Appendix E) and in Table 8 and Table 9.

Based on the modelling process and inputs adopted, and the lack of event based data available to improve the model accuracy, the results generated from all of the modelled scenarios must be considered to have an accuracy of approximately +/-0.5m.

3.4. Model Calibration and Validation

Model calibration is the optimisation of model variables (roughness factors, grid size, blockages) to meet an observed output. Model validation is undertaken by independently modelling measured events (such as the 1990 flood) using the calibrated model, outside of the calibration period. Where the modelled and actual results are similar, the model is validated.

No model calibration or validation was undertaken. Instead, a comparison between two flood models and a sensitivity assessment of the variables were carried out. The DHI flood modelling (Atiquzzaman and Britton 2013) was seen to result in a similar inundation extent and overall depth for the 1% AEP event, as shown in Figure 5.

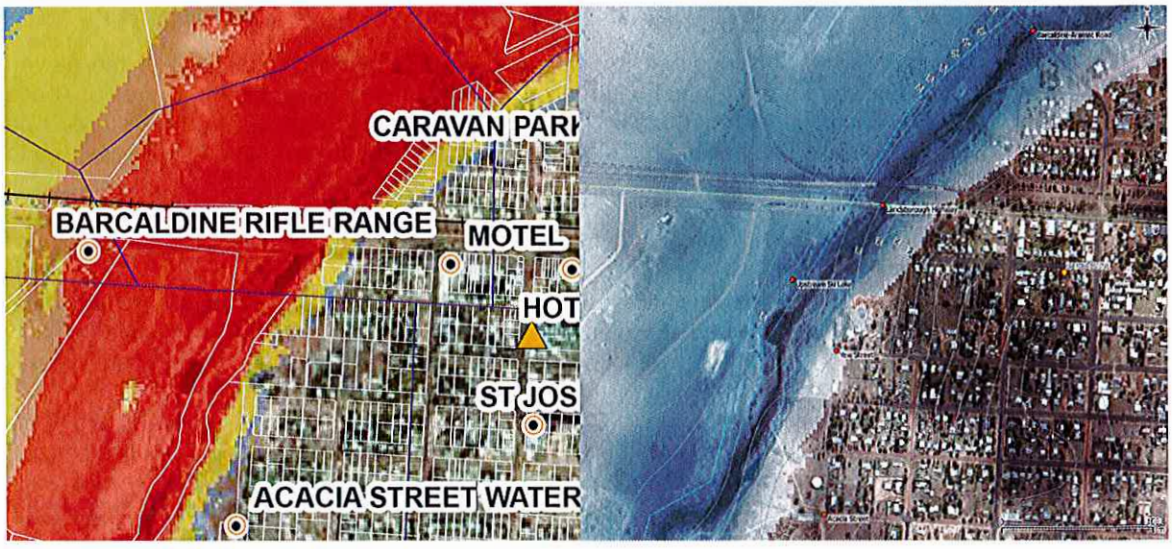

Figure 4 Comparison of flood inundation extents a) DHI Figure 3 b) ACS Figure 5

As noted earlier the RORB hydrology modelling showed significant differences in peak discharges between this flood assessment and the DHI flood modelling. In turn, the flood extents between the two models varies in some significance. This is likely attributed to the difference in modelling methods. DHI flood modelling targeted a specific observed flood level and volume of water discharge. To do this, peaking factors of certain flows were required to calibrate the model. This may have caused the model to meet observed flood levels in certain areas of the town, but not others.

As per the DHI Flood Modelling report, recommendation 13 states "*The scaling factor (7.43) derived obtained from the modelling for Alice River inflows to the modelling should be verified as this may overestimate the design flows by inducing backwater effects on Lagoon Creek".*

As the previous flood modelling reports did not use similar reporting locations for the flood depth, no further comparison was undertaken.

4. Flood Impact Assessment

A comparison between the flood impacts at the pre and post development stage was carried out. Visual plans for maximum depth (m), velocity (m/s) and flood hazard (m^2/s) were produced (refer to Appendix E) using the unit interval criteria suggested by the Qld Reconstruction Authority. The flood events presented in the mapping include 50%, 10%, 5%, 1% and 0.2% AEP and the PMF. At point water surface depths were extracted from the data (Table 8 and Table 9).

Eleven assessment locations were identified as follows:

- Barcaldine-Aramac Road crossing
- Landsborough Highway crossing (at two locations)
- Yew Street
- Acacia Street
- Bauhina St House
- 123 Ironwood Drive
- Upstream Ski Lake
- Downstream Ski Lake
- Plane St
- Brigalow Road
- Myrtle Street

The construction of the ski park will reduce the volume of the flood plain that is available for flood water storage. The flood impacts were greater for the post developed scenarios including increased inundation depths at the points of interest, an increase in inundation area and increase in flood hazard.

The post development scenario shows an increase in flood level at all assessed locations. Of the eleven locations assessed, five locations were shown to not be impacted during the pre development scenario. These all remained unaffected at the developed scenario. The flood levels downstream of the ski lake showed no significant change in inundation depth. The maximum velocities for all scenarios were seen to increase due to the restricted flood plain width.

The following key impacts were realised in the modelling between the pre and post-developed scenarios:

- The area of flood inundation increased, primarily to the west of the site and a minor increase in area to the east of the site. The ski park was surrounded by floodwater at the 10% AEP event and inundated (at a low depth) between the 5% and 2% AEP events. Flood water inflows will occur through the ski park spillway during a 10% AEP event.
- The increase in water level is estimated to impact five additional properties (four to the east and one to the west of the site) at the 1% AEP event, based on the pre and post developed flood models produced as part of this study. Those properties already impacted will see a further increase in flood depth. The increases range in depth from approximately 500 to 700mm on the western side of the ski park, approximately 300mm due east of the ski park and approximately 200 to 300mm on the eastern side of Lagoon Creek north of the Landsborough Highway. An increase in flood plain width is expected of between 0 and 15m to the east and between 0 and 70m to the west.

4.1. Landsborough Highway Assessment

A review of the potential impacts at the Landsborough Highway crossing was carried out, to assess the potential for increased road closures as a result of the ski lake construction. It is understood that the highway currently closes during significant rainfall events. Based on the modelling closure is likely in events greater than a 50% AEP.

The duration in which the highway will be closed during rainfall events is predicted to remain at a similar length following the ski park construction. Further, the ski park is not expected to increase the road closure times at Barcaldine Aramac Road. Refer to Table 6 and Table 7.

5. Flood Mitigation Strategies

As identified in the preceding sections, the construction of the ski park will have some increased impact to flood levels, extents and velocities in the areas immediately adjacent and upstream of the ski park. In order for the ski park development to satisfy the requirements of the *Assessment Benchmarks – Natural Hazards, Risk and Resilience* of the State Planning Policy 2017 and the requirements of the Barcaldine Shire Council Planning Scheme 2006 *Open Space and Recreation Zone Code, Table 4.7.3.4 – Part B PC42 Flooding,* a number of strategies are recommended to be incorporated into the development.

The *Assessment Benchmarks – Natural Hazards, Risk and Resilience* as it relates to flood hazard under the State Planning Policy 2017 require that; -

1. *Development avoids natural hazard areas, or where it is not possible to avoid the natural hazard area, development mitigates the risks to people and property to an acceptable or tolerable level.*
2. *Development supports and does not hinder disaster management response or recovery capacity and capabilities.*
3. *Development directly, indirectly and cumulatively avoids an increase in the severity of the natural hazard and the potential for damage on the site or to other properties.*
4. *Risks to public safety and the environment from the location of hazardous materials and the release of these materials as a result of a natural hazard are avoided.*
5. *The natural processes and the protective function of landforms and the vegetation that can mitigate risks associated with the natural hazard are maintained or enhanced.*

PC42 Flooding under the Open Space and Recreation Zone Code, Table 4.7.3.4 – Part B, of the Barcaldine Shire Planning Scheme 2006 (V2) states that;

> *Premises" are designed and located so as:*
> *(a) not to be adversely impacted upon by flooding;*
> *(b) to protect life and property; and*
> *(c) not to have an undesirable impact on the extent or magnitude of flooding.*

The following section details the recommended strategies to achieve benchmarks as detailed above.

5.1. Potential Mitigations Options

A number of flood mitigation options have been identified that could be considered for future implementation to reduce the flood impact to the development, properties, the environment and public safety. These options not only address the strategies to mitigate flood impacts with respect to the ski park development but also the flood impacts generally as experienced by the town due to the proximity of Lagoon Creek.

5.1.1. Ski Park Flood Mitigation Options

The proposed ski park will be impacted by all flow events greater than and including the 63.2% AEP and is likely to be inundated in events greater than a 5% AEP. The ski park is to be constructed to withstand inundation and the embankments armoured to protect against erosive flow velocities along the outside embankment toe. Rock armouring along the embankment toe and maintained grass cover over the batters and crest are recommended. The modelling indicates that there is likely to be a small increase to the flow velocities in the adjacent Lagoon Creek and flood plain. These velocities however are not significant enough that the existing stream environment would be detrimentally impacted unless evidence of pre-existing erosion issues are evident.

Infrastructure associated with the ski park including clubhouse and kiosk should be constructed such that the occupied floor level is a minimum of 500mm above the 1%AEP defined flood level (DFL). Buildings should be designed and constructed to withstand flood impacts, including the design of footings and foundations to take account of static and dynamic loads (including debris loads and any reduced bearing capacity owing to submerged soils). Hazardous materials associated with the ski park should be housed above the DFL and suitably bunded. Wastewater infrastructure associated with the ski park facilities should be located where possible above the DFL or alternatively suitably sealed to ensure that the potential for ingress of flood water or egress of wastewater is minimised.

Closure of the ski park to the public is recommended should a flood event greater that a 50% AEP be predicted. Flood events greater than this will see the Landsborough Highway closed and access limited to the Barcaldine Town Centre and community infrastructure such as the hospital.

The proposed ski park will not create a fundamental increase in stormwater generated over the development area and as such detention or retention storages are not required. Additionally any stormwater runoff that is generated across the development will be directed to Lagoon Creek, the identified lawful point of discharge for the undeveloped site. Stormwater easements or reserves are not warranted in this case.

5.1.2. Impacted Properties Flood Mitigation Options

The proposed ski park, due to its location within the Lagoon Creek floodplain, will increase flood levels in the area adjacent to the ski park as well as upstream of the ski park. The increased flood extent is estimated to impact five additional properties (four to the east and one to the west of the site) at the 1% AEP event, based on the pre and post developed flood models produced as part of this study. Those properties already identified as being impacted prior to the development will likely see a further increase in flood depth. The increases range in depth from approximately 500 to 700mm on the western side of the ski park, approximately 300mm due east of the ski park and approximately 200 to 300mm on the eastern side of Lagoon Creek north of the Landsborough Highway. An increase in flood plain width is expected of between 0 and 15m to the east and between 0 and 70m to the west.

According to the Barcaldine Shire Council Planning Scheme Zoning Map the impacted properties (both pre and post developed) are within the Open Space and Recreation (OSR) zone, Mixed Use (MU) zone and Commercial zone. The majority of the impacted lots (pre and post development) are unimproved, however there are some impacted developed lots (dwellings) in the MU zone to the east of Lagoon Creek and north of the Landsborough Highway. The lots to the west of the ski park where the Barcaldine Rifle Club and Clay Target Club are established are also impacted. Some of these developed lots are expected to experience inundation to buildings in both the pre and post developed scenarios albeit to a greater extent in the post developed scenario. The remainder of the developed lots will be expected to experience flooding to yards and under dwellings in both the pre and post developed scenarios again to a greater extent in the post developed scenario.

Should the expected increased impacts be considered acceptable then consideration should be given to reviewing and updating the existing town flood warning and evacuation procedures to ensure residents are provided with adequate time to secure and protect property, and to evacuate if necessary. A suggested trigger event for evacuation is the 20% AEP.

A number of flood mitigation options have been identified should the expected increased flood impacts not be considered acceptable. These include:

1. Raising impacted dwellings above the modelled 1% AEP flood level

2. Facilitate a land swap for land owners whom properties are impacted, to relocate to an alternative flood free lot of equivalent size.
3. Construct flood mitigation levee.

Identified Options 1 and 2 have not been considered further due to the likely unreasonable level of costs associated with facilitating the options.

Option 3 has been considered further as part of this assessment as a potentially viable option to not only mitigate the impacts of the ski park on the flood hazard but also to mitigate the flood hazard as it existed pre development. The proposed flood mitigation levee assessed is detailed in concept layout ACS-190005-LEV-06 (Appendix C) and is proposed to be located to protect properties north of the Landsborough Highway in the MU zone. The levee alignment proposed is over vacant Crown land. The levee considered is proposed to be constructed as an earth embankment with a break where it crosses the Barcaldine Aramac Road. The open section would be closed with stockpiled earth when a flood event is predicted. The trigger event for closing the levee is suggested to be a 10% AEP.

The proposed levee has been included in the flood modelling to assess the potential impacts to flood depths, velocities and hazard. The results of this modelling are included in Table 6 to Table 9 as Scenario 3. The modelling shows that there is likely to be negligible difference to the unprotected impacted properties between the developed unmitigated and mitigated scenarios. The proposed levee has been designed with a 500mm freeboard for a modelled 1% AEP flood event.

The levee embankment if considered for adoption should be constructed to withstand inundation and the embankments armoured to protect against erosive flow velocities along the outside embankment toe. Rock armouring along the embankment toe where velocities greater than 1m/s are expected and maintained grass/ground cover over the batters and crest are recommended. One-way drainage infrastructure through the levee must be incorporated to allow stormwater collected behind the levee to be drained to Lagoon Creek. This location is recommended to be coincident with the current stormwater drain on crown land on the corner of Plane and Brigalow St. As the drain discharges directly to Lagoon Creek, stormwater easements or reserves are not warranted.

The proposed levee will not create a fundamental increase in stormwater generated over the levee development area and as such detention or retention storages are not required.

The modelling indicates that there is likely to be a small increase to the flow velocities in Lagoon Creek and the flood plain adjacent to the levee location. These velocities however are not significant enough that the existing stream environment would be detrimentally impacted unless evidence of pre-existing erosion issues are evident.

A Levee Operations and Maintenance Manual has been prepared and is provided as Appendix D.

5.1.3. Future Planning Flood Mitigation Options

No changes to the existing Barcaldine Shire Council Planning Scheme Zoning Map are considered necessary as a result of the proposed development and change to flood hazard should the proposed levee be constructed. Should the unmitigated flood impacts be considered acceptable consideration should be given to amending the Barcaldine Shire Council Planning Scheme Zoning Map to change Lots 1 to 11 RY185 from MU to OSR and retained as open creek side parkland.

Future development on lots identified as being within the flood zone must be constructed such that the occupied floor level is a minimum of 500mm above the 1%AEP defined flood level (DFL). Buildings should be designed and constructed to withstand flood impacts, including the design of footings and foundations to take account of static and dynamic loads (including debris loads and any reduced bearing capacity owing to submerged soils). Reference is made to *Flood Resilient Building Guidance for Queensland Homes* (QRA 2019). Hazardous materials associated with future development should be housed above the DFL and suitably bunded. Wastewater infrastructure associated with future development should be located where possible above the DFL or alternatively suitably sealed to ensure that the potential for ingress of flood water or egress of wastewater is minimised. Plant and equipment including electrical fittings should be located where possible above the DFL or alternatively suitably sealed to ensure that the potential for ingress of flood water or egress of wastewater is minimised.

The majority of the Barcaldine Township is identified as flood free including community facilities such as the Barcaldine Hospital, Civic Centre, State School and Show Grounds. These facilities would be considered as essential locations for refuge during a significant flood event. Direct flood free access from identified impacted properties to these locations can be achieved along existing local streets.

6. Flood Modelling Results Summary

The following tables provide a summary of the modelling results as referenced throughout this report.

Table 6 Duration of inundation above 0.2 m depth at the Landsborough Highway (hours)

AEP	Scenario 1	Scenario 2	Scenario 3
10%	18.67	17.67	18.17
5%	22.33	21.0	21.5
2%	25.67	24.33	24.83
1%	27	26	26.5

Table 7 Duration of inundation above 0.2 m depth at Barcaldine Aramac Road (hours)

AEP	Scenario 1	Scenario 2	Scenario 3
10%	30.00	28.17	27.5
5%	34.00	32.17	31.5
2%	36.67	35.0	34.33
1%	38.00	36.17	35.5

Table 8 Flood Impact Assessment – Scenarios 1, 2, and 3

id	NAME	Max Depth (m)											
		Scenario 1 - Existing Condition				Scenario 2 - Post Development Unmitigated				Scenario 3 - Post Development Mitigated – Levee			
		10%	5%	2%	1%	10%	5%	2%	1%	10%	5%	2%	1%
1	Barcaldine-Aramac Road	1.49	1.62	1.85	2.06	1.52	1.77	2.13	2.33	1.53	1.78	2.09	2.28
2	Landsborough Highway	0.99	1.16	1.42	1.64	1.20	1.48	1.79	1.98	1.19	1.48	1.79	1.98
3	Yew Street	-	-	0.22	0.44	-	0.27	0.51	0.69	-	0.22	0.54	0.75
4	Acacia Street	-	-	-	-	-	-	-	-	-	0	-	-
5	Bauhina St - house	-	-	-	-	-	-	-	-	-	0	-	-
6	123 Ironwood Drive	-	-	-	-	-	-	-	-	-	0	-	-
7	Upstream Ski Lake	1.41	1.59	1.91	2.21	1.68	2.04	2.31	2.55	1.68	1.99	2.31	2.51
8	Downstream Ski Lake	1.54	1.79	2.10	2.35	1.49	1.67	2.06	2.28	1.49	1.71	2.06	2.31
9	Plane Street	0.84	1.02	1.22	1.46	0.93	1.18	1.45	1.68	-	-	-	-
10	Brigalow Road	0.64	0.79	1.01	1.19	0.70	0.95	1.26	1.45	-	-	-	-
11	Myrtle Street	-	-	0.17	0.38	-	0.07	0.36	0.57	-	-	-	-

Table 9 *Flood Impact Assessment – Scenarios 2 and 3 Increase in Depth compared to Scenario 1*

id	NAME	Increase in Max Depth (compared to existing / scenario 1) (m)							
		Scenario 2 - Post Development Unmitigated (vs Scenario 1)				Scenario 3 - Post Development Mitigated – Levee (vs Scenario 1)			
		10%	5%	2%	1%	10%	5%	2%	1%
1	Barcaldine-Aramac Road	0.03	0.15	0.28	0.27	0.04	0.16	0.24	0.22
2	Landsborough Highway	0.21	0.32	0.37	0.34	0.20	0.32	0.37	0.34
3	Yew Street	-	-	0.29	0.25	-	-	0.32	0.31
4	Acacia Street	-	-	-	-	-	-	-	-
5	Bauhina St - house	-	-	-	-	-	-	-	-
6	123 Ironwood Drive (note 1)	-	-	-	-	-	-	-	-
7	Upstream Ski Lake	0.27	0.45	0.4	0.34	0.27	0.40	0.40	0.30
8	Downstream Ski Lake	-0.05	-0.12	-0.04	-0.07	-0.05	-0.08	-0.04	-0.04
9	Plane Street	0.09	0.16	0.23	0.22	-	-	-	-
10	Brigalow Road	0.06	0.16	0.25	0.26	-	-	-	-
11	Myrtle Street	-	-	0.19	0.19	-	-	-	-

Note 1. Several buildings on this property were shown to be inundated in both the pre and post development models, however the point of assessment recorded no impacts.

7. Recommendations and Limitations

7.1. Recommendations

The following recommendations are made for future stages of this project and associated projects:

- The flood inundation study should be reviewed in context of the local disaster management plans and the estimated impacts to services and infrastructure should be determined.
- Further detailed design of the flood levee mitigation option including protected side drainage infrastructure.
- Implementation of other suggested flood resilience strategies for the proposed development and future development within the flood zone.

7.2. Limitations

This report is provided for the purpose of advising potential increase in flood inundation levels due to the construction of the proposed Barcaldine Ski Lake and flood mitigation options. In addition, the following limitations of this study should be noted:

- This flood model and associated results should not be used for purposes other than those documented within this report.
- This flood inundation model should not be used for development or assessment modelling, other than for the assessment of the Barcaldine Recreation Park and ski lake and flood mitigation levee.
- No event based calibration has been carried out for the hydrological or hydraulic models.
- No statistical analysis, levels of uncertainty or confidence levels have been calculated for this study.
- Climate change has not been factored into this assessment and was outside of the scope of works. Climate change may result in a broad range of impacts due to more intense rainfall events, changes in annual and seasonal rainfall and increasing intensity or reach of cyclones. Barcaldine is located in the Climate Change in Australia 'Rangelands North' sub-cluster (CSIRO 2016) which is projected to experience an increased intensity of extreme rainfall events with a high level of confidence.
- Based on the modelling process and inputs adopted, and the lack of event based data available to improve the model accuracy, the results generated from all of the modelled scenarios must be considered to have an accuracy of approximately +/-0.5m.
- The flood model does not consider the possible impacts to flood levels of a coincident flood event in the Alice River.

8. Conclusion

The construction of the Barcaldine Recreation Park and ski lake was shown to result in an increase in flood levels for all modelled events. The increase was estimated to be most significant at the upstream toe of the proposed ski lake embankments with minimal impacts evident further downstream. Upstream and adjacent to the site were shown to experience the most significant increases in flood inundation depth.

The flood mitigation strategies outlined in section 5 will provide improved flood resilience against the existing flood hazard and the potential flood hazard created by the proposed ski park.

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ACS Engineers
CIVIL | ENVIRONMENTAL | PROJECT MANAGEMENT

APPENDICES

Appendix A) SMK Design Plans

BARCALDINE RECREATION PARK

PREPARED BY SMK CONSULTANTS FOR BARCALDINE REGIONAL COUNCIL

DATE: 22-03-2018

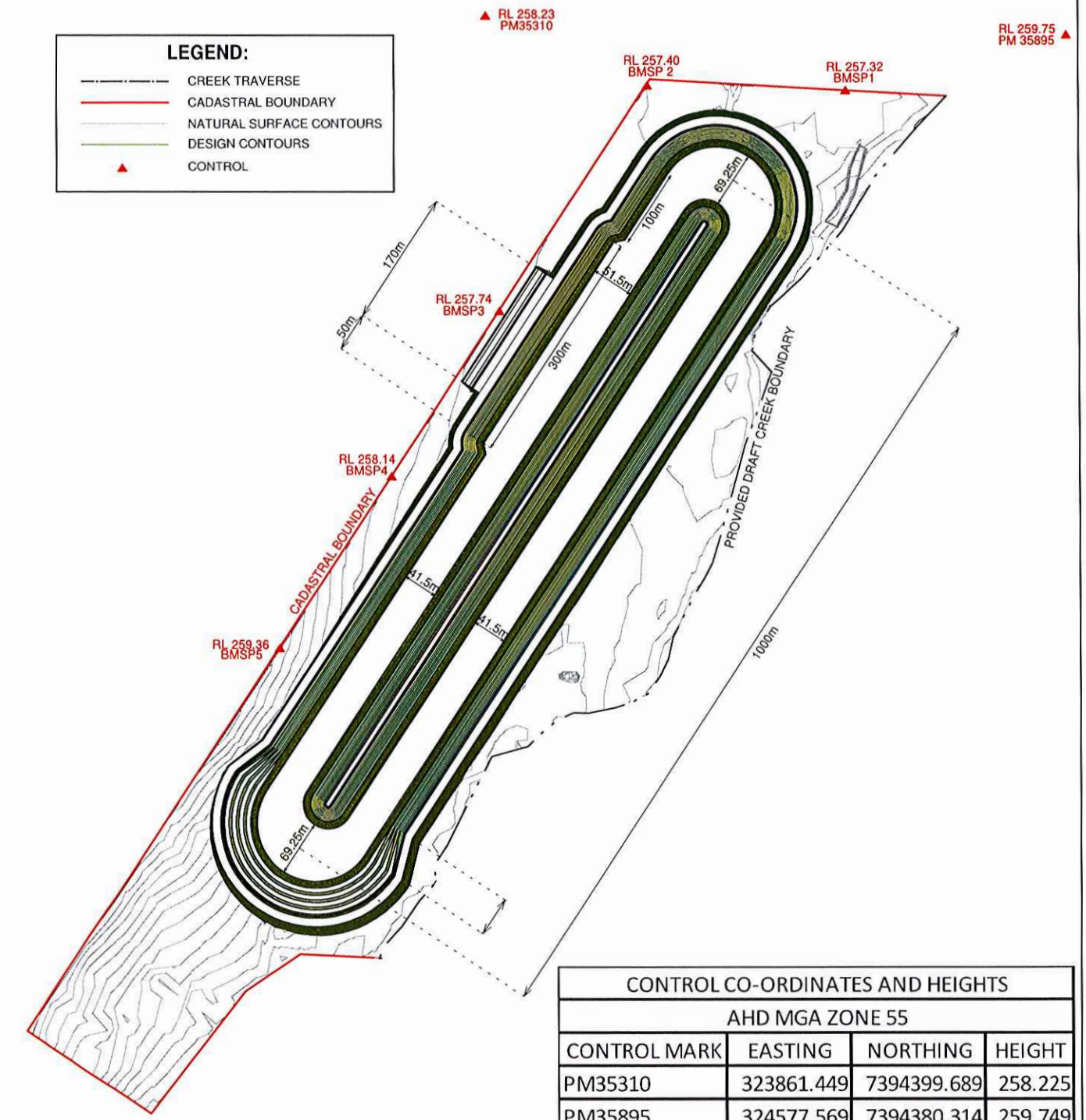
PRIMARY PLAN SET WITH SPECIFICATION (VOLUME 3):

1 - COVER SHEET
2 - LAKE LOCALITY PLAN
3 - CONTOUR MAP OF DESIGN SURFACE WITH CONTROL
4 - OVERVIEW SHOWING SECTION DETAILS
5 - SECTION AA DETAIL
6 - SECTION BB DETAIL
7 - SECTION CC DETAIL
8 - SECTION DD DETAIL
9 - SECTION EE DETAIL
10-EARTHWORKS SPECIFICATION

TENDER SUBMISSION DOCUMENT
(SEPARATE DOCUMENT - VOLUME 2)

SCALES : HORIZ (A3) VERT DATUM : -	**S.M.K. CONSULTANTS** surveying - irrigation - environmental PO BOX 774 MOREE 2400 PHONE (02) 67 521021	CLIENT : BARCALDINE REGIONAL COUNCIL PROJECT : BARCALDINE RECREATION PARK	DESCRIPTION : COVER SHEET	PLAN REVISION : A FIRST ISSUE 22-3	FILE No. 17-412 DATE 22-3-18	DRAWING No. 17-412-COVER SHEET No. 1 OF 10
SURVEYED SMK CONSULTANTS DESIGNED SMK CONSULTANTS CHECKED P. COVELL					DRAWING FILE : FINAL DESIGN WITH NS.vcd CALC. FILE : -	

SCALES: HORIZ 1 in 6000 VERT DATUM: AHD MGA ZONE 55	A3	**SMK CONSULTANTS** surveying - irrigation - environmental PO BOX 774 MOREE 2400 PHONE (02) 67 521021	CLIENT: BARCALDINE REGIONAL COUNCIL PROJECT: BARCALDINE RECREATION PARK	DESCRIPTION: PLAN SHOWING OFFSETS FROM PROPERTY BOUNDARIES TO PROPOSED POND	PLAN REVISION: / DATE A FIRST ISSUE 22-03-2018 B C	SHEET No. 2 of 10 JOB No. 17-412 COMPUTER FILE: Boundary Offsets.mjo
SURVEYED MARK CARRIGAN DESIGNED MARK CARRIGAN CHECKED PAUL COVELL						



CONTROL CO-ORDINATES AND HEIGHTS			
AHD MGA ZONE 55			
CONTROL MARK	EASTING	NORTHING	HEIGHT
PM35310	323861.449	7394399.689	258.225
PM35895	324577.569	7394380.314	259.749
BMSP1	324312.356	7394307.662	257.323
BMSP2	324063.738	7394313.832	257.403
BMSP3	323876.722	7394031.647	257.745
BMSP4	323740.425	7393825.216	258.142
BMSP5	323599.350	7393609.620	259.364

PLAN REVISION :	DATE			FILE No. 17-412	DRAWING No. 17-412-CONT
A FIRST ISSUE	22-3	E		DATE 22-3-18	SHEET No. 3 OF 10
B		F		DRAWING FILE : FINAL DESIGN WITH NS.vcd	
C		G		CALC. FILE : FINAL DESIGN WITH NS.ocs	

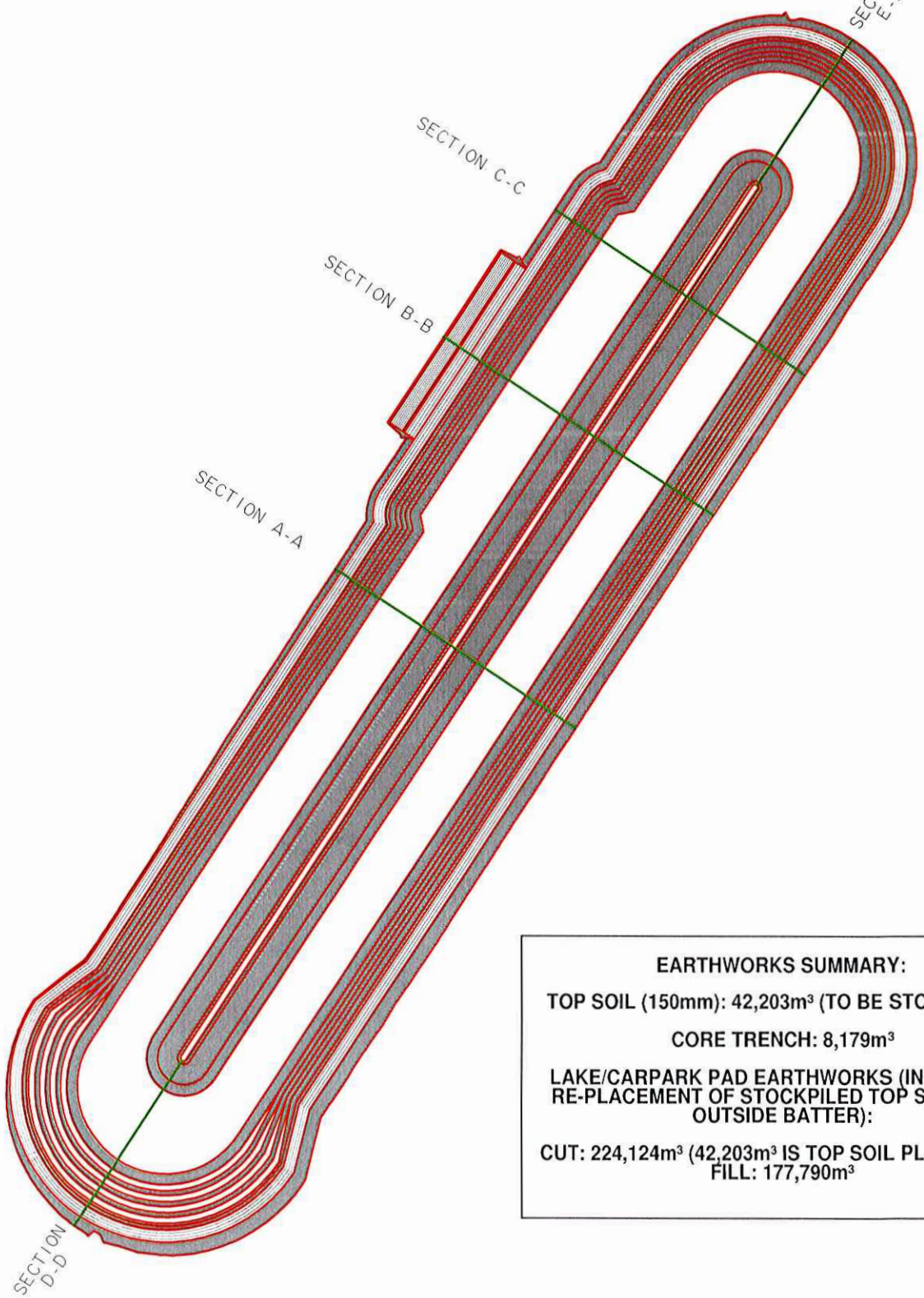
SCALES : HORIZ 1 in 5,000 (A3)
CONTOUR INT. 0.2m
DATUM : AHD-MGA ZONE 55
SURVEYED SMK CONSULTANTS
DESIGNED SMK CONSULTANTS
CHECKED P. COVELL

S.M.K. CONSULTANTS
surveying - irrigation - environmental
PO BOX 774 MOREE 2400
PHONE (02) 67 521021

CLIENT : BARCALDINE SHIRE COUNCIL

PROJECT : BARCALDINE RECREATION PARK

DESCRIPTION : PROPOSED SKI LAKE - CONTOUR MAP



EARTHWORKS SUMMARY:

TOP SOIL (150mm): 42,203m³ (TO BE STOCKPILED)

CORE TRENCH: 8,179m³

LAKE/CARPARK PAD EARTHWORKS (INCLUDING RE-PLACEMENT OF STOCKPILED TOP SOIL INTO OUTSIDE BATTER):

CUT: 224,124m³ (42,203m³ IS TOP SOIL PLACEMENT)
FILL: 177,790m³

PLAN REVISION :		DATE				FILE No. 17-412	DRAWING No. 17-412-SEC
A	FIRST ISSUE	22-3	D			DATE 22-3-18	DRAWING No. 4 - 10
B			E			DRAWING FILE : FINAL DESIGN.vcd	
C			F			CALC. FILE : TYPICAL SECTION.ocs	
			G				

SCALES : HORIZ 1 in 3,500 (A3)
VERT -
DATUM : AHD MGA Z55

SURVEYED SMK CONSULTANTS
DESIGNED SMK CONSULTANTS
CHECKED P. COVELL

S.M.K. CONSULTANTS
surveying - irrigation - environmental
PO BOX 774 MOREE 2400
PHONE (02) 67 521021

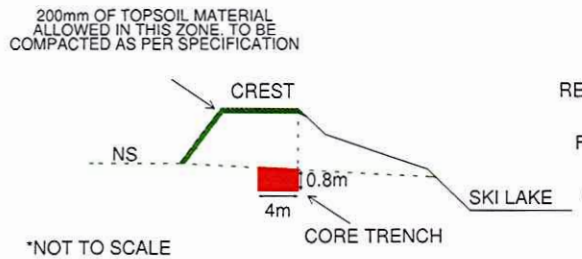
CLIENT : BARCALDINE REGIONAL COUNCIL

PROJECT : BARCALDINE RECREATION PARK

DESCRIPTION : FINAL POND DESIGN SHOWING SECTIONS

SECTION A-A (SEE PLAN 17-412-SEC)

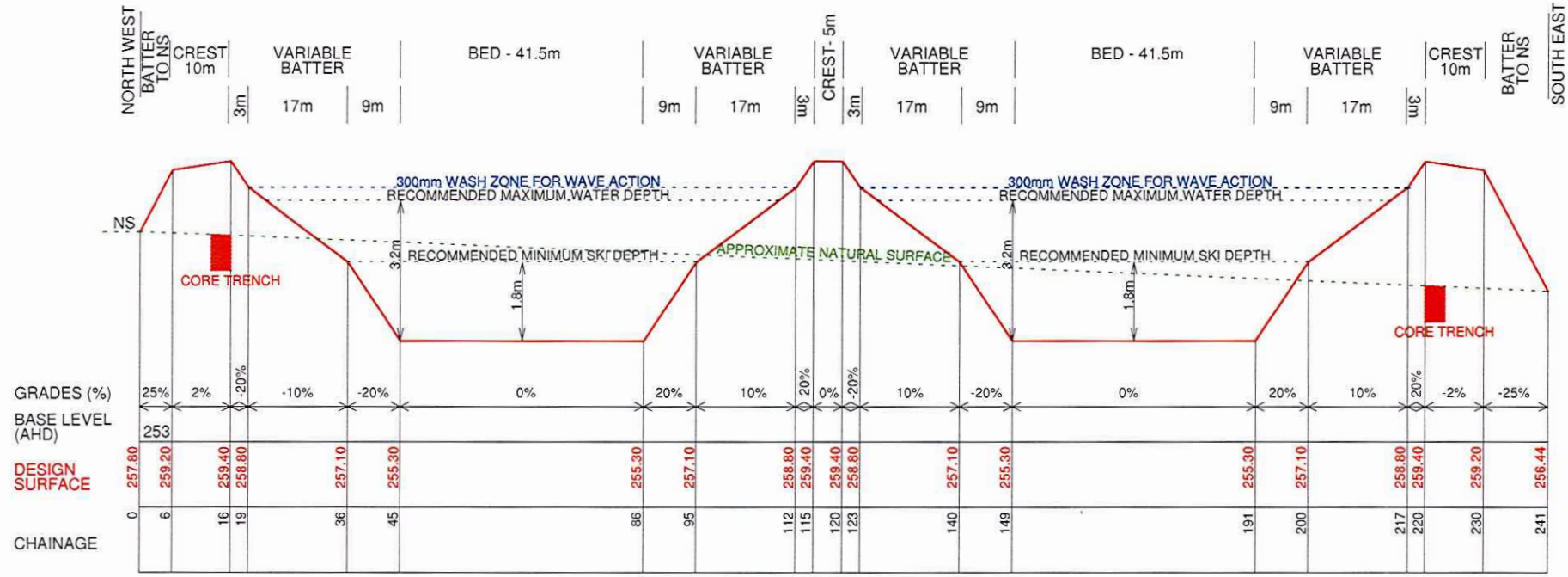
CORE TRENCH/TOP SOIL DETAIL



RED HATCHING DENOTES CORE TRENCH DETAIL

- CORE TRENCH TO BE EXCAVATED FOR ENTIRETY OF INSIDE CREST PERIMETER

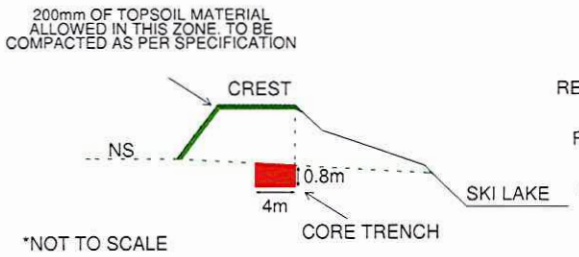
- CORE TRENCH IS TO BE FILLED AND COMPACTED WITH SELECT CLAY MATERIAL



SCALES : HORIZ 1 in 750 (A3) VERT 1 in 100 DATUM : AHD MGA Z55 SURVEYED SMK CONSULTANTS DESIGNED SMK CONSULTANTS CHECKED P. COVELL	**S.M.K. CONSULTANTS** surveying - irrigation - environmental PO BOX 774 MOREE 2400 PHONE (02) 67 521021	CLIENT : BARCALDINE REGIONAL COUNCIL PROJECT : BARCALDINE RECREATION PARK	DESCRIPTION : TYPICAL SECTION - SECTION A-A (SEE PLAN 17-412-SEC)	PLAN REVISION : DATE A FIRST ISSUE 22-3 B C D E F G	FILE No. 17-412 DATE 22-3-18 DRAWING FILE : FINAL DESIGN.vcd CALC. FILE : TYPICAL SECTIONS.ocs	DRAWING No. 17-412-SECAA SHEET No. 5 OF 10

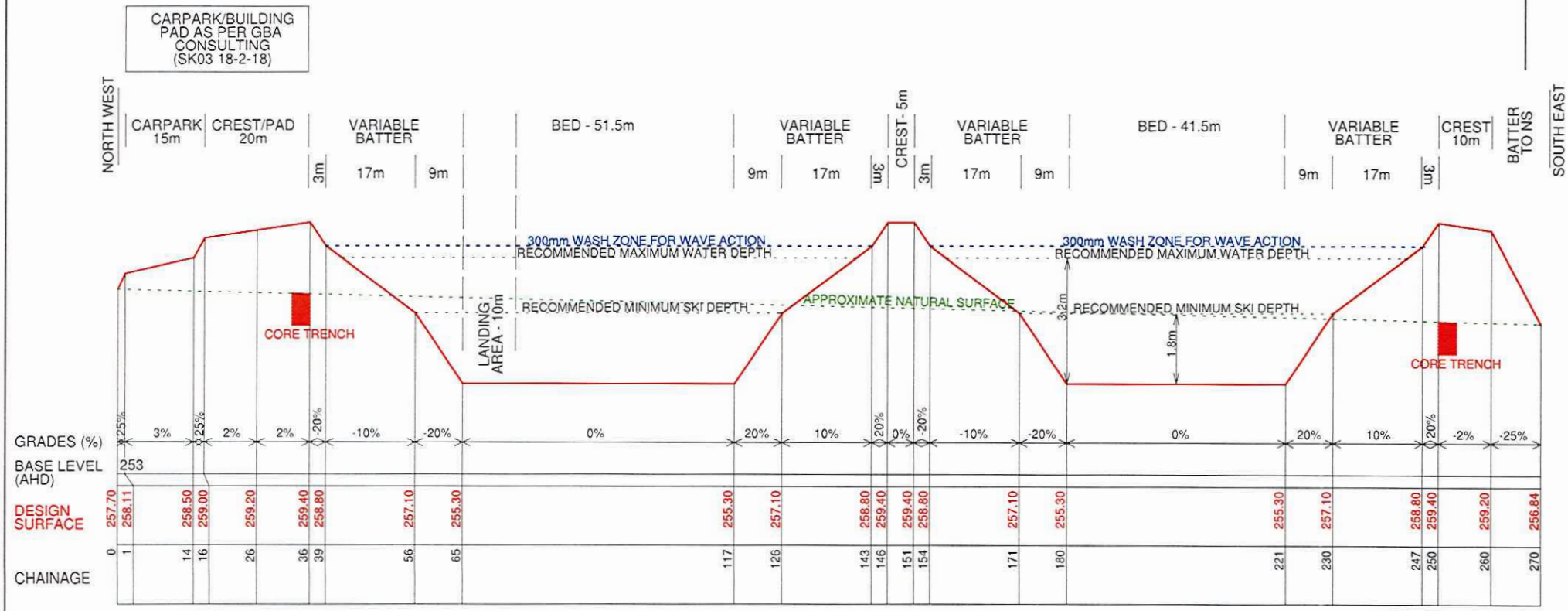
SECTION B-B (SEE PLAN 17-412-SEC)

CORE TRENCH/TOP SOIL DETAIL



RED HATCHING DENOTES CORE TRENCH DETAIL

- CORE TRENCH TO BE EXCAVATED FOR ENTIRETY OF INSIDE CREST PERIMETER
- CORE TRENCH IS TO BE FILLED AND COMPACTED WITH SELECT CLAY MATERIAL



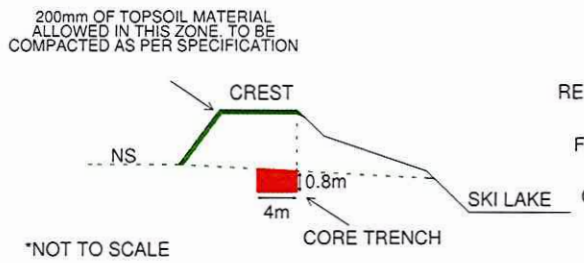
SCALES : HORIZ 1 in 750 (A3) VERT 1 in 100 DATUM : AHD MGA Z55 SURVEYED SMK CONSULTANTS DESIGNED SMK CONSULTANTS CHECKED P. COVELL	**S.M.K. CONSULTANTS** surveying - irrigation - environmental PO BOX 774 MOREE 2400 PHONE (02) 67 521021	CLIENT : BARCALDINE REGIONAL COUNCIL PROJECT : BARCALDINE RECREATION PARK	DESCRIPTION : TYPICAL SECTION - SECTION B-B (SEE PLAN 17-412-SEC)

PLAN REVISION :		DATE		
A	FIRST ISSUE	22-3	D	
B			E	
C			F	
			G	

FILE No. 17-412
DATE 22-3-18
DRAWING No. 17-412-SECBB
SHEET No. 6 OF 10
DRAWING FILE : FINAL DESIGN.vcd
CALC. FILE : TYPICAL SECTIONS.ocs

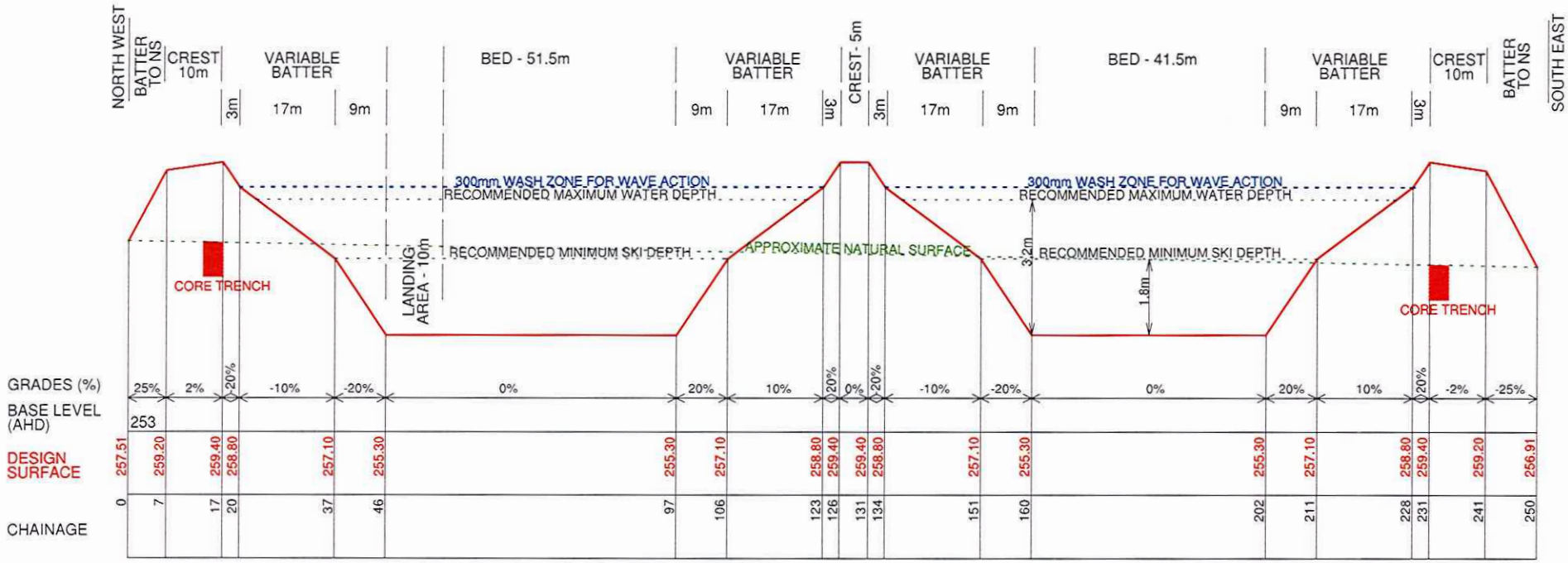
SECTION C-C (SEE PLAN 17-412-SEC)

CORE TRENCH/TOP SOIL DETAIL



RED HATCHING DENOTES CORE TRENCH DETAIL

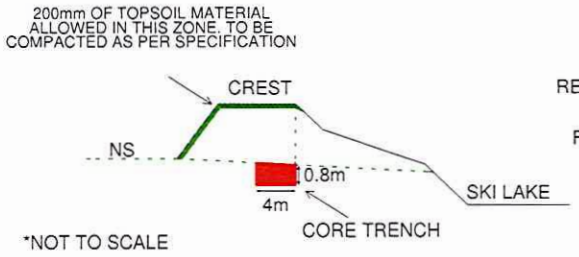
- CORE TRENCH TO BE EXCAVATED FOR ENTIRETY OF INSIDE CREST PERIMETER
- CORE TRENCH IS TO BE FILLED AND COMPACTED WITH SELECT CLAY MATERIAL



SCALES : HORIZ 1 in 750 [A3] VERT 1 in 100 DATUM : AHD MGA 255 SURVEYED SMK CONSULTANTS DESIGNED SMK CONSULTANTS CHECKED P. COVELL	**S.M.K. CONSULTANTS** surveying - irrigation - environmental PO BOX 774 MOREE 2400 PHONE (02) 67 521021	CLIENT : BARCALDINE REGIONAL COUNCIL PROJECT : BARCALDINE RECREATION PARK	DESCRIPTION : TYPICAL SECTION - SECTION C-C (SEE PLAN 17-412-SEC)	PLAN REVISION : DATE A FIRST ISSUE 22-3 B C D E F G	FILE No. 17-412 DATE 22-3-18 DRAWING No. 17-412-SECC SHEET No. 7 OF 10 DRAWING FILE : FINAL DESIGN.vcd CALC. FILE : TYPICAL SECTIONS.ocs

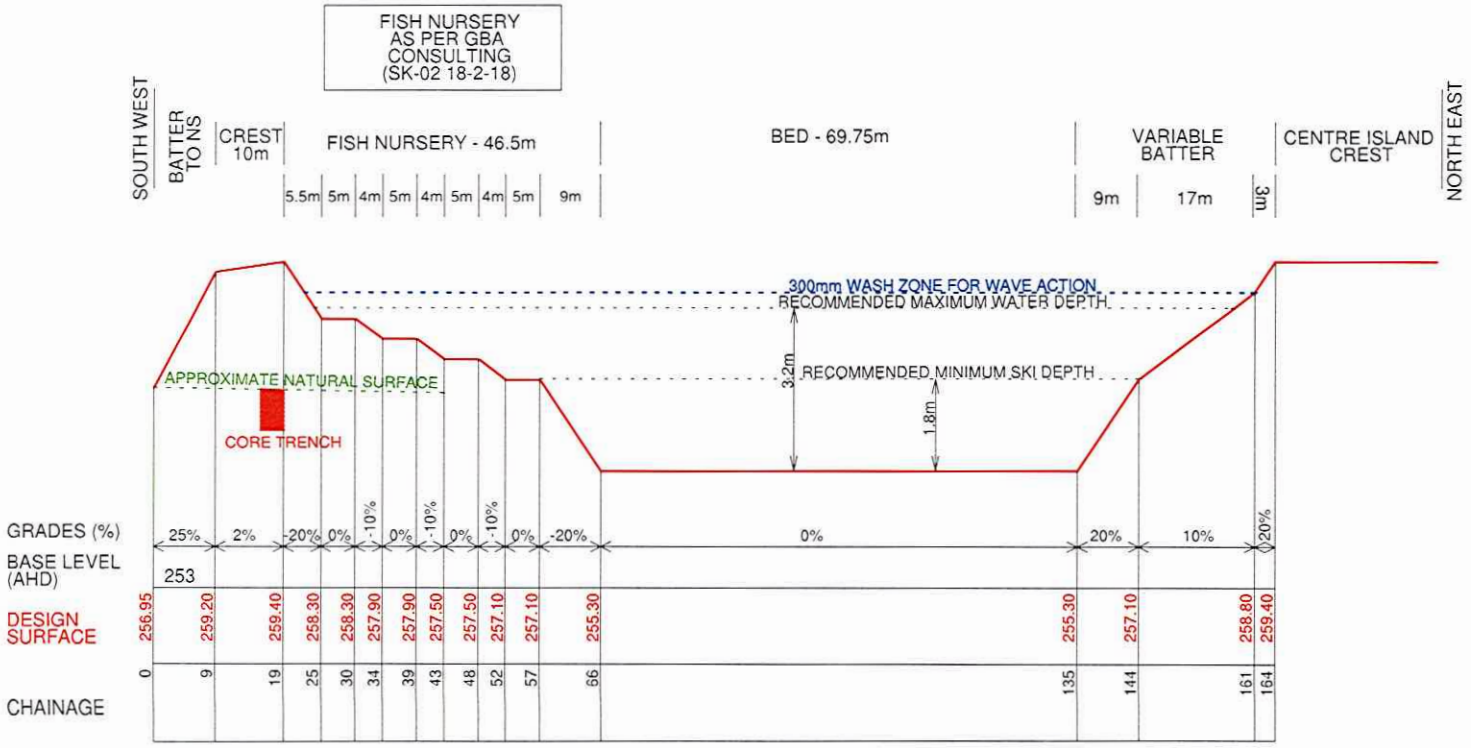
SECTION D-D (SEE PLAN 17-412-SEC)

CORE TRENCH/TOP SOIL DETAIL



RED HATCHING DENOTES CORE TRENCH DETAIL

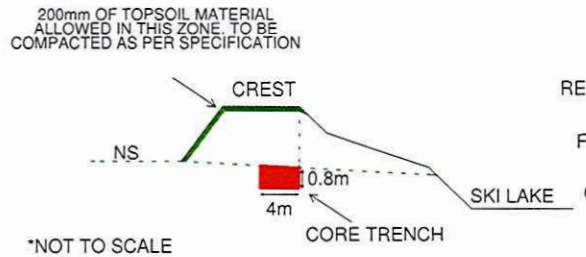
- CORE TRENCH TO BE EXCAVATED FOR ENTIRETY OF INSIDE CREST PERIMETER
- CORE TRENCH IS TO BE FILLED AND COMPACTED WITH SELECT CLAY MATERIAL



SCALES : HORIZ 1 in 750 VERT 1 in 100 (A3) DATUM : AHD MGA Z56	**S.M.K. CONSULTANTS** surveying - irrigation - environmental PO BOX 774 MOREE 2400 PHONE (02) 67 521021	CLIENT : BARCALDINE REGIONAL COUNCIL	DESCRIPTION : TYPICAL SECTION - SECTION D-D (SEE PLAN 17-412-SEC)	PLAN REVISION : A FIRST ISSUE 22-3 B C D E F G	FILE No. 17-412 DATE 22-3-18 DRAWING No. 17-412-SECDD SHEET No. 8 OF 10
SURVEYED SMK CONSULTANTS DESIGNED SMK CONSULTANTS CHECKED P. COVELL		PROJECT : BARCALDINE RECREATION PARK			DRAWING FILE : FINAL DESIGN.vcd CALC. FILE : TYPICAL SECTIONS.ocs

SECTION E-E (SEE PLAN 17-412-SEC)

CORE TRENCH/TOP SOIL DETAIL



RED HATCHING DENOTES CORE TRENCH DETAIL

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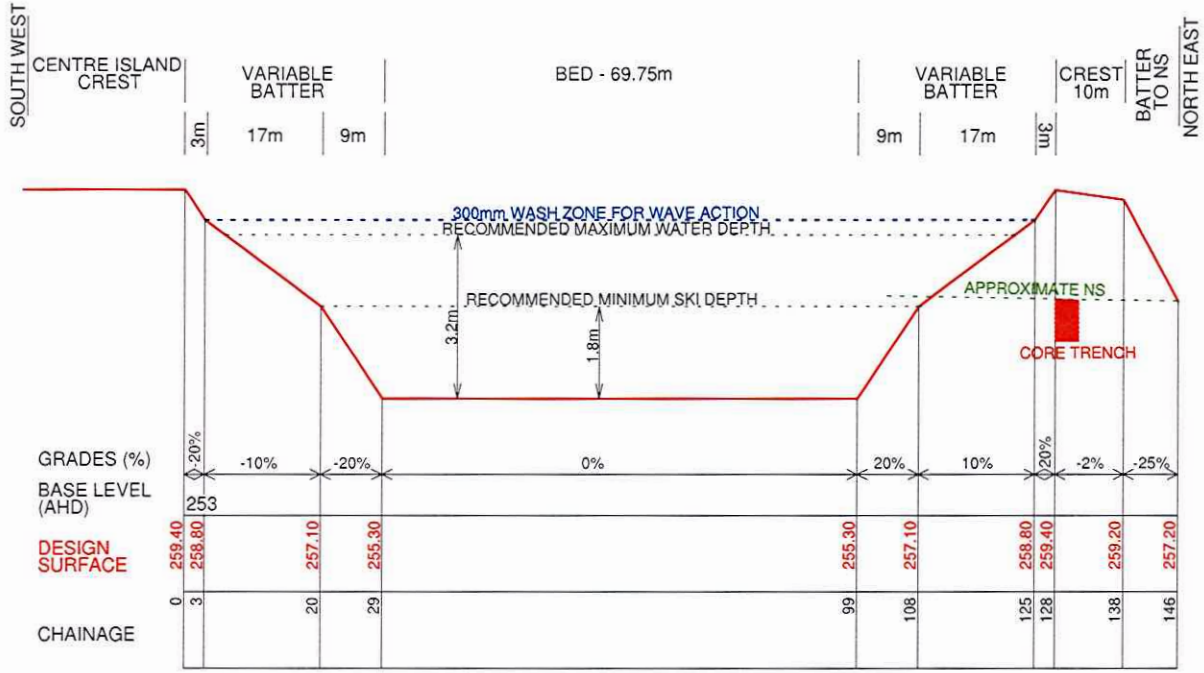
- CORE TRENCH IS TO BE FILLED AND COMPACTED WITH SELECT CLAY MATERIAL



SCALES : HORIZ 1 in 750 (A3) VERT 1 in 100 DATUM : AHD MGA 255 SURVEYED SMK CONSULTANTS DESIGNED SMK CONSULTANTS CHECKED P. COVELL	**S.M.K. CONSULTANTS** surveying - irrigation - environmental PO BOX 774 MOREE 2400 PHONE (02) 67 521021	CLIENT : BARCALDINE REGIONAL COUNCIL PROJECT : BARCALDINE RECREATION PARK	DESCRIPTION : TYPICAL SECTION - SECTION E-E (SEE PLAN 17-412-SEC)	PLAN REVISION : A FIRST ISSUE 22-3 B C DATE D E F G	FILE No. 17-412 DATE 22-3-18 DRAWING No. 17-412-SECEE SHEET No. 9 OF 10 DRAWING FILE : FINAL DESIGN.vcd CALC. FILE : TYPICAL SECTIONS.ocs

1. The contractor will be required to reach agreement with the principal as regards to the method of construction and material and machinery used. Construction methods presented in the document "Guidelines for Ring tank storages" prepared by the IAL (2007) are to be adopted.

A returnable document as part of the tender shall be a detailed method statement indicating the method proposed by the contractor to achieve the proposed compaction including the machinery involved. The proposed method shall be proved on-site by the Contractor by the test method outlined in clause 4 prior to full commencement under the contract.

This is a HOLD POINT under the contract. If the method proposed does not comply with the test under clause 4 then the contractor is to modify his method until he is able to satisfy the test. Further filling of the wall will cease if the initial method test is a fail and on subsequent retesting all work shall cease until the suspect section of wall is repaired to the satisfaction of the principal's supervisor.

2. The cut to fill ratio of approximately 1.25 to 1 was used in the determination of cut required from the floor of the storage to achieve the required embankment fill. That is 1.25cum of cut is required to fill 1cum of embankment.

The tendered price is on the total fill volume only. The depth of cut in the borrow is only for information purposes. The Contractor is to satisfy himself as to the suitability of this ratio and adjust the depth of cut accordingly. The borrow figure and depth of cut is an estimate only and no responsibly is taken by the principal. The floor of each pond is to be flat no holes or high points are to be left after construction.

3. A core trench approx 0.8m deep and 4m wide is to be cut as indicated on the attached cross sections prior to construction of the wall. The core trench is to be keyed into a depth that ensures backfill is placed in contact with existing moist wall material. No new material is to be placed on top of dry material within the cut-off trench. Cut-off trench is to be backfilled with selected clay material compacted to the standard required as specified below.

4. The clay wall is to be well graded impervious material classified as CL or CH in accordance with the soil classification system described in Appendix A (Table A1) AS1726 and approved by the engineer. Furthermore the core material shall conform to the following particle size distribution and plasticity limits:

PARTICLE SIZE DISTRIBUTION	
AS Metric Sieve Size (mm)	Percentage Passing (By Dry Weight)
75	100
19	70-100
2.36	40-100
0.075	25-90

PLASTICITY INDEX ON FINES FRACTION PASSING 0.425 mm SIEVE	
AS Metric Sieve Size (mm)	Percentage Passing (By Dry Weight)
75	100
19	70-100
2.36	40-100
0.075	25-90

Emerson's aggregate classification	3-6

Material shall be placed in the clay core in 150mm layers and compacted to a minimum of 96% of dry density of the material placed as determined by procedures given in AS 1289 5.1.1 - Standard Compaction using a vibrating sheep foot roller or other means - machine rolled.

The material shall be tested to determine compliance with the above requirements. This initial and subsequent testing shall be at the expense of the Contractor. The initial test shall occur on a straight section of wall when the backfill surface is a minimum of 300mm above ground level and 150m of wall fill is available for testing. Five (5) tests shall be done on this section. This is a HOLD POINT under the contract and further filling of the wall shall cease until compliance with this hold point occurs. Refer to Clause 6.

After proof of method of compaction is achieved one (1) compaction test per 400 m section of wall shall be supplied by the contractor. Supervisor is to be present when soil testing is undertaken. Notice of 24 hours to be given to Supervisor as to time of compaction testing.

5. Clay material to be used for construction of the embankment is to be well graded impervious material classified as CL or CH in accordance with the soil classification system described in Appendix A (Table A1) AS1726 and approved by the engineer. The clay material is to be obtained from the floor of the entire pond and only taken in the areas and depths specified in the plans.

6. Embankment construction is to be undertaken in layers not exceeding 150mm thickness. All material placed shall be at the approval of the Engineer/Supervisor. Embankment fill material shall be compacted to a minimum dry density ratio of 96% to AS 1289 5.1.1 - Standard Compaction using a vibrating sheep foot roller or other method - machine rolled. The embankment constructed each day shall be raised to its finsihed level such that each days construction leaves a finished section of bank.

7. The finished embankment shall be constructed in accordance with the levels and grades shown on the drawings.

8. Prior to commencement of filling or borrowing. The area to be filled or borrow from shall undergo clearing and grubbing and the top dry material is to be removed and stockpiled in the non-excavation area for use later in the day to complete the wall. The area shall be scarified or ripped with a tyned implement. All loose, soft, sandy and/ or yielding material shall be removed and replaced by the Contractor with sound materials to the satisfaction of the Superintendent, at no additional cost. The area to be stripped of topsoil is restricted to the area that will be used that day. This is to preserve soil moisture.

9. All top soil and vegetative matter from all borrow areas is to be removed to a depth of 150mm and stock piled for later use in the top layers of the embankment where specified.

10. After excavation of the topsoil material from fill areas the subgrade shall be thoroughly compacted to a minimum dry density of 96% to a depth of 150mm.

11. Moisture content of material to be placed in the embankment and core trench shall be within the range of ± 3% of standard optimum moisture content as per AS1289.

12. Excess topsoil shall be used as directed by the engineer.

13. The embankment and floor of the storage shall have a maximum permeability rate of 0.1mm/day.

14. All cut off trenches are to be in compliance with QLD Work Health & Safety requirements.

15. If machinery is to be used for wall compaction as part of the established method then only the same weight machines are allowed to be used during construction and compaction of the wall. Lighter machinery such as graders and laser buckets can be used for haul road maintence only. Compactors and Scrapers are to be used to achieve the required compaction specification.

16. The embankment shall be evenly graded and trimmed in accordance with the drawings. Embankment shall remain stable under design condition, during construction and during periodic cleaning/scraping out operation with earthmoving equipment. Embankments shall not settle more than 5% of their finished construction level. Levels on the drawing indicate embankment height after settling.

17. The Ponds will be checked on completion by the Principals' surveyor.

18. All banks are to be graded on completion to provide a smooth running surface for vehicles.

19. If the contractor encounters any unsuitable soil types during construction, he/she is to notify the Principal immediately

20. The contractor is responsible for maintaining the site during the course of the contract. Irrespective of whether part of the construction has been passed by the owner's supervisor the contractor is still responsible for the protection of that item from damage until the completion of all construction. This protection is to include damage occurring due to the passage of machinery, vehicles and erosion by rain. If such damage occurs then the contractor shall restore the surface to that specified in the design. Contractor is responsible for all contamination issues caused by spillage of oils and other contaminants.

The Defects Liability period shall be as per conditions of tendering. The defects liability period shall commence after final inspection has occurred and all embankments have been passed by the Supervisor, and shall only extend to the structural integrity of the constructed wall with respect to leakage or failure to hold water. The defects liability does not include general maintenance and grading.

21. At the end of the project, after all items have been passed by the Principal's supervisor, a final inspection will occur by the Principal with the contractor. The Principal will supply the contractor with a list of items that need rectification (if any problems exist). Once these items have been rectified, a final payment by the owner to the contractor will be made. It is expected that prior to this final inspection all embankments and borrow areas are to be graded including all batters.

22. The contractor is to guarantee a list of all equipment intended for use of the project. This same equipment is to remain on site throughout the duration of the contract and to be operational. Equipment which suffers failure during the contract shall be replaced immediately by a replacement machine of equivalent size.

23. A wet weather clause is to be agreed to between the contractor and Principal prior to commencement of the contract.

24. The Contractor will supply fuel for all work to be undertaken by the contractor as specified in this contract and following the acceptance of the estimated figures

25. The Principal will require a detailed as built survey and plans of the finished storage bank and borrow area upon completion of the project. The survey and plans are to be provided to the Principal as part of the "As built documentation" for completion of the contract. The survey is to be undertaken by a Licensed Surveyor.

26.
a. The Project Principal is Barcaldine Regional Council (BRC)

b. BRC or their agent will confer with the Contractor daily or at other times determined by BRC concerning the standard of the Contractor's operations.

c. In the event of any quality problems arising from the Contractor's provision of Services, BRC will advise the Contractor as soon as they are observed. The Contractor must at BRC's reasonable requirements, and direction, correct the problem.

SCALES : HORIZ NOT TO SCALE (A3)
VERT _____
DATUM : -

SURVEYED SMK CONSULTANTS
DESIGNED SMK CONSULTANTS
CHECKED P. COVELL

S.M.K. CONSULTANTS
surveying - irrigation - environmental
PO BOX 774 MOREE 2400
PHONE (02) 67 521021

CLIENT : BARCALDINE REGIONAL COUNCIL

PROJECT : BARCALDINE RECREATION PARK

DESCRIPTION : SKI LAKE EARTHWORKS SPECIFICATION

PLAN REVISION :		DATE		
A	FIRST ISSUE	22-3	D	
B			E	
C			F	
			G	

FILE No. 18-412
DATE 22-3-18
DRAWING No. 18-412-SPEC
SHEET No. 9 OF 10
DRAWING FILE : FINAL DESIGN.vwd
CALC. FILE : -

Appendix B) ACS Engineers Spillway Design Plans

BARCALDINE SKI PARK SPILLWAY

DRAWING SCHEDULE		
SHEET #	TITLE	REVISION
00	COVER PAGE	F
01	SPILLWAY LOCATION	B
02	SPILLWAY SECTION DETAILS	E
03	SPILLWAY RENO MATTRESS PROTECTION DETAILS	G

REVISION/DETAILS	DWN	DATE
F SPILLWAY ROCK PROTECTION UPDATED	KMP	10/19
E SET INVERT TO 258.50m	JDM	08/19
D ADDED INVERT OPTION NOTES	JDM	08/19
C SPILLWAY BATTER UPDATED	KMP	08/19
B UPDATES TO 02 & 03	JDM	06/19
A INITIAL DESIGN	JDM	06/19

SURVEY DATA
DATUM: GDA94
MAP GRID: MGA-56
HEIGHT ORIGIN: -
SURVEY BOOKS: -
DES: JDM DATE: 05/19

GEORGE BOURNE AND ASSOCIATES
PO BOX 191 BARCALDINE QLD 4725
BARCALDINE SKI PARK
BARCALDINE

COVER PAGE

ENGINEERING CERTIFICATION (RPEQ)

#	FIELD	NAME	SIGNATURE	DATE
13697	CIVIL	S. SHAY		23/10/19

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Beaudesert QLD 4285
(07) 5541 3500
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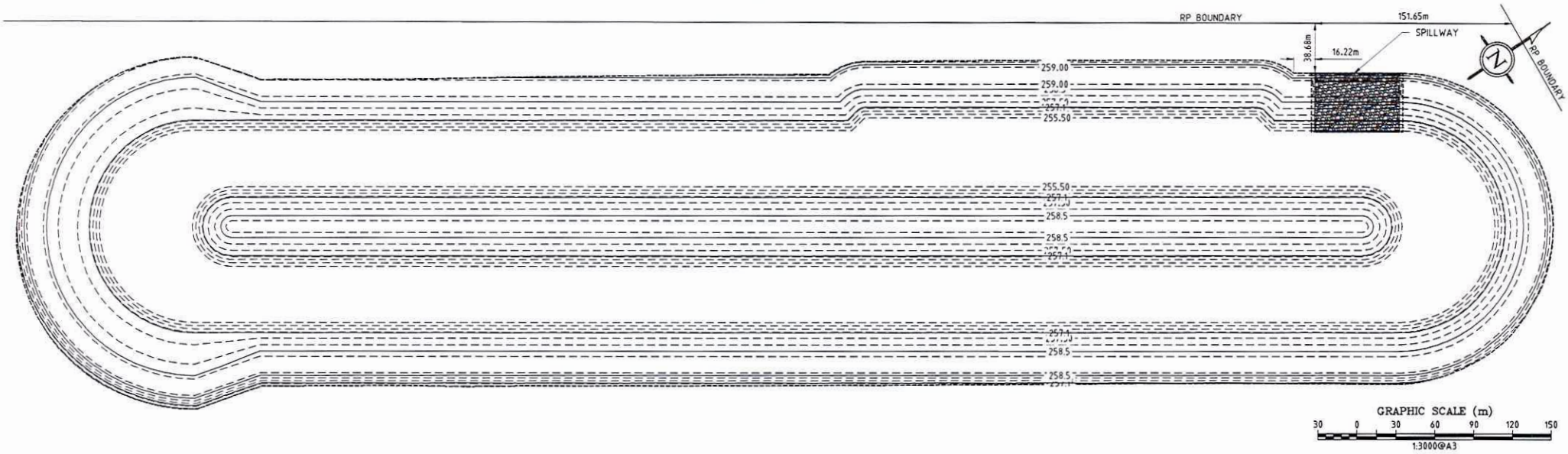
DRAWING NUMBER: ACS-190005-SKI-00

F

00 OF 03

LOCALITY PLAN



SKI PARK

				SURVEY DATA		GEORGE BOURNE AND ASSOCIATES	SPILLWAY LOCATION
				DATUM: GDA94		PO BOX 191 BARCALDINE QLD 4725	
				MAP GRID: MGA-56			
				HEIGHT ORIGIN: -		BARCALDINE SKI PARK	
				SURVEY BOOKS: -			
B	SPILLWAY BATTER UPDATED	KMP	08/19			BARCALDINE	
A	INITIAL DESIGN	JDM	06/19	JDM	05/19		
	REVISION/DETAILS	DWN	DATE	DES	DATE		

ENGINEERING CERTIFICATION (RPEQ)

#	FIELD	NAME	SIGNATURE	DATE
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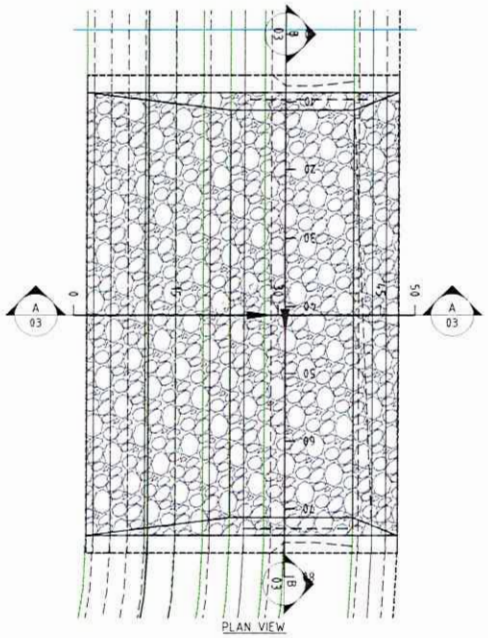
DRAWING NUMBER: ACS-190005-SKI-01

B

01 OF 03



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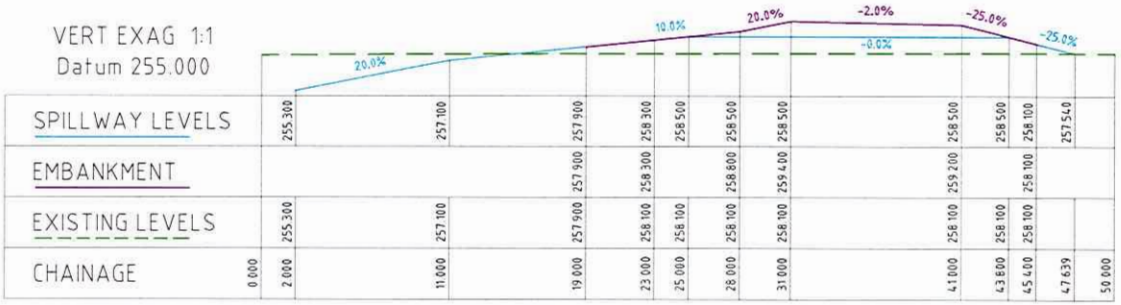
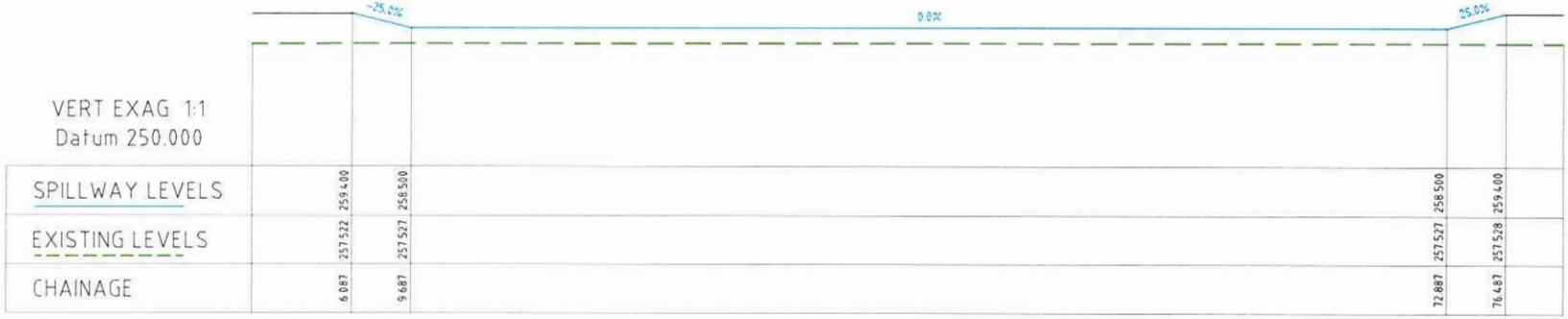


A-A LONG SECTION



B-B LONG SECTION

E	SET INVERT TO 258.50m	JDM	08/19
D	ADDED INVERT OPTION NOTES	JDM	08/19
C	SPILLWAY BATTER UPDATED	KMP	08/19
B	REMOVE EXTRA SURFACE FROM PROFILE VIEW	JDM	06/19
A	INITIAL DESIGN	JDM	06/19
	REVISION/DETAILS	DWN	DATE

SURVEY DATA
DATUM: GDA94
MAP GRID: MGA-56
HEIGHT ORIGIN: -
SURVEY BOOKS: -

DES	DATE
JDM	05/19

GEORGE BOURNE AND ASSOCIATES
PO BOX 191 BARCALDINE QLD 4725
BARCALDINE SKI PARK
BARCALDINE

SPILLWAY SECTION DETAILS

ENGINEERING CERTIFICATION (RPEQ)

#	FIELD	NAME	SIGNATURE	DATE
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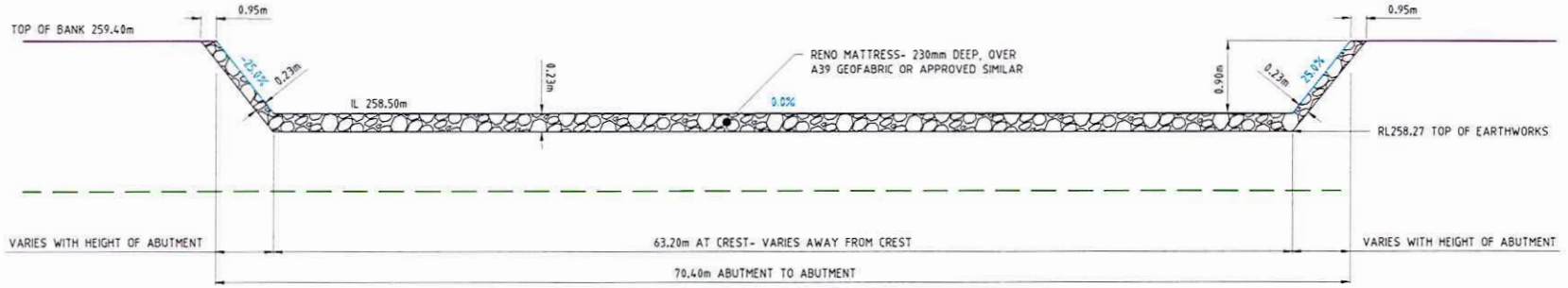
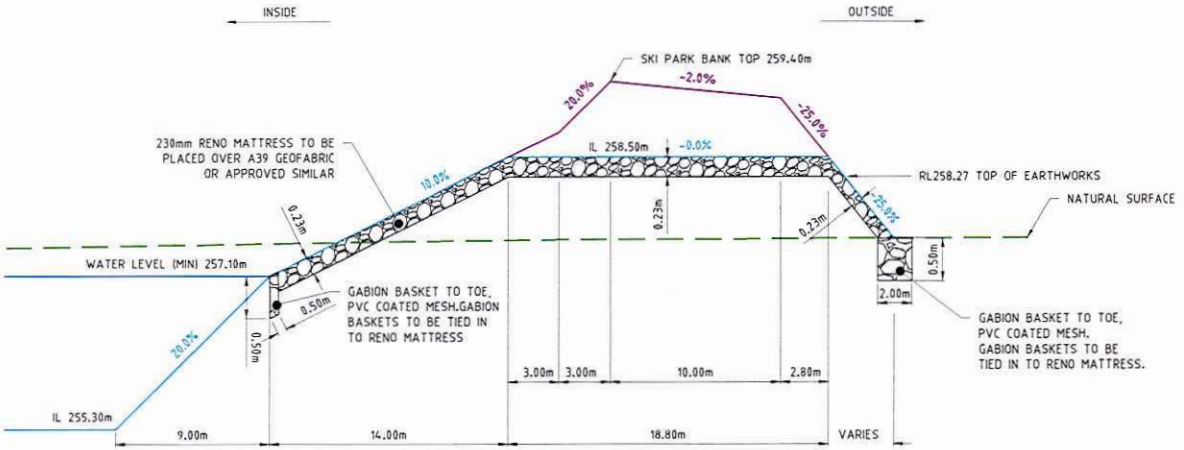
E
02 OF 03

SPILLWAY MATERIAL VOLUME		
GABION (RENO) MATTRESS	200mm Ø D50 @ 0.23m THICKNESS, PVC COVERED MESH	554m³
GABION BASKETS AT TOES	INSIDE - 0.5x0.5x64 OUTSIDE - 0.5x2x64	80m³
GEOFABRIC	A39 GEOFABRIC (OR SIMILAR)	2660m²

GABION CAGE DETAILS
INSIDE TOE - 1mx0.5mx64m
OUTSIDE TOE - 0.5mx2mx64m



SPILLWAY TYPICAL SECTION
CROSS SECTION 1:5V



SPILLWAY TYPICAL SECTION
LONG SECTION 1:5V

REV	REVISION/DETAILS	DWN	DATE
G	RENO MATTRESS & GABION BASKET ADDED	KMP	10/19
F	SET INVERT TO 258.50m	JDM	08/19
E	ADDED INVERT OPTION NOTES	JDM	08/19
D	SPILLWAY BATTER & QUANTITIES UPDATED	KMP	08/19
C	QUANTITIES ADDED	KMP	07/19
B	NOTE CHANGE	JDM	06/19
A	INITIAL DESIGN	JDM	06/19

SURVEY DATA
DATUM: GDA94
MAP GRID: MGA-56
HEIGHT ORIGIN: -
SURVEY BOOKS: -
DES: JDM — DATE: 05/19

GEORGE BOURNE AND ASSOCIATES
PO BOX 191 BARCALDINE QLD 4725
BARCALDINE SKI PARK
BARCALDINE

SPILLWAY RENO MATTRESS PROTECTION DETAILS

ENGINEERING CERTIFICATION (RPEQ)

#	FIELD	NAME	SIGNATURE	DATE
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DRAWING NUMBER: ACS-190005-SKI-03
G
03 OF 03

Appendix C) Flood Protection Levee Concept Plan

			SURVEY DATA	GEORGE BOURNE AND ASSOCIATES	FLOOD LEVEE-OPTION 6
			DATUM: GDA94	PO BOX 191 BARCALDINE QLD 4725	
			MAP GRID: MGA-55		
			HEIGHT ORIGIN: -	BARCALDINE FLOOD MITIGATION LEVEE	
			SURVEY BOOKS: -		
A	LEVEE OPTION 6	DGS 07/2020	DGS 07/2020	BARCALDINE	
	REVISION/DETAILS	DWN DATE	DES DATE		

ENGINEERING CERTIFICATION (RPEQ)

#	FIELD	NAME	SIGNATURE	DATE

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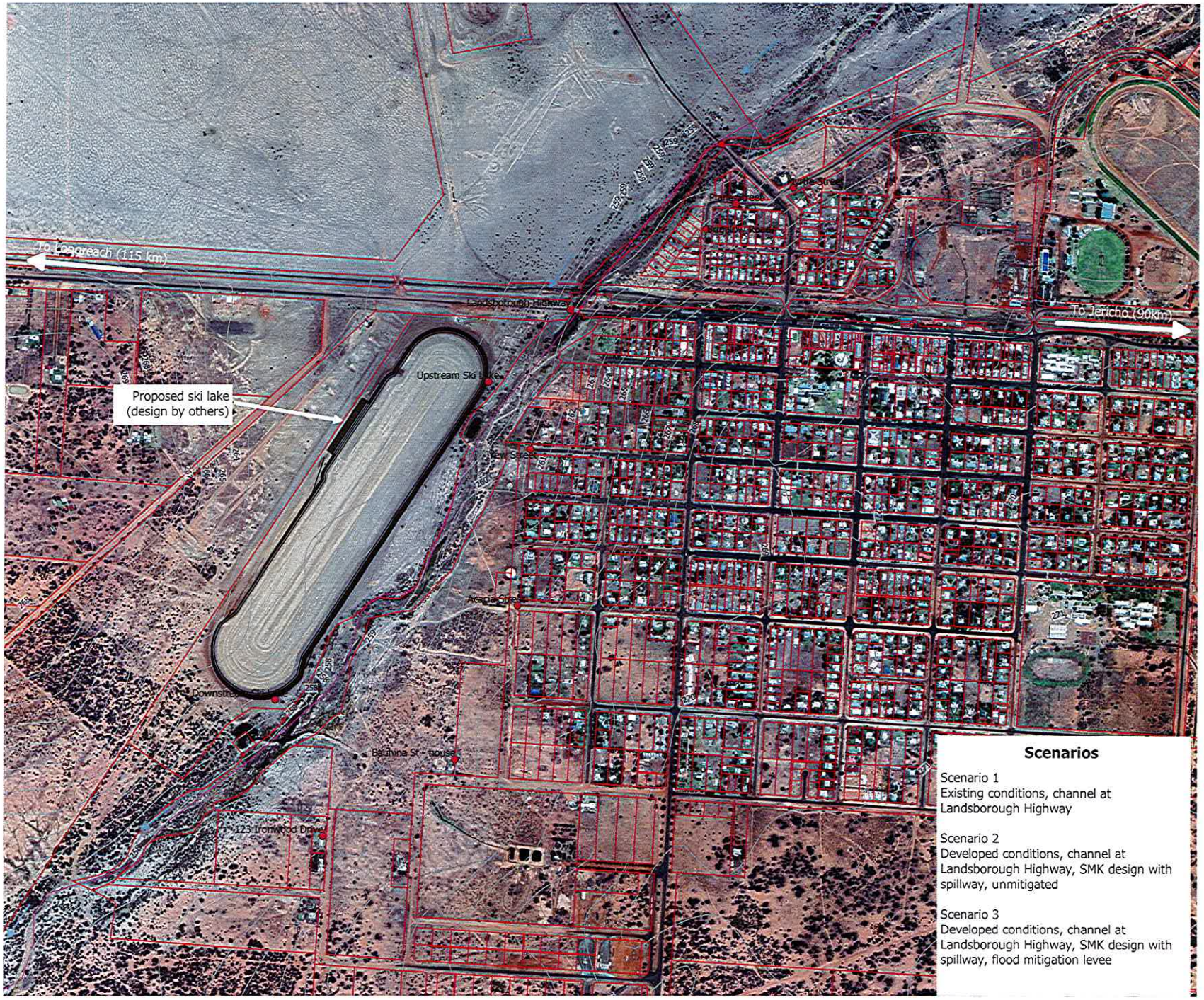
DRAWING NUMBER: ACS-190005-LEV-06

A

06 OF 06

Appendix D) Levee Maintenance Plan

Appendix E) Flood Impact Assessment Figures



Scenarios

Scenario 1
Existing conditions, channel at Landsborough Highway

Scenario 2
Developed conditions, channel at Landsborough Highway, SMK design with spillway, unmitigated

Scenario 3
Developed conditions, channel at Landsborough Highway, SMK design with spillway, flood mitigation levee

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Barcaldine Recreation Park Flood Impact Assessment

Figure 1 of 40.
Flood Innundation Mapping Overview

Legend

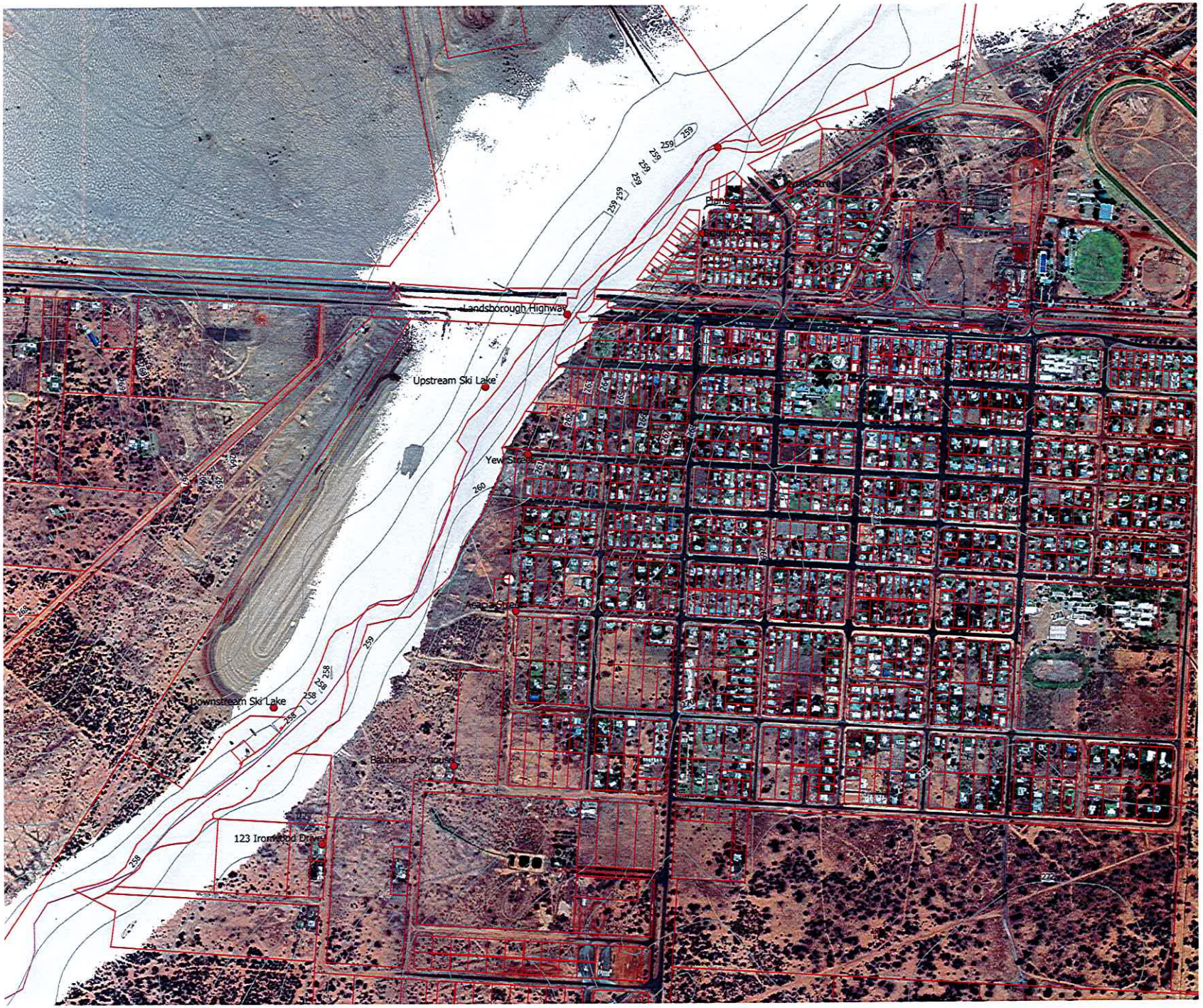
- Flood innundation_Critical Points
- Contours
- SMK Design
- Cadastral_data_LOTBDY
- Surface HydroLines National

A3 Scale: 1:10000
GDA 1994 / MGA Zone 55

Job ID: 190005
23/07/2020

N

0 100 200 300 400 m



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Barcaldine Recreation Park Flood Impact Assessment

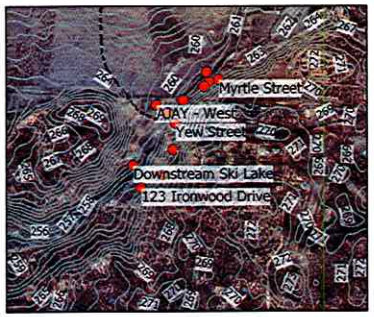
Figure 2 of 40.
Flood Innundation Mapping
Scenario 1 - 50% Aep

Legend

- Cadastral_data_LOTBDY
- Flood innundation_Critical Points-
- contour
- Surface HydroLines National

Depth (Max) m

- 0
- 0.5
- 1
- 1.5
- 2
- 2.5
- 3
- 3.5
- 4
- 4.5
- 5
- 5.5
- 6



A3 Scale: 1:10000
GDA 1994 / MGA Zone 55

Job ID: 190005
23/07/2020

N

0 100 200 300 400 m

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Barcaldine Recreation Park Flood Impact Assessment

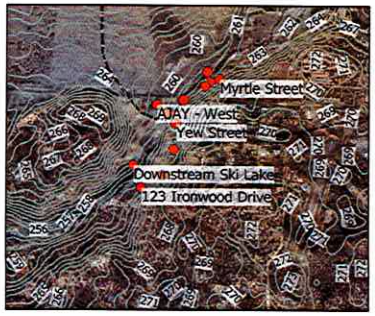
Figure 3 of 40.
Flood Innundation Mapping
Scenario 1 - 10% Aep

Legend

- SMK Design cont contour LineString
- Cadastral_data_LOTBDY
- Flood innundation_Critical Points-
- contour
- Surface HydroLines National

Depth (Max) m

- 0
- 0.5
- 1
- 1.5
- 2
- 2.5
- 3
- 3.5
- 4
- 4.5
- 5
- 5.5
- 6



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GDA 1994 / MGA Zone 55

Job ID: 190005
23/07/2020

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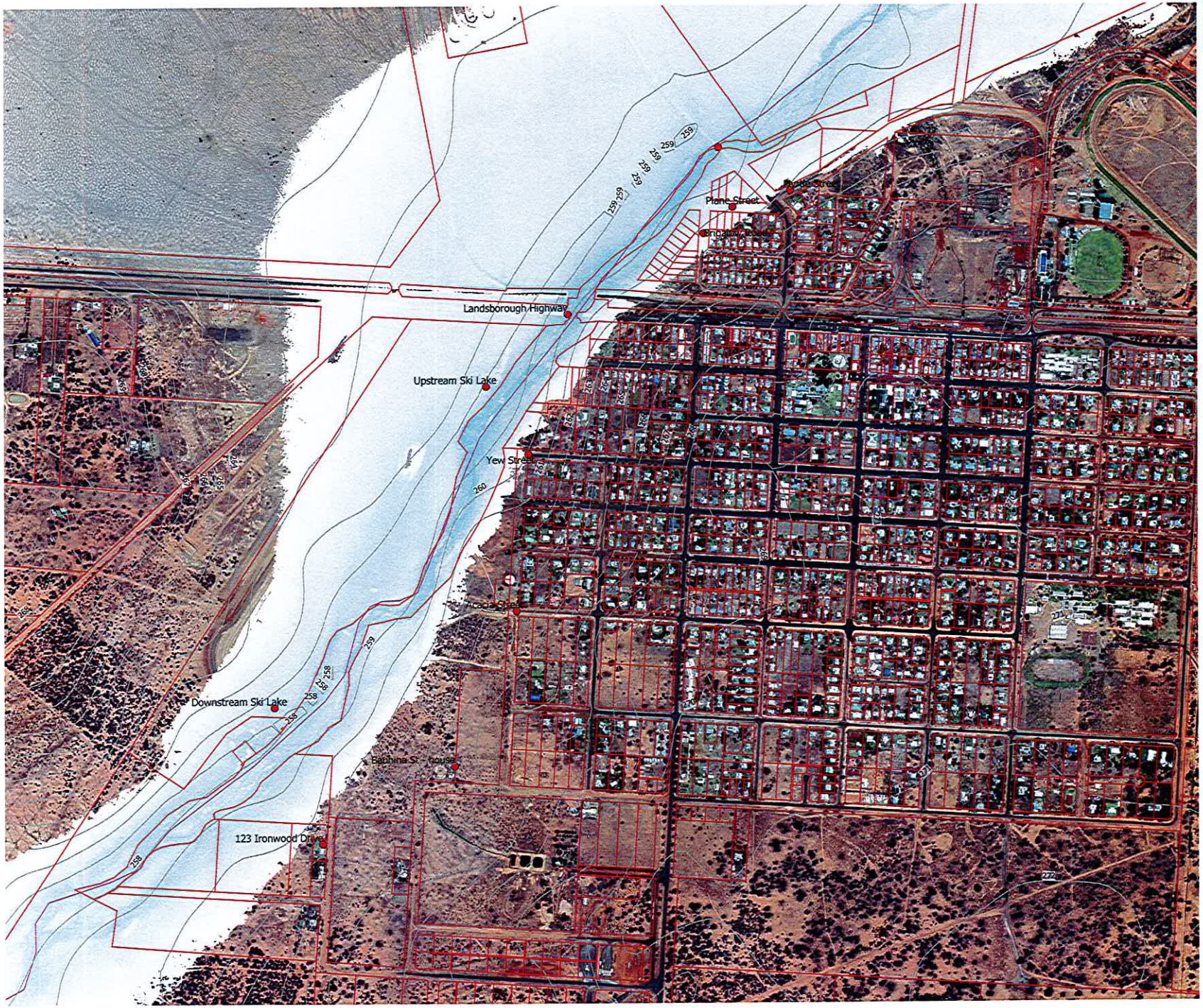

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Barcaldine Recreation Park Flood Impact Assessment

Figure 4 of 40.
Flood Innundation Mapping
Scenario 1 - 5% Aep

Legend

- SMK Design cont contour LineString
- Cadastral_data_LOTBDY
- Flood innundation_Critical Points-
- contour
- Surface HydroLines National

Depth (Max) m

- 0
- 0.5
- 1
- 1.5
- 2
- 2.5
- 3
- 3.5
- 4
- 4.5
- 5
- 5.5
- 6

A3 Scale: 1:10000
GDA 1994 / MGA Zone 55

Job ID: 190005
23/07/2020

N

0 100 200 300 400 m

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Barcaldine Recreation Park Flood Impact Assessment

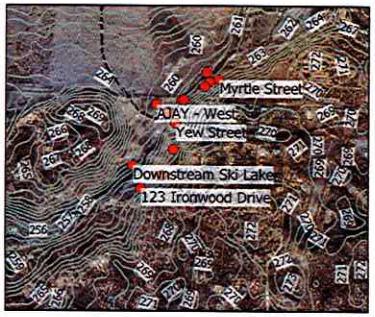
Figure 5 of 40.
Flood Innundation Mapping
Scenario 1 - 1% Aep

Legend

- SMK Design cont contour LineString
- Cadastral_data_LOTBDY
- Flood innundation_Critical Points-contour
- Surface HydroLines National

Depth (Max) m

- 0
- 0.5
- 1
- 1.5
- 2
- 2.5
- 3
- 3.5
- 4
- 4.5
- 5
- 5.5
- 6



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GDA 1994 / MGA Zone 55

Job ID: 190005
23/07/2020

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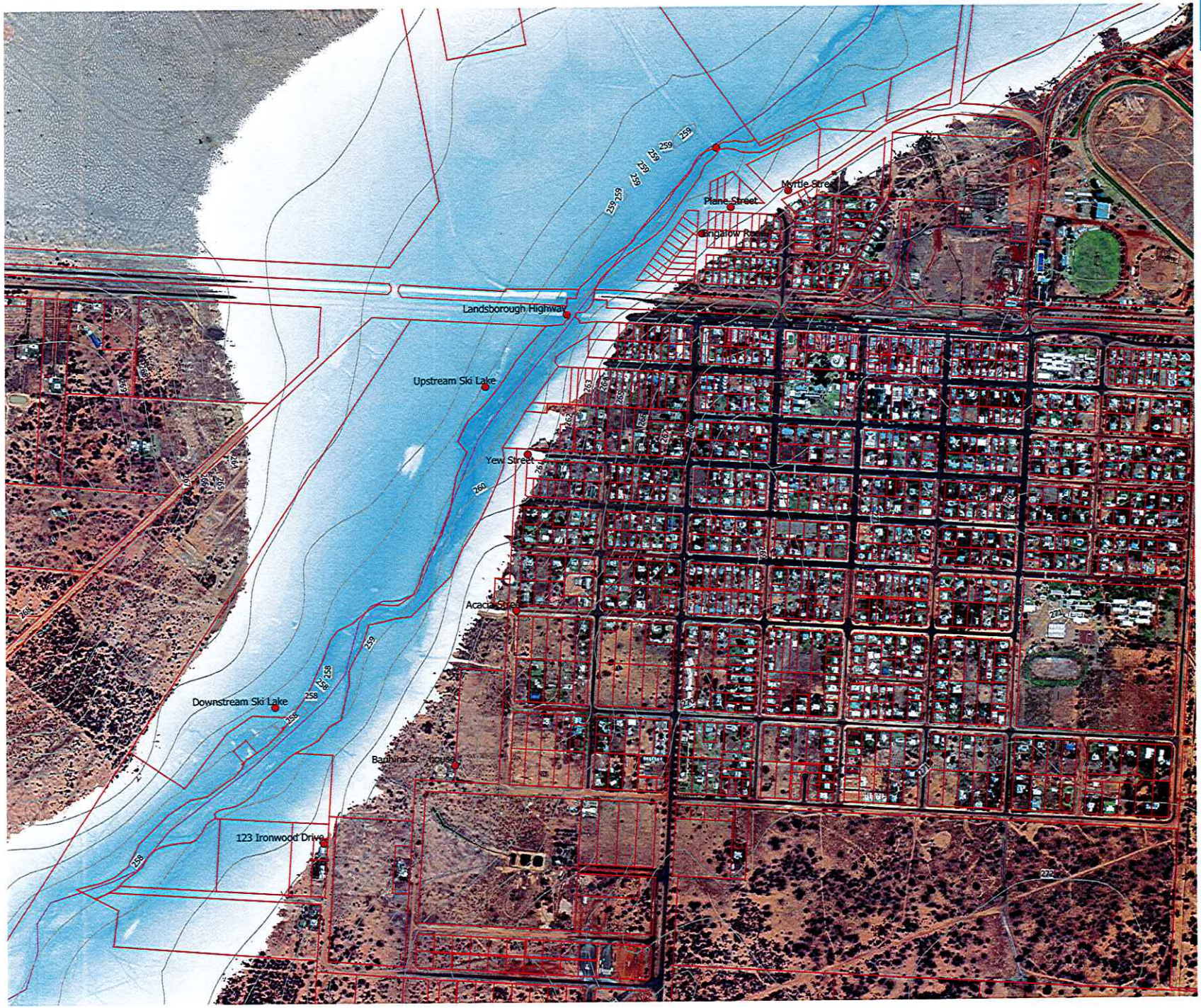

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Barcaldine Recreation Park Flood Impact Assessment

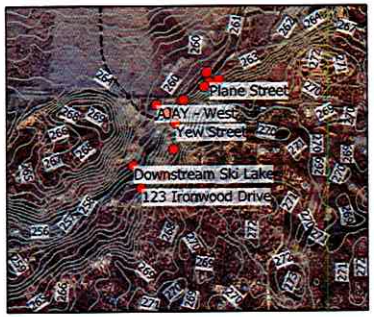
Figure 6 of 40.
Flood Innundation Mapping
Scenario 1 - 0.2% Aep

Legend

- SMK Design cont contour LineString
- Cadastral_data_LOTBDY
- Flood innundation_Critical Points-
- contour
- Surface HydroLines National

Depth (Max) m

- 0
- 0.5
- 1
- 1.5
- 2
- 2.5
- 3
- 3.5
- 4
- 4.5
- 5
- 5.5
- 6



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Job ID: 190005
23/07/2020

N

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