

4.3 SURFACE WATER AND FLOODING

4.3.1 Existing Environment

This section responds to submissions which questioned the characterisation of the existing condition of the Mooki River.

Submission reference: SIG13, P62 and P68

Summary response: Baseline water quality monitoring data indicates that the Mooki River is generally safe for recreational and irrigation use but does exceed the ANZECC irrigation and recreational trigger values for iron.

Aquatic surveys along the Mooki River were conducted as part of the Ecological Impact Assessment for the Project in accordance with The Australia Wide Assessment of River Health: NSW AusRivAS Sampling and Processing Manual.

This assessment found that the Mooki River has been extensively cleared of aquatic flora and fauna habitat and is considered to be highly degraded.

The water quality characterisation of the Mooki River provided in Section 3.4 of the Surface Water Impact Assessment (Appendix S of the EIS) is based on the available recorded water quality data from NOW and has been compared to the trigger values in the Australia and New Zealand Environment Conservation Council (ANZECC) *Water Quality Guidelines* (ANZECC, 2000). The trigger value is a water quality concentration that has been previously found to be toxic to some aquatic species. ANZECC water quality trigger values have been provided for different uses including recreation, ecosystem protection and irrigation. A higher water quality standard is required for ecosystem protection than for recreation or irrigation purposes. The ANZECC trigger values are not based on data specific to the Mooki River catchment and as such, are only guidelines. The water quality monitoring data suggests that the Mooki River is generally safe for recreational and irrigation use but does exceed the ANZECC irrigation and recreational trigger values for iron.

Some submissions were received expressing concern about the reference in the EIS to the Mooki River being in a “*highly degrade*” state. These references refer to the current state of the aquatic flora and fauna habitat. As described in Section 5.1.2 of the Ecological Impact Assessment, aquatic surveys were conducted along the Mooki River in accordance with *The Australia Wide Assessment of River Health: NSW AusRivAS Sampling and Processing Manual* (Turak and Waddel, 2002). This assessment found that aquatic habitat along the Mooki River and Native Dog Gully is highly degraded. This is consistent with the findings of Thoms et al., 1999.

Native riparian and floodplain vegetation has been historically cleared for agriculture and now it is practically non-existent, with the exception of a few scattered paddock trees. This is demonstrated in **Plate 1** and **Plate 2**.

The floodplain is intensively cropped, and cultivated land extends to within 2 to 10 m of the bank edge at many locations. Erosion has been exacerbated by the removal of vegetated ground cover, which has resulted in severe erosion of the steeper river banks, and the formation of channels that have formed as a result of heavy rainfall and run-off. Erosion has caused sedimentation of the river, resulting in a turbid water column and soft substratum

The Mooki River and Native Dog Gully are considered to be in poor physical condition (Thoms et al., 1999) and provide highly simplified aquatic habitat with little or no riparian and instream vegetation, or rocks and snags required for aquatic macroinvertebrate habitation. The Mooki River has a degraded channel and banks, with the deposition of fine clay and silt materials (Thoms et al., 1999). Few macroinvertebrates can colonise and survive on bare substrates, even if water quality is suitable (Chessman, 2003).



Plate 1
Mooki River Habitat 1



Plate 2
Mooki River Habitat 2

4.3.2 Baseline Data

This section responds to submissions which questioned the adequacy of the baseline surface water monitoring data used for the Surface Water Impact Assessment.

Submission reference: RA2, SIG10, SIG14, P20, P26, P30, P57 and P67

Summary response: More than two years of available surface water quality baseline data was utilised in the Surface Water Impact Assessment, as per the DGRs for the Project. Baseline surface water monitoring has continued for the Project with up to four years data now available. The baseline data utilised in the Surface Water Impact Assessment is considered adequate to characterise the existing surface water environment.

The EIS provides a summary of the available surface water quality baseline data collected from 12 sites to January 2012 (more than two years of baseline data) in the surrounding receiving waters. These results suggest that background concentrations of some pollutants are well above the ANZECC trigger values for ecosystem protection. Preliminary surface water quality objective trigger values were developed based on either the ANZECC trigger values or the 80th percentile of data collected to this date (Table 10.7 of the Surface Water Impact Assessment). Any potential release of water from the Project that exceeds these trigger values must be assessed to determine whether the Project may influence downstream water quality.

Additional water quality data has been collected following the completion of the EIS, providing more than four years of data at some locations. Shenhua Watermark propose to develop site specific water quality objectives for the receiving watercourses based on recorded water quality data in consultation with NOW and the EPA as part of the development of the Water Management Plan for the Project. Although the use of two years of surface water quality data in the Surface Water Impact Assessment (with up to 30 samples collected at some locations) is valid for setting water quality objectives, the use of the larger dataset will improve the determination of site specific water quality objectives.

NOW notes in its submission that a maximum pH value of 12.2 recorded at SWM01 on the 21 January 2010 represents a geochemically extreme environment in which some toxic elements may be highly soluble. Further review of the water quality data suggests that this value may be a recording error because the recorded value at the upstream station SWM4 and downstream station SWM2 on that day was 7.37 and 8.47, respectively. In addition, all other pH recordings to date at all stations are below a pH of 9.5 and 93% of recordings are below a pH of 9. On this basis, the Mooki River would not be considered a geochemically extreme environment.

4.3.3 Water Management Strategy

General

This section addresses the submissions from stakeholders which questioned the mine water management strategy and its basis.

Submission reference: RA3, SIG2, SIG5, SIG6, SIG8, SIG9, SIG10, SIG13, SIG14, P1, P2, P3, P4, P8, P18, P20, P22, P25, P30, P36, P37, P39, P41, P48, P49, P50, P53, P55, P57, P60, P62, P65, P66, P67, P71, P72, P73, P83, P88, P100, P101, P102 and P104

Summary response: The water management strategy for the Project is based on the primary principle of separating water from different sources in terms of water quality. This ensures all water of poor quality that does not meet the adopted water quality criteria is contained on site. Releases are only proposed from OEA runoff following treatment and only then when it meets the agreed adopted water quality criteria. Mine water (i.e. water that has generally come in contact with coal) will not be discharged from the Project and will be preferentially used to meet site water demands.

Section 4 of the Surface Water Impact Assessment describes the proposed surface water management strategy and infrastructure, which is based on the primary principle of separating water from different sources in terms of water quality. The surface water management strategy for the Project has been therefore developed by categorising the surface water runoff into the following three types:

- Clean water – surface runoff from areas where water quality is unaffected by mining operations. Clean water includes runoff from undisturbed areas and any fully rehabilitated areas which will be diverted around disturbed areas to maximise the availability of surface water for downstream water users;
- Sediment-laden water – surface runoff water from areas that are disturbed by mining operations (including OEAs). This runoff does not come into contact with coal or other carbonaceous material and may contain high sediment loads, but does not contain contaminated material or high salt concentrations. This runoff may be suitable for release offsite after treatment to ensure that water quality is within the adopted water quality criteria; and
- Mine water – includes water that has generally come in contact with coal such as seepage, groundwater and surface runoff to the open cut mining area or runoff from the CHPP and ROM coal stockpiles. This water may contain elevated concentrations of salt and other contaminants.

The key principles for the management of these three surface water runoff categories are as follows:

- Clean surface water runoff from undisturbed areas will be diverted, wherever possible, around areas disturbed by mining and released from the site, minimising the capture of clean surface runoff;
- Sediment-laden surface runoff from OEAs will be managed through a sediment and erosion control plan with water captured in sediment dams and treated to improve water quality prior to release from the site, or returned to the mine water system if the water quality is not suitable for release; and
- Mine water will be collected in onsite storages and used preferentially to satisfy site water demands. It will not be released from the site.

Note that the term “dirty water” used in the EIS and also in the Surface Water Impact Assessment has sometimes been used to refer to both sediment-laden water and mine water. Given the above, the suggestion by CCAG that the strategy is focussed on sediment-laden water is not correct. The primary strategy is to ensure all water of poor quality that does not meet the adopted water quality criteria is contained on site.

Water releases from the Project will only occur from surface water runoff from the OEAs, which are not coal affected, during rainfall events that exceed the system design criteria based *Managing Urban Stormwater, Soils and Construction* (Landcom, 2004) and *Managing Urban Stormwater, Soils and Construction, Volume 2E Mine and Quarries* (DECC, 2008). Under most rainfall conditions, all site runoff will be stored on site and reused, with releases from sediment dams only occurring when water quality objectives are met as specified in the EPL conditions for the required discharge points. Releases of water that have come in contact with coal or carbonaceous material are not proposed. Dilution of water release is not proposed as a mitigation measure. Release conditions will be based on the baseline water quality objectives, which at this stage are proposed to be the lesser of either the ANZECC trigger values for ecosystem protection (95% level of protection) or the 80th percentile of the background water quality.

Nil Discharge Mine versus Release in Extreme Events

This section addresses the submissions from stakeholders regarding the occurrence of offsite discharges.

Submission reference: RA3, SIG2, SIG5, SIG6, SIG8, SIG9, SIG10, SIG13, SIG14, P1, P2, P3, P4, P8, P18, P20, P22, P25, P30, P36, P37, P39, P41, P48, P49, P50, P53, P55, P57, P60, P62, P65, P66, P67, P71, P72, P73, P83, P88, P100, P101, P102 and P104

Summary response: “Sediment-laden” water (i.e. surface runoff water from areas that are disturbed by mining operations) will be captured in sediment dams and treated to improve water quality prior to release from the site in accordance with discharge locations and criteria specified in the EPL, or returned to the mine water system if the water quality is not suitable for release.

“Mine water” (i.e. water that has generally come in contact with coal) will not be discharged from the Project and will be used to meet site water demands. The results of site water balance modelling indicate that there will be no release of “mine water” from the mine site under any rainfall conditions that have been experienced in the area during the past 100 years.

A number of stakeholders have raised concerns regarding the occurrence of offsite discharges. Particular statements from the EIS and Surface Water Impact Assessment which appear to have caused confusion include:

- Runoff water will only be released from the site if the quality is acceptable and during a rainfall event that exceeds the design capacity of the sediment dam; and
- The mine water management system will have the capacity to contain all mine water on site without the need for offsite releases.

These statements are both correct and when taken in context, actually refer to two different “types” of water, in terms of water quality. The first statement refers to “sediment-laden” water and the second refers to “mine water”.

Further clarification of the surface water management strategy and a more detailed description of water “types” are provided in **Section 4.3.3** (*‘General’*) of this RTS.

“*Sediment-laden*” water does not come into contact with coal or other carbonaceous material and may contain high sediment loads, but does not contain contaminated material or high salt concentrations. Sediment dams are used to treat this type of water by reducing suspended solid concentrations. Although this water may be released to the receiving environment if the water quality is acceptable (as discussed in **Section 4.3.3** (*‘Management of Sediment-laden Surface Runoff’*) of this RTS), under normal operations water captured in the sediment dams will be pumped back into the Dirty Water Dam for use on site.

Sediment dams will be sized in accordance with the relevant legislation and guidelines, however overflows may occur following rainfall events which exceed the design capacity (typically the 90th percentile five-day rainfall depth). **Section 4.3.3** (*‘Management of Sediment-laden Surface Runoff’*) of this RTS provides further detail on the management principles for sediment-laden water.

“*Mine water*” is of lower quality than “*sediment-laden*” water. This type of water will not be discharged from the site and will be preferentially used to meet site water demands. Further detail on the management principles and the commitment to containing “*mine water*” on site is provided in **Section 4.3.3** (*‘Containment of Mine Affected Water’*) of this RTS.

The results of site water balance modelling indicate that there will be no release of “*mine water*” from the Project under any rainfall conditions that have been experienced in the area during the past 100 years. SIG10 and P30 suggest the EIS states that “*Based on the configuration and capacity of the proposed water management system, there will be no uncontrolled offsite spills from mine water storages or controlled discharges during non-extreme events*”. This statement is not contained within the Surface Water Impact Assessment or EIS main document. A similar statement is found in the EIS main document (“*Based on the configuration and capacity of the proposed water management system, there will be no uncontrolled offsite spills from mine water storages or controlled discharges*”), however the statement does not limit this to “*non-extreme events*”.

Containment of Mine Affected Water

This section addresses the submissions from stakeholders regarding the design of the mine water management system and the containment of mine water.

Submission reference: RA3, SIG2, SIG5, SIG6, SIG8, SIG9, SIG10, SIG13, SIG14, P1, P2, P3, P4, P8, P18, P20, P22, P25, P30, P36, P37, P39, P41, P48, P49, P50, P53, P55, P57, P60, P62, P65, P66, P67, P71, P72, P73, P83, P88, P100, P101, P102 and P104

Summary response: The mine water management system has been designed to ensure sufficient storage capacity exists to contain all mine-affected runoff. The results of the water balance model indicate that no uncontrolled discharges (overflows) of mine-affected water will occur. The results of site water balance modelling indicate that there will be no release of “mine water” from the mine site under any rainfall conditions that have been experienced in the area during the past 100 years.

The mine water management system has been designed to ensure sufficient storage capacity exists to contain all mine-affected runoff for the historical period of climate data from 1889 to 2010, consistent with statements in Section 7.10.8, Section 10.2 and Section 11 of the Surface Water Impact Assessment. For this climatic period, the results of the water balance model indicate that no simulated uncontrolled discharges (overflows) of mine-affected water will occur. The discharge of untreated mine water is not part of the water management system design for the Project.

In the unlikely event that rainfall exceeds that experienced between 1889 and 2010 (as used for water balance modelling), Shenhua Watermark has a contingency plan to accommodate a surplus of water on site, as identified in Section 3.9.1 of the EIS main document. The commitment has been made that *“part of the open cut mining area will be used to store this [mine affected/dirty] water which will be later reused in the mine water management system”*.

As detailed in Section 7.3.3 of the EIS, this will be achieved by either sacrificing a portion of the active Eastern Mining Area during the initial stages of mining or, after mining proceeds to the Southern and Western Mining Areas, maintaining areas of temporary storage as the Eastern and Southern Mining Areas are progressively rehabilitated. Mining operations would also be curtailed as required.

Mine water storage dams will be constructed to minimise seepage/leakage of water to the receiving environment. Detailed design of mine water dams will be undertaken in the detailed design stage of the Project, following the granting of the relevant approvals.

Management of Sediment-laden Surface Runoff

This section addresses the submissions from stakeholders regarding the management of sediment-laden surface runoff and the potential for and quality of sediment dam overflows.

Submission reference: RA3, SIG2, SIG5, SIG6, SIG8, SIG9, SIG10, SIG13, SIG14, P1, P2, P3, P4, P8, P18, P20, P22, P25, P30, P36, P37, P39, P41, P48, P49, P50, P53, P55, P57, P60, P62, P65, P66, P67, P71, P72, P73, P83, P88, P100, P101, P102 and P104

Summary response: “Sediment-laden” water (i.e. surface runoff water from areas that are disturbed by mining operations) will be captured in sediment dams and treated to improve water quality prior to release from the site in accordance with the discharge locations and criteria specified in the EPL, or returned to the mine water system if the water quality is not suitable for release.

There appears to be a common misunderstanding in many submissions regarding the operation of the water management system with regard to discharging water offsite. For example, P3 states *“there is a risk of contaminated water being released from the sediment dam during rainfall events where it exceeds the capacity. With the unpredictable rainfall events this situation is considered most probable and the releasing of contaminated water across the black soil plains and into our ground water systems is unacceptable”*. Many other submissions contain similar statements.

A description of and management objectives for “sediment-laden” water are provided in **Section 4.3.3** (‘General’) of this RTS.

Sediment-laden runoff will be managed under an Erosion and Sediment Control Plan with the primary management strategy being rehabilitation to reduce erosion. Prior to rehabilitation, runoff from these areas will be collected in sediment dams for treatment as it may contain high sediment loads. Under most rainfall conditions, water accumulating in sediment dams will be pumped back into the mine water system within five days after a rainfall event to ensure there is sufficient storage volume for the next rainfall event. This water will be recycled to meet water demands for coal processing and dust suppression.

If the sediment dams are not able to be dewatered to the Dirty Water System within five days, excess water will be transferred to the active mining area and flocculation of sediment dams will be used to ensure that any discharges will be within the limits specified in EPL conditions for those points. During major rainfall events that exceed the capacity of the sediment dams (which are designed to a government-specified standard), some overflows from sediment dams may occur after a period of time to allow any suspended sediment to settle out of suspension. No overflows will occur from the water management system for “mine water”, which is separate from the system for managing sediment-laden water.

If adequate water is available on site, sediment dams may be dewatered to receiving waters via EPL discharge points where the water quality achieves the discharge limits specified in the EPL conditions. These EPL conditions will be based on background water quality data in the receiving waters. If the quality of this water is not suitable for release to receiving waters, it will be pumped back into the mine water management system. The discharge criteria that are relevant to the release of water from sediment basins of the Project are governed by the design criteria set out in the relevant guidelines (Landcom, 2004; DECC, 2008a). The recommended Total Suspended Solids (TSS) concentration limit in DECC (2008a) is 50 mg/L, which is similar to the background water quality of the receiving waters as presented in Table 3.7 of the Surface Water Impact Assessment. On this basis, any release of water from the sediment basins is not expected to impact on the downstream water quality.

The Erosion and Sediment Control Plan will be developed as part of the detailed design of the Project. Additional sediment and erosion control measures are identified in Section 10.3 of the Surface Water Impact Assessment. As described in Section 7.8 of the Surface Water Impact Assessment, preliminary sizing of the sediment dams has been undertaken in accordance with the current recommended design standards. The storage capacities are calculated based on containing the 90th percentile five-day rainfall at Gunnedah. In practical terms, the dams are capable of capturing and diverting water into the mine water management system for 90% of all rainfall events. Sediment dam sizes and locations will be confirmed during detailed design.

Saline Water Treatment

This section addresses the submissions from stakeholders regarding the requirement for treatment of saline water.

Submission reference: SIG10 and P30

Summary response: Saline waters will be contained within the mine water system for reuse in dust suppression and processing of coal in the CHPP. Most of the salt within the mine water management system is lost in the CHPP, which is then exported offsite with product coal or deposited with the waste generated by mechanical dewatering.

Saline waters will be contained within the mine water system for reuse in dust suppression and processing of coal in the CHPP. Water balance modelling of the mine water management system predicts Total Dissolved Solids (TDS) concentrations in the mine water storages of between 1,200 mg/L to 4,000 mg/L with median concentrations around 2,300 mg/L.

The salt water balance, which is explained further in **Section 4.3.14** below, shows that most of the salt within the mine water management system is lost in the CHPP, which is then exported offsite with product coal or deposited with the waste generated by mechanical dewatering. The mine affected water will not be used to irrigate natural ground to impact on soils.

Sewage

This section addresses the submissions from stakeholders regarding the requirement for treatment of sewage.

Submission reference: SIG10

As noted in Section 7.25.2 of the EIS, sewage will be managed via an onsite sewerage treatment facility. Further details are provided in **Section 4.25** of this RTS.

Drought Periods

This section addresses the submissions from stakeholders in regard to the suitability of the surface water management strategy for drought periods.

Submission reference: RA16

Summary response: The water management strategy has been developed for both wet periods and dry periods. Offsite supplies, obtained from licensed sources, may be used to supplement the on-site supplies during extended dry periods in accordance with the rules of the relevant water sharing plans.

The water management strategy has been developed for both wet periods and dry periods. The system has been designed to collect on site water during the wet periods for use during the dry periods. Offsite supplies, obtained from licensed sources, may be used to supplement the onsite supplies during extended dry periods. In accordance with the rules of the relevant water sharing plans, this will not reduce the entitlements of other licensed water users. Further details on the source of water during dry periods are provided in **Section 4.3.9** of this RTS.

Uncontrolled Spills of Mine Affected Water

This section addresses the submission from a stakeholder regarding emergency response plans in the event of an uncontrolled discharge of mine affected water.

Submission reference: SIG10

Summary response: The mine water management system has been designed to prevent spills from the dams containing mine affected water. Water balance modelling has also demonstrated that the proposed system would not spill mine affected water under any rainfall event over the last 100 years.

The mine water management system has been designed to prevent spills from the dams containing mine affected water. Water balance modelling has also demonstrated that the proposed system would not spill mine affected water over the historical period of rainfall record. This is because the mine affected water dams (dirty water dam and coal contact dam) have minimal catchment. Mine affected water in excess of the capacity of these dams will remain within the mining area until it can be dewatered to the mine water dams for reuse. Shenhua Watermark has committed to sacrificing a portion of the open mining area to allow mining to continue when this occurs (see Section 7.3.3 of the EIS main document).

The management of risks associated with engineering failures will be addressed through appropriate management plans which will be developed in consultation with government agencies.

4.3.4 Water Balance Model Assumptions and Methodology

General Methodology

This section addresses the submissions from stakeholders regarding the water balance modelling methodology.

Submission reference: RA13, P67

Summary response: The proposed surface water management system and the water balance modelling methodology are consistent with current industry best practice and the DGRs issued for the Project.

The proposed surface water management system and the water balance modelling methodology and inputs described in detail in the Surface Water Impact Assessment are consistent with current industry best practice and the DGRs issued for the Project.

The water balance model is based on the proposed changes in the mine plan over the life of the Project and has been simulated under 92 different climatic sequences, taken from the historical record of climate data for the Project site. This assessment methodology ensures the surface water management system proposed for the Project is robust and can withstand extended wet and dry periods.

Uncertainties in the water balance modelling methodology are discussed below.

Data Availability, Limitations and Uncertainties

This section addresses the submissions from stakeholders regarding the validity of assumptions and input data utilised for water balance modelling.

Submission reference: RA13 and SIG10

Summary response: The assumptions and methodology used in the water balance model are credible, justified and consistent with industry best practice and the DGRs, having been based on the best available data.

The assumptions made and the methodology used in the water balance model is credible, justified and consistent with industry best practice and the DGRs, having been based on the best available data.

Additional surface water monitoring data will be collected to update and validate the water balance model as mining progresses. The updated model results will be used to refine the operation of the site water management system to minimise the capture of clean water and maximise the use of mine affected water to mitigate downstream impacts.

Additional information that will be collected to update the OPSIM surface water model and improve the water management system would include:

- Pump volumes and water use rates;
- Site rainfall;
- Water levels in key storages within the water management system; and
- Monitoring of sediment dams to assess compliance with EPL conditions.

The operational rules for the water management system have been derived to satisfy both wet and dry periods and generally have fixed upper and lower bounds. These operating rules are generally based around ensuring no spills occur from the mine water dams and keeping the open cut mining area as dry as possible. There is generally no need to alter these rules for extended wet periods as the objectives are the same.

Notwithstanding this, Section 7.12 of the Surface Water Impact Assessment describes how adaptive management of the Project's water management system will be implemented to reduce risks associated with climatic variability and optimise the system performance during operation of the Project.

Evaporation and Evapotranspiration

This section addresses the submissions from stakeholders regarding the adopted evaporation and evapotranspiration rates for water balance modelling.

Submission reference: RA13 and SIG10

Summary response: Morton's Lake evaporation was used to estimate evaporation loss from storages in the water balance model. Soil moisture evapotranspiration losses were estimated using Morton's Lake evaporation with an evapotranspiration factor. This methodology is consistent with industry best practice and the DGRs.

Morton's Lake evaporation was used to estimate evaporation loss from storages in the water balance model. Soil moisture evapotranspiration losses in the Australian Water Balance Model (AWBM) included in the water balance model were estimated using Morton's Lake evaporation with an evapotranspiration factor. The SILO Data Drill data set is commonly used on similar projects and has been found to provide a reasonable representation of mine site evaporation. The SILO Data Drill data set is provided on a daily time step and is based on interpolated historical data and has been adjusted for data gaps.

Mean annual evaporation at the Gunnedah Resource Centre (BOM Station No. 055024) is 1,752 mm, which compares well to the value of 1,781 mm from the SILO Data Drill data set for the same period of record.

4.3.5 Australian Water Balance Model

This section addresses the submissions from stakeholders regarding the suitability of the AWBM used for the surface water modelling.

Submission reference: RA13 and SIG10

Summary response: Model parameters were calibrated to recorded rainfall and stream flows and were further verified with a simulation of the Lake Goran water balance. Overall, the calibration and verification process adopted to determine the model parameters is robust and to industry recognised standards.

The Australian Water Balance Model (AWBM) is a daily catchment water balance model utilised for estimating runoff from ungauged catchments. The model was developed in the early 1990's and has been used extensively across Australia (Boughton, 2003).

The AWBM parameters listed in Table 6.3 of the Surface Water Impact Assessment are a result of the development and calibration of a rainfall runoff model for the Mooki River catchment, as described in detail in Section 6 of the Surface Water Impact Assessment. These parameters were calibrated to recorded rainfall and stream flows and were further verified with a simulation of the Lake Goran water balance. Calibration was achieved through both visual comparisons of stream flows and flow duration curves and statistical comparisons using the sum of the squares of the differences of recorded and simulated water levels and flows.

Previous studies (Zhang et al., 1997) have indicated that significant recharge of the alluvial aquifers occurs through infiltration of runoff from the Liverpool Ranges. As explained in Section 6.3.2 of the Surface Water Impact Assessment, a transmission loss was adopted to represent groundwater recharge from surface runoff, as well as water extracted for agricultural use. Without this, the rainfall runoff model of the Mooki River catchment would overestimate surface runoff at locations downstream from the Liverpool Ranges. Overall, the calibration and verification process adopted to determine the model parameters is robust and to industry recognised standards.

The AWBM rainfall runoff model was also used to model catchment runoff in the water balance model for the Project. Catchments across the site were characterised into similar land use types that are expected to have similar runoff characteristics. For natural/undisturbed areas, the calibrated AWBM parameters (from Section 6 of the Surface Water Impact Assessment) were adopted.

The parameters for the other land use types on site were based on previous experience at other mine sites and available literature (ACARP, 2001). Whilst these parameters are not calibrated (because the mine has not been built), a sensitivity assessment of increasing or decreasing the adopted runoff coefficients by 10% (discussed in Section 7.11 of the Surface Water Impact Assessment) shows the water management system is robust and does not increase the likelihood of an overflow from the mine water system.

Water Quality

This section addresses the submissions from stakeholders regarding the validity of only using salinity in the water balance model to assess water quality impacts.

Submission reference: SIG10, P4, P20, P57 and P67

Summary response: Only waters from the sediment dam system, which have not come into contact with coal, will be released from the site once the relevant water quality criteria have been met as specified in the EPL discharge point's conditions.

Only waters from the sediment dam system, which have not come into contact with coal, will be released from the site. The water quality of any releases will be in accordance with the requirements as specified in the EPL discharge point's conditions.

Groundwater Inflows to the Water Management System

This section addresses the submission from a stakeholder regarding the groundwater inflow rates adopted for water balance modelling.

Submission reference: SIG10

Summary response: The groundwater inflow rates adopted were as reported in the Groundwater Impact Assessment for the Project. The adopted groundwater inflow rate for each representative stage in the water balance model is the average groundwater inflow over the duration of that representative stage.

The water balance model was simulated using seven representative mine stages over the 30 year mine life, as described in Section 7.3 of the Surface Water Impact Assessment. The adopted groundwater inflow rate for each representative stage in the water balance model is the average groundwater inflow over the duration of that representative stage, as shown in Table 7.10, Section 7.7.1 of the Surface Water Impact Assessment. The duration of each representative stage is provided in Table 7.2, Section 7.3.2 of the Surface Water Impact Assessment. The groundwater inflow rates adopted were supplied by Australasian Groundwater and Environmental Consultants (AGE) and are reported in the Groundwater Impact Assessment (Appendix T of the EIS, Figure 10.7, Section 10.4).

The groundwater inflow rate adopted for the Year 25 mine stage (371 ML/annum) is the average of groundwater inflows reporting to the active mining area (as provided by AGE, 2012) in the Groundwater Impact Assessment that was independently peer reviewed) over Years 23 to 26. The use of the average inflow rate over this period would have a very small effect on the overall site water balance and would not increase the likelihood of an offsite discharge from the mine water management system.

4.3.6 Dust Suppression

This section addresses the submission from a stakeholder regarding the adopted haul road dust suppression water rate for the water balance modelling.

Submission reference: RA2

Summary response: Shenhua Watermark has committed to the use of speed control signage, water carts and/or dust suppressants on haul roads to reduce dust emissions. This will reduce the required volume of water for dust control. Therefore, water use for dust suppression for the Project will be lower than at other mines which do not use dust suppressants.

The adopted water demand rate for haul road dust suppression in the EIS is consistent with measured rates at comparable mines. Shenhua Watermark has committed to the use of speed control signage, water carts and/or dust suppressants which reduce the required volume of water for dust control and for this reason; water use for dust suppression on haul roads at the Project will be lower than at other mines which do not use dust suppressants.

Table 6 shows recorded water use volumes for dust suppression at 14 mines in the Hunter Valley and Gunnedah Basin. Dust suppression water volumes are dependent on the size of the mine and hence vary significantly. **Table 7** shows dust suppression volumes converted to an area-based rate (where area information is available) which is more directly comparable between projects. The adopted water application rate for the Project is similar to recorded rates at other projects, even though some of those projects do not use dust suppressants.

Table 6
Summary of Reported Dust Suppression Water Use for Existing Mines

Mine	Reported Dust Suppression Usage (ML/annum)									
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Rocglen	-	-	-	-	-	53 ^a	74 ^a	107 ^a	100 ^{a,b}	-
Werris Creek	-	-	-	-	-	130 ^a	155	140	189	376 ^b
Tarrawonga	-	-	-	-	92 ^a	73 ^a	160 ^a	184 ^{a,b}	369 ^{a,b}	-
Boggabri	-	-	-	-	168 ^c	233 ^c	262 ^c	400 ^c	-	-
Sunnyside	-	-	-	-	-	36 ^a	31 ^a	45 ^a	-	-
Drayton	-	-	-	-	603	814	720	600	600	-
Mt Arthur Coal	2410	2900	794	1095	1071	1280	1375	2086 ^d	1248 ^d	-
Muswellbrook	-	-	-	-	-	-	540	437	538	-
Mangoola	-	-	-	-	-	-	-	201	332	-
Bengalla	390	460	438	205	338	421	229	360 ^e	746 ^e	-
Mount Pleasant	-	-	-	-	-	-	-	-	-	-
Mount Thorley Warkworth	-	1424	1320	-	1157 ^f	1199 ^f	1255 ^f	1195 ^f	1263 ^f	-
Hunter Valley Operations	-	-	1798 ^f	1970 ^f	1615 ^f	1533 ^f	3304 ^f	1504 ^f	1932 ^f	-
Mt Owen Complex	410 ^c	470 ^c	520 ^c	850 ^c	813 ^c	-	-	-	817 ^c	-

Note: (-) Could not be sourced/not available; (a) mine site and processing facility dust suppression; (b) dust suppression used to dispose of excess water in-mining area; (c) total dust suppression/no breakdown in dust suppression usages provided; (d) used dust suppressant; (e) including open water evaporation, seepage and water carts; (f) includes haul roads, mining areas and coal stockpiles.

Table 7
Comparison of Haul Road Water Application Rates

Subject	mm/day	L/m ² /hr ^a	PRP Reported Control Efficiency
Average Evapotranspiration	4.1	0.41	-
Adopted for Water Balance Modelling in Surface Water Impact Assessment			
With dust suppressant (Years 5, 10, 15, 21)	1.92 ^b	0.19 ^b	-
Without dust suppressant (Years 2, 25, 30)	4	0.4	-
ACARP (2008a)			
Median	2.5	0.25	-
Leading practice	1.26	0.13	-
Mount Thorley Warkworth (Without dust suppressant)	2.7-3.4 ^c	0.27-0.34	47%-58%
Hunter Valley Operations (Without dust suppressant)	1.9 ^d	0.19	62%
Bengalla (Without dust suppressant)	3.9 ^a	0.39	76%
Mt Owen (Without dust suppressant)	0.735 ^a	0.0735	76%

Note: (a) based on a 10 hour watering day; (b) equivalent to 0.08 L/m²/hr for a 24 hour period; (c) assumed a 10 hour watering day; (d) calculated by WRM from other information available.

The use of road watering to control dust emissions from haul roads is based on maintaining moisture at the road surface. A surface moisture content of about 5% is required to achieve a PM₁₀ control efficiency of 80% (Buonicore and Davis, 1992). The primary loss of moisture from the road surface is due to evaporation because compaction prevents significant infiltration loss. Hence, maintaining a given moisture content on haul roads only requires the application of sufficient water to replace evaporation. Where additives are used (as proposed as an option for the Project), the volume of water is less than evaporation due to binding of particles at the road surface. In addition, road watering requirements are reduced or eliminated on days when rainfall occurs.

The average evapotranspiration rate within the Project Boundary is about 4.1 mm per day. The adopted road watering application rate for the EIS was 1.92 mm per day which represents a reduction of approximately 50% to account for the effects of speed control signage, water carts and/or dust suppressants.

The submission refers to “commitments to apply some two litres/square metre/hour or more to haul road surfaces” at comparable projects in the Gunnedah Basin. It is possible that this represents a maximum watering rate under adverse climatic conditions (hot and windy summer day) rather than an annual average. The submission also refers to a potential “25 fold increase in water demand for haul road dust suppression”, implying a water application rate of 48 mm per day (2 mm per hour x 24 hours).

As shown in **Table 7**, recorded water use for dust suppression at comparable projects is typically less than 10% of this value. Application of 48 mm of water per day would vastly exceed evaporation loss, resulting in runoff from haul roads and associated safety issues (ACARP 2008a; Donnelly et al., 2011).

An assessment of the availability of make-up water supply from groundwater has been completed by GHD (GHD, 2013 – see **Section 4.3.10** of this RTS). The assessment found that an existing irrigation bore on Shenhua Watermark owned land could supply approximately 75 L/s (2,365 ML/annum) (subject to licensing requirements), which is significantly greater than the forecast external water supply requirement under extreme drought conditions (900 ML/annum). Hence, even if the actual dust suppression requirements for the Project are greater than predicted, adequate water supply will be available to ensure that target dust control efficiency is achieved.

4.3.7 Water Balance Model Results

Static Simulation Results

This section addresses the submission from a stakeholder regarding the results of the static water balance modelling.

Submission reference: SIG10

Summary response: The static water balance modelling provides an indication of the performance of the water balance under the specific operating rules adopted for that stage of operation and allows for a comparison of inflows and outflows between the different stages. In reality, the operational rules of each stage would not be fixed for the life of the Project, as per the modelling methodology for a static simulation.

SIG10 raises a concern regarding apparent discrepancies in the results provided in Table 29 of the EIS main document. The reason for the apparent discrepancy in water volumes retained on site in sediment dams is that water is pumped out of the sediment dams and into the Dirty Water Dam for use on site. As this is an internal transfer of the water management system, it is not included in the tabulated results provided, which only show the inputs and outputs from the water management system as a whole. The results provided in Table 29 of the EIS show that the water management system balances, with gross water inputs to the system (including rainfall / runoff yield and groundwater) plus externally sourced water, equalling the gross water outputs from the system (evaporation, demands and sediment dam releases) plus the water retained on site.

Water retained in the proposed open cut mining areas is considered as part of the Static Simulation results. It is listed in Table 7.13 of the Surface Water Impact Assessment under “Water Retained Onsite” as “Active Mining Area”. The water retained in the mining area would also include water retained in pore water within the active mining areas.

SIG10 also notes the potential for discharge volumes of up to 307 ML/annum from sediment dams as a result of the Project. This relates to the static simulation results, which as explained in Section 7.3.1 of the Surface Water Impact Assessment, is useful for providing an indication of the water balance under the specific operating rules adopted for that stage of operation and allows for a comparison of inflows and outflows between the different stages.

In reality, the operational rules of each stage would not be fixed for the life of the Project, as per the modelling methodology for a static simulation. The forecast results provide a better indication of expected overflows from sediment dams.

External Water Requirements

This section addresses the submission from a stakeholder regarding the forecast external water requirements for the Project.

Submission reference: RA2

Summary response: Offsite water may be required for all percentile results due to evaporation from the Turkey's Nest Dam which is only supplied from offsite water supplies. Hence, even under wet conditions, there will still be evaporation from the Turkey's Nest Dam which the model replenishes by importing a small amount of water from offsite.

RA2 queries why the water balance modelling shows that some imported water will be required even in 1 and 10 percentile wet years, despite onsite water being sufficient to satisfy demands 90% of the time.

The percentile results presented in the Surface Water Impact Assessment do not show results for wet "years" and do not represent continuous results from a single modelled climate sequence. A percentile trace shows the percentile chance of a particular value on a single day. See Section 7.3.2 and Section 7.10.4 of the Surface Water Impact Assessment for detail on forecast simulation methodology and Section 7.10.4 of the Surface Water Impact Assessment for more information on the interpretation of forecast simulation results.

The reason that some offsite water may be required for all percentile results is due to evaporation from the Turkey's Nest Dam which is only supplied from offsite water supplies. Hence, even under wet conditions, there will still be evaporation from the Turkey's Nest Dam which the model replenishes by importing a small amount of water from offsite sources.

4.3.8 Water Balance Model Sensitivity to Climate Change

This section addresses the submissions from stakeholders regarding the effect of climate change on the water balance model.

Submission reference: RA13, SIG2 and P30

Summary response: An assessment of the effect of climate change on the water balance model results was undertaken using forecasts by CSIRO. The model results indicate some changes in the performance of the site water management system. However, the results indicate that the system can still be operated to achieve the key design criterion of no spills from the mine water management system.

Overview

An assessment of the effect of climate change on the water balance model results was undertaken using forecasts by CSIRO. The model results indicate some changes in the performance of the site water management system.

However, the system can still be operated to achieve the key design criterion of no spills of mine water from the water management system. Further details on the methodology and results of the sensitivity assessment are provided below.

Adopted Climate Scenarios

Projections of Australia's future climate were obtained from the "Climate Change in Australia" service (DCEE, 2013), developed by CSIRO and the BoM through the Australian Climate Change Science Program. An explanation on the available climate change projections by the Climate Change in Australia service is provided below:

"Projections are given relative to the period 1980-1999 (referred to as the 1990 baseline for convenience). The projections give an estimate of the average climate around 2030, 2050 and 2070, taking into account consistency among climate models. Individual years will show variation from this average. The 50th percentile (the mid-point of the spread of model results) provides a best estimate result. The 10th and 90th percentiles (lowest 10% and highest 10% of the spread of model results) provide a range of uncertainty. Emissions scenarios are from the IPCC Special Report on Emission Scenarios. Low emissions is the B1 scenario, medium is A1B and high is A1FI."

Climate change projections were chosen based on the medium emissions scenario for 2030 for the 10th and 90th percentile estimates to provide an indication of variation in potential climate change.

Table 8 shows the range of projected change in rainfall and evaporation provided by the Climate Change in Australia service for the relevant area of the Project. The adopted projected percentage changes, shown in **Table 8**, were applied to the daily time series of rainfall and evaporation used in the water balance model, whilst all other inputs and operating rules remained unchanged. Scenario 1 represents conditions that are 10% drier than current with no change in evaporation and Scenario 2 represents conditions that are 5% wetter than current and 8% greater evaporation rates. Scenario 1 and Scenario 2 were compared to the modelling results presented in the Surface Water Impact Assessment, which will be referred to as the base case.

Table 8
Climate Change Projection for 2030 – Medium Emission Scenario

Scenario Name	Climate Change Projection Estimate	Rainfall		Evaporation	
		Projected Range	Adopted	Projected Range	Adopted
Scenario 1	10%ile	-10% to -5%	-10%	-2% to 2%	0%
Scenario 2	90%ile	2% to 5%	5%	4% to 8%	8%

Model Results – Scenario 1

The results of the forecast water balance simulation for Scenario 1 (10% drier conditions) are summarised as follows:

- The volume of water held on site is reduced:
 - At any point in time prior to Year 26, there is a 50% chance that the Dirty Water System will be less than 600 ML;
 - There is a 10% chance that the Dirty Water System will be at or above the Maximum Operating Volume at any point in time after about 15 years, compared to 7 years for the base case.
- There are no modelled spills from the Dirty Water System;
- The risk of water accumulating in the active mining area is significantly reduced. This is due to less inflow to the active mining area from direct rainfall and runoff, and also due to the Dirty Water System reaching the Maximum Operating Volume (set to prevent spills) less often, resulting in more available storage space for dewatering to occur when it is required:
 - For the 1st and 10th percentile traces, at the end of mine life there is a 50-55% decrease in the active mining area stored water volume, compared to the base case; and
 - For the 50th percentile trace, the active mining area is essentially completely dewatered at any point in time over the mine life, compared to accumulating 780 ML at the end of mine life for the base case;
- The risk of requiring offsite water increases in order to supplement the reduced volumes of water available on-site:
 - There is a 50% chance that a total volume of 360 ML, at most, of offsite supplies will be required to supply operational demand in Year 6 and Year 7, compared to 143 ML in Year 7 for the base case;
 - There is a 10% chance (90th percentile results) that a total volume of at least 670 ML to 700 ML of offsite supplies will be required per annum to supply operational demand between Year 4 to Year 14, compared to 580 ML in Year 5 and Year 7 for the base case; and
 - There is 1% chance (99th percentile results) that a total volume of approximately 940 ML to 960 ML of offsite supplies will be required per annum to supply operational demand between Year 4 to Year 17, compared to 900 ML to 920 ML per annum between Year 5 to Year 17 for the base case; and
 - By the end of mine life, the cumulative offsite water requirement for the 30 year mine life has:
 - Increased by 240% for the 50th percentile results trace, compared to the base case; and
 - Increased by 50% for the 10th percentile results trace, compared to the base case; and

- Increased by 11% for the 1st percentile results trace, compared to the base case;
- The risk of sediment dams spilling is reduced, as there is more available storage space in the Dirty Water System.

Model Results – Scenario 2

The results of the forecast water balance simulation for Scenario 2 (5% wetter conditions) are summarised as follows:

- The effect of the increase in rainfall is largely offset by the increase in evaporation. The combined effect of these two changes has resulted in an overall increase of water captured on site:
 - The volume of water held on site is slightly higher, resulting in an increased risk of reaching the Maximum Operating Volume of the Dirty Water System;
- The risk of water accumulating in the active mining area is slightly increased:
 - For the 1st and 10th percentile traces, at the end of mine life there is a 10-15% increase in the active mining area stored water volume, compared to the base case; and
 - For the 50th percentile trace, at the end of mine life there is a 20% increase in the active mining area stored water volume, compared to the base case, however over the majority of mine life (i.e. the first ~25 years), there remains a 50% chance that the active mining area will be completely dewatered at any point in time;
- The risk of requiring offsite water decreases slightly, as there is more water captured on-site which is preferentially used to meet site demands:
 - Apart from the first year, there is at least a 50% chance that the requirement for offsite supplies will not exceed 50 ML in any year; and
 - The 90th and 99th percentile results traces, although slightly lowered, remain practically unchanged. So there remains a 1% chance that a total volume of approximately 900 ML to 920 ML of offsite supplies will be required per annum to supply operational demand between Year 5 to Year 17 and a 10% chance of requiring around 550ML per annum between Year 5 to Year 8.
 - By the end of mine life, the cumulative offsite water requirement for the 30 year mine life has:
 - Decreased by 24% for the 50th percentile results trace, compared to the base case; and
 - Decreased by 9% for the 10th percentile results trace, compared to the base case; and
 - Decreased by 1.5% for the 1st percentile results trace, compared to the base case;

- The risk of sediment dams spilling is slightly increased, as the Dirty Water System is at or above its Maximum Operating Volume more frequently. As described in the Surface Water Impact Assessment, in reality, if the sediment dams are not able to be dewatered to the Dirty Water System within 5 days, excess water will be transferred to the active mining area and flocculation will be used to ensure that any overflows will be within EPL discharge limits.

Summary

Scenario 1 resulted in a much lower risk of water accumulating in the active mining area (50-55% lower at the end of mine life for the 1st and 10th percentile traces) and an increased risk of requiring offsite water supplies (11% increase and 50% increase in the cumulative requirement over the entire mine life for the 1st and 10th percentile results traces, respectively).

Scenario 2 resulted in a slight increase in the risk of water accumulating in the active mining area (10-15% higher at the end of mine life for the 1st and 10th percentile traces). However the model results confirm that the water management system will operate successfully under this scenario. As described in **Section 4.3.3** ('Containment of Mine Affected Water) of this RTS, the commitment has been made in Section 3.9.1 of the EIS that "part of the open cut mining area will be used to store this [mine affected / dirty] water which will be later reused in the mine water management system", as required.

4.3.9 Change in Flow Regime / Catchments

This section responds to the submissions raised by stakeholders regarding the potential loss of surface water from the water supply catchment.

Submission reference: RA7, RA12, SIG5, SIG6, SIG8, SIG9, SIG10, SIG14, P3, P8, P18, P20, P22, P27, P30, P36, P39, P41, P57, P65, P66, P71, P72, P100 and P104

Summary response: The assessment of catchment loss has been updated to include a number of minor adjustments. These adjustments, based on improved definition of catchment boundaries, reduce the maximum amount of catchment captured in Watermark Gully during mine operations to 14% and reduce the percentage increase in Watermark Gully catchment post mining (from 13% to 9%).

Section 5.4 of the Surface Water Impact Assessment assesses the potential impact of loss of catchment areas draining to Watermark Gully, Native Dog Gully and Lake Goran due to capture of runoff within onsite storages and the open cut mining area.

A number of submissions raise a concern with the potential for Watermark Gully to be affected by a reduction in catchment of 25%, as stated in the Executive Summary and Section 11 of the Surface Water Impact Assessment. This percentage refers to the Year 30 mine plan and does not account for the areas of established rehabilitation where runoff will be released offsite (which reduces the catchment loss) and as a result is not a true reflection of the loss of catchment and downstream flow.

The assessment of catchment loss in the Surface Water Impact Assessment has been updated to include a number of minor adjustments. These adjustments, based on improved definition of catchment boundaries, reduce the maximum amount of catchment captured in Watermark Gully during mine operations to 14%.

This also reduces the increase in Watermark Gully catchment post mining (from 13% to 9%). Further detail is provided on the revised loss of catchment assessment in the following sections.

Revised Assessment of Catchment Loss – During Operations

During active mining operations, the mine water management system will capture runoff from areas that would have previously flowed to the receiving waters of Watermark Gully, Native Dog Gully or Lake Goran. The loss of catchment assessment provided in Section 5.4.1 of the Surface Water Impact Assessment has been updated to include a portion of catchment that was previously assumed to be directed into the Native Dog Gully catchment but will actually drain to Watermark Gully. This reduces the amount of catchment “lost” in the Watermark Gully catchment to the Kamilaroi Highway, resulting in a maximum loss of catchment of 14% for the Year 25 mine plan.

Table 9 shows the updated catchment areas captured within the mine water management system for various stages of the Project. The catchment areas shown in **Table 9** are the maximum catchment areas captured, which does not directly relate to the loss of catchment flow because of the potential for releases from sediment dams. As rehabilitation of the OEA progresses and the quality of surface runoff improves, runoff from fully rehabilitated areas will drain back into the downstream catchment (details are provided in Section 7.4 of the Surface Water Impact Assessment). This will minimise the loss of catchment flows to the receiving environment. The maximum catchment areas therefore captured by the Project represent:

- Less than 0.75% of the Mooki River catchment to the Breeza Gauge (3,630 km²) excluding the Lake Goran and Yarraman Creek catchment;
- Approximately 14% of the catchment area of Watermark Gully to the Kamilaroi Highway for the Year 25 mine plan;
- Approximately 29% of the catchment of Native Dog Gully (excluding Yarraman Creek) for the Year 21 mine plan; and
- Less than 0.4% of the catchment to Lake Goran.

Table 9
Catchment Area Captured Within the Mine Water Management System

Catchment	Catchment Area (km ²)	Captured Catchment Area (km ²)						
		Year 2	Year 5	Year 10	Year 15	Year 21	Year 25	Year 30
Watermark Gully/ Mooki River North	54.4	1.8	5.0	6.0	4.3	7.3	7.8	4.7
Native Dog Gully	67.9	5.3	6.8	9.1	13.6	19.7	6.8	5.8
Lake Goran	1,365	0.0	0.0	0.0	0.0	0.0	2.6	4.5

Revised Assessment of Catchment Loss – Post Mining

At the completion of mining, surface runoff from rehabilitated OEAs will drain freely from the site in a similar manner to existing conditions. An area of approximately 1.1 km² will drain to the final void, which originally drained to Lake Goran. The assessment of post mining catchment loss was updated to include a portion of catchment which was previously assumed to be directed into the Watermark Gully catchment but actually reports to the Lake Goran catchment. This reduces the increase in the Watermark Gully catchment draining to the Kamilaroi Highway post mining to 9% (compared to 13% reported in the Surface Water Impact Assessment).

The final landform catchment boundaries are shown in **Figure 24**. The net change in catchment area draining from the site is summarised in **Table 10**. The changed topography as a result of the Project final landform will have the following impacts on catchment areas:

- The catchment draining to the north to the Kamilaroi Highway will increase by 5 km² (an increase of approximately 9%), which includes Watermark Gully (3.6 km²) and small areas on the eastern side of the Disturbance Boundary draining towards the Mooki River floodplain (1.4 km²);
- The catchment draining to Lake Goran will be reduced by 4.5 km². This represents a reduction in catchment area of less than 0.4% and, in practical terms, will have no measureable impact on inflows to the lake; and
- The catchment draining south to Native Dog Gully (excluding Yarraman Creek) and the Mooki River floodplain will be reduced by 1.6 km², a decrease of approximately 2%.

Table 10
Change in Catchment Area – Final Landform

Receiving Watercourse	Change in Catchment Area (km ²)
Watermark Gully	+3.6
Mooki River North	+1.4
Native Dog Gully / Mooki River South	-1.6
Lake Goran	-4.5
Final Void	+1.1

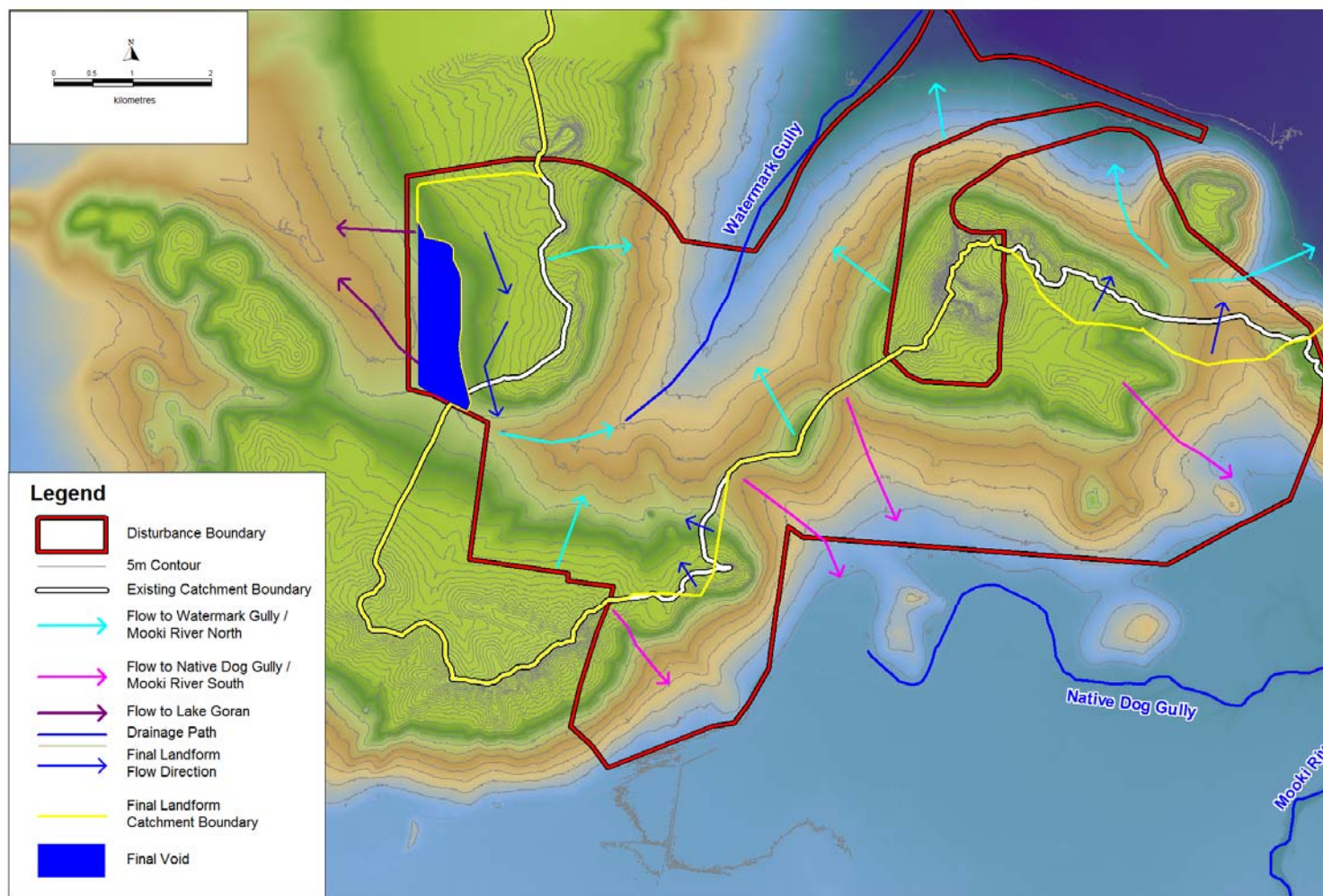


Figure 24
Final Landform Catchment Boundaries

Impact of Catchment Area Changes on a Water Source

There are two water sources potentially impacted by the Project; the Lake Goran Water Source and the Mooki River Water Source. The maximum loss of catchment due to the Project to the Mooki River (to the Breeza Gauge) is less than 0.75% and the loss of catchment to the Lake Goran catchment both during and post mining represents less than 0.4%. These reductions in catchment areas will have no measureable impact on inflows to the Mooki River, Lake Goran or the existing surface Water Access Licences from these sources, particularly given the majority of runoff is generated by the upper catchment areas with a higher rainfall. As a result, the reduction in catchment area and runoff will have an immeasurable impact on Mooki River flows and Mooki River unregulated users.

Note that the proposed sediment and mine water dams are solely for the capture, containment and recirculation of mine affected water consistent with best management practice and as such are exempt from the requirement for water supply works approvals and WALs under the WM Act. On this basis, water captured in the site water management structures with the exception of rainfall runoff from undisturbed natural catchments, is not subject to licensing.

Impact of Watermark Gully Catchment Change

The maximum loss of Watermark Gully catchment to the Kamilaroi Highway is 14% in Year 25. Note that this represents only one stage of mining. The remainder of the mine stages have less catchment captured by the Project. There will also be no long term reduction in catchment or flows to Watermark Gully, with an increase of 9% to the Kamilaroi Highway expected post mining.

Watermark Gully within the Project Boundary is an ill-defined first order watercourse, highly ephemeral and flows only for short periods during and immediately after rainfall. The flow frequency analysis, provided in Section 8.4 of the Surface Water Impact Assessment, estimates that Watermark Gully would be dry about 97.9% of the time under existing conditions. A review of the available aerial photography indicates that flows from Watermark Gully would spread out onto the Mooki River floodplain downstream of the Kamilaroi Highway. This area also receives runoff from the Mooki River floodplain and floodwater from the Mooki River. Flows from Watermark Gully, the Mooki River floodplain and overflows from the Mooki River drain in an ill-defined manner for approximately 13 km across intensively cropped farm land to what is known as Curlewis Swamp.

The catchment draining to Curlewis Swamp is approximately 250 km². The maximum loss of catchment draining to Curlewis Swamp during operations would be 3.1% (Year 21) with the catchment increasing by 1.9% post mining.

Given the existing drainage conditions across the Mooki River floodplain, it is likely that Curlewis Swamp would only receive runoff from within the Project Boundary during significant and extended rainfall events with the remainder of smaller rainfall events captured by the floodplain. The majority of runoff collected within Curlewis Swamp would be from very localised rainfall and overflows from the Mooki River. On this basis, the impact of the Project on Curlewis Swamp would be negligible.

There is little opportunity to capture and harvest Watermark Gully flows for stock and domestic use once it reaches the Mooki River floodplain. Stock and domestic supplies from surface water in this area are taken from farm dams that collect runoff from contour banks that will not be impacted by the Project. As a result, the Project is not expected to impact on the existing harvestable right of adjoining landowners.

Impact of Native Dog Gully Catchment Change

The maximum loss of catchment to Native Dog Gully (excluding Yarraman Creek) is 29% in Year 21. Again, this is a temporary phase during mining, with all other representative mine stages expected to have less catchment captured, with a final reduction of about 2% post mining.

Given that Native Dog Gully receives flows from the Mooki River, Yarraman Creek and overflows from Lake Goran, the loss of flow in Native Dog Gully is not expected to be significant. If the Yarraman Creek catchment (which drains to Native Dog Gully in low flow conditions) is also accounted for, the maximum loss of catchment during operations would represent 3.5% in Year 21 and less than 0.5% post mining.

4.3.10 Water Supply

This section addresses the submissions from stakeholders regarding the requirement, source and availability for supplementary water supply from offsite.

Submission reference: RA2, RA13, RA16, SIG10, SIG14, P18, P20, P30, P45, P57 and P62

Summary response: Very little of the offsite water requirement can be obtained from the Mooki River, due to the Mooki River generally being dry at the times when offsite water is required. The maximum external make-up water supply (600 ML/annum or 19 L/s) has been demonstrated to be obtained from existing or proposed bores on Shenhua Watermark owned land, subject to appropriate water licensing.

The Project will require water to meet operational water demands, such as coal processing and dust suppression. What cannot be sourced from onsite will need to be sourced from off-site.

Two potential sources of offsite water supply have been identified:

- Surface water via a pump station at the Mooki River; and
- Transfer of water from Groundwater Management Zones via a bore field.

The investigation into potential sources of offsite water supply (detailed in the following sections) shows that very little of the offsite water requirement can be obtained from the Mooki River, due to the Mooki River generally being dry at the times when offsite water is required. A hydrogeological assessment by GHD (GHD, 2013) indicates that the maximum external make-up water supply (600 ML/annum or 19 L/s) could be obtained from an existing irrigation bore on Shenhua Watermark owned land, or other existing or proposed bores, subject to appropriate water licensing.

External Water Supply Requirements

The site water management system has been designed to maximise reuse of onsite surface runoff and groundwater inflows, and hence reduce the requirements from offsite water supply sources. The Surface Water Impact Assessment provides detailed analysis to estimate the offsite water requirements, which vary significantly from year to year due to climatic variability, as well as the dynamic nature of the mine itself.

Results of the water balance model from the Surface Water Impact Assessment show that:

- On average, different stages of mining will operate with a net water deficit of the order of 20 to 150 ML/annum (the site water balance will vary significantly from year to year, depending upon climatic conditions); and
- On average, water collected onsite, such as groundwater inflow and surface runoff to mining areas and storages should be able to meet all mine water demands about 90% of the time.
- There is a 10% chance that the volume of external water supply required in any year will be of the order of 300 to 500 ML/annum.

Under extreme drought conditions (1% probability), the annual volume of external water supply could potentially be 900 ML/annum. External Water Supply Source and Availability

Extraction from the Mooki River is subject to the appropriate WALs and the rules specified in the *Water Sharing Plan for the Phillips Creek, Mooki River, Quirindi Creek and Warrah Creek Water Sources 2003*. Section 17 of the water sharing plan states:

“(2) The following flow classes are established in the Mooki River Water Source as the basis for sharing of daily flows:

(a) very low flow class at or less than 100 ML/day on a rising river and at or less than 50 ML/day on a falling river, as measured at the Mooki River at Breeza and protected through to the end of the system

Note. The 100 ML/day corresponds to the estimated 18th percentile of flows for all days of the year, and is referred to as the commence to pump on a rising river and the 50 ML/day is referred to as the cease to pump on a falling.”

The site water balance model was used to assess the volumes potentially available for harvesting from surface flow in the Mooki River (assuming licences are available) taking into account the cease to pump restrictions described above. Stage 2 (Year 5) of the Project has the greatest offsite water requirements. Based on the recorded Mooki River stream flows at Breeza (1958 to 2010), the sources of offsite water requirements for Stage 2 (Year 5) of the Project are presented in **Figure 25**. Note that the maximum annual offsite water requirement appears to be 600 ML/annum (as opposed to 900 ML/annum reported in the Surface Water Impact Assessment) as recorded Mooki River stream flows have been used (1958-2010) for the analysis rather than simulated Mooki River stream flows (1889-2011).

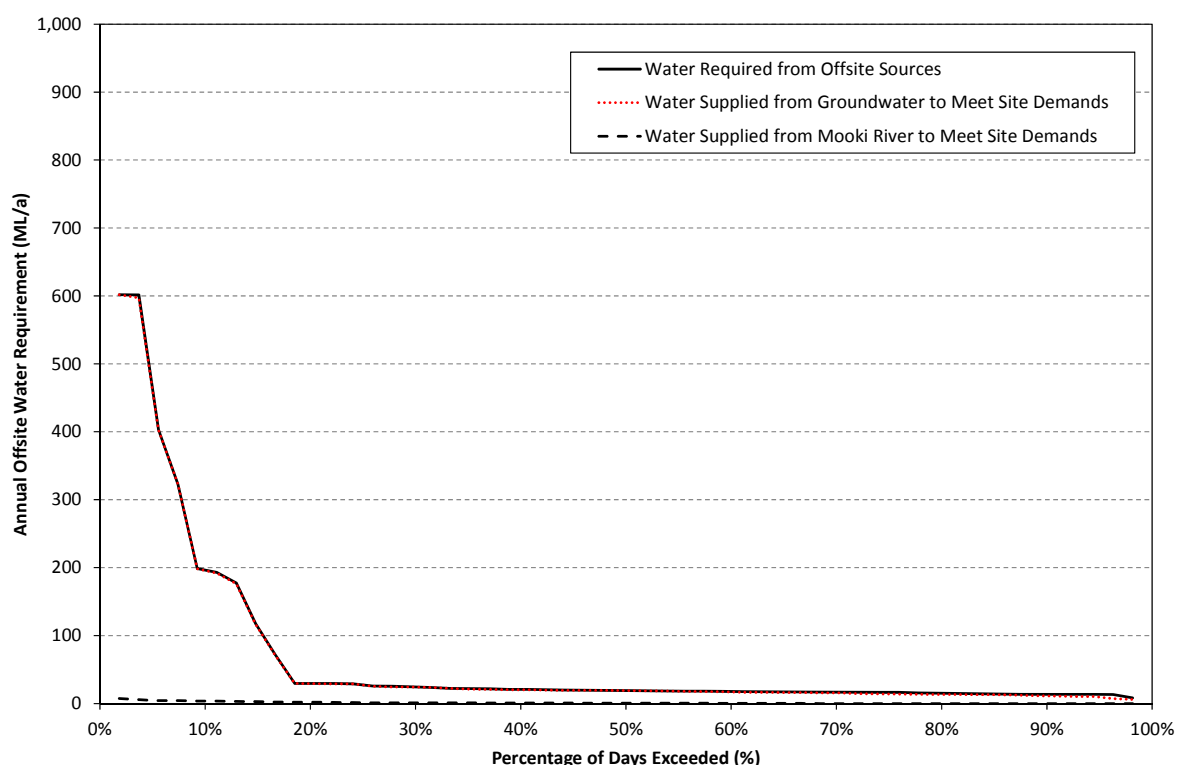


Figure 25
Offsite Water Requirement and Supply Source – Using Recorded Mooki River Streamflows (1958-2010)

Figure 25 shows that very little of the offsite water requirement can be obtained from the Mooki River. This is due to the timing of the offsite water requirements as the Mooki River is generally dry when offsite water is required. When the Mooki River is flowing, there is usually enough water on site to meet demands.

Figure 26 and **Figure 27** show the offsite water requirements and Mooki River flows which would occur if a climatic year similar to that of 1960 occurred during Year 5 of the mine life. Total annual rainfall for 1960 was 616 mm, which is slightly less than the average annual rainfall of 639 mm/annum, and the site deficit is 602 ML/annum. The results show that the majority of offsite water supply would need to be obtained from groundwater rather than flow in the Mooki River.

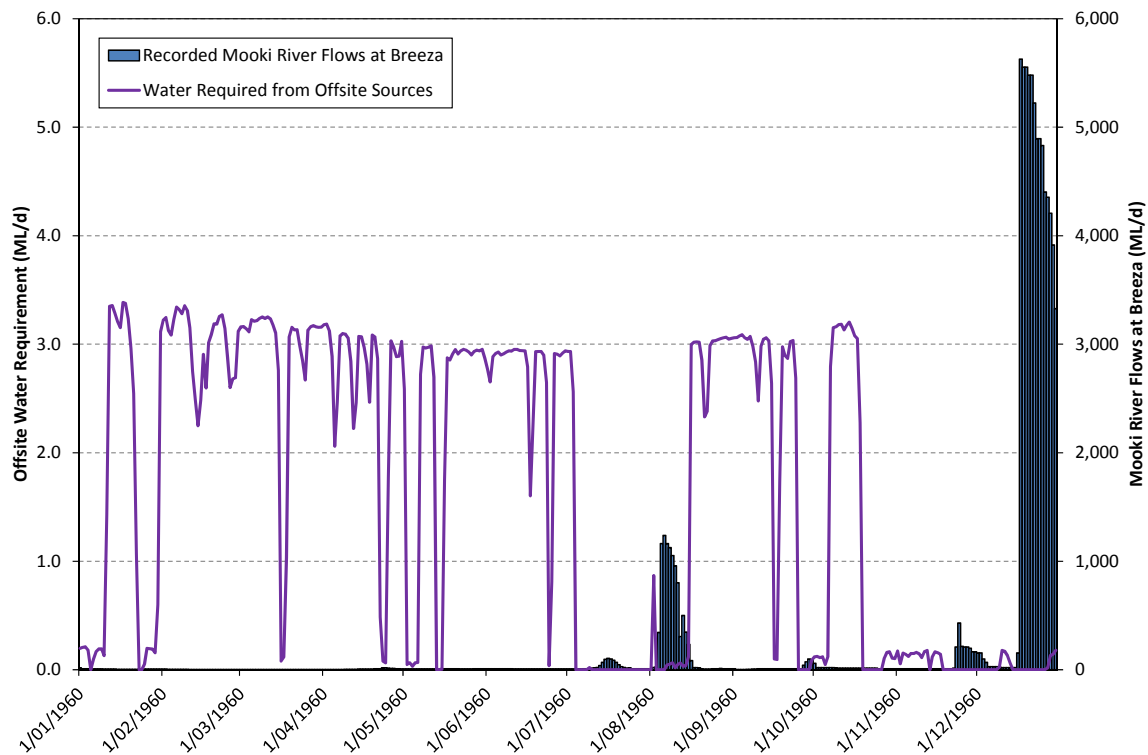


Figure 26
Offsite Water Requirements versus Mooki River Streamflows

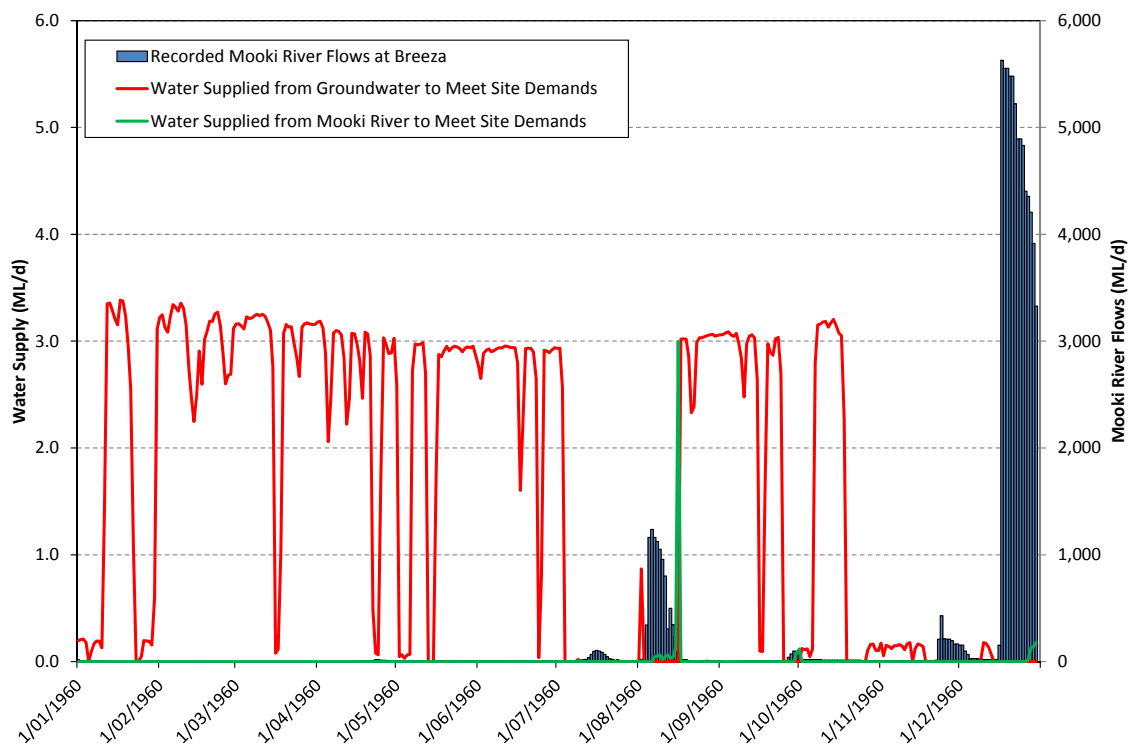


Figure 27
Water Supply Source versus Mooki River Streamflows

Figure 28, Figure 29 and Figure 30 show the water supply sources to meet the site water demands for three sample climatic realisations of the entire Project life (30 years). Realisation 70 represents a drier 30 year period, realisation 83 presents a wetter period, and realisation 90 represents the median. The majority of site water demands are supplied from the site water management system. During dry periods, some water is required from offsite sources, largely supplied by groundwater. The Mooki River contributes very little to site water demands.

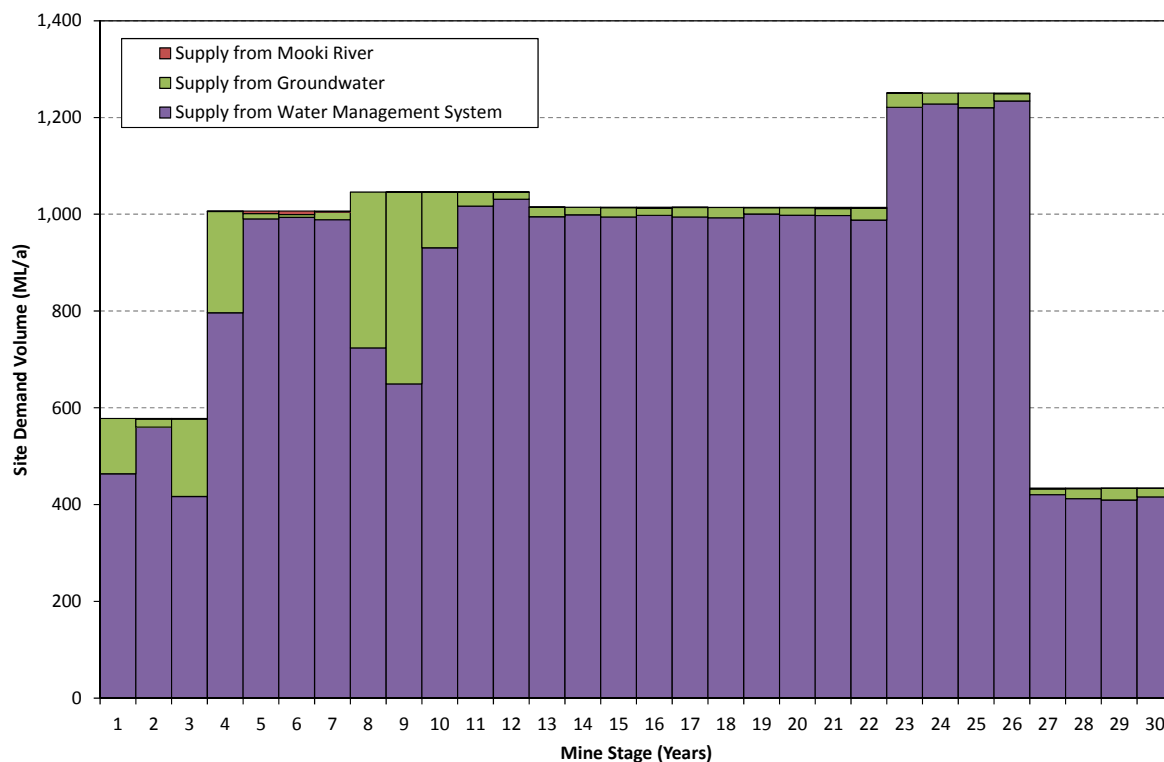


Figure 28
Source of Site Water Demand, Realisation 70

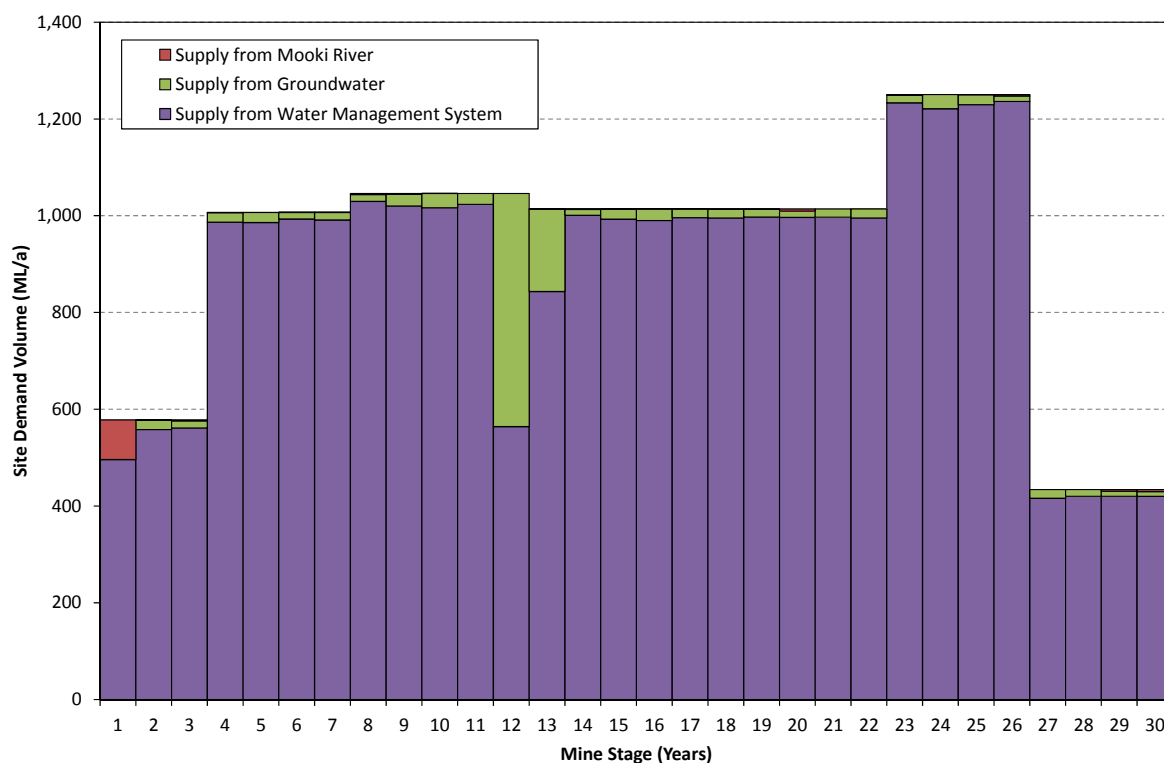


Figure 29
Source of Site Water Demand, Realisation 83

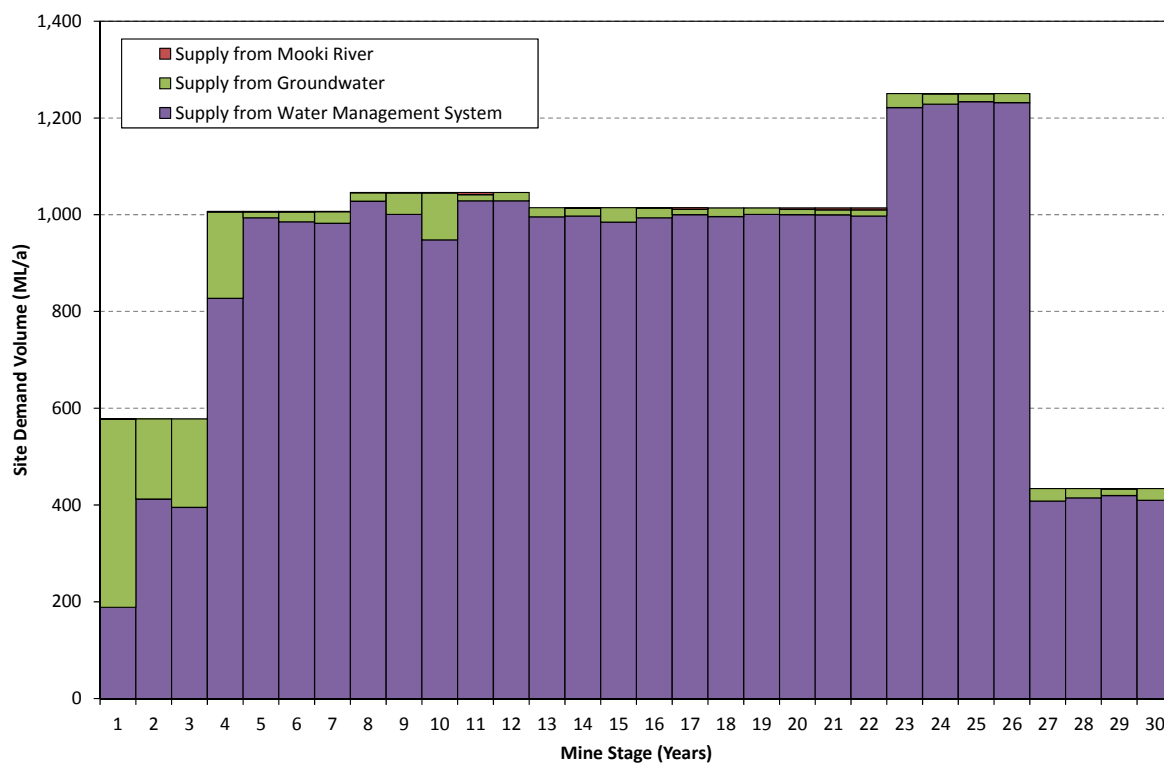


Figure 30
Source of Site Water Demand, Realisation 92

GHD (2013) conducted a hydrogeological review to determine the feasibility of utilising groundwater to provide the maximum external make-up water supply for the Project in a dry year (up to 600 ML/annum or 19 L/s). This assessment was based on available bore data, geological logs, aquifer test data and local knowledge as provided by former landowners as part of bore audit interviews. The assessment focussed solely on property owned by Shenhua Watermark immediately adjacent to the Project.

The assessment found that an existing irrigation bore on Shenhua Watermark-owned land (GW28622), located approximately 800m east of the Project Boundary within Groundwater Management Zone 8, has a high yield in the order of 75 L/s with good water quality. Therefore, the maximum required external make-up water supply (up to 600 ML/annum or 19 L/s) could be obtained from the existing irrigation bore. Alternatively, a new bore could be established on the property which is also considered highly likely to provide the required yields.

The assessment also found that the establishment of a new bore in the vicinity of WM0427A within Groundwater Management Zone 7 could provide the required yield, with a lesser water quality. The water quality is not a key consideration in this regard as the water will be used in the CHPP. Therefore this alternative is also considered feasible.

Further, an existing test bore within Groundwater Management Zone 7 could provide the required yield and is considered feasible. Finally, an existing weathered interburden bore in the Western proposed Mining Area utilising Murray-Darling Basin Gunnedah-Oxley Basin Porous rock groundwater source could provide low yields whilst facilitating localised dewatering.

Therefore, the assessment demonstrates that it is feasible to utilise groundwater to provide the external make-up water supply for the Project. Any water transfer would be conducted in accordance with the rules of the relevant water sharing plans and water access licences. The EIS main document (Section 7.14) demonstrated the ability for the Project to obtain the necessary water access licences on an open market to authorise the take of water by the Project.

Mooki River Pipeline

The above analysis of site demands and Mooki River flows demonstrates that harvesting of water from the Mooki River is unlikely to be a primary water source for the Project because river flow only occurs after significant rainfall which results in increased water availability on the site. Similarly, under very dry conditions when imported water may be required for the Project, there is unlikely to be available surface flow in the river. For these reasons, the Mooki River pump station maybe constructed, as required. If the pump station is required, the design and construction would be in accordance with industry best practice. Numerous similar river pump stations are constructed across the Namoi Valley.

4.3.11 Mooki River Flooding

This section responds to the submissions raised by stakeholders regarding the Mooki River flood assessment.

Submission reference: RA12, RA13, SIG10, SIG14, SIG12, P25, P30 and P49

Summary response: A small loss of floodplain storage associated with the Project will have a very small impact on Mooki River flood levels with a maximum increase in flood levels of less than 5 mm for the 100 year Average Recurrence Interval (ARI) flood event. This impact would diminish rapidly with distance and would be negligible within 100 m to 200 m from the Project Boundary. In practical terms, the impacts of the flood levee on Mooki River flooding would be undetectable.

A number of submissions raise issues related to the assessment of the flooding of the Mooki River. The adopted methodology for the flood assessment is based on standard industry practice; the DGRs issued for the Project and are appropriate for the purpose of this study.

As noted in Section 9.7.2 of the Surface Water Impact Assessment, the small loss of floodplain storage associated with the Project will have a very small impact on Mooki River flood levels with a maximum increase in flood levels of less than 5 mm for the 100 year ARI flood event. This impact would diminish rapidly with distance and would be negligible within 100 m to 200 m from the Project Boundary. In practical terms, the impacts of the flood levee on Mooki River flooding would be undetectable and hence no specific mitigation measures are proposed. Notwithstanding, a licence under Part 8 of the Water Act will be sought for the works prior to construction.

The potential impacts of soil settlement on the floodplain due to groundwater drawdown have not been explicitly modelled in the Mooki River flood model. The SRK geotechnical report (contained in the Groundwater Impact Assessment, Appendix T of the EIS) estimates ground surface settlement of up to 350 mm near the southern boundary of the Eastern Mining Area, reducing to less than 100 mm within 200 m to the south. The reduction in surface levels associated with settlement would increase floodplain storage at a given level, resulting in lower flood levels across the floodplain. Due to the extensive width of the floodplain, the reduction in flood levels would be much lower than the maximum settlement; possibly of the order of 50 mm or less. It is possible that the effects of soil saturation during the extended rainfall that would precede a flood event would cause soil swelling that would reduce the effects of settlement.

The submission from NFA has requested that an assessment be undertaken of the flooding risk associated with overflows from the sediment basins. By their very nature, sediment basins mitigate downstream flows below existing conditions by capturing and containing runoff. As a result, overflows from these relatively small catchments will not impact on flooding along the major watercourse. Localised flows downstream of the basins will be mitigated through measures such as level spreaders to ensure any overflows drain in a similar manner to existing conditions, albeit at a lower rate.

4.3.12 Watermark Gully Flooding

This section responds to the submissions raised by stakeholders regarding the Watermark Gully flood assessment.

Submission reference: RA7, RA12 and RA13

Summary response: A more detailed assessment of impacts on Watermark Gully has now been completed which provides a more accurate description of flood behaviour across the wide flat floodplain in the vicinity of the Kamilaroi Highway. The results of the detailed modelling showed that the flood impacts on the Kamilaroi Highway are negligible (30 to 40 mm).

No mine related infrastructure is proposed within the 100 year ARI flood extent of Watermark Gully.

A number of submissions related to the impacts of the Project on flooding at the Kamilaroi Highway crossing of Watermark Gully. Flood impacts on Watermark Gully have been investigated in further detail as part of this RTS using a two-dimensional hydraulic model as described in the following sections.

Overview

As described in Section 8 of the Surface Water Impact Assessment, a portion of the captured Watermark Gully catchment during mine operations will be released once OEAs are completely rehabilitated. The total catchment area of Watermark Gully at the Kamilaroi Highway, for the post mine conditions, is 43.0 km², which is 3.6 km² larger than the catchment area for existing conditions. The RAFTS model, described in Section 8.2 of the Surface Water Impact Assessment EIS, indicates that the peak discharges of the 2 year and 100 year ARI design floods increase by 1m³/s and 11 m³/s respectively upstream of the Kamilaroi Highway.

A more detailed assessment of impacts on Watermark Gully has now been completed based on a two-dimensional TUFLOW model which provides a more accurate description of flood behaviour across the wide flat floodplain in the vicinity of the Kamilaroi Highway. The results of the detailed modelling showed that the flood impacts on the Kamilaroi Highway are negligible.

Note that no mine related infrastructure is proposed within the 100 year ARI flood extent of Watermark Gully.

Design Flood Discharges

The design discharges estimated by the RAFTS model described in Section 8 in the Surface Water Impact Assessment were adopted for the TUFLOW model.

TUFLOW Model Configuration – Existing Conditions

Figure 31 shows the spatial extent of the Watermark Gully TUFLOW model for existing (pre-mine) conditions. The model extends about 7.5 km upstream and 0.3 km downstream of the Kamilaroi Highway. The modelled study area covers approximately 6.4 km². A fine 2m grid size and a one second time step were adopted for the upper catchment to assess the proposed Watermark Gully diversion. A 4 m grid size and 2 second time step were adopted for the lower catchment to assess the flood impact on the Kamilaroi Highway.

Figure 31 also shows the locations of the 2D inflow and outflow boundaries adopted in the TUFLOW model. The existing conditions TUFLOW model includes seven inflow boundaries along Watermark Gully. The names of the inflow boundaries correspond to the names of the sub-catchments in the RAFTS model described in the Surface Water Impact Assessment.

A tailwater level of 279.5 m AHD downstream of the railway was adopted as the outflow boundary for this study. The design flood level at the Kamilaroi Highway was found to be insensitive to the tailwater levels downstream of the railway and is likely to be controlled by the capacity of railway culverts.

The TUFLOW model uses Manning's 'n' values to represent hydraulic resistance (notionally channel or floodplain roughness). Discrete regions of continuous vegetation types and land uses were mapped, and appropriate roughness values assigned to each region. Vegetation and land use mapping was undertaken using an aerial photograph of the area captured in December 2010 (provided by Hansen Bailey). **Table 11** shows the adopted Manning's 'n' values.

Table 11
Adopted Manning's 'n' Values

Surface Type	Manning's 'n'
Channel	0.035
Floodplain	0.040
Vegetated overbank	0.070
Water body	0.030

Figure 31 shows the locations of the culvert crossings within the TUFLOW model. **Table 12** shows the details of existing culvert crossings. Culverts were modelled as one dimensional structure. The configurations of the culvert crossings were estimated based on a site visit, photographs and topographic survey data.

Table 12
Adopted Culvert Crossing Details

Culvert Crossing	Type	Width or Diameter (m)	Height (m)	No. of Culverts
Railway	RCBC	2.4	0.9	3
		1.2	0.9	20
Rail_East1	RCBC	1.2	0.9	4
Rail_East2	RCBC	1.2	0.9	2
Hwy_Culv	RCBC	1.2	0.9	4

TUFLOW Model Configuration – Post Mining Conditions

Figure 31 also shows the configuration of the Watermark Gully TUFLOW model for post mine conditions. The extents of the model are the same as for the existing conditions with approximately 0.3 km² area excluded at the upper catchment of Watermark Gully due to the proposed mine overburden emplacement. Four additional local inflow boundaries are included in the post mine conditions model to represent extra catchments to be released once overburden emplacements are completely rehabilitated. The proposed Watermark Gully diversion, described in **Section 4.3.13** below was also included.

Peak Flood Level Impact

Figure 32 and **Figure 33** show the peak flood level impacts of the post mine conditions for the 2 year and 100 year ARI design flood events. The model results show that:

- Along the upper reach of Watermark Gully, the 2 year and 100 year ARI peak flood levels increase by up to 0.3 m and 1.0 m respectively compared to pre-mine conditions. These flood level increases are associated with the diversion of the upper portion of Watermark Gully which will be managed within the Project Boundary; and
- At the Kamilaroi Highway, the 2 year and 100 year ARI peak flood levels increase by up to 0.04 m and 0.03 m respectively compared to pre-mine conditions. These small increases in peak flood level are unlikely to have a noticeable impact on flooding at the Kamilaroi Highway.

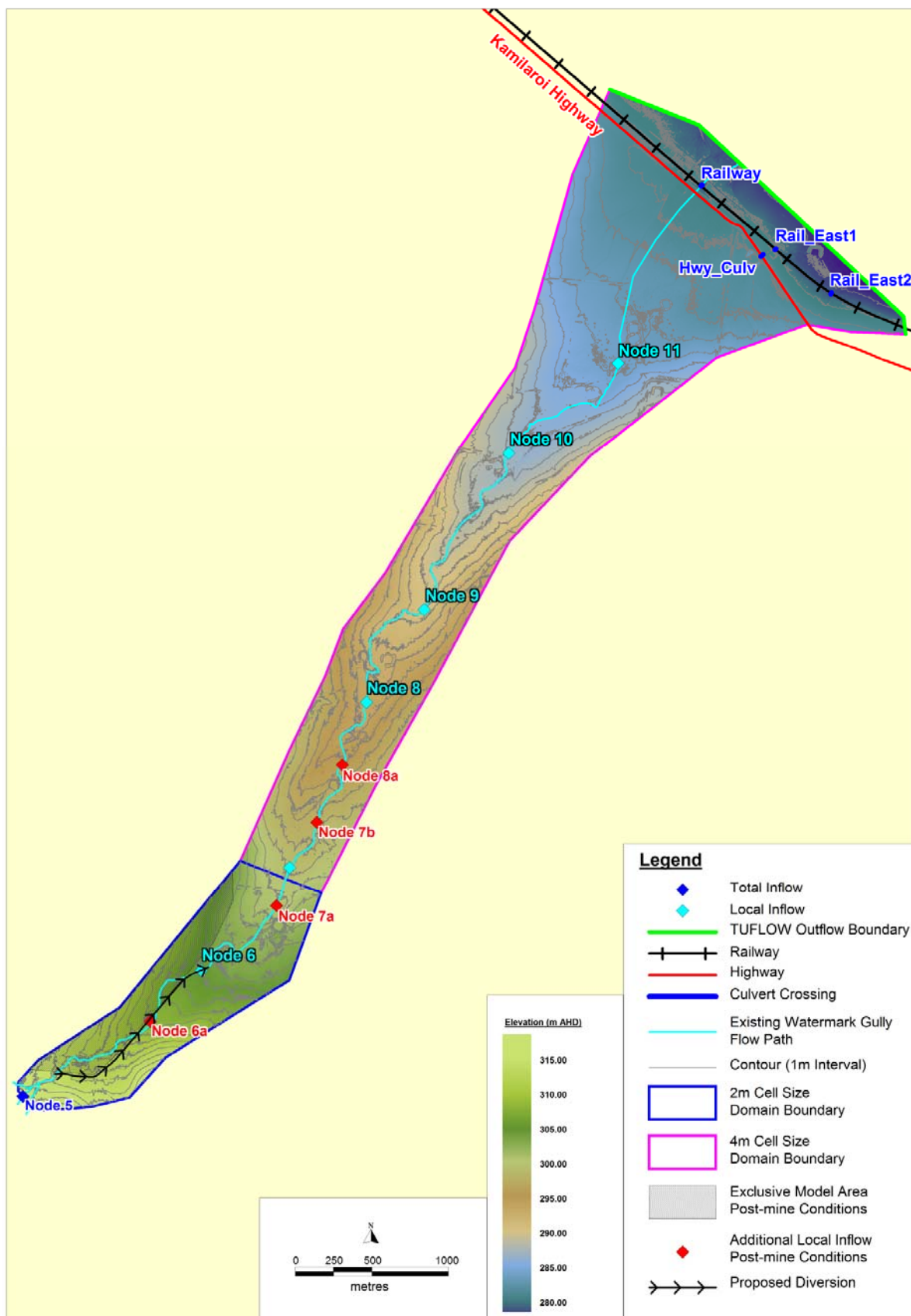


Figure 31
Watermark Gully TUFLOW Model Configuration

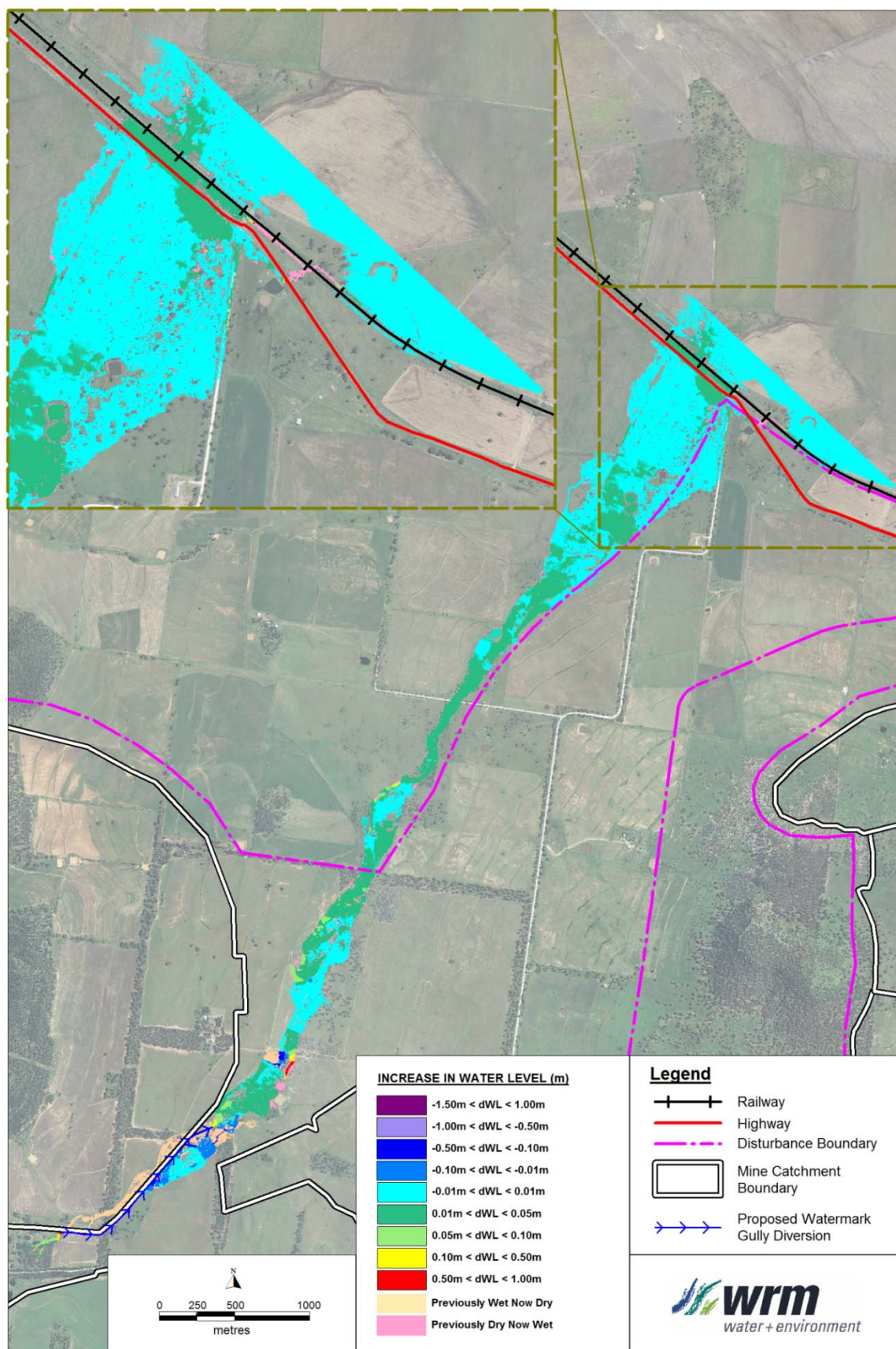


Figure 32
Watermark Gully Post Mine Flood Level Impacts (2 Year ARI)

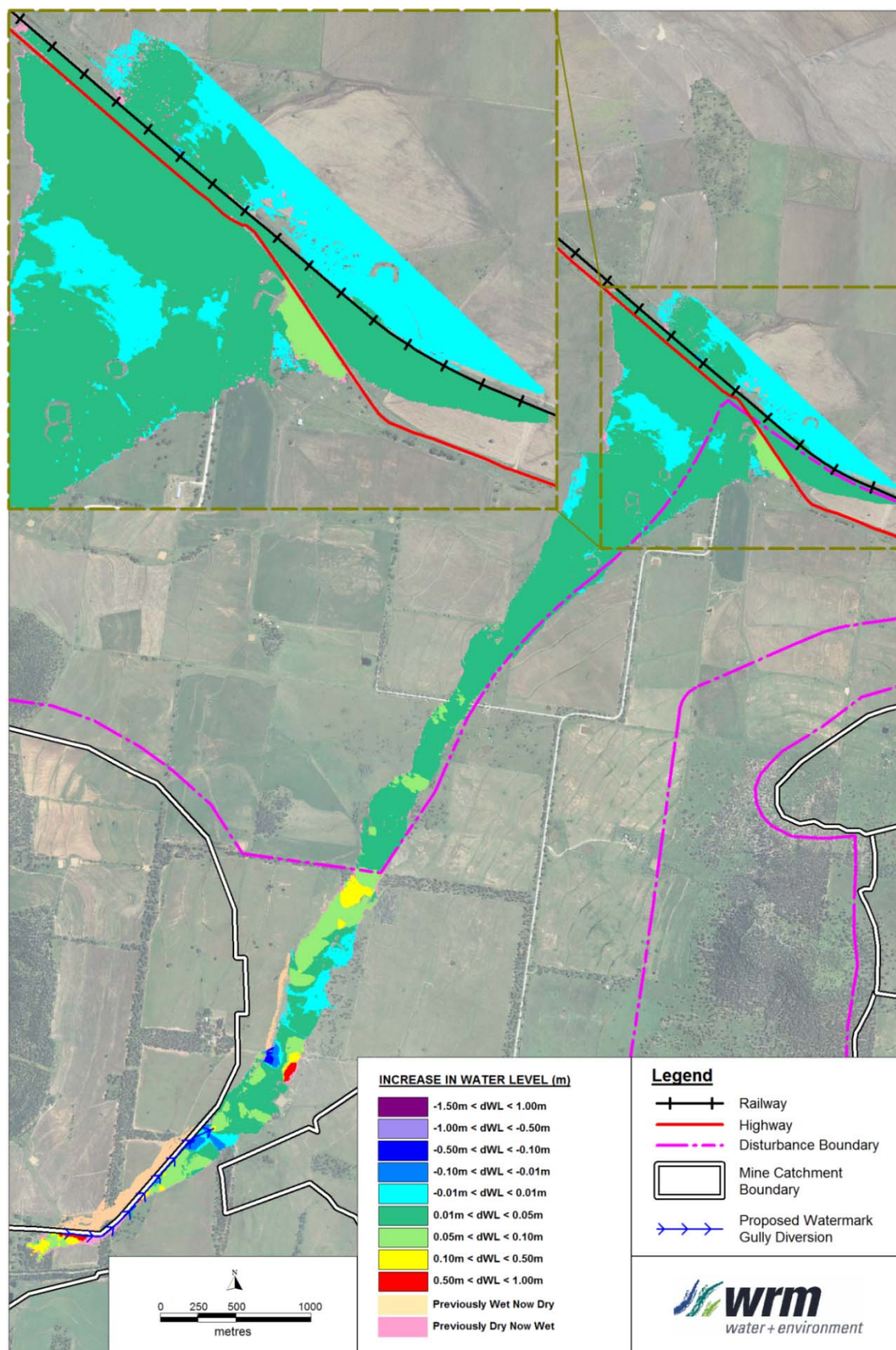


Figure 33
Watermark Gully Post Mine Flood Level Impacts (100 Year ARI)

Kamilaroi Highway Flood Duration Impact

Figure 34 shows a rating curve derived from the TUFLOW model for Watermark Gully at the Kamilaroi Highway. **Figure 35** and **Figure 36** show the design discharge hydrographs for Watermark Gully at the Kamilaroi Highway, estimated by the RAFTS model for the existing and post mine conditions. The flood depths on the lowest section of the Kamilaroi Highway crossing of Watermark Gully were estimated by the RAFTS design discharges and the TUFLOW model rating curve. The results show that:

- The maximum 2 year ARI flood depth on the Kamilaroi Highway for both existing and proposed conditions is less than 0.3 m. This means that the project will have no adverse effect on the trafficability of the highway for this event;
- For the critical duration 2 year ARI design storm event, water may flow across the highway for about 15 hours. The increase in catchment area due to the project may result in an increase of approximately 0.5 hours in the duration of inundation; and
- For the critical duration 100 year ARI design storm event, the duration of flow greater than 0.3 m deep may increase from approximately 10.5 hours to 11 hours.

The impacts of the increased Watermark Gully catchment area on flooding of the Kamilaroi Highway will vary from event to event, depending on the storm duration and intensity. However, based on an assessment of critical duration design storm events, the impacts are likely to increase the duration of inundation by less than 5%.

Shenhua Watermark will ensure that the Watermark Gully diversion will return the catchment to pre-mine development flood flow rates and velocities. This will be detailed in the Water Management Plan to be prepared for the Project.

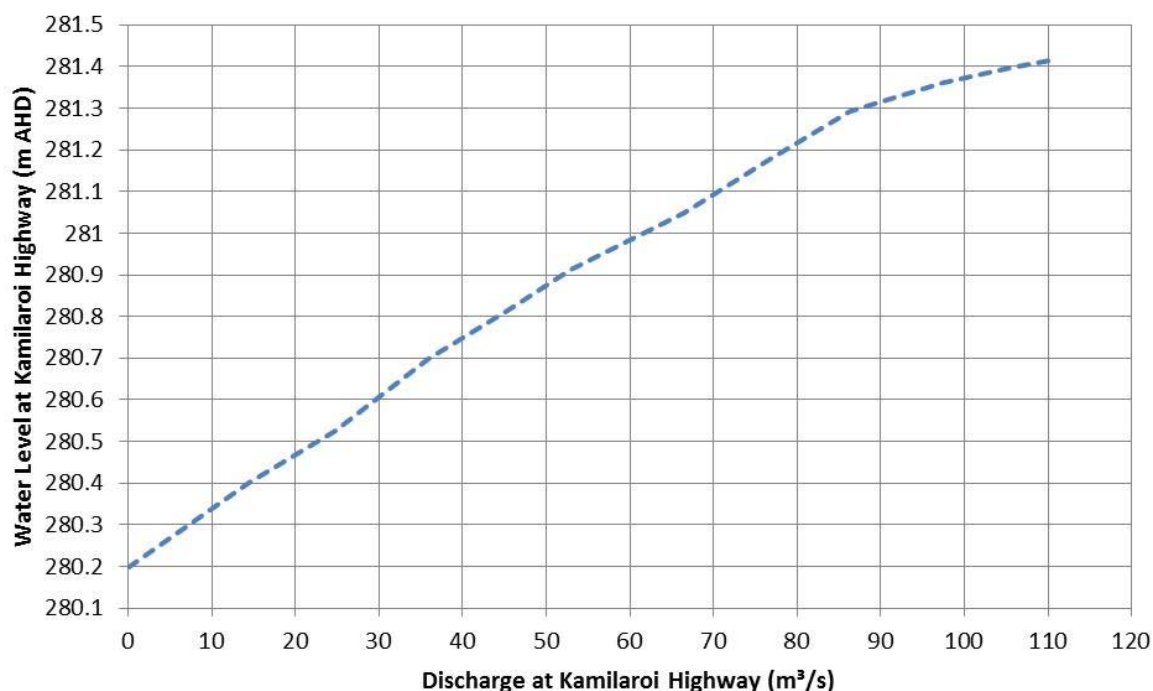


Figure 34
Watermark Gully Rating Curve at Kamilaroi Highway (Derived from Watermark Gully TUFLOW Model)

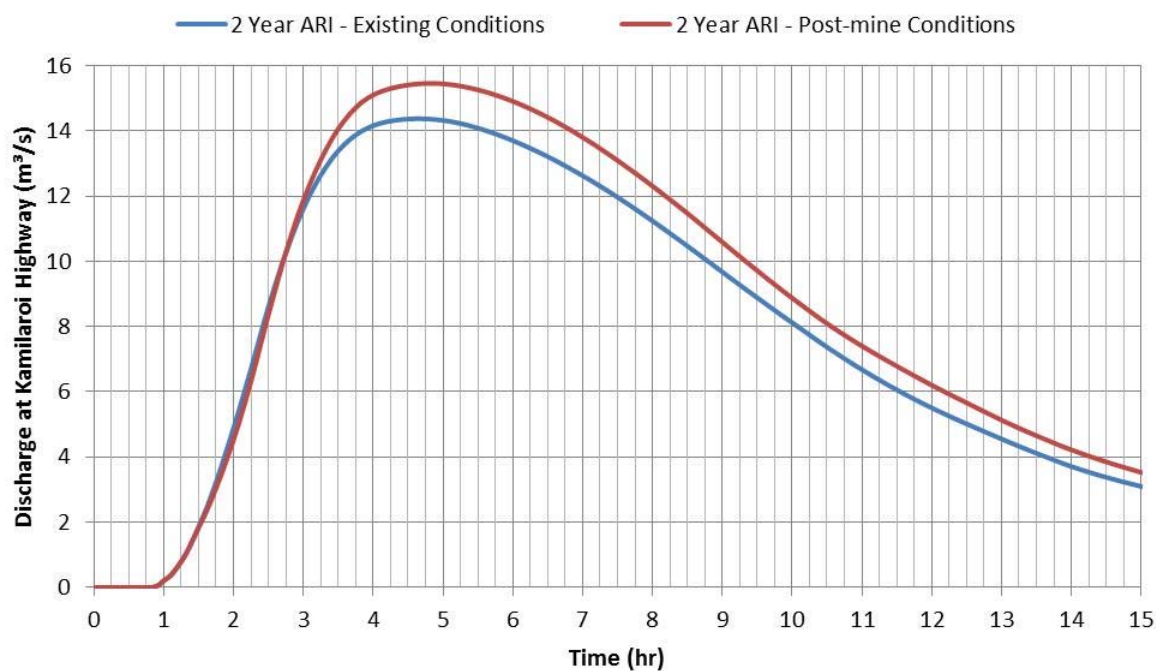


Figure 35
Watermark Gully RAFTS Model Discharges at Kamilaroi Highway (2 Year ARI Event)

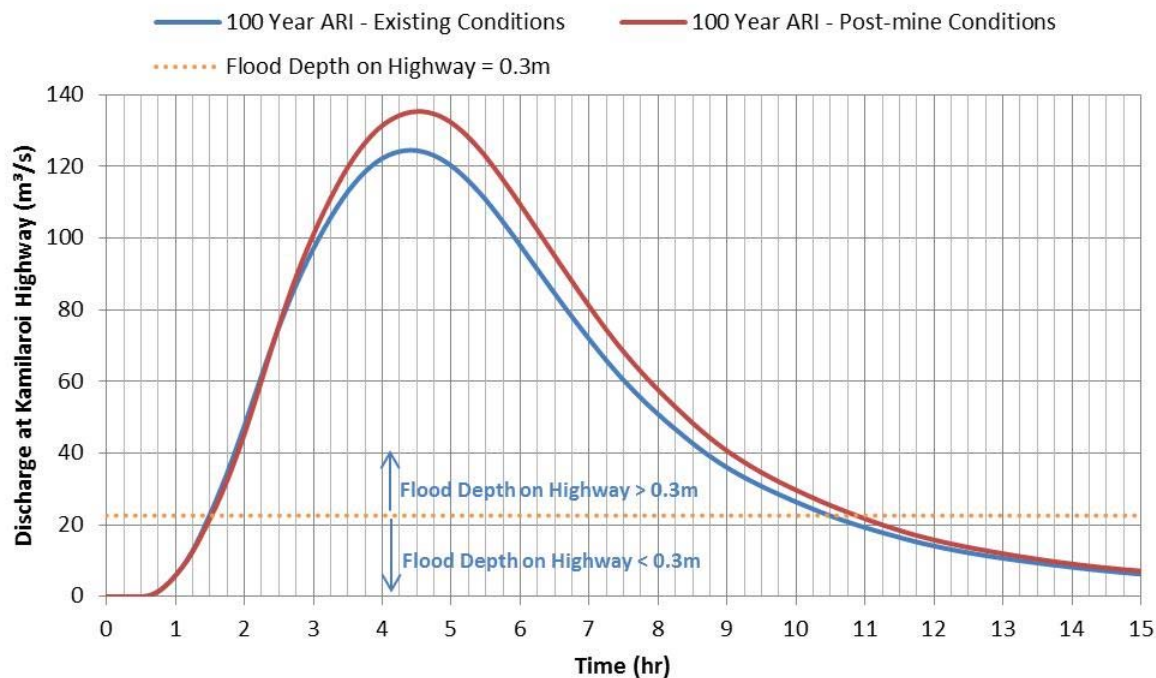


Figure 36
Watermark Gully RAFTS Model Discharges at Kamilaroi Highway (100 Year ARI Event)

4.3.13 Watermark Gully Diversion

This section responds to the submissions raised by stakeholders regarding the proposed Watermark Gully diversion.

Submission reference: RA13, SIG10 and P30

Summary response: The proposed OEA for the Western Mining Area will cross the main channel of Watermark Gully at some locations. Hence, a diversion of the main channel further to the east will be required. Further detail on the design and hydraulic characteristics of the proposed diversion will be provided in a Channel Diversion Plan, to be developed in consultation with the NOW.

The proposed OEA for the Western Mining Area will cross the main channel of Watermark Gully at some locations. Hence, a diversion of the main channel further to the east will be required. Note that the upper reaches of Watermark Gully are effectively a first order watercourse that has been heavily modified by agricultural activity, including construction of farm dams and contour banks. The existing main channel of Watermark Gully is poorly defined.

Further detail on the design and hydraulic characteristics of the proposed diversion will be provided in a Channel Diversion Plan, to be developed in consultation with the NOW. An indicative alignment of the proposed diversion channel is shown in **Figure 37**.

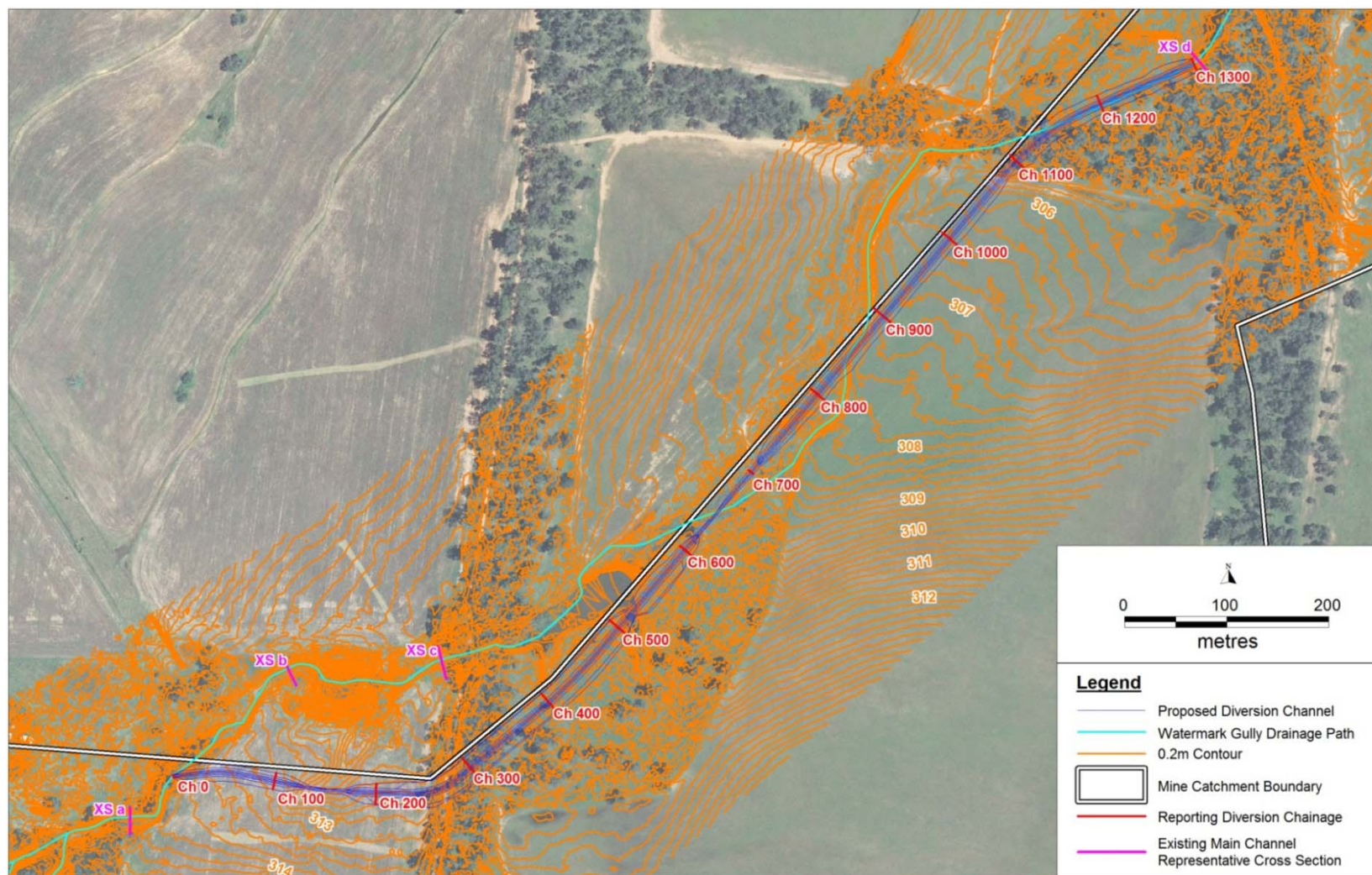


Figure 37
Watermark Gully Diversion – Indicative Alignment

4.3.14 Salt Balance

This section responds to the submissions raised by stakeholders regarding the salt balance assessment for the Project, including the methodology and assumptions. This section also responds to submissions from stakeholders suggesting that the salt load from the Project to will be significant and impact surrounding waters and land uses.

Submission reference: RA13, SIG9, SIG10, P1, P20, P25, P30, P39, P41, P53 and P57

Summary response: The model results show that the total average salt load released offsite in surface runoff is not significantly increased by the Project. The maximum total average salt load of 66.0 t/day occurs in Year 30 of the Project and represents an increase in the pre-mine salt load of approximately 1% for that year.

Native Dog Gully has high salinity under existing conditions and may contribute to a small observed increase in Mooki River salinity downstream of Native Dog Gully.

General

Section 7.13 of the Surface Water Impact Assessment provided a surface runoff salt balance for the Project. The OPSIM model was used to assess the Project impacts on surface runoff salt load on the receiving catchments of Watermark Gully, Lake Goran and Native Dog Gully. Further detail on the Project salt balance is provided in the following section.

Figure 38 shows a schematic of the salt inputs and outputs from the Project's water management system. Overall, the Project has a net water demand, and water is used preferentially from the Dirty Water System to meet site demands.

Salt inputs to the water management system include salts in the groundwater inflows, catchment runoff, direct rainfall, and raw water. Salt outputs from the water management system include salts which are lost through the CHPP in the tailings / coal rejects and product coal, dust suppression and offsite discharges from the sediment water system (there are no offsite discharges from the mine water system). The CHPP is a net user of water, as during the washing and sizing process the moisture content of the rejects material is increased. This process traps water (and salt) in the rejects material. The material is then disposed of in dedicated zones within the OEA (see **Section 4.5.10** of this RTS).

Recycled water is the first preference for water demands used for dust suppression. The salts that are entrained in the water used for dust suppression increase the salinity of surface runoff from those areas. This has been accounted for in the salt balance as an increase in the catchment salt generation rate for those land use classifications (refer Table 7.16 in the Surface Water Impact Assessment).

Table 13 shows the average annual salt balance for the Project's water management system. The representative salinity assigned to the runoff from rehabilitated areas has been updated from that shown in Table 7.16 in the Surface Water Impact Assessment; all other representative salinities remain unchanged. The runoff for rehabilitated OEAs has been split between surface and baseflow components, with a higher representative salinity applied to the baseflow component. Newly rehabilitated areas have been assigned a conservatively high baseflow salinity of 5,000 mg/L, equivalent to that used for seepage from active overburden.

Rehabilitated areas that have been established for a while have been assigned a much lower, but still conservative baseflow salinity of 2,500 mg/L (50% of estimated short-term maximum of 5,000 mg/L).

Based on column leachate testing data, salinity is expected to reduce over time as readily available salt is flushed from the system (see Appendix T and W of the EIS). The representative salinity assigned to the surface flow component of the rehabilitated runoff remains unchanged at 800 mg/L (adopted value higher than recorded Mooki River runoff salinity of about 550 mg/L – see Table 3.7 of the Surface Water Impact Assessment). Review of the results indicates the following:

- Catchment runoff is the greatest contributor to the water management system salt inputs;
- Net loss from the CHPP contributes the greatest salt loss for Years 5, 15 and 25. In Year 30 the CHPP throughput (and salt loss in the CHPP process) is considerably reduced; and
- The salts lost from sediment dam system offsite spills are less than the salt inputs from the sediment dam system catchment runoff. This is because water from the sediment dam system is pumped to the dirty water system for use in site demands.

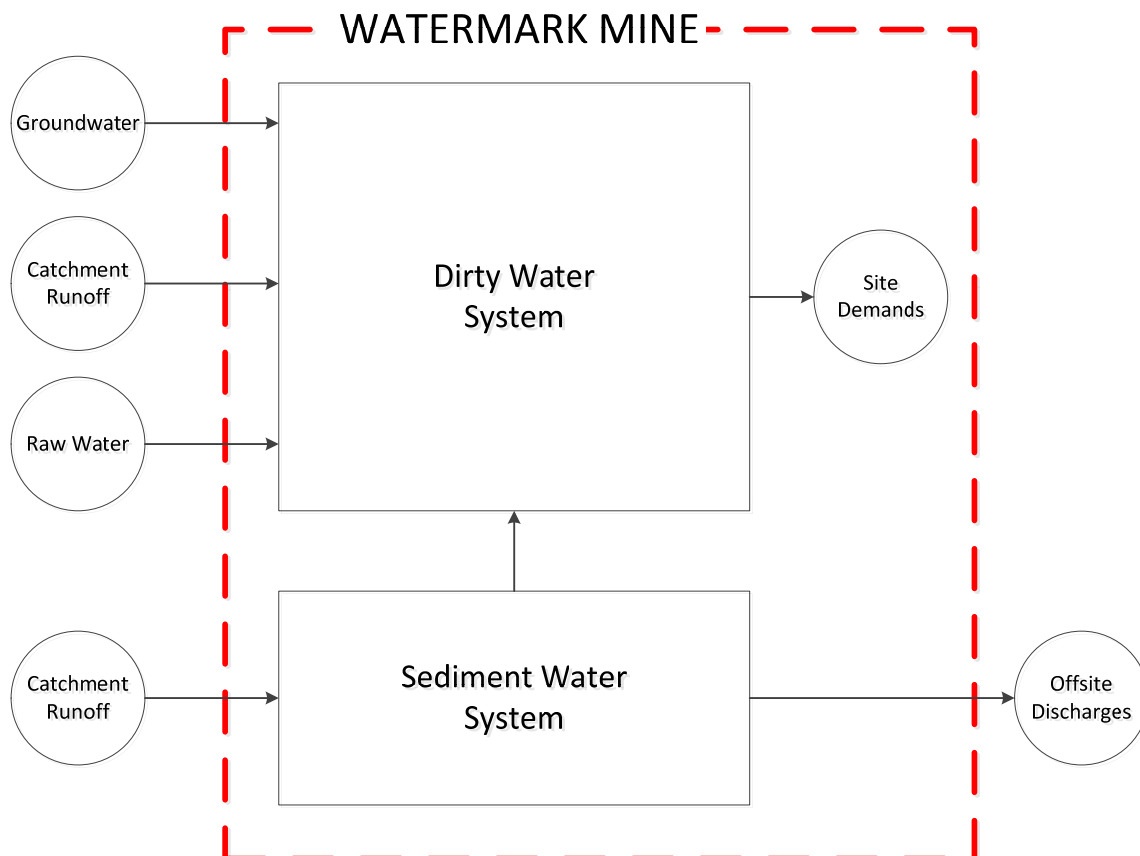


Figure 38
Surface Water Salt Load Schematic

Table 13
Average Annual Salt Balance

Average Annual Salt Balance (t/day)					
Year	Year 5	Year 15	Year 25	Year 30	
Salt Inputs					
Catchment Runoff					
<i>Dirty Water System</i>	1.4	1.4	1.4	1.4	
<i>Active Mining Area</i>	2.2	3.2	2.6	1.6	
<i>Turkey's Nest Dam</i>	0	0	0	0	
<i>Sediment Dams</i>	1.8	1.7	2.1	1.9	
Total	5.4	6.3	6.1	4.9	
Offsite water supplies	0.2	0.1	0.1	0.0	
Groundwater Inflow to Open Cut Mining Areas	0.1	0.3	3.0	1.1	
Gross Salt Inputs	5.7	6.7	9.2	6.0	
Salt Outputs					
Net Loss from CHPP	4.0	4.5	5.0	1.4	
Vehicle Wash	0.03	0.03	0.04	0.05	
ROM Bin Dust Suppression	0.3	0.3	0.4	0.1	
Stockpile Dust Suppression	0.2	0.2	0.2	0.1	
Haul Road Dust Suppression	0.8	1.1	2.6	2.6	
Sediment Dams Spill Offsite	0.3	0.4	0.7	0.9	
Gross Salt Outputs	5.6	6.5	8.9	5.1	
Salt Retained Onsite					
Net Inventory					
<i>Dirty Water System</i>	0.07	0.10	0.08	0.09	
<i>Active Mining Area</i>	0.00	0.07	0.13	0.56	
<i>Turkey's Nest Dam</i>	0.01	0.01	0.01	0.03	
<i>Sediment Dams</i>	0	0.02	0.02	0.01	
Gross Salt Retained Onsite	0.1	0.2	0.2	0.7	

Surface Water Salt Load Impacts on Receiving Catchments

The surface water salt load on the receiving environment is potentially impacted in two ways:

- A reduction in catchment area results in an effective reduction in salt load to the receiving environment; and
- An increase in salt load from sediment dam overflows.

These three catchments drain to the Mooki River, which in turn is a tributary of the Namoi River. The Namoi River is one of the Murray-Darling Basin's major sub-catchments in New South Wales.

Table 14 provides a summary of the salt loads for the pre-mine catchments and selected stages of the mine life. The model results show that the total average salt load released offsite in surface runoff is not significantly increased by the Project.

The maximum total average salt load of 66.0 t/day occurs in Year 30 of the Project and represents an increase in the pre-mine salt load of approximately 1% for that year.

The salt load released to Native Dog Gully is not significantly affected by the Project. The salt load drops by about 10% in Year 15.

The salt load released to Watermark Gully (including other unnamed tributaries draining north to the Mooki River) is reduced by 4% in Year 5. The salt load to Watermark Gully is elevated in Year 25 and Year 30 with a modelled increase of 8% and 33% respectively. Note that this represents a likely upper limit of the salt load impact since the quality of surface runoff from rehabilitated areas is likely to improve over time.

Under normal operation, overburden runoff collected in sediment dams is pumped back for use in the mine water management system. Sediment dams would only spill following extended periods of significant or extreme rainfall events. Under these conditions, it is likely that the quality of water collected in sediment dams would be improved by significant fresh runoff inflows.

Table 14
Long Term Average Surface Water Salt Loads

Average Annual Salt Load (t/day)					
	Existing	Year 5	Year 15	Year 25	Year 30
Watermark Gully Salt Load					
<i>Catchment Runoff</i>	2.4	2.2	2.3	2.2	2.5
<i>Sediment Dam Overflows</i>	0.0	0.1	0.1	0.4	0.8
Total	2.4	2.3	2.4	2.6	3.3
Native Dog Gully Salt Load					
<i>Catchment Runoff</i>	3.0	2.7	2.4	2.9	2.9
<i>Sediment Dam Overflows</i>	0.0	0.2	0.4	0.3	0.2
Total	3.0	2.9	2.7	3.2	3.1
Lake Goran Salt Load					
<i>Catchment Runoff</i>	59.9	59.9	59.9	59.8	59.6
<i>Sediment Dam Overflows</i>	0.0	0.0	0.0	0.0	0.0
Total	59.9	59.9	59.9	59.8	59.6
Gross Salt Inputs	65.2	65.1	65.0	65.5	66.0

Table 15 shows details of NSW Government streamflow and water quality monitoring stations for the Mooki River and Namoi River. The Namoi River at Goangra station was the reference point for 'end-of-valley' targets set in the Murray-Darling Basin Authority – Basin Salinity Management Strategy 2001-2015 (August 2001).

Table 15
Streamflow and Water Quality Gauging Stations

Station Name	Station No.	Catchment Area (km ²)	Commence Flow Data	Commence EC Data
Mooki River at Ruvigne	419084	6,584 ^{*a}	29/06/1994	04/07/1994
Mooki River at Caroonna	419034	2,180	22/05/1979	27/05/1995 ^{*b}
Namoi River at Goangra	419026	36,290	02/02/1971	03/06/1995

Note: ^{*a} Includes Lake Goran catchment area; ^{*b} Missing period of data from 1998 to 2012.

Salt load at each gauging station was calculated by assuming an Electrical Conductivity (EC) to TDS ratio of 0.68. **Figure 39** and **Figure 40** show the calculated salt load at Mooki River at Ruvigne and Namoi River at Goangra, respectively. Note that a few years have periods of missing data, as noted in the figure.

Over the 17 years of monitoring, the salt load at Ruvigne ranges between 0.00-131% of the salt load at Goangra. On average, the salt load at Ruvigne is 39% of the salt load at Goangra. The total salt load input of the Project reaches a maximum in Year 25 of approximately 9 t/day, or 3,290 t/annum. Only a fraction of this leaves the site in sediment dam overflows; a maximum of 0.9 t/day or 329 t/annum in Year 30. A reduction of the Lake Goran and Native Dog Gully catchments results in a reduction of 0.4 t/day or 146 t/annum of salt load to the receiving catchments. The net result is an average increase of 0.4 t/day or 146 t/annum to the receiving environment in Year 30. This equates to approximately 0.7% of the average salt load at Ruvigne over the period 1995 to 2012, and approximately 0.2% of the average salt load at Goangra over the period 1996 to 2012.

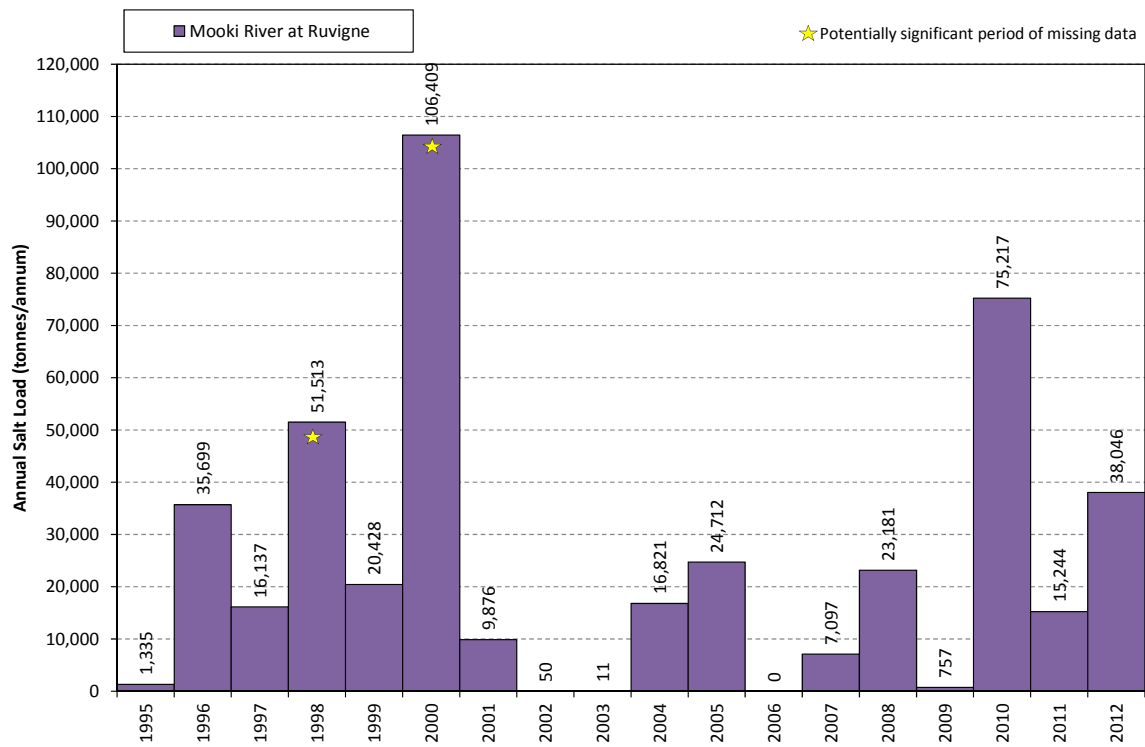


Figure 39
Mooki River at Ruvigne Calculated Salt Load

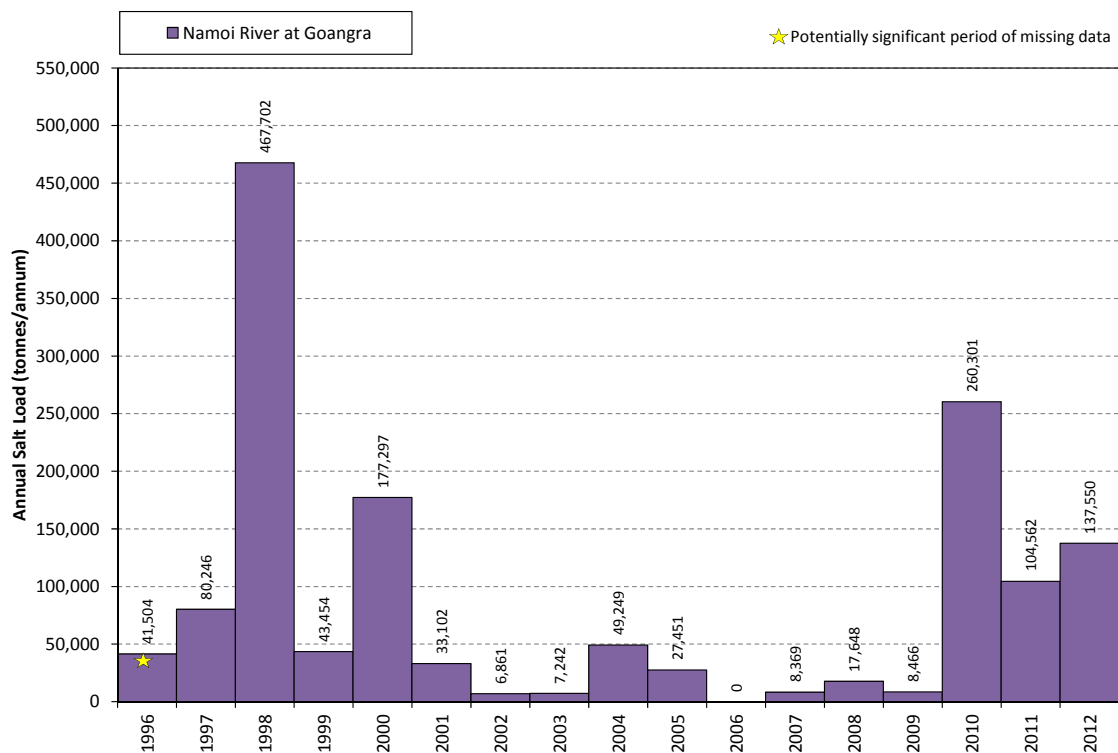


Figure 40
Namoi River at Goangra Calculated Salt Load

Native Dog Gully Salt Load Contributions to Mooki River

As described in **Section 4.3.2**, a baseline surface water monitoring program has been undertaken from October 2009 to date, as described in Section 3.4.2 of the Surface Water Impact Assessment. There are two monitoring sites at Native Dog Gully, as well as a monitoring site on the Mooki River upstream of the Native Dog Gully confluence, and another monitoring site downstream of the Native Dog Gully confluence, among others. The catchment area of Native Dog Gully (including Yarraman Creek but not including Lake Goran) to the confluence of the Mooki River is approximately 584 km². The catchment area of the Mooki River to the confluence of Native Dog Gully is approximately 3,036 km², approximately 5 times greater than the Native Dog Gully catchment.

Figure 41 shows the EC monitoring results for Native Dog Gully, as well as daily rainfall recorded at the BOM station at Breeza (Main Street) (#55008). Review of the results shows that there are high EC readings in Native Dog Gully. However it is not known if the gully was flowing during these periods of high salinity, or if the results are caused by evaporation in isolated pools of water. In general, the high EC readings occur after periods of low or no rainfall (as recorded at Breeza), which suggests that there was little or no flow. Salt loads in Native Dog Gully cannot be accurately estimated as there is no stream flow monitoring data available for Native Dog Gully. The median EC values at SWM06 and SWM15 are 2,449 and 1,135 µS/cm over the period October 2009 to June 2013.

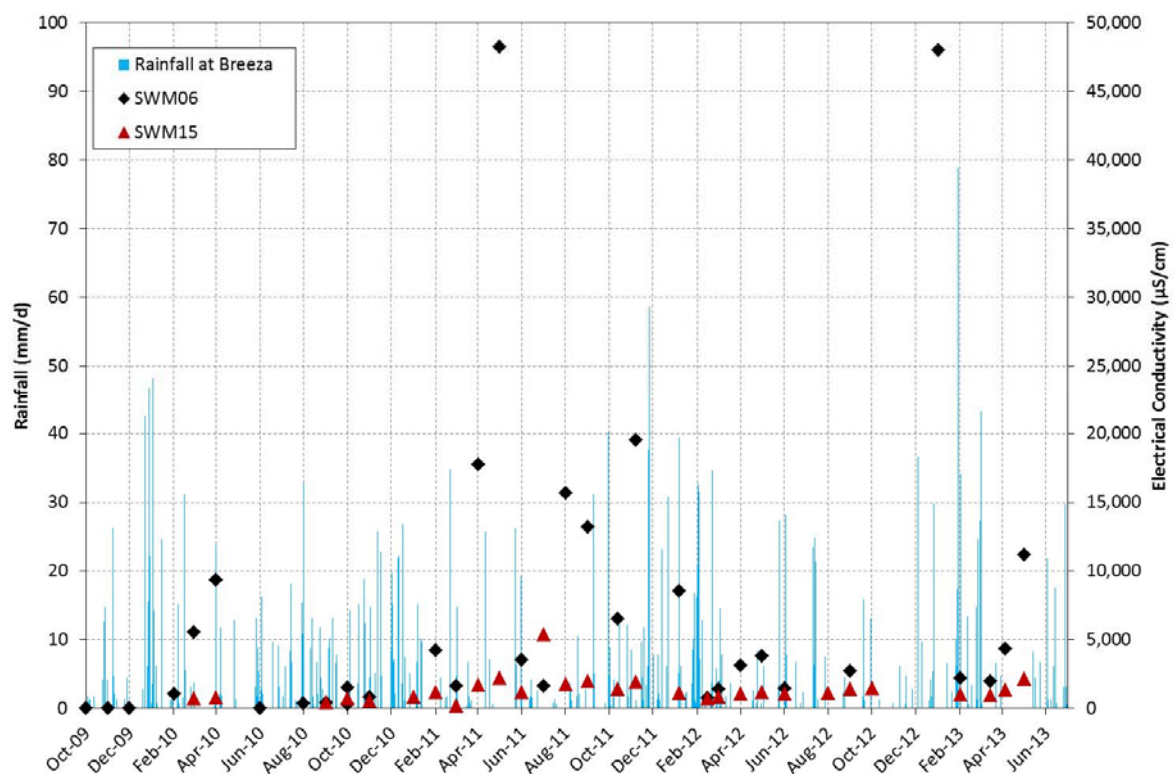


Figure 41
Native Dog Gully Water Quality (Electrical Conductivity) Monitoring Results

Figure 42 shows the EC monitoring results for the Mooki River monitoring sites located directly upstream and downstream of the Native Dog Gully confluence. Review of the results indicates that there is a slight trend (14%) of increasing salinity across the Native Dog Gully confluence. However there are also a number of occasions where the Mooki River salinity has remained unchanged or has even decreased downstream of the Native Dog Gully confluence. These results show that Native Dog Gully has high salinity under existing conditions and may contribute to a small observed increase in Mooki River salinity downstream of Native Dog Gully.

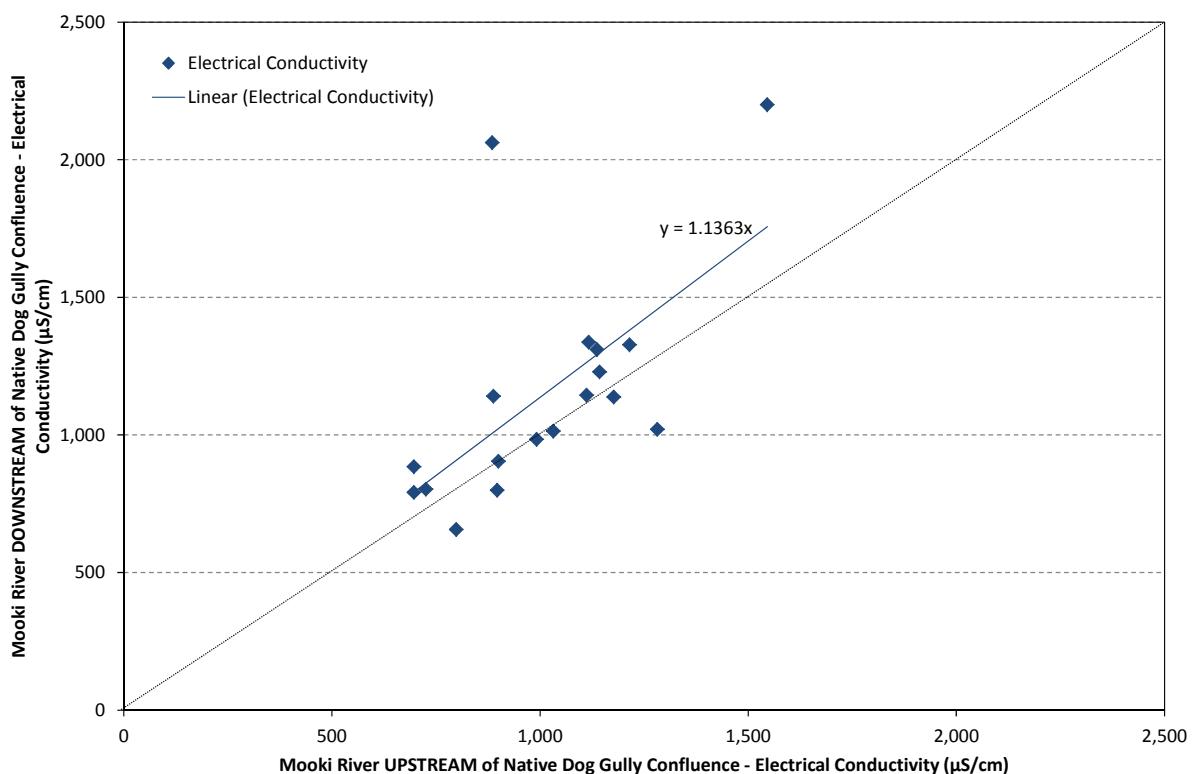


Figure 42
Mooki River Water Quality (Electrical Conductivity) Upstream and Downstream of Native Dog Gully Confluence

4.3.15 Final Void and Landform

A number of submissions commented on the discrepancy in the recovery rate and water level estimated by the surface water OPSIM model compared with the groundwater MODFLOW model. Some submissions also indicated a concern about the potentially saline nature of the water in the final void post mining, and requested more information on the impact of the void on the alluvial aquifer systems. This section addresses the submissions from stakeholders regarding the final void water balance.

Submission reference: RA3, RA13, SIG9, SIG10, SIG14, P14 and P30

Summary response: The assessment of final void behaviour has been refined to improve consistency between the surface water and groundwater models of the final void, based on more detailed consideration of interactions between the final void lake and the surrounding groundwater. Both models predict a long term equilibrium water level in the open void of about 280 m AHD. Both models confirm freeboard of about 40 m thereby indicating that the final void will not overflow.

The open void will remain a permanent sink for groundwater flow and the saline water that will develop within the void lake will not be able to flow to the adjacent alluvial aquifers.

Revised Water Balance Assessment

Section 7.14 of the Surface Water Impact Assessment describes the post-closure water balance for the final void. Following mine closure, there are no further operational water demands and all infrastructure and mine water storages are rehabilitated, leaving a final void in the Western Mining Area. The water balance and final equilibrium water level of the final void is dependent on the rainfall and runoff entering the void, evaporation loss from the void, and the inflow or outflow of groundwater. Surface runoff draining into the void is minimised by the inclusion of contour banks and drains in the final void landform, as described in Section 8.3.5 of the Surface Water Impact Assessment.

The assessment of final void behaviour has been refined to improve consistency between the surface water and groundwater models of the final void, based on more detailed consideration of interactions between the final void lake and the surrounding groundwater, as described below.

Methodology for Revised Groundwater Modelling

A number of submissions commented on the discrepancy in the recovery rate and water level estimated by the surface water OPSIM model compared with the groundwater MODFLOW model. Further work described below assessed the reason for the discrepancy between the models, which was related to the different temporal and spatial resolution of the models. Further information on the post mining water level and salinity in the final void is also provided.

The MODFLOW groundwater model described in the Groundwater Impact Assessment (Appendix T of the EIS) reported a stabilised water level in the final void of 303 m AHD, compared with 275 to 305 m AHD simulated by the OPSIM surface water model outlined in the Surface Water Impact Assessment (Appendix S of the EIS). The water level in the OPSIM model recovered much more quickly than the MODFLOW model, with water levels reaching equilibrium within 300 years, compared to about 2,000 years in the MODFLOW model.

The Groundwater Impact Assessment (Appendix T of the EIS) concluded the more rapid recovery was because the OPSIM model simulated daily rainfall, which included storm events. During these events, the final void lake recovers faster than the MODFLOW groundwater model, which uses annual average rainfall rates. The use of annual average rainfall effectively smooths storm events and enhances the effect of evaporation in the MODFLOW groundwater model. Another factor contributing to the more rapid recovery time in the OPSIM model was the fact the OPSIM model more accurately represented the volume of the open void, compared to the groundwater model that was restricted by the 50 m x 50 m mesh in the model.

The further investigation also revealed the MODFLOW model had adopted a higher rate of recharge to the final void, compared with the OPSIM model.

The groundwater model simulated 90% of rainfall over the overburden catchment area entered the final void. The OPSIM model applied 100% of annual rainfall and 70% of pan evaporation to the final void lake catchment area where a sharp change in the slope surface occurs, which was significantly smaller than the area in the MODFLOW model. The OPSIM model assumed the direct rainfall on the void lake was approximately 1 ML/day, based on historical rainfall records. Australasian Groundwater and Environmental Consultants adjusted the area of the final void lake in the MODFLOW model to be similar to the OPSIM model and simulated the recovery in the void lake level. **Table 16** presents the updated rainfall and evaporation rates adopted in the MODFLOW model.

Table 16
Water Inflows and Outflows to Final Void Lake

Model	Rainfall Recharge ML/day	Evaporation ML/day	Groundwater Inflow ML/day
OPSIM (EIS)	1.1	1.3	0.4
MODFLOW updated	1.6	1.9	0.4

Figure 43 shows the recovery in the void lake level predicted by the updated MODFLOW groundwater model with an adopted lower recharge rate. The model predicts the water level will stabilise in the final void at 280 m AHD after approximately 1,500 years, which is a good agreement with the OPSIM model. **Section 4.3.15** (*‘Comparison of Surface and Groundwater Model Results’*) below compares the results of the MODFLOW model with the OPSIM model.

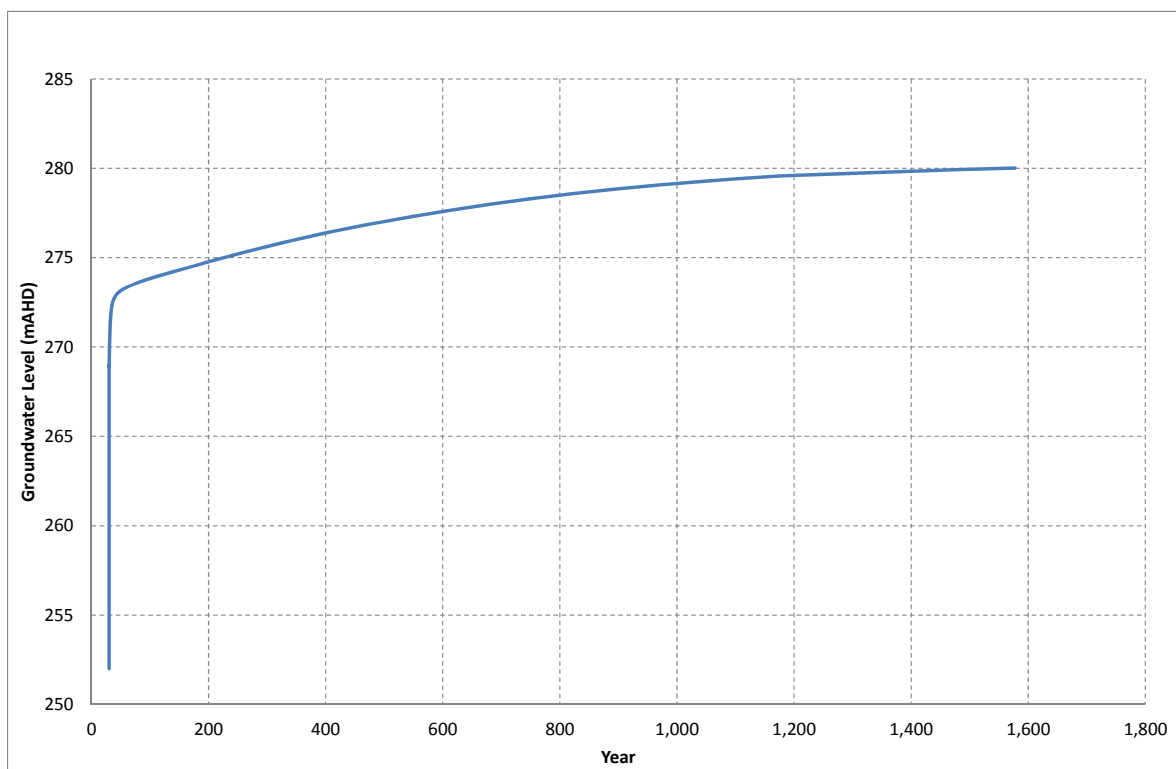


Figure 43
MODFLOW Model Simulated Recovery in Void Lake Level

Void Losing / Gaining Conditions

As discussed above, the MODFLOW groundwater model for the EIS simulated annual average rainfall conditions and did not represent high intensity rainfall events. During these events, rainfall exceeds evaporation, and therefore the inputs to the final void lake are greater than the outputs. There is potential during these events for the lake level to rise rapidly, above the groundwater level, resulting in flow of water from the void lake into the surrounding coal seams and OEA. The groundwater model estimated the rate of flow of water from the open void into the surrounding geology by raising water levels in the open void by 5 m for a period of 24 hours. Following this, the void lake levels were allowed to slowly fall to the steady state equilibrated level of 280 m AHD. The OPSIM model then used this data, as described below, to assess the impact on post mining water level and salinity.

Adopted Groundwater Interactions in Surface Water Model

The behaviour of the final void was simulated using the OPSIM surface water model as described in Section 7.14 of the Surface Water Impact Assessment, using a modified groundwater inflow/outflow relationship derived from the revised MODFLOW groundwater model. The groundwater interaction was simulated in the surface water model as follows:

- Up to a void water level of 280.39 m AHD, the groundwater inflow to the final void is constant at 0.42 ML/day; and
- As the final void lake level increases above 280.4 m AHD (for example following a rainfall event), sufficient head is temporarily available to drive water out of the final void until the system again reaches equilibrium with the surrounding groundwater.

Table 17 shows the adopted relationship between lake level and groundwater outflow rate, based on results from the MODFLOW groundwater model.

Table 17
Adopted Lake Level Dependent Ground Water Outflows

Adopted Lake Level Dependent Groundwater Outflows	
m AHD	ML/day
280.40	0.002
280.50	0.10
280.75	0.35
281.00	0.60
281.25	0.86
281.5	1.11
281.75	1.36
282.00	1.61
282.25	1.86
282.5	2.11
282.75	2.36
283.00	2.61

Comparison of Surface and Groundwater Model Results

Adopting an evaporation factor of 0.7 (to account for the void lake being protected from the sun and wind), the OPSIM surface water model (with the refined groundwater interactions) indicates a long term equilibrium water level between 277.7 and 281.2 m AHD after approximately 100 years, as shown in **Figure 44**. The freeboard between the final water level surface and the void spill height is approximately 40m. Hence, the final void will never overflow. The model results show that the void water level rarely exceeds the level of 280.4 m AHD when temporary outflow commences. **Table 18** shows the average daily water balance after approximately 100 years when the water level has essentially reached equilibrium.

Table 18
Final Void Water Balance from OPSIM Surface Water Model

Water Balance Component		kL/day
Inflows	Direct Rainfall	856
	Catchment Inflow	201
	Groundwater (below 280.4 m AHD)	312
Outflows	Evaporation	1,338
	Groundwater (above 280.4 m AHD)	31
Net Inflow / Outflow		0

Table 23 shows direct rainfall and evaporation dominate the water balance of the void lake. The outflow of groundwater from the void lake is a relatively small component of the water balance and indicates the volume of water seeping from the void would be minor. Figure 44 compares the simulated final void water levels from the OPSIM and MODFLOW models. Both models predict a long term equilibrium water level in the open void of about 280 m AHD, although the groundwater model still reaches equilibrium at a much slower rate, as discussed in **Section 4.3.15** (*'Methodology for Revised Groundwater Modelling'*) above. Both models do confirm freeboard of about 40 m indicating it is improbable the final void will overflow.

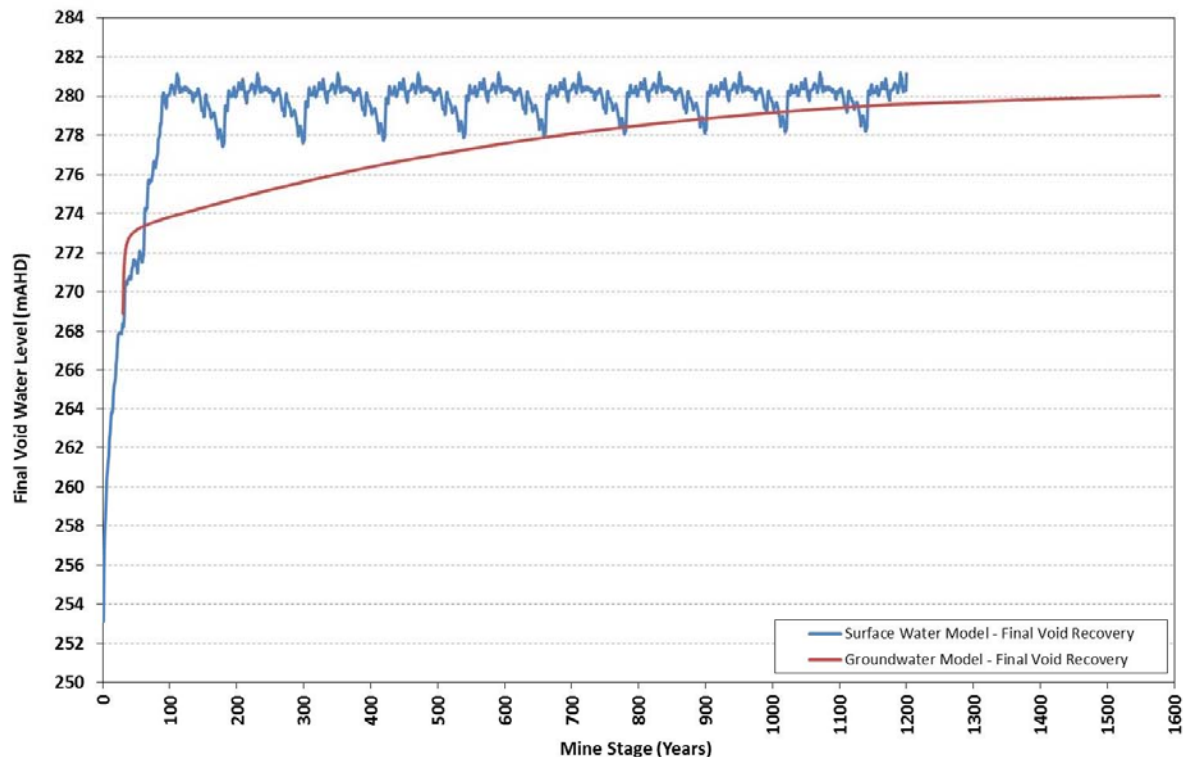


Figure 44
Simulated Final Void Water Level from Surface Water and Groundwater Models

Water Quality

As noted in the Namoi CMA submission, of the EIS main document incorrectly described the average rate of rise in salinity in the final void. The average rate of rise was correctly shown in Figure 7.14 of the Surface Water Impact Assessment. This equates to approximately 6,500 mg/L per 150 years.

The OPSIM model further assessed the final void water quality using the OPSIM water balance results described in **Section 4.3.15** (*'Comparison of Surface and Groundwater Model Results'*) above, which allows for outflow of water to the surrounding geological units during storm events. The groundwater model presented in the Groundwater Impact Assessment did not allow for this outflow when large volumes of water report to the final void lake. These events raise lake water levels rapidly, and reverse the flow of lake water back into the surrounding aquifers in the OPSIM model. The model also simulates the salt load of the sub-surface outflow being drawn back into the final void when equilibrium is again reached following a significant rainfall event, and groundwater inflow to the final void recommences. This is discussed further in **Section 4.3.15** (*'Potential Impact on Surrounding Aquifer Systems'*) below. Evaporation removes water without removing salt and therefore increases the salt concentrations in the void lake. The following salt concentrations (represented as Total Dissolved Solids) were applied in the model:

- Surface runoff from rehabilitated areas = 800 mg/L (adopted value higher than recorded Mooki River runoff salinity of about 550 mg/L – see Table 3.7 of the Surface Water Impact Assessment);

- Seepage inflow from rehabilitated overburden = 2,500 mg/L (50% of estimated conservative short-term maximum of 5,000 mg/L. Salinity is expected to reduce over time as readily available salt is flushed from the system (see Appendix T and W of the EIS); and
- Groundwater inflows = 3,000 mg/L (groundwater concentration assumed by Terrenus (see Appendix 7 in Appendix T of the EIS) using Project groundwater quality data (GHD, 2013) in the general vicinity of the Western Mining Area) .

Figure 45 shows the modelled salt concentration of the final void, as TDS (in mg/L), over 500 years.



Figure 45
Final Void Total Dissolved Solids Concentration (Evaporation Factor of 0.7)

Based on the adopted model assumptions, salinity will increase at a rate of approximately 6,000 mg/L per 100 years, reaching approximately 32,500 mg/L after 500 years.

Table 19 shows the simulated average daily salt balance over 500 years. The input to the final void salt balance is dominated by the sub-surface inflows. Intermittent sub-surface outflow, generated by temporary rises of the lake water level above the regional groundwater level in response to heavy rainfall events, allows some salt to leave the final void into the surrounding coal seams and OEA. The potential for the outflow from the void water to contaminate surrounding aquifer systems was considered further below.

Table 19
Average Daily Final Void Salt Balance

Salt Balance Component		kg/day
Inflows	Direct rainfall	0
	Surface runoff inflow	443
	Sub-surface inflow (below 280.4 m AHD)	1,409
Outflows	Evaporation	0
	Sub-surface outflow (above 280.4 m AHD)	441
Salt Retained		1,411

Potential Impact on Surrounding Aquifer Systems

Figure 46 shows the stabilised groundwater levels around the final void 2,000 years after mining. An inward hydraulic gradient remains post mining that draws groundwater from the surrounding coal measures and OEA into the void. The zone of influence extends between about 1 km to 2 km around the open void. The hydraulic gradient is relatively steep at between 1 m in 20 m and 1 in 80 m. As the outflow from the final void lake is predicted to be relatively limited, averaging about 30 kilolitre (kL)/day, it is considered the zone of depressurisation will capture the limited outflows generated by large rainfall events. This water will seep into the coal measures and OEA, but then slowly drain back into the final void after the water level in the lake falls and the zone of depressurisation re-establishes. The effect of this is that the open void will remain a permanent sink for groundwater flow and the saline water that will develop within the void lake will not be able to flow to the adjacent alluvial aquifers.

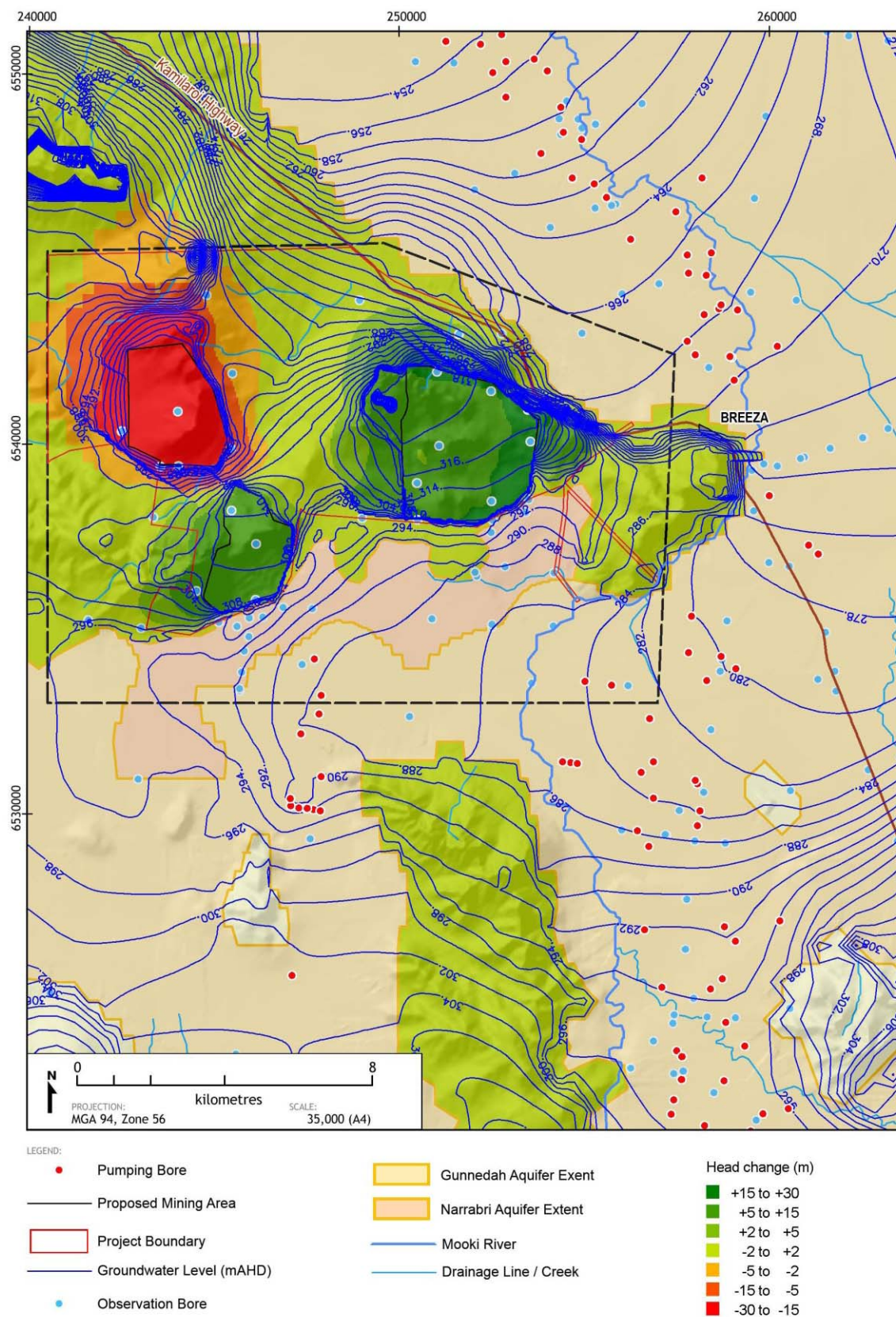


Figure 46
Stabilised Groundwater Levels Around Open Void

Management

Shenhua Watermark will prepare a Final Void Management Plan for the Project. The plan will justify the need for a final void to remain at the end of mine life and provide design criteria for the final void, which will prevent impact to surrounding groundwater systems.

Shenhua Watermark considers that a sustainable final void can be developed, as conceptually shown in **Plate 5**. The artist's impression of the final void below has been developed in consideration of the detailed mine plans for the Project, proposed mine closure and rehabilitation strategies (i.e. battering low walls and establishing vegetation), final void water levels provided by WRM and Australasian Groundwater and Environmental Consultants (and discussed above) and surrounding topography (Mt Watermark can be seen in the background). The artist's impression of the final void demonstrates that an attractive, sustainable void can be developed for the Project and further, that Shenhua Watermark is committed to achieving this.

The Greenwood void at the Vickery Mine near Gunnedah further provides an existing example of the development of a sustainable final void. The Vickery Project mined between 1991 and 1998 using open cut methods. The Greenwood void remained after mining was completed around 1998. The area was rehabilitated by Coal and Allied and the remaining void is shown in the photographs below, which demonstrates it is possible to integrate the open voids remaining after mining into the surrounding landscape.

The Rehabilitation Management Plan for the Project will aim to create a final void, which like the Greenwood void (shown in **Plate 3** and **Plate 4** – dated 20 January 2012) at the Vickery Mine does not detract from the surrounding landscape and is not a long term liability for the state of New South Wales. The regular updates required to the groundwater model will also continue to assess the impact of the final void and the relationship with the surrounding aquifer systems. If necessary, WALs will be relinquished post mining to account for any long term take of groundwater due to the evaporative pumping effect of the void lake.



Source: Merrick, 2013

Plate 3
Photograph of Greenwood Void 1



Source: Merrick, 2013

Plate 4
Photograph of Greenwood Void 2

4.3.16 Water Quality Impacts

This section addresses the submissions from stakeholders regarding the impacts of the Project on water quality in the water supply catchment.

Submission: RA13, SIG10, SIG14, P4, P16, P20, P30, P57, P60, P67

Summary response: There will be no releases of mine affected water from the Project (water that may contain carbonaceous material). Some releases of sediment laden water are expected to occur but only after a period of settlement to reduce sediment loads. Any releases of water will meet EPL discharge limits or will be pumped back into the water management system and reused.

Impacts on Water Quality in Water Supply Catchment

Several submissions were received concerning the water quality of releases from the Project. As described in **Section 4.3.3** of this RTS, modelling has shown that there will be no releases of mine affected water (water that may contain carbonaceous material). Some releases of sediment affected water are expected to occur but only after a period of settlement to reduce sediment loads. Any releases of water will meet EPL discharge limits or will be pumped back into the water management system and reused. The EPL discharge limits will be based on background water quality data in the receiving water and as such, any releases of water will be of similar quality to existing conditions.

As discussed above, extensive geochemical testing has been undertaken to characterise the waste material to determine potential runoff quality. The geochemical testing is presented in the Geochemical Impact Assessment (Appendix W of the EIS). With respect to metal toxicants, the geochemical testing found that the concentration of total metals in overburden /interburden and coal reject material was below guideline criteria for soils. The study concluded that the concentration of traces metal in runoff and seepage from most overburden / interburden and coal reject material is likely to be low.

At the completion of mining, rehabilitation of the OEAs with topsoil and revegetation is likely to improve runoff quality.

With respect to heavy metals such as lead and arsenic (mentioned by Submission P20), leachate testing found levels were orders of magnitudes lower than guideline levels for soils with lead levels below detection limits in both the overburden and coal seams. Detection limits were set below ANZECC trigger values for ecosystem protection (99% level of protection).

It is noted that background concentrations of metal toxicants in the Mooki River, particularly chromium, copper and iron are above ANZECC (2000) trigger values for ecosystem protection.

Notwithstanding the above, data collected as part of the surface water monitoring program will enable water quality and management practices to be evaluated over the course of the Project. Should water quality become an issue, measures can be implemented to improve the placement of overburden material with different runoff characteristics to improve runoff water quality. This will be documented in the Water Management Plan to be prepared for the Project.

Water Quality Impacts on Lake Goran

Submission P16 expresses concern that water will flow from the western perimeter of the Project into Lake Goran. Any surface runoff from the Western Mining Area will either drain to Watermark Gully or be collected within the open cut mining area which will form the western boundary of disturbance. No area disturbed by mining activities will drain to Lake Goran to impact on its water quality.

4.3.17 Cumulative Impacts

This section addresses the submissions from stakeholders regarding potential cumulative impacts of the Project on surface water resources.

Submissions: SIG10, SIG14, SIG12, P20, P30

Summary response: In regard to cumulative impacts on water supply, any take of water from the Mooki River, whether it be for industrial or agricultural use is managed through the relevant water sharing plan. The water sharing plan has considered the cumulative impacts of all water uses in the catchment to ensure the environmental needs of the catchment are satisfied. The Project will comply with the provisions of this plan to ensure that any cumulative impacts are minimised.

Several submissions were received concerning the potential cumulative impacts on the Mooki River should multiple mining developments be approved in the catchment. There is currently one operating mine in the catchment (Werris Creek) and another potential project (Caroona). Several mines are operating further downstream between Gunnedah and Narrabri but these do not impact on the Mooki River. With respect to cumulative impacts on water supply, any take of water from the Mooki River, whether it be for industrial or agricultural use is managed through the *Water Sharing Plan for the Philips Creek, Mooki River, Quirindi Creek and Warrah Creek Water Sources*. This plan is a legal document made under the *Water Management Act 2000*. The water sharing rules in this plan are designed to provide for the environmental needs of the river, as well as directing how water will be allocated and shared among different water users.

In other words, the water sharing plan has considered the cumulative impacts of all water uses in the catchment to ensure the environmental needs of the catchment are satisfied. The Project will comply with the provisions of this plan to ensure that any cumulative impacts are minimised.

There will be some loss of catchment and reduction in flow associated with the Project. The final void will be located within the Lake Goran Water Source and as such, will not impact on the Mooki River Water Source. In fact, there is a moderate increase in catchment to the Mooki River post mining. As stated in **Section 4.3.9** above, the loss of catchment area to Lake Goran at the completion of mining is small (0.4%). Several final voids in this catchment would be required before an impact on this water source was measurable.

With respect to water quality, the EPL release conditions given under the *Protection of the Environment Operations Act 1997* will ensure cumulative impacts on water quality from this Project and any other project are managed. The water quality release conditions will be based on background water quality in the receiving waters. On this basis, the quality of releases should be no worse than the background water quality of the Mooki River. This would be the case if multiple mines were releasing at the same time.

A review of the Werris Creek Mine Annual Environmental Management Report for 2012-2013 (available on the Werris Creek Mine website) shows releases were made on seven occasions over the reporting period. All controlled and wet weather discharge events from their dirty water system were in compliance with their licence conditions.

4.3.18 Monitoring

This section addresses the submissions from stakeholders regarding the surface water monitoring requirements of the Project.

Submissions: RA13, SIG10, P57

Summary response: Shenhua Watermark will monitor surface water quality in accordance with the approved Water Management Plan to be developed for the Project. The plan will identify the monitoring locations, the frequency of monitoring as well as the monitoring standards. It will also detail the trigger values for the potential risks.

Monitoring Plan

Shenhua Watermark will monitor surface water quality in accordance with the approved Water Management Plan for the Project. The Surface Water Impact Assessment has provided an overview of the proposed surface water quality monitoring plan for the Project, including preliminary water quality performance criteria to be used to trigger a management action. This monitoring plan will be updated as part of a comprehensive Water Management Plan that will be developed for the Project. The monitoring program will include the following:

- Surface water quality monitoring;
- Channel stability monitoring for the Watermark Gully diversion; and
- Onsite water monitoring.

The plan will identify the monitoring locations, the frequency of monitoring as well as the monitoring standards. It will also detail the trigger values for the potential risks that have been identified in the Surface Water Impact Assessment and detailed in the Water Management Plan.

The water quality trigger values will be based on the EPL conditions or the ANZECC guideline trigger values.

Water Take

In accordance with the requirements of NOW, Shenhua Watermark commits to maintaining records of water taken from all water sources. Records of water taken will be included in the Annual Review.

Sewage Treatment and Waterway Crossings

CCAG has requested monitoring programs that address DOE Requirement 16 for sewage treatment and waterway crossings. As described in Section 7.25 of the EIS, sewage will be managed by an onsite sewerage treatment facility. Further details on the sewage treatment proposed by the Project are provided in **Section 4.25** of this RTS.

At present, no crossings of a watercourse are proposed as part of the Project and as such a monitoring program is not required.

4.3.19 Mitigation and Management Measures

This section addresses the submissions from stakeholders regarding the Project's requirement for mitigation strategies.

Submissions: RA12, SIG10, SIG12, P22, P71

Summary response: EPL conditions and Water Access Licence conditions limit impacts on water quality and flow to predetermined levels.

NSW Fisheries and CCAG suggest that Shenhua Watermark has not committed to clearly developed mitigation strategies for possible changes in groundwater levels or quality and surface water flow or quality. With respect to surface water flow or quality, the potential risks have been identified using the best available data and management strategies have been developed and comprehensively assessed using the water balance model. Note that EPL conditions and Water Access Licence conditions limit impacts on water quality and flow to predetermined levels.

Several opportunities are available if mine water quality is worse than expected or mine water inflows are greater than expected, given the requirement for offsite water supplies to meet mine site water demands. For instance, a larger out-of-mining area storage (dirty water dam) could be constructed to contain mine affected water. This will reduce the reliance on offsite supplies. If runoff water quality from the OEAs is worse than expected, then sediment dam volumes could be increased or the pump capacity increased.