



NEW HOPE
GROUP

5. Surface Water Resources



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5 Surface Water Resources

5.1 Introduction

This Chapter describes the existing environment for surface water resources that may be affected by the revised Project. This Chapter identifies the potential impacts the revised Project may have on the existing environment and the measures required for the mitigation of potential impacts.

This assessment covers:

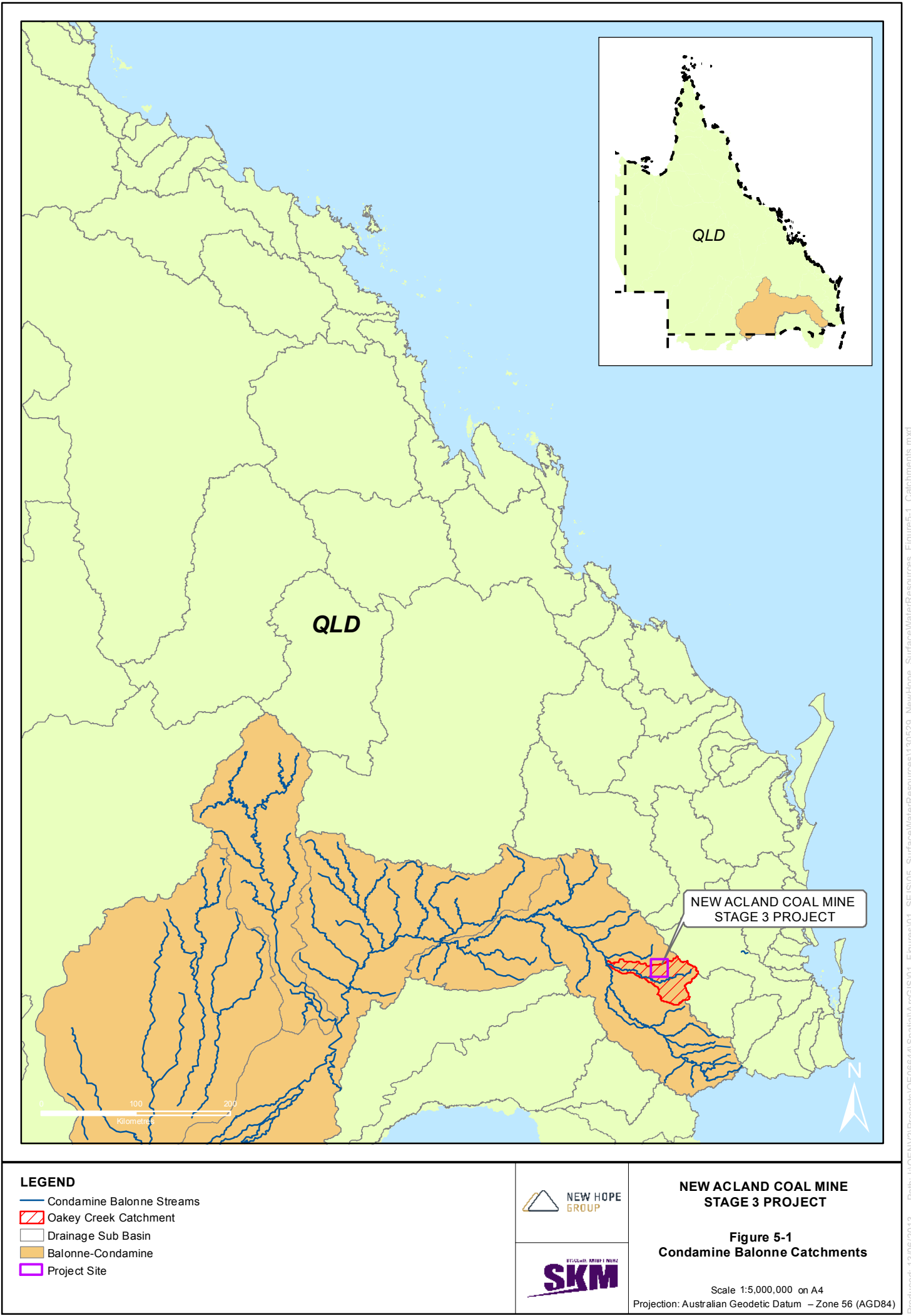
- the existing flood and flow regime including upstream and downstream conditions;
- the existing water users and uses;
- the proposed site water management; and
- water quality.

5.2 Regional Context

The revised Project site is located in undulating terrain that spans the Lagoon Creek catchment. Lagoon Creek is an ephemeral creek flowing only following periods of significant rainfall. Lagoon Creek has a total catchment area of 200 km² with 146 km² of the catchment area located upstream of the Jondaryan Township. The creek headwaters are located 6 km north east of the revised Project site. This upper catchment, outside the revised Project site, has an area of approximately 16.3 km². The catchment area upstream of and including the revised Project site is 85 km², approximately 42% of the total Lagoon Creek catchment. Lagoon Creek flows into Oakey Creek which is part of the larger Condamine River Catchment.

The Upper Condamine River catchment has an area of approximately 13,000 km². The Upper Condamine is part of the Condamine-Balonne Basin which includes most of the Darling Downs and forms part of the Murray Darling Basin Catchment.

Figure 5-1 provides an overview of the Condamine and Balonne Catchment and the Oakey Creek Sub catchment. The water resources of the Condamine and Balonne Catchment are discussed further in **Section 5.3**.



5.3 Legislative Framework

Lagoon, Doctors and Oakey Creeks are declared water courses under the *Water Act 2000* (Water Act). Resources within a declared water course are managed by the State and may be subject to licensing provisions (DNRM, 2013a). The DNRM defines the upstream limit of a watercourse as being the point where the stream becomes so small that it does not have sustained base flows after rainfall events – usually evident by the lack of riverine vegetation species or aquatic-dependant habitat such as pools and riffles (the natural limit) unless otherwise declared by the Water Regulation. Lagoon Creek has no declared upstream or downstream limit (DNRW, 2013).

Lagoon Creek is part of the greater Condamine and Balonne Catchment which is subject to the requirements of the *Water Resource (Condamine and Balonne) Plan 2004*, (the WRP) under the Water Act. The WRP outlines the availability of water in the catchment and defines the framework for managing the allocations and use of water resources. The WRP includes provisions for holders of a mining lease to undertake activities within a watercourse provided these are undertaken in accordance with the environmental authority for the mining lease. Where relevant the NHG will seek permits for minor works within the Lagoon Creek watercourse, e.g. road access tracks under the revised Project's environmental authority. These minor works will be established through detailed mine planning.

The WRP manages the taking or interfering of water in a watercourse. The WRP also includes provisions for holders of a mining lease to taking and store water from overland flow. The intent of this provision is to allow water that flows through disturbed areas, referred to as "mine-affected water" to be managed to minimise water quality impacts on downstream users and the environment. The taking and storing of overland flow water is only permitted in accordance with the environmental authority for the mining lease.

The details and guidelines for the implementation of the WRP are outlined in the *Condamine and Balonne Resource Operations Plan 2008 Amended December 2011 (Revision 3)* (the ROP). It is noted that the ROP, in its current format, does not include the Oakey Creek catchment. A draft amendment to the ROP was released on the 28th of October for public comment. The draft amendment establishes the Gowrie and Oakey Creek Water Management Area to manage unsupplemented water and converts existing water harvesting licences to tradable water allocations. Lagoon Creek forms Zone GOU-09 of the water management area, within which there is currently only one water user. This user is described further in Section 5.4. While the ROP amendment is in draft form the 2008 Moratorium on the – Condamine and Balonne water resource plan area (which includes the Oakey Creek Catchment) remains in place.

The Condamine and Balonne Catchment forms one of the upper catchments of the Murray Darling Basin. As such the catchment is also subject to the provisions of the Federal *Water Act 2007*. The Federal *Water Act 2007*, establishes the Murray-Darling Basin Authority (MDBA) with the functions and powers, including enforcement powers, needed to ensure that Basin water resources are managed in an integrated and sustainable way. The *Federal Water Act 2007* also requires the MDBA to prepare the Basin Plan – a strategic plan for the management of water resources in the Murray-Darling Basin. The Act provides the Australian Competition and Consumer Commission (ACCC) with a key role in developing and enforcing water charge and water market rules along the lines agreed in the National Water Initiative.

The ROP identifies four Water Supply Schemes for supplemented water. Supplemented water users have an authority to operate water infrastructure and have a high priority for water allocations compared to unsupplemented users. The supplemented water supply schemes include, the Upper Condamine, Chinchilla Weir, Maranoa River and St George. Lagoon Creek has no influence on the Upper Condamine or Maranoa River Supply Scheme which are upstream of the Oakey Creek Confluence.

The Chinchilla Weir and St George water supply schemes are located downstream of the revised Project Site. This water is supplied to high and medium priority water users through a number of dams and weirs. The Chinchilla Weir Water Supply Scheme is the smaller of the downstream water supply schemes with a maximum permitted distribution of 5,637 ML. The largest highest priority user of the Scheme at 1160 ML per annum is the Chinchilla region of the Western Downs Regional Council. The St George Water Supply Scheme is significantly larger with maximum permitted distribution of 84,575 ML (medium and high priority). This includes 3,000 ML per annum allocated at high priority to Sunwater.

At the peak of mining operations the mine water management system will capture rainfall runoff from up to 10 km² of the Lagoon Creek catchment. This mine-affected catchment area constitutes less than 0.1% of the total catchment area to the Chinchilla Weir Water Supply Scheme and less than 0.001% of the total catchment area to the St George Water Supply Scheme. Therefore any reduction of overland flow to the downstream water supply schemes, caused by capture of run-off on the mine site, will be negligible. Similarly, the Project is expected to have a negligible impact on downstream rivers and watercourses including the Murray Darling Basin.

The WRP also specifies Environmental Flow Objectives (EFO's) and Water Allocation Security Objectives (WASO) for the region. The EFO's for the WRP are that the *"extent to which a performance indicators, at each node described in Schedule 2, expressed as a percentage of the pre-development flow pattern is less than 66% or more than 133% of the same indicator is to be minimised"*. The closest node to the revised Project (Schedule 2) is located at Chinchilla Weir. As the revised Project constitutes less than 0.1% of the catchment to this node the percentage change to the pre-development flow pattern is expected to be less than 0.1% and well within the EFO's indicators. Similarly the impacts to water volume under the WASO's are expected to be well within the annual volume probability and 45% annual volume probability objectives. Section 5.4 provides a comparison of the flow exceedance probability under existing conditions and with the revised Project.

The revised Project is not seeking a water supply allocation. A maximum water supply allocation to the Mine of 5,650 ML/year is already available from two sources. The smaller of the two sources is brine water from the Oakey Reverse Osmosis Water Treatment Plant. The major source is via a long term contract to the year 2055 with the TRC to purchase up to 5,500 ML per annum of Class A+ recycled water from the WWRF. Class A+ is the highest class of recycled water for non-drinking purposes in Queensland. The duration of this supply contract is well beyond the projected life of mine. The 45 km pipeline and infrastructure was constructed in 2009 and is fully operational. This water supply contract is a beneficial use of a wastewater and therefore does not introduce new impacts on water resource availability within the Chinchilla Weir or St George Water Supply Schemes.

NAC commissioned a new water pipeline from the TRC WWRF to the Mine in 2009. This project was subject to a separate approvals process under the SDPWO Act for which an EIS was approved by the

Queensland CoG during late 2008. A 43 year Agreement has been established between the TRC and NAC to supply the Project with Class A⁺ recycled water up to a maximum of 5,500 ML per annum. The impacts of the pipeline are therefore excluded from this assessment.

5.4 Existing Water Users

A list of existing surface water users was compiled through a search of the DNRm database on surface water extraction licences within Lagoon, Oakey and Doctors Creeks downstream of the revised Project site. The search revealed 15 surface water licences, consisting of 11 licences for water harvesting purposes and three licences for irrigation purposes and one for both irrigation and water harvesting. These surface water licences are all located a significant distance downstream with the closest located 19 km downstream of the revised Project site. All but one of the licences are located downstream of the confluence with Oakey Creek and Lagoon Creek. A summary of these licences is provided in **Table 5-1**. The location of these lots is illustrated in **Figure 5-4**.

Table 5-1 Surface Water Extraction Licences

Authorisation No	Lot / Plan	Creek	Purpose
18143R	110 / AG1841	Oakey Creek	Irrigation
182982	86 / AG1796	Oakey Creek	Water harvesting
35478R	1 / RP122994	Oakey Creek	Water harvesting
35480WR	3 / RP122994	Oakey Creek	Irrigation; Water harvesting
35525WR	297 / A34722	Oakey Creek	Water harvesting
35679R	1 / RP64853	Oakey Creek	Water harvesting
42816R	1 / RP81265	Oakey Creek	Water harvesting
46029R	81 / AG1794	Oakey Creek	Water harvesting
56010R	2 / RP188947	Lagoon Creek	Water harvesting
51871R	2 / RP188947	Oakey Creek	Irrigation
55909R	83 / AG1794	Oakey Creek	Irrigation
55935R	9 / RP7980	Oakey Creek	Irrigation
56090WR	5 / RP124540	Oakey Creek	Water harvesting
58572R	3 / RP57668	Oakey Creek	Water harvesting
58674R	8 / RP7980	Oakey Creek	Water harvesting

It is also noted that Lagoon Creek includes a number of small on-stream rural dams. These existing stream dams attenuate flows in the creek, particularly for smaller events. However, all of the land on which these dams are located is owned by the APC.

The Department of Science, Information Technology, Innovation and the Arts (DISITA) are currently developing a daily rainfall runoff model for the upper Condamine catchment using the Sacramento model. The model has been developed to provide a long term historical flow series for the Gowrie Oakey Creek catchment to support the ROP amendment. The model was developed using upstream

and downstream gauges and calibrated back to 1922. While this project was not finalised at the time of writing, DISITA have provided the output for the flow apportioned to the Lagoon Creek catchment for use by the revised Project. This flow was apportioned based on the creek catchment area.

The Lagoon Creek flow series provided by the DISITA was used to determine the potential change on the flow regime in Lagoon Creek as a result of the revised Project. **Figure 5-2** illustrates the potential change in the flow exceedance curve as a result of the change in overland flow area due to the revised Project. **Figure 5-2** illustrates minimal change in the flow exceedance curve as a result of the revised Project. This is not unexpected with the revised Project capturing less than 5% of the total Lagoon Creek catchment flows at the peak of the mining activities. This translates to less than 0.5% of the total Oakey Creek catchment to Fairview. Furthermore, it is noted that the mine water management system will include a controlled release which will further minimise the impacts of the revised Project on water users in Lagoon Creek.

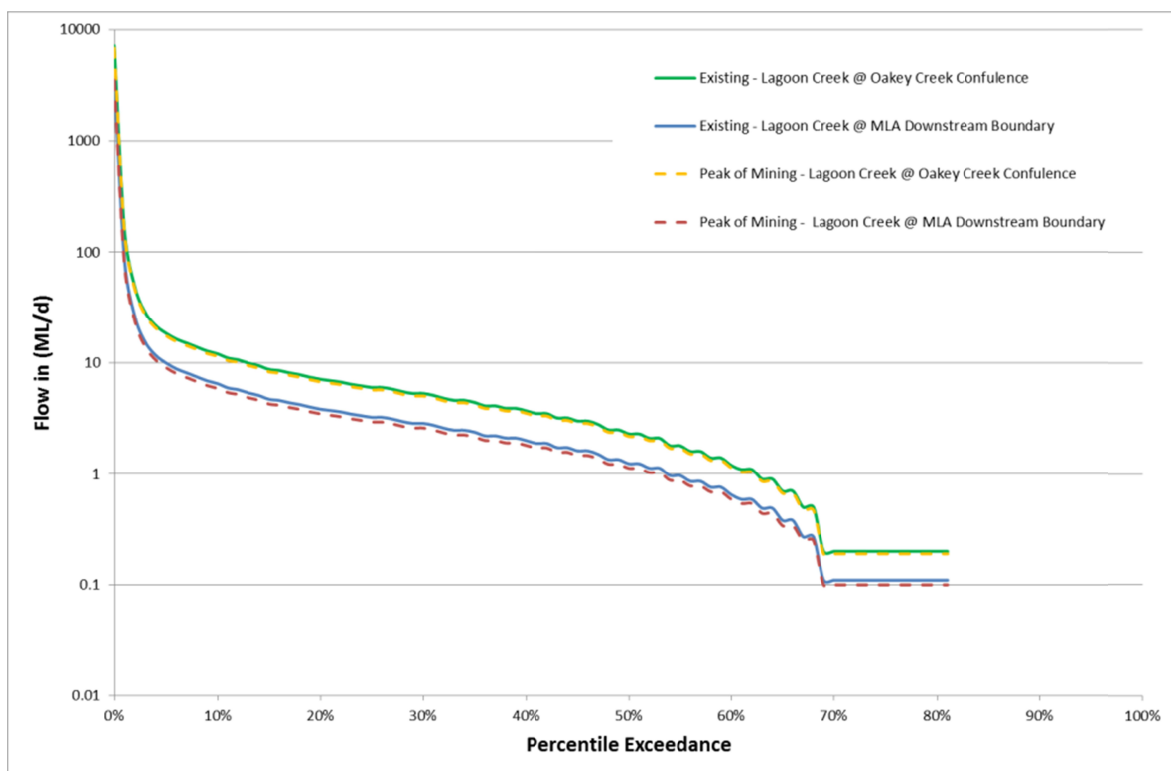


Figure 5-2 Predicted Changes to Lagoon Creek Flow Exceedance

The flow series provided by DISITA was used to assess the potential for impacts to the Lagoon Creek water licence holder. A spells analysis was undertaken over the flow series under the existing conditions and with the revised Project. A spells analysis identifies the number of flow events over a specified threshold, the duration of the event over this threshold and the number of days between events (spells). The spells analysis assists in identifying how access to water under a water harvesting licence may change as a result of a change in the catchment, such as the revised Project.

The Lagoon Creek water harvesting licence conditions permit water harvesting when the passing flow is in excess of 0.1 m³/s or 8.64 ML/d. Therefore, the spells analysis was undertaken for flows in excess of 8.64 ML/d. Spells were considered independent if the interval between flows was more than 7 days apart. The spells analysis predicted that over the 116 year flow series there were 1,103 spells where flow was above the 8.64 ML/d threshold. This is equivalent to 2.60% of the total number of days in the flow series. With the revised Project this reduced to 1073 spells this equates to a 2.53% of the total flow series. This change of 0.07% is considered very small. **Figure 5-3** presents the change in the number of days where flow is above the threshold and the time interval between spells for the 10th, 50th and 90th percentile. **Figure 5-3** illustrates that there is no change to the duration of flow at the 50th percentile and with the duration of flow reduced by only 1 day at the 90th percentile.

Figure 5-3 also illustrates that on average the number of days between flows events will be very similar at 19 days compared to 20 days with less than 5 days difference at the 90th percentile. This change is considered minor and is not considered to materially change the licence holder's access to water.

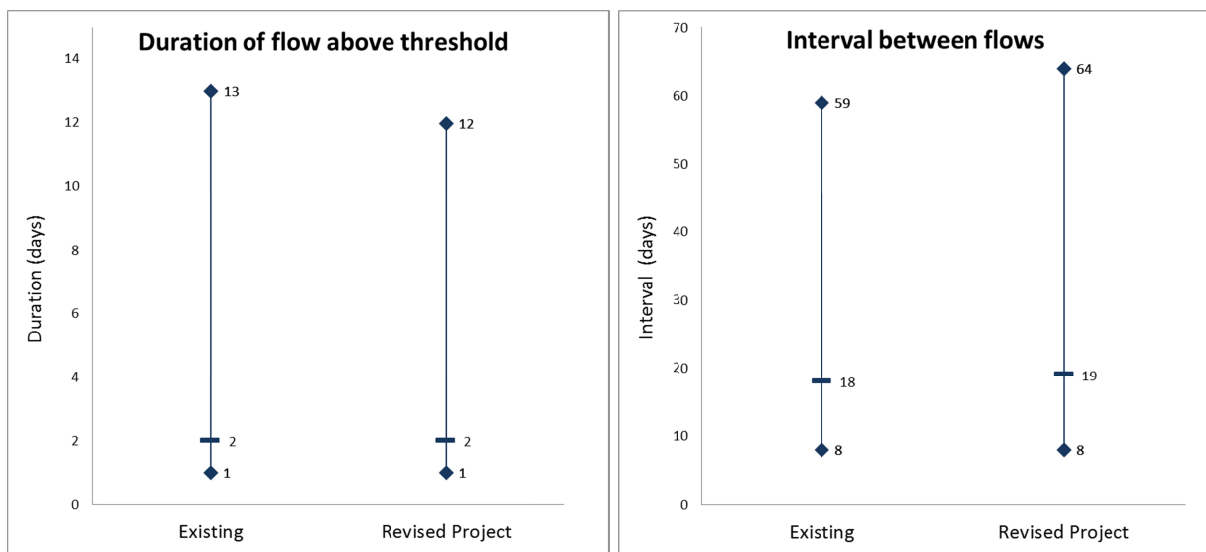
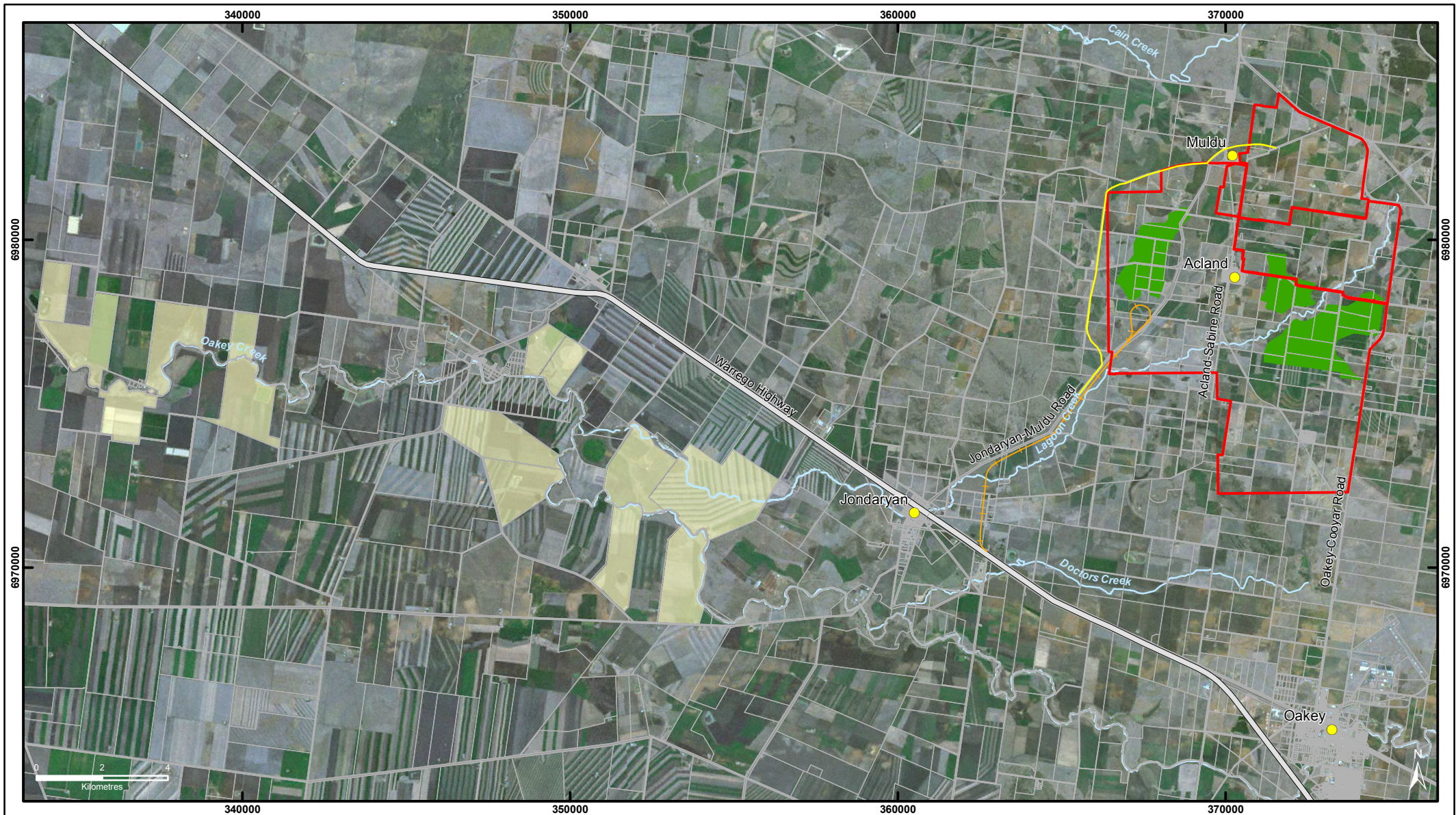


Figure 5-3 Spells analysis for flows above 8.64 ML/d for the 10th, 50th and 90th percentile

A spells analysis was also undertaken for flows downstream of the Lagoon and Oakey Creek confluence. The analysis found that there was no change to the average number of flow days a year where flow is in excess of 0.01 m³/s. It is therefore considered that there will be negligible impacts to water licence holders and stock and domestic users downstream of the revised Project site.

The calibrated Sacramento model parameters were also provided by the DISITA and used to determine flow release conditions for the mine water management system. This approach is discussed further in **Section 5.13.4**.



LEGEND

- Towns and Localities
- Rail Spur
- Roads
- Highway
- Creeks
- Jondaryan-Muldu Road Diversion
- Cadastre
- Mining Tenements
- Stage 3 Pit Areas
- Surface Water Licences (DNRM, 2013)



NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 5-4
Existing Licenced Water Users

Scale 1:158,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

5.5 Environmental Values and Water Quality Objectives

Environmental Protection Policies (EPPs) are developed under the EP Act to provide frameworks and guidelines in conjunction with *Environmental Protection Regulation 2008*, to identify environmental values to be protected, and to manage specific aspects of Queensland's environment. A key objective of the EPPs is to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, and maintains the ecological process on which life depends.

The *Environmental Protection (Water) Policy 2008* (EPP (Water)), is intended to prevent activities that harm the environment or waterway without due regard to the provisions of the EP Act. The EPP (Water) provides a framework for identifying environmental values to be protected for Queensland waters and deciding the water quality objectives to protect or enhance those environmental values, including their biological integrity and suitability for drinking, recreational, agricultural and industrial uses. One or all of the environmental values in the EPP (Water) can be chosen for a particular water body.

Draft environmental values for surface waters in the Condamine catchment have been released by the Condamine Alliance (2012) and were used to determine the environmental values for Lagoon Creek. The draft environmental values that apply to Lagoon Creek were those identified for the upper Oakey Creek sub-catchment (Condamine Alliance 2012) and are listed in **Table 5-2**.

Table 5-2 Draft environmental values and description identified for Lagoon Creek (Condamine Alliance 2012).

Environmental Value		Description
	Aquatic Ecosystems	A community of organisms living within or adjacent to water, including riparian or foreshore area. Levels of protection for aquatic ecosystems: - High ecological/conservation value waters (HEV): waters in which the biological integrity is unmodified or highly valued - Slightly to moderately disturbed (SMD): waters that retain biological integrity but are affected by human activity. - Highly disturbed (HD): waters that are significantly degraded by human activity and have lower ecological value
	Irrigation	Suitability of water supply for irrigation-for example, irrigation of crops, pastures, parks, gardens and recreational areas.
	Farm Water Supply	Suitability of domestic farm water supply, other than drinking water. For example, water used for laundry and produce preparation.
	Stock Watering	Suitability of water supply for production of healthy livestock.
	Human Consumers of Aquatic Foods	Health of humans consuming aquatic foods-such as fish, crustaceans and shellfish (other than oysters) from natural waterways.

Environmental Value		Description
	Visual Recreation	Amenity of waterways for recreation which does not involve any contact with water-for example, walking and picnicking adjacent to a waterway.
	Drinking Water	Suitability of raw drinking water supply. This assumes minimal treatment of water is required-for example, coarse screening and/or disinfection.

All relevant environmental values need to be considered when evaluating a water body. The level of environmental and water quality protection must be determined to maintain each of the environmental values. Management goals that are established to protect the environmental values should reflect the specific problems and/or threats to the values, desired levels of protection and key attributes that must be protected (ANZECC & ARMCANZ, 2000).

There are four levels of aquatic ecosystem condition and protection under EPP (Water) (Section 6), which are:

- **high conservation / ecological value systems:** the biological integrity of an aquatic ecosystem that is effectively unmodified or highly valued;
- **slightly disturbed systems:** the biological integrity of an aquatic ecosystem that has effectively unmodified biological indicators, but slightly modified physical, chemical or other indicators;
- **moderately disturbed systems:** the biological integrity of an aquatic ecosystem that is adversely affected by human activity to a relatively small but measurable degree; and
- **highly disturbed systems:** the biological integrity of an aquatic ecosystem that is measurably degraded and of lower ecological value than waters mentioned in the above three descriptions.

The values of Lagoon Creek have been heavily impact on by current land use practices, specifically the area used for stock access. Much of the riparian zone and creek banks have been damaged with obvious signs of scour and erosion. Lagoon Creek was defined as slightly to moderately disturbed aquatic ecosystem for the purposes of applying water quality guidelines and trigger values and this intends to produce a level of 95% protection of species.

At present, local water quality objectives to protect the Lagoon Creek EV's have not been published, and are currently in development by EHP (EHP, 2012) in conjunction with the Condamine Alliance under the EPP (Water). It is noted that in 2008, prior to the EPP (Water), Natural Solutions on behalf of the Condamine Alliance developed local water quality guidelines for the Condamine catchment. These now superseded, local water quality guidelines are generally consistent with Australian Water Quality Guidelines (AWQG)'s (Natural Solutions, 2008). Therefore, in lieu of any local water quality guidelines under the EPP (Water), the AWQG's have been adopted.

The water quality guidelines adopted for the relevant water quality parameters within Lagoon Creek are presented in **Table 5-3**. The parameters are based on the AWQG's guideline values for the protection of aquatic ecosystems. This decision is based on recently released local water quality objectives for adjacent catchments such as the Fitzroy River Basin, for which the objectives that apply to the protection of aquatic ecosystems and for drinking water supply are the most stringent.

Table 5-3 provides the pH, dissolved oxygen, turbidity and nutrient concentrations assessed against the AWQG's for freshwaters of south east Australia. Metals are assessed against the trigger values for freshwaters in the AWQG and trigger values were corrected for hardness according to the methodology in the guidelines (ANZECC, 2000). Electrical conductivity was assessed against the regional salinity guidelines of the Queensland Water Quality Guidelines (QWQG) using the 75th percentile for the Condamine-Macintyre zone.

Table 5-3 Lagoon Creek Water quality guidelines for the protection of aquatic ecosystems

Water quality variable	Guideline Value	Water quality variable	Guideline Value
pH	6.5-7.5	Metals (Dissolved)	
EC ($\mu\text{S}/\text{cm}$) ^{\$}	<500	Arsenic (As) (mg/L)	<0.013
Turbidity (NTU)	<25	Cadmium (mg/L)	<0.0002
Dissolved oxygen (DO) (% saturation (mg/L)	90-110%	Chromium III (Cr) (mg/L)	<0.0027
Total suspended solids (TSS) (mg/L)	-	Copper (Cu) (mg/L)*	<0.0014
Hardness (CaCO_3) (mg/L)	-	Lead (mg/L)*	<0.0034
Sulfate (SO_4)* (mg/L)	-	Nickel (Ni) (mg/L)*	<0.011
Ammonia (NH_3) (mg/L)	<0.010	Zinc (Zn) (mg/L)*	<0.008
Dissolved inorganic nitrogen (DIN) (mg/L)	<0.015	Manganese (Mn) (mg/L)	1.9
Total nitrogen (TN) (mg/L)	<0.25	Mercury (Hg) (mg/L)	<0.00006
Total phosphorus (TP) (mg L^{-1})	<0.030	Beryllium (Be) (mg/L)**	*
Filterable reactive phosphorus (FRP) (mg/L)	<0.015	Vanadium* (V) (mg/L)**	*
TPH C6 - C9 Fraction* (mg/L)	-	Cobalt* (Co) (mg/L)**	*
TPH C10 - C36 Fraction* (mg L^{-1})	-	Barium* (Ba) (mg/L)**	*

Notes: * indicates requirement for hardness correction of trigger values (TVs). (**) Indicates trigger values are not specified in AWQG. All trigger values derived from AWQG except for \$ which is derived from the QWQG

In addition to the water quality objectives outlined in **Table 5-3**, water quality guidelines for the protection of drinking water supply (raw water) have additional water quality indicators. These parameters include concentrations of toxins, sulphate and hardness. While no water quality objectives for the protection of drinking water have been set for the Condamine catchment the objectives from the adjacent Dawson River sub catchment have been reviewed. These values are presented in **Table 5-4**; several of these parameters, such as turbidity, will be derived from regionally sourced water quality data and therefore do not represent valid guidelines for waters of the Condamine. However, parameters such as sodium concentration are likely to be standard values for all sub-basins.

Table 5-4 Water Quality Objectives for the protection of drinking water supply

Indicator	Water Quality Objective EPP (Water) for the Dawson River sub-basin
Blue-green algae (cyanobacteria) *	< 5,000 cells/mL
Algal toxin	Level 1: 0.1 µg/L Microcystin * Level 2: 4 µg/L Microcystin*
Cryptosporidium *	0 cysts
Giardia*	0 cysts
Sodium*	30 mg L ⁻¹
Sulfate*	200 mg L ⁻¹
Colour*	Level 1: 50 Hazen Units No Level 2
Hardness*	Level 1 > 150 mg/L Level2 > 200 mg/L
E. coli	None specified for raw water (<10 cfu's for irrigation supply of raw human food crops)
pH	6.5-8.5
Turbidity	Level 1: 500 NTU Level 2: 1000 NTU
Conductivity	Level 1: > 400 µS/cm Level 2 same as Level 1 (no treatment options to remove salt)
Dissolved oxygen	Level 1: < 4 mg/L at surface No Level 2

Source: EPP (Water) Dawson River Sub-basin.

*indicates a WQO more stringent than for protection of aquatic ecosystem or one not covered by the aquatic ecosystem environmental value.

*Level 1 denotes Level 1 Hazard and Critical Control Point (HACCP) response rating, namely: treatment-plant-process-change required to ensure water quality and quantity to customers is not compromised.

*Level 2 denotes Level 2 Hazard and Critical Control Point (HACCP) response rating, namely: treatment-plant-process-change required but water quality and quantity to customers may still be compromised.

5.6 Water Quality

5.6.1 Water Quality Sampling Methods

Historical water quality data for Lagoon Creek is limited. DNRM operate one regional water quality gauge on Oakey Creek at Fairview downstream of the confluence with Lagoon Creek. This gauge is located downstream of the Lagoon and Oakey Creek confluence and downstream of several towns, and agricultural areas. Water quality at this site is unlikely to be representative of that in Lagoon Creek as it is influenced by the water quality in Oakey Creek, which up until 2009 included the releases from the upstream Toowoomba Water Treatment Facility. To this day releases from the Toowoomba Water Treatment Facility occur on occasion dependant on the volume of water pumped through the Wetalla pipeline.

Water quality data was available from routine water monitoring conducted by NAC under its current environmental monitoring plan for the Mine and from two targeted monitoring events. The monitoring program assesses water quality at the locations outlined in **Table 5-5** and illustrated in **Figure 5-5**.

Table 5-5 Water Quality Sampling Sites

Site Code	Description
LCU1	Monitoring site located on Lagoon Creek upstream of the existing mining operation. This site is monitored under the Mine's EA.
LCD1	Monitoring site located on Lagoon Creek downstream of the existing mining operation. This site is in the approximate location of the proposed Manning Vale East pit. This site is monitored under the Mine's EA.
LCD2	Monitoring site located on Lagoon Creek downstream of the existing mining operation. This site is downstream of the proposed Manning Vale East pit. This site is monitored under the Mine's EA.
Site 1, 3, 4 and 5	These 4 sites are located within 200 m of each other and are at the upstream boundary of the revised Project pit areas, insitu sampling was undertaken at this site in 2009 to support the revised Projects baseline activities.
Site 2	Located downstream approximately 5 kms downstream of the downstream boundary of the revised Project mining area (DS1), insitu sampling was undertaken at this site in 2009 to support the revised Projects baseline activities.
AH4	Aquatic ecology monitoring site 4, downstream of the existing mining operations and immediately adjacent to the northern extent of the Manning Vale East and Wileroo pits.
DS1	New water quality monitoring site located at the downstream boundary of the revised Project mining area.

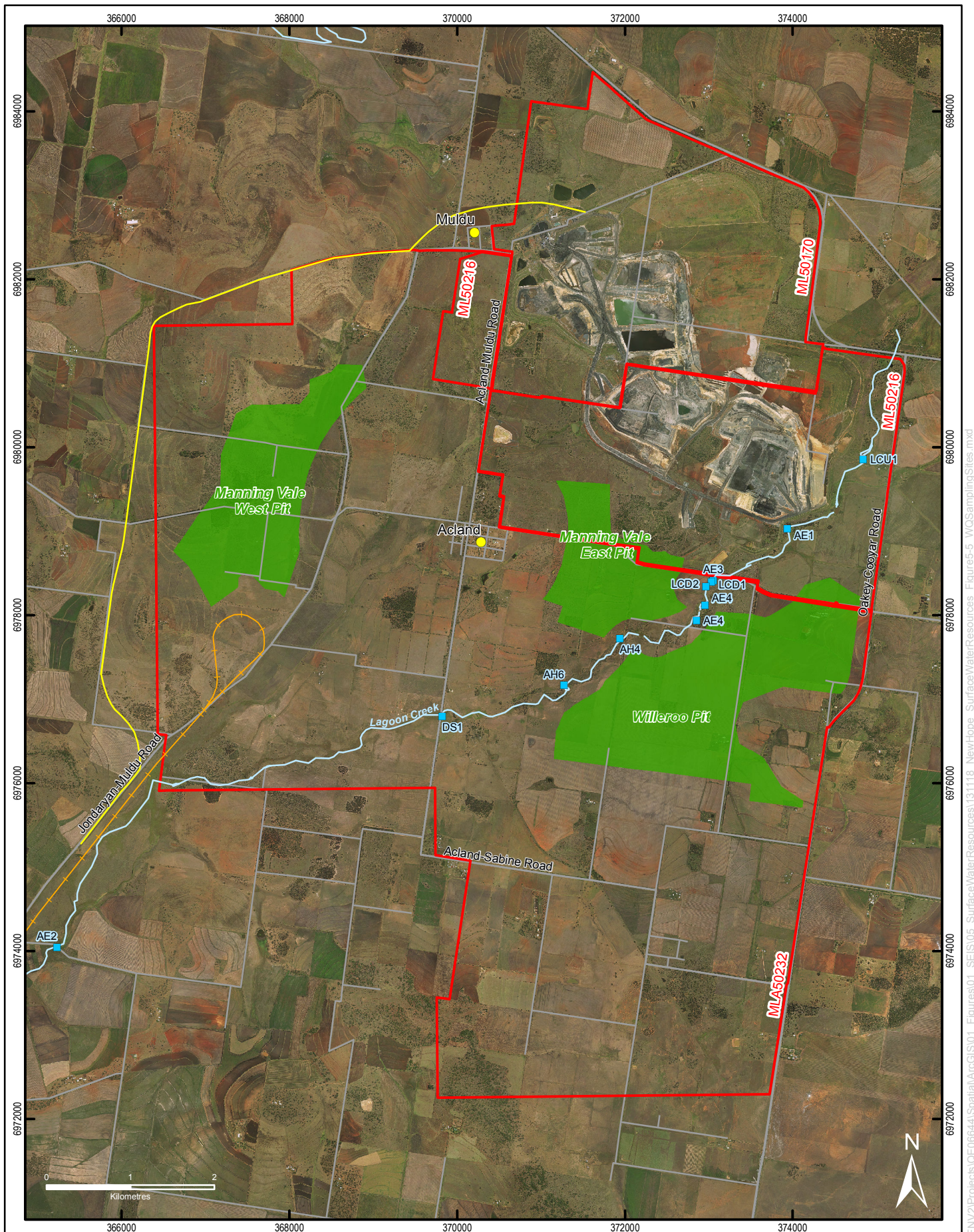
Water quality monitoring was conducted at established monitoring sites on Lagoon Creek upstream (LCU1) and downstream (LCD1 and LCD2) of the existing mining operation in accordance with the Mine's EA between 2009 and 2011. Sampling of surface waters was undertaken by NAC's environmental officers using on-site field equipment. Water samples were collected for measurements of temperature, dissolved oxygen, electrical conductivity, pH, and analysis of sulphate and suspended sediments.

A single monitoring event was conducted between 23rd January 2008 and 24th January 2008 at four sites upstream (Site 1, Site 3, Site 4, Site 5) and one site downstream (Site 2) of the Project. In-situ measurements of temperature, dissolved oxygen, electrical conductivity, and pH, were taken with a TROLL 9500 Professional XP multi-parameter water quality probe and logger. Measurements were taken near the middle of the watercourse at each location, at a depth of approximately 15 cm. All water quality equipment was calibrated prior to undertaking the field based assessments.

An additional monitoring event was conducted on 8th March 2013 during a period of flow at two established monitoring sites upstream (LCU1) and downstream of the Mine and at an additional two downstream sites, with one site being downstream of the revised Project. In-situ measurements of temperature, dissolved oxygen, electrical conductivity, pH, and sampling of surface waters were undertaken by NAC's environmental officers using on-site field equipment. Water samples were collected for chemical analysis of the following parameters:

- Metals - total and dissolved (As, Be, Co, Cr, Cu, Hg, Ni, Mg, Ba, V, Zn);
- Nutrients (TP, TN, FRP, DIN, NH₃);
- Major cations and anions;
- Total petroleum hydrocarbons (TPH C6-C36);
- Total Suspended Solids (TSS); and
- Pesticides.

Water samples were preserved and transported to SGS, a NATA accredited laboratory within the specific holding times for analysis. The water quality sampling was conducted in accordance with AS/NZ 5667.11:1998 Water Quality – Sampling Part 1, Part 6 and Part 11, (Standards Australia 1998) and with the Queensland Monitoring and Sampling Manual (DERM 2009).



LEGEND

- Towns and Localities
- Sample Site
- Rail Spur
- Roads
- Creeks
- Mining Tenements
- Stage 3 Pit Areas



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**Figure 5-5
Water Quality Sample Sites**

Scale 1:60,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

5.6.2 Lagoon Creek Water Quality

Table 5-6 provides the median and ranges of water quality variables from the long term monitoring at the DNRM Oakey Creek at Fairview gauging station and NAC's existing EA monitoring. **Table 5-6** also provides the physicochemistry values recorded during a period of no flow during the 2008 monitoring event. **Table 5-7** provides a summary of results for water quality monitoring during a flow event (2013), including physicochemical properties, concentrations of nutrients, major ions and dissolved metals. Full sets of water quality results are provided in **Appendix G.3.1**.

Table 5-6 Water Quality Data

Site	Time/ Date	Temp (°C)	Suspended Solids (mg/L)	Turbidity (NTU)	pH	DO (ppm)	Sulphate (mg/L)	EC (µS/cm)
Guideline		N/A	N/A	<25	6.5-7.5	90-110%	<200	<500
Regional Water Quality Sampling								
Oakey Creek at Fairview (DNRM)	1995 - 2012	20.50 5.9- 34.8	N/A	84 (10 – 999)	8.10 (5.4- 10.4)	1.2 to 17.8 (mg/L)^	43 (3 - 269)	1018 (159 – 3204)
Environmental Authority Monitoring								
LCU1	2008- 2013	22.40 (15.5- 30.5)	18 (2-179)	N/A	7.46 (6.6- 8.4)	N/A	2 (1-190)	210.0 (97-590)
LCD1	2008- 2013	23.85 (17.9- 29.6)	11 (1-335)	N/A	7.80 (7.3- 8.9)	N/A	25 (3-220)	418.5 (176- 3900)
LCD2	2008- 2013	23.40 (19.3- 29.6)	10 (2-353)	N/A	7.80 (7.4- 8.9)	N/A	30 (1-200)	596.0 (136- 1700)
Insitu Sampling No Flow Event (January 2008)								
Lagoon Creek (Site 1)	23/1 13:25	31.42	N/A	94.89	8.90	111.67	N/A	596.4
Lagoon Creek (Site 2)	23/1 15:40	26.34	N/A	33.35	8.91	95.23	N/A	463.1
Lagoon Creek (Site 3)	23/1 17:30	25.99	N/A	3.15	8.03	94.73	N/A	8 089.6
Lagoon Creek (Site 4)	24/1 14:30	26.89	N/A	20.45	8.52	65.61	N/A	642.1
Lagoon Creek (Site 5)	24/1 15:20	30.93	N/A	16.95	8.69	92.10	N/a	636.9

*Note: Bold indicates exceedance of relevant guidelines, shaded cells indicate median exceeds relevant guidelines. ^ gauge only reports in mg/L

Table 5-7 Water quality monitoring during a period of flow (March 2013)

Water quality variable	Unit	Guideline	LCU1	LCD1	AE4	DS1
Flow		N/A	Yes	Yes	Yes	Yes
Temperature*	°C	N/A	23.9	25.9	21.9	21.6
Dissolved oxygen	%	90-110%	15.0	51.8	44.3	46.0
pH	pH Units	6.5-7.5	7.0	7.5	7.6	7.4
Electrical conductivity	µS/cm	<500	240	310	240	280
Turbidity	NTU	<25	8.6	55	19	10
Total nitrogen	mg/L	<0.25	1.4	0.84	1.2	0.97
Ammonia	mg/L	<0.010	0.35	0.037	0.061	0.040
Total phosphorus	mg/L	<0.030	0.15	0.12	0.31	0.26
Filterable reactive phosphorus	mg/L	<0.015	0.052	0.059	0.18	0.17
DIN	mg/L		0.02	0.29	0.02	<0.02
Sodium [#]	mg/L		12	32	15	15
Sulphate [#]	mg/L		1	20	4	5
Total hardness [#]	mg/L	Level 1 >150 Level2 > 200	95	84	98	110
Calcium*	mg/L		20	15	23	22
Magnesium*	mg/L		5.9	8.4	7.7	8.0
Potassium*	mg/L		10	6.0	12	11
Fluoride*	mg/L		<0.1	0.6	0.2	0.1
Chloride*	mg/L		9	26	10	13
Dissolved metals						
Arsenic (As)	µg/L	<0.013	2	1	2	2
Chromium, (Cr)	µg/L	<0.0027	btl (8.5)	btl (7.7)	btl (8.7)	btl (9.6)
Copper, (Cu)	µg/L	<0.0014	2 (3.7)	3 (3.4)	4 (3.8)	3 (4.2)
Manganese, (Mn)	µg/L	1.9	1	btl	22	1
Mercury (Hg)	mg/L	<0.00006	btl	btl	btl	btl
Nickel, (Ni)	µg/L	<0.011	5 (29)	2 (26)	4 (30)	4 (24)
Zinc (Zn)	µg/L	<0.008	btl (21.3)	btl 19.2)	6 (21.9)	btl (24.1)
Barium, (Ba)*	µg/L		39	28	69	61
Beryllium, (Be)*	µg/L		<1	<1	<1	<1
Cobalt, (Co)*	µg/L		<1	<1	<1	<1
Vanadium, (V)*	µg/L		2	4	8	5

Note - * indicates no guidelines currently available. # shows water quality indicator values used for protection of drinking water supply (for example the see the EPP (Water) Dawson River Sub-basin), all other indicator values apply to the protection of aquatic ecosystem. Values in brackets are the trigger values for dissolved metals that require a hardness correction (AWQG). Below detection limits (btl) indicates the variable was below detection limits of the laboratory analysis. Shaded and bold values indicate exceedance of the relevant guideline.

Physicochemistry

The water temperatures varied between sites depending on location, time and volume of water at the sample location. Guidelines are not set for temperature but long-term monitoring from Lagoon Creek and Oakey Creek provides expected ranges for waters in the subcatchments. Water temperatures during January were at the upper range temperature range, whilst water temperatures in March were closer to the mid-range. However the results were within the expected range for these seasons.

The long term monitoring undertaken under the Mine's EA illustrates a spatial trend in the pH and EC values. Median pH and EC values were higher at sites downstream of the Mine with pH exceeding guidelines at the both downstream sites and EC exceeding guidelines at LCD2. EC was below guidelines during the flow event and contrasted with the high EC values recorded in the no-flow period. pH values were higher during the no-flow monitoring event although pH varies diurnally and seasonally and single measurement were within the ranges recorded from the long term monitoring. pH measurement during the flow event were slightly lower than the long term medians. Median pH and EC values from the Fairview gauging station exceeded the guidelines and indicate that this may be a feature of the Oakey Creek subcatchment, possibly due to the higher alkalinity and salinity of the local soils.

Dissolved oxygen was below guidelines at all sites during the flow period with very low concentrations at the site upstream of the Mine and concentrations similar at the three downstream sites. Turbidity was variable between sites during periods of both flow and no-flow and exceeded guidelines at three sites but values were not as high as commonly occur in some waterways of the Condamine catchment (CBWC, 1999) and a spatial trend was not evident.

Nutrients and major ions

Total and filterable fractions of nitrogen and phosphorus exceeded guidelines at all sites during the period of flow. Total nitrogen was similar between sites and ammonia concentrations were extremely high at the site upstream of the Mine. At the site immediately downstream, ammonia concentration was an order of magnitude lower and coincided with a spike in Dissolved Inorganic Nitrogen (DIN) concentration. This observation suggests substantial oxidation of ammonia occurring over this section of Lagoon Creek. Total phosphorus and FRP tended to increase downstream and may result from the greater catchment area for mobilisation of phosphorus from soils. Concentrations of major ions were similar between sites and no spatial trend was evident.

Dissolved metals and Toxicants

Dissolved concentrations of metals were below guidelines with the exception of copper, which was detected at all sites and exceeded the guidelines at AE4; this site also had a notably higher concentration of manganese. Concentrations of pesticides and hydrocarbons were below detection limits at all sites.

Environmental considerations

Water in the Condamine catchment is generally high in concentrations of total phosphorus and in turbidity (CBWC, 1999) and is indicative of catchments that are affected by agriculture. The revised Project site has been impacted by land uses including grazing and dryland cropping. These land-use practices have affected the surrounding waterways including Lagoon Creek. The very high concentrations of nutrients in Lagoon Creek during the flow period indicate mobilisation of inorganic and organic forms of nitrogen and phosphorus from catchment run-off possibly related to agricultural

activities. The concentrations of dissolved oxygen during the period of flow were low and were possibly due to the decomposition of suspended and dissolved organic matter in the rainfall run-off. The turbidity in Lagoon Creek and Oakey Creek was low in comparison to other subcatchments of the Condamine River basin, where high turbidity has been identified as a major influencing and limiting factor for the EV's. The long term monitoring results of EC in Lagoon Creek indicate increased EC levels downstream of the Mine. While it is expected that the EC of Lagoon Creek may increase following controlled releases from the Mine, all releases are undertaken based on strict water quality targets. It is noted that EC values are generally below guideline values at all sites. Furthermore, EC values immediately downstream of the Mine are significantly lower than the EC values at the DNRM monitoring site on Oakey Creek. This observation suggests that the EC values of the Lagoon Creek catchment are generally lower than the Oakey Creek catchment.

The water quality of the Lagoon Creek catchment is also impacted by the ephemeral nature of Lagoon Creek. Ephemeral waters are variable in their water quality primarily due to the irregularity and intensity of flow/rainfall events. The Study area experiences seasonal and highly variable rainfall. Large flow events will generally carry a large sediment load, which can be intensified by a long dry period. Flows and connectivity are also impacted by the numerous waterway barriers as a result of the construction of in-stream farm dams.

The variability in the rainfall/flow/drought cycle of ephemeral streams can lead to similar variation in the physical and chemical properties of the water compared with more permanent water bodies. In view of this variability, the current Australian and New Zealand Guidelines for Fresh and Marine Water Quality, (the ANZECC Guidelines) are often not suitable for such ephemeral environments. Two characteristics that often typify ephemeral streams are high turbidity and high sediment loads. However, other physicochemical properties can vary greatly in these systems. Variations in water quality may also exist over small spatial scales resulting from differing land management practices and local industry discharging or releasing waters into ephemeral streams.

From an ecological perspective, in addition to variable water quality over varying temporal and spatial scales, it is the period for which waters within ephemeral streams are connected, the frequency of connectivity and detachment, and the physical/chemical properties of these waters that are also critical factors in the survival of aquatic communities. The aquatic ecosystem values of the revised Project area are discussed in **Chapter 8**.

The general water guidelines that have been applied need to be considered with reference to local water quality conditions. The long term monitoring at Oakey Creek and Lagoon Creek provide a local context for water quality and are useful for interpreting water quality data, particularly prior to the release of WQO's for the Condamine catchment.

5.7 Geomorphology

The revised Project site is located within the Lagoon Creek catchment. The majority of the terrain within these catchments is undulating and land use is predominantly grazing. Historically, Lagoon Creek is grazed and cultivated up to and within the creek channel. In the upper reaches of the catchment, the terrain becomes steeper and possesses tracts of remnant vegetation. Higher, localised peaks in the Lagoon Creek catchment are also vegetated with trees.

Lagoon Creek is an ephemeral waterway that has historically been used for agricultural purposes, and as a result, is a disturbed creek system. The Lagoon Creek channel includes a number of in-stream farm dams which disrupt the natural flow regime. The main channel of Lagoon creek is poorly defined with significant erosion along the creek banks. The Upper Condamine catchment was assessed as part of the State of the Rivers report, completed in 1994. The report notes existing issues of erosion and a lack of riparian vegetation, but that the majority of the existing banks were stable despite signs of erosion.

A site visit was undertaken on 29th October 2008 following a period of prolonged drought and again on 31st January 2013, six days after the Australia Day flood event to assess the existing condition of the Lagoon Creek within the Study area.

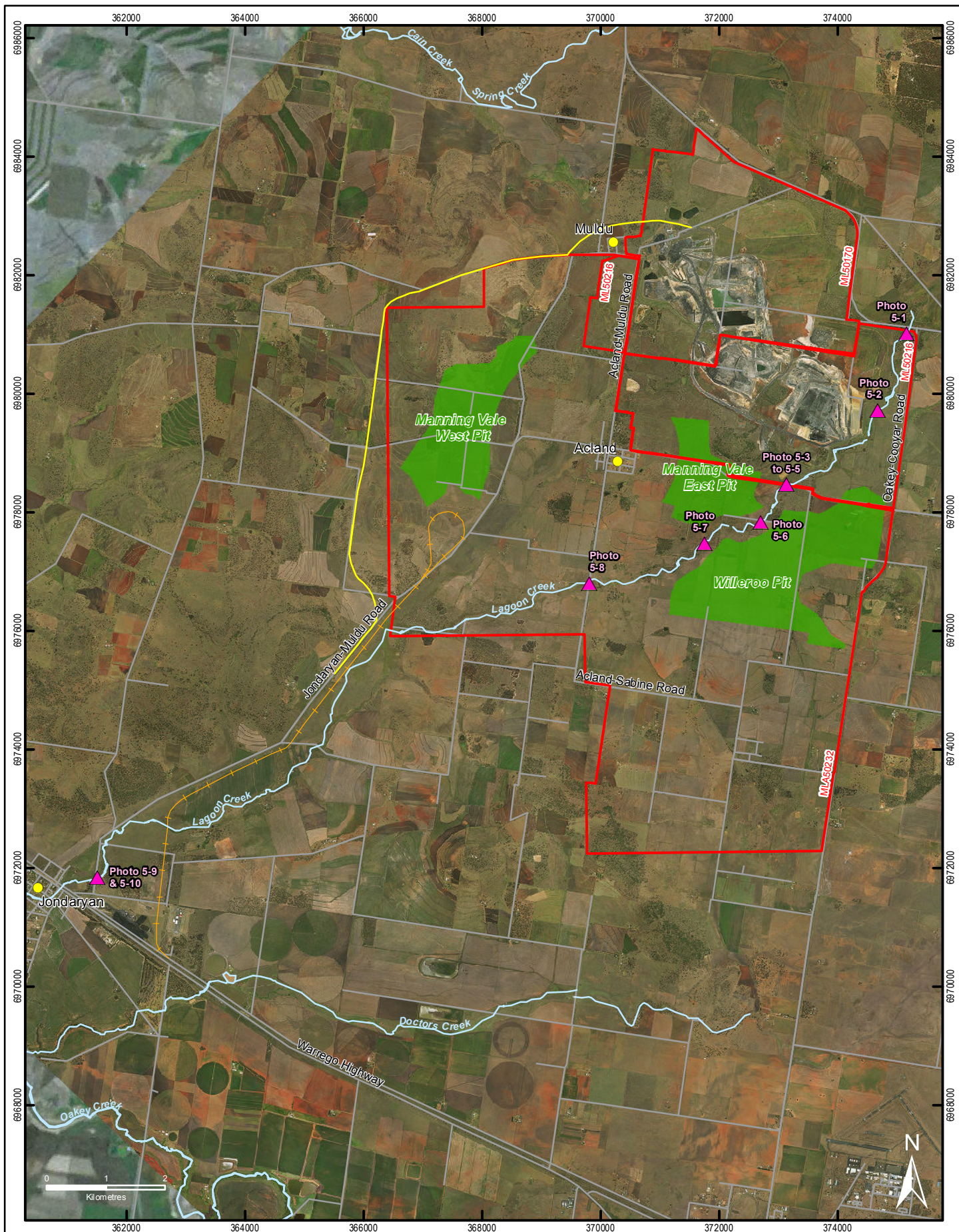
Photograph 5-1 through to **Photograph 5-10** illustrate the existing geomorphic condition of Lagoon Creek, upstream and downstream of the mine location. **Figure 5-6** illustrates the approximate location of these photos.



Photograph 5-1 Lagoon Creek's upstream crossing of the Mine Lease Boundary (2008)

Photograph 5-1 illustrates the existing conditions of Lagoon Creek as it crosses into the Mine. The figure is representative of the Lagoon catchment with a poorly defined creek channel.

Photograph 5-2 indicates the channel definition further south adjacent to the existing South Pit and upstream of the Study area. **Photograph 5-2** also illustrates significant erosion and degradation of the existing creek channel. Wet weather prevented access to these locations in 2013.



LEGEND

- Towns and Localities
- ▲ Geomorph Approximate Photo Locations
- Rail Spur
- Roads
- Creeks
- Mining Tenements
- Stage 3 Pit Areas



NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 5-6
Geomorphic Photo Locations

Scale 1:85,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)



Photograph 5-2 Lagoon Creek's channel adjacent to the South Pit (2008)



Photograph 5-3 Lagoon Creek's channel looking downstream of Acland Road to Study area (2008)



Photograph 5-4 Lagoon Creek's channel looking downstream of Acland Road (Flow Event 27th January 2013)

Photograph 5-3 illustrates the existing conditions of Lagoon Creek following drought in 2008 looking into the revised Project area just downstream of Acland Road. The photo illustrates the relatively narrow and shallow nature of the creek channel. **Photograph 5-4** was taken in approximately the same location following the Australia Day rainfall event in January 2013 and illustrates a flow event in Lagoon Creek. **Photograph 5-5** was taken at approximately the same location several days later with shallow standing water observed in the Study area immediately downstream of the road crossing. No obvious signs of erosion were observed.



Photograph 5-5 Lagoon Creek's channel looking downstream of Acland Road to the Study area (2013)



Photograph 5-6 Lagoon Creek's adjacent to the Study Area (2008)



Photograph 5-7 Lagoon Creek's adjacent to the Study area (2008)

Photograph 5-6 and **Photograph 5-7** illustrate the Lagoon Creek channel adjacent to the Study area. The photos illustrate the discontinuity of the channel with sections of relatively defined channel and large sections of floodplain. This is also illustrated in **Photograph 5-8** which illustrates the Lagoon creek channel looking upstream into the Study area from the approximately location of downstream boundary of the MLA.



Photograph 5-8 Lagoon Creek looking upstream of Acland-Sabine Road to Study area (2013)

Photograph 5-9 and **Photograph 5-10** characterise the Lagoon Creek downstream of the proposed railway line looking towards Jondaryan. The photos illustrate the expansive floodplain and limited channel definition.



Photograph 5-9 Lagoon Creek looking Downstream to Jondaryan at Railway Location (2008)



Photograph 5-10 Lagoon Creek looking Downstream to Jondaryan at Railway Location (2013)

5.7.1 Potential Impacts on Water Quality and Geomorphology

The revised Project includes an operational separation distance of approximately 150 m from the banks of Lagoon Creek to the edge of the mining pits, which includes a 50 m buffer adjacent the creek for conservation purposes. This buffer distance is consistent with the requirements of the *Vegetation Management Act 1999*, which protects remnant vegetation growing within 50m of a watercourse. In addition to this (Rutherford *et al.* 2001) recommends that offsets are determined based on:

- A starting width of 5 m; plus
- A width not less than the height of the bank from bank toe to bank crest; plus
- A width equal to amount of bank migration expected to occur in the time it takes for vegetation to establish.

Rutherford *et al.* recommends widths of riparian vegetation are derived based on the 1993 study of contemporary rates of both channel widening and outside bend migration undertaken by Ian Drummond and Associated. This study identifies a maximum vegetation establishment time of 25 years and a bank erosion rate of 1 m/year. Therefore the recommended offset for Lagoon Creek would be in the order of 35 m. This indicates that the 50 m buffer and 150 m offset for Lagoon Creek is well in excess of the current industry standards.

Lagoon Creek is an ephemeral Creek, the rise and fall of floodwaters typically occurs within a period of hours (refer Section 5.11.3), As such infiltration of Lagoon Creek flood flows, into the pit is considered unlikely, particularly over the 150 m separation distance. Furthermore, there are no near surface aquifers in the vicinity of Lagoon Creek (refer to **Chapter 6** – Groundwater, Section 6.2.11) and as such there is not expected to be impacts on groundwater due Lagoon Creek buffer.

As a result of this offset, there is not expected to be any significant disturbance to Lagoon Creek and subsequent impacts on water quality. The offset has the potential to improve water quality within Lagoon Creek by preserving the creek and its riparian zone from agricultural activities. A proposed extension of the conservation zone along Lagoon Creek from the Mine area to the revised Project site will allow riparian vegetation to re-establish, improving the channel stability and subsequently the water quality and associated environmental values.

The potential impacts of the revised Project on water quality may result from:

- increased sediment load or chemical spillage during construction; and
- a reduction in water quality through controlled or uncontrolled releases from the mine water management system.

The risks associated with releases from the mine water management system are discussed in further detail in **Section 5.13.4** and mitigation measures including soil and erosion control are presented in **Section 5.14**.

5.8 Regional Climate and Streamflow Records

The Bureau of Meteorology (BoM) operates rainfall and evaporation gauges for several locations in the vicinity of the revised Project site. The historical rainfall and evaporation records were analysed to determine the climate at the revised Project site. The rainfall and evaporation gauges are summarised in **Table 5-8**. The locations of the gauges are illustrated in **Figure 5-8**.

Table 5-8 Rainfall and Evaporation Gauge Data

Gauge Number	Catchment	Name	Open - Closed	Number of Years of data	Location (degrees south)	Location (degrees west)
040431	Oakey	Geham State School	1912 - 1974	63 (23% missing)	27.4	152.02
041074	Doctors	Netherby	1929 -1981	52 (3% missing)	27.35	151.8
041053	Lagoon	Jondaryan Post Office	1899 – 2012	>110 (10% missing)	27.36	151.59
041024	Doctors	Doctors Creek	1906 - 2005	99 (10% missing)	27.21	181.85
041000	Lagoon	Acland Post Office	1912 -1992	81 (5% missing)	27.3	151.69
041039	Gowrie	Gowrie Junction	1899 -1972	73 (5% missing)	27.5	151.9
041359*	Oakey	Oakey Aero	1973 -2012	34 (8% missing)	27.4	151.74
NAC^	Lagoon	New Acland Mine	2008-2013	5 (not recorded)	27.27	151.69

Note: * Evaporation Gauge, ^New Acland mine site gauge – tipping bucket gauge therefore missing days not recorded

Monthly rainfall and evaporation averages are presented in **Figure 5-7**. The results are indicative of a dry climate showing evaporation exceeding average rainfall for every month of the year. These results also illustrate the seasonal variation of rainfall in the area.

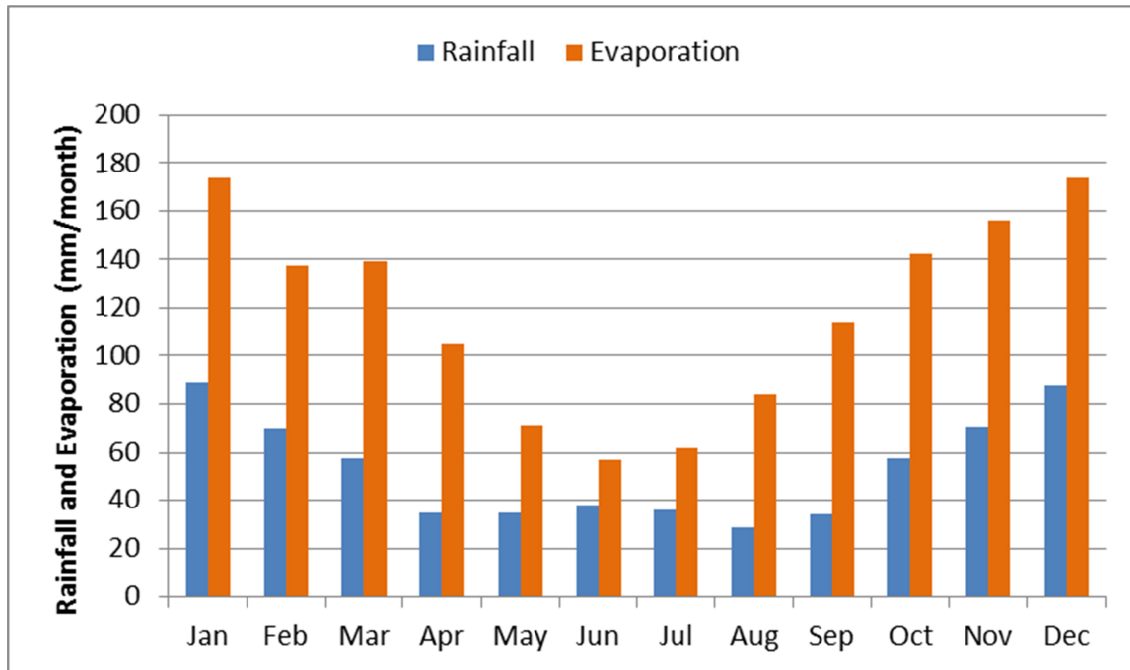
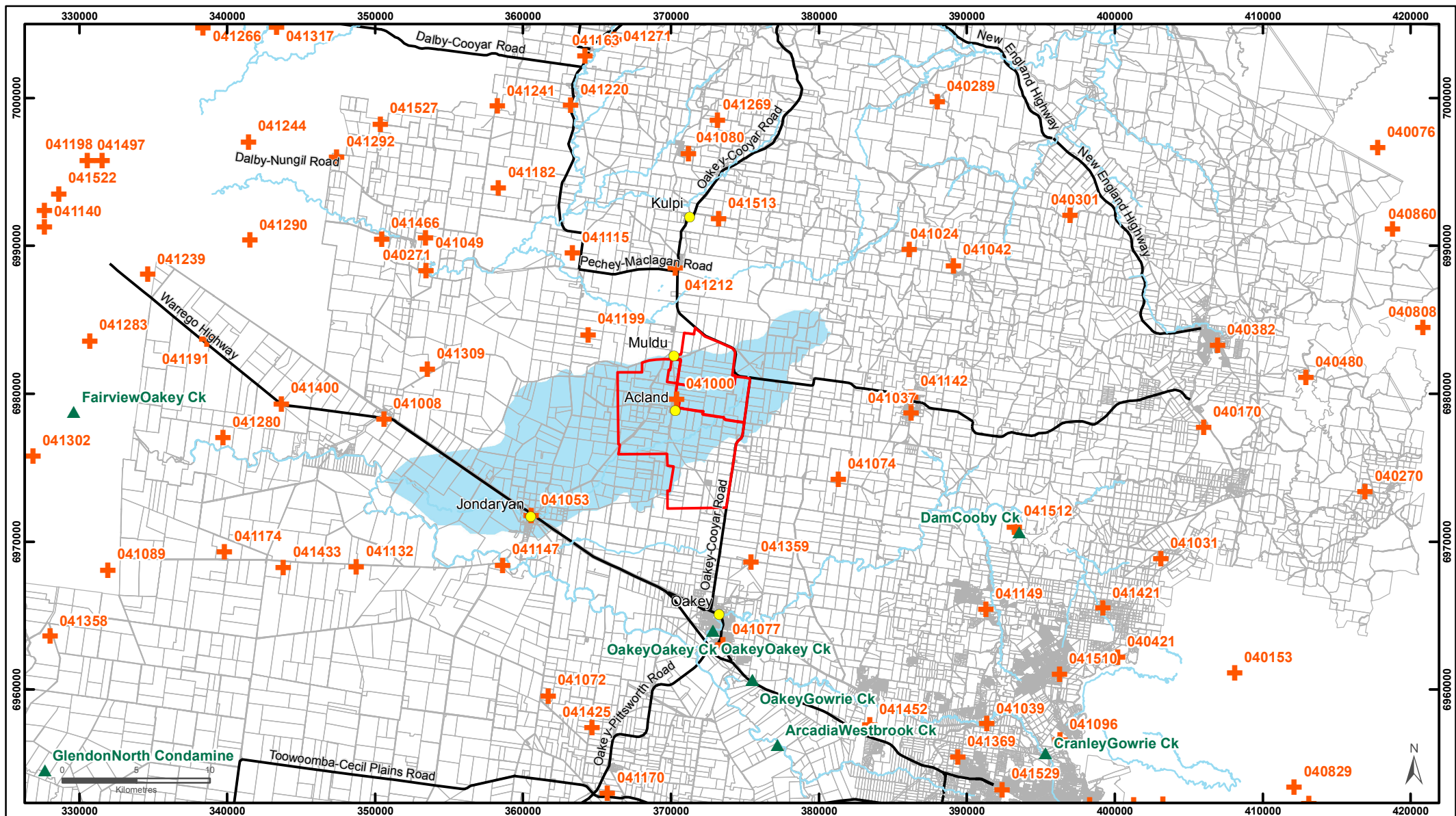


Figure 5-7 Average Monthly Rainfall Data (041053) and Evaporation Data (041359)



LEGEND

-  Towns and Localities  Cadastre
 Streamflow Gauges  Mining Tenements
 Daily Rainfall Gauge
 Road
 Creeks



**NEW ACLAND COAL MINE
STAGE 3 PROJECT**

Figure 5-8
Location of Gauged Rainfall
and Streamflow Data

Scale 1:350,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

The DEHP does not operate stream gauges within close proximity to the revised Project site. There are several gauges in the vicinity of the catchment on Oakey and Gowrie Creek. **Table 5-9** outlines the stream flow gauge details. The location of the gauges is shown in **Figure 5-8**.

Table 5-9 Stream flow Gauge details

Gauge Number	River Name	Catchment Area (km ²)	Open - Closed	Missing Data	Location (degrees south)	Location (degrees west)
422312A	Cooby Ck Dam	184	1935 -1940	20%	27.38	151.92
422326A	Gowrie Ck at Cranley	47	1969 -present	4%	27.52	151.94
422332A	Gowrie Ck at Oakey	142	1967 -1981	4%	27.47	151.74
422332B	Gowrie Ck at Oakey	142	1992 - present	4%	27.47	151.74
422330A	Oakey Ck at Oakey	540	1967 -1976	7%	27.44	151.71
422330B	Oakey Ck at Oakey	545	1976 -1981	12%	27.44	151.71
422350A	Oakey Ck at Fairview	1970	1980 - present	2%	27.30	151.28
422331A	Westbrook Ck at Arcadia	256	1967 -1981	17%	27.51	151.76
422333A	Condamine at Loudoun Bridge	12380	1969- present	6%	27.22	151.18

The nearest stream flow gauge downstream of the revised Project site is the Oakey Creek gauge at Fairview. The Fairview gauge has 33 years of data but receives flow from a number of other catchments resulting in a catchment area approximately 10 times the Lagoon Creek catchment area. The Gowrie creek gauges are considered to have upstream catchments materially different to that of Lagoon Creek with significant urban areas and historical flows, prior to 2009, influenced by releases from the TRC WWRF. Therefore stream flow gauge no. 422330, Oakey Creek at Oakey, was used to provide an overview of typical stream flows in the Study area.

It is noted that since 2007, NAC has operated two water level loggers on Lagoon Creek. These loggers record water surface level and indicate the ephemeral nature of the creek with long periods of zero depth records. A rating curve was developed for these gauges based on the LIDAR data collected for the revised Project. This has enabled flows to be estimated for the recorded water surface levels. However, Lagoon Creek is a relatively small channel with poorly defined bed and banks and a large floodplain which conveys a significant volume of water during a flow event. As such the error range on the rating curve developed for the gauges is significant and the resulting accuracy of the flow data was not sufficient to support development of a daily rainfall runoff model for the Lagoon Creek catchment. The levels recorded at the NAC gauges are discussed in the description of the January 2011 and 2013 flood events in **Section 5.10.4**.

The daily discharge exceedance curve for Oakey Creek at Oakey is provided in **Figure 5-9**.

Figure 5-9 indicates that Oakey Creek is dry 50% of days, a result typical of an ephemeral creek. **Figure 5-9** also illustrates the exceedance curve for the simulated flows in Lagoon Creek, provided by DISITA, which indicates Lagoon Creek is dry 20% of days, while this flow is simulated based on a calibration point significantly further downstream the results indicate the ephemeral nature of the creek and the significant proportion of zero and low flow days.

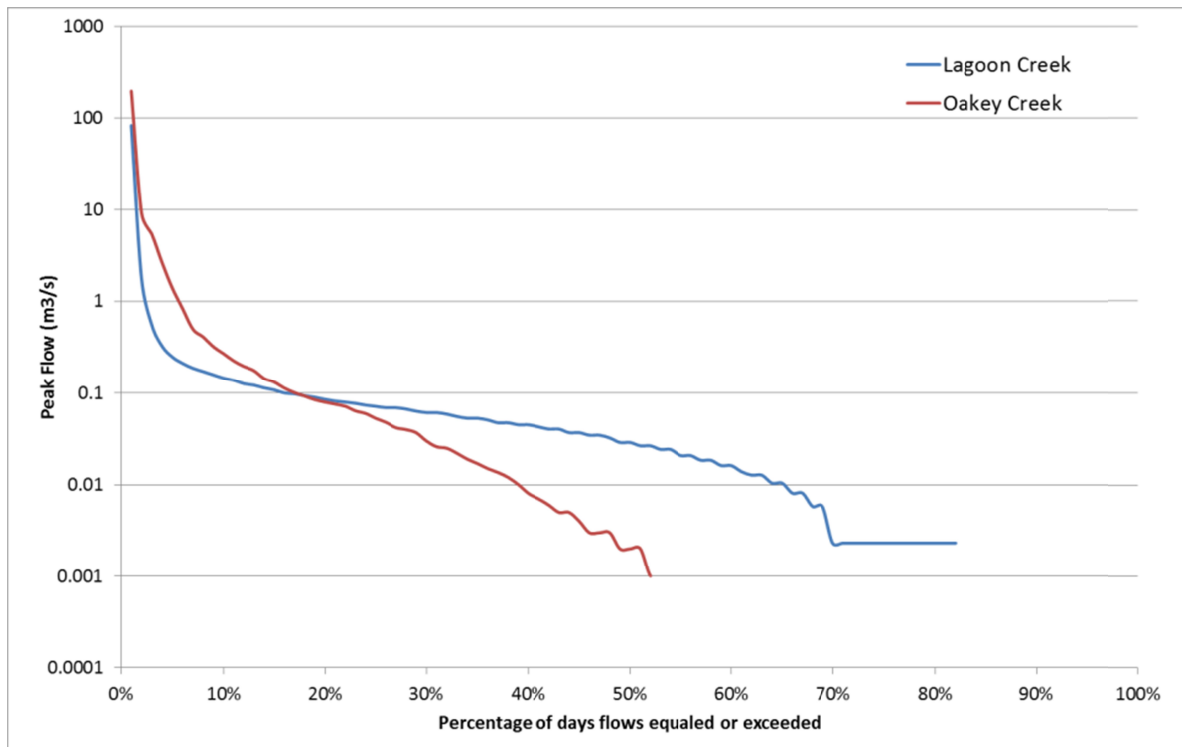


Figure 5-9 Daily Discharge Exceedance Curve Oakey Creek at Oakey & Simulated Lagoon Creek

The period of record for the Oakey Creek gauge at Oakey has a short and broken record with a significant proportion of missing data. The stream flow records, listed in **Table 5-9**, were therefore assumed insufficient to support a flood frequency assessment.

A regional flood frequency was performed for the Study area and was used to verify the Lagoon Creek Design Hydrology; this aspect is discussed further in **Section 5.10.4**.

5.9 Existing Catchment Flood Hydrology

Hydrologic analysis was performed for flows in Lagoon Creek using the *XP-RAFTS* software package. *XP-RAFTS* is a run-off routing model that has been applied to watersheds ranging from rural to fully urban environments with catchments varying from less than 1 ha to several thousand square kilometres. The *XP-RAFTS* model uses rainfall patterns and depths as well as physical catchment characteristics to estimate catchment flow. The catchment characteristics are described by parameters such as catchment area, average slope and resistance. Catchment response to rainfall was described in the form of a loss model with initial and continuing rainfall losses.

Catchment delineation, slope and roughness parameters were developed based on LIDAR terrain data with a $\pm 0.12\text{m}$ vertical accuracy and aerial photography. A Manning's 'n' roughness of 0.06 was adopted for cleared agricultural land, consistent with the *RAFTS Manual* (WP-Software, 1994). All catchment areas were assumed to be 100% pervious.

The main stream channel routing between each *RAFTS* sub-catchments is modelled through link-lags. The link-lag routing has been modelled as fixed time link-lags based on the average stream velocity of 1.5 m/s determined from Manning's equation assuming a hydraulic radius of 1 based on the assumption of wide floodplain flows. However, as illustrated in **Figure 5-10**, the hydraulic model extent included the entire Lagoon Creek catchment with only one total hydrograph introduced into the hydraulic model. Therefore the majority of the routing between sub-catchments occurs within the hydraulic model as such the link lag assumption is not material to the resulting flood model results.

As there was no historical gauging for this catchment, loss parameters used in the model were adopted from regional averages (Ilahee, 2005) and adjusted, along with the storage routing parameter to provide peak flows that were consistent with those observed in the regional flood frequency analysis. The final adopted values are presented in **Table 5-10**. It is noted that due to the inter-catchment routing occurring through the hydraulic model domain, this process involved both hydrologic and hydraulic modelling.

Table 5-10 Loss and Routing Parameters

Parameter	Annual Exceedance Probability (AEP)		
	1 in 10	1 in 100	1 in 1000
Initial Loss (mm)	25	5	0
Continuing Loss (mm/hr)	4	2	0
B – Storage Multiplier	0.6	0.6	0.6

It is noted that the B multiplier factor of 0.6 is considered low for a catchment such as Lagoon Creek which is dominated by floodplain flows. Lower B multiplier values result in higher peaked flood events and this value was required to achieve flood peaks for the rare flood events (1 in 1000 AEP) that are consistent with the range expected through the regional flood frequency analysis. It is therefore considered that the adopted B multiplier value is appropriate for the purposes of the assessment.

The Lagoon Creek catchment was modelled as 17 sub-catchments, presented in **Figure 5-10**.

Table 5-11 presents shows the adopted catchment parameters.

Table 5-11 Adopted Hydrologic Model Parameters

Catchment	Area (ha)	Slope (%)
A	1123	1.52
B	1276	0.98
C	1268	0.89
D	1656	0.80
E	1606	0.57
F	1397	0.54
G	1445	0.56
H	688	0.65
I	388	0.73
J	455	0.78
K	917	1.17
L	126	0.53
M	370	1.22
N	528	1.09
O	370	0.13

Design rainfall depths were determined using the CRC-Forge method for Queensland (DNRW, 2005) for AEPs up to and including the 1 in 2,000 AEP. The CRC-Forge point based rainfall depths for the 1 in 100 AEP design storm were compared to those of Australian Rainfall & Runoff (AR&R). Comparison of the results found very small differences in the two methods. Limited spatial variation in rainfall was observed across the catchment; therefore a uniform rainfall depth was adopted.

An Areal Reduction Factor (ARF) is used in the modelling process to represent the likelihood that rainfall does not fall uniformly across a large catchment. The catchment area for Lagoon Creek dictated that an ARF be applied to the point rainfall to develop catchment based rainfall. The ARF is based on the storm duration and catchment area. The adopted method for estimation of an ARF is from the Extreme Rainfall Estimation Project (DNRW, 2005), which produced a set of ARF's for Queensland. The analysis used a modified Bell's Method (i.e. nominal circular 'catchments' for sampling over areas 125 km² to 8,000 km²). The adopted formula for the derivation of an ARF was:

$$ARF = 1 - 0.2257 (\text{Area}^{0.1685} - 0.8306 \log (\text{Duration})) \text{Duration}^{-0.3994}$$

A conservative assumption was made to determine the ARF for the catchment to the downstream extent of the Study area, rather than the entire Lagoon Creek catchment area. This methodology provided higher rainfall depths and is considered an appropriately conservative assumption for the design for the Lagoon Creek levee. The developed ARF for Lagoon Creek to the downstream extent of the revised Project site was 0.95 for the critical storm duration of 6 hours.

Probable Maximum Precipitation (PMP) depths were estimated using the Generalised Tropical Storm Method (BoM, 2003a; 2003b) and Generalised Short Duration Method (BoM, 2003c). Rainfall depths

for intermediate AEPs were determined using log-linear interpolation according to methods in Book VI of Australian Rainfall and Runoff (Nathan and Weinmann, 1999).

5.9.1 Verification of Results

The results of the hydrologic modelling are verified through the hydraulic modelling, as routing between sub-catchments is modelled in the hydraulic model domain.

The results of the hydrologic modelling in the upper section of the catchment were also compared to the results of a rational method calculation. This check was only performed for the total flow to catchment B as the rational method is only applicable for small catchments of less than 25 km². The results indicated that the rational method and RAFTS modelling are comparable with a value of 134 m³/s and 112 m³/s for the 1 in 100 AEP respectively.

5.10 Existing Flooding Characteristics

The existing flood characteristics of Lagoon Creek were assessed using the TUFLOW hydraulic modelling package. The two dimensional nature of the TUFLOW model is particularly appropriate for catchments with poorly defined channels and extensive floodplain flow such as Lagoon Creek.

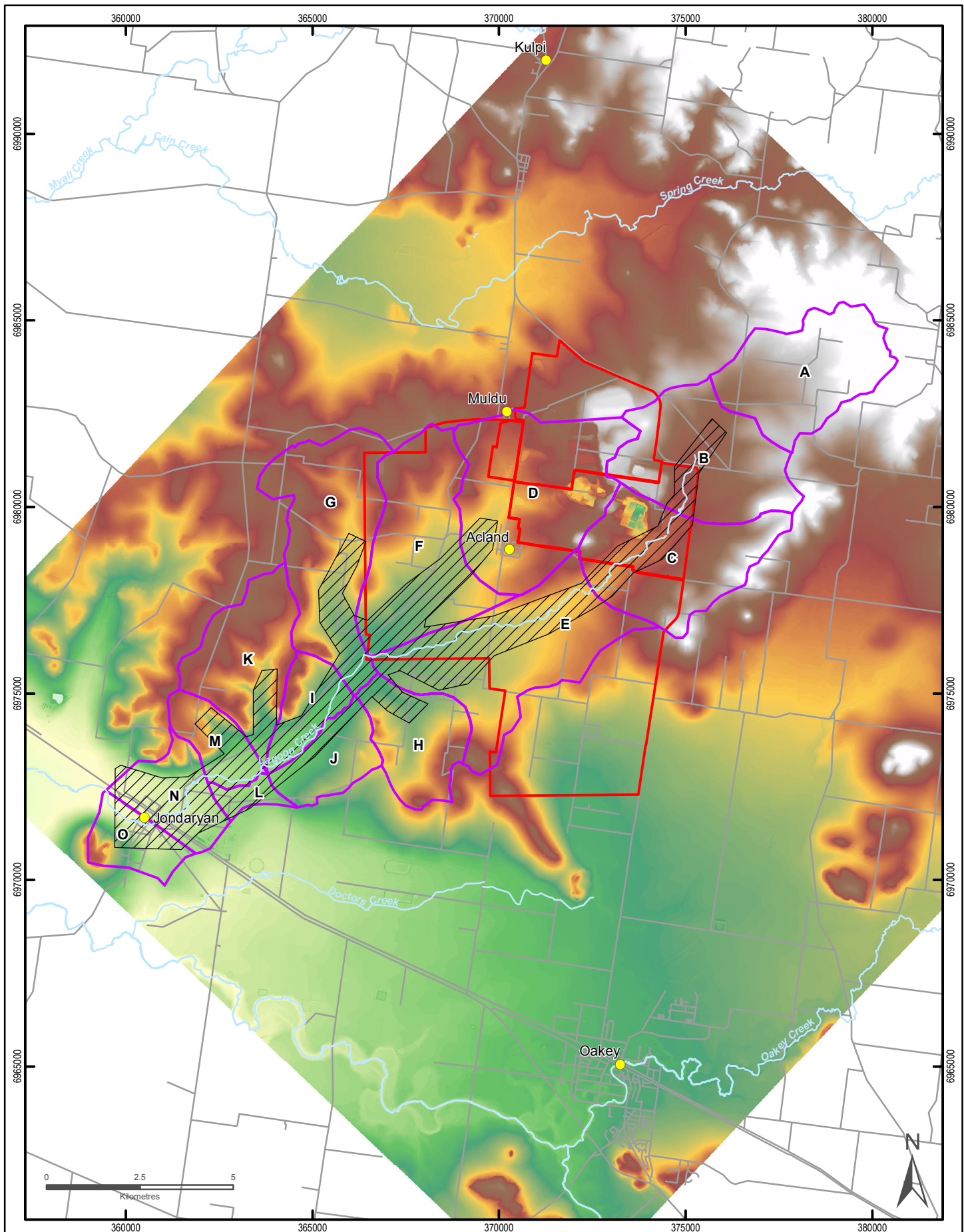
5.10.1 Model Area and Terrain Development

The hydraulic model coverage adopted for this investigation extended from north of the Mine downstream to the Warrego Highway and Jondaryan and included a tributary of Lagoon Creek which crosses the proposed rail spur and balloon loop. The model area is illustrated in **Figure 5-10**.

The formulation of a hydraulic model grid was achieved by the development of a Triangular Irregular Model (TIN) of the ALS survey points, with a terrain grid developed from the TIN. The data source for the TIN was the LIDAR data with a +/-0.12 m vertical accuracy and a +/-0.26 m horizontal accuracy.

The hydraulic modelling adopted a 10 m grid resolution for the representation of the terrain. The grid resolution was selected given the size of the model, lack of channel definition and predominately floodplain based flows. This grid resolution was considered appropriate with the width of Lagoon Creek in the downstream reach near Jondaryan and the proposed rail crossing in the order of 50 m. While the creek width in the upper reaches is in the order of 5 m the 10 m grid resolution is considered to provide conservative results for the Lagoon creek flood levees, with the majority of the creek conveyance provided within the floodplain.

To enhance the reliability of this data, key features including the stream centreline, existing Lagoon Creek Levee and the Warrego Highway were sampled from the 1m LIDAR grid and stamped onto the TUFLOW model as ridge or gully lines.



LEGEND

- Towns and Localities
- Roads
- Creeks
- Mining Tenements
- Lagoon Creek Sub Catchments
- Terrain Elevation
 - High : 604
 - Low : 335
- Hydraulic Model Extent



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**Figure 5-10 -Extent of Hydrologic
and Hydraulic Model**

Scale 1:135,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

5.10.2 Adopted Design Parameters

The hydraulic modelling adopted a uniform Manning's n roughness value of 0.04 for the floodplain. This value is consistent with those recommended by Chow (Open Channel Hydraulics, 1959) for field crops and scattered brush areas. A Manning's n value of 0.08 was adopted for the main channel of Lagoon Creek. This decision was based on aerial photography and field inspections which indicated reeds, long grass and scattered trees within the main channel of Lagoon Creek. A sensitivity analysis of the effect of the Manning's n value on water surface levels was performed and the results found that the model was not sensitive to Manning's with an overbank value of 0.03 and creek of 0.045 resulting in a water surface level difference of less than 4 mm.

Crossings of major existing infrastructure including the Warrego Highway and railway line were modelled in one dimension using TUFLOW esy code with standard entrance and exit losses.

5.10.3 Boundary Conditions

The hydrology developed in **Section 5.9.1** was input to the hydraulic modelling through a number of source areas within the model area. Catchments outside of the model area were incorporated through the introduction of RAFTS total flow hydrographs. Total flow hydrographs incorporated routed sub-catchments from all linked catchments upstream of the revised Project site. The hydraulic model accounts for sub-catchment routing for catchments within the model.

The downstream boundary condition for Lagoon Creek utilised a water level discharge relationship (Q-H relationship) based on the terrain at the location of the boundary.

5.10.4 Model Verification

The peak flows were compared to the results of a regional flood frequency analysis undertaken for several gauges of similar magnitude within the Study area. The results of the regional flood frequency analysis are plotted based on catchment area in **Figure 5-11**. **Figure 5-11** illustrates that the 1 in 10 and 1 in 100 AEP peak flows are generally within the range expected for a catchment of similar size within the vicinity of the Project site.

It is noted that **Figure 5-11** illustrates the 1 in 1,000 AEP is at the lower end of the expected range. However, it is noted that there is significant uncertainty associated with this regional flood frequency estimates for rare events such as the 1 in 1,000 AEP, due to the relative short length of flow records from the surrounding gauges. A sensitivity analysis was undertaken whereby the peak flows from the 1 in 1,000 AEP flow hydrograph were increased by 20% to examine the implications of a higher 1 in 1,000 AEP flood peak. The sensitivity assessment indicated that the relative levels of impacts associated with the revised Project were not changed as a result of the increased peak flows. Furthermore, NAC have opted to adopt a higher flood immunity for their flood levees of the PMF and as such the risk associated with the uncertainty for the 1 in 1,000 AEP is not considered to alter the findings of this impact assessment.

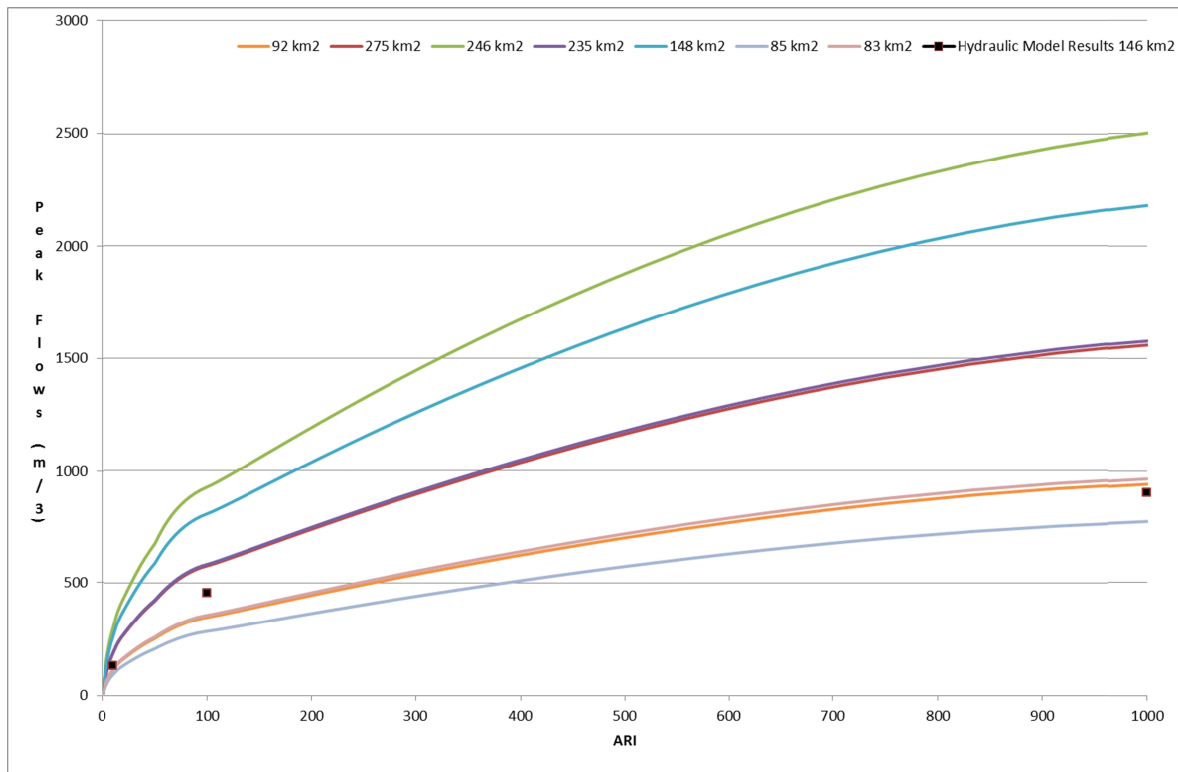


Figure 5-11 Regional Flood Frequency Verification of Results

At the time of writing the Queensland Reconstruction Authority (QldRA) had just released the results of their level 2 flood assessment at Jondaryan. The level 2 assessment included a flood analysis for Lagoon Creek at Jondaryan based on a flood frequency analysis for the Oakey Creek gauge at Fairview. **Table 5-12** provides a comparison of the peak flows within the TUFLOW model and the results of the Flood Frequency Analysis completed by the QldRA. The comparison indicates that the TUFLOW hydraulic model peak flows are not inconsistent with those of the QRA flood analysis.

Table 5-12 Estimation of Design Peak Flows for Lagoon Creek

AEP (1 in Y)	Lagoon Creek Peak Flow (m³/s) at Jondaryan	
	New Acland TUFLOW model	QldRA FFA
1 in 10	130	N/A
1 in 20	Not modelled	240
1 in 50	Not modelled	360
1 in 100	455	470
1 in 200	Not modelled	610
1 in 500	Not modelled	800
1 in 1,000	905	N/A
PMF	4,131	N/A

January 2011

The NAC rainfall and Lagoon Creek data logger records were reviewed to determine the magnitude of the January 2011 event and the potential to calibrate the flood model to the January 2011 flood event.

Rainfall records from NAC's site data, surrounding gauges at Jondaryan and Oakey and radar rainfall were reviewed. In January 2011, two significant rainfall events occurred in the region (10th and 11th January, respectively). However, the NAC site rainfall records provide a combined reading for the 9th and 10th January and a second combined reading on the 11th and 12th January. This occurrence was due to the manual emptying of the gauge not occurring over the weekend of the 8th and 9th January and on the 11th January as the Mine was closed due to flooding. As a result it is difficult to discern the rainfall events from the Mine's rainfall records. **Table 5-13** presents the Mine's rainfall records which were compared to rainfall totals for gauges within the region. The results suggest that the rainfall recorded within the upper parts of the Lagoon Creek catchment may have been higher than those recorded at surrounding rainfall gauges. This outcome is not unexpected with the January 2011 rainfall observed to be highly variable with significant difference in rainfall intensity across the region ranging from 1 in 50 to 1 in 1,000+ AEPs.

Table 5-13 Comparison of gauged January 2011 rainfall data

Comparison of Rainfall Data				
Date	NAC Rainfall (mm/d)	Jondaryan Post Office	Rosalie Plains	Oakey Aero
06-Jan-11	8	20	47	50.4
07-Jan-11	52	31.8	14.6	10.2
08-Jan-11	12	6.8	3.8	11
09-Jan-11	83*	12.8	76.2*	4.2
10-Jan-11		64.6		64
11-Jan-11	65*	36.2	48	78.8
12-Jan-11		3.4	0	6.2

*Rainfall recorded over two days

There is limited pluviograph information for the region to define the temporal pattern of the rainfall event/s and support model calibration to the January 2011 event or to accurately determine the AEP of the rainfall intensity. NAC's two Lagoon Creek flow loggers suggest the January 2011 event peaked over a 6 hour period. Assuming a 6 hour rainfall event, the rainfall totals would provide a rainfall intensity suggesting the order of magnitude of the January 2011 event was a 1 in 10 AEP. This finding is generally consistent with the flood frequency analysis undertaken by the QldRA (QldRA, 2012). The QldRA analysis suggested that the January 2011 event in Oakey Creek at the Fairview gauge was approximately an 18% AEP event, which is equivalent to a 1 in 5 to 1 in 10 AEP.

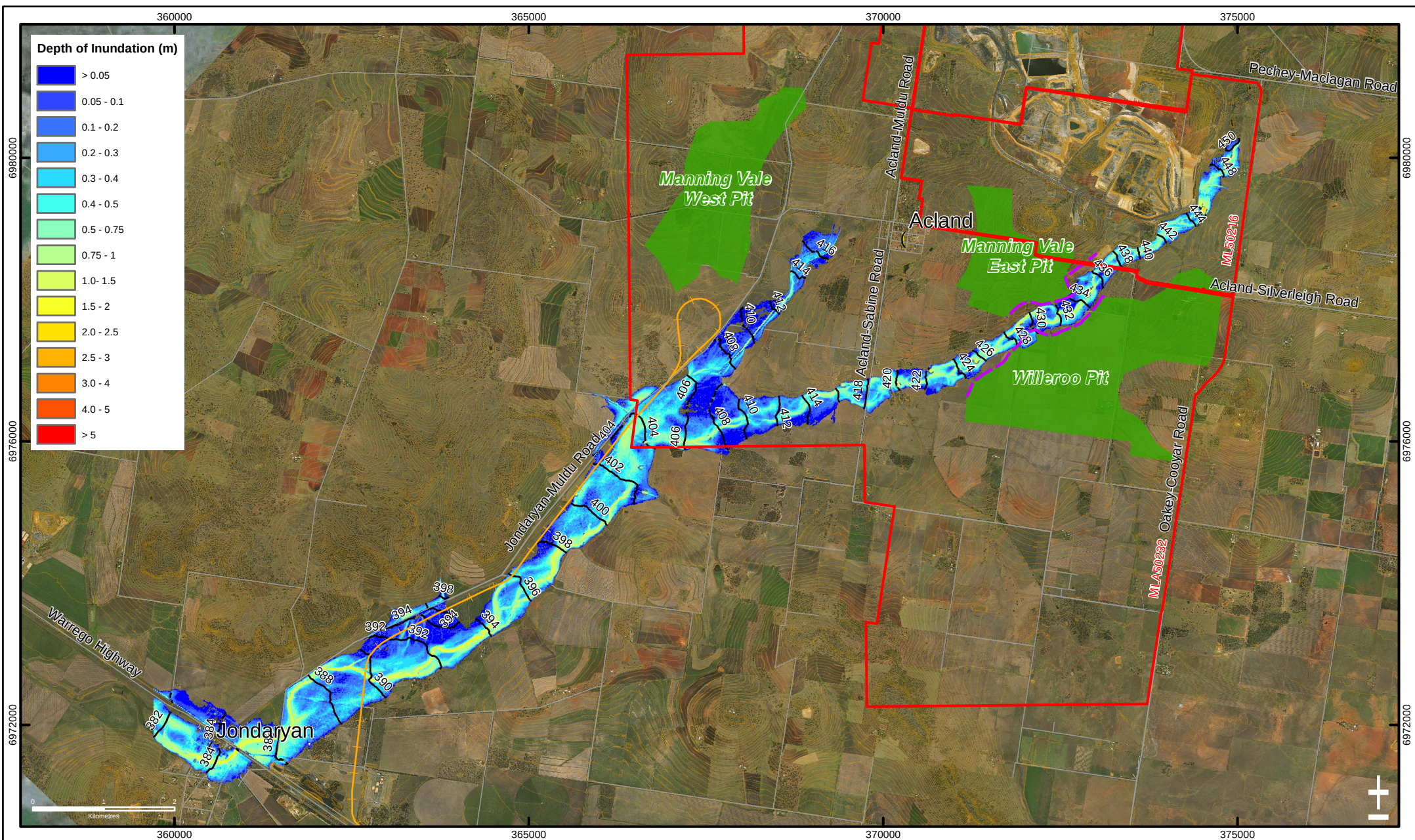
As discussed in **Section 5.8**, the peak flow of the events could not accurately be determined from the data collected by NAC's water level loggers. However, the peak flood depths were compared to the flood model results for the design flood events with downstream logger reporting water surface levels in the order of 397.37 m AHD, approximately 400 mm less than the modelled design flood water surface level of the 1 in 10 AEP. The recorded flood level at the downstream logger for the January 2013 event was significantly less at 396.68 m AHD.

The available historical data suggests that the magnitude of the January 2011 event was in the order of a 1 in 10 to 1 in 20 AEP flood event. While there was insufficient data to support calibration of the models to this event, it is noted that the impact of the revised Project on design events of similar magnitude to the January 2011 flood event is considered in this assessment.

5.10.5 Results

Figure 5-12 to **Figure 5-15** present the existing model results for flood depth and flow velocity for the 1 in 10 and 1 in 100 AEP flood events. The results indicate the shallow and wide nature of flood flows within the catchment. Flow depths within the creek channel are typically in the order of 1 m to 1.5 m for the 1 in 10 AEP and 1.5 m to 2 m for the 1 in 100 AEP flood event. Flow depths on the floodplain are typically less than 1 m for the 1 in 100 AEP and less than 300 mm for the 1 in 10 AEP. Flow velocities vary with flows of up to 1 m/s and 1.5 m/s within the creek channel in the upper reaches surrounding the revised Project's mining area and 1.4 m/s and 1.8 m/s downstream near Jondaryan for the 1 in 10 AEP and 1 in 100 AEP respectively. Flow velocities on the floodplain are typically less than 1 m/s for the 1 in 100 AEP.

Figure 5-16 and **Figure 5-17** present the existing flood depth and water surface level contours for the 1 in 1,000 and PMF flood extent. The results indicate that the proposed flood levees protect the revised Project's mine pit areas for events up to and including the PMF.



LEGEND

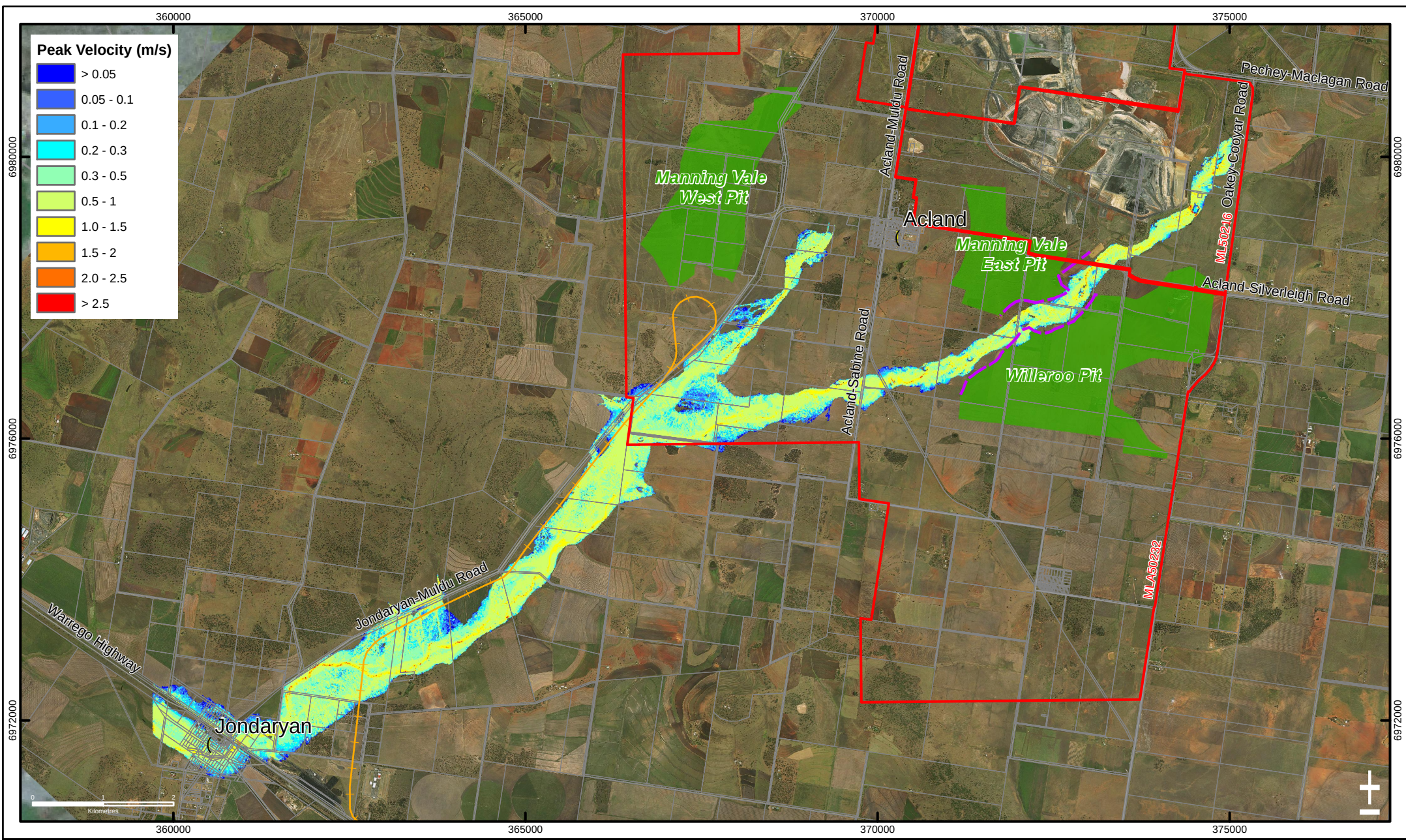
- | | |
|--------------------------|--|
| () Towns and Localities | — Water Surface Level (m AHD) |
| — Proposed Rail Spur | — Topographical Contours (2m interval) |
| — Proposed Flood Levee | □ Mining Tenements |
| — Roads | ■ Stage 3 Pit Areas |



NEW ACLAND COAL MINE STAGE 3 PROJECT

**Figure 5-12 - Existing Peak Flood
Depth 1 in 10 AEP**

Scale 1:70,000 on A4
Projection: Australian Geodetic Datum - Zone 56 (AGD84)



- LEGEND**
- () Towns and Localities
 - Proposed Flood Levee
 - Proposed Rail Spur
 - Roads
 - Cadastre
 - Mining Tenements
 - Stage 3 Pit Areas

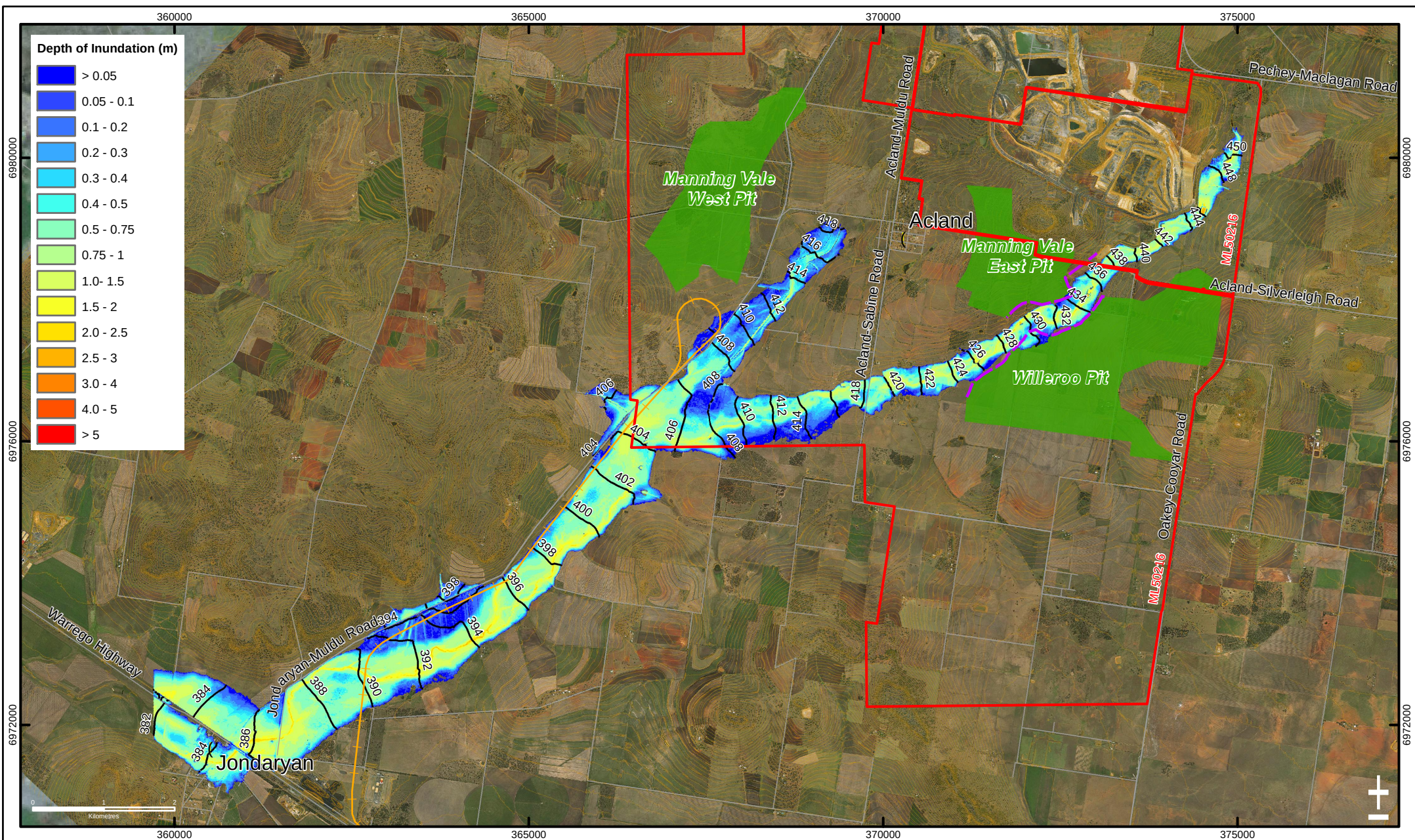


**NEW ACLAND COAL MINE
STAGE 3 PROJECT**

**Figure 5-13 - Existing Peak Flood
Velocity 1 in 10 AEP**

Scale 1:70,000 on A4
Projection: Australian Geodetic Datum - Zone 56 (AGD84)

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Produced: 9/02/2014



LEGEND

- (Towns and Localities
- Water Surface Level (m AHD)
- + Proposed Rail Spur
- Topographical Contours (2m interval)
- Proposed Flood Levee
- Mining Tenements
- Roads
- Stage 3 Pit Areas

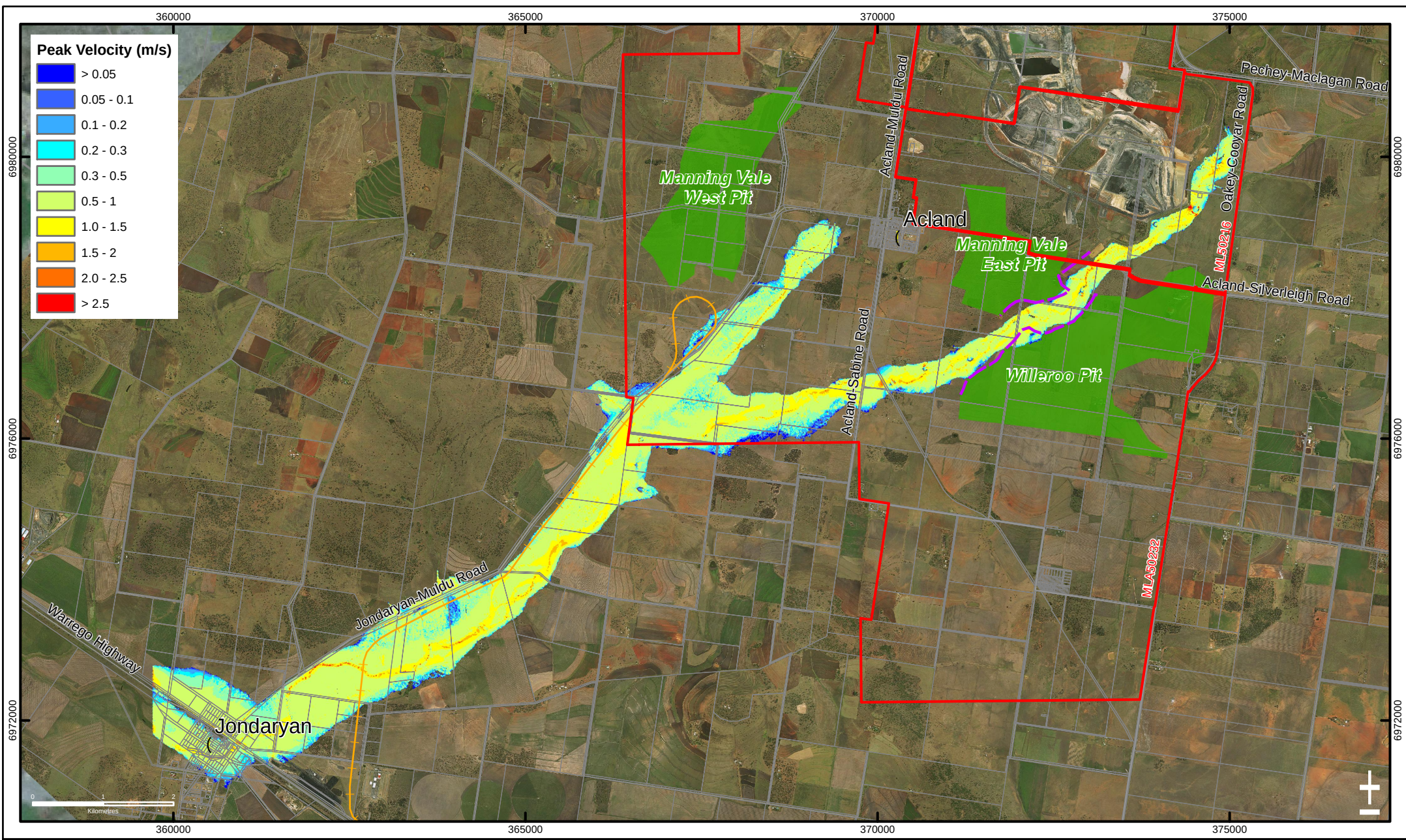
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Figure 5-14 - Existing Peak Flood
Depth 1 in 100 AEP

Scale 1:70,000 on A4
Projection: Australian Geodetic Datum - Zone 56 (AGD84)



- LEGEND**
- () Towns and Localities
 - Proposed Rail Spur
 - Proposed Flood Levee
 - Roads
 - Cadastre
 - Mining Tenements
 - Stage 3 Pit Areas

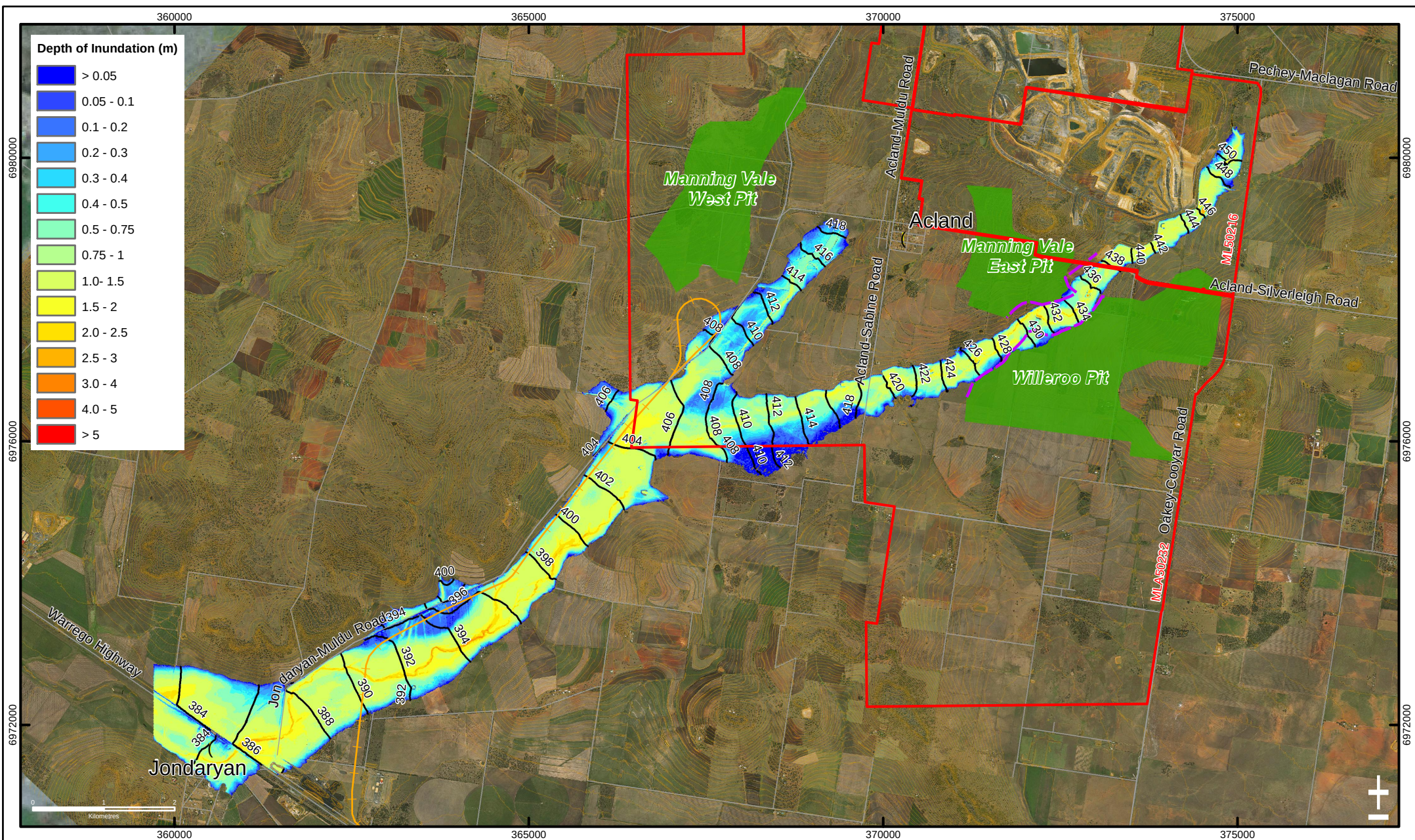


**NEW ACLAND COAL MINE
STAGE 3 PROJECT**

**Figure 5-15 - Existing Peak Flood
Velocity 1 in 100 AEP**

Scale 1:70,000 on A4
Projection: Australian Geodetic Datum - Zone 56 (AGD84)

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- LEGEND**
- () Towns and Localities
 - Water Surface Level (m AHD)
 - Proposed Rail Spur
 - Topographical Contours (2m interval)
 - Proposed Flood Levee
 - Mining Tenements
 - Roads
 - Stage 3 Pit Areas

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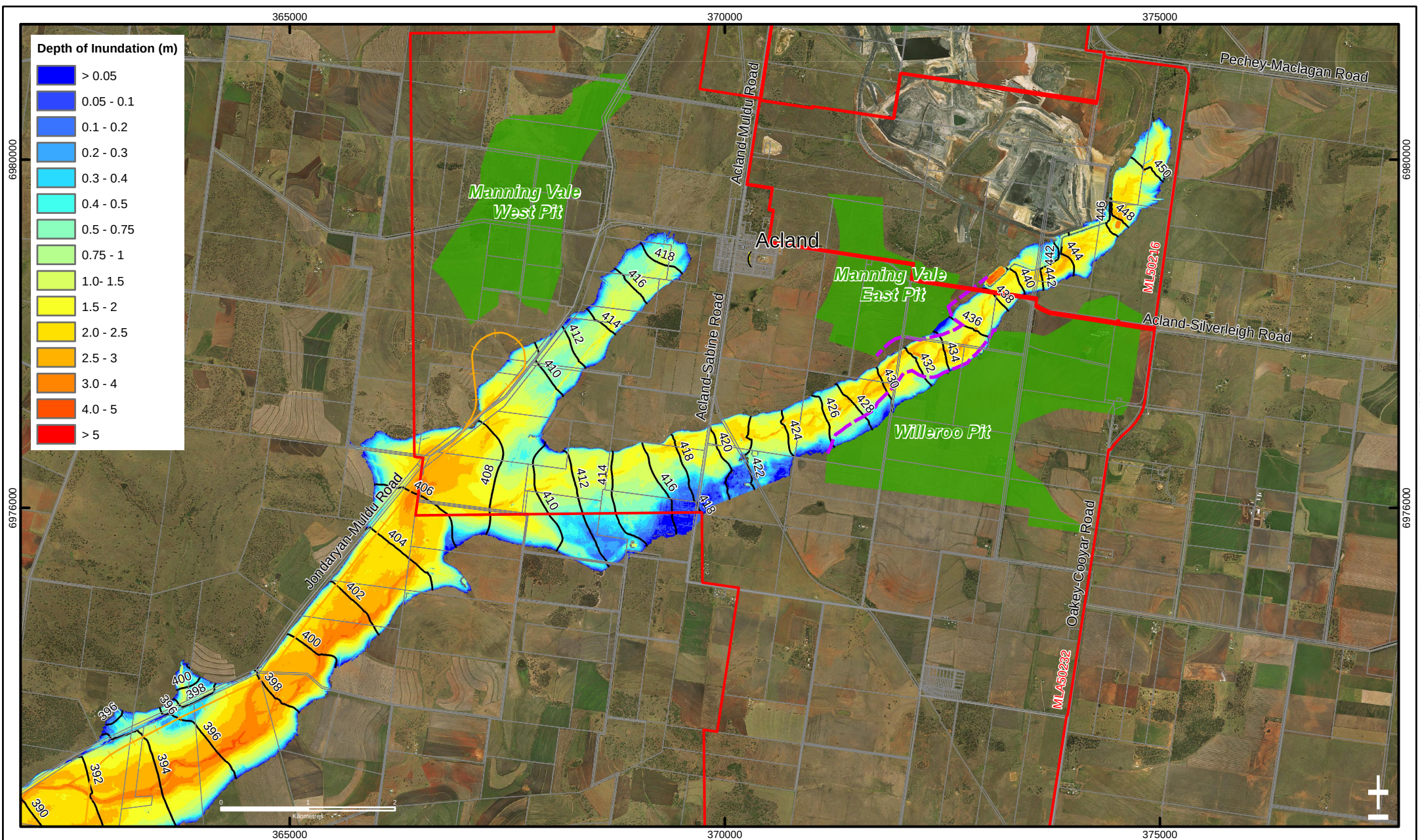
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STAGE 3 PROJECT**

**Figure 5-16 - Existing Peak Flood
Depth 1 in 1000 AEP**

Scale 1:70,000 on A4
Projection: Australian Geodetic Datum - Zone 56 (AGD84)

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LEGEND

() Towns and Localities	▭ Cadastre
— Proposed Rail Spur	▭ Mining Tenements
— Proposed Flood Levee	▭ Stage 3 Pit Areas
— Roads	

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STAGE 3 PROJECT**

Figure 5-17 - Existing Peak Depth PMF

Scale 1:57,000 on A4
Projection: Australian Geodetic Datum - Zone 56 (AGD84)

5.11 Developed Flooding Characteristics

Flood modelling of the developed conditions for the proposed mining activities was undertaken to determine the flood protection strategy for the revised Project and to assess potential impacts on flooding caused by the revised Project. Flood impacts are discussed in **Section 5.11.3**.

5.11.1 Model Area and Terrain Development

Terrain for the developed condition was created from the existing bathymetry, discussed in **Section 5.10.1**. Modifications were made to the existing terrain to add the:

- flood levees along the Manning Vale East and Willeroo pits; and
- rail spur and balloon loop.

The flood levees were modelled as an infinitely high wall to ensure it provided flood immunity for all modelled cases. No functional elements of the revised Project are proposed to be located between the levee and Lagoon Creek, except for one dedicated creek crossing for coal haulage to the CHPP from the Willeroo resource area.

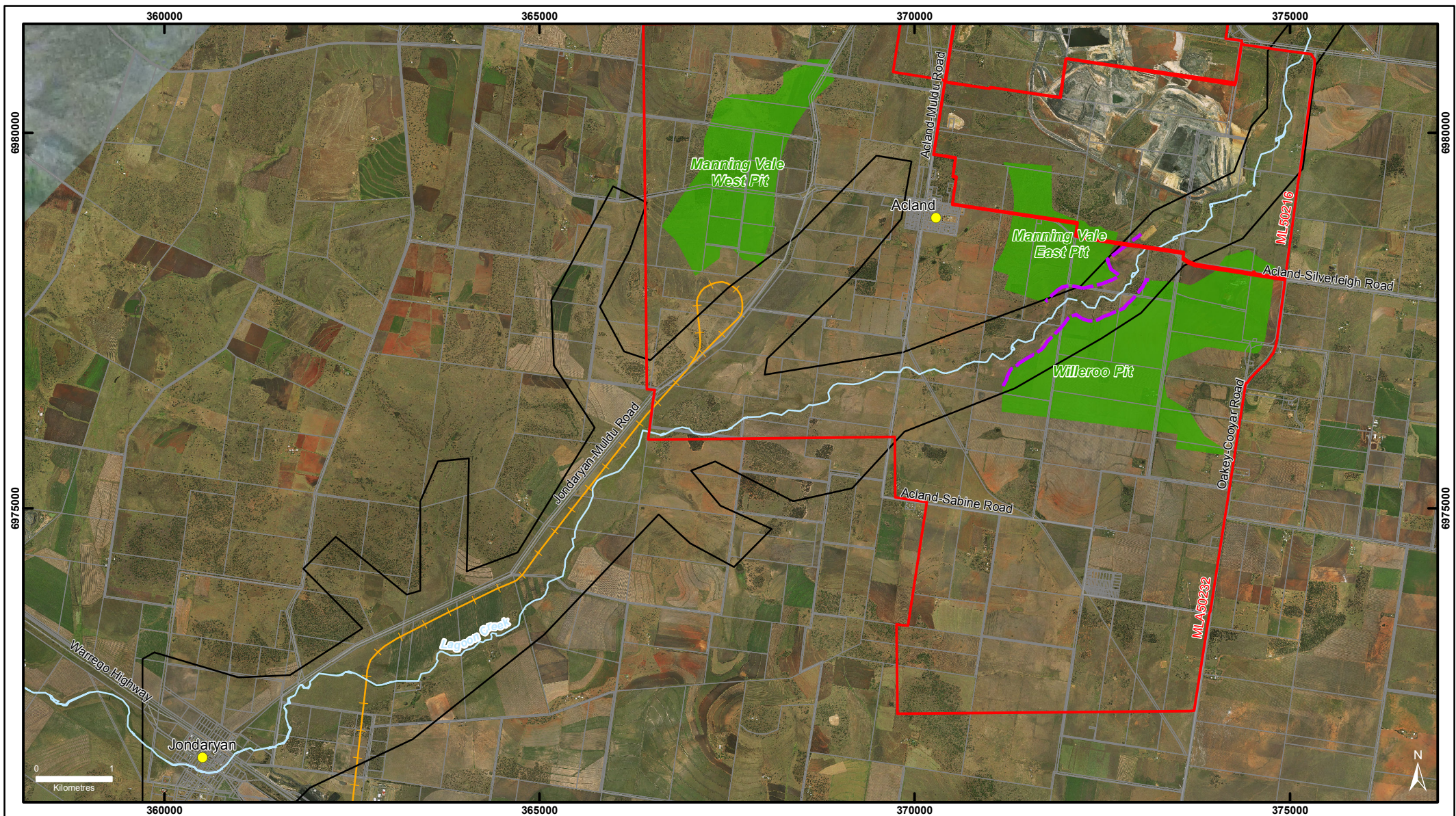
Maximum flood heights along this wall were extracted to obtain the level of the levee banks. The levee banks will be designed to provide a PMF flood immunity with a 0.5 m freeboard in accordance with NHG's design standards for the existing Stage 2 levee. It is noted that this level of protection is higher than the a 1 in 1,000 AEP flood immunity required by the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams*, DNRM, February 2012.

The rail spur and balloon loop alignments and track levels were imported into the model bathymetry to replace existing terrain. Where the rail corridor passed through areas of high flow as identified in the existing case model, a 10 m grid cell was left open to simulate flow through a culvert. A table drain will also be constructed on the northern side of the railway corridor within the rail easement between Jondaryan-Muldu Road. This table drain will convey flows from minor drainage paths north of Jondaryan-Muldu Road south to designated crossings under the railway line. These table drains will be designed so that there is no increase to flood levels on the Jondaryan-Muldu Road as a result of the rail corridor.

The flow through the major crossing of Lagoon Creek adjacent to the existing Jondaryan-Muldu Road was simulated through a 60 m wide grid cell opening. This design is relatively consistent with the existing QR railway crossing at Jondaryan which is approximately 58 m wide.

Two additional flow openings of 60 m each were modelled on the floodplain either side of the main railway crossing to provide additional conveyance of floodplain flows. The maximum flood heights along the railway were extracted to obtain the level of the railway. The railway was designed to provide 1 in 100 AEP flood immunity with a 300 mm freeboard. This approach is consistent with Queensland Rail Design Guidelines. It is noted that the vertical accuracy of the LIDAR is well within the adopted freeboard of both the levee and railway. However detailed ground survey will be undertaken to support the final design of the railway and levee.

The location of these model features incorporated into the hydraulic model are presented in **Figure 5-18**.



LEGEND

- | | |
|------------------------|--------------------------|
| ● Towns and Localities | ▭ Cadastre |
| — Proposed Rail Spur | ▭ Mining Tenements |
| — Proposed Flood Levee | ▭ Stage 3 Pit Areas |
| — Creeks | ▭ Hydraulic Model Extent |
| — Roads | |

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**Figure 5-18 - Developed Flood
Conditions Modelled Infrastructure**

Scale 1:69,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

5.11.2 Model Parameters

Model parameters including Manning's Roughness, boundary conditions and initial conditions remained consistent with those used in the existing conditions model described in **Section 5.10.2**.

Flow constriction cells were modelled at each of the openings along the railway corridor. These flow constriction cells simulate the entrance and exit losses associated with cross drainage structures such as culverts and bridge piers.

5.11.3 Flood Impacts

The results of the developed case flood modelling are presented in **Figure 5-20** to **Figure 5-30**. **Figure 5-25** and **Figure 5-26** present the flood depth and velocity afflux for the 1 in 100 AEP flood event.

Minor increases in flood levels at the location of the flood levee were observed in the order of 0.5 m for the 1 in 1,000 AEP. However, all of these increases are contained within the revised Projects mining lease area. The results indicate only minor changes to flow velocity in the mine area as a result of the flood levees encroaching on the floodplain.

No change in the flood velocity or levels was observed for the 1 in 10 AEP within the revised Project site. This result is because the flood levees are located outside of the 1 in 10 AEP flood extent.

The revised Project's railway crossing of Lagoon Creek results in an increase in flood levels immediately upstream of the railway crossing of up to 1.2 m. However these impacts reduce to zero within 500 m of the railway crossing. The majority of the land impacted by the increased water surface levels is owned by the APC. There is a small parcel of land of approximately 0.5 ha which is likely to be impacted by the revised Project railway crossing, through an increase in water levels of approximately 150 mm over land not previously inundated. NAC are currently in discussions with this land owner regarding this impact and will seek to reduce this impact to zero through detailed design or through a compensation agreement with the land owner.

There is no increase in the extent of inundation or water surface levels on any properties not owned by NAC. Downstream of the new railway crossing there is a minor decrease in flood levels of approximately 0.2 m, a result of the railway embankment which attenuates the flood peak. This decrease in flood level is accompanied by an increase in peak flow velocity immediately downstream of the railway drainage crossings in the order of 0.5 m/s. This velocity increase increases the peak velocities in this area to 1.5 m/s. However, this increase is completely contained within land owned by the Acland Pastoral Company (APC). The need for scour protection at the outlet of the culvert crossing will be assessed and incorporated in the revised Projects detailed design.

Minor increases in flood levels for the 1 in 10 AEP flood event were observed upstream of the railway line in the order of 0.3 m. These impacts are completely contained within land owned by APC.

In events greater than a 1 in 100 AEP flood event the railway line will be overtopped by flood waters. This outcome is also demonstrated in the 1 in 1,000 AEP flood event. However, the railway line attenuates the flood peak such that when the railway overtops the increase in flood levels downstream of the railway line is less than the existing 1 in 1,000 AEP flood depths and extent of inundation. It is

noted that in a 1 in 1,000 AEP, there is a minor increase in flood levels on an adjacent property upstream of the proposed railway line. This increase is less than 300 mm and is contained to a small area of agricultural land in the order of 0.5 ha. This increase is not considered to increase the flood hazard or development potential for this property. As previously discussed, NAC is currently in discussions with this land owner regarding this impact and will seek to reduce this impact to zero through detailed design or through a compensation agreement with the land owner.

As part of the impact assessment changes to the duration of flooding and flood warning were examined for Jondaryan. **Figure 5-19** illustrates the design flood hydrograph exported from the TUFLOW flood model under existing and developed conditions. **Figure 5-19** illustrates that there is actually a very minor increase in the time prior to the flood peak as a result of the revised Project. This result is due to the attenuation of the flood peak through the railway crossings. It is therefore considered that the revised Project will not have significant impacts on the flood warning in Jondaryan.

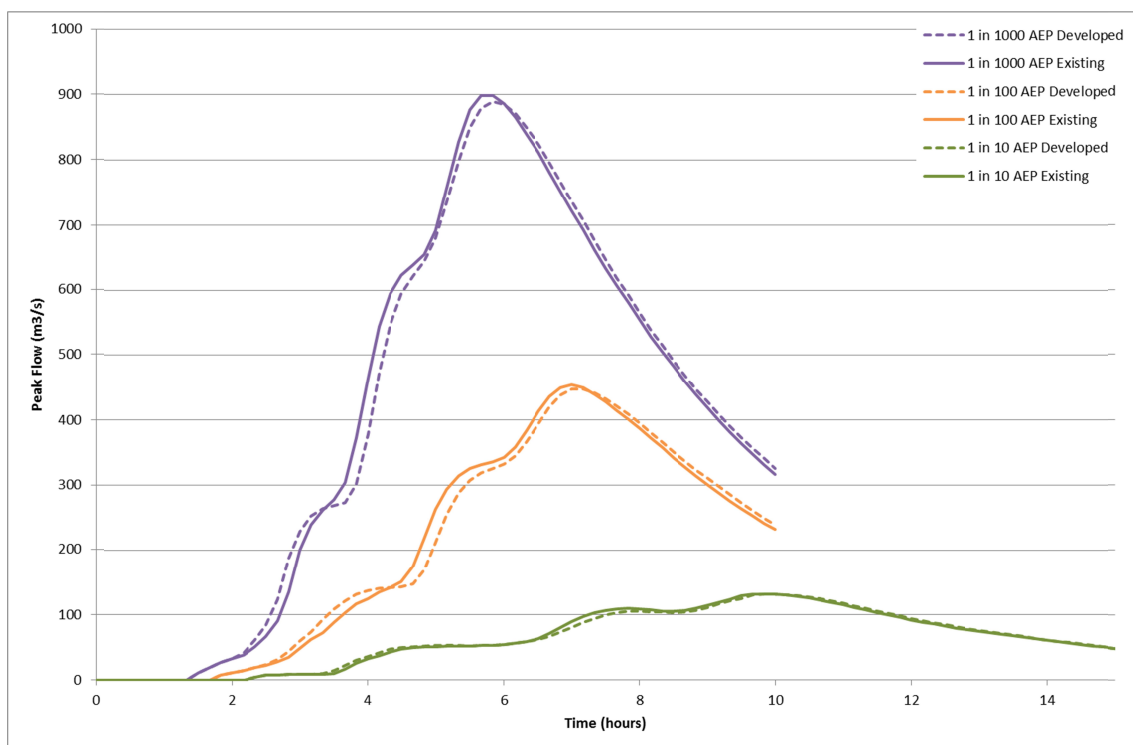
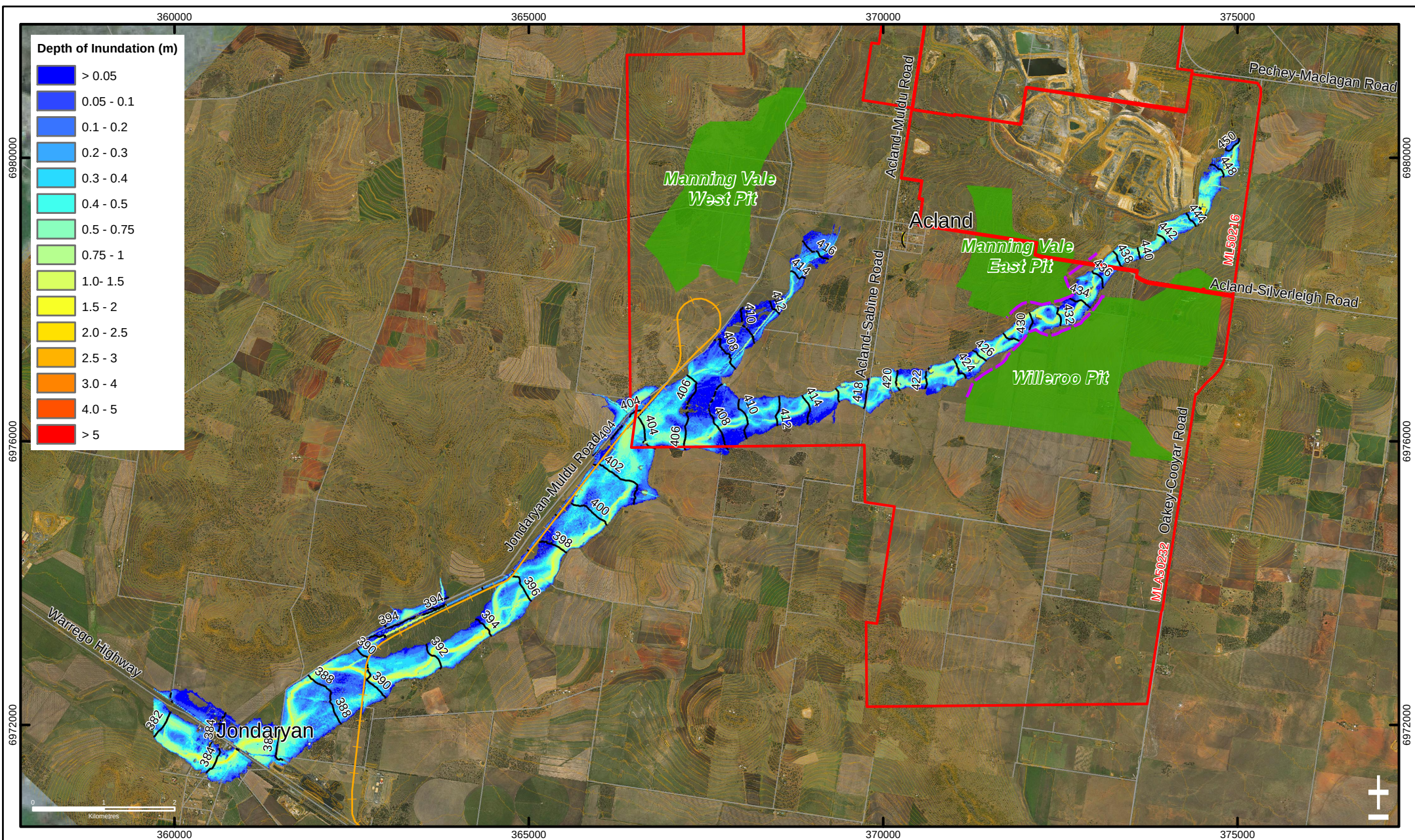


Figure 5-19 Peak Flood Warning Jondaryan

The flood modelling evaluation discussed above is based only on conceptual design parameters. The levee alignment, freeboard, civil and geotechnical design will be revised through the detailed design phase of the revised Project. However, any refinements made during detailed design will not exceed the level of impact detailed in this Chapter. Construction of the levees is detailed in **Section 3.7.12** of **Appendix J.19**.

The township of Oakey is located upstream of the Lagoon Creek and Oakey Creek confluence on a separate tributary to that of Lagoon Creek. Therefore as no impacts are predicted at Jondaryan there will be no flooding impacts at the township of Oakey. Similarly Acland is located approximately 1 km outside of the floodplain of a minor tributary of Lagoon Creek, and as such the revised Project will not have any impacts on flooding in Acland.





LEGEND

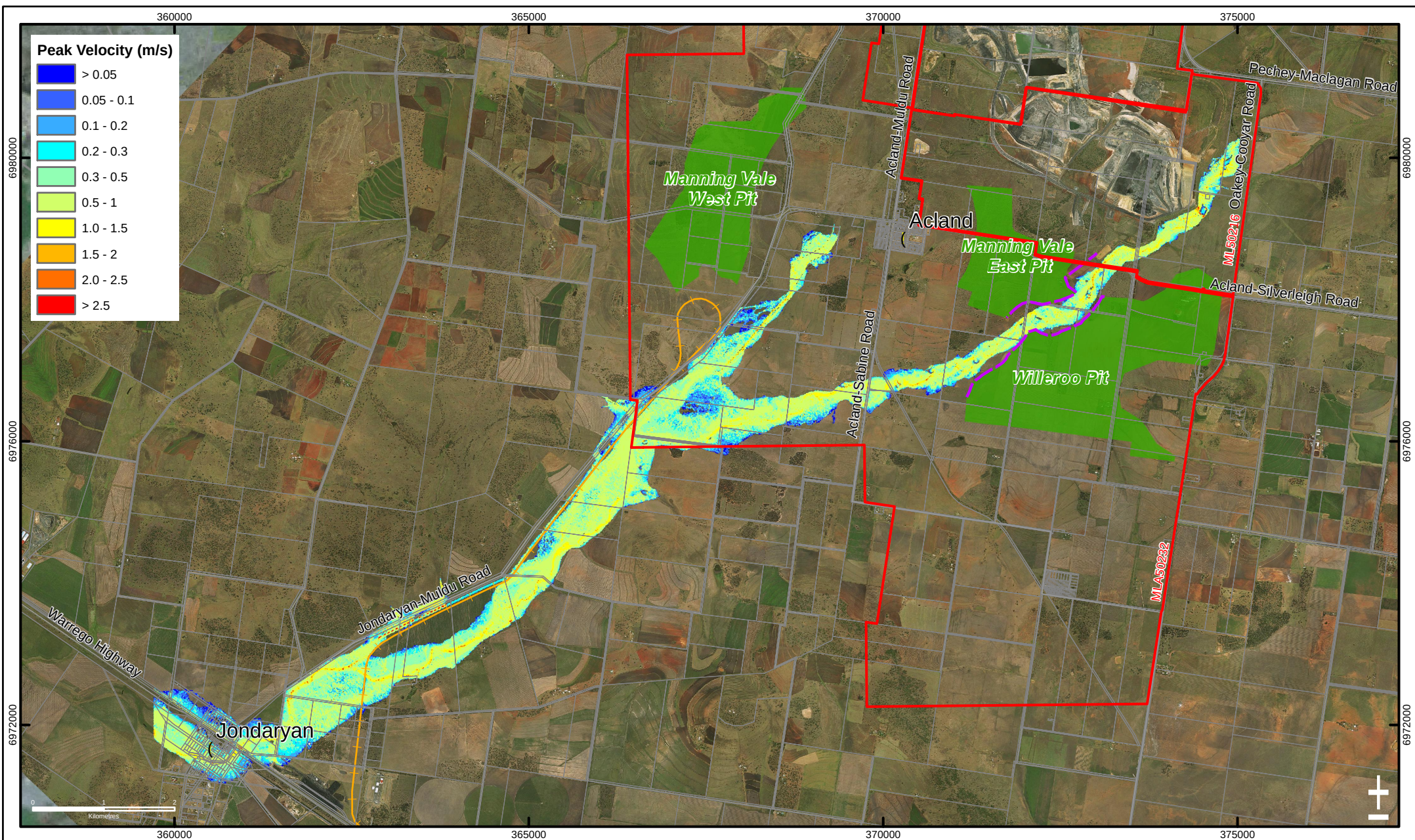
- | | |
|--------------------------|---------------------|
| () Towns and Localities | □ Cadastre |
| — Proposed Rail Spur | □ Mining Tenements |
| — Proposed Flood Levee | ■ Stage 3 Pit Areas |
| — Roads | |



NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 5-21 - Afflux 1 in 10 AEP

Scale 1:70,000 on A4
Projection: Australian Geodetic Datum - Zone 56 (AGD84)



LEGEND

- (Towns and Localities
- + Proposed Rail Spur
- Proposed Flood Levee
- Roads
- Cadastre
- Mining Tenements
- Stage 3 Pit Areas

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Figure 5-22 - Developed Peak Flood
Velocity 1 in 10 AEP

Scale 1:70,000 on A4
Projection: Australian Geodetic Datum - Zone 56 (AGD84)



LEGEND

- Towns and Localities
- Cadastre
- Proposed Rail Spur
- Mining Tenements
- Proposed Flood Levee
- Stage 3 Pit Areas
- Roads

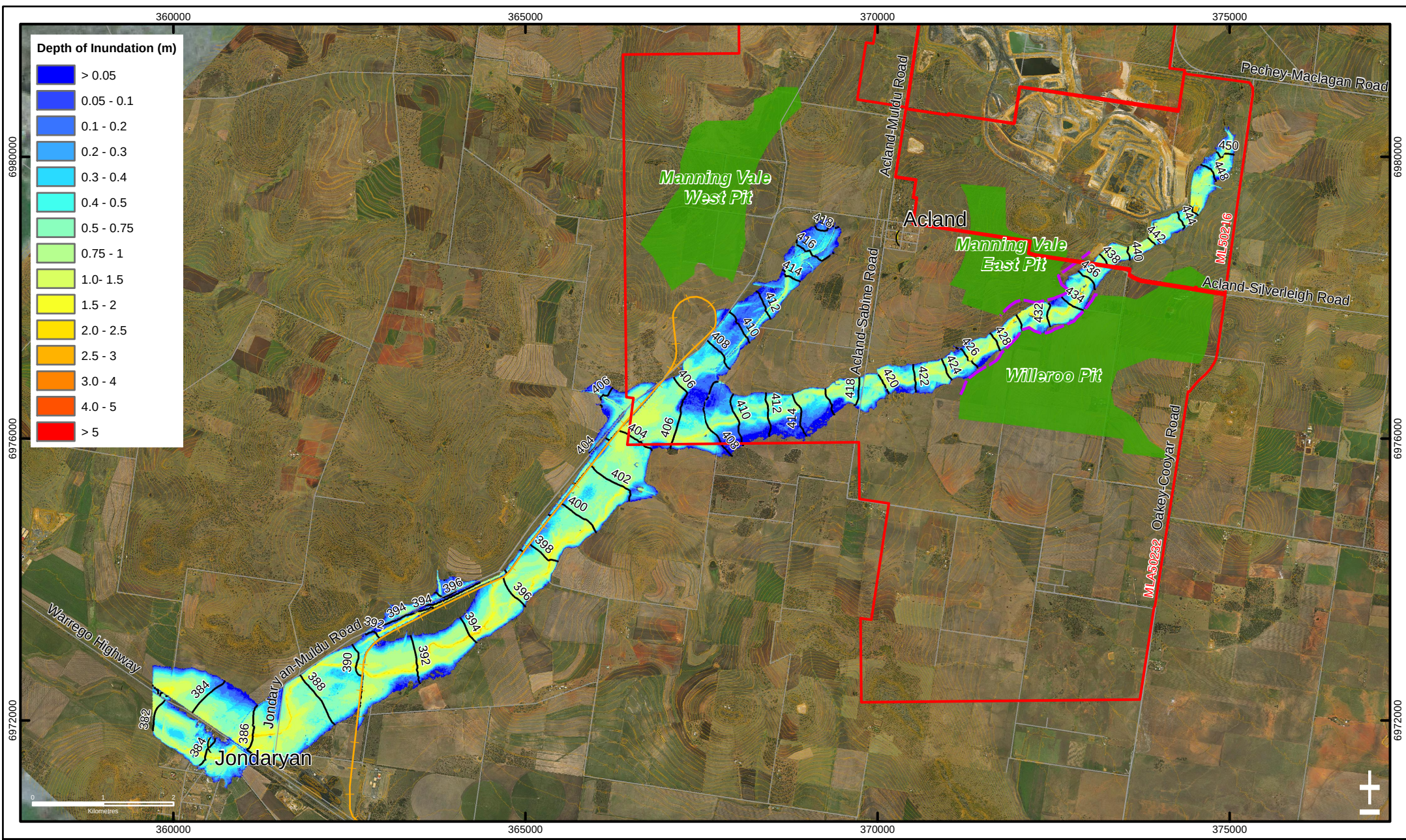
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NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 5-23 - Velocity Afflux 1 in 10 AEP

Scale 1:70,000 on A4
Projection: Australian Geodetic Datum - Zone 56 (AGD84)



**NEW ACLAND COAL MINE
STAGE 3 PROJECT**

**Figure 5-24 - Developed Peak Flood
Depth 1 in 100 AEP**

Scale 1:70,000 on A4
Projection: Australian Geodetic Datum - Zone 56 (AGD84)

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Produced: 9/02/2014



LEGEND

- () Towns and Localities
- Proposed Flood Levee
- + Proposed Rail Spur
- Roads
- ▭ Cadastre
- ▭ Mining Tenements
- ▭ Stage 3 Pit Areas

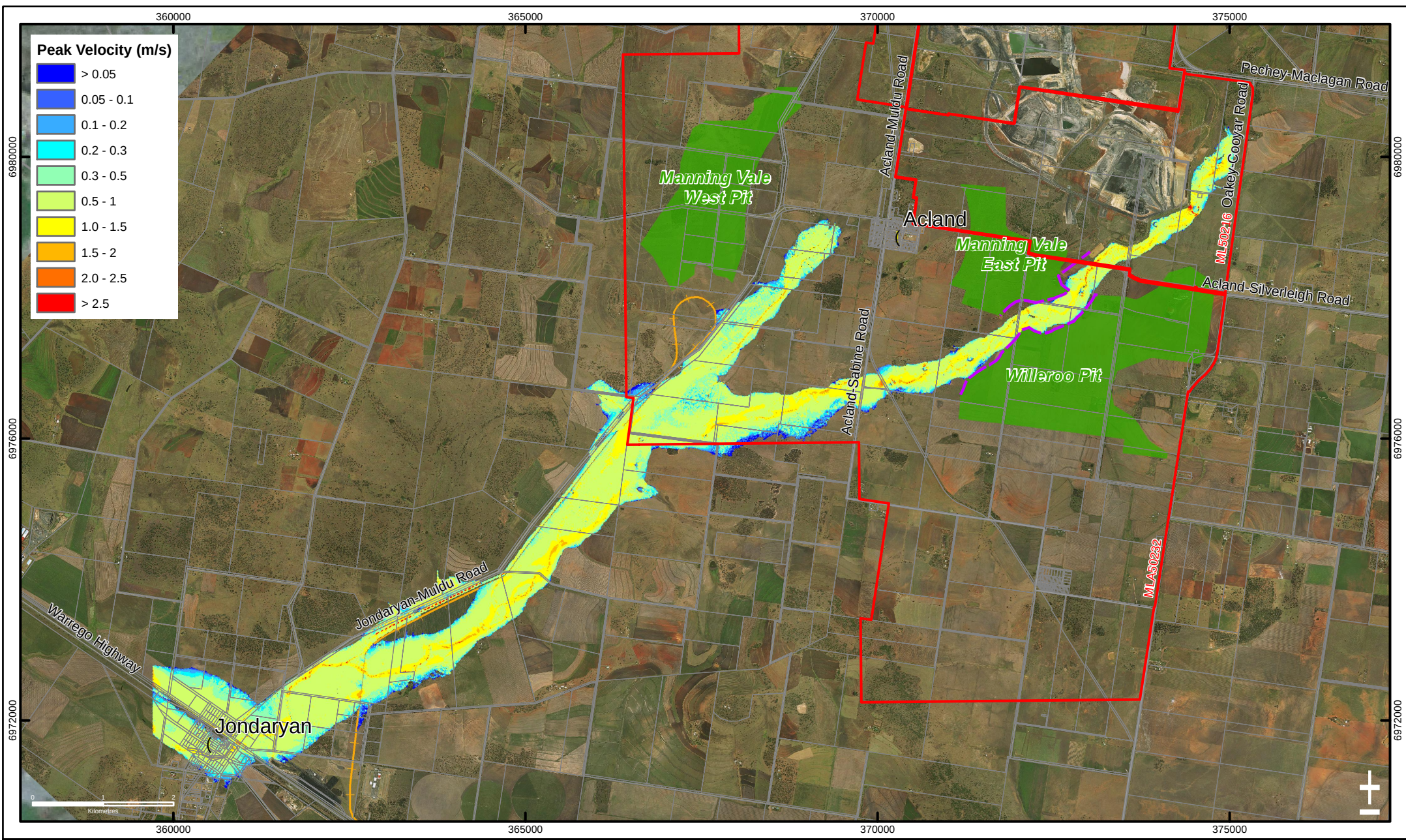


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STAGE 3 PROJECT**

Figure 5-25 - Afflux 1 in 100 AEP

Scale 1:70,000 on A4
Projection: Australian Geodetic Datum - Zone 56 (AGD84)

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- LEGEND**
- () Towns and Localities
 - + Proposed Rail Spur
 - Proposed Flood Levee
 - Roads
 - Cadastre
 - Mining Tenements
 - Stage 3 Pit Areas

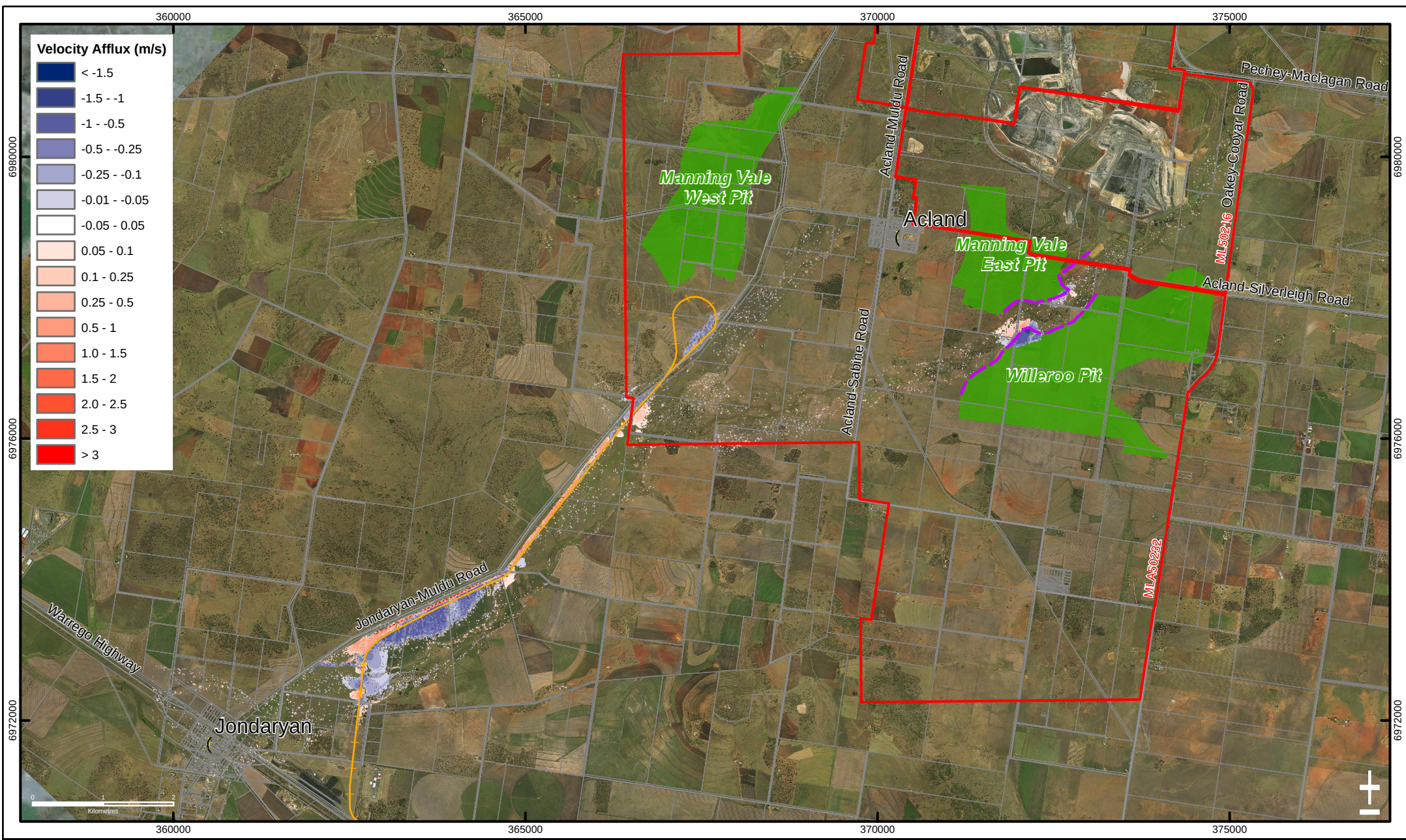


**NEW ACLAND COAL MINE
STAGE 3 PROJECT**

**Figure 5-26 - Developed Peak Flood
Velocity 1 in 100 AEP**

Scale 1:70,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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LEGEND

- (Towns and Localities
- + Proposed Rail Spur
- Proposed Flood Levee
- Roads
- Cadastre
- Mining Tenements
- Stage 3 Pit Areas

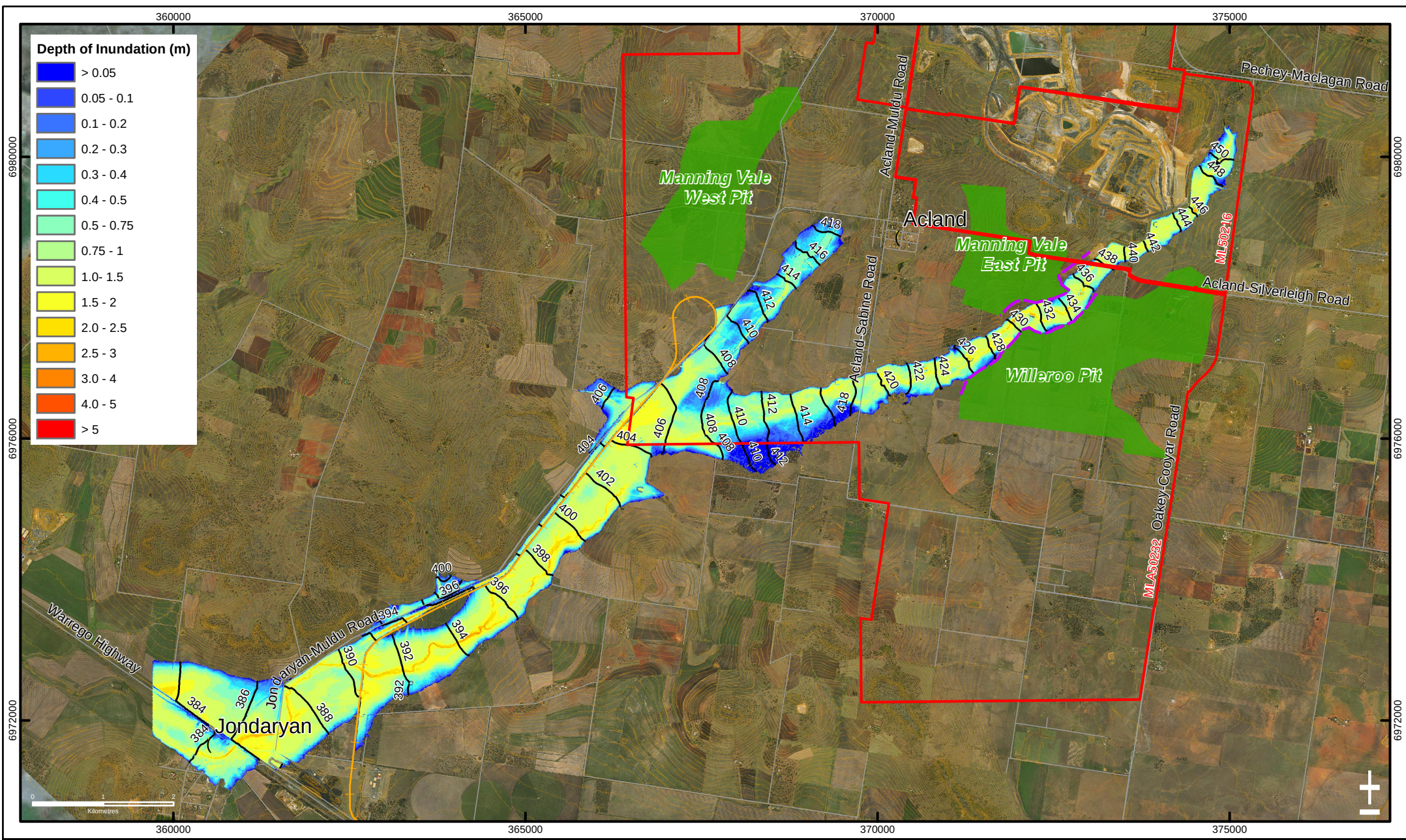
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Figure 5-27 - Velocity Afflux
1 in 100 AEP

Scale 1:70,000 on A4
Projection: Australian Geodetic Datum - Zone 56 (AGD84)



- LEGEND**
- () Towns and Localities
 - Water Surface Level (m AHD)
 - Proposed Rail Spur
 - Topographical Contours (2m interval)
 - Proposed Flood Levee
 - Mining Tenements
 - Roads
 - Stage 3 Pit Areas



**NEW ACLAND COAL MINE
STAGE 3 PROJECT**

**Figure 5-28 - Developed Peak Flood
Depth 1 in 1000 AEP**

Scale 1:70,000 on A4
Projection: Australian Geodetic Datum - Zone 56 (AGD84)

Produced: 9/02/2014 Path: I:\QB\NZP\Project\QED\664\Spatial\ArcGIS\01_Figures\01_SEIS\02_SurfaceWaterResources_Figures\28_DevelopedPeakFloodDepth_1in1000AEP_A4.mxd



- LEGEND**
- () Towns and Localities
 - + Proposed Rail Spur
 - Proposed Flood Levee
 - Roads
 - Cadastre
 - Mining Tenements
 - Stage 3 Pit Areas

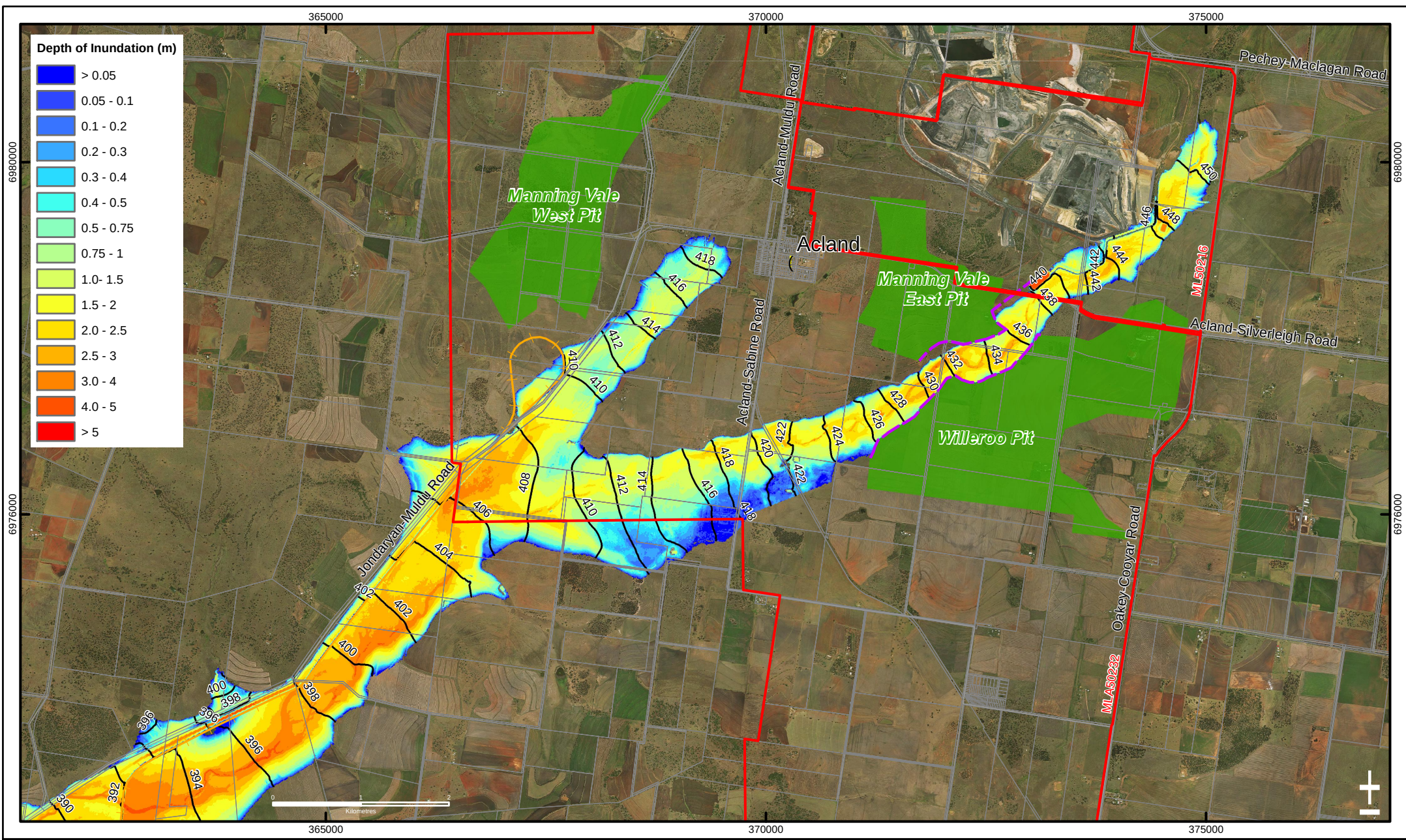


**NEW ACLAND COAL MINE
STAGE 3 PROJECT**

Figure 5-29 - Afflux 1 in 1000 AEP

Scale 1:70,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 9/02/2014 Path: I:\QB\NZ\Projects\QED\66445\patial\ArcGIS\01_Figures\01_SEIS\02_SurfaceWaterResources\4\Figures\1311111_NewHope_SurfaceWaterResources_Figures-29_DepthAfflux_1in1000AEP_A4.mxd



LEGEND

- () Towns and Localities
- Water Surface Level (m AHD)
- + Proposed Rail Spur
- Cadastre
- Proposed Flood Levee
- Mining Tenements
- Roads
- Stage 3 Pit Areas



**NEW ACLAND COAL MINE
STAGE 3 PROJECT**

**Figure 5-30 - Developed Peak
Depth PMF**

Scale 1:56,000 on A4
Projection: Australian Geodetic Datum - Zone 56 (AGD84)

Path: I:\QB\NZP\Project\QED\6645\Spatial\ArcGIS\01_Figures\01_SEIS\02_SurfaceWaterResources\44\Figures\131111_NewHope_SurfaceWaterResources_Figures\50_DevelopedPeakFloodDepth_PMF_A4.mxd

5.12 Final Landform Flood Protection

NAC have committed to design the revised Project's final landform so that any depressions and or hills are located outside the PMF flood extent. **Figure 5-30** illustrates the PMF flood extent in the vicinity of the revised Project. **Figure 5-30** shows that the existing site is predominantly not affected by flooding in the PMF event. Similarly, the currently proposed depressed landform locations are generally not affected by the PMF. Further refinement of the depressed landform locations through detailed design and mine planning will ensure that the depressed landform locations are not affected by the predicted PMF. As a result, there are no flood impacts predicted for the revised Project's final landform.

The final landform will contain water at its lowest point due to inflows from groundwater inflows. Modelling of the groundwater inflows including consideration for rainfall and evaporation is presented in **Chapter 6** Groundwater. **Chapter 6** also includes a discussion on water quality within the final landform. Water in the final landform will be located over 50 m below natural surface level and as a result there is no risk of contamination of other surface waters from groundwater inflows to the final landform.

5.13 Site Water Management

The philosophy of the water management strategy is to provide adequate water to the revised Project site to operate successfully while minimising environmental impacts by collecting and managing dirty runoff water. The Mine's water management system is based on the following key principles:

- where possible, stormwater runoff from undisturbed areas both on and surrounding the revised Project site will be diverted away from disturbed areas and released directly into adjacent waterways.
- disturbed area runoff will be captured in sediment dams and used preferentially for dust suppression or as process water in the CHPP.
- water will be recycled from the IPTSFs to supplement the water supply for coal washing.
- mine-affected water will be treated through settling in sedimentation basins and/or oil-water separators to allow as required discharges off-site that comply with the revised Project's EA.
- recycled water from the TRC's WWRF is pumped to the site as the main operational water supply.
- Shallow groundwater bores will be treated to supply potable water for human use.
- infrastructure and mining areas will be protected from flooding using flood levees.
- all significant quantities of hydrocarbon and chemical products stored on site will be stored in temporary or permanent bunding.
- spill capture and retention devices will be used for refuelling and similar areas.
- oily water areas will be captured and treated using an oil-water separator.
- progressive rehabilitation will be employed to revegetate disturbed areas no longer required for operational use. .

5.13.1 Components of the Water Management System

The revised Project's water management system will, in its initial stages, operate in conjunction with the Mine water management system. As a result, the water management strategy for the revised Project will utilise existing water management infrastructure designed and constructed as part of the Mine. The key components of the mine water management system are the:

- WWRF pipeline;
- process water dams;
- environmental dams;
- sedimentation dams; and
- tailings dams.

Where practical, the stormwater runoff from clean, undisturbed catchments will be diverted around disturbed areas using bunds and channels and released directly into adjacent gullies and waterways. Rainfall runoff from disturbed areas including un-rehabilitated spoil areas will be collected. Spoil area runoff will report to sediment and environmental water dams for treatment before potential release off site. Water that reports to a mine pit floor will be pumped to environment dams and stored for use to supplement the revised Project's water demands for activities, such as dust suppression.

The sections below outline the purpose of each component of the water management system. The operation of the existing water management system is described in detail in **Chapter 3**. The operation of the revised Project water management system is discussed in **Section 5.13.4**.

Water Supply

The Mine has secured a water supply allocation of up to 5,650 ML/year. The major source of this allocation is via a long term contract to the year 2055 with the TRC that allows the purchase of up to 5,500 ML per annum of Class A+ recycled water from the WWRF. The duration of this supply contract is well beyond the projected life of mine. This water supply option represents a beneficial use of a wastewater product and has eliminated the Project's reliance on deep sourced groundwater from the Great Artesian Basin. **Chapter 3** outlines the details with regard to the TRC's WWRF agreement with the NHG.

Process Water Dams

Water from the WWRF is supplied to the revised Project site via a pipeline and delivered to the Process Water Dam (PWD) 1 within the Mine site. Water from PWD 1 will be balanced with PWD 2 and will supply the revised Project's new CHPP 3.

The process water dams are used to supply process water to the CHPPs. The process water dams also aid in the management and segregation of clean and dirty water at the revised Project site. The process water dams generally do not have a local catchment and will only receive clean water inflows from the WWRF pipeline, recycled water from the mine water management system, direct rainfall and recycled brine water in small periodic quantities from the Oakey Reverse Osmosis Water Treatment Plant. Water that has been settled in the sediment dams and tailings storage facilities can be transferred to the process water dams to maximise sediment dam capacity providing optimal storage volume for flood events.

Environment Dams for Pit Water Storage

The new mining areas of Manning Vale East and Manning Vale West and Willeroo are located within the upper sections of the Lagoon Creek catchment. As a result, the area of undisturbed or disturbed catchment upstream of the pits is minimal. The majority of water that collects on the site accumulates in the pits as a result of direct rainfall runoff and groundwater infiltration from in situ strata (high wall) and backfilled areas (low wall). Water that collects in the mine pits will be captured in small temporary sumps where it is used for dust suppression activities. During high rainfall periods, excess pit water will be pumped to sedimentation dams for eventual use by the CHPP Precinct. Three additional environment dams will be constructed for the revised Project's Manning Vale East, Manning Vale West and Willeroo resource areas. These dams will be constructed in close proximity and on the downstream edge of the pit to minimise pumping costs.

Rainfall runoff from the two out of pit spoil dumps at the Manning Vale West and Willeroo mine pits will be captured in sediment dams with any overflows diverted to the environment dams via diversion bunds. The placement of these bunds will be determined through the detailed mine planning and will change as the mine pit progresses. As the disturbed area is in the upper parts of the catchment and the out of pit dump areas are relatively small, the environment dams will manage a relatively small catchment area. As a result inflows to the environment dams can be largely controlled through the pump rates from the adjacent pit.

A controlled release system is proposed from the new Environment Dams. The purpose of the controlled releases is to allow relatively clean water from a significant rainfall event to be removed from the site, rather than collected in the pits and increase in salinity through evaporation. This controlled release system will also assist in minimising the revised Project's impacts to flows in Lagoon Creek. The controlled release system will be based on specific water quality targets. The NHG's plans regarding how it will carefully manage pit water to ensure controlled discharges of treated water off site is further discussed in **Section 5.13.4**.

The environmental dams are normally located downstream of existing sedimentation and raw water dams. The environmental dams provide additional storage and treatment for water in significant rainfall events and mitigate against uncontrolled releases to the downstream environment. As is currently practised, water captured by the environmental dams will be used to supplement the revised Project's water requirements. This practice is employed to maximise the EDs storage capacity and reduce the risk of off-site discharges. Water may also be transferred from the sediment dams to the environmental dams to maintain the optimum operating level for the sediment dams. The placement of the environmental dams will require consideration of the mine pit progression and will be finalised through the detailed mine planning.

Sediment Dams

Sediment Dams will be required to entrap soil and other particles eroded from moderately disturbed areas due to rainfall runoff within the revised Project's site. The Mine area currently employs Sediment Dams 1 and 2. As required, new Sediment Dams will be constructed for the revised Project's Manning Vale West, Manning Vale East and Willeroo resource areas.

Typically, the Sediment Dams will receive rainfall runoff from out-of-pit dumps that are being progressively rehabilitated or areas disturbed by clearing and access tracks. These dams will also provide additional emergency storage for water captured in the revised Project's operational mining

pits by direct rainfall or groundwater infiltration. Water from the Sediment dams will also be used preferentially for dust suppression and as appropriate to supplement the CHPP Precinct's process water demands.

Sediment Dams will be designed to provide enough storage volume to capture a 24 hr 10 yr ARI storm event for sufficient time to settle 0.05 mm diameter (course silt) particles; and maximise the length of the dam relative to the width of the dam to maximise hydraulic retention time and deposition. The placement of the Sediment Dams will require consideration of the mine pit progression and will be finalised through the detailed mine planning. Bunding and or catch drains will be used to direct runoff into sediment dams and or overflows from the sediment dams. These bunds and / or catch drains will be incorporated into the mine pit progression. This will minimise the site's reliance upon pumping infrastructure.

Tailings Dams

The current tailings strategy that is being utilised on-site involves progressive construction of in-pit tailings cells as part of the dump design. This approach will continue to be practised as the preferred option for the revised Project. The tailings storage facilities currently on site or proposed for development will possess sufficient capacity to hold the tailings produced by the revised Project. This tailings management scenario is discussed further in **Chapter 3**.

Summary of Mine Water Management Infrastructure

Table 5-14 and **Figure 5-31** provide a summary of the current and proposed mine water management infrastructure for the revised Project.

Table 5-14 Summary of Mine Water Management System Storages

Structure	Size	Location
Existing Water Management Infrastructure		
Environmental Dam 1	126 ML	Northwest mining lease boundary area (ML50170).
Environmental Dam 2	232 ML	Downstream of the tailings dam, southwest mining lease boundary area (ML50170).
Environmental Dam 3	45 ML	Southern mining lease boundary (ML50216)
Environmental Dam 4*	110 ML	Southwest mining lease boundary area (ML50216), captures surface water runoff from the centre pit's disturbance area.
Sediment Dam 1	97 ML (including 16 ML of sediment)	Near the product coal haul road exit, western mining lease boundary area (ML50170).
Sediment Dam 2	62 ML	Near the South Pit's out-of-pit dump (ML50216)
Process Water Dam 1	136 ML	North of the main administration area, adjacent the main access to the Mine (ML50170).
Process Water Dam 2	175 ML	Immediately east of Process Water Dam 1 (ML50170)
Tailings Dam (Out-of-pit) TSF 1 – Stage 1 & 2	2,550 ML (of tailings)	Western mining lease boundary area (south of the RoM stockpile area) (ML 50170). – Stage 1 is under rehabilitation.

Structure	Size	Location
Existing Water Management Infrastructure		
Tailings Dam (In-pit) IPTSF 1	2,800 ML (of tailings)	Within the North Pit (ML 50170)
Tailings Dam (In-pit) IPTSF 2-1	3,320 ML (of tailings)	Within the North Pit (ML 50170)
Tailings Dam (In-pit) IPTSF 2-2	3,400 ML (of tailings)	Within the North Pit (ML 50170)
Tailings Dam (In-Pit) TSF 3	TBA (under construction)	Within the Centre Pit (ML50216)
Return Water Dam	300 ML	Upstream of Environmental Dam 2, western mining lease boundary area (ML50170).
Lagoon Creek Flood Bund	Approx. 3 m high and 3 km in length	Between Lagoon Creek and the South Pit area (ML50216).
Revised Project Water Management Infrastructure		
Environment Dam 5 Manning Vale West	250 ML	Southwest of Manning Vale West final pit extent
Environment Dam 6 Manning Vale East	250 ML	South of Manning Vale East final pit extent
Environment Dam 7 Willeroo	350 ML	Southeast of Willeroo final pit extent
Sediment Dam 3 Manning Vale East Pit	160 ML	North of Manning Vale East Pit
Sediment Dam 4 Willeroo Pit	130 ML	North of Willeroo Pit
Lagoon Creek Flood Levee 2	Approximately 3.5 m high and 1.5 km in length	Between Lagoon Creek and the Manning Vale East Pit area
Lagoon Creek Flood Levee 3	Approximately 3.5 m high and 2 km in length	Between Lagoon Creek and the Willeroo Pit area

*will become Sediment Dam 5 in the revised project.



LEGEND

- Towns and Localities
- ▲ Existing Release Point
- ▲ Proposed Release Point
- Existing Dam**
- Environment Dam (ED)
- Raw Water (RW)
- Proposed Dams
- Roads
- Creeks
- Jondaryan-Muldu Road Diversion
- Mining Tenements
- Stage 3 Pit Areas

NEW HOPE GROUP

SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 5-31 - Location of Water Management Structures

Scale 1:62,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

5.13.2 Legislative Context

This Section details the Queensland legislation relating to storages and dams on mine sites in Queensland relevant to the revised Project.

The Water Supply (Safety and Reliability) Act 2008 (WSSR Act) sets out the requirements for *referable dams*. Generally, these requirements relate to dams that exceed certain height and volume criteria, or have a population at risk if there were to fail. A dam that contains *hazardous waste* is not necessarily considered a *referable dam* under these guidelines.

The EP Act outlines the procedures for the authorisation of dams or levees constructed as part of an ERA. This is outlined in the guideline titled “*Structures which are dams or levees constructed as part of environmentally relevant activities*” (EHP, 2013). This guideline requires a hazard assessment to determine if a storage is considered as a regulated structure for the purpose of the authority. Storages are generally described as regulated if they contain mine water with contaminant concentrations that exceed published acceptance criteria or if the dam were to fail or overflow, that it would detrimentally affect the environment, people or water for human or stock consumption. Storages assessed as *Significant Hazard* or *High Hazard* are classified as *regulated dams*. *Regulated Dams* must be licensed by DNRM, and for the revised Project’s EA, must be designed according to guidelines set out in the manual and inspected annually by a suitably qualified professional.

Release of potentially contaminated water to a receiving water body is governed by the EPP (Water).

5.13.3 Licensing Water Management Infrastructure

The Environment Dams will receive pit water, and therefore, are likely to contain contaminant concentrations (salinity) that will exceed the guidelines. As a result, it is anticipated that the three new Environment Dams will be classified as *regulated structures* and will need to be designed and licensed accordingly. The proposed Lagoon Creek flood protection levee will also require licencing as a *regulated structure*.

The remaining dams on site will contain either raw water or spoil run-off, and therefore, are not expected to be considered *regulated structures* because they are unlikely to exceed the specified water quality guidelines. These dams will also be small and will not trigger the criteria to be classed as *referable dams* under the WSSR Act (i.e. based on the planned capacity and wall heights, and the low risk to populations downstream in the event of failure). During the development of the revised Project, should a referable dam be required, appropriate assessment and approvals will be sought. **Table 5-15** outlines the preliminary dam hazard classification for the revised Project.

Table 5-15 Preliminary Dam Hazard classification

Storage	Scenario	Hazard Category	Overall Hazard Category	Comments
Sediment Dams	Failure to Contain	Low	Low	Low volume of water, no downstream infrastructure, population at risk or significant environmental values.
	Dam Break	Low		
	Contaminate	Low		
Environment Dams	Failure to Contain	Significant	Significant	Large volume of water of potentially poor water quality (saline). Location is such that people are routinely present, loss of life or harm is possible but not expected.
	Dam Break	Significant		
	Contaminate	Significant		

A licensed release point will be required from the Environment Dams for controlled releases to Lagoon Creek. Conditions for these controlled releases will be incorporated into the Project's EA. The proposed release conditions are discussed further in **Section 5.13.4**. In lieu of guidelines specific to the Condamine Catchment, these draft conditions have been developed with reference to EHP's *Final Model Conditions for Coal Mines in the Fitzroy Basin* (EHP, 2013) and are consistent with the outcomes of the *Study of Cumulative Impacts on Water Quality of Mining Activities in the Fitzroy Basin Report* (DERM 2009), which provide the most recent industry guidelines for controlled mine water releases.

Information on the environmental objectives and ecological condition of the downstream receiving environment is presented in **Section 5.5**. Information on the likelihood of controlled releases is presented in **Section 5.13.4** below and the potential impacts on the downstream receiving environment are presented in **Chapter 8**. The revised Project will not require additional licensing for waterway diversions as there are no diversions planned.

5.13.4 Water Balance Modelling

Methodology

The performance of the revised Project's water management system was assessed using the modelling software program GoldSim. GoldSim is a software package developed by the GoldSim Technology Group to model continuous systems and has the ability to track the movement of water with time based inputs and operating rules.

The water balance model was established at a daily resolution and developed to predict the operation of the Mine's current and proposed water management system. The results of the water balance illustrate the revised Project's capacity to manage weather extremes over the mine's life. The objectives of the mine water balance are to:

- control the release of water from the storages so that that releases occur in a manner that minimises impacts upon downstream users and the environment;
- manage dam storages so that they maintain water to the operation of the revised Project;
- maximise pit operability through bunding and transferring water to sedimentation dams; and
- control and manage the separation and use of clean and dirty water.

The water balance model was developed from a schematisation of the water management system, based on the component descriptions outlined in **Section 5.13.1** and based on the mine sequence plans illustrated in **Chapter 3**. The water balance model schematisation is illustrated in **Figure 5-32**.

Climate Inputs

The water balance model was based on a probabilistic rainfall generation. The purpose of the probabilistic rainfall generation is to develop a range of climate sequences for the life of the revised Project based on the recorded historical rainfall data of the Study area. The probabilistic rainfall data was generated from recorded historical data using the Stochastic Climate Library for 500 replicates over 15 year sequences of daily rainfall data. This method allows assessment of a wide range of rainfall sequences which may be experienced over the life of the revised Project and the calculation of a range of exceedance probabilities. Evaporation from the site was determined based on monthly averages as recorded at gauge 041359 Oakey Aero.

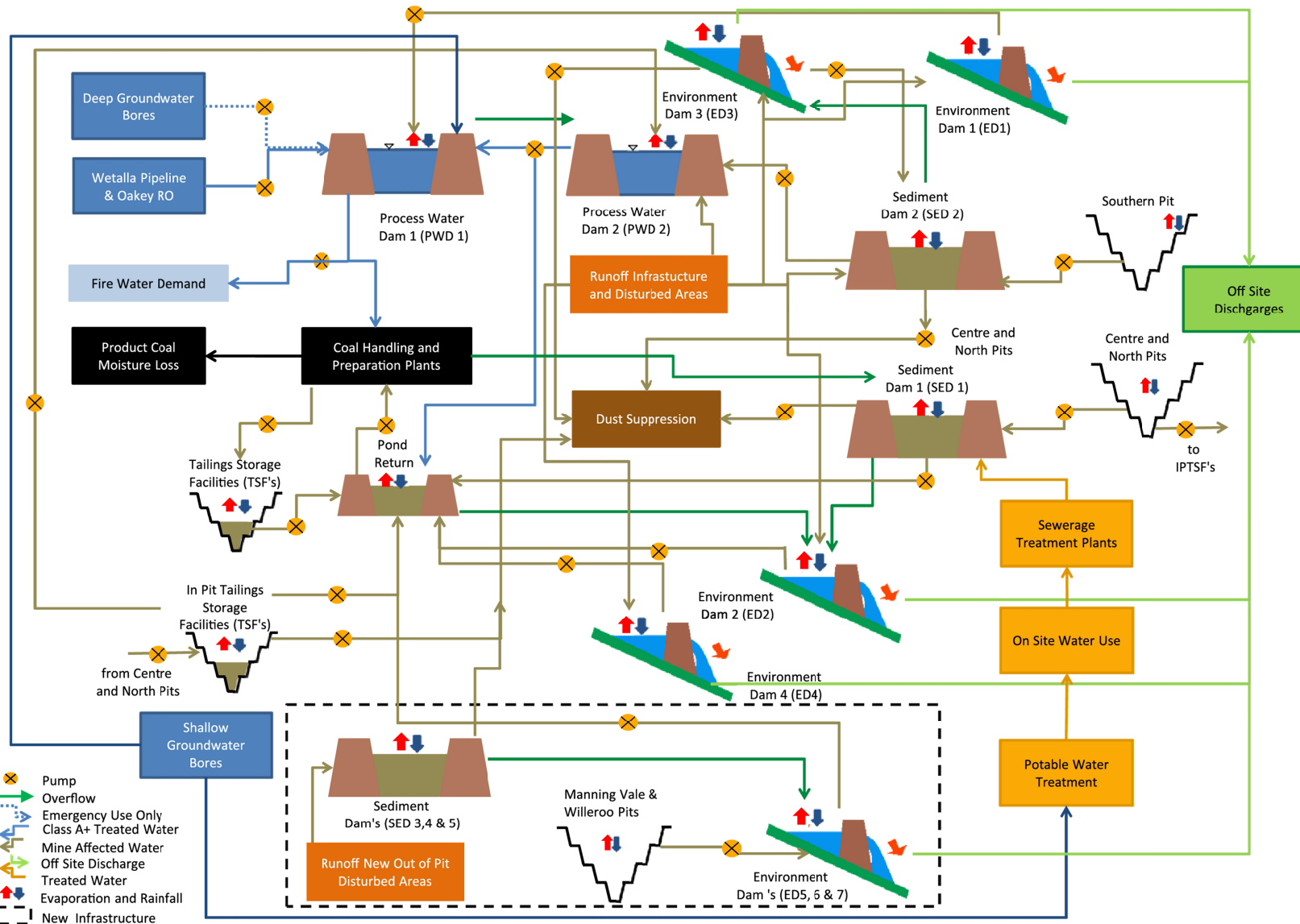


Figure 5-32 Water Balance Model Schematic

Mine Water Sources and Demands

The revised Project's water sources and demands vary over its life. A summary of the annual average volumes is shown below in **Table 5-16** and **Table 5-17**. The catchments that contribute to the water balance are discussed in further detail in the following Section.

Table 5-16 Mine Water Inflows

Description	Value
Rainfall	500 Stochastic Replicates based on data generated from gauge 041053 at Jondaryan Post Office.
Wetalla Pipeline	5 500 ML per annum from the WWRF at a rate of 340 cum /hr
Oakey Reverse Osmosis Plant	150 ML per annum
Ground and surface water capture	Varying with mine life climate, refer to contributing catchments
Deep and Shallow Groundwater Bores	Not considered in the Water Balance. Water Balance developed assuming zero inputs from groundwater bores. Shallow Groundwater bores will be used to supply potable water to the site and it is assumed that this supply will be sufficient to meet potable water demands.
Groundwater Inflow to the Pits	Output of groundwater modelling, varies over the life of mine (typically between 2.5 to 0.5 ML/d)

Table 5-17 Mine and Future Project Raw Water Demands

Water Supply Activity	Current Usage (approx) (ML/ year)	Future Usage (2021) (approx) (ML/ year)
Operation of the CHPPs	5,280	8,250
Wash down of machinery		
Fire suppression		
Shower and ablution use		
Dust suppression (~ 45 L/RoM tonne)	432	675
TOTAL USAGE	5,712	8,925
Estimated recovery Tailings Storage Facilities (50%)	2,860	4,460
Estimated water collected at site (rainfall runoff & groundwater inflows)	740	1,170
TOTAL NET WATER USAGE (~265 L/RoM tonne)	2,112	3,295

Contributing Catchments

The revised Project's water demands and catchments change over its operation. To assess this, several mine stages were examined. Catchment areas were determined from the mine plans and GIS analysis and are presented below in **Table 5-19**. A description of each catchment type is provided below.

- **Ex Pit Dump** – Surface runoff reports to sedimentation basins and seepage through the dump flows to the dump toe and into sedimentation basins;
- **In Pit Dump** – Surface runoff reports to sedimentation basins or the pit floor dependant on the topography of the mine pit. The majority of water from the in pit dumps reports to the pit floor. Seepage from spoil will report to the mine pit floor and be considered by the water balance;
- **Ex Pit Rehabilitated** – The direction of runoff is consistent of that with the ex-pit dump until the area becomes fully rehabilitated and is diverted clear of the system to the natural waterway. Until this time, the rehabilitated area differs only from the dump area by the assumed soil storage characteristics outlined in **Table 5-18**;
- **In Pit Rehabilitated** – Differing from the in pit dump, rehabilitated areas have been backfilled to natural surface levels and may be bunded to report directly to the sedimentation dams, thereby maximising pit operability. Seepage from these areas will report to the mine pit. Once the area is fully rehabilitated it will be diverted clear of the system to the natural waterway;
- **Mining Area/Pit Floor** – This area represents the active mining area and mine pit floor. All runoff reports to the mine pit floor; and
- **Disturbed and Pre-Strip Area** – This represents areas that have already been stripped of top soil in preparation for mining or have been disturbed from their natural state in some way. Runoff from these areas typically flows into the pit or a sedimentation dam based on the slope and orientation of the area.
- **Undisturbed Area** – Where possible, areas that have not been disturbed will be diverted around water storages and discharged to local streams. Where this is not practical, runoff will be collected and used to meet site demands.

A key difference between each of these areas is the assumed soil storage characteristics. Surface water runoff in the model is generated based on a conceptual soil storage capacity and base flow index. The soil storage capacity represents the depth of soil storage which must be filled before runoff occurs. This soil storage capacity is based on the stage of mining or rehabilitation. The base flow index designates the rainfall that becomes surface runoff and a proportion that goes to groundwater. **Table 5-18** outlines the conceptual soil storage capacities and base flow index for the revised Project site. The values adopted in **Table 5-18** are consistent with those adopted from similar open cut mining operations in Queensland.

Table 5-18 Conceptual Soil Storage Characteristics

Land Use	Mining Pits	Spoil Dump	Undisturbed Area	Pre Strip Area	Rehabilitated Spoil Dump
Small Storage Capacity (mm)	5	40	7	20	7
Medium Storage Capacity (mm)	10	220	120	150	120
Large Storage Capacity	25	300	150	220	150
Small Area Proportion	0.134	0.134	0.134	0.134	0.134
Medium Area Proportion	0.134	0.134	0.134	0.134	0.134
Baseflow Index	0.1	0.1	0.1	0.1	0.1
Baseflow Coefficient	0.8	0.5	0.5	0.5	0.5

Table 5-19 Mine Water Balance Catchment Areas

Catchment		AREA (ha)					
		2013	2019	2021	2023	2025	2029
MANNING VALE EAST PIT	Mining Area	-	28	36	46	23	16
	Disturbed Area	-	44	48	43	37	28
	Undisturbed Area	-	168	168	-	33	44
	In Pit Dump	-	29	45	53	58	40
	In Pit Rehabilitated	-	-	15	48	-	-
MANNING VALE WEST PIT	Mining Area	-	29	25	35	26	31
	Disturbed Area	-	46	32	33	32	32
	Undisturbed Area	-	135	15	-	-	14
	In Pit Dump	-	163	33	41	37	42
	In Pit Rehabilitated	-	-	118	-	-	55
WILLEROO PIT	Mining Area	-	33	41	37	25	14
	Disturbed Area	-	39	44	45	39	63
	Undisturbed Area	-	72	45	-	-	71
	In Pit Dump	-	81	53	72	53	76
	In Pit Rehabilitated	-	-	90	-	-	-

Water Balance Operating Rules and Assumptions

The water balance is based on several operating rules and assumptions as outlined below.

- The water balance starts at a volume of zero.
- Process water demands have priority. These demands can only be withdrawn from water in the raw water dams.
- A minimum WWRF pipeline inflow of 3,000 ML per annum must be used or stored on-site.
- If the Mine has less than two days CHPP process water supply in storage, WWRF pipeline pumping hours may be increased up to 4,800 ML per annum to ensure the Mine does not dry out.
- The WWRF pipeline inflows are delivered to RWD 1. Water is supplied to the Project's CHPP precinct via a gravity fed pipeline.
- Water collected from rainfall runoff within the revised Project mining areas can be transferred back to the Mine's water management system, via the Pond Return dam to be used to supplement process water requirements.
- With the exception of the central connection to the Pond Return dam, water cannot be pumped between storages more than 1 km apart. That is, water from storages to the south of the South Pit could not be pumped up to the existing storages in the north east section of the Mine. However, water may be gravity fed between the revised Project storages, through pipelines or channels and bunding.

- Pumping rates for transfers between eligible storages are up to 4 ML/d.
- Pit dewatering rates are typically 40 l/s increasing up to 200 l/s following periods of extended significant rainfall.
- Dust suppression demands can be withdrawn from sediment dams, environmental dams, pit sumps or mine voids. Dust suppression demands are preferentially withdrawn from sediment dams to maximise available storage.
- Dust suppression demands are reduced on days when the daily rainfall total is in excess of 5 mm.
- Dust suppression is not required on days when rainfall exceeds 10 mm.

The revised Project operating rules and assumptions will be confirmed through detailed design in accordance with the mine plan.

Site Surface Water Quality

The water balance model was developed to include a high level salt balance to track both the quantity and quality of water on-site. The salt balance tracks the water quality in all of the inflows to the revised Project's Sediment Dams and Environment Dams and subsequent affects from evaporation and releases on the storage water quality. The water quality values are presented in **Table 5-20**. These adopted values are consistent with other water balance models developed from Mine site records. In particular, the assumed salinity for undisturbed catchments is consistent with the median values from the Existing EA water quality monitoring along Lagoon Creek (refer to **Section 5.6.2**).

Table 5-20 Assumed Salinity

Source	Assumed Salinity (µs/cm)
Undisturbed Catchments	400
Spoil Dumps and Industrial Areas	500
Raw water pipeline	250
Receiving Waters	400
Pit Water	4,000

The above salinity values are converted to a concentration in milligrams per litre using a multiplication factor of 0.67 (Measuring Salinity DERM, June 2007) to quantify the mass of salt transferred in the model. The salt balance is used as an indicator of water quality. Actual releases will be made based on sampling and monitoring of a number of water quality parameters.

Salinity values for undisturbed catchments and receiving waters are based on water quality records from other Project sites. For modelling purposes, a conservative assumption was made to assume a salinity level of 4,000 µs/cm for all water pumped from the in-pit sumps.

Controlled Release Conditions

A controlled release strategy is proposed as part of the revised Project's site water management to support proactive management of water during periods of extended rainfall. The controlled release strategy has been developed to minimise the potential for impacts on water quality, aquatic ecology and existing users downstream. The strategy seeks to optimise the potential for the controlled release of good quality water, so that it does not become saline as a result of prolonged storage. The

strategy has benefits for downstream users and the environment, by releasing good quality water from large rainfall events, the impacts of the mine on the overland flow regime are further minimised.

Following the 2008 flooding in the Fitzroy Basin, the then DERM published several documents to provide guidelines on the discharge licensing for coal mines in the Fitzroy Basin. These documents include:

- *A Study of the Cumulative Impacts on Water Quality of Mining Activities in the Fitzroy River Basin* (Qld Environmental Protection Agency (now DERM), April 2009). This study recommended approaches to standardise the licensing and discharges from mines to the Fitzroy River basin. The study also provides a cumulative risk assessment matrix to assess the mine discharges, and is discussed further below.
- *Conditions for Coal Mines in the Fitzroy Basin – Approach to Discharge Licensing Version 10*, (DERM, June 2009). This document includes references to studies by Hart (2008) and states that salinity effects on macroinvertebrates are unlikely at or below 1,000 $\mu\text{S}/\text{cm}$.
- *Final Model Water Conditions for Coal Mines in the Fitzroy Basin* (EHP, 2013). This document outlines how discharge conditions should be determined and managed under the Environmental Authority.

The above guidelines are considered to form the latest industry standards for mine water releases and in lieu of catchment specific guidelines, have been adopted for the revised Project. The revised Project proposes that controlled releases be made to Lagoon Creek on the Mine. Releases will be made in accordance with the principles outlined in the *Final Model Water Conditions for Coal Mines in the Fitzroy Basin* (EHP, 2013). The release conditions were developed to only allow discharges that are less than 1,000 $\mu\text{S}/\text{cm}$ downstream of the point of discharge.

The Lagoon Creek historical flow series which was provided by DSITIA, and discussed in **Section 5.1**, was used to derive flow statistics to inform the Lagoon Creek release conditions as an output of the calibrated Sacramento Model for the Oakey Creek catchment. Missing days and dry days within the streamflow series were excluded from the analysis. As a conservative measure, flows which recorded less than 1 ML/d were considered to be dry and also excluded from the analysis. Percentage exceedance values were then calculated on the remaining data set and are presented in **Table 5-21**.

Table 5-21 Release Conditions

Receiving Water Flow Criteria for Discharge (ML/d)	Approximate % of Lagoon Creek Streamflow	Maximum release rate*	Electrical Conductivity Release Limits (µs/cm)
Low Flow < 4 ML/d for a period of 28 days after natural flow events that exceed 4 ML/d	< 20%	<1.5 ML/d	700
Medium Flow (low) > 4ML/d	> 20%	<1.5 ML/d	1,500
		<0.7 ML/d	2,500
		<0.5 ML/d	3,500
Medium Flow (high) > 11.5 ML/d	> 40%	<3 ML/d	1,500
		<2 ML/d	2,500
		<1.3 ML/d	3,500
High Flow > 34 ML/d	> 60%	<8ML/d	1,500
		<6ML/d	2,500
		<6 ML/d	3,500
		<2.8 ML/d	4,500
		<1.7 ML/d	7,500
Very High Flow > 66ML/d	> 80%	<4.5 ML/d	4,500

In order to simulate flow conditions in Lagoon Creek for the 500 replicates of probabilistic rainfall data, a Sacramento rainfall runoff model was developed within the GOLDSIM model. Parameters for the Calibrated Oakey Creek Sacramento model were provided by DSITIA and are shown in **Table 5-22**.

The controlled release strategy proposes one release point to Lagoon Creek. No release points are proposed on any adjacent gullies including Spring and Myall Creek as these gullies are considered to have insufficient annual flows to support a the revised Project's controlled release strategy. The connection of the three environmental dams to this release point will be established through detailed design of the water management system and take into account infrastructure and site constraints, this may include gravity fed pipelines and or the placement of smaller intermediate storages to support a pumping regime.

Table 5-22 Sacramento Model parameters for Lagoon Creek

Parameter	Value
Lztwm	100
Uzfwm	90
Uzk	0.18
Rexp	1
Uztwm	72
Pfree	0.1475
Zperc	200
Lzfpm	30
Side	0.001
Lzsk	0.8
Pctim	0.0028
Lzfsm	40
Sarva	0.0029
Lzpk	0.005
Adimp	0.0001
Ssout	0.001

Mine Water Balance Results

Demand Reliability

The water balance model was used to predict the reliability of the demands for the operations including the clean water, process water and dust suppression demands from varying water sources. The model was also used to predict the adequacy of the site storage to manage extreme rainfall events. The model was run for 500 climates replicates over the 12 year mine sequence.

Table 5-23 below presents the reliability of the major site water demands. The water balance predicted zero days of deficit for the CHPP plants supply with demands supplied on 100% of days for all scenarios modelled. Similarly, the dust suppression demands are met on 99.9% of days with only a minor volumetric deficit predicted for the 1% exceedance over the total life of mine.

Table 5-23 Reliability Demand for Site

Demands	Number of Days Demand Supplied (%)		Total Mine Life Volume Deficit (ML)	
	50% Exceedance	1% Exceedance	50% Exceedance	1% Exceedance
Potable Water/Fire Fighting	100	100	0	0
CHPP Demands	100	100	0	0
Dust Suppression	100	99.9	0	200

Mine Water Management

Three additional environment dams are proposed to manage rainfall runoff from mine affected areas. These dams are located adjacent to the Manning Vale East, Manning Vale West and Willeroo Pits.

Figure 5-33 illustrates the combined volume contained within these storages over the life of mine.

The results indicate that the proposed water management system, and combined storage of 800 ML will be more than sufficient to manage the revised Project's climatic extremes.

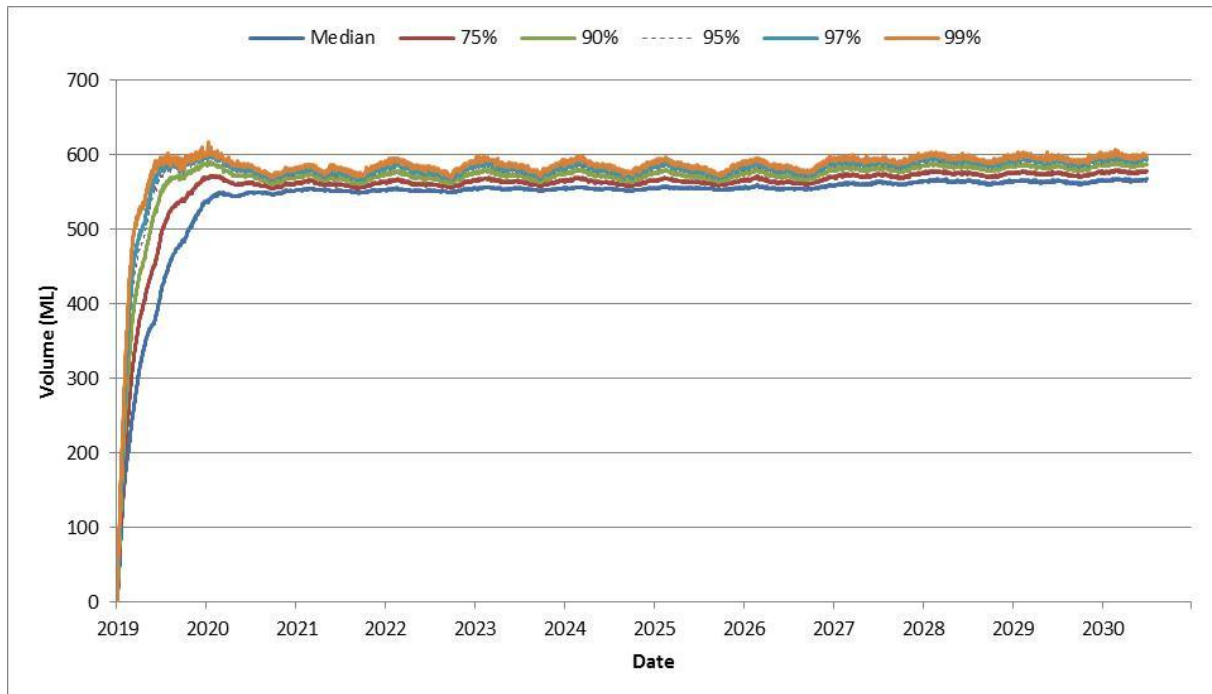


Figure 5-33 Combined volume in additional on-site storages

The potential for in-pit flooding due to an extreme rainfall event or period of continuous heavy rainfall was also examined. **Figure 5-34** illustrates the number of days over the life of mine where in pit flooding would exceed 100 ML, resulting in disruptions to the mining operations. The results indicate that for the 3% exceedance probability there would be a risk of up to 30 days of mining interruptions and a risk of up to 4 months of delays at the 1% exceedance probability through the first 10 years of mining operations. Additional water accumulation is expected in later mine life to an increase in predicted groundwater inflows. This risk is considered to be a low likelihood, and in the event that this occurs the NHG will manage the impacts through additional pump infrastructure.

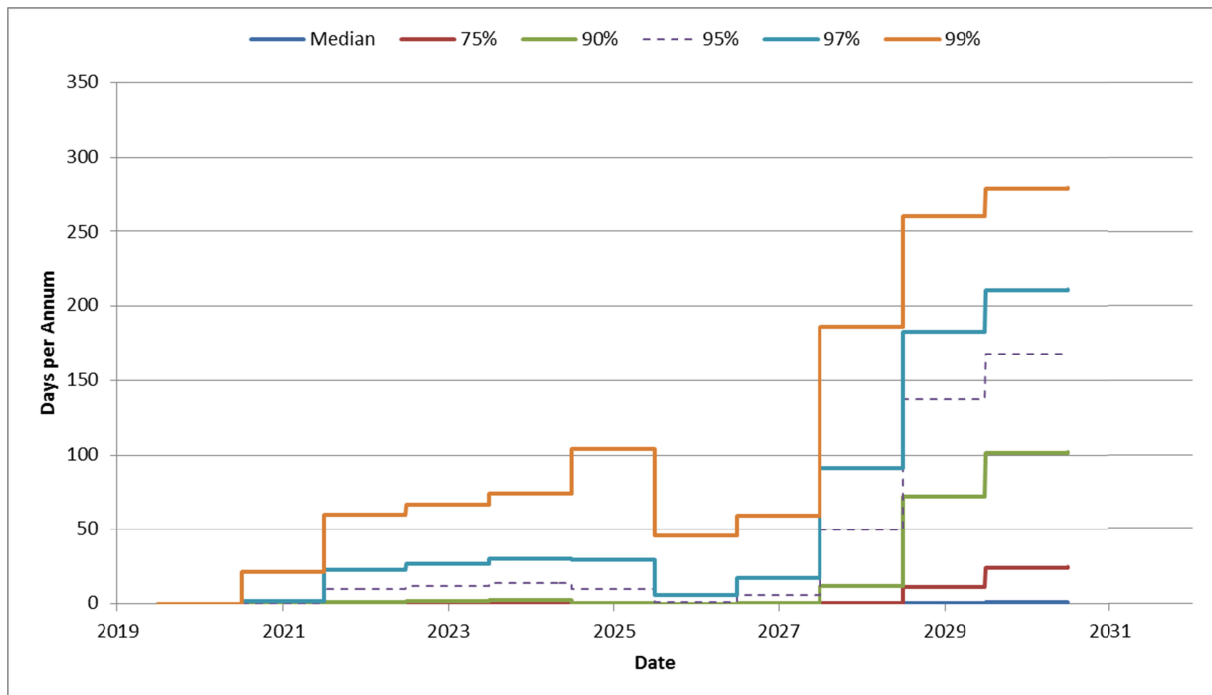


Figure 5-34 Days of pit flooding greater than 100 ML per annum

Controlled Release

The average annual volume released to Lagoon Creek over the revised Project life of mine is illustrated in **Figure 5-35**. The results indicate that in an average year only minor releases in the order of 20 ML/year will be made to Lagoon Creek with releases increasing to a maximum of 170 ML/year in the 1% exceedance probability (very wet year). This volume of water is minimal, with the ephemeral nature of Lagoon Creek restricting the opportunity for release of large volumes of mine-affected water. However, the release condition is still considered important for the revised Project and in keeping with current industry guidelines. The release condition allows for good quality water to be released off site following periods of significant rainfall. This approach prevents good quality water increasing in salinity through evaporation and maximises the available storage within the mine site to manage climatic extremes.

Figure 5-36 illustrates the predicted salinity within Lagoon Creek at the point immediately downstream of the mine water releases. The results illustrate the adopted baseline salinity of approximately 400 $\mu\text{S}/\text{cm}$ (as discussed in **Table 5-20** and **Section 5.6.2**), with salinity values increasing to up to 700 $\mu\text{S}/\text{cm}$ during the 1% exceedance probability release conditions. These results indicate the proposed controlled release system is unlikely to result in significant changes to the salinity in Lagoon Creek, with this value below the median values recorded at the downstream Oakey Gauge and consistent with recorded values during the Lagoon Creek flow events (1,000 $\mu\text{S}/\text{cm}$).

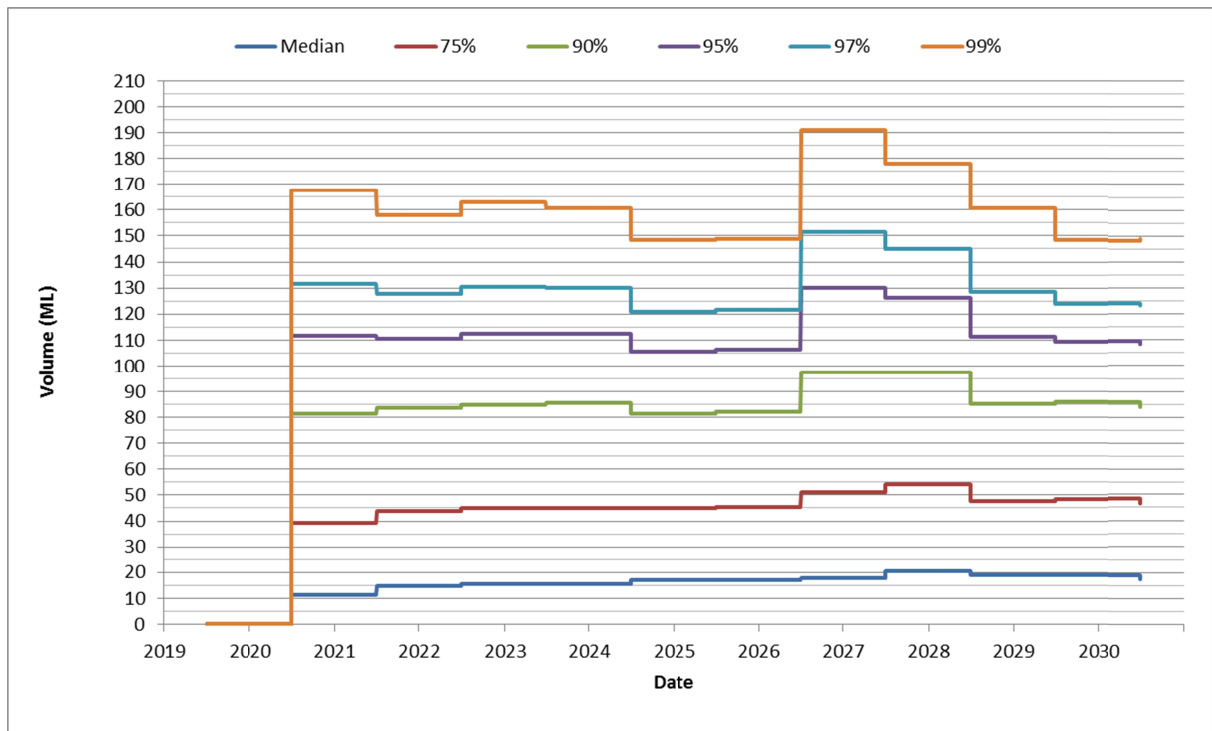


Figure 5-35 Annual Controlled Release Volume

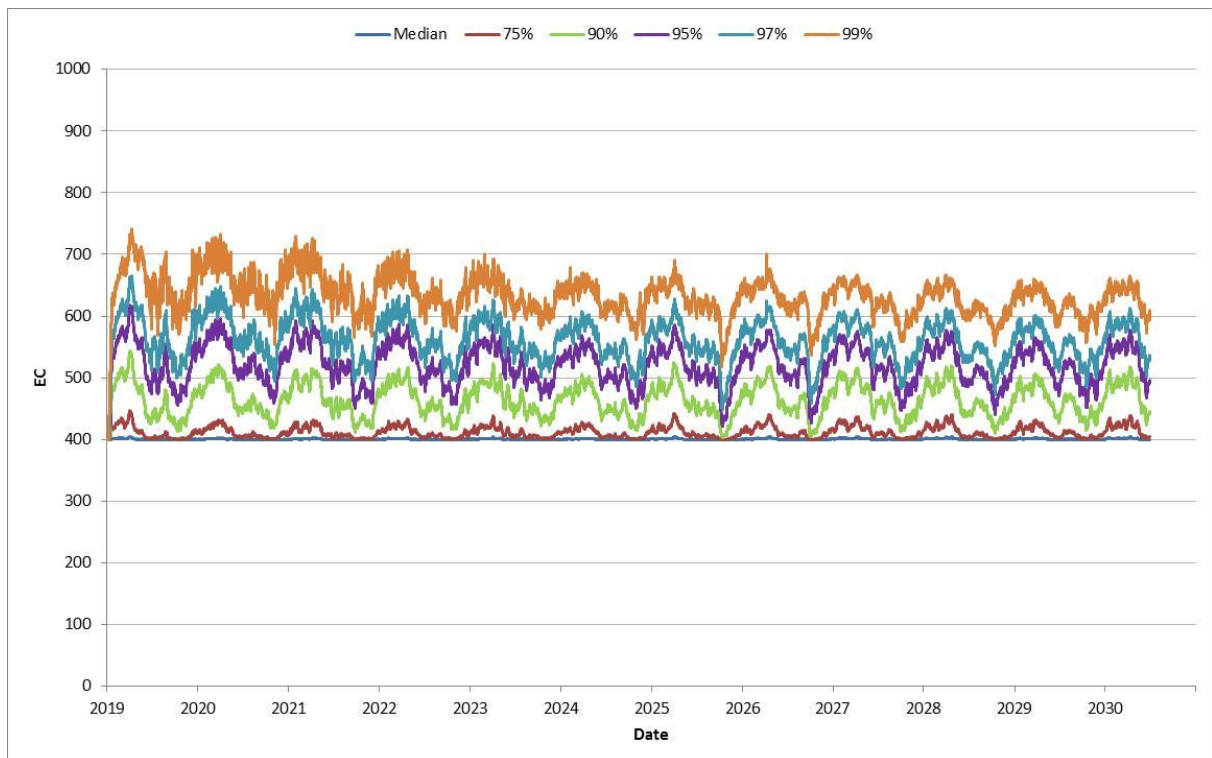


Figure 5-36 Salinity of Lagoon Creek downstream of mixing point

A study by the then DERM in 2009 developed a risk assessment framework based on the ambient EC levels and the frequency and volume of mine discharges in the Fitzroy River catchment. The study was aimed at identifying the risks of cumulative mine releases within a catchment. While there is limited mining activity in the Condamine River catchment the process of the development of the framework is relevant. The results of the water balance modelling indicate median discharges of less than 20 ML/ year with a high probability (1% exceedance) of an annual discharge volume of less than 170 ML/year and water quality of the receiving environment being less than 700 $\mu\text{S}/\text{cm}$. This is considered to be a “Low” water quality risk to receiving waters being less than the 90th percentile EC value at the downstream Fairview gauging station. The flow frequency and volume is also considered to be a “Very Low” risk with release on only a few days and average volumes well below 100 ML per year. The revised Project’s controlled release system is therefore predicted to be a ‘Low’ risk. As such the impacts of the proposed controlled release system on water quality and the downstream environment is predicted to be minimal. Furthermore a controlled release system of good quality water minimises the impact of the revised Project on overland flow paths and hence the volume of water available to downstream users.

This matter is discussed further in **Chapter 9**. The cumulative risk assessment framework produced by the then DERM is provided for reference in **Appendix G.3.2**.

It is noted that while the mine water balance model indicates there will be no uncontrolled release from the revised Project due to extended rainfall, there is the potential for uncontrolled release due to the failure of water storage infrastructure e.g. dam break due to a structural failure or changes to the dam operation. The risk of failure of this infrastructure is addressed through the regulated structures guideline. Storages considered to present a significant hazard to the downstream environment, water quality or people will be designed to comply with these guidelines and will be inspected annually by a registered professional engineer. It is therefore considered highly unlikely that there would be any uncontrolled releases from the revised Project’s mine water management system.

5.14 Potential Impacts and Mitigation Measures

5.14.1 Management Intent

The 'management intent for waters' is set out in Section 14 of the *Environmental Protection (Water) Policy 2009* (EPP (Water)). This section of the EPP (Water) sets out what NAC is required to take into consideration when proposing to release waste water, in this case water from the Environmental Dams, to a watercourse.

The EPP (Water) states the following.

High Ecological Value Waters – the measures for the indicators for all environmental values are maintained.

Slightly Disturbed Waters – the measures for the slightly modified physical or chemical indicators are progressively improved to achieve the water quality objectives for high ecological value water.

Moderately Disturbed Waters –

- if the measures for indicators of the environmental values achieve the water quality objectives for the water—the measures for the indicators are maintained at levels that achieve the water quality objectives for the water.
- if the measures for indicators of the environmental values do not achieve the water quality objectives for the water—the measures for indicators of the environmental values are improved to achieve the water quality objectives for the water.

Highly Disturbed Waters – the measures for the indicators of all environmental values are progressively improved to achieve the water quality objectives for water.

Based on the above parameters and those EVs outlined for Lagoon Creek in **Section 5.5**, all values were either slight to moderately disturbed due to historical land use practices, such as stock access, land clearing and agriculture. This assessment is supported with the water quality data collected in **Section 5.6** also indicating that the majority of samples, including those taken upstream of the Mine exceeded ANZECC and QWQG criteria.

It is the intention of the NAC to minimise the impact on Lagoon Creek where the mining operation has an influence, and to ensure that practices do not further degrade the environs. The measures undertaken to ensure these outcomes are achieved are discussed in **Section 5.14.2**.

5.14.2 Mitigation Measures

The key activities that will require mitigation measures to prevent or minimise adverse water quality impacts during construction are:

- hydrocarbon spills from the CHPP area, vehicles and other plant and equipment contaminating surrounding water with chemicals, hydrocarbons, oil and grease;
- clearing of vegetation and stripping of top soils;
- handling and storage of fuels during construction and operation and;
- any releases of water from the site and site sedimentation dams.

Work methods will be developed and included in the Contractor Environmental Management Plans. These methods will detail appropriate control and mitigation measures for the revised Project. In addition to these measures, the specific environmental management conditions will be implemented to mitigate the impacts of the construction of the railway line crossing of Lagoon Creek. The following outlines the major mitigation measures that will be implemented where practicable during the construction phase. Importantly, current good practice erosion and sediment control measures will be provided as outlined in the *EPA Urban Stormwater Management Erosion and Sediment Control (2008)* and the Institution of Engineers publication *IECA Best Practice Erosion and Sediment Control Guidelines (2008)* to comply with the EPP (Water). These measures include:

- construction work in creeks will be undertaken in dry weather and conditions of minimal or no flow;
- weather conditions will be monitored so that work in creek crossings and erosion prone areas will not take place if rain and/or extreme weather (e.g. storms) are forecast;
- sedimentation fences and bunds will be used to contain fill or excavated material during construction;
- fill and excavated material will be stockpiled away from gully heads, active creek banks, bank erosion or other unstable areas;
- local runoff from disturbed areas will be routed clear of disturbed areas;
- assessment of the integrity and effectiveness of erosion control measures will be undertaken at regular periods and following significant rainfall events; and
- if required the erection of temporary waterway barriers during construction will include the provision to transfer flows from upstream of the works to the downstream channel without passing through the disturbed construction site.

Operational activities that have the potential to compromise water quality conditions at and downstream of the revised Project site, including the following:

- runoff from disturbed areas conveying increased sediment load and pollutant load to the site's sediment dams;
- operation and management of bunded fuel tanks, dangerous goods containers, hazardous chemicals and workshop wastes (batteries, oil filters), and handling and storage of fuels on site; and
- controlled releases from the revised Project's Sediment and/or Environmental Dam(s).

The controls to mitigate potential environmental impacts from operational activities are detailed in the revised Project's EM Plan in **Chapter 21**. The following management strategies will be implemented by the revised Project to protect surface water quality and the downstream receiving environment.

- An operational separation distance of approximately 150 m will be maintained from the edge of the mining pits to Lagoon Creek, which will include a 50 m conservation buffer where no mining activities will be undertaken.

- The current conservation zone, 50 m either side of Lagoon Creek, from the Mine will be extended into the revised Project area to promote the re-establishment of the riparian zone. No mining activities will occur within the proposed conservation zone.
- Sediment dams, environmental dams, pit water storage and other water management structures (e.g. bunds and drains) will be used appropriately by the revised Project as per the Water Resource Management Plan (WRMP).
- The revised Project's water management will be based on the separation and management of clean and dirty water catchments.
- Water capture within the revised Project's clean areas will be diverted around operational areas and where practical, allowed to discharge off site as part of normal overland flow.
- Water from disturbed areas within the revised Project site will be diverted to sediment dams for treatment and possible reuse as a supplementary supply for the revised Project's water requirement.
- Surface runoff from the revised Project's potentially contaminated areas, such as infrastructure areas, will receive additional levels of treatment (e.g. oil-water separators and bunding). Water captured by these devices will be preferentially reused on site, while captured oil will be collected for recycling by a licensed contractor.
- Progressive rehabilitation will be undertaken as the revised Project's operational areas become available to reduce the amount of disturbed areas.
- Fuel, dangerous goods and hazardous chemicals will be managed as outlined by current standards, guidelines and in compliance with statutory requirements.
- Refuelling locations and handling of fuels will be undertaken away from all waterways including creeks and drainage paths.
- NAC's existing SOP for spills and emergency response procedures will be expanded to incorporate the revised Project. Spill recovery and containment equipment will be available when working adjacent to sensitive drainage paths and within other areas, such as workshops.
- NAC will continue to commit to investigating all legitimate surface water complaints, and if a genuine problem is identified, conduct immediate remediation measures and establish standard operating procedures to minimise the possibility of a reoccurrence of the original issue.
- NAC's current water quality monitoring program will be expanded to incorporate the operational and decommissioning phases of the revised Project. The program is designed to ensure the WRMP is effective, to demonstrate compliance with the Mine's strict discharge limits, and to ensure the downstream water quality (physico-chemical parameters, at a minimum) is not being adversely impacted. In general, the monitoring program will include the following actions.
- Water quality will be measured upstream and downstream of the revised Project site. Basic water quality indicators (i.e. Salinity, pH, DO, EC, temperature) will continue to be monitored on a monthly basis, or when water is present, and heavy metals, nutrients, anions and cations monitored twice annually.
- During any release event, the receiving water will be monitored upstream (50 m to 100 m upstream of the release point) and downstream (200 m downstream of the release point)

locations. Water quality variables will include basic water quality indicators, suspended solids, heavy metals, nutrients, anions and cations.

- Progressive rehabilitation of areas impacted by operational activities will be undertaken as soon as practical in order to reduce the amount of exposed soil.
- Fuel, dangerous goods, hazardous chemicals and work shop wastes will be managed to ensure compliance with current industry standards and guidelines for safety and environmental protection. These management actions will focus on handling, storage, spill containment, emergency response, establishment of 'standard operating procedures' for key operational aspects, and development of a responsibility matrix for operational and reporting matters.

As per the management intent under the EPP (Water), where possible NHG will seek to improve the environmental values of the Lagoon Creek catchment through the preservation of the main channel and the riparian zone 50 m either side of the creek. The NHG's implementation of the above management strategies for surface water management under normal circumstances will minimise the risk of adverse impacts to the water quality of Lagoon Creek, Oakey Creek and the Condamine River downstream of the revised Project.

A WRMP will be developed for the revised Project to ensure the protection of surrounding waterways (downstream receiving environment). A draft of WRMP is provided in **Appendix J.4**.

5.15 Summary of Surface Water Impacts

The revised Project site is located within the Lagoon Creek catchment of the greater Condamine River catchment. Lagoon Creek is an ephemeral creek, with a shallow, narrow poorly defined channel and wide floodplains. The creek has been moderately disturbed through past agricultural practices including a number of in-stream dams. NAC is not proposing to divert or alter the Lagoon Creek channel and has offset the revised Project's resource areas from the creek bank by approximately 150 m. Importantly, the 150 m operational offset includes a commitment by NAC to a 50 m 'no mining' buffer to promote the re-establishment of the creek's riparian zone. The buffer distance either side of Lagoon Creek within the revised Project area will be incorporated into the Mine's current conservation zone,

NAC will expand the existing Lagoon Creek monitoring program as part of the WRMP for the revised Project. The WRMP is located in **Appendix J.4**.

Surface Water Flow

The revised Project is not expected to have a significant impact on the existing flood regime. Impacts to flooding as a result of the proposed flood protection levee and railway crossing are largely located on land owned by the APC. Furthermore, the analysis indicates that there would not be additional flooding impacts at Jondaryan as a result of the revised Project.

Flood protection for the revised Project's resource areas will be provided through two flood levees designed to provide protection from a PMF flood event, which is well in excess of the current legislative requirements. In addition, NAC has committed to ensuring the revised Project's final landform is outside the existing PMF flood extent, and as a result, there are no flooding impacts on the key aspects of the proposed final landform (i.e. the depressed and elevated landforms).

The revised Project will have a negligible impact on the existing flow regime. No licenced surface water users were identified on Lagoon Creek with the closest downstream user located after the Oakey Creek confluence 19 km downstream of the revised Project site. Therefore, the impacts of the revised Project to downstream users and the environment are expected to be negligible.

NAC is not seeking any new water allocations. The majority of the revised Project water demands are provided from the WWRF through a pipeline constructed in 2009. This beneficial use of a waste water product ensures the revised Project possesses a sufficient and reliable water supply.

As part of NAC's water management system, runoff from disturbed areas will be captured and treated with an amount available for reuse by the revised Project's mining activities. In line with current industry guidelines, NAC's water management system will include a controlled release system to manage rainfall events and minimise adverse impacts to the downstream receiving environment. The ephemeral nature of Lagoon Creek means that controlled releases will occur on a minimal basis over the life of the revised Project, and as a result, are not expected to have a significant impact on water quality, aquatic ecology and downstream water users.

Surface Water Quality

Static testing of soil and mine waste has determined that although some mine waste (principally interburden) could produce minor amounts of acid, the spoil is predominantly non-acid forming, as discussed in **Section 4.7.7**. This is supported by surface water quality monitoring at the Mine over a 10 year period that show long term trends of neutral pH, as demonstrated in **Section 4.7.6**. The seepage and drainage from in-pit spoil backfilled to the Mine pit voids is contained within the Mine water management system. External spoil piles have water management infrastructure that directs surface runoff to sediment dams.

Tailings is pumped to ITSFs within mined voids, as described in **Section 3.7.4**. The water quality in these voids is neutral to alkaline and will have variable concentrations of salts that are dependent, in part, on the effect of rain and evaporation. Metal concentrations in the tailings water ponds will similarly fluctuate depending on dilution and are not expected to exceed ANZECC stock water guidelines (based on available water quality results from February 2012 and August 2013).

Mine impacted water from the CHPP, tailings and spoil facilities and other areas within the mine is contained within the water management infrastructure, as presented in **Section 3.9.2** and there will not be uncontrolled discharges of mine impacted water to the environment. Water balance modelling on the mine water management system suggests that controlled discharges to the environment will be limited in frequency and duration, as presented in **Section 5.13.4**. Engineering controls within the Mine water management system will provide mitigation to preclude adverse effects on terrestrial and aquatic freshwater flora and fauna. This will be achieved through a controlled release strategy whereby the concentration of salt that is released to the rivers will not exceed the assimilative capacity of the receiving environment, as depicted in **Table 5-20**.