BENGALLA Mining Company

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Dry Creek Interim Management System and Conceptual Re-instatement Study

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July 2013

Bengalla Mining Company

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Certified to ISO 9001, ISO 14001, AS/NZS 4801
A GRI Rating: Sustainability Report 2011

Revision	Details	Date	Amended By
00	Original	6 December 2012	
B	Formatting changes	5 July 2013	J. Burnie

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Signed:

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Signed:

Approved by: Andrew Russell

Signed:

Date: 5 July 2013

Distribution: Bengalla Mining Company, Hansen Bailey

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Executive summary

Bengalla Mining Company is currently seeking Development Consent under Part 4 of Division 4.1 of the *Environmental Planning and Assessment Act 1979* to facilitate the continuation of open cut coal mining for a further 24 years. The Project will result in the impact to an approximate 4 km section of Dry Creek and will require the diversion of Dry Creek until it can be reinstated prior to the completion of mining in approximately Year 24. An Environmental Impact Statement is currently being prepared from which this assessment will form part of.

Bengalla Mining Company Pty Limited engaged Parsons Brinckerhoff to undertake an interim management system and conceptual Dry Creek re-establishment study that will allow mining operations to continue west for the Project.

The overall Dry Creek relocation project has seen a significant number of higher level studies completed from conceptual and prefeasibility through to feasibility phases from 2007 to 2012, to determine the preferred option for the Project. Studies previously undertaken in relation to the relocation of Dry Creek include:

- Concept Study (January 2007).
- Value Management (March 2010).
- Order of Magnitude Study (July 2010).
- Options Evaluation Workshop (July 2010).
- Pre-feasibility Study (November 2010).
- Pre-feasibility addendum (December 2010).
- Bridging Study (January 2011).
- Feasibility Study (February 2012).

This report outlines the studies listed above and how each progressed from a broad range of ideas being generated through the development and evaluation of those ideas and finally to selection of a preferred option by Bengalla Mining Company Pty Limited for the interim management system and Dry Creek re-establishment.

1. Introduction

1.1 Background

Parsons Brinckerhoff was commissioned by Bengalla Mining Company Pty Limited (BMC), to undertake an interim management system and conceptual Dry Creek re-establishment study for the Continuation of the Bengalla Mine Project (the Project). This assessment will form part of the Environmental Impact Statement (EIS) supporting an application for Development Consent under Part 4, Division 4.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The Project is generally comprised of:

- Open cut mining towards the west at a rate of up to 15 million tonnes per annum (Mtpa) of run of mine (ROM) coal for 24 years.
- Continued use of the existing dragline, truck fleet and excavator fleet (with progressive replacement).
- An out of pit Overburden Emplacement Area (OEA) to the west of Dry Creek which may be utilised for excess spoil material until it is intercepted by mining.
- Continued use, extension or relocation to existing infrastructure, including administration and parking facilities, in-pit facilities (including dragline shut down and erection pad), helipad, tyre laydown area, explosives and reload storage facility, core shed workshop and administration buildings, roads, reject bin, ROM Hopper, water management infrastructure, supporting power infrastructure, and ancillary infrastructure.
- Construction and use of various items of new infrastructure (including radio tower, extensions to Main Infrastructure Area (MIA), Mount Pleasant Staged Discharge Dam and associated water reticulation infrastructure, additional ROM coal stockpile and upgrade to the emergency ROM coal stockpile along with associated conveyor network).
- Processing, handling and transportation of coal via the (upgraded) CHPP and rail loop for export and domestic sale.
- Continued rejects and tailings co-disposal in the Main OEA and temporary in pit reject emplacement.
- Relocation of a 3 km section of Bengalla Link Road after Year 15 near the existing mine access road to facilitate coal extraction.
- The diversion of Dry Creek via dams and pipe work with a later permanent alignment of Dry Creek through rehabilitation areas when emplacement areas are suitably advanced.
- Relocation of water storage infrastructure as mining progresses through existing dams (including the Staged Discharge Dam, raw water dam).
- A workforce of approximately 900 full time equivalent personnel (plus contractors) at peak production.

1.2 Document objectives and structure

The document initially outlines the process and options considered for the re-establishment of Dry Creek prior to selection of a preferred option.

BMC's preferred option interim management system, and final Dry Creek re-establishment are then detailed in the following areas:

- design assumptions
- design basis
- design development
- safety in design.

The content of this report has been prepared in consideration of the relevant Director General's Requirements (DGRs) dated 13 March 2012 including submission to the DGRs from NSW office of Water (NOW) which are repeated below for information.

- For flood works, drainage works and water supply works which capture, store, convey, divert or impound water (such as a tank, dam, water pipe, irrigation channel, bank, levee, or weir), the EIS must provide the following details:
  - purpose, location and construction
  - whether the work is on a watercourse
  - size, storage capacity and expected annual extraction volumes
  - whether the work is affected by flood flows
  - details of any proposal for shared use, rights and entitlement of the work.
- Assessment and design principles relating to the proposed diversion and reconstruction of Dry Creek should be in accordance with *A Rehabilitation Manual for Australian Streams* Vol 2, CRC for Catchment Hydrology, LWRRDC 2000 ISBN 0 642 76030 6.

1.3 Dry Creek catchment characteristics

The Dry Creek catchment north of Wybong Road comprises approximately 665 hectares. An additional 580 hectares contributes to flows in Dry Creek downstream of Wybong Road that is largely within the Project Boundary.

Parsons Brinckerhoff understands the catchment has been mostly cleared for agriculture and is dominated by grasslands, although some areas of scattered woodland remain. The original character of the vegetation has been greatly altered as a result of previous agricultural land use. Small patches of remnant woodland vegetation occur in the western portion of the catchment.

A photographic record which provides a visual representation of Dry Creek within the Project Boundary was prepared by Parsons Brinckerhoff and is included in Appendix A.

The catchment slopes vary from 1% along the edges of Dry Creek main channel within the Project Boundary to approximately 30% in the headwaters of the catchment to the north of the Project Boundary.

1.4 Available information

1.4.1 Client supplied

- Aerial survey to Map Grid of Australia (MGA94) datum with an accuracy level of approximately 100 mm in the vertical. This survey was sourced by Rio Tinto Coal Australia for the Mount Pleasant Project. The survey was obtained by BMC after agreement with Mount Pleasant.
- Historic discharge volumes for the existing BMC environmental dam.
- Proposed final Dry Creek landform computer model dated 1st December 2011.
- Topographical map of Bengalla mine site.
- Power load study report.
- Bengalla Power Transformers Specification - BMC-M-11.

1.4.2 Reference documents

1.4.2.1 Civil

- NSW Dams Safety Act 1978.
- NSW Dams Safety Committee (DSC) – Dam Guidance Sheets.
- NSW Dept. of Conservation & Land Management Guidelines.
- NSW Department of Housing Blue Book – Managing Urban Stormwater – Soil & Conservation.
- ANCOLD Guidelines relative to dam design, construction and management.
- Floodplain Development Manual, NSW Government 2005.
- Waterway Design – A Guide to the Hydraulic Design of Bridges, Culverts and Floodways, AustRoads, 1994.
- Works and Watercourse Design Guideline, NSW Government Department of Natural Resources, 2007.
- Director Generals Requirements – 13 March 2012.
- A Rehabilitation Manual for Australian Streams Vol 2, CRC for Catchment Hydrology, LWRRDC 2000 ISBN 0 642 76030 6.

1.4.2.2 Pumps and pipelines

- AS/NZS 4130:2009 Polyethylene (PE) pipes for pressure applications.
- AS 2200:2006 Design charts for water supply and sewerage.
- WSA 01-2004 3rd Edition Polyethylene Pipeline Code.
- WSA 03-2002 Product and Material Information and Guidance for Water Supply Code of Australia.
- US Department of Transport, Federal Highway Administration – Hydraulic Engineering Circular No 14 – Hydraulic Design of Energy Dissipators for Culverts & Channels (HEC 14).

1.4.2.3 Electrical and communications

- NSW Electricity Supply Act 1995.
- NSW Electricity Supply (General) Regulation 2001.
- NSW Service and Installation Rules 2006.
- AS 2067-2008 Substation and high voltage installations exceeding 1 kV ac.
- AS 3007 Set-2007 – Electrical installations for surface mines.
- AS/NZS 3000-2007 – Electrical Installations.
- AS 3008.1.1-2009 – Electrical installations – selection of cables.
- AS 2081 Electrical equipment for coal and shale mines.
- AS 4871 Electrical equipment for mines and quarries.

2. Options considered

Parsons Brinckerhoff has completed a significant number of higher level studies for the Dry Creek relocation project. These studies included conceptual, prefeasibility through to feasibility phases completed over a five year period from 2007 to 2012.

A summary of each of the previous studies including options considered is provided below.

2.1 Concept study (2007)

In 2007, Parsons Brinckerhoff prepared a preliminary design and construction cost estimate for BMC for the diversion of Dry Creek to enable the continuation of mining operations west of existing approved operations. The design was limited spatially by the presence of Wybong Road and the western boundary of the existing BMC mining lease ML 1397.

The vertical profile was limited by the invert of the culverts conveying Dry Creek beneath Wybong Road. The proposed Dry Creek diversion was designed on an open channel that drained by gravity west from the existing culverts under Wybong Road and then south outside the western boundary of ML 1397. It was characterised by a depth of cut up to 20 m.

2.2 Value management workshop (March, 2010)

Project conditions for the Dry Creek relocation had changed since the 2007 concept study, primarily:

- The creek diversion alignment was required to not preclude mining activities in ML1397.
- There were now potential opportunities to modify the catchment via mine water and clean water dams north of Wybong Road in consultation with the Mount Pleasant Project.

As such, BMC engaged Parsons Brinckerhoff to develop options for the Dry Creek relocation project through a value management/value engineering process. The process was designed to develop broad Dry Creek relocation schemes for development in a future Order of Magnitude study.

A value management workshop was held at Bengalla Mine with representatives from the Bengalla Joint Venture, Rio Tinto's Mount Pleasant Mine project team, Hansen Bailey (HB) and Parsons Brinckerhoff. Based on initial discussions at the workshop, the following three functions were considered to be essential in developing an option:

- Environmental: environmental considerations, final option to enable approvable option (internal and external).
- Engineering: maintain a waterway/flow.
- Cost: create/maximise value.

An initial list of options was put forward at the workshop for discussion by the whole group. After syndicate group discussions to develop the ideas on the list, a reviewed list of options with reasons for rejection or refinement was prepared. Table 2.1 describes the reviewed options. The names and descriptions of the options are as were described at the workshop.

Table 2.1 Initial Dry Creek relocation options

Option	Result of initial round of evaluation (deleted or retained) and reasons	Result of second round of evaluation based on "knock-out" developed in workshop and reasons if rejected
INTERIM OPTIONS		
A + Diversion source at RW1 spillway	▪ Deleted ▪ Does not fit with Mount Pleasant and BMC mine plans	
B + Diversion source at RW1 spillway	Deleted ▪ Excessive cost	
C + Diversion source at RW1 spillway	Deleted but could incorporate into Option G ▪ Not current option ▪ Stage 1 – west – stage 2 (30years) up and over the rehabilitation area	
D + Diversion source at RW1 spillway	Deleted, same as spillway + x metres	
E + Diversion source at RW1 spillway	Deleted, same as spillway + x metres	
A + Diversion source at RW1 spillway + x metres	Deleted ▪ Does not fit with MTP and BMC mine plan	
B + Diversion source at RW1 spillway + x metres	Deleted ▪ Excessive cost	
C + Diversion source at RW1 spillway + x metres	Deleted but could incorporate into Option G ▪ Not current option ▪ Stage 1 – west – stage 2 (30years) up and over the rehabilitation area	
D + Diversion source at RW1 spillway + x metres	Retained ▪ Look to modify location of MTP dam to allow construction of water course/contour drain	Accepted
E + Diversion source at RW1 spillway + x metres	Retained	Accepted
D + Split northern catchment into two dams	D + Split northern catchment into two dams & E + Split northern catchment into two dams merged but then deleted as D + diversion and E + diversion need to be treated separately and cover this merged option. ▪ Same for both options as delivery gravity to same point at NW corner for flow to river	

Option	Result of initial round of evaluation (deleted or retained) and reasons	Result of second round of evaluation based on "knock-out" developed in workshop and reasons if rejected
E + Split northern catchment into two dams	▪ High dam allows MTP to separate clean catchment (for harvest rights) from pitwater ▪ Diversion channel allows to cut off more catchment above pitwater ▪ Reduces cut and length ▪ Higher impact on MTP infrastructure ▪ Relatively high cost and low risk	
G = dam, pipe and pump (Wybong Road)	Retained ▪ Short term solution (10 years) ▪ Relies on long term land form solution (long term solution to be combined with Option C) ▪ Sterilise small area of coal to pit floor to create clean water pump well ▪ High risk/low capital ▪ Is it a diversion – is there a precedent	Accepted
DRY CREEK RELOCATION		
A = Gravity (culverts at Wybong Road) to East (adjacent Wybong Road)	Deleted due to: ▪ Sterilise coal along Wybong Road ▪ Potentially 50 m cut ▪ Mining catchments (water quality, increased flow)	
B = Gravity (culverts at Wybong Road) to North	Deleted due to: ▪ Significant cut due to topography ▪ Intersects/restricts mining area	
C = Gravity (culverts at Wybong Road) to East across the BMC rehabilitation area	Deleted as a standalone option ▪ May prove feasible when combined with Option G, provided the construction timing fits the BMC dump plan ▪ Would only work as a pump option or pump /gravity hybrid solution	
D = Gravity (culverts at Wybong Road) to West	Deleted ▪ Feasible as a hybrid solution – pump to the north east corner of AL13, then drain by gravity ▪ Avoids the mining area and infrastructure ▪ Environmental offset requirements	
E = Gravity (culverts at Wybong Road) to South (west then south)	Retained ▪ Original concept is feasible subject to NPV and as the first stage of a multiple stage solution	Accepted

Option	Result of initial round of evaluation (deleted or retained) and reasons	Result of second round of evaluation based on "knock-out" developed in workshop and reasons if rejected
H = Mt Arthur pit solution (2,000ML)	Retained ▪ Turns all clean water into dirty water	Accepted
I = Leave creek essentially in same location	Retained ▪ Straighten creek and mine up to creek alignment ▪ Lower cost ▪ Lower mine efficiency versus need to change direction	Rejected ▪ Size of pillar would decrease net present value (NPV) ▪ Environmental impact ▪ Untenable from land acquisition ▪ Severely compromises development programs

2.3 Order of magnitude study (July, 2010)

In July 2010, Parsons Brinckerhoff prepared an Order of Magnitude Study to further investigate the options identified as potentials in the value management workshop. The five potential options formed the basis for seven options that were developed in the order of magnitude study. The seven options prepared at the time are described below. General arrangement drawings for the options are contained within Appendix B.

- Options 1 and 6 – gravity drainage solutions that drain west then south around AL13. These options were characterised by deep cuts (up to 75 m) and extensive earthworks (up to 21 million bank cubic metres of cut).
- Options 2 to 5 – taking into account that the Mount Pleasant Project team were considering various options for their raw water management system at the time, a clean water runoff dam was included immediately upstream of Wybong Road to provide protection against inundation of the BMC void as mining at Bengalla progresses past the existing creek line. These options drained south to the Hunter River or west to Sandy Creek. It should be noted that Option 4 included a combined BMC/Mount Pleasant Project discharge dam.
- Option 7 – this option comprised a dam immediately downstream of Wybong Road on the Dry Creek alignment. The dam storage was to be pumped to a notional Dry Creek channel realigned west of AL13 and draining south to the Hunter River.

Options 1 and 6 were considered long term options as they provided free draining solutions. The other five options required pumps and pipelines and were hence considered to be interim options. These interim options then required Dry Creek to be reinstated through the proposed BMC OEA.

2.4 Value management (options evaluation) workshop (July, 2010)

The options evaluation workshop focused on developing suitable evaluation criteria that represented the priorities of the individual project stakeholders attending the workshop.

An initial list of 22 evaluation criteria identified by the attendees was refined to six items. The adopted evaluation criteria comprised:

- Approvability (statutory) – potential to gain all of the required regulatory approvals required to build and operate the infrastructure.
- Design robustness – the ability of the option to satisfy the design intent risk.
- Operational interaction – clarity of responsibility for ownership and operation between the stakeholders.
- Resource recovery – potential to affect efficient resource recovery.
- Owner's approval.
- Schedule – potential for extended program to adversely impact the Bengalla Mine or proposed Mount Pleasant Project operations.

By consensus, the attendees assigned each criterion a relative weighting and then scored each option on the above criteria. The estimated cost was subsequently factored into the assessment to give a value ratio for each option.

Based on the value ratios, Option 7 was taken to the pre-feasibility study as the base case. Options 3 and 4 were identified for further development in the pre-feasibility phase given there was negligible difference separating them as the next preferred option.

2.5 Pre-feasibility study (2010)

This study aimed to refine the three preferred options identified in the Order of Magnitude study (renamed in this study Options 1, 2 and 3) to increase the order of accuracy of the capital cost estimate, and to recommend an option(s) to take forward to the feasibility stage.

Geotechnical assumptions, environmental characteristics and design criteria were assumed based on Parsons Brinckerhoff's previous project experience with creek diversions in the Hunter Valley, aerial survey data and aerial photography.

The study recommended that Option 3 be adopted for the feasibility stage as the base case. Option 2 was also to be considered for further development to provide operational flexibility for BMC in relation to when Dry Creek is reinstated through the spoil dump area and to minimise the risks associated with constrained dump profiles.

2.5.1 Pre-feasibility addendum

BMC requested Parsons Brinckerhoff to prepare an addendum to the pre-feasibility study to develop sub-options that were called Options 2A, 2B, 3A and 3B. These options were variations to Option 2 and 3 and were developed during the review phase of the pre-feasibility study. These variations offered additional alternatives for the relocation of Dry Creek previously not explored. They were identified as they would:

- Increase flexibility for BMC in the alignment and timing of the Dry Creek reinstatement across the rehabilitation area.
- Provide flexibility for BMC to extend their mining operations west of AL13.

2.5.2 Bridging study

In Option 2 of the pre-feasibility study, a dam for the purpose of discharging water to the Hunter River under the Hunter River Salinity Trading Scheme (HRSTS) that was separate to the Mount Pleasant Project's raw water dam was proposed to be located west of AL13. This dam also included storage capacity equivalent to BMC's existing environmental dam that is proposed to be mined out. At the Value Management workshop held on 29 July 2010 prior to the pre-feasibility study, this arrangement was assessed as feasible by assuming a management plan, procedures and monitoring were able to be established to track volumes of water and water quality in the dam contributed by Mount Pleasant and BMC. This management plan would allow tracking of salinity credits under the HRSTS when discharges were possible. It is noted that in the workshop the criteria 'operational interaction', which related to this sharing, was ranked as the least important factor, out of a total of six factors, when comparing various options.

The intent of the bridging study was to investigate the construction cost of two separate dams having the same total volume as the proposed combined discharge dam. This would eliminate operational issues associated with having a combined discharge dam. The additional sub-options that emerged from this study were known as Option 2A1 and 2A2, and 3A1 and 3A2.

2.6 Feasibility Study (2012)

The feasibility study initially aimed to refine the two preferred options and sub-options, Option 2A1 and 2A2 and Option 3A1 and 3A2, identified in the pre-feasibility addendum to increase the order of accuracy of the capital cost estimates for these options. The options represented the preferred arrangements covering the two different scenarios of the adjacent Mount Pleasant Project proceeding or not proceeding in a timeframe that would facilitate the continuation of the Bengalla Mine Project.

During this study, BMC requested that Option 2B and Option 3B from the pre-feasibility addendum also be included in this feasibility study.

3. Selected interim management system

Subsequent to the feasibility study, BMC selected Option 2A2 as the preferred interim management system option for the Project. As for the feasibility study, all the interim management system options were to be followed by the re-establishment of Dry Creek across final rehabilitated landform of the emplacement areas.

Option 2A2 was adopted by BMC for the interim management system as to mitigate the Project interrupting the Mount Pleasant Project's currently approved discharge route (via RW1 into Dry Creek) it is proposed that BMC, as part of the Project, will construct a 300 ML Mount Pleasant Discharge Dam 1 (MTP DW1) and associated pipeline (see Figure 3.1) in accordance with relevant guidelines and standards.

Following the receipt of Development Consent, if granted, BMC will construct MTP DW1 within a mutually agreeable timeframe, but prior to the commencement of mining operations associated with the Mount Pleasant Project. MTP DW1 will not be utilised in the Project water management system.

Option 2A2 was adopted by BMC for the interim management system as it allows that mining efficiency for the Project is maximised, was compatible with the Mount Pleasant Project's approved works and includes the two separate discharge dams that allow the two mines to remain independent for the HRSTS.

Appendix C contains drawings prepared for this study including general arrangements that summarises Option 2A2, referred to from here in this report as the 'preferred option' or just the interim water management system.

3.1 Option details

The preferred option as presented and assessed in the Mount Pleasant Mine Environmental Impact Statement (MTP EIS) (ERM Mitchell McCotter 1997) demonstrates that the interim water management system developed for the Project is practical with extensive consideration provided in relation to the layout of the approved Mount Pleasant Project. Figure 3.1 illustrates the layout of the interim water management system.

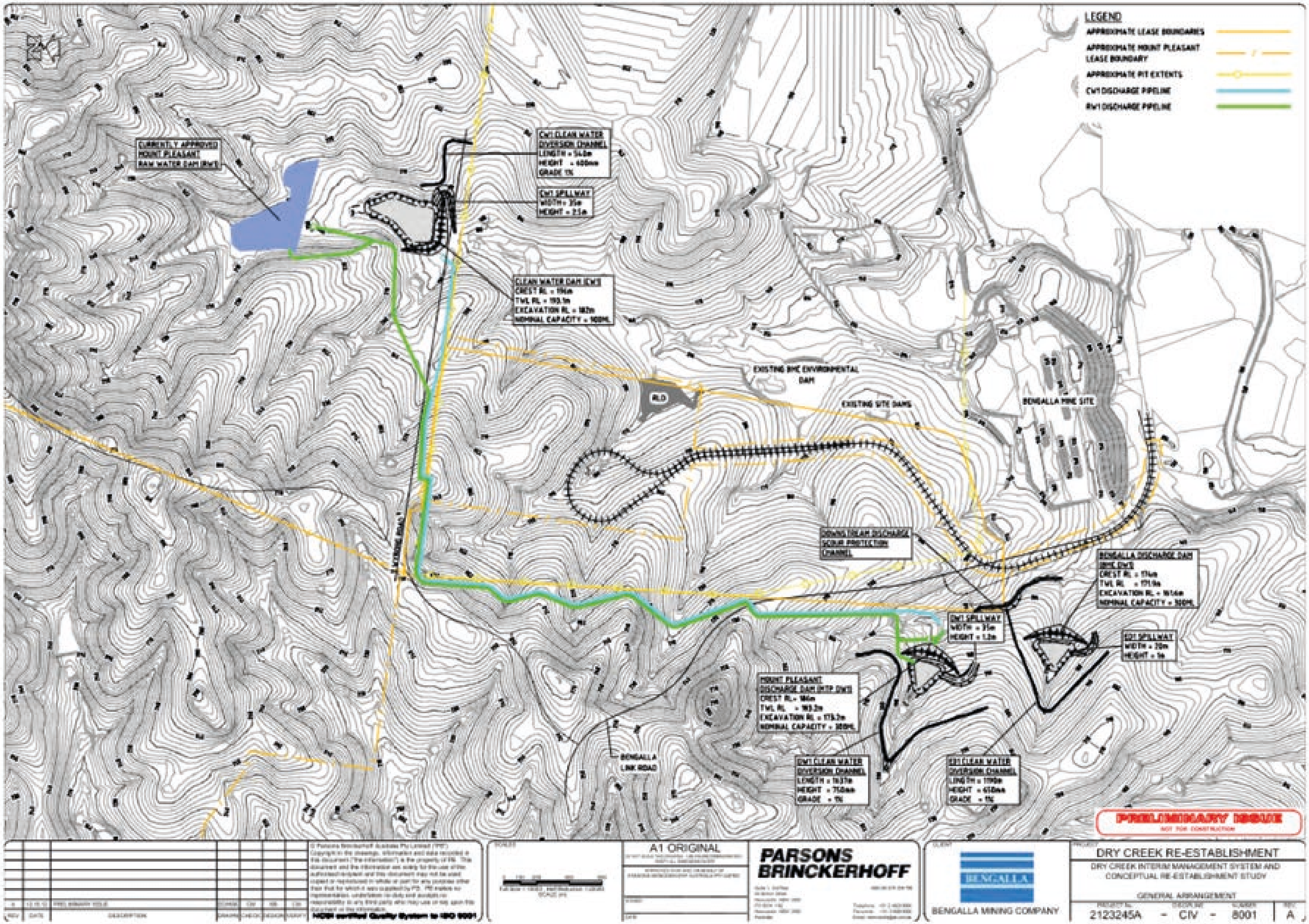


Figure 3.1 Interim management system option – general arrangement

A summary of the interim water management system for the Project is provided below:

- Construction of a clean water dam (CW1) for BMC north of Wybong Road. The dam has been designed to capture the runoff generated from the 1 in 200 year average recurrence interval (ARI), 72 hour storm prior to passing under Wybong Road. Noting that this dam is essentially all surcharge capacity, CW1 has a surcharge capacity of 900 ML to reduce the potential for runoff entering the Project's void. Should the Mount Pleasant Project proceed, the clean water catchment would decrease due to their infrastructure occupying part of the catchment.

- Two separate 300 ML discharge dams located in the west of the Project Boundary. One would be Mount Pleasant's discharge dam (MTP DW1). The other would act as BMC's discharge dam (BMC DW1) and would be a relocation of the existing BMC environmental (or staged discharge) dam; During periods of high rainfall, excess water from the Project can be discharged via BMC DW1 into the Hunter River under the Hunter River Salinity Trading Scheme (HRSTS) during periods of 'high' or 'flood' flows. Discharges will be conducted in accordance with BMC's Environment Protection Licence (EPL) 6538 (which will be varied for the Project) and the *Hunter River Salinity Trading Scheme Regulation 2002*.

- Construction of an approximately 6.4 km long raw water pipeline system from RW1 to the proposed MTP DW1. The pipeline would be bi-directional to allow water to be pumped back to the raw water dam should it be needed back for the Mount Pleasant Project. MTP DW1 and associated pipeline will be constructed by BMC for the Project however Coal & Allied would seek any additional required approvals under the EP&A Act or other relevant legislation to facilitate its use.

- Construction of an approximately 5.4 km long clean water pipeline system from CW1 to a release point in the west of the Project Boundary for release of clean water into the Dry Creek catchment. An energy dissipating structure would be constructed at the end of the pipeline.

- Construction of a pumping station at the outlet of CW1 for the pipeline mentioned in the point above.

- Construction of a downstream scour protection channel to reduce the potential for further scour to the existing topography as a result of both discharge dam and clean water discharge.

- Associated electrical work required for the above to be constructed and operated.

- Construction of the re-established Dry Creek once the final landform is developed following mining operations (see Section 10).

4. Design assumptions

This chapter outlines assumptions made in the design process to date.

4.1 Dams and channels

4.1.1 Clean water dam (CW1)

The following assumptions have been made during the development of the design for CW1:

- The dam capacity is based on normally being empty at the start of the 1 in 200 year average recurrence interval (ARI), 72 hour storm event with a requirement to empty the dam within 14 days following a storm event in order to deal with the same design event again. This time period equates to a design flow of approximately 1,085 L/s. The outlet structure is to be designed to accommodate this flow.
- Based on available geotechnical data, a key trench depth of 3 m into hard clay has been nominated with vertical and horizontal sand filters.
- Select clay fill material for use in the embankments would be won from the excavated storage area.
- The Dams Safety Committee (DSC) would in principle endorse the dam cross sectional design based on the consequence category estimated by Parsons Brinckerhoff. The Project team attended a meeting on 22 August 2012 to discuss the Project including the proposed CW1 construction.
- An access track from Wybong Road to the dam would be required.
- Some excess clay fill material may be sourced from the excavated storage area to assist the Mount Pleasant Project in the construction of their RW1 embankment location if required. Should this material not be required, it would be transferred across Wybong Road under a strict Traffic Control Plan to the approval of Muswellbrook Shire Council.

4.1.2 Discharge dams (MTP DW1 & BMC DW1)

The following assumptions have been made during the development of the design of the two DW1 dams:

- Based on available geotechnical data, a key trench base founded 1 m into extremely weathered rock (approximate depth 3 m) has been nominated for BMC DW1 with vertical and horizontal sand filters.
- Based on available geotechnical data, a key trench base founded 0.5 m into low permeability rock (approximate depth 9.5 m for the highest section of the dam alignment) has been nominated for MTP DW1 with vertical and horizontal sand filters. This is due to the presence of a highly permeable zone of weathered rock.
- Select clay fill material for use in the embankments would be won from the excavated storage area of each dam.

- Outlet structures have been sized for an average discharge rate of 125 ML/day which equates to the largest single day discharge recorded for the existing BMC environmental dam.
- Clean water diversion channels would be constructed upslope of both dams to minimise the external catchment reporting to the dam.
- The DSC would in principle endorse the dam cross sectional designs based on the consequence category estimated by Parsons Brinckerhoff. The Project team attended a meeting on 22 August 2012 to discuss the Project including the proposed BMC DW1 and BMC DW1 construction.
- Access tracks from Bengalla Link Road to the dams would be required.

4.1.3 Downstream scour protection channel

The following assumptions have been made during the development of the design of the downstream scour protection channel:

- The existing topography downstream of the proposed clean water pipeline discharge is already extensively scoured.
- This work is to formalise an already existing natural channel with a minimum width of 10 m.
- Rock rip rap scour protection has been provided where velocities are in excess of 2 m/s for the 1 in 100 year peak flows.

4.1.4 Re-establishment of Dry Creek

The following assumptions have been made during the development of the design of the re-establishment of Dry Creek:

- The design has been based on the Project Year 24 Mine Plan supplied by BMC dated 1 December 2011.
- The horizontal alignment supplied in the landform has been followed however widening has been undertaken where necessary based on hydraulic modelling.
- The vertical alignment has been used as a guide however changes to the vertical geometry are required based on hydraulic modelling and to minimise zones and extents of rip rap scour protection.
- A low flow channel is to convey the two year ARI flows with the overall channel cross section to contain flows up to and including the 100 year ARI event.
- The final landform would be constructed of mine spoil and as such a 2 m thick select clay fill layer would be required for the length of the alignment. It is assumed that BMC over years of mining would stockpile clay in a suitable location for an experienced contractor to condition and use in the construction of the re-establishment of Dry Creek.
- Stabilisation of the top 300 mm of select clay fill with 2% gypsum would be required.

- The re-established Dry Creek would be topsoiled, seeded and hydro mulched to the extents of the select clay fill. Any vegetation outside these limits is considered to be included in BMC's rehabilitation program. The final design criteria and objectives for the re-establishment of Dry Creek would be included in a Rehabilitation and Final Landform Management Plan to be developed in consultation with the relevant authorities and to the satisfaction of the Department of Infrastructure and Planning.

- The termination of the re-established Dry Creek has been selected at a location which is assumed not to be affected by future proposed mining operations and returns to the current Dry Creek catchment.

4.2 Pumps and pipelines

The following assumptions have been made during the development of the design for the pumps and pipelines component of the study:

- The clean water system has been designed based on the requirement to drain the clean water dam CW1 in 14 days, resulting in a design flow of 1085 L/s.

- The raw water system has been designed to deliver a maximum flow of 40 L/s to discharge dam (MTP DW1).

- Geotechnical conditions below the dam foundations support the construction of below dam wall outlet pipelines.

- Geotechnical conditions at proposed pump station sites support a slab-on-the-ground type structure without the need for footings.

- Muswellbrook Shire Council may require that trenchless construction technology be adopted where pipelines cross local roads in order to minimise disruptions to the public road users.

4.3 Electrical and communications

The following assumptions have been made during the development of the design for the electrical and communications component of the study:

- Mount Pleasant Project raw water dam power supply would be available for raw water pumps.

- BMC and the Mount Pleasant water management systems would operate independently.

- Where the impedance values of the transformers are not known, transformer impedance values based on the worst case values given in AS 2374 are suitable for use in the calculations.

- Discrimination settings can be achieved using the selected breakers. Discrimination settings were not checked for circuit breaker sizing.

- Fault limiting fuses can be added to ensure the fault current rating of the circuit breakers is greater than the board fault level. Fuse sizes and locations would need to be confirmed during detailed design.

- Pumps at the CW1 can be started sequentially to minimise the voltage drop across the transformer and cables.
- Cables are sized based on AS3008 with an assumed soil thermal resistivity of 1.2 and an ambient air temperature of 40 degrees C.
- 22kV is the nominal voltage available at the transformer HV terminals. The nominal voltage would be used for motor starting voltage drop calculations.
- Earthing cables specified are sufficient to carry the maximum fault current.
- Motor heaters are required.

The design for the transmission line infrastructure is based on the following assumptions:

- A multiple voltage transmission line (66kV with underslung 22kV) is permitted on site. The new 66kV transmission line is required due to the relocation of the existing 66kV transmission line.
- The 66kV transmission line would need to be commissioned while the CW1 is operational. Prior to commissioning, the 66kV transmission line would be de-energised and earthed at both ends.
- The mine site uses a reticulated earth system.

The design for the generator (auxiliary power supply) infrastructure is based on the following assumptions:

- Two emergency power generators for the pump station options are required as the clean water dam (CW1) is deemed critical infrastructure. An additional generator would be installed as a standby.
- A mine infrastructure area located containerised central generation system (generators and fuel storage) is required. This would allow relocation of the generators and fuel storage to a laydown area next to the pump station should the supply transmission line be compromised.
- The generators would have the ability to synchronise to the site network power. This is required to reduce the risk associated with possible delays with a future Ausgrid application to upgrade supply Bengalla.
- Site has a minimum of 14 days diesel storage (approx. 140,000L) at all times.

The design for the communications infrastructure is based on the following assumptions:

- Optical Ground Wire (OPGW) connection is possible using the proposed electrical infrastructure from BMC.
- A backup or diverse link to CW1 is required due to the criticality of the control required.
- Separate communications equipment and towers are required for both Bengalla and Mount Pleasant Project.
- A 30 m tower is adequate to provide a point to point link to each respective mine. This would be reviewed in the next phase with radio analysis.

5. Design basis

The design basis for the Dry Creek study was broken down into three disciplines: dams and channels, pumps and pipelines, and electrical and communications. The following sections outline the design basis for each of the disciplines.

5.1 Dams and channels

5.1.1 Clean water dam (CW1)

CW1 provides protection for the Bengalla void as mining progresses for the Project. As RW1 has clean water diversion channels around its storage to minimise the effects of the catchment, CW1 captures the remaining overland flows from the catchment north of Wybong Road. The storage of CW1 can be released (via pumps and pipelines) at any time as it is clean water and also guards against associated clean water harvesting rights issues in the catchment. It is proposed that CW1 will be maintained empty to ensure that clean water movement to the Hunter River will not be significantly impaired.

The following design criteria have been adopted for the purposes of the study:

▪ Design life	Approximately 20 years (decommissioned once Dry Creek is re-established).
▪ Catchment area	Total catchment – 603 ha (designed to capture all clean water runoff with or without mining operations commencing for the Mount Pleasant Project).
▪ Storage capacity	900 ML (including excavated storage).
▪ Surcharge capacity	The dam is designed to be operated empty and as such the entire dam volume to the invert of the spillway is surcharge capacity. This has been sized for a 1 in 200 year ARI, 72 hour storm event less the pumping capacity required to empty the storage in 14 days.
▪ Embankment	Zoned earthfill embankment with selected clayfill core and horizontal and vertical sand filters with 3H:1V upstream and downstream batters 3 m trafficable crest width comprising 200 mm gravel capping layer and 2.0 m wide safety bunds (0.5 m high).
▪ Embankment height	13.5 m maximum height at centreline.
▪ Spillway capacity	Sized to pass 1 in 100,000 year ARI event to satisfy DSC requirements for High C consequence category. Rock rip rap scour protection provided to minimise erosion and scour within outlet channel and at sections of the base of the dam embankment.
▪ Spillway section	Trapezoidal cross section with 35 m base width and 3H:1V side slopes.
▪ Estimated DSC Consequence Category	High C.
▪ Minimum freeboard (DSC 3B)	0.4 m.

relocation of the existing BMC Staged Discharge Dam).

The following design criteria have been adopted for the purposes of the study:

▪ Design life	Assume life of mine.
▪ Catchment area (MTP DW1)	Total catchment – 104 ha. Catchment area – 15 ha (excluding catchment area contained by diversion channels).
▪ Catchment area (BMC DW1)	Total catchment – 58 ha. Catchment area – 13 ha (excluding catchment area contained by diversion channels).
▪ Storage capacity	300 ML for individual dams including excavated storage @ top operating level.
▪ Surcharge capacity	Storage between top operating water level and the spillway invert sized for a 1 in 100 year ARI, 72 hour storm event. ≈ 63 ML – MTP DW1. ≈ 40 ML – BMC DW1.
▪ Embankment	Zoned earthfill embankment with selected clayfill core and horizontal and vertical sand filters with 3H:1V upstream and downstream batters 3 m trafficable crest width comprising 200 mm gravel capping layer and 2.0 m wide safety bunds (0.5 m high).
▪ Embankment height (MTP DW1)	16.6 m maximum height at centreline.
▪ Embankment height (BMC DW1)	17.9 m maximum height at centreline.
▪ Spillway capacity (MTP DW1)	Sized to pass 1 in 100,000 year ARI event to satisfy DSC requirements for High C consequence category. Nominal 6 m rock rip rap scour protection provided to minimise erosion and scour within outlet channel.
▪ Spillway section (MTP DW1)	Trapezoidal cross section with 35 m base width and 3H:1V side slopes.
▪ Estimated DSC Consequence Category (MTP DW1)	High C.
▪ Estimated DSC Consequence Category (BMC DW1)	Significant.
▪ Minimum freeboard (DSC 3B)	0.4 m.

5.1.3 Diversion channels

Permanent diversion channels are located upstream of both DW1s to divert clean stormwater runoff away from the dams.

The following design criteria have been adopted for the purposes of the study:

- Design life — Life of mine.
- Design capacity ARI — 1 in 100 year ARI peak flow event.
- Channel cross section — 3 m base width, 3H:1V side slopes.
- Minimum grade — 0.65%: Desirable minimum 1.0%.
- Manning's n — 0.020 (velocity assessment).
  0.035 (capacity assessment).
- Channel lining — Channel linings suitable to provide stable channel for: 1 in 10 year ARI event
  Grass lining provided where V_{50} < 2 m/s.
  Rock scour protection where $V_{50} \geq$ 2 m/s.

5.1.4 Scour protection for channel downstream of discharge dams

A downstream scour protection channel is proposed to formalise the downstream flow path from the CW1 and MTP DW1 discharges and protect the already extensively scoured natural channel in the area.

The following design criteria have been adopted for the purposes of the study:

- Design life — Life of mine.
-
- Design capacity ARI — 1 in 100 year ARI peak flow event.
- Channel cross section — 10 m base width, 3H:1V side slopes.
- Minimum grade — 1.0%.
- Manning's n — 0.020 (velocity assessment).
  0.035 (capacity assessment).
- Channel lining — Channel linings suitable to provide stable channel for 1 in 50 year ARI event.
  Grass lining provided where V_{50} < 2 m/s.
  Rock scour protection where $V_{50} \geq$ 2 m/s.

5.1.5 Re-establishment of Dry Creek

Dry Creek is to be re-established once mining operations have passed through the existing natural alignment of the creek and are sufficiently advanced to allow the overburden emplacement area to be established back to sufficient height. This is anticipated to occur after Year 15 of the Project. This is to be constructed to remove the requirement for a clean water dam and pumping system to divert flow around mining.

The following design criteria have been adopted for the purposes of the study:

- The channel is to follow as close as possible the plan/horizontal alignment indicated in the Year 24 computer model supplied to Parsons Brinckerhoff dated 1st December 2011.
- Provide a 2-stage flow channel with the lower stage capable of safely conveying flood events to and including the 2 year ARI event, and the upper stage capable of safely conveying events up to and including the 100 year ARI event, consistent with good practice flood management guidelines.
- Provide a channel cross section and roughness that allows opportunity for environmental enhancement.
- Provide a channel horizontal and vertical alignment that minimises flow velocities and erosion potential and allows opportunities for environmental enhancement.
- Provide a stable channel that would resist erosion and scour under flood events up to and including the 50 year ARI flood event, consistent with good practice erosion and sedimentation control guidelines.

5.2 Pumps and pipelines

The pumps and pipelines component of the Project comprises of two separate water systems. The first system is to drain clean stormwater runoff captured in BMC's proposed CW1 and release it to a downstream creek, in a manner that does not impede the Project. The second system is to construct the necessary infrastructure components to convey raw water from the Mount Pleasant raw water dam (RW1) to a discharge water dam. As discussed in Section 3 MTP DW1 and associated pipeline will be constructed by BMC for the Project however, Coal & Allied would seek any additional required approvals under the EP&A Act or other relevant legislation to facilitate its use.

Reference guidelines and codes that have been utilised in compiling the design basis for the respective systems can be found in Section 1.4.2.2.

5.2.1 General

General design considerations applicable to the water management systems described above are as follows:

- Pipelines to comprise butt welded co-extruded thermally protected (white) high density polyethylene pipes (PE100) laid on an engineered pipeline formation above ground.
- Pipelines would not incorporate flanged joints unless they are required for the inclusion of fixtures or appurtenances. Should pipelines require relocation in the future they would have to be cut into moveable sections before relocation and re-welded once relocated.
- Both pipelines would be co-aligned in a services corridor including combined pipeline and access track formation, environmental bunding, an overhead powerline easement and a catch water berm. The formation has been widened to allow for snaking of the pipelines above ground.

- Pipes are to be sized such that they deliver the required design flow in an aged condition.
- Pipeline appurtenances such as air valves and scour valves are to be located above ground to avoid valve chambers that would constitute a confined space.
- Both pipeline systems would incorporate pigging facilities for cleaning the pipeline.
- Pipe pressure classes have been determined based on required delivery pressures, making allowances for de-rating due to temperature and surge effects, but not, after taking into account all factors, to be less than PN10.
- No allowance has been made for cyclic fatigue de-rating of pressure classes due to the infrequent use of the pipelines.

5.2.2 Raw water system

The specific design criteria adopted for the raw water system for the purposes of the study is listed in Table 5.1.

Table 5.1 Raw water system criteria

System element	Criteria
Operational requirements	
System delivery	3.45 ML/day or 40 L/s (nominated during the pre-feasibility study)
Design flow envelope (ML/day)	No envelope – considered to be a batch flow system with no allowance for augmentation
Design life of system	50 years for pipeline and fixed structures
	15 years for fixed mechanical equipment
System configuration	Transfer facility to be bi-directional between raw water dam RW1 and MTP discharge dam DW1. No pump station is required downstream of the BMC DW1 dam.
Pigging	Pig launching facility provided at RW1 pump station and receiving station at the bifurcation valve station near the DW1 discharge dam embankment
Pressure pipeline design criteria	
Pumped medium	Saline raw water collected from mining areas at the Mount Pleasant mine
Pipeline configuration	Single pipeline above ground, with buried sections below roadways and access tracks, laid parallel to the clean water system pipeline wherever possible
Pipeline optimisation	Not considered due to infrequent pipeline use
Kinematic viscosity of water	1.01×10^{-6} m^2/s for water at 20°C (AS 2200 – 2006)
Colebrook –White friction factor (k)	0.015 mm (range in AS 2200 – 2006 : 0.003 – 0.015 mm)
Pipeline sizing	Based on acceptable velocity envelope
Acceptable velocity range	$1.0 \leq v \leq 2$ m/s
Selected pipe size	Based on criteria a DN250mm pipeline was selected
Design pipeline temperature	35°C
Permissible system operating head after temperature de-rating	PN10 (80 m), PN12.5 (100 m), PN16 (128 m), PN20 (160 m) – (Vinidex HDPE Design Manual – Table 4.7)

System element	Criteria
Allowance for thermal movements	Snaking induced by anchoring the pipe at 60m intervals to allow for a 2.5m lateral deflection based on a maximum diurnal temperature fluctuation of 18°C
Minimum Hydraulic Grade Line (HGL) at any point	10 m above natural ground level at all locations
Wave celerity to determine transients	PN10 (290 m/s), PN12.5 (320 m/s), PN16 (360 m/s)
Pipeline appurtenances	
Air valves	At all high points
Air valve sizing	In accordance with American Water Works Association (AWWA) Manual M51 – Air Release, Air Vacuum and Combination Air Valves
Scour valves	At all low points with Camlok fittings to allow for scouring to tankers rather than release into local creeks
Pipeline bunding	In the event of rupture the pipeline spills into an environmental bund which discharges to environmental dams at low points, sized to hold an hour of pumped flow
Fittings	All fittings and appurtenances to be PN16
Transient mitigation measures	None required
Pipeline outlet	
Outlet configuration	The raw water pipeline discharges into either DW1 or RW1 depending on the direction of pumping. In order to achieve bi-directionality a valve-controlled branch facility is provided near each dam embankment (bifurcation station)
Discharge to dam	A pipeline from the valve-controlled branch facility discharges into both DW1 and RW1 via a precast concrete headwall with downstream riprap protection located in the impoundment zone of the dam
Velocity	Discharge velocities are low at approximately 1.2 m/s, and hence no special erosion protection requirements are necessary at the pipe discharge point
Pump station	
Pump station configuration	Two land based stations downstream of the dam embankments, one at DW1 and one at RW1 comprising of an uncovered concrete slab-on-ground on which pumps, valves and motor control centres are mounted
Pig launching facility	Provided at RW1 pump station due to the lower operating head from RW1 to DW1, with the retrieval station located at the bifurcation valve station
Pump configuration	Single duty and single standby pump
Maximum dynamic pumping head	RW1 to MTP DW1 – 70 m
(RW1 and CW1 on Mount Pleasant land)	MTP DW1 to RW1 –105 m
Fixed pump type	Centrifugal single stage end suction pumps
Pump motor	Fixed speed electrically driven with direct coupled drive
Pump control	Manual operation by way of remote SCADA system at the Mount Pleasant mine infrastructure area control centre
Leak detection	Electromagnetic flow meters are provided at the RW1 and DW1 pump stations and at the dam discharge points. These would be used to monitor the water balance in the system, if the meters detect an imbalance pumps would be switched off and an alarm signal displayed on the Mount Pleasant SCADA system.

5.2.3 Clean water system

The specific design criteria adopted for the clean water system for the purposes of the study is listed in Table 5.2.

Table 5.2 Clean water system criteria

System element	Criteria
Operational requirements	
System delivery	Drain CW1 in 14 days or 1,085 L/s (nominated during the pre-feasibility study)
Design flow envelope (ML/day)	No envelope – considered to be a batch flow system with no allowance for augmentation
Design life of system	50 years for pipeline and fixed structures
	15 years for fixed mechanical equipment
System configuration	Transfer to be uni-directional from CW1 to the creek outlet
Pigging	Pig launching facility provided at CW1 pump station and receiving station at the flow control station immediately upstream of the discharge point
Pressure pipeline design criteria	
Pumped medium	Stormwater runoff from the CW1 catchment consistent with slightly turbid surface water with little to no salinity
Pipeline configuration	Single pipeline above ground with buried sections below roadways and access tracks laid parallel to the raw water system pipeline wherever possible
Pipeline optimisation	Undertaken during pre-feasibility study and determined to be a DN710mm size
Kinematic viscosity of water	1.01×10^{-6} m^2/s for water at 20°C (AS 2200 – 2006)
Colebrook –White friction factor (k)	0.015 mm (range in AS 2200 – 2006 : 0.003 – 0.015mm)
Pipeline sizing	Based on acceptable velocity envelope
Acceptable velocity range	$1.0 \leq v \leq 4.0$ m/s (infrequently used) maximum velocity more a function of tolerable transients resulting from changes to steady state hydraulics
Selected pipe size	Based on optimisation undertaken during pre-feasibility study a DN710mm pipeline was selected
Design pipeline temperature	35°C
Permissible system operating head after temperature de-rating	PN10 (80 m), PN12.5 (100 m), PN16 (128 m), PN20 (160 m) – (Vinidex HDPE Design Manual – Table 4.7)
Allowance for thermal movements	Snaking induced by anchoring the pipe at 60 m intervals to allow for a 2.5 m lateral deflection based on a maximum diurnal temperature fluctuation of 18°C
Minimum Hydraulic Grade Line (HGL) at any point	10 m above natural ground level at all locations
Wave celerity to determine transients	PN10 (290 m/s), PN12.5 (320 m/s), PN16 (360 m/s)
Pipeline appurtenances	
Air valves	At all high points
Air valve sizing	In accordance with American Water Works Association (AWWA) Manual M51 – Air Release, Air Vacuum and Combination Air Valves
Scour valves	At all low points with discharge directly to local creeks
Pipeline bunding	Not specifically required

System element	Criteria
Fittings	All fittings and appurtenances to be PN16
Transient mitigation measures	None required
Pipeline outlet	
Flow control	Orifice plate incorporated immediately upstream of outlet point to raise the upstream HGL and achieve an HGL at least 10 m above ground level for the extent of the pipeline
Outlet configuration	Pipeline discharge to creek via an impact energy dissipation structure designed in accordance with the HEC-14 guideline (see listed references)
Pump station	
Pump station configuration	Land based pump station comprising of an uncovered slab-on-ground structure.
Pig launching facility	Provided at CW1 pump station with the retrieval station located at the flow control station immediately upstream of the discharge point
Pump configuration	Three duty and single standby pumps (subject to confirmation from supplier)
Maximum dynamic pumping head	CW1– 100 m
Fixed pump type	Centrifugal single stage split case pumps (land based and mounted on pontoons i.e. same pump type for both configurations)
Pump motor	Fixed speed electrically driven with direct coupled drive
Pump control	Manual operation by way of remote SCADA system at the Bengalla mine infrastructure area control centre
Leak detection	Not specifically provided as pumped medium is not environmentally detrimental

5.3 Electrical and communications

Due to limited availability of technical information, assumed specifications and design documentation have been used as the basis for the electrical design criteria in conjunction with the following site specific criteria:

- BMC water infrastructure within the Project Boundary would be fed from the BMC power system.
- Water infrastructure located outside of the Project Boundary would be fed from Ausgrid.
- Independent electrical and communications infrastructure would be used to operate and communicate from the dams to each mine.
- To minimise CAPEX transmission lines would follow pipeline routes.
- Transmission lines would be located to avoid coal sterilisation.
- 66kV and 22kV systems would be based on the existing conductors used on site.

6. Geotechnical site conditions

As part of the feasibility study, Parsons Brinckerhoff undertook geotechnical investigations at the proposed infrastructure locations. An interpretive report was prepared following the investigations which covered all six options in the feasibility study.

The investigation comprised drilling fourteen boreholes with packer testing and excavating thirty-two test pits across the various locations. Boreholes and test pits at the CW1 locations both north and south of Wybong Road typically encountered a deep residual sandy clay/clayey sand soil through the drainage lines overlying extremely low to very low strength rock. The investigation for the discharge dams located to the west of the existing Bengalla Link Road generally encountered a shallow residual soil profile overlying very low to medium strength rock. The dam locations are generally disused farmland previously used for grazing.

Laboratory results indicated that the residual soil across the site was generally low to medium plasticity, moderately reactive and partially to fully dispersive. The site soils are likely to be generally suitable for use in the construction of the dam embankments following some treatment to control dispersion and shrink/swell.

Packer testing and water losses recorded during drilling indicated that the rock mass across the site generally has a low to moderate permeability with some higher permeable layers.

6.1 Clean water dam (CW1)

Topsoils generally comprised low plasticity sandy clay/silt to depths of 0.05–0.25 m underlain by colluvial silty clay on the hill slopes, which was between 0.1 m to 0.4 m thick and alluvial silty clay between 0.4 m to 1.0 m thick in the drainage lines. These soils were underlain by very stiff to hard, medium plasticity, residual sandy clay/clayey sand. Residual soils were encountered to depths of 7.0 m to 15.0 m in drainage lines.

Residual soils were underlain by weathered rock. Weathered rock consisted of generally highly to distinctly weathered siltstone and sandstone of extremely low to low strength. Typically rock strength increased with depth.

6.2 Discharge dams (MTP DW1 & BMC DW1)

Topsoil was generally found to depths between 0.05 m to 0.2 m and occasionally underlain by soft alluvial/colluvial silty clay between 0.2 m to 0.9 m thick. Residual, very stiff to hard, medium plasticity sandy clay was typically found underlying the alluvial/colluvial material overlying weathered rock.

Weathered siltstone and sandstone was generally encountered between depths of 1.0 m and 3.6 m and was typically moderately to distinctly weathered (which is slightly less weathering than the CW1 sites).

No groundwater was encountered during the investigation at the discharge dam locations.

7. Dam and channel design development

The design criteria outlined in Section 5.1 was used as a basis for the development of the designs to 'feasibility stage'.

A geotechnical design report for the dams was prepared following assessment of the site conditions. The report outlines the detailed design of the dam cross sections and forms the basis for the design development.

Drawings for the infrastructure are included in Appendix C.

7.1 Clean water dam (CW1)

Several concept options for the location of CW1 were assessed by Parsons Brinckerhoff. The options assessed possible locations given the constraint of Mount Pleasant's approved infrastructure and potential future options. BMC's proposed CW1 location consists of an embankment and excavated storage to achieve the required storage volume without encroaching on Mount Pleasant's approved RW1 embankment to the north.

7.1.1 Outlet structure

An outlet structure is required for CW1 to enable the clean water from the dams to be pumped around the proposed mine void and released into the Dry Creek catchment.

The outlet pipe is a single 750 mm diameter pipe and has been designed as a trench installation to be constructed below the dam foundation and cut off trench. The trench would be backfilled using Zone 1 clays to prevent seepage paths developing along the pipe trench. A concrete plug 5 m long is provided directly below the dam cut off trench. The pipes shall comprise spigot and socket joined cement mortar lined ductile iron pipes (DICL).

7.1.2 Spillway

Emergency spillways are located to the east of the dam embankments and have been sized for a 1 in 100,000 year annual exceedance probability storm event based on DSC requirements. The spillway channels incorporate rip rap scour protection with an allowance for rock filled mattresses and gabions to the toe of the dam embankments due to the close proximity of the spillway channels which are constrained by Wybong Road in the south.

7.2 Discharge dams (MTP DW1 & BMC DW1)

Release of raw water to the Hunter River under the HRSTS is proposed to be undertaken separately for Mount Pleasant (MTP DW1) (following receipt of appropriate approvals) and BMC (BMC DW1).

The locations selected for the discharge dams follow the pre-feasibility bridging study locations of suitable natural valleys west of Bengalla Link Road. During geotechnical investigations it was discovered that there are higher seepage results at the northern of the two locations due to the presence of a higher permeability zone of weathered rock. This high seepage would require a much deeper key trench than the southern location.

7.2.1 Outlet structure

Similar to the CW1 embankment, outlet structures for the discharge dams have been designed as trenched installations to be constructed below the dam foundation and cut off trench. Pipe trenches would be backfilled using Zone 1 clays to prevent seepage paths developing along the pipe trench. A concrete plug 5 m long would be provided directly below the dam cut off trenches. Pipelines would comprise spigot and socket joined cement mortar lined ductile iron pipes (DICL).

The pipelines have been sized so as to restrict the maximum discharge rate when the dam is full to equate to a pipeline velocity of less than 4.5 m/s while achieving an average discharge rate of 125 ML/day. Prolonged operation of DICL pipelines at greater than this velocity can damage linings. In order to reduce velocities in the pipelines, orifice plates have been incorporated at the valve and metering station sized to creating a headloss sufficient to reduce outlet velocities.

A valve and metering station has been provided at the outlet from each discharge dam to facilitate automatic release of water by way of a motor actuated valve as well as a metering system so the volume of water released can be accurately measured and reported under the HRSTS.

For discharge dam MTP DW1 the valve station incorporates a reducing tee that supplies water to the raw water pump station for raw water return to RW1. The tee occurs upstream of the discharge flow meter so pumped flow back to RW1 is not erroneously recorded as a discharge to the creek. Independent flow meters are provided immediately downstream of the pump station to record the volume of water returned to RW1.

Once discharge water has passed through the valve and metering station it is discharged into the creek through an impact energy dissipater, which is a relatively small concrete box-like structure that requires no tailwater for successful performance. Energy dissipation is initiated by flow striking a vertical baffle and being redirected upstream by the horizontal portion of the baffle and the floor creating horizontal eddies.

7.2.2 Spillway

Emergency spillways have been incorporated into the discharge dams to prevent failure of the dam by overtopping during large storm events. The emergency spillways direct dam overflows away from the dam embankments and are excavated into the natural topography.

7.3 Diversion channels

A single diversion drain diverts upstream clean water runoff from the east of CW1 to the clean water dam storage.

Additional clean water diversion channels are located upstream of the discharge dams. These channels would minimise the volume of water entering the discharge dams. Runoff generated from extreme storm events that exceed the capacity of the diversion channels would be captured by the discharge dams.

7.4 Scour protection for channel downstream of discharge dams

The additional flows to the natural downstream topography due to the clean water and discharge dam outlets were assessed for their effects on scour in the natural downstream topography. A HECRAS analysis (a computer model developed by the Hydrologic Engineering Centre, U.S. Army Corps of Engineers) was undertaken to estimate velocities along the channel and assess if any rock scour protection was necessary.

The 1 in 100 year ARI peak flow event for the existing natural catchment was estimated to be 13.7 m^3/s. The peak flow storm event for this catchment has a time of concentration of 80 minutes with a resulting storm duration of 210 minutes.

The combined flow rate of the pumped flow from CW1, MTP DW1 and BMC DW1 is 4.6 m^3/s including 1.0 m^3/s direct from CW1. We note the probability of a licensed discharge event from both discharge dams (adequate flow in the Hunter River) coinciding with a peak flow storm event (localised, relatively short duration storm) is relatively low. The probability of the peak flow storm event occurring and the CW1 pumps running is higher. In this case 1.0 m^3/s flow would be added to the existing estimated peak flow of 13.7 m^3/s.

A 600 m section was assessed as requiring formalisation to lower longitudinal grades and reduce velocities. A 10 m wide channel has been designed to accommodate these flows with rock scour protection also nominated in sections. An allowance for gypsum stabilising of the base is also included to minimise dispersion of material.

8. Pumps and pipelines design development

The design criteria outlined in Section 5 was used as a basis for the development of the designs to ‘feasibility stage’.

The following sections summarise the key issues that have driven the development of the pumps and pipelines design.

8.1 Pipeline alignment and services corridor

Key issues that have driven the pipeline alignment and services corridor are:

- Alignments of clean and raw water pipelines are included in a services corridor that can be serviced by a single access track and includes an overhead powerline.
- Criteria for the selection of the proposed services corridor included:
  - location of relevant Dry Creek relocation infrastructure
  - locating the corridor to the west of the future BMC mine extent
  - minimising the length of the pipelines while restricting corridor vertical grades to those acceptable to all weather trafficability
  - avoiding crossing rail and road infrastructure where possible
  - clustering pipeline outlet and dam discharge locations to simplify power and communications provision
  - containing the corridor within mine owned land.
- The formation for the services corridor incorporates a 4 m wide gravelled access track adjacent to a 4 m wide platform on which parallel DN710mm and DN250mm pipes are laid for the clean water and raw water systems respectively. The 4 m wide pipeline formation includes a 2.5 m wide expansion zone for the polyethylene pipes (PE100). This is provided to accommodate the 'snaking’ of above ground PE100 pipelines that occurs due to thermal expansion and contraction. The pipelines would be anchored or staked at 60 m intervals to restrict the lateral movement of the pipelines to within the allocated 2.5 m width.
- The corridor includes an overhead powerline easement parallel and off-set by 16 m, from the edge of the access track. This easement zone would not be on a formed surface and would essentially be on cleared natural ground. An upstream catch water berm is provided along the corridor to reduce the stormwater runoff reporting to the services corridor. This berm is sized to divert a 10 year ARI storm event away from the services corridor. The services corridor would have a total width of 45 m.
- Pipelines would be laid above ground to reduce the capital cost of the systems but would be buried below watercourses to prevent wash-away during high ARI rainfall events in addition to below road crossings.
- In order to provide all weather access to the pipelines for inspection and maintenance purposes, floodway crossings would be provided where the access track crosses watercourses. These crossings would comprise twin DN600mm reinforced concrete pipes below a 10 m long by 4 m wide concrete causeway. These have nominally been designed to be trafficable in a 5 year ARI peak flow storm event.

- The services corridor incorporates an environmental drain or bund that captures any raw water that may escape from the raw water system due to pipe rupture. These drains report to environmental ponds at low points on the alignment, which are sized to capture an hour of pumped flow. The raw water system has been equipped with flow totalising instrumentation that would monitor the water balance in the system and detect any difference between the volume of water leaving the pump station and that arriving at the receiving dam. An imbalance in flow readings would trigger a pump shut down and activate an alarm.

- No pipeline appurtenances such as air and scour valves are to be located in buried pits or chambers avoiding the need for operating staff to enter confined spaces to access infrastructure.

- Pipelines have been specified as co-extruded PE100 (white pipes) to counter the detrimental effect of temperature on the pressure capability of PE100 pipes. An operating temperature of 35°C has been used for design purposes.

- Where there is a possibility of vacuum conditions arising in the pipeline due to any operating condition, a minimum pressure class of PN12.5 has been adopted to eliminate the possibility of buckling collapse of pipelines.

- A pigging facility has been introduced for each system to facilitate cleaning of pipelines periodically, after comments received during the Safety in Design workshop.

- The clean water pipeline releases directly to a creek adjacent to the discharge dams while the raw water pipeline discharges directly into the impoundment area of RW1 on the one end and the MTP DW1 on the other. Erosion protection is provided at the discharge point for all pipelines, comprising an impact energy dissipater for the clean water pipeline and a simple precast concrete headwall with downstream rip rap protection for the raw water pipeline.

8.2 Pump stations

Where possible, pump stations have been designed as land-based installations located approximately 20 m from the toe of the downstream embankment of the relevant dams. From a design perspective, this results in a permanent positive suction head on the pump inlet so no priming of pumps would be required and low pressure cavitation issues are eliminated. It also allows for easy access for maintenance.

Pump stations all comprise a simple slab-on–ground structure with pumps, valves and meters mounted on it. No covering structure has been provided. Valves have been allowed for so that pump stations may be isolated from supply dams and discharge pipelines for maintenance.

All pump stations are provided with a redundancy of at least one pump.

9. Electrical and communications design development

9.1 High voltage

Key issues during the design development included:

- The likelihood that the existing Ausgrid 11kV infrastructure could not manage the anticipated increased load to CW1.
- The discharge dams are proposed to be connected to the Ausgrid network due to the small loads, close proximity to the Ausgrid network and the discharge dams being located outside of the mine lease.
- The use of an interim transmission line for CW1 was discounted early in the investigation as mining would occur in that area during the operational time frame.
- The Safety in Design review identified that as part of the mine development plan a 66KV transmission line would be required to be relocated to along the proposed 22kV CW1 supply long term route. Options investigated following the Safety in Design meeting included:
  - Building separate 22kV and 66kV transmission lines when they are required. This was discarded as the additional costs and increased easement required resulted in lost mine production.
  - Building a 66kV transmission line and utilising it at 22kV until the 66kV relocation is required. This was discarded due to the requirement for a HV substation resulting in additional costs and space requirements to transform the voltage from 66kV to 22kV and then 22kV to 0.415kV within the limited space that is available at the CW1 site.
  - Building a 66kV transmission line and operating at 66kV. This option was discarded due to the cost and space issues noted above on item (ii).
  - Building a 66kV transmission line with 22kV underslung. The 66kV transmission line would be de-energised and earthed at both ends until required. This was the recommended option as it provides the ability to relocate the 66kV transmission line in the future at minimal additional cost while minimising easement requirements for CW1 substations and transmission lines.

9.2 Clean water pump station (CW1)

Key issues during the design development included:

- Power to the pump station would be supplied from the BMC high voltage power supply network or generators.

9.3 Discharge dam pump station (MTP DW1 & BMC DW1)

Key issues during the design development included:

- Separate switchboards would be required for Mount Pleasant and Bengalla discharge dams.
- Separate local Ausgrid 11kV connections have been provided for each discharge dam. The proposed power supply to the dams would be from a dedicated local Ausgrid 11kV overhead line.

9.4 PLC control system and SCADA

9.4.1 Clean water pump station (CW1)

The pump station would be controlled via a Programmable Logic Controller (PLC) to start and stop the pumps according to measured dam levels (primary control). When the dam level is detected at the minimum height practical to start the pumps, the pumps would be started and when the dam level is detected as low, pumps would be stopped.

9.4.2 Discharge dam control station – Bengalla (BMC DW1)

The control station would be controlled via a Programmable Logic Controller (PLC) to open the discharge valve and release water from the discharge dam (flowing to the Hunter River). This would only occur when a permit to release water under the HRSTS is provided to BMC.

9.5 Communications

The communications strategy is based around both radio and optical ground wire (OPGW) fibre links. 30 m towers at discharge dams and CW1 are proposed to provide a point to point link to each respective mine. It is assumed that BMC already has Motorola Canopy towers that can be used to complete each link. This would be reviewed in the next phase with a radio analysis.

10. Dry Creek re-establishment design development

The option presented in this study relies on pumping from a clean water dam to discharge clean water harvested to protect the BMC mining area. This option is considered an interim management system as the pumping arrangement would not be acceptable as a permanent configuration when the mine moves into care and maintenance prior to closure.

The re-establishment of Dry Creek is the final permanent solution and is based on constructing a channel through the overburden emplacement area. Section 2 of this report summarises all the options reviewed to arrive at this permanent solution.

10.1 Flows

To assess the provided alignment and refine as required, a HECRAS hydraulic model of the creek was developed to assess channel capacities for flood conveyance, and channel geometry and alignment for minimisation of scour potential and provision of environmental enhancement opportunities.

Existing catchment flows were determined using the Rational Method and a summary of the flows is presented in Table 10.1. The total catchment area was estimated to be 1,644 hectares and is unchanged from the catchment area prior to development. It is noted that this area includes the catchment area near the downstream extent of the re-established Dry Creek (hence flows adopted are conservative in the upstream reaches of the channel). Any future drop structures from the final landform catchments would be documented in a Dry Creek Management Plan and accounted for in design.

Table 10.1 Dry Creek catchment flows

1yr ARI	2yr ARI	5yr ARI	10yr ARI	20yr ARI	50yr ARI	100yr ARI
6.3 m^3/s	9.5 m^3/s	14.3 m^3/s	18.4 m^3/s	23.9 m^3/s	33.0 m^3/s	41.8 m^3/s

10.2 Geometry

10.2.1 Overview

Several options were assessed to determine an optimum solution which would strike a balance between:

- Minimising modifications to the provided final landform channel geometry.
- Providing the required capacity for flood conveyance.
- Providing opportunities for environmental enhancement within the re-established creek corridor.
- Providing long term stability.

The option presented in this study closest follows the vertical alignment with modifications where necessary to keep grades and hence velocities at a level that minimises the erosion and scour potential under extreme flood events. It is assumed that the final landform would be shaped as per the proposed re-established Dry Creek alignment to minimise the amount of bulk earthworks construction required prior to an experienced contractor being engaged for the final shaping, lining and scour protection. Drawing 8005 in Appendix C illustrates the conceptual proposed re-established Dry Creek design and is shown in Figure 10.1.

The termination of the creek alignment was selected based on the provided final landform contours and at a location in which is reconnected to the existing Dry Creek alignment west of the Bengalla Rail Loop.

10.2.2 Channel cross section

The proposed cross section is shown on Drawing 8006 in Appendix C and is portioned into two sections. A low flow channel to cater for relatively frequent flood events up to the 2 year ARI event and a larger high flow channel to contain flows up to and including the 100 year ARI event. Details of the re-established Dry Creek are summarised in Table 10.2.

Table 10.2 Re-established Dry Creek design characteristics

Parameter	Design size
Channel length	4,500 m
Base width	8 m
Low flow channel side slopes	1V:4H
Low flow channel depth	0.77 m
High flow channel side slopes	1V:10H
High flow channel depth	varies
Manning’s n	0.04
Channel slope	varies
Rock scour protection	where velocity > 2m/s for the 1 in 50 ARI event

As the re-establishment of the creek would be constructed on mine spoil, a 2 m thick select clay fill layer has been included in the design for the length of the alignment to reduce seepage into the spoil. Within the last five years, a similar but shorter arrangement was approved and then constructed for Xstrata’s Mount Owen operations. The clay required is assumed to be won by BMC during its mining operations and stockpiled for later use by a construction contractor. As the quality of this material is unconfirmed at this stage, an allowance for gypsum stabilising the top 300 mm has also been included. This allowance would be reviewed prior to construction when material proposed for the clay lining is available for testing.

The channel cross section incorporates a wide flow channel with shallow gradient side slopes in both the low and high flow channels. This minimises flood depths and velocities, therefore minimising the level of flood hazard and erosion potential within the channel when conveying significant flows. The wide, open and shallow gradient features of the cross section provide opportunity for environmental enhancement of the channel through establishment of vegetation. A relatively high value of Manning’s roughness has been assumed which would allow significant vegetation growth to establish within the channel in the long term without affecting flood capacity. Figure 10.2 shows the proposed channel cross section.

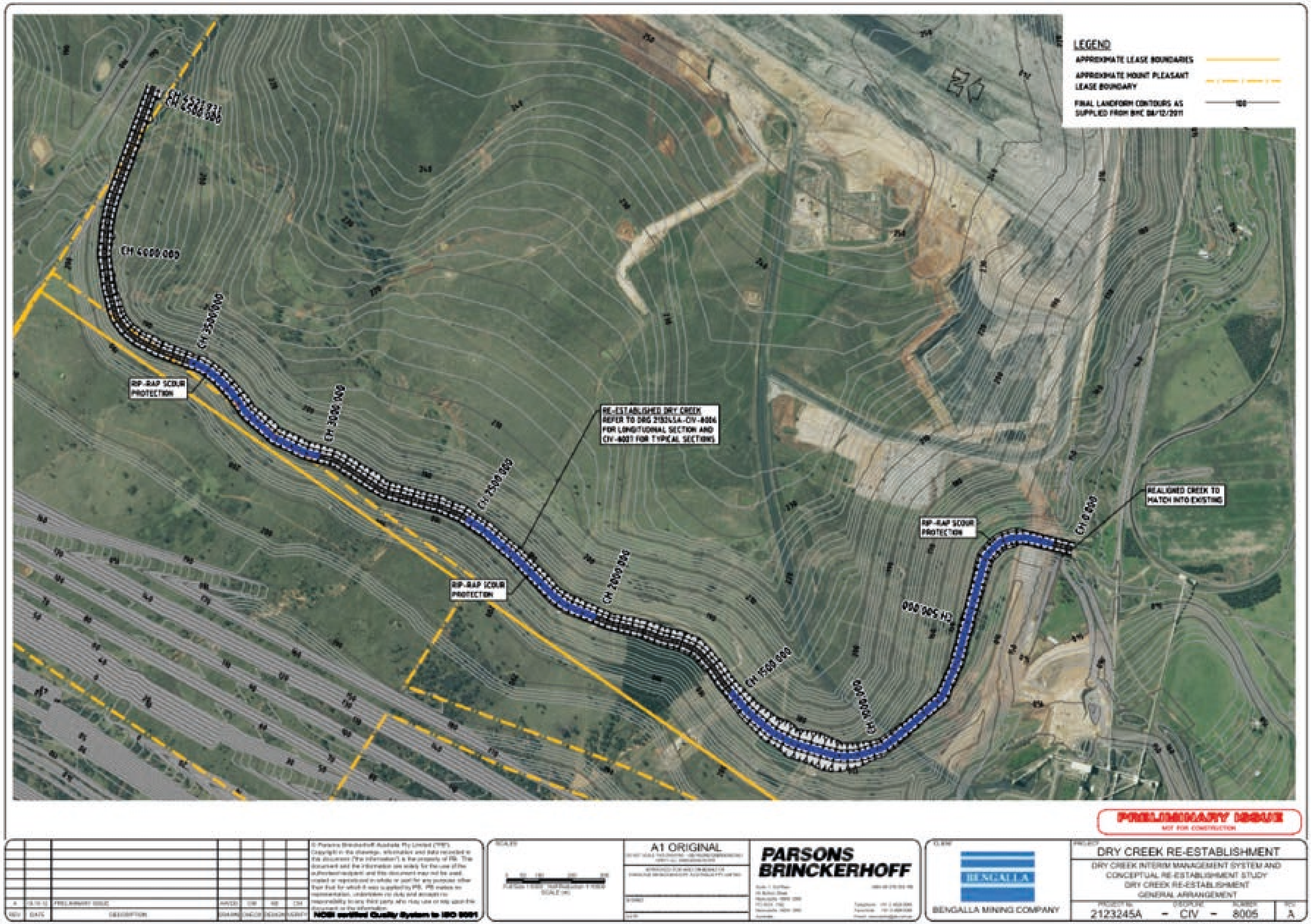


Figure 10.1 Conceptual proposed re-established Dry Creek alignment

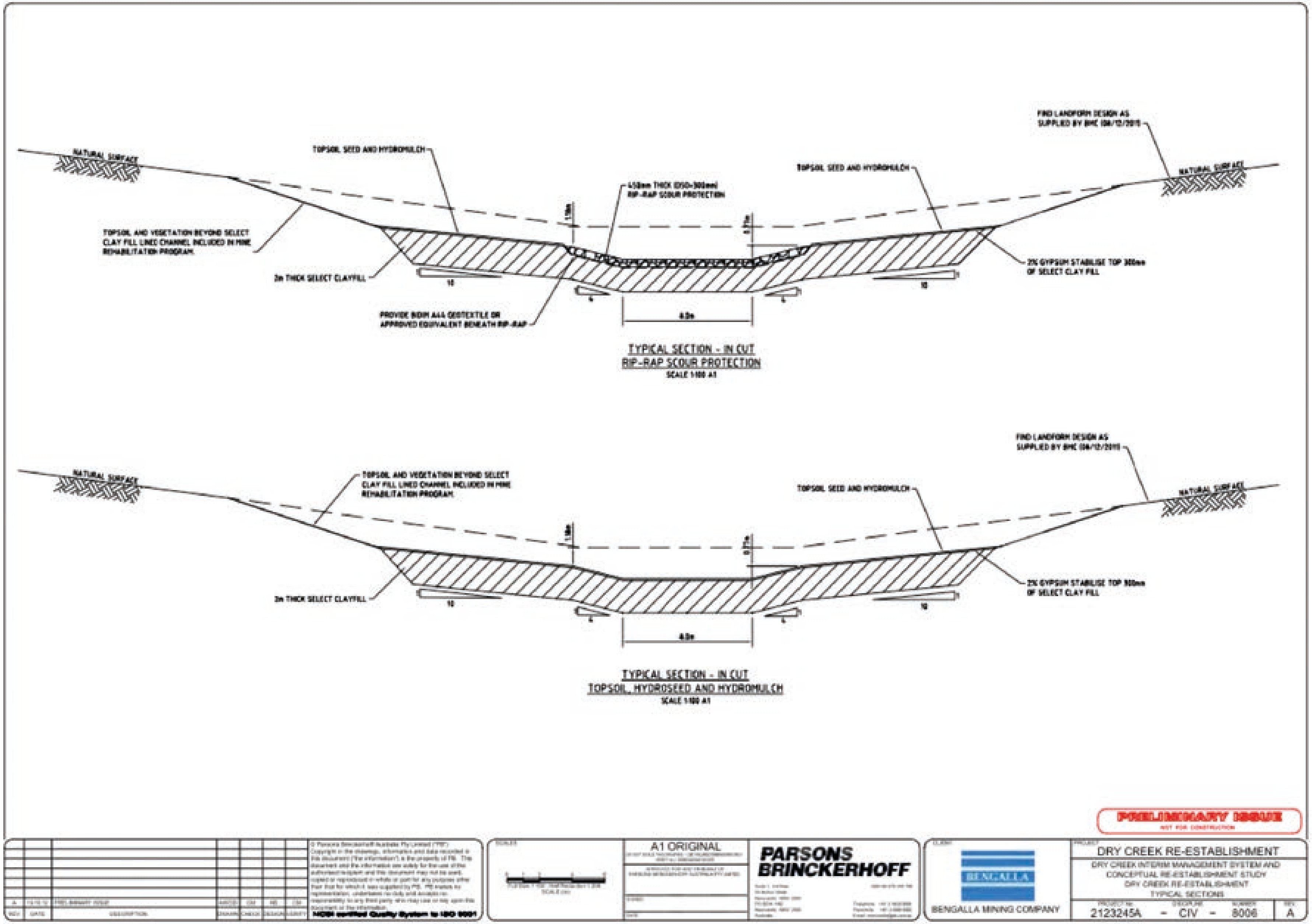


Figure 10.2 Conceptual proposed cross section for Dry Creek

10.2.3 Alignment and longitudinal profile

The proposed alignment and longitudinal profile are shown on Drawings 8005 and 8007 in Appendix C. The landform design provided the opportunity to design the re-established creek with a reasonably meandering course, which provides some variation in flow energy and velocity that is typically displayed in natural creeks. The longitudinal profile was designed to minimise steep gradients and drops that would produce excessive flow velocities requiring extensive rock protection and armouring of the channel to resist scour.

However, given the site constraints it was not possible to design out all steep gradients within the channel, and some areas of rip rap protection to resist scour and erosion are required. The rip rap design is indicated on Drawing 8005 in Appendix C. In these steep sections the rip rap is designed to resist erosion and scour for events up to and including the 50 year ARI event. Therefore, the design provides a highly stable channel that would resist erosion and sedimentation processes under extreme flood events.

10.3 Impacts of the creek re-establishment

The re-established creek has been designed to safely convey flood flows in accordance with good practice flood management and watercourse stability guidelines. The catchment area and design flood flows are unchanged from the pre-development condition; therefore, the re-established creek does not result in increased peak flows from the catchment. It is likely that the re-established creek results in a modified flow hydrograph at its downstream end where it re-joins the natural channel, due to the modified stream length and floodplain characteristics. While the re-established creek is likely to be more efficient at conveying flow than in the pre-development case, a longer stream length has been introduced which would offset the effect of increased flow efficiency. Further assessment of the impacts on the flow hydrograph would be investigated at the next stage of design; however, at this stage it is envisaged that these impacts are likely to be minor.

The design also provides opportunity for environmental enhancement of the creek corridor through provision of a reasonably meandering horizontal alignment with generally shallow longitudinal gradients; and a varied two-stage cross section with shallow side slopes and significant capacity for vegetation growth.

10.4 Monitoring and maintenance

BMC will develop a Dry Creek Rehabilitation Management Plan in consultation with the relevant regulators which will outline monitoring requirements and maintenance works during establishment of the channel.

Appendix A

Photographic record of Dry Creek


Legend
GPS Photo Location
GPS Photo Direction
Photo 1
Photo 2
Photo 3
Photo 4
Photo 5
Photo 6
Photo 7
Photo 8
Photo 9
Photo 10
Photo 11
Photo 12
Photo 13
Photo 14
Photo 15
Photo 16
Photo 17
Photo 18
Photo 19
Photo 20
Photo 21
Photo 22
Photo 23
Photo 24
Photo 25
Photo 26
Photo 27
Photo 28
Photo 29
Photo 30
Photo 31
Photo 32
Photo 33
Photo 34
Photo 35
Photo 36
Photo 37
Photo 38
Photo 39
Photo 40
Photo 41
Photo 42
Bengalla Dry Creek Project
Overview
PARSONS BRINCKERHOFF

Bengalla Dry Creek Project

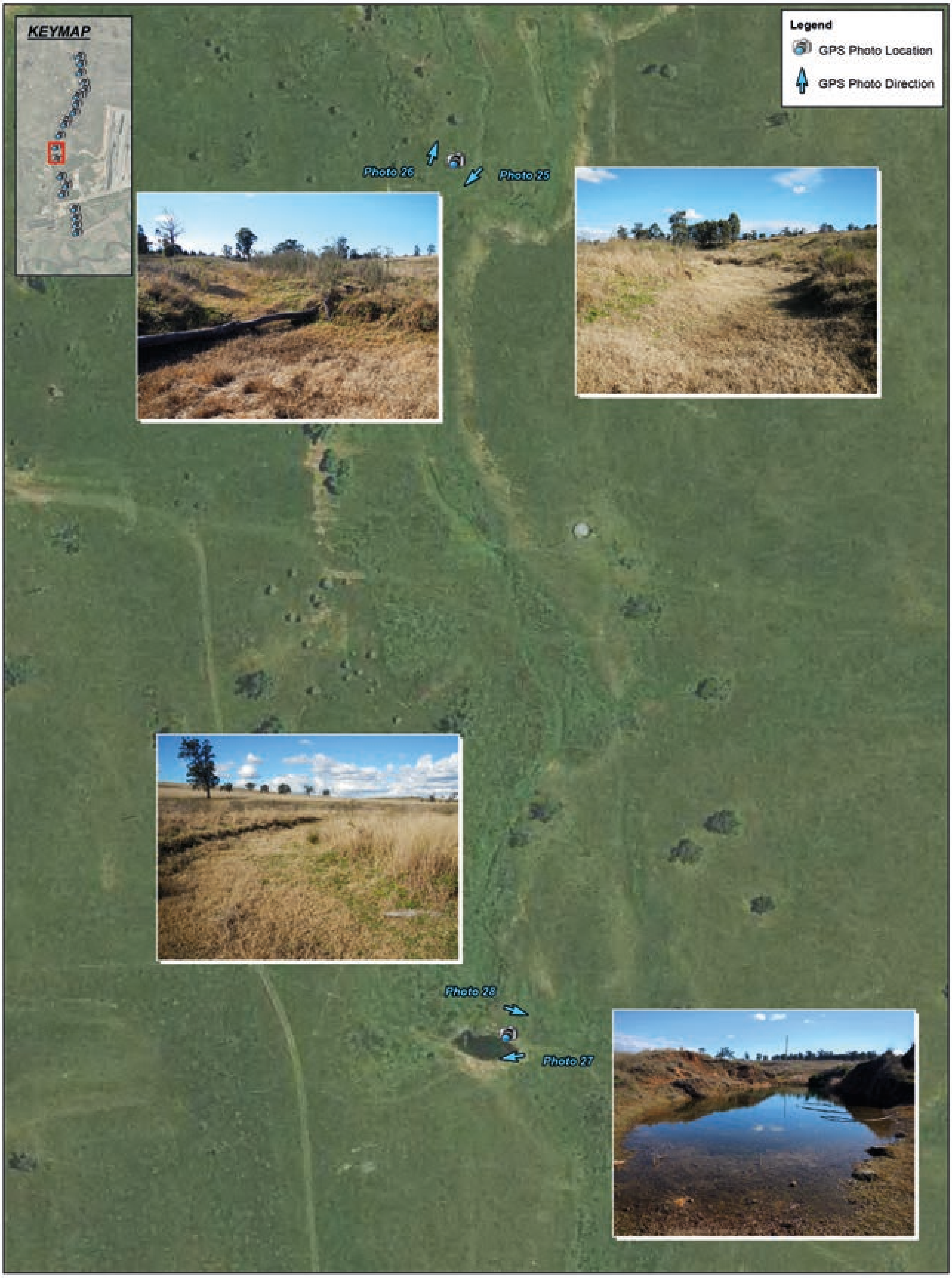
Figure 1
GPS Photo Locations Sheet 1

PARSONS BRINCKERHOFF


KEYMAP
Legend
GPS Photo Location
GPS Photo Direction
Photo 7
Photo 8
Photo 10
Photo 9
Photo 12
Photo 11
Data Source:
Drawing No: Sheet_2
Author: XX
Date: XX/XX/2011
Editor: XX
Print Date: 25/07/2012
Revision: A1
Review: XX
Scale 1:1,500
Scale correct when printed at A3 Format
www.pb.com.au
Bengalla Dry Creek Project
Figure 2
GPS Photo Locations Sheet 2
PARSONS BRINCKERHOFF


KEYMAP
Legend
GPS Photo Location
GPS Photo Direction
Photo 13
Photo 14
Photo 15
Photo 16
Photo 17
Photo 18
Data Source:
Drawing No: Sheet_3
Author: XX
Date: XX/XX/2011
Editor: XX
Print Date: 25/07/2012
Revision: A1
Review: XX
Scale 1:1,500
Scale correct when printed at A3 Portrait
www.pb.com.au
Bengalla Dry Creek Project
Figure 3
GPS Photo Locations Sheet 3
PARSONS BRINCKERHOFF


KEYMAP
Legend
GPS Photo Location
GPS Photo Direction
Photo 20
Photo 19
Photo 22
Photo 21
Photo 24
Photo 23
Bengalla Dry Creek Project
Figure 4
GPS Photo Locations Sheet 4
PARSONS BRINCKERHOFF



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Editor: XX	Print Date: 25/07/2012	
Revision: A1	Review: XX	Scale correct when printed at A3 Portrait

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Bengalla Dry Creek Project

Figure 5
GPS Photo Locations Sheet 5

PARSONS BRINCKERHOFF

Data Source:	Drawing No: Sheet_6	Scale 1:1,500	Bengalla Dry Creek Project
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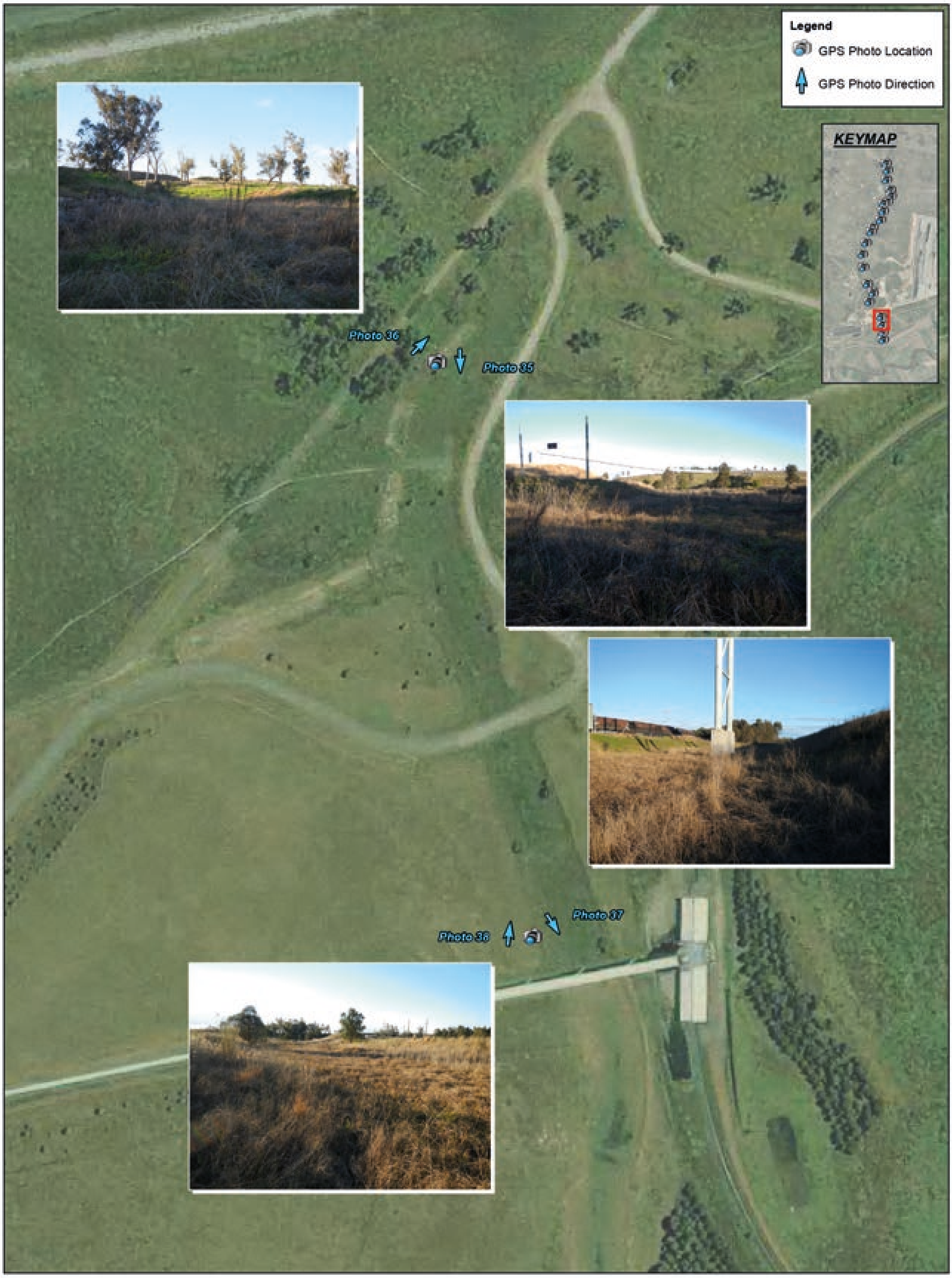
	Editor: XX / Print Date: 25/07/2012		GPS Photo Locations Sheet 6
	Revision: A1 / Review: XX	Scale correct when printed at A3 Format	PARSONS BRINCKERHOFF
Client Name Goes Here in Text		www.pb.com.au	



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Editor: XX	Print Date: 25/07/2012	
Revision: A1	Review: XX	

Data Source:

www.pb.com.au

Bengalla Dry Creek Project

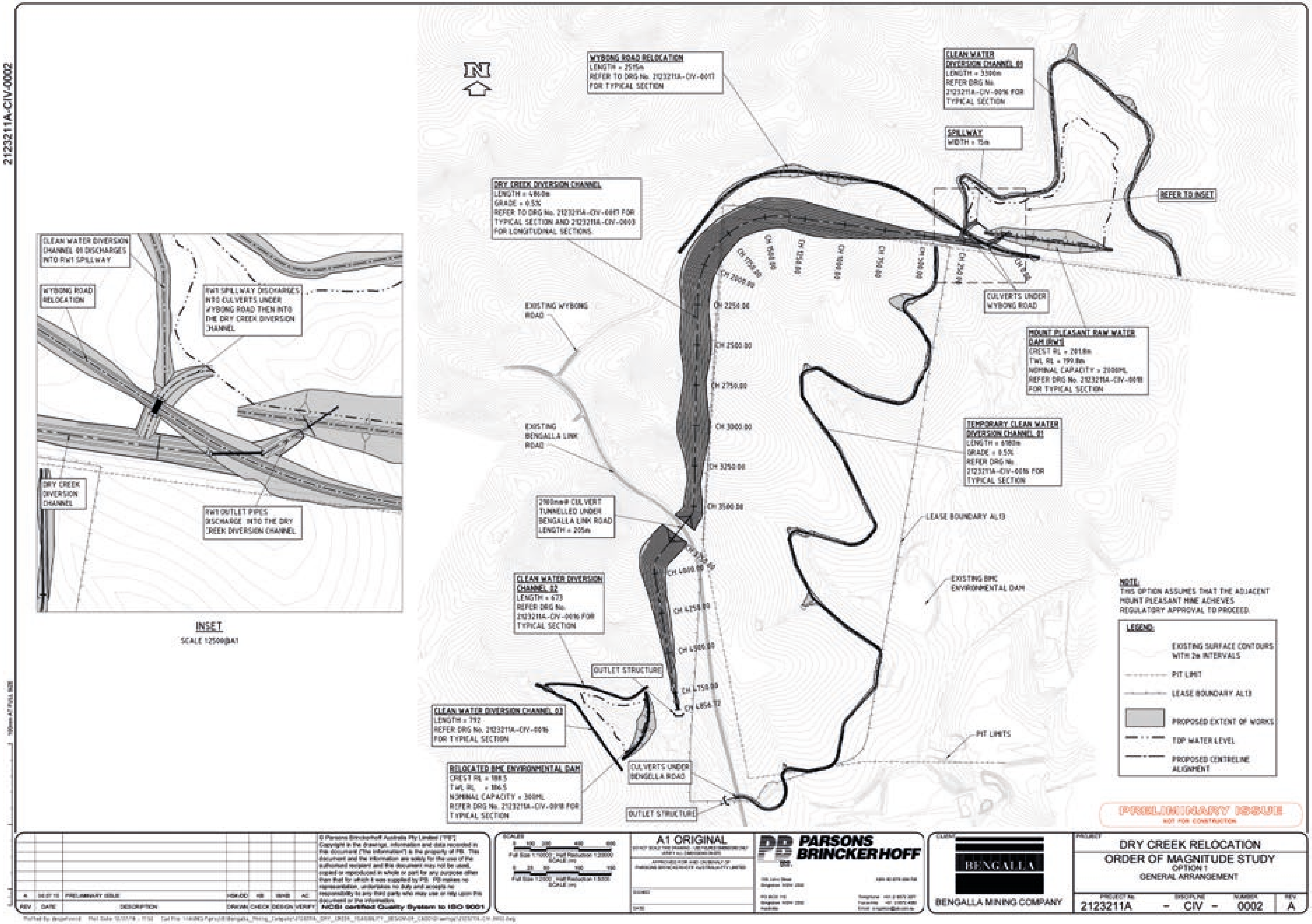
Figure 7
GPS Photo Locations Sheet 7

PARSONS BRINCKERHOFF

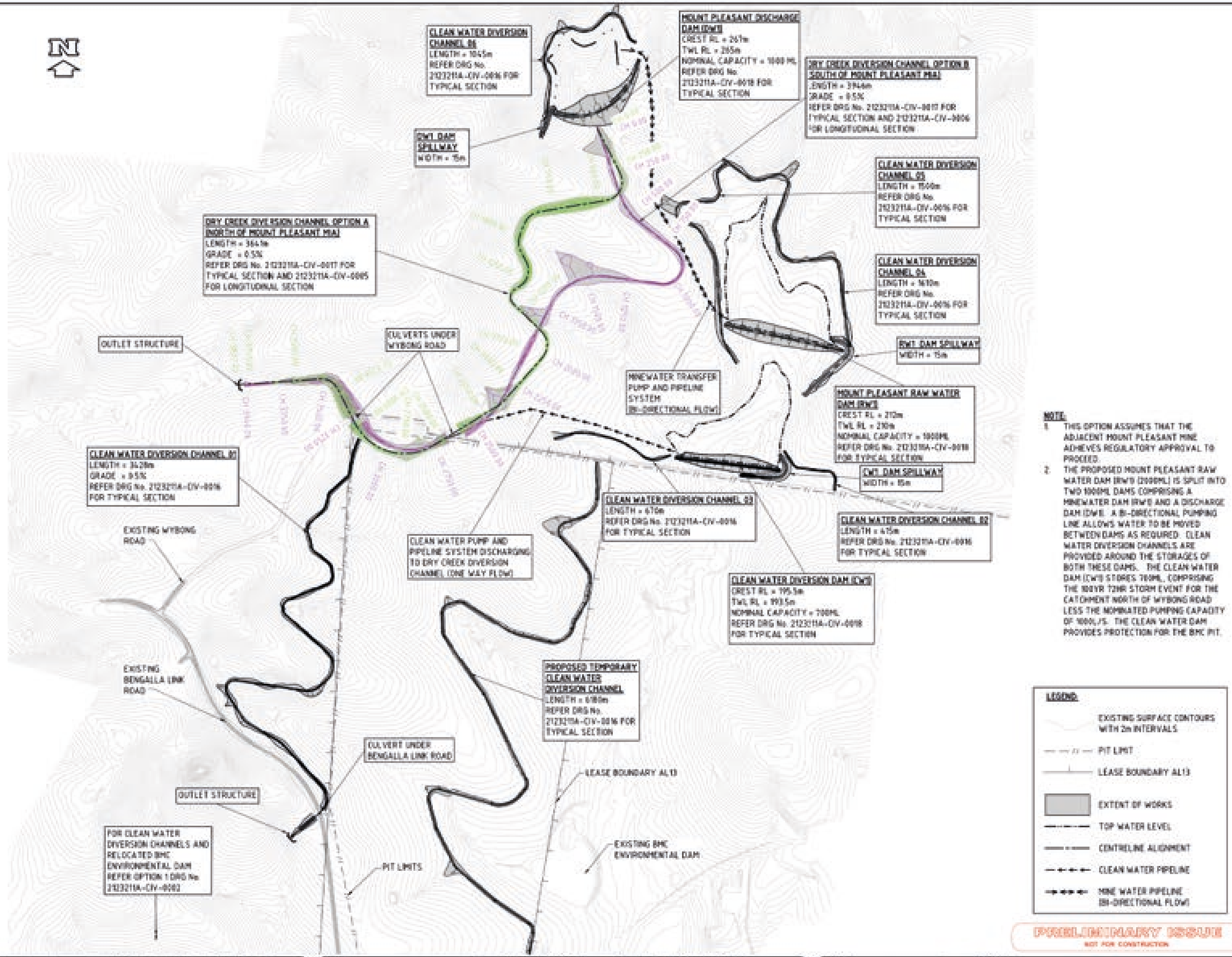

Legend
GPS Photo Location
GPS Photo Direction
KEYMAP
Photo 40
Photo 39
Photo 41
Photo 42
Bengalla Dry Creek Project
Figure 8
GPS Photo Locations Sheet 8
PARSONS BRINCKERHOFF

Appendix B

Order of magnitude study
Dry Creek relocation options
drawings


2123211A-CIV-0002
WYBONG ROAD RELOCATION
LENGTH = 2515m
REFER TO DRG No. 2123211A-CIV-0017 FOR TYPICAL SECTION
CLEAN WATER DIVERSION CHANNEL 00
LENGTH = 3300m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
SPILLWAY
WIDTH = 15m
REFER TO INSET
DRY CREEK DIVERSION CHANNEL
LENGTH = 4860m
GRADE = 0.5%
REFER TO DRG No. 2123211A-CIV-0017 FOR TYPICAL SECTION AND 2123211A-CIV-0003 FOR LONGITUDINAL SECTIONS.
CULVERTS UNDER WYBONG ROAD
MOUNT PLEASANT RAW WATER DAM (RW1)
CREST RL = 201.8m
TWL RL = 199.8m
NOMINAL CAPACITY = 2000ML
REFER DRG No. 2123211A-CIV-0018 FOR TYPICAL SECTION
EXISTING WYBONG ROAD
EXISTING BENGALLA LINK ROAD
TEMPORARY CLEAN WATER DIVERSION CHANNEL 01
LENGTH = 6180m
GRADE = 0.5%
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
2100mmØ CULVERT TUNNELLED UNDER BENGALLA LINK ROAD
LENGTH = 205m
LEASE BOUNDARY AL13
CLEAN WATER DIVERSION CHANNEL 02
LENGTH = 673
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
EXISTING BMC ENVIRONMENTAL DAM
OUTLET STRUCTURE
CLEAN WATER DIVERSION CHANNEL 03
LENGTH = 792
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
PIT LIMITS
RELOCATED BMC ENVIRONMENTAL DAM
CREST RL = 188.5
TWL RL = 186.5
NOMINAL CAPACITY = 300ML
REFER DRG No. 2123211A-CIV-0018 FOR TYPICAL SECTION
CULVERTS UNDER BENGALLA ROAD
OUTLET STRUCTURE
CLEAN WATER DIVERSION CHANNEL 00 DISCHARGES INTO RW1 SPILLWAY
WYBONG ROAD RELOCATION
RW1 SPILLWAY DISCHARGES INTO CULVERTS UNDER WYBONG ROAD THEN INTO THE DRY CREEK DIVERSION CHANNEL
DRY CREEK DIVERSION CHANNEL
RW1 OUTLET PIPES DISCHARGE INTO THE DRY CREEK DIVERSION CHANNEL
INSET
SCALE 1:2500@A1
NOTE:
THIS OPTION ASSUMES THAT THE ADJACENT MOUNT PLEASANT MINE ACHIEVES REGULATORY APPROVAL TO PROCEED.
LEGEND:
EXISTING SURFACE CONTOURS WITH 2m INTERVALS
PIT LIMIT
LEASE BOUNDARY AL13
PROPOSED EXTENT OF WORKS
TOP WATER LEVEL
PROPOSED CENTRELINE ALIGNMENT
PRELIMINARY ISSUE
NOT FOR CONSTRUCTION
A1 ORIGINAL
PARSONS BRINCKERHOFF
NCSI certified Quality System to ISO 9001
BENGALLA
BENGALLA MINING COMPANY
DRY CREEK RELOCATION
ORDER OF MAGNITUDE STUDY
OPTION 1
GENERAL ARRANGEMENT
2123211A - CIV - 0002 A

2123211A-CIV-0004



NOTE:
1. THIS OPTION ASSUMES THAT THE ADJACENT MOUNT PLEASANT MINE ACHIEVES REGULATORY APPROVAL TO PROCEED.
2. THE PROPOSED MOUNT PLEASANT RAW WATER DAM (RW1) (2000ML) IS SPLIT INTO TWO 1000ML DAMS COMPRISING A MINEWATER DAM (RW1) AND A DISCHARGE DAM (DW1). A BI-DIRECTIONAL PUMPING LINE ALLOWS WATER TO BE MOVED BETWEEN DAMS AS REQUIRED. CLEAN WATER DIVERSION CHANNELS ARE PROVIDED AROUND THE STORAGES OF BOTH THESE DAMS. THE CLEAN WATER DAM (CW1) STORES 700ML, COMPRISING THE 100YR 72HR STORM EVENT FOR THE CATCHMENT NORTH OF WYBONG ROAD LESS THE NOMINATED PUMPING CAPACITY OF 1000L/S. THE CLEAN WATER DAM PROVIDES PROTECTION FOR THE BMC PIT.

REV	DATE	DESCRIPTION	DRAWN	CHECK	DESIGN	VERIFY
A	06.07.10	PRELIMINARY ISSUE	HSK/DD	KB	MKB	AC

SCALES
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SCALE (m)

A1 ORIGINAL

PARSONS BRINCKERHOFF

CLIENT: BENGALLA
BENGALLA MINING COMPANY

PROJECT: DRY CREEK RELOCATION
ORDER OF MAGNITUDE STUDY
OPTION 2
GENERAL ARRANGEMENT

PROJECT No.	DISCIPLINE	NUMBER	REV
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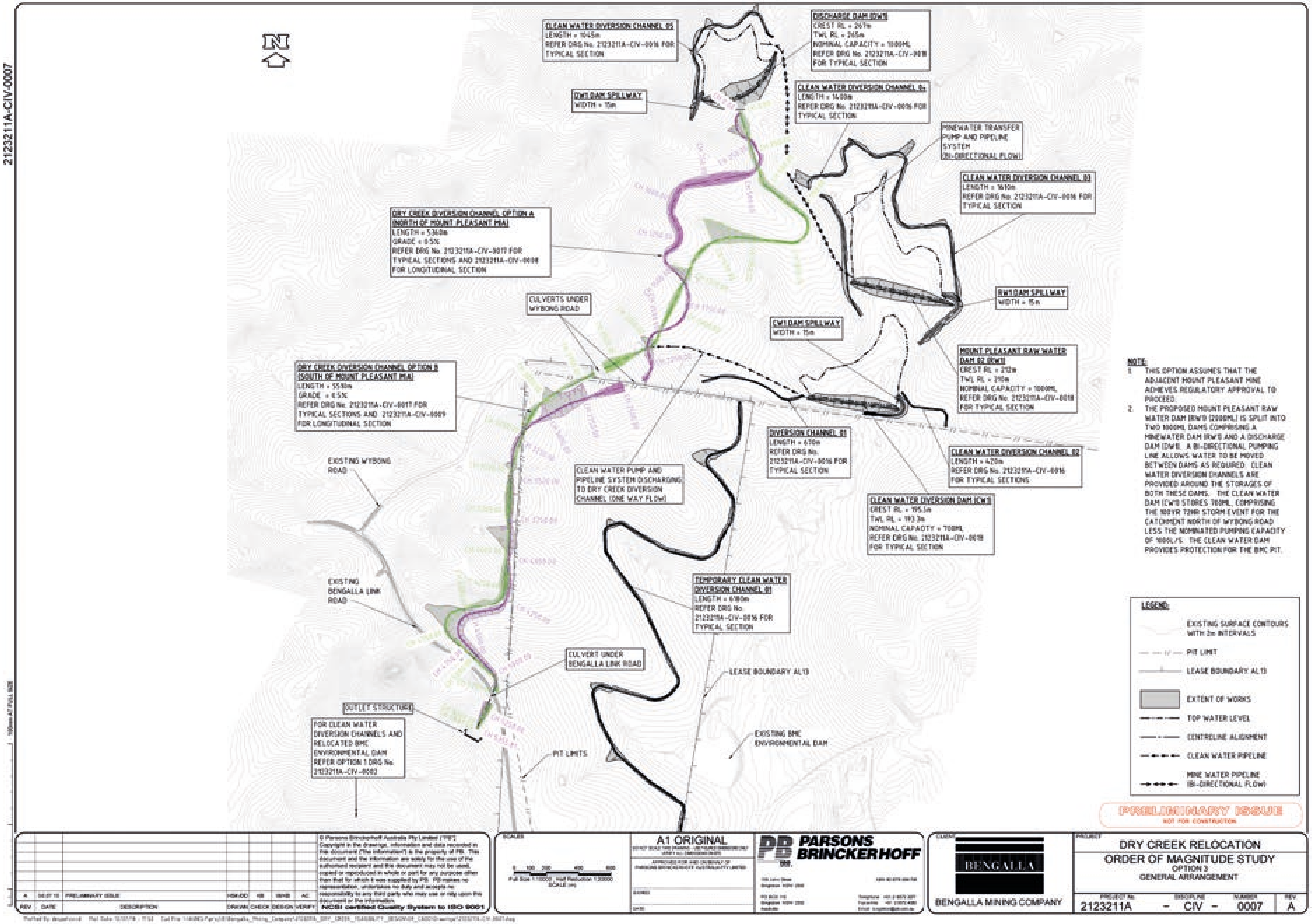
2123211A-CIV-0007
CLEAN WATER DIVERSION CHANNEL 05
LENGTH = 1045m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
DISCHARGE DAM (DW1)
CREST RL = 267m
TWL RL = 265m
NOMINAL CAPACITY = 1000ML
REFER DRG No. 2123211A-CIV-0018 FOR TYPICAL SECTION
DW1 DAM SPILLWAY
WIDTH = 15m
CLEAN WATER DIVERSION CHANNEL 04
LENGTH = 1400m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
MINEWATER TRANSFER PUMP AND PIPELINE SYSTEM (BI-DIRECTIONAL FLOW)
CLEAN WATER DIVERSION CHANNEL 03
LENGTH = 1610m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
DRY CREEK DIVERSION CHANNEL OPTION A (NORTH OF MOUNT PLEASANT MIA)
LENGTH = 5360m
GRADE = 0.5%
REFER DRG No. 2123211A-CIV-0017 FOR TYPICAL SECTIONS AND 2123211A-CIV-0008 FOR LONGITUDINAL SECTION
CULVERTS UNDER WYBONG ROAD
RW1 DAM SPILLWAY
WIDTH = 15m
CW1 DAM SPILLWAY
WIDTH = 15m
MOUNT PLEASANT RAW WATER DAM 02 (RW1)
CREST RL = 212m
TWL RL = 210m
NOMINAL CAPACITY = 1000ML
REFER DRG No. 2123211A-CIV-0018 FOR TYPICAL SECTION
DRY CREEK DIVERSION CHANNEL OPTION B (SOUTH OF MOUNT PLEASANT MIA)
LENGTH = 5510m
GRADE = 0.5%
REFER DRG No. 2123211A-CIV-0017 FOR TYPICAL SECTIONS AND 2123211A-CIV-0009 FOR LONGITUDINAL SECTION
DIVERSION CHANNEL 01
LENGTH = 670m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
CLEAN WATER DIVERSION CHANNEL 02
LENGTH = 420m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTIONS
EXISTING WYBONG ROAD
CLEAN WATER PUMP AND PIPELINE SYSTEM DISCHARGING TO DRY CREEK DIVERSION CHANNEL (ONE WAY FLOW)
CLEAN WATER DIVERSION DAM (CW1)
CREST RL = 195.3m
TWL RL = 193.3m
NOMINAL CAPACITY = 700ML
REFER DRG No. 2123211A-CIV-0018 FOR TYPICAL SECTION
NOTE:
1. THIS OPTION ASSUMES THAT THE ADJACENT MOUNT PLEASANT MINE ACHIEVES REGULATORY APPROVAL TO PROCEED.
2. THE PROPOSED MOUNT PLEASANT RAW WATER DAM (RW1) (2000ML) IS SPLIT INTO TWO 1000ML DAMS COMPRISING A MINEWATER DAM (RW1) AND A DISCHARGE DAM (DW1). A BI-DIRECTIONAL PUMPING LINE ALLOWS WATER TO BE MOVED BETWEEN DAMS AS REQUIRED. CLEAN WATER DIVERSION CHANNELS ARE PROVIDED AROUND THE STORAGES OF BOTH THESE DAMS. THE CLEAN WATER DAM (CW1) STORES 700ML, COMPRISING THE 100YR 72HR STORM EVENT FOR THE CATCHMENT NORTH OF WYBONG ROAD LESS THE NOMINATED PUMPING CAPACITY OF 1000L/S. THE CLEAN WATER DAM PROVIDES PROTECTION FOR THE BMC PIT.
EXISTING BENGALLA LINK ROAD
TEMPORARY CLEAN WATER DIVERSION CHANNEL 01
LENGTH = 6180m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
LEGEND:
EXISTING SURFACE CONTOURS WITH 2m INTERVALS
PIT LIMIT
LEASE BOUNDARY AL13
EXTENT OF WORKS
TOP WATER LEVEL
CENTRELINE ALIGNMENT
CLEAN WATER PIPELINE
MINE WATER PIPELINE (BI-DIRECTIONAL FLOW)
CULVERT UNDER BENGALLA LINK ROAD
LEASE BOUNDARY AL13
OUTLET STRUCTURE
FOR CLEAN WATER DIVERSION CHANNELS AND RELOCATED BMC ENVIRONMENTAL DAM
REFER OPTION 1 DRG No. 2123211A-CIV-0003
PIT LIMITS
EXISTING BMC ENVIRONMENTAL DAM
PRELIMINARY ISSUE
NOT FOR CONSTRUCTION
A1 ORIGINAL
PARSONS BRINCKERHOFF
NCSI certified Quality System to ISO 9001
BENGALLA
BENGALLA MINING COMPANY
DRY CREEK RELOCATION
ORDER OF MAGNITUDE STUDY
OPTION 3
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2123211A - CIV - 0007 A
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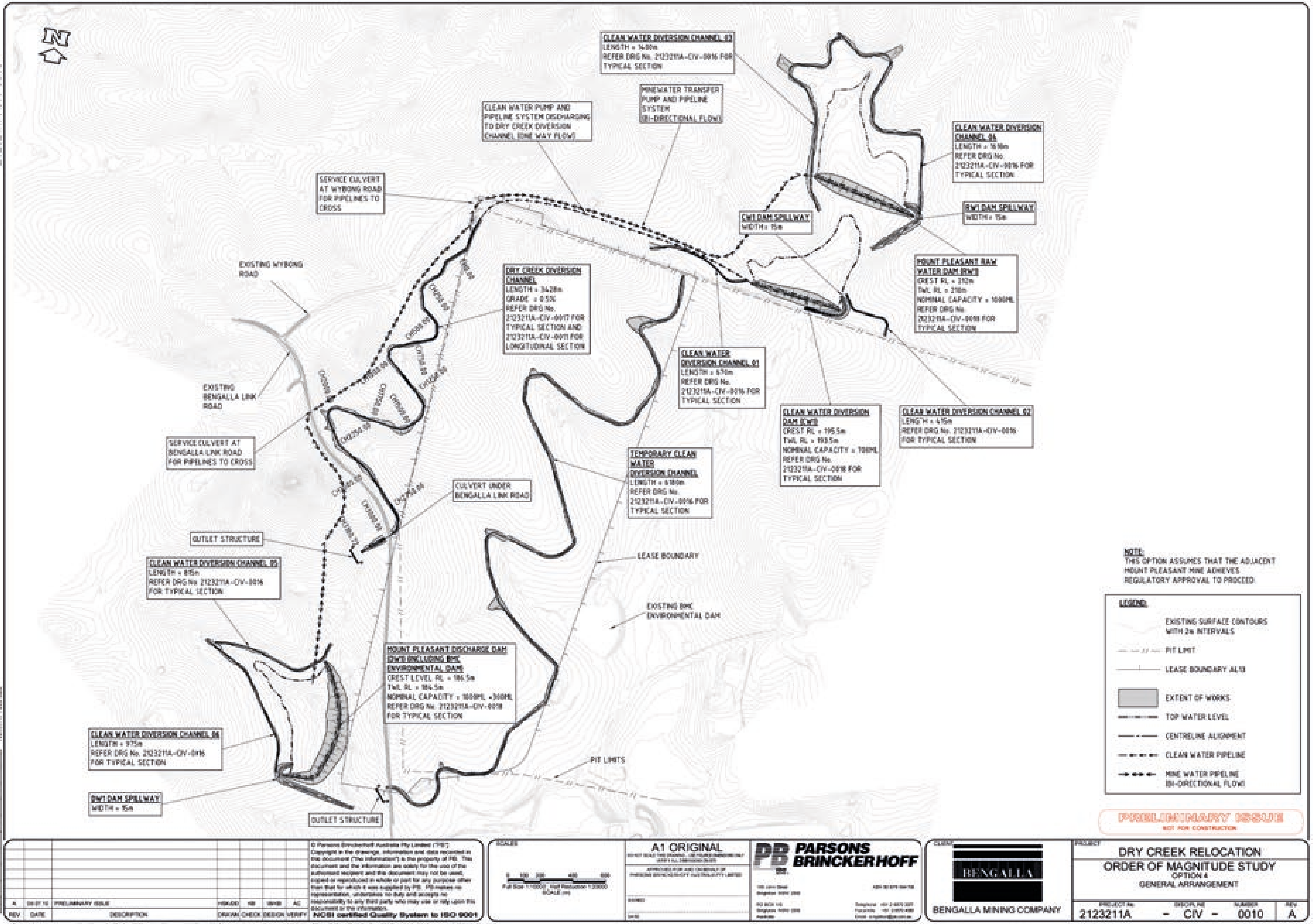
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CLEAN WATER DIVERSION CHANNEL 03
LENGTH = 1400m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
MINEWATER TRANSFER PUMP AND PIPELINE SYSTEM (BI-DIRECTIONAL FLOW)
CLEAN WATER PUMP AND PIPELINE SYSTEM DISCHARGING TO DRY CREEK DIVERSION CHANNEL (ONE WAY FLOW)
CLEAN WATER DIVERSION CHANNEL 04
LENGTH = 1610m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
SERVICE CULVERT AT WYBONG ROAD FOR PIPELINES TO CROSS
RW1 DAM SPILLWAY
WIDTH = 15m
CW1 DAM SPILLWAY
WIDTH = 15m
EXISTING WYBONG ROAD
DRY CREEK DIVERSION CHANNEL
LENGTH = 3428m
GRADE = 0.5%
REFER DRG No. 2123211A-CIV-0017 FOR TYPICAL SECTION AND 2123211A-CIV-0011 FOR LONGITUDINAL SECTION
MOUNT PLEASANT RAW WATER DAM (RW1)
CREST RL = 212m
TWL RL = 210m
NOMINAL CAPACITY = 1000ML
REFER DRG No. 2123211A-CIV-0018 FOR TYPICAL SECTION
CLEAN WATER DIVERSION CHANNEL 01
LENGTH = 670m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
EXISTING BENGALLA LINK ROAD
CLEAN WATER DIVERSION DAM (CW1)
CREST RL = 195.5m
TWL RL = 193.5m
NOMINAL CAPACITY = 700ML
REFER DRG No. 2123211A-CIV-0018 FOR TYPICAL SECTION
CLEAN WATER DIVERSION CHANNEL 02
LENGTH = 415m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
SERVICE CULVERT AT BENGALLA LINK ROAD FOR PIPELINES TO CROSS
TEMPORARY CLEAN WATER DIVERSION CHANNEL
LENGTH = 6180m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
CULVERT UNDER BENGALLA LINK ROAD
OUTLET STRUCTURE
LEASE BOUNDARY
CLEAN WATER DIVERSION CHANNEL 05
LENGTH = 815m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
EXISTING BMC ENVIRONMENTAL DAM
NOTE:
THIS OPTION ASSUMES THAT THE ADJACENT MOUNT PLEASANT MINE ACHIEVES REGULATORY APPROVAL TO PROCEED.
MOUNT PLEASANT DISCHARGE DAM (DW1) (INCLUDING BMC ENVIRONMENTAL DAM)
CREST LEVEL RL = 186.5m
TWL RL = 184.5m
NOMINAL CAPACITY = 1000ML +300ML
REFER DRG No. 2123211A-CIV-0018 FOR TYPICAL SECTION
LEGEND:
EXISTING SURFACE CONTOURS WITH 2m INTERVALS
PIT LIMIT
LEASE BOUNDARY AL13
EXTENT OF WORKS
TOP WATER LEVEL
CENTRELINE ALIGNMENT
CLEAN WATER PIPELINE
MINE WATER PIPELINE (BI-DIRECTIONAL FLOW)
CLEAN WATER DIVERSION CHANNEL 06
LENGTH = 975m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
PIT LIMITS
DW1 DAM SPILLWAY
WIDTH = 15m
OUTLET STRUCTURE
PRELIMINARY ISSUE
NOT FOR CONSTRUCTION
A1 ORIGINAL
PARSONS BRINCKERHOFF
BENGALLA
BENGALLA MINING COMPANY
DRY CREEK RELOCATION
ORDER OF MAGNITUDE STUDY
OPTION 4
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2123211A - CIV - 0010 A
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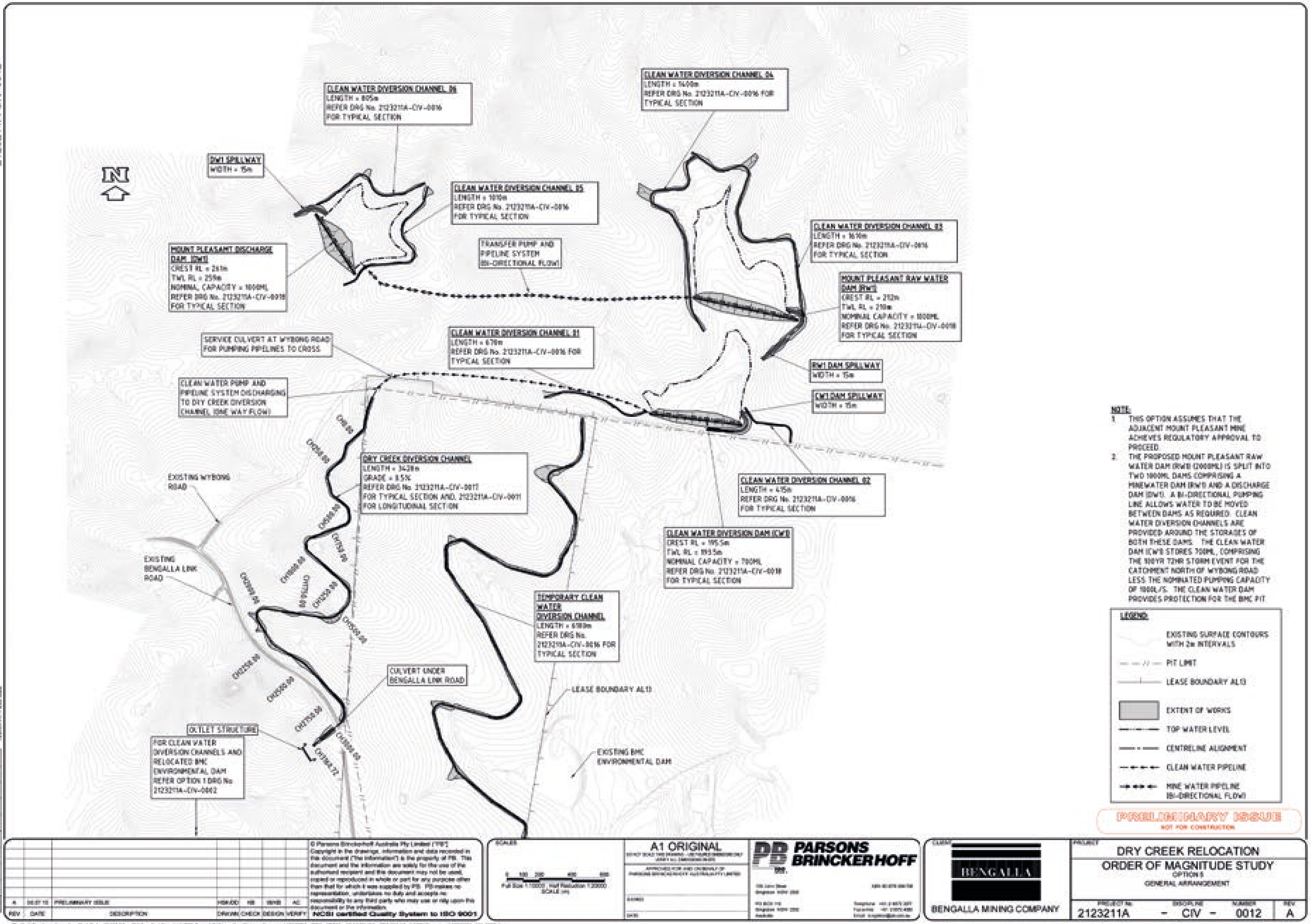
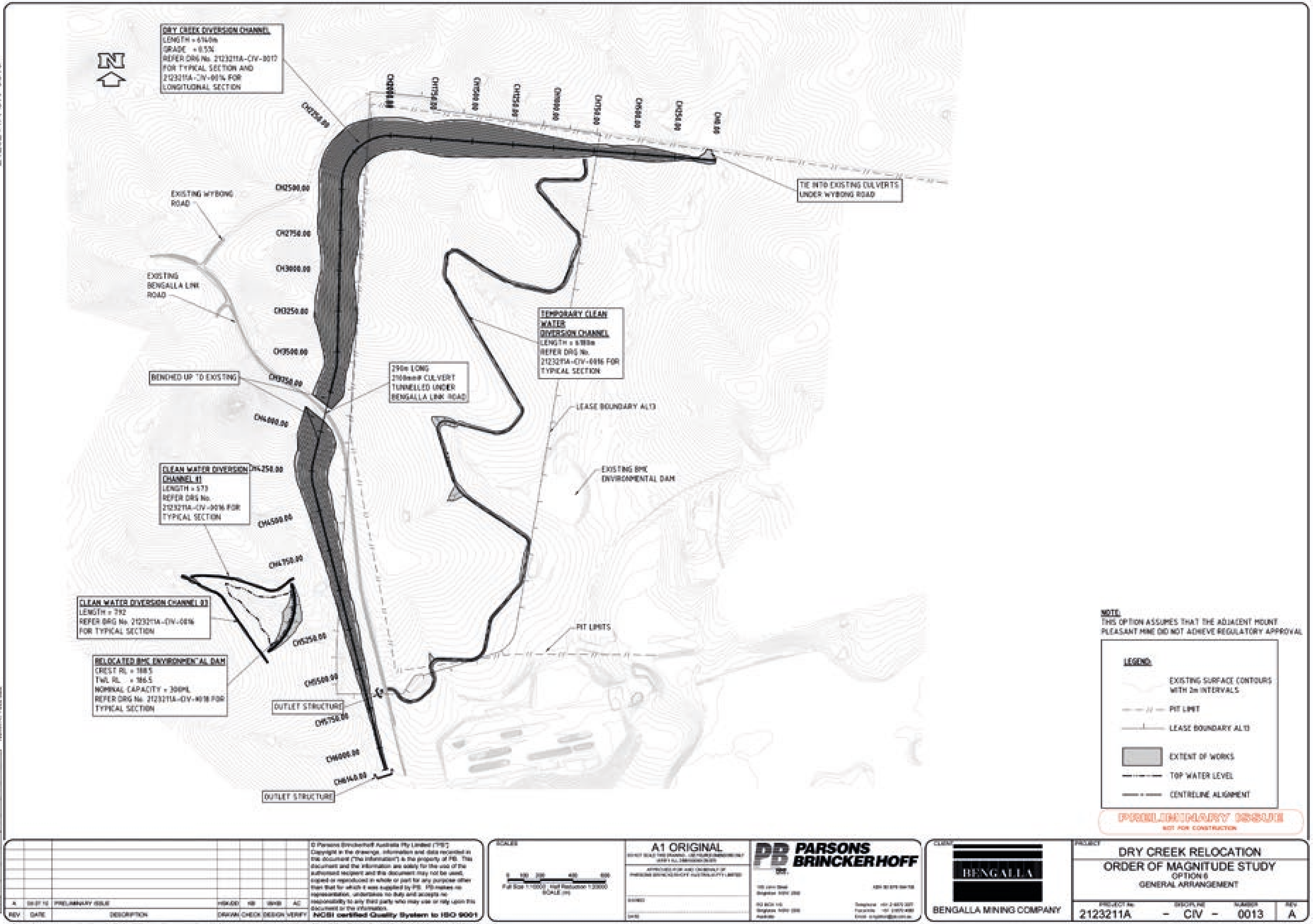
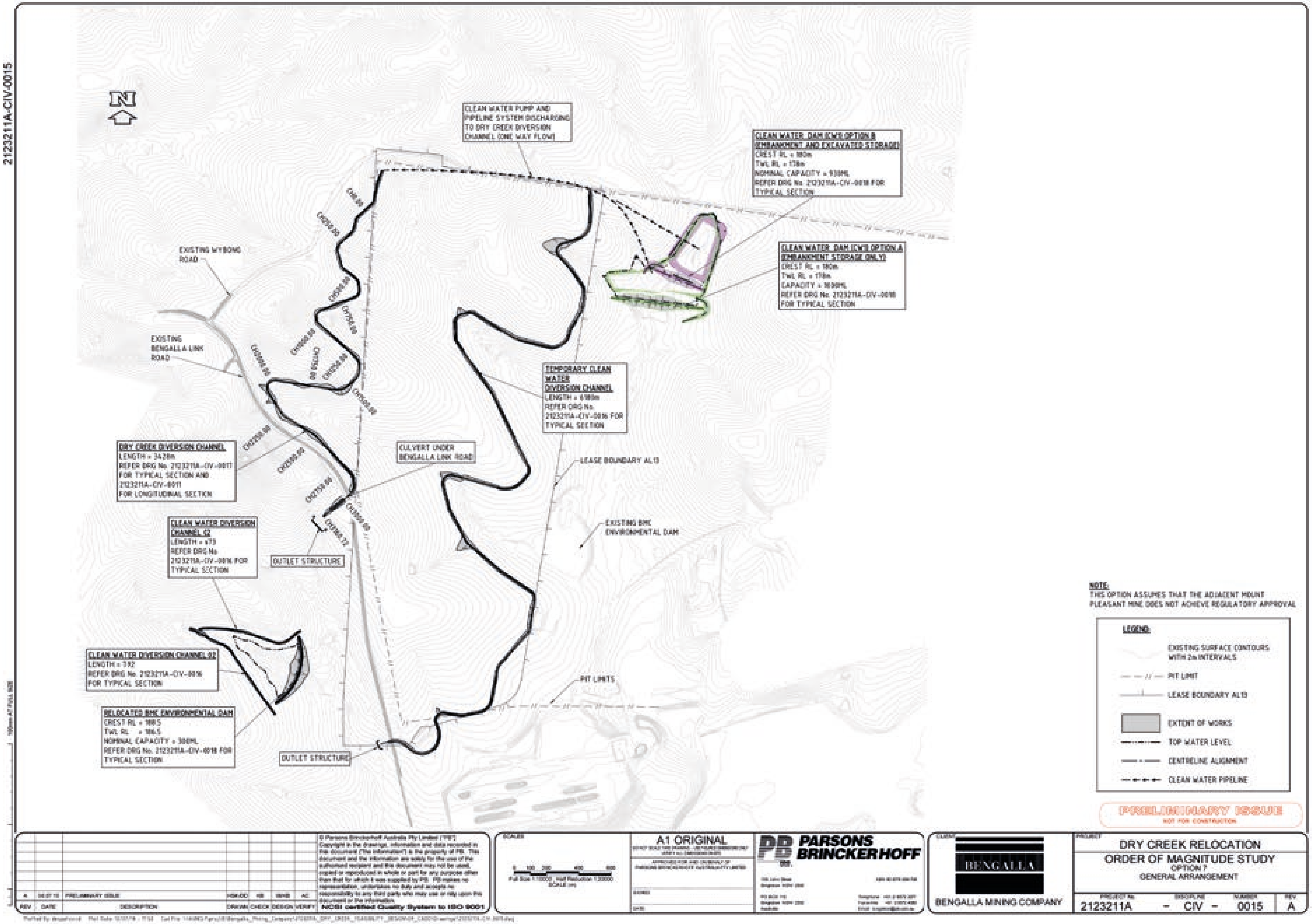
NCSI certified Quality System to ISO 9001


2123211A-CIV-0012
N
CLEAN WATER DIVERSION CHANNEL 06
LENGTH = 805m
REFER DRG No. 2123211A-CIV-0016
FOR TYPICAL SECTION
CLEAN WATER DIVERSION CHANNEL 04
LENGTH = 1400m
REFER DRG No. 2123211A-CIV-0016 FOR
TYPICAL SECTION
DW1 SPILLWAY
WIDTH = 15m
CLEAN WATER DIVERSION CHANNEL 05
LENGTH = 1010m
REFER DRG No. 2123211A-CIV-0016
FOR TYPICAL SECTION
MOUNT PLEASANT DISCHARGE
DAM (DW1)
CREST RL = 261m
TWL RL = 259m
NOMINAL CAPACITY = 1000ML
REFER DRG No. 2123211A-CIV-0018
FOR TYPICAL SECTION
TRANSFER PUMP AND
PIPELINE SYSTEM
(BI-DIRECTIONAL FLOW)
CLEAN WATER DIVERSION CHANNEL 03
LENGTH = 1610m
REFER DRG No. 2123211A-CIV-0016
FOR TYPICAL SECTION
MOUNT PLEASANT RAW WATER
DAM (RW1)
CREST RL = 212m
TWL RL = 210m
NOMINAL CAPACITY = 1000ML
REFER DRG No. 2123211A-CIV-0018
FOR TYPICAL SECTION
SERVICE CULVERT AT WYBONG ROAD
FOR PUMPING PIPELINES TO CROSS
CLEAN WATER DIVERSION CHANNEL 01
LENGTH = 670m
REFER DRG No. 2123211A-CIV-0016 FOR
TYPICAL SECTION
RW1 DAM SPILLWAY
WIDTH = 15m
CLEAN WATER PUMP AND
PIPELINE SYSTEM DISCHARGING
TO DRY CREEK DIVERSION
CHANNEL (ONE WAY FLOW)
CW1 DAM SPILLWAY
WIDTH = 15m
DRY CREEK DIVERSION CHANNEL
LENGTH = 3428m
GRADE = 0.5%
REFER DRG No. 2123211A-CIV-0017
FOR TYPICAL SECTION AND, 2123211A-CIV-0011
FOR LONGITUDINAL SECTION
CLEAN WATER DIVERSION CHANNEL 02
LENGTH = 415m
REFER DRG No. 2123211A-CIV-0016
FOR TYPICAL SECTION
EXISTING WYBONG
ROAD
CLEAN WATER DIVERSION DAM (CW1)
CREST RL = 195.5m
TWL RL = 193.5m
NOMINAL CAPACITY = 700ML
REFER DRG No. 2123211A-CIV-0018
FOR TYPICAL SECTION
EXISTING
BENGALLA LINK
ROAD
TEMPORARY CLEAN
WATER
DIVERSION CHANNEL
LENGTH = 6180m
REFER DRG No.
2123211A-CIV-0016 FOR
TYPICAL SECTION
CULVERT UNDER
BENGALLA LINK ROAD
LEASE BOUNDARY AL13
OUTLET STRUCTURE
FOR CLEAN WATER
DIVERSION CHANNELS AND
RELOCATED BMC
ENVIRONMENTAL DAM
REFER OPTION 1 DRG No.
2123211A-CIV-0002
EXISTING BMC
ENVIRONMENTAL DAM
NOTE:
1. THIS OPTION ASSUMES THAT THE ADJACENT MOUNT PLEASANT MINE ACHIEVES REGULATORY APPROVAL TO PROCEED.
2. THE PROPOSED MOUNT PLEASANT RAW WATER DAM (RW1) (2000ML) IS SPLIT INTO TWO 1000ML DAMS COMPRISING A MINEWATER DAM (RW1) AND A DISCHARGE DAM (DW1). A BI-DIRECTIONAL PUMPING LINE ALLOWS WATER TO BE MOVED BETWEEN DAMS AS REQUIRED. CLEAN WATER DIVERSION CHANNELS ARE PROVIDED AROUND THE STORAGES OF BOTH THESE DAMS. THE CLEAN WATER DAM (CW1) STORES 700ML, COMPRISING THE 100YR 72HR STORM EVENT FOR THE CATCHMENT NORTH OF WYBONG ROAD LESS THE NOMINATED PUMPING CAPACITY OF 1000L/S. THE CLEAN WATER DAM PROVIDES PROTECTION FOR THE BMC PIT
LEGEND:
EXISTING SURFACE CONTOURS WITH 2m INTERVALS
PIT LIMIT
LEASE BOUNDARY AL13
EXTENT OF WORKS
TOP WATER LEVEL
CENTRELINE ALIGNMENT
CLEAN WATER PIPELINE
MINE WATER PIPELINE (BI-DIRECTIONAL FLOW)
PRELIMINARY ISSUE
NOT FOR CONSTRUCTION
A1 ORIGINAL
PARSONS BRINCKERHOFF
BENGALLA
BENGALLA MINING COMPANY
DRY CREEK RELOCATION
ORDER OF MAGNITUDE STUDY
OPTION 5
GENERAL ARRANGEMENT
2123211A - CIV - 0012 A
NCSI certified Quality System to ISO 9001

2123211A-CIV-0013



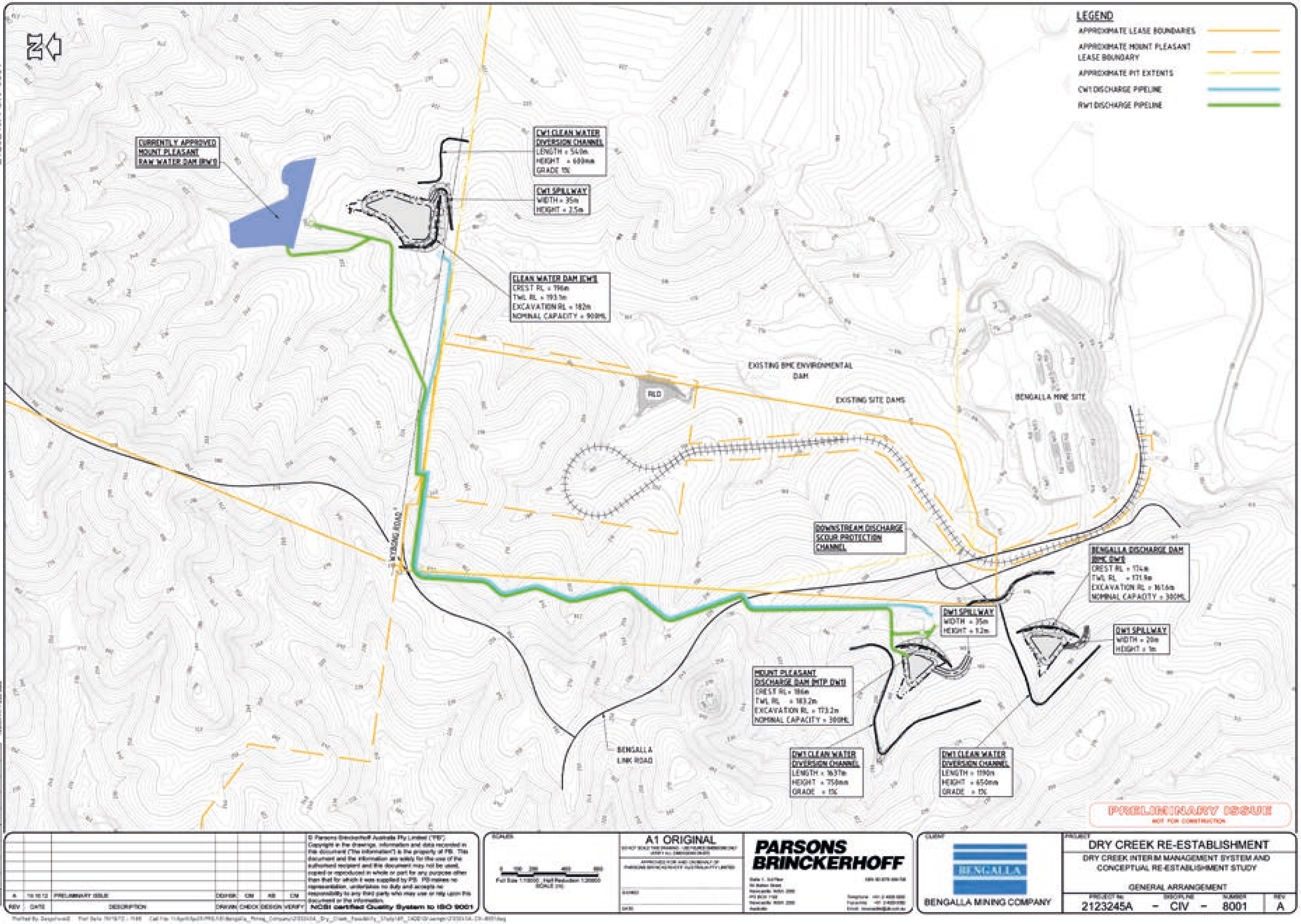
Dry Creek Interim Management System and Conceptual Re-establishment Study

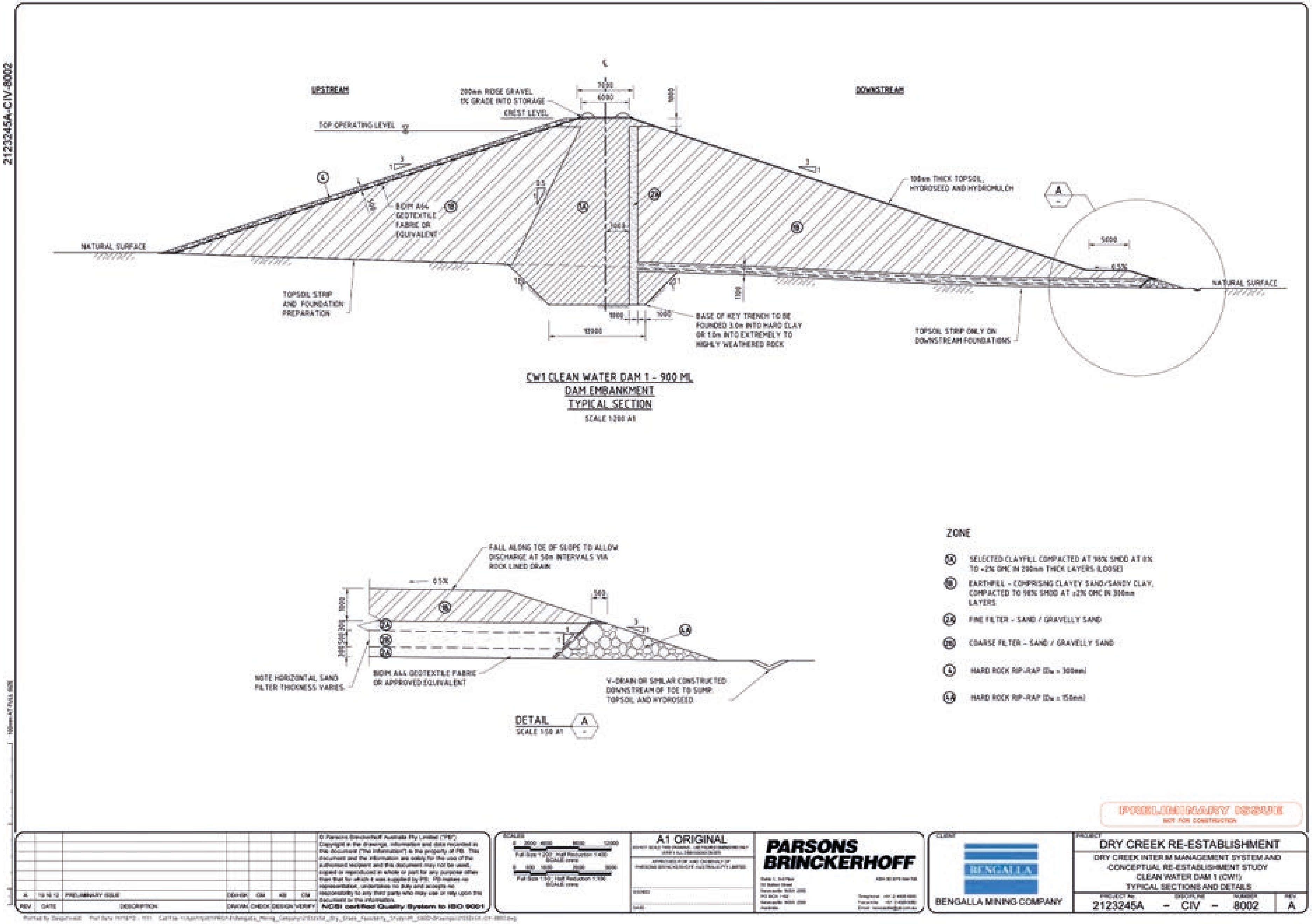

2123211A-CIV-0015
N
CLEAN WATER PUMP AND PIPELINE SYSTEM DISCHARGING TO DRY CREEK DIVERSION CHANNEL (ONE WAY FLOW)
CLEAN WATER DAM (CW1) OPTION B (EMBANKMENT AND EXCAVATED STORAGE)
CREST RL = 180m
TWL RL = 178m
NOMINAL CAPACITY = 930ML
REFER DRG No. 2123211A-CIV-0018 FOR TYPICAL SECTION
CLEAN WATER DAM (CW1) OPTION A (EMBANKMENT STORAGE ONLY)
CREST RL = 180m
TWL RL = 178m
CAPACITY = 1000ML
REFER DRG No. 2123211A-CIV-0018 FOR TYPICAL SECTION
EXISTING WYBONG ROAD
EXISTING BENGALLA LINK ROAD
TEMPORARY CLEAN WATER DIVERSION CHANNEL
LENGTH = 6180m
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
DRY CREEK DIVERSION CHANNEL
LENGTH = 3428m
REFER DRG No. 2123211A-CIV-0017 FOR TYPICAL SECTION AND 2123211A-CIV-0011 FOR LONGITUDINAL SECTION
CULVERT UNDER BENGALLA LINK ROAD
LEASE BOUNDARY AL13
CLEAN WATER DIVERSION CHANNEL 02
LENGTH = 473
REFER DRG No 2123211A-CIV-0016 FOR TYPICAL SECTION
OUTLET STRUCTURE
EXISTING BMC ENVIRONMENTAL DAM
CLEAN WATER DIVERSION CHANNEL 03
LENGTH = 792
REFER DRG No. 2123211A-CIV-0016 FOR TYPICAL SECTION
PIT LIMITS
RELOCATED BMC ENVIRONMENTAL DAM
CREST RL = 188.5
TWL RL = 186.5
NOMINAL CAPACITY = 300ML
REFER DRG No. 2123211A-CIV-0018 FOR TYPICAL SECTION
OUTLET STRUCTURE
NOTE:
THIS OPTION ASSUMES THAT THE ADJACENT MOUNT PLEASANT MINE DOES NOT ACHIEVE REGULATORY APPROVAL
LEGEND:
EXISTING SURFACE CONTOURS WITH 2m INTERVALS
PIT LIMIT
LEASE BOUNDARY AL13
EXTENT OF WORKS
TOP WATER LEVEL
CENTRELINE ALIGNMENT
CLEAN WATER PIPELINE
PRELIMINARY ISSUE
NOT FOR CONSTRUCTION
A1 ORIGINAL
PARSONS BRINCKERHOFF
NCSI certified Quality System to ISO 9001
A PRELIMINARY ISSUE
REV DATE DESCRIPTION DRAWN CHECK DESIGN VERIFY
BENGALLA
BENGALLA MINING COMPANY
DRY CREEK RELOCATION
ORDER OF MAGNITUDE STUDY
OPTION 7
GENERAL ARRANGEMENT
2123211A - CIV - 0015 A

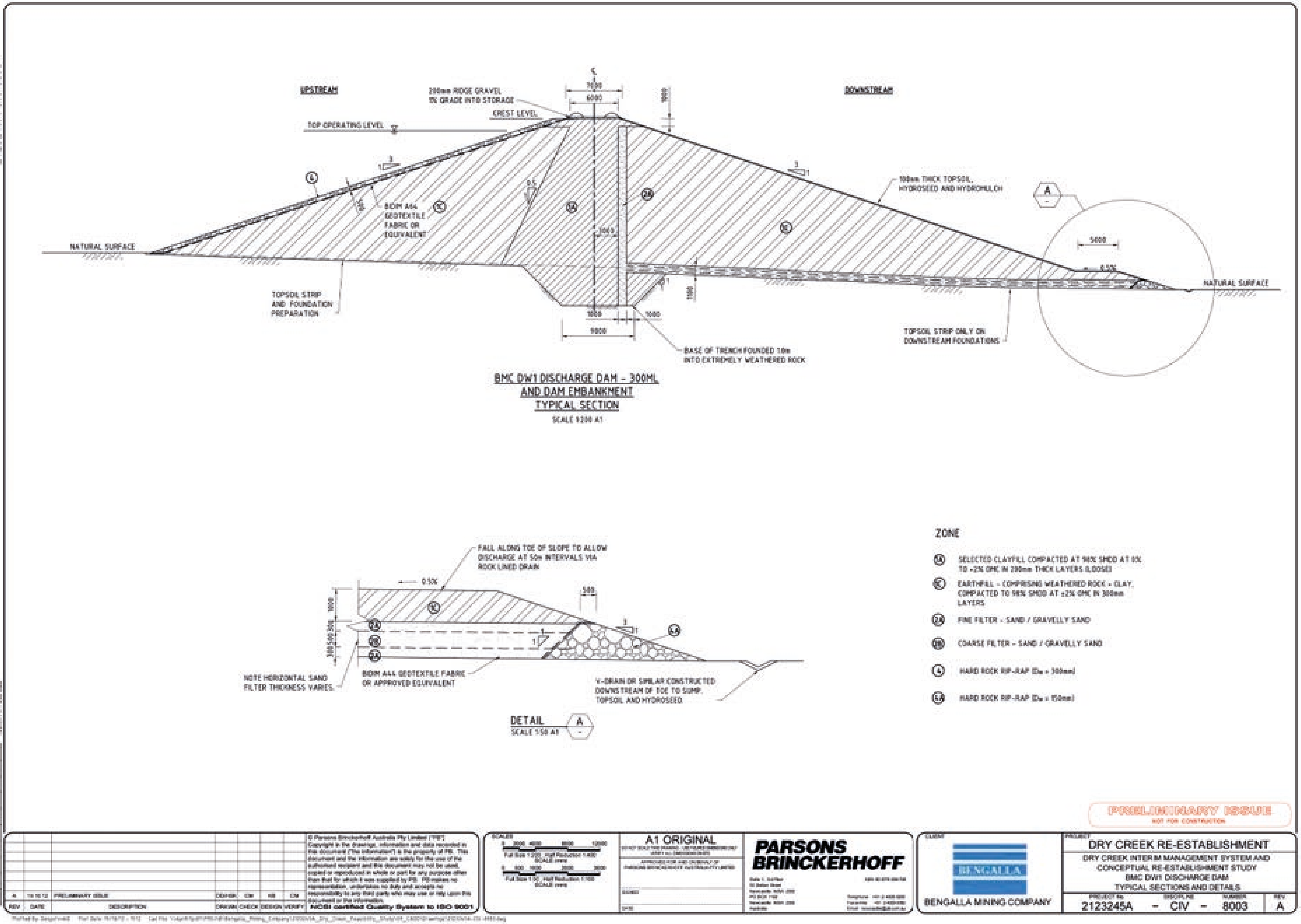
Appendix C

Dry Creek interim management system and conceptual re-establishment drawings

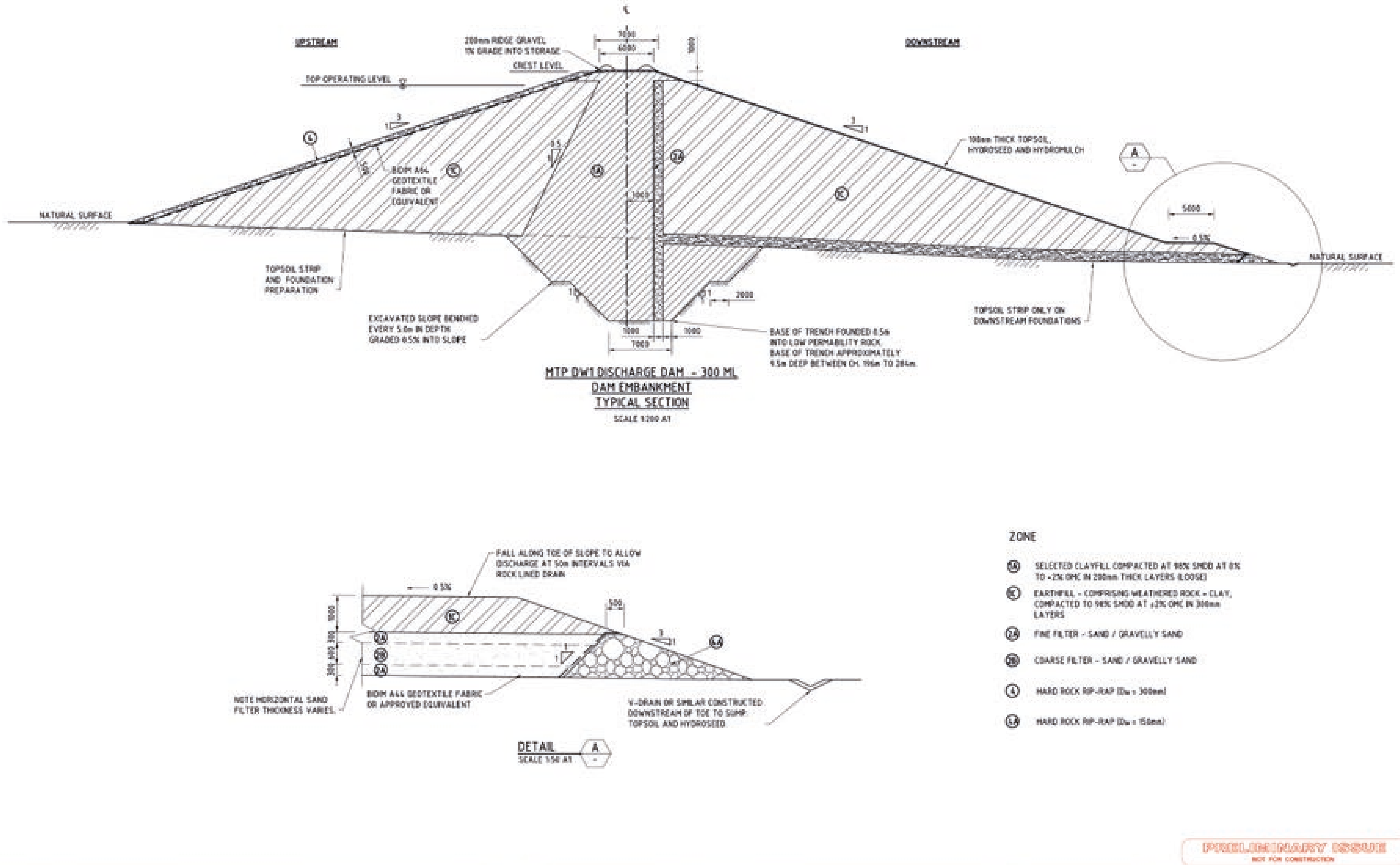
Dry Creek Interim Management System and Conceptual Re-establishment Study




2123245A-CIV-8002
UPSTREAM
DOWNSTREAM
200mm RIDGE GRAVEL
1% GRADE INTO STORAGE
CREST LEVEL
TOP OPERATING LEVEL
7030
6000
1000
NATURAL SURFACE
BIDIM A64 GEOTEXTILE FABRIC OR EQUIVALENT
100mm THICK TOPSOIL, HYDROSEED AND HYDROMULCH
5000
0.5%
TOPSOIL STRIP AND FOUNDATION PREPARATION
1000
12000
BASE OF KEY TRENCH TO BE FOUNDED 3.0m INTO HARD CLAY OR 1.0m INTO EXTREMELY TO HIGHLY WEATHERED ROCK
TOPSOIL STRIP ONLY ON DOWNSTREAM FOUNDATIONS
CW1 CLEAN WATER DAM 1 - 900 ML
DAM EMBANKMENT
TYPICAL SECTION
SCALE 1:200 A1
FALL ALONG TOE OF SLOPE TO ALLOW DISCHARGE AT 50m INTERVALS VIA ROCK LINED DRAIN
NOTE HORIZONTAL SAND FILTER THICKNESS VARIES.
BIDIM A64 GEOTEXTILE FABRIC OR APPROVED EQUIVALENT
V-DRAIN OR SIMILAR CONSTRUCTED DOWNSTREAM OF TOE TO SUMP. TOPSOIL AND HYDROSEED.
DETAIL A
SCALE 1:50 A1
ZONE
1A SELECTED CLAYFILL COMPACTED AT 98% SMDD AT 0% TO +2% OMC IN 200mm THICK LAYERS (LOOSE)
1B EARTHFILL - COMPRISING CLAYEY SAND/SANDY CLAY, COMPACTED TO 98% SMDD AT ±2% OMC IN 300mm LAYERS
2A FINE FILTER - SAND / GRAVELLY SAND
2B COARSE FILTER - SAND / GRAVELLY SAND
4 HARD ROCK RIP-RAP (D50 = 300mm)
4A HARD ROCK RIP-RAP (D50 = 150mm)
PRELIMINARY ISSUE
NOT FOR CONSTRUCTION
A 10.10.12 PRELIMINARY ISSUE
REV DATE DESCRIPTION DRAWN CHECK DESIGN VERIFY
NCSI certified Quality System to ISO 9001
A1 ORIGINAL
PARSONS BRINCKERHOFF
BENGALLA
BENGALLA MINING COMPANY
DRY CREEK RE-ESTABLISHMENT
DRY CREEK INTERIM MANAGEMENT SYSTEM AND CONCEPTUAL RE-ESTABLISHMENT STUDY
CLEAN WATER DAM 1 (CW1)
TYPICAL SECTIONS AND DETAILS
2123245A - CIV - 8002 A


2123245A-CIV-8003
UPSTREAM
DOWNSTREAM
200mm RIDGE GRAVEL 1% GRADE INTO STORAGE
CREST LEVEL
TOP OPERATING LEVEL
NATURAL SURFACE
BIDIM A44 GEOTEXTILE FABRIC OR EQUIVALENT
100mm THICK TOPSOIL, HYDROSEED AND HYDROMULCH
TOPSOIL STRIP AND FOUNDATION PREPARATION
BASE OF TRENCH FOUNDED 1.0m INTO EXTREMELY WEATHERED ROCK
TOPSOIL STRIP ONLY ON DOWNSTREAM FOUNDATIONS
BMC DW1 DISCHARGE DAM - 300ML AND DAM EMBANKMENT TYPICAL SECTION
SCALE 1:200 A1
FALL ALONG TOE OF SLOPE TO ALLOW DISCHARGE AT 50m INTERVALS VIA ROCK LINED DRAIN
NOTE HORIZONTAL SAND FILTER THICKNESS VARIES.
BIDIM A44 GEOTEXTILE FABRIC OR APPROVED EQUIVALENT
V-DRAIN OR SIMILAR CONSTRUCTED DOWNSTREAM OF TOE TO SUMP. TOPSOIL AND HYDROSEED.
DETAIL A
SCALE 1:50 A1
ZONE
1A SELECTED CLAYFILL COMPACTED AT 98% SMDD AT 0% TO +2% OMC IN 200mm THICK LAYERS (LOOSE)
1C EARTHFILL - COMPRISING WEATHERED ROCK + CLAY, COMPACTED TO 98% SMDD AT ±2% OMC IN 300mm LAYERS
2A FINE FILTER - SAND / GRAVELLY SAND
2B COARSE FILTER - SAND / GRAVELLY SAND
4 HARD ROCK RIP-RAP (D50 = 300mm)
4A HARD ROCK RIP-RAP (D50 = 150mm)
PRELIMINARY ISSUE
NOT FOR CONSTRUCTION
A1 ORIGINAL
PARSONS BRINCKERHOFF
BENGALLA
BENGALLA MINING COMPANY
DRY CREEK RE-ESTABLISHMENT
DRY CREEK INTERIM MANAGEMENT SYSTEM AND CONCEPTUAL RE-ESTABLISHMENT STUDY
BMC DW1 DISCHARGE DAM
TYPICAL SECTIONS AND DETAILS
2123245A - CIV - 8003 A
NCSI certified Quality System to ISO 9001

2123245A-CIV-8004



REV	DATE	DESCRIPTION	DRAWN	CHECK	DESIGN	VERIFY
A	19.10.12	PRELIMINARY ISSUE	DD/HSK	CM	KB	CM

NCSI certified Quality System to ISO 9001

A1 ORIGINAL

PARSONS BRINCKERHOFF

CLIENT: BENGALLA MINING COMPANY

PROJECT: DRY CREEK RE-ESTABLISHMENT

DRY CREEK INTERIM MANAGEMENT SYSTEM AND CONCEPTUAL RE-ESTABLISHMENT STUDY
MTP DW1 DISCHARGE DAM
TYPICAL SECTIONS AND DETAILS

PROJECT No	DISCIPLINE	NUMBER	REV
2123245A	CIV	8004	A

2123245A-CIV-8005

PRELIMINARY ISSUE
NOT FOR CONSTRUCTION

REV	DATE	DESCRIPTION	DRAWN	CHECK	DESIGN	VERIFY
A	19.10.12	PRELIMINARY ISSUE	AW/DD	CM	KB	CM

SCALES
Full Size 1:5000 ; Half Reduction 1:10000
SCALE (m)

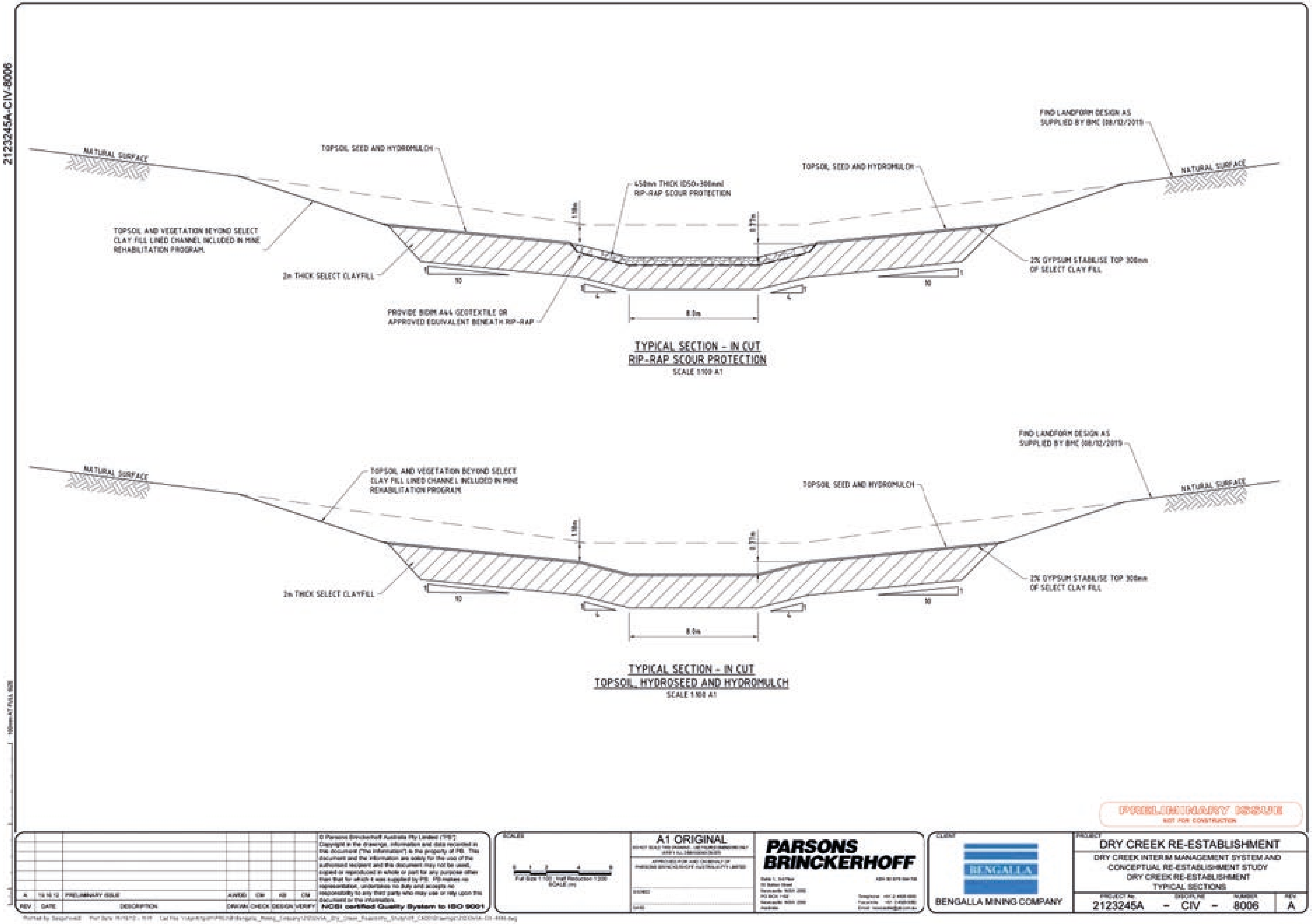
A1 ORIGINAL

PARSONS BRINCKERHOFF

CLIENT
BENGALLA
BENGALLA MINING COMPANY

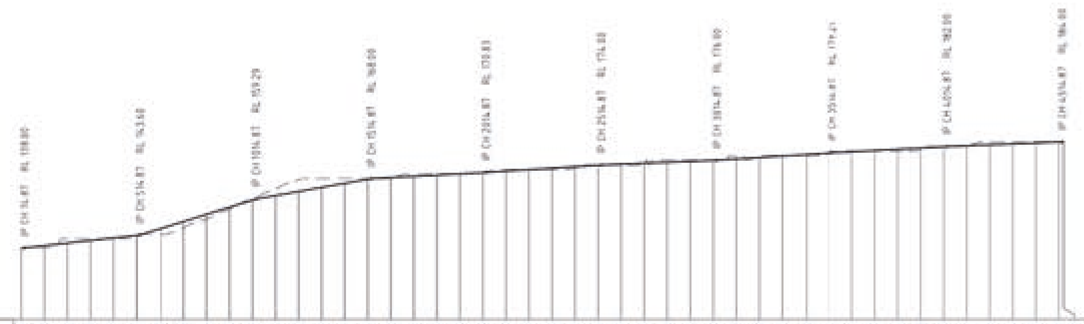
PROJECT
DRY CREEK RE-ESTABLISHMENT
DRY CREEK INTERIM MANAGEMENT SYSTEM AND CONCEPTUAL RE-ESTABLISHMENT STUDY
DRY CREEK RE-ESTABLISHMENT
GENERAL ARRANGEMENT

PROJECT No.	DISCIPLINE	NUMBER	REV
2123245A	CIV	8005	A



Dry Creek Interim Management System and Conceptual Re-establishment Study

2123245A-CIV-8007



CHAINAGE	EXISTING LEVELS	FILL +/CUT -	DESIGN LEVELS
0.0	138.000	-0.059	137.941
100.0	138.000	0.953	138.953
200.0	142.000	-1.927	140.073
300.0	142.000	-0.807	141.193
400.0	142.000	0.310	142.310
500.0	143.358	0.076	143.433
600.0	144.000	0.271	144.271
700.0	146.510	2.899	149.409
800.0	150.485	2.062	152.547
900.0	154.806	0.879	155.685
1000.0	159.039	-0.216	158.823
1100.0	164.000	-3.271	160.729
1200.0	167.467	-4.952	162.515
1300.0	168.000	-3.743	164.257
1400.0	168.000	-2.001	165.999
1500.0	168.000	-0.259	167.741
1600.0	168.000	0.482	168.482
1700.0	170.000	-0.952	169.048
1800.0	170.000	-0.386	169.614
1900.0	170.000	0.180	170.180
2000.0	170.753	-0.007	170.746
2100.0	172.000	-0.630	171.370
2200.0	172.000	0.004	172.004
2300.0	172.000	0.638	172.638
2400.0	172.648	0.604	173.272
2500.0	174.000	-0.094	173.906
2600.0	174.000	0.341	174.341
2700.0	174.040	0.700	174.741
2800.0	176.000	-0.859	175.141
2900.0	176.000	-0.459	175.541
3000.0	176.000	-0.059	175.941
3100.0	177.354	-0.807	176.547
3200.0	178.000	-0.811	177.189
3300.0	178.000	-0.169	177.831
3400.0	178.000	0.473	178.473
3500.0	179.161	-0.044	179.116
3600.0	180.000	-0.315	179.685
3700.0	180.000	0.243	180.243
3800.0	180.000	0.801	180.801
3900.0	180.665	0.694	181.359
4000.0	182.000	-0.083	181.917
4100.0	182.169	0.172	182.341
4200.0	183.638	-0.898	182.741
4300.0	183.866	-0.725	183.141
4400.0	184.000	-0.459	183.541
4500.0	184.000	-0.059	183.941
4521.9	184.000	0.000	184.000

LONGITUDINAL SECTION - RE-ESTABLISHED DRY CREEK
HORZ 1:10000 VERT 1:1000

PRELIMINARY ISSUE
NOT FOR CONSTRUCTION

REV	DATE	DESCRIPTION	DRAWN	CHECK	DESIGN	VERIFY
A	19.10.12	PRELIMINARY ISSUE	DD	CM	KB	CM

SCALES
Full Size 1:10000 ; Half Reduction 1:20000 SCALE (m)
Full Size 1:1000 ; Half Reduction 1:2000 SCALE (m)

A1 ORIGINAL

PARSONS BRINCKERHOFF

CLIENT
BENGALLA
BENGALLA MINING COMPANY

PROJECT
DRY CREEK RE-ESTABLISHMENT
DRY CREEK INTERIM MANAGEMENT SYSTEM AND
DRY CREEK INTERIM MANAGEMENT SYSTEM AND
DRY CREEK RE-ESTABLISHMENT
LONGITUDINAL SECTION

PROJECT No		DISCIPLINE		NUMBER	REV
2123245A	-	CIV	-	8007	A