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31 January 2017

Mr Howard Reed
Director, Resource Assessments
NSW Department of Planning and Environment
GPO Box 39
SYDNEY NSW 2001

Dear Howard

RE: SSD-5144 MOD 4 Response to Submissions Letter Report

Set out below is Centennial Mandalong's response to matters raised following public exhibition of the SSD-5144 Modification 4 Statement of Environmental Effects (SEE). A formal response to matters raised was requested by the Department of Planning and Environment (DP&E) in correspondence dated 20 December 2016.

Background

Centennial Mandalong lodged an application and supporting SEE to modify State Significant Development (SSD) consent SSD-5144 pursuant to Section 96(2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The application is seeking approval for the extension of longwall panels 22 and 23 within the existing development consent boundary. This extension will produce an approximate additional 1.4 million tonnes of coal to be extracted within the current annual extraction rate and mine life.

The application and supporting SEE were placed on public exhibition from 1 December 2016 to 15 December 2016. Eight government agency submissions (including Lake Macquarie City Council), two non-governmental organisation submissions and 11 public submissions were received. Of the 11 public submissions, nine objected to the modification and two were in support. Additional matters requiring clarification were raised by DP&E in correspondence dated 20 December 2016. **Attachment 1** summarises each submission (Section 1) and responds to matters raised (Section 2) in addition to responding to the additional matters raised by DP&E (Section 3).

Modification Contact

I can be contacted on (02) 4935 8901 or via email iain.hornshaw@centennialcoal.com.au should DP&E have any queries regarding this Response to Submissions Letter Report.

Yours sincerely

Iain Hornshaw
Approvals Coordinator

Encl: Attachment 1 – Summary and Response to Submissions
Attachment 2 – Updated Water Management Plan

Centennial Mandalong Pty Limited ABN 74 101 508 892

Attachment 1 – Summary and Response to Submissions

1. Submissions Summary

1.1 Summary of Government Agency Submissions

Raised By	Summary of Issue
Department of Primary Industries (DPI)	The proponent should update the water management plan, to be developed in consultation with DPI Water to address the following: • Remediation measures and water licensing requirements for tensile and compressive cracks which may develop in the surface zone. • A monitoring and rehabilitation strategy for Tobins Creek. Monitoring should include the sections directly above the proposed longwall extension, including the two unnamed 1st order tributaries. • Monitoring of the vegetation communities listed in section 9.3.3. being MU1, MU5, MU17o, MU37d and MU46. • Make good provisions for impacted surface and groundwater users. This commitment should not be exclusive to a drawdown of 2 m but rather whereby drawdown has reduced the capacity of take for licensed purposes and/or basic landholder rights. • Consideration should also be given to a private bore monitoring network, subject to access agreements.
	The proponent should provide a consolidated list of all licences held by Centennial Coal in relation to Mandalong Mine under both the Water Management Act 2000 and the Water Act 1912. This should include detail regarding current take from these licences and the excess water entitlement held proposed to account for the incremental increase of take from the proposed modification.
	All water storages/dams should be presented in a table detailing capacity, stream order and licensing status, for example how the storages/dams are linked to Water Access Licence (WAL), exempt or within harvestable right.
	Predicted subsidence will increase ponding in some areas and will have impacts on flooding. The proponent should provide further detailed information as to the impacts on the catchment area of the Dora Creek Water Source. This is important for understanding the licensing requirements in the final landform.
Division of Resources and Energy (DRE)	The information provided does adequately identify and address risks to the environment associated with the Modification. The proposed modification has the same surface footprint as currently approved under SSD-5144 and there is no change to the final land use it is considered that no further information is required.
Environment Protection Authority (EPA)	The EPA has reviewed the SEE and has determined that the proposed modification will not require a variation of the proponent's Environment Protection Licence. Consequently, the EPA has no objection to the proposed modification of the development consent.

Hunter New England Population Health (HNEPH)	The SEE has been reviewed by HNEPH with particular attention paid to the management of air quality, noise, water and other issues that may impact on public health. No physical changes to the mine's infrastructure or the surface footprint are proposed and the modification is anticipated to pose minimal environmental and social effects beyond those previously assessed and approved. For this reason HNEPH considers the modification would have minimal health impact.
Heritage Council of NSW	The modified Environmental Assessment and the documents supporting the proposed modification are reviewed and as the delegate of the Heritage Council of NSW, I provide the following comments: • The proposed development would not impact on any SHR items. • The proposed modification does not alter the consent boundary for this coal mine. • The proposed modification is unlikely to have an additional impact beyond those previously assessed. • If, during the course of development works, significant European cultural heritage material is identified, works should cease in that area immediately. The NSW Heritage Division should be notified and works recommenced only when an appropriate and approved management strategy is implemented.
Lake Macquarie City Council (LMCC)	LMCC raise issues pertaining to SSD-5144 Modification 3 regarding an increase to the annual production limit from 6 million tonners per annum to 6.5 million tonnes per annum. Modification 3 was approved on 16 November 2016.
Office of Environment and Heritage (OEH)	The proponent, in consultation with the registered Aboriginal parties, propose to manage Aboriginal heritage under Centennial Coal's Northern Region Aboriginal Cultural Heritage Management Plan. This plan will be updated to include the location and significance of the sites found in the Study Area. OEH therefore has no concerns with respect to Aboriginal cultural heritage management for this project. OEH recommends that the following conditions be included in any consent granted for this Project: • Aboriginal cultural heritage management for the proposed modification must be undertaken in accordance with the approved Northern Region Aboriginal Cultural Heritage Management Plan. • The Proponent must update the existing Northern Region Aboriginal Cultural Heritage Management Plan to include any Aboriginal cultural constraints within the project area prior to commencing any ground disturbance or development works subject to this development.

	Neither property 73 or 206 are predicted to be adversely affected flood-wise by the modification. OEH has no objection to the current application. The water assessment shows that the previous approval already has, or soon will have, an adverse impact on some private properties from increased flood frequency. Granting approval without indemnity transfers liability from the mine to the NSW Government. This is not supported by OEH.
	The lack of adequate survey of the project area undertaken to date is problematic. While the impacts of mine subsidence from extended longwall panels 22 and 23 and likely to be minor, they may not be if poorly know faults, shear zones or other geological structures are intersected that transfer more of the mining void to the surface. Therefore for this project OEH recommends the following conditions of consent. • That prior to mining commencing, the biodiversity value of the area is quantified by appropriate survey, or if that is not possible then that the proponent commissions an expert report on the threatened biodiversity values of the site, in accordance with the Framework for Biodiversity Assessment. • That any harm to threatened biodiversity caused by the mining of the new longwall panel areas is assessed by the Framework for Biodiversity Assessment, and, if required, offset in accordance with the NSW Biodiversity Offsets Policy for Major Projects.
Roads and Maritime Services (RMS)	Roads and Maritime has reviewed the information provided and raises no objection to or requirements for the proposed development as it is considered there will be no significant impact on the nearby classified (State) road network.

1.2 Summary of Non-Governmental Organisation Submissions

Raised By	Summary of Issue
Hunter Environment Lobby Inc. (HEL)	HEL would like to object to the above extension project on one of the important bases of interference with valuable water resources within the Dora Creek catchment area. This catchment is very valuable to the quality of water resources for Central Coast residents. The diminution of the value of the Morans Creek and Tobins Creek catchment areas expressed in Appendix 5 of the Water resources Impact Assessment is alarming. The statement that suggests that these catchments or creeks do not have surface flow for the entire year is simplistic. The very fact that rainfall periods vary greatly and so does creek flow indicates that in some years flows are high and others not. This is the very basic nature of water cycles. The fact that we have Millennial Droughts and floods attest to

	this. To pre-empt the notion of undermining these tributaries based on simple equations as expressed in the Assessment could be seen to be dangerous for future water resources.
	The other major concern expressed in the Assessment is the problem of salty brine. The tonnage of salt extracted from groundwater inflows into the mine begins with 1283 tonnes per annum, to almost 3000 tonnes per annum in 2036. These vast amounts of salt extractions transferred to the Borehole Dam and subsequent discharges are not clearly defined. We find these amounts extreme and would like to see some explanation of this issue? Much more detail is required and greater explanation of the mechanics of controlling and discharge should be clearly shown in the public arena.
Hunter Communities Network	The impacts on alluvial aquifers that provide base flows to the ephemeral creeks has not been satisfactorily assessed for cumulative damage to the creek systems.
	The predicted changes to flooding regimes and increase in ponding demonstrate long-term impacts that may have adverse ecological outcomes in the creek systems.
	The issue of increased salinity in mine waste water production is a key issue that has not been adequately assessed or mitigated.

1.3 Summary of Public Submissions

Raised By	Summary of Issue
176366 175805	Submissions in support of the Modification
177046 177405 177413 177389 177546 177292	The diminution of the value of the Morans Creek and Tobins Creek catchment areas expressed in Appendix 5 of the Water resources Impact Assessment is alarming. The statement that suggests that these catchments or creeks do not have surface flow for the entire year is simplistic. The very fact that rainfall periods vary greatly and so does creek flow indicates that in some years flows are high and others not. This is the very basic nature of water cycles. To pre-empt the notion of undermining these tributaries based on simple equations as expressed in the Assessment is outright flippant and dangerous for future water resources. Planning need to have experts revisit the value of these water resources as they impact also on the important Stockton Creek resource which is also a major source for the integrity of the ecology of Dora Creek.
	The other major concern expressed in the Assessment is the problem of salty brine. The tonnage of salt extracted from groundwater inflows into the mine begins with 1283

	tonnes per annum, to almost 3000 tonnes per annum in 2036. These vast amounts of salt extractions transferred to the Borehole Dam and subsequent discharges are not clearly defined. Much more detail is required and greater explanation of the mechanics of controlling and discharge should be clearly shown in the public arena. It is important for local populations to understand how these large salt depositions are handled over the life of the mine and also the long term impact of saline action upon water resources and fertile land in the vicinity of the catchment areas impacted by this extension. Planning NSW must have Centennial Coal produce clear and defined data for display prior to any approval of this extension being granted.
177546	There is a clear threat of contamination of Muddy Lake, which is a SEPP14 protected resource, by inflow of saline water from the mine. Under no circumstance must a SEPP14 wetland be subjected to unnatural impacts which is why they are afforded the highest order of protection. Planning NSW need to reassess the plan to avoid such impact.
177627	I wish to record my objection to the above proposal, both in general as to any further extensions being granted, and more specifically having regard to the inadequacy of the documentation presented in support of the current modification. It would be pointless to attempt to engage in detail with the flaws in the data provided, and the credibility of the conclusions advanced. Sadly, what we have here is yet another example of a pseudo scientific report, crafted by eagerly compliant consultants solely for the purpose of advancing their client's commercial interests, and in the hope that your Department will automatically rubber-stamp it.
177401	The proponent applied for modification on panels 22-23 in September this year. The application was successful. Centennial has had three successful applications with this mine this year. I believe it is too hasty to approve any more modifications until effects of previous modifications are known, in particular "Modification 2 Mandalong Southern Extension Project".
	There are concerns around the effects on ground water and surface water, any modification that has the potential to affect ground and surface water and threatened ecosystems should not be allowed. As the Department of Planning knows already, that ground water cannot recharge quickly and if contaminated presents massive problems and consequences. The case at Williamtown, comes to mind.
	The Modification has the potential to effect the Dora Creek Catchment and thus impacting on Lake Macquarie itself. I believe it is prudent to wait to see the outcomes other the other three modifications before allowing the approval of

	this modification.
177393	I understand that there has been an observation of limited water running down the creeks in question. However I point out that water flow will infact vary from year to year and further more whilst there may not be viable water on any given year it does not mean that underground water is not present in these creeks.
	This proposed plan has negative impacts for the local community and well as the global community concerning climate change. I feel it's a little patronising to point out the climate change effects from coal mining I'm sure the panel is coming from and educated back ground and understands well and also values the opinion of the global scientific community.

2. Response to Submissions

2.1 Government Agency Submissions

2.1.1 Department of Primary Industries

Submission matter: The proponent should update the water management plan, to be developed in consultation with DPI Water, to address the following:

Response: The Water Management Plan (WMP; GHD 2016b) prepared for the Extraction Plan for secondary extraction of longwalls 22 and 23 has been updated to include the recommendations of DPI Water. The following sections provide a summary of how these comments have been addressed in the WMP. The updated WMP forms **Attachment 2** to this Letter Report.

Submission matter: Remediation measures and water licensing requirements for tensile and compressive racks which may develop in the surface zone.

Response: Water loss as a result of surface cracks is considered unlikely to occur. No water loss has been observed previously due to the mining of longwalls with less depth of cover (compared to longwalls 22 and 23). In the unlikely event that subsidence causes significant surface cracks, remediation measures to prevent water loss are provided in Appendix D of the WMP.

Water licensing requirements have not been considered due to the low likelihood of water loss as a result of surface cracks. The Trigger Action Response Plan (TARP) provided in Appendix E of the WMP specifies that any loss of water supply may need to be licensed.

Submission matter: A monitoring and rehabilitation strategy for Tobins Creek. Monitoring should include the sections directly above the proposed longwall extension, including the two unnamed 1st order tributaries.

Response: The watercourse stability monitoring program detailed by the WMP has been updated to include the two first order tributaries of Tobins Creek. Remediation measures for creek realignment and bed stabilisation measures are provided in Appendix D of the WMP and within the TARP included in Appendix 1 of the LW22-23 Extraction Plan – Land Management Plan.

Submission matter: Monitoring of the vegetation communities listed in section 9.3.3. being MU1, MU5, MU17o, MU37d and MU46.

Response: The Biodiversity Management Plan prepared for the Extraction Plan outlines the proposed monitoring of vegetation communities regarding secondary extraction of longwalls 22 and 23.

Submission matter: Make good provisions for impacted surface and groundwater users. This commitment should not be exclusive to a drawdown of 2 m but rather whereby drawdown has reduced the capacity of take for licensed purposes and/or basic landholder rights.

Response: The TARP in Appendix E of the WMP includes provisions for the replacement of water supply by Centennial Mandalong.

Submission matter: Consideration should also be given to a private bore monitoring network, subject to access agreements.

Response: There are no private bores currently in the Mandalong Mine groundwater monitoring network. In future, if private bores are in a suitable location, then Centennial Mandalong will attempt to gain approval and access for monitoring.

Submission matter: The proponent should provide a consolidated list of all licences held by Centennial Coal in relation to Mandalong Mine under both the Water Management Act 2000 and the Water Act 1912. This should include detail regarding current take from these licences and the excess water entitlement held proposed to account for the incremental increase of take from the proposed modification.

Response: The North Coast Fractured and Porous Rock Groundwater Sources Water Sharing Plan commenced on 1 July 2016 under the *Water Management Act 2000* and regulates the interception and extraction of groundwater from the fractured and porous rock aquifer within the plan boundary, which includes Mandalong Mine.

Centennial Mandalong currently holds one water access licence (WAL 39767) for the extraction of up to 1,825 ML/year via the Cooranbong bore (works approval 20WA218789) from the Cooranbong Underground Storage area into the Borehole Dam at Cooranbong Entry Site. The annual underground water extraction volumes via the Cooranbong bore from 2013 to 2016 are provided in **Table 1**.

Table 1: Annual Underground Water Extraction Volumes

Period	Underground water extraction
1 July 2013 to 30 June 2014	474 ML
1 July 2014 to 30 June 2015	471 ML
1 July 2015 to 30 June 2016	910 ML

Hydrogeological modelling was undertaken to estimate groundwater seepage into the Mandalong Mine workings and predict groundwater drawdown associated with the mine and the modification. The predicted groundwater inflows into the underground workings were incorporated into the site water and salt balance model. This GoldSim model was used to predict the volume of underground water extracted via the Cooranbong bore, which is presented in **Figure 1** along with the total underground water extraction licensed under WAL 39767 of 1,825 ML/year.

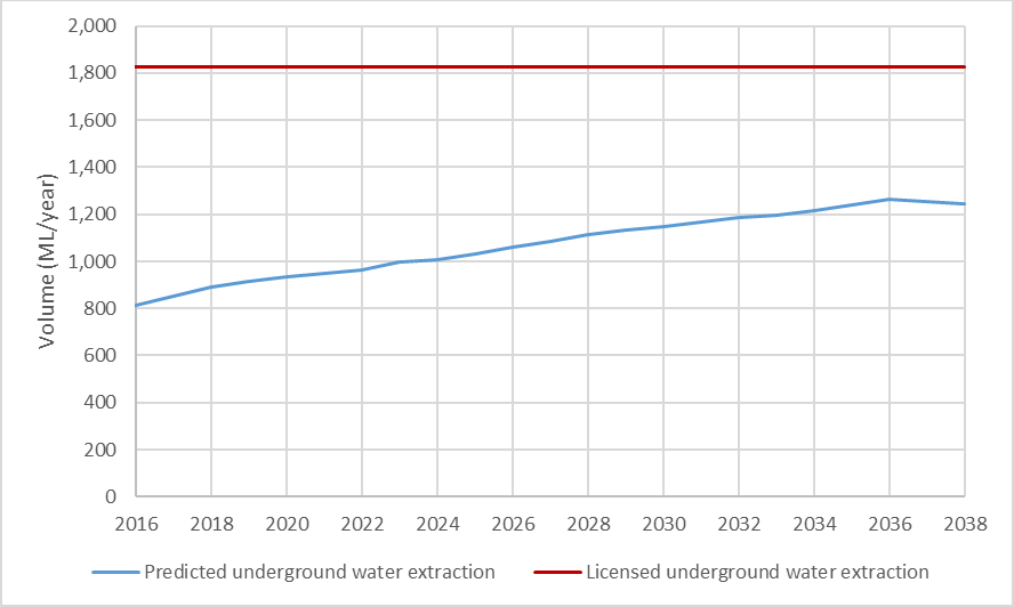


Figure 1: Predicted and Licenced Underground Water Extraction

As shown in **Figure 1**, extractions from the Cooranbong Underground Storage area into the Borehole Dam at Cooranbong Entry Site are predicted to peak at 1,263 ML/year in 2036. This volume is less than the licensed extraction volume under WAL 39767 of 1,825 ML/year. As such, no changes to WAL 39767 are proposed as part of the Project.

No take of water is predicted from the alluvium or the unregulated surface water within the Project area.

A number of licences are held by Centennial Mandalong under the *Water Act 1912* for groundwater monitoring bores. The details of these bores are provided in Table 5-1 of the Mod 4 Water Resources Impact Assessment (WRIA; GHD 2016a).

Submission matter: All water storages/dams should be presented in a table detailing capacity, stream order and licensing status, for example how the storages/dams are linked to Water Access Licence (WAL), exempt or within harvestable right.

Response: **Table 2** presents the capacity and licensing status of all surface water storages at the Mandalong Mine Access Site and Mandalong South Surface Site. All storages are off-line and as such no stream order is applicable. No changes to the surface water management at the Mandalong Mine Access Site or Mandalong South Surface Site are proposed as part of the Project.

The guidelines for determining the capacity of dams under a harvestable right indicate that the following dams are exempt from the calculation of harvestable right and do not require a licence (DPI Water 2016):

- Dams for the control or prevention of soil erosion where no water is reticulated or pumped from them.
- Dams for the capture, containment and recirculation of drainage.
- Dams without a catchment.

The surface water storages associated with the three surface sites at Mandalong Mine all fall into one of the above categories and therefore do not require licensing under the *Water Management Act 2000*.

Table 2: Storage Details

Storage	Capacity	Licensing status
Mandalong Mine Access Site		
Clean Water Dam	0.9 ML	Exempt – for the control/prevention of soil erosion
Sediment Control Dam	0.4 ML	Exempt – for the capture, containment and recirculation of drainage/effluent
Macrophyte Pond	0.2 ML	Exempt – turkey nest dam with no catchment
Mandalong South Surface Site		
Sediment Dam*	1.2 ML	Exempt – for the capture, containment and recirculation of drainage/effluent

* Sediment Dam at Mandalong South Surface Site is yet to be constructed.

Submission matter: Predicted subsidence will increase ponding in some areas and will have impacts on flooding. The proponent should provide further detailed information as to the impacts on the catchment area of the Dora Creek Water Source. This is important for understanding the licensing requirements in the final landform.

Response: As was the case with the Mandalong Southern Extension Project (SSD-5144), drainage works will be undertaken to relieve areas of increased remnant ponding as a result of the Modification. Triggers for undertaking drainage works will be where new remnant ponding areas are created as a result of mine induced subsidence and there is a new detrimental impact on habitat and it is practical to do so. Any mitigation works will be determined in consultation with the landowner and relevant government agencies.

Where drainage works are not possible and increased remnant ponding is predicted, an estimate of the volume of lost water will be used to determine licensing requirements as part of the Extraction Plan WMP.

2.1.2 Division of Resources and Energy

Submission matter: The information provided does adequately identify and address risks to the environment associated with the Modification. The proposed modification has the same surface footprint as currently approved under SSD-5144 and there is no change to the final land use it is considered that no further information is required.

Response: Noted.

2.1.3 Environment Protection Authority

Submission matter: The EPA has reviewed the SEE and has determined that the proposed modification will not require a variation of the proponent's Environment Protection Licence. Consequently, the EPA has no objection to the proposed modification of the development consent.

Response: Noted.

2.1.4 Hunter New England Population Health

Submission matter: The SEE has been reviewed by HNEPH with particular attention paid to the management of air quality, noise, water and other issues that may impact on public health. No physical changes to the mine's infrastructure or the surface footprint are proposed and the modification is anticipated to pose minimal environmental and social effects beyond those previously assessed and approved. For this reason HNEPH considers the modification would have minimal health impact.

Response: Noted.

2.1.5 Heritage Council of NSW

Submission matter: The modified Environmental Assessment and the documents supporting the proposed modification are reviewed and as the delegate of the Heritage Council of NSW, I provide the following comments:

- *The proposed development would not impact on any SHR items.*
- *The proposed modification does not alter the consent boundary for this coal mine.*
- *The proposed modification is unlikely to have an additional impact beyond those previously assessed.*
- *If, during the course of development works, significant European cultural heritage material is identified, works should cease in that area immediately. The NSW Heritage Division should be notified and works recommenced only when an appropriate and approved management strategy is implemented.*

Response: Noted. Should significant European cultural heritage material be identified Centennial Mandalong will cease works and notify the Heritage Council of NSW to determine appropriate action in accordance with the Centennial Coal Northern Region Historic Heritage Management Plan.

2.1.6 Lake Macquarie City Council

Submission matter: LMCC raise issues pertaining to SSD-5144 Modification 3 regarding an increase to the annual production limit from 6 million tonners per annum to 6.5 million tonnes per annum. Modification 3 was approved on 16 November 2016.

Response: A Response to Submissions letter report regarding SSD-5144 Modification 3 was submitted to DP&E on 1 November 2016. The letter report specifically addressed matters raised by LMCC regarding greenhouse emissions in addition to the continued research and development of VAM RAB technology.

2.1.7 Office of Environment and Heritage

Submission matter: The proponent, in consultation with the registered Aboriginal parties, propose to manage Aboriginal heritage under Centennial Coal's Northern Region Aboriginal Cultural Heritage Management Plan. This plan will be updated to include the location and significance of the sites found in the Study Area.

OEH therefore has no concerns with respect to Aboriginal cultural heritage management for this project. OEH recommends that the following conditions be included in any consent granted for this Project:

- *Aboriginal cultural heritage management for the proposed modification must be undertaken in accordance with the approved Northern Region Aboriginal Cultural Heritage Management Plan.*
- *The Proponent must update the existing Northern Region Aboriginal Cultural Heritage Management Plan to include any Aboriginal cultural constraints within the project area prior to commencing any ground disturbance or development works subject to this development.*

Response: Noted. Centennial Mandalong supports OEH's recommended conditions of consent regarding Cultural Heritage.

Submission matter: Neither property 73 or 206 are predicted to be adversely affected flood-wise by the modification. OEH has no objection to the current application.

Response: Noted.

Submission matter: The lack of adequate survey of the project area undertaken to date is problematic. While the impacts of mine subsidence from extended longwall panels 22 and 23 and likely to be minor, they may not be if poorly know faults, shear zones or other geological structures are intersected that transfer more of the mining void to the surface. Therefore for this project OEH recommends the following conditions of consent.

- *That prior to mining commencing, the biodiversity value of the area is quantified by appropriate survey, or if that is not possible then that the proponent commissions an expert report on the threatened biodiversity values of the site, in accordance with the Framework for Biodiversity Assessment.*
- *That any harm to threatened biodiversity caused by the mining of the new longwall panel areas is assessed by the Framework for Biodiversity Assessment, and, if required, offset in accordance with the NSW Biodiversity Offsets Policy for Major Projects.*

Response: The biodiversity value of the area will be determined in accordance with the Framework for Biodiversity Assessment. The majority of required surveys have already been undertaken in line with the Biobanking Assessment Methodology. The remaining surveys will be completed by 6 February 2017. Following the completion of the surveys a Biodiversity Assessment Report with the associated inventory report will be produced and a copy forwarded to both DP&E and OEH for review prior to the commencement of longwall 22 extraction.

2.1.8 Roads and Maritime Services

Submission matter: Roads and Maritime has reviewed the information provided and raises no objection to or requirements for the proposed development as it is

considered there will be no significant impact on the nearby classified (State) road network.

Response: Noted.

2.2 Non-Governmental Organisation Submissions

2.2.1 Hunter Environment Lobby Inc.

Submission matter: HEL would like to object to the above extension project on one of the important bases of interference with valuable water resources within the Dora Creek catchment area. This catchment is very valuable to the quality of water resources for Central Coast residents.

The diminution of the value of the Morans Creek and Tobins Creek catchment areas expressed in Appendix 5 of the Water resources Impact Assessment is alarming. The statement that suggests that these catchments or creeks do not have surface flow for the entire year is simplistic.

The very fact that rainfall periods vary greatly and so does creek flow indicates that in some years flows are high and others not. This is the very basic nature of water cycles. The fact that we have Millennial Droughts and floods attest to this.

To pre-empt the notion of undermining these tributaries based on simple equations as expressed in the Assessment could be seen to be dangerous for future water resources.

Response: The WRIA (GHD 2016a) notes that the study area is located within the upper reaches of Morans Creek and Tobins Creek and includes several unnamed tributaries. Both creeks are ephemeral, with periods of limited or no flow during low rainfall. The SEE and WRIA have been prepared in accordance with relevant assessment guidelines and are considered to adequately address the impacts on surface water. With the proposed mitigation and management measures described in the WRIA and Extraction Plan WMP (GHD 2016b; Attachment 2), the Modification's impacts on water resources are not predicted to be significant.

Submission matter: The other major concern expressed in the Assessment is the problem of salty brine. The tonnage of salt extracted from groundwater inflows into the mine begins with 1283 tonnes per annum, to almost 3000 tonnes per annum in 2036. These vast amounts of salt extractions transferred to the Borehole Dam and subsequent discharges are not clearly defined.

We find these amounts extreme and would like to see some explanation of this issue? Much more detail is required and greater explanation of the mechanics of controlling and discharge should be clearly shown in the public arena.

Response: In order for underground mining activities to be safe, the dewatering of the mine workings is required. This is undertaken through pumps located at the workings, transferring water to a centralised underground storage known as the Cooranbong Underground Storage. From here, water is transferred to the surface where it is directed to LDP001 (at the Cooranbong Entry Site) and discharged to the receiving environment. This action is approved as part of the Northern Coal Logistics Project (SSD-5145). The Modification proposes no change to the operation of the existing licensed discharge point.

The classification of discharges as salty brine is misleading, as the water has an EC varying from 3,880 µS/cm to 4,720 µS/cm (20^{th} and 80^{th} percentile, respectively) which can be described as brackish.

The receiving environment for LDP001 is Muddy Lake, which is a connected estuarine system to Lake Macquarie. Muddy Lake can be separated into two cells (east and west) with Wangi Wangi Road separating the two. The hydrology of the lake was recently assessed as part of consent conditions fulfilled by the Mandalong Southern Extension Project and Northern Coal Logistics Project and indicated that discharges had some influence on the cell to the west of Wangi Wangi Road (level and quality). The east cell is dominated by tidal influences of Lake Macquarie which includes also the elevated EC of Lake Macquarie.

Current investigations into the presence of Green and Golden Bell Frog communities present within Muddy Lake are underway as part of the conditions specific to actions approved under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

2.2.2 Hunter Communities Network

Submission matter: The impacts on alluvial aquifers that provide base flows to the ephemeral creeks has not been satisfactorily assessed for cumulative damage to the creek systems.

Response: Mandalong Mine has an extensive groundwater monitoring network which includes specific alluvial monitoring. It can be inferred that if decreasing trends in alluvial aquifer monitoring was to occur that similar impacts would be observed in the creek systems. As part of the Extraction Plan WMP (GHD 2016b; Attachment 2), undermined creeks are proposed to be visually assessed to determine physical changes in creek form and the occurrence of cracking. Similarly, alluvial levels will form groundwater monitoring as part of the Extraction Plan WMP and will identify any impacts to baseflow contribution to creeks within the mining area.

Submission matter: The predicted changes to flooding regimes and increase in ponding demonstrate long-term impacts that may have adverse ecological outcomes in the creek systems.

Response: Areas of increased ponding as a result of the modification will be mitigated with drainage works to relieve potential ponding impacts. Triggers for undertaking drainage works will be where new remnant ponding areas are created as a result of mine induced subsidence and there is a new detrimental impact on habitat, and it is practical to do so. Any mitigation works will be determined in consultation with the landowner and relevant government agencies.

Submission matter: The issue of increased salinity in mine waste water production is a key issue that has not been adequately assessed or mitigated.

Response: The modification indicates that there will be no change in the discharge quality of water being managed at Licenced Discharge Points.

2.3 Public Submissions

2.3.1 176366 & 175805

Submission matter: Submissions in support of the Modification.

Response: Noted.

2.3.2 177046, 177292, 177389, 177405, 177413 and 177546

Submission matter: The diminution of the value of the Morans Creek and Tobins Creek catchment areas expressed in Appendix 5 of the Water resources Impact Assessment is alarming. The statement that suggests that these catchments or creeks do not have surface flow for the entire year is simplistic. The very fact that rainfall periods vary greatly and so does creek flow indicates that in some years flows are high and others not. This is the very basic nature of water cycles.

To pre-empt the notion of undermining these tributaries based on simple equations as expressed in the Assessment is outright flippant and dangerous for future water resources. Planning need to have experts revisit the value of these water resources as they impact also on the important Stockton Creek resource which is also a major source for the integrity of the ecology of Dora Creek.

Response: Refer to response in Section 2.2.1.

Submission matter: The other major concern expressed in the Assessment is the problem of salty brine. The tonnage of salt extracted from groundwater inflows into the mine begins with 1283 tonnes per annum, to almost 3000 tonnes per annum in 2036. These vast amounts of salt extractions transferred to the Borehole Dam and subsequent discharges are not clearly defined. Much more detail is required and greater explanation of the mechanics of controlling and discharge should be clearly shown in the public arena.

It is important for local populations to understand how these large salt depositions are handled over the life of the mine and also the long term impact of saline action upon water resources and fertile land in the vicinity of the catchment areas impacted by this extension. Planning NSW must have Centennial Coal produce clear and defined data for display prior to any approval of this extension being granted.

Response: Refer to response in Section 2.2.1.

2.3.3 177546

Submission matter: There is a clear threat of contamination of Muddy Lake, which is a SEPP14 protected resource, by inflow of saline water from the mine. Under no circumstance must a SEPP14 wetland be subjected to unnatural impacts which is why they are afforded the highest order of protection. Planning NSW need to reassess the plan to avoid such impact.

Response: There is no proposed change to the discharge activities that have been approved as part of the Northern Coal Logistics Project (SSD-5145). Current investigations into the presence of Green and Golden Bell Frog communities present within Muddy Lake are underway as part of the approval conditions specific to actions approved under the EPBC Act.

2.3.4 177627

Submission matter: I wish to record my objection to the above proposal, both in general as to any further extensions being granted, and more specifically having regard to the inadequacy of the documentation presented in support of the current modification.

It would be pointless to attempt to engage in detail with the flaws in the data provided, and the credibility of the conclusions advanced.

Sadly, what we have here is yet another example of a pseudo scientific report, crafted by eagerly compliant consultants solely for the purpose of advancing their client's commercial interests, and in the hope that your Department will automatically rubber-stamp it.

Response: The SEE and its supporting technical assessments have been prepared by appropriately qualified and experienced technical specialists in accordance with the NSW regulatory framework as outlined in Section 5 of the SEE. It contains all available information that is relevant to the environmental assessment of the proposed development to which the document relates. Limitations in the assessment, for example the lack of ecological field investigations, have been highlighted where relevant.

2.3.5 177401

Submission matter: The proponent applied for modification on panels 22-23 in September this year. The application was successful. Centennial has had three successful applications with this mine this year. I believe it is too hasty to approve any more modifications until effects of previous modifications are known, in particular "Modification 2 Mandalong Southern Extension Project".

Response: First workings development of longwall panels occurs in advance of secondary longwall extraction. Centennial Coal personnel met with DP&E representatives on 9 August 2016 to discuss the proposed extensions and modifications required to enable business continuity at Mandalong Mine. Due to the mine's extraction schedule, it was agreed to submit one modification application for the extension of longwall panels 22 and 23 and a separate modification application for the extension of longwall panel 24 and addition of longwall panel 24A. Modification 2 which was approved on 22 September 2016 enabled the extended development of first workings associated with the maingates for longwall panels 22 and 23 which was required in October 2016 to permit operational continuity.

Submission matter: There are concerns around the effects on ground water and surface water, any modification that has the potential to affect ground and surface water and threatened ecosystems should not be allowed. As the Department of Planning knows already, that ground water cannot recharge quickly and if contaminated presents massive problems and consequences. The case at Williamtown, comes to mind.

Response: The SEE and WRIA have been prepared in accordance with relevant assessment guidelines and are considered to adequately address the impacts to surface water. With the proposed mitigation and management measures

described in the WRIA and Extraction Plan WMP, the Modification's impacts on water resources are not predicted to be significant.

Submission matter: The Modification has the potential to effect the Dora Creek Catchment and thus impacting on Lake Macquarie itself. I believe it is prudent to wait to see the outcomes other the other three modifications before allowing the approval of this modification.

Response: The three modifications to development consent SSD-5144 referred to have been approved by DP&E. The SEE and WRIA have been prepared in accordance with relevant assessment guidelines and are considered to adequately address the impacts on surface water. With the proposed mitigation and management measures described in the WRIA and Extraction Plan WMP, the Modification's impacts on water resources are not predicted to be significant. Additionally refer to the section above regarding how Modifications 2 and 4 relate to operational longwall continuity at Mandalong Mine.

2.3.6 177393

Submission matter: I understand that there has been an observation of limited water running down the creeks in question. However I point out that water flow will infact vary from year to year and further more whilst there may not be viable water on any given year it does not mean that underground water is not present in these creeks.

Response: Refer to response in Sections 2.2.1 and 2.2.2.

Submission matter: This proposed plan has negative impacts for the local community and well as the global community concerning climate change. I feel it's a little patronising to point out the climate change effects from coal mining I'm sure the panel is coming from an educated background and understands well and also values the opinion of the global scientific community.

Response: The additional 1.4 Mt coal proposed to be extracted as part of the extension to longwall panels 22 and 23 will be achieved within the current annual extraction rate and mine life. The estimated incremental GHG emissions are therefore regarded as a component of the total life of mine GHG emissions based on 6.5 Mtpa being extracted over 25 years. Centennial Mandalong will continue to support research into suitable abatement technologies regarding ventilation air methane.

3. Response to Additional Information Requested by DP&E – Attachment A of Request for Response to Submissions Dated 20 December 2016

3.1 Subsidence

DPE requests additional information on the buildings titled 'A' and 'C' in Table 3 of the Subsidence Predictions Report. These buildings are expected to experience vertical subsidence of 840 mm and 770 mm respectively. It is requested that a description of the existing buildings be provided as well as an assessment of the likely subsidence impacts including the consideration of mitigation.

Building A

Building A is a horse shelter of timber construction with a corrugated iron roof as shown in **Plate 1** below. The structure is included in the Property Subsidence Management Plan (PSMP) for Property Reference 73 included in the LW22-23 Extraction Plan. There is no mitigation proposed and no damage to the structure is expected from the predicted subsidence from Longwall 22. This is consistent with previous experience at Mandalong Mine on similar type structures.

As detailed in the PSMP process, subsidence monitoring/inspections will be conducted pre and post mining. Any damage to the structure or roof drainage will be repaired by Centennial Mandalong.

Plate 1: Building A - Open Horse Shelter on Property Reference 73

Building C

Building C is located on Property Reference 80. The building is a single storey timber cabin with no connected services and is not used for permanent occupation. A photograph of the cabin is shown in **Plate 2** below.

Plate 2: Building C – Single Storey Timber Cabin on Property Reference 80

The cabin is included in the PSMP for Property Reference 80 and included in the LW22-23 Extraction Plan. Minimal impact to the cabin is expected. Pre and post subsidence monitoring /inspections will be conducted as part of the PSMP process for the property.

Please clarify the difference between the existing and proposed subsidence predictions at the four locations specified in Table 3 of the Subsidence Predictions Report.

Subsidence Predictions in the Cooranbong Colliery Life Extension Project Environmental Impact Statement (Umwelt 1997) indicate both Building A (horse shelter) and Building B (dwelling) on Property Reference 73 were located beyond the 20mm limit of subsidence of the proposed mining area (**Plate 3** and **Plate 4**).

Umwelt (1997) indicates that Building C (cabin) on Property Reference 80 was not constructed at the time the EIS was prepared. As detailed in the LW22-23 Extraction Plan, no Mine Subsidence Board transactions are on file.

Subsidence Predictions from Umwelt (1997) indicate that Building D (dwelling) on Property Reference 207 was located beyond the 20mm limit of subsidence of the proposed mining area (**Plate 3** and **Plate 4**).

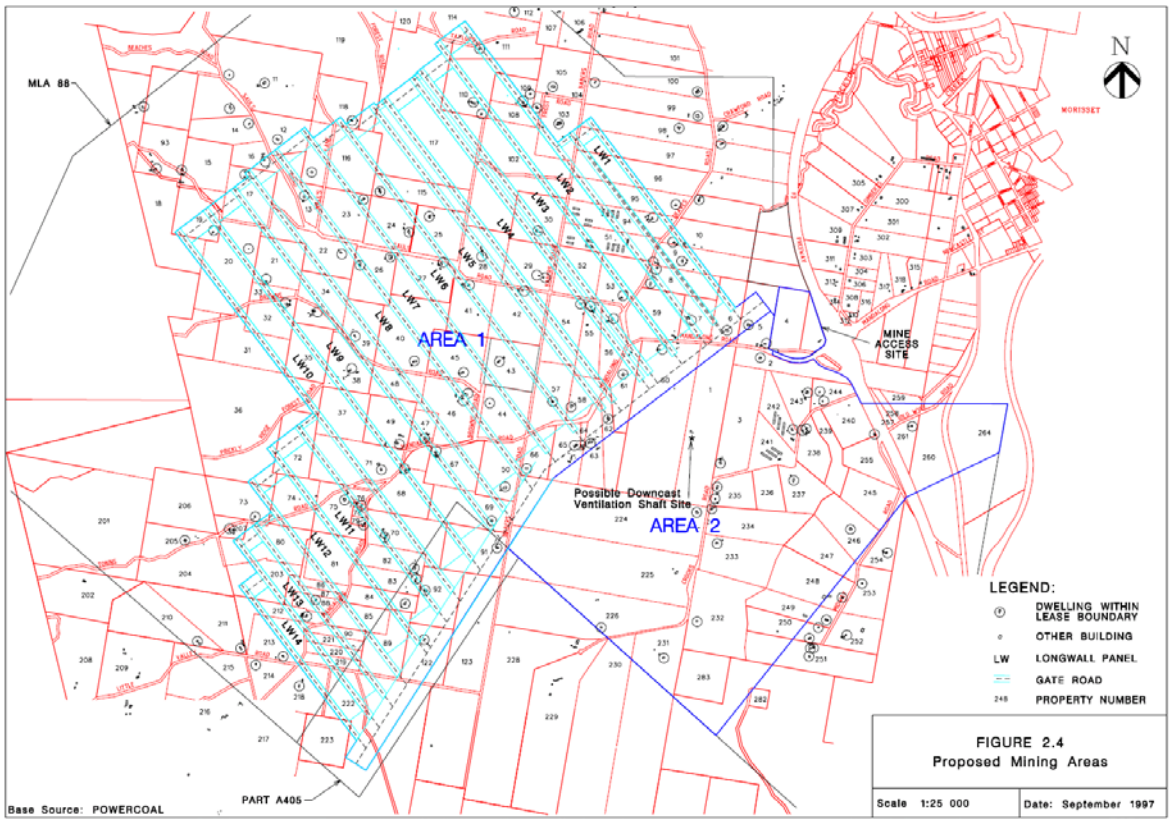


Plate 3: Cooranbong Colliery Environmental Impact Statement Figure 2.4 Proposed Mining Areas

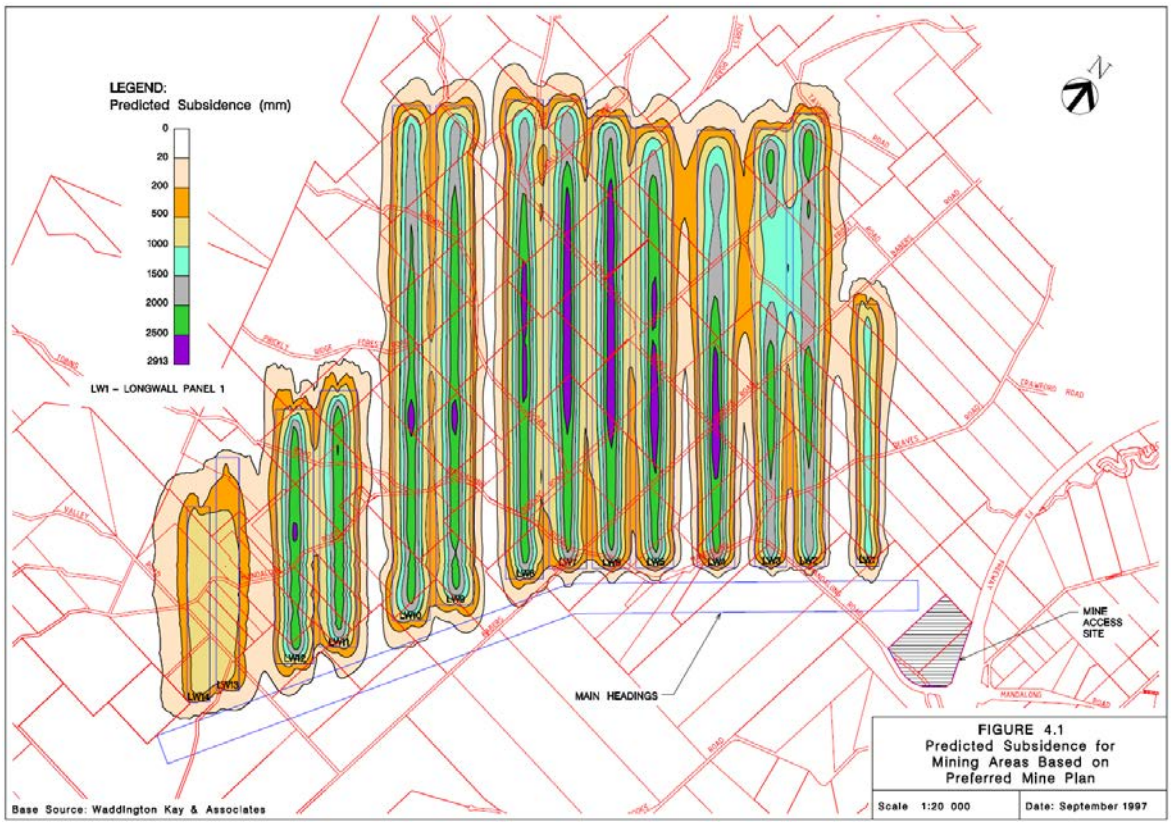


Plate 4: Cooranbong Colliery Environmental Impact Statement Figure 4.1 Predicted Subsidence for Mining Areas Based on Preferred Mine Plan

Further information is required regarding the impacts of subsidence on Transmission Tower T47 and any mitigation / management measures that will be applied.

Centennial Mandalong has recently entered into a contract with TransGrid to construct concrete cruciform footings on TL24 Towers 45, 46 and 47, with construction to commence on Tower 47 in late February 2017. The construction of cruciform footings on transmission towers is a proven and accepted method for managing the impact of mine subsidence.

This method of mitigation was supported by the Division of Resources and Energy (DRE) during a meeting held on 7 April 2016 between TransGrid, Mine Subsidence Board, DRE and Centennial Mandalong.

A TransGrid Management Plan will be developed in consultation with TransGrid following the completion of cruciform construction on Tower 47 and prior to the tower being affected by subsidence from Longwall 22.

4. References

DPI Water (2016) Dams in NSW: Do you need a licence? NSW Department of Primary Industries – Water, site accessed: http://www.water.nsw.gov.au/__data/assets/pdf_file/0005/599117/Dams-in-nsw-do-you-need-a-licence.pdf.

GHD (2016a) Mandalong Longwall Panel 22 to 23 Modification: Water Resources Impact Assessment. Prepared by GHD Pty Ltd for Centennial Mandalong Pty Limited.

GHD (2016b) Water Management Plan: Extraction Plan LW22-23, MEMS-EP-9000-WMP-9010. Prepared by GHD Pty Ltd for Centennial Mandalong Pty Limited.

Umwelt (1997) Cooranbong Colliery Life Extension Project Environmental Impact Statement. Prepared by Umwelt (Australia) Pty Ltd for Newcom Colliery Pty Limited.

Attachment 2 – Updated Water Management Plan

Centennial Coal

GHD

Water Management Plan

Extraction Plan LW22-23

MEMS-EP-9000-WMP-9010

January 2017

Centennial Coal Environment Matters

Table of contents

Table index

Figure index

Appendices

Glossary

Alkalinity	A measure of the ability of an aqueous solution to neutralise acids. Alkalinity of natural waters is due primarily to the presence of hydroxides, bicarbonates and carbonates. It is expressed in units of calcium carbonate ($CaCO_3$).
Alluvial	Deposition from running waters.
Aquifer	An underground layer of permeable material from which groundwater can be usefully extracted.
Australian Height Datum	A common national surface level datum approximately corresponding to sea level
Average recurrence interval	A statistical estimate of the average period in years between the occurrence of a flood of a given size or larger, e.g. floods with a discharge equivalent to the 1 in 100-year average recurrence interval flood event will occur on average once every 100 years.
Baseflow	The component of flow in a watercourse that is driven from the discharge of underground water.
Baseline monitoring	Monitoring conducted over time to collect a body of information to define specific characteristics of an area (e.g. species occurrence or water quality) prior to the commencement of a specific activity.
Bore	Constructed connection between the surface and a groundwater source that enables groundwater to be transferred to the surface either naturally or through artificial means.
Catchment	The land area draining through the main stream, as well as tributary streams, to a particular location.
Cumulative rainfall departure	Monthly accumulation of the difference between the observed monthly rainfall and long-term average monthly rainfall.
Dewatering	The removal or pumping of water from an above or below ground storage, including the mine water within the water collection system of mine workings. Water removed from mine workings is regarded as dewatering unless the workings are flooded and at equilibrium with the surrounding strata (in which case the removal is considered groundwater extraction).
Discharge	The quantity of water per unit of time flowing in a stream, for example cubic metres per second or megalitres per day.
Electrical conductivity	A measure of the concentration of dissolved salts in water.
Ephemeral	Stream that is usually dry, but may contain water for rare and irregular periods, usually after significant rain.

Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or overland runoff before entering a watercourse and/or coastal inundation resulting from super elevated sea levels and/or waves overtopping coastline defences.
Fracture	Cracks within the strata that develop naturally or as a result of underground works.
Geomorphology	Scientific study of landforms, their evolution and the processes that shape them. In this report relates to the form and structure of waterways.
Groundwater	Water occurring naturally below ground level.
Groundwater extraction	For the purposes of this report, groundwater extraction has been defined as the removal of groundwater from a groundwater source or aquifer, either via direct removal for use via a production bore or via incidental flow of groundwater from the aquifer into the mine workings during and after mining. Groundwater extraction includes the pumping of underground water from flooded mine workings in equilibrium with the surrounding strata as well as the removal of water from perched aquifers recharged directly from rainfall infiltration.
Guideline value	The concentration or load of physicochemical characteristics of an aquatic ecosystem, below which there exists a low risk that adverse ecological effects will occur. They indicate a risk of impact if exceeded and should 'trigger' action to conduct further investigations or to implement management or remedial processes.
Hydrogeology	The area of geology that deals with the distribution and movement of groundwater in soils and rocks.
Hydrology	The study of rainfall and surface water runoff processes.
Infiltration	The downward movement of water into soil and rock. It is largely governed by the structural condition of the soil, the nature of the soil surface (including presence of vegetation) and the antecedent moisture content of the soil.
Interseam	The strata between the coal seams.
Ion	Electrically charged atom.
Licensed discharge point	A location where the premises discharge water in accordance with conditions stipulated within the site environmental protection licence.
Longwall	Longwall mining is a form of underground coal mining where a block of coal is mined using a longwall shearer. The longwall mining method is supported by roadway development, mined using a continuous miner unit.
Median	The middle value, such that there is an equal number of higher and lower values. Also referred to as the 50th percentile.
Overburden	The strata between the recoverable topsoil and the upper coal seam.

Percentile	The value of a variable below which a certain percent of observations fall. For example, the 80th percentile is the value below which 80% of values are found.
Permian Age	The youngest geological period of the Palaeozoic era, covering a span between approximately 250 and 290 million years.
pH	The value taken to represent the acidity or alkalinity of an aqueous solution. It is defined as the negative logarithm of the hydrogen ion concentration of the solution.
Potable water	Water of a quality suitable for drinking.
Reach	Defined section of a stream with a uniform character and behaviour.
Recharge	Inflow of water from surrounding strata into underground mine workings via infiltration. This can be as a result of rainfall events or from surrounding aquifers.
Riparian	Pertaining to, or situated on, the bank of a river or other water body.
Run of mine	Raw coal production (unprocessed).
Sediment	Soil or other particles that settle to the bottom of lakes, rivers, oceans and other waters.
Strata	Geological layers below the ground surface.
Stream order	Stream classification system, where order 1 is for headwater (new) streams at the top of a catchment. Order number increases downstream using a defined methodology related to the branching of streams.
Subsidence	The vertical difference between the pre-mining surface level and the post-mining surface level at a point.
Surface water	Water that is derived from precipitation or pumped from underground and may be stored in dams, rivers, creeks and drainage lines.
Topography	Representation of the features and configuration of land surfaces.
Tributary	A stream or river that flows into a main river or lake.
Turbidity	A measure of clarity (turbidity) of water. Turbidity in excess of 5 NTU is just noticeable to the average person.

Abbreviations

AHD	Australian Height Datum
ARI	Average recurrence interval
bgl	Below ground level
Centennial	Centennial Coal Company Pty Limited
Centennial Mandalong	Centennial Mandalong Pty Limited
CES	Cooranbong Entry Site
CRD	Cumulative rainfall departure
DES	Delta Entry Site
DGV	Default guideline value
DP&E	Department of Planning and Environment
DPI Water	Department of Primary Industries – Water
EC	Electrical conductivity
EPA	Environmental Protection Authority
EPL	Environment protection licence
GDE	Groundwater dependent ecosystem
HARTT	Hydrograph Analysis: Rainfall and Time Trends
km	Kilometre
L/s	Litre per second
LDP	Licensed discharge point
m	Metre
m/year	Metre per year
mg/L	Milligram per litre
ML	Megalitre
ML/day	Megalitre per day
ML/year	Megalitre per year
mm	Millimetre
MMAS	Mandalong Mine Access Site
MSSS	Mandalong South Surface Site
NTU	Nephelometric turbidity unit

OEH	Office of Environment and Heritage
ROM	Run of mine
SSGV	Site-specific guideline value
TARP	Trigger action response plan
TSS	Total suspended solids
Umwelt	Umwelt (Australia) Pty Limited
WAL	Water access licence
WMP	Water management plan
µS/cm	Microsiemens per centimetre

1. Introduction

1.1 Background

Mandalong Mine is an underground coal mine located approximately 35 km south-west of Newcastle on the western side of Lake Macquarie. Centennial Mandalong Pty Limited (Centennial Mandalong), which is a wholly owned subsidiary of Centennial Coal Company Limited (Centennial), acquired the mine in August 2002, with mining operations commencing in 2005. Mandalong Mine consists of underground mine workings and surface facilities located at four sites: Mandalong Mine Access Site (MMAS), Cooranbong Entry Site (CES), Mandalong South Surface Site (MSSS) and Delta Entry Site (DES). The location of the surface sites and the Mandalong Mine Holding Boundary are shown in Figure 1-1.

Mandalong Mine currently operates under development consent SSD-5144, granted by the Planning Assessment Commission on 12 October 2015 for the Mandalong Southern Extension Project. The development consent provides for an extension of the mining area with a production limit of 6 million tonnes per annum of thermal coal from the West Wallarah and Wallarah-Great Northern seams.

This Water Management Plan (WMP) has been prepared for the Extraction Plan for secondary extraction of longwalls 22 and 23. The mine plan for longwalls 22 and 23 is shown in Figure 1-2 and potential subsidence predictions are shown on Figure 1-3. The WMP has been developed for the management of potential impacts to watercourses and aquifers from the proposed second workings of longwalls 22 and 23 at Mandalong Mine, as stipulated by development consent SSD-5144.

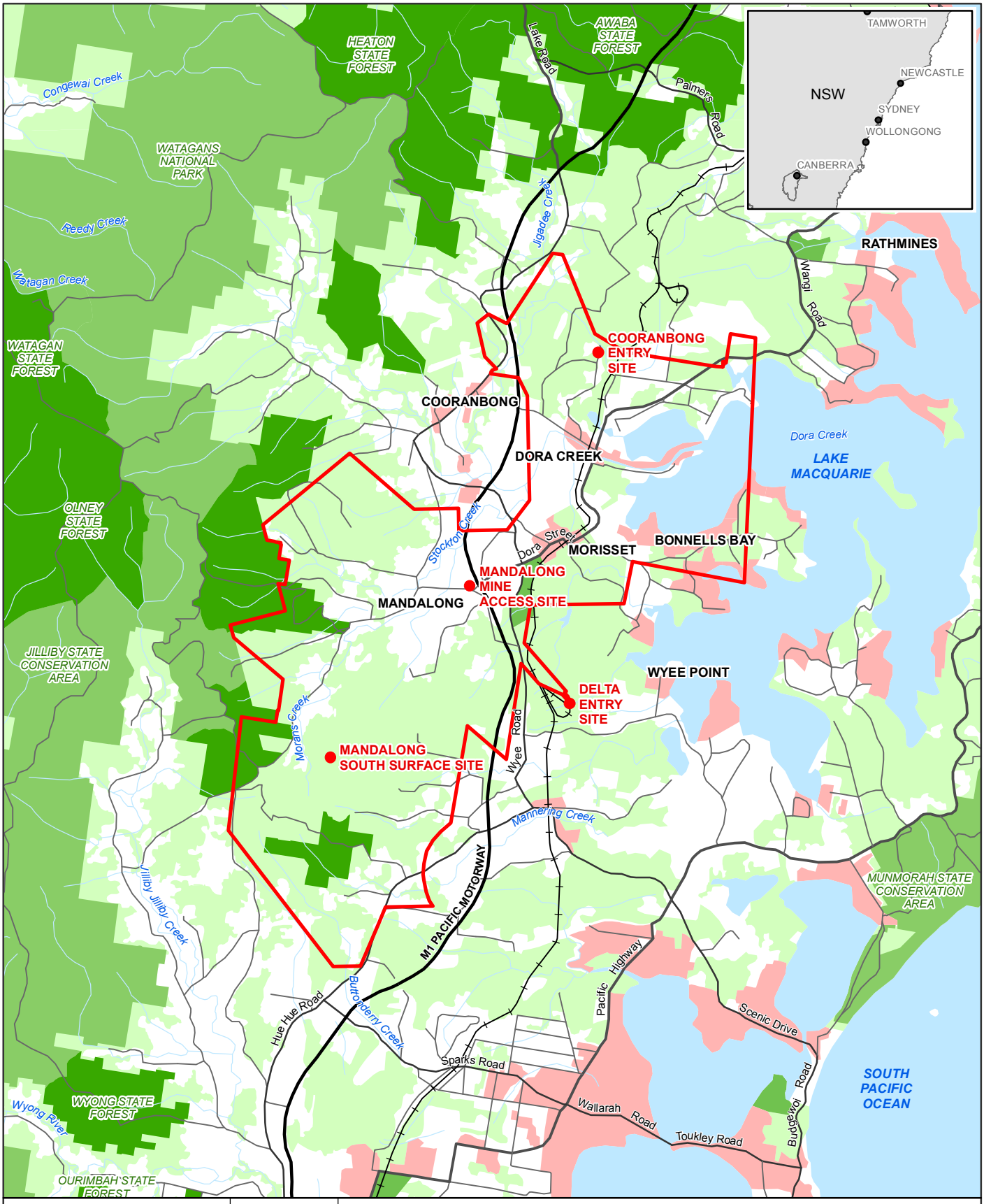
In accordance with the conditions of development consent SSD-5144 for Mandalong Mine, the WMP has been prepared by Jessica Thompson and Lachlan Hammersley and reviewed by Dr Stuart Gray of GHD Pty Ltd in consultation with Centennial Mandalong.

The WMP was provided to the NSW Environment Protection Authority (EPA), NSW Department of Primary Industries – Water (DPI Water) and NSW Office of Environment and Heritage (OEH) for consultation in July 2016. Responses were received from EPA on 29 August 2016 and DPI Water on 16 August 2016. The comments are provided in Appendix A, along with where these comments have been addressed in the WMP. Recommendations for the WMP received from DPI Water on 19 December 2016 in response to the Statement of Environmental Effects for the Mandalong Longwall Panel 22 to 23 Modification are also included in Appendix A.

1.2 Overview of site operations

The currently approved Mandalong Mine comprises the underground workings and surface infrastructure of the following:

- MMAS, encompassing underground workings and associated surface infrastructure near Morisset.
- Delivery of run of mine (ROM) coal from the underground workings to the CES. The CES coal handling and processing facilities are approved under the Northern Coal Logistic Project (SSD-5145).
- Delivery of ROM coal from the underground workings to the DES, located near Wyee at the Vales Point Rail Unloader Facility. The coal handling facility is approved under DA35-2-2004.



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0 0.5 1 2 3 4
Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- Site location
- Project application area
- Existing rail
- Motorway
- Principal road
- Secondary road
- Minor road
- Watercourse
- Watercourse area
- Built up area
- Recreation areas
- Nature conservation
- State forest
- Forest or shrub

LOCATION	Mandalong
DRAWN	K.S
CHECKED	L.H.
APPROVED	S.G.
SCALE	refer to scalebar

Extraction Plan LW22-23
Water Management Plan

Locality Plan

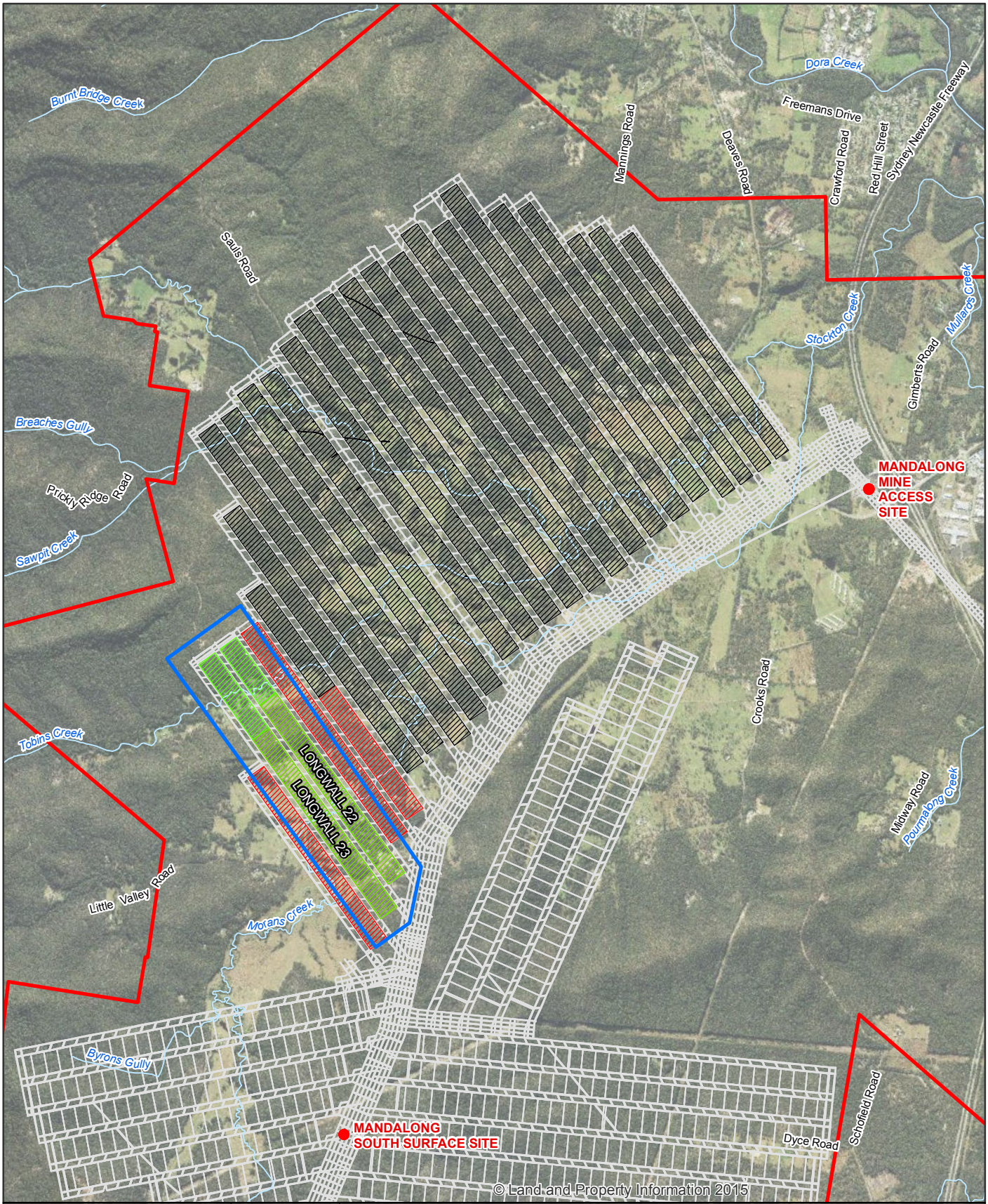
Centennial Coal
Mandalong

DATE 5/10/2016

Figure 1-1

GIS Filename: G:\22\0105001\GIS\Maps\Deliverables\Hunter\Mandalong\2218510\EPWMP\2218510_EPWMP_01_LocalityPlan_0.mxd

Data source: Commonwealth of Australia (Geoscience Australia): 250K Topographic Data Series 3, 2006; Centennial: Holdings Boundary, 2016. Created by: smacdonald, kpsroba



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Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- Site location
- Proposed secondary extraction area
- Approved Mine Workings
- Study area
- Project application area
- Approved secondary extraction
- Existing extraction area
- Waterway

LOCATION	Mandalong
DRAWN	K.S.
CHECKED	L.H.
APPROVED	S.G.
SCALE	refer to scalebar

Extraction Plan LW22-23 Water Management Plan

Mine Plan

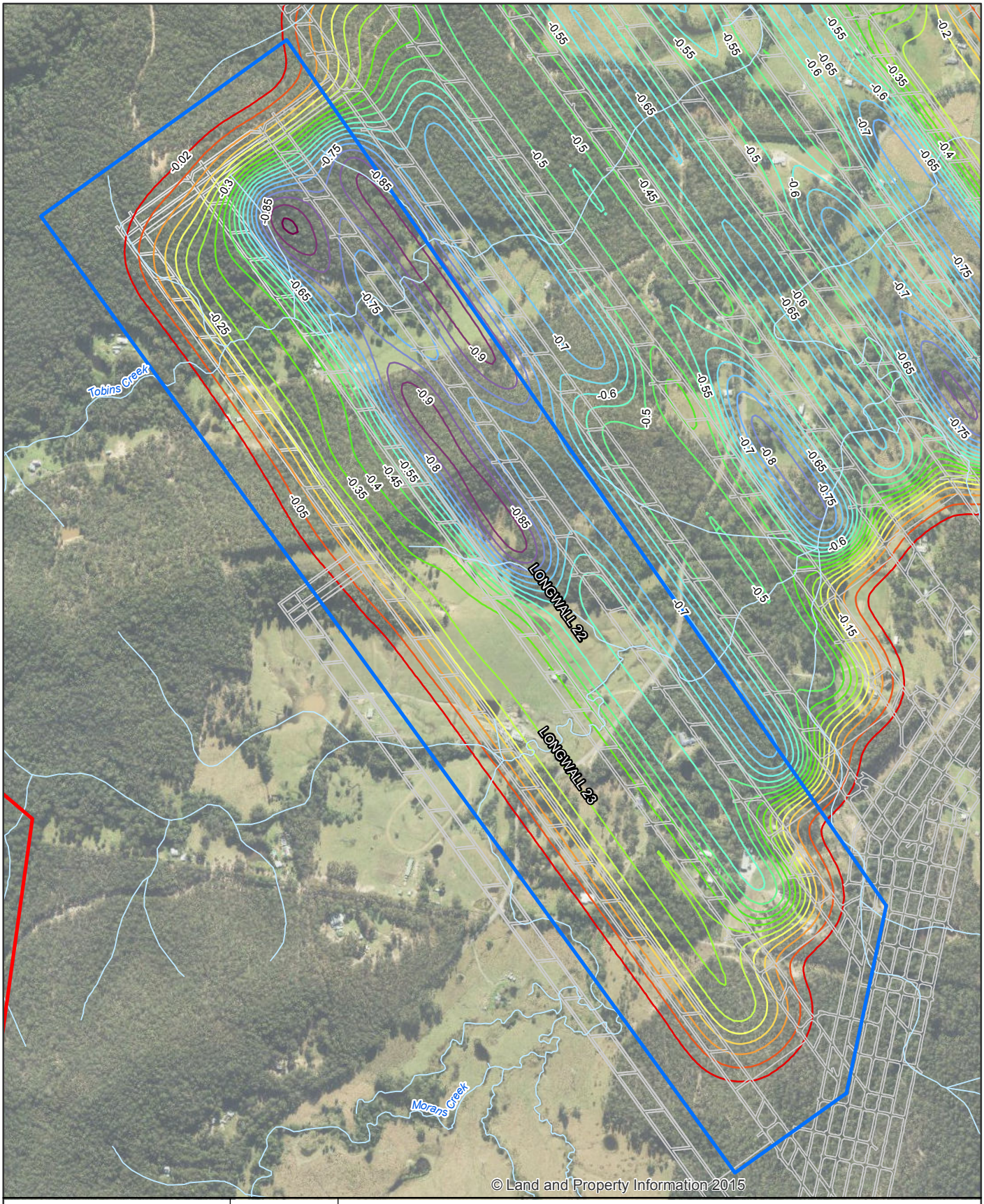
Centennial Coal
Mandalong

DATE 5/10/2016

Figure 1-2

GIS Filename: G:\22\0105001\GIS\Maps\Deliverables\Hunter\Mandalong\2218510\EPWMP\2218510_EPWMP_02_MinePlan_0.mxd

Data source: LPI:DTDB/Imagery, 2012/2015. Centennial: Mine workings, Extraction area, consent boundary, 2016. Created by: smacdonald, kpsroba



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Metres

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Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND
- Site location
- Study area
- Project application area
- Approved Mine Workings
- Waterway

LOCATION	Mandalong
DRAWN	K.S.
CHECKED	L.H.
APPROVED	S.G.
SCALE	refer to scalebar

Extraction Plan LW22-23
Water Management Plan

Subsidence Predictions For Longwalls 22 and 23

Centennial Coal
Mandalong

DATE 5/10/2016

Figure 1-3

GIS Filename: G:\22\0105001\GIS\Maps\Deliverables\Hunter\Mandalong\2218510\EPWMP\2218510_EPWMP_06_SubsMinePlan_0.mxd

Data source: LPI:DCDB, 2012. Centennial: Mine workings, Extraction area, consent boundary, Subsidence prediction, 2016. GSS, Imagery. Created by: smacdonald, kpsroba

- MSSS, which is yet to be constructed, encompassing ventilation shafts, ventilation fans and underground delivery boreholes located approximately 6 km south-west of the MMAS.

1.3 Study area

The study area for this WMP primarily encompasses the 26.5 degree angle of draw around the secondary extraction areas of longwalls 22 and 23 as shown in Figure 1-2. However, this WMP also considers impacts on mine water inflows, underground water storages and groundwater bores that extend beyond the primary study area.

1.4 Background

Mandalong Mine is an underground coal mine located approximately 35 km south-west of Newcastle on the western side of Lake Macquarie. Centennial Mandalong Pty Limited (Centennial Mandalong), which is a wholly owned subsidiary of Centennial Coal Company Limited (Centennial), acquired the mine in August 2002, with mining operations commencing in 2005. Mandalong Mine consists of underground mine workings and surface facilities located at four sites: Mandalong Mine Access Site (MMAS), Cooranbong Entry Site (CES), Mandalong South Surface Site (MSSS) and Delta Entry Site (DES). The location of the surface sites and the Mandalong Mine Holding Boundary are shown in Figure 1-1.

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This Water Management Plan (WMP) has been prepared for the Extraction Plan for secondary extraction of longwalls 22 and 23. The mine plan for longwalls 22 and 23 is shown in Figure 1-2 and potential subsidence predictions are shown on Figure 1-3. The WMP has been developed for the management of potential impacts to watercourses and aquifers from the proposed second workings of longwalls 22 and 23 at Mandalong Mine, as stipulated by development consent SSD-5144.

In accordance with the conditions of development consent SSD-5144 for Mandalong Mine, the WMP has been prepared by Jessica Thompson and Lachlan Hammersley and reviewed by Dr Stuart Gray of GHD Pty Ltd in consultation with Centennial Mandalong.

The WMP was provided to the NSW Environment Protection Authority (EPA), NSW Department of Primary Industries – Water (DPI Water) and NSW Office of Environment and Heritage (OEH) for consultation in July 2016. Responses were received from EPA on 29 August 2016 and DPI Water on 16 August 2016. The comments are provided in Appendix A, along with where these comments have been addressed in the WMP. Recommendations for the WMP received from DPI Water on 19 December 2016 in response to the Statement of Environmental Effects for the Mandalong Longwall Panel 22 to 23 Modification are also included in Appendix A.

1.5 Purpose

The WMP addresses specific water components of development consent SSD-5144, which was granted by the NSW Planning Assessment Commission on 12 October 2015 for the Mandalong Southern Extension Project. Schedule 4, Section 6 (i) of development consent SSD-5144 requires Centennial Mandalong to develop and implement a WMP as part of the Extraction Plan for longwalls 22 and 23. The relevant requirements of the WMP content are outlined in Table 1-1, along with the sections of the plan where these have been addressed.

Table 1-1 Development consent SSD-5144 requirements for Water Management Plan

Condition	Where addressed
Detailed baseline data on groundwater levels, yield and quality in the region, and in privately owned groundwater bores that could be affected by the second workings.	Section 3
Surface water and groundwater impact assessment criteria, including trigger levels for investigating any potentially adverse impacts on water resources or water quality.	Section 4
A program to monitor and report on stream morphology and stream flows, and assessment of any changes resulting from subsidence impacts, including scouring and ponding.	Section 5
A program to monitor flooding (including updated flood modelling); with recommendations to minimise, manage and mitigate (whether prospectively or retrospectively) flood impacts on residences, private properties, roads, other infrastructure and other built features.	Section 5
A groundwater monitoring program which: a. includes a comprehensive monitoring bore network, ensuring all bore casings are above ground level and are purged before sampling b. samples on a monthly basis for the first two years of the development, and quarterly thereafter, unless directed by the Secretary; c. monitors and reports on: i. groundwater inflows to the mine; ii. background changes in groundwater yield/quality against mine-induced changes; and iii. impacts to: - regional and local (including alluvial) aquifers; - groundwater supply to private bores; and - groundwater dependent ecosystems and riparian vegetation.	Section 2
A program to validate the groundwater model for the development, and compare monitoring results with modelled predictions.	Section 6
A plan to respond to any exceedances of the groundwater assessment criteria.	Section 7

The statement of commitments made as part of the Mandalong Southern Extension Project for each extraction plan, with respect to surface water and groundwater, are outlined in Table 1-2, along with the sections of the plan where these have been addressed.

Bore GW078601 is located above Longwall 64 within the Southern Extension Area and monitoring of this bore will be included in the relevant WMP for the Extraction Plan for Longwall 64.

Table 1-2 Statement of commitments

Commitment	Where addressed
Proposed locations of nested monitoring bores at locations where the depth of cover is less than 250 m. This is primarily throughout the north-eastern extent within the Wyee Creek and Mannering Creek catchments. It is intended to install three monitoring bores (nested) above each of the proposed longwall panels (two years prior to mining and pending landholder granting access) where the depth of cover is less than 250 m to monitor groundwater levels, pH and electrical conductivity. Monitoring will continue for a period of two years following the completion of mining in the subsequent adjacent panel.	Section 2.2.1
Groundwater monitoring bores and/or vibrating wire piezometers within the Southern Extension Area to monitor the height of groundwater depressurisation prior to extraction of longwalls with lower depth of cover. An adaptive management approach will be adopted to ensure that if there is a risk of fracturing extending up to alluvial aquifers (based on monitoring data) actions will be taken to mitigate these impacts.	Section 2.2.1
Installation of groundwater monitoring bores within areas of groundwater dependant ecosystems.	Section 2.2.1
Monitoring of bore GW078601, which is the only registered water supply bore within the Southern Extension Area, subject to landowner approval.	See above.
Monitoring of the watercourses within the Southern Extension Area to be undermined, particularly in locations identified as potential scouring points, to evaluate watercourse stability. Monitoring will be undertaken before and after undermining of the areas, with additional inspection of these locations following significant rainfall events.	Section 2.1.3
Surface water quality monitoring at the same locations within the Southern Extension Area used to gather background information.	Section 2.1.1
Continuous stream flow monitoring on Morans Creek, Mannering Creek, and Wyee Creek will be undertaken two years prior to mining and for two years after the completion of mining the adjacent longwall panel.	Section 2.1.2
TARPs for the management of subsidence impacts on watercourses in consultation with relevant government agencies.	Section 7.1

In addition to the conditions of development consent SSD-5144 and the statement of commitments made as part of the Mandalong Southern Extension Project, current environment protection licence (EPL) details and groundwater bore licences have been summarised in Section 1.2.2 of the *Mandalong Mine: Water Management Plan* (GHD, 2016a).

Details on the environment characterising (climate, topography and hydrogeology, geology and hydrology) relevant to the study area have also been provided in Section 4 of the *Mandalong Mine: Water Management Plan* (GHD, 2016a).

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2. Monitoring requirements

A comprehensive groundwater and surface water monitoring program has been developed by Mandalong Mine. *Mandalong Mine: Water Management Plan* (GHD, 2016a) provides the details of the groundwater and surface water monitoring programs. Monitoring includes groundwater level and quality and surface water quality, flow and watercourse stability. The main objective of monitoring is to ensure that water management measures implemented function as designed.

A summary of the monitoring requirements relevant to extraction of longwalls 22 and 23 is provided in the following sections. Refer to the *Mandalong Mine: Water Management Plan* (GHD, 2016a) for further details of the monitoring program at Mandalong Mine.

2.1 Surface water

2.1.1 Surface water quality

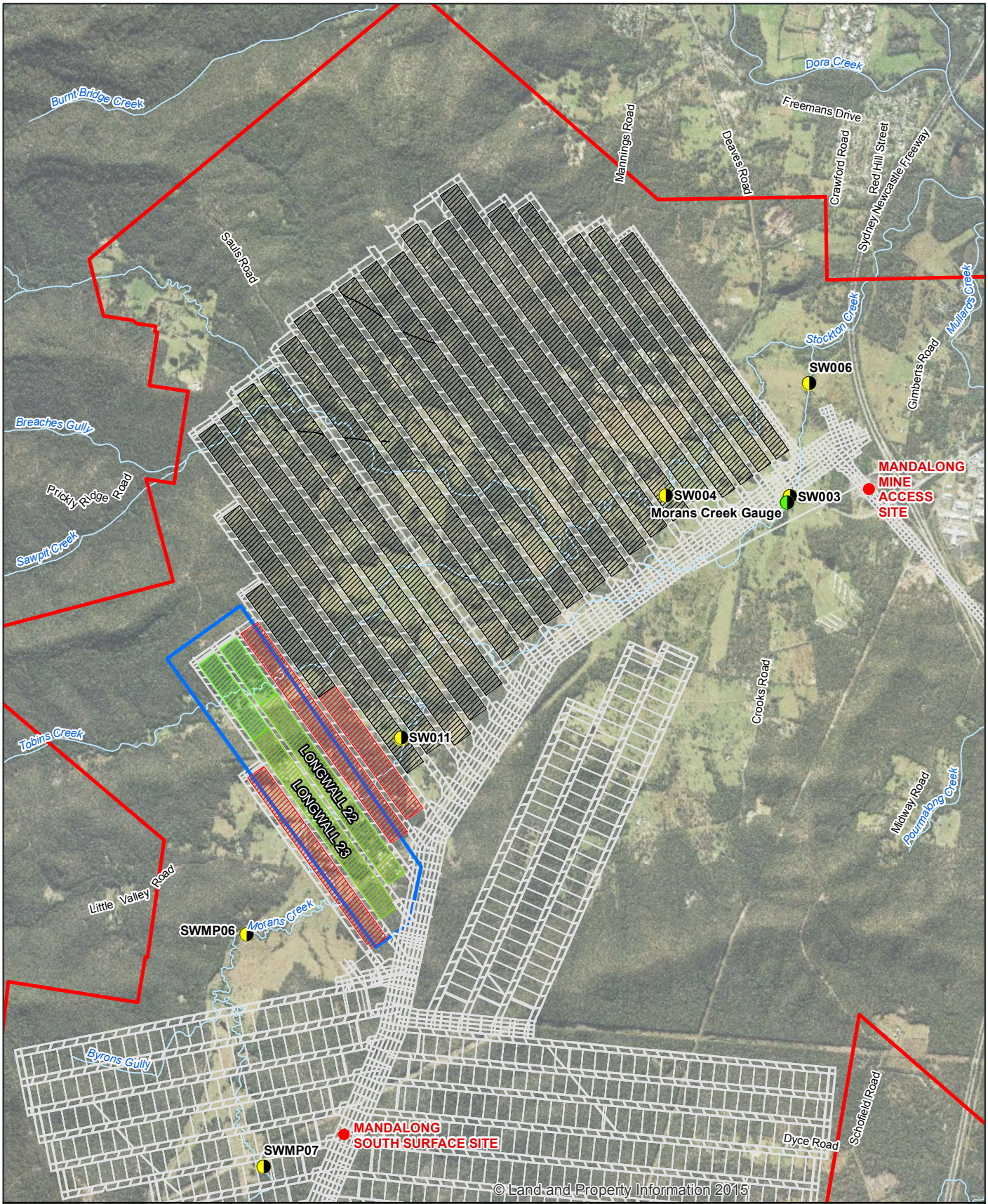
Watercourse quality monitoring is undertaken within the following catchments around MMAS and MSSS:

- Morans Creek.
- Stockton Creek.

Figure 2-1 presents the relevant surface water monitoring locations. Water quality sampling frequency and monitored parameters for each location is summarised in Table 2-1.

Table 2-1 Surface water quality monitoring frequency and parameters

Location	Frequency	Parameters
SW003, SW004, SW006, SW011	Quarterly	**Physicochemical parameters:** electrical conductivity (EC), pH, oil and grease, total suspended solids (TSS), turbidity. **Nutrients:** ammonia, total nitrogen, total phosphorus. **Metals (dissolved and total):** aluminium, arsenic, boron, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, zinc.
SWMP06 and SWMP07	Quarterly	**Physicochemical parameters:** EC, hardness, pH, oil and grease, total dissolved solids, TSS, turbidity. **Nutrients:** ammonia, biochemical oxygen demand, total Kjeldahl nitrogen, total nitrogen, total phosphorus. **Major ions:** alkalinity, calcium, chloride, magnesium, potassium, sodium, sulfate. **Metals (dissolved and total):** aluminium, arsenic, barium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, zinc. **Others:** cyanide, fluoride, oil and grease.



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0 150 300 600 900 1,200

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- Surface water monitoring location
- Morans Creek Gauge
- Site location
- Project application area
- Proposed secondary extraction area
- Study area
- Approved Mine Workings
- Approved secondary extraction
- Existing extraction area
- Waterway

LOCATION	Mandalong
DRAWN	K.S.
CHECKED	L.H.
APPROVED	S.G.
SCALE	refer to scalebar

Extraction Plan LW22-23
Water Management Plan

Surface Water Monitoring Locations

Centennial Coal
Mandalong

DATE 5/10/2016

Figure 2-1

GIS Filename: G:\22\0105001\GIS\Maps\Deliverables\Hunter\Mandalong\2218510\EPWMP\2218510_EPWMP_03_SW_Monitoring_0.mxd

Data source: LPI:DCDB/Imagery, 2012/2015. Centennial: Mine workings, Extraction area, consent boundary, 2016. Created by: smacdonald, kpsroba

2.1.2 Flow monitoring

There exists two public watercourse stream gauges located on Jilliby Creek (ID 211010) and Wyee Creek (ID 211001). Both are not continuously monitored sites and the data is considered to be unreliable. Centennial Mandalong installed a flow and level gauge on Morans Creek in 2006 and recorded data up until 2009. The gauge is located approximately 4.8 km downstream of longwalls 22 to 23, as shown in Figure 2-1. Centennial Mandalong is currently in the process of replacing this flow gauge to continue monitoring flows within Morans Creek.

2.1.3 Stream and flow path inspections

The predicted subsidence related changes to stream channel condition are assessed in the Mandalong Mine Flood Path Condition Report for each reach above a longwall panel, by using the photographic monitoring points to define the pre-mining channel condition and subsidence induced changes to stream characteristics. This monitoring will continue for longwalls 22 and 23.

The monitoring points are located in areas of highest potential differential subsidence, typically above the centre of the longwall panels and intersection with creek beds, to monitor the effects of subsidence on stream condition and changes in stream grade. Observations on the streams condition recorded at these points include stream geomorphology (including subsidence, scouring and ponding), bank height and width, bed condition (where observable), erosion, channel flood brake out, vegetation community and subsidence deformation.

Pre-mining surveys are conducted prior to the commencement of each longwall panel. The stream condition surveys are undertaken bi-annually with the observations reported annually. The bi-annual Mandalong Mine flood path inspections aim to identify the impacts which may trigger mitigation.

Monitoring extents, for relevant waterway reaches above longwalls 22 and 23, are provided in Figure 2-2.

2.2 Groundwater

2.2.1 Monitoring network

Groundwater monitoring for water quality (pH and EC) and water levels will occur on a monthly basis for the first two years of the program and quarterly thereafter, unless directed by the Secretary. Depth of cover above longwalls 22 and 23 is greater than 250 m and in accordance with the statement of commitments as part of development consent SSD-5144, additional monitoring bores are not required. It is recommended that existing groundwater monitoring bores are continued to be monitored.

Details of the groundwater bores are summarised in Table 2-2 and the locations shown in Figure 2-3. Some bores contain water level loggers for continuous monitoring of groundwater levels. All bore casings are above ground level. Bores that have been identified as being regularly inundated with surface water will be purged prior to sampling to remove any influence of surface water on monitoring results.

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0 45 90 180 270 360

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- Site location
- Proposed secondary extraction area
- Approved Mine Workings
- Monitored watercourses
- Study area
- Project application area
- Approved secondary extraction
- Existing extraction area
- Waterway

LOCATION	Mandalong
DRAWN	K.S.
CHECKED	L.H.
APPROVED	S.G.
SCALE	refer to scalebar

Extraction Plan LW22-23
Water Management Plan

Watercourse Stability Monitoring For Extraction of LW22 - 23

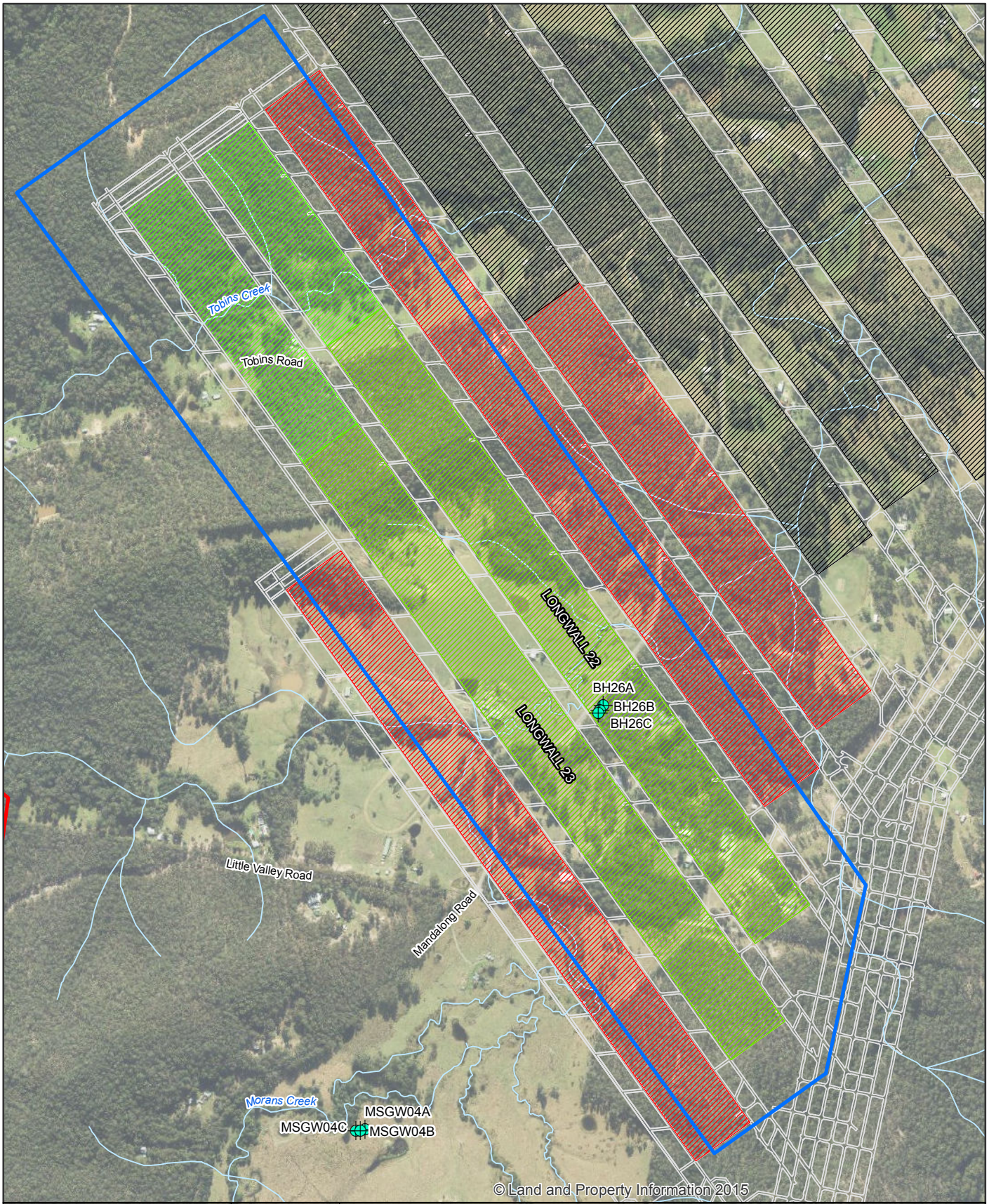
Centennial Coal
Mandalong

DATE 23/01/2017

Figure 2-2

GIS Filename: G:\22\0105001\GIS\Maps\Deliverables\Hunter\Mandalong\2218510\EPWMP\2218510_EPWMP_05_MoransWatercourse_1.mxd

Data source: LPI:DCDB/Imagery, 2012/2015. Centennial: Mine workings, Extraction area, consent boundary, 2016. Umwelt: Monitoring, Impacts, 2016. Created by: smacdonald, kpsroba



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Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- Groundwater monitoring location
- Study area
- Project application area
- Proposed secondary extraction area
- Approved secondary extraction
- Existing extraction area
- Approved Mine Workings
- Waterway

LOCATION	Mandalong
DRAWN	K.S.
CHECKED	L.H.
APPROVED	S.G.
SCALE	refer to scalebar

Extraction Plan LW22-23

Water Management Plan

Groundwater Monitoring Locations

Centennial Coal
Mandalong

DATE 5/10/2016

Figure 2-3

GIS Filename: G:\22\0105001\GIS\Maps\Deliverables\Hunter\Mandalong\2218510\EPWMP\2218510_EPWMP_07_GW_Monitoring_0.mxd

Data source: LPI:DCDB/Imagery, 2012/2015. Centennial: Mine workings, Extraction area, consent boundary, 2016. Created by: smacdonald, kpsroba

Table 2-2 Groundwater monitoring bore details

Bore	Monitoring period	Lithology	Longwall area
BH26A	Oct 2011 – present	Alluvium	LW22
BH26B	Oct 2011 – present	Sandstone	LW22
BH26C	Oct 2011 – present	Conglomerate	LW22
MSGW04A	September 2011 – present	Morans Creek alluvium	–
MSGW04B	September 2011 – present	Sandstone (Tuggerah)	–
MSGW04C	September 2011 – present	Conglomerate (Munmorah)	–

2.2.2 Underground water transfers

An overview of underground water management is shown in Figure 2-4. Daily monitoring of the following underground water transfers is undertaken:

- Supply of potable water to mining equipment within the Mandalong workings.
- Transfer of dirty mine water from the 69 c/t area to the Cooranbong Underground Storage area.
- Transfer of water from the 151 c/t area to the Cooranbong Underground Storage area.
- Transfer of surface water from Sediment Dams 1 and 2 at the CES to the Cooranbong Underground Storage.
- Transfer of surface water from the 5 ML Dam at the CES to the Cooranbong Underground Storage.
- Transfer of surface water from the gross pollutant trap at the CES (also referred to as Coal Handling Plant Settlement Tank) to the Cooranbong Underground Storage.
- Extraction of water from the Cooranbong Underground Storage area via licensed Cooranbong bore (works approval 20WA217077 and water access licence (WAL) 39767).

In addition, monthly monitoring of water levels within the Cooranbong Underground Storage will be undertaken.

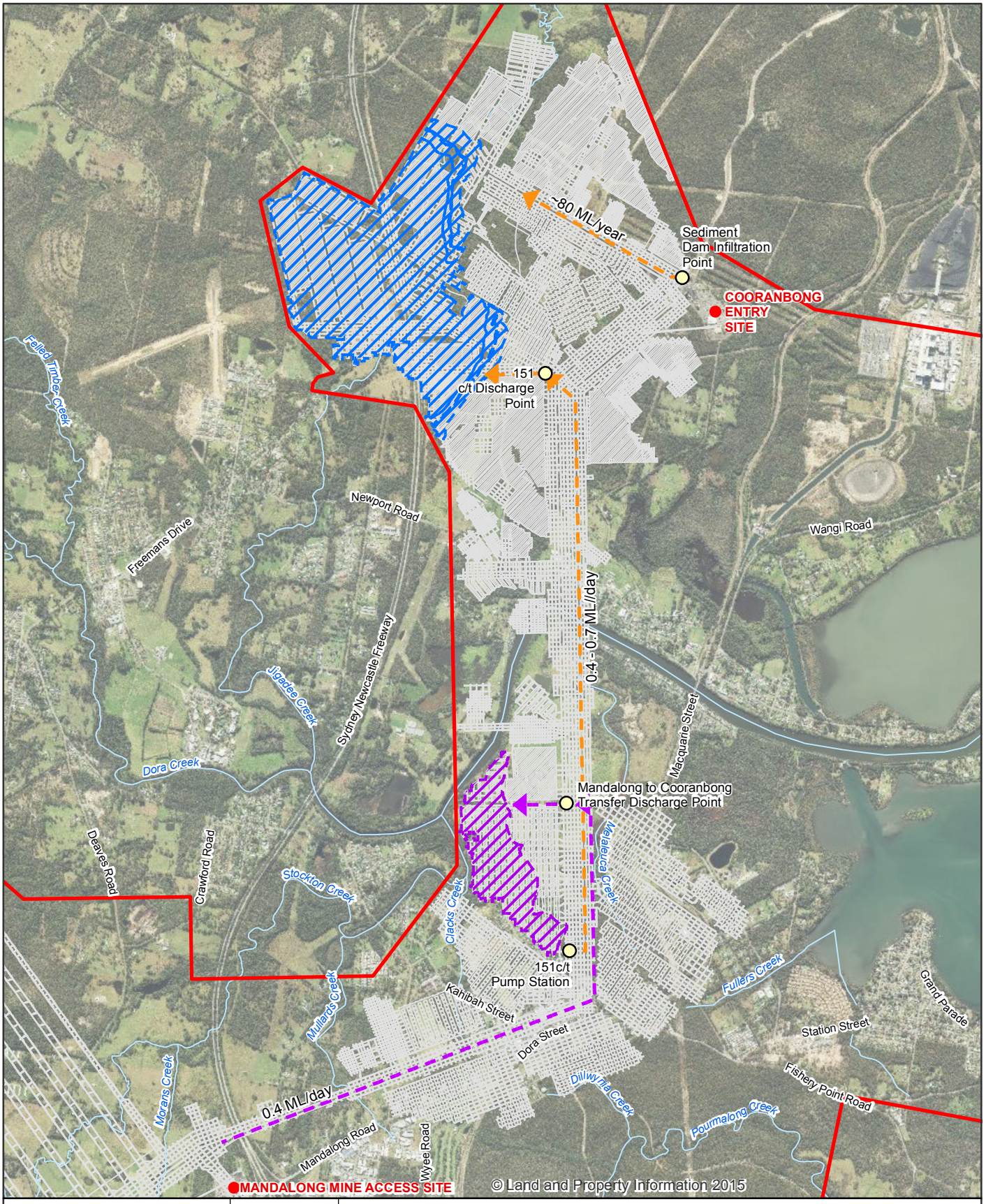
2.2.3 Groundwater inflows into the mine

Groundwater inflows to the mine are dewatered to the Cooranbong Underground Storage area and subsequently discharged from licensed discharge point LDP001 at CES in accordance with EPL 365.

Annual calculation

Groundwater inflows from adjacent strata into the mine workings are calculated on an annual basis in accordance with the requirements and methodology specified in the *Groundwater Monitoring and Contingency Plan* (GHD, 2016b). This methodology specifies that the calculation of groundwater inflows into the mine includes converting the annual change in water level of the Cooranbong Underground Storage to a change in volumetric storage based on an assessment of floor contours of the underground workings. The actual annual volume of groundwater removed by the extraction bore is calculated using the following formula:

Groundwater inflow = Δ storage + extraction volume – inputs



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0 150 300 600 900 1,200

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- Site location
- Project application area
- Approved Mine Workings
- Cooranbong Transfer Locations
- Cooranbong Goaf
- Cooranbong Settling
- Mandalong Mine Dirty Water Pump Transfer
- Water Transfer
- Waterway

LOCATION	Mandalong
DRAWN	K.S.
CHECKED	L.H.
APPROVED	S.G.
SCALE	refer to scalebar

Extraction Plan LW22-23
Water Management Plan
Current Cooranbong Underground Water Management

Centennial Coal
Mandalong

DATE 7/10/2016

Figure 2-4

GIS Filename: G:\22\01050001\GIS\Maps\Deliverables\Hunter\Mandalong\2218510\EPWMP\2218510_EPWMP_09_Cooranbong_0.mxd

Data source: LPI:DCDB/Imagery, 2012/2015. Centennial: Mine workings, Extraction area, consent boundary, 2016. Created by: smacdonald, kpsroba

Where groundwater inflow is the seepage of groundwater from adjacent strata into the workings, the extraction volume is the annual sum of the daily measured volumes extracted by the bore and the inputs are the annual sum of transfers of potable water and mine water from the CES and Mandalong workings.

Hydrogeological model

Figure 2-5 shows the total predicted groundwater inflows into the drained workings from transient run 24 (best fit from transient recalibration) presented in the modification for longwalls 22 and 23 (GHD, 2016d). Total groundwater inflows into the connected Cooranbong, Mandalong and Mandalong South workings are predicted to peak at approximately 2.1 ML/day in 2036. The peak predicted groundwater inflow is less than the peak groundwater inflow assessed as part of the approved Mandalong Southern Extension Project (GHD, 2013), which is also presented in Figure 2-5. The predicted groundwater inflow is lower due to recalibration of the hydrogeological model (GHD, 2016c).

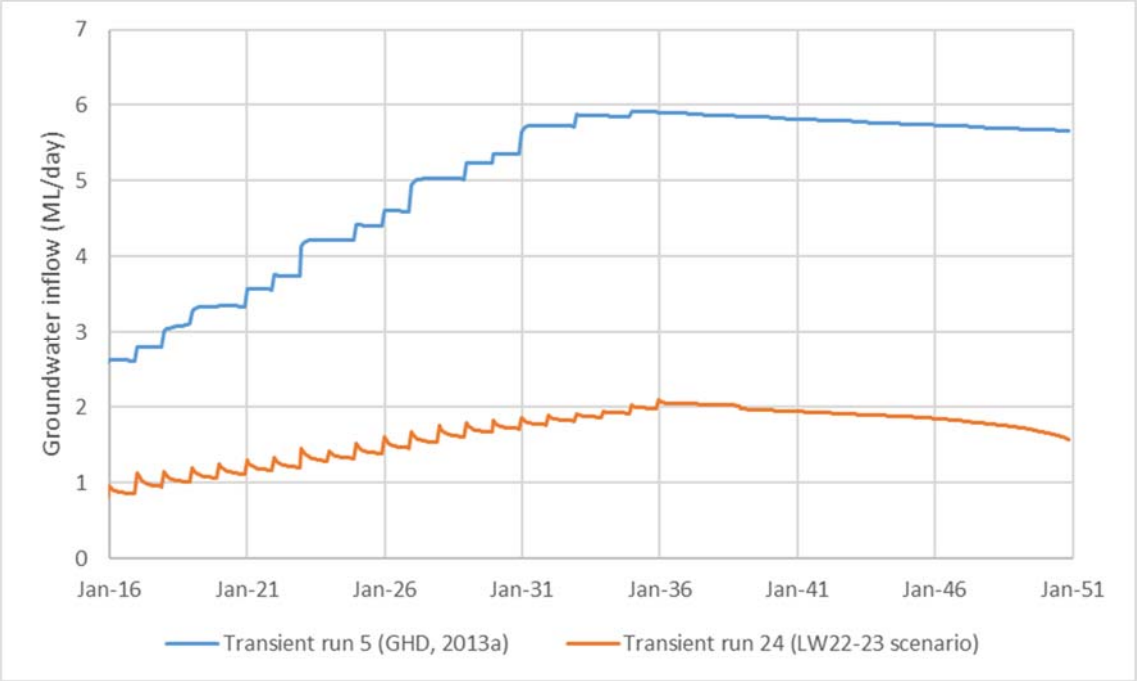


Figure 2-5 Modelled groundwater inflows into the Cooranbong, Mandalong and Mandalong South workings

3. Baseline data

3.1 Surface water

The study area is located within the upper reaches of Morans Creek and Tobins Creek and includes several unnamed tributaries. Both Morans Creek and Tobins Creek are north-easterly flowing tributaries of Stockton Creek, which discharge into the estuarine reach of Dora Creek approximately 8 km north east of the study area. Both creeks are ephemeral, with periods of limited or no flow during low rainfall.

3.1.1 Surface water quality

Table 3-1 presents the extent of baseline watercourse quality data recorded within Morans Creek and Stockton Creek. Figure 2-1 presents the relevant surface water monitoring locations.

Table 3-1 Period of recorded water quality data

Data	Site	Period from	Period to	Number of points
SW003 – SW011	MMAS	March 2011	June 2016	42
SWMP06 – SWMP07	MSSS	June 2011	June 2016	42

Appendix B presents the baseline data for water quality within Stockton Creek and Morans Creek.

Baseline data for upstream Morans Creek presented a fresh water system with a near-neutral pH. Metal parameters including arsenic, boron, cadmium, chromium, copper, mercury, lead, selenium and silver were found to have concentrations below the limit of reporting.

Aluminium, cobalt and iron parameters are elevated within the catchment and this is supported by upstream monitoring results.

3.1.2 Flow monitoring

Figure 3-1 presents the level recorded by the flow gauge on Morans Creek between 2006 and 2008. Table 3-2 presents the statistics of the flow monitoring data.

Table 3-2 Flow monitoring data for Morans Creek

Statistic	Year		
	2006	2007	2008
Percentage of year monitored	100%	46.7%	69.6%
Annual rainfall total	828 mm	1508 mm	1,577 mm
Volume recorded*	2,542 ML	2,296 ML	N/A

* Estimated from data provided. Gauge rating data to be confirmed.

Water levels within Morans Creek indicate a general creek response of up to 0.5 m to rainfall greater than 50 mm/day. Due to the inconsistent gauging recordings a reliable correlation between rainfall and level was not possible.

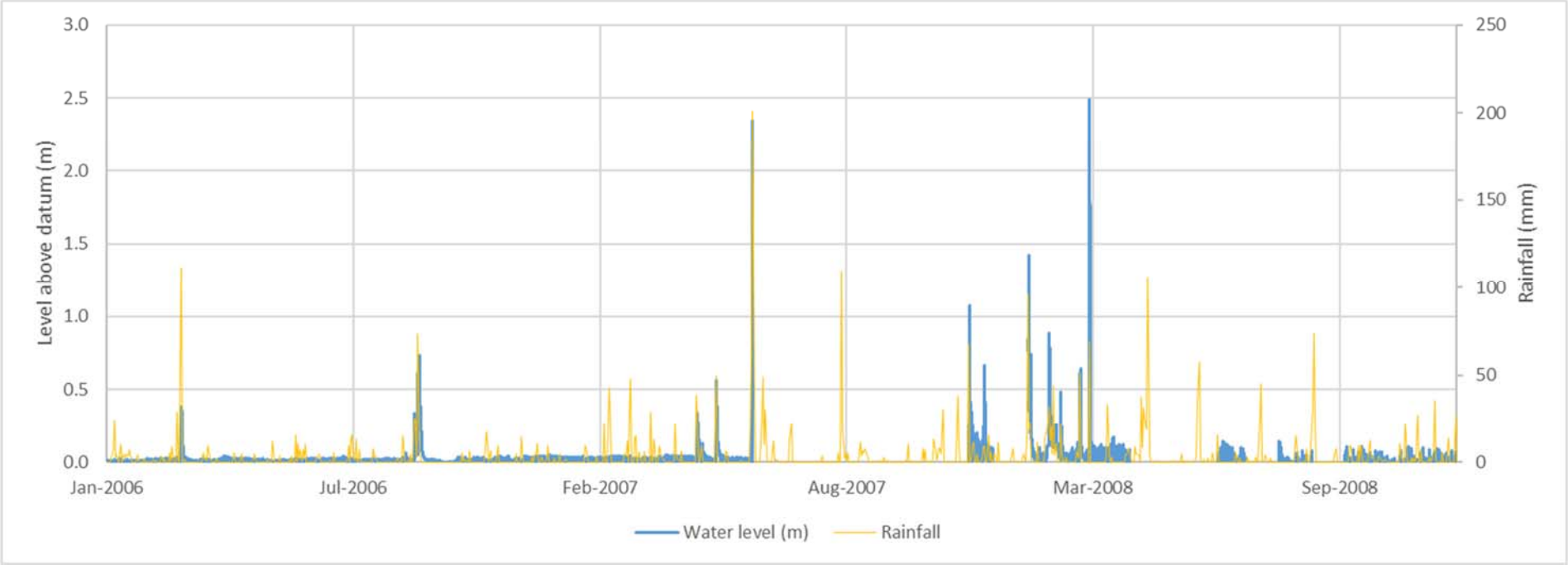


Figure 3-1 Level gauging within Morans Creek from 2006 to 2008

3.2 Groundwater

The groundwater sources in the vicinity of the study area are generally low yielding and predominantly weathered and/or fractured sandstone, coal seams with some clayey quaternary alluvium. Groundwater sources in the study area would be classified as 'less productive', in accordance with the NSW Aquifer Interference Policy (DPI, 2012a).

3.2.1 Overview

Alluvial groundwater sources

The alluvium throughout the study area forms an unconfined shallow aquifer with a water table typically ranging in depth from less than 1 m and up to about 3 m below ground level (bgl) and aquifer thickness less than 20 m. The alluvial groundwater is moderately acidic to slightly alkaline, brackish to saline, extremely hard and of sodium chloride type (GHD, 2013).

Due to the relatively high silt and clay content of the alluvium, the groundwater yields are relatively low (typically less than 1 L/s). As a result of the low yield and relatively poor water quality, there are very few registered private alluvial groundwater bores throughout the study area. The environmental value of the alluvial groundwater is considered to be generally 'primary industry' (specifically stock watering), with the saline groundwater generally only suitable for stock watering (GHD, 2013). The review of registered private alluvial bores in Section 3.2.3 identified limited use of alluvial groundwater in the vicinity of Mandalong Mine for irrigation and domestic use.

Groundwater monitoring bores BH26A and MSGW04A, which are located within the alluvium, will allow for the assessment of potential change during the mining of longwalls 22 and 23 due to proximity to the longwalls.

Porous and fractured rock water sources

Coal seam

The piezometric head within the Permian coal seams tends to reflect the natural topography and the orientation and dip of the seams, with reduced pressures at major surface drainage areas and in areas of coal extraction. Where coal seam groundwater has not been depressurised, the groundwater head generally tends to be in the order of 0 m Australian Height Datum (AHD) due to the coastal environment.

Permeability testing undertaken in 1996 and 1997 on the West Wallarah Seam and overburden strata in the existing Mandalong Mine area is reported in Pacific Power International (1997). Results indicate a variable hydraulic conductivity for the seam, ranging from 10^{-9} m/s to 10^{-5} m/s (0.03 m/year to 300 m/year). Areas of higher hydraulic conductivity coincide with areas where the coal is more intensively jointed or fractured, although the majority of the seam was generally found to be of lower hydraulic conductivity.

Recent permeability testing of the West Wallarah and Wallarah/Great Northern seams (at depths of 285 m to 300 m bgl) undertaken in 2011 as part of the Mandalong Southern Extension exploration program measured hydraulic conductivities ranging from approximately 0.75 m/year to 35 m/year (Sigra, 2011).

Groundwater inflows into the existing Cooranbong and Mandalong workings from the coal seam and adjacent strata are reported by Centennial Mandalong to be relatively low. Further details on the underground water level management can be found in Section 4 of *Mandalong Southern Extension Project: Groundwater Impact Assessment* (GHD, 2013).

Overburden rock

The overburden and interseam strata within the Newcastle Coalfield tend to have very low hydraulic conductivities (in the order of 0.0003 m/year to 0.03 m/year), unless joints or fracturing creates a secondary permeability (Pacific Power International, 1997). Groundwater within the overburden rock above the West Wallarah Seam primarily occurs within weathered or fractured Triassic sandstone.

Permeability testing of the overburden rock was undertaken in 2011 as part of the Mandalong Southern Extension exploration program (Sigra, 2011). The measured hydraulic conductivities and strata depths were as follows:

- 0.02 m/year (158.8–286.5 m bgl).
- 0.007 m/year (177.4–268.4 m bgl).
- 0.03 m/year (122.4–268.4 m bgl).

There has been a drop in relative groundwater level measured at most of the existing deeper monitoring bores screened within overburden rock above the existing Mandalong Mine longwalls.

Groundwater monitoring bores BH26B, BH26C MSGW04B and MSGW04C are located within the overburden material, will allow for the assessment of potential change during the mining of longwalls 22 and 23 due to proximity to the longwalls.

3.2.2 Groundwater levels and quality

A statistical summary of Mandalong Mine alluvial groundwater levels and quality is provided in Appendix B. Graphs of water level, pH and EC have been presented for bores where monthly sampling of groundwater quality has occurred including BH26A, BH26B and MSGW04A. These water level and water quality graphs are shown in Figure 3-2 to Figure 3-4.

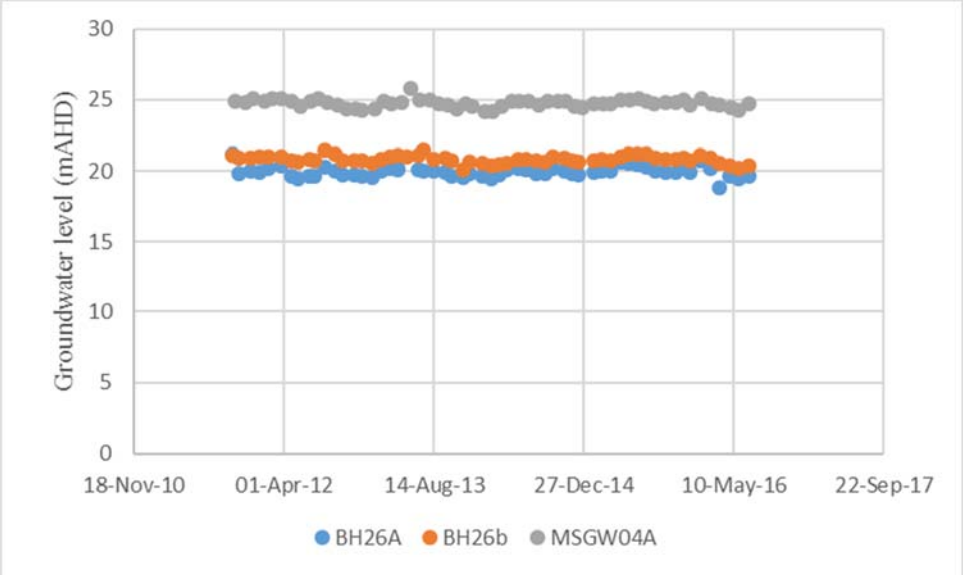


Figure 3-2 Groundwater level at BH26A, BH26B and MSGW04A

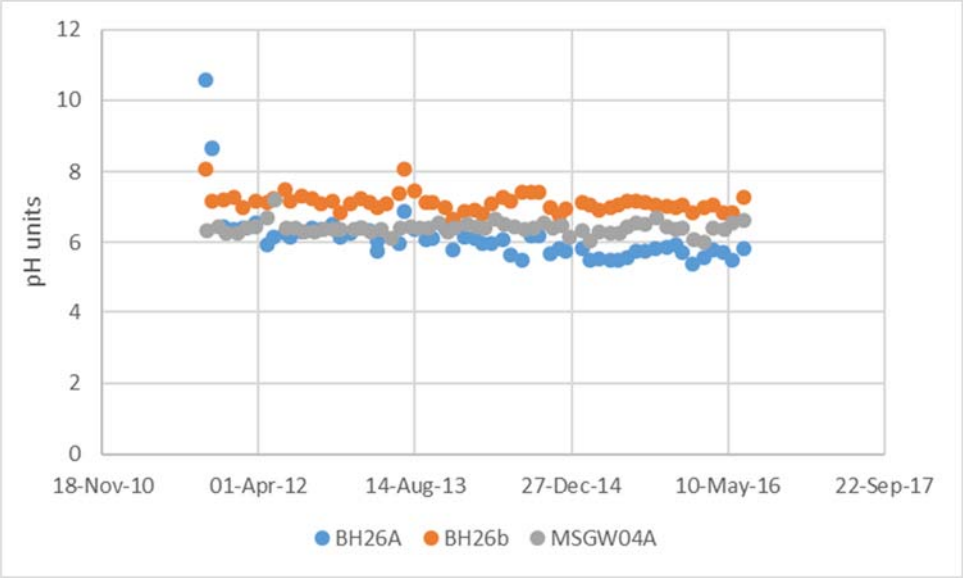


Figure 3-3 Monitored pH at BH26A, BH26B and MSGW04A

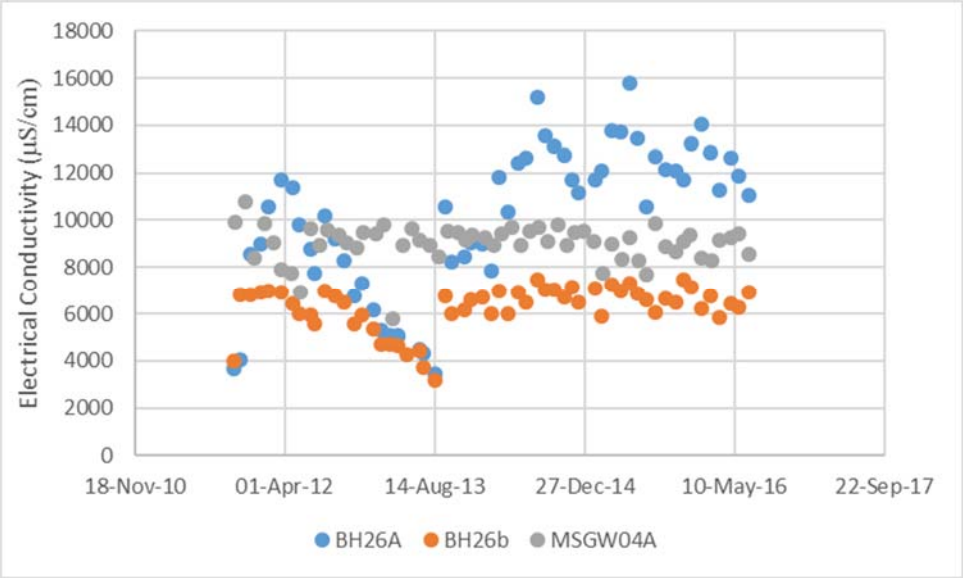


Figure 3-4 Monitored electrical conductivity at BH26A, BH26B and MSGW04A

Groundwater quality

At most alluvial bores groundwater pH is consistently within the range 5 to 8. Groundwater EC varies considerably within alluvium across the mining area, ranging from less than 1,000 µS/cm to over 10,000 µS/cm. The quality of the porous and fractured rock groundwater sources is slightly alkaline and brackish to saline. EC typically ranges from about 6,000 µS/cm to over 10,000 µS/cm (GHD, 2016d).

As discussed in the Mandalong Southern Extension Project response to submissions, there was variability in groundwater EC at a number of monitoring bores at Mandalong Mine. As part of the response to submissions process it was identified that this variability in EC was attributable to sampling of bores by bailing. Since January 2015, monitoring bores at Mandalong Mine have been sampled using low flow techniques where possible (i.e. peristaltic pump or Micro-purge pump). Additionally, bores that were identified as being regularly inundated with surface water have been purged prior to sampling to remove any influence of surface water on monitoring results. Following the update of groundwater monitoring methodology, variability in observed EC has reduced.

Underground water levels

Water levels in the Cooranbong Underground Storage area have been monitored by Centennial Mandalong since December 2011. The measured water levels (corrected to AHD) between December 2011 and June 2016 are shown in Figure 3-5. The following observations have been made over this period:

- For the period prior to March 2013, the average rate of dewatering of the Cooranbong underground storage dam was 1.5 ML/day and the water level rose by approximately 5 m over this period.
- Over the period March to August 2013, the underground water level rose by a further 4 m since the pump was not in operation for most of this time.
- Between mid-August 2013 and February 2014, the average extraction rate was approximately 2.6 ML/day and the water level reduced by 6 m.
- Between February and September 2014, there was no extraction of water from the Cooranbong Underground Storage and the water level rose by approximately 11 m.
- Between October 2014 and January 2015, the average extraction rate was approximately 1.9 ML/day and the water level reduced by 1 m.
- Between January and March 2015 there was no pumping for most of this time and the water level rose 2 m.
- Between March and May 2015, the average extraction rate was approximately 2 ML/day and the water level dropped 0.15 m.
- Between June 2015 and November 2015, the average extraction rate was 3.0 ML/day and the water level reduced by 8.83 m.
- During December 2015 and January 2016, the average extraction rate was 2.7 ML/day and the water level reduced by 0.22 m.
- Between February 2016 and May 2016, the average extraction rate was 1.6 ML/day and the water level rose 1.6 m. This included a period where pumping ceased between April to May 2016 for LDP001 upgrade.
- During June 2016, the average extraction rate was 3.3 ML/day and the water level reduced by 1.12 m.

Based on an assessment of the floor contours of the Cooranbong workings, the underground water storage area has a capacity of approximately 4,200 ML (assuming void height of 3 m and void ratio of 0.4). Once the underground water storage reaches full capacity, the water spills to the south back towards the active Mandalong workings.

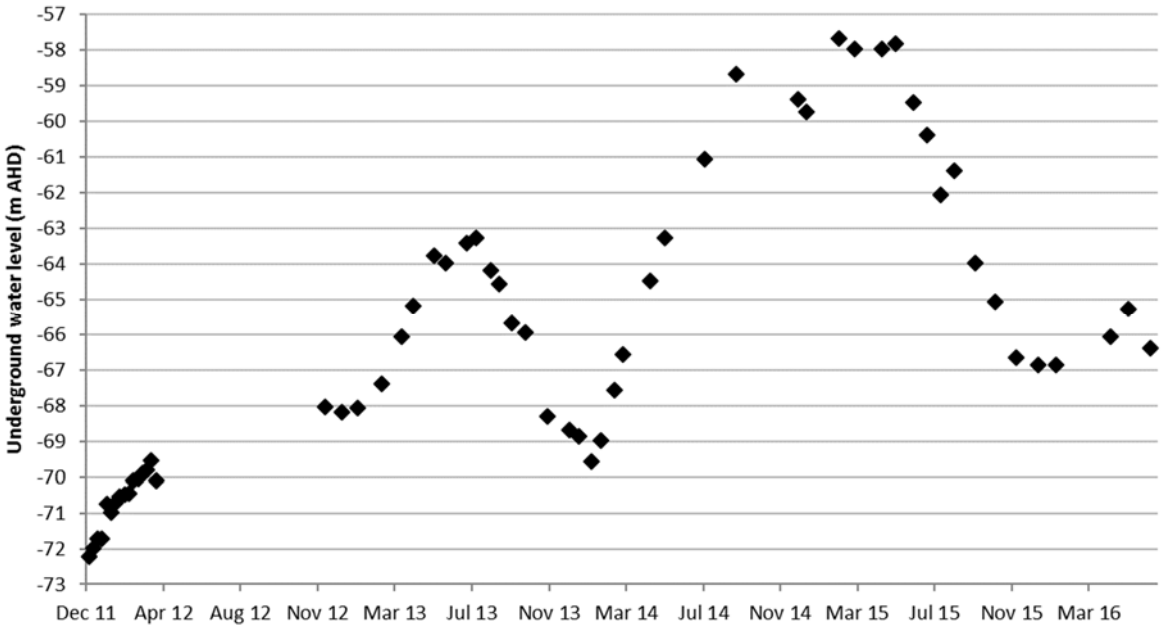


Figure 3-5 Cooranbong Underground Storage water levels

Groundwater levels

HARTT (Hydrograph Analysis: Rainfall and Time Trends) analysis was undertaken for each alluvial dataset as part of the modification for the extension of secondary extraction of longwalls 22 and 23 (GHD, 2016d). The HARTT analysis was used to establish the relationship between groundwater levels and rainfall and detect underlying trends in groundwater level that are independent of rainfall. Of the alluvial bores monitored, only bores BH24A, BH25A, MSGW01 and MSGW04A had statistically significant decreasing trends in groundwater level above the limit of reading of groundwater measurement (i.e. 0.1 m).

Visual inspection of the hydrograph for BH24A indicated that groundwater levels fell after undermining at BH24A from approximately 16.8 m AHD in January 2014 to 14.8 m AHD in August 2014. Analysis of the post August 2014 hydrograph indicates that levels at this monitoring location have shown a statistically insignificant increasing trend (independent of rainfall) with levels responding to cumulative rainfall departure (CRD).

Visual inspection of the hydrograph for BH25A indicated there has been no clear change in groundwater levels due to mining. The visual inspection of the hydrograph indicated that post mining, groundwater levels have remained within the observed range of pre-mining levels and post-mining groundwater levels have continued to respond to CRD. Visual review of the hydrograph did indicate some temporary, short-term variation in groundwater levels following mining.

The variation in groundwater levels at BH24A and BH25A are assumed to be a result of the development of shallow tensile and compressive cracks resulting in localised increases in hydraulic conductivity and porosity. It is expected that these cracks would fill over time and the hydraulic conductivity and porosity should return to pre-mining values.

MSGW01 and MSGW04A are located in the vicinity of the future Mandalong South longwalls. Visual inspection of hydrographs indicates that groundwater levels at MSGW01 have consistently fluctuated between 41 m AHD and 42.5 m AHD while groundwater levels at MSGW04A have generally fluctuated between 24 m AHD and 25.2 m AHD. It is assumed that the decreasing time trends (independent of rainfall) in groundwater level at MSGW01 and MSGW04A are not mining related, but are due to groundwater levels remaining within these historical range of levels, despite a general increasing trend in CRD over the past 18 months.

3.2.3 Groundwater users

NSW Bore Database search

The search of the NSW groundwater bore database (DPI Water, 2016) identified 127 bores in a 5 km radius of the existing, approved and proposed Mandalong Mine workings. The majority (64) registered as monitoring/test bores, one bore registered for monitoring/town water supply and the remainder (62) being registered for domestic, irrigation and/or stock use. Approximate bore locations are shown in Figure 3-6 and bore details are outlined in Appendix C.

The registered domestic and stock bores that were identified primarily extract groundwater from the Triassic sandstone and conglomerate formations with yields generally less than 1 L/s.

Groundwater dependent ecosystems and riparian vegetation

The potential vegetation GDEs within the study area (RPS, 2016) include:

- Coastal Wet Gully Forest.
- Alluvial Tall Moist Forest.
- Alluvial Floodplain Cabbage Gum Forest.

These potential GDEs generally coincide with the creeks and drainage lines within the Mandalong Mine site (GHD, 2016d). The watercourses identified within the study area are the reaches of Morans Creek and the Tobins Creek (running approximately parallel and 800 m north to Morans Creek). Shallow unconfined alluvium has been identified along these two creek lines.

Ecological communities within the study area are likely to be utilising shallow aquifers associated with ephemeral drainage lines and have therefore been considered as unlikely to be entirely groundwater dependent. This occurrence has been supported by the fact that the plant species within this vegetation community are not restricted to alluvial drainage lines; they can occur along moist sheltered gully areas, creek lines, as well as dry slopes. Therefore, they can be termed as facultative ecosystems.

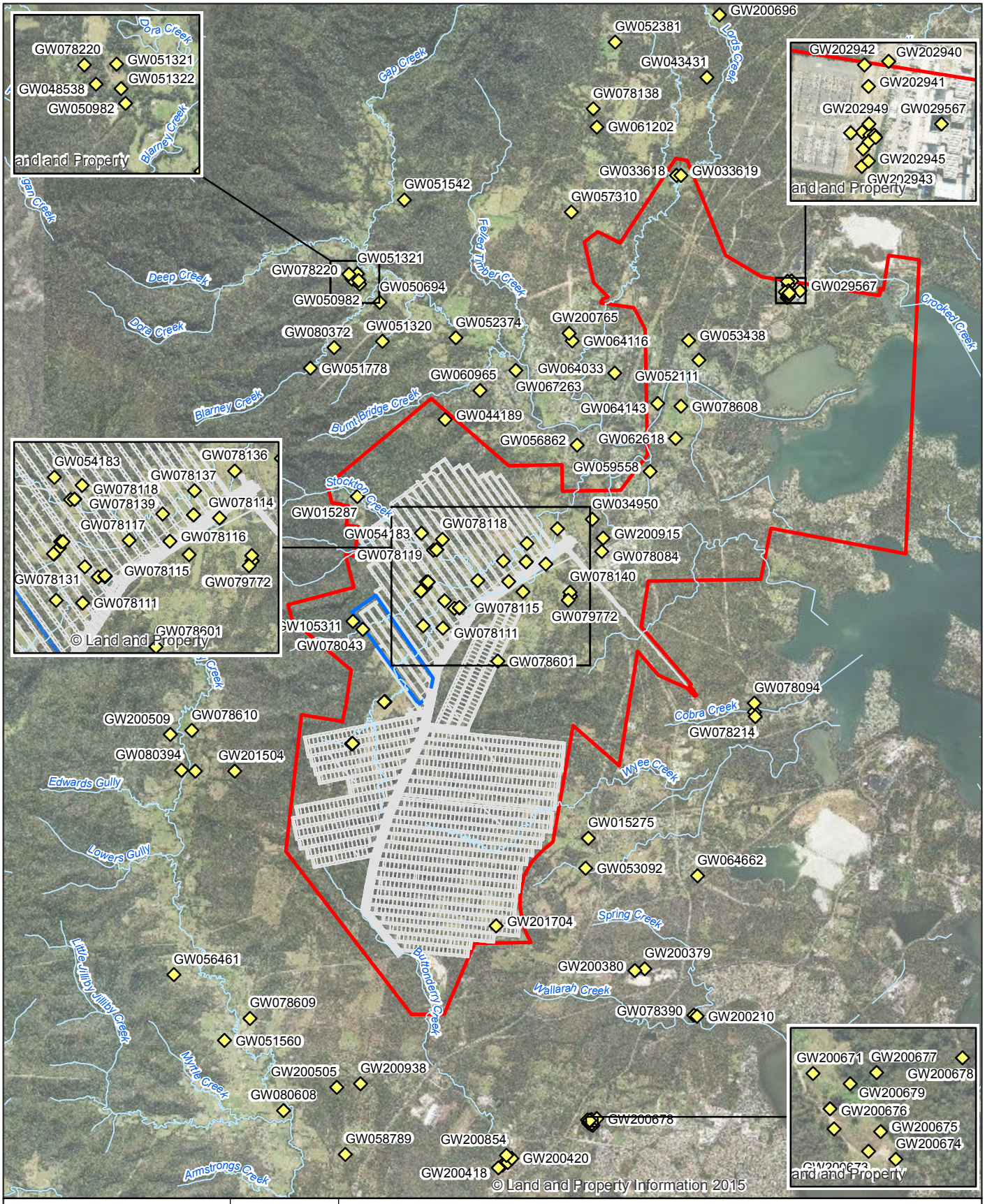
Facultative ecosystems have been described as '*a GDE that is not entirely dependent on groundwater, and may rely on groundwater on a seasonal basis or only during extended drought periods. At other times, water requirements may be met by soil or surface water*' (DPI, 2012b).

The facultative GDEs that have been identified as having potential to occur within the study area generally exist as moist sheltered gully forest along creek lines and are not considered to be completely reliant on groundwater for its persistence (RPS, 2016).

Impacts of mining longwalls 22 and 23 on GDEs and riparian vegetation is predicted to be negligible as the groundwater levels are not expected to vary significantly due to mining and depth of cover in the vicinity of longwalls 22 and 23 is greater than 200 m (GHD, 2013; GHD 2016d). As such, no additional monitoring bores are recommended to be installed to monitor potential impacts on GDEs.

3.3 Wetland management

Currently eight wetlands are monitored biannually (April and November). Baseline monitoring of the wetlands has been undertaken since 2009. Of the eight wetlands, three are control sites and five are within subsidence effected areas. Refer to the Mandalong Wetland Management Plan within the Biodiversity Management Plan for further information regarding wetland management requirements.



1:125,000 for A4

0 500 1,000 2,000 3,000 4,000

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- Registered bore
- Study area
- Project application area
- Approved Mine Workings
- Waterway

LOCATION	Mandalong
DRAWN	K.S.
CHECKED	L.H.
APPROVED	S.G.
SCALE	refer to scalebar

Extraction Plan LW22-23
Water Management Plan
NSW Bore Database
Search Results

Centennial Coal
Mandalong

DATE 7/10/2016

Figure 3-6

GIS Filename: G:\22\0105001\GIS\Maps\Deliverables\Hunter\Mandalong\2218510\EPWMP\2218510_EPWMP_04_NSWBoreSearch_0.mxd

Data source: LPI:DCDB/Imagery, 2012/2015. Centennial: Mine workings, Extraction area, consent boundary, 2016. OOW: Pinneena, Registered Bore, 2010. Created by: smacdonald, kpsroba

4. Impact assessment criteria

4.1 Surface water quality

Site-specific guideline values (SSGVs) have been derived following ANZECC (2000) guidelines and are applied to watercourse monitoring within Morans Creek (GHD, 2016d). SSGVs have been selected based on a review of default guideline values (DGVs) presented by ANZECC (2000) and data collected at upstream monitoring locations SWMP06 and SWMP07. Table 4-1 presents the recommended SSGV, as well as the DGVs and results for SWMP06 and SWMP07. The numbers in bold are those selected as the SSGV for each analyte.

Table 4-1 Site-specific guideline values for monitoring watercourse quality

Parameter	Units	DGV	SWMP06 80th percentile	SWMP07 80th percentile	Recommended SSGV
Physicochemical parameters					
EC	µS/cm	200	**940**	755	940
pH	pH units	6.5–**9.0**	**6.2**[1]–6.7	6.5[1]–7.0	6.2–9.0
TSS	mg/L	6	**47**	16	47
Turbidity	NTU	6	**58**	53	58
Nutrients					
Ammonia	mg/L	**0.9**	0.07	0.15	0.9
Total nitrogen	mg/L	0.35	1.18	**1.52**	1.52
Total phosphorus	mg/L	0.025	0.08	**0.11**	0.11
Dissolved metals					
Aluminium	mg/L	0.055	0.70	**0.78**	0.78
Arsenic	mg/L	**0.024**	0.001	0.001	0.024
Barium	mg/L	–	**0.083**	0.066	0.083
Boron	mg/L	**0.37**	0.05	0.05	0.37
Cadmium	mg/L	**0.0002**	0.0001	0.0001	0.0002
Chromium	mg/L	**0.001**	**0.001**	**0.001**	0.001
Cobalt	mg/L	0.0025	**0.009**	0.001	0.009
Copper	mg/L	0.0014	0.001	**0.002**	0.002
Iron	mg/L	0.3	**3.61**	3.11	3.61
Lead	mg/L	**0.0034**	0.001	0.001	0.0034

Parameter	Units	DGV	SWMP06 80th percentile	SWMP07 80th percentile	Recommended SSGV
Manganese	mg/L	**1.9**	0.828	1.744	1.9
Mercury	mg/L	**0.0006**	0.0001	0.0001	0.0006
Nickel	mg/L	**0.011**	0.006	0.004	0.011
Selenium	mg/L	**0.011**[2]	0.01	0.01	0.011
Silver	mg/L	0.00005	**0.001**	**0.001**	0.001
Zinc	mg/L	**0.008**	0.007	0.006	0.008
Other parameters					
Cyanide (total)	mg/L	**0.004**	**0.004**	**0.004**	0.004

1. 20th percentile value.
2. Guideline value for total selenium.

4.2 Groundwater

4.2.1 Groundwater levels

Based on the statistical analysis of alluvial groundwater levels, alluvial groundwater is highly responsive to rainfall and generally not impacted by mining.

For alluvial bores not impacted by mining, the adopted trigger value for groundwater level is the maximum recorded depth to groundwater in the historical dataset. These depths are shown in Appendix B. Water pressure drop within porous and fractured groundwater sources is generally expected up to a maximum of approximately 230 m above mine workings based on monitoring data to date. Hydrographs within these sources will be reviewed annually in combination with a review of subsidence parameters. Further investigations within these sources are triggered if an adjacent landholder complains about declining groundwater levels in their bore.

4.2.2 Groundwater quality

As outlined in Section 3.1, there is considerable natural variability in groundwater pH and EC in both alluvial and porous and fractured rock groundwater sources. In addition, the beneficial uses of this groundwater are limited due to the high EC.

As discussed in the Mandalong Southern Extension Project response to submissions, there was variability in groundwater EC at a number of monitoring bores at Mandalong Mine. As part of the response to submissions process it was identified that this variability in EC was attributable to sampling of bores by bailing. Since January 2015, monitoring bores at Mandalong Mine have been sampled using low flow techniques where possible (i.e. peristaltic pump or Micro-purge pump). Additionally, bores that were identified as being regularly inundated with surface water have been purged prior to sampling to remove any influence of surface water on monitoring results. Following the update of groundwater monitoring methodology, variability in observed EC has reduced.

Due to the high historical variability in groundwater quality, it is not proposed to adopt specific trigger values for each bore as is the case for alluvial groundwater levels. The adopted trigger

for groundwater quality is a complaint by an adjacent landholder regarding declining groundwater quality in their bore.

4.2.3 Underground water management

The spill level of the Cooranbong Underground Storage area is approximately -50 m AHD. Based on the observed rate of rise in water levels, it is proposed that a 5 m buffer be maintained. Hence, the adopted trigger value for the Cooranbong Underground Storage is -55 m AHD. Should this trigger level be exceeded, it will be necessary to reduce inputs to the storage and/or increase the extraction rate.

4.3 Performance criteria

4.3.1 Watercourses

Watercourses are to be managed for water quality and flow volume. Criteria for these aspects are provided in Table 4-2.

Table 4-2 Watercourse criteria

Aspect	Criteria	Performance criteria achieved
Watercourse quality	Below SSGVs provided in Table 4-1.	Likely
Watercourse flow	Above or within 50th percentile historical dry weather flow volume.	Likely

The stream flow monitoring station is located on Morans Creek, downstream of the study area. The location of the flow monitoring station is provided on Figure 2-1.

4.3.2 Stream health

To manage stream health criteria has been developed based on geomorphic condition and waterway stability. The criteria are applicable to the watercourse stability of potentially impacted reaches of Morans Creek and the Tobins Creek (running approximately parallel and 800 m north to Morans Creek). Table 4-3 presents the criteria for stream health.

Table 4-3 Stream health criteria

Aspect	Criteria	Performance criteria achieved
Geomorphic condition and watercourse stability		
Incisional processes and instabilities Waterway bed condition	Occurrence of erosional processes does not occur as a result of subsidence.	Likely
Waterway cross sectional area	Change in cross sectional area does not vary beyond the predictions of the subsidence modelling undertaken as part of impact assessment.	Likely

Aspect	Criteria	Performance criteria achieved
Stream gradient	Change in stream gradient does not vary beyond the predictions of the subsidence modelling undertaken as part of impact assessment.	Likely
Watercourse subsidence		
3rd order and above streams GDEs	No connective cracking between the surface, or the base of the alluvium, and the underground workings. No subsidence impact or environmental consequence greater than minor.	Likely
1st and 2nd order streams	No subsidence impact or environmental consequences greater than predicted by impact assessment. No connective cracking between the surface and the underground workings.	Likely

Notes:

- Classification of streams in accordance with Strahler stream order system.
- Detailed performance indicators (including impact assessment criteria) for each of these performance measures will be detailed in the various management plans that are required under this consent.
- Measurement and/or monitoring of compliance with performance measures and performance indicators is to be undertaken using generally accepted methods that are appropriate to the environment and circumstances in which the feature or characteristic is located. These methods are to be fully described in the relevant management plans. In event of a dispute over the appropriateness of proposed methods, the Secretary will be the final arbiter.

4.3.3 Groundwater environment

Table 4-4 below presents the groundwater environment management criteria for Mandalong Mine.

Table 4-4 Groundwater environment criteria

Aspect	Criteria	Performance criteria achieved
Groundwater level	Groundwater level is below the maximum recorded depth to groundwater in the historical datasets for bores listed in Appendix B.	Likely
Groundwater quality	No groundwater access complaints.	Likely

Aspect	Criteria	Performance criteria achieved
Underground water level/storage	Water level is maintained below -55 m AHD.	Likely

5. Mandalong Valley flooding

5.1 Flood modelling

The flood model is updated as part of each Extraction Plan to ensure subsidence impacts on flood levels, creek stability and ponding are within predictions.

5.2 Predicted changes to flooding regimes

As part of the Mandalong Mine Modification 3 application, Umwelt (2016) predicted flood depths as a result of subsidence for longwalls 18 to 23. The predicted changes to flood behaviour are likely to be limited to within the zone of predicted subsidence. Umwelt (2016) identified potential impacts to four specific channels that are relevant to longwalls 22 and 23. These include:

- Channel 1, Sawpit Creek – within the study area this channel flows in an approximately north easterly direction through Property 20. Within the study area the creek has an average grade of 0.24% with an average modelled flood depth of 1.6 m in the 100 year ARI storm event.
- Channel 2, Tobins Creek – within the study area this channel flows in an approximately north easterly direction, parallel to the northern side of Tobins Road through Properties 206, 207, 73, 74, 75 and 71. The creek line crosses Prickly Ridge Road just norther of the road's juncture with Tobins Road. Within the study area, the creek has an average grade of 0.36% with an average modelled flood depth of 1.45 m in the 100 year ARI storm event.
- Channel 3, Morans Creek – within the study area Morans Creek flows in an approximately northerly direction through Properties 89, 85, 84, 83, 82 and 70, east of Mandalong Road. Within the study area, the creek has an average grade of 0.28% with an average modelled flood depth of 1.40 m in the 100 year ARI storm event.
- Channel 4, unnamed tributary of Morans Creek – within the study area this channel flows in an approximately easterly direction through Properties 213, 212, 88, 87, 86, 84 and 83, north west of Mandalong Road. Within the study area, the creek has an average grade of 0.38% with an average modelled flood depth of 1.10 m in the 100 year ARI storm event.

The predicted changes to flooding regimes are consistent with the impacts assessed and approved as part of the impact assessment for the Mandalong Longwall Panel 22 to 23 Modification Project (GHD, 2016d).

5.3 Predicted risks to channel stability

As part of subsidence impacts, localised changes in grade will be limited to channel sections downstream of chain pillars. In these areas grade can change between 1% to 4%. As this will result in similar gradients to existing channels the creation of new areas of in-channel ponding may occur. Table 5-1 provides the predicted grade change within each impacted channel.

Table 5-1 Predicted grade change for potentially impacted drainage channels (Umwelt, 2016)

Drainage channel	Channel length (m)	Max. predicted subsidence (mm) and location	Average predicted grade change (%) (pre mining and subsidence)	Max predicted grade change (%) (pre mining and subsidence) and location
Channel 1, Sawpit Creek	749	309 Longwall 18	-0.02% (0.26% to 0.24%)	4.06% (2.28% to 6.33%) (Longwall 18)
Channel 2, Tobins Creek	2,094	919 Longwall 21	-0.02% (0.38% to 0.36%)	3.14% (0.04% to 3.18%) (Longwall 21)
Channel 3, Morans Creek	1,527	824 Longwall 19	0.05% (0.23% to 0.28%)	1.41% (0.92% to 2.33%) (Longwall 18)
Channel 4, unnamed tributary of Morans Creek	1,570	725 Longwall 21	0.03% (0.35% to 0.38%)	1.57% (0.10% to 1.60%) (Longwall 21)

Mitigation measures relating to instream works are to be developed in consultation with DPI Water. Typical mitigation measures for surface and groundwater remediation are provided in Appendix D.

The predicted risks to channel stability are consistent with the impacts assessed and approved as part of the impact assessment for the Mandalong Longwall Panel 22 to 23 Modification Project (GHD, 2016d).

5.4 Predicted changes to ponding

Umwelt (2016) have predicted an increase to remanent ponding areas as a result of Longwalls 22 to 23 compared with to pre-mining conditions.

The following locations in Table 5-2 are proposed to be monitored for managing potential remnant ponding impacts. Table 5-2 also provides the suggested mitigation/remediation works proposed for each instance of remnant ponding.

Table 5-2 Monitoring locations and possible mitigation/remediation works (Umwelt, 2016)

Location	Property	Description	Possible mitigation/ remediation works
A	Property 68	Paddock	Drainage works
B	Property 70	Channel	Drainage works
C	Property 74	Dams	Drainage works
D	Property 82	Channel	Drainage works

Location	Property	Description	Possible mitigation/ remediation works
E	Property 90	Paddock	Drainage works
F	Property 213	Trotting Track	Drainage works
G	Property 219 and Property 220	Paddock	Drainage works
H	Property 219 and Property 220	Channel	Drainage works

The predicted changes to ponding are consistent with the impacts assessed and approved as part of the impact assessment for the Mandalong Longwall Panel 22 to 23 Modification Project (GHD, 2016d).

6. Groundwater model validation program

6.1 Data review

The groundwater model validation program compares groundwater monitoring results with modelled groundwater level predictions. As specified in the *Mandalong Mine: Water Management Plan* (GHD, 2016a), the model will be reviewed against the monitoring data annually. Model re-calibration is undertaken as required (typically after exceedance of a stage 2 trigger for groundwater level as specified in the TARP in Appendix E) or every three years.

Upon receipt of groundwater monitoring results, the following review processes will be undertaken:

- Data will be compared to the specified trigger values where applicable.
- If result(s) do not meet specified trigger values further investigation will be required at the respective location.

Centennial Mandalong will undertake an annual review of monitoring data to compare groundwater levels to rainfall and identify trends, and to assess statistically significant changes in groundwater quality.

6.2 Cooranbong bore annual compliance report

Centennial Mandalong currently holds a works approval (20WA217077) and WAL (WAL 39767) under the North Coast Fractured and Porous Rock Groundwater Sources Water Sharing Plan for the extraction of up to 1,825 ML/year of underground mine water from the Cooranbong Underground Storage area into the Borehole Dam at the CES. An annual groundwater report is required by the bore licence, which includes a calculation of the groundwater take from the fractured and porous rock groundwater sources in accordance with the *Groundwater Monitoring and Contingency Plan* (GHD, 2016b).

7. Risks and mitigation plan

7.1 Trigger action response plans

Trigger action response plans (TARPs) are provided in Appendix E for:

- Watercourses.
- Groundwater environment.
- Stream health.
- Flooding.

7.2 Management plan review

This WMP will be reviewed as a result of:

- Any significant change to water management practices.
- Continual exceedance of trigger values.

A review of this WMP will be undertaken by a suitably qualified person and also should consider consultation with the appropriate local and state government authorities.

Table 7-1 Summary of management actions and mitigation measures

Required action	Frequency
Undertake monthly groundwater monitoring in accordance with Section 5.	Monthly for the first two years of the project and quarterly thereafter
Undertake daily monitoring of underground water transfers specified in Section 2.2.2.	Daily
Stream and flow path monitoring specified in Section 5 and Appendix E.	Bi-annually
Respond to exceedances of trigger values in accordance with the TARP presented in Section 3.2.2, Section 4 and Section 5.	Ongoing
Undertake an annual review and report on groundwater monitoring data as presented in Section 6.	Annually
Compare hydrogeological model predictions with monitoring data on an annual basis and re-calibrate the hydrogeological model as required as presented in Section 6.	Annually
Calculate annual groundwater take from the fractured and porous rock groundwater sources in accordance with the *Groundwater Monitoring and Contingency Plan* for the Cooranbong Extraction Bore (GHD, 2016b).	Annually

7.3 Reporting

Outcomes from the monitoring programs will be reported annually through the Annual Review. This reporting will cover outcomes such as background changes in groundwater yield/quality against mine-induced changes and impacts to regional and local (including alluvial) groundwater sources, groundwater inflows to the mine, groundwater supply to private bores and GDEs and riparian vegetation health.

8. References

ANZECC (2000), *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australia and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

DPI (2012a) *NSW Aquifer Interference Policy: NSW Government policy for the licensing and assessment of aquifer interference activities*, NSW Department of Primary Industries.

DPI (2012b) *Risk assessment guidelines for groundwater dependent ecosystems*: *Volume 1 – The conceptual framework*, NSW Department of Primary Industries, Office of Water.

DPI Water (2016) *Continuous water monitoring network,* Department of Primary Industry – Water (site access: http://allwaterdata.water.nsw.gov.au/water.stm).

GHD (2013), *Mandalong Southern Extension Project: Groundwater Impact Assessment,* prepared by GHD Pty Ltd for Centennial Mandalong Pty Limited.

GHD (2016a) *Mandalong: Mine Water Management Plan*, prepared by GHD Pty Ltd for Centennial Mandalong Pty Limited.

GHD (2016b) *Groundwater Monitoring and Contingency Plan, Cooranbong Entry Site,* prepared by GHD Pty Ltd for Centennial Mandalong Pty Limited.

GHD (2016c) *Mandalong Tonnage Production Project – Groundwater and Water Balance Modelling Report,* prepared by GHD Pty Ltd for Centennial Mandalong Pty Limited.

GHD (2016d) *Longwall 22 and 23 Modification, Water Resources Impact Assessment,* prepared by GHD Pty Ltd for Centennial Mandalong Pty Limited.

RPS (2016) *Biodiversity Assessment Report – Mandalong Transmission Line TL24 Relocation Project*, prepared by RPS Australia East Pty Ltd for Centennial Mandalong Pty Limited.

Sigra (2011) *Permeability Testing at Borehole C050W650,* prepared by Sigra Pty Ltd for Centennial Coal Company Limited.

Umwelt (2016) *Centennial Mandalong Flood Assessment – Longwalls 22 to 23,* prepared by Umwelt (Australia) Pty Limited for Centennial Mandalong Pty Limited.

Appendices

Appendix A – Consultation outcomes

Comment	Response
EPA (letter dated 29 August 2016)	
Acknowledged receipt of the WMP. EPA clarified their role to set environmental objectives. As such no comment provided on the WMP.	Noted.
DPI Water (letter dated 16 August 2016)	
There is insufficient information available to understand the Water Management Plan that has been established. The relevance of the findings, conclusions and recommendations of the supplementary report (G1455B_RTS support_Report, 2014) prepared to investigate concerns over the benchmarking water quality data has not been referenced. It has not been reported within the WMP document, what guidelines or statistical processes will be followed to identify the background levels from any contamination impact or, with the exception of water levels, the identification of any thresholds warranting a trigger action and response plan (TARP). This includes both groundwater model predictions and mine inflows. There are a number of private bores that overlie or are within proximity to the mine where there is negligible baseline data to inform the assessment of mine related impact should a complaint be lodged.	As stated in Section 4.2.2 and discussed in the Mandalong Southern Extension Project response to submissions, there was variability in groundwater EC at a number of monitoring bores at Mandalong Mine. As part of the response to submissions process it was identified that this variability in EC was attributable to sampling of bores by bailing. Since January 2015, monitoring bores at Mandalong Mine have been sampled using low flow techniques where possible (i.e. peristaltic pump or Micro-purge pump). Additionally, bores that were identified as being regularly inundated with surface water have been purged prior to sampling to remove any influence of surface water on monitoring results. Following the update of groundwater monitoring methodology, variability in observed EC has reduced. Due to the historical variability in groundwater quality, it is not proposed to adopt specific trigger values for each bore (as is the case for alluvial groundwater levels). The adopted trigger for groundwater quality is a complaint by an adjacent landholder regarding declining groundwater quality in their bore. The process for comparing groundwater monitoring data to hydrogeological model predictions is outlined in Section 6.1. There are no private bores currently in the Mandalong Mine groundwater monitoring network. In future, if private bores are in a suitable location, then Centennial will attempt to gain approval for monitoring.

Comment	Response
Overall, the WMP is an incomplete document; its content and design is hampered by the fact that it hasn't considered the proponent's commitments to monitor and evaluate GDEs, collect baseline data from private bores and cross reference the recent investigation looking at issues with the groundwater monitoring program. The fact that many aspects are incomplete or undone means that the present WMP should be regarded as preliminary only and be further developed, subject to consultation with, and to the satisfaction of DPI Water.	As stated in the WMP for Mandalong Mine (GHD 2016a), additional monitoring bores will be installed as part of future extraction plans in the vicinity of GDEs where depth of cover is less than 200 m. Issues regarding the collection of groundwater data from private bores and the recent investigation looking at issues with the groundwater monitoring program are addressed above.
Further work is required to address a range of matters as documented within the 'Mandalong Southern Extension EIS Groundwater Quality Response to Submission Support 2014', Project No G14558, Australian Pty Ltd. Groundwater and Environmental Consultants. This is required to guide the location and design of piezometers selected for the intended monitoring purpose. Groundwater quality and robustness of baseline data should be reviewed prior to adopting the statistical process defining the Trigger Action Response Plan (TARP) thresholds. The TARP thresholds should then be developed to a prescriptive level.	As stated in Section 4.2.2 and discussed in the Mandalong Southern Extension Project response to submissions, there was variability in groundwater EC at a number of monitoring bores at Mandalong Mine. As part of the response to submissions process it was identified that this variability in EC was attributable to sampling of bores by bailing without initial purging. Since January 2015, monitoring bores at Mandalong Mine have been sampled using low flow techniques where possible with initial purging until EC and pH stabilise. Additionally, bores that were identified as being regularly inundated with surface water have been regularly purged prior to sampling to remove any influence of surface water on monitoring results. Following the update of groundwater monitoring methodology, variability in observed EC has reduced.
The method for quantifying groundwater take should be developed to a prescriptive level and be consistent between both the WMP and the 20BL173524 Annual Compliance Report.	As specified in Section 2.2.3, groundwater inflows from adjacent strata into the mine workings are calculated on an annual basis in accordance with the requirements and methodology specified in the *Groundwater Monitoring and Contingency Plan* (GHD, 2016b). This plan specifies the methodology utilised in the 20BL173524 Annual Compliance Report.

Comment	Response
The groundwater model validation program comparing groundwater monitoring results with modelled groundwater level predictions needs to be developed to a prescriptive level.	As stated in Section 6.1, the groundwater model validation program compares groundwater monitoring results with modelled groundwater level predictions. As specified in the WMP for Mandalong Mine (GHD 2016a), the model will be reviewed against the monitoring data annually. Model re-calibration is undertaken as required (typically after exceedance of a stage 2 trigger for groundwater level as specified in the TARP in Appendix E) or every three years.
Where landholders are agreeable, private bores should be included within the monitoring program.	There are no private bores currently in the Mandalong Mine groundwater monitoring network. In future, if private bores are in a suitable location, then Centennial will attempt to gain approval for monitoring.
Groundwater monitoring and evaluation should be included adjacent to mapped potential GDEs where depth of overburden is less than 200m. This being consistent with the commitment made as part of the 'Mandalong Southern Extension Response to Submissions'. The GDE assessment should be supported by the instream vegetation monitoring program where applicable.	As discussed in the WMP for Mandalong Mine (GHD 2016a), monitoring bores in the vicinity of GDEs where depth of cover is less than 200 m will be established as part of the relevant Extraction Plan WMP. As discussed in Section 2.2.1, the depth of overburden above longwalls 22 and 23 is greater than 250 m and therefore additional monitoring locations are not recommended within this document.
Trigger Action Response Plan (TARP) for groundwater level – the TARP outlines that loss of water supply from an adjacent landholder is only replaced if groundwater levels do not recover after six months. This could leave a landholder without an adequate water supply for a period of 6 months or greater. This is not an acceptable response and should be addressed further in the TARP.	The TARP includes a trigger based on a complaint from an adjacent landholder regarding declining groundwater level or groundwater quality.
The conditions of consent require that the WMP includes a site water balance, which has not been provided within the WMP.	The conditions of development consent SSD-5144 (refer Table 1-1) do not require a site water balance for the Extraction Plan WMP. Refer to the WMP for Mandalong Mine (GHD 2016a) for details of the site water balance.

Comment	Response
There is no information within the WMP on water licensing, including licensing requirements and licences held. This information must be presented in the WMP outlining all take of water from all water sources and how this is accounted for, including reference to specific licences, accounting methods or exemptions.	Water licensing details and requirements are provided in the Regional Water Management Plan (that encompasses the northern coal operations owned by Centennial) and the Mandalong Mine WMP (GHD 2016a).
The EIS for the Mandalong Southern Extension identified that groundwater inflows are predicted to increase from 712ML/yr at the existing operation to a maximum of 2158ML/yr with the southern extension. The proponent currently has a licence to take groundwater from the fractured rock and porous rock aquifer under the Water Act 1912 for 1825ML/yr. The proposal to increase the maximum groundwater take to 5.9ML/d (2154ML/yr) requires additional entitlement. This was outlined within DPI Water's response to the EIS. There is no discussion within the WMP on how or when this additional entitlement will be sought. DPI Water notes that an embargo order was made on 5 February 2016 covering groundwater within the Hunter water shortage zone, which includes the area of the Mandalong Mine (http://www. water. nsw.gov. au/_data/assets/pdf_file/0008/590921 /160205-hunter-groundwater embargo-order. pdf). The proponent must demonstrate in the WMP how it will obtain this additional entitlement and ensure sufficient entitlement is held prior to commencement of operations involving the additional take.	The hydrogeological model developed as part of the Mandalong Southern Extension Project has been re-calibrated to updated calculated groundwater make. The re-calibrated model predicts inflows to the mine to peak in 2036 at approximately 2.1 ML/day. These hydrogeological model predictions were used in the water balance to predict the volume of water transferred from the Cooranbong Underground Storage, which requires licensing. The peak annual volume of groundwater extracted from the Cooranbong Underground Storage is predicted to be 1,264 ML, which is below the current licensed volume of 1,825 ML held by Centennial Mandalong under WAL 39767. As such, no additional entitlements are required for Mandalong Mine.
Section 4.2 "Predicted risks to channel stability" – the mitigation/remediation measures described in the WMP in relation to channel stability are "drainage works" with a note that "mitigation measures relating to instream works are to be developed in consultation with the Department of Primary Industries (DPI) Water". This is not sufficient detail to describe how channel instability will be mitigated and remediated. The WMP should be updated to include specific detail on this.	The WMP has been updated to provide typical mitigation measures in Appendix D.

Comment	Response
Flow monitoring is only proposed at one point on Morans Creek. There is no discussion of why other watercourses potentially impacted are not proposed to be monitored for flow. It is considered that the proposed monitoring is insufficient to assess against performance criteria and possible impacts related to both subsidence and water discharges. The monitoring plan should be updated to include appropriate surface flow monitoring to enable assessment against performance criteria.	Centennial are currently installing new gauging equipment associated with the waterways potentially impacted by underground mining. Once these become operational, the WMP will be revised.
Stream health monitoring – The WMP outlines that stream health criteria have been developed based on geomorphic condition and waterway stability. The only monitoring proposed, however, is on Morans Creek in the vicinity of long walls 24A and 24 (as depicted on Figure 5.1). This is insufficient to assess against performance criteria and possible impacts related to subsidence. Further stream health monitoring should be included on other watercourses and areas potentially impacted by the mine.	The stream health monitoring requirements have been updated to include all waterway reaches above longwalls 22 and 23, as shown in Figure 2-2.
TARP for water quality – There is no action proposed to mitigate or improve water quality issues, only to undertake additional monitoring. The TARP should be updated to include mitigation and remediation measures.	The TARP for water quality has been updated to initiate remediation actions provided in Appendix D.
TARP for water flow – The only action proposed is to "review mine plan in context of local geological structures". This section must include an action to appropriately license baseflow loss through a water access licence. There should also be specific actions to mitigate and prevent future loss of baseflow.	The TARP for water flow has been updated to initiate remediation actions provided in Appendix D.
A statistical summary is provided in Appendix D. The beneficial use of stock watering is appropriate for Permian aquifers of Sydney Basin North Coast Groundwater Source. The alluvial groundwater is more variable with limited potable use and one private bore registered for irrigation use.	The WMP has been updated to provide revised statistical summary of groundwater quality data provided, in Appendix B.

Comment	Response
Of note in Table D2 (Appendix B) is the considerable variation in electrical conductivity (EC) for the monitoring bores. The Department raised concerns during assessment of the Southern Extension Project EIS on this matter. Such wide ranging EC results are not characteristic of the groundwater environment (unless tidal influences) drawing into question the validity of the water quality data. This led to a subsequent Response to Submission (RtS) supplementary report (G1455B_RTS support_Report). That Report identified a number of potential issues with the program and made a series of recommendations to improve the program. DPI Water accepted the RtS report conclusions and recommendations as a pathway forward.	Addressed above.
The WMP doesn't reference this RtS document and presents no familiarity with the issues with the water quality dataset noted during the EIS review stage. The WMP does not draw upon the conclusions and recommendations of the supplementary report G1455B_RTS Support_Report) prepared to investigate this concern.	Addressed above.
There are a number of private bores that either directly overlie or in close proximity to the mine. This includes two private bores above LW panels LW22-24A.	There are no private bores currently in the Mandalong Mine groundwater monitoring network. In future, if private bores are in a suitable location, then Centennial will attempt to gain approval for monitoring.
The WMP doesn't present any baseline data of the private bores to inform an assessment of mine related impact should a complaint be lodged. It is recommended that given the lack of baseline data for private bores, where landholders are agreeable, these bores be included within the monitoring program.	There are no private bores currently in the Mandalong Mine groundwater monitoring network. In future, if private bores are in a suitable location, then Centennial will attempt to gain approval for monitoring.
Defined water level triggers noted for the monitoring bores. However, as noted above, there are a number of private bores that directly overlie the mine including two private bores above LW panels LW22-24A.	There are no private bores currently in the Mandalong Mine groundwater monitoring network. In future, if private bores are in a suitable location, then Centennial will attempt to gain approval for monitoring.

Comment	Response
The WMP doesn't present any baseline data of the private bores to inform an assessment of mine related impact should a complaint be lodged.	There are no private bores currently in the Mandalong Mine groundwater monitoring network. In future, if private bores are in a suitable location, then Centennial will attempt to gain approval for monitoring.
There is no definition of what a statistically significant change in pH or EC means in context with the data presented. The WMP doesn't document or segregate any issues with the historical dataset noted during the EIS review stage or draw upon the conclusions and recommendations of the supplementary report G1455B_RTS Support_Report, 2014).	Issues with historical dataset addressed above. Triggers for groundwater quality are based on a complaint from adjacent landholder regarding declining water quality.
The WMP doesn't include a 'Table 4.3. However, Table D2 in the appendices lists a series of monitoring bores.	The WMP has been revised to provide details of monitoring bores in Table 2-2.
DPI Water is aware an extensive groundwater monitoring network has been developed by Centennial Coal at the Mandalong Mine, with monitoring undertaken on many of the established bores since August 1997.	Noted.
The G1455B_RTS Support Report (2014) not referenced in the WMP identified a number of monitoring bores constructed at ground level and flooding issues were likely contributing to erratic electrical conductivity measurements. Additionally there was discussion on very low volume purging. The WMP draw upon the findings, conclusions and recommendations of the supplementary report (G1455B_RTS support_Report,2014).	Addressed above.

Comment	Response
This is a description of the discharge volumes and not mine inflows. It is understood that potable water is also pumped into the mine for use. Bore 20BL173524 extracts water from an underground storage area within the Cooranbong underground workings. The extracted water is transferred by overland pipe to the Cooranbong Services Site to the east and discharges into water management storages before discharging through Licenced Discharge Point (LDP) 001. Unless 1:1 ratio (mine inflow/ licenced discharge) is to be inferred, a water balance estimate will be required to inform the mine inflow take. The 20BL173524 Annual Compliance Report 2014 indicates: Groundwater inflow = Δ storage + extraction volume - inputs. Hence, a difference in processes defined.	As specified in Section 2.2.3, groundwater inflows from adjacent strata into the mine workings are calculated on an annual basis in accordance with the requirements and methodology specified in the *Groundwater Monitoring and Contingency Plan* (GHD, 2016b). This plan specifies the methodology utilised in the 20BL173524 Annual Compliance Report.
No descriptive proposal of how the impact of 'negligible' for GDEs is measured or demonstrated. However, the TARP outlines that Biannual inspections for instream vegetation will be undertaken. Visual inspections to assess change in extent and density of vegetation not specific to season.	As stated in Section 3.2.3, impacts of mining longwalls 22 and 23 on GDEs and riparian vegetation is predicted to be negligible as the groundwater levels are not expected to vary significantly due to mining and depth of cover in the vicinity of longwalls 22 and 23 is greater than 200 m (GHD, 2013; GHD 2016d).
The assessment of instream vegetation should be coupled to inform the GDE assessment.	Noted.
Additionally, DPI Water sought during the Centennial Manda long Southern Extension Project assessment that the proponent commit to expand the groundwater monitoring and evaluation program to include monitoring the water table/quality adjacent to mapped potential GDEs where depth of overburden is less than 200m. The RtS advised a commitment to do so and within the revised Statement of Commitments **Section 5.0** of this Response to Submissions. The WMP does not provide any guidance on this monitoring commitment.	As discussed in the WMP for Mandalong Mine (GHD 2016a), monitoring bores in the vicinity of GDEs where depth of cover is less than 200 m will be established as part of the relevant extraction plan WMP. As discussed in Section 2.2.1, the depth of overburden above longwalls 22 and 23 is greater than 250 m and therefore additional monitoring locations are not recommended within this document.

Comment	Response
It is unclear what trigger values or thresholds are being referenced here.	Model re-calibration is undertaken as required (typically after exceedance of a stage 2 trigger for groundwater level as specified in the TARP in Appendix E) or every three years.
As per previous comments. There is no definition of what a statistically significant change in pH or EC means in context with the data presented. The WMP doesn't document or segregate any issues with the historical dataset noted during the EIS review stage or draw upon the conclusions and recommendations of the supplementary report (G1455B_RTS Support_Report, 2014).	Issues with historical dataset addressed above. Triggers for groundwater quality are based on a complaint from adjacent landholder regarding declining water quality.
The WMP doesn't present any baseline data of the private bores to inform an assessment of mine related impact should a complaint be lodged. It is recommended that given the lack of baseline data for private bores, where landholders are agreeable, these bores be included within the monitoring program.	There are no private bores currently in the Mandalong Mine groundwater monitoring network. In future, if private bores are in a suitable location, then Centennial will attempt to gain approval for monitoring.
There is insufficient information available to understand the Water Management Plan that has been established. The relevance of the findings, conclusions and recommendations of the supplementary report (G1455B_RTS support_Report, 2014) prepared to investigate concerns over the benchmarking water quality data has not been referenced It has not been reported within the WMP document, what guidelines or statistical processes will be followed to identify the background levels from any contamination impact or, with the exception of water levels, the identification of any thresholds warranting a trigger action and response plan (TARP). This includes both groundwater model predictions and mine inflows. There are a number of private bores that overlie and within proximity to the mine where there is negligible baseline data to inform the assessment of mine related impact should a complaint be lodged.	Addressed above.

Comment	Response
Overall, the WMP is an incomplete document; its content and design is hampered by the fact that it hasn't considered the proponent's commitments to monitor and evaluate GDEs, collect baseline data from private bores and cross reference the recent investigation looking at issues with the groundwater monitoring program. The fact that many aspects are incomplete or undone means that the present WMP should be regarded as *preliminary only* and be further developed, subject to consultation with, and to the satisfaction of DPI Water.	Addressed above.
DPI Water (letter dated 19 December 2016)	
Remediation measures and water licensing requirements for tensile and compressive cracks, which may develop in the surface zone.	Water loss as a result of surface cracks is considered unlikely. No water loss has been observed previously due to the mining of longwalls with less depth of cover (compared to longwalls 22 and 23). In the unlikely event that subsidence causes significant surface cracks, remediation measures to prevent water loss are provided in Appendix D. Water licensing requirements have not been considered due to the low likelihood of water loss as a result of surface cracks. The TARP in Appendix E specifies that any loss of water supply may need to be licensed.
A monitoring and rehabilitation strategy for Tobins Creek. Monitoring should include the sections directly above the proposed longwall extension, including the two unnamed 1st order tributaries.	Watercourse stability monitoring has been updated to include the two first order tributaries of Tobins Creek (refer Figure 2-2). Remediation measures for creek realignment and bed stabilisation measures are provided in Appendix D. Further details of the rehabilitation of Tobins Creek are provided in the Rehabilitation Management Plan for Mandalong Mine.
Monitoring of the vegetation communities MU 1, MU 5, MU17o, MU 37d and MU 46.	Refer to the Extraction Plan Biodiversity Management Plan for monitoring requirements of vegetation communities.

Comment	Response
Make good provisions for impacted surface and groundwater users. This commitment should not be exclusive to a drawdown of 2 m but rather whereby drawdown has reduced the capacity of take for licensed purposes and/or basic landholder rights.	The TARP in Appendix E includes provisions for the replacement of water supply by Centennial Mandalong.
Consideration should also be given to a private bore monitoring network, subject to access agreements.	There are no private bores currently in the Mandalong Mine groundwater monitoring network. In future, if private bores are in a suitable location, then Centennial will attempt to gain approval for monitoring.

Appendix B – Baseline data

B.1 Surface water

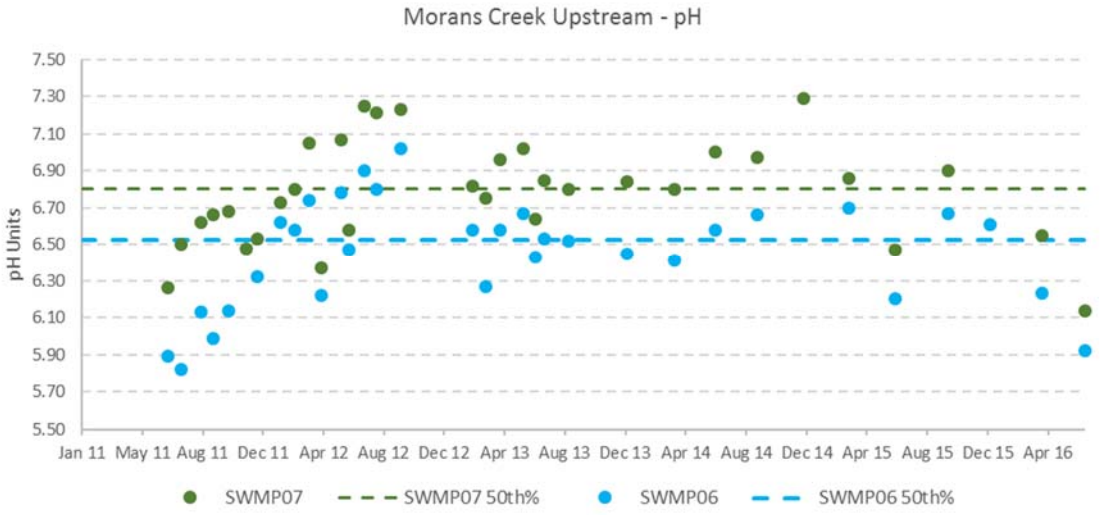
Table B-1 Median surface water monitoring sites water quality results

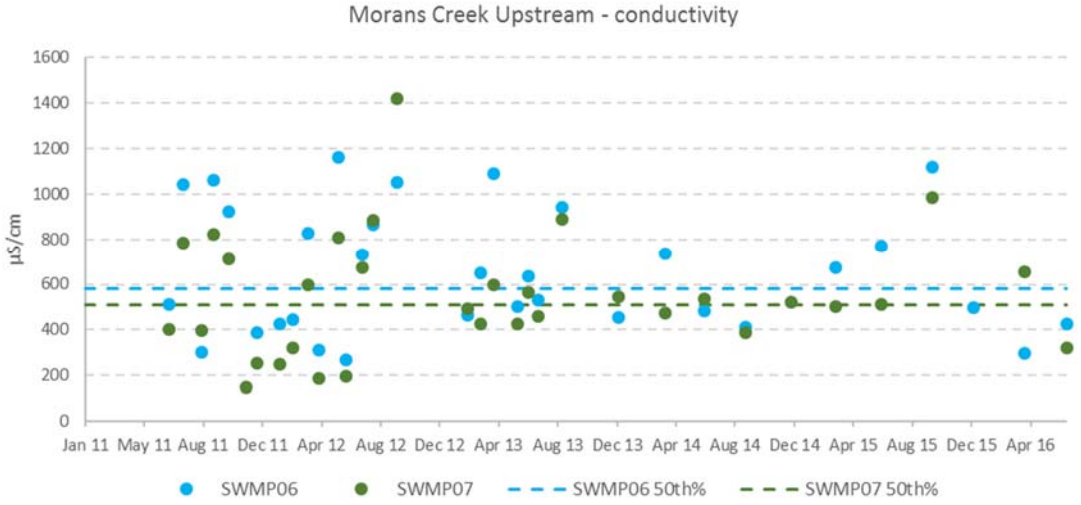
Parameter	Units	SW003	SW004	SW006	SW011	SWMP06	SWMP07
Physicochemical parameters							
EC	µS/cm	415	649	390	544	583	510
pH	pH units	6.5	7.0	6.5	6.7	6.5	6.8
TSS	mg/L	7	10	16	17	25	8
Turbidity	NTU	22	24	25	32	32	28
Nutrients							
Ammonia	mg/L	0.02	0.17	–	0.01	0.03	0.05
BOD	mg/L	–	–	–	–	2	2
TKN	mg/L	–	–	–	–	0.7	0.8
Total nitrogen	mg/L	–	–	–	0.03	0.7	0.9
Total phosphorus	mg/L	–	–	–	–	0.04	0.06
Anions							
Alkalinity (total)	mg/L	–	–	–	–	26	40
Chloride	mg/L	86	136	–	104	147	119
Sulfate	mg/L	9	10	–	4	12	10
Cations							
Calcium	mg/L	–	–	–	–	5	5
Magnesium	mg/L	–	–	–	–	12	10
Potassium	mg/L	–	–	–	–	3	4
Sodium	mg/L	–	–	–	–	84	76
Dissolved metals							
Aluminium	mg/L	–	–	–	–	0.29	0.32
Arsenic	mg/L	0.001	0.002	–	0.001	0.001	0.001
Barium	mg/L	0.005	0.063	–	0.039	0.065	0.050
Boron	mg/L	0.001	0.05	–	0.05	0.05	0.05
Cadmium	mg/L	0.0001	0.0001	–	0.0001	0.0001	0.0001

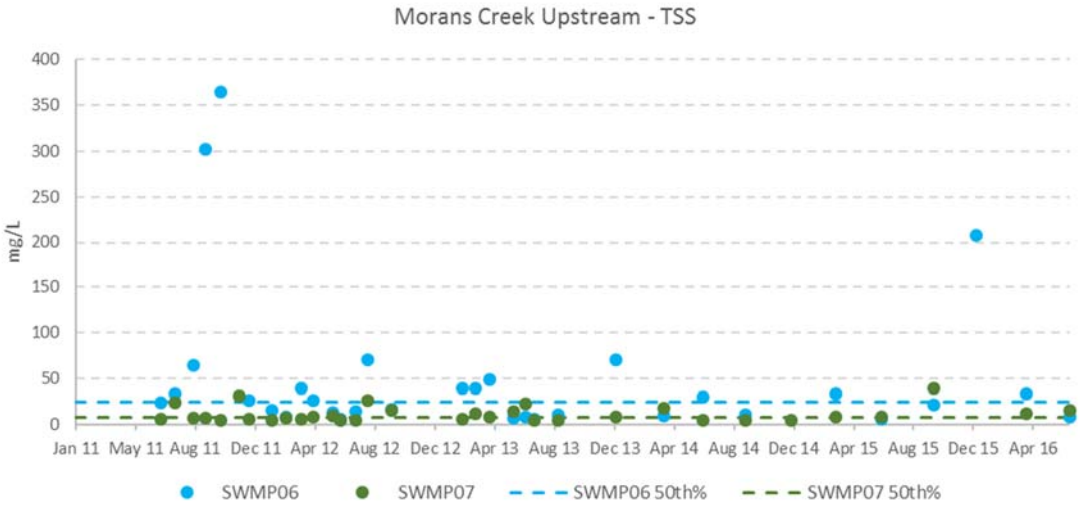
Parameter	Units	SW003	SW004	SW006	SW011	SWMP06	SWMP07
Chromium	mg/L	–	–	–	–	0.001	0.001
Cobalt	mg/L	–	–	–	–	0.004	0.001
Copper	mg/L	0.001	0.001	–	0.001	0.001	0.001
Iron	mg/L	1.14	3.47	–	2.00	2.55	2.29
Lead	mg/L	0.001	0.001	–	0.001	0.001	0.001
Manganese	mg/L	0.158	1.51	–	0.635	0.312	0.369
Mercury	mg/L	0.0001	0.0001	–	0.0001	0.0001	0.0001
Nickel	mg/L	–	–	–	–	0.005	0.003
Selenium	mg/L	0.01	0.01	–	0.01	0.01	0.01
Silver	mg/L	0.001	0.001	–	0.001	0.001	0.001
Zinc	mg/L	0.008	0.005	–	0.006	0.005	0.005
Total metals							
Aluminium	mg/L	–	–	–	–	0.84	0.78
Arsenic	mg/L	0.001	0.004	–	0.003	0.001	0.001
Barium	mg/L	0.053	0.162	–	0.008	0.081	0.058
Boron	mg/L	0.05	0.05	–	0.05	0.05	0.05
Cadmium	mg/L	0.0001	0.0001	–	0.0001	0.0001	0.0001
Chromium	mg/L	–	–	–	–	0.001	0.001
Cobalt	mg/L	–	–	–	–	0.007	0.002
Copper	mg/L	0.002	0.002	–	0.002	0.002	0.002
Iron	mg/L	2.35	5.28	–	7.61	6.42	4.76
Lead	mg/L	0.001	0.001	–	0.001	0.001	0.001
Manganese	mg/L	0.256	2.137	–	1.635	0.453	0.524
Mercury	mg/L	0.0001	0.0001	–	0.0001	0.0001	0.0001
Nickel	mg/L	–	–	–	–	0.007	0.004
Selenium	mg/L	0.01	0.01	–	0.01	0.01	0.01
Silver	mg/L	0.01	0.001	–	0.001	0.001	0.001
Zinc	mg/L	0.019	0.015	–	0.013	0.008	0.008

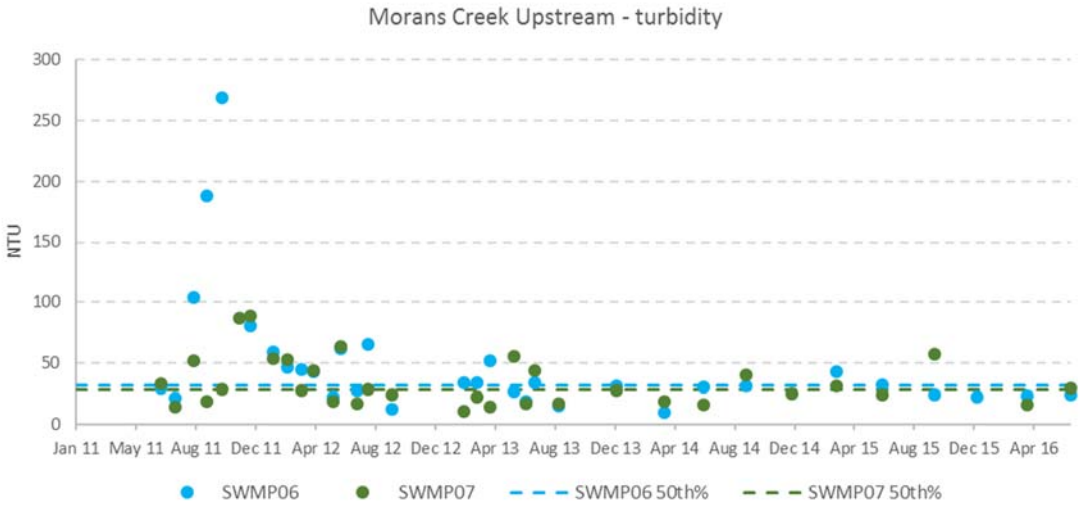
Parameter	Units	SW003	SW004	SW006	SW011	SWMP06	SWMP07
Other parameters							
Cyanide	mg/L	0.004	0.004	–	0.004	0.004	0.004
Fluoride	mg/L	0.01	0.1	–	0.01	0.1	0.1
Oil and grease	mg/L	2	2	2	2	2	2

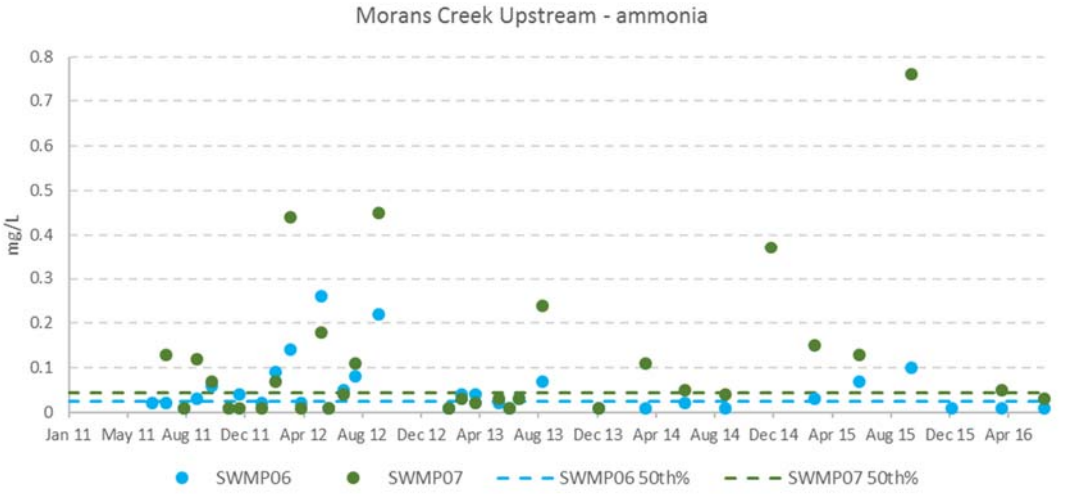
Morans Creek upstream

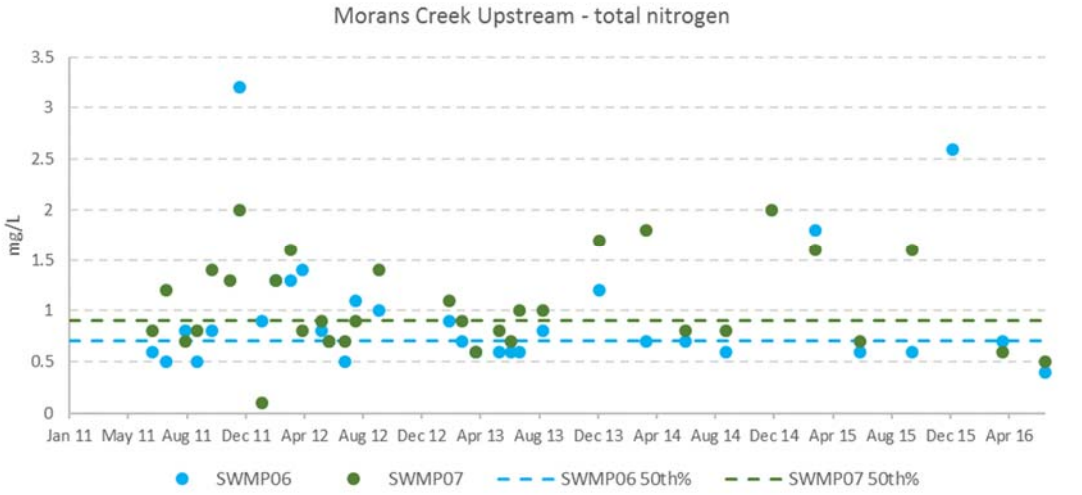


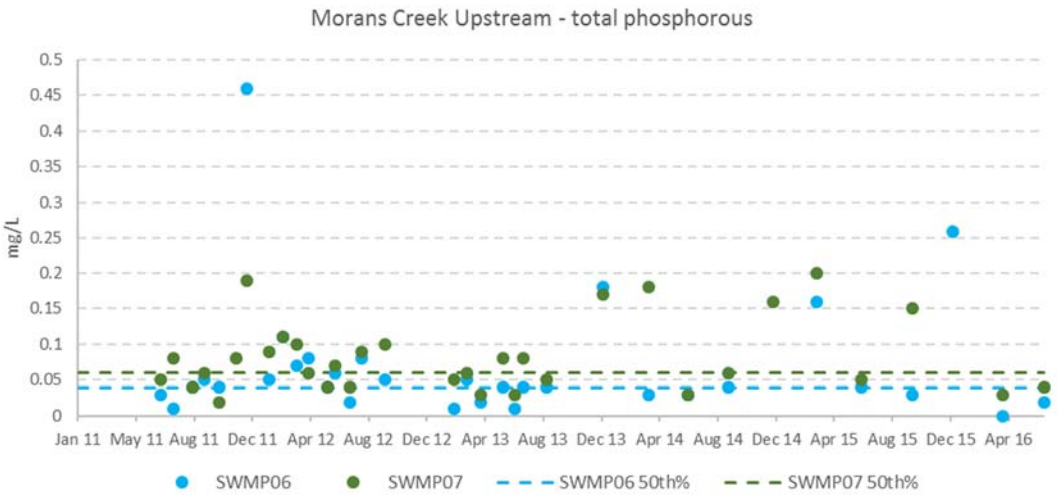


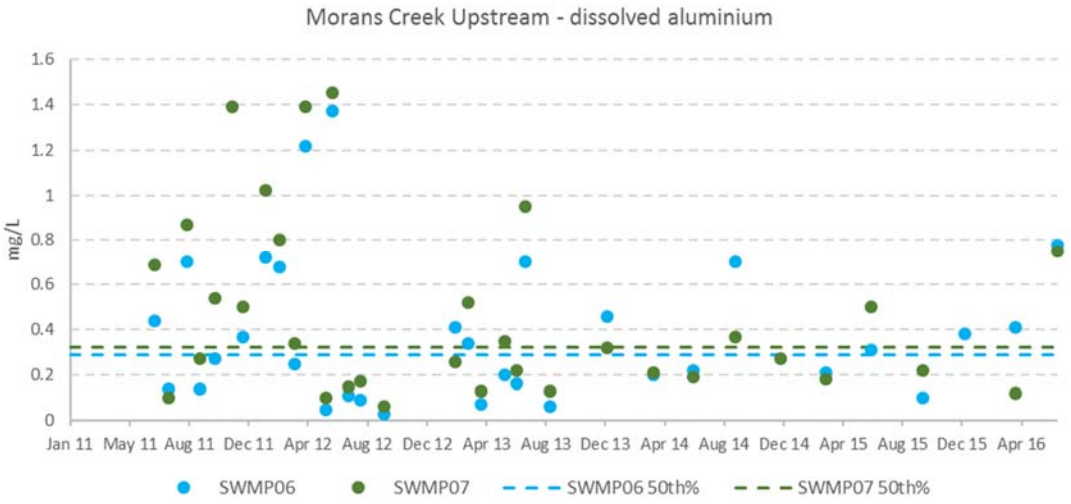


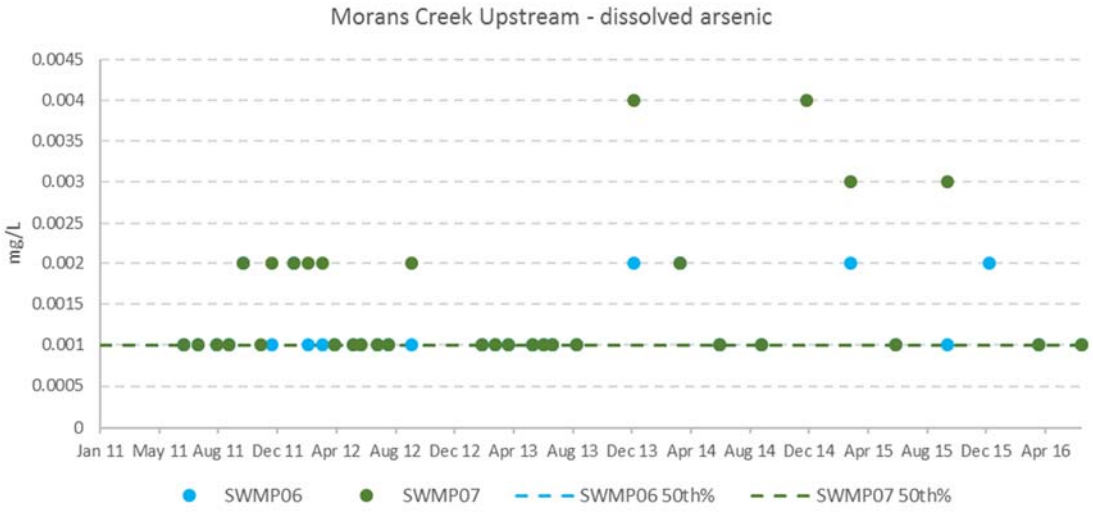

Morans Creek Upstream - turbidity
NTU
300
250
200
150
100
50
0
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SWMP06
SWMP07
SWMP06 50th%
SWMP07 50th%

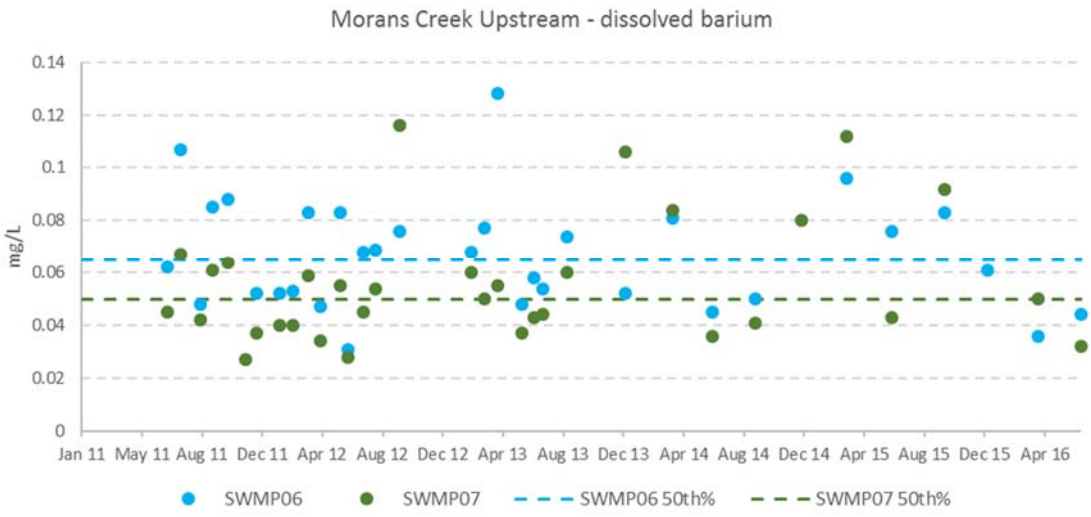

Morans Creek Upstream - ammonia
mg/L
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SWMP06
SWMP07
SWMP06 50th%
SWMP07 50th%

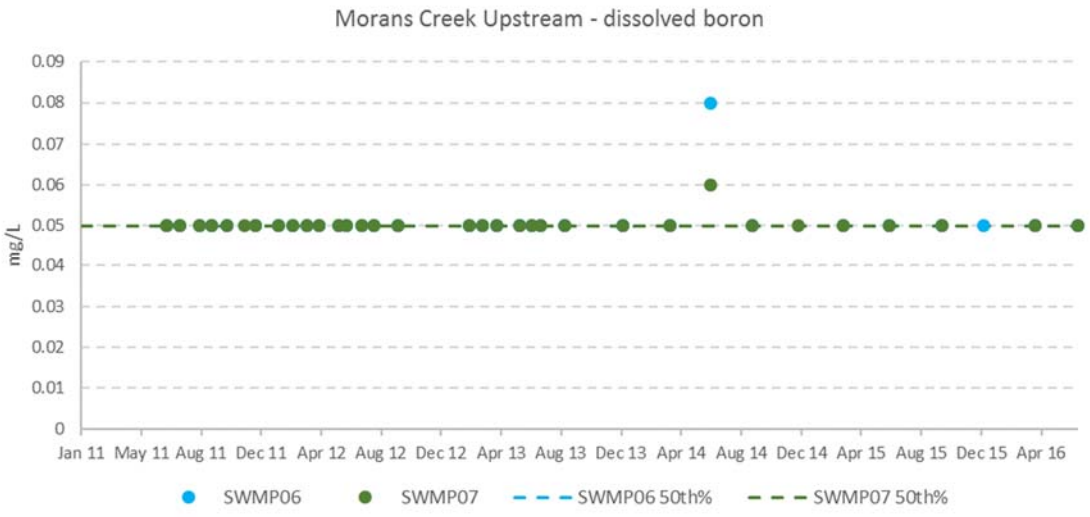

Morans Creek Upstream - total nitrogen
mg/L
3.5
3
2.5
2
1.5
1
0.5
0
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SWMP06
SWMP07
SWMP06 50th%
SWMP07 50th%

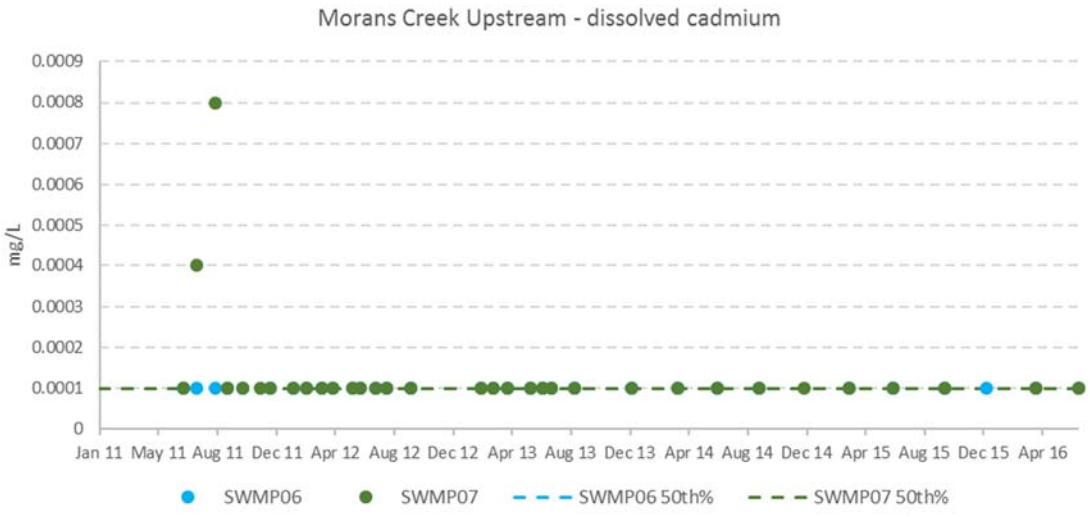

Morans Creek Upstream - total phosphorous
mg/L
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SWMP06
SWMP07
SWMP06 50th%
SWMP07 50th%

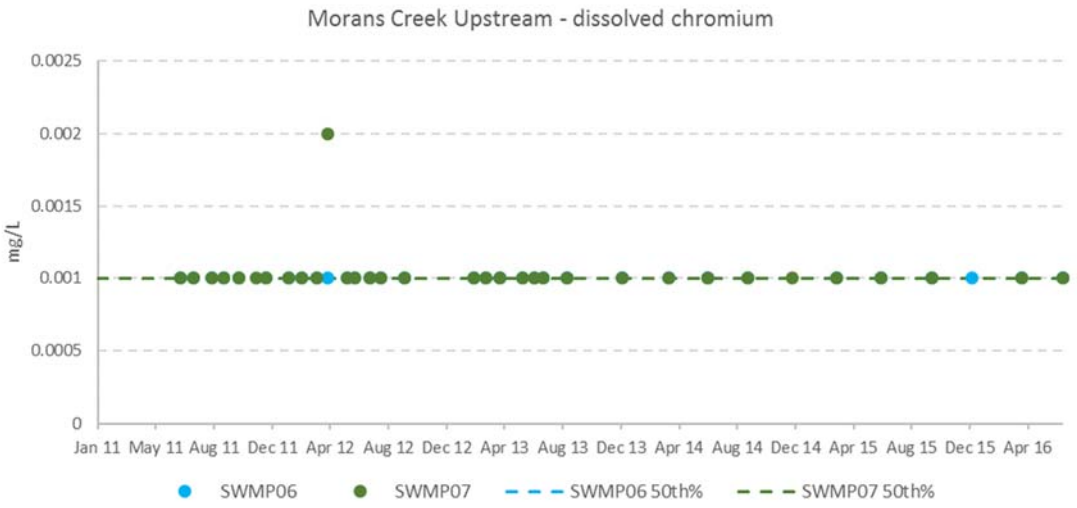

Morans Creek Upstream - dissolved aluminium
mg/L
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SWMP06
SWMP07
SWMP06 50th%
SWMP07 50th%

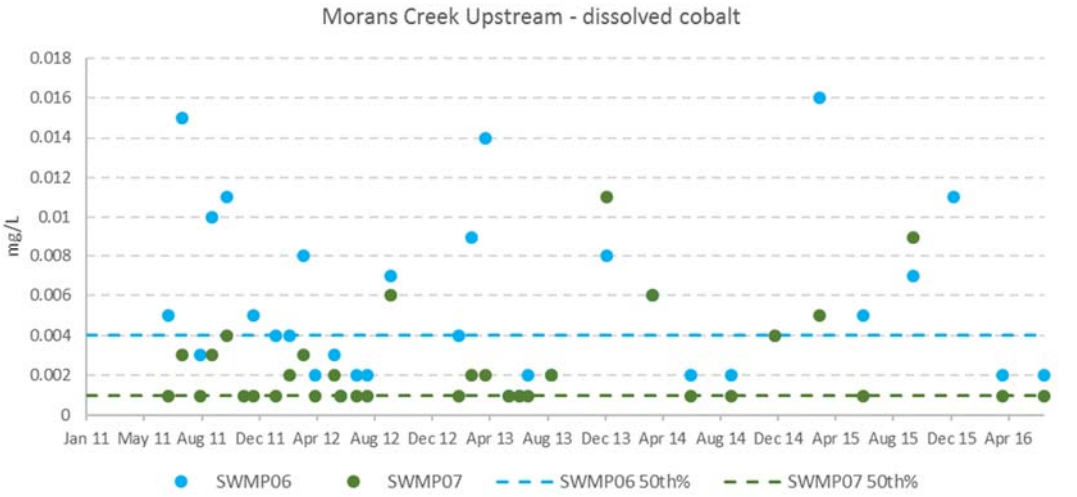

Morans Creek Upstream - dissolved arsenic
mg/L
0.0045
0.004
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SWMP06
SWMP07
SWMP06 50th%
SWMP07 50th%

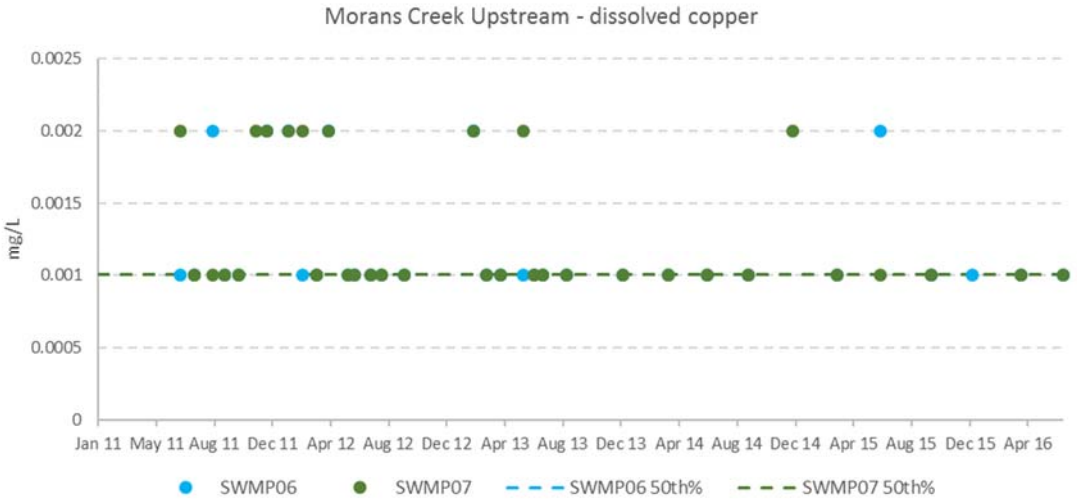

Morans Creek Upstream - dissolved barium
mg/L
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SWMP06
SWMP07
SWMP06 50th%
SWMP07 50th%

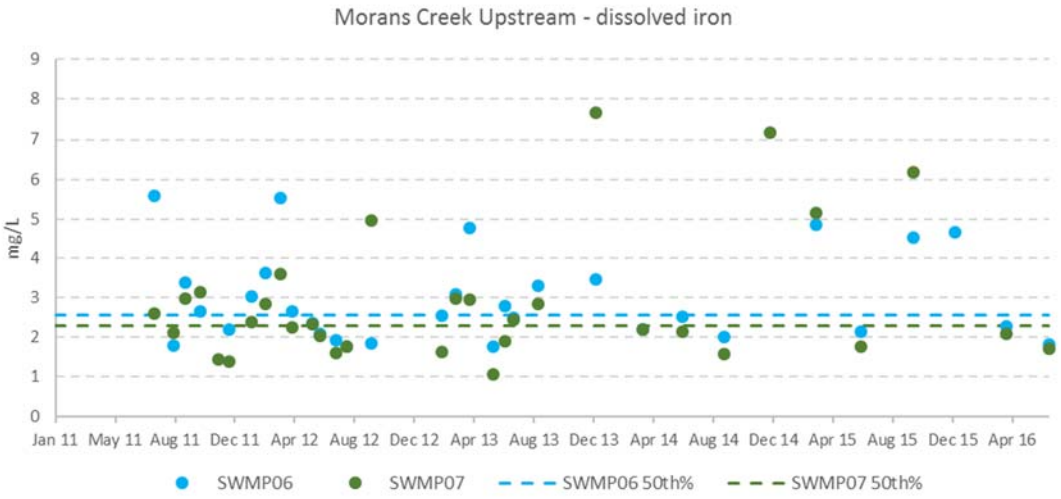

Morans Creek Upstream - dissolved boron
mg/L
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SWMP06
SWMP07
SWMP06 50th%
SWMP07 50th%

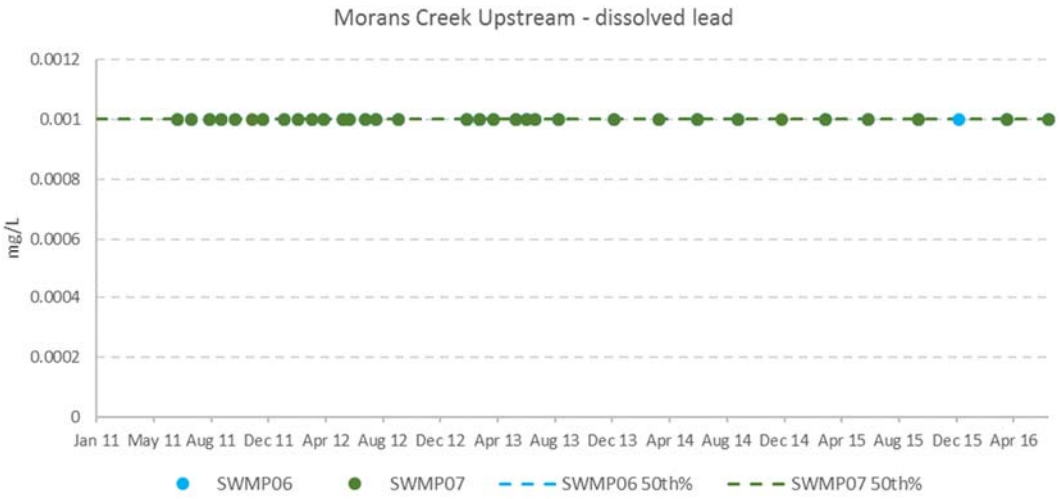

Morans Creek Upstream - dissolved cadmium
mg/L
0.0009
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SWMP06
SWMP07
SWMP06 50th%
SWMP07 50th%

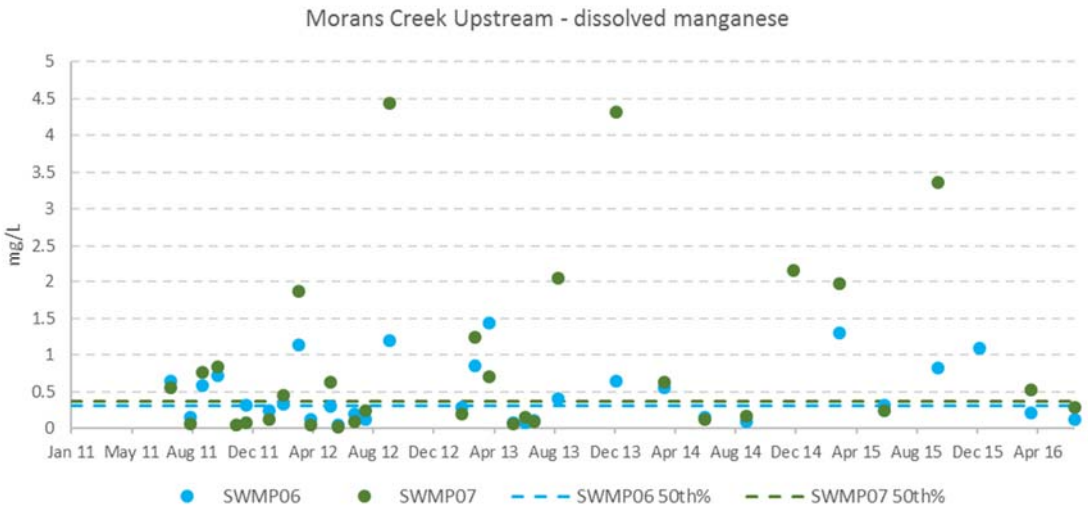

Morans Creek Upstream - dissolved chromium
0.0025
0.002
0.0015
0.001
0.0005
0
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SWMP06
SWMP07
SWMP06 50th%
SWMP07 50th%

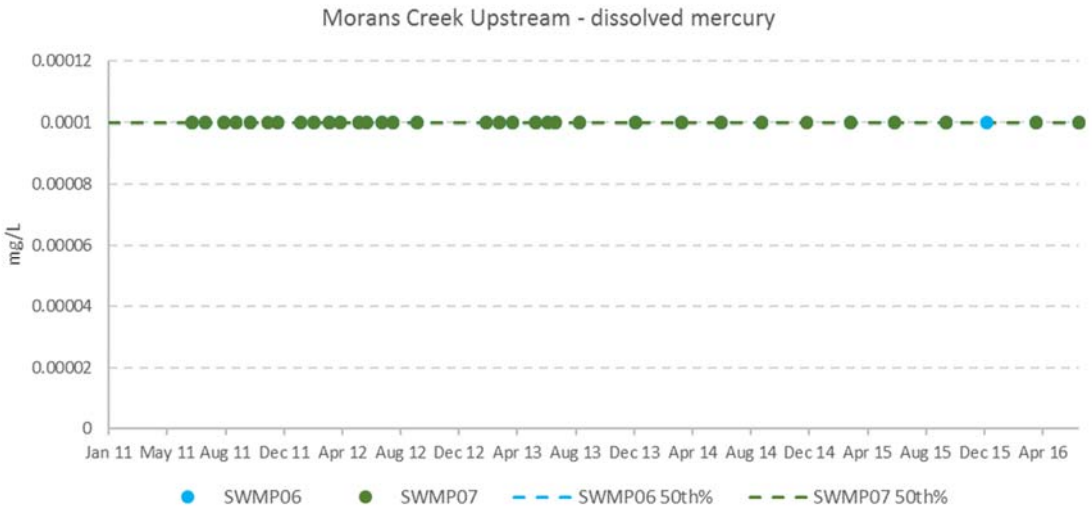

Morans Creek Upstream - dissolved cobalt
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SWMP06
SWMP07
SWMP06 50th%
SWMP07 50th%

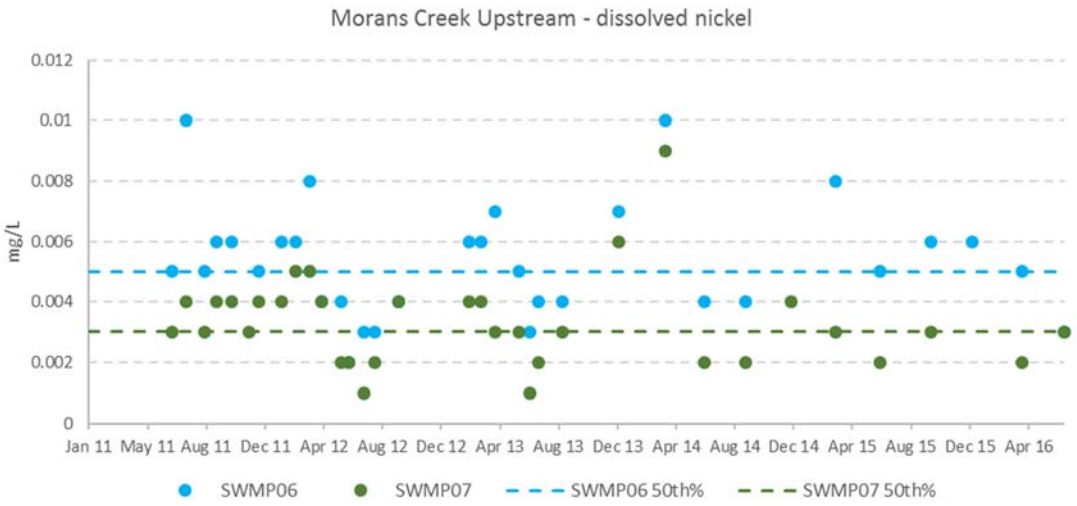

Morans Creek Upstream - dissolved copper
0.0025
0.002
0.0015
0.001
0.0005
0
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SWMP06
SWMP07
SWMP06 50th%
SWMP07 50th%

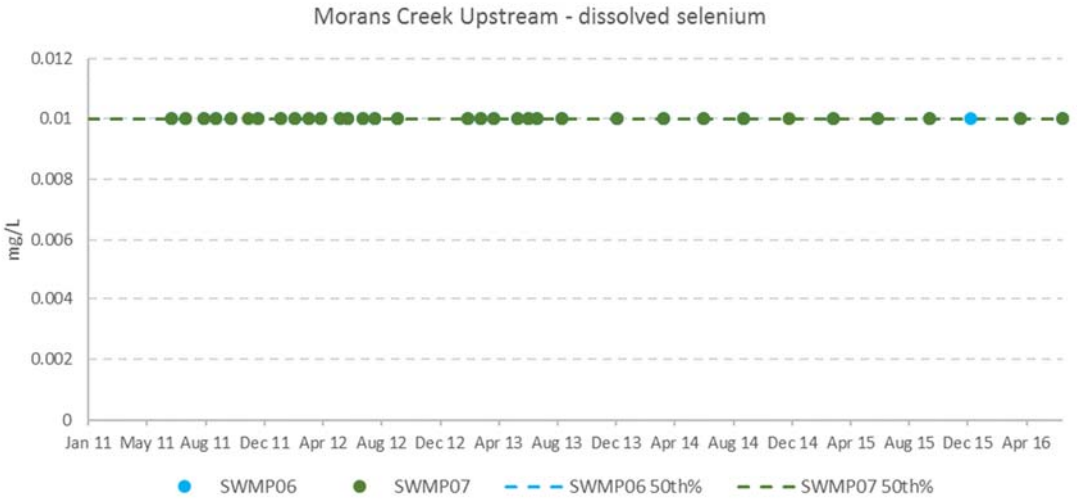

Morans Creek Upstream - dissolved iron
mg/L
0
1
2
3
4
5
6
7
8
9
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SWMP06
SWMP07
SWMP06 50th%
SWMP07 50th%

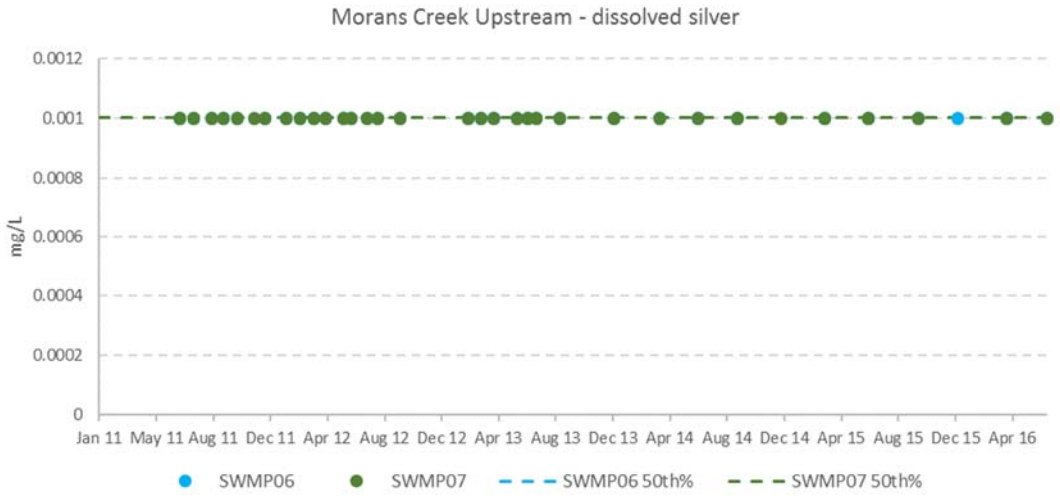

Morans Creek Upstream - dissolved lead
mg/L
0
0.0002
0.0004
0.0006
0.0008
0.001
0.0012
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SWMP06
SWMP07
SWMP06 50th%
SWMP07 50th%

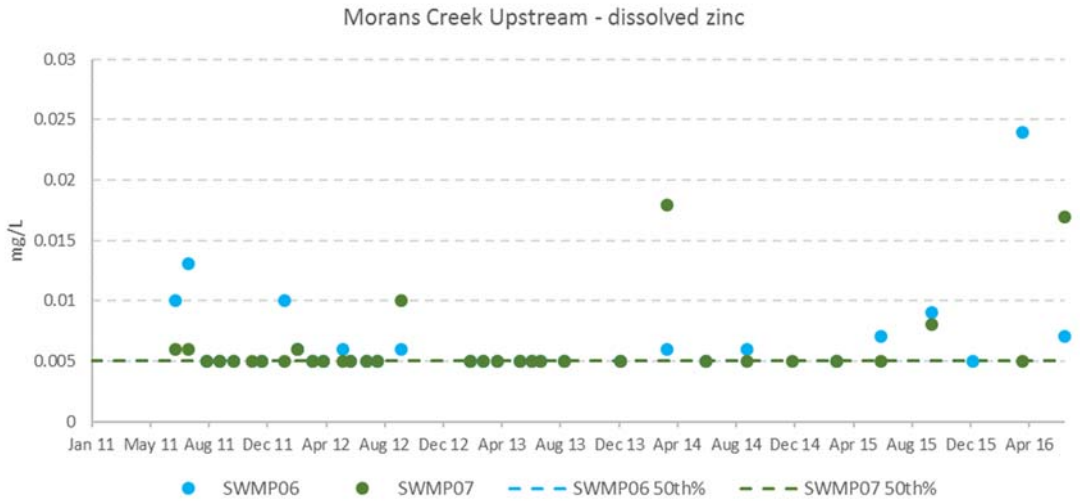

Morans Creek Upstream - dissolved manganese
mg/L
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SWMP06
SWMP07
SWMP06 50th%
SWMP07 50th%


Morans Creek Upstream - dissolved mercury
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SWMP06
SWMP07
SWMP06 50th%
SWMP07 50th%

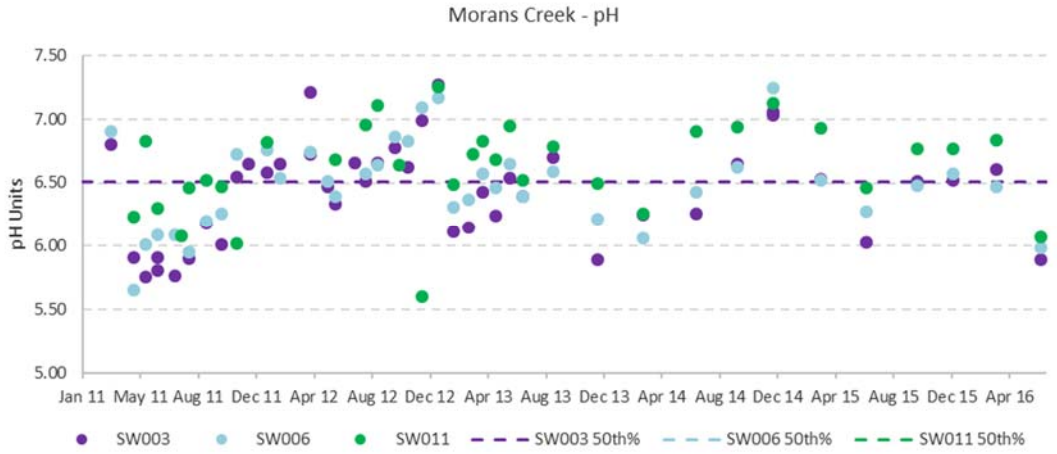

Morans Creek Upstream - dissolved nickel
0.012
0.01
0.008
0.006
0.004
0.002
0
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SWMP06
SWMP07
SWMP06 50th%
SWMP07 50th%

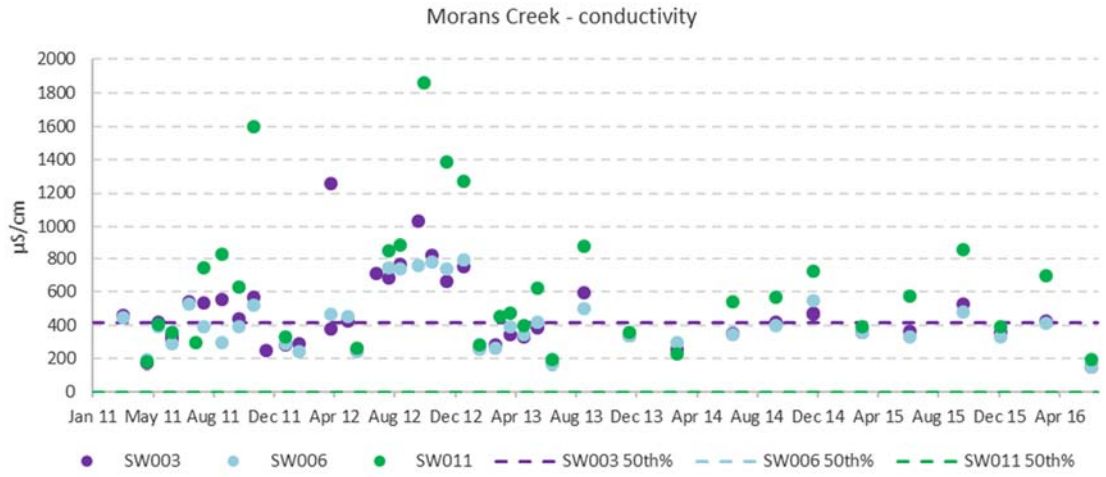

Morans Creek Upstream - dissolved selenium
0.012
0.01
0.008
0.006
0.004
0.002
0
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SWMP06
SWMP07
SWMP06 50th%
SWMP07 50th%

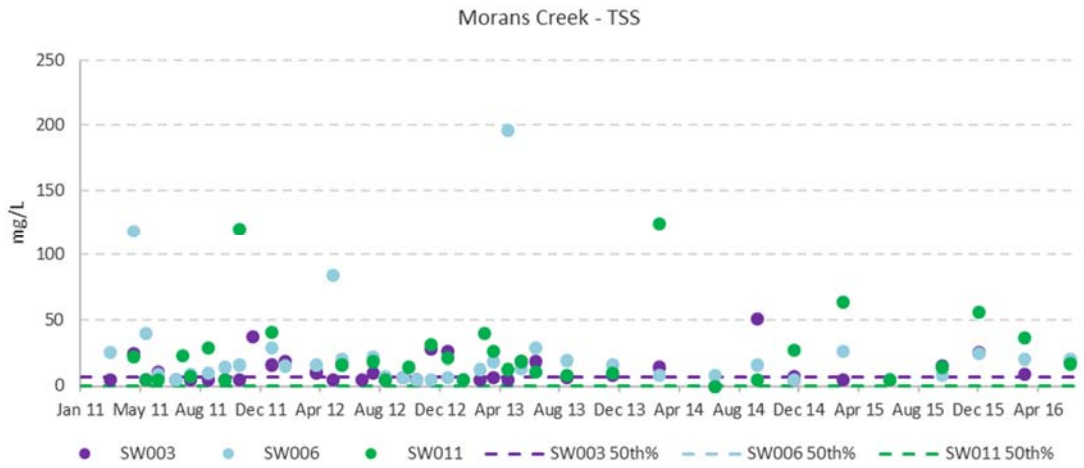

Morans Creek Upstream - dissolved silver
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SWMP06
SWMP07
SWMP06 50th%
SWMP07 50th%

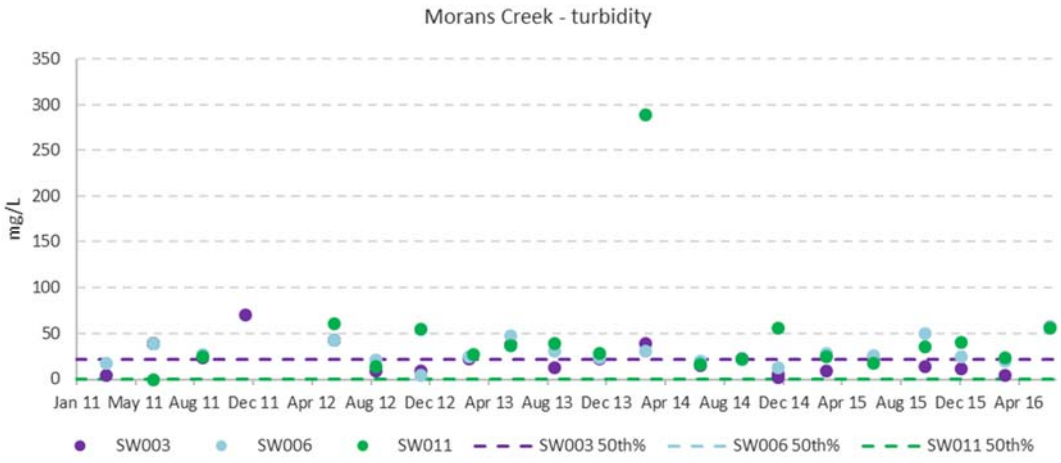

Morans Creek Upstream - dissolved zinc
0.03
0.025
0.02
0.015
0.01
0.005
0
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SWMP06
SWMP07
SWMP06 50th%
SWMP07 50th%

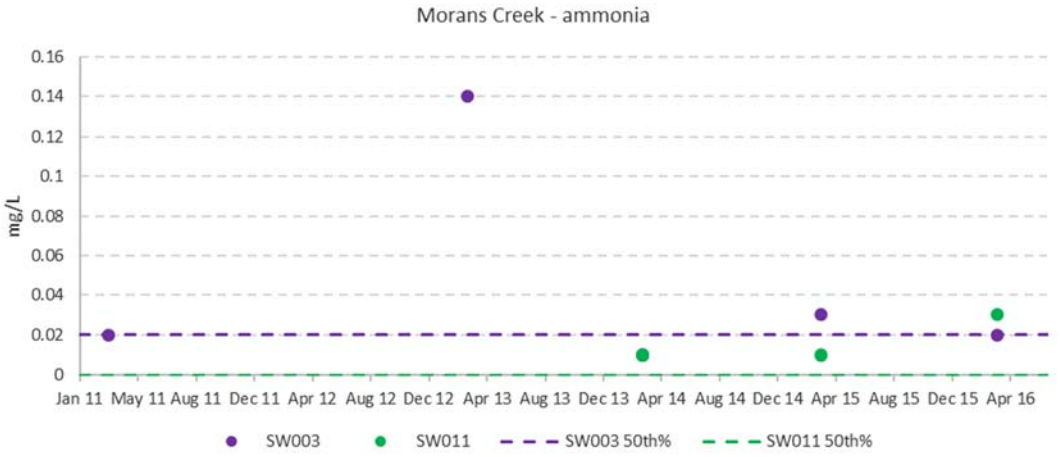
Morans Creek downstream

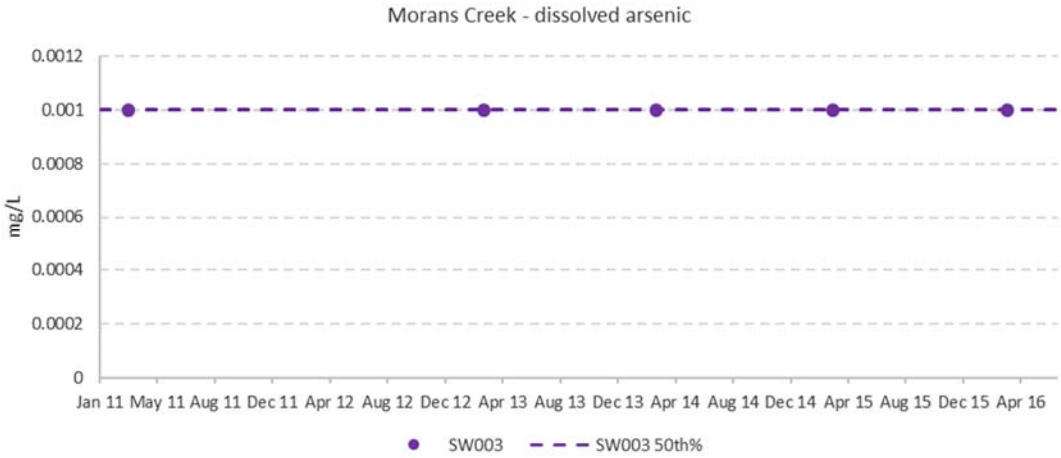


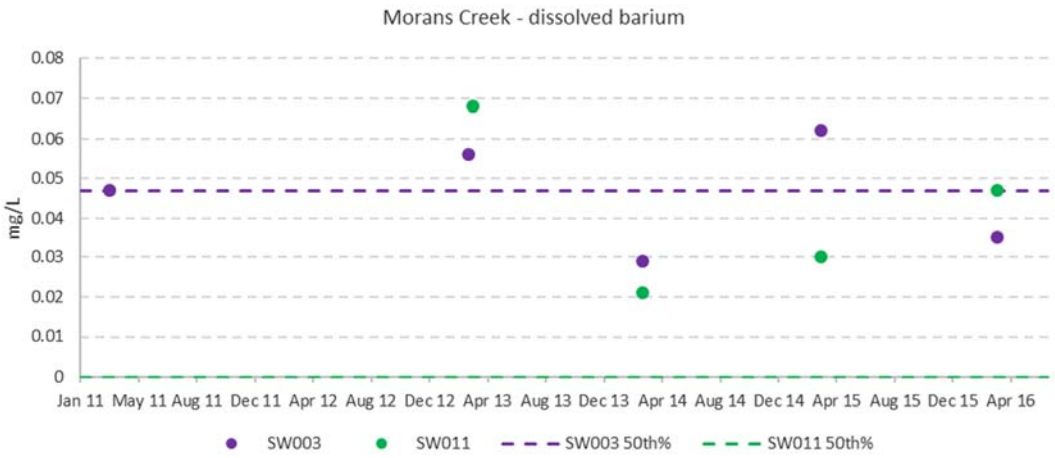


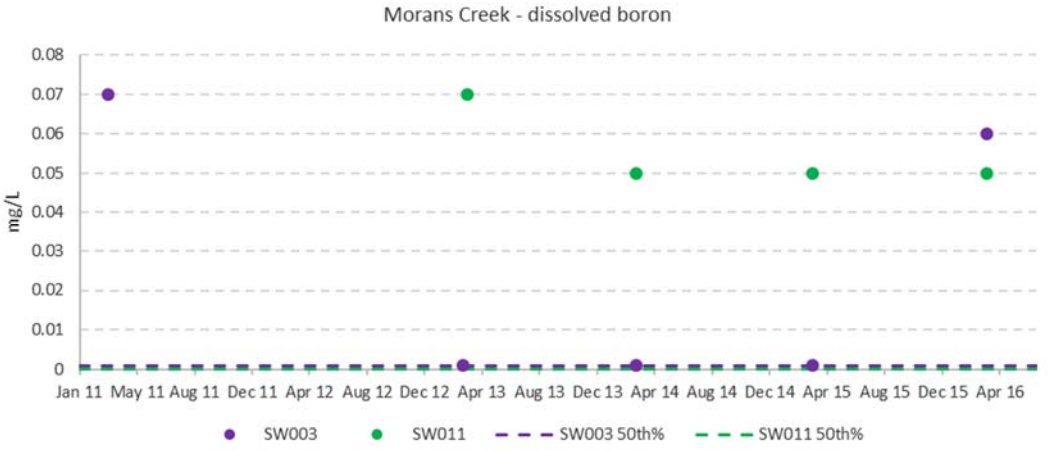


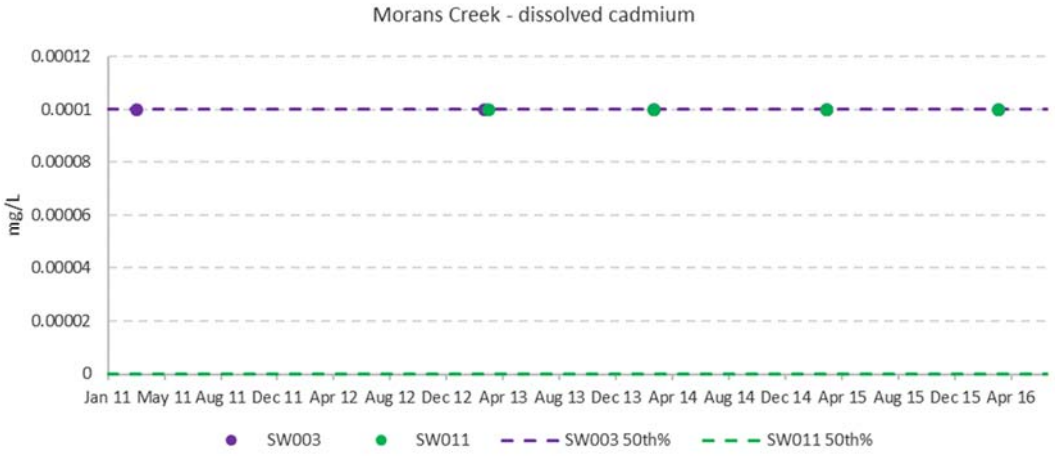

Morans Creek - turbidity
mg/L
350
300
250
200
150
100
50
0
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW003
SW006
SW011
SW003 50th%
SW006 50th%
SW011 50th%

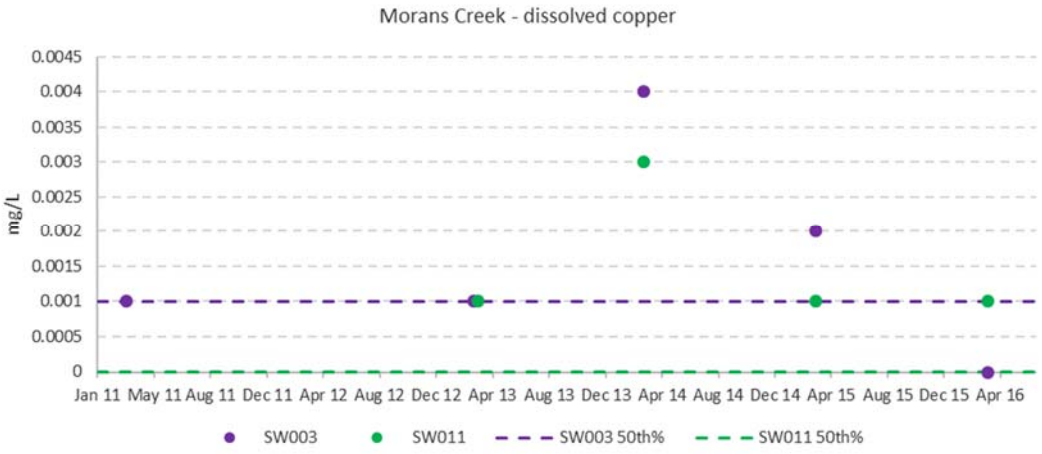

Morans Creek - ammonia
mg/L
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW003
SW011
SW003 50th%
SW011 50th%

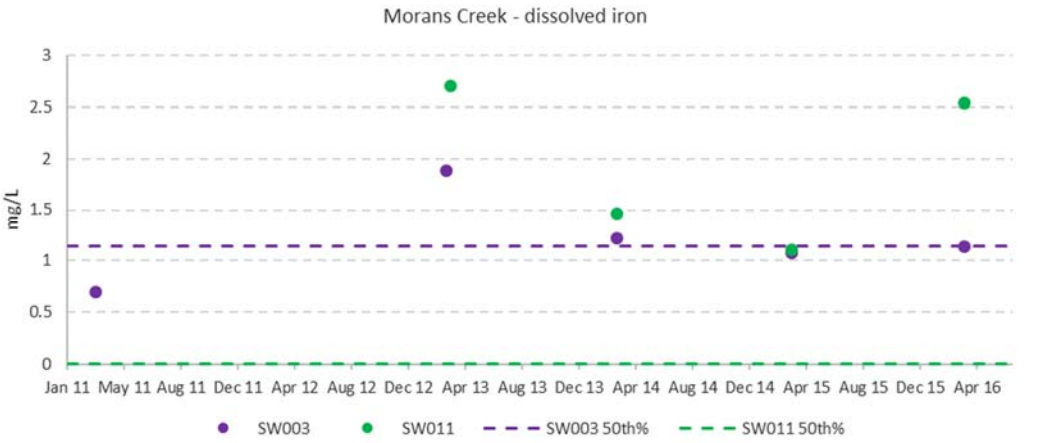

Morans Creek - dissolved arsenic
mg/L
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW003
SW003 50th%

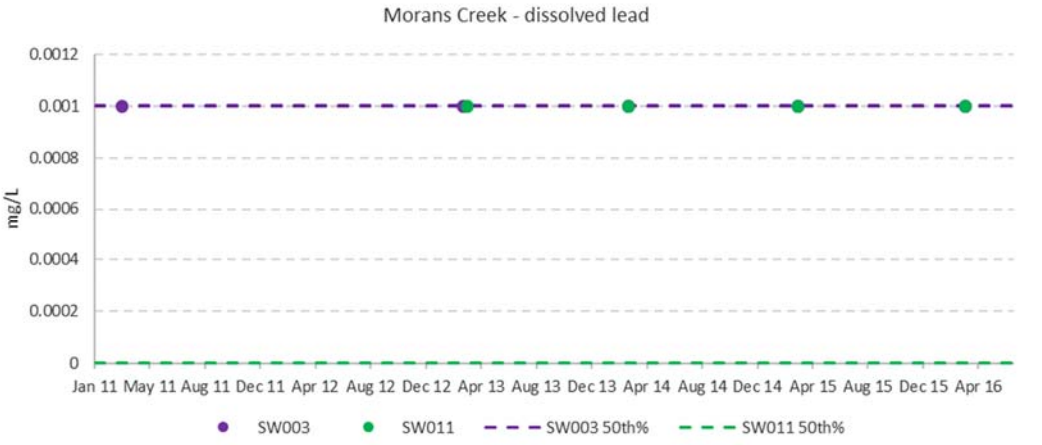

Morans Creek - dissolved barium
mg/L
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW003
SW011
SW003 50th%
SW011 50th%

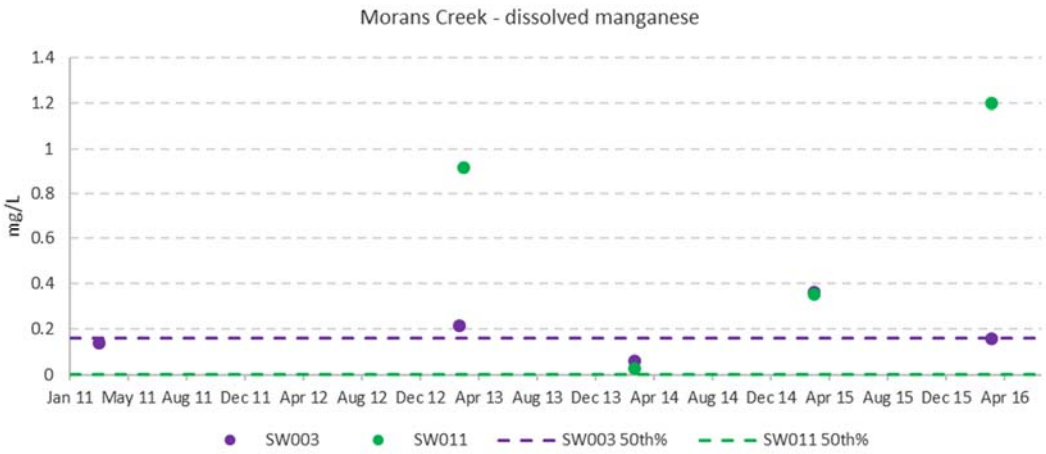

Morans Creek - dissolved boron
mg/L
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW003
SW011
SW003 50th%
SW011 50th%

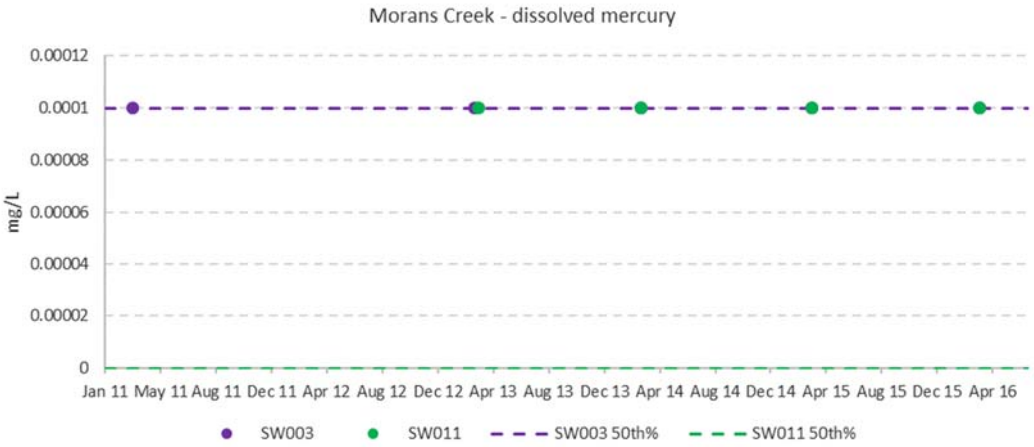

Morans Creek - dissolved cadmium
mg/L
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW003
SW011
SW003 50th%
SW011 50th%

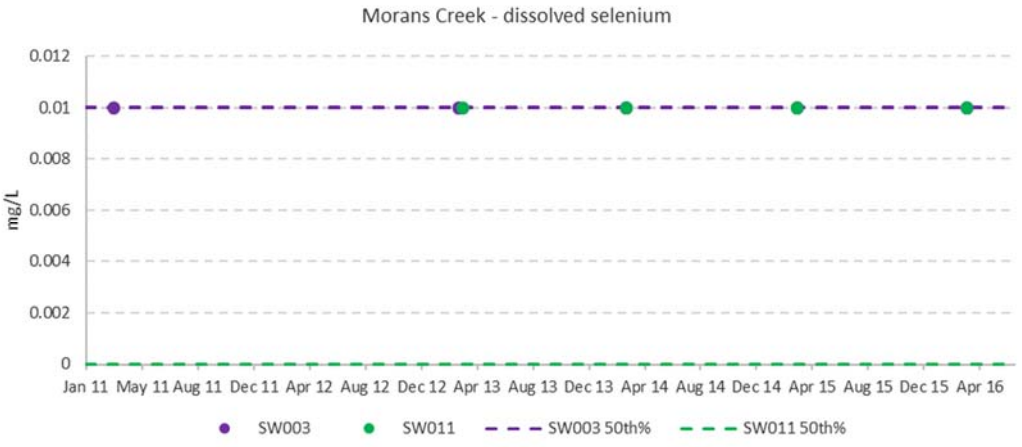

Morans Creek - dissolved copper
mg/L
0.0045
0.004
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW003
SW011
SW003 50th%
SW011 50th%

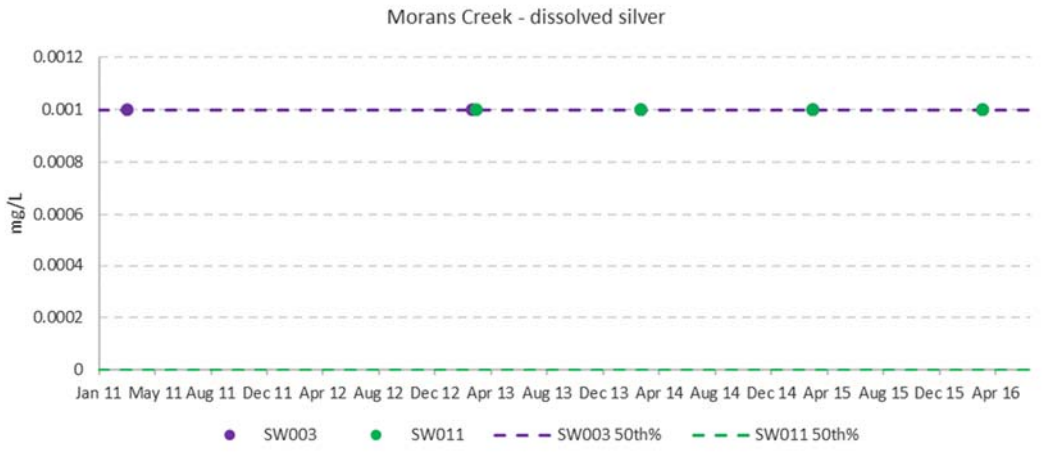

Morans Creek - dissolved iron
mg/L
3
2.5
2
1.5
1
0.5
0
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW003
SW011
SW003 50th%
SW011 50th%

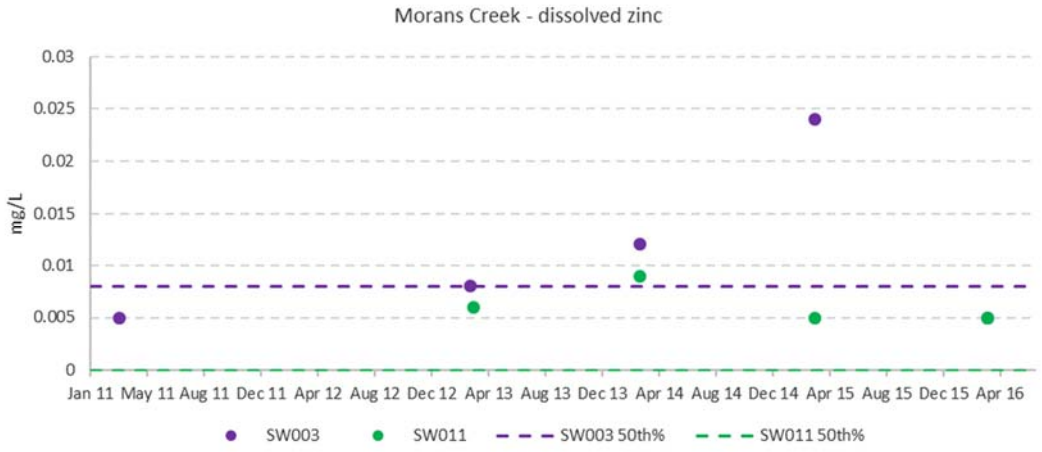

Morans Creek - dissolved lead
mg/L
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW003
SW011
SW003 50th%
SW011 50th%


Morans Creek - dissolved manganese
mg/L
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW003
SW011
SW003 50th%
SW011 50th%

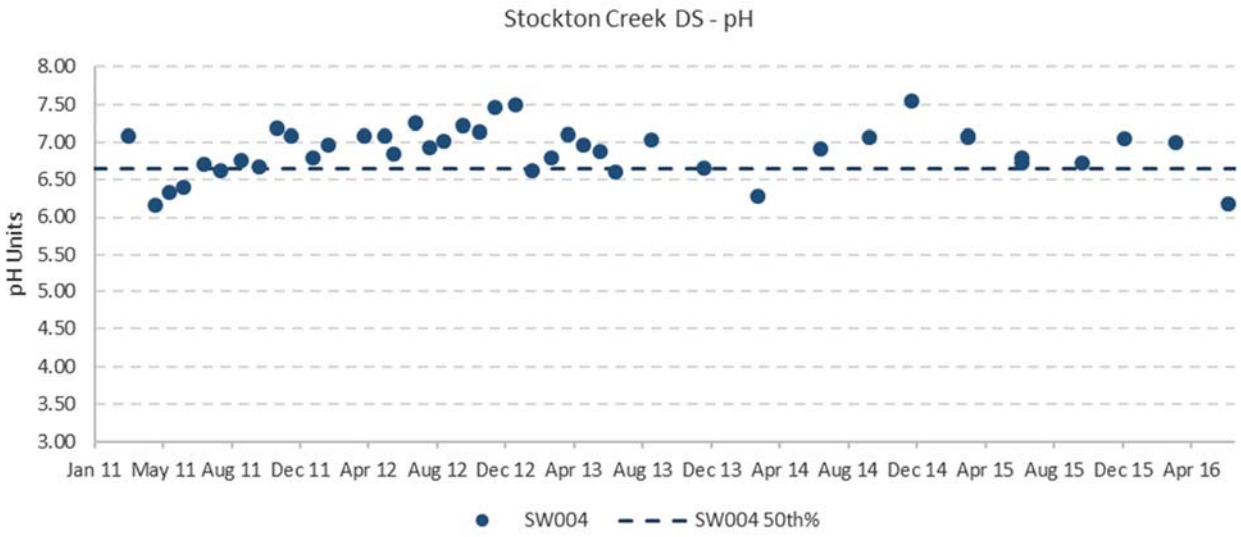

Morans Creek - dissolved mercury
mg/L
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW003
SW011
SW003 50th%
SW011 50th%

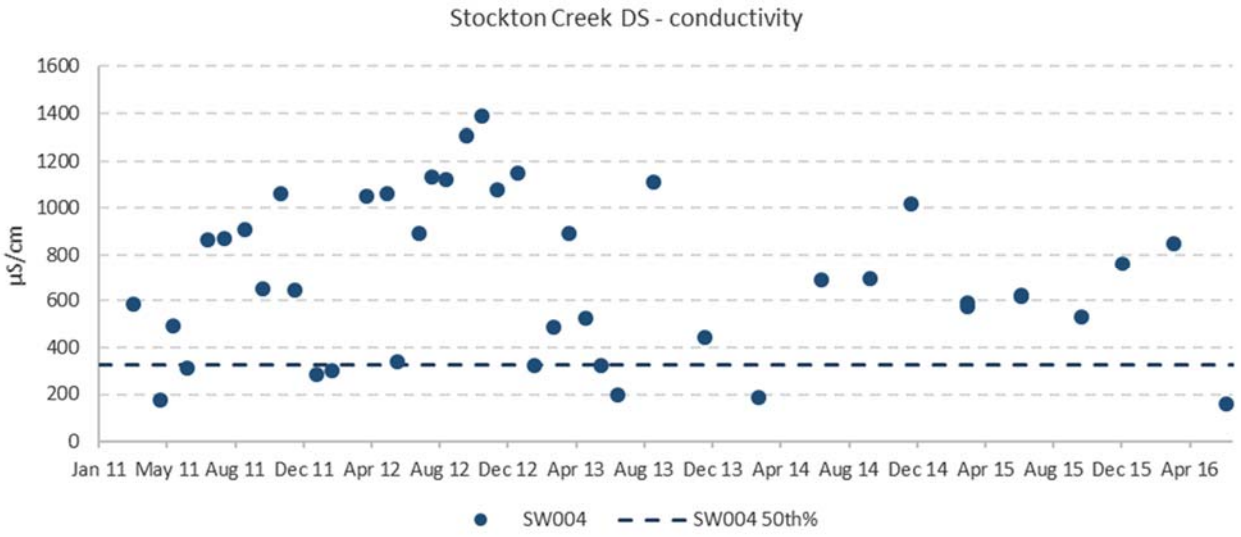

Morans Creek - dissolved selenium
mg/L
0.012
0.01
0.008
0.006
0.004
0.002
0
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW003
SW011
SW003 50th%
SW011 50th%

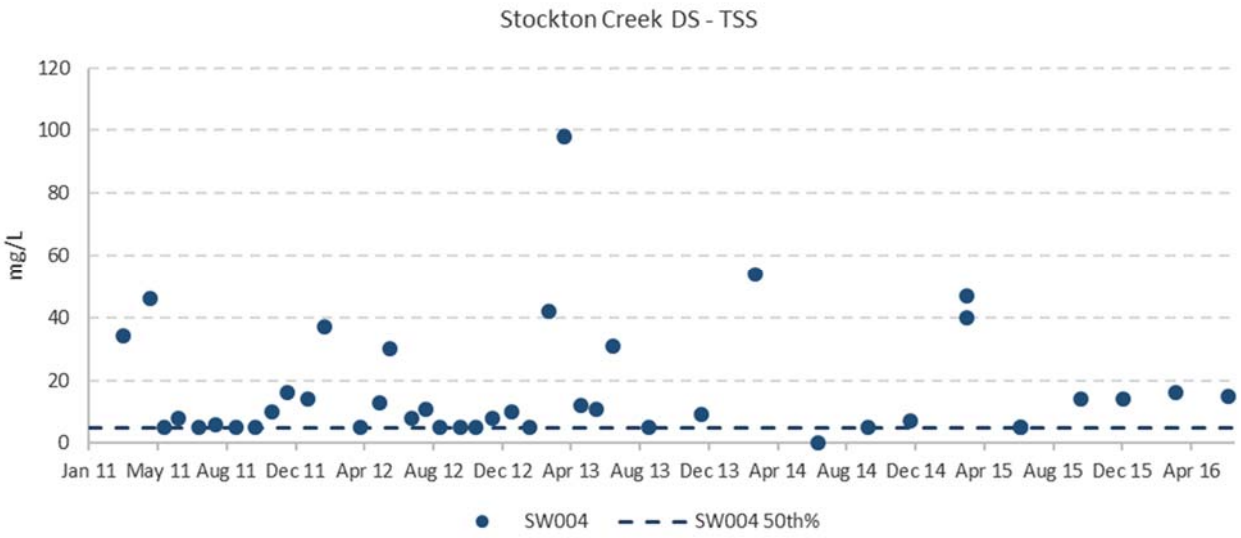

Morans Creek - dissolved silver
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW003
SW011
SW003 50th%
SW011 50th%

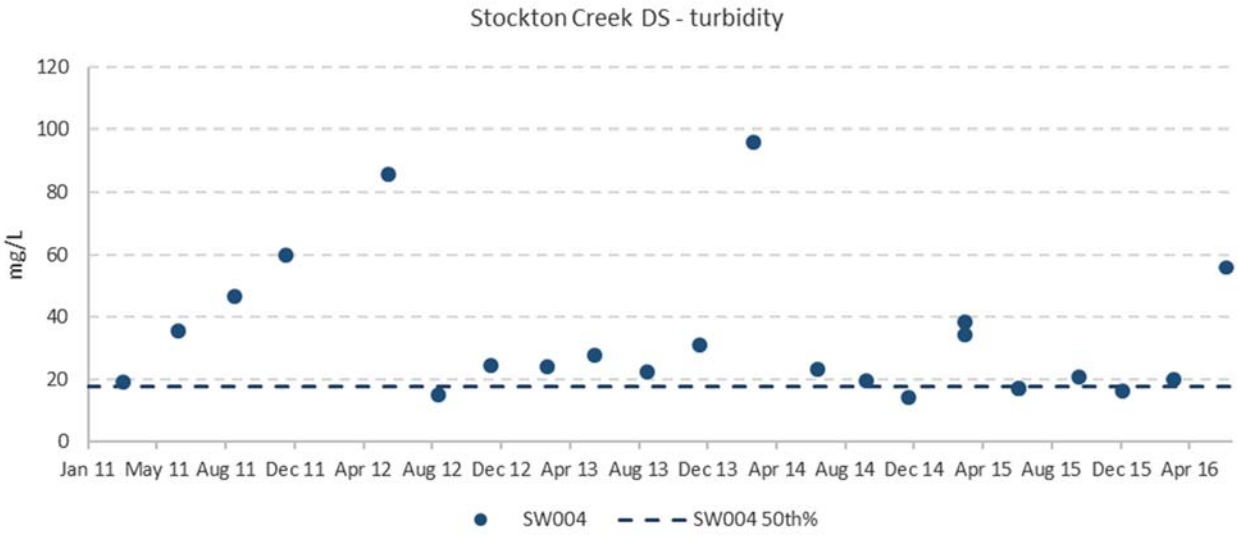

Morans Creek - dissolved zinc
0.03
0.025
0.02
0.015
0.01
0.005
0
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW003
SW011
SW003 50th%
SW011 50th%

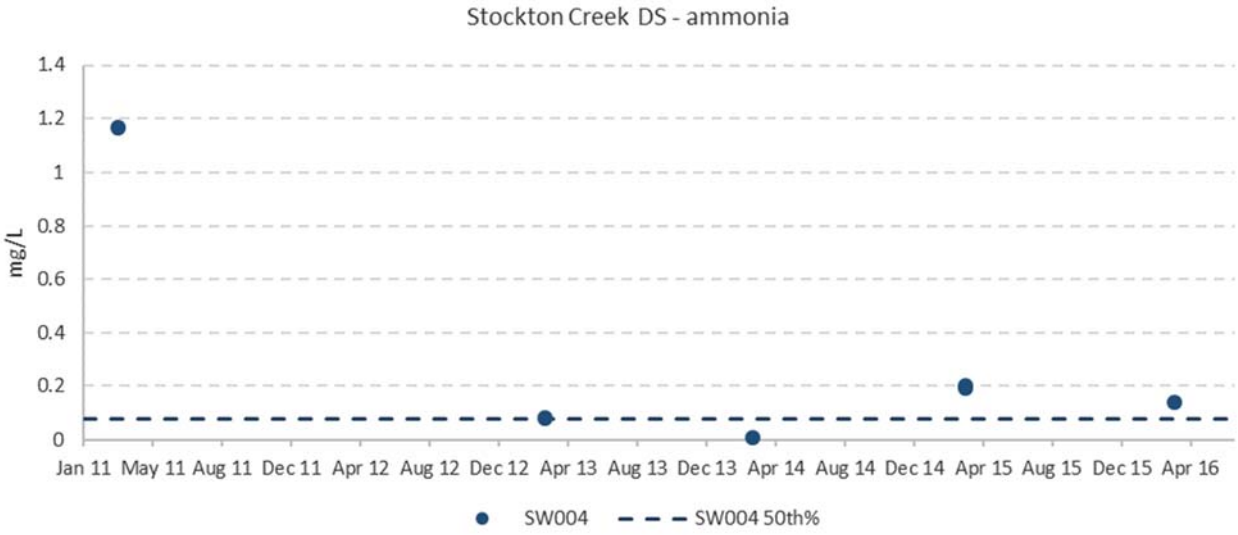
Stockton Creek downstream

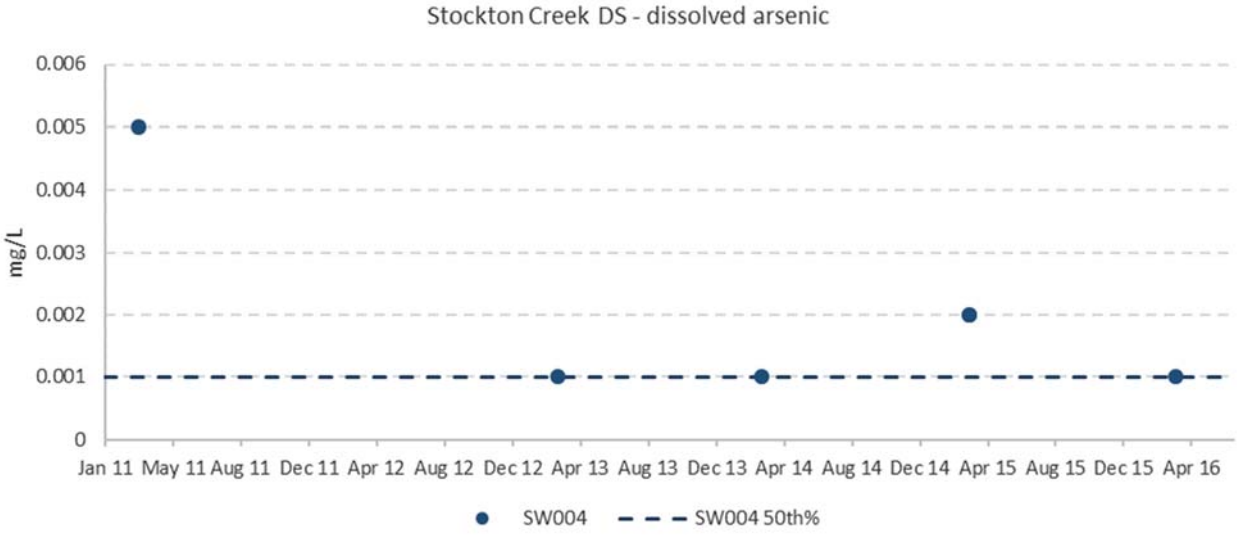


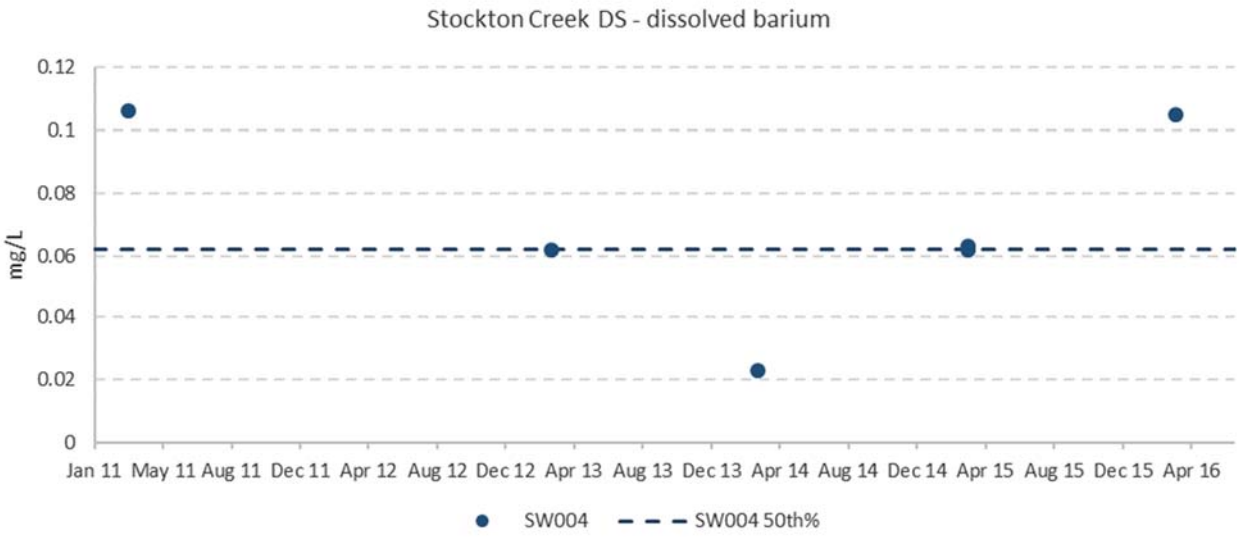


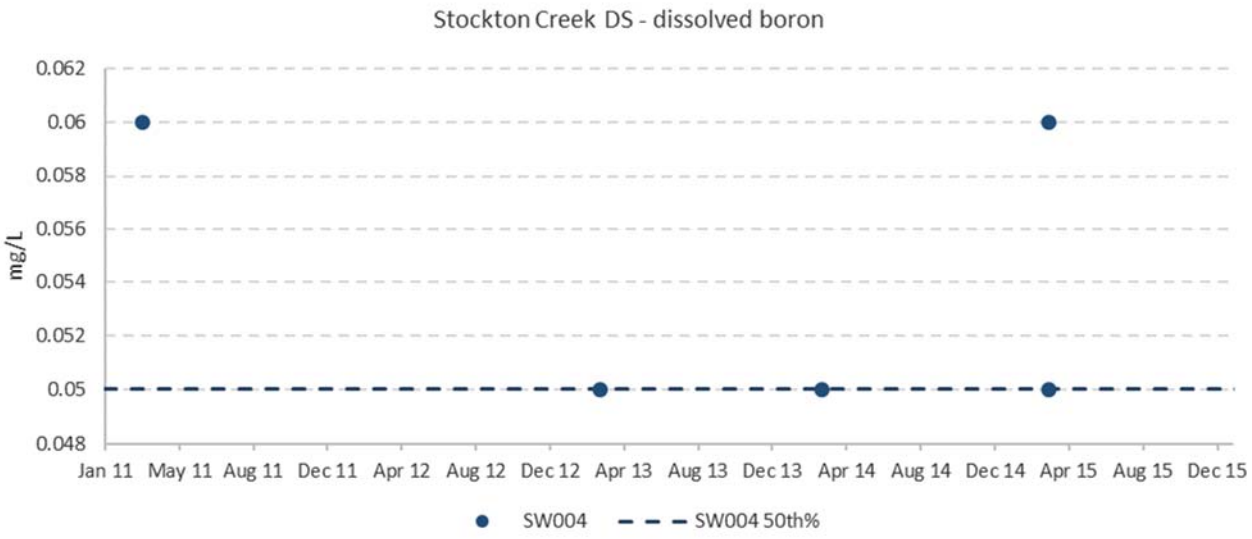


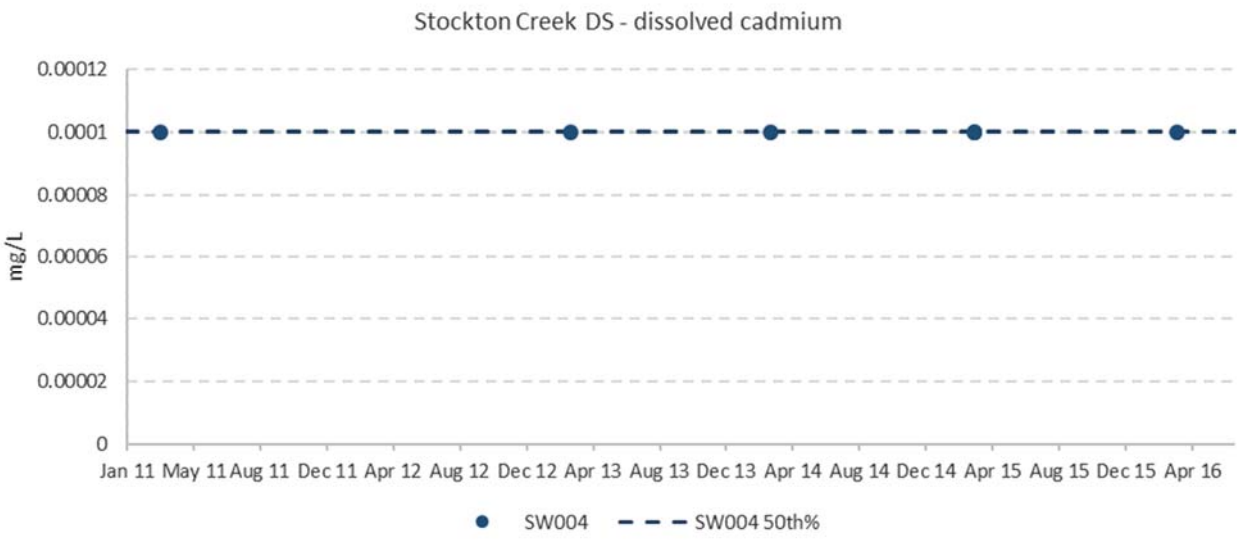

Stockton Creek DS - turbidity
120
100
80
60
40
20
0
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW004
SW004 50th%

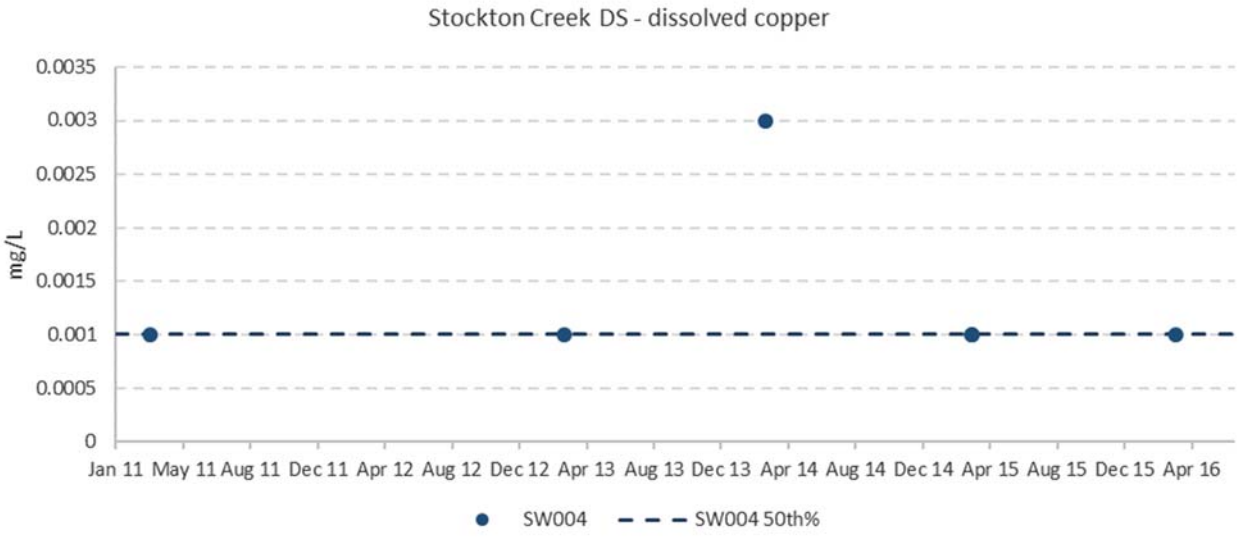

Stockton Creek DS - ammonia
1.4
1.2
1
0.8
0.6
0.4
0.2
0
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW004
SW004 50th%

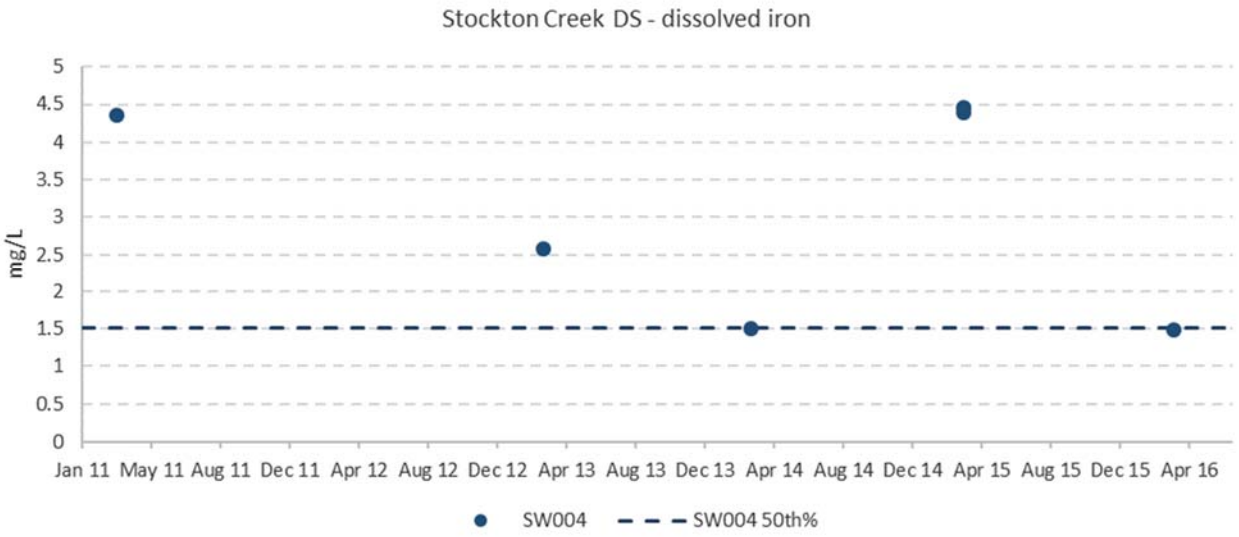

Stockton Creek DS - dissolved arsenic
0.006
0.005
0.004
0.003
0.002
0.001
0
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW004
SW004 50th%

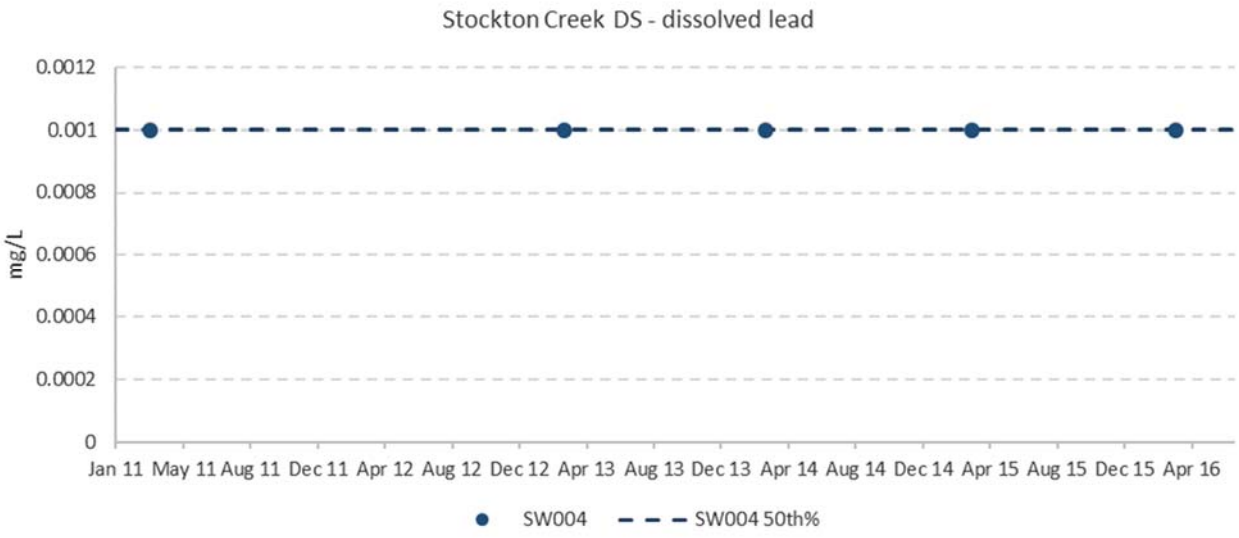

Stockton Creek DS - dissolved barium
0.12
0.1
0.08
0.06
0.04
0.02
0
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW004
SW004 50th%

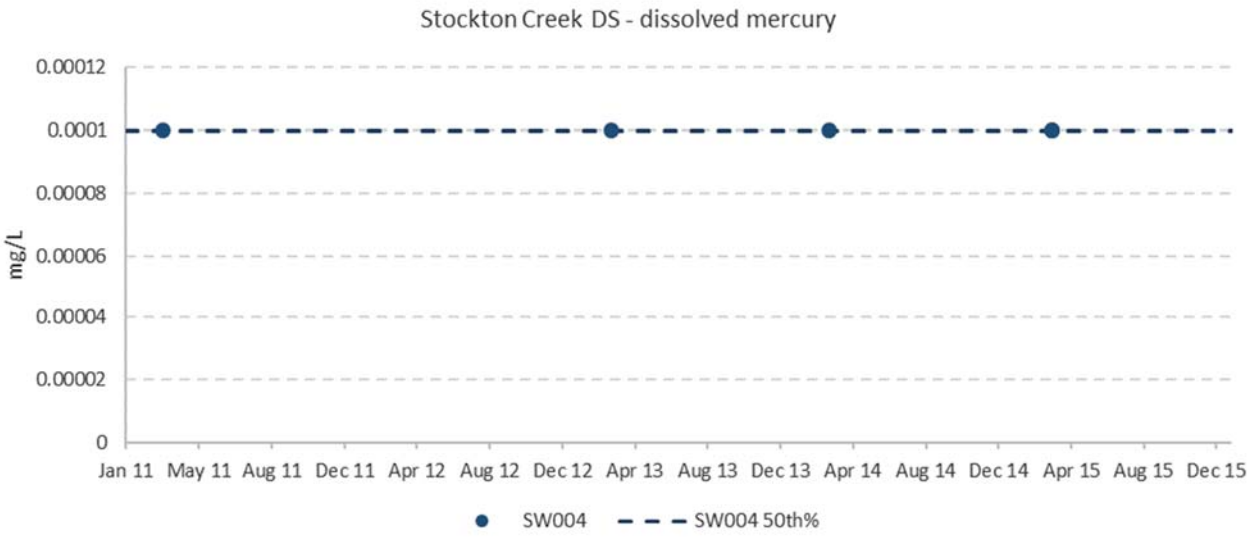

Stockton Creek DS - dissolved boron
0.062
0.06
0.058
0.056
0.054
0.052
0.05
0.048
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15
SW004
SW004 50th%

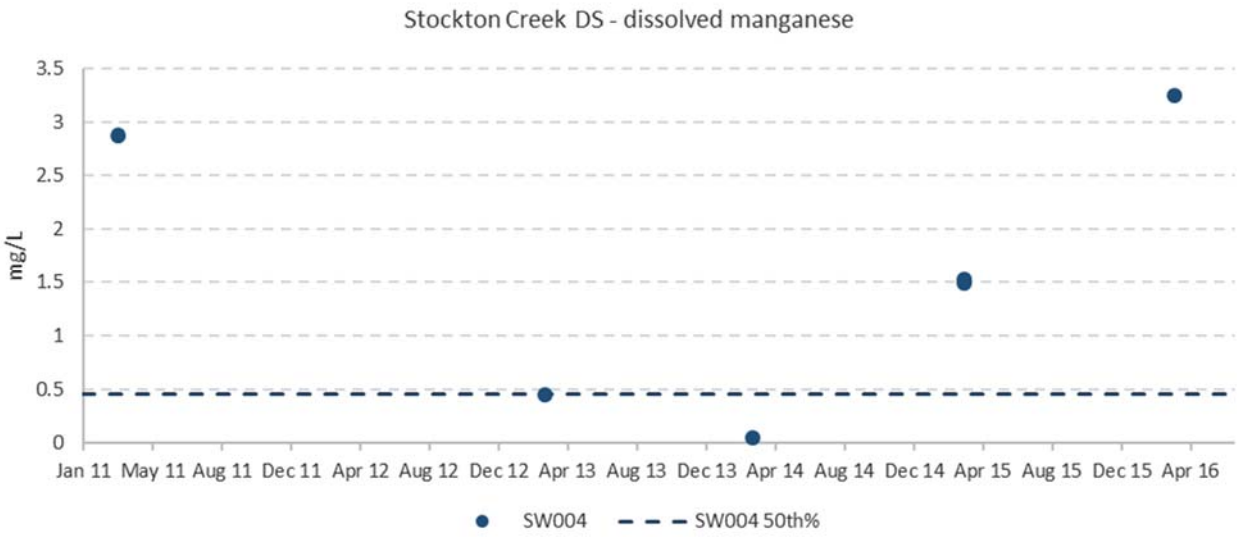

Stockton Creek DS - dissolved cadmium
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW004
SW004 50th%

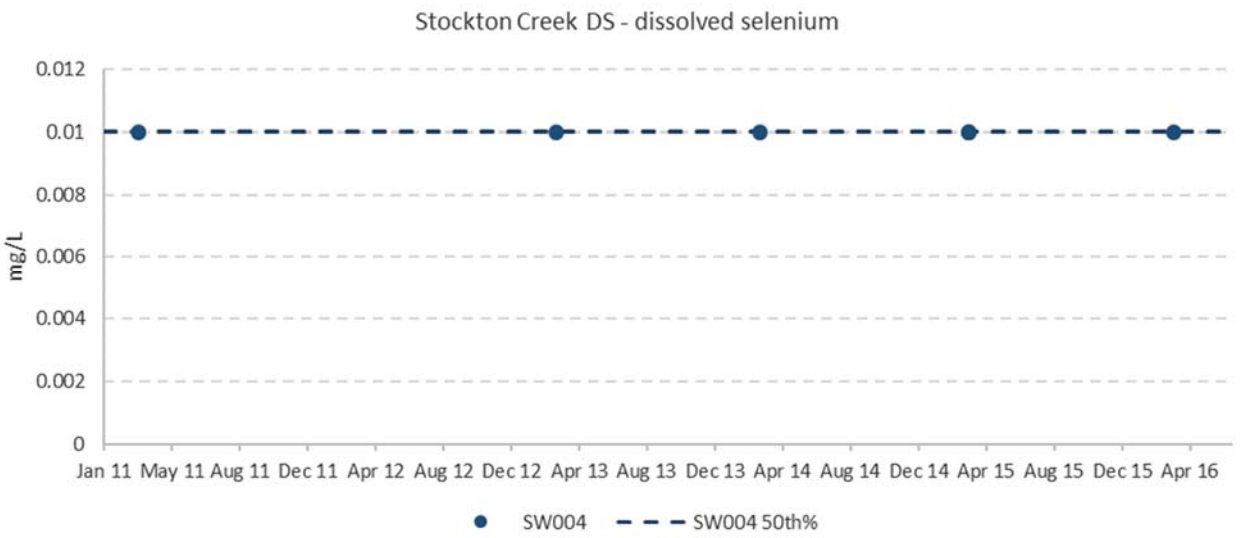

Stockton Creek DS - dissolved copper
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW004
SW004 50th%

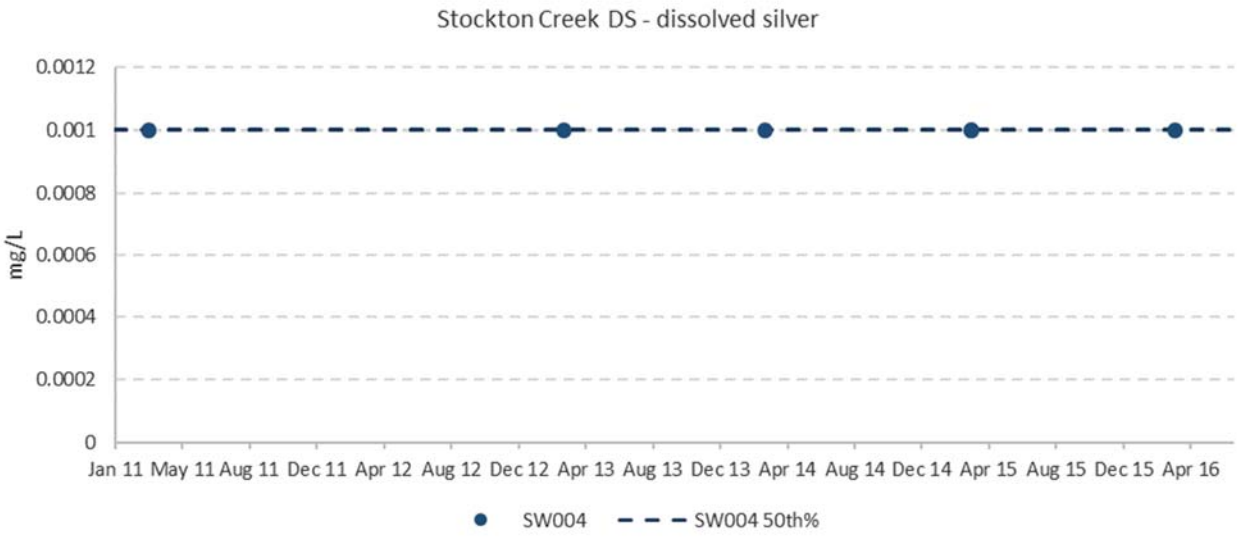

Stockton Creek DS - dissolved iron
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW004
SW004 50th%

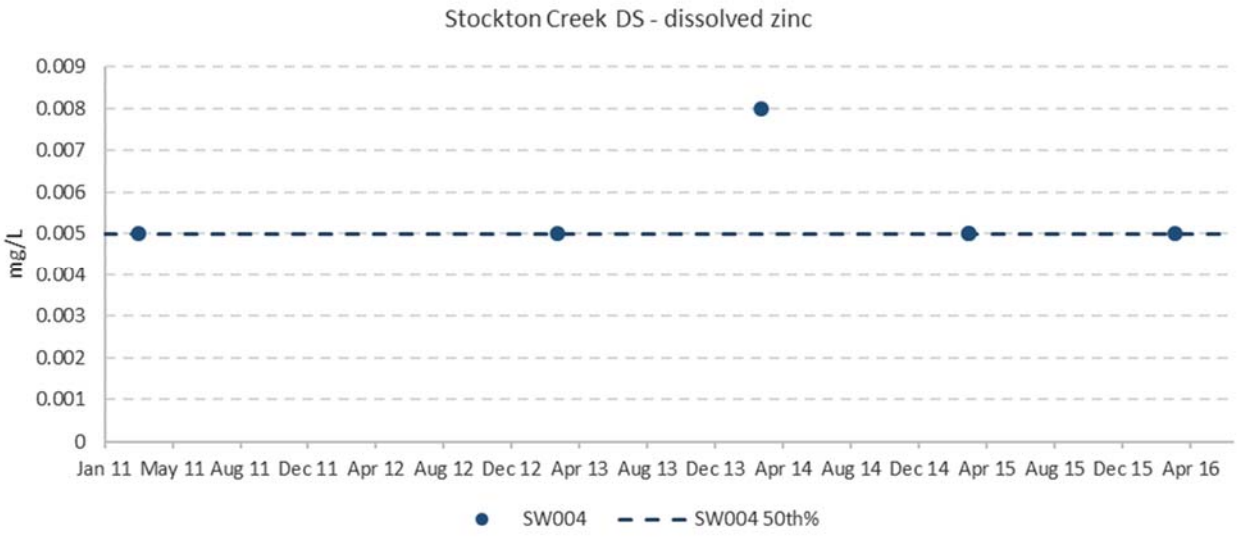

Stockton Creek DS - dissolved lead
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW004
SW004 50th%


Stockton Creek DS - dissolved mercury
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15
SW004
SW004 50th%


Stockton Creek DS - dissolved manganese
3.5
3
2.5
2
1.5
1
0.5
0
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW004
SW004 50th%


Stockton Creek DS - dissolved selenium
0.012
0.01
0.008
0.006
0.004
0.002
0
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW004
SW004 50th%


Stockton Creek DS - dissolved silver
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW004
SW004 50th%


Stockton Creek DS - dissolved zinc
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
mg/L
Jan 11 May 11 Aug 11 Dec 11 Apr 12 Aug 12 Dec 12 Apr 13 Aug 13 Dec 13 Apr 14 Aug 14 Dec 14 Apr 15 Aug 15 Dec 15 Apr 16
SW004
SW004 50th%

B.2 Groundwater

Table B-2 Baseline groundwater level and quality data

Bore	Depth to groundwater (m)					pH					EC (µS/cm)				
	Min	Max	Median	20th	80th	Min	Max	Median	20th	80th	Min	Max	Median	20th	80th
BH26A	0.52	2.26	1.83	1.60	2.04	5.7	10.6	6.3	6.1	6.4	3,420	11,810	8,255	5,048	9,888
MSGW04A	1.29	2.93	2.30	2.12	2.51	6.0	7.2	6.4	6.3	6.5	5,780	10760	9150	8468	9558
MSGW04B	4.34	15.31	6.10	5.24	11.18	6.6	7.93	6.9	6.6	7.1	5,830	8,970	7,785	7,260	8,186
MSGW04C	4.42	97.74	18.99	7.67	38.62	7.0	12.7	8.0	7.3	11.2	4,770	9,960	6,460	5,222	7,772

Appendix C – Registered groundwater bores

Bore	Easting	Northing	Depth (m)	Licence status	Authorised use	Surface water level (m bgl)	Yield (L/s)	Salinity (mg/L)	Aquifer
GW015275	356866	6327914	4.5	Active	Stock, irrigation, domestic	3.9	0.15	Fresh	Clay, sand
GW015287	351406	6335997	44.1	Active	Stock, irrigation	–	–	3,001–7,000	–
GW021578	355396	6334454	3.6	Active	Stock, domestic	2.4	0.13	Fair	Sand
GW029567	361864	6340863	3	Active	Stock, irrigation, domestic, farming	2.1	–	–	Sandstone, gravel
GW033618	358945	6343594	30.4	Active	Stock	–	–	–	Sandstone, shale
GW033619	359049	6343596	21.3	Active	Stock	–	1.52	–	Sandstone, shale
GW034950	356963	6335463	76.2	Active	Stock, domestic	14.9	0.25	Poor	Conglomerate
GW043431	359665	6345915	38.1	Active	Stock	1.8	–	–	–
GW044189	353479	6337815	3.6	Active	Stock, domestic	–	–	0–500	–
GW048538	351276	6341139	26	Active	Domestic	7	0.13, 0.63	–	–
GW050694	351933	6340595	30	Active	Stock, domestic	12	1.5	Good	Shale
GW050982	351460	6341019	24.4	Active	Domestic	–	–	–	–
GW051320	351999	6339672	46	Active	Stock, domestic	9	0.38	Good	Conglomerate
GW051321	351404	6341265	46	Active	Stock, domestic	–	1.89	–	Shale

Bore	Easting	Northing	Depth (m)	Licence status	Authorised use	Surface water level (m bgl)	Yield (L/s)	Salinity (mg/L)	Aquifer
GW051322	351432	6341111	53	Active	Stock, domestic	9	0.13	–	Shale
GW051542	352519	6343007	38	Active	Stock, domestic	12.2	1.7	Good	Sandstone
GW051560	348262	6323132	33	Active	Stock, farming	13	5	–	Sandstone
GW051778	350297	6339030	41	Active	Stock, domestic	10	0.13, 1.13, 0.5	–	Conglomerate, shale, sandstone
GW052111	359475	6339227	49	Active	Stock	10.5	0.1, 0.27	Good	Conglomerate, sandstone
GW052255	356445	6333638	114	Active	Stock	8.7	0.07, 0.1, 0.23	–	Shale, Conglomerate
GW052374	353735	6339759	38	Active	Stock, domestic	18	2.52	–	Sandstone
GW052381	357498	6346746	35	Withdrawn	Stock, domestic	13	0.76	Good	Coal
GW053092	356798	6327205	0	Cancelled	Irrigation, stock, domestic	–	–	–	Sand
GW053438	359235	6339686	53	Lapsed	Stock, irrigation, domestic	–	0.44	1,001–3,000	Shale
GW054183	352923	6335126	18.3	Active	Domestic	–	–	Fair	–
GW056461	347072	6324685	23	Active	Domestic, stock	9	2.52	–	Unknown
GW056862	356600	6337214	45	Active	Stock, domestic	–	–	–	–

Bore	Easting	Northing	Depth (m)	Licence status	Authorised use	Surface water level (m bgl)	Yield (L/s)	Salinity (mg/L)	Aquifer
GW057310	356467	6342726	61	Active	Stock, domestic, farming	6	0.07	–	Shale
GW058789	351125	6320435	29	Withdrawn	Stock, domestic	–	–	Salty	Ironstone
GW059558	358320	6336592	5	Active	Stock, domestic, farming	–	–	–	–
GW060965	354299	6338505	33.6	Active	Stock, domestic	29	0.38	Salty	Shale
GW061202	357061	6344737	50.3	Active	Stock, domestic	21.9	0.1, 0.2	1,001–3,000	Siltstone, Coal
GW061226	356445	6333638	117.3	Active	Stock, domestic	24.4, 83	3, 0.1, 0.1	3,001–7,000	Sandstone, shale
GW062618	358931	6337371	34.5	Active	Domestic	16.4	34, 53	–	–
GW064033	357483	6338921	49.4	Active	Stock, domestic	12.2	0.06, 0.1, 0.15	501–1,000	Sandstone
GW064116	356486	6339677	21.3	Active	Stock, domestic	–	0.3, 0.6	0–500	Sandstone
GW064143	358504	6338197	24.3	Active	Stock, domestic	–	–	1,001–3,000	Gravel
GW064662	359443	6327028	24	Active	Domestic	7	–	–	Sandstone
GW067263	355148	6338979	10	Active	Stock, domestic	3	0.15	–	–
GW078043	351532	6332856	33	Active	Stock, domestic	16, 18	–	–	Sandstone

Bore	Easting	Northing	Depth (m)	Licence status	Authorised use	Surface water level (m bgl)	Yield (L/s)	Salinity (mg/L)	Aquifer
GW078060	360787	6330898	28	Active	Domestic	15	1.25	Fresh	Conglomerate
GW078084	357181	6334696	62	Active	Stock, domestic	5	0.05, 0.1	Fresh	Sandstone
GW078094	360784	6331113	30.4	Active	Domestic, stock	5	0.2, 0.3	480, 500	Sandstone
GW078110	352956	6332939	7.3	Active	Monitoring bore	–	–	5,100	Sand
GW078111	353423	6332885	12.2	Active	Monitoring bore	–	–	–	–
GW078113	353009	6333865	12.2	Active	Monitoring bore	2.35	–	1,630	Silt, sand
GW078114	355863	6334400	12	Active	Monitoring bore	3.48	–	650	Sand
GW078115	355319	6333746	10.4	Active	Monitoring bore	0.99	–	5,370	Sand
GW078116	354978	6333987	8.5	Active	Monitoring bore	1.74	–	10,880	Sand
GW078117	354252	6334007	13.7	Active	Monitoring bore	1.68	–	2,380	Sand
GW078118	353418	6334980	15.8	Active	Monitoring bore	2.38	–	820	Sand
GW078119	353204	6334731	9.1	Active	Monitoring bore	2.66	–	230	Sand
GW078131	353466	6333532	12.5	Active	Monitoring bore	1.58	–	310	Sand
GW078132	353702	6333351	14.6	Active	Monitoring bore	1.65	–	5,100	Sand
GW078136	356136	6335236	9	Active	Monitoring bore	4.5	–	370	Sand
GW078137	355416	6334886	5.5	Active	Monitoring bore	5.35	–	2,720	Sand
GW078138	356976	6345167	120	Cancelled	Test bore	35	0.2, 0.6	320, 470	Sandstone

Bore	Easting	Northing	Depth (m)	Licence status	Authorised use	Surface water level (m bgl)	Yield (L/s)	Salinity (mg/L)	Aquifer
GW078139	354851	6334477	9.1	Active	Monitoring bore	2.9	–	1,560	Sand
GW078140	356434	6333731	180	Cancelled	Test bore	16	0.2	634	Coal
GW078214	360811	6330799	36	Active	Stock, domestic	12, 9	0.63, 2	Fresh	Sandy clay, sandstone
GW078220	351203	6341259	23	Active	Stock, domestic	10	7	1,280	Clay
GW078390	359361	6323730	3	Active	Domestic	–	–	–	–
GW078601	354731	6332103	18.85	Active	Stock, domestic	4.5	1.1	1,600	Weathered sandstone
GW078608	359054	6338132	60	Active	Stock, domestic	–	–	–	–
GW078609	348866	6323656	70	Active	Stock, domestic	–	–	–	Sandstone, mudstone
GW078610	347495	6330465	316.2	Active	Stock, domestic	–	–	–	–
GW079772	356385	6333546	234	Cancelled	Test bore	–	0.1, 0.2	2,900, 1,500	Sandstone, coal
GW080372	350851	6339519	75	Active	Stock, domestic	3	0.15	–	Sandstone, siltstone
GW080394	347251	6329529	42	Active	Stock, domestic	18	2.6	6,230	Sandstone
GW080608	349661	6321471	48	Active	Stock, domestic	3.2	0.4	–	Shale
GW105311	351296	6333045	198	Abandoned	Stock, domestic	–	–	–	–
GW200210	359439	6323706	4.5	Active	Domestic	3.5	1	–	–
GW200302	354830	6320184	180	Active	Test bore	–	0.35	7,750	Sandstone

Bore	Easting	Northing	Depth (m)	Licence status	Authorised use	Surface water level (m bgl)	Yield (L/s)	Salinity (mg/L)	Aquifer
GW200379	358197	6324827	6	Active	Monitoring bore	5.6	–	–	Clay
GW200380	357960	6324782	6	Active	Monitoring bore	5	–	–	Clay
GW200419	354958	6320242	4.2	Active	Test bore	–	–	–	Clay, sand
GW200420	355056	6320343	4.25	Active	Test bore	–	–	–	–
GW200505	350914	6322022	54	Active	Stock, domestic	15, 18.5	0.1, 0.25	Fresh	gravel, conglomerate
GW200509	346985	6330372	100	Active	Stock, domestic	–	0.01	–	Sandstone
GW200671	356845	6321257	5.5	Active	Monitoring bore	–	–	–	–
GW200672	356876	6321175	4.5	Active	Monitoring bore	–	–	–	–
GW200673	356927	6321142	4.5	Active	Monitoring bore	–	–	–	–
GW200674	356967	6321130	4.5	Active	Monitoring bore	–	–	–	–
GW200675	356945	6321171	3	Active	Monitoring bore	–	–	–	–
GW200676	356870	6321205	4.5	Active	Monitoring bore	–	–	–	–
GW200677	356939	6321258	3	Active	Monitoring bore	–	–	–	–
GW200678	357066	6321280	3	Active	Monitoring bore, town water supply	–	–	–	–
GW200679	356900	6321242	4.8	Active	Monitoring bore	–	–	–	–
GW200696	359964	6347393	66	Cancelled	Test bore	–	–	–	–

Bore	Easting	Northing	Depth (m)	Licence status	Authorised use	Surface water level (m bgl)	Yield (L/s)	Salinity (mg/L)	Aquifer
GW200765	356404	6339855	8	Active	Domestic	–	–	–	-
GW200854	354927	6320417	2.9	Active	Monitoring bore	2.3	–	–	Clay
GW200915	357208	6335014	60	Active	Stock, domestic	–	–	–	–
GW200938	351483	6322112	36	Active	Stock, domestic	14	0.1, 0.5	–	Conglomerate
GW201396	353820	6333360	9	Active	Monitoring bore	2.5	–	–	Clayey sand, sand
GW201397	353821	6333365	30.5	Active	Monitoring bore	20	–	–	Sandstone
GW201398	353822	6333372	58	Active	Monitoring bore	51	–	–	Sandstone, mudstone
GW201399	352912	6333760	30.1	Active	Monitoring bore	27	–	–	Sandstone, mudstone
GW201400	352906	6333763	63	Active	Monitoring bore	54	–	–	Sandstone, mudstone
GW201401	353283	6334737	32.85	Active	Monitoring bore	29.5	–	–	Sandstone, mudstone
GW201402	353281	6334735	60	Active	Monitoring bore	55	–	–	Sandstone
GW201403	353034	6333976	21	Active	Monitoring bore	16	–	–	Sandstone, mudstone
GW201404	353073	6333977	34.1	Active	Monitoring bore	24	–	–	Sandstone
GW201405	353073	6333978	60	Active	Monitoring bore	56	–	–	Sandstone
GW201504	348505	6329500	205	Active	Test bore	11	0.5	3610	Clay, shale
GW202940	361666	6341097	4.5	Active	Monitoring bore	1.6	–	–	Clayey sand
GW202941	361591	6341004	5.5	Active	Monitoring bore	2.03	–	–	Sand, sandy clay

Bore	Easting	Northing	Depth (m)	Licence status	Authorised use	Surface water level (m bgl)	Yield (L/s)	Salinity (mg/L)	Aquifer
GW202942	361575	6341085	6	Active	Monitoring bore	1.81	–	–	Silty clay, gravelly sandy clay
GW202943	361566	6340704	8	Active	Monitoring bore	4.68	–	–	Gravel, conglomerate
GW202944	361571	6340770	8.5	Active	Monitoring bore	5.3	–	–	Weathered conglomerate
GW202945	361591	6340725		Active	Monitoring bore	5.11	–	–	Conglmerate, coal
GW202946	361568	6340833	8.4	Active	Monitoring bore	4.79	–	–	Conglomerate
GW202947	361596	6340822	9	Active	Monitoring bore	3.94	–	–	Silty clay
GW202948	361613	6340821	9.5	Active	Monitoring bore	2.9	–	–	Silty sand, sandy gravelly clay
GW202949	361593	6340864	9	Active	Monitoring bore	4.09	–	–	Sandy, silty clay
GW202950	361523	6340829	9	Active	Monitoring bore	1.17	–	–	Clay
GW202951	361592	6340796	9	Active	Monitoring bore	5.82	–	–	Fill
GW202952	361618	6340813	19	Active	Monitoring bore	5.35	–	–	Clay
GW201578	355396	6334454	3.6	Active	Stock, domestic	2.4	0.13	–	Sand
GW201648	352065	6331146	19.4	Active	Monitoring bore	1.4	–	–	Silty clay, sandy clay
GW201649	352055	6331144	150	Active	Monitoring bore	6.3	0.3, 1.6	3,800, 4,600	Sandstone

Bore	Easting	Northing	Depth (m)	Licence status	Authorised use	Surface water level (m bgl)	Yield (L/s)	Salinity (mg/L)	Aquifer
GW201650	352045	6331143	48.1	Active	Monitoring bore	5.5	1.5, 0.4	4,100, 3,200	Sandstone
GW201651	351273	6330153	6.5	Active	Monitoring bore	–	–	–	Sandstone
GW201652	351288	6330152	48	Active	Monitoring bore	6.3	0.2	5,000	Sandstone
GW201653	351291	6330161	156	Active	Monitoring bore	5	0.25	4,350	Sandstone
GW202180	347573	6329504	30	Active	Stock, domestic	–	4.5, 8	1,000	Sandstone
GW201704	354686	6325840	7.2	Active	Monitoring bore	1.9	–	–	Sandy clay, sandstone
GW200418	354740	6320120	4.45	Active	Test bore	–	–	–	Clay

Appendix D – Surface and groundwater remediation measures

Remedial strategies have been conceptualised for Mandalong Mine as part of previous extraction management plans. Strategies can take one of two forms:

- **Soft engineering solutions** which comprise of elements such as coir logs, jute matting, geotextile, rock armouring, timber log dissipaters and a range of other options that are generally designed to repair cracks and erosion and prevent recurrence by regulating the flow of surface and subsurface water. These solutions are generally biodegradable and therefore integrate into the riparian systems.
- **Hard engineering solutions** comprise the use of concrete and various grouting techniques as well as earthworks. These solutions are used where either subsidence is persistent and results in water losses from waterways or areas of remanent ponding are impacting on waterway hydraulics or impacting on property.

A hierarchy of control will be used when implementing remediation works. Soft engineering solutions will be used initially to remediate any impacts that may occur. These soft engineering works will be monitored and maintained to ensure design performance. Hard engineering solutions will be used if monitoring demonstrates that the soft engineering solutions require additional works.

Potential engineering solutions may include but not limited to the following seven typical mitigation measures, discussed in Sections E.1 to E.6 below. To accommodate for improvements in technology and research, a detailed investigation into the remediation measure will need to be conducted prior to the implementation of any engineering solution.

D.1 Surface water drainage to mitigate ponding

Where subsidence has resulted in a significant increase in remnant ponding, surface or sub-surface water drains can be constructed to improve water carriage on a property. These drains need to be designed so they have sufficient capacity to drain areas affected by ponding. These drains are typically of a shallow design depending on existing surface gradients and direct surface water to established drainage lines. Any drainage works on private property are undertaken in consultation with the landowner and facilitated by and access agreement.

D.2 Infilling of surface cracks to prevent surface water loss

In the unlikely event that subsidence causes significant surface cracks, these may be in filled to prevent the loss of surface water. Surface cracks are typically remediated by backfilling these with surrounding surface material then re-grading to create a level surface. Disturbed areas are then rehabilitated by planting native endemic species to prevent soil erosion.

D.3 Creek realignment measures to improve flows

If sections of the creek bed become hydrologically isolated or have significant areas of additional pooling caused by changes in bed gradients, then these bed sections may need to be realigned to improve flows. Realignments need to be designed based on surveyed long sections to best suit existing creek grades. This remediation measure typical involves excavating to regrade a creek bed section or removing elevated sections causing a constriction to flow. Upstream water would need to be contained to allow excavation and following realignment similar soil material would be re-instated to stabilise the creek bed. Permits to work within a waterway would need to be obtained from the relevant government department prior to commencing works. Where remediation is required on private property, any remediation will be undertaken in consultation with the landowner and facilitated by land access agreements.

D.4 Creek bed stabilisation measures to reduce erosion

Where creek gradient changes result in a significant increase in erosion, it may be necessary to reduce flow velocities in the creek bed to prevent further scouring and the resultant erosion. This can be achieved by a number of methods ranging from constructing bends in the creek line to establishing weir pools. These methods would require specific design to quantify the amount of flow reduction to stabilise the creek. It may also be necessary to stabilise banks. This may be done by re-grading bank areas to reduce incised sections and stabilising the soil by re-vegetating banks.

D.5 Measures to control out of channel erosion

Contour bunds can be used to redirect surface flows from areas at risk of increased erosion particularly, where exposed soils are subject to out of channel flood flows. These contour bunds act to reduce the flow path and redirect water away from areas of erosion. The contour bunds are typically constructed on a low gradient following an existing contour level redirecting surface water into existing drainage channels or water structures. Areas at risk of erosion can then be rehabilitated by establishing vegetation cover using native endemic species.

D.6 Bentonite cut off trenches to control groundwater flows

If near-surface cracking results in drainage of groundwater from the alluvial creek system, this may be remediated by constructing bentonite-filled cut of trenches. These trenches can be constructed to prevent lateral drainage of the groundwater and redirect this back into the existing groundwater dependent system. The trenches need to be positioned and design based on site specific information however, they generally consist of subsurface trench excavations filled with bentonite at the limit of a groundwater system to redirect lateral groundwater flows back into an existing groundwater system.

D.7 Grouting of rock bars

If rock bars are present in creek beds and these are affected by subsidence cracking this may lead to a loss of surface water from a creek. Ongoing monitoring of water loss should be undertaken to determine if long-term effects are evident. Where it is possible, grouting of cracks in rock bars may be effective in reducing water loss and returning surface water flows.

Appendix E – Trigger action response plans

Aspect	Normal	Trigger 1	Trigger 2	Response
Groundwater environment				
Groundwater quality	No complaints from adjacent bore owners regarding groundwater quality. **Action: Continue to monitor on monthly basis**	Complaint from an adjacent bore owner regarding declining groundwater quality. **Action: Environmental Coordinator to initiate an investigation to determine if the change in groundwater quality is due to mining related activity.**	Investigation into Stage 1 Trigger identifies that change in groundwater quality is due to mining related activity. **Action: Loss of water supply from an adjacent landholder will need to be replaced by Centennial Mandalong. If environmental impacts are unacceptable, remediation options will be considered**.	**Trigger 1: Notify Environmental Coordinator/Mine Manager.** **Trigger 2: Notify DPI Water.** **Notify any potential effected landowners.**

Aspect	Normal	Trigger 1	Trigger 2	Response
Groundwater level	Depth to alluvial groundwater is less than the adopted values specified in Table 3-2, based on climatic variation. No complaints from adjacent bore owners regarding groundwater levels.	Depth to alluvial groundwater exceeds the adopted values specified in Table 3-2. Complaint from adjacent bore owner regarding declining groundwater levels. **Action: Environmental Coordinator to initiate an investigation to determine if the change in groundwater level is due to mining related activity. If mining related, a review within six months is required to determine whether groundwater levels have recovered.**	Groundwater levels do not recover after six months. **Action: Loss of alluvial groundwater may need to be licensed under the WSP.** **Loss of water supply from an adjacent landholder will need to be replaced by Centennial Mandalong.**	**Trigger 1: Notify Environmental Coordinator/Mine Manager.** **Trigger 2: Notify DPI Water.** **Notify any potential effected landowners.**

Aspect	Normal	Trigger 1	Trigger 2	Response
Watercourse and Flooding				
Flooding	Subsidence levels are within predications. No increase in post mining out of channel flood levels identified by flood model. **Action: Continue flood hydrology modelling with each extraction application.**	Subsidence levels 1.5 times greater than predicted Increase in post mining out of channel flood depths causing ponding above predicted. **Action: Determine extent of increase in flood depths and if any potential loss of vegetation due to inundation. Consult with ecologist, landowner and government departments on developing whether mitigation measures are required to improve water drainage.**	Subsidence levels two times greater than predicted Significant increase in post mining out of channel flood depths causing ponding. **Action: Refer to EMP for potential engineering solution** **Consult with ecologist, landowner and government departments on flood drainage remediation measures and implement/report effectiveness of measures.**	**Trigger 1: Notify Environmental Coordinator/Mine Manager.** **Trigger 2: Notify DPI Water.**

Aspect	Normal	Trigger 1	Trigger 2	Response
Water quality	Water quality at monitoring locations consistent with historical baseline or are below DTVs.	Water quality is above DTV downstream of operations for at least one parameter and one round. **Action: Investigate potential sources. Undertake additional monitoring. Implement where appropriate remediation actions as per Appendix D.**	Water quality is above DTV downstream of operations for at least two parameters and more than one round. **Action: Investigate potential sources. Undertake additional monitoring. Undertake sampling of downstream monitoring locations. Implement where appropriate remediation actions as per Appendix D.**	**Trigger 1: Notify Environmental Coordinator/Mine Manager.** **Trigger 2: Notify DPI Water.**

Aspect	Normal	Trigger 1	Trigger 2	Response
Water flow	Creek flow rates consistent with median results of baseline. Relationships with rainfall are consistent with historical average.	Appreciable loss of baseflow compared with historical data and reference sites. **Action: Investigate hydrologic performance of creek.** **Repeat water quality sampling**.	No baseflow observed within creeks compared with historical data and reference sites. **Action: Review mine plan in context of local geological structures.** **Quantify volumetric loss of baseflow and report to DPI Water.** **Implement where appropriate groundwater remediation actions as per Appendix D.** **Loss of water supply from an adjacent landholder will need to be replaced by Centennial Mandalong.**	**Trigger 1: Notify Environmental Coordinator/Mine Manager.** **Trigger 2: Notify DPI Water and DRE.**

Aspect	Normal	Trigger 1	Trigger 2	Response
Geomorphic condition and watercourse stability				
Watercourse instabilities	Watercourse monitoring indicates no areas of instabilities from visual inspections. **Action: Continue site inspections in accordance with the monitoring program.**	Watercourse monitoring indicates one or more areas of instabilities in watercourses. **Action: Seek to stabilise the instabilities, which may include advice from a geomorphic specialist.** **Investigate cause for instabilities, and whether recent construction works or subsidence have created the instability.**	Watercourse monitoring indicates one or more areas of instabilities in watercourses. Causing sediment loads to migrate and or impact to riparian vegetation. **Action: Seek to stabilise the instabilities, which may include advice from a geomorphic specialist.** **Investigate cause for instabilities, and whether recent construction works or subsidence have created the instability**.	**Trigger 1: Notify Environmental Coordinator/Mine Manager.** **Trigger 2: Notify DPI Water.**

Aspect	Normal	Trigger 1	Trigger 2	Response
Aquatic ecology				
Instream vegetation	Biannual inspections indicate no significant change in instream vegetation quality or extent. No significant variation in vegetation extent or quality when compared with reference sites.	Visual inspections show change in extent and density of vegetation not specific to season. Introduction of increase number of exotic species. **Action: Review activities likely to influence vegetation.** **Review flow data or rainfall events.** **Consider using RCE measure to quantify change from historical results.**	Vegetation significantly altered as a result of physical clearing or impact. **Action: Increase monitoring rounds for six months following vegetation impact.** **Undertake water quality monitoring to determine potential impact on in-situ conditions.** **Stabilise creek banks.**	**Trigger 1: Notify Environmental Coordinator/Mine Manager.** **Trigger 2: Notify DPI Water.** **Notify OEH.**

Aspect	Normal	Trigger 1	Trigger 2	Response
In situ water quality	Biannual inspections indicate no significant variation in field parameters of water quality. No significant variation in field parameters of water quality when compared with reference sites.	Poor water quality concentrations observed compared with historical results. **Action: Investigate sources of water quality degradation.** **Repeat sampling within one week.**	Continued poor water quality concentrations observed compared with historical results. **Action: Review catchment inputs.** **Inspect waterway upstream of monitoring location.** **Undertake analysis of full suite of parameters.**	**Trigger 1: Notify Environmental Coordinator/Mine Manager.** **Trigger 2: Notify OEH.**

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Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

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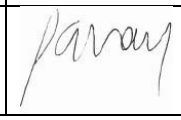
https://projects.ghd.com/OC/Newcastle/mandalonglw2224amod/Delivery/Documents/2218510-REP-1_ExtractPlan_WMP_LW22to23.docx

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	T Davies	L Hammersley	*L Hammersley*	S Gray	*S Gray*	07/10/2016
1	I Gilmore	L Hammersley	*L Hammersley*	S Gray	*S Gray*	14/12/2016
2	T Davies	L Hammersley		S Gray		30/01/2017

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