
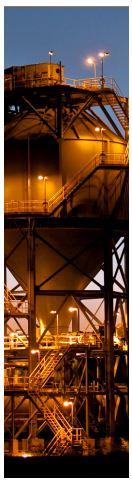
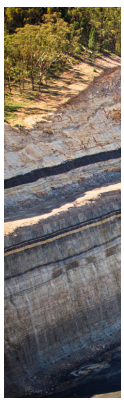



MOOLARBENCOAL

Moolarben Coal Complex
UG4 Ancillary Works Modification

Modification Report

APPENDIX C

FLOODING REVIEW

YANCOAL
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MOOLARBEN COAL OPERATIONS

UG4 ANCILLARY WORKS MODIFICATION FLOODING REVIEW

ARKHILL ENGINEERS

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For	By	Name	Position	Signed	Date
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Table of Contents

List of Tables

List of Figures

1. INTRODUCTION

1.1 Study Background

Moolarben Coal Operations Pty Ltd (MCO), a wholly owned subsidiary of Yancoal Australia Limited (Yancoal), operates the Moolarben Coal Complex, which is located approximately 40 kilometres (km) north of Mudgee in the Western Coalfields of New South Wales (NSW).

The Moolarben Coal Complex comprises four approved open cut coal mining areas (OC1 to OC4), three approved underground coal mining areas (UG1, UG2 and UG4) and other mining related infrastructure, including coal processing and transport facilities. Mining operations at the Moolarben Coal Complex are currently approved until 31 December 2038, and will continue to be carried out in accordance with Project Approval (05_0117) Moolarben Coal Project Stage 1 (MCP Stage 1) dated 6 September 2007 (as modified) and Project Approval (08_0135) (Moolarben Coal Project Stage 2) (MCP Stage 2) dated 30 January 2015 (as modified). Stages 1 and 2 of the Moolarben Coal Complex were declared State Significant Development under the NSW Environmental Planning and Assessment Act, 1979 (EP&A Act) on 28 June 2019.

MCO is seeking to modify the Moolarben Coal Complex Stage 1 Project Approval (05_0117) referred to as the UG4 Ancillary Works Modification (the Modification) under section 4.55(2) of the Environmental Planning and Assessment Act, 1979 (EP&A Act) to allow for changes to the currently approved operations, including:

- Dewatering bore sites including an access and infrastructure corridor;
- New remote services infrastructure area;
- New internal road crossing of Bora Creek to provide access to the remote services infrastructure area;
- New downcast ventilation shaft compound and associated infrastructure (e.g. access track, ballast drop hole, storage sheds, water tanks, etc.);
- New site access to the ventilation shaft compound via Ulan Road; and
- Other minor ancillary infrastructure.

The Modification would not change the approved longwall panel layout, panel widths, extraction height, sequence or production limits or the distance between longwalls and the Drip and Corner Gorge. As a result of the above there would be changes in surface disturbance limits at the Moolarben Coal Complex.

Arkhill Engineers have been engaged by MCO to undertake a Flooding Review of the proposed Modification. The assessment has focused on the following two areas due to the proximity to drainage lines and associated Ulan Road crossings:

- UG4 Ventilation Fan Site – located adjacent to Drainage Line No. 1 (herein referred to as the North site); and
- UG4 Remote Services Infrastructure Area (RSIA) – located adjacent to Bora Creek (herein referred to as the South site).

The purpose of this Flooding Review is to:

- determine and assess the impacts of the proposed crossings of Drainage Line 1 and Bora Creek;
- assess the flood immunity of the existing water crossing infrastructure on Ulan Road and adjacent MCO infrastructure;
- provide an overview of the hydrological and hydraulic modelling process used in performing the assessment;
- describe which guidelines and to what criteria the new infrastructure would be designed and constructed in accordance with; and

- include photographs of similar culverts which provide an example of successful implementation of such infrastructure.

Specifically, the assessment involved determination of the peak flood levels and flood behaviour at the two (2) sites for a range of design flood events, including the 5% Annual Exceedance Probability (AEP), 2% AEP and 1% AEP design flood events.

1.2 Study Location and Catchment

The study locality is shown in **Figure 1-1**. The site is situated within the Mid-Western Regional Local Government Area (LGA). The two watercourses related to this Modification are Bora Creek and an unnamed second order drainage line, Drainage Line 1. Both watercourses join the Goulburn River west of Ulan Road.

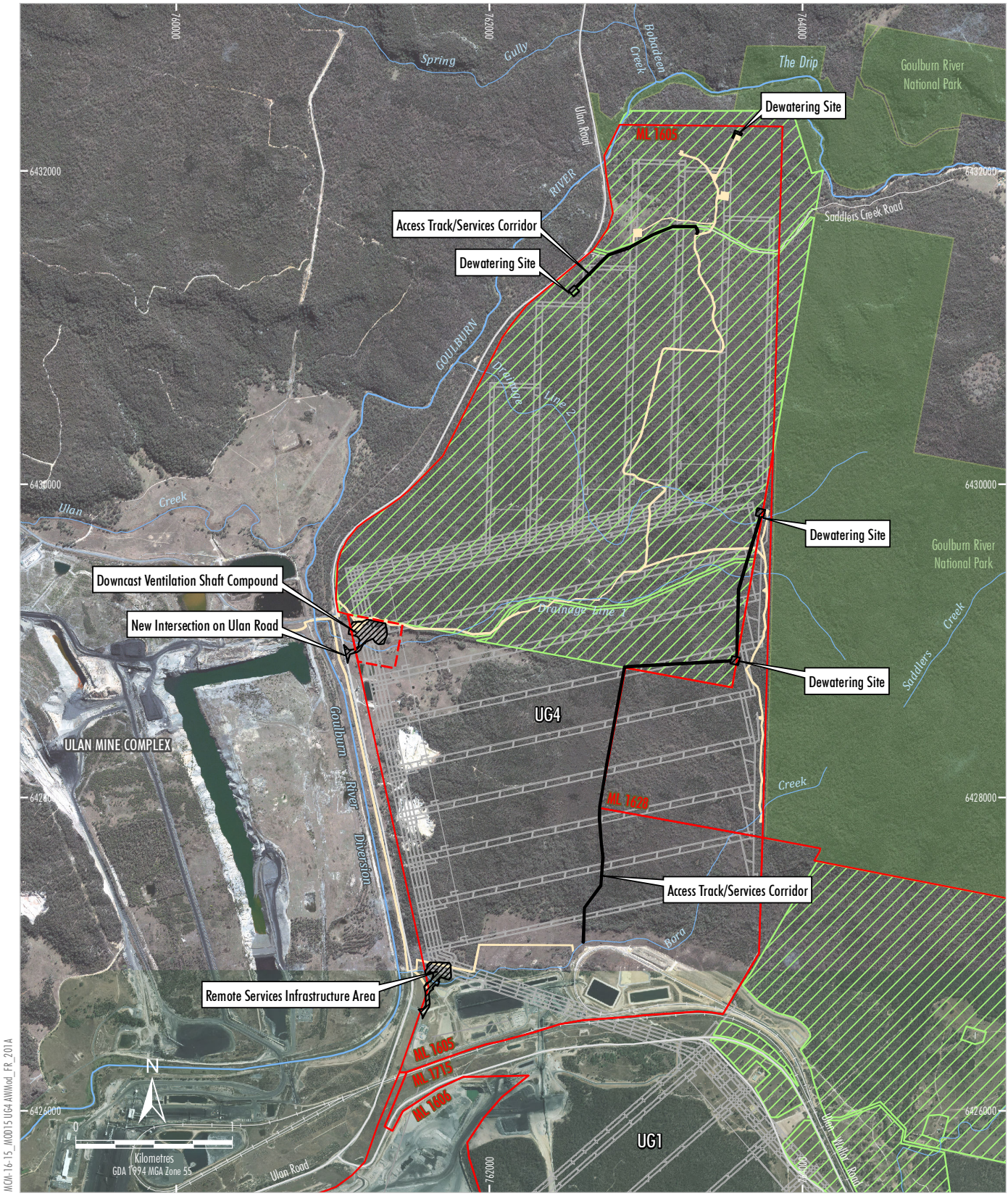
The Bora Creek main stream length is approximately 3.5km, with a catchment area of 5.3km^2. Drainage Line 1 has a main stream length of approximately 3.9km, with a catchment area of 4.2km^2. The Goulburn River is a much larger river system that has a catchment area of around 173 km^2 upstream of the study area.

The study catchment is located on the Great Dividing Range. The topography is undulating and grades relatively steeply from the upper slopes to the floodplain around the Goulburn River. The upper catchments are densely vegetated. Local topography of the site, as defined by the available LiDAR data, is shown on **Figure 3-1**. The north site area and south site area are typically elevated between 400 to 420m Australian Height Datum (AHD) and 410 to 425m AHD respectively.

The catchment area boundary that contains mine/coal contact surface water runoff from the CHPP has been specifically excluded from this assessment as these areas would be managed by MCO in accordance with the MCO Surface Water Management Plan and are designed to contain events up to the 2%AEP 72 hour storm.

The areas excluded are as shown in **Figure 3-1**, and are described as follows:

- the CHPP plant area;
- material handling plant, water treatment facilities and laydown pads;
- coal stockpiles;
- the rail loop and storage dams; and
- various access roads and drainage areas that report surface water runoff to the CHPP storage dams located to the north and west of the coal stockpiles and CHPP areas.



MCM-16-15_MOD15 UG4 AWMod_FR_201A

LEGEND

- Mining Lease Boundary
- Mining Lease Application Boundary
- Existing Biodiversity Offset Area
- Existing/Approved Development
- Underground Longwall Layout
- Pipeline and Borefield Infrastructure
- UG4 Ancillary Works Modification
- Indicative Surface Infrastructure Area

Source: MCO (2019); NSW Department of Planning, Industry and Environment (2019)
Orthophoto Mosaic: MCO (April 2016 - May 2012)

MOOLARBENCOAL

MOOLARBEN COAL COMPLEX

Site Locality

Figure 1.1

2. PROPOSED DEVELOPMENT AND DESIGN GUIDELINES

2.1 Overview

The North site is located approximately 2km north of the Coal Handling Preparation Plant (CHPP) and Bora Creek. The works proposed at this site includes the following key features:

- A new intersection located on Ulan Road;
- Downcast Ventilation Fan Compound and Laydown Pad area, connecting the surface to the UG4 workings;
- A new access road, which crosses Drainage Line 1 to access the compound from Ulan Road; and
- Erosion and sediment controls for the area.

The South site is located immediately north of Bora Creek and also north west of the CHPP. The works proposed at this site include the following key features:

- A new intersection to be located off the existing private access road to the CHPP;
- A new RSIA compound area connecting the surface to the UG4 workings;
- A new access road, which crosses Bora Creek to access the RSIA from the existing CHPP private access road; and
- Erosion and sediment controls for the area.

The flood study identifies the hydraulic performance and flood behaviour of the two areas for 5%, 2% and 1% AEP events. Relevant aspects of the objectives of Section F3 of the floodplain manual have been considered for the above listed events.

2.1.1 Intersection Design

The intersection treatments shall be designed:

- in accordance with *Austroads Part 4A: Unsignalised and Signalised Intersections* guideline;
- to include new table drains to the intersection with links to existing drainage and culverts; and
- to accommodate semi-trailer truck access and turning in accordance with Austroads Standards.

The design of intersection treatments shall be performed so that there is no increase in the frequency of flooding on Ulan Road.

2.1.2 Private Access Road Design

The access roads shall be designed: in accordance with the relevant aspects of the following indicative design objectives:

- in accordance with *Austroads Part 3: Geometric Design* guideline;
- in accordance with *Guidelines for Controlled Activities on Waterfront Land* (DPI 2007);
- in accordance with *Guidelines for Fish Friendly Waterway Crossings* (NSW Fisheries, 2003) and *Why Do Fish Need To Cross The Road? Fish Passage Requirements for Waterway Crossings* (NSW Fisheries 2003);
- with Table drains constructed where the access road is in cut; and
- for a low speed environment.

The design of new access roads shall be performed so that there is no increase in the frequency of flooding on Ulan Road.

MCO have selected the new internal road culverts to be designed to provide flood immunity for the private access roads, for design flood events up to approximately the 5% AEP. Limiting the size of culverts to cater for the 5% AEP event aids in the attenuation of flows in both Drainage Line 1 and Bora Creek, so that there is no negative impact to flood immunity of Ulan Road.

Key features for the new culverts are as follows:

- Culvert C13 – comprises a twin cell reinforced concrete box culvert – nominal size 2 x 2700mm x 2100mm high;
- Culvert C23 – comprises a twin cell concrete pipe culvert – nominal size 2 x 1200mm diameter;
- Culvert C24 - comprises a single cell reinforced concrete box culvert – nominal size 3600mm x 2400mm high; and
- Minor culverts are to be included at the intersection areas – sizes are to be confirmed during the detail design phase.

Examples of culverts to be constructed as part of the work are shown in **Figure 2-1**, **Figure 2-2**, and **Figure 2-3**.

For flooding exceeding the 5% AEP event, but limited to the 1% AEP event, flows which result in overtopping of the new private access roads shall be limited in depth and velocity, so that the Hazard Vulnerability Classification for the crossing is limited to Class H1, in accordance with Australian Rainfall and Runoff (ARR) 2016.

The design of new culverts shall be performed so that there is no increase in the frequency of flooding on Ulan Road, nor any backwater impacts adjacent to MCO infrastructure.

Figure 2-1 - Example of Proposed Culvert C13

Figure 2-2 - Example of Proposed Culvert C23

Figure 2-3 - Example of Proposed Culvert C24

2.1.3 Laydown Pad Areas

The laydown pads are designed above the 1% AEP design flood event.

Clean water diversion drains around the laydown pad areas will also be designed and installed to cater for the 1% AEP event.

The design of new laydown pad areas shall be performed so that there is no increase in the frequency of flooding on Ulan Road.

3. MODEL DEVELOPMENT

3.1 Hydrological Model

An XP-RAFTS hydrologic model was developed to simulate the rate at which rainfall runs off the two catchments associated with Bora Creek and Drainage Line 1 (**Figure 3-1**). The amount of rainfall runoff and the attenuation of the flood wave as it travels down the catchment are dependent on:

- The catchment slope, area, vegetation and other characteristics;
- Variations in the distribution, intensity and amount of rainfall; and
- The antecedent conditions (dryness/wetness) of the catchment.

The hydrologic model was split into a network of sub-catchments considering the uniformity in their slope, land-use, vegetation density as shown in **Figure 3-1**. Catchment properties were determined from the Digital Elevation Model (DEM) and aerial photography. The conservatively adopted PERN values (resulting in higher flowrate estimates and flood levels) considered whether the sub-catchment could be described as either forested area (PERN of 0.10) or cleared (PERN of 0.05). Rainfall intensity-frequency-durations (IFD) values and temporal patterns were adopted in accordance with the standard procedures outlined in ARR. Design rainfall data was sourced from the BoM 2016 IFDs, whilst the rainfall-runoff procedures including temporal patterns and losses recommended by ARR 2001 were adopted. An aerial reduction factor of 0.98 was applied, in accordance with the ARR 2016 procedures. An initial loss of 10 mm and a continuing loss of 2.5 mm/h were adopted.

The hydrologic model produces a series of flow hydrographs for use in the hydraulic model to simulate the passage of the flood through the catchment. Hydrographs at the proposed roads crossings for Bora Creek and Drainage Line 1 (marked in **Figure 3-1**) are presented in **Figure 3-2** and **Figure 3-3** respectively. The modelled peak flow rates (extracted from the TUFLOW hydraulic model) are provided in **Table 3-1**.

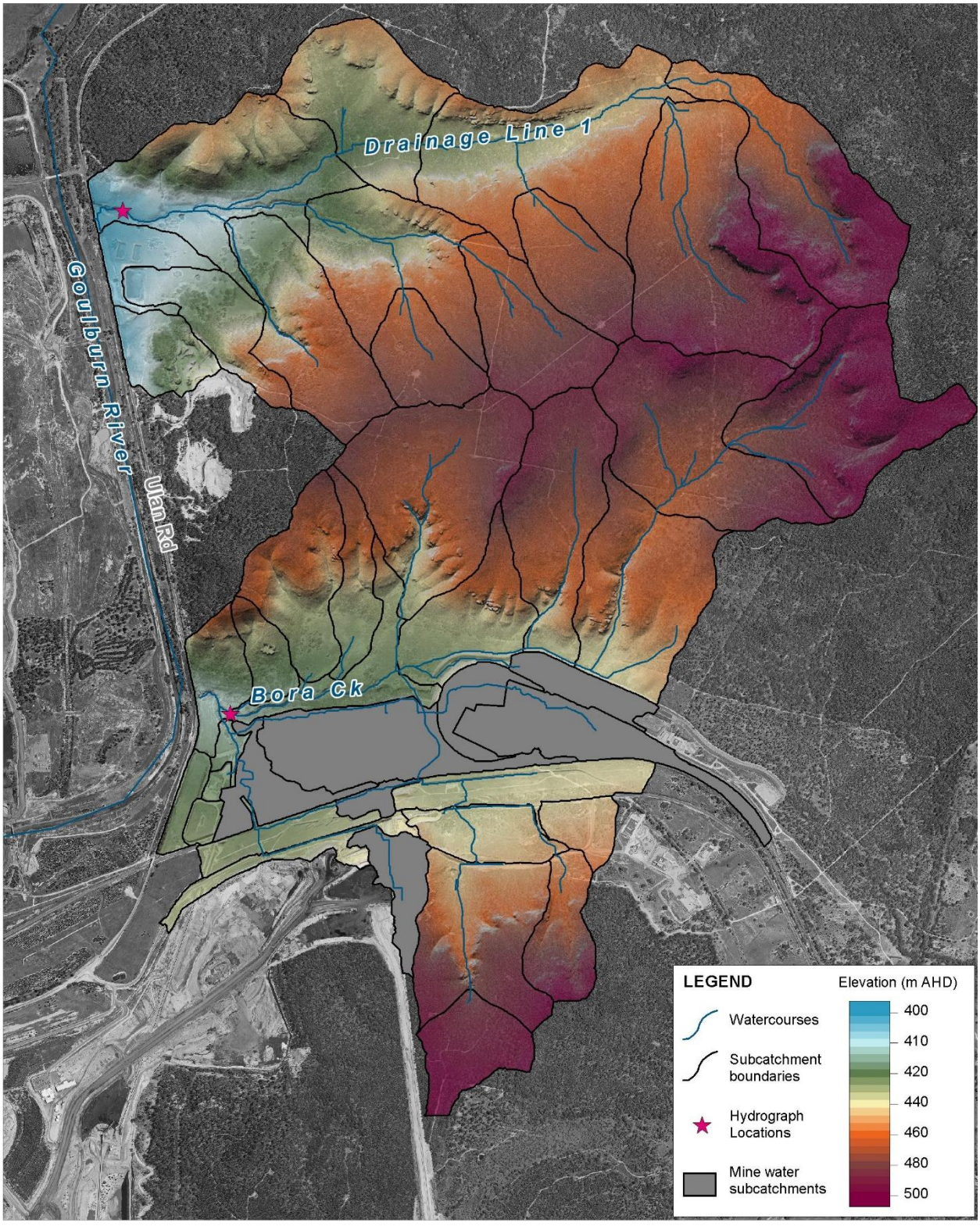


Figure 3-1 - RAFTS Model Sub-catchment Layout

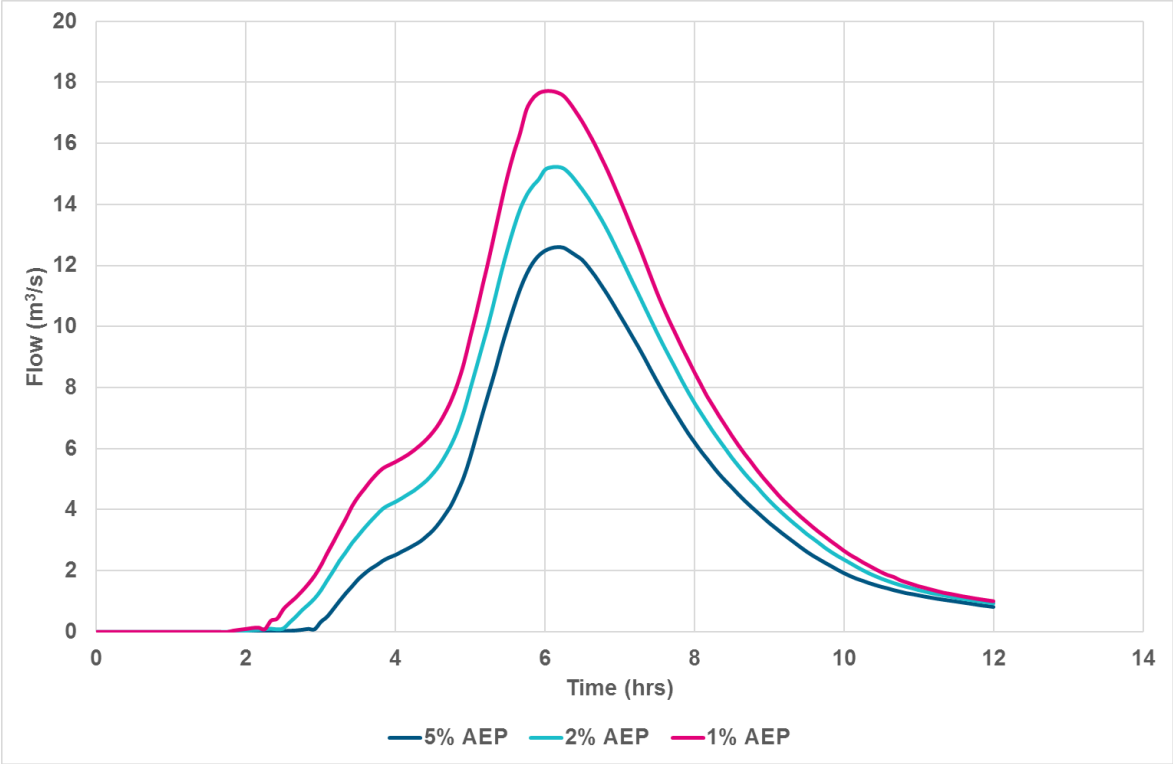


Figure 3-2 - Drainage Line 1 Catchment Hydrograph

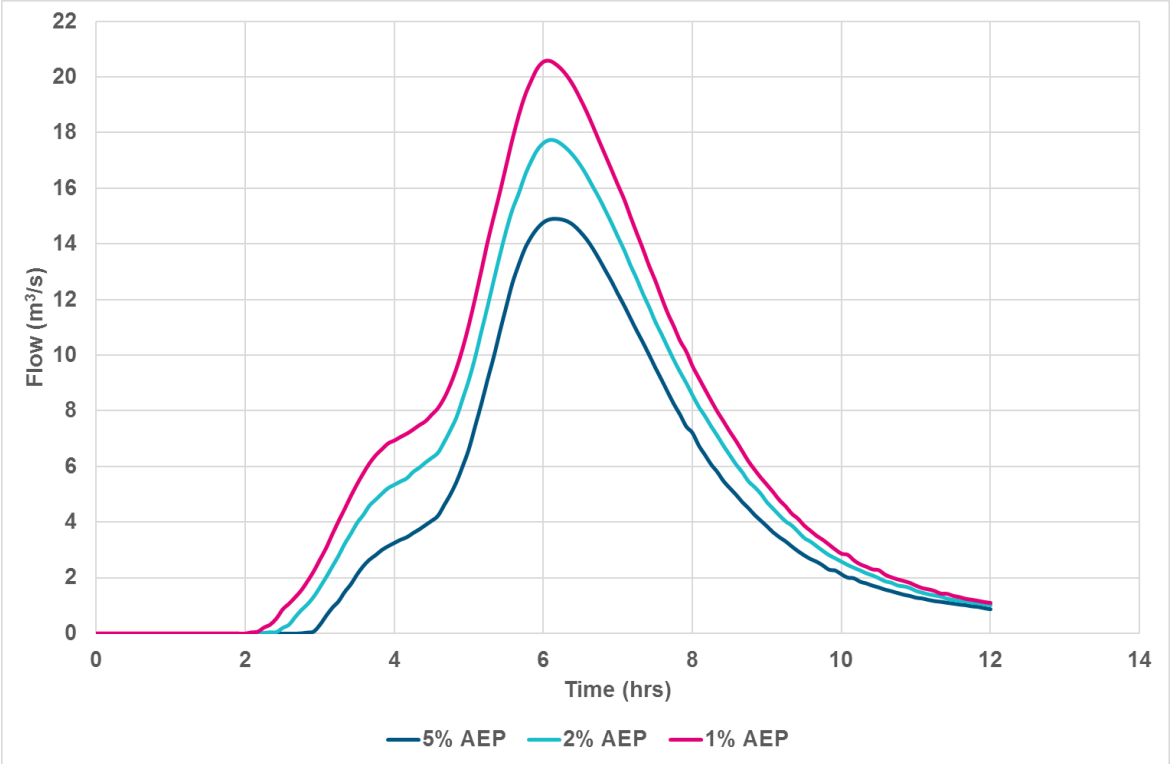


Figure 3-3 - Bora Creek Catchment Hydrograph

Table 3-1 - Modelled (TUFLOW) Design Event Peak Flow Rates

Flood Event	Flow rate (m^3/s)
Drainage Line 1 – 5% AEP	12.6
Drainage Line 1 – 2% AEP	15.2
Drainage Line 1 – 1% AEP	17.7
Bora Creek – 5% AEP	14.9
Bora Creek – 2% AEP	17.7
Bora Creek – 1% AEP	20.6

3.2 ARR 2016 Sensitivity

The rainfall-runoff procedures outlined in ARR 2016 are in a period of industry review and have been found to under-estimate peak design flood flows. A set of NSW-specific guidelines were recently released that recommend reduced design rainfall losses to rectify the under-estimation. Due to the uncertainty regarding the use of ARR 2016, this assessment adopted the rainfall temporal patterns and losses recommended in ARR 2001. However, a sensitivity analysis was undertaken, simulating the RAFTS hydrologic model using the full procedures outlined in ARR 2016 and the recent NSW-specific rainfall loss guidance. The peak flows derived from the RAFTS model for the sub-catchment outlet upstream of each culvert crossing location are presented in **Table 3-2** for both the adopted ARR 2001 and the ARR 2016 approaches.

Table 3-2 - Comparison of RAFTS Peak Flow Rates (m^3/s)

Flood Event	Adopted	ARR 2016
Drainage Line 1 – 5% AEP	14.6	13.0
Drainage Line 1 – 2% AEP	17.4	16.2
Drainage Line 1 – 1% AEP	20.3	18.8
Bora Creek – 5% AEP	15.8	14.5
Bora Creek – 2% AEP	18.9	18.3
Bora Creek – 1% AEP	22.1	21.4

The results in **Table 3-2** show that although the ARR 2016 flows are slightly lower than those that have been adopted for the assessment, they are reasonably consistent. It should be noted that the peak flows presented in **Table 3-2** differ to those of **Table 3-1** due to the more simplified flow routing methods within RAFTS, compared to the full hydraulic simulation within TUFLOW. The RAFTS model employs a simple time lag routing between sub-catchments. In the TUFLOW model the sub-catchment inflows applied at the upstream ends of the models flow through around a 1 km length of the hydraulic model, through which the flood flows are attenuated by local floodplain storage and culverts etc. This typically produces a lower peak flow when the sub-catchment flows combine at the downstream end when compared directly to the equivalent flow location in RAFTS.

4. HYDRAULIC MODEL

Two separate TUFLOW hydraulic models – North site and South site (associated with Drainage Line 1 and Bora Creek respectively) were developed for this study. TUFLOW is a two-dimensional (2D) hydraulic modelling software developed to simulate flood depths, extents and velocities.

The modelled area for the North site covers around 380ha, with the area for the South site being around 530ha. The upstream inflow boundaries are located a substantial distance from the modelled crossing locations, whilst the downstream boundaries are located at the confluence of the respective watercourses with the Goulburn River.

A TUFLOW model cell size of 2m was adopted to sufficiently represent the in-channel and over-bank flow distribution across the model area at the scale required for this study. The TUFLOW model samples cell elevations from a 2m grid cell resolution DEM of the floodplain topography, which was generated from the 2015 LiDAR data. This was augmented by additional survey datasets provided by MCO for the CHPP Area, the existing culvert crossings of Ulan Road, and Ulan road surface detail survey pickup where required and available.

Outputs from the XP-RAFTS hydrologic model are applied as local sub-catchment inflows within the TUFLOW model domain. Downstream model boundaries are provided to allow flood flows to exit the model domain. Both models define the downstream boundary as a fixed water level, which has been set to the corresponding design peak flood condition in the Goulburn River. The downstream water levels used for each modelled event are presented in **Table 4-1**.

Table 4-1 - Adopted Downstream Boundary Levels (m AHD)

Design Event	Drainage Line 1	Bora Creek
5% AEP	399.98	409.19
2% AEP	400.49	409.31
1% AEP	400.95	409.52

Hydraulic roughness zones were assigned in the TUFLOW model to represent the variation in flow resistance. The spatial distribution of these zones (e.g. paved driveway areas, cleared land or vegetated areas) was informed by inspection of aerial photography. The adopted roughness values are listed in **Table 4-2**.

Table 4-2 - Adopted Manning 'n' Roughness Values

Land Use	Manning's 'n' Value
Cleared	0.05
Vegetated	0.10

Culvert cross drainage structures have been included in the TUFLOW model as 1D structures dynamically linked into the 2D domain. **Figure 4-1** shows the location of the modelled culverts at both the North and South sites, with **Table 4-3** providing culvert details as used within the hydraulic model.

Table 4-3 - Modelled Culvert Details

Culvert ID	Culvert Status	Modelled Structure / Dimensions
C11	Existing	Twin rectangular box culvert 2.7m x 2.2m
C12	Existing	Triple circular culvert 0.6m diameter
C13	New	Twin rectangular box culvert 2.7m x 2.1m
C21	Existing	Single circular culvert 0.9m diameter
C22	Existing	Twin circular culvert 0.9m diameter
C23	New	Twin circular culvert 1.2m diameter
C24	New	Single rectangular box culvert 3.6m x 2.4m
C25	Existing	Five circular culverts 1.5m diameter
C26	Existing	Nine circular culverts 0.6m diameter
C27	Existing	Twin circular culvert 0.9m diameter

Figure 4-1 - Culvert Locations

5. FLOOD IMPACT ASSESSMENT

5.1 Existing Flood Behaviour

The establishment of existing design flood conditions provides for the description of:

- General flood behaviour throughout the study area;
- Existing flooding conditions for a range of design flood events; and
- Constraints and limitations to potential work with respect to flooding regimes.

Design flood modelling results (peak flood depths, water level contours and velocity vectors) for the existing scenario are provided in Appendix A for the range of design events considered and are used as a baseline for the assessment of the proposed development scenario. During the 5% and 2% AEP, Ulan Road in proximity to the North site remains free from flood waters however during the 1% AEP the road is overtopped, with flood water of less than 0.15m. During the 5% AEP, 2% AEP and 1% AEP Ulan Road in proximity to the South site remains free from flood waters.

Table 5-1 summaries peak flood levels, velocities and bed shear stresses at four locations for the northern works and four locations for the southern works, with the respective locations shown in **Figure 5-1**. For the velocities and bed shear stresses (**Table 5-1)**, values are provided for the channel cross-section average, with peak values provided in parentheses. Existing conditions flood modelling results (peak flood depths, water level contours and velocity vectors) for the developed scenario are provided in Appendix A. For peak flow rates as determined by the TUFLOW modelling for the sub-catchment outlet upstream of each culvert crossing location, refer to **Table 3-1**.

Figure 5-1 - Point of Interest Locations

5.2 Developed Scenario

The developed case scenario was represented through modification of the existing scenario TUFLOW model. The modifications included the addition of the proposed earthworks and cross-drainage culvert details for the North and South sites.

The crest level of the proposed access roads are 402.5m AHD for the Drainage Line 1 crossing and 414.0m AHD for the Bora Creek crossing. The developed case scenario models were simulated for the range of design flood events considered and compared to the existing scenario results for the purposes of assessing potential flood impacts associated with the proposed development. A developed case scenario was also run with a 20% blockage of the proposed culvert structures. Design flood modelling results

(peak flood depths, water level contours and velocity vectors) for the developed scenario are provided in Appendix B.

The peak flood levels, velocities and bed shear stresses for the developed scenario and developed scenario with blockages are provided in **Table 5-2** and **Table 5-3** respectively. It can be seen in **Table 5-2** that the modelled peak flood results associated with the proposed development are generally consistent with or less than the existing modelled peak flood results, and the modification will have no adverse impacts on Ulan Road.

Table 5-1 - Existing Modelled Peak Flood Results

Location	Peak Flood Level (m AHD)			Peak Velocity (m/s)			Bed Shear Stress (kg/m)		
	5% AEP	2% AEP	1% AEP	5% AEP	2% AEP	1% AEP	5% AEP	2% AEP	1% AEP
N1	401.8	401.8	401.9	1.4 (1.8)	1.4 (1.9)	1.4 (2.0)	61 (86)	67 (96)	70 (104)
N2	401.2	401.3	401.5	1.1 (2.1)	1.1 (2.2)	1.0 (2.0)	56 (121)	59 (129)	45 (111)
N3	400.8	401.0	401.4	2.7 (4.3)	2.2 (4.3)	1.6 (2.5)	235 (657)	167 (461)	86 (220)
N4	400.3	400.8	401.3	0.8 (1.0)	0.5 (0.8)	0.3 (0.8)	21 (57)	7 (13)	4 (12)
S1	413.8	413.9	414.0	0.6 (1.3)	0.6 (1.3)	0.6 (1.3)	73 (278)	76 (277)	75 (277)
S2	413.7	413.8	413.8	0.8 (1.4)	0.7 (1.4)	0.6 (1.5)	126 (387)	98 (380)	81 (379)
S3	412.7	412.8	413.0	0.6 (1.3)	0.7 (1.4)	0.7 (1.5)	58 (142)	65 (155)	68 (169)
S4	410.9	411.1	411.3	1.2 (2.0)	1.2 (2.1)	1.2 (2.1)	55 (110)	61 (120)	60 (123)

Table 5-2 - Developed Modelled Peak Flood Results

Location	Peak Flood Level (m AHD)			Peak Velocity (m/s)			Bed Shear Stress (kg/m)		
	5% AEP	2% AEP	1% AEP	5% AEP	2% AEP	1% AEP	5% AEP	2% AEP	1% AEP
N1	402.1	402.3	402.5	0.8 (1.8)	0.5 (1.8)	0.4 (1.8)	33 (130)	20 (129)	16 (127)
N2	401.3	401.3	401.5	1.6 (3.9)	1.7 (4.0)	1.3 (4.3)	142 (627)	155 (653)	126 (649)
N3	400.8	401.0	401.4	2.7 (4.2)	2.2 (4.3)	1.6 (2.5)	235 (656)	171 (483)	86 (193)
N4	400.3	400.8	401.3	0.8 (0.8)	0.5 (0.8)	0.3 (0.8)	21 (51)	6 (13)	4 (11)
S1	414.0	414.2	414.3	0.4 (1.0)	0.3 (1.0)	0.3 (1.1)	42 (190)	41 (226)	37 (189)
S2	413.6	413.8	413.9	0.5 (1.2)	0.5 (1.1)	0.5 (1.1)	60 (244)	55 (226)	59 (190)
S3	412.7	412.8	413.0	0.5 (1.2)	0.5 (1.3)	0.6 (1.4)	40 (123)	44 (130)	49 (143)
S4	410.9	411.1	411.3	1.3 (2.0)	1.2 (2.1)	1.2 (2.1)	56 (114)	61 (124)	59 (123)

Table 5-3 - Developed Modelled Peak Flood Results with Blockages

Location	Peak Flood Level (m AHD)			Peak Velocity (m/s)			Bed Shear Stress (kg/m)		
	5% AEP	2% AEP	1% AEP	5% AEP	2% AEP	1% AEP	5% AEP	2% AEP	1% AEP
N1	402.3	402.5	402.6	0.4 (1.6)	0.4 (1.6)	0.3 (1.5)	16 (113)	13 (113)	11 (118)
N2	401.3	401.3	401.6	1.6 (3.9)	1.7 (4.0)	1.0 (4.3)	148 (584)	155 (581)	90 (696)
N3	400.8	401.0	401.4	2.7 (4.3)	2.2 (4.3)	1.6 (2.5)	236 (533)	169 (384)	86 (220)
N4	400.3	400.8	401.3	0.7 (1.0)	0.5 (0.8)	0.3 (0.8)	21 (53)	7 (13)	4 (12)
S1	414.2	414.3	414.4	0.3 (0.5)	0.2 (0.6)	0.3 (0.6)	21 (115)	20 (74)	20 (114)
S2	413.6	413.8	413.9	0.4 (0.8)	0.5 (1.0)	0.4 (1.0)	44 (177)	49 (151)	41 (179)
S3	412.7	412.8	413.0	0.5 (1.2)	0.5 (1.3)	0.6 (1.4)	40 (123)	45 (129)	49 (144)
S4	410.9	411.1	411.3	1.3 (2.0)	1.2 (2.1)	1.2 (2.1)	57 (113)	60 (120)	60 (127)

Flood Impact mapping is presented in Appendix C and Appendix D for the no blockages and 20% blockage scenarios respectively. The mapping shows that the flood impacts associated with the proposed earthworks and creek crossings are localised to the areas around the crossing locations. Design event flood maps are presented in Appendix A and Appendix B for the existing scenario and proposed development respectively. Figure A-3 depicts the North site under a 1% AEP design event scenario without the modification, it can be seen that the Ulan Road would receive flow during this event. Figure B-3 depicts the same site (North Site) with the proposed modification, under a 1% AEP design event indicating water levels on Ulan Road would be generally consistent albeit slightly less with the proposed modification.

Flood immunity at the proposed RSIA and Ventilation Fan Compound for events up to the 1% AEP is achieved at both the North and South sites, as is shown in the flood mapping as presented in Appendix C and Appendix D. The modification will have no adverse impacts on the flood immunity of Ulan Road.

6. CONCLUSION

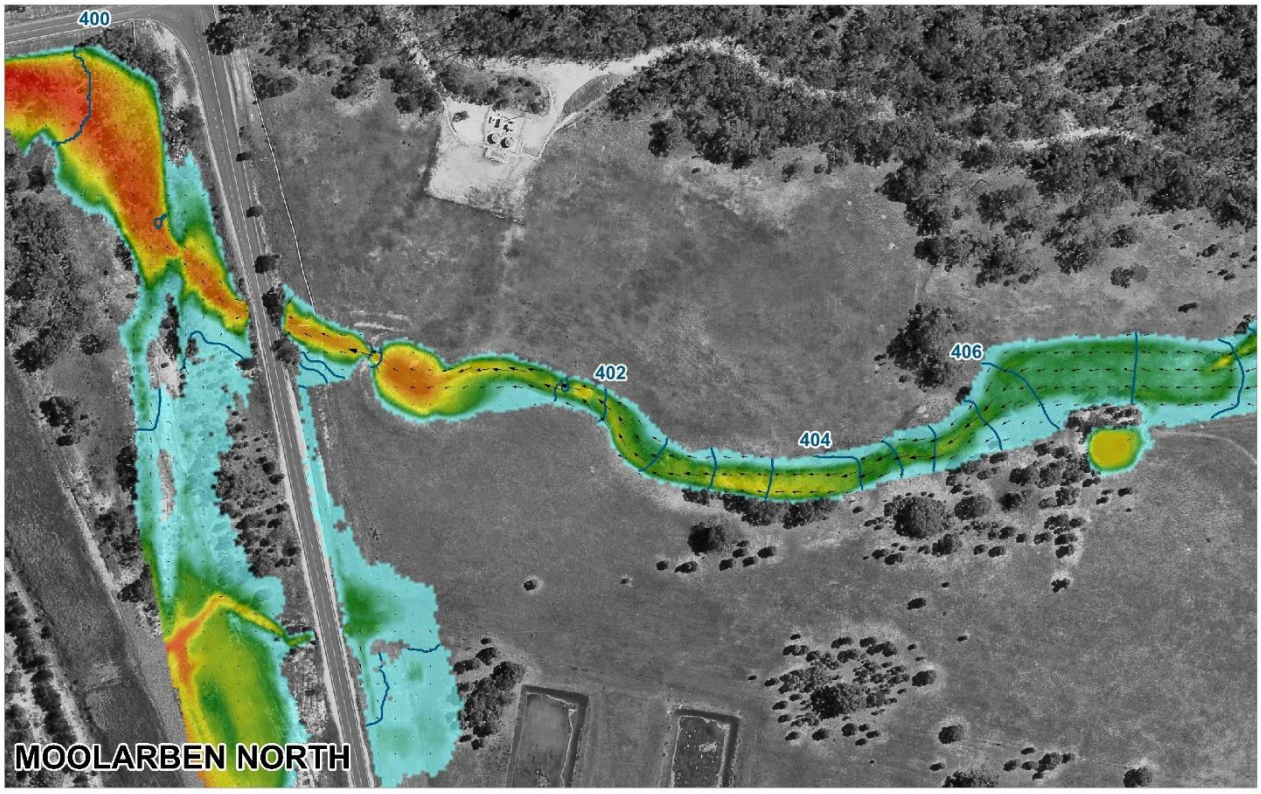
Hydrologic and hydraulic models have been developed to assess the potential flood impacts and the flood immunity of proposed works crossing Drainage Line 1 and Bora Creek.

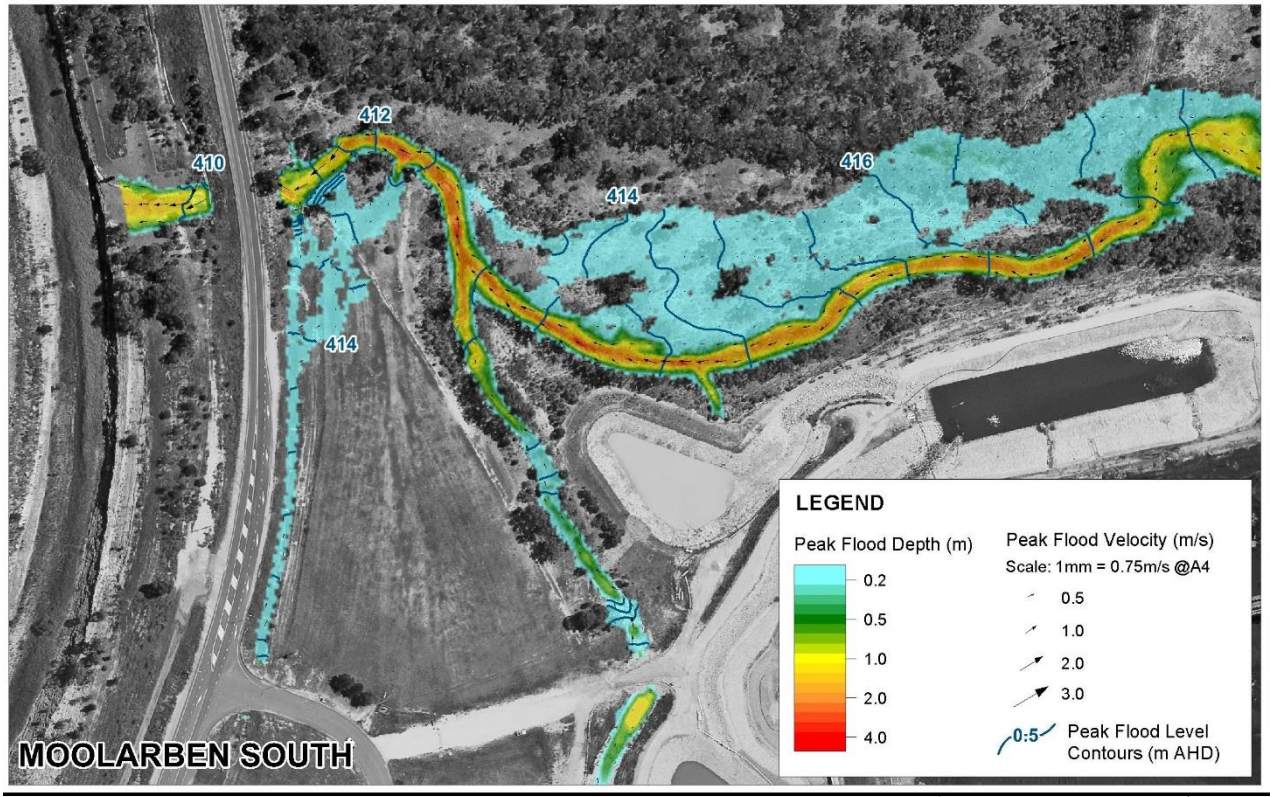
The flood impacts associated with the proposed earthworks and creek crossings are localised to the areas around the new internal road creek crossings, and culvert C13 and C24 locations (i.e. located on land owned by MCO).

The proposed development at the North and South sites are not expected to cause any adverse changes to flood immunity of Ulan Road. The proposed RSIA, Vent Shaft Compound, and other infrastructure have been designed to provide immunity against the 1% AEP design event. The proposed internal Bora Creek access road crossing and Drainage Line 1 access road crossing culverts have been designed to provide appropriate immunity for MCO's operational use (approximately 5% AEP flood immunity). The proposed internal Bora Creek access road crossing is not expected to cause any backwater effects that impact on the adjacent MCO infrastructure.

APPENDIX A

EXISTING SCENARIO DESIGN EVENT FLOOD MAPS

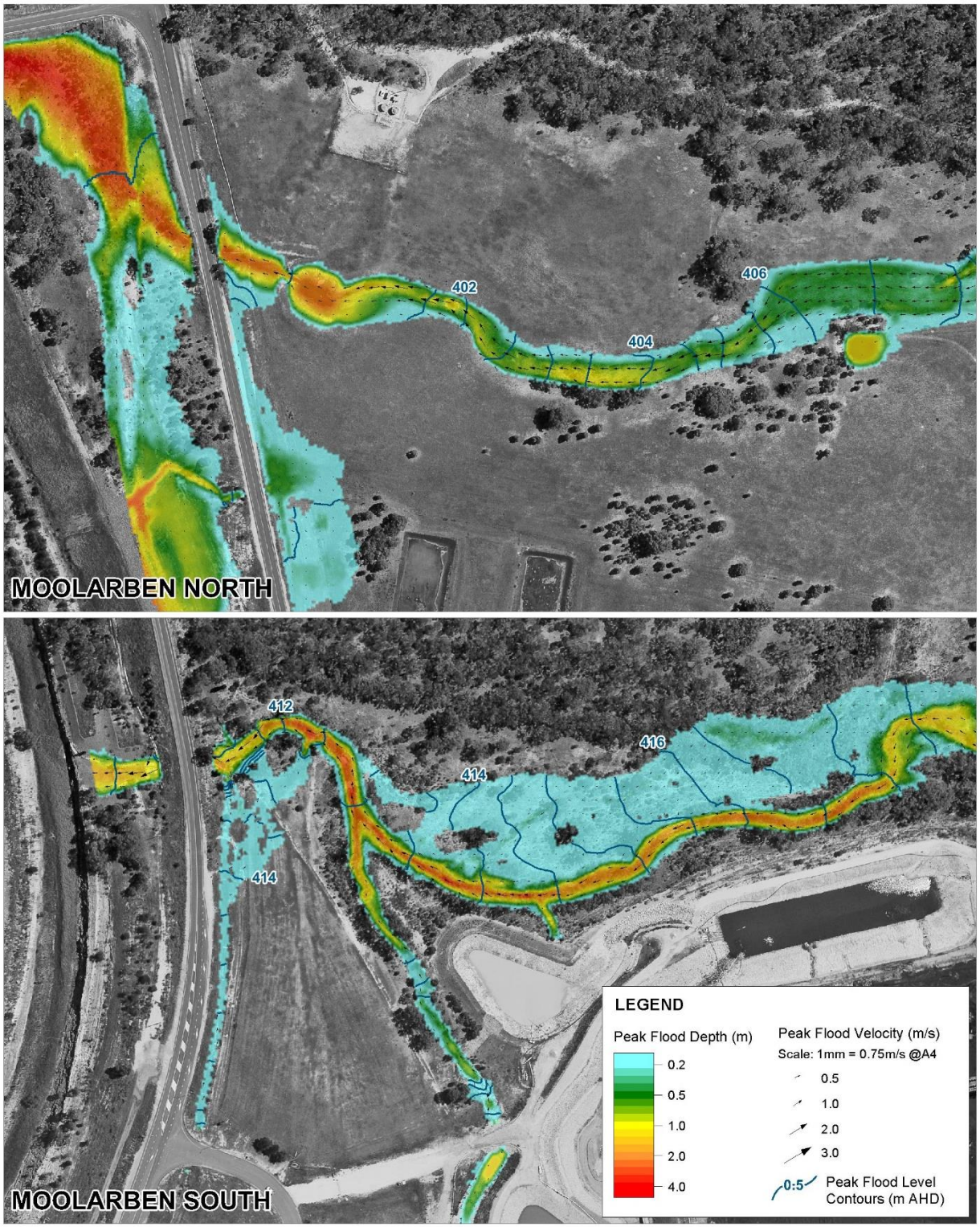




Title:

Existing Scenario
5% AEP Design Event Peak Flood Depths and Velocities

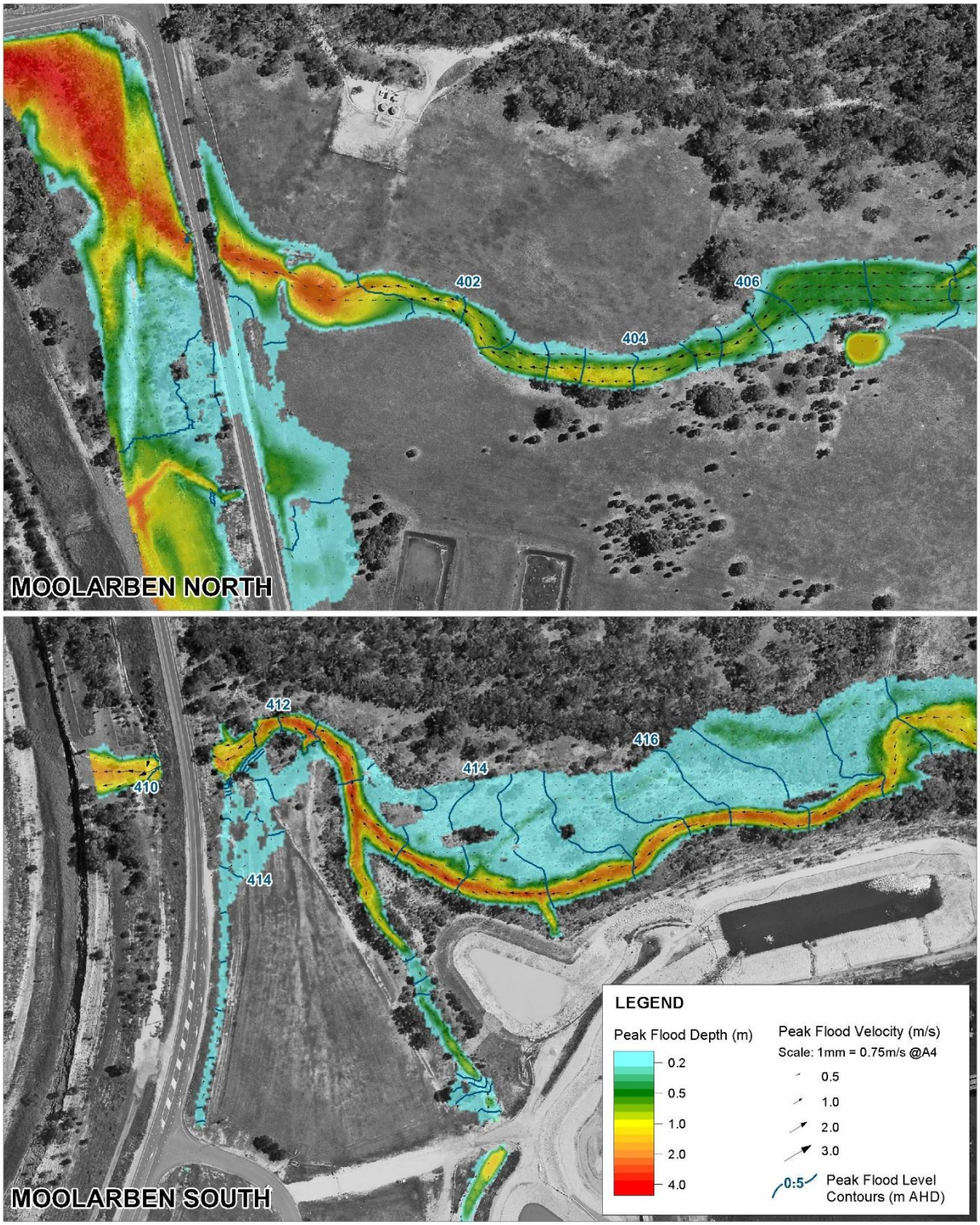
Figure:	Rev:
A-1	**A**



Title:

Existing Scenario
2% AEP Design Event Peak Flood Depths and Velocities

Figure:	Rev:
A-2	**A**



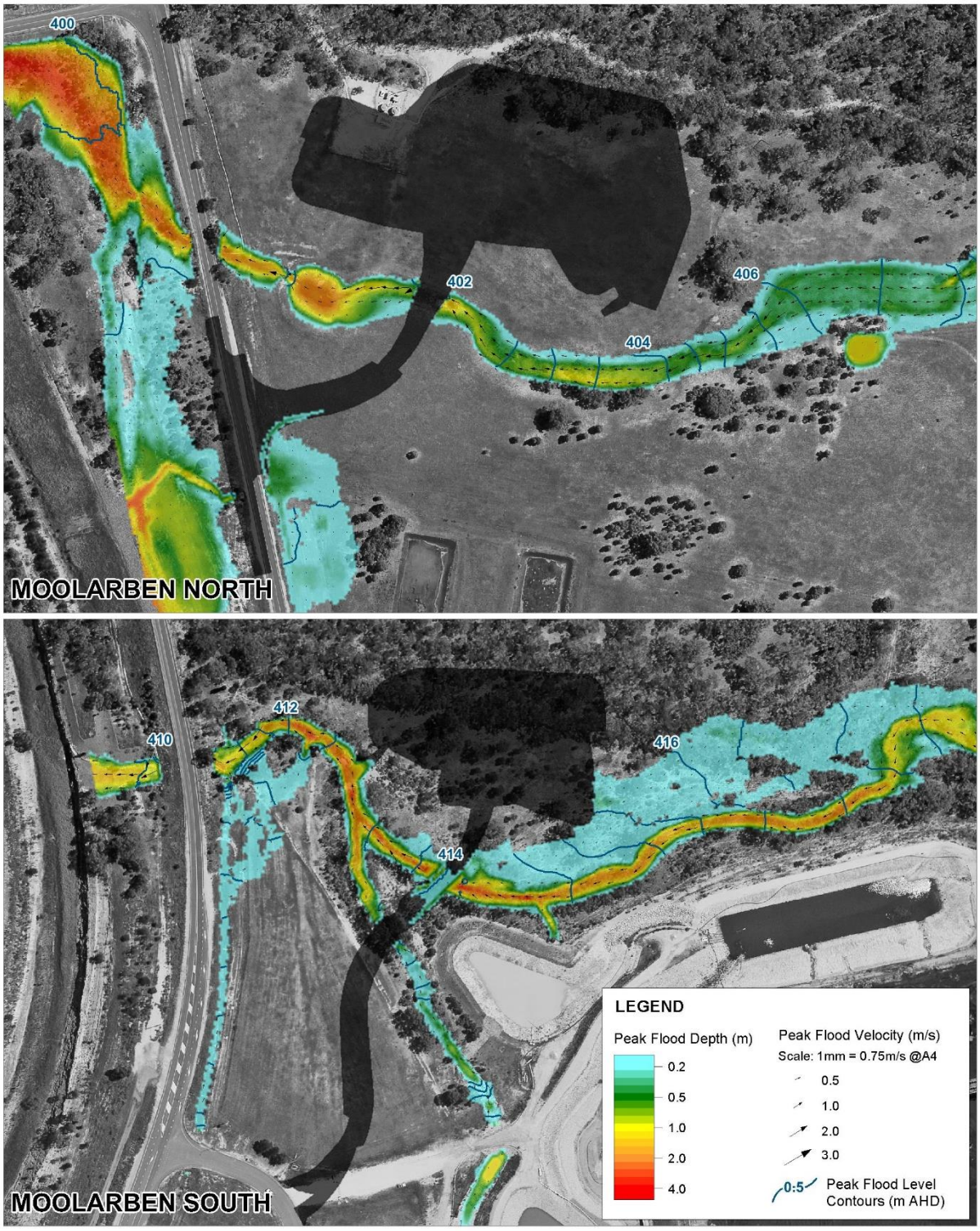
Title:

Existing Scenario
1% AEP Design Event Peak Flood Depths and Velocities

Figure:	Rev:
A-3	**A**

APPENDIX B

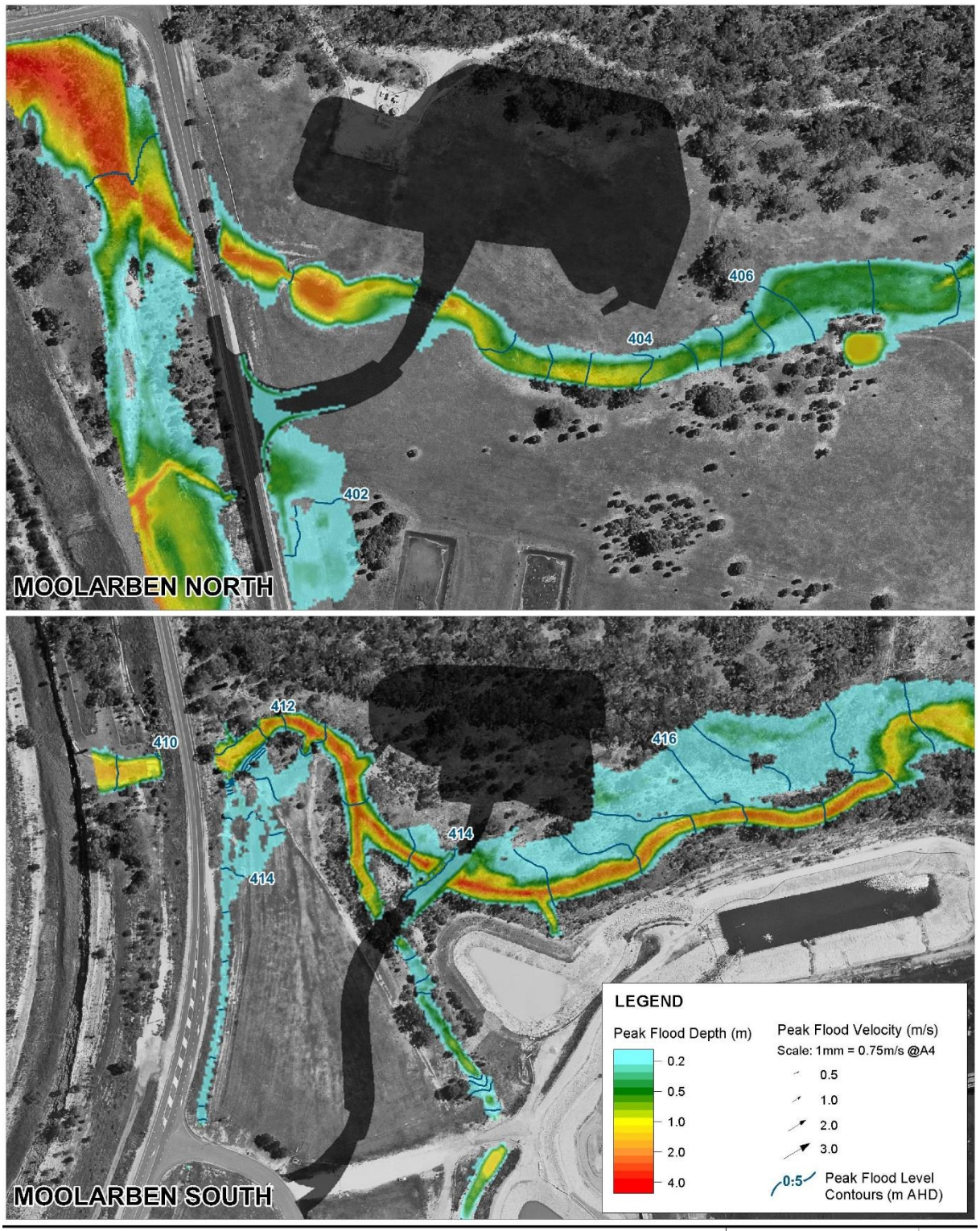
DEVELOPED SCENARIO DESIGN EVENT FLOOD MAPS WITH INDICATIVE DEVELOPMENT AREAS



Title:

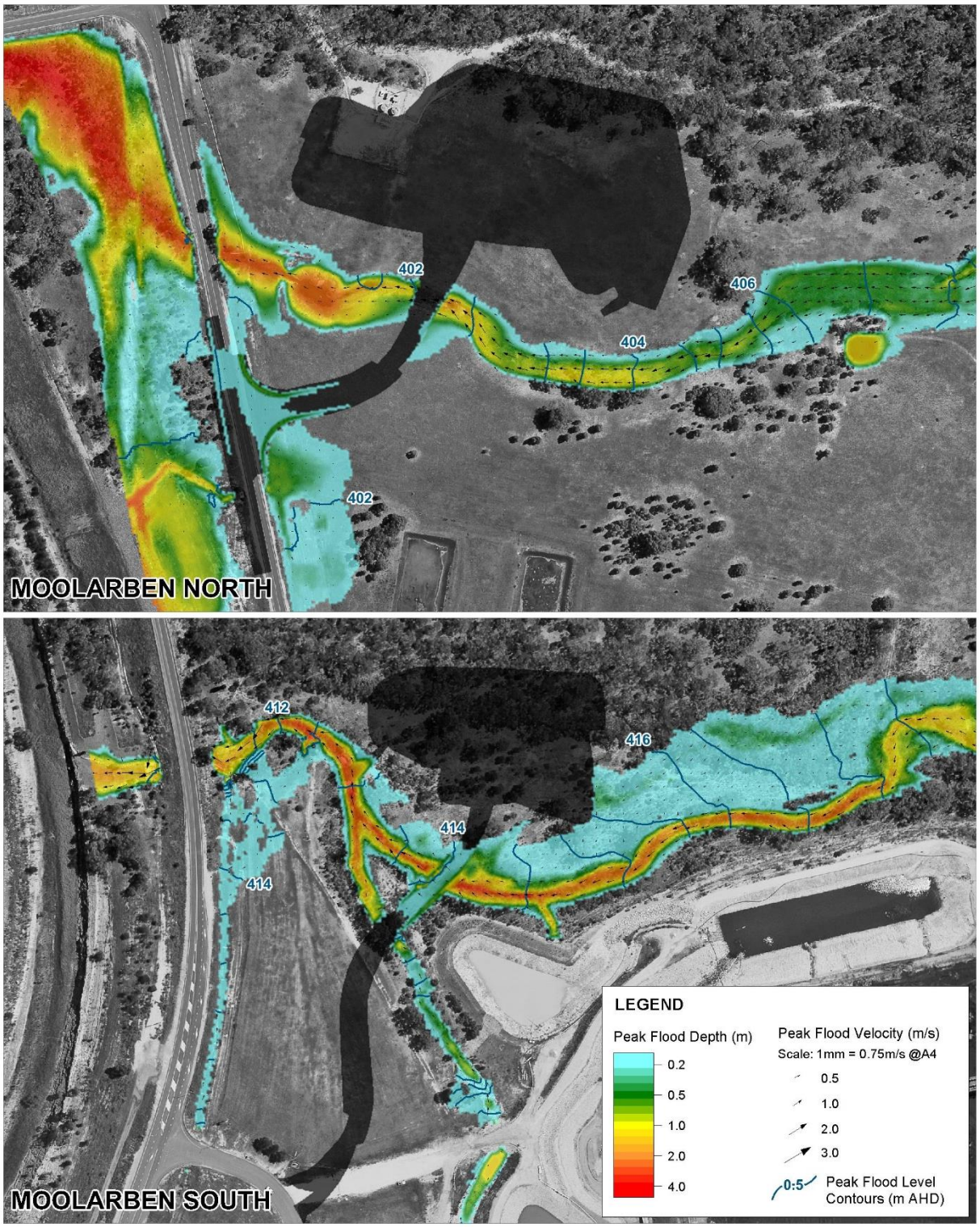
Developed Scenario
5% AEP Design Event Peak Flood Depths and Velocities

Figure:	Rev:
B-1	**A**



Title:
Developed Scenario
2% AEP Design Event Peak Flood Depths and Velocities

Figure:	Rev:
B-2	**A**

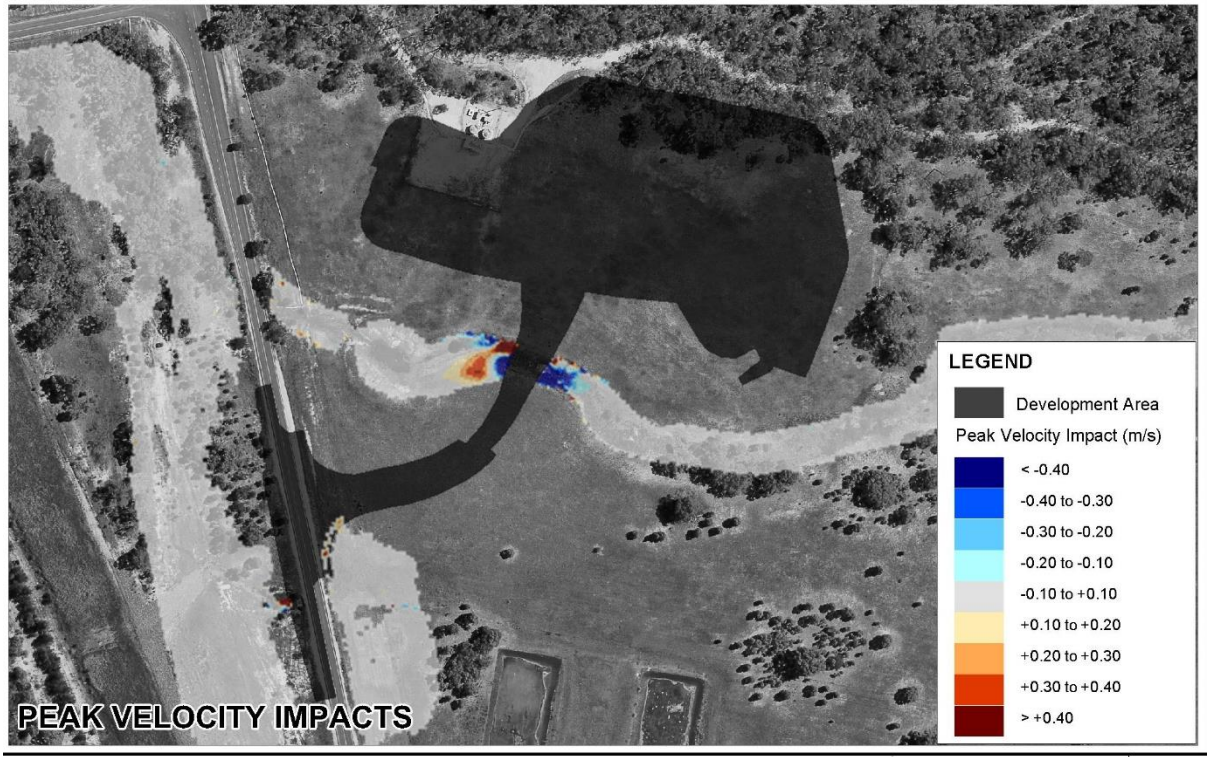


Title:
Developed Scenario
1% AEP Design Event Peak Flood Depths and Velocities

Figure:	Rev:
B-3	**A**

APPENDIX C

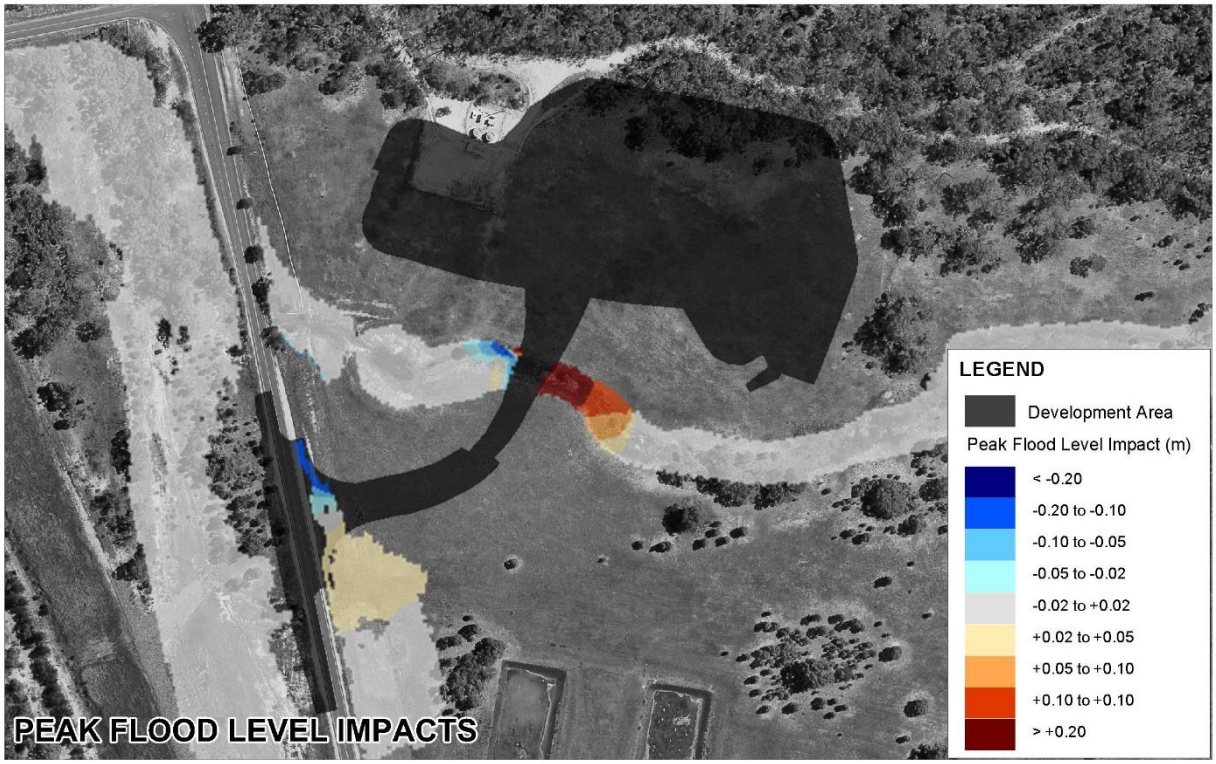
PEAK FLOOD LEVEL AND VELOCITY IMPACT MAPS WITH INDICATIVE DEVELOPMENT AREAS

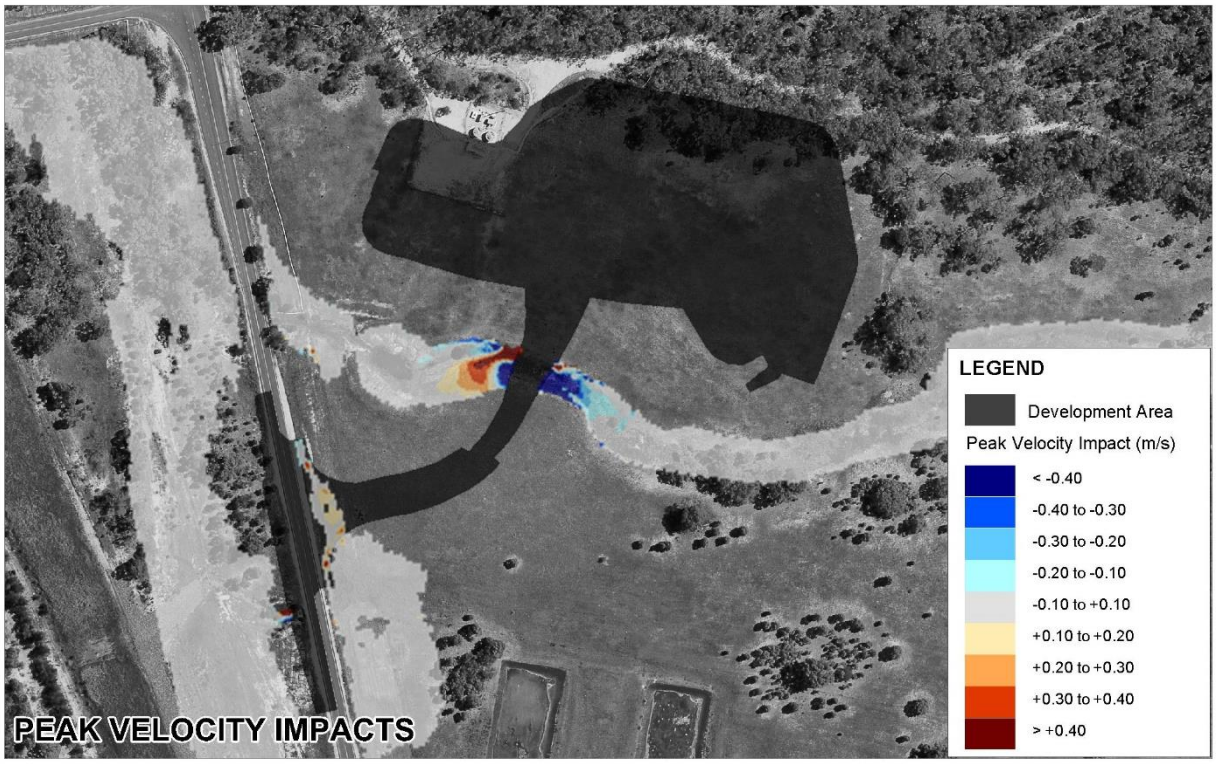


Title:

Moolarben North 5% AEP Design Event
Peak Flood Level and Velocity Impacts

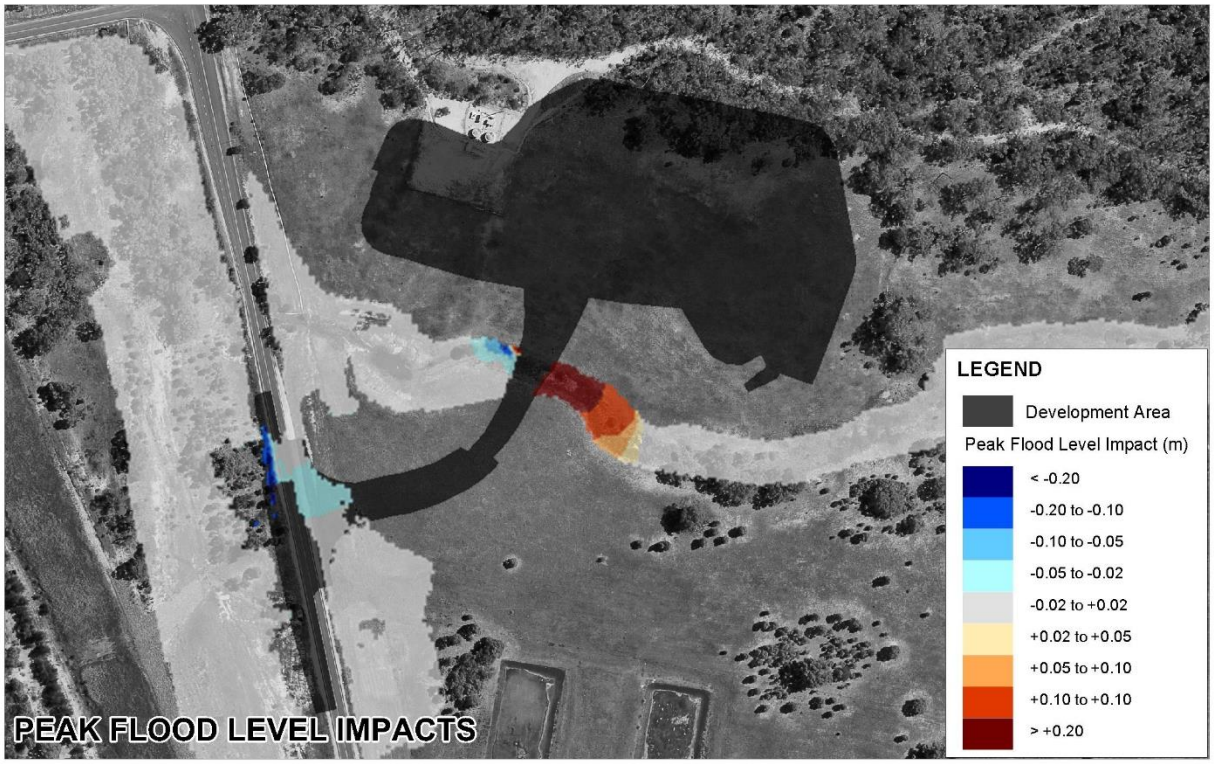
Figure:	Rev:
C-1	**A**

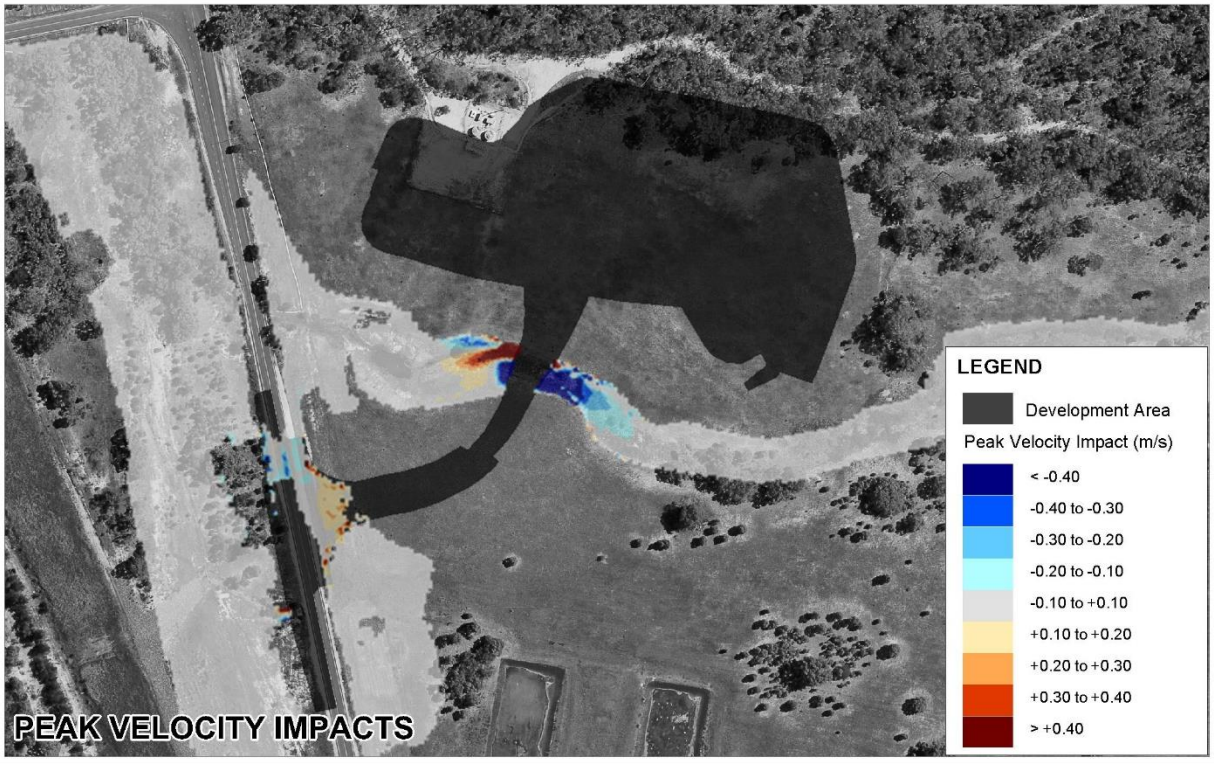




Title:
Moolarben North 2% AEP Design Event
Peak Flood Level and Velocity Impacts

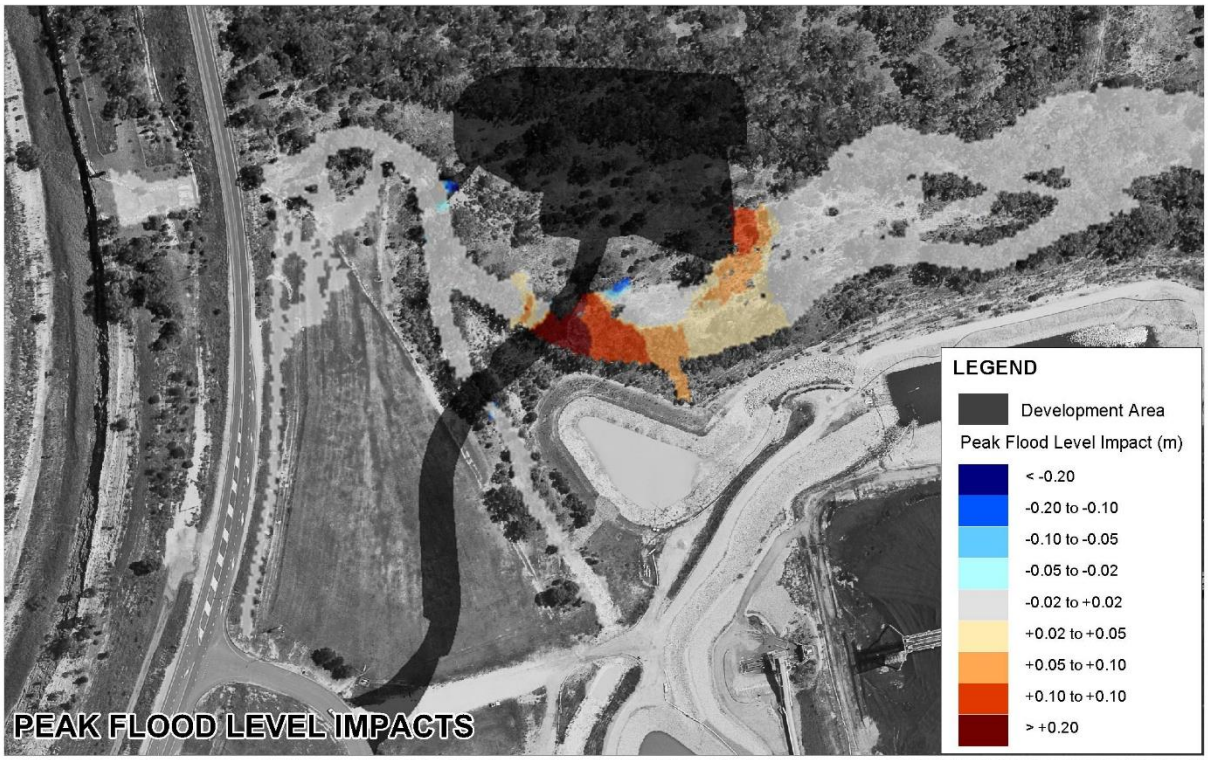
Figure:	Rev:
C-2	**A**

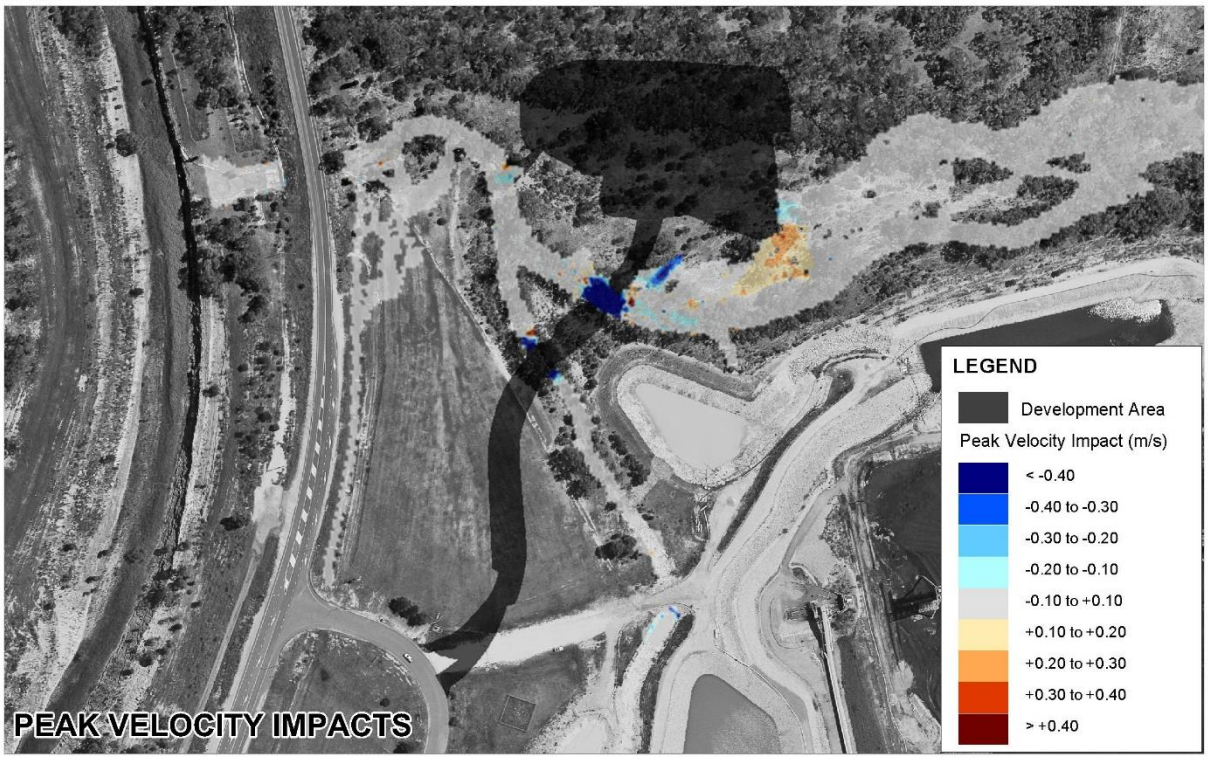




Title:
Moolarben North 1% AEP Design Event
Peak Flood Level and Velocity Impacts

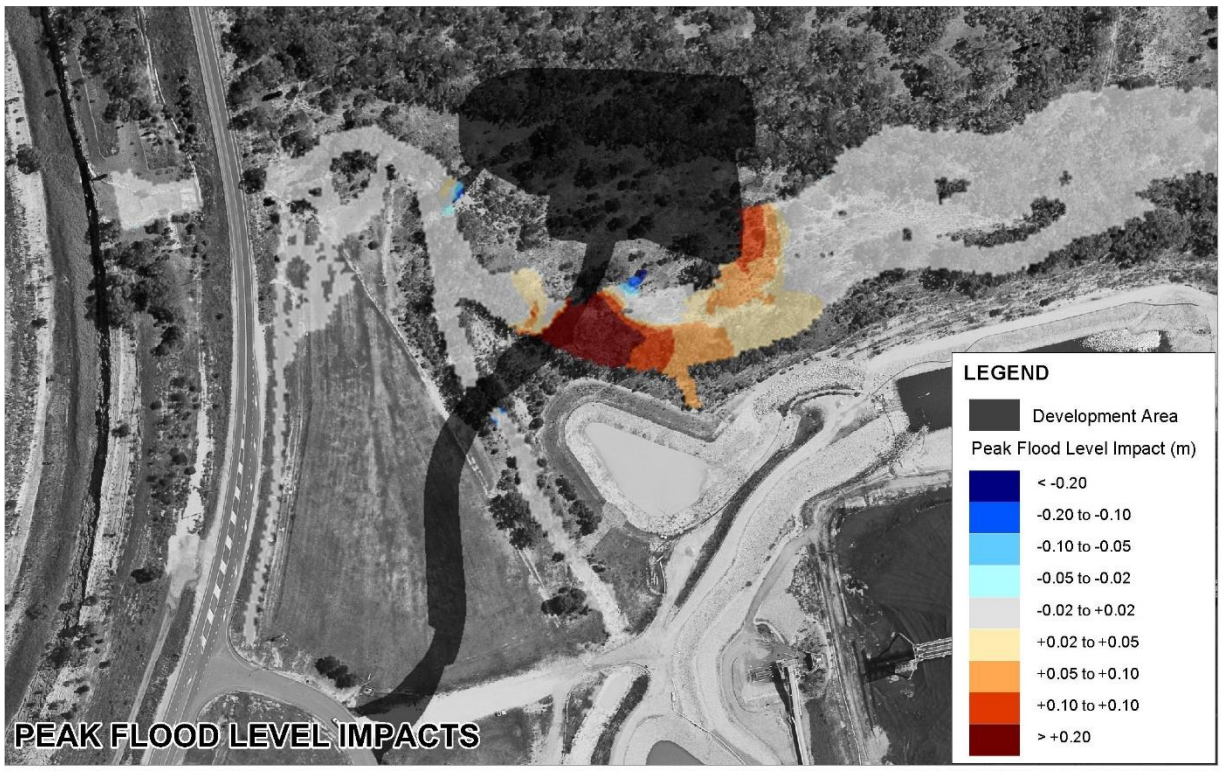
Figure:	Rev:
C-3	**A**

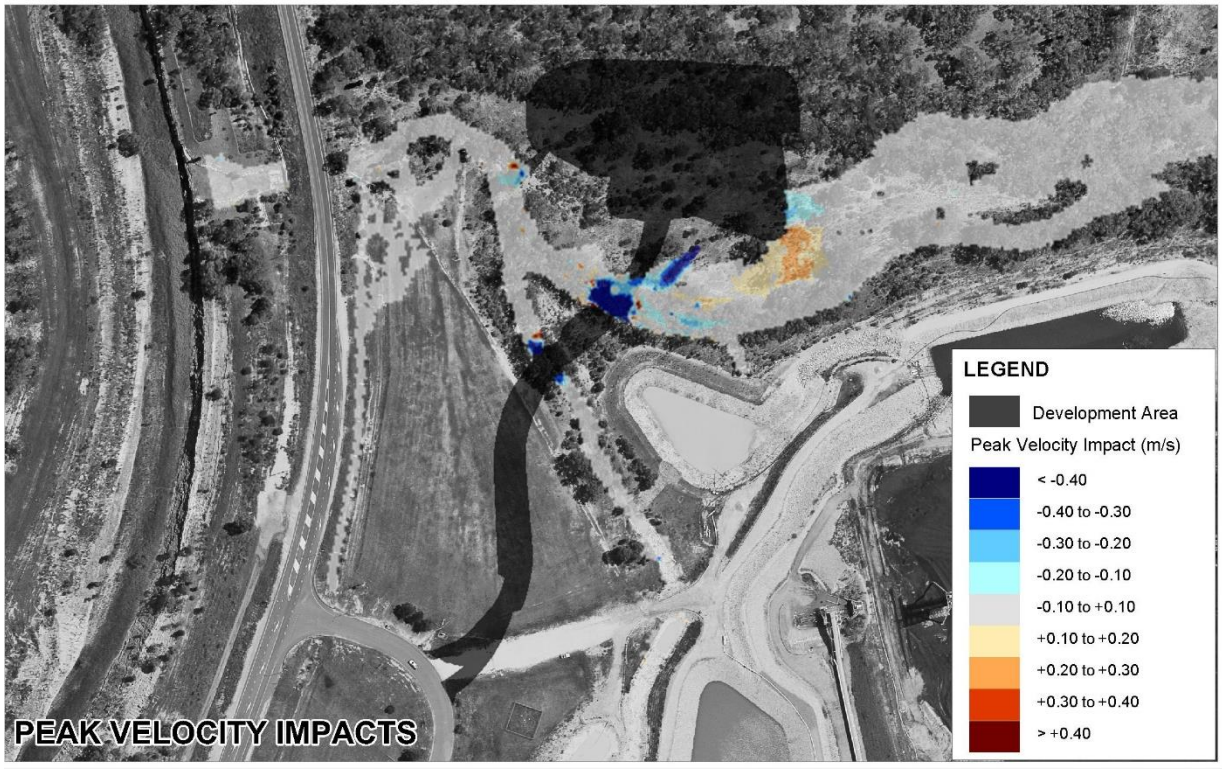




Title:
Moolarben South 5% AEP Design Event
Peak Flood Level and Velocity Impacts

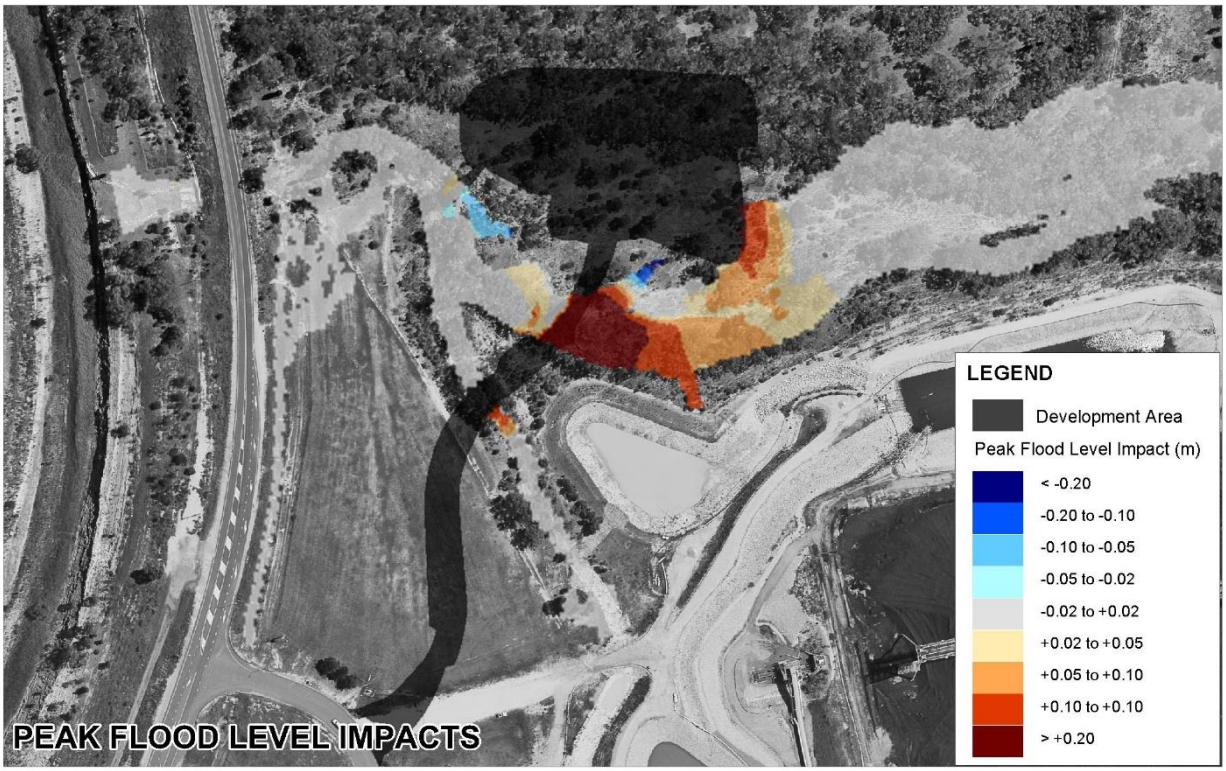
Figure:	Rev:
C-4	**A**

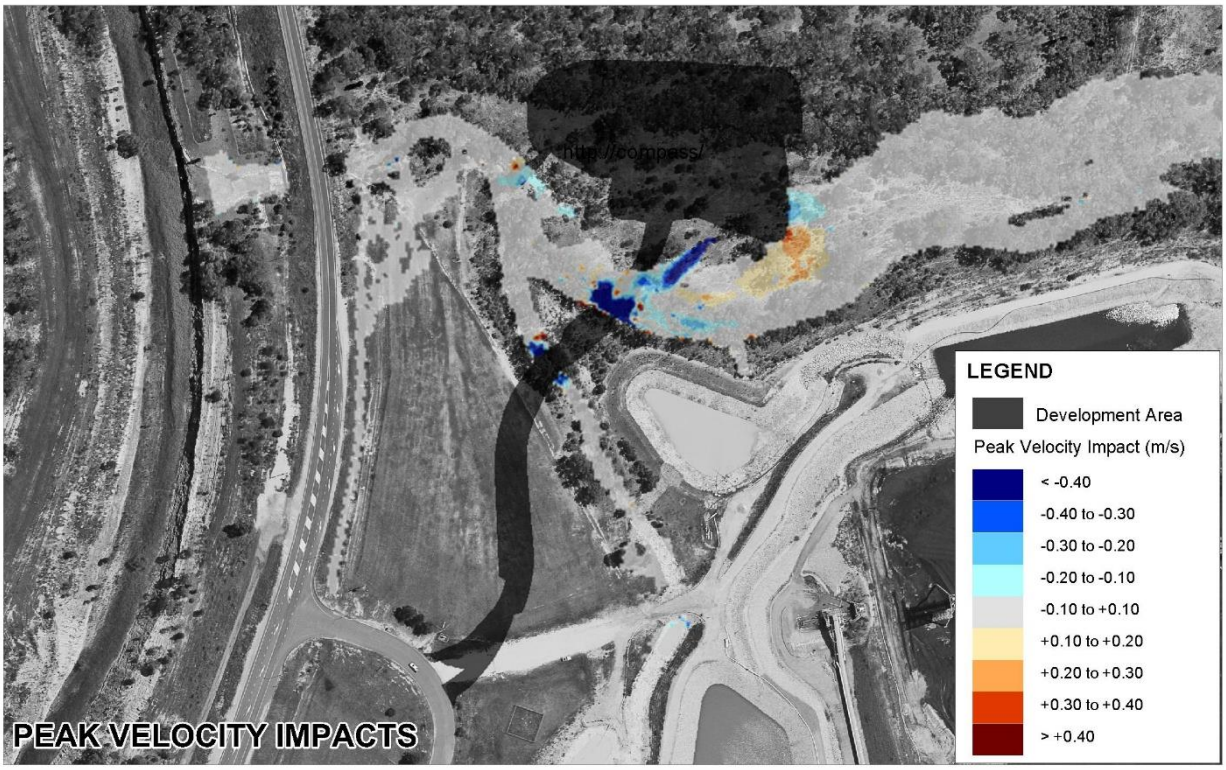




Title:
Moolarben South 2% AEP Design Event
Peak Flood Level and Velocity Impacts

Figure:	Rev:
C-5	**A**





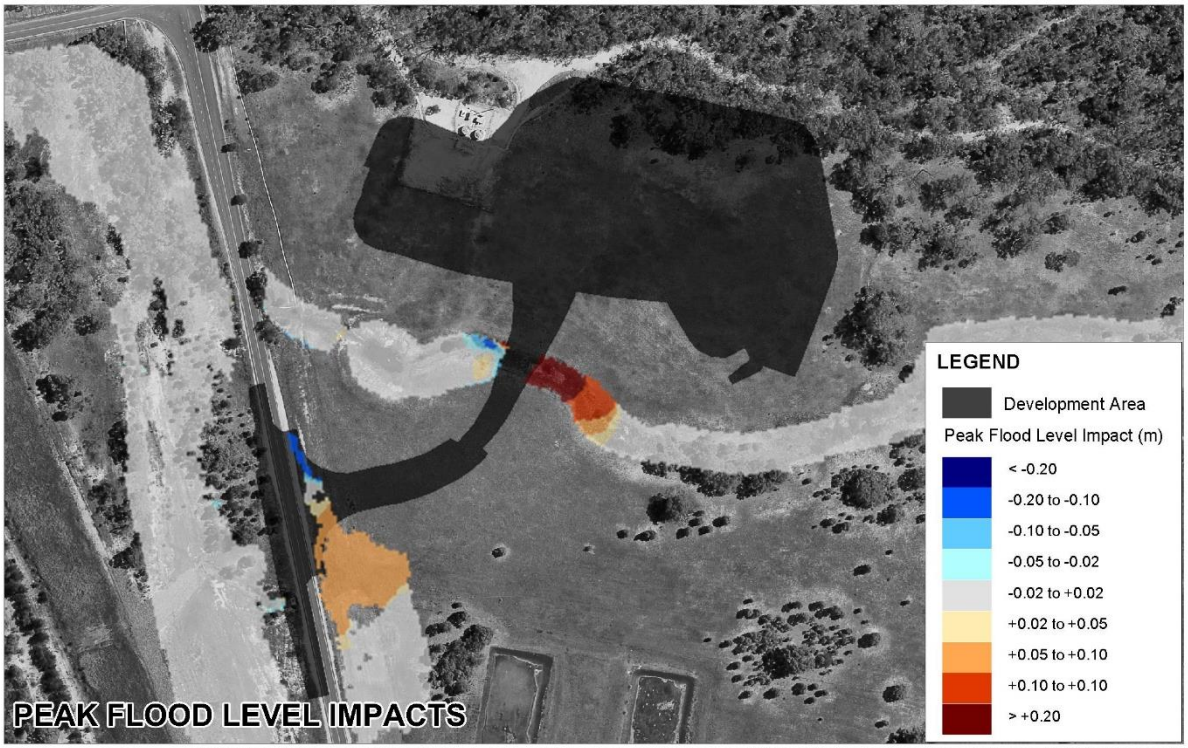
Title:
Moolarben South 1% AEP Design Event
Peak Flood Level and Velocity Impacts

Figure: **C-6**

Rev: **A**

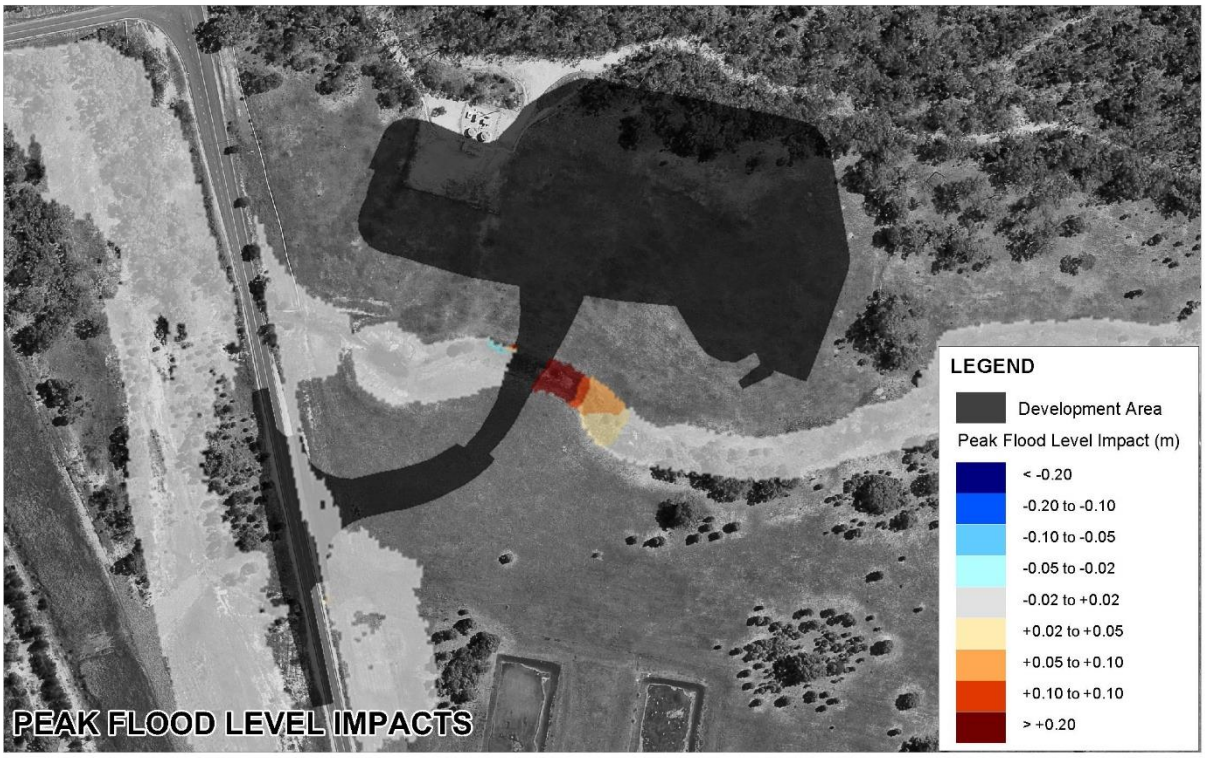
APPENDIX D

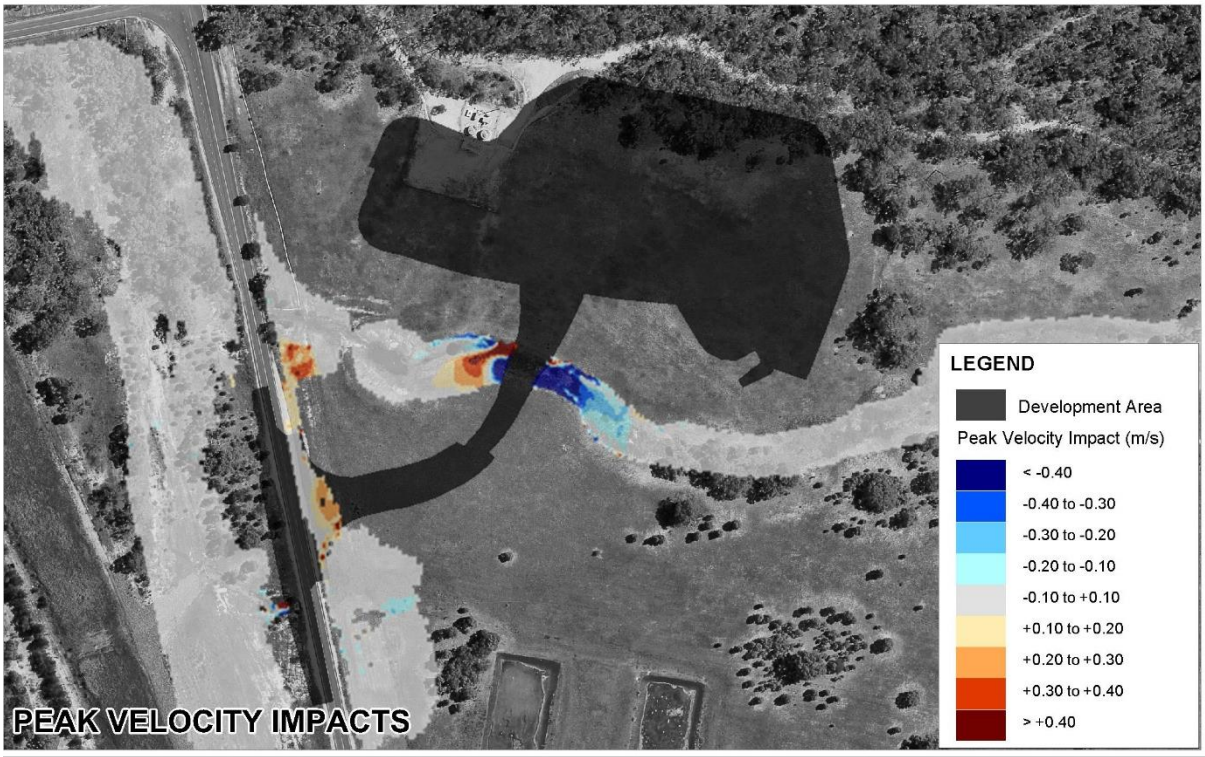
PEAK FLOOD LEVEL AND VELOCITY IMPACT MAPS WITH BLOCKAGES WITH INDICATIVE DEVELOPMENT AREAS



Title:
Moolarben North 5% AEP Design Event with Blockages Peak Flood Level and Velocity Impacts

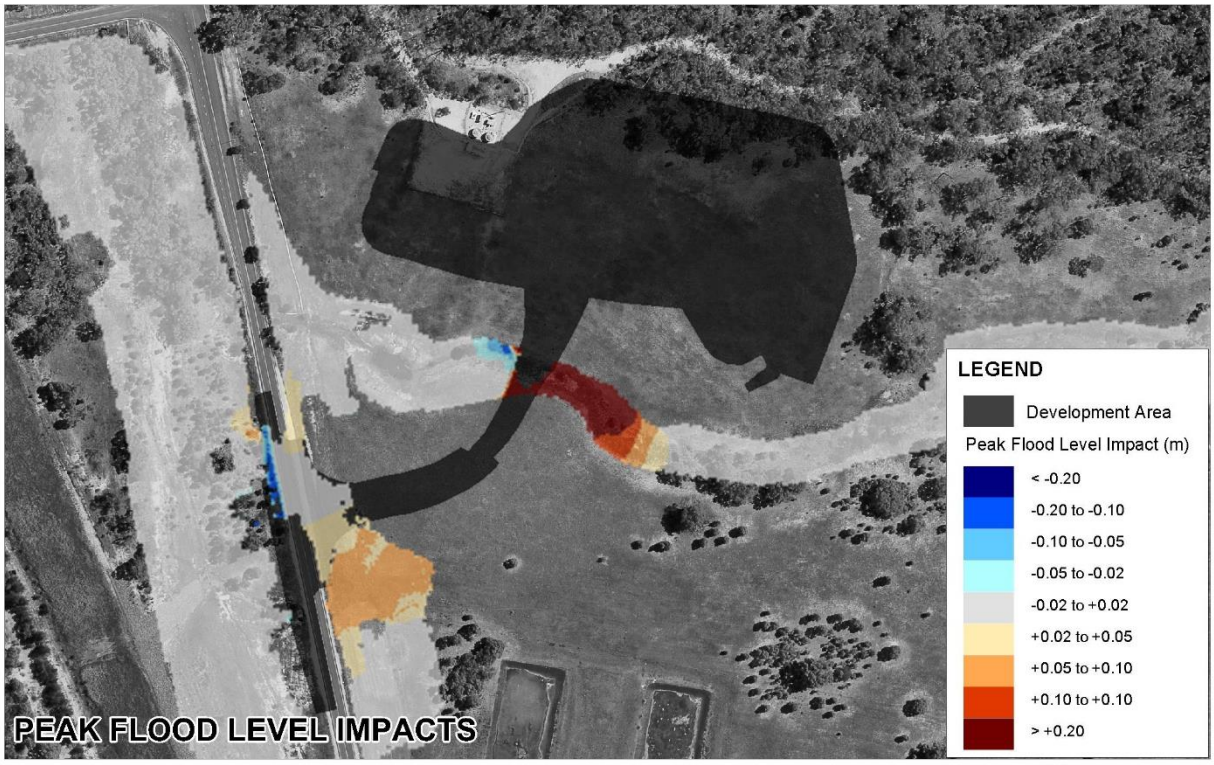
Figure:	Rev:
D-1	**A**

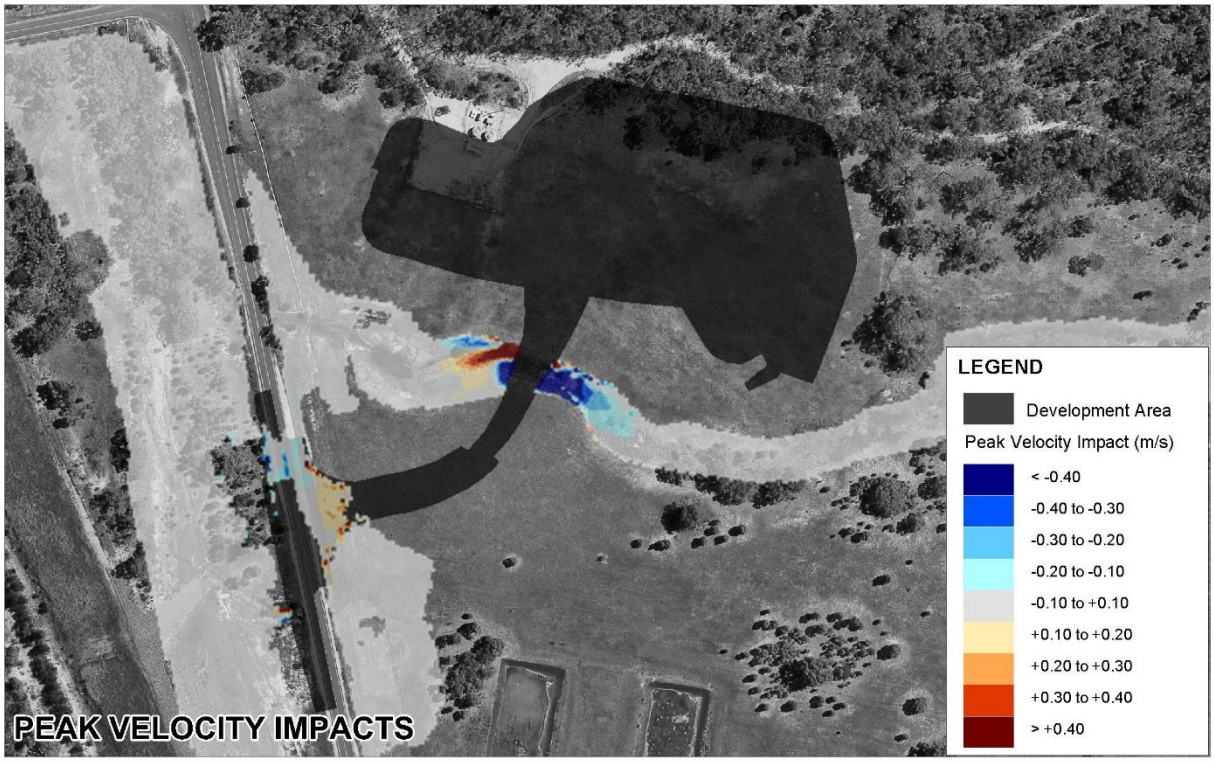




Title:
Moolarben North 2% AEP Design Event with Blockages Peak Flood Level and Velocity Impacts

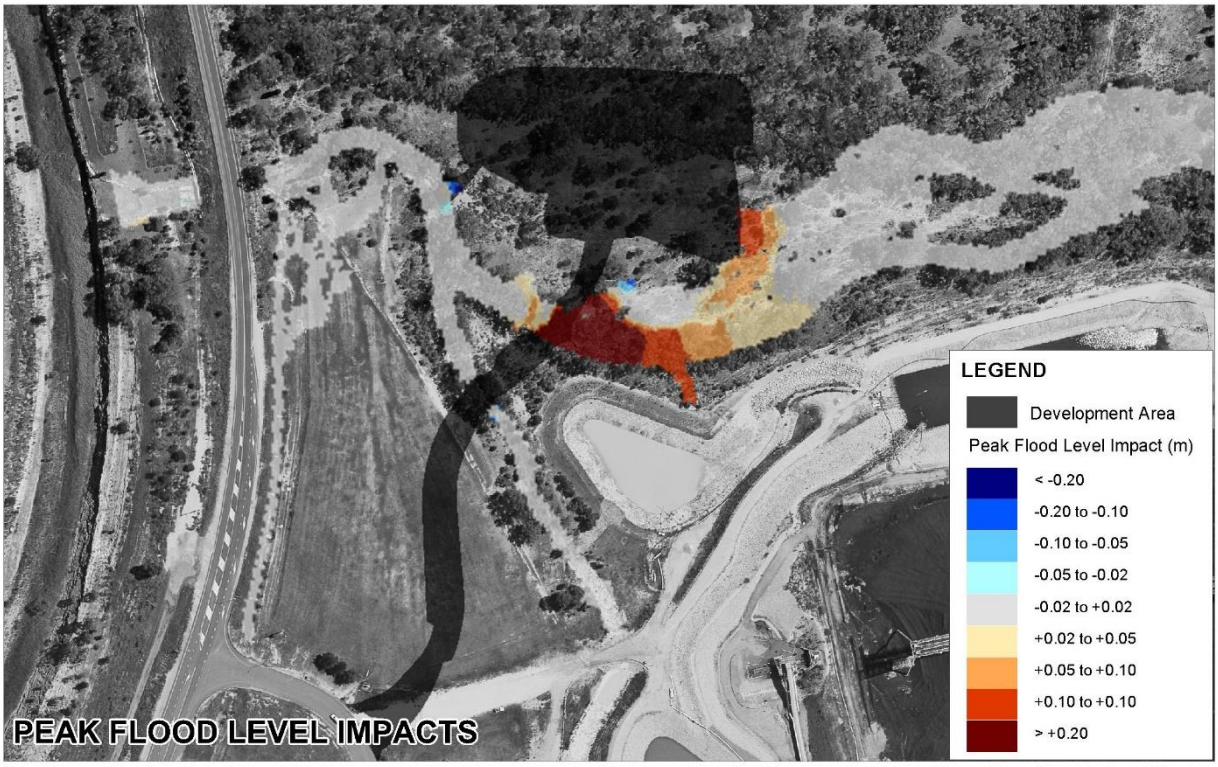
Figure:	Rev:
D-2	**A**

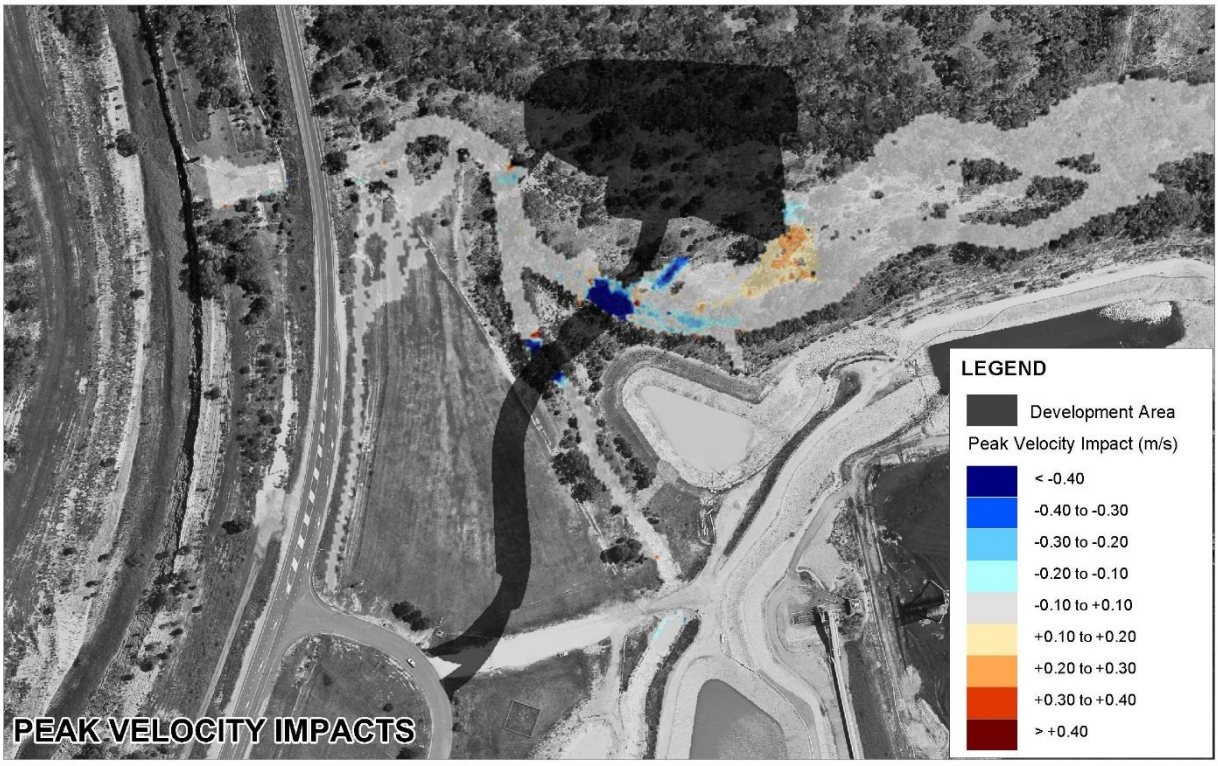




Title:
Moolarben North 1% AEP Design Event with Blockages Peak Flood Level and Velocity Impacts

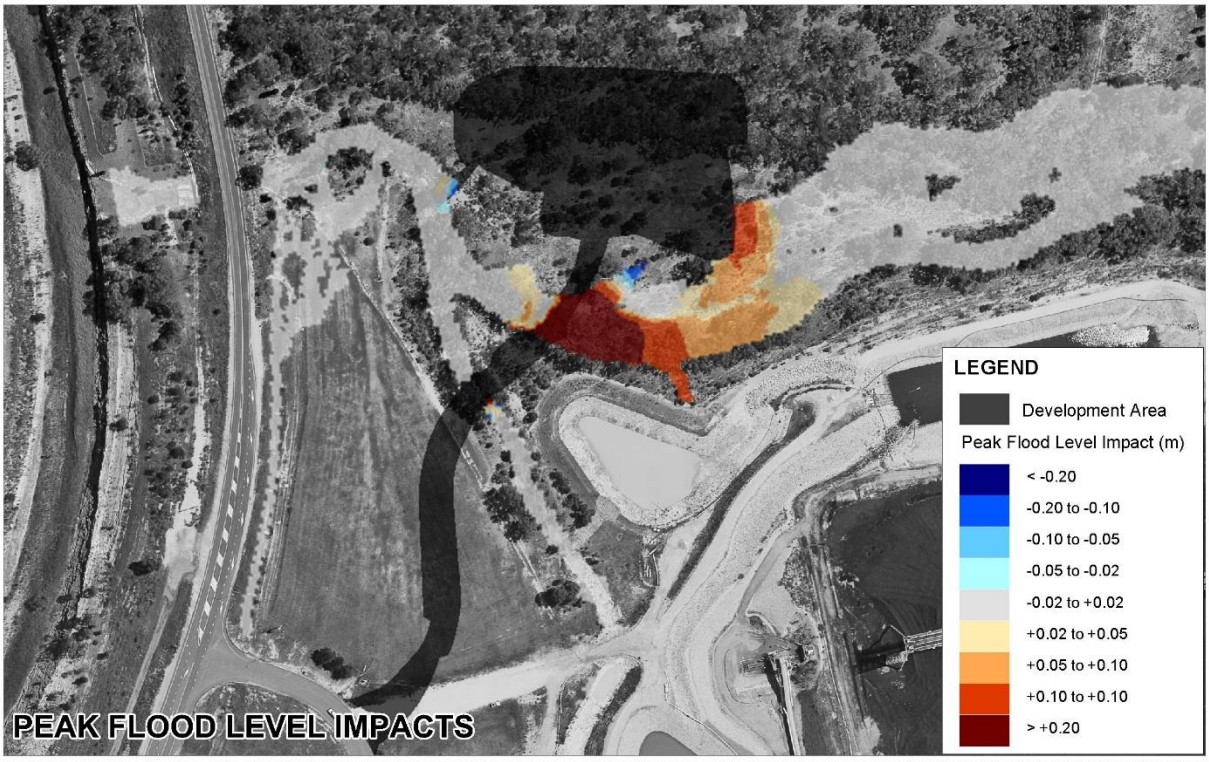
Figure:	Rev:
D-3	**A**

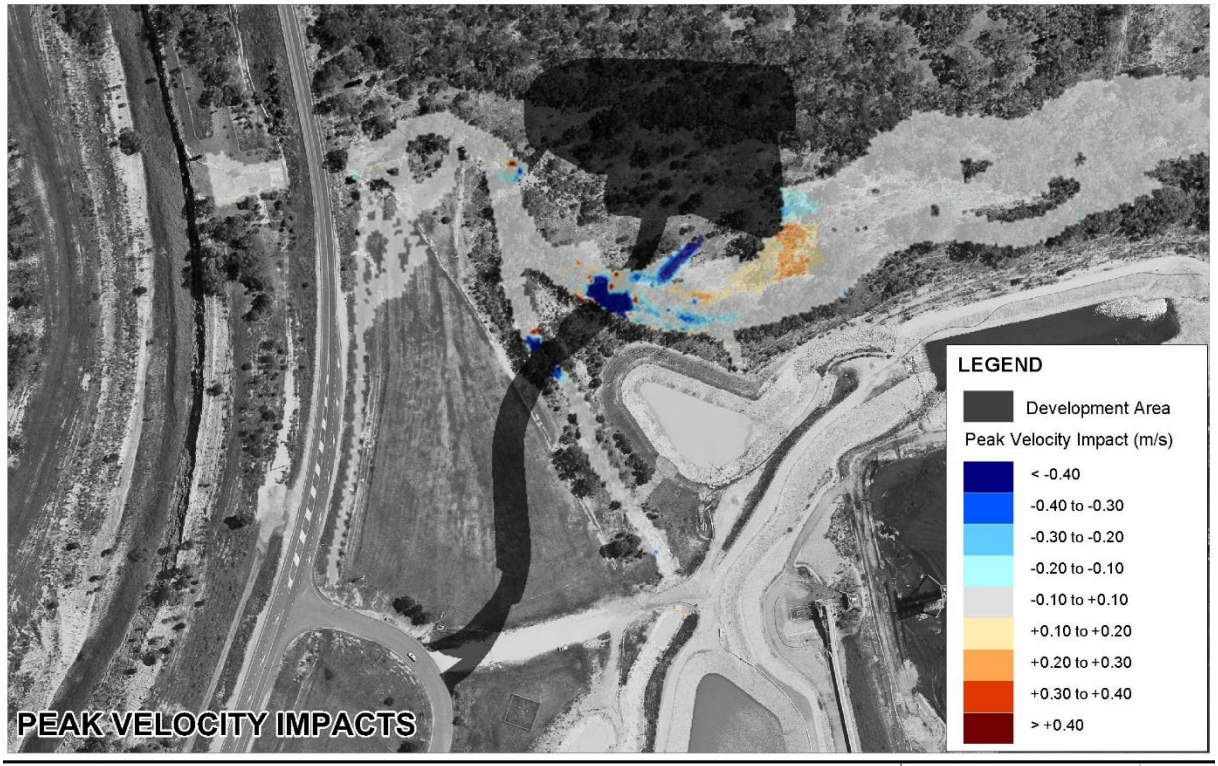




Title:
Moolarben South 5% AEP Design Event with Blockages Peak Flood Level and Velocity Impacts

Figure:	Rev:
D-4	**A**

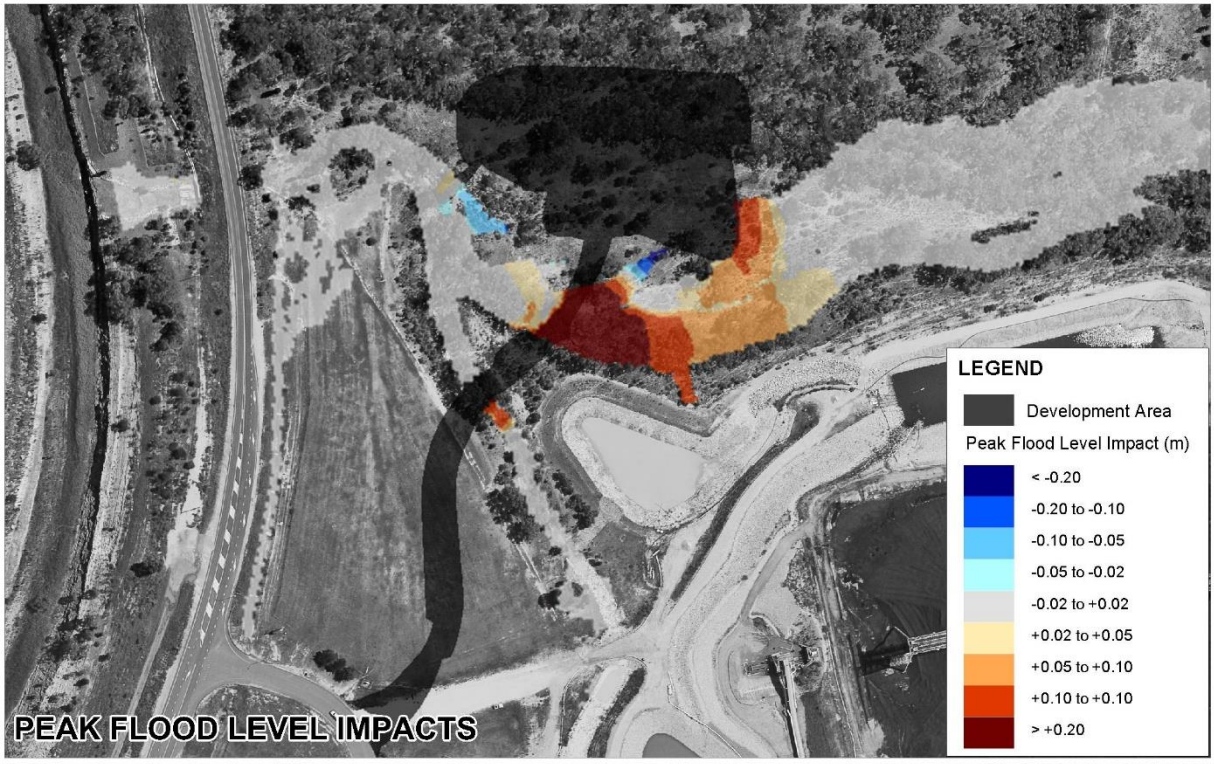


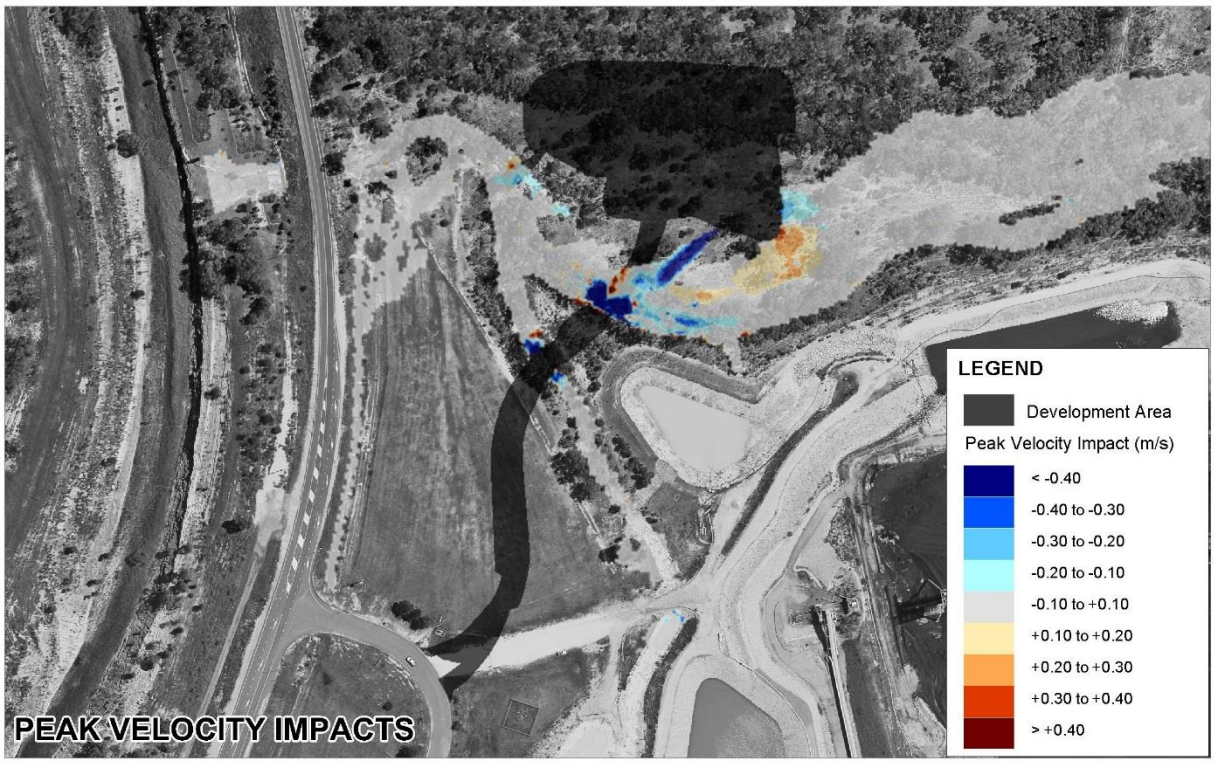


Title:
Moolarben South 2% AEP Design Event with Blockages Peak Flood Level and Velocity Impacts

Figure: **D-5**

Rev: **A**





Title:
Moolarben South 1% AEP Design Event with Blockages Peak Flood Level and Velocity Impacts

Figure:	Rev:
D-6	**A**