MAJOR PROJECT ASSESSMENT: Russell Vale Colliery Underground Expansion Project (MP 09_0013)

Secretary's
Environmental Assessment Report
Section 75I of the
Environmental Planning and Assessment Act 1979

December 2014

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EXECUTIVE SUMMARY

Wollongong Coal Pty Ltd (Wollongong Coal) owns and operates the Russell Vale Colliery (Russell Vale) which is located in the Illawarra region, approximately eight kilometres (km) north of Wollongong and 70 km south of Sydney.

Wollongong Coal was formerly known as Gujarat NRE Coking Coal Ltd and the Russell Vale Colliery was formerly known as the NRE No. 1 Colliery. Jindal Steel and Power Limited acquired a majority stake in Gujarat NRE Coking Coal Ltd in October 2013.

The Russell Vale mining lease area is mostly covered by native bushland. The land is owned and managed by the Sydney Catchment Authority (SCA) and lies within the Metropolitan Special Area water catchment and contains much of the reservoir behind Cataract Dam, which supplies potable water to Sydney.

Mining at Russell Vale has been undertaken since 1887. Mining is currently taking place under the Preliminary Works Project (PWP) approval, granted by the Planning Assessment Commission (PAC) under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) on 13 October 2011. This approval allows extraction of up to 1 million tonnes per annum (Mtpa) of run-of-mine (ROM) coking coal through longwall mining in the Wongawilli Seam from three panels (Longwalls 4, 5 and a small part of Longwall 6) until 31 December 2015. Extraction of Longwall 5 was completed in early January 2014.

Wollongong Coal is proposing to expand its longwall mining operations further to the northwest across the Wonga East area, to extract 4.7 million tonnes (Mt) of ROM coal over a project life of 5 years. The proposal – known as the Underground Expansion Project (UEP) – involves the extraction of coal from eight longwalls (Longwalls 1, 2, 3, 6, 7, 9, 10 and 11) and the continued operation of the mine's surface facilities site. The proposal would also consolidate the approved PWP mining operations, together with the UEP, into one integrated project approval.

Following the repeal of Part 3A of the EP&A Act, the project is classified as a 'transitional Part 3A project' under savings and transitional provisions within Schedule 6A of the Act. This means the assessment of the merits of the project must be completed under the provisions of the former Part 3A. The Minister for Planning is the approval authority for the project application; however, the application falls within the terms of the Minister's delegation of 10 November 2014. Under the delegation the PAC must determine the application as more than 25 public submissions objected to the project.

The Department made the Environmental Assessment (EA) publicly available from 18 February 2013 until 5 April 2013. The Department received 840 submissions on the project, including 12 from public authorities, 2 from special interest groups and 826 from the general public. Of the submissions from the general public, 54% supported the project and 46% objected.

In response to substantial issues raised in agency and public submissions and in independent expert reviews of the EA undertaken for the Department, Wollongong Coal made major changes to the original project and prepared a Preferred Project Report (PPR). The changes included:

- reducing the proposed project life from 18 years to 5 years;
- reducing the total ROM coal production from 31 Mt to 4.7 Mt;
- removing all proposed longwall mining (7 panels) from the Wonga West area and removing one panel (Longwall 8) from the Wonga East area;
- reorienting the remaining 8 longwall panels in the Wonga East area to minimise impacts to identified significant natural features; and
- removing the proposed Bulli West Bulli Seam first workings, Balgownie Seam first workings and Wonga Mains driveage.

The Department forwarded the PPR to all relevant government authorities and made the document publicly available on its website. The Department received comments from 8 agencies and 13 members of the public and community groups. All of the 13 public submissions objected to the preferred UEP.

The Department has completed its preliminary assessment of the merits of the preferred UEP. The key issues relate to:

- potential subsidence-related impacts on 9 upland swamps, which cover a total area of 17.51 hectares, 51% of which would be directly undermined;
- potential impacts on local and regional surface water and groundwater resources; and
- potential flooding impacts along Bellambi Gully and Bellambi Creek.

The Department considers that these impacts can be adequately mitigated, managed and/or offset through the implementation of a number of commitments made by Wollongong Coal and conditions recommended by the Department, including:

- setting (or continuing) a performance measure of 'negligible' for 2 swamps;
- setting the requirement for offsetting subsidence impacts as 'greater than negligible' for 8 swamps;
- setting performance measures of 'negligible' environmental consequences for the Cataract River and Cataract Creek;
- setting performance measures of 'negligible' leakage from Cataract Reservoir and negligible reduction in the water quality of the reservoir;
- if any performance measures and/or offset triggers are exceeded, requiring Wollongong Coal to remediate the impacts or provide an offset;
- requiring the preparation and implementation of an Extraction Plan, including a Water Management Plan to provide information on baseline data, surface and groundwater impact assessment criteria and comprehensive surface and groundwater monitoring programs;
- requiring the preparation and implementation of an Upland Swamp Monitoring Program to provide a comprehensive information base and to determine with certainty whether swamp performance measures are being met and triggers for the provision of offsets are appropriately set and monitored;
- requiring the implementation of all reasonable and feasible noise mitigation measures at the pit top site and limiting operations during the evening and night-time periods to ensure compliance with amenity-based project noise criteria;
- requiring the preparation and implementation of a comprehensive Noise Management Plan, including details of a program to operate a real-time noise monitoring system; and
- requiring the implementation of recommendations from a revised Bellambi Gully Flood Study which requires the conveyance of the 100 year ARI flood.

To effectively avoid, minimise and/or offset the predicted residual impacts of the preferred UEP, the Department has recommended conditions to ensure the project complies with relevant criteria and standards, and operates consistent with current best practice for the regulation of mining projects in NSW.

Finally, the Department has weighed the residual impacts of the project against its social and economic benefits. This assessment has found that the preferred UEP would result in significant social and economic benefits for both the local area as well as the State as a whole.

As estimated within the PPR, these benefits include:

- continued direct employment of 219 people and additional direct employment of 81 people during operation;
- direct employment of an additional 100 people during construction;
- indirect employment of up to 1,498 people in the local and regional area;
- $85 million in capital investment during construction ($18 million) and operation ($67 million)
- $34 million to the State in royalty revenue; and
- $110 million to the Commonwealth in tax revenue.

The Department has tested the sensitivity of these previous estimates to recent coal prices and concluded that the benefits of the project would remain positive to the local and regional area and the State economy.

The Department has concluded that the preferred UEP would generate a number of positive benefits and that the predicted impacts can be effectively managed through the implementation of strict conditions. Consequently, the Department considers that the project is in the public interest and should be approved, subject to stringent conditions.

1 BACKGROUND

1.1 Project Locations

Wollongong Coal Pty Ltd (formerly Gujarat NRE Coking Coal Ltd) owns and operates the Russell Vale Colliery (Russell Vale) which is located in the Illawarra region, approximately eight kilometres (km) north of Wollongong and 70 km south of Sydney (see **Figure 1**). Jindal Steel and Power Limited acquired a majority stake in Gujarat NRE Coking Coal Ltd in October 2013. The mine was known as the NRE No. 1 Colliery prior to February 2014.

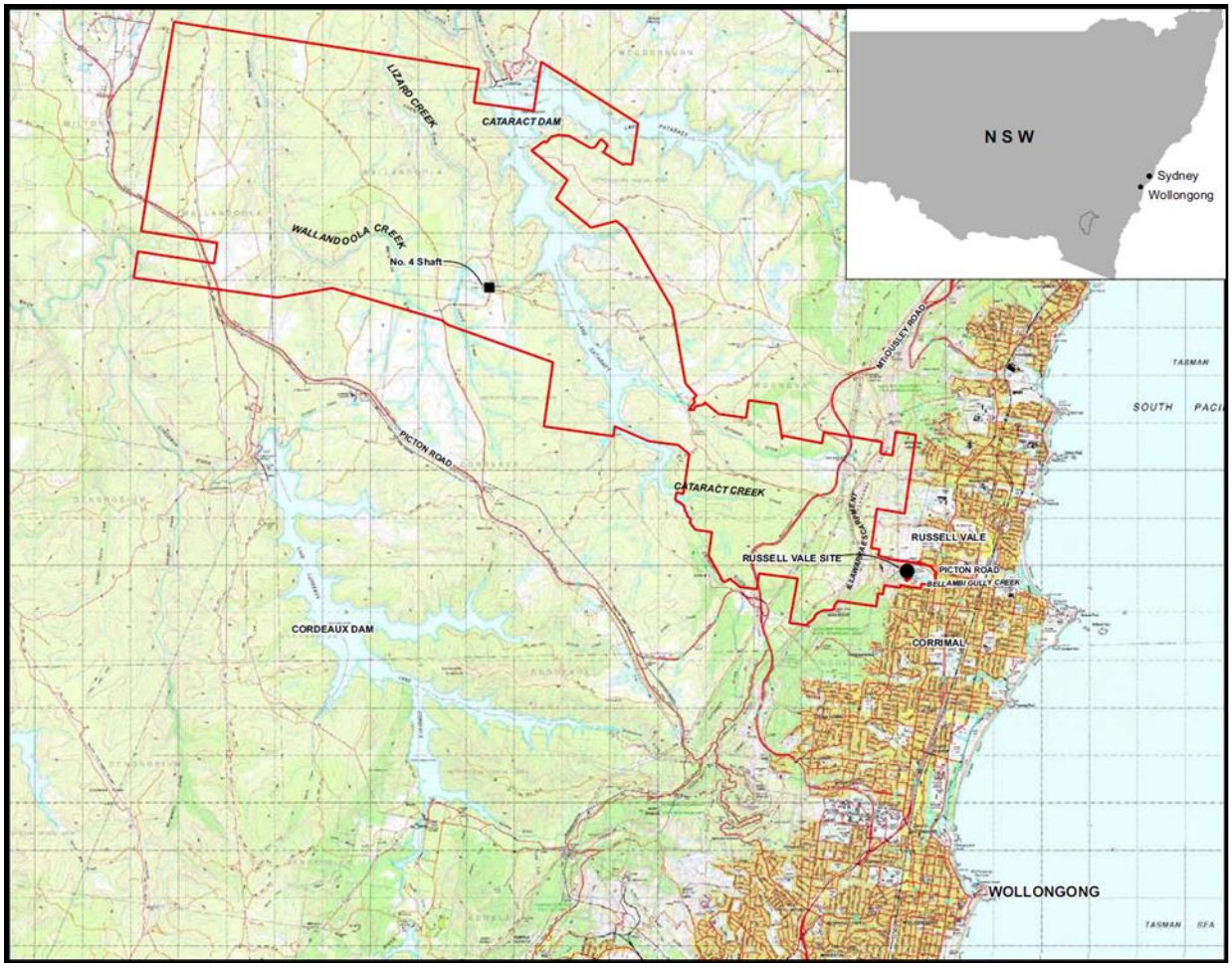

Figure 1: *Regional location and existing project area (marked in red edge)*

1.2 Project Setting

Russell Vale is located within the Wollongong and Wollondilly local government areas (LGAs). The project application area covers over 6,500 hectares (ha) and the majority of this comprises an extensive underground mining lease area, which lies under the Woronora Plateau west of the Illawarra Escarpment.

The surface facilities site comprises approximately 100 ha, located on the foot slopes of the Illawarra Escarpment at Russell Vale, west of the Princes Highway (see **Figure 2**). Residential areas in Russell Vale and Corrimal are located to the east and south of the site respectively.

In addition to the surface facilities, Russell Vale has four ventilation shafts (Shafts 1, 2, 3 and 5) and an access shaft for personnel and materials to the workings (No. 4 Shaft), which is located approximately 20 km to the northwest, and is accessed from Picton Road.

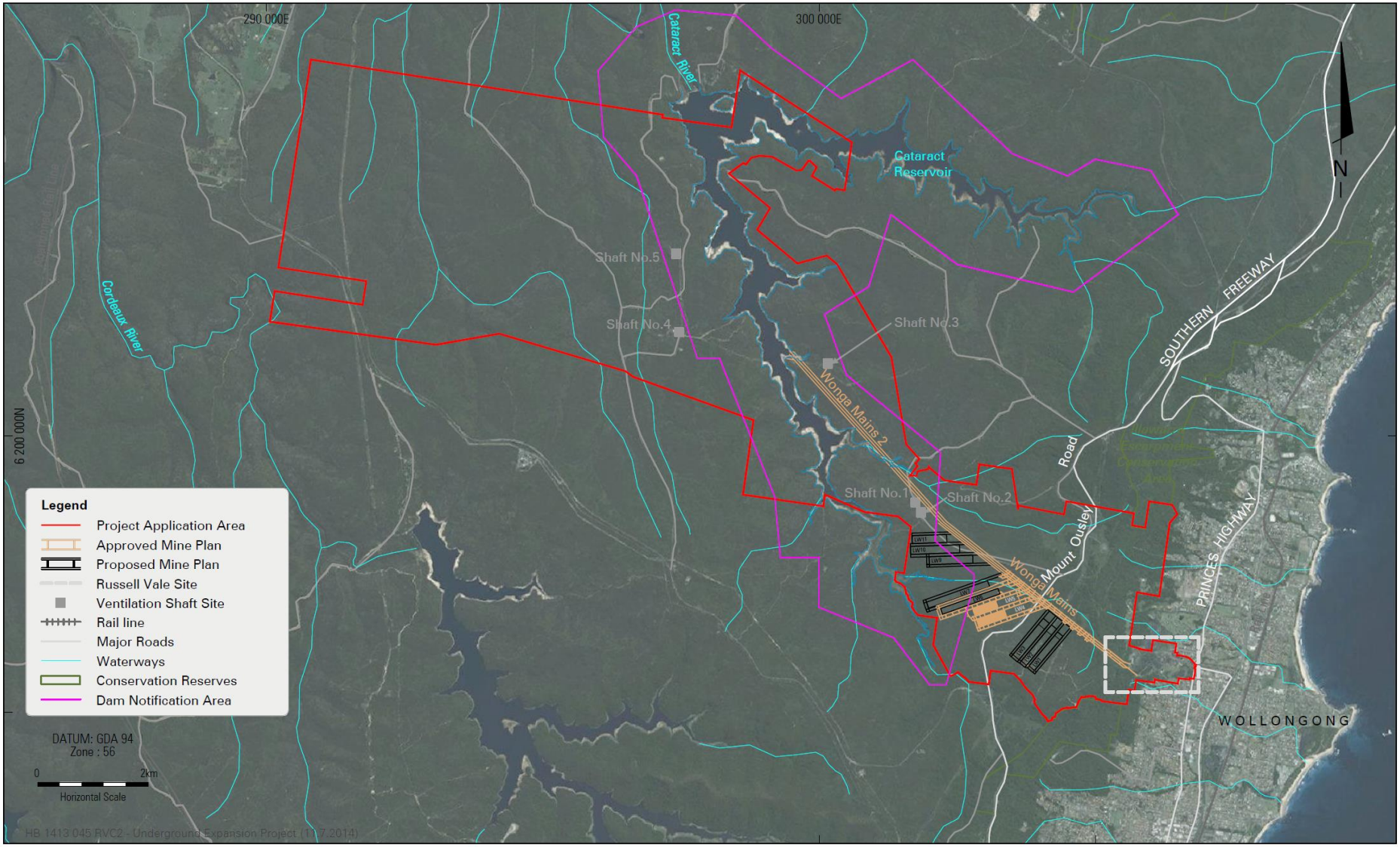

Figure 2: *Proposed mining areas and existing workings at Russell Vale Colliery*

As shown on **Figure 2**, the area of proposed mining is mostly covered by native bushland and includes creeks, tributaries and upland swamps. The vast majority of the land is owned and managed by the Sydney Catchment Authority (SCA) and lies within the Metropolitan Special Area water catchment. The site is overlain by much of the reservoir behind Cataract Dam, which supplies potable water to Sydney. It also includes part of the Southern Freeway (ie Mount Ousley Road), a Telstra fibre optic cable, fire trails and various electrical transmission lines. Other key features close to the area of proposed mining include Picton Road, Cataract River, Cataract Creek and Bellambi Gully Creek.

1.3 History of Mining

Mining at Russell Vale has been undertaken since 1887 using a range of mining techniques including bord and pillar mining, pillar extraction and longwall mining. The Bulli Seam was previously mined using pillar extraction techniques (early to mid-1900s) and the Balgownie Seam was extracted using longwall mining techniques (between 1970 - 1982 and 2001 - 2003). More recently, longwall mining commenced in the underlying Wongawilli Seam (2012 – early 2014).

1.4 Existing Project Approval and Operations

Russell Vale is currently operating under the Preliminary Works Project (PWP) approval which was granted by the Planning Assessment Commission (PAC) under Part 3A of the Environmental Planning and Assessment Act 1979 (EP&A Act) on 13 October 2011. This project approval (MP 10_0046) has subsequently been modified on three occasions, and currently allows:

- extraction of up to 1 million tonnes per annum (Mtpa) of run-of-mine (ROM) coking coal through:
  - first workings and pillar extraction from the Bulli and Wongawilli Seams; and
  - longwall mining in the Wongawilli Seam from two panels (Longwalls 4 and 5) and the first 365 metres (m) of a third panel (Longwall 6);
- development of the maingate for Longwall 6;
- upgrade of existing mining infrastructure at the mine's surface facilities site; and
- trucking of ROM coal from Russell Vale to Port Kembla Coal Terminal (PKCT).

The modified PWP approval allows mining operations at Russell Vale to take place until 31 December 2015.

Extraction of Longwall 5 was completed in early January 2014 and the development of the maingate for Longwall 6 was completed in late June 2014. Wollongong Coal is currently driving the mains for the Wonga East area.

2 PROPOSED PROJECT

Wollongong Coal is proposing to expand its longwall mining operations further to the northwest across the Wonga East area, to extract 4.7 Mt of ROM coal over a project life of 5 years.

The proposal – known as the Underground Expansion Project (UEP) – involves the extraction of coal from eight longwalls (LWs 1-3, 6, 7 and LWs 9-11) and the continued operation of the mine's surface facilities site. The major components of the project are summarised in Table 1 and depicted in Figures 3 and 4.

The proposal would consolidate the approved mining operations within the PWP approval into one integrated approval for the UEP.

The original UEP was described in detail in the environmental assessment (EA) (see **Appendix A**) first submitted in support of the project application in August 2009. Following an extensive adequacy review process, the EA was only exhibited in early 2013. However, in response to substantial issues raised in agency and public submissions and in independent expert reviews undertaken for the Department, Wollongong Coal made significant changes to the original project. The changes are outlined in a Preferred Project Report (PPR), which was submitted in combination with the Response to Submissions (RTS) in September 2013 (see **Appendix B**). The Department's assessment is based on the preferred UEP layout as described in the PPR.

For the sake of simplicity, all references in this report to the project's proponent are to Wollongong Coal, although many of the actions taken and documents prepared (up to and including the RTS/PPR) were under the control of Gujarat NRE Coking Coal Ltd.

Table 1: *Major components of the Russell Vale Preferred Underground Expansion Project*

Aspect	Preferred UEP Project
Project Summary	• **Continued longwall mining operations to extract 4.7 Mt of ROM coal from the Wongawilli Seam in the Wonga East area over a period of 5 years;** • **Upgraded and continued operation of the pit top area, support facilities and utilities;** • **Continued minimal processing (sizing and screening) of up to 3 Mtpa of ROM coal at the pit top area;** • **Continued exploration activities, environmental monitoring and maintenance of access to the existing underground workings and surface infrastructure within exploration and mining tenements in the Wonga West domain;** • **Continued transport of ROM coal from the mine by road to the PKCT for export; and** • **Disposal of coal rejects adjacent to the mine site and rehabilitation of the site.**
Project Life and Mining Schedule	• 5 years, in general accordance with the following sequence: o LWs 6 and 7 – 2015; o LWs 1 and 2 – 2016; o LWs 3 and 9 – 2017; o LW 10 – 2018; and o LW 11 – 2019.
Project Application Area	Covers an area of 6,973 ha and includes Consolidated Coal Lease (CCL) 745, Mining Purposes Lease (MPL) 271 and Mining Lease (ML) 1575.
Mining and Reserves	• Extraction of approximately 4.7 Mt of ROM coal. • Production of up to 3 Mtpa of product coal for export.
Coal Production	• Coal production includes sizing and screening (no washing or other processing). The small amount of waste rock that may be produced during processing would be re-used on-site or else disposed of at the adjacent coal wash waste emplacement.
Water Demand and Supply	• Potable water demands at the Russell Vale pit top site would continue to be met by connection to Sydney Water's reticulated water supply. • Water demands at the No. 4 shaft would continue to be met by a combination of raw water purchased from SCA and recycled processed water. • Maximum groundwater inflows from both Bulli and Wongawilli Seams are estimated at 2.29 megalitres/day (ML/day). It is predicted that total water demand for mining operations would be 4.2 ML/day. • Water demand would be met by sourcing groundwater from old and new workings and surface water runoff from mine operational areas, with purchase of bulk raw water from SCA as required.
Employment	• Long-term employment of 300 employees and contractors. • Short-term construction workforce of up to 100 employees at various stages of the project.
Pit Top Surface Facility	• Existing facilities include administration offices and amenities, workshops, car parking areas, internal roads, five portal entries, ROM coal stockpile area and reclaim tunnel, two decline conveyor belts, coal breaker building, truck load-out facilities, vehicle wash, weigh bridge, water treatment and management facilities, fuel and oil storage facilities, electrical substation, four ventilation shafts and one access shaft (see **Figure 3**). • Construction of two new stockpiles (140,000 tonnes each), truck loading facilities, a designated coal dispatch road and a 6 ML settling pond. • Upgrade of water management system.
Support Facilities and Utilities	• Continued use of four ventilation shafts (Nos 1, 2, 3 and 5) and a shaft to provide personnel and materials access to the workings (No. 4 Shaft); • Access roads, water and electrical facilities.
Hours of Operation	• Underground operations: 24 hours, 7 days a week. • Coal Haulage: 7 am to 10 pm Monday to Friday; and 8 am to 6 pm Saturdays, Sundays and Public Holidays.
Mine Site Access	• Site access is via a private driveway from Bellambi Lane, at a signalised intersection. • The main access to underground workings is via No. 4 Shaft which is accessed from Picton Road.
Product Coal Transport	• Transport of ROM coal from the mine by road to the PKCT for export.
Rehabilitation	• Rehabilitation of all surface facilities following at the completion of mining.
Capital Value	• $85 million.

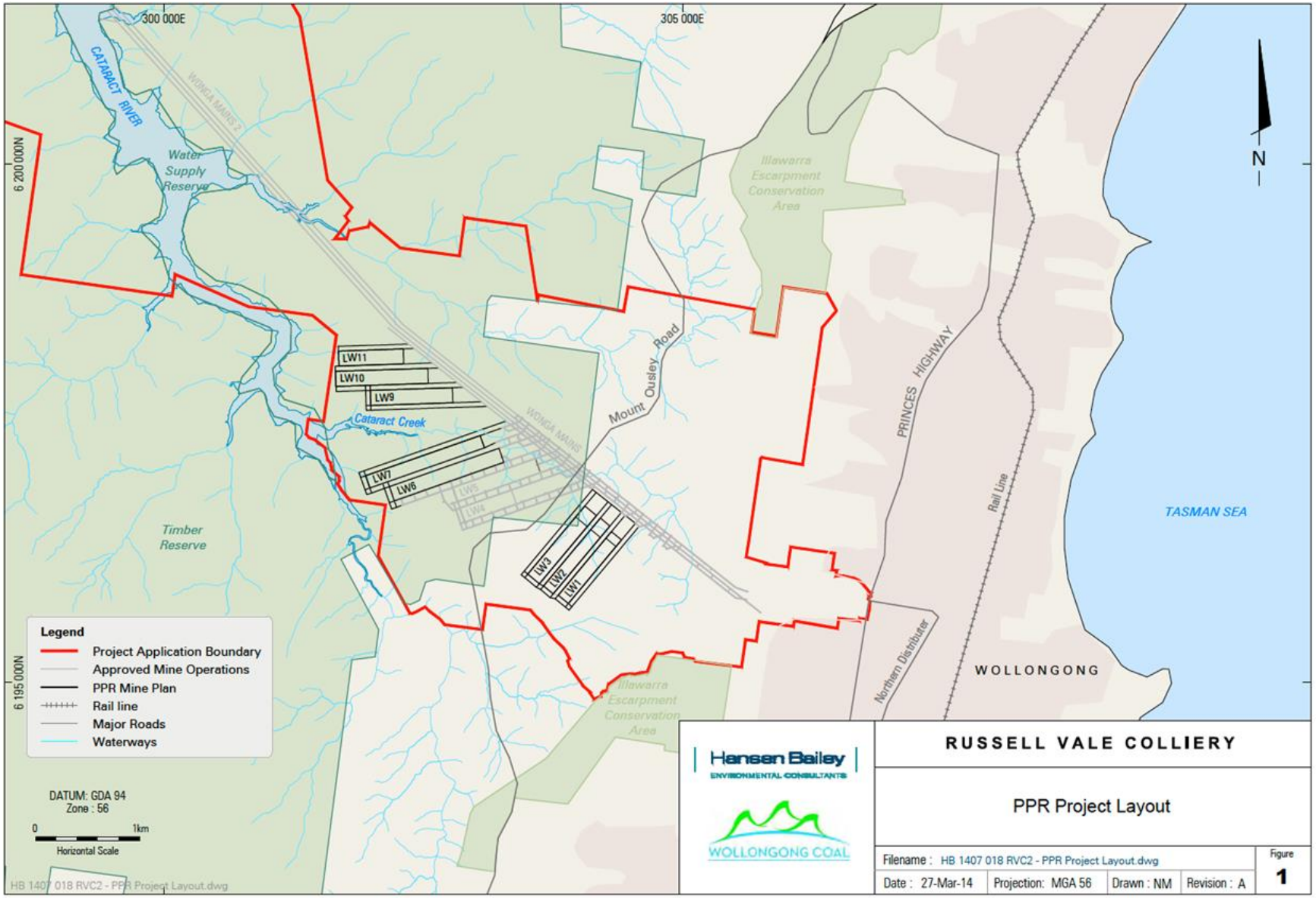

Figure 3: *Preferred UEP longwall layout*

Figure 4: *Pit top surface facilities*

Under the PPR, the UEP application was amended by:

- reducing the proposed project life from 18 years to 5 years;
- reducing the total ROM coal production from 31 Mt to 4.7 Mt;
- removing all proposed longwall mining (7 panels) from the Wonga West area and removing one panel (LW 8) from the Wonga East area;
- reorienting the remaining 8 longwall panels in the Wonga East area to minimise impacts to identified significant natural features; and
- removing the proposed Bulli West Bulli Seam first workings, Balgownie Seam first workings and Wonga Mains driveage.

A comparison of the general extent and panel orientation of the original project (shown in red) and the preferred UEP (shown in green) is provided in Figure 5.

The preferred UEP results in significant reductions in potential environmental impacts when compared to the original project. These include:

- no mining directly beneath the main channels of Cataract Creek, Cataract River or Bellambi Creek;
- no mining beneath the 3rd and 4th order streams of Cataract Creek;
- minimising and avoiding potential impacts to 'swamps of special significance' (including CCUS1, CCUS5 and CCUS10);
- minimising potential impact on Cataract Reservoir by removing longwall extraction from below the Full Supply Level (FSL) and outside the 35 degree Angle of Draw (AOD);
- minimising mining through geological features, including Dyke D8;
- moving longwall extraction of LW 1-3 further away from the Illawarra Escarpment and Mount Ousley Road; and
- reducing potential impacts on cliff lines, heritage sites and threatened species habitat.

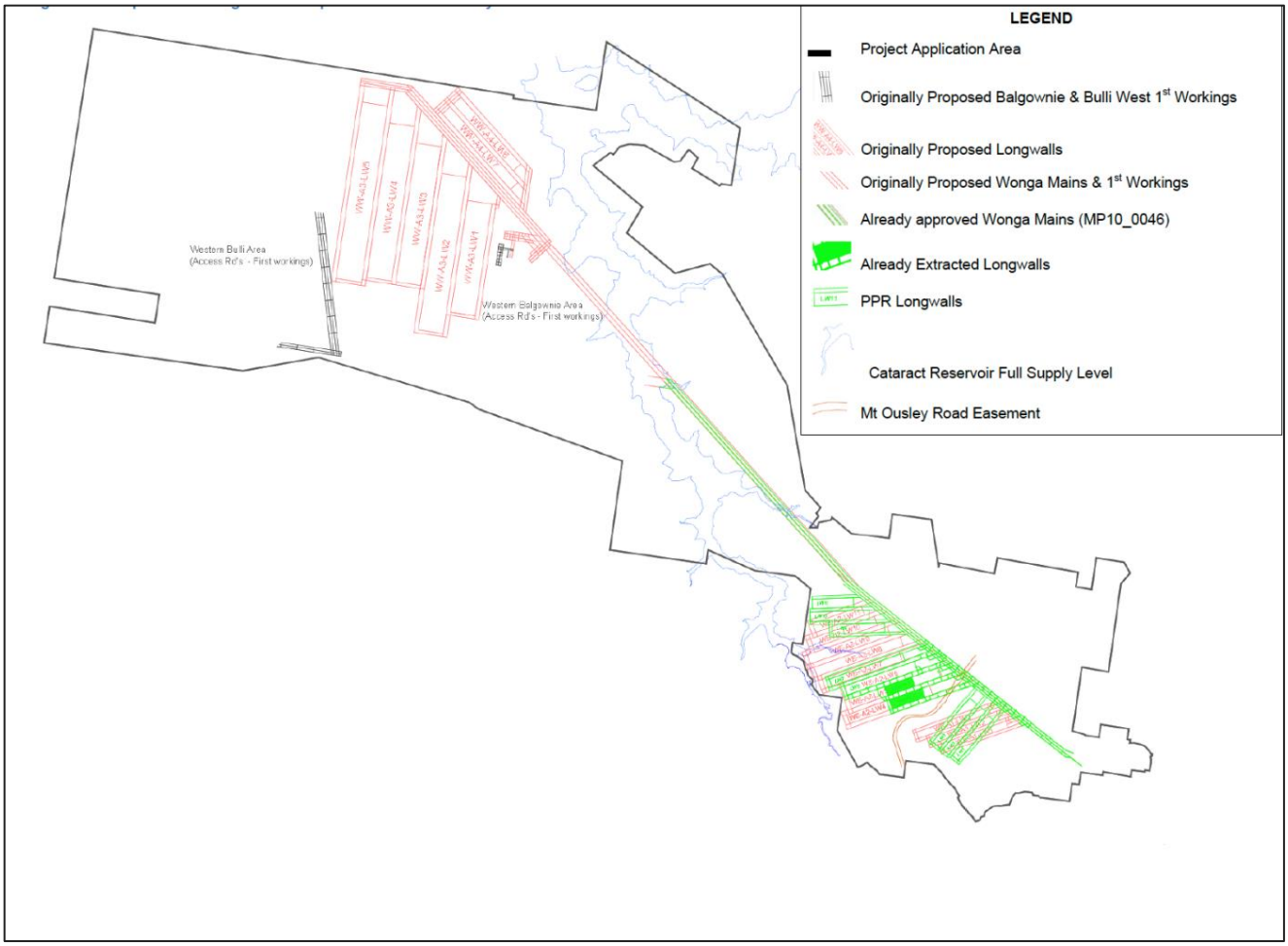

Figure 5: *Comparison of original EA proposal and PPR mine layout*

3 STRATEGIC CONTEXT

3.1 Economic Importance of Mining in the Illawarra

The Southern Coalfield is a major source of high-quality hard coking coal used for the production of steel, both in Australia and internationally. The unique nature of this hard coking coal resource within NSW makes it a very important contributor to the local, regional and State economies. The proximity of the Southern Coalfield to the coast and the PKCT is a major factor supporting export of coal from the region. It also supports the BlueScope Steelworks at Port Kembla.

Wollongong Coal owns and operates both the Russell Vale Colliery and the nearby Wongawilli Colliery. Together they have approval to produce up to 3 Mtpa of ROM coal and directly employ about 600 people.

The proposed project would ensure continued and new direct employment of approximately 300 persons at the Russell Vale Colliery, and indirect employment of up to an additional 1,498 people. The great majority of Wollongong Coal's employees reside within the Illawarra Region, and the majority of payments to employees, suppliers and contractors are paid into the regional economy. Continued local employment is particularly significant in the Illawarra Region, considering that the Illawarra Statistical District, in which 90% of Russell Vale Colliery employees reside, has the highest unemployment rate in Australia (10.2%). More specifically, Wollongong LGA, in which 60% of Russell Vale Colliery employees reside, has the 9th highest unemployment rate in Australia.

The Department understands that, if the project application is not approved, the colliery would shut down. This may in turn threaten the viability of the Wongawilli Colliery, which is currently on care and maintenance, following a roof collapse which buried its longwall machine.

3.2 Mining in the Drinking Water Catchment

A significant portion of the preferred UEP longwall layout lies within the Dam Safety Committee's (DSC's) Notification Area for Cataract Dam and its stored waters. This includes the western extents of LWs 6, 7, 9, 10 and LW 11 (refer to **Figure 2**).

In 2013, the then Board of the SCA adopted a policy position that the SCA would oppose any longwall mining within the DSC Notification Areas. These are areas where the DSC considers and controls the potential impacts of coal and other mining on dam infrastructure and stored waters. As such, they are 'investigation areas' for technical review and regulation of mining and related impacts, rather than areas where mining has been prohibited. For the past 35 years, the DSC has played a significant role in determining the type and extent of coal mining allowed in the vicinity of dams. Provisions of the *Mining Act 1992* permit the DSC to recommend changes to mining lease conditions within notification areas, effectively giving the DSC power over what mining may take place.

To date, SCA has provided no research or technical argument to support its position to oppose mining within the Notification Areas. The SCA is also not a determining authority for mining proposals and its policy position is not NSW Government policy. Current Government policy is that mining is permissible in the DSC Notification Areas, subject to consent and DSC approval. In considering whether to grant consent, the consent authority must consider the risk of impacts (eg damage to water-related infrastructure such as dams and storages or water take from the catchment), weigh this up against the potential benefits and decide what is in the public interest.

To examine the matters which led the SCA Board to adopt its position, the Government asked the NSW Chief Scientist and Engineer to consider the impacts of underground mining in the water supply catchments as part of her existing Independent Review of Coal Seam Gas activities in NSW. This report was published in May 2014 and found that:

- water quality issues can largely be managed through treatment works and the current multi-barrier process operated by the SCA and Sydney Water for protecting water quality for Sydney's consumers is sufficient, by and large, to protect water quality no matter the type of adverse impact;
- the current cautious approach by the DSC and other Government agencies appears to be preventing development that could cause obvious disastrous cumulative impact and therefore there is no reason to stop longwall mining immediately;
- however, there is insufficient data available to provide a deep and reliable understanding of the cumulative impacts of mining in the Catchment; and
- more data is required to adequately assess and model potential water quantity losses and their causes, however current activities should proceed while this data is gathered as current impacts do not seem to affect water quantity in a major way.

3.3 Upland Swamps

In December 2006, the NSW Government established an independent inquiry into underground coal mining in the Southern Coalfield. The Inquiry was established because of concerns held within both Government and the community over existing and potential impacts of underground mining operations on natural features, including upland swamps. In July 2008, the Southern Coalfield Inquiry released a report titled the *Independent Strategic Review of Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield*.

The Southern Coalfield Inquiry examined the impacts and consequences of longwall mining on upland swamps. It noted the lack of robust scientific information that would support a conclusion about the relationship between longwall mining, risk or impact and possible consequences. The Inquiry recommended the additional identification and assessment of the significance of swamps, as well as the establishment of risk management zones to minimise impacts on swamps considered to have special significance.

These recommendations were considered and refined during the PAC's later merit reviews of the Metropolitan Coal Project in 2009 and the Bulli Seam Operations Project in 2011. These reviews used a risk assessment approach for swamps, which involved:

- defining the subsidence impact parameters relevant to individual swamps;
- identifying all swamps in the project areas and characterising them in terms of their biodiversity, topographic and hydrologic features;
- identifying any swamps of special significance based on their conservation value and supported by evidence of substantial size, unusual complexity, contiguous habitat, presence of threatened species, etc;
- assessing the risk of negative environmental consequences for individual swamps; and
- determining the acceptability of negative environmental consequences.

When determining the acceptability of negative environmental consequences, the PAC adopted the standard that swamps of special significance were to be protected from negative environmental consequences. All other swamps should be protected unless the costs of avoidance would be prohibitive and mitigation or remediation options were not reasonable or feasible. In this case, an offset strategy should be developed. The PAC reports made it clear that, for mining to proceed in the catchment, some swamps not classified as being of special significance would be impacted.

Since publication of these PAC reports, all upland swamps in the Southern Coalfield have been listed as Endangered Ecological Communities (EECs) under both the NSW *Threatened Species Conservation Act 1995* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Office of Environment & Heritage (OEH) has also recently released the *NSW Biodiversity Offset Policy for Major Projects* (Offset Policy). It is acknowledged that subsidence-related impacts are expressly excluded from the Offset Policy. The Department is currently holding discussions with OEH about the most appropriate approach to include potential impacts to swamps from underground mining operations into the Offset Policy. However, in the interim the Department believes the conceptual approaches to offsetting outlined in the Offset Policy should be generally applied.

This approach requires avoidance where possible, then minimising, mitigating and remediating (in that order). However, beyond this framework of impact minimisation, it is recognised that trade-offs may be necessary. Where trade-offs are considered necessary, then developers should be required to provide suitable compensatory offsets for negative environmental consequences.

Within the Offset Policy, there is a clear preference for like-for-like direct offsets. However, the capacity for like-for-like offsets for upland swamps in the Southern Coalfields is very limited, given that the vast majority of swamps are located within conservation reserves or on other publicly-owned land. Therefore, the Offset Policy makes provision for direct payments into an offsets fund (to be established as soon as practicable) or funding or undertaking of important supplementary measures such as:

- actions outlined in threatened species recovery programs;
- actions that contribute to threat abatement programs;
- biodiversity research and survey programs; and/or
- rehabilitating degraded habitats.

Under the Offset Policy, offsets should be proportional to the level of impact or damage to the swamp that has occurred.

4 STATUTORY CONTEXT

4.1 Major Project

Following the repeal of Part 3A of the EP&A Act, the UEP is classified as a 'transitional Part 3A project' under savings and transitional provisions in Schedule 6A of the Act. This means that assessment of the merits of the project must be completed under the provisions of the former Part 3A.

The Minister for Planning is the approval authority for the project application. However, the application falls within the terms of the Minister's delegation to the PAC of 10 November 2014 as more than 25 of the public submissions objected to the project. Consequently, the PAC is required to determine the application.

4.2 Permissibility

The UEP is located in both the Wollongong and Wollondilly LGAs. Under the *Wollongong Local Environmental Plan 2009* (Wollongong LEP), the project application area is located across a number of zones, including Zone RU1 Primary Production, E2 Environmental Conservation, and SP2 Infrastructure. Extractive industries are permissible with development consent in RU1 but prohibited in both zones E2 and SP2.

The objectives of the E2 Environmental Conservation zone are to:

- protect, manage and restore areas of high ecological, scientific, cultural or aesthetic values;
- prevent development that could destroy, damage or otherwise have an adverse effect on those values;
- retain and enhance the visual and scenic qualities of the Illawarra Escarpment; and
- maintain the quality of the water supply for Sydney and the Illawarra by protecting land forming part of the Sydney drinking water catchment (within the meaning of *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011*) to enable the management and appropriate use of the land by the Sydney Catchment Authority.

The objectives of the SP2 Infrastructure zone are to:
- provide for infrastructure and related uses;
- prevent development that is not compatible with or that may detract from the provision of infrastructure; and
- provide for key transport corridors.

Under the *Wollondilly Local Environmental Plan 2011* (Wollondilly LEP), the project application area is located in zone E2 Environmental Conservation. Mining is prohibited in this zone. The objectives of this zone are to:
- protect, manage and restore areas of high ecological, scientific, cultural or aesthetic values; and
- protect development that could destroy, damage or otherwise have an adverse effect on those values.

Despite these prohibitions under the Wollongong and Wollondilly LEPs, clause 7(1)(a) of the *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* makes underground mining permissible with consent on any land. Consequently, all aspects of the project are permissible with development consent.

During its assessment process, the Department has considered the merits of allowing the project to be developed on land where it is classified as prohibited development under the LEPs, and whether it would offend the objectives of the relevant zones. It has also consulted with the SCA, OEH and Wollongong City Council (Council) on the matter. Following consideration, the Department is satisfied that the project should be allowed to be developed on land within the E2 and SP2 zones because there would be:
- no significant impacts on scientific, cultural or aesthetic values;
- negligible impacts on drinking water supply or quality;
- limited and generally unavoidable impacts on upland swamps, but these would be closely monitored and any impacts leading to greater than negligible environmental consequences would be fully offset;

4.3 Integrated and Other Approvals

Under Section 75U of the EP&A Act, a number of other statutory approvals have been integrated into the major project approval process and are not required to be separately obtained for the project. These include:
- heritage-related approvals under the *National Parks and Wildlife Act 1974* and *Heritage Act 1977*; and
- water-related approvals under the *Water Management Act 2000*.

Under Section 75V of the EP&A Act, a number of other approvals are required to be obtained, but these approvals must be approved in a manner that is substantially consistent with any Part 3A approval for the project. These include:
- mining leases under the *Mining Act 1992*;
- approvals under the *Mine Subsidence Compensation Act 1961*;
- consents under Section 138 of the *Roads Act 1993*; and
- environment protection licences (EPLs) under the *Protection of the Environment Operations Act 1997*.

The Department has consulted with the relevant government authorities responsible for these other approvals (see **Section 5**), and considered the relevant issues relating to these approvals in its assessment of the project (see **Section 6**). None of the relevant authorities object to the project on grounds that relate to these other approvals, subject to the imposition of suitable conditions.

4.4 *Environment Protection and Biodiversity Conservation Act 1999*

On 14 November 2014 the Commonwealth Department of Environment (DOE) declared the UEP to be a 'controlled action' under the EPBC Act as it has the potential to impact listed threatened species and communities. As such, the UEP also requires assessment and approval under the EPBC Act before it can proceed.

4.5 Environmental Planning Instruments

Under Section 75I of the EP&A Act, the Secretary's environmental assessment report for the project is required to include a copy of, or reference to, the provisions of environmental planning instruments (EPIs) that substantially govern the carrying out of the project.

Consideration of the relevant EPIs was provided in Section 4 of the EA and has been further considered by the Department (**Appendix C**). The Department is satisfied that Wollongong Coal has adequately considered the requirement of the applicable EPIs as part of the assessment of the project and that none of these instruments substantially govern the carrying out of the project.

The *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011* (SEPP Sydney Drinking Water Catchment) applies to land within the hydrological catchments that contribute to Sydney's drinking water supply. The aims of this Policy are to:

- provide for healthy water catchments that will deliver high quality water while permitting development that is compatible with that goal;
- provide that a consent authority must not grant consent to a proposed development unless it is satisfied that the proposed development will have a neutral or beneficial effect on water quality; and
- support the maintenance or achievement of specified water quality objectives for the Sydney drinking water catchment.

A large part of the proposed preferred UEP area is designated as a *Schedule 1 Restricted Access Area* (ie Metropolitan Special Area) under the *Sydney Water Catchment Management Act 1998*, managed by the SCA. As discussed in **Section 6.4** below, the Department is satisfied that the project would have a neutral impact on water quality within the catchment and that the project would not contravene the aims of this SEPP.

The *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* (Mining SEPP) was recently modified to require consent authorities to consider the significance of the resource when considering the merits any mining proposal, as well as the economic benefits to the State and region of any such proposal.

While these provisions of the Mining SEPP do not strictly apply to the UEP (because it is a transitional Part 3A project), consistent with longstanding practice the Department has considered these matters in its assessment of the merits of the proposal.

This assessment has concluded that:

- the UEP coal resource is significant based on:
  - its high-quality hard coking coal used for the production of steel and other metallurgical purposes;
  - its strategic location in the Southern Coalfields and its close proximity to key regional infrastructure, in particular PKCT;
  - the relationship of the resource to the existing PWP, and the synergies this presents for utilising existing infrastructure and reducing the capital costs associated with extracting the resource; and
- the project would generate substantial socio-economic benefits including:
  - continued direct employment of 219 people and additional direct employment of 81 people during operation;
  - direct employment of an additional 100 people during construction;
  - indirect employment of up to 1,498 people in the local and regional area;
  - $85 million in capital investment during construction ($18 million) and operation ($67 million)
  - $34 million to the State in royalty revenue; and
  - $110 million to the Commonwealth in tax revenue.

4.6 Objects of the *Environmental Planning and Assessment Act 1979*

Decision-makers (including the Minister's delegate) should consider the objects of the EP&A Act when making decisions under the Act. These objects are detailed in section 5 of the Act, and include:

> *'The objects of this Act are:*
>
> *(a) to encourage:*
>
> *(i) the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment,*
>
> *(ii) the promotion and co-ordination of the orderly and economic use and development of land,*
>
> *(vi) the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats, and*
>
> *(vii) ecologically sustainable development (ESD).'*

The Department is satisfied that the project encourages the proper use of resources (Object 5(a)(i)) and the promotion of orderly and economic use of the land (Object 5(a)(ii)), particularly as the subject coal resource is located within an area known to contain one of the few high quality coking coal resources in the State, is adjacent to existing mining operations, can be carried out using existing infrastructure, and would provide socio-economic and public benefits.

Consideration of environmental protection (Object 5(a)(vi)) is provided in **Section 6** of this report. Following its assessment, the Department is satisfied that the project is able to be undertaken in a manner that would maintain or improve biodiversity values of the locality in the medium to long-term.

The Department has fully considered the encouragement of ecologically sustainable development (ESD) (Object 5(a)(vii)) in its assessment of the merits of the project application in **Section 6** below, and sought to integrate all significant economic and environmental considerations and avoid any serious or irreversible damage to the environment, based on an assessment of risk-weighted consequences. It has also considered Wollongong Coal's assessment of these matters, including its assessment of the alternatives of not proceeding with or using alternate transport and extraction methods, in its EA and subsequent PPR. Based on this consideration, the Department is satisfied that the project can be carried out in a manner that is consistent with the principles of ESD.

4.7 Statement of Compliance

Under Section 75I of the EP&A Act, the Secretary's report is required to include a statement relating to compliance with the environmental assessment requirements for the project. The Department is satisfied that the environmental assessment requirements have been complied with.

4.8 PAC Review

On 9 December 2014, the Minister for Planning asked the PAC to review the merits of the preferred UEP. Due to the level of interest in the project and the complexity of its potential subsidence and water resource impacts, the Minister also requested that the PAC hold public hearings during the reviews. The terms of reference for this PAC review are set out below.

Once it receives the PAC's review report, the Department would finalise its assessment of the merits of the project and refer the project application back to the PAC for determination.

1. Carry out a review of the Russell Vale Colliery Underground Expansion Project, and:

- *a) consider the EA for the project, the issues raised in submissions, the formal response to submissions, the Preferred Project Report, the Residual Matters Report, the Department of Planning & Environment's preliminary assessment report of the project, and any other relevant information provided on the project to the Commission during the course of the review;*
- *b) assess the merits of the project as a whole, paying particular attention to the potential impacts to:*
  - *upland swamps and water resources (especially Cataract Creek and the stored waters of Cataract Reservoir) resulting from mine subsidence; and*
  - *residents in the vicinity of the Russell Vale pit top resulting from noise and air emissions and the trucking of product coal;*
- *c) apply all relevant NSW Government policies in that consideration and assessment; and*
- *d) provide recommendations on any reasonable and feasible measures that could be implemented to avoid, reduce and/or offset the potential impacts of the project.*

2. Conduct public hearings on the project no later than 30 January 2015.

3. Complete the review by 20 March 2015, unless the Secretary of the Department of Planning and Environment agrees otherwise.

5 CONSULTATION

5.1 Consultation Process

In accordance with Section 75H(3) of the EP&A Act, the Department:

- made the EA publicly available from 18 February 2013 until 5 April 2013:
  - on the Department's website,
  - at the Department's Information Centre and the offices of Wollongong City Council and Wollondilly Shire Council, and
  - at the offices of the Nature Conservation Council;
- notified relevant State government agencies, Wollongong City Council and Wollondilly Shire Council by letter; and
- advertised the exhibition of the EA in the Illawarra Mercury and Sydney Morning Herald.

During the exhibition period, the Department received 840 submissions on the project, comprising:

- 12 from public authorities;
- 2 from special interest groups; and
- 826 from the general public.

Of the submissions received from the general public, 747 (over 90%) were form letters that either objected (329) or supported the project (418).

After Wollongong Coal made significant changes to the original project, the Department forwarded the PPR to all relevant government authorities and made the document publicly available on its website. The Department received comments from 8 agencies and 13 members of the pubic and community groups.

Copies of all submissions received on the EA and PPR are attached as **Appendix D**.

Of the 828 public and special interest group submissions received during exhibition of the EA, 53% supported the project and 46% objected to the project. All of the 13 submissions received in response to the PPR objected to the preferred UEP.

5.2 Key Issues Raised

The key environmental issues raised in submissions from objectors were potential subsidence impacts on natural features (including surface water, groundwater, upland swamps and biodiversity) and built features (including Cataract Reservoir and Aboriginal heritage). These concerns are addressed in detail in **Section 6** of this report, with a particular focus on Cataract Creek, upland swamps and the Cataract Reservoir. Other environmental concerns raised in submissions include potential impacts associated with the pit top operations, including impacts on noise, surface water management, air quality and traffic. These latter issues are discussed in **Section 6.7** and in **Table 11**.

The public submissions in support of the project cited employment and socio-economic benefits in the Wollongong region as key reasons why the project should be approved.

The number of times that each issue was raised in public submissions is shown in **Figure 6**, below.

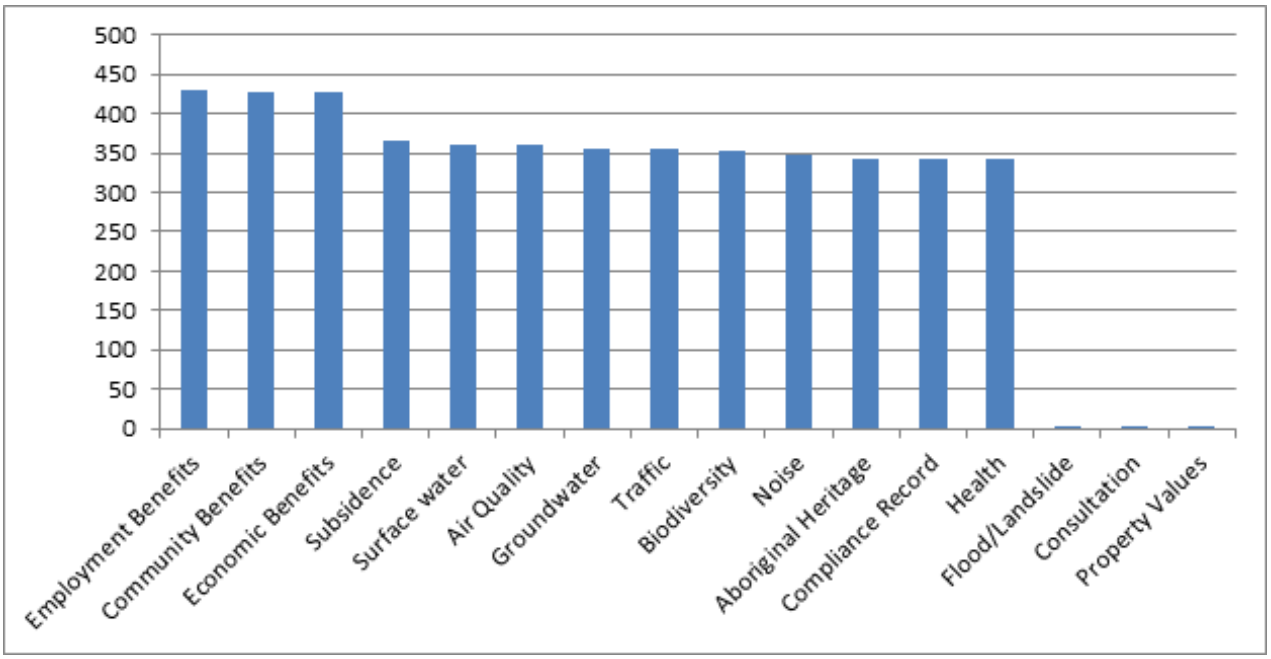

Figure 6: *Key issues for special interest groups and the community (including form letters)*

5.3 Response to Submissions and Residual Matters Report

As indicated in **Section 2**, Wollongong Coal provided a formal Response to Submissions (RTS) on the EA in the PPR, which was submitted to the Department in September 2013 (see **Appendix B**). In June 2014, at the request of the Department, Wollongong Coal provided an addendum to its PPR/RTS, which provided a range of additional information to address key residual issues raised by the agencies. This document is titled the Residual Matters Report (RMR) and was submitted to the Department in June 2014 (see **Appendix E**).

The RMR contains a significant amount of additional updated information that replaces much of the information contained in the EA and PPR/RTS. The RMR includes a:

- revised *Subsidence Assessment* undertaken by SCT Operations Pty Ltd (18 June 2014) (Appendix B);
- revised *Groundwater Assessment* undertaken by GeoTerra Pty Ltd (19 June 2014) (Appendix C);
- *Peer Review* of the *Groundwater Assessment,* undertaken by Dr Noel Merrick of HydroSimulations (22 June 2014) (Appendix D);

- *Groundwater & Surface Water Response to Submissions Residual Matters Addendum*, prepared by GeoTerra Pty Ltd (19 June 2014) (Appendix E);
- revised *Surface Water Modelling* report undertaken by WRM (30 May 2014) (Appendix F);
- revised *Biodiversity Assessment* undertaken by Biosis Pty Ltd (20 June 2014) (Appendix G);
- revised *Heritage Assessment* undertaken by Biosis Pty Ltd (27 March 2014) (Appendix H);
- revised *Traffic & Transport Impact Assessment* undertaken by Cardno Pty Ltd (April 2014) (Appendix I); and
- *Geological Report on the Wonga East Area* undertaken by Gujarat NRE Coking Coal Limited, (May 2014) (Appendix K).

Since this time, Wollongong Coal has also provided the following additional information in relation to flooding, groundwater and noise:

- the *Bellambi Gully Flood Study* (25 November 2014) undertaken by Cardno;
- a letter report from Wollongong Coal Ltd to the Department providing additional information on the *Underground Expansion Project Groundwater Assessment* (26 September 2014) in relation to total groundwater inflow; and
- a *Noise Impact Assessment* (September 2014) undertaken by Wilkinson Murray to assess noise from the existing and proposed pit top operations and truck movements.

A copy of this additional information is provided in **Appendix F**.

The RMR and additional information were sent to relevant agencies for final comments. The **Office of Environment and Heritage** (OEH) (including the Heritage Division), the **Department of Primary Industries** (DPI) and its component **NSW Office of Water** (NOW) and the **Sydney Catchment Authority** (SCA) provided further comments which outlined their residual concerns. The **Dams Safety Committee** (DSC), the **Environmental Protection Authority** (EPA), **Roads and Maritime Services** (RMS) and **Wollongong City Council** (Council) did not provide further comments to the Department. A full copy of agency comments on the RMR and additional information is included in **Appendix D**.

5.4 Residual Concerns in Agency Submissions

OEH remains concerned about the potential impacts of the project on overlying upland swamps and believes the mining layout should be amended to avoid impacts to these natural features and associated threatened species habitat. If amendments to the mining layout are not considered feasible, then OEH considers that a biodiversity offset strategy, addressing both swamps and threatened species, should be prepared.

OEH's Heritage Division is satisfied with the commitments made by Wollongong Coal in relation to the protection and management of heritage items on site, and notes that these commitments would be included in the new Heritage Management Plan for the project.

SCA objects to the proposal, particularly because it is partly located in the DSC's Notification Area surrounding Cataract Reservoir (see **Figure 2**). SCA is also concerned over a lack of specificity in the subsidence predictions, incomplete knowledge of geological structures, potential loss of water from Cataract Reservoir and the potential impacts on upland swamps.

NOW has not identified any specific concerns about the potential impacts of the project. NOW indicates that the groundwater modelling satisfies the requirements of the *NSW Aquifer Interference Policy*, but requests that a discrepancy between the groundwater and surface water models over the predicted loss of surface water is clarified. Clarification in relation to this issue is provided in **Section 6.2** of this report.

DSC raised concern about the impact of mining on the water security of Cataract Reservoir (ie the potential for leakages) and asked for the groundwater model to be revised to address the possibility of losses from the reservoir. This information was provided in the RMR. The Department has also recommended a condition requiring Wollongong Coal to install a borehole between LWs 6 & 7 and the reservoir to investigate and monitor groundwater depressurisation during mining.

Several longwalls associated with the UEP also fall within DSC's Notification Area for the Cataract Reservoir. Wollongong Coal is required to lodge an application with the DSC to mine within this Notification Area.

DRE raised concerns in relation to the subsidence predictions and impact assessment contained in the EA. DRE indicated that the subsidence predictions were underestimated and that risks of pillar run and potential impacts on key built features in the vicinity of LWs 1 to 3 should be further assessed. DRE also requested additional information in relation to rehabilitation and the post-mining landform design. The additional information requested by DRE was included in the RMR and is discussed in detail in **Section 6.1** below.

RMS raised no concerns, but requested that any technical implications regarding subsidence impacts on roads are referred to the Wollongong Coal - RMS Technical Committee.

EPA was satisfied that its comments on the pit top operations were adequately addressed in the PPR/RTS. The EPA has subsequently been provided with a copy of the revised *Noise Impact Assessment* (Wilkinson Murray, September 2014 – refer to **Appendix F**) for the project. The Department and the EPA have conducted several meetings to discuss the assessment and the most appropriate approach to setting noise criteria for the UEP. The EPA has indicated that it would reflect the noise criteria included in any consent granted for the development in a subsequent Environment Protection Licence for the pit top site. The EPA also requested the opportunity to review management plans for the project.

Council remains concerned about the impact of the proposal on upland swamps and states that the proposed longwalls should be removed, shortened or reoriented to avoid impacts. Council also indicated that, in the absence of any alternative noise attenuation measures, Wollongong Coal should be required to install three acoustic barriers around the perimeter of the pit top area. As discussed in detail in **Section 6.7.1** of this report, the revised Noise Impact Assessment indicates that the reduction achieved by the implementation of noise walls would be minimal (ie reductions range between 1-2 dB(A)). Therefore, installing these noise walls is not considered an effective noise mitigation measure. Alternative, more effective noise mitigation proposals are discussed in detail in **Section 6.7.1** of this report.

5.5 IESC Advice

On 12 August 2014, the Department requested that the Commonwealth Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) provide advice on the adequacy of Wollongong Coal's subsidence, groundwater and surface water assessments for the preferred UEP. A copy of the advice received from the IESC and Wollongong Coal's response to this advice is provided in **Appendix G.**

A summary of the advice received from the IESC and the sections of this report where the relevant issues are considered is provided in **Table 2** below.

Table 2: *Key IESC conclusions*

Issue	Key IESC Conclusion	Where considered
Relevant data and information	• The monitoring of water level, as opposed to flow, in Cataract Creek does not enable the rainfall runoff model to be calibrated within the subcatchment and reduces confidence in predictions.	Section 6.4
	• There has been reasonable mapping of 39 upland headwater swamps. However, hydrological characterisation of all potentially impacted swamps has not been done and should include field data to inform conceptual understanding of individual swamp hydrology, determination of the distribution of perched water within swamps and all water inputs and outputs.	Section 6.3
Application of appropriate methodologies	• Methods for predicting subsidence in the assessment by SCT are generally appropriate. However, insufficient consideration has been given to the potential impacts of subsidence on surface water systems and upland swamps.	Sections 6.3 & 6.5
	• The use of a 0.7 times depth of cover setback as a mitigation measure for protecting water storage within Cataract Reservoir needs to be justified, given the proximity to multiple overlying extraction zones.	Section 6.2
	• The applicability of the Tammetta model to the prediction of height of fracturing and depressurisation of multi-seamed mining is not supported by evidence and may under-predict fracturing and increases in hydraulic conductivities.	Section 6.4
	• Predictive uncertainty analysis should include consideration of potential effects of increased and variable vertical hydraulic conductivity as a result of mine subsidence.	Section 6.5
	• The regional scale groundwater model does not enable prediction of impacts to swamp hydrology at a scale suitable for informing management and mitigation options.	Section 6.3
	• Potential impacts to surface water in Bellambi Gully cannot be assessed as the project assessment documentation does not include an up-to-date water balance or an updated flood study.	Section 6.7.2
Reasonable values and parameters in calculation	• The greatest uncertainties regarding the groundwater model are related to the hydraulic and spatial characteristics of the fracture zone.	Section 6.5
	• Calibrated hydraulic conductivity values are only partially reported and those reported for the fracture zones are lower than values measured from other studies within the southern coalfields potentially leading to underestimation of drawdown and loss of baseflow.	Section 6.4

	• The value used for evapotranspiration is significantly higher than predicted for the area by the Bureau of Meteorology, leading to potential overestimation of groundwater losses to evapotranspiration from low elevation areas within the model.	Section 6.5
	• Scenarios modelled for subsidence induced surface water losses are not justified and have not been linked to the mechanisms which are likely to cause impacts. As such, there is low confidence in predicted impacts to Cataract Creek and the Reservoir.	Section 6.4

6 ASSESSMENT

In its assessment of the merits of the project application, the Department has considered:
- the project EA;
- submissions from the public and the relevant agencies;
- Wollongong Coal's RTS/PPR and RMR;
- relevant environmental planning instruments, policies and guidelines; and
- the requirements of the EP&A Act, including the objects of the Act.

The Department has also commissioned independent expert advice to assist with its assessment of the UEP, specifically in relation to:
- subsidence impacts (Dr Bruce Hebblewhite);
- groundwater impacts (Mr Paul Tammetta); and
- surface water impacts (Evans & Peck).

Copies of the expert review reports are attached at **Appendix H**. The outcomes of these reviews have informed the Department's confidence in the predictions for the UEP.

6.1 Subsidence

Underground Mining Environment

The preferred UEP involves extraction of coal from eight longwalls in the Wongawilli Seam, which is the lowest seam within the Illawarra Coal Measures. Longwall extraction has previously taken place in the overlying Balgownie Seam, and bord and pillar and pillar extraction has previously taken place in the uppermost Bulli Seam. Thus the project involves 'multi-seam' mining, where subsidence impacts from the deepest mining would add to (and possibly intensify) the subsidence impacts that previously took place as a result of mining in the two higher seams.

The eight longwalls have been designed to minimise the surface and other environmental impacts from subsidence with narrow panel widths (ranging from 125 m to 150 m) and large chain pillars (40 m to 45 m wide). The overburden depth ranges from 250 m above the northern parts of LWs 2 and 3 through to 390 m above the central part of LWs 10 and 11. To avoid key surface features the longwall lengths vary from 630 m (LW 11) to 1,175 m (LW 7).

Accurate prediction of subsidence effects and subsidence impacts in this complex engineering environment can present challenges when compared to single-seam extraction. This is particularly the case because the extent of pillar extraction in the Bulli Seam (which took place up to 100 years ago) is not always accurately recorded on the available maps of coal mine workings. Therefore, it cannot be known with certainty that the roof of the Bulli Seam workings has fully collapsed (ie subsided) at all locations. Remnant pillars may continue to be present in the Bulli Seam workings, but possibly do not retain a high level of inherent strength or stability. Given these inherent uncertainties, and the inability to fully eliminate them, it is appropriate that subsidence predictions and management err towards conservatism.

However, it is also important to note that previous mining provides a number of opportunities that are not usually available in single seam mining applications. This includes more detailed knowledge of the nature, location, and characteristics of geological structures, actual measurement of the subsidence behaviour of the overburden strata at the site during previous mining, and an extended baseline of some 60-100 years to study the recovery of natural features from previous subsidence impacts.

Surface Features

As shown in **Figure 7**, the UEP is situated in a highly constrained environment. The Illawarra Escarpment is located not far to the east, an impounded section of the Cataract River is located to the west and Cataract Creek flows towards the west through the middle of the project area, draining directly into Cataract Reservoir.

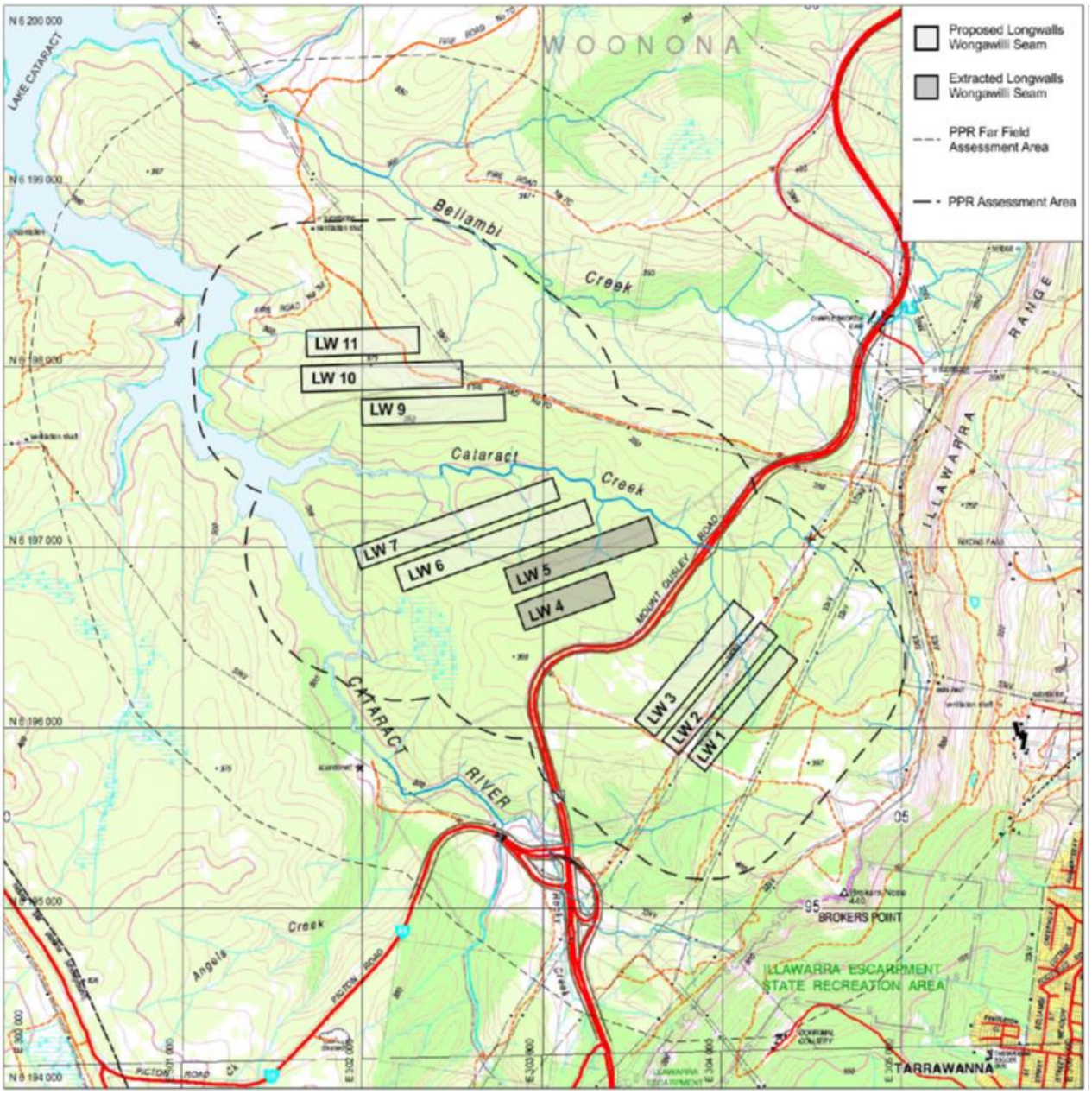

Figure 7: *Key surface features in the vicinity of the Preferred UEP*

Wollongong Coal has designed the preferred UEP longwall layout to avoid mining directly under Cataract River or the 3rd and 4th order sections of Cataract Creek. However, LWs 2 and 3 would mine under a 2nd order section of the southern branch of Cataract Creek and LWs 6 and 7 would mine under several 1st order ephemeral tributaries, which drain in a northerly direction into Cataract Creek.

The UEP area contains 39 upland swamps which mainly occur in headwater tributary valleys over Hawkesbury Sandstone. The longwalls have been positioned to avoid the majority of these swamps, including most of the larger, contiguous, more complex swamp systems. However, the preferred UEP would partially undermine the upper margins of 4 swamps (CCUS1, CCUS5, CCUS10 and BCUS4) and would fully undermine an additional 5 swamps (CCUS2, CCUS4, CCUS11, BCUS11 and CCUS12). It is important to note that the majority of these swamps have previously been mined under in both the Bulli and Balgownie Seams.

The project area also contains numerous sandstone rock formations on the upper slopes associated with Hawkesbury Sandstone. Some archaeological heritage sites are located within this outcrop. Several 1st order tributaries of Cataract Creek have formed waterfalls where they flow over Hawkesbury Sandstone formations.

The preferred UEP is located in an area dominated by native bushland. The only built features in the area include Mt Ousley Road, four power transmission lines and Cataract Reservoir. Mount Ousley Road is located far enough away from the nearest longwall (LW 3) to be protected from subsidence-related impacts. However,

the power transmission lines located over LWs 1 and 2 may require special protection measures and monitoring during mining operations.

As shown in **Figure 2**, the western sections of LW 6, 7 and LW 9 to 11 fall within the DSC's Notification Area for Cataract Reservoir. To protect the stored waters of the reservoir, Wollongong Coal has positioned the longwalls to avoid extraction within 0.7 times depth of cover (equivalent to 35° AOD) from the full supply level (FSL) of Cataract Reservoir, including the section of the reservoir that extends up Cataract Creek.

Subsidence Assessment

SCT Operations Pty Ltd (SCT) prepared a detailed Subsidence Assessment (September 2013) to predict subsidence effects and to assess potential subsidence impacts associated with the preferred UEP. This assessment was subsequently updated to include subsidence monitoring results to the end of LW 5, revision of the valley closure estimates, and identification of a small sandstone cliff formation downstream of swamp CCUS4. The updated Subsidence Assessment (June 2014) was included in Appendix B of the RMR.

The updated subsidence assessment also addresses recommendations made in Dr Hebblewhite's review of the original UEP Subsidence Assessment. Dr Hebblewhite's review is attached in **Appendix H**. The Department has relied on SCT's updated Subsidence Assessment for its assessment of the preferred UEP's potential subsidence impacts.

The Subsidence Assessment's predictions were primarily based on existing monitoring data for the Bulli, Balgownie and Wongawilli Seams, including:

- subsidence profile measures during the 1990s for extraction in the Bulli Seam, with adjustments made based on surface observations for the Balgownie Seam;
- measured subsidence data sourced from the mine archives for the Balgownie Seam; and
- subsidence predictions and measured subsidence profiles for the Wongawilli Seam based on mining in LWs 4 and 5.

The Department is satisfied that the approach used by SCT to predict subsidence movements is appropriate and provides a strong basis for predictions in the complex multi-seam environment, particularly considering that actual subsidence data from mining in LWs 4 and 5 in the Wongawilli Seam have been used to provide confirmation of behaviours when a third seam is mined. Dr Hebblewhite agrees that the approaches used to predict subsidence are valid and appropriate.

Review of Mining in Longwalls 4 and 5

SCT notes that the monitoring results available for LWs 4 and 5 indicate that the subsidence behaviour is predictable, albeit with somewhat different characteristics to subsidence over single seam mining operations. The effect of the overlying goaf areas is to reduce the stiffness and rigidity of the overburden strata, which leads to reduced bridging capacity in these strata and significantly increased maximum subsidence for the same overburden depth and longwall panel geometry.

SCT states that, in previously undisturbed overburden strata, the maximum subsidence above a 150 m wide longwall panel at 300 - 360 m depth would be of the order of 0.1 - 0.3 m, leading to barely perceptible impacts. However, the measured maximum 'sag' subsidence in both LW 4 and LW 5 has been 1.8 m, due to the 'softening' of overburden strata by previous mining and consequent reduced bridging capacity (see **Figure 8**).

Although the amount of vertical subsidence associated with multi-seam mining is significantly greater than for single-seam mining, the lateral extent of vertical subsidence is similar (see **Figure 9**). SCT reports that the measured subsidence in LWs 4 and 5 did not extend greatly over the adjoining pillars. This is the key outcome of the monitoring data – subsidence is predominantly constrained to the area immediately above the longwall panel itself, and is expressed as narrow subsidence troughs which are relatively deep and steep sided.

The Department is satisfied that the subsidence effects associated with extraction of LWs 4 and 5 were limited in scale and extent and generally limited to the panel footprint. They are not, in themselves, of concern.

Predicted Subsidence Effects

Table 3 provides a summary of the predicted subsidence effects modelled to occur over the longwalls within the preferred UEP and compares these to the actual subsidence measurements taken for LWs 4 and 5 (included in bold in parentheses).

Maximum subsidence over individual longwall panels in the Wongawilli Seam is predicted to range from 1.5 m over the slightly narrower LW 7 through to 2.6 m over LW 3, where the overburden depth is shallowest and there is overlying goaf in both seams.

Maximum tilts are expected to range up to maxima of 24 millimetres/metres (mm/m) over LW 10 through to maxima of 51 mm/m above LW 3, and are most likely to occur at panel edges and in areas of topographic changes in gradient. Maximum strains over individual longwall panels are expected to range from maxima of 14 mm/m over LW 10 to maxima of 31 mm/m over LW 3. The maximum tensile strains are most likely to occur at topographic high points and maximum compressive strains are most likely to occur at topographic low points. SCT states that, across the majority of each longwall panel, tilts and strains would be significantly less than these maxima, with most tilts anticipated to be in the range of 50-90% of the peak value and most strains anticipated to be in the range of 20-30% of the peak value, for each longwall.

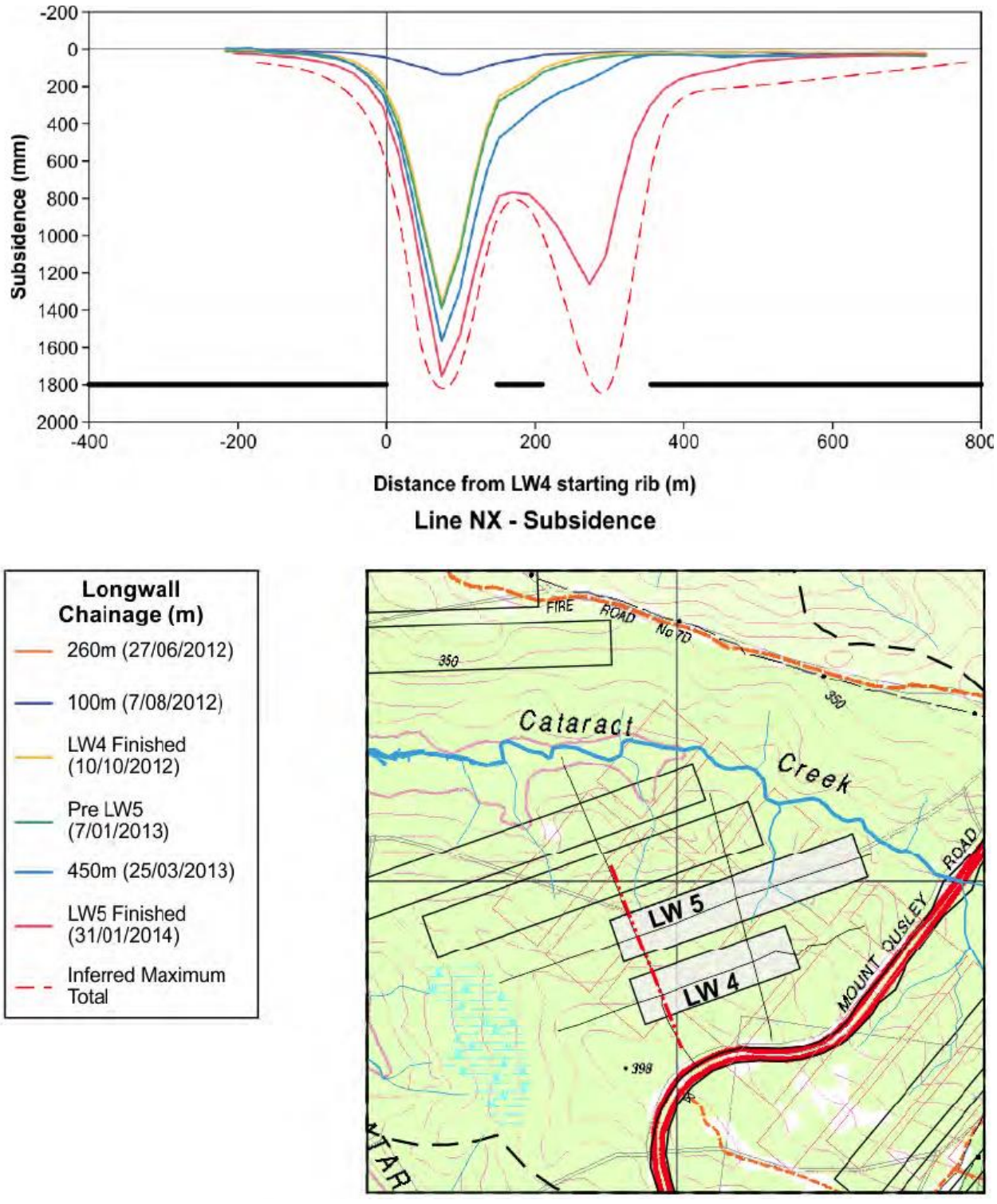

Figure 8: *Typical subsidence monitoring results for Longwalls 4 and 5 (Wongawilli Seam)*

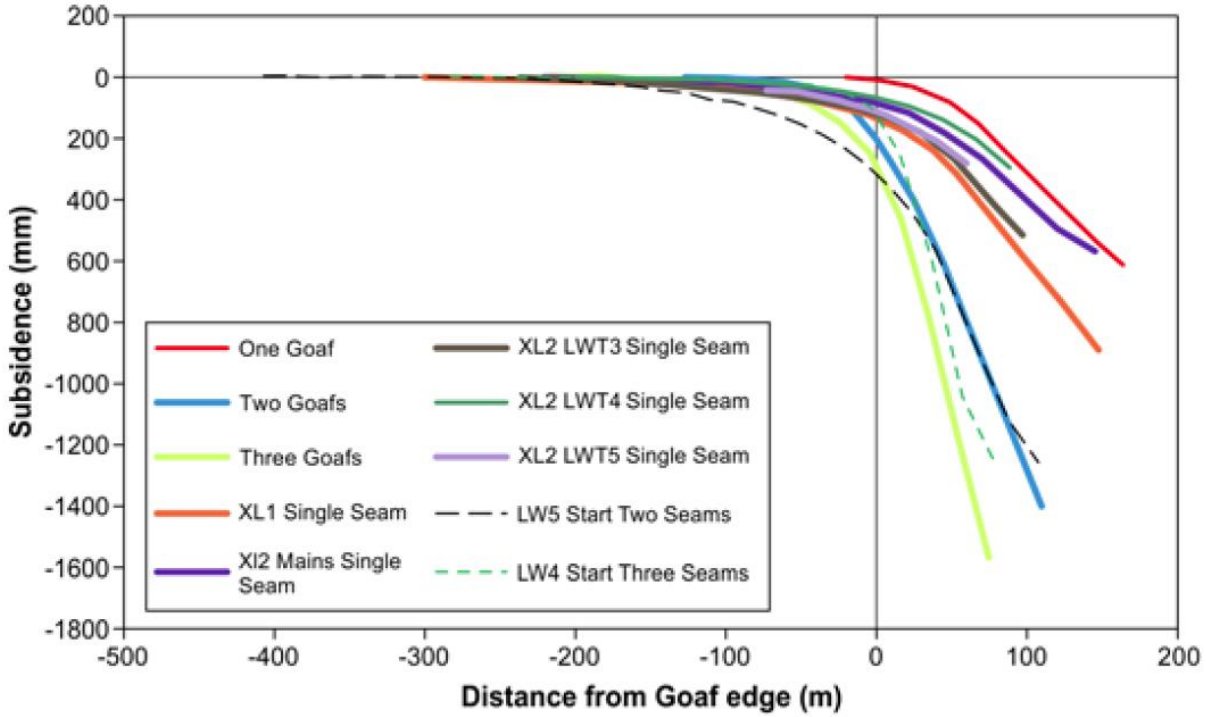

Figure 9: *Summary of goaf edge profiles for multi-seam mining*

Table 3: *Actual and predicted subsidence measurements*

Longwall	*Previous Bulli and Balgownie Seam Subsidence[1] (m)*	*Predicted Additional Subsidence for Preferred UEP and Measured (in bold) (m)*	*Predicted Tilt for Preferred UEP and Measured (in bold) (mm/m)*	*Predicted Tensile Strain for Preferred UEP and Measured (in bold) (mm/m)*	*Predicted Compressive Strain for Preferred UEP and Measured (in bold) (mm/m)*	*Predicted Maximum Closure on Cataract Creek (Southern Tributary in brackets – LWs 1-3) (mm)*
1	1.3	2.1	40	12	24	n/a (700)
2	1.1	2.1	40	12	24	n/a (300)
3	1.3	2.6	51	15	31	n/a (150)
4	1.9	2.1 (**1.8**)	35 (**30**)	10.5 (**7.5**)	21 (**14**)	n/a
5	0.9	1.9 (**1.8**)	36 (**16**)	10.8 (**6**)	22 (**12**)	300 (**49**)
6	1.5	2.1	38	11	23	290
7	1.2	1.5	28	8	17	290
9	0.5	2.1	32	10	19	50
10	0.6	1.6	24	7	14	30
11	0.6	2.1	30	9	18	10

Note: 1. Cumulative figures including measured subsidence in the Balgownie Seam and estimates of subsidence in the Bulli Seam.

Total closures are predicted to range up to 290 millimetres (mm) adjacent to the end of LWs 6 and 7, and up to 700 mm across the 2nd order southern tributary of Cataract Creek above LWs 1 to 3. SCT reports that the valley closure estimates presented in **Table 3** were predicted using the ACARP Method, which is based on experience of closure in deep gorges at high stress levels. Monitoring undertaken for Longwall 5 indicates that actual measurements of valley closure are significantly less (see level in parentheses).

Figure 10 presents the contours for predicted vertical subsidence over the preferred UEP longwalls relative to the surface features.

SCT considers there to be some potential for pillar instability in the Bulli Seam to cause additional surface subsidence of up to about 0.5 m in localised areas. The area most likely to be affected by pillar instability is located at the northern end of LW 1 (see orange shaded area on **Figure 10**). As discussed in more detail below, the additional subsidence that may result from pillar instability is not considered to have potential to cause any significant additional impacts compared to those that are already predicted.

Subsidence beyond the goaf edge is predicted to be similar to the subsidence observed during mining of LWs 4 and 5. SCT states that vertical movements of >20 mm are expected to be limited to within a distance of 0.7 times the overburden depth from the nearest goaf edge, which is equivalent to an AOD of 35°. This results in a subsidence profile that falls predominantly within the footprint of the panel being mined (see Figure 8).

Dr Hebblewhite agrees that "*overall, the results and predictions appear sound, having used industry 'best practice' prediction methodologies*". The Department accepts SCT's subsidence predictions as reasonable. However, the Department notes that the predictions are made from a relatively small database of observed data and that there is still scope for localised anomalies due to the multi-seam environment, geological structures and other effects in natural systems which are not fully predictable. Consequently, the Extraction Plan for the preferred UEP would need to include detailed monitoring and validation of SCT's predictions.

Subsidence Impacts on Built Features

SCT assessed the potential subsidence impacts on surface features as a result of mining associated with the preferred UEP. In terms of built features located in the general vicinity of the project (see **Figures 7** and **10)**, the Department is satisfied that:

- *Mount Ousley Road* is protected from direct mine subsidence by a horizontal distance from the nearest goaf edge (ie 380 m from LW 3 goaf) substantially greater than half overburden depth (ie 150 m). Low levels of vertical subsidence (ie <100 mm) are predicted, but these are considered to be insignificant for all practical purposes. Minor surface cracking was evident on Mount Ousley Road following extraction of LW 4, which is located a similar distance from the road as LW 3. However, this cracking did not affect the safety or serviceability of the road, and was appropriately managed by Wollongong Coal in accordance with the conditions of its existing approval;
- *Picton Road Interchange* is protected from subsidence associated with LWs 1 to 5, as these panels are located on the opposite side of Cataract River and predominantly below the slope leading down to Cataract Creek. As these longwall panels would start below the ridge and would be mined away to the north, horizontal movements in a downward direction are considered unlikely; and
- *telecommunication infrastructure* on Brokers Nose is protected from subsidence by a horizontal distance of approximately 1 km from LW 1.

Dr Hebblewhite supports the conclusion that impacts to these built features are likely to be minimal to negligible. The Department is satisfied that the subsidence impacts of the preferred UEP on these built features can be suitably managed to ensure acceptable outcomes via the standard Extraction Plan process, and has drafted conditions to ensure this occurs.

The Department notes that the structural integrity of *transmission lines and associated towers,* located in two corridors between Mount Ousley Road and the Illawarra Escarpment, may be compromised during mining of LWs 1 to 3. SCT indicates that horizontal movements in the vicinity of the towers are expected to range up to 700 mm, which may cause cracking and structural damage to four towers (T55, T56, E67 and E68) if the movements occur differentially between the tower legs. Although four additional towers (T54, T57, E66 and E69) are relatively remote from mining (AOD between 23° and 30°), SCT indicates that a low level of hazard still exists that could also compromise the structural integrity of these towers.

As mentioned above, there is an area where there is considered to be some potential for pillar collapse in the Bulli Seam to cause additional subsidence (see orange shaded area on **Figure 10**). SCT has confirmed that the transmission towers and poles are located outside this area, and that any additional subsidence that may result from pillar instability is unlikely to cause any significant additional impacts to this infrastructure.

SCT recommends that a technical committee comprising representatives from Wollongong Coal, the power utility company and government regulators is established to monitor and manage potential impacts of mining on the power transmission towers. SCT states that several of the towers are likely to require the construction of cruciform bases to ensure that the risks associated with differential subsidence are eliminated.

The Department accepts that potential impacts to these transmission towers can be managed and that the appropriate forum to facilitate this would be via a joint technical committee. The Department notes that it is common practice for mining companies to establish such committees to manage potential impacts on key infrastructure within mine subsidence areas. Wollongong Coal has committed to establish this committee.

Subsidence impacts on Cataract Reservoir, which is technically a built feature, are discussed in **Section 6.2** below. Subsidence impacts on natural features are discussed in detail in the subsequent sections of this report. This includes impacts on upland swamps (see **Section 6.3)**, Cataract Creek and associated tributaries (see **Section 6.4**), groundwater (see **Section 6.5**), cliffs (**Section 6.6**) and Aboriginal heritage sites (**Section 6.9**).

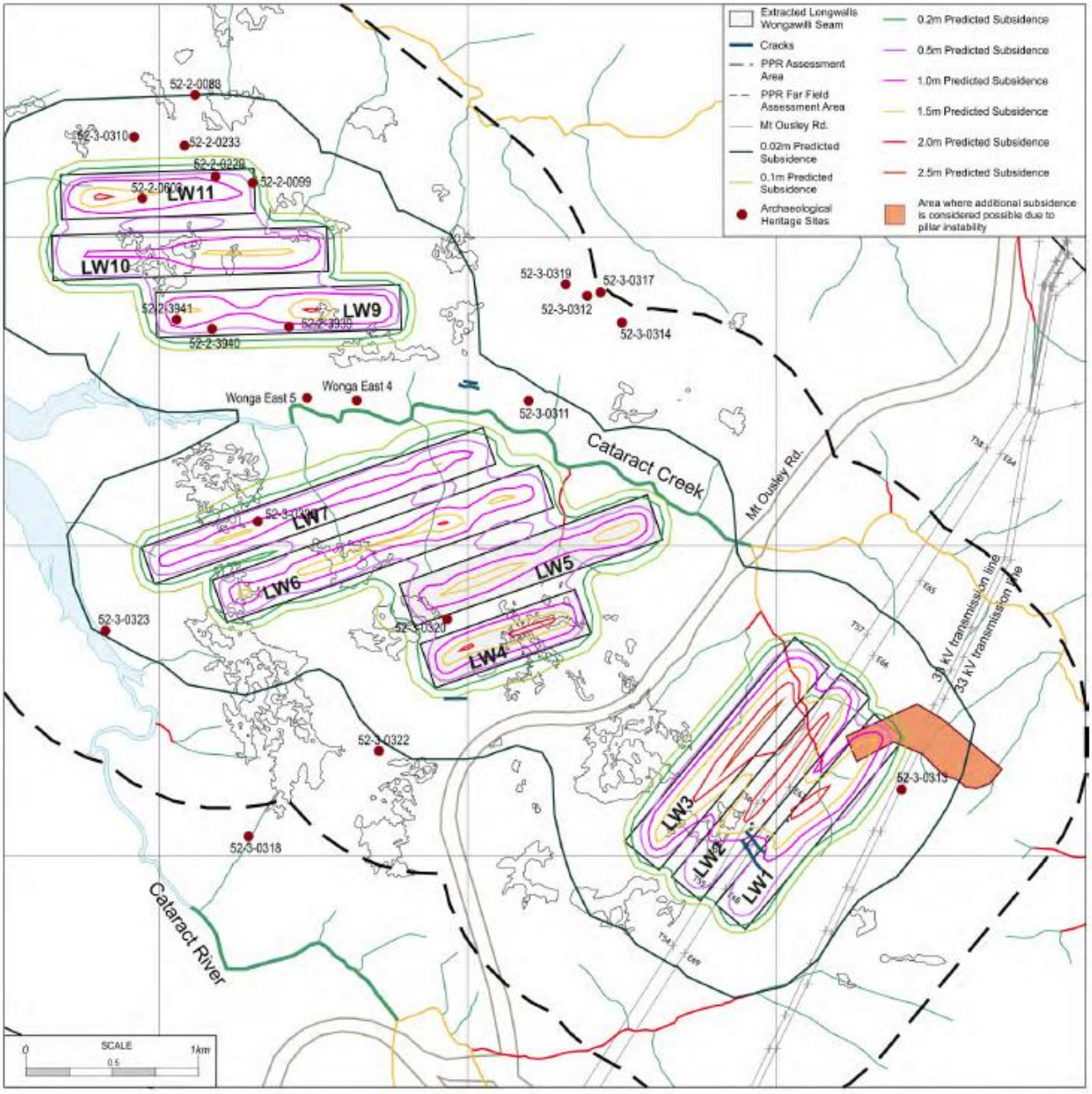

Figure 10: *Contours of Predicted Subsidence from the Preferred UEP (Wongawilli Seam)*

6.2 Cataract Reservoir

Numerous submissions, including those from DSC and SCA, raised concerns about whether the set-back distance from the preferred UEP longwall panels (particularly LW 7) to the Cataract Reservoir is sufficient to protect the stored waters of the reservoir. Concerns were also raised about the geological structures, including the Corrimal Fault and Dyke 8, providing potential hydraulic connectivity between the mine and the reservoir.

Setback Distance

Wollongong Coal has designed the preferred UEP longwall layout to avoid any coal extraction inside the 35° AOD from the Reservoir's full storage level (FSL). The 35° AOD is the area within which the DSC is unlikely to grant approval for any mining causing subsidence. However, a very small area of LW 6 and the western portions of LWs 7, 9, 10 and 11 fall within the 26.5° AOD from the FSL of the reservoir (refer to **Figure 2**). The 26.5° AOD is the area within which DSC closely examines mining proposals causing subsidence before considering approval. The DSC's purpose is to protect the reliability of water supply and the structural integrity of the reservoir from the potential impacts of mining.

The horizontal distance in the seam from the extracted seam to the point immediately below FSL that is equivalent to a 35° AOD varies according to the overburden depth. For the nearest longwall (LW 7), which has an overburden depth of about 290 m, a 203 m setback from FSL to the surface footprint of LW 7 is equivalent to a 35° AOD (or 0.7 times the overburden depth to the coal seam from FSL).

The Department notes that this is a standard setback requirement that is typically considered to provide a high level of protection for the stored waters of a reservoir.

However, the DSC, NOW and the IESC raised concerns about the presence of a Bulli Seam goaf in the barrier between LW 7 and the reservoir, which has the potential to reduce the effectiveness of the barrier. A detailed discussion on this topic is provided by SCT in its updated Subsidence Assessment (see Appendix B of the RMR). This discussion was provided in response to deficiencies identified by Dr Hebblewhite in the original Subsidence Assessment.

SCT notes that there are a number of areas where the Bulli Seam has been extracted that are located within the 0.7 times depth protection zone around the FSL. However, there does not appear to be any direct connection between the reservoir and the mining horizon though these mining areas. SCT notes that, although the presence of Bulli Seam goaf areas may reduce the effectiveness of this 0.7 times depth barrier for mining of LW 7, the pathway for seepage from the reservoir to the mine is likely to be predominantly along horizontal shear planes at or just below the level of the valley. As discussed in more detail in **Section 6.5**, the calculated height of depressurisation for the Bulli Seam pillar workings is well below the level of any horizontal shear planes capable of interaction with the reservoir.

On this basis, SCT concludes that there is no potential for the existing Bulli Seam goaf areas to significantly reduce the effectiveness of the 0.7 times depth barrier for LW 7. The Department accepts this conclusion, however considers that Wollongong Coal should be required to implement a borehole monitoring program ahead and adjacent to mining in LW 7 to provide data for an adaptive management strategy, to be implemented if necessary. Dr Hebblewhite supports this approach. The nature and extent of the recommended monitoring program is further discussed in **Section 6.5**.

Geological Structures

In response to issues raised in submissions, and at the request of the Department, Wollongong Coal undertook additional field inspections and prepared additional reports to investigate the significance of geological structures in the vicinity of the preferred UEP area, as follows:

- *Geological Report on the Wonga East Area* (May 2014); and
- *Geological Report on the Corrimal Fault* (June 2014).

The first of these reports was included in Appendix K of the RMR and the second report was included in Appendix C in the RTS for MOD 2. The geological reports include results from reviews of historic mine geological surveys, detailed LiDAR (Light Detection and Ranging) topographic data at 1 m contour intervals and aerial photography. The reports also provide results of recent ground-truthing traverses, which were undertaken at the request of the Department to provide additional information on the likelihood of a fault line (known as the Corrimal Fault) extending further to the northwest of LWs 6 and 7. The surveys were undertaken along the known and predicted alignment of the fault, extending in a northwesterly direction to both the eastern and western banks of the Cataract Reservoir.

Wollongong Coal states that a significant benefit of previous mining within the Bulli and Balgownie Seams, and the recent mining of LWs 4 and 5 in the Wongawilli Seam, is that the geological structures in the area are now well understood and defined. SCT believes that the level of information available on geological structures in the vicinity of the preferred UEP area is far in excess of the detail that is usually available and more than adequate to confirm potential impacts.

The Corrimal Fault and Dyke 8 and are the only known significant geological structures in the vicinity of the preferred UEP longwalls that could influence potential hydraulic connectivity between the mine workings and the reservoir. The location of these geological structures is shown in **Figure 11**.

Corrimal Fault

As shown in **Figure 11**, the Corrimal Fault extends for at least some 3000 m in a northwest-southeast orientation in the southern part of the Wonga East area. The fault was first intersected in the Wongawilli Seam during the development of Maingate 5 and again during the development of Maingate 6. Wollongong Coal reports that, in the vicinity of Maingate 5, the fault was a single, tight structure with a maximum displacement of 1.8 m decreasing to 0.35 m to the northwest. Near Maingate 6 the fault fragments into several small-scale

faults of an erratic character, which are considered to be typical of a terminating fault structure. Wollongong Coal anticipates that the fault would continue to decrease and terminate within about 500 m from Maingate 6.

More information about the northwestern extent of the fault would be available when the maingates for LW 7 are driven. However, Wollongong Coal and SCT consider that hydraulic conductivity between the mine workings and the reservoir via the Corrimal Fault is unlikely given that:

- the fault is fragmented in the vicinity of LW 6 and likely to terminate part way through LW 7;
- ground movements associated with previous mining in the Bulli and Wongawilli Seams do not appear to have resulted in any hydraulic connectivity with the reservoir;
- no surface expression of the Corrimal Fault was found during the ground-truthing traverses to the northwest of the existing fault alignment (including on the banks of the reservoir); and
- no water make was observed from the fault plane in the overlying Bulli and Balgownie Seam workings, and no water make has been observed in the Wongawilli Seam workings to date.

Wollongong Coal and SCT also believe that reactivation along the fault plane as a result of subsidence and goaf formation is unlikely, given that the recent extraction of LWs 4 and 5, which were a minimum distance of 140 m from the fault plane, has not resulted in any evidence of reactivation of the fault. The Department accepts that the existing information provides a high level of confidence that the Corrimal Fault peters out in the vicinity of proposed LW 7, and that a hydraulic connection between the fault and Cataract Reservoir is unlikely.

Dyke 8

As shown in **Figure 11**, Dyke 8 extends over 7 km in a northwest-southeast orientation and crosses the central portion of the Wonga East area. The dyke extends through the proposed LWs 1 to 3, 6 and the reservoir. It has previously been mined through in the Wongawilli Seam during mining of LW 5, as well as during previous mining in both the Bulli and Balgownie Seams. The dyke has a recorded thickness of between 2.1 m and 3.1 m and has been identified at the surface near Mt Ousley Road where it was 0.28 m thick and has withered to soft clay.

Wollongong Coal reports that no water has been detected at any of the recent intersections of Dyke 8, indicating that it is unlikely to be a conduit for water from the coal seams above or other overlying strata. SCT states that its experience in the Southern Coalfield indicates that dykes are very rarely hydraulically conductive, except where affected by mining subsidence at shallow depth. Given the significant overburden depths associated with mining in the preferred UEP area (ie >255 m) and the large distance of the nearest longwall from the reservoir (560 m from LW 10), SCT conclude that Dyke 8 is not expected to increase hydraulic conductivity between the reservoir and the mine.

The Department accepts this conclusion and notes that it is consistent with experience at almost all other dyke intersections in the Southern Coalfield.

6.3 Upland Swamps

Biosis Pty Ltd (Biosis) prepared a comprehensive swamp impact assessment for all upland swamps within Wollongong Coal's UEP area (see Appendix G of the EA). This report involved the use of LiDAR data to identify upland swamps and detailed ground-truthing and mapping of all vegetation sub-communities within these swamps. The Biosis report also draws on baseline monitoring of several swamps which has been undertaken since Autumn 2011. OEH and SCA have commented on the good quality of the Biosis report, and the Department considers it to be the most comprehensive swamp impact assessment yet undertaken in the Southern Coalfield.

Additional field inspections, which have been conducted since the original Biosis assessment, have identified the presence of small waterfalls at two of the swamps that were not apparent in the original LiDAR surveys. In light of this, Biosis updated the original swamp impact assessment contained in the EA. The revised assessment is included as Appendix G of the RMR.

Avoidance

It is important to recognise that Wollongong Coal has committed to avoid and significantly minimise impacts to upland swamps as a result of its previous major changes to the UEP project. These changes have included removing all of Wonga West from the current project application and re-orientating some previously proposed longwalls in the Wonga East area to avoid and minimise impacts. The revised mine plan reduced the number of swamps potentially impacted from 39 to 13. Of the 13 swamps in the Wonga East area, 3 have been either fully or partially been undermined by extraction of LWs 4 and 5 (CCUS3, CCUS6 and CCUS23) and one would be partially undermined by the initial 365 m extraction of LW 6 (CRUS1) (see **Figure 12**).

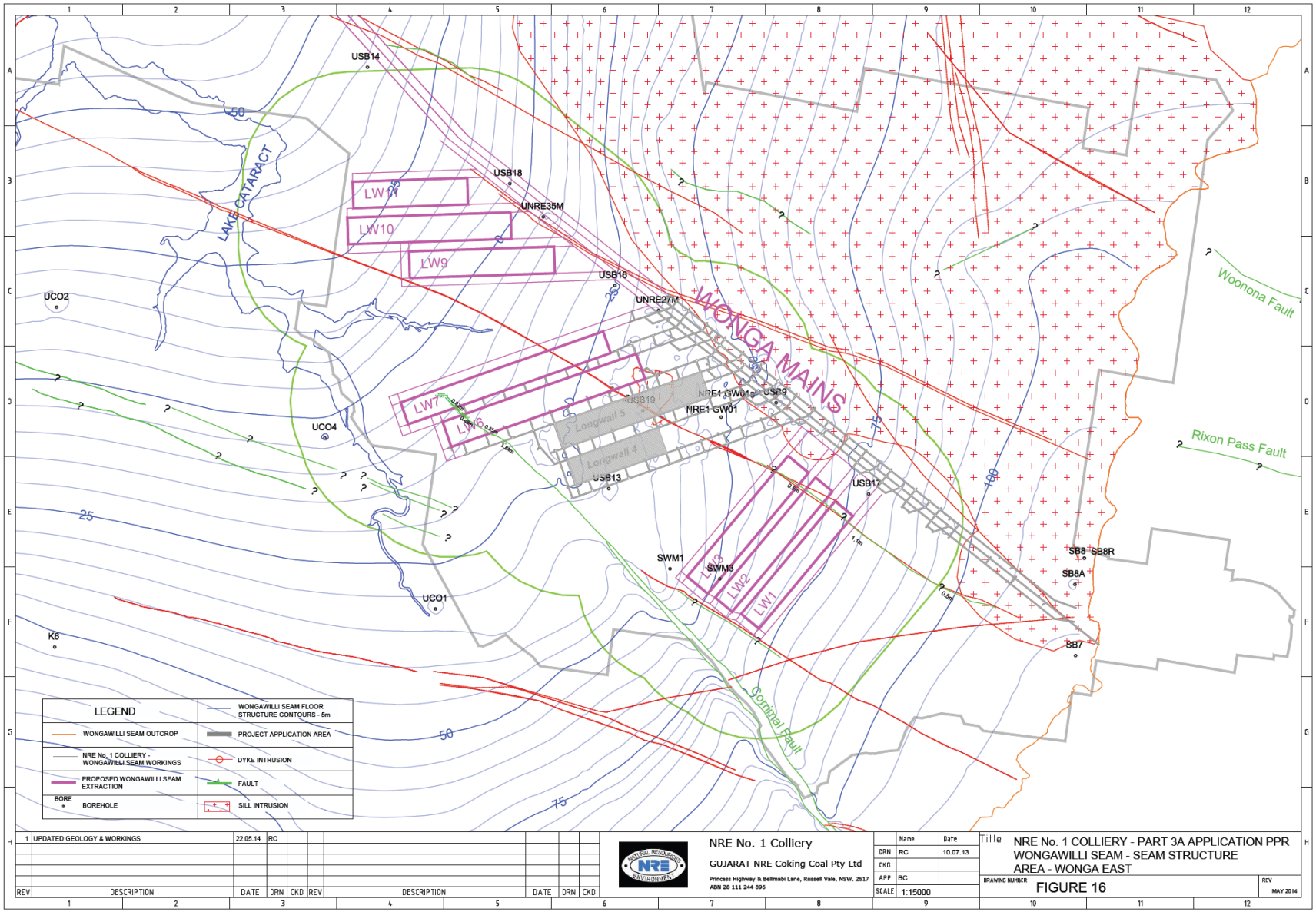

Figure 11: *Regional location of Dyke 8 and the Corrimal Fault*

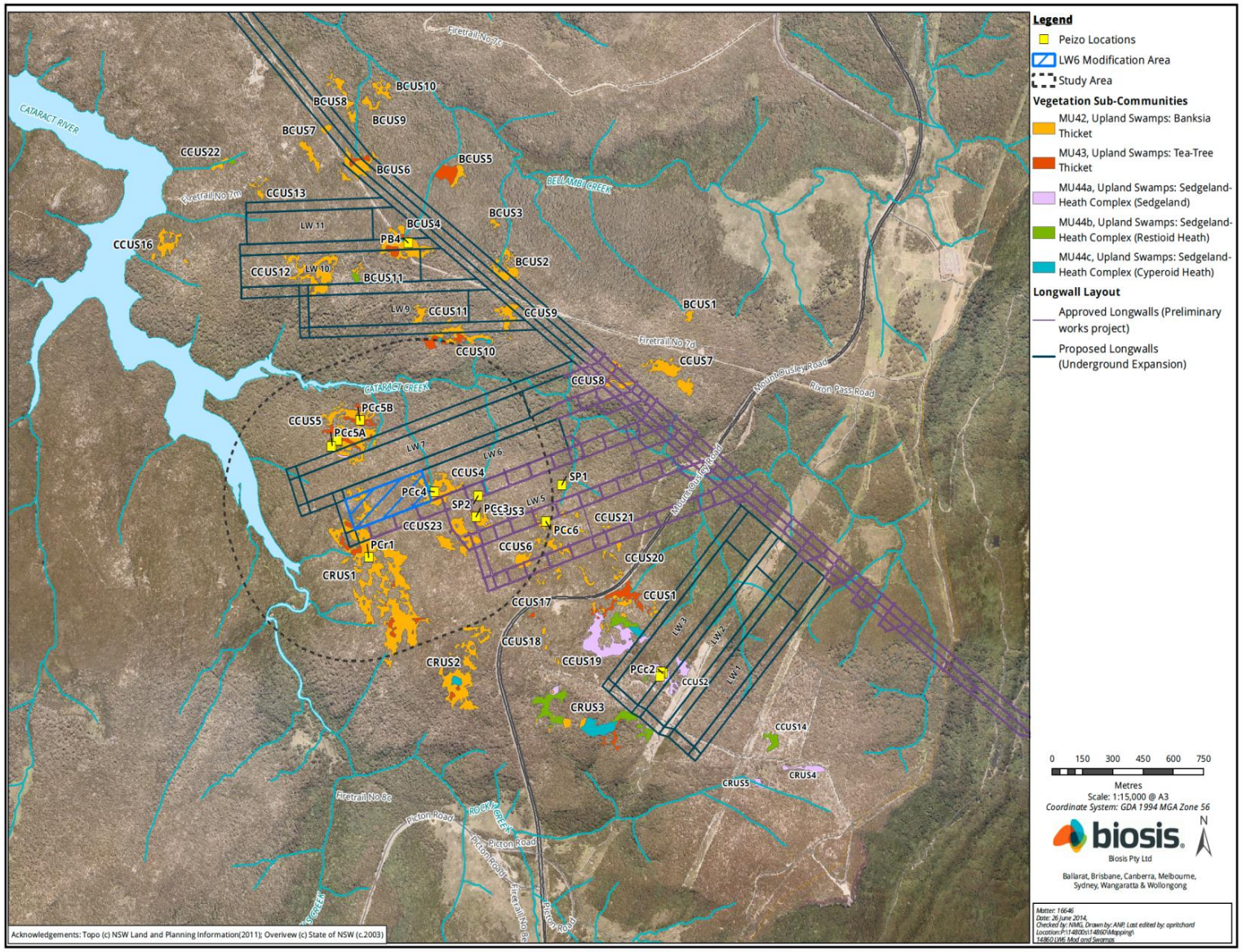

***Figure 12**: Location of upland swamps in the vicinity of the Preferred UEP area*

Biosis indicated that there is a high risk of subsidence impact to swamp CCUS4 (located over the eastern extent of LW 6), a moderate risk of impact to swamp BCUS4 (located partially over LW 10), and a low risk of potential subsidence impacts to the remaining swamps in the preferred UEP area.

This conclusion was supported by Evans & Peck (January, 2014 – see **Appendix H**), which was engaged by the Department to undertake an independent expert review of the surface water issues associated with the UEP, including a detailed review of Biosis's original swamp impact assessment. Both specialists agreed that only 2 swamps (CCUS4 and BCUS4) in the Wonga East area had a greater than low risk of potential subsidence impacts.

The Department is satisfied that Wollongong Coal has made major changes to its original UEP to avoid a significant number of upland swamps, and accepts that the company has done everything reasonable and feasible to avoid and/or minimise the impacts of the project on swamps. It could not do morw without seriously compromising the viability of the UEP.

The Department also notes that the PAC slightly reduced Wollongong Coal's proposed extraction of LW 6 as part of its recent determination of MP 10_0046 MOD 2 in order to avoid directly undermining swamp CCUS4 and allow monitoring and data collection of any changes in the swamp. The proposed monitoring regime for this swamp is discussed further below.

Historic Mining Impacts to Swamps

It is also important to note that the majority of swamps in the Wonga East area have been subject to previous subsidence impacts associated with mining of the Bulli and Balgownie Seams. Previous mining has resulted in compressive strains ranging from 0.9 to 21.4 mm/m and tensile strains ranging from 0.4 to 10.7 mm/m. SCT indicates that, when strains are greater than about 1 - 2 mm/m in tension and 2 - 3 mm/m in compression, perceptible fracturing of the sandstone strata below swamps is expected, which would result in short term loss of piezometric pressure in shallow groundwater resulting from rainfall within some swamps. The magnitude of tilts and strains from previous mining are therefore likely to have already resulted in some fracturing of the bedrock beneath the upland swamps.

Despite this likelihood, Biosis states that the majority of upland swamps in the Wonga East area are thriving, both in terms of the health of their vegetation communities and baseflows. SCT and Biosis therefore suggest that the drop in near-surface piezometric pressure recently observed following undermining of other swamps in the Southern Coalfield may not have a significant impact on their long-term health. While carefully noting this position, the Department is unable to agree with it in the absence of significant, long-term longitudinal studies of swamp health before, during and following mining.

The Biosis assessment also provides a summary of additional data available following recent mining at Wongawilli Colliery, as well as data from the extraction of LWs 4 and 5. Monitoring results from extraction of LWs 11, 12, 19 and LW 20 at Wongawilli Colliery indicate that, despite measured tilts of up to 6.8 mm/m, no observable adverse impacts to groundwater level variability or vegetation within the four overlying swamps have been observed. Similarly, the recent extraction of LWs 4 and 5, which undermined swamps CCUS3, CCUS6 and CCUS23 (see **Figure 12**), has not resulted in any observable adverse impacts, despite the high levels of tilt and strain.

The Department accepts that predicting impacts on swamps is complex, particularly in relation to changes brought about by multi-seam mining, and that it is still unclear how sensitive swamps are to mining subsidence. There is currently an incomplete data set regarding short-term, medium-term, long-term and catastrophic impacts on swamps by longwall mining in the Southern Coalfield. There is also a lack of data on which to draw quantitative conclusions regarding the nature and degree of impact of the two previous episodes of undermining beneath many of the swamps in Wonga East. The IESC support these views.

However, there appears to be no evidence of large-scale loss of or impacts on upland swamps undermined by the relatively narrow longwalls which have been employed at either Russell Vale or Wongawilli Colliery. Further, the current condition of the swamps, following two previous subsidence episodes, appears to be much better and more resilient than many observers might have predicted.

A visit by Departmental and other agency officers in May 2014 showed reasonable outflow from the downstream neck of CCUS4 over a rock shelf and small waterfall (see **Photo 1**) and general good health in the swamp vegetation (see **Photo 2**). A very substantial but aged tensional crack (20 - 30 cm in width and several metres in depth) in a rock shelf at the edge of the valley to the northwest of this swamp was also seen. This crack probably resulted from longwall mining in the Balgownie Seam in 1980-82. Thus, the significant scale of previous impacts (see also **Table 3**) and the current resilience of the swamp, including its surface water discharge, were both observed.

Photo 1: *Sandstone cliff downstream of Swamp CCUS4, showing surface drainage from the downstream neck of the swamp*

Photo 2: *Swamp CCUS4, showing Tea-Tree Thicket and a small Sedgeland Community*

Potential Mining Impacts to Swamps

As indicated above, the preferred UEP has the potential to impact an additional 9 swamps. This excludes the 3 swamps located over LWs 4 and 5 which have already been undermined, and one of the swamps (CRUS1) over the initial 365 m of LW 6 which was recently approved for extraction (via MOD 2). However, given that the eastern portion of swamp CCUS4 has the potential to be impacted by the extraction of the remainder of LW 6, this swamp has been further considered as part of this assessment.

The 9 swamps potentially impacted by the preferred UEP cover a total area of approximately 17.51 ha. The area of the swamps to be directly undermined is about 8.98 ha (51%) (see **Figure 12** and **Table 4**). Based on the SCT's Subsidence Assessment above, it is reasonable to conclude that the likelihood of direct impacts to these swamps would be limited to the area directly undermined.

Biosis states that potential impacts to these swamps would primarily result from:

- fracturing of bedrock beneath the swamps, resulting in increased porosity and permeability, with potential for surface waters to drain into deeper sandstone strata;
- tilting in upland swamps resulting in the redistribution of perched water levels and surface runoff, and potential scouring and erosion; and
- changes in baseflow discharges.

Biosis provided an overall assessment of the potential for impact to occur in the affected areas of swamp, based on the updated subsidence predictions and groundwater modelling results, as well as revised flow accumulation modelling. The risk assessment identified CCUS4 as having a 'high' risk of negative environmental impacts, swamp BCUS4 as having a 'moderate' risk of negative environmental impacts and the remaining swamps as having a 'low' risk of negative environmental impacts. A summary of the assessment results are provided in **Table 4**.

Table 4: *Risk assessment for upland swamps potentially impacted by the Preferred UEP*

Swamp	Swamp Area (area undermined) (ha)	Risk Assessment			
		Groundwater	Flow Accumulation	Compressive Tilts and Strains	Final (Highest) Risk Ranking
CCUS1	4.81 (0.24)	N/A	Low	Medium	Low
CCUS2	1.21 (1.21)	Low	Low	Low	Low
CCUS4	1.77 (1.77)	Medium	Low	High	High
CCUS5	3.45 (1.04)	Low	Medium	Low	Low
CCUS10	1.63 (0.41)	N/A	Low	Low	Low
CCUS11	0.34 (0.34)	N/A	Medium	Low	Low
CCUS12	1.84 (1.84)	N/A	Negligible	Low	Low
BCUS4	2.20 (1.87)	Low	Medium	Low	Medium
BCUS11	0.26 (0.26)	N/A	Negligible	Low	Low
Total Area	**17.51 (8.98)**				

Biosis notes that the risk ranking for swamp CCUS4 was increased from a 'moderate' ranking in the original assessment to a 'high' ranking in the updated assessment based on the identification of a sandstone small cliff formation with overhang, which forms a small waterfall at the downstream neck of the swamp (see **Photo 1**). The small cliff is approximately 110 m in length, and tapers in height from rocky outcrops at either end to a maximum height at the watercourse of about 7.1 m. The waterfall drains into a 1st order tributary of Cataract Creek. There is evidence of impacts from previous undermining, including the partial collapse of a nearby 20 m section of the overhang and the tensional crack noted above.

Biosis indicates that no observable adverse consequences are anticipated on the water holding capacity, water quality or ecosystem health of the majority of swamps (5.34 ha or 59% of the total swamp area to be undermined) in the project area because:

- the swamps are not predicted to undergo sufficient compressive tilts or strains to generate cracks in the underlying or adjacent sandstone; and/or
- the sections of the swamps to be undermined are largely dry and unlikely to support significant groundwater resources; and/or
- significant changes in water run-off are likely to be limited to small sections or portions of the upland swamps.

Biosis indicates that the only exceptions to this are in relation to swamps CCUS4 and BCUS4. For swamp CCUS4, SCT states that subsidence is expected to cause further impacts to the part of CCUS4 directly overlying LW 6, including possible rock falls, cracking of the sandstone bedrock base of the swamp and

surface water diversions. Biosis considers that, as this sandstone formation forms a rockbar at the downstream extent of CCUS4, there is a high risk that any further fracturing is likely to result in changes in swamp hydrology, including water-holding capacity. The Department agrees, while noting that the swamp currently discharges surface water at the rockshelf and waterfall, notwithstanding undermining by the Balgownie Seam longwalls in 1980-82.

Biosis assessed swamp BCUS4 as having a 'medium' risk of negative environmental consequences because a large portion (85%) of the swamp would be directly undermined by LW 10. Redistribution of water within the swamp may result in decreased water flow through a patch of Tea-tree Thicket, and may result in changes to vegetation composition.

Based on Biosis's assessment, 3.64 ha (or 41%) of the total area of swamps to the undermined within the preferred UEP are at a greater than low risk of negative environmental consequences. The Department considers that Biosis's assessment of impacts is reasonable.

However, in its submission on the preferred UEP, OEH did not accept that any swamps at a moderate to high risk of subsidence-induced fracturing should be assessed to have a low overall risk of impact. As a result, OEH undertook its own risk assessment for each swamp (refer to Appendix 1 of OEH's submission at **Appendix D**), which concluded that:

- 1 swamp (CCUS1) is assessed to have a low risk of impact;
- 1 swamp (CCUS12) is assessed as having a moderate to high risk of impact; and
- 7 swamps (CCUS2, CCUS4, CCUS5, CCUS10, CCUS11, BCUS4 and BCUS11) are assessed as having a high risk of impact.

OEH indicates that its assessment of moderate to high risk ranking for the majority of swamps was based on the potential for fracturing of the bedrock base and draining of perched aquifers within the swamps.

Performance Measures and Offsets

The key questions are whether the swamps should be subject to performance measures, at what level they should be set, and for what level of impact Wollongong Coal should be required to provide an offset. Performance measures should be set at levels which are likely to be achievable by the project as approved. It is inappropriate that performance measures are set which are not able to be achieved, or that are unlikely to be achieved.

The OEH submission stated that longwall mining beneath upland swamps on the Woronora Plateau should meet performance measures of 'nil' to 'negligible' environmental consequences. However, OEH further considered that this performance measure is unlikely to be achieved for the majority of upland swamps in the UEP area (with the exception of swamp CCUS1) and that consequently Wollongong Coal should prepare an offset strategy in the expectation that this performance measure would not be met.

The Department agrees with OEH that Wollongong Coal may not achieve a performance measure of 'nil' or 'negligible' in relation to the 9 swamps in the UEP area, other than CCUS1. Further, given the existing multi-seam mining, and the uncertainty associated with impacts, the precise level of impact to the swamps cannot be accurately predicted. Thus performance measures may not be the best way to manage impacts which may be construed as 'likely to occur but uncertain in expected extent and significance'.

OEH's recently-released Offset Policy only deals with offsetting impacts which are total (ie complete clearing), rather than partial, and, on this basis, specifically excludes impacts associated with mine subsidence. However, the Department and OEH have been working together to develop an appropriate policy framework for offsetting subsidence impacts on swamps.

The critical issues to finalise are:

- impact triggers leading to requirements for offsets;
- monitoring to be carried out to identify impacts and environmental consequences (including monitoring timeframes, given that some changes to vegetation communities and overall swamp resilience may take considerable time to become apparent);
- methods for assessing the extent of biodiversity impacts and the biodiversity value of the proposed offset; and
- development of factors (ratios) to be applied to partial impacts of varying intensity and significance.

The Department's views are based on the position that offsets should be directly proportional to the level or degree of impact or damage that has occurred, and that a total offset is not appropriate in the case of partial impacts. This work is complex and may take some time to finalise. The Department will keep the PAC informed of progress in this work, which may lead to changes in the Department's recommended conditions.

The first of these issues involves defining a suitable trigger for impacts above which offsets are required. OEH's view is that environmental consequences 'greater than negligible' should lead to offsets. While the Department's recently recommended conditions (including for the MP 10_0046 MOD 2 approval) were expressed in terms of 'minor environmental consequences', there was no intention that this should exclude impacts which are 'greater than negligible'. Thus the Department has accepted OEH's proposed revisions to the manner in which its recommended conditions are expressed.

It will also be necessary to develop triggers for increasing levels of impact and environmental consequence, as well as to flesh out monitoring requirements (including the relationships between changes in shallow groundwater levels as a performance indicator and potential early warning of more substantial impacts on vegetation and ecosystem functionality).

OEH has also agreed to prepare a new set of metrics which it would test for inclusion within the Offset Policy to calculate biodiversity values of upland swamps that may be partially impacted and their proposed offsets.

As recommended by the PAC in its MOD 2 determination report, the Department has given careful consideration to when, where and what (size and nature) offsets are required as part of the UEP. In considering the appropriate management regime for swamps which may be impacted by the UEP, the Department has taken a number of factors into account, including:

- the substantial avoidance measures previously adopted by Wollongong Coal;
- the majority of the remaining 9 swamps have been undermined and subsided on two occasions previously, and so cannot be considered as 'pristine';
- notwithstanding these previous impacts, the swamps are presently in good condition;
- subsidence impacts are likely to be confined to the direct footprint of the UEP longwalls, with a worst-case total of not more than 8.98 ha, but probably substantially less; and
- there is little evidence to date of successful remediation of significant impacts to upland swamps and that impacts from extensive remediation works may be worse than the environmental benefits that result.

On these bases, the Department considers that the approval should contain a trigger (rather than a performance measure) which requires a proportional offset for impacts on swamps, where those impacts are greater than 'negligible' environmental consequences and remediation is not possible or is not effective. The trigger is proposed to be defined as:

- greater than negligible erosion of the surface of the swamp;
- greater than negligible changes in the size of the swamp;
- greater than negligible changes in the ecosystem functionality of the swamp;
- greater than negligible change to the composition or distribution of species within the swamp; and
- greater than negligible change to the structural integrity of controlling rockbar/s for the swamp.

The Department considers that this is an appropriate level beyond which an offset should be required from Wollongong Coal. The Department considers that such offsets should be directly proportional to the level of impact, and while giving preference to like-for-like physical offsets, conditions of approval should also allow for offsets to include direct payments into OEH's offsets fund (once it is established) or funding or undertaking of supplementary measures such as:

- actions outlined in threatened species recovery programs;
- actions that contribute to threat abatement programs;
- biodiversity research and survey programs; and/or
- rehabilitating degraded habitats.

The Department has recommended that the existing conditions of approval reflect these options. The Department considers this management regime is a robust way of dealing with any unavoidable impacts on upland swamps. It also deals with the uncertainty associated with the levels of impact which may occur to swamps and is consistent with the Offset Policy's approach to managing biodiversity impacts. The Department would seek clear confirmation from Wollongong Coal that it had secured appropriate biodiversity offset sites, or was proposing suitable alternative offsets in line with the Offset Policy, prior to approving an Extraction Plan permitting longwall extraction in the UEP area.

The Department agrees with both Biosis and OEH's conclusion that there is a low risk of potential impacts on swamp CCUS1, particularly considering that only a very small area (ie <5%) of the swamp would be undermined, and believes that a performance measure of 'negligible' is appropriate for this swamp.

Monitoring and Management

Further discussions with OEH will take place before the Department can finalise the detailed monitoring requirements necessary to underpin the implementation of the offset conditions. However, it is expected that these can be included within the Extraction Plan required prior to longwall mining under the UEP.

In particular, monitoring must be clearly directed towards identifying whether performance measures have been met and/or offset triggers have been breached, in addition to more-general monitoring requirements. Application of draft conditions, as currently proposed, would require a rigorous monitoring regime and a Trigger, Action, Response Plan (TARP) to provide a clear basis to decide whether or not the performance measures and conditions are being met, whether any offset triggers have been breached and certainty in determining the appropriate management response to exceedances and breaches.

Wollongong Coal is already monitoring the terrestrial and aquatic ecology of many of the swamps and has installed 9 piezometers in and near 6 swamps to measure perched water table levels (see **Figure 13**). The Department and Evans & Peck agree that this monitoring program provides an excellent basis for achieving a better understanding of the hydrology of headwater swamps in the area.

However, Evans & Peck also recommended that additional monitoring and analysis activities should include:

- establishing piezometers at the upslope and downslope ends of some swamps in order to better understand down-slope movement of shallow groundwater;
- adding two flow monitoring points to swamps in which pairs of piezometers (upslope and downslope) are to be installed;
- monthly review of the water balance of all the monitored swamps based on recorded rainfall, estimated evapotranspiration and recorded water levels and outflow measurements; and
- characterisation of soils within the swamps to determine:
  - porosity;
  - a basis for relating piezometer water levels to rainfall and evapotranspiration; and
  - presence or absence of clay materials at the interface with the underlying sandstone which could mitigate water loss from the swamp to the underlying sandstone in the event that subsidence-induced cracking of the sandstone occurred.

The Department agrees that this monitoring would be sufficient to determine if the performance measures and conditions are being met and would provide valuable information on the magnitude of any medium to long-term mining-related impacts to swamps. The monitoring would also significantly enhance the body of knowledge relating to the hydrology of headwater swamps and their roles in sustaining different vegetation communities and providing baseflow to creek systems.

The Department notes that Wollongong Coal has installed piezometers and commenced intense monitoring at swamp CCUS4. This is in line with recommendations made by the PAC in its determination report for MOD 2 to monitor any changes in this swamp from mining operations.

The Department is also satisfied that this monitoring is in line with recommendations made by the IESC that hydrological characterisation of all potentially impacted swamps should include field data to inform conceptual understanding of individual swamp hydrology, determination of the distribution of perched water within swamps and water inputs and outputs.

Consequently, the Department has recommended that this monitoring regime apply to the swamps in the UEP area and be included in an Upland Swamp Monitoring Program required prior to commencement of longwall extraction. Wollongong Coal has already moved to install this additional monitoring. A further 7 piezometers are currently being installed in this area (see **Figure 13**).

The Department is satisfied that the TARP for upland swamps included in the existing Biodiversity Management Plan component of the Extraction Plan for LW 5 is comprehensive and can be readily extended to the UEP.

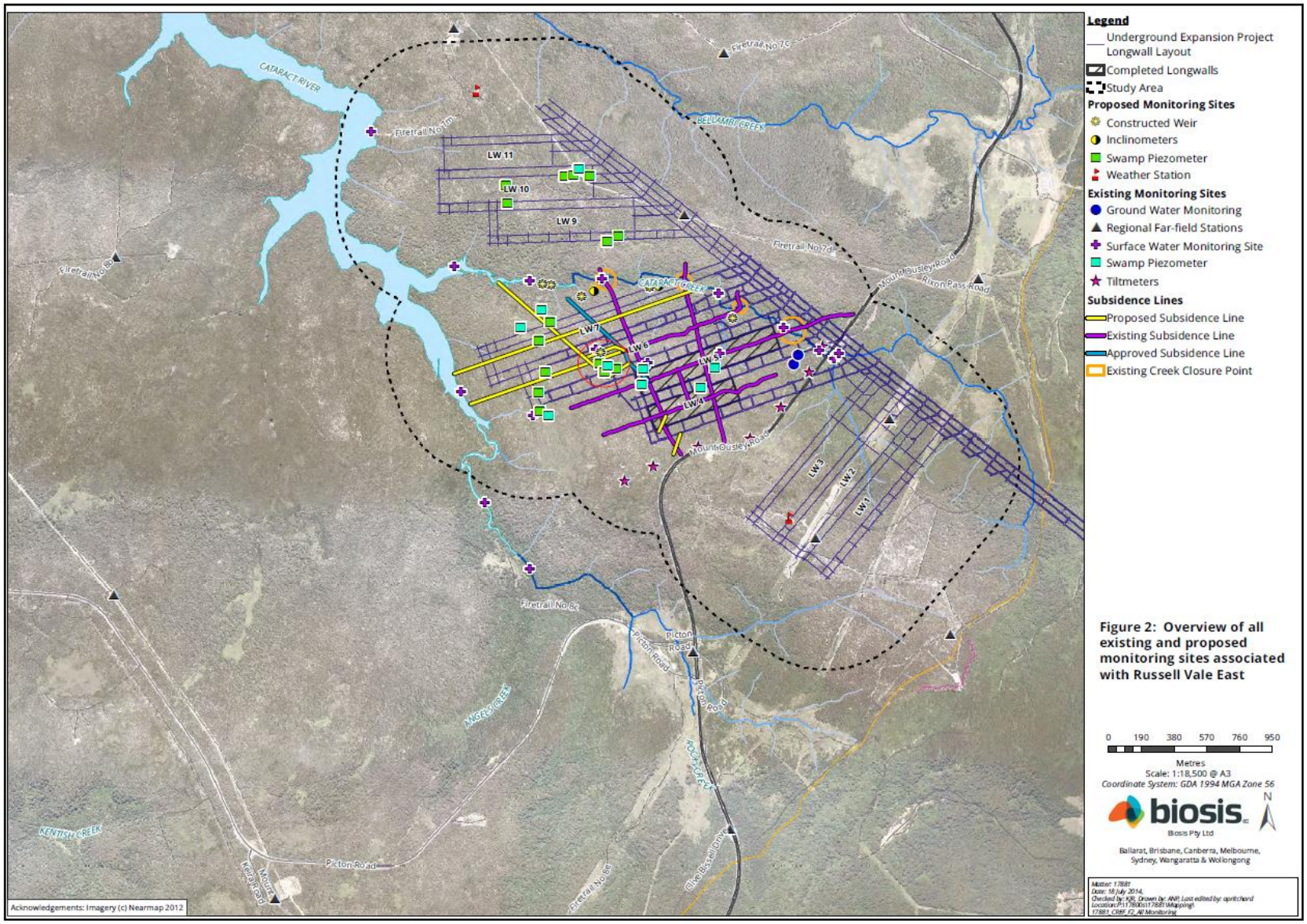

Figure 2: Overview of all existing and proposed monitoring sites associated with Russell Vale East

***Figure 13**: Existing and proposed monitoring sites (Swamp CCUS4 sites shown in red circle)*

Conclusion

Extraction of longwalls associated with the UEP has the potential to impact on 9 upland swamps. There is general agreement that there are low risks of potential impacts on swamp CCUS1 considering that only a very small area (ie <5%) of the swamp would be undermined. There is also general agreement that there would be a higher risk of impact to swamps CCUS4 and BCUS4 due to the large portion of the swamps that would be directly undermined, potential cracking of the sandstone bedrock base of CCUS4 and surface water diversions which may impact vegetation communities.

However, Biosis and OEH do not agree about the level of risk of impact to the remaining 6 swamps (CCUS2, CCUS5, CCUS10, CCUS11, CCUS12 and BCUS11). OEH believes that these swamps have a high risk of impact based on the potential for fracturing of the bedrock base of the swamp and draining of perched aquifers within the swamps. Biosis believes that these swamps have a low risk of impact because sections of the swamps to be undermined are largely dry and unlikely to support significant groundwater resources and significant changes in water run-off are likely to be limited to small sections or portions of the upland swamps.

It is generally accepted that predicting subsidence impacts on swamps is complex, particularly in relation to changes brought about by multi-seam mining, and that it is still unclear how sensitive swamps are to mining subsidence. Most swamps above and adjacent to the proposed longwalls have been previously subject to significant tilts and strains from mining of the Bulli and Balgownie Seams, and yet these swamps appear to contain healthy vegetation communities and baseflows.

The Department accepts that the potential for impacts to swamp CCUS1 is low and recommends that the existing performance measure of 'negligible' is reflected in the new approval. However, given that the remaining 8 swamps have already been impacted by mining and that only a proportion of the total area of swamps is likely to be impacted, the Department recommends that they are subject to offset requirements where impacts exceed 'negligible environmental consequences', defined as:

- greater than negligible erosion of the surface of the swamp;
- greater than negligible changes in the size of the swamp;
- greater than negligible changes in the ecosystem functionality of the swamp;
- greater than negligible change to the composition or distribution of species within the swamp; and
- greater than negligible change to the structural integrity of controlling rockbar/s for the swamp.

The Department considers that offsets should be directly proportional to the level of impact, and while giving preference to like-for-like physical offsets, conditions of approval should also allow for offsets to include direct payments into OEH's offsets fund or funding or undertaking of supplementary measures such as:

- actions outlined in threatened species recovery programs;
- actions that contribute to threat abatement programs;
- biodiversity research and survey programs; and/or
- rehabilitating degraded habitats.

While Wollongong Coal has already installed a substantial monitoring regime in and around the swamps, the Department has recommended additional monitoring (via an Upland Swamp Monitoring Program required prior to commencement of longwall extraction) to provide a more comprehensive information base and to determine with certainty whether performance measures and conditions are being met. Wollongong Coal has already moved to install this additional monitoring. Further discussions with OEH will take place before the Department can finalise the detailed monitoring requirements necessary to underpin application of the offset conditions. However, it is expected that these can be included in the Extraction Plan required under the UEP.

6.4 Surface Water Resources

Surface Water Environment

The proposed longwall panels associated with the UEP predominantly underlie the Cataract Creek catchment, and to a lesser degree, the Cataract River and Bellambi Creek catchments. Cataract Creek has permanent flows to the west, draining directly into Cataract Reservoir. The proposed mine plan has been specifically designed to avoid directly undermining the main channels of Cataract and Bellambi Creeks, Cataract River or Cataract Reservoir. However, mining would be undertaken directly under a series of 1st and 2nd order tributaries to Cataract Creek (see **Figure 10**).

The UEP area is part of Metropolitan Sydney's potable water supply catchment and is managed by the SCA with the aim of protecting water quantity and quality. The western extent of LWs 6, 7, 9, 10 and LW 11 also fall within the DSC's Lake Cataract Notification Area for the Cataract Reservoir (see **Figure 2**). As such, Wollongong Coal is required to lodge a separate application with the DSC to mine within the Notification Area.

Surface Water Assessments

The EA includes a Surface Water Modelling Assessment prepared by WRM Water & Environment Pty Ltd (WRM November 2012) to describe the catchment and streams potentially impacted by mining associated with the preferred UEP, and to model the relative contributions of potentially-affected and unaffected parts of the catchment to the reservoir. The EA also includes a Stream Assessment undertaken by GeoTerra (November 2012). These surface water specialist reports are included in Appendix O of the EA.

An updated Surface Water Modelling Assessment (WRM, May 2014) is included as the RMR's Appendix F. The updated assessment includes additional modelling to assess the potential impacts of subsidence cracking in tributaries on the streamflow in Cataract Creek, in the context of the full period of available climate data.

In addition, Appendix E of the RMR includes a Groundwater & Surface Water Addendum (GeoTerra, June 2014) which provides updated information on stream water quality and assesses potential stream effects, impacts and consequences associated with the preferred UEP.

The Department is satisfied that there is a significant quantity of available surface water information, which is sufficient to assess the impacts of the preferred UEP.

Potential Impacts within Proposed Mining Areas

Potential impacts to surface waters in the vicinity of the UEP longwalls would primarily result from:

- valley closure and stream bed cracking potentially altering stream hydrology in Cataract River, Cataract and Bellambi Creeks and associated tributaries; and
- increased connectivity between the surface and groundwater systems resulting in loss of baseflow to creeks and tributaries.

Valley Closure and Stream Bed Cracking

Cataract Creek is a relatively steep watercourse, particularly in its headwaters, and flows to the reservoir through a series of short pools, rock bars and boulder fields. While the creek lies within a plateau of Hawkesbury Sandstone and outcrops are evident in the catchment headwaters, the stream itself does not have a bed of Hawkesbury Sandstone. GeoTerra reports that the reaches of the creek in the vicinity of the UEP longwalls have eroded through the Hawkesbury Sandstone and sequentially through a number of underlying geological strata (the Newport and Garie Formations and the Bald Hill Claystone) and into the uppermost layers of the Bulgo Sandstone. The downstream section of the creek in the vicinity of LWs 4-7 and LW 9 has a much lower gradient and comprises interspersed incised channels in sandy clay colluvium and cobble/boulder constrained pools and rock bars of Bulgo Sandstone. Thus the bed and substrate of Cataract Creek is fundamentally different to many streams in the Southern Coalfield which have shown significant subsidence impacts from mining (eg Waratah Rivulet).

Longwall mining beneath or close to streams in the Southern Coalfield where the streambed composes Hawkesbury Sandstone commonly causes streambed cracking and potential environmental consequences such as the draining of pools, loss of surface flows through the bed of the stream, iron staining, water opacity and water quality deterioration.

While Cataract Creek has also previously been partially undermined by longwall mining in the Balgownie Seam and bord and pillar and pillar extraction mining in the Bulli Seam, very little evidence has been found of existing stream bed cracking, and there is no apparent evidence of flow loss or adverse effects on pool levels. Detailed observations by Wollongong Coal and its consultants have also revealed no evidence that extraction of the Wongawilli Seam associated with LWs 4 and 5 has caused any subsidence impacts on the creek.

Cataract Creek does not appear therefore to have been impacted by previous mining in the same way as streambeds located on Hawkesbury Sandstone. SCT believes that the Bulgo Sandstone in the bed of Cataract Creek does not react to compressive strains in the same way as the Hawkesbury Sandstone. The Southern Coalfield Inquiry reported that there are substantial directional horizontal stresses present in the Southern Coalfield. Highly competent (ie massive and strong) geological strata (such as the Hawkesbury Sandstone) carry the load of these stresses and resist stress relief. Strata that are less strong (such as claystones and the relatively soft Bulgo Sandstone) deform more easily to release these horizontal stresses. Thus, valleys which cut through the Hawkesbury Sandstone into the softer underlying rocks represent a natural opportunity for gradual stress relief over geologic time. Subsidence of the valley therefore does not act as a trigger to relieve regional horizontal stresses. On this basis, SCT states that valley closure (or horizontal movement in a downslope direction) appears to be concentrated on a horizon at the bottom of the overlying Hawkesbury Sandstone, which in this case, is above the level of the creek channel. The Department accepts that this is the most likely explanation of the limited subsidence impacts on Cataract Creek.

SCT states that the valley closure estimates presented in **Table 3** are predicted using the ACARP Method, which bases predictions on experience of closure in deep gorges at high stress levels. Monitoring undertaken for LW 5 indicates that actual measurements of valley closure are 40% less than predicted (see figures in brackets in **Table 3**). Upper limit total closures are predicted to range up to 700 mm across the 2nd order reach of Cataract Creek above LWs 1 to 3 and up to 290 mm adjacent to the end of LWs 6 and 7 (see **Figure 10**).

SCT expect that valley closures near LWs 1 to 3 would cause perceptible cracking and surface flow diversion, particularly in the upper reaches of the southern branch of Cataract Creek where it flows across Hawkesbury Sandstone outcrop above LW 1. Some loss of surface water and iron staining is predicted in this area as a result. Significant iron staining and flow diversion is not predicted in the other reaches of Cataract Creek due to the presence of the Bald Hill Claystone creek bed.

The Department's surface water expert peer reviewer, Mr Paul Tammetta, raised concerns in relation to potential connective cracking at the northern corner of LW 7 and risks to the capacity of the channel of Cataract Creek to transmit surface water (refer to **Appendix H**). Mr Tammetta noted that the level of this risk is difficult to quantify in multi-seam situations, but that it warrants consideration. In response, as part of its PPR, Wollongong Coal committed to shifting the LW 7 panel further to the south to avoid any part of the adjacent Bulli bord and pillar panel to minimise risks of connective cracking along Cataract Creek. However, Mr Tammetta indicated that:

> *"Despite the absence of existing full extraction workings over a small strip of about 50m width, there may still be a risk to the capacity of the channel of cataract Creek to transmit surface water. There may also still be a risk of direct hydraulic connection between the creek channel and goaf, through the collapsed zone, where the channel comes close to the panel edge."*

However, SCT indicates that connective cracking and flow diversions along this section of Cataract Creek are not expected to be significant for the reasons outlined above. Both SCT and Mr Tammetta agree that a program of predicting, monitoring and response (potentially limiting the length of the longwall panel) is the most effective method of managing this uncertainty. The adaptive management method proposed is described below.

SCT reports that the southern end of LW 7 is located below the slopes that lead down to Cataract River and that only very low levels of valley closure are expected. The maximum valley closure indicated by the ACARP method is approximately 30 mm, which SCT states would have no perceptible impact on Cataract River. No valley closure or stream bed cracking is predicted along Bellambi Creek due to the large distance between the extraction area and the creek (>700 m).

Baseflow losses

In response to issues raised by OEH, the RMR includes estimates of baseflow losses from surface water systems, including potential loss of flow via stream bed cracking and possible losses from valley closure in Cataract Creek. These estimates were undertaken by both GeoTerra (June 2014) and WRM (May 2014) and are included in Appendices C and F of the RMR, respectively.

The WRM estimates used a model of Lake Cataract to investigate the impact that various loss rates from the upstream catchment would have on reservoir yield. This included baseflow losses from Cataract Creek as well as all other individual tributaries within the Wonga East area that drain to the creek. The WRM model provides what may be best characterised as a 'coarse estimate' of median streamflow losses of 0.9 ML/day and median baseflow losses of 0.61 ML/day, compared with an estimated median flow in Cataract Creek close to the reservoir of 2.54 ML/day and median baseflow of 1.71 ML/day. These figures are very likely to be a substantial over-estimate, since they are based on total loss of both streamflow and baseflow within the entire affected area of land. On this basis, the model does demonstrate that even total loss of streamflow and baseflow would have negligible impacts on the water level of Cataract Reservoir.

A summary of Geoterra's more-refined predictions on baseflow losses from depressurisation associated with extraction of the UEP longwalls is provided in **Table 5**. Geoterra predicts that the UEP would result in total reduced baseflows to the connected surface water system by a maximum of 0.0187 ML/day or 6.83 ML/year. Stream flow modelling indicates that the average daily stream flow from Cataract Creek to Cataract Reservoir is 11.2 ML/day. Geoterra consider that the modelled reductions in baseflow in Cataract Creek (0.12%), Cataract River (0.03%) and Bellambi Creek (0.02%) are very minor.

Geoterra also predicts minor leakage from the Cataract Reservoir of 0.005 ML/day or 1.83 ML/year to the underlying groundwater system due to depressurisation of the regional groundwater system (see **Section 6.5** below). GeoTerra states that these modelled losses represent less than 0.007% of the low level, or 0.002% of the full storage capacity of Cataract Reservoir.

Table 5: *Modelled baseflow losses*

Watercourse	Baseflow Loss ML/day and ML/year	Change due to UEP compared to current flows ML/day and ML/year
Cataract Creek		
- Current	0.005 / 1.83	-
- End of mining	0.018 / 6.57	0.013 / 4.74
Cataract River		
- Current	0.0007 / 0.26	-
- End of mining	0.004 / 1.46	0.0033 / 1.20
Bellambi Creek		
- Current	0.0006 / 0.22	-
- End of mining	0.003 / 1.10	0.0024 / 0.88
TOTAL	**-**	**0.0187 / 6.83**

DPI raised concerns about the differences between WRM's and Geoterra's estimates of baseflow losses. The Department first notes the two reports have been prepared with different purposes and from a different frame of reference. Whereas the Geoterra report is essentially a predictive report, the WRM model does not seek to make any firm or reliable predictions or estimates. Instead, it uses a pure modelling approach, assessing (for example) how various levels of streamflow loss would impact on reservoir storage volumes. However, it does this in a reasonably blunt fashion, by removing entire catchments from total flow calculations, while nonetheless recognising that 'the likelihood of losing all tributary streamflow to the underground workings via subsidence cracking is very improbable.' It also undertakes this calculation regardless of rainfall intensity and periodicity. The 'additional effect of catchment losses was assumed to be proportionally the same for all flows', ie even storm events and flood flows were assumed to report to the mine workings, rather than to primarily travel overland and down the streambed. Although it presents some useful comparative data, it also presents a number of results that are highly unlikely to eventuate in reality.

Therefore, the Department considers that the GeoTerra assessment presents more realistic predictions and is the more useful report for assessing the actual impacts of the UEP.

On this basis, the Department is satisfied that baseflow losses associated with the UEP are likely to be small (ie <7 ML/year). Even if these losses were to increase by several orders of magnitude, they would still be considered acceptable. Any baseflow losses are expected to report to the surface either further downstream in Cataract Creek, or else directly to the reservoir. Baseflow losses are therefore highly unlikely to result in adverse impacts to Cataract Creek or Cataract Reservoir yields.

Surface Water Licensing

Under the *Water Management Act 2000*, Wollongong Coal is required to hold a surface water access licence for predicted baseflow reductions within the Upper Nepean and Upstream Warragamba Water Source. According to the *Water Sharing Plan for the Greater Metropolitan Region Unregulated Rivers Water Source 2011*, there are 15,540 one-megalitre (ML) unit shares in this water source, which provides sufficient market depth for Wollongong Coal to secure the required 8.66 ML/year (baseflow plus reservoir leakage) water licence. Wollongong Coal currently does not hold any licences for surface water use for the region, but has confirmed that it has commenced negotiations to source this licence.

Performance Measures

OEH and SCA consider that Wollongong should meet performance measures of 'negligible' environmental consequences for the Cataract River, Cataract Creek and Bellambi Creek. Geoterra is satisfied that these performance measures can be met, and Wollongong Coal has included them in their Statement of Commitments for the UEP.

The Department agrees that impacts on surface water quality and quantity as a result of mining associated with the UEP are likely to be insignificant, and has recommended that Cataract River and Cataract Creek are subject to performance measures of 'negligible' environmental consequences, including:

- *negligible* diversion of flows or changes in the natural drainage behaviour of pools;
- *negligible* gas releases and iron staining;
- *negligible* increase in water cloudiness;
- *negligible* increase in bank erosion;
- *negligible* increase in sediment load;
- *negligible* increase in the volume of water reporting to the reservoir;

The Department has also recommended performance measures requiring negligible reduction in the quantity or quality of surface water inflows to the Cataract Reservoir. On this basis, the Department is satisfied that the risk of any negative impacts on the water quality of Cataract Reservoir is very low.

It is considered appropriate that all other watercourses and tributaries are subject to performance measures of 'no greater impact or environmental consequence than predicted in the EA'. This would allow for the minor impacts predicted in the Cataract Creek tributary which traverses Hawkesbury Sandstone over LW 1. The Department considers that this is an appropriate level beyond which Wollongong Coal would be required to take all reasonable and feasible steps to avoid further impact (ie limiting the length of a longwall panel), remediate the impact or environmental consequence, or provide an offset.

Monitoring and Management

The Department believes that a rigorous monitoring regime and associated TARP is necessary to provide a clear basis to decide whether or not the surface water performance measures and are being met and certainty in determining the appropriate management response to any exceedance.

The Department is satisfied that Wollongong Coal is implementing a comprehensive surface water monitoring regime along both Cataract Creek and Cataract River, which includes:

- 2 stream flow monitoring stations along Cataract Creek, which would be designed to monitor changes in stream flow; and
- 10 stream monitoring sites along Cataract Creek, 4 along Cataract Creek tributaries and 4 along Cataract River, which are regularly monitored for stream and pool water levels, flow depths and rates, water quality, channel stability and erosion.

The Department notes that the IESC recommended that stream flow, rather than water level monitoring, is undertaken along Cataract Creek to allow the rainfall runoff model to be calibrated within the subcatchment and increase confidence in baseflow predictions. The installation of the 2 stream flow monitoring stations along Cataract Creek would provide the data to allow the surface water model to be validated during the life of the project.

Wollongong Coal would also be required to prepare a comprehensive Water Management Plan as part of its Extraction Plan prior to the commencement of longwall mining under the UEP. The Department is satisfied that a Water Management Plan would provide an appropriate adaptive management approach to prevent any adverse impacts on Cataract Creek or Cataract Reservoir.

Conclusion

The Department is satisfied that the potential for loss of surface water baseflows as a result of mining associated with the UEP is minor and would not result in any significant environmental consequences on Cataract Creek or the stored waters of Cataract Reservoir. Potential losses of <9 ML/year are considered very small in a water source with a total of 15,540 ML of unit shares, particularly since this loss must be subject to a licence.

The Department has recommended conditions of approval which include performance measures requiring negligible reduction in the volume of water in Cataract Creek reporting to the Cataract Reservoir. The Department considers that this condition is sufficient to manage the potential impacts on Cataract Creek and the reservoir.

6.5 Groundwater

Groundwater Systems

Groundwater systems within the vicinity of the UEP can be broadly defined as either shallow or deep aquifers. Shallow systems include soils and the underlying weathered bedrock on hill slopes, plateaus, swamps and minor alluvial deposits (primarily associated with Cataract Creek). Deep systems exist within unweathered bedrock and comprise rock strata with a porous matrix (commonly sandstones) sometimes enhanced by fracturing. These two types of groundwater systems are recharged by rainfall and runoff over geologic time.

As discussed in **Sections 6.3** and **6.4**, shallow alluvial groundwater systems may be impacted by surface cracking which can cause subsurface flow diversions and swamp drying and (if it is associated with connective cracking) can allow surface waters to leak into the mine goaf. Deep systems may be impacted by aquifer depressurisation, groundwater connectivity to mined goaves and to springs on the Illawarra Escarpment to the east.

Deep groundwater aquifers in the Southern Coalfield generally have high levels of salinity and are not very productive or able to be used beneficially, indicating low rates of recharge from overlying surface waters.

There are very minor productive supplies of groundwater within the Narrabeen Group, including the Bulgo Sandstone, but these have significantly lower yielding aquifers than the overlying Hawkesbury Sandstone. The Bulgo Sandstone aquifers can contain salinities of up to 1500 milligrams/litre. There are no registered bores within Wollongong Coal's mining lease and no groundwater extraction is conducted in the vicinity of the proposed UEP longwalls.

Groundwater Assessments

The EA includes a groundwater assessment, undertaken by GeoTerra and GES (2012) (Annex P of EA). Wollongong Coal subsequently engaged GeoTerra to update the original groundwater assessment to assess potential changes to the groundwater system specific to the preferred UEP. The updated assessment is included as Appendix C of the RMR.

In addition, on 26 September 2014 Wollongong Coal provided a letter report to the Department providing additional information in relation to cumulative groundwater inflows (including Wonga East and Wonga West areas). A copy of this report is provided as **Appendix F**.

Wollongong Coal engaged Dr Noel Merrick of Hydro Simulations to undertake a peer review of the groundwater assessment (see **Appendix E**). The peer review report indicates that:

> *"The Russell Vale Groundwater Model has been developed competently and is 'fit for purpose' for addressing the potential environmental impacts from the proposed underground mining operations and for estimating indicative dewatering rates".*

NOW has confirmed that the modelling study and review report satisfy the requirements of the *NSW Aquifer Interference Policy* (AIP).

Groundwater Predictions

Non-alluvial shallow groundwater aquifers

GeoTerra reports that, where mining of all three seams has occurred, there is a potential for interaction between surface water features and the top of the depressurised groundwater zone recharged from rainfall and adjacent creeks. The potential may be enhanced if there is interaction between the hill-slope basal shear plane that may have been reactivated by subsidence and the top of the zone of depressurisation above each longwall panel.

OEH and DSC raised concerns that the height of groundwater depressurisation above the UEP longwalls may extend into the basal shear planes and shallow aquifers of the Bulgo Sandstone where previous mining has taken place. GeoTerra accepts that this is possible for mining in shallower areas such as the northern ends of LWs 2 and 3, as well as the northern end of LW 7. However, as discussed previously, Geoterra notes that the shifting of LW 7 to the south (to avoid the previous mined seams limits the potential for interaction between the surface water features and the top of the depressurised groundwater zone in this area.

Given the depth of cover associated with the remaining longwalls (255 – 385 m), interaction between the surface water features and the top of the depressurised groundwater zone is considered unlikely. The maximum predicted depressurisation contour for the upper strata (Hawkesbury Sandstone as well as the underlying Newport/Garie Formation, the Bald Hill Claystone and the Upper Bulgo Sandstone) is shown in **Figure 14**. Up to 1 m drawdown is predicted over the northern ends of LWs 1-3 and LWs 6-7.

GeoTerra also predicts that there may be transfer of a small volume of water from the Cataract Reservoir to the underlying groundwater system due to depressurisation of the regional groundwater system. This sub-surface transfer is predicted to be 0.005 ML/day (1.83 ML/year). This represents less than 0.007% of the low level, or 0.002% of the FSL of the reservoir, and can be considered negligible.

Deep groundwater aquifers

Modelled drawdown within the deep aquifers (Bulgo Sandstone) is shown in **Figure 15**. Up to 45 m drawdown is predicted within the footprint of LWs 6, 7 and part of LW 9. Elsewhere over LWs 1-3, drawdown of up to 25m occurs at the completion of mining.

Groundwater Inflows

Current measured groundwater inflow from deep aquifers to the Wonga East workings, after extraction of LW 5, is 1.05 ML/day (383 ML/year). The GeoTerra model predicts that this rate of inflow would increase after extraction of LWs 8 to 11, to a maximum of 1.7 ML/day (620 ML/year). These modelled seepage rates into the Wongawilli Seam workings may be enhanced if unidentified fracture-related storages are intercepted, which GeoTerra reports may lead to short term increases of potentially up to 0.1 – 0.5 ML/day. These additional inflows would be expected to dissipate over a period of weeks or months.

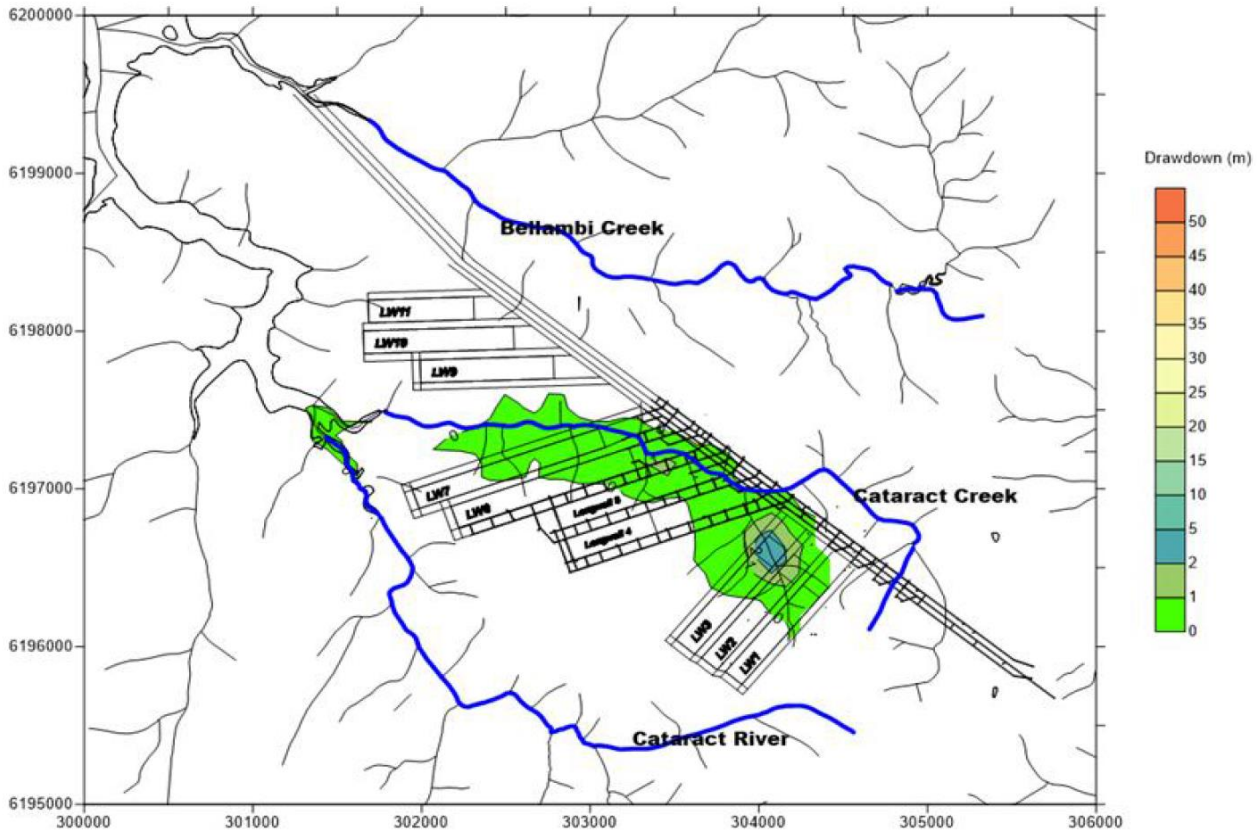

Figure 14: *Depressurisation of upper strata associated with mining the UEP Longwalls (50 years after mining)*

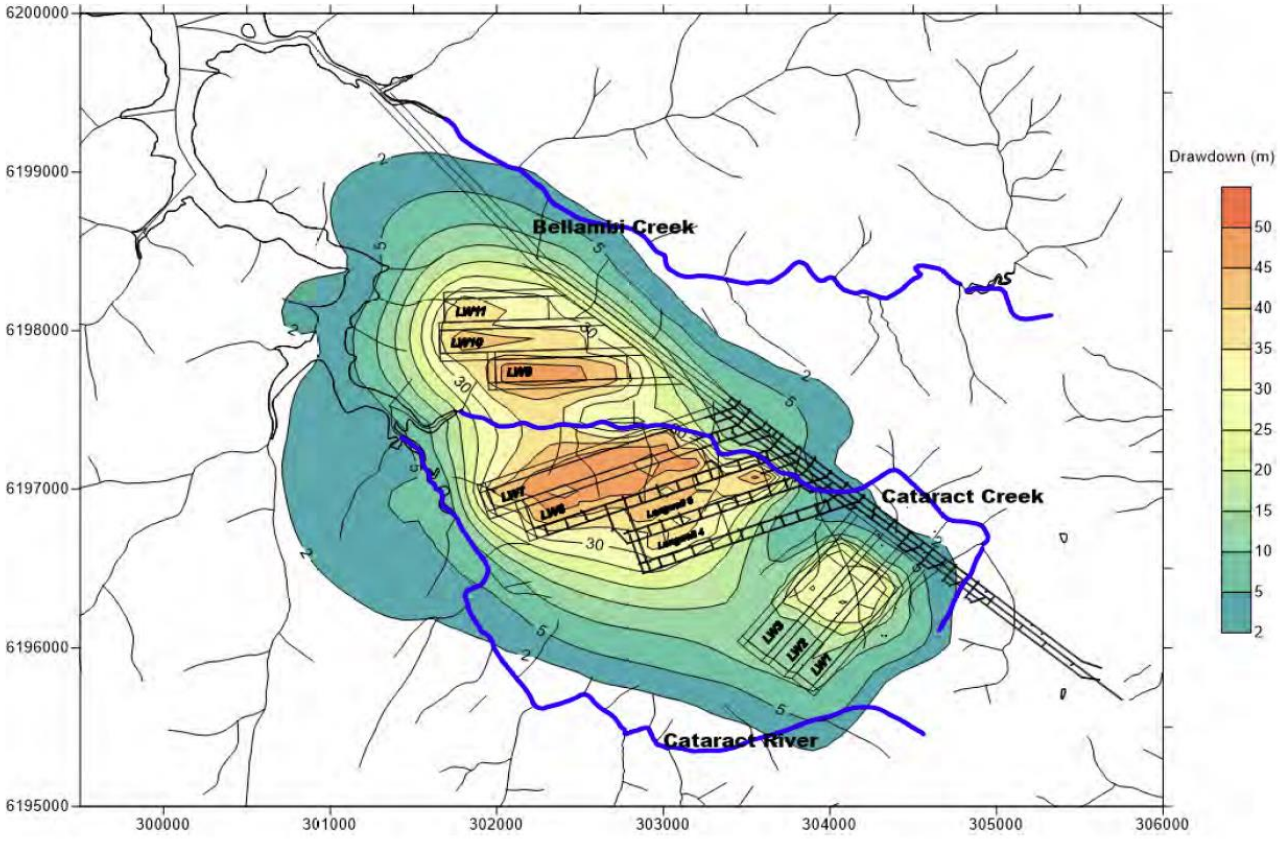

Figure 15: *Upper Bulgo Sandstone drawdown after mining the UEP Longwalls*

In addition, Wollongong Coal has reported an additional groundwater inflow of 0.59 ML/day (214 ML/year) to the completed Bullii Seam workings in the Wonga West area (see **Appendix F**).

Groundwater Quality
In terms of groundwater quality, GeoTerra states that the UEP may result in some localised iron hydroxide precipitation and some lowering of pH if the groundwater is exposed to freshly-fractured rock surfaces through dissolution of unweathered iron sulphide or carbonate minerals. However, it is important to note that groundwater quality in the region has not been adversely affected by previous mining and that many aquifers in the Southern Coalfield already have significant iron hydroxide levels.

NSW Aquifer Interference Policy
In accordance with the AIP, GeoTerra completed an assessment of the minimal impact considerations for 'less productive porous rock water sources' and 'perched ephemeral aquifer water sources'. The assessment concluded that the criteria for minimal impact would not be exceeded. NOW has confirmed that the project would meet the Level 1 impact thresholds of the AIP, which it considers to be acceptable.

Groundwater Licensing
Under the *Water Management Act 2000*, Wollongong Coal is required to hold a water access licence (WAL) for groundwater take within the *Sydney Basin Nepean Groundwater Source* in accordance with the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* (Groundwater WSP). The Groundwater WSP controls all aquifers below the surface of the ground, including alluvium, weathered and basement rocks. Under the Groundwater WSP, the proposed mining is located within Management Zone 2 of the *Sydney Basin Nepean Groundwater Source*.

Wollongong Coal has confirmed that it currently holds a groundwater licence under Part 5 of the *Water Act 1912* for 365 ML/year, and that this would need to be converted to a WAL. Since the Groundwater WSP applies to all aquifers, Wollongong Coal would require WALs for all groundwater taken in the course of mining. The predicted maximum inflow to the Wonga East workings is 620 ML/year, which includes approximately 73 ML/year of seepage inflow from adjoining, up gradient decommissioned workings, which is not required to be licensed. Leakage from the reservoir is predicted to be 1.83 ML/year. Inflow from the completed Wonga West workings is predicted to be 214 ML/year. Therefore, Wollongong Coal requires a WAL for at least 396 ML/year in addition to its current licence.

There are 16,283 ML of unit shares in this water source, which is considered sufficient to allow conversion and/or new licensing of both the existing and modelled groundwater take.

Monitoring and Management
The Department notes that monitoring of the multi-seam estimated height of depressurisation in the vicinity of the UEP is currently limited to one location (GW-01) east of LW 4. To further investigate and monitor the height of groundwater depressurisation, the PAC included a condition in the MOD 2 approval requiring Wollongong Coal to install a borehole between Longwall 6 and the reservoir prior to extraction of the initial length of Longwall 6.

Wollongong Coal has confirmed that it has approval from SCA to establish additional bores in the UEP area, including a bore located between Longwall 6 and the reservoir, and that the bore locations were negotiated and agreed with SCA and the DSC (refer to **Figure 13**).

The Department is satisfied that these boreholes would provide valuable information on groundwater depressurisation in multi-seam environments and has recommended a condition requiring them to be installed prior to any extraction associated with the UEP.

To ensure that the risk of groundwater impacts is adequately managed, the Department has also recommended that Wollongong Coal is required to:
- obtain appropriate water licences from NOW for groundwater inflows to the mine; and
- develop a comprehensive Water Management Plan for the project in consultation with relevant authorities, that includes:
  - groundwater monitoring program;
  - impact assessment criteria or trigger values; and
  - a program to validate the groundwater model for the project, and compare monitoring results with modelled predictions.

Conclusion
The Department is satisfied that the groundwater assessment provides a sound basis for assessing the potential groundwater impacts of the project. It is also satisfied that the proposed mining within the UEP area

can be managed such that it would not result in any significant impacts on groundwater resources, and that Wollongong Coal should have no trouble securing the additional necessary licences to account for its groundwater take.

6.6 Cliffs and Steep Slopes

As shown in **Figure 16**, there are numerous sandstone cliff formations located within the Hawkesbury Sandstone outcrop in the UEP area. All except a few isolated sections are less than 5 m high and none are considered to be 'significant'[1]. Many of these features have previously undermined.

The most significant cliff formations are those associated with Brokers Nose on the Illawarra Escarpment located about 900 m east of the southern end of LW 1. Brokers Nose is remote from the proposed mining and SCT consider that there is no potential for mining subsidence movements to impact cliff formations along the Illawarra Escarpment.

A number of short sections of cliffs of between 3 m and 10 m in height are located on the northern side of Cataract Creek. Several short sections of cliffs, typically less than 3 m high but up to about 7 m are located on drainage lines along the Hawkesbury Sandstone outcrop on the southern side of Cataract Creek. A small sandstone cliff formation is also located immediately downstream of swamp CCUS4.

Wollongong Coal reports that there are about 720 m of cliffs that are greater than 5 m in height in the UEP area, and that about 130 m of these would be directly undermined. SCT predicts that there is some potential for rock falls on up to 5% of the length of cliff formations directly undermined, with potential for perceptible impacts such as tension cracking on up to 30% of the length of cliffs directly undermined and extending outside the goaf edge to a distance of 0.4 times overburden depth (typically about 140 m).

Rock fall has the potential to affect fauna habitat and Aboriginal heritage sites (see **Table 3** and **Section 6.7**). It could also jeopardize public safety. However, as the vast majority of the land above the proposed mining area is owned and managed by SCA for the purpose of maintaining Sydney's water supply, the public safety risks associated with rock falls are considered to be extremely low and manageable.

The Department is satisfied that mining would not impact the most significant cliffs in the region and that the total length of the other cliff formations potentially impacted is small and is therefore acceptable. Consequently, the Department believes that subsidence impacts on cliffs and steep slopes can be managed via the standard Extraction Plan process, and has recommended conditions to ensure this occurs.

6.7 Pit Top Operations

Potential environmental impacts associated with the operation of the Russell Vale surface infrastructure pit top area are discussed in detail. This includes potential noise impacts (see **Section 6.7.1)**, surface water management (see **Section 6.7.2**) and air quality impacts (**Section 6.7.3**).

6.7.1 Noise

The EA included a Noise Assessment undertaken by ERM (Annex H). In response to issues raised by the Department (discussed below), Wollongong Coal subsequently engaged Wilkinson Murray to update the Noise Assessment in accordance with applicable guidelines, including the *NSW Industrial Noise Policy* (INP) and the *Road Noise Policy*. Importantly, the revised Noise Assessment considers the historical context of the mine and noise levels generated by both past and present operations. A copy of the revised noise assessment is included in **Appendix F**.

As the Russell Vale pit top site predates the surrounding residential dwellings, the interface between these two land uses is defined as a Suburban/Industrial Interface under the INP. The key aspect of the assessment was therefore undertaken with reference to the predicted changes to noise impacts on the local community in the vicinity of the pit top site and along the Bellambi Lane haulage route, rather than to a background level measured in the absence of the colliery. The assessment considers the operational noise, sleep disturbance and road traffic noise impacts of the UEP on residential properties surrounding the site.

Historical Context of Noise Generation

The pit top site has been operated as a colliery pit top since 1887. The surface facilities have continued to be located in the same area whilst mechanisation has resulted in extraction techniques transitioning from hand workings to continuous mining, and ultimately to longwall mining. From the 1960s until 2003 a coal washery and coal preparation plant operated on site.

[1] Using the significance criteria developed by the PAC in 2010 for the Bulli Seam Operations Report.

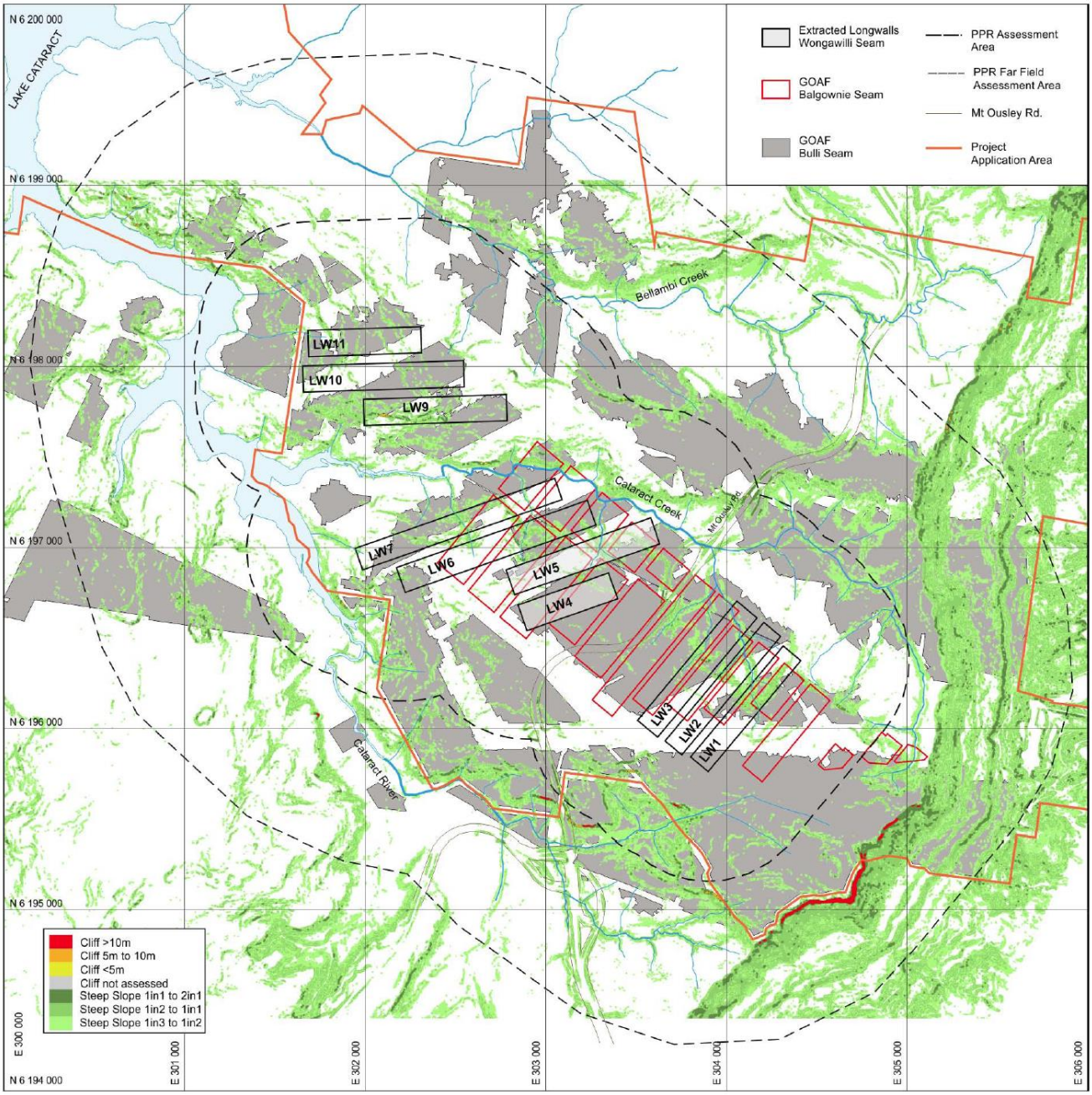

Figure 16: *Location of Steep Slopes and Cliffs*

Washeries are traditionally a significant source of noise annoyance and often the source of complaints regarding low frequency noise and tones. Considering the very old surface facilities and significant use of old mobile fleet, it is straightforward that previous operations would have had a much larger and more intense noise footprint than currently exists. To reflect this reality, the revised noise assessment presents historical monitoring data (from 1980 onwards), and models previous operational noise scenarios. **Table 6** below presents a summary of historical night-time noise levels, matched to current receiver locations (see **Figure 17**) and compares these to the current and proposed operational scenarios.

Table 6: *Night-time noise levels – historic, current and proposed*

Receiver Id	***Location***	***Noise Level dB(A)***		
		Historic	***Existing Night***	***Proposed Night***
R1	16 West St, Russell Vale	56	45	43
R2	30 West St, Russell Vale	52 - 59	47	44
R4	13 Broker St, Russell Vale	48	45	43
R9	109 Midgley St, Corrimal	N/A	42	43
R12	46 Lyndon St, Corrimal	Low 40s - 47	40	39

Figure 17: *Location of receivers surrounding Russell Vale Colliery*

The actual and predicted noise levels presented in **Table 6** show that the noise levels in the vicinity of the pit top operations have been reducing from historic levels, and are predicted to continue to reduce under the proposed UEP.

Revised Noise Assessment

The original Noise Assessment undertaken in 2012 (Annex H of the EA) modelled noise levels and compared the results against intrusive noise criteria based on background noise levels. Whilst the Department had some concerns regarding the resulting prediction of low levels of noise impacts in the EA, the data presented by the noise consultant supported the predicted levels. However, the methodology adopted by ERM failed to deliver realistic and practical outcomes for a number of reasons, including:

- *Use of the Bureau of Meteorology's Bellambi Point Weather Station* – this is located on an exposed ocean point which experiences high winds and no significant temperature inversion. Although it is only located 3.5 km from the colliery, the meteorological conditions under the escarpment where the mine is located are considerably different. In particular, the area is prone to significant drainage flows which were not accounted for in the ERM assessment. The colliery has now installed its own on-site weather station which was primarily used in determining the prevailing meteorological conditions used in the revised noise assessment. The Department is satisfied that the on-site weather station provides representative data for the colliery's noise catchment. The on-site weather data indicates noise is being enhanced by particular meteorological conditions, especially to the southeast on cold Winter nights. This is consistent with local observations and monitoring of elevated noise levels during these conditions;
- *Sound Power Levels* – the noise consultant engaged to undertake the noise mitigation works and prepare the revised noise assessment (Wilkinson Murray) has used higher plant and equipment sound power levels than those used in the original ERM assessment. The Department believes that the revised sound power levels are more representative of actual equipment performance; and
- *Non-Inclusion of Equipment in Noise Model* – the ERM assessment may not have included all significant items of noisy plant and equipment in the noise model.

The combined result of the assumptions and methodology used in ERM's noise assessment was to significantly underestimate the noise being generated by the Russell Vale pit top site during periods when it operated to capacity. The Department's noise specialist has conducted a comprehensive review of the methodology used in the revised noise assessment and is confident that it is representative of existing and future operational activities under the UEP.

Development of Noise Objectives

The INP sets out an iterative process for developing project noise objectives. The first step in the process involves establishing Project Specific Noise Levels (PSNLs) which are based on the more stringent of the Intrusive Noise Criteria or the Amenity Noise Criteria. These PSNLs are non-mandatory noise goals. Generally the Intrusive Noise Criteria informs the PSNLs as it is simply the addition of 5 dB(A) to the Rating Background Level, which is often reasonably low in suburban or rural environments. For the UEP the applicable PSNLs are presented in **Table 7**.

Table 7: *Project Specific Noise Levels*

Receiver #	*Day*	*Evening*	*Night*
R1 – R4	42	41	40
R5 – R8	48	45	42
R9 – R14	40	40	38

The second step in the process applies where a new project cannot meet these criteria. In such cases, if the social and economic benefits of the project are considered to be high enough, noise criteria up to 5 dB(A) above the PSNLs can be set, if a range of conditions have been met.

An alternate second step exists in the INP where it contemplates situations in which an existing industrial site has been operating for a long period in a particular noise catchment, or where residential development has encroached on a previously remote industry. This step has been developed in recognition that it is often unreasonable or impractical for an existing industry to comply with 'greenfield' noise criteria.

The establishment of the Russell Vale pit top site predates the development of the existing residential areas that surround it. These residents have knowingly moved into an area with a high existing noise exposure. In such cases it is appropriate to consider the residential area surrounding the colliery as being in an interface zone. The Amenity Noise Criteria for a Suburban/Industrial Interface, based on the INP, are shown in **Table 8**.

Table 8: *Suburban/industrial interface amenity criteria*

Time of Day	Recommended Noise Level dB(A)			
	Acceptable		Recommended Maximum	
	Leq (period)	Equivalent[1] Leq (15 minute)	Leq (period)	Equivalent[1] Leq (15 minute)
Day	60	63	65	68
Evening	50	53	55	58
Night	45	48	50	53

[1] Amenity criteria are based on a period (day, evening or night) average. To provide an easier to measure compliance number, the equivalent Leq(15 minute) value is usually obtained by adding 3 dB(A).

Amenity criteria are designed to set acceptable and upper limits for all combined industrial noise sources in a noise catchment. The Russell Vale pit top site is the only industrial noise source in the catchment and as a consequence of current land use zoning no further industrial noise sources can be established nearby. Therefore, in the knowledge that there can be no further increase in industrial noise, the Department believes it is reasonable to limit noise from the Russell Vale pit top site to levels that do not exceed the Acceptable Amenity Criteria for the area.

In the third and final step, weight must be given to the NSW Government's new *Voluntary Land Acquisition and Mitigation Policy* which gives guidance on how exceedances of PSNLs should be managed.

However, before consideration can be given to accepting levels that exceed PSNLs, there must be consideration of what reasonable and feasible measures can be undertaken to reduce noise impacts.

Reasonable and Feasible Mitigation and Best Practice

To minimise the noise impacts of its operations, Wollongong Coal is proposing to implement all reasonable and feasible noise mitigation measures. Under the INP, these measures are grouped into three categories:

- controlling noise at source, either by using:
  - Best Available Technology Economically Available (BATEA); and
  - Best Management Practice (BMP), which includes restricting the use of equipment at certain times, scheduling noisier activities during the day, and (increasingly) using real-time noise management;
- controlling the transmission of noise with bunds or buffer areas; and
- controlling noise at the receiver.

Wollongong Coal's noise assessment is based on a combination of the first two measures. In regards to the third measure, the *Voluntary Land Acquisition and Mitigation Policy* states that a consent authority cannot grant voluntary mitigation and acquisition rights to reduce operational noise impacts of a development for:

> *"existing developments with legacy noise issues, where the modification would have beneficial or negligible noise impacts. In such cases, these legacy noise issues should be addressed through site-specific pollution reduction programs under the Protection of the Environment Operations Act 1997".*

Mitigation Measures Undertaken and Practices Employed

As a result of long occupation of the site, until recently much of the plant and equipment as well as work practices were dated and did not represent best practice. Whilst the old washery has been demolished, the Department identified a number of noise sources that it believed could be mitigated. Consequently, a number of noise surveys were undertaken to identify areas for improvement. To date, the following noise mitigation works have been implemented at the site:

- cladding and enclosure of the transfer station;
- construction of surrounding bunds;
- improvements to the conveyor systems;
- significant work on the tripper (which is now some 8 dB(A) quieter than previous).

In addition, work is expected to be completed in May 2015 on an underground reclaimer which would result in a significant reduction in the handling of coal by mobile fleet.

Whilst the Department has received very few complaints regarding noise, it is understood that the most annoying aspects relate to the noise of material being dropped from the tripper onto the coal stockpile and from noise associated with mobile fleet movements in the stockpile area. Currently, mobile fleet can only operate during the day and evening and it is proposed to continue this restriction. However, with the commissioning of the underground reclaimer, the mobile fleet would reduce to just one dozer. Wollongong Coal has committed to only using one noise-attenuated dozer and to using the smallest one required for the job. In this respect, and following discussions with the noise consultant, a reduction in the highest predicted noise values for the evening period by 3 dB(A) has been factored into the noise predictions.

In regards to noise from material dropping on the stockpile, discussions with nearby residents indicated that rather than coal dropping onto the stockpile, the unusual high noise events are likely to result from hard rock material hitting other hard rock material. To minimise the potential for these 'rock-on-rock' impacts occurring, the Department has developed conditions to limit the amount of hard rock material that can be transported to the surface at night. Furthermore, where it is known that igneous dyke material would be encountered, conditions have been recommended which only allow this operation during day and evening operations. A real time noise monitoring system has also been installed to monitor operational levels.

In line with the Department's noise expert's expectations, current noise modelling has shown that a noise barrier previously proposed (in the ERM noise assessment) to the northeast of the site would not provide any significant additional attenuation. It is therefore recommended that this barrier not be constructed.

Maintaining the existing restrictions on Wollongong Coal's operations effectively means that the only surface activity that can occur during the sensitive night-time period is the running of coal onto the stockpile. The Department has evaluated the mitigation measures already implemented and restrictions on equipment and transfer of material to the surface during night-time operations, and has concluded that all reasonable and feasible measures have been adopted. Notwithstanding, the Department also proposes that regular noise audits are conducted to identify any areas for further improvement.

Predicted Noise Impacts and Project Criteria

The predicted noise levels in **Table 9** below represent worst case scenarios that would only occur less than 10% of the time. The noise levels in **Table 9** include an adjustment for the use of a quieter stockpile dozer. Although the predicted noise levels mostly exceed the PSNLs, in no case do the predicted levels exceed the Acceptable Amenity Criteria. These criteria are 5 dB(A) below the Recommended Maximum Amenity Criteria for residential areas surrounding the pit top. This supports the position that these noise levels are reasonable for the area surrounding the pit top and would not adversely impact on the existing amenity of the location. In line with current EPA practice, where the predicted levels are below the nominal criteria, the Department has set the project criteria to the predicted level (ie the lesser level).

Predictions of evening noise impacts have been calculated on the basis that operational activities would continue for the full evening period (ie 6 pm – 10 pm) seven days a week. However, in reality, restrictions on transport of coal from the colliery and coal receival at PKCT mean that the colliery would effectively operate in the quieter 'night mode' from before 10 pm on Monday to Friday and before 6 pm on Saturdays, Sundays and Public Holidays. 'Night mode' is also extended until 8 am on Saturdays, Sundays and Public Holidays.

Table 9 shows that, at most, one property is predicted to experience any increase in existing noise levels under the UEP. Receiver 9 is predicted to experience an increase of 1 dB(A). Notwithstanding that such an increase would not be noticeable, under conditions proposed by the Department that restrict the number of stockpile sites, it is likely that Receiver 9 would actually receive a 1 dB(A) decrease on existing noise levels. This level has not currently been accounted for, but is based on modelled scenarios.

Table 9: *Predicted noise levels and recommended noise criteria*

Receiver #	Time Period	Noise Level Leq(15 minute) dB(A)					Sleep Disturbance L1(1 min)
		Existing	Predicted Level	PSNL	Acceptable Amenity Criteria	Recommended Maximum Amenity Criteria	
R1	Day	51	51	42	63	68	50
	Evening	54	53	41	53	58	
	Night	45	43	40	48	53	
R2	Day	54	54	42	63	68	50
	Evening	56	53	41	53	58	
	Night	47	44	40	48	53	
R3	Day	53	53	42	63	68	50
	Evening	55	53	41	53	58	
	Night	46	44	40	48	53	
R4	Day	51	51	42	63	68	50
	Evening	55	53	41	53	58	
	Night	45	43	40	48	53	
R5	Day	52	52	48	63	68	52
	Evening	55	53	45	53	58	
	Night	43	41	42	48	53	
R6	Day	51	51	48	63	68	52
	Evening	56	53	45	53	58	
	Night	43	41	42	48	53	
R7	Day	52	52	48	63	68	52

	Evening	56	53	45	53	58	
	Night	44	44	42	48	53	
R8	Day	51	51	48	63	68	52
	Evening	56	53	45	53	58	
	Night	46	46	42	48	53	
R9	Day	44	43	40	63	68	48
	Evening	47	46	40	53	58	
	Night	42	**43**	38	48	53	
R10	Day	42	42	40	63	68	48
	Evening	45	44	40	53	58	
	Night	42	43	38	48	53	
R11	Day	40	40	40	63	68	48
	Evening	43	43	40	53	58	
	Night	40	40	38	48	53	
R12	Day	42	42	40	63	68	48
	Evening	43	42	40	53	58	
	Night	40	39	38	48	53	
R13	Day	45	45	40	63	68	48
	Evening	46	46	40	53	58	
	Night	42	42	38	48	53	
R14	Day	44	44	40	63	68	48
	Evening	46	46	40	53	58	
	Night	42	40	38	48	53	

Low Frequency Noise

Potential sources of low frequency noise at a mine site are generally limited to washeries and crushing plants, neither of which are present at the Russell Vale pit top site. Noise monitoring has not identified any previous low frequency noise impacts.

Sleep Disturbance

The noise assessment includes an analysis of the potential for sleep disturbance associated with mining operations during the night-time period. The assessment indicates that the project would not exceed the applicable sleep disturbance objectives at any location apart from a minor 1 dB(A) exceedance at R2. This exceedance in not considered excessive as it is still below conservative levels suggested in the World Health Organisation's *Night Noise Guidelines for Europe.* However, residents living close to mines should be able to have undisturbed sleep and consequently the Department has recommended upper limits to control maximum noise events. Moreover, based on anecdotal evidence that the tipping of hard rock waste material onto the stockpile can increase peak noise levels, the Department has developed conditions aimed at limiting the amount of such material that is transported to the surface during the night.

Traffic Noise

Coal from the pit top site is currently delivered to PKCT using trucks which initially travel along the four-lane Bellambi Lane. This route has a long history as a coal transport corridor to the Northern Distributor (now Memorial Drive). The nearest residences to the north are in Keerong Avenue as the northern side of the road is a disused rail corridor (which previously serviced the mine). The south side of Bellambi Lane is zoned light industrial land and as such the isolated residences located in this zone do not have noise criteria assigned to them under the Road Noise Policy.

From 1992 until 2009 Bellambi Lane formed part of State Highway 1 (the Princes Highway) with correspondingly high levels of road traffic noise experienced on both the southern side of Bellambi Lane and the rear of residences on Keerong Avenue to the north. Following the extension of the Northern Distributor, there was a considerable reduction in traffic volumes on Bellambi Lane.

The proposal to increase transport of coal from a current level of 1 Mtpa to 3 Mtpa has been estimated to increase the current road traffic noise levels by up to 1.7 dB(A). This is considered negligible, particularly within the historical context of noise generated on Bellambi Lane until 2009, which were much higher than future predictions. The Road Noise Policy sets noise criteria for two periods – 7 am to 10 pm and 10 pm to 7 am. Trucking from Russell Vale on Bellambi Lane would only take place during the first of these periods. Once trucks leave Bellambi Lane they travel on high traffic volume roads to PKCT. The impact of increased truck volumes on these roads is insignificant and does not trigger the need for any further consideration of noise.

6.7.2 Surface Water Management

Assessments
The EA includes a water assessment undertaken by Beca Pty Ltd which focuses on potential surface water impacts at the surface facilities pit top site (Annex B). In addition, in response to a draft Order issued by the Department, Wollongong Coal engaged Cardno Pty Ltd to prepare a Flood Study for Bellambi Gully. A copy of this study is provided at **Appendix F**.

Existing Water Management
The existing drainage of the pit top area includes a stormwater pipeline which directs clean water flows in Bellambi Gully below the existing ROM stockpile. In the past, blockages in the pipeline have resulted in overflows and flooding of residential areas further downstream in Bellambi Gully, particularly in 1998. The potential for flooding is of particular concern as overland flows have the potential to be mixed with coal from the ROM stockpile and other sediment on-site.

Wollongong Coal currently holds an Environmental Protection Licence (EPL 12040) that allows discharge of up to 2.5 ML/d of treated water from a single licensed discharge point (Russell Vale LDP2) into Bellambi Gully under dry weather conditions. Beca has indicated that the proposed UEP would not involve a change to the amount of water discharged into Bellambi Gully or Bellambi Creek.

The EA provides monitoring results that indicate that the water quality at the discharge point from the surface facilities site sometimes exceeds the Australian and New Zealand Environment and Conservation Council's (ANZECC's) freshwater guidelines for lowland rivers. However, discharges comply with the EPL requirements and have a similar water quality to the background water quality in the creek (refer to **Table 10** below).

Table 10: *Water quality in Bellambi Gully*

Analyte	Bellambi Gully 1	Bellambi Creek Discharge LDP2	ANZECC Guidelines	EPL limits
pH	8.1-9.2	7.1-9	6.5-8(9)	6.5-9.2
Oil & Grease mg/L	<0.1	<0.1	-	10
Total Dissolved Solids mg/L	1220-1900	1100-1900	125-2200	-
TKN mg/L	0.4-0.9	0.4-1.1	0.5	-
TP mg/L	0.08-0.3	0.03-0.12	0.05	-
TSS mg/L	1-52	13-27	-	50

Proposed upgrades to water management
On 6 May 2014, the Department's Compliance Branch issued Wollongong Coal with a draft Order in response to its failure to complete its proposed Bellambi Gully realignment works, as proposed in the Statement of Commitments first included in the PWP approval in 2011. NRE had committed to undertake these works in response to the major pollution incident arising from the 1998 floods, which involved the Bellambi Gully overtopping the constructed underground culvert beneath the pit top site area, and consequently scouring a significant quantity of coal from the mine's ROM stockpile, which in turn was transported off the site, affecting a number of residences and the creekline. Under the Statement of Commitments, the works were required to be completed by 31 December 2013.

In response to the draft Order, Wollongong Coal indicated that the original undertaking as presented in the EA for the PWP was made on the basis of incomplete and incorrect information regarding the cause of the overtopping incident. Wollongong Coal subsequently committed to preparing a detailed flood mitigation study to assess the flood risks and determine the most appropriate flood mitigation option for the surface infrastructure and stockpile areas at the pit top site.

The Department has since received the resultant Bellambi Gully Flood Study (refer to **Appendix F**), The Bellambi Gully Flood Study includes a review of all past flood studies, a topographic survey and a digital terrain model, identification of peak flows (5, 10 and 100 year ARI), a flood model based on three scenarios and recommended flood mitigation measures.

The study indicates that runoff originating from the Illawarra Escarpment flows down the escarpment's heavily vegetated, steep slopes to the Russell Vale site in the foothills, where it enters the Bellambi Gully. Some reaches of the watercourse are conveyed by pipes and constructed channels within the site. The total catchment area is 427 ha and the total creek length is 4.3 km.

Cardno modelled three scenarios to assess flooding throughout the site. The models represented 100 year ARI events where the current stormwater pipes are completely blocked, 20% blocked and fully operational. Results indicate that flooding within the site is significant under all these scenarios. In all scenarios, while overland flows are mainly contained within the stockpile area, they also overtop the access road and continue as sheet flow towards and onto Bellambi Lane and eventually to Bellambi Creek.

The study recommends a range of mitigation measures to reduce clean runoff entering the stockpile area, while conveying all site runoff in a controlled way to Bellambi Gully and ultimately to Bellambi Creek (ie preventing flooding of Bellambi Lane). In summary, these measures include:

- raising the stockpile area access road, installing a new culvert and formalising the open channel via a swale with a 5 m base close to the southern margin of Bellambi Lane;
- implementing a debris control structure at the 1800 mm diameter pipe entrance;
- formalising the swale in the vicinity of the 600 mm clean water inlet;
- upgrading the existing 600 mm diameter clean water pipe to an 825 mm diameter pipe;
- installing culverts across the access road along the northern boundary of the site; and
- ongoing maintenance of the system.

Cardno states that the proposed culvert and swale structure would be adequate to convey the 100 year ARI flows and eliminate the flooding on Bellambi Lane, even if the existing and upgraded stormwater pipes become 20% blocked.

The Department considers that the Cardno report, as presented, does not contain sufficient information for it to support the proposed option. For example, there is no information as to whether there is any residual risk of the coal stockpile being eroded or scoured. It also doesn't address what size of flood is likely to lead to overland flows (ie the point at which the capacity of the pipe network is exceeded). Most importantly, there is no comparative analysis between its recommended approach and the re-establishment of the original creek alignment previously proposed (and still required under existing conditions of approval).

Council has also completed a review of the flood study and requested that it be revised to use a standard modelling approach which assesses the 100 year ARI, adopts appropriate tailwater levels and applies a 100% blockage criterion for all stormwater pipes less than 6 m in diameter.

Wollongong Coal is currently in the process of revising the flood model to address both Council's and the Department's concerns. It is expected that the revised report would be finalised within approximately 2 weeks. The Department expects that it would be in a position to recommend one option or the other prior to the PAC providing a review report on the UEP. It is proposed that a discussion of the recommended option and associated conditions are included in an addendum report to the PAC.

Site Water Balance

As indicated in **Section 6.5**, the maximum predicted groundwater inflows from both the Bulli and Wongawilli Seams are estimated at 2.29 ML/day. Beca predicts that total water demand for mining operations would be around 4.2 ML/day. Water demand would be met by sourcing groundwater from old and new workings and surface water runoff from mine operational areas, with purchase of bulk raw water from SCA as required.

The Department has recommended that Wollongong Coal is required to prepare a Site Water Balance as part of the Water Management Plan within 6 months of approval of the project.

6.7.3 Air Quality

Assessment

The EA includes an air quality assessment prepared by ERM which addresses operational activities at the pit top area (see Annex I of EA). The existing and proposed activities likely to generate particulate emissions include ROM coal stockpe, loading activities of haul trucks, using on-site unsealed haul roads, and transfer and handling of coal by mobile plant.

The assessment was undertaken in accordance with the applicable guidelines, including the EPA's *Approved Methods for Modelling and Assessment of Air Pollutants in NSW.* The assessment used background air quality measurements from EPA monitors and climatic data from the Bureau of Meteorology's weather station, both of which are located 6 km south of the site.

In its submission on the EA, the EPA raised a number of concerns in relation to the air quality assessment, including questioning the significant sources incorporated in the modelling, as well as the source of both background air and meteorological data. In its submission, Council indicated that Wollongong Coal should be

required to implement a range of air quality mitigation measures prior to the commencement of mining operations associated with the UEP.

In the PPR, Wollongong Coal included a detailed response to all issues raised by both the EPA and Council in relation to the air quality assessment. This included confirmation that the full range of mitigation and management measures proposed by Council have been implemented on-site or are proposed to be implemented prior to mining operations under the UEP. Both the EPA and Council have confirmed that they are satisfied that Wollongong Coal has addressed all of the issues raised in their original submissions.

Vent shafts for the mine have not been included in the assessment, as they are located on the Woronora Plateau well removed from sensitive receivers, and are not expected to result in any significant emissions or impacts.

Mitigation Measures

Wollongong Coal has implemented a range of air quality mitigation measures associated with the existing mining operations. These measures include:

- decommissioning the Balgownie belt and bins and the Bulli decline belt;
- construction of a new stackout conveyer and tripper system;
- covering coal conveyors to the stockpile area;
- installation of an automatically controlled stockpile spray system;
- use of mobile water trucks;
- a new truck washing facility used by all trucks prior to departure from the site;
- covering all loads prior to leaving the site;
- sealing pit top truck haulage roads and parking areas;
- the use of a bobcat mounted road sweeper on all sealed areas;
- the use of fixed water sprays on surface and underground coal conveyors; and
- operating a comprehensive air quality management system, including 12 dust deposit gauges (DDGs) and two real-time high volume air samplers (HVASs).

In addition, Wollongong Coal has committed to constructing a new fully enclosed coal screening and sizing plant prior to the commencement of longwall mining operations under the UEP.

The Department is satisfied that these measures represent current best management practice and that Wollongong Coal is complying with the existing requirements in its PWP approval in relation to air quality.

The Department notes also that the EPA is currently driving the implementation of air emissions reduction measures at coal mines throughout NSW under its "Dust Stop Program". EPA has imposed a Pollution Reduction Program (PRP) on the site's EPL requiring a site-specific best management practice review and report aimed at further reducing emissions of particulate matter. This report was prepared by PAE Holmes on behalf of Wollongong Coal in October 2012, and recommends that additional controls (beyond those listed above) could include measures such as the use of chemical suppressants on stockpiles and on haul roads. The EPA would manage the implementation of these additional measures, if they are considered necessary.

Impact Assessment

In general, the predicted air quality contours for TSP, PM_{10} and deposited dust are localised around the surface facilities site and decrease rapidly away from the site. The air quality assessment predicts that dust emissions generated under the UEP would comply with all relevant dust criteria at privately-owned residences in the vicinity of the pit top site. Similarly, the cumulative impact assessment predicts that the cumulative dust levels would remain in compliance with all relevant criteria.

The only exception to this is in relation to short-term (24-hour) *cumulative* impacts. The modelling predicts that the PM_{10} 24-hour criterion would be exceeded on one occasion over the year when emissions are considered in conjunction with existing background concentrations. This exceedance would only occur on rare occasions under worst-case meteorological conditions. The Department and EPA accept that the 24-hour PM_{10} emissions can be adequately managed through the continued operation of the real-time air management system. The Department has therefore recommended conditions to ensure this system continues to be used to guide day to day planning of activities at the pit top site, and assist in preventing air quality impacts during adverse weather conditions.

The Department has recently released its *Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments* (November, 2014). The project would not trigger any of the relevant air quality criteria under this policy.

Monitoring

Under its existing EPL, Wollongong Coal is required to monitor dust via 5 DDGs located in the vicinity of the pit top area. However, Wollongong Coal has confirmed that it has installed an additional 7 DDGs, and that 3 of these are located in local schools. In addition, two real-time HVAS air quality monitoring systems capable of recording TSP, PM_{10} and $PM_{2.5}$ emissions have been installed at the boundaries of the site.

The Department and EPA are satisfied that this air quality monitoring network is sufficient to ensure compliance with relevant air quality criteria for the project.

Conclusion

The Department is satisfied that the predicted air quality impacts associated with the project are generally acceptable, and that the risks of adverse impacts are low and can be adequately managed through the implementation of best practice mitigation and management measures. The Department is also satisfied that the EPA is driving implementation of mitigation and management measures through the enforcement of the PRP required under the site's EPL.

The Department has recommended conditions requiring Wollongong Coal to:

- comply with contemporary air quality criteria;
- implement all reasonable and feasible 'source-based' measures to minimise dust emissions on site;
- continue to implement a real-time dust monitoring program and an active air quality management system which includes an early warning alert system to identify and manage potential exceedances; and
- develop a comprehensive Air Quality and Greenhouse Gas Management Plan.

6.8 Socio-Economic

The EA includes social and economic impact assessments which relate to the original UEP. These were revised to be made relevant to the preferred UEP and included in the PPR. The PPR identifies that the UEP would provide considerable socio-economic benefits including the:

- continued direct employment of 219 people and additional direct employment of 81 people during operation;
- direct employment of an additional 100 people during construction;
- indirect employment of up to 1,498 people in the local and regional area;
- $85 million in capital investment during construction ($18 million) and operation ($67 million)
- $34 million to the State in coal royalty revenues; and
- $110 million to the Commonwealth in tax revenue.

Unemployment in the Illawarra Region has been historically higher than in other areas of NSW. In April 2013, Russell Vale employed 287 full time workers, of whom 62% reside locally in the Wollongong LGA and 90% reside in the Illawarra Region (ie the Illawarra Statistical Division). The UEP would require 300 workers during its proposed five-year operation, as well as an additional 100 workers during construction of pit top upgrades. As a result of the large number of directly employed workers residing in the local and regional area, the Department expects that a large proportion of workers' salaries would be reinvested and circulated through these communities.

In addition to the direct employment of workers at the mine, the PPR estimates that the UEP would result in the indirect employment of 1,498 full time equivalent positions in the Illawarra Region. In considering this estimate, the Department recognises that employment multipliers may only provide an imprecise indication of the potential benefit.

In its recent submission responding to the PAC review report for the Stratford Extension Project, DRE determined a multiplier based on empirical evidence from the NSW Minerals Council's 2012/13 survey of NSW mining. This surveyed received results from 26 exploration and mining companies active in NSW and identified a multiplier of around 5.5. The DRE adopted a conservative multiplier of 4 in testing the indirect employment benefit of the Stratford Extension Project. As this was generated from a Statewide survey, it could be equally applied to the UEP as an estimate of indirect employment benefit.

The Department accepts that there would be a benefit from flow-on effects from the operation of the mine resulting in indirect employment in the local and regional areas. It is also expected that further indirect employment may be generated elsewhere in the State (eg in Metropolitan Sydney). In an area where unemployment has been high, the UEP represents a significant benefit to local and regional communities based on the high proportion of workers who reside in the area, indirect employment and the circulation of salaries throughout these communities.

The injection of $85 million in capital and operation expenditure into the mine is projected to generate $580 million in regional output over the operational life of the mine. Again, the use of multipliers to determine this benefit is recognised by the Department as not being an exact science. The Department acknowledges this, and the fact that some of the equipment and supplies may be sourced from outside the region, thereby reducing the full benefit to the area. However, the Department is of the view that this investment in capital and operational expenditure is significant and would result in benefits to local and regional areas and to the State.

The UEP would result in the extraction of 4.7 Mt of ROM coal which is estimated to generate $400 million in revenue for Wollongong Coal, $34 million in coal royalties for the State and $110 million in taxes for the Commonwealth. This revenue estimation is based on 52.6% coking coal sold at a rate of $150/tonne and 28.6% thermal coal sold at a rate of $90/tonne, with production averaging 934,000 tpa and adjusted by 8% over five years to determine the present value at the end of the project.

The Department notes that current coking and thermal coal prices are approximately 12-15% lower than the assumed prices presented in the PPR. It is therefore possible that the stated benefits of the project in terms of State royalties and Commonwealth taxes would be less based on a lower coal price. Whilst it is difficult to predict future coal prices, the Department is of the view that, in the event that coal prices continue at current levels over the short-term, the approximate reduction in royalties of $5 million (or 15%) and taxes by $110 million (15%) would still lead to considerable benefits to the State and Australian Governments.

In addition to the costed benefits, the continued use of existing infrastructure and shaft access for mining operations preserves the value of these assets and generates a funding stream to enable the ongoing preservation of items of cultural heritage significance. Such funding may be unavailable or be required to be obtained from alternate sources such as government grants in the absence of the UEP.

In summary, the Department acknowledges the difficulty in predicting future coal prices and the uncertainty around the use of multipliers to determine benefits such as indirect employment and increases to regional output. The Department has therefore carefully scrutinised the information presented and considered alternate multipliers as compared to those provided by Wollongong Coal in order to identify the potential range in economic benefits that may be generated by the project. In doing so, the Department is of the view that the UEP would result in significant socio-economic benefits to the local and regional areas and to the State of NSW.

6.9 Other Issues

Other environmental issues associated with the proposed project are considered in **Table 11**.

Table 11: *Other issues*

Issue	Potential impact and consideration	Conclusion and recommendation
Biodiversity	• The EA includes a series of terrestrial and aquatic ecological impact assessments (see Appendices Q-T of the EA). An updated ecological assessment undertaken by Biosis was included in the RMR (see Appendix G). This assessment took into account the revised subsidence predictions and groundwater model results, as well as additional surveys undertaken for the threatened Giant Dragonfly. • Biosis identifies that 2 flora species and 7 fauna species listed under the EPBC Act and/or TSC Act have the potential to occur in and be dependent on habitat in the Wonga East area. • The proposed UEP does not require the direct removal of native vegetation or fauna habitat. The key concern relating to biodiversity impacts is the potential for habitat alteration due to subsidence, which is listed as a Key Threatening Process under the TSC Act. • Biosis concluded that there would be no significant subsidence-related impacts to threatened flora or fauna species. • At OEH's request, Wollongong Coal engaged Biosis to undertake additional surveys for the Giant Dragonfly in late 2013 and early 2014. These additional surveys found exuviae (ie shed exoskeletons) for this species in upland swamps CCUS4 and CRUS1. Biosis considers that the risk of changes in water availability impacting on habitat for the Giant Dragonfly in CCUS4 is high. However, Biosis concludes that impacts are unlikely to result in significant impact to the local population of this species,	• The Department is satisfied that it is unlikely that there would be any significant impacts to biodiversity as a result of the UEP. • As discussed in **Section 6.3**, the Department has recommended that Wollongong Coal offset environmental consequences greater than 'negligible' for eight upland swamps. • The Department has also recommended a performance measure requiring not more than negligible environmental consequences on threatened species, populations or their habitats and EECs.

Issue	Potential impact and consideration	Conclusion and recommendation
	as the Giant Dragonfly has been recorded elsewhere in the immediate area, and the species has regularly been observed in previously undermined upland swamps.	
Aboriginal Heritage	• The EA contains an Aboriginal heritage assessment carried out by ERM in consultation with local Aboriginal groups (Annex U of the EA). This assessment was updated and made relevant to the preferred UEP longwall layout by Biosis (refer to Attachment C of the PPR). To address comments received by OEH and Council, the Biosis assessment also included additional consultation with Aboriginal stakeholders, additional survey effort (including the use of LiDAR mapping of cliffs) and a revision of the impact and significance assessment for the UEP. • Biosis has confirmed that the changes to the project as part of the preferred UEP have resulted in a significant reduction in predicted impacts to Aboriginal cultural heritage sites. This includes avoiding impact to all of the sites within the Wonga West area and avoiding or reducing impact to 9 known sites within the Wonga East area. • The assessment indicates that a total of 21 sites were located within the Preferred UEP area. The majority of the sites comprise shelters with deposits, however several axe grinding groove sites, shelters with art and an open camp site were also identified. • Biosis has confirmed that none of the sites would be permanently removed by the UEP, but that several have the potential to be impacted by subsidence-related impacts. • The risk of impact to the vast majority of the sites (18) is considered to be very low or negligible, primarily due to the location of the sites away from the UEP longwalls and the predicted low level of subsidence in these areas. • The remaining 3 sites are located in areas proposed to be undermined. Two sites (52-2-3939 and Site 52-2-3940) comprise shelters with deposits and form part of a sandstone cliff formation over Longwall 9. These sites were assessed by Biosis as being of high cultural significance and moderate scientific significance. However, as the sites are relatively short in length and located away from the main cliff line, Biosis indicated that potential subsidence impacts represent a low risk to the significance of these sites. • The only site assessed by Biosis as having a greater-than-low risk of impact is a shelter with art and artefact site (52-2-0603) located directly over Longwall 11. The site was assessed as having high cultural significance but low scientific significance. Biosis indicates that this site has a moderate risk of impact from potential rock falls. • Wollongong Coal has committed to monitor and record all the sites pre-during and post-mining operations and implement additional management and mitigation measures, in consultation with a qualified archaeologist and the Aboriginal community, if impacts are identified.	• The Department, OEH and Council are satisfied with the level of assessment undertaken in relation to Aboriginal assessment, as well as the scope and extent of consultation with Aboriginal stakeholders. • The Department has recommended performance measures that allow no greater impact to Aboriginal heritage sites than predicted in the EA. • Wollongong Coal would be required to prepare a Heritage Management Plan in consultation with Aboriginal stakeholders, OEH and Council and to the satisfaction of the Secretary.
Non-Aboriginal Heritage	• The EA contains a Historic heritage assessment undertaken by ERM (Annex I of EA). • Russell Vale (previously the South Bulli Colliery) is identified as an "*archaeological site or heritage site with an archaeological component*" under the Wollongong LEP 2009. The Illawarra REP No. 1 (a deemed SEPP) specifically identifies a further seven items of heritage significance located within the pit top area which were associated with historic mining activities. • Other items of heritage significance in the UEP area include the Cataract Dam, which is listed under the Wollondilly LEP 2011 and the Illawarra Escarpment, which is listed on the registers of the National Estate and National Trust. • ERM indicate that the project poses no risk of impact to items of heritage significance in the vicinity of the UEP area because: - the new stockpiles and infrastructure upgrades proposed at	• The Department is satisfied with the level of assessment undertaken in relation to cultural heritage and that the management and archival recording measures proposed are consistent with the requirements of the Heritage Council. • The Department is satisfied that the UEP would not impact on the Cataract Dam or the

Issue	Potential impact and consideration	Conclusion and recommendation
	the pit top area are located away from all historic heritage items and all upgrades to the site would be consistent with historic uses; - there is no risk of impact to the significance of the Illawarra Escarpment or Cataract Dam as existing mine drifts and roadways are to be utilised and there is a significant exclusion zone for secondary extraction around the dam wall. • As requested by the Heritage Council, Wollongong Coal has committed to: - preparing a Heritage Management Plan, which includes a procedure for managing heritage items on-site and procedures to follow the discovery of unanticipated relics; - undertaking archival recording of the 1887 portal and other site features in accordance with Heritage Archival Recording standards, and lodging copies with appropriate repositories; and - retaining items of moveable heritage at their current locations and engaging a conservator to provide advice on long term storage of the items.	Illawarra Escarpment. • The Department has recommended a condition requiring a Heritage Management Plan to be developed in consultation with Council and OEH, to record and manage historic heritage items across the site.
Traffic	• The EA includes a comprehensive assessment of the potential traffic impacts of the UEP undertaken by Cardno, including assessments undertaken in response to residual matters raised by Council and RMS, and subsequent assessments for the PPR (see Appendix E & J of the EA, and Appendix I of the RMR). • The Department considers the key issue to be the impact of an additional 11 laden coal trucks per hour (a total of 17/hr) on the haul route road network, particularly on Bellambi Lane (formerly part of the Princes Highway), the only local road along the fixed haul route. • Cardno predicted that the performance of key intersections and carriageways along the haul route would remain at acceptable levels, with the level of service remaining unchanged in nearly all circumstances including Bellambi Lane and Memorial Drive (formerly the Northern Distributor), both of which were of particular concern to objectors. • The only exception would be for parts of the Princes Motorway (formerly the Southern Freeway), where sections are approaching or exceeding capacity. Neither the Department nor RMS consider this to be of significant concern, given that modelling undertaken for future traffic growth indicated that coal trucks represent only a minor proportion of the peak hour directional traffic volumes (0.3 to 1% of total traffic). • Notwithstanding the predicted low level of impact to performance on Bellambi Lane, Council considers that Wollongong Coal should be required to financially contribute towards the maintenance of Bellambi Lane. The Department does not support this view, given that: - the life of the project is relatively short (5 years); - Bellambi Lane has been built to a standard that supports high capacity heavy vehicle traffic (as a former arterial road); and - coal trucks would represent a minor proportion of traffic during peak hour (less than 1%). • Council also considers that Wollongong Coal should be required to seal and line-mark the employee car park. The Department does not consider this requirement would contribute significantly to the management of the mine, particularly given that the UEP is only a 5 year project.	• The Department has recommended that Wollongong Coal is required to prepare and implement a Traffic Management Plan, which would include a drivers' code of conduct, to minimise the impacts of trucks on local residents and road users.
Greenhouse Gas Emissions	• The PPR includes a Greenhouse Gas (GHG) emissions assessment which predicts that a total of 8.1 Million tonnes CO_2-e ($MtCO_2$-e) would be generated over the life of the UEP. • This is equivalent to 0.097% of NSW and 0.027% of Australia's annual Scope 1 and Scope 2 site emissions. • The vast majority (90%) of emissions are scope 3 emissions,	• The Department accepts that the GHG emissions predicted to be generated by the UEP are minor, on a state, national and international scale.

Issue	Potential impact and consideration	Conclusion and recommendation
	associated with the eventual use of coal mined at the site. • The assessment concludes that the total GHG emissions from the UEP represent a very small proportion of current and global GHG emissions, and when considered in isolation, the project would have a negligible contribution to global warming/climate change. • Wollongong Coal has committed to: - installing sensors in all exhaust fans and air intakes to monitor precise volumes of GHG emissions; - upgrades to internal surface haulage routes to improve efficiency of on-site operations; and - conducting energy audits to minimise energy use and operating at optimum energy levels.	• The Department has recommended conditions requiring Wollongong Coal to prepare an Air Quality & Greenhouse Gas Management Plan.
Waste	• The EA includes a detailed assessment of the nature and volume of construction and operational waste streams predicted to be generated. • Wollongong Coal has committed to continuing to implement a hierarchical waste management system which focuses on avoidance, reduction, reuse and recycling of waste streams.	• The Department has recommended conditions requiring Wollongong Coal to minimise, monitor and manage waste generated, including any coal rejects.
Emplacement Area	• One of the issues raised in the PAC's Public Meeting and in submissions for MOD 2 was concerns about the sites emplacement area, which is located immediately to the north of the pit top area (see **Figure 3**). • Concerns included dust generation from exposed surfaces and the water quality in the Hicks Street gully which drains the emplacement area. Similar concerns have been previously raised directly with the Department. • The emplacement area is outside of the project boundary for the UEP and is subject to a separate development application (D89/839) issued by Council in 1990. Wollongong Coal has confirmed that it has no intention of using this area under the UEP approval, but would continue to use it to emplace minor quantities of stone and other reject material under the existing Council consent. • Wollongong Coal has confirmed that the emplacement area is subject to the same EPL as the pit top area. • The Department notes that the existing air quality monitoring system at the pit top site includes the emplacement area and that no exceedances of air quality criteria have been recorded in the vicinity of the area. • The EPA has confirmed that water discharges from the area meet EPL limits.	• The emplacement area is regulated under a separate DA and EPL and would not be used as part of the UEP.
Rehabilitation	• Long-term rehabilitation objectives for all surface infrastructure sites include the preservation of all items of heritage significance (in accordance with the Heritage Management Plan), removal of non-heritage mine infrastructure and services (including dams, sealing shafts and entrances), maintenance of roads in serviceable conditions, stabilisation of all site benches and slopes and re-vegetation of disturbed areas. • Rehabilitation criteria are proposed consistent with the surrounding land use zonings, with the majority of land being environmental conservation (E2), management zones (E3) and primary production (RU1).	• The Department and DRE are satisfied that the proposed rehabilitation strategy provides an appropriate basis for rehabilitation over both the short (<5 years) and long-term (>5 years). • The Department has recommended that Wollongong Coal is required to prepare a Rehabilitation Management Plan.

7 RECOMMENDED CONDITIONS

The Department has prepared recommended conditions of approval for the project (see **Appendix H**). These conditions are required to:

- prevent, minimise, and/or offset adverse impacts of the project;

- set standards and performance measures for acceptable environmental performance;
- ensure regular monitoring and reporting; and
- provide for the ongoing environmental management of the project.

The Department believes the conditions reflect current best practice for the regulation of underground coal mines in the Southern Coalfield of NSW. Wollongong Coal has reviewed and accepted the recommended conditions. Key agencies, including OEH and EOA, have also been provided with the conditions but are yet to comment.

The Department will further review these conditions following the PAC's merit review.

8 CONCLUSION

The Department has assessed the project application, EA, submissions on the project and Wollongong Coal's PPR/RTS and RMR, in accordance with the objects of the EP&A Act. The Department has also considered its contracted independent expert reviews of the subsidence, surface water and groundwater assessments, as well as the advice of the IESC.

The project involves expanding the existing longwall mining operations further to the northwest across the Wonga East area, to extract 4.7 Mt of ROM coal over a project life of 5 years.

This assessment has concluded that the UEP coal resource is significant based on it being high quality hard coking coal used for steel production, its access to existing mine infrastructure and its close proximity to key regional infrastructure, in particular PKCT.

The project represents a logical extension of existing mining operations at Russell Vale and would make use of existing surface infrastructure and facilities. The project would provide continued economic and social benefits for the Wollongong region and to NSW, including (as stated in the PPR):

- continued direct employment of 219 people and additional direct employment of 81 people during operations;
- direct employment of an additional 100 people during construction;
- indirect employment of up to 1,498 people in the local and regional area;
- $85 million in capital investment during construction ($18 million) and operation ($67 million);
- $34 million to the State in royalty revenue; and
- $110 million to the Commonwealth in tax revenue.

With regard to the potential amenity impacts of the project, the assessment concludes that the noise and air quality impacts on surrounding residences have decreased substantially from historic levels and that, under the UEP, they would further decrease compared to the current situation. This is due to an extensive range of mitigation and management measures that have been, and would continue to be, implemented at the pit top surface facilities.

The assessment also concludes that, despite additional coal trucks being required to haul coal from the site to PKCT, the performance of key intersections and carriageways along the haul route would remain at acceptable levels and the predicted increase in traffic noise levels along the route would be negligible.

In relation to upland swamps, the Department accepts that Wollongong Coal has made major changes to its original project to avoid a significant number of upland swamps and accepts that it is not possible to economically lay out the remaining longwall panels to avoid all swamps. It is generally agreed that predicting impacts on swamps is complex, particularly in relation to changes brought about by multi-seam mining, and that it is still unclear how sensitive swamps are to mining subsidence. The Department accepts that up to 8 swamps may experience greater than negligible environmental consequences as a result of subsidence-related impacts. The Department has recommended that Wollongong Coal is required to offset any impacts to swamps that are greater than negligible.

In addition, the Department has recommended that Wollongong Coal be required to prepare and implement a comprehensive Upland Swamp Monitoring Program to provide baseline information and to determine with certainty whether swamp performance measures are being met and triggers for the provision of offsets are appropriately set and monitored.

The Department is satisfied that the potential for loss of surface water baseflows as a result of mining associated with the UEP is minor and would not result in any significant environmental consequences on

Cataract Creek or the stored waters of Cataract Reservoir. Similarly, the Department is satisfied that the proposed mining within the UEP area can be managed such that it would not result in any significant impacts on groundwater resources. Water extracted from the coal seam and any minor loss of surface flows or baseflow can be licensed under the *Water Management Act 2000* and Wollongong Coal should have no trouble securing the necessary water access licences.

Large storm events and the existing constraints of the stormwater management system at Russell Vale together have the potential to lead to significant flooding impacts along Bellambi Gully and further downstream in Bellambi Creek. To mitigate this risk, it is proposed that Wollongong Coal is required to implement significant works in accordance with the recommendations of its revised Bellambi Gully Flood Study.

Based on its assessment, the Department is satisfied that Wollongong Coal has designed the project in a manner that achieves an appropriate balance between maximising recovery of coal resources and minimising potential impacts on the environment, while further reducing impacts on neighbouring residents.

The Department has drafted a detailed set of conditions to ensure that the project complies with applicable criteria and standards, and to ensure that the predicted residual impacts are effectively minimised, mitigated and/or compensated for. The Department believes these conditions reflect current best practice for the regulation of underground coal mining projects in NSW, particularly the Southern Coalfield.

On balance, the Department believes that the project's benefits outweigh its residual impacts that it is in the public interest and should be approved, subject to stringent conditions.

9 RECOMMENDATION

It is RECOMMENDED that the Planning Assessment Commission exercise the powers and functions delegated to it in the Minister for Planning's Instrument of Delegation, dated 10 November 2014, and:

- **considers** the findings and recommendations of this report;
- **approves** the project application, subject to conditions; and
- **signs** the attached instrument of approval (**Appendix I**).

Howard Reed
Manager
Mining Projects 10·12·14

10/12/14

David Kitto
A/ Executive Director
Resource Assessments

Marcus Ray
Acting Deputy Secretary
Planning Services 11/12/14

APPENDIX A – ENVIRONMENTAL ASSESSMENT

APPENDIX B – PREFERRED PROJECT REPORT / RESPONSE TO SUBMISSIONS

See the Department's website links at:

http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=3448

APPENDIX C – CONSIDERATION OF EPIS

SEPP (Major Development) 2005

The UEP is a 'transitional Part 3A project' under schedule 6A of the EP&A Act to which repealed provisions of *State Environmental Planning Policy (Major Development) 2005* (Major Development SEPP) continue to apply as in force at the time of repeal. The project is identified for assessment under Part 3A by clause 5, schedule 1 of the Major Development SEPP and requires the Minister's approval under section 75D of the EP&A Act.

SEPP (Mining, Petroleum Production and Extractive Industries) 2007

The *State Environmental Planning Policy (Mining, Petroleum and Extractive Industries) 2007* (Mining SEPP), makes underground mining permissible with development consent on any land (clause 7(1)(a)) and requires the 'consent authority' to consider the following:

1. compatibility of the proposal with other land uses;
2. natural resource management and environmental management;
3. resource recovery;
4. road transport; and
5. rehabilitation.

Since the application was made, the Mining SEPP has been amended to require the principal consideration in determining whether to grant consent under this part to an additional consideration; the significance of the resource.

Whilst none of these provisions of the Mining SEPP strictly apply to the UEP (because it is a transitional Part 3A project and there is no 'consent authority' as such), consistent with long-standing practice, the Department has considered these matters in its assessment of the merits of the proposal.

The Russell Vale UEP is considered to be a relatively significant coal resource as it is a major source of high quality hard coking coal used in the production of steel, its significant size (around 4.7 Mt), its strategic location in close proximity to key regional infrastructure, in particular PKCT and because it forms an extension of the existing Russell Vale underground mine and would utilise the site's existing infrastructure. The UEP would contribute $85 million of additional capital investment in the Wollongong LGA and $34 million to the State through royalties. Finally, it would result in a range of significant beneficial social and economic impacts, including the continued direct employment of 300 employees and estimated indirect employment of 1,498 additional people beyond mid-2015. More than half of the direct employees reside in the Wollongong LGA and the majority (90%) reside in the Illawarra Region.

The Department has fully considered all other matters listed under Part 3 in its merit assessment (see **Section 6** above). Having considered these matters in detail, the Department is generally satisfied that the proposed development should be approved subject to conditions aimed at ensuring that the development is undertaken in an environmentally responsible manner.

SEPP (Sydney Drinking Water Catchment) 2011

This SEPP applies to land within Sydney's drinking water catchment and aims to provide healthy water catchments whilst permitting development compatible with this goal. The SEPP also limits a consent authority from granting consent to proposed development under Part 4 unless it would have a neutral or beneficial effect on water quality. Although this requirement does not specifically apply to an application under Part 3A of the EP&A Act, a detailed assessment of the impacts of the development on surface and groundwater together with a consideration of submissions received from relevant agencies including SCA, DSC and NOW and relevant reports in the EA, PPR/RTS and RMR is provided in this report. From this detailed assessment, the Department is satisfied that:

- the potential for loss of surface water base flows as a result of mining would be minor and not result in any significant environmental consequences on Cataract Creek or any negative impacts on the water quality of the stored waters within Cataract Reservoir (which is part of Sydney's drinking water supply);
- proposed mining can be managed to avoid significant impacts on groundwater resources; and
- monitoring and management of water quality and potential for groundwater depressurisation would occur in accordance with a comprehensive Water Management Plan prepared in consultation with relevant government agencies.

The Department is therefore satisfied that the project is generally consistent with the aims and objectives of *SEPP (Sydney Drinking Water Catchment) 2011*.

SEPP (Infrastructure) 2007

State Environmental Planning Policy (Infrastructure) 2007 (Infrastructure SEPP) aims to facilitate the efficient delivery of infrastructure across the State through several means including the identification of matters to be considered in the assessment of development adjacent to infrastructure. The Department is satisfied that subsidence impacts on the nearby electricity transmission towers caused by the mining of LW 1 - 3 could be appropriately monitored and managed in consultation with the asset owner and government agencies as part of a Built Features Management Plan within the Extraction Plan.

In accordance with clause 104 of the Infrastructure SEPP, the application was referred to the RMS and no concerns were raised (see **Section 5**).

SEPP No. 33 – Hazardous and Offensive Development

This SEPP governs the assessment of development for the purpose of a 'potentially hazardous industry' or 'potentially offensive industry'. Hazardous materials would be managed in accordance with the mine's existing management practices and updated where new procedures do not exist for a work activity.

SEPP No. 44 – Koala Habitat Protection

This SEPP requires the consideration of the presence of any core or potential Koala habitat. Wollongong and Wollondilly LGAs are listed as an area to which this SEPP applies. The PPR/RTS includes a detailed fauna assessment which found that there are no Koalas in the assessment area above proposed mining. However, there is potential Koala habitat within the assessment area due to the presence of feed tree species. SEPP 44 does not prevent development from occurring in areas of potential Koala habitat. Whilst the PPR does not provide further impact assessment, the EA notes the potential for trees to lean off-axis, and experience strain to root systems possibly leading to tree fall as a result of subsidence effects of tilt and strain. The EA stated that isolated tree falls would have a negligible impact on vegetation community composition. The Department accepts that the proposal would have a negligible impact to potential Koala habitat, and consequently the project is consistent with the aims, objectives and requirements of SEPP 44.

Illawarra Regional Environmental Plan No. 1

The Illawarra Regional Environmental Plan No 1 (Illawarra REP) became a deemed SEPP on 1 July 2009. Part 4 of the Illawarra REP applies to coal mining and includes objectives to avoid sterilisation of coal resources, eliminate road haulage of coal, and minimise impacts associated with coal washing. An assessment of the potential to eliminate haulage of coal on public roads found that it was not practical given the lack of available alternative infrastructure. Coal washing is not currently undertaken at Russell Vale.

Part 12 of the Illawarra REP applies to development on the Illawarra Escarpment and includes the objective of protecting the natural environment and scenic amenity of the escarpment area, while accommodating the needs of the coal industry. Part 15 requires a consideration of the impacts of development on heritage features. The Department is satisfied that the project would not result in an unacceptable impact on the escarpment area or to heritage features.

Wollongong Local Environmental Plan (LEP) 2009 and Wollondilly Local Environmental Plan (LEP) 2011

Identification of land use zonings, permissibility of the UEP and consistency with the objectives of the relevant land use zones under the Wollongong LEP 2009 and the Wollondilly LEP 2011 is discussed in **Section 4.2** of this report.

APPENDIX D – FULL COPY OF SUBMISSIONS

APPENDIX E – RESIDUAL MATTERS REPORT

See the Department's website links at:

http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=3448

APPENDIX F – ADDITIONAL INFORMATION RECEIVED

- *Bellambi Gully Flood Study* (27 August 2014) undertaken by Cardno;
- letter report from Wollongong Coal Ltd to the Department providing additional information in relation to total groundwater inflow; and
- *Noise Impact Assessment* (September 2014) undertaken by Wilkinson Murray.

APPENDIX G – IESC ADVICE AND WOLLONGONG COAL'S RESPONSE

APPENDIX H – EXPERT REVIEWS

See the Department's website links at:

http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=3448

APPENDIX I – INSTRUMENT OF APPROVAL

Wollongong Coal Limited

Bellambi Gully Flood Study

NA82014089

Prepared for
Wollongong Coal Limited

27 August 2014

WOLLONGONG COAL

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Shaping the Future

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Appendices

1 Introduction

1.1 Background

Wollongong Coal Limited (WCL) has engaged Cardno (NSW/ACT) Pty Ltd to undertake a flood study for Bellambi Gully to determine the existing flood conditions at the Russell Vale Colliery site and recommend potential flood mitigation measures.

A hydrological assessment of the site was previously carried out in 2009 by BECA. The main outcome of the study suggests that stormwater conveyance through the site may be improved through diversion of flows from Bellambi Gully around coal stockpile areas. Maintenance measures were also recommended as methods to improve the conveyance of the existing channel and minimise the likelihood of failure.

This study aims to present alternative mitigation measures for WCL to undertake in order to reduce flooding impacts downstream of the site, particularly those associated with coal stockpile washouts as a result of flooding.

1.1.1 Site Description

The Russell Vale Colliery site is located within the Southern Coalfields Region of NSW. The site is approximately 8 km north of Wollongong and 70 km south of Sydney and lies within the local government areas (LGAs) of Wollongong and Wollondilly in the Illawarra region.

The Russell Vale Colliery site is located on the lower slopes and foothills of the Illawarra Escarpment. The vicinity surrounding the site to the north, south and east is mainly comprised of residential properties of Russell Vale, Bellambi and Corrimal respectively. The Russell Vale golf course is situated to the north of the site. The west and east of the site is directly bounded by the Woronora Plateau and Princes Highway respectively.

The site study area includes the Illawarra Escarpment and extends towards the Bellambi Creek approximately 250m west of the Princes Highway.

1.1.2 Bellambi Gully

The total Bellambi Gully catchment area is 427 ha and the total creek length is 4.3km. Runoff originating from the Illawarra Escarpment flows down the heavily vegetated steep slopes of the escarpment to the Russell Vale Colliery site at the foothills, where it enters the Bellambi Gully watercourse. Some reaches of the watercourse are conveyed by pipes and constructed channels within the site.

The main Bellambi Gully watercourse within the site connects to an 1800 mm diameter clean-water pipeline (approx. 660 m in length) before discharging into Bellambi Creek. Another 600 mm diameter pipe collects a fraction of the upstream stormwater runoff and also connects to the 1800 mm diameter clean-water pipeline. The site stormwater captured by the pipe bypasses the main stockpile area, and discharges to the licensed discharge point (LDP2) into Bellambi Creek approximately 250 m to the west of the Princes Highway.

Bellambi Creek flows underneath the Princes Highway via a 2.4 m W x 1.5 m H box culvert. Flows are conveyed via a number of culvert structures under roads and rail ultimately discharging at Bellambi Beach. The length of the creek from the colliery discharge point to the ocean outfall is approximately 3 km.

1.2 Scope of Work

The scope of work consists of the following:

> Review existing flood studies relevant to the catchment;

> Compile and review topographic survey and ALS information of the study area and develop a Digital Terrain Model (DTM);

> Identify sub-catchments and peak flows derived in previous flood studies (5, 10 and 100 year ARI from BECA 2009);

> Develop a 1D flood model (configure parameters, baseline conditions and incorporate existing culvert structures) and simulate to establish existing conditions;

> Identify key areas to be addressed based on flood modelling results;

> Identify opportunities for flood mitigation such as vegetation management, channel / culvert upgrades etc. with consideration of site constraints; and

> Incorporate alternative flood mitigation measures and quantify improvements to flooding/ conveyance.

2 Available Data

2.1 Previous Studies

2.1.1 Combined Catchments of Whartons, Collins and Farrahars Creeks, Bellambi Gully and Bellambi Lake Flood Study (Lyall & Associates Consulting Water Engineers, 2011)

The flood study combines the Whartons, Collins and Farrahars Creeks catchment area along with the Bellambi Gully and Bellambi Lake catchments. The flood study is referred to as the Combined FS in this report.

The study was undertaken to assess and define the flood behaviour within the study area under current conditions. The information obtained from the assessment forms the basis of the Floodplain Risk Management Plan for the study area.

The flood behaviour was assessed using hydrological and hydraulic computer modelling. Sensitivity analyses were also carried out to verify the parameters adopted and assumptions made in the development of the hydraulic model. The flood information obtained from the analysis was presented in terms of flows, levels and velocities ranges between the 5 to 500 year Average Recurrence Interval (ARI) storm events including the Probable Maximum Flood (PMF).

2.1.2 Water Management Report No.1 Colliery Russell Vale (BECA, 2010)

A Water Management Report for the operation of Wollongong Coal Limited (previously known as Gujarat NRE), No.1 Colliery at Russell Vale was prepared by BECA in 2010. The information presented in the report includes the current and future water management at the Russell Vale and Shaft No. 4 sites, water balance for the Russell Vale site, the collection and treatment of mine water and dirty storm water, the quantity and quality of water discharged to Bellambi Gully as well as the impacts in terms of water quality discharged to Bellambi Gully.

The report recommends further investigation of water treatment and reuse on site, including the management of solids from the water treatment plant site and also recommends improving the stormwater conveyance across the site to reduce the risk of failure to the current system.

2.1.3 Gujarat NRE Stormwater Hydrology Review (BECA, 2009)

A hydrological investigation of the clean stormwater system at the Russell Vale mine site was undertaken by BECA. The stormwater system on site was deemed inadequate following the 1998 flood event which resulted in large quantities of runoff diverting through the existing coal stockpile originating from the steep escarpment slopes.

The objective of the assessment was to review the existing stormwater system, identify inefficiencies in the system and propose measures and potential upgrades to the current system to reduce the likelihood of future failures.

The proposed measures include the maintenance and upgrade of existing diversion channels and flowpaths, the construction of open channels and diversion drains around the proposed stockpile area, and the maintenance and implementation of scour protection devices in areas susceptible to erosion. Some of the recommended measures suggested have since been undertaken on site.

The hydrological investigation report produced from this assessment was included in the appendix of the Water Management Report (BECA, 2010).

2.2 Survey

2.2.1 Detailed Site Survey

A detailed site survey was undertaken in 2010 by Wollongong Coal Limited (WCL) and provided in **Appendix A**. The survey includes the escarpment to the west and extends towards Princes Highway to the east of the WCL Russell Vale Colliery site.

2.2.2 Aerial Laser Survey (ALS) Data

The ALS data tile W3066194 collected by AAM between May 2005 and October 2006 was used to define catchment boundaries and to represent the existing surface beyond the extent of the detailed site survey.

An updated laser survey of the site, collected in May 2014 was used to better define the current site topography specifically through the stockpile area. This survey was used to model the existing site conditions in the hydraulic analysis.

3 Hydrological Data

3.1 Sub-Catchment Topology

Sub-catchments delineated from the previous study by BECA (2009) were based on the proposed scenario catchments (**Appendix A**). As such, peak flows derived from the previous study were re-assessed and delineated based on the detailed site survey and ALS data to represent the existing conditions on site. Stormwater runoff from the north western sub-catchments discharges towards the north while the remaining sub-catchments discharge towards the stormwater systems. The stormwater systems are separated into the dirty water (DW) and clean water (CW) systems.

The two stormwater systems are as follows:

1. DW – runoff primarily from the stockpile area and along the conveyor portal are directed to the dirty water stormwater system to be treated before discharging into Bellambi Creek.

2. CW – runoff through the southern extent of the site flows through the natural Bellambi Gully watercourse before connecting to the 1800 mm diameter main stormwater pipeline. Runoff generated through the centre and along the northern access road falls towards the stockpile area where it enters a 600 mm diameter pipe. The pipe then connects to the 1800mm diameter main stormwater pipeline. The main stormwater pipeline is 660 m long and conveys the upstream runoff towards the Bellambi Creek licensed discharge point (LDP2), approximately 250 m upstream of Princes Highway.

3.2 Design Storms

Peak flows presented in the BECA report were used as a basis for this assessment (review of these flows is beyond the scope of this assessment). Peak flows of the upstream catchments entering the multiple discharge points downstream were determined, and are presented in **Table 3-1**.

Table 3-1 Peak Flows

Catchments (BECA)	Area (ha)	Discharge Location	Adopted Peak Flows (m^3/s)		
			5 year ARI	10 year ARI	100 year ARI
U1	10.69	CW	2.83	3.58	6.39
U2	9.76	CW	2.5	3.13	5.66
U3	8.63	North	2.21	2.77	5
U4	0.5	North	0.226	0.274	0.459
U5	0.4	North	0.189	0.237	0.367
M1	6.12	DW & CW	1.89	2.28	3.92
M2	1.28	North	0.528	0.625	0.995
M3	3.31	CW	0.734	0.923	1.73
M4	0.43	CW	0.149	0.181	0.3
M5	3.34	CW	0.874	1.1	1.98
M6	1.36	CW	0.368	0.47	0.818
M7	1.73	DW	0.654	0.778	1.29
M8	1.78	CW	0.473	0.615	1.09
L1	4.84	CW	0.738	0.951	1.94
L2	12.07	DW	2.84	3.52	6.51

4 Hydraulic Analysis

4.1 Selection of Hydraulic Model

4.1.1 Model Parameters

A HECRAS 1D steady-state hydraulic model was developed for the site, using ALS data and detailed site survey. Runoff generated from the site is conveyed beneath the stockpile area before discharging into Bellambi Creek. As such, the upstream model boundary was established within the stockpile area and extends towards the Bellambi Creek discharge. A plan view of the model is presented in **Appendix B**.

The Manning's n roughness values along the channel were adopted from the Combined FS report (Lyall & Associates, 2011) and are presented in **Table 4-1.**

Table 4-1 Manning's 'n' Roughness Values

Surface Type (Combine FS)	Surface Type (Cardno)	Manning's 'n' Value
Asphalt, river bed or pillowcrete	Roads, stockpile area, creek bed	0.02
Grass or lawns	Grassed areas	0.045
Dense vegetation	Dense vegetated areas	0.135

Building structures within the modelling extents were represented as obstructions. Tailwater levels were adopted from the Collins Creek Flood Study (Lyall & Associates, 2011) and taken immediately downstream of the discharge location within Bellambi Creek. Tailwater levels for the modelled storm events are presented in **Table 4-2**.

Table 4-2 Downstream Tailwater Levels (Bellambi Creek Discharge)

Storm Event	Tailwater Levels
5 year ARI	30 m AHD
10 year ARI	30 m AHD
100 year ARI	30 m AHD

4.1.2 Modelling Approach

Three main pipes located within the stockpile area were identified to receive the DW and CW flows from the upslope catchments. **Table 4-3** presents the pipe capacities, the total flows and the corresponding contributing catchments for the DW and CW pipes in the 5, 10 and 100 year ARI storm events.

The full capacities for the pipes (no blockage assumed) were determined using the Manning's Equation. Flows in excess of the pipe's capacity were modelled as overland flows at the pipe inlets in the 1d hydraulic model.

The 450 mm DW pipe underneath the stockpile area was formerly designed to receive the first flush flow from catchment M1 as well as stormwater flows from catchments L1 and L2. However, based on the information presented in the report by BECA (2009), the maximum flow rate of the DW first flush pipe in catchment M1 is 0.02 m^3/s, which is lower than the 5 year ARI catchment flows. Hence, it was assumed that all the designed flows from M1 bypasses the first flush system and are completely captured by the CW system.

The report also states that flows from catchment M7 should be considered "dirty". Based on the topographical data, it has been confirmed that flows from M7 are currently directed to the 450 mm DW pipe.

Flows from catchments M5, M6 and M8 as well as flows within the north extent of catchments M1 and M3 are directed towards the 600mm CW pipe. The main 1800 mm CW pipe receives flows from the 600 mm CW pipe as well as catchments M4, U1, U2 and the remaining flows within the south extents of catchments M1 and M3.

Table 4-3 Steady State Flows

Pipe Type	Contributing Catchments	Pipe Capacity (m^3/s)	Peak Flow Rate (m^3/s)		
			5 year ARI	10 year ARI	100 year ARI
450 mm DW	M7, L1 and L2.	0.817	4.23	5.25	9.74
600 mm CW	North of M1 and M3. M5, M6 and M8.	1.63	3.03	3.79	6.71
1800 mm CW	M1, M3, M4, M5, M6, M8, U1 and U2.	24.9	9.82	12.28	21.89

Based on the values presented in **Table 4-3**, it can be seen that the 450 mm DW and 600 mm CW pipes do not have sufficient capacity to convey flows exceeding and including the 5 year ARI event. Runoff is generated from the excess flows, causing coal stockpile washout in all modelled scenarios (see **Section 4.1.3** for details of scenarios).

However, the 1800 mm CW pipe has adequate capacity to receive the upstream catchment flows including flows from the 600 mm CW pipe.

4.1.3 Model Scenarios

The model was established based on the three scenarios presented in **Table 4-4**.

Table 4-4 Model Scenarios

Scenario	Details
1	This model is based on the event where the stormwater systems are completely blocked, i.e. catchment flows are entirely conveyed as overland flows.
2	A conservative model is established as the second scenario where a 20% blockage was applied to the receiving stormwater pipes (i.e. CW and DW systems within the stockpile area). Flows exceeding the capacity of the pipes were modelled as overland flows.
3	The third modelled scenario is based on the event where the stormwater systems are fully functional i.e. CW and DW pipes are flowing full. Flows exceeding the capacity of the pipes were modelled as overland flows.

4.2 Modelling Results

Results generated indicate that flooding within the site is significant, and is mainly contained within the stockpile area in all modelled scenarios. Flooding within the site remains significant in the third modelled scenario (i.e. unblocked) although the majority of flows are captured within the stormwater pipes.

Runoff from the stockpile area overtops the access road near the settling ponds and continues as sheet flow downstream towards Bellambi Lane in all modelled scenarios. Overtopping flows conveyed along Bellambi Lane have the potential to convey coal stockpile washouts downstream. Flood modelling results are included in **Appendix B** while the flood extents maps for the modelled scenarios are presented in **Appendix C**.

5 Flood Mitigation

5.1 Proposed Flood Mitigation Measures

Based on the flood assessment results and information gathered from the site inspection, flooding caused by site runoff can be alleviated by optimising the existing structures in addition to implementing upgrades on site.

The key flooding issues identified and the corresponding proposed mitigation measures are presented as follows. The locations of the proposed mitigations are presented in **Appendix D** (refer numbers 1-5).

1. **Raise stockpile area access road, install new culvert and formalize open channel**

   The location where the overflow occurs should be upgraded to prevent coal washout downstream. Flooding can be contained within the site by raising the stockpile area access road and installing a culvert. The culvert would connect to the proposed grass-lined swale on the east side of the stockpile area access road before discharging into Bellambi Creek.

   The proposed culvert would consist of a 2x 1.2 (w) x 1.2 (h) Reinforced Concrete Box Culvert (RCBC), and would cater for 100 year ARI flows under Scenario 2 (i.e. assuming DW and CW pipes presented in **Table 4-3** are 20% blocked).

2. **Debris control structures at the 1800mm pipe inlet and the M3 Culvert**

   The probability of blockage of the 1800 mm pipe, and the M3 culvert (near the conveyor) can be reduced by implementing a Debris Control Structure (DCS) at the respective inlets. Additionally, rehabilitation and opening up of the M3 culvert will further reduce the probability of blockage of the M3 culvert. This would increase the efficiency of the stormwater systems and reduce occurrence of overflows from the natural Bellambi Gully watercourse into the stockpile area.

   The efficiency of the DCS's can be improved by inclusion of a Debris Control Management Procedure (DCMP) in the existing Surface Water Management Plan. The DCMP would include measures to ensure the DCS is maintained regularly with additional maintenance both before predicted storms and after storm events.

3. **Formalisation of the 600 mm clean stormwater**

   The existing 600 mm clean stormwater pipe has a capacity of 1.6 m^3/s (6% slope), which is not sufficient to convey the 100 year ARI catchment runoff (6.7 m^3/s). However, the operation of the pipe inlet can be improved by formalising the swale in the vicinity of the inlet. The swale functions to capture the clean water (CW) flows from the upslope catchments (M5, M6, M8 and north of M1 and M3) and convey it towards the CW pipeline system. Formalisation of the swale will provide sufficient capacity to capture the CW flows and ensure CW does not overtop into the stockpile area.

   A Manning's calculation confirms that upgrading to an 825 mm diameter pipe would convey flows up to the 100 year ARI storm, between the pipe inlet and the 1800 mm pipe. This can be considered as an additional measure, and would likely present challenges in implementation due to the coal stockpiles and existing structures.

4. **Maintenance to existing structures**

   It was observed in the site inspection that the existing debris control screens (trash racks) were fully blocked with rocks and boulders conveyed from the upstream creek banks.

   Appropriate maintenance should be carried out immediately upstream and downstream of the existing debris control structures within the Bellambi Gully to avoid any blockage of the system. Blockage of these upstream culverts tends to lead to uncontrolled surface flows into the stockpile area.

5. Upgrade through roads

To decrease the amount of clean stormwater runoff entering the stockpile area, culverts may be installed across the access road along the northern boundary of the site to direct flows from the catchment M8 directly towards Bellambi Creek.

This option is considered as an alternative and can decrease runoff conveyed towards the existing 600 mm CW pipe, which has a limited capacity (as discussed in Option 3).

5.2 Discussion

5.2.1 Blockage

Mitigation Option 2 proposes the design and construction of debris control structures at the M3 culvert (near the conveyor) and the 1800 mm diameter culvert. According to Council's blockage policy, both culverts should be considered blocked for the 100 year ARI flood event. The implication of assuming these culverts as blocked is that clean water would be diverted from the existing watercourse, down the conveyor portal and through the coal stockpile before being discharged into Bellambi Creek (see **Table 4-3** for culvert capacity and 100 year ARI flows from contributing catchments). However, if the inlets are rehabilitated and an additional DCS constructed and maintained as part of a DCMP, it is considered likely that the culverts will remain relatively free of debris. In this case, culverts have been modelled as 20% blocked to remain conservative.

If both culverts are assumed as 20% blocked (i.e. 1800 mm pipe and M3 culvert), results indicate that they achieve adequate conveyance in the 100 year ARI storm. In this scenario, clean-water flows would avoid the coal stockpile area, reducing the potential for pollution of the downstream watercourse.

However, should a 100% blockage policy be adopted (for culverts less than 6m clear span), additional flows would be conveyed to the culvert beneath the stockpile area access road (i.e. flows not diverted by the 1800 mm pipe beneath the stockpile area). In this case, a 6m clear span box culvert would likely be sufficient to convey all site flows (and mitigate overtopping onto Bellambi Lane).

5.2.2 Water Quality

Water quality requirements are beyond the scope of this report. Notwithstanding, given the importance of runoff water quality leaving the site (and that water quality issues are somewhat connected to flooding issues in this case), this section has been compiled to provide a preliminary discussion of the potential water quality implications resulting from the proposed flood mitigation methodology.

A 6ML dry sediment basin near the proximity of the stockpile access road as proposed in Appendix C (Stormwater Hydrology Review) of the Water Management Report (BECA, 2010) is currently being assessed. The Stormwater Hydrology Review (BECA, 2009) advises that all existing and proposed dirty water from the site up to the 10 year ARI event should be directed into the dry sediment basin for treatment before discharging through the licensed discharge point (LDPs) at Bellambi Creek.

It is noted that some site discharge will still flow through the coal stockpiles even in the 20% blockage scenario. Based on the previous submission, the sizing and assessment of this basin has been based on hydrographs for the entire stockpile area and the requirement to contain all storms up to and including a 10 year ARI event. However, further investigations will be required to confirm that the basin size will be adequate to treat excess flows not captured by the 20% blocked dirty and clean stormwater pipes within the stockpile area.

5.2.3 Earthworks

The embankment upstream of the proposed culvert should be excavated to allow unrestricted conveyance towards the structure. Additionally, the embankment downstream of the culvert will have to be excavated for the construction of the swale. Further modelling and surface design should be undertaken in subsequent design phases. We also recommend detailed survey of the current site be undertaken prior to any design works.

5.3 Hydraulic Modelling of the Proposed Scenario

The proposed RCBC and grass lined swale discussed for mitigation Option 1 (refer Section 5.1) was modelled using HECRAS. A 20% blockage was applied to the existing pipes upstream of culvert (as mentioned in Section 5.2.1).

5.3.1 Modelling Results

The results of this assessment demonstrate that the proposed culvert under the stockpile area access road is adequate to convey the excess overland flows (flows not captured by the pipes with 20% blockage applied) from the site, for flows up to the 100 year ARI flood event. The dimensions for the proposed grass lined swale to adequately convey the 100 year ARI flows has 1V:3H side walls with a 5m base width. Flood modelling results demonstrate that the proposed measures are effective in eliminating flooding on Bellambi Lane. The flood extents map is presented in **Appendix F**.

5.3.2 Discussion

It was proposed in the Stormwater Hydrology Review report (BECA, 2009) that the clean water system be diverted around the stockpile area through a proposed diversion channel. Implementation would require that diversion drains, land grading, bunds and road crests be constructed within the steep batters and access roads within the upstream catchments to ensure that all clean water flows be directed towards the proposed diversion channel. Reno mattresses and drop structures using gabion basket within catchments M1, M3, M5 and M6 were also proposed to improve the efficiency of the stormwater conveyance through the site. Implementation of the proposed measures would require annual inspections and ongoing maintenance to the existing and proposed structures. Geotechnical assessment would be required to determine the stability of the proposed channel realignment area prior to any detailed design works. Given the significant capital and maintenance costs associated with this approach, the potential for alternative approaches have been explored in this report.

Based on the assessments undertaken, it was demonstrated that the existing stormwater system is adequate for managing flows on site (except the capacity of the 600 mm CW pipe); on the condition that maintenance is undertaken regularly. As such, the alternative measures explored were focused on providing effective structures through optimising the existing stormwater systems on site.

The alternative approach chosen for the site, i.e. upgrading the stockpile access road at the location where the overland flows occur; will be subject to the implementation of debris control structures at the inlet of the culverts upstream, formalisation of the swale at the 600 mm clean stormwater pipe inlet and also upgrading the 600 mm to a 825 mm diameter pipe. These options will also require maintenance to be carried out regularly to ensure blockage is continually minimised through the system.

The alternative measures are more effective than the measures proposed by BECA (2009) in terms of managing flood flows on site as the existing flow conveyance; specifically through the steep batters, natural slopes and stockpile area are maintained. Maintaining the existing structures and flow conveyance on site will reduce the margin of error during construction and provide an effective final design of the proposed structures. Additionally, as less implementation works will be required, the alternative options are considered more cost efficient than the measures proposed in the Stormwater Hydrology Review (BECA, 2009).

6 Conclusions

The following can be concluded from the Bellambi Gully flood assessment:

1. Runoff generated within the site is currently conveyed under the stockpile area before discharging into Bellambi Creek.
2. Three scenarios were modelled to assess flooding throughout the site. The models represent events where the stormwater pipes are completely blocked, 20% blocked and fully operational.
3. Results indicate that flooding within the site is significant in all modelled scenarios; however overland flows are mainly contained within the stockpile area in all modelled storm events.
4. Modelling results indicate that overland flows currently overtop the access road and continue as sheet flow downstream towards Bellambi Lane in all modelled scenarios.
5. The proposed mitigation measures are aimed to reduce clean runoff entering the stockpile area, while conveying all site runoff in a controlled way to Bellambi Creek.
6. Mitigation measures suggested for the site are as follows:
    - Raising the stockpile area access road and installing new culverts to convey the site runoff across the access road, into a proposed grass-lined swale before discharging into Bellambi Creek.
    - Implementing a debris control structure at the 1800 mm diameter pipe and M3 culvert opening to reduce probability of blockage within the system due to debris from upstream catchment.
    - Formalising the swale in the vicinity of the existing 600 mm clean water inlet. This would provide increased temporary storage for stormwater which helps to manage peak flows from the upstream catchment and to ensure all the clean water runoff is captured before entering the stockpile area.
    - Upgrading the existing 600 mm diameter clean water pipe to an 825 mm diameter pipe should be considered although the other proposed mitigation measures does not rely on this upgrade (and was not modelled in the proposed scenario model).
    - Appropriate maintenance should be carried out immediately upstream and downstream of the existing debris control structures within the Bellambi Gully to minimise the potential for blockage of the system.
    - Culverts may be installed across the access road along the northern boundary of the site to direct flows from catchment M8 directly towards Bellambi Creek, in order to reduce clean water runoff conveyed into the stockpile area.
7. Flood modelling results of the proposed scenario demonstrate that the proposed culvert and swale structures are adequate to convey the 100 year ARI flows and eliminate the flooding on Bellambi Lane.
8. The alternative measures explored in this report were focused on providing effective structures through optimising the existing stormwater systems on site. These are considered more cost efficient than the implementation measures proposed in the Stormwater Hydrology Review (BECA, 2009).
9. The alternative options also propose to maintain the existing flow conveyance through the site. As such, the measures proposed are considered more effective in terms managing flood flows on site, than the measures proposed in the Stormwater Hydrology Review (BECA, 2009).
10. Should a 100% blockage policy be adopted (for culverts less than 6m clear span), additional flows would be conveyed to the culvert beneath the access road (i.e. flows not diverted by the 1800 mm

pipe beneath the stockpile area). In this case, a 6m clear span box culvert would likely be sufficient to convey all site flows (and mitigate overtopping onto Bellambi Lane).

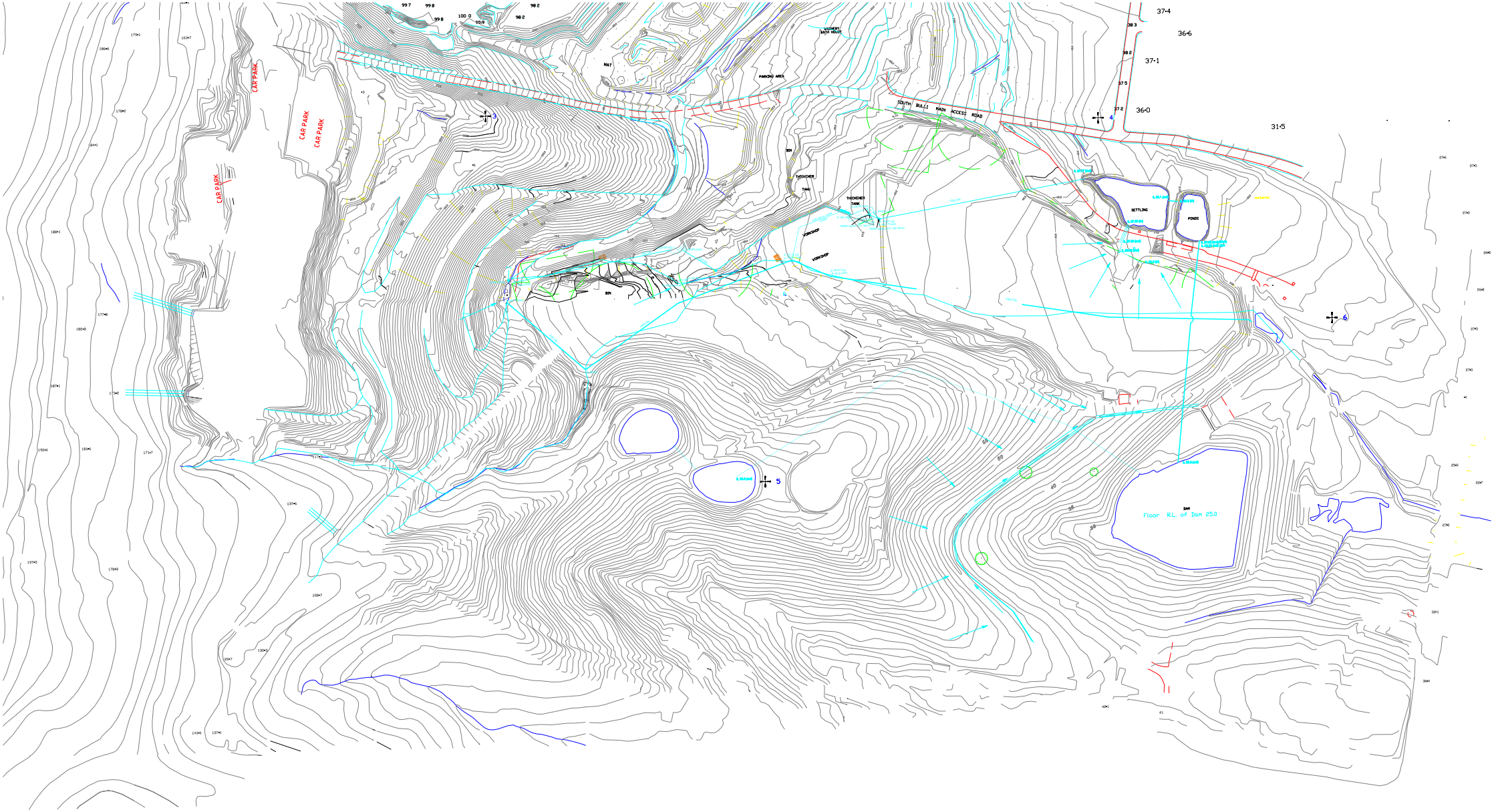
11. Further investigations should be undertaken to confirm that the dry sediment basin proposed in the Stormwater Hydrology Review (BECA, 2009) will be adequate to treat excess flows not captured by the 20% blocked dirty and clean stormwater pipes within the stockpile area before discharging into Bellambi Creek (design of treatment measures to achieve this is beyond the scope of this report).
12. Designs presented in this report are preliminary only. Detailed survey of the current site is required prior to any subsequent design works.
13. Flood mitigation measures presented in this report may provide an alternative to the measures presented in the Stormwater Hydrology Review (BECA, 2009), with the exception of water quality measures (e.g. sediment basin) which have not been considered in this report.

Bellambi Gully Flood Study

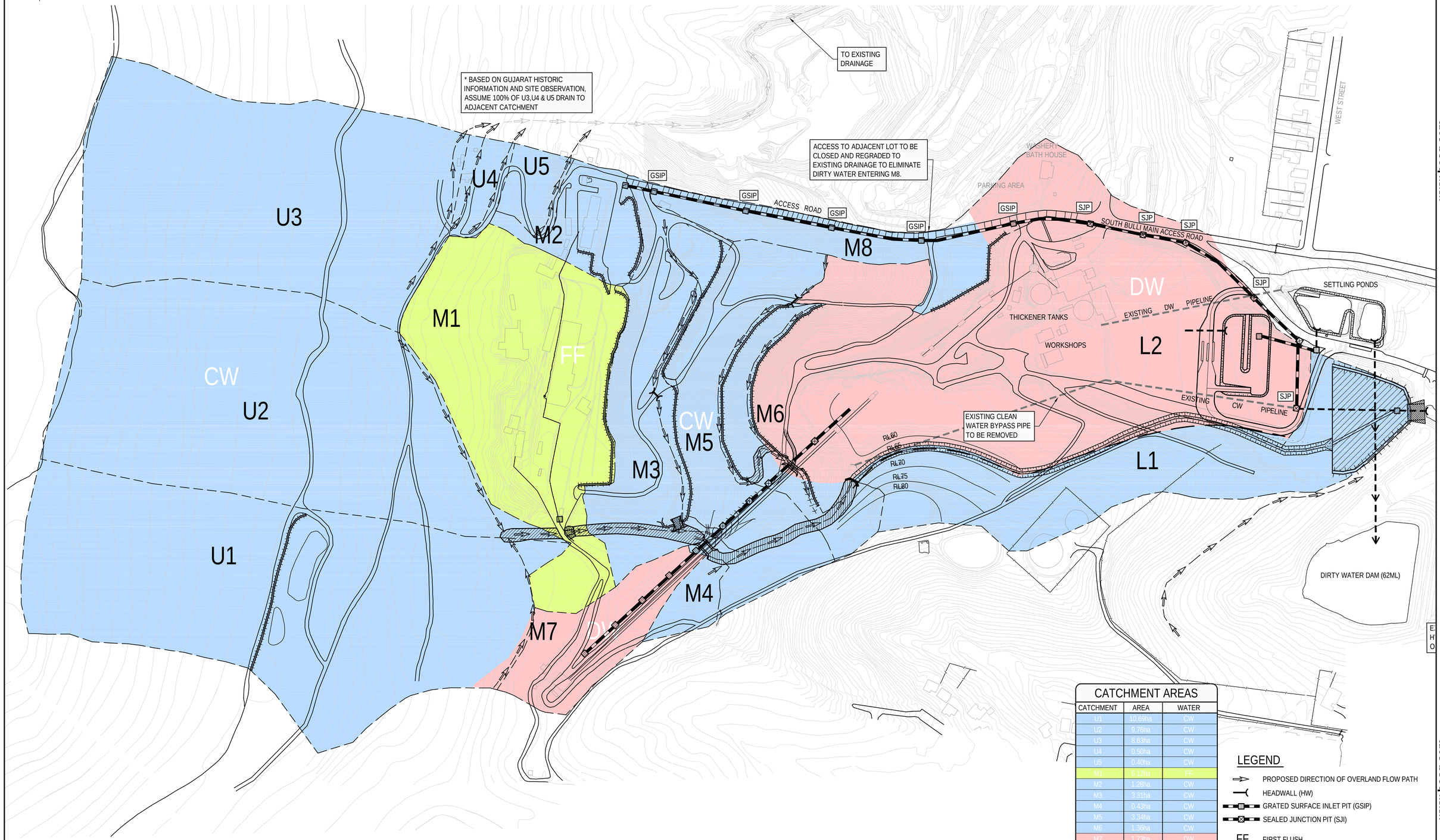
APPENDIX A
AVAILABLE INFORMATION

Cardno
Shaping the Future

Site Survey


CAR PARK
CAR PARK
CAR PARK
CAR PARK
MAIN ACCESS ROAD
SETTLING PONDS
THICKENER TANK
Floor R.L. of Dam 25.0

Drawing Plotted: 04 May 2010 13:51



CATCHMENT AREAS		
CATCHMENT	AREA	WATER
U1	10.69ha	CW
U2	9.76ha	CW
U3	8.63ha	CW
U4	0.50ha	CW
U5	0.40ha	CW
M1	6.12ha	FF
M2	1.28ha	CW
M3	3.31ha	CW
M4	0.43ha	CW
M5	3.34ha	CW
M6	1.36ha	CW
M7	1.73ha	DW
M8	1.12ha	CW
M9	0.66ha	CW
L1	4.84ha	CW
L2	12.07ha	DW

LEGEND

- PROPOSED DIRECTION OF OVERLAND FLOW PATH
- HEADWALL (HW)
- GRATED SURFACE INLET PIT (GSIP)
- SEALED JUNCTION PIT (SJI)
- FF FIRST FLUSH
- CW CLEAN WATER
- DW DIRTY WATER

FOR INFORMATION
NOT FOR CONSTRUCTION

0 1000m
SCALE

No.	Revision	By	Chk	Appd	Date
B	CONCEPT DESIGN - NOT FOR CONSTRUCTION	AS	SM		8/10/09
A	CONCEPT DESIGN - ISSUED FOR REVIEW	SK	SM		23/7/09

Drawing Originator: Beca

Original Scale (A1) 1:2000
Reduced Scale (A3) 1:4000

Design	PI	23/7/09	Approved For Construction*
Drawn	SK	23/7/09	
Dsg Verifier	SM	29/9/09	
Dwg Check			Date

* Refer to Revision 1 for Original Signature

Client: GUJARAT NRE

Project: GUJARAT No. 1 HYDROLOGICAL INVESTIGATION

Title: SITE LAYOUT CLEAN/DIRTY WATER REGIONS

Discipline: CIVIL

Drawing No.: 2591308-C-SK7

Rev.: B

DO NOT SCALE

IF IN DOUBT ASK.

www.beca.com

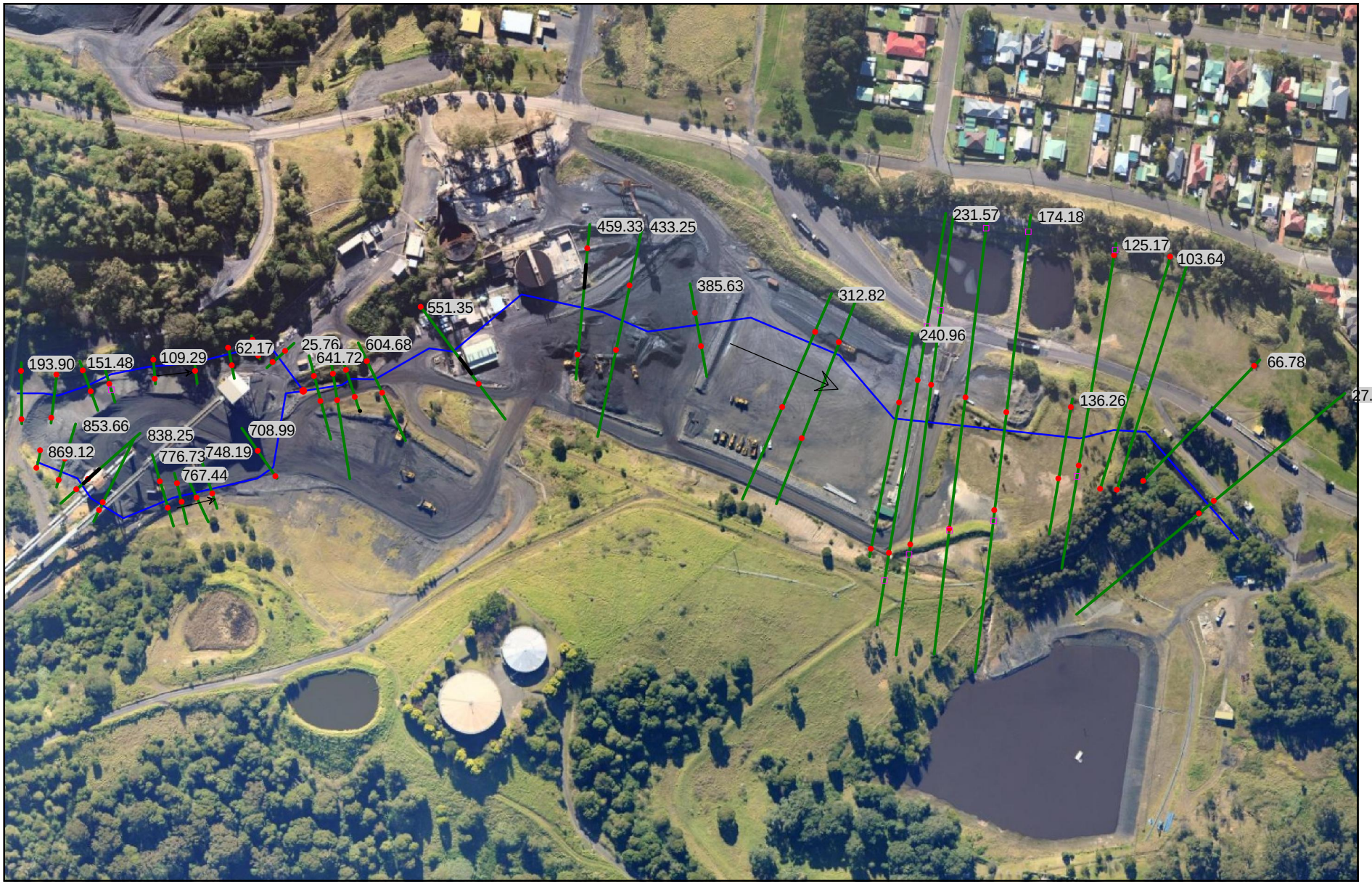
Document No. 2591308-C-SK7.dwg

Bellambi Gully Flood Study

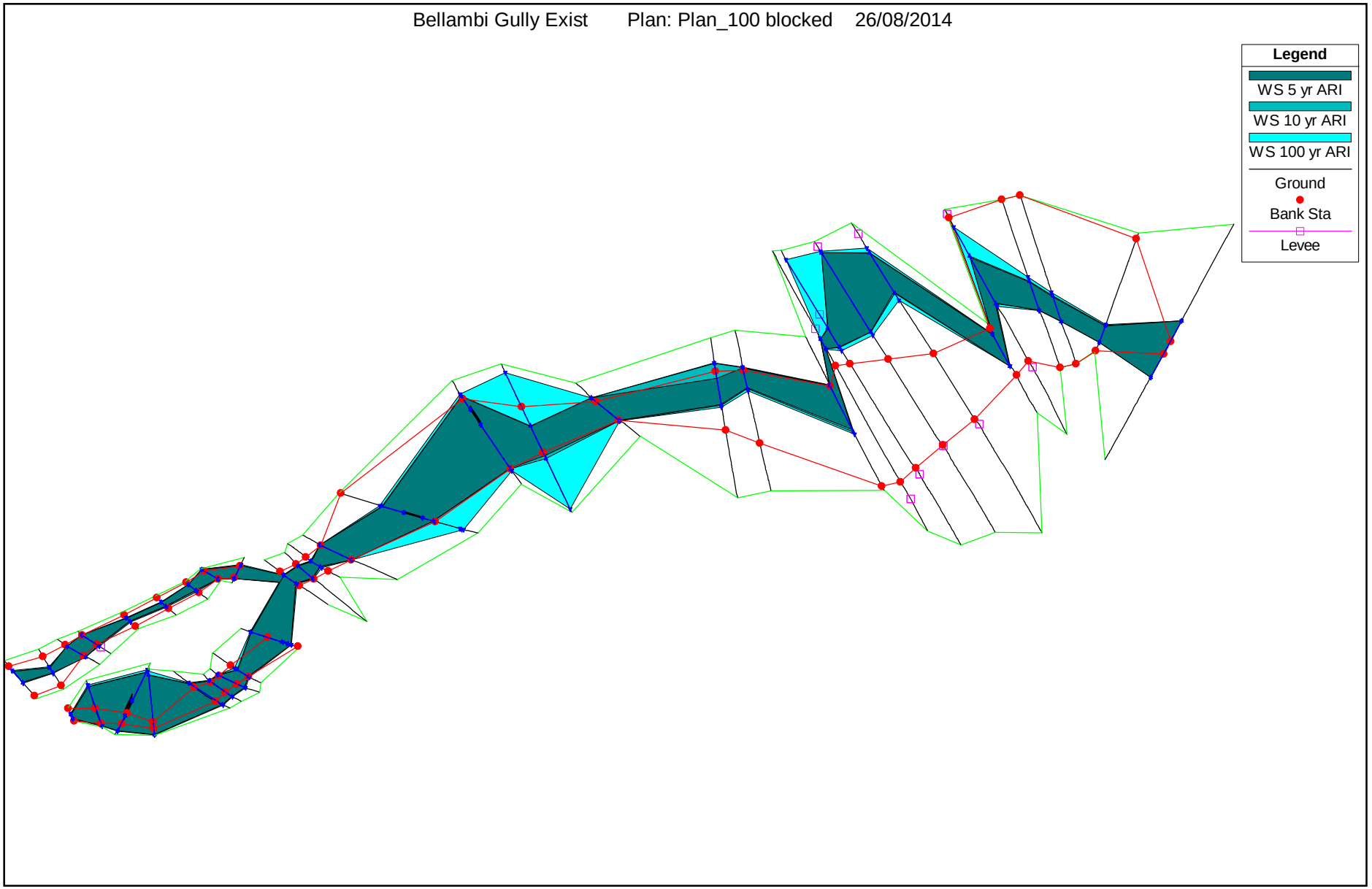
APPENDIX B
EXISTING HYDRAULIC FLOOD MODEL

Cardno
Shaping the Future

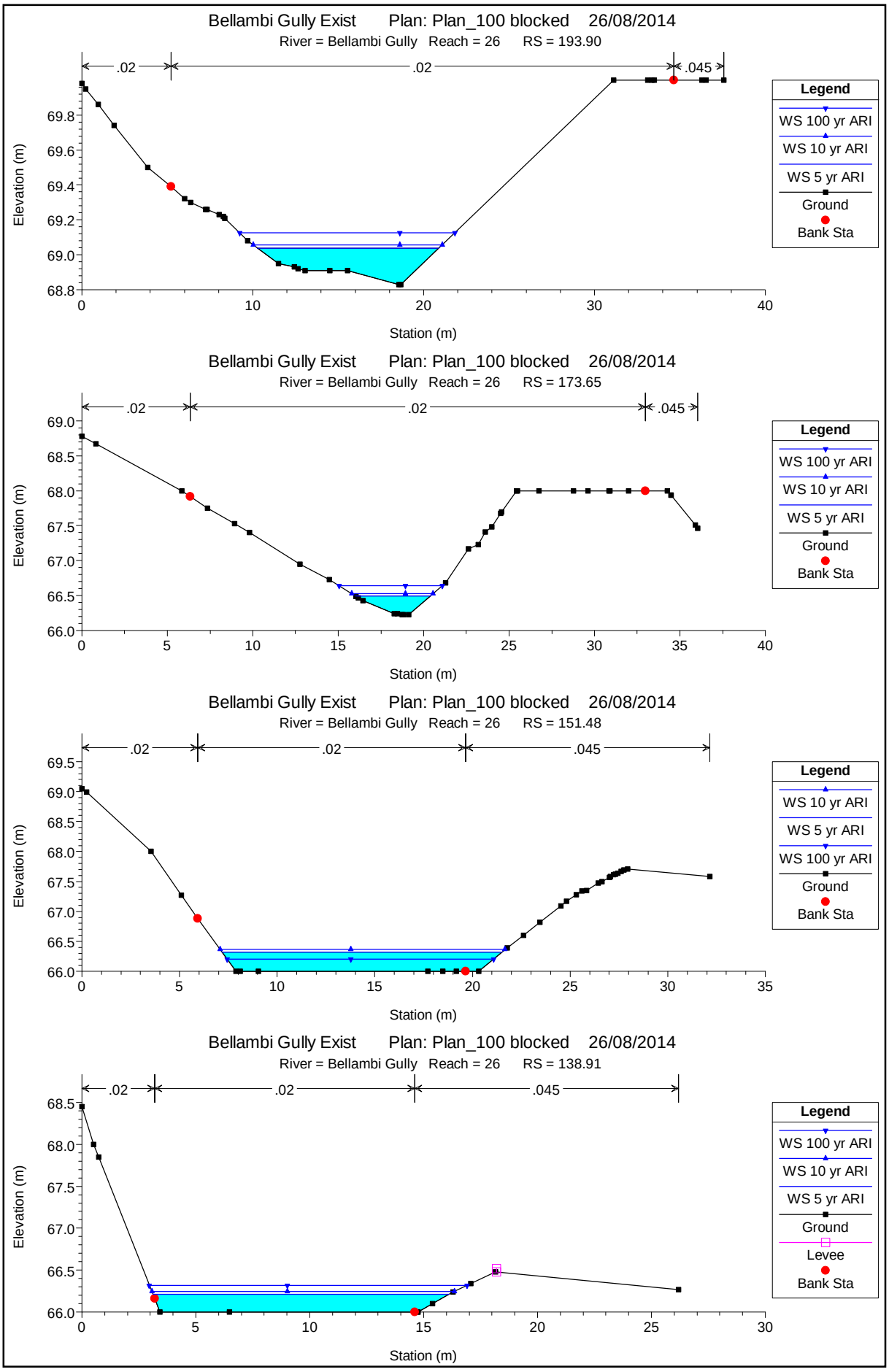
HECRAS Model View

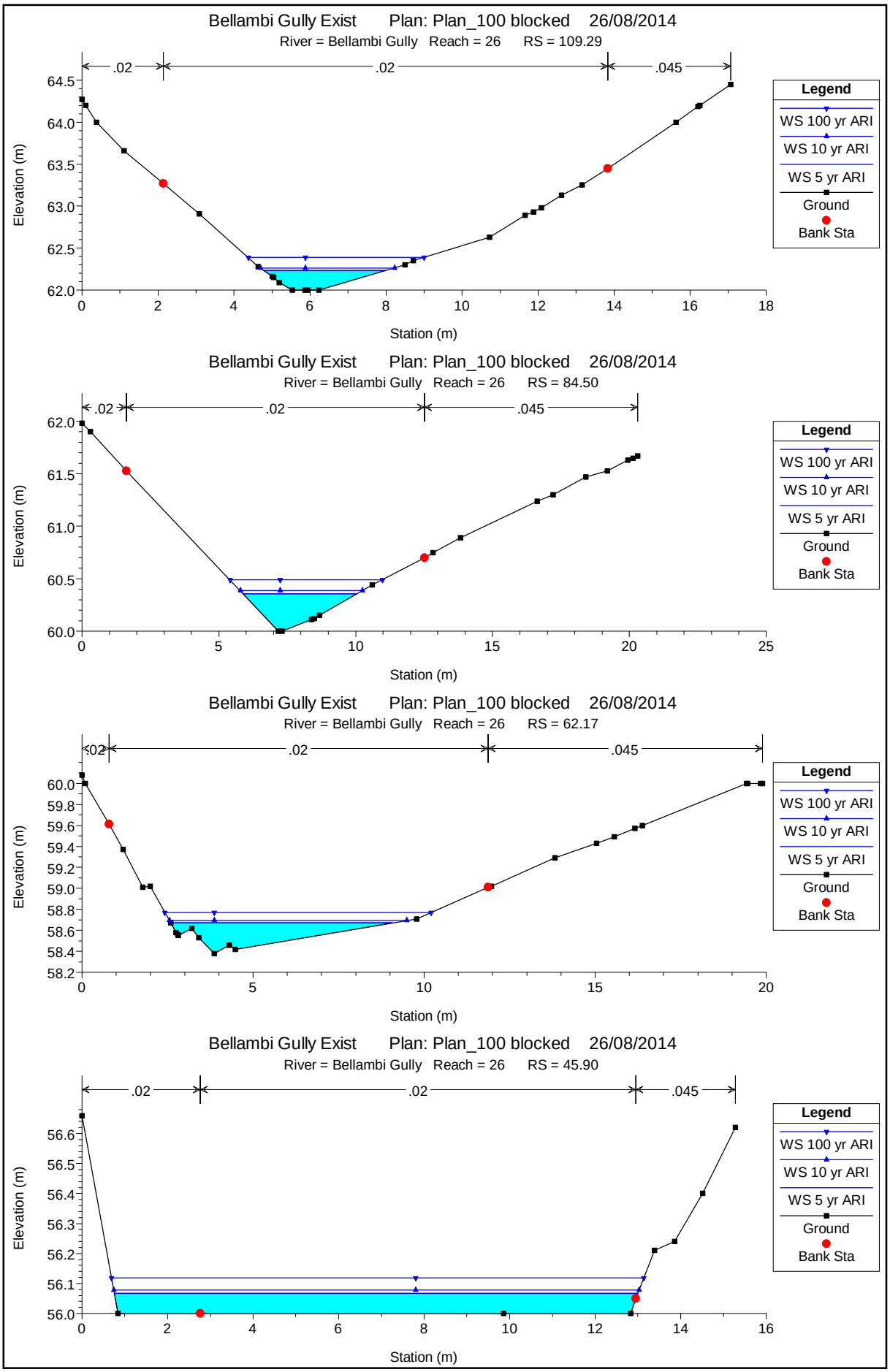


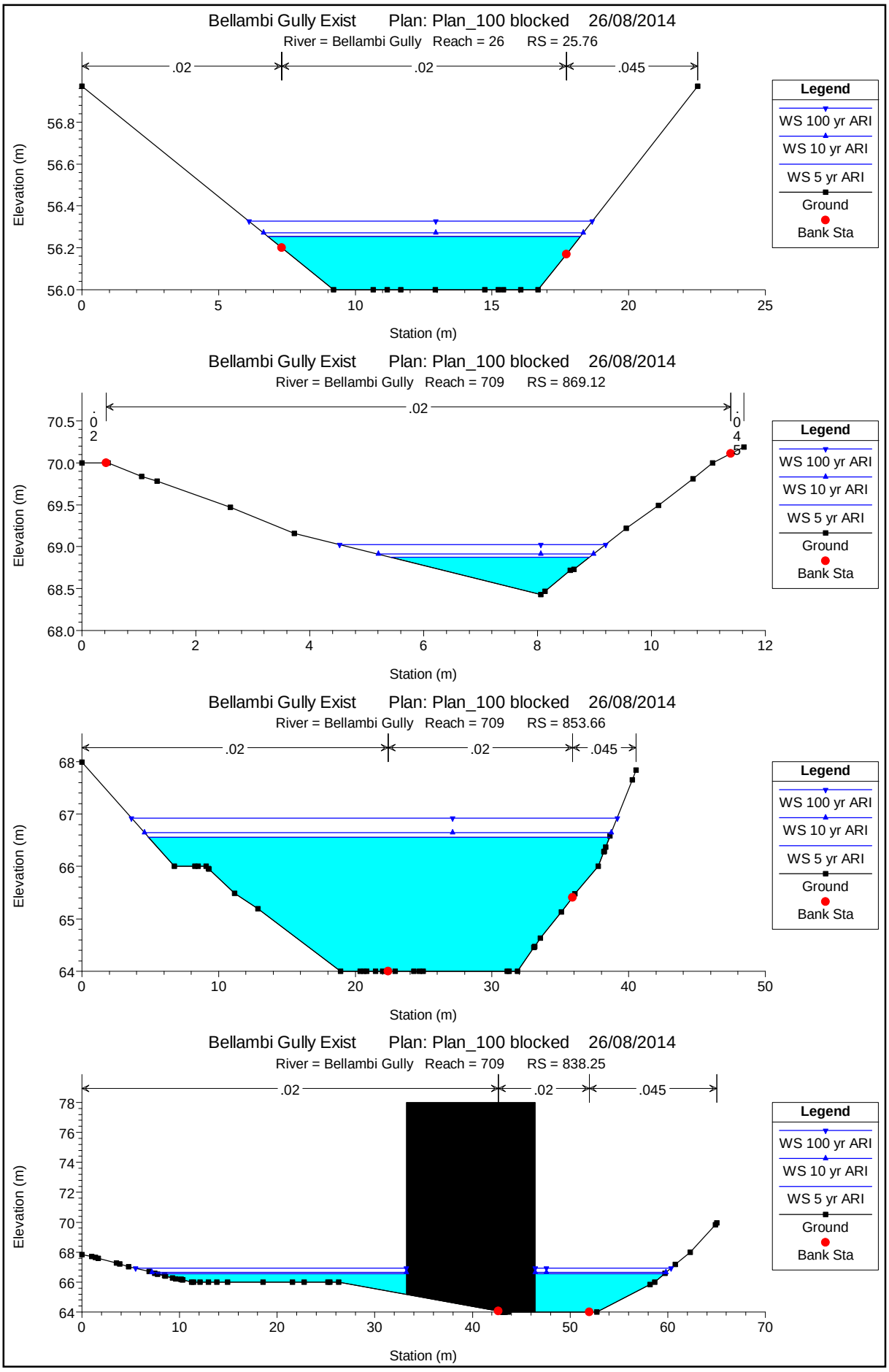
Plan View Scenario 1



Cross Sections




Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 26 RS = 109.29
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 26 RS = 84.50
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 26 RS = 62.17
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 26 RS = 45.90
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta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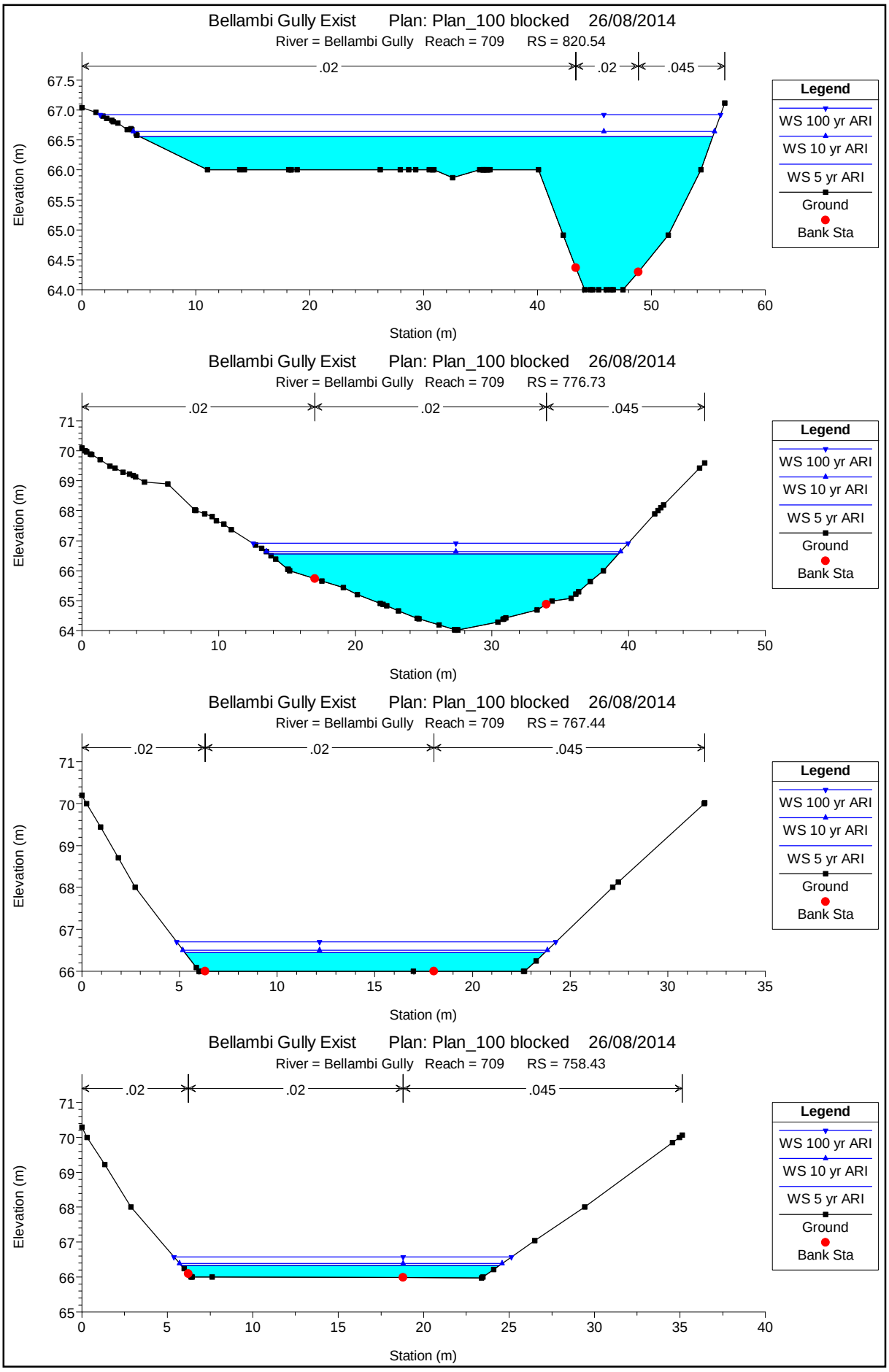
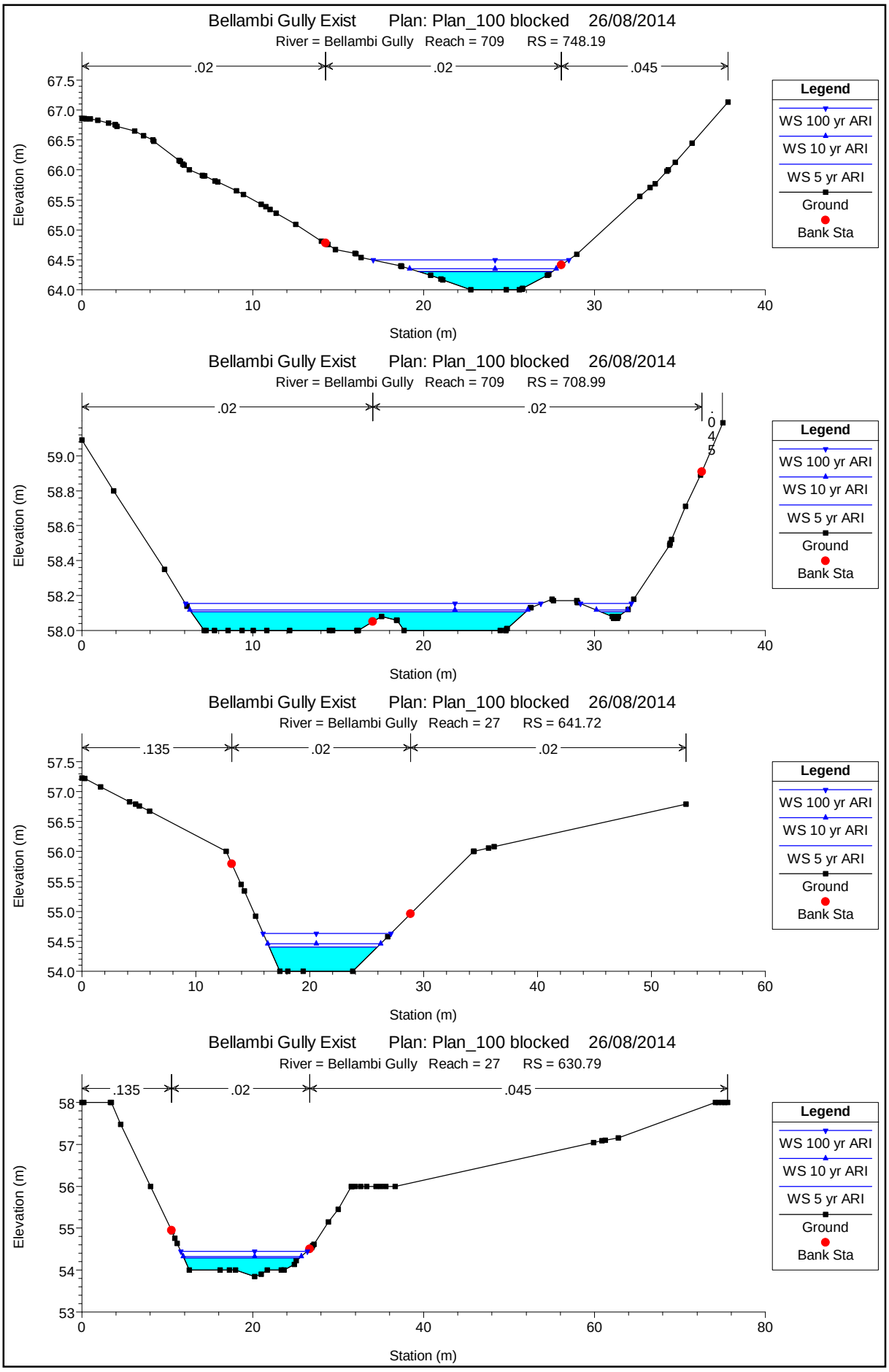
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 869.12
.02
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 853.66
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 838.25
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta


Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 820.54
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 776.73
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 767.44
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 758.43
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta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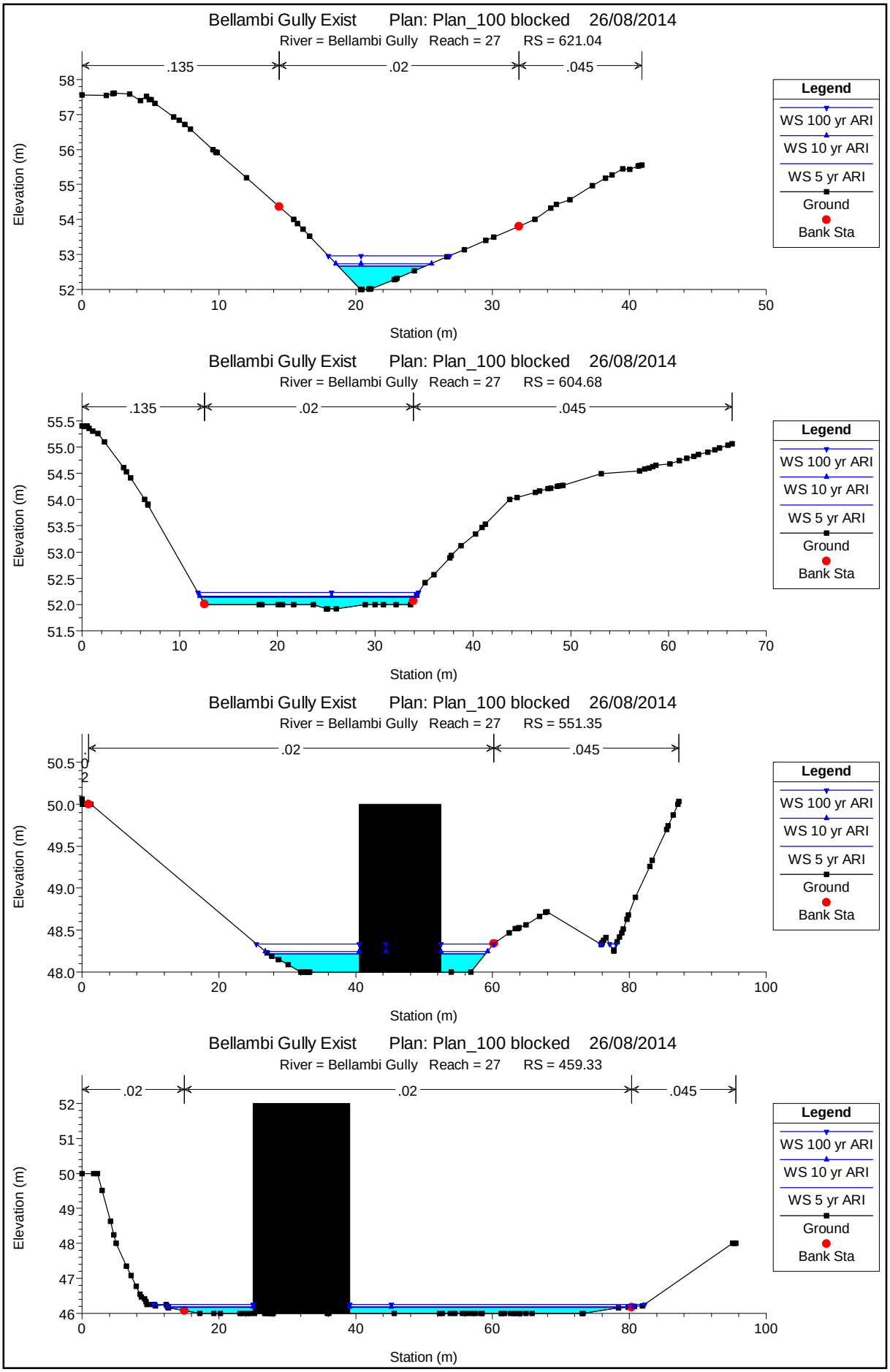
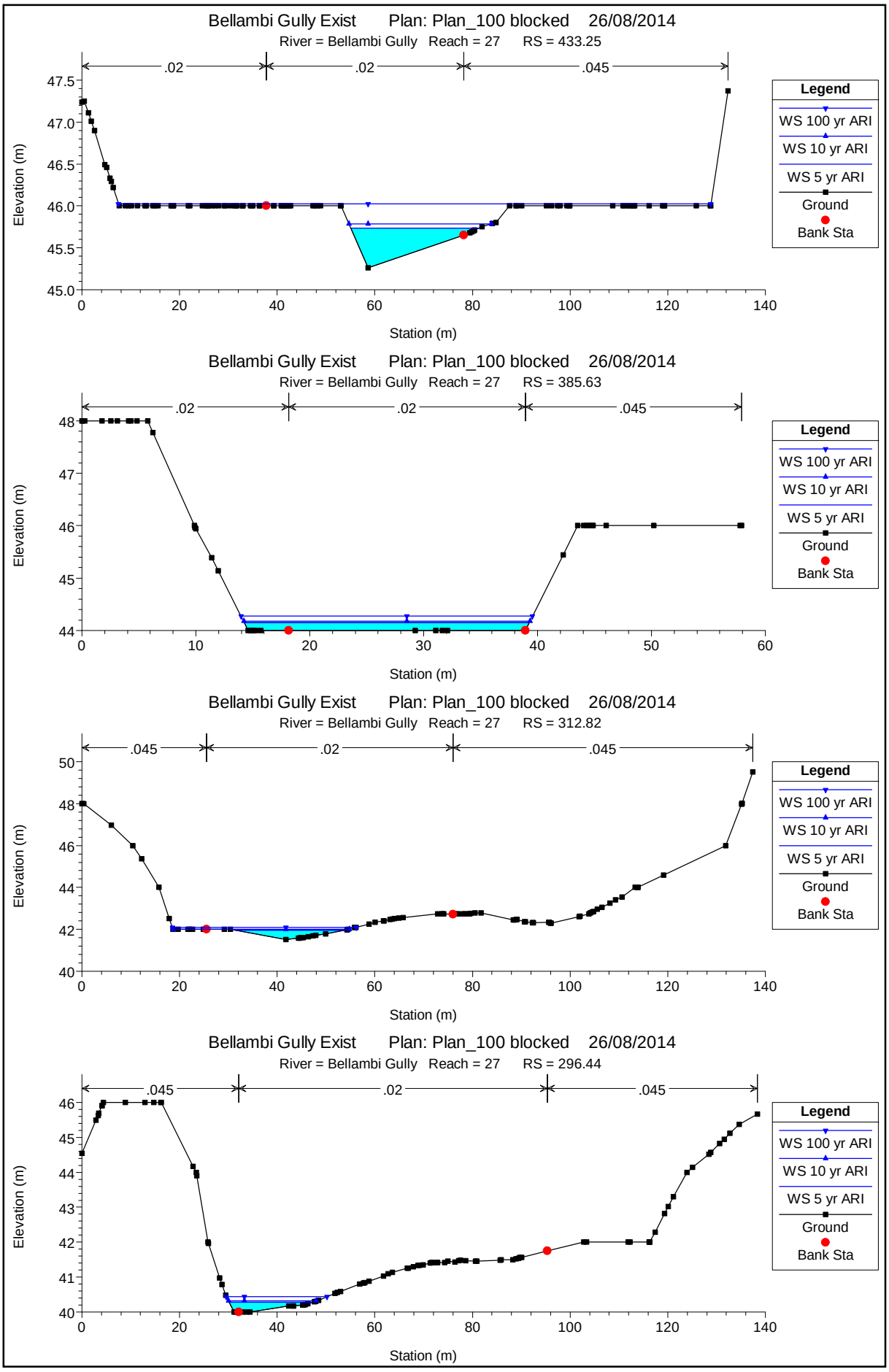
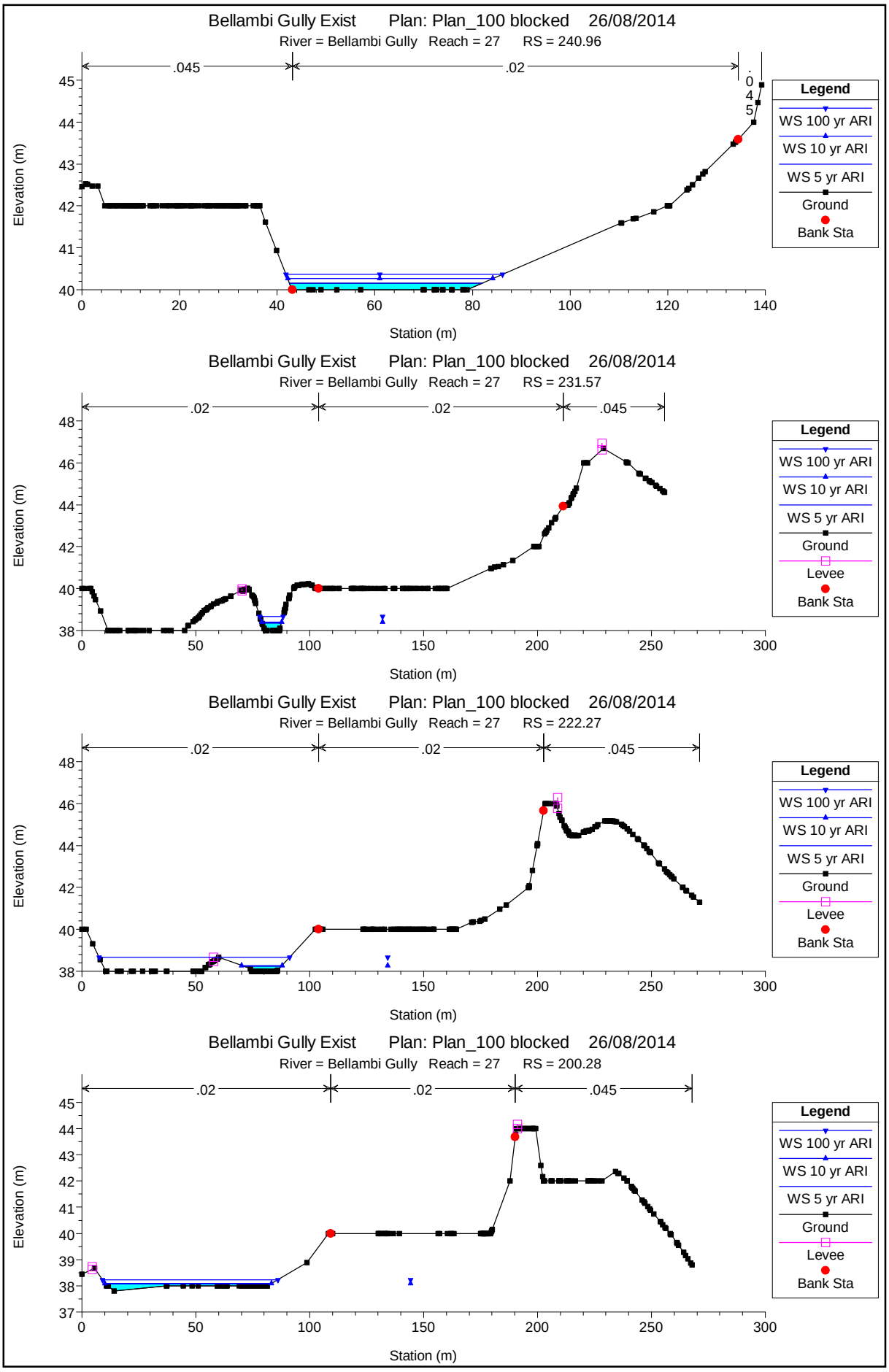
River = Bellambi Gully Reach = 709 RS = 748.19
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 708.99
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 641.72
.135
.02
.02
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 630.79
.135
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta


Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 621.04
.135
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 604.68
.135
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 551.35
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 459.33
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta


Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 433.25
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 385.63
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 312.82
.045
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 296.44
.045
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta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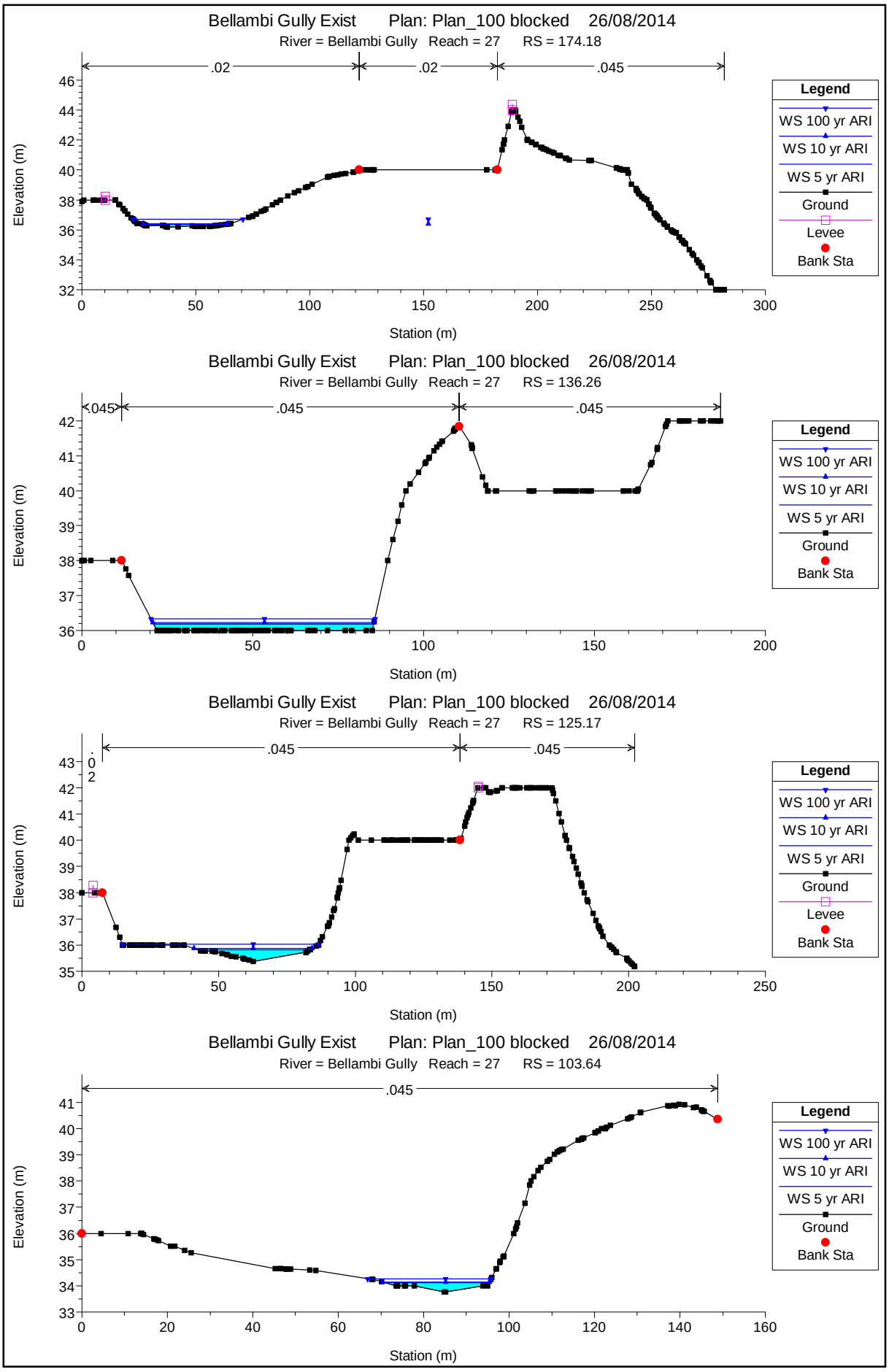
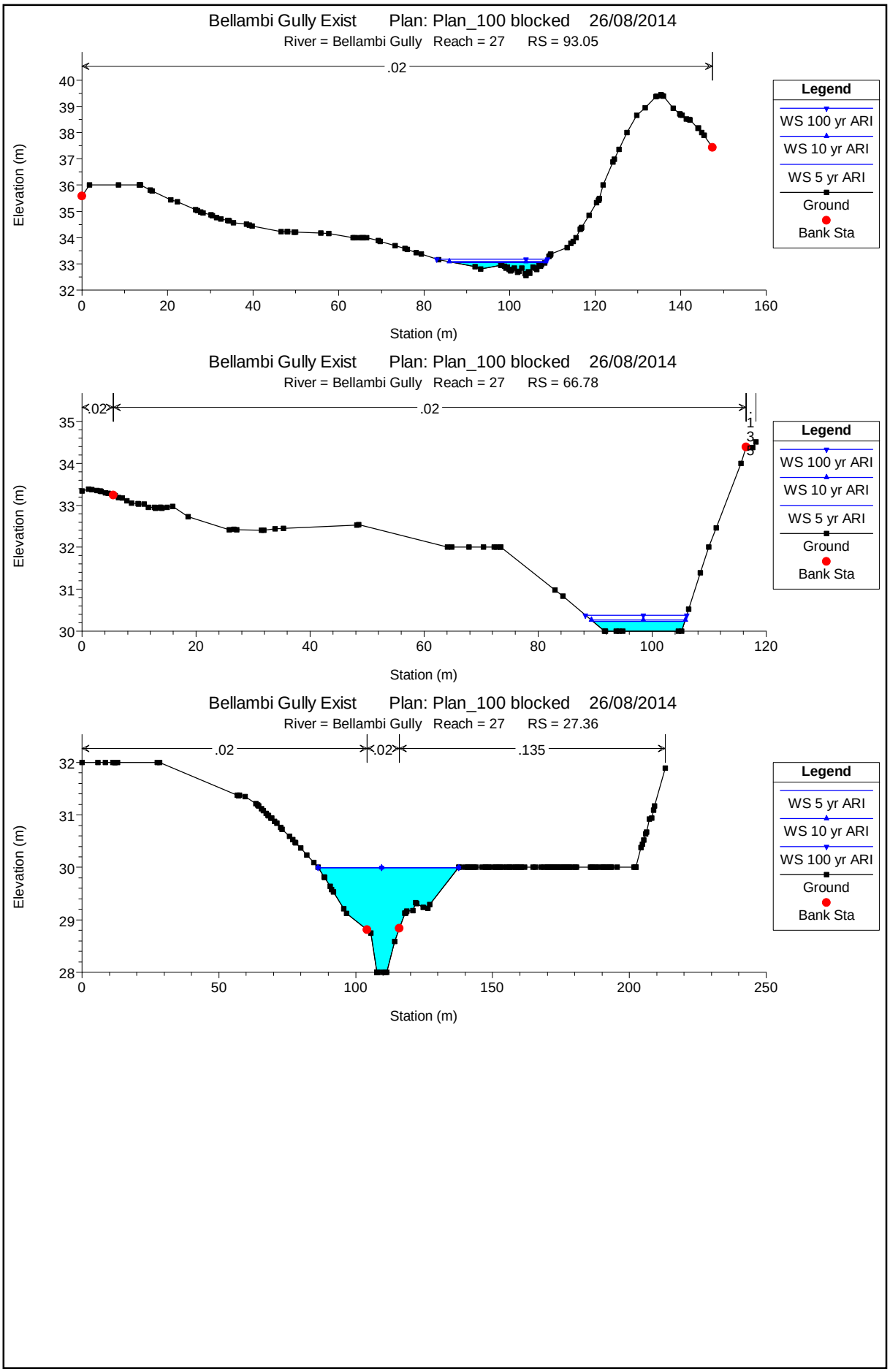
River = Bellambi Gully Reach = 27 RS = 240.96
.045
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 231.57
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Levee
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 222.27
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Levee
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 200.28
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Levee
Bank Sta


Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 174.18
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Levee
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 136.26
.045
.045
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 125.17
.045
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Levee
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 103.64
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta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River = Bellambi Gully Reach = 27 RS = 93.05
.02
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 66.78
.02
.02
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_100 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 27.36
.02
.02
.135
Elevation (m)
Station (m)
Legend
WS 5 yr ARI
WS 10 yr ARI
WS 100 yr ARI
Ground
Bank Sta

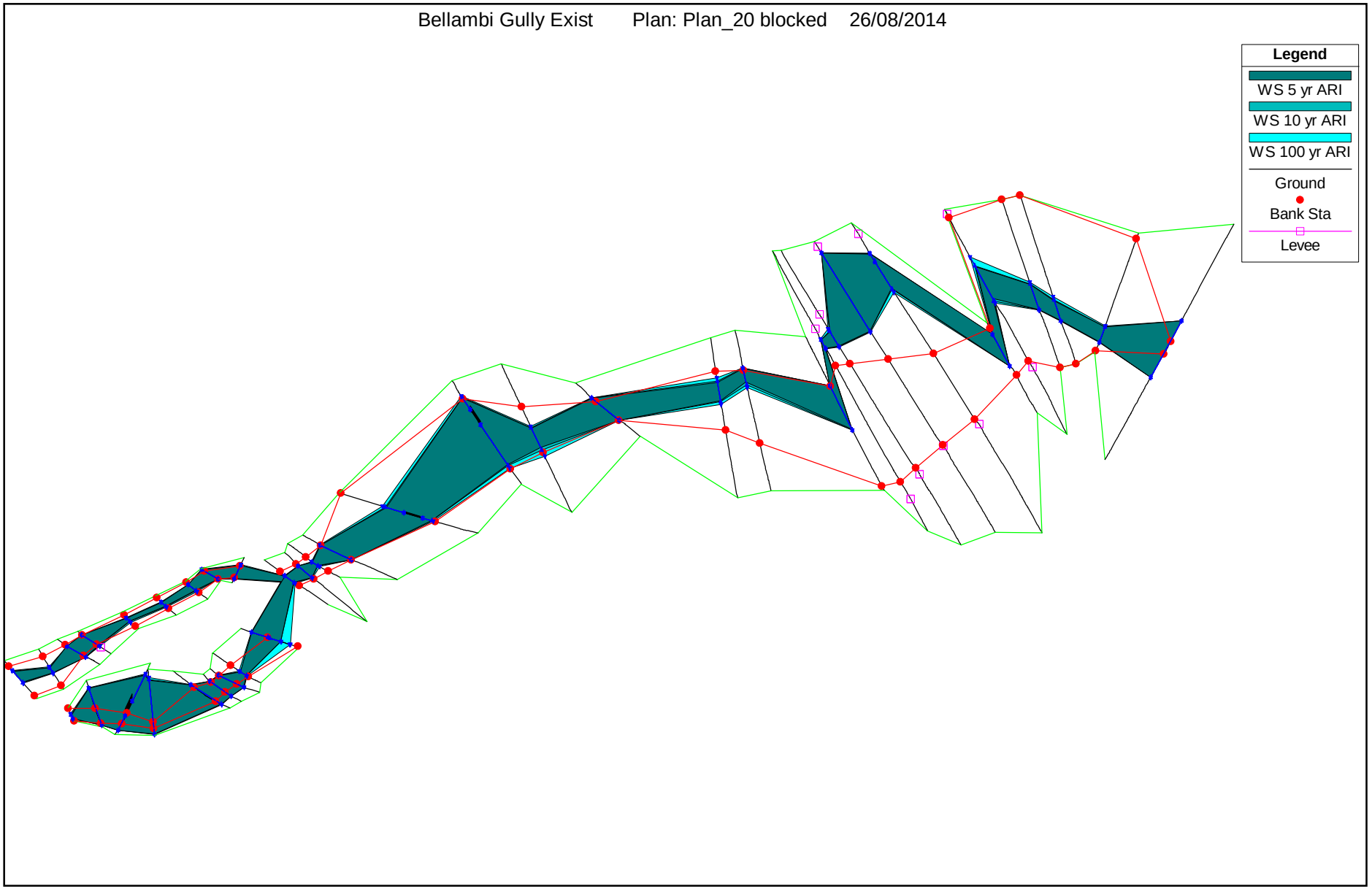
HEC-RAS Plan: 100block

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Hydr Depth
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)
26	193.90	5 yr ARI	3.58	68.83	69.04	69.14	69.43	0.050030	2.76	1.30	0.12
26	193.90	10 yr ARI	4.47	68.83	69.06	69.18	69.50	0.050062	2.96	1.51	0.14
26	193.90	100 yr ARI	8.45	68.83	69.13	69.31	69.80	0.050036	3.63	2.33	0.18
26	173.65	5 yr ARI	3.58	66.23	66.50	66.74	67.83	0.122719	5.12	0.70	0.16
26	173.65	10 yr ARI	4.47	66.23	66.53	66.79	67.95	0.112730	5.28	0.85	0.18
26	173.65	100 yr ARI	8.45	66.23	66.64	66.98	68.36	0.091113	5.80	1.46	0.24
26	151.48	5 yr ARI	3.58	66.00	66.32	66.20	66.36	0.001501	0.89	4.30	0.30
26	151.48	10 yr ARI	4.47	66.00	66.36	66.24	66.41	0.001543	0.97	4.91	0.34
26	151.48	100 yr ARI	8.45	66.00	66.21	66.36	66.75	0.037652	3.33	2.68	0.20
26	138.91	5 yr ARI	3.58	66.00	66.21	66.21	66.32	0.006889	1.46	2.57	0.20
26	138.91	10 yr ARI	4.47	66.00	66.25	66.25	66.37	0.006327	1.56	3.04	0.23
26	138.91	100 yr ARI	8.45	66.00	66.32	66.37	66.57	0.009500	2.26	4.02	0.29
26	109.29	5 yr ARI	3.58	62.00	62.23	62.56	65.38	0.339075	7.86	0.46	0.14
26	109.29	10 yr ARI	4.47	62.00	62.26	62.62	65.48	0.299590	7.95	0.56	0.16
26	109.29	100 yr ARI	8.45	62.00	62.39	62.82	65.54	0.177988	7.87	1.07	0.23
26	84.50	5 yr ARI	3.58	60.00	60.35	60.58	61.37	0.072849	4.46	0.80	0.19
26	84.50	10 yr ARI	4.47	60.00	60.39	60.64	61.55	0.075442	4.79	0.93	0.21
26	84.50	100 yr ARI	8.45	60.00	60.49	60.83	62.21	0.082851	5.81	1.45	0.26
26	62.17	5 yr ARI	3.58	58.38	58.67	58.85	59.49	0.092625	4.02	0.89	0.14
26	62.17	10 yr ARI	4.47	58.38	58.69	58.89	59.62	0.092361	4.26	1.05	0.15
26	62.17	100 yr ARI	8.45	58.38	58.77	59.05	60.17	0.091494	5.24	1.61	0.21
26	45.90	5 yr ARI	3.58	56.00	56.07	56.20	57.04	0.282651	4.39	0.82	0.07
26	45.90	10 yr ARI	4.47	56.00	56.08	56.24	57.21	0.270561	4.74	0.95	0.08
26	45.90	100 yr ARI	8.45	56.00	56.12	56.36	57.86	0.239159	5.89	1.45	0.12
26	25.76	5 yr ARI	3.58	56.00	56.25	56.26	56.37	0.006557	1.51	2.41	0.21
26	25.76	10 yr ARI	4.47	56.00	56.27	56.30	56.43	0.008015	1.75	2.60	0.22
26	25.76	100 yr ARI	8.45	56.00	56.33	56.44	56.69	0.014217	2.67	3.28	0.26
709	869.12	5 yr ARI	3.03	68.43	68.87	69.09	69.67	0.050055	3.96	0.76	0.22
709	869.12	10 yr ARI	3.79	68.43	68.91	69.15	69.81	0.050059	4.19	0.90	0.24
709	869.12	100 yr ARI	6.71	68.43	69.03	69.33	70.22	0.050076	4.84	1.39	0.30
709	853.66	5 yr ARI	3.03	64.00	66.56	64.17	66.56	0.000000	0.06	59.84	1.77
709	853.66	10 yr ARI	3.79	64.00	66.64	64.20	66.64	0.000001	0.07	62.71	1.84
709	853.66	100 yr ARI	6.71	64.00	66.92	64.29	66.92	0.000001	0.11	72.46	2.04
709	838.25	5 yr ARI	3.03	64.00	66.56		66.56	0.000002	0.11	41.83	1.08
709	838.25	10 yr ARI	3.79	64.00	66.64		66.64	0.000003	0.13	45.13	1.15
709	838.25	100 yr ARI	6.71	64.00	66.92		66.92	0.000005	0.18	56.44	1.36
709	820.54	5 yr ARI	3.03	64.00	66.56		66.56	0.000002	0.12	44.97	0.89
709	820.54	10 yr ARI	3.79	64.00	66.64		66.64	0.000002	0.14	49.25	0.97
709	820.54	100 yr ARI	6.71	64.00	66.92		66.92	0.000004	0.19	64.00	1.18
709	776.73	5 yr ARI	9.82	64.01	66.56		66.56	0.000014	0.29	39.23	1.53
709	776.73	10 yr ARI	12.28	64.01	66.64		66.64	0.000019	0.34	41.36	1.59
709	776.73	100 yr ARI	21.89	64.01	66.91		66.92	0.000038	0.53	48.60	1.77
709	767.44	5 yr ARI	9.82	66.00	66.44		66.55	0.002807	1.54	7.80	0.42
709	767.44	10 yr ARI	12.28	66.00	66.51		66.63	0.002826	1.69	8.95	0.48
709	767.44	100 yr ARI	21.89	66.00	66.70	66.59	66.90	0.002994	2.16	12.65	0.65
709	758.43	5 yr ARI	9.82	65.99	66.34	66.34	66.50	0.006423	1.95	6.11	0.33
709	758.43	10 yr ARI	12.28	65.99	66.39	66.39	66.58	0.006175	2.10	7.10	0.38
709	758.43	100 yr ARI	21.89	65.99	66.57	66.57	66.85	0.005296	2.52	10.70	0.54
709	748.19	5 yr ARI	9.82	64.00	64.30	64.63	66.16	0.119464	6.04	1.62	0.21
709	748.19	10 yr ARI	12.28	64.00	64.35	64.69	66.26	0.104834	6.13	2.00	0.23
709	748.19	100 yr ARI	21.89	64.00	64.50	64.90	66.54	0.076054	6.34	3.47	0.30
709	708.99	5 yr ARI	9.82	58.00	58.11	58.29	59.53	0.268377	4.72	1.88	0.09
709	708.99	10 yr ARI	12.28	58.00	58.12	58.33	59.92	0.305430	5.29	2.09	0.10
709	708.99	100 yr ARI	21.89	58.00	58.15	58.46	61.08	0.354168	6.64	2.93	0.12
27	641.72	5 yr ARI	14.05	54.00	54.41	54.68	55.36	0.031874	4.32	3.25	0.34
27	641.72	10 yr ARI	17.53	54.00	54.46	54.77	55.56	0.032028	4.65	3.77	0.38
27	641.72	100 yr ARI	31.63	54.00	54.63	55.07	56.28	0.033713	5.69	5.56	0.50
27	630.79	5 yr ARI	14.05	53.85	54.29	54.48	54.95	0.027276	3.59	3.91	0.29
27	630.79	10 yr ARI	17.53	53.85	54.33	54.56	55.14	0.029695	3.99	4.39	0.32

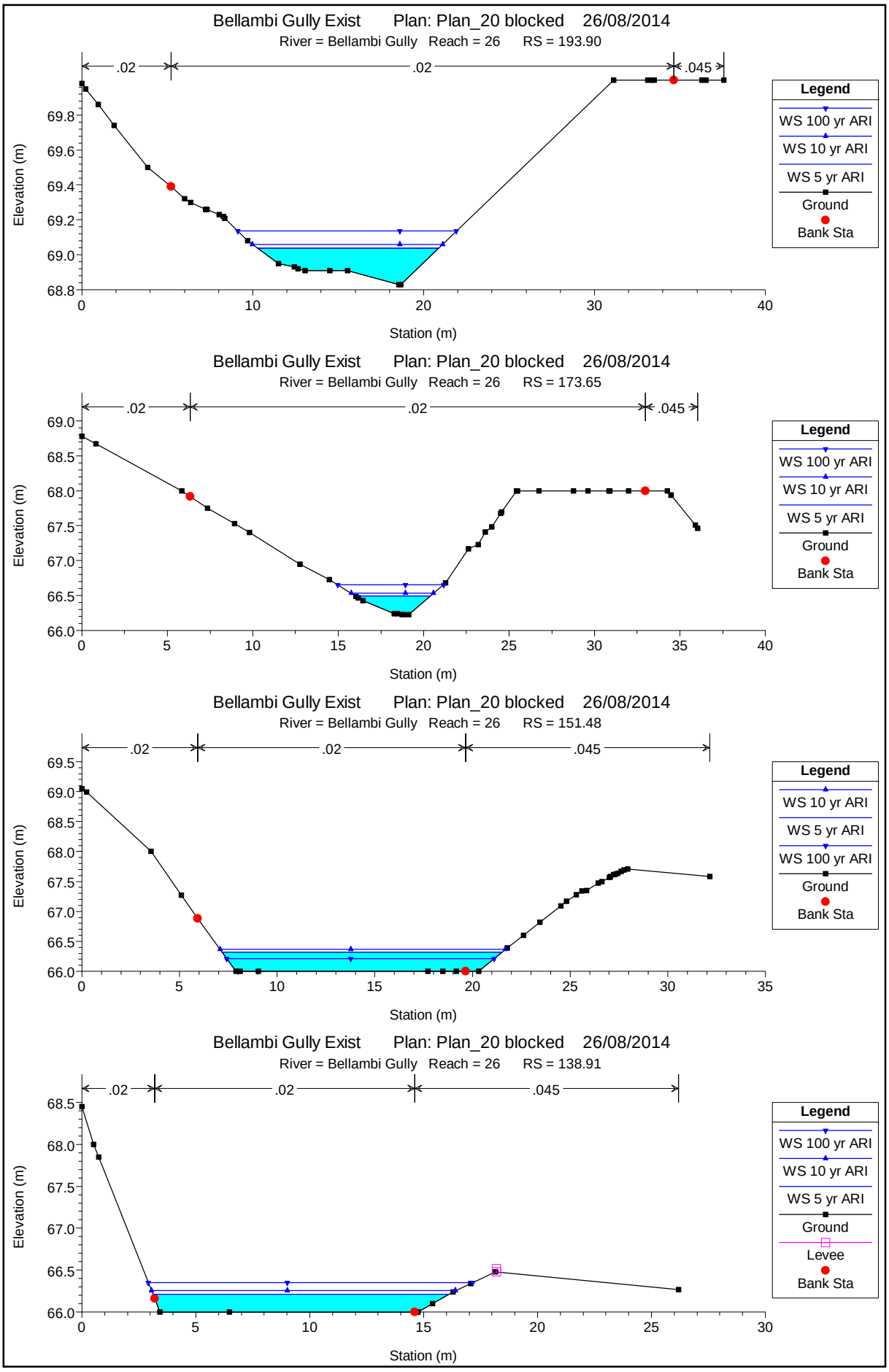
HEC-RAS Plan: 100block (Continued)

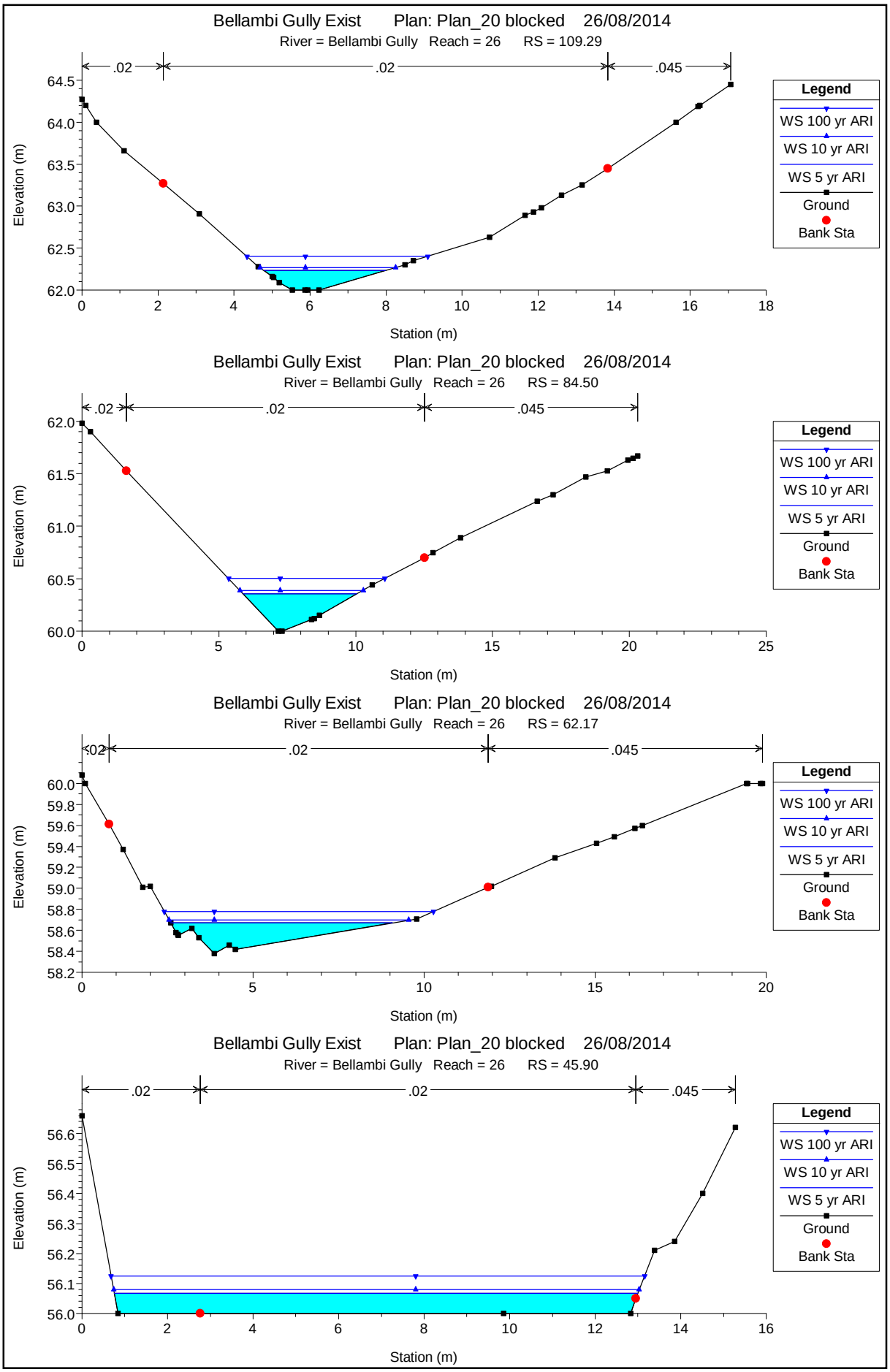
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Hydr Depth
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)
27	630.79	100 yr ARI	31.63	53.85	54.44	54.81	55.81	0.035410	5.18	6.10	0.41
27	621.04	5 yr ARI	14.05	52.00	52.67	53.09	54.46	0.055056	5.94	2.37	0.37
27	621.04	10 yr ARI	17.53	52.00	52.74	53.20	54.65	0.051478	6.12	2.86	0.41
27	621.04	100 yr ARI	31.63	52.00	52.97	53.54	55.33	0.045848	6.81	4.65	0.52
27	604.68	5 yr ARI	14.05	51.92	52.14	52.34	53.08	0.089622	4.29	3.31	0.15
27	604.68	10 yr ARI	17.53	51.92	52.16	52.40	53.31	0.094391	4.76	3.73	0.17
27	604.68	100 yr ARI	31.63	51.92	52.23	52.59	54.12	0.099065	6.11	5.28	0.23
27	551.35	5 yr ARI	14.05	48.00	48.22	48.41	49.02	0.064310	3.97	3.54	0.18
27	551.35	10 yr ARI	17.53	48.00	48.25	48.47	49.16	0.063276	4.25	4.13	0.20
27	551.35	100 yr ARI	31.63	48.00	48.34	48.66	49.72	0.065685	5.21	6.11	0.26
27	459.33	5 yr ARI	14.05	46.00	46.17	46.21	46.33	0.014913	1.76	8.04	0.15
27	459.33	10 yr ARI	17.53	46.00	46.19	46.24	46.38	0.015576	1.94	9.12	0.17
27	459.33	100 yr ARI	31.63	46.00	46.26	46.35	46.58	0.017619	2.54	12.71	0.22
27	433.25	5 yr ARI	14.05	45.26	45.73	45.80	45.98	0.011090	2.21	6.46	0.25
27	433.25	10 yr ARI	17.53	45.26	45.79	45.86	46.06	0.009665	2.30	7.93	0.27
27	433.25	100 yr ARI	31.63	45.26	46.03	46.10	46.26	0.008004	2.18	18.02	0.15
27	385.63	5 yr ARI	14.05	44.00	44.15	44.32	44.86	0.067873	3.74	3.80	0.15
27	385.63	10 yr ARI	17.53	44.00	44.18	44.37	45.02	0.068241	4.09	4.34	0.17
27	385.63	100 yr ARI	31.63	44.00	44.27	44.55	45.39	0.050179	4.72	6.83	0.27
27	312.82	5 yr ARI	14.05	41.52	41.96	42.08	42.32	0.019629	2.67	5.26	0.24
27	312.82	10 yr ARI	17.53	41.52	42.01	42.12	42.37	0.020406	2.65	6.71	0.19
27	312.82	100 yr ARI	31.63	41.52	42.09	42.28	42.70	0.025233	3.49	9.58	0.25
27	296.44	5 yr ARI	14.05	40.00	40.28	40.53	41.58	0.118659	5.21	2.90	0.17
27	296.44	10 yr ARI	17.53	40.00	40.31	40.59	41.64	0.097690	5.26	3.59	0.20
27	296.44	100 yr ARI	31.63	40.00	40.44	40.80	41.98	0.066082	5.64	6.04	0.29
27	240.96	5 yr ARI	14.05	40.00	40.16	40.24	40.44	0.027760	2.37	5.96	0.15
27	240.96	10 yr ARI	17.53	40.00	40.27	40.28	40.41	0.007522	1.71	10.33	0.25
27	240.96	100 yr ARI	31.63	40.00	40.37	40.41	40.61	0.008041	2.17	14.76	0.33
27	231.57	5 yr ARI	14.05	40.00	38.36	38.70	39.79	0.054696		2.65	0.31
27	231.57	10 yr ARI	17.53	40.00	38.41	38.80	40.04	0.053014		3.10	0.35
27	231.57	100 yr ARI	31.63	40.00	38.67	39.14	40.28	0.028599		5.64	0.55
27	222.27	5 yr ARI	14.05	40.00	38.25	38.47	39.12	0.058698		3.40	0.20
27	222.27	10 yr ARI	17.53	40.00	38.28	38.54	39.36	0.066834		3.80	0.21
27	222.27	100 yr ARI	31.63	40.00	38.67	38.67	38.70	0.000452		45.14	0.54
27	200.28	5 yr ARI	14.05	40.00	38.09	38.12	38.22	0.018636		8.58	0.12
27	200.28	10 yr ARI	17.53	40.00	38.10	38.15	38.28	0.022554		9.26	0.13
27	200.28	100 yr ARI	31.63	40.00	38.24	38.24	38.37	0.006184		19.87	0.26
27	174.18	5 yr ARI	14.05	40.00	36.36	36.51	37.12	0.125273		3.65	0.10
27	174.18	10 yr ARI	17.53	40.00	36.39	36.55	37.13	0.094497		4.59	0.12
27	174.18	100 yr ARI	31.63	40.00	36.71	36.67	36.86	0.003901		18.92	0.39
27	136.26	5 yr ARI	14.05	36.00	36.19	36.17	36.26	0.024550	1.15	12.23	0.19
27	136.26	10 yr ARI	17.53	36.00	36.22	36.20	36.30	0.022992	1.23	14.27	0.22
27	136.26	100 yr ARI	31.63	36.00	36.33		36.44	0.019476	1.47	21.48	0.33
27	125.17	5 yr ARI	14.05	35.38	35.82	35.82	35.94	0.034400	1.52	9.24	0.22
27	125.17	10 yr ARI	17.53	35.38	35.87	35.87	36.00	0.032223	1.60	10.96	0.25
27	125.17	100 yr ARI	31.63	35.38	36.03	36.03	36.17	0.031228	1.63	19.35	0.27
27	103.64	5 yr ARI	14.05	33.76	34.12	34.26	34.59	0.175939	3.07	4.58	0.19
27	103.64	10 yr ARI	17.53	33.76	34.15	34.31	34.70	0.174752	3.30	5.31	0.21
27	103.64	100 yr ARI	31.63	33.76	34.27	34.48	34.96	0.141328	3.70	8.55	0.30
27	93.05	5 yr ARI	14.05	32.56	33.05	33.22	33.69	0.048622	3.56	3.95	0.19
27	93.05	10 yr ARI	17.53	32.56	33.08	33.27	33.81	0.047865	3.79	4.62	0.21
27	93.05	100 yr ARI	31.63	32.56	33.18	33.45	34.17	0.043482	4.41	7.18	0.28
27	66.78	5 yr ARI	14.05	30.00	30.23	30.45	31.09	0.053602	4.11	3.42	0.21
27	66.78	10 yr ARI	17.53	30.00	30.26	30.51	31.26	0.052531	4.42	3.96	0.24
27	66.78	100 yr ARI	31.63	30.00	30.38	30.74	31.81	0.048655	5.31	5.96	0.34
27	27.36	5 yr ARI	14.05	28.00	30.00	28.86	30.01	0.000054	0.51	44.69	0.87
27	27.36	10 yr ARI	17.53	28.00	30.00	28.96	30.02	0.000085	0.64	44.69	0.87
27	27.36	100 yr ARI	31.63	28.00	30.00	29.26	30.05	0.000276	1.15	44.69	0.87

Plan View Scenario 2



Cross Sections




Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 26 RS = 109.29
.02
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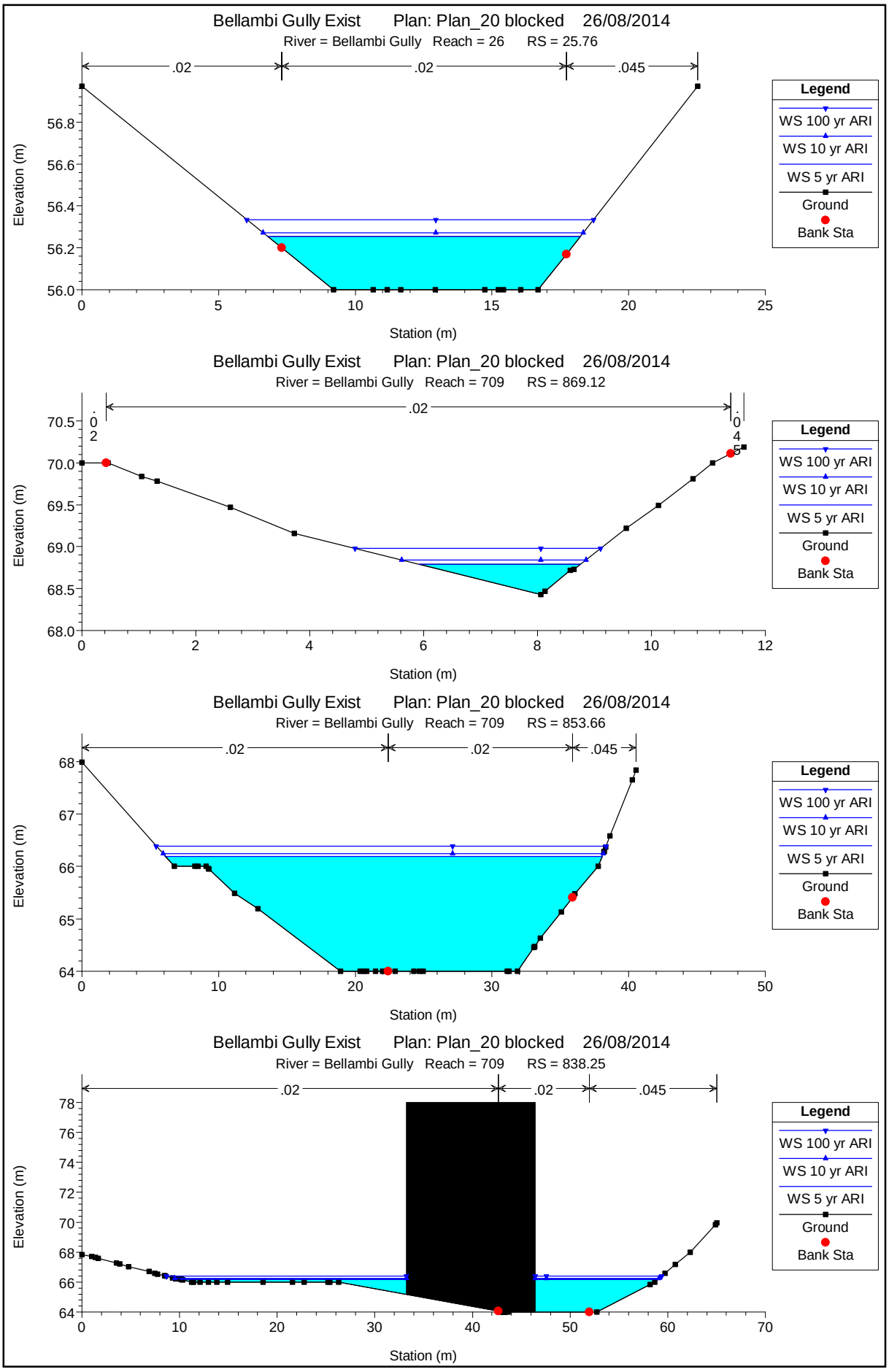
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 26 RS = 84.50
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 26 RS = 62.17
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 26 RS = 45.90
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta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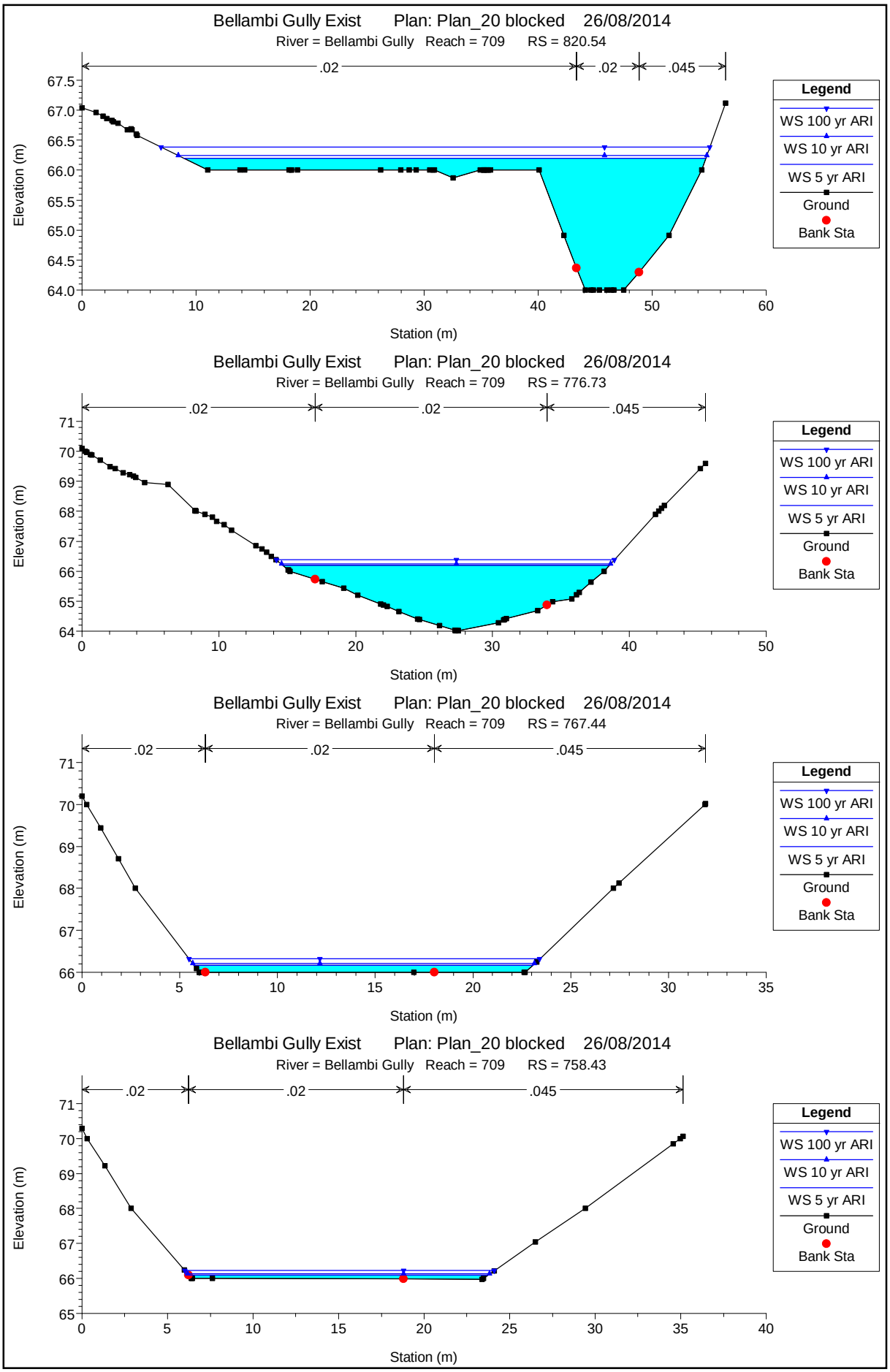
River = Bellambi Gully Reach = 26 RS = 25.76
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 869.12
.02
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 853.66
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 838.25
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta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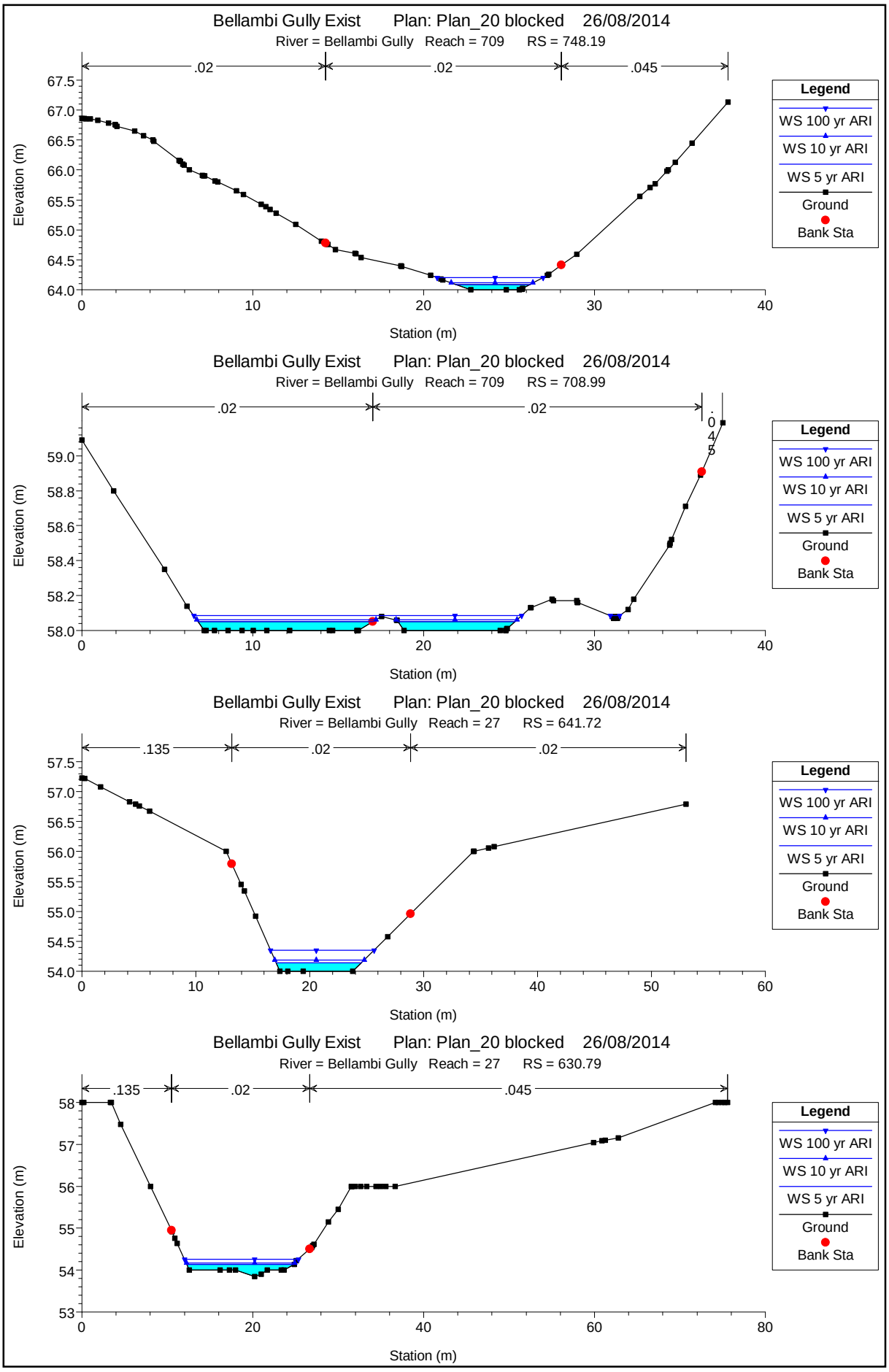
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 776.73
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 767.44
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 758.43
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta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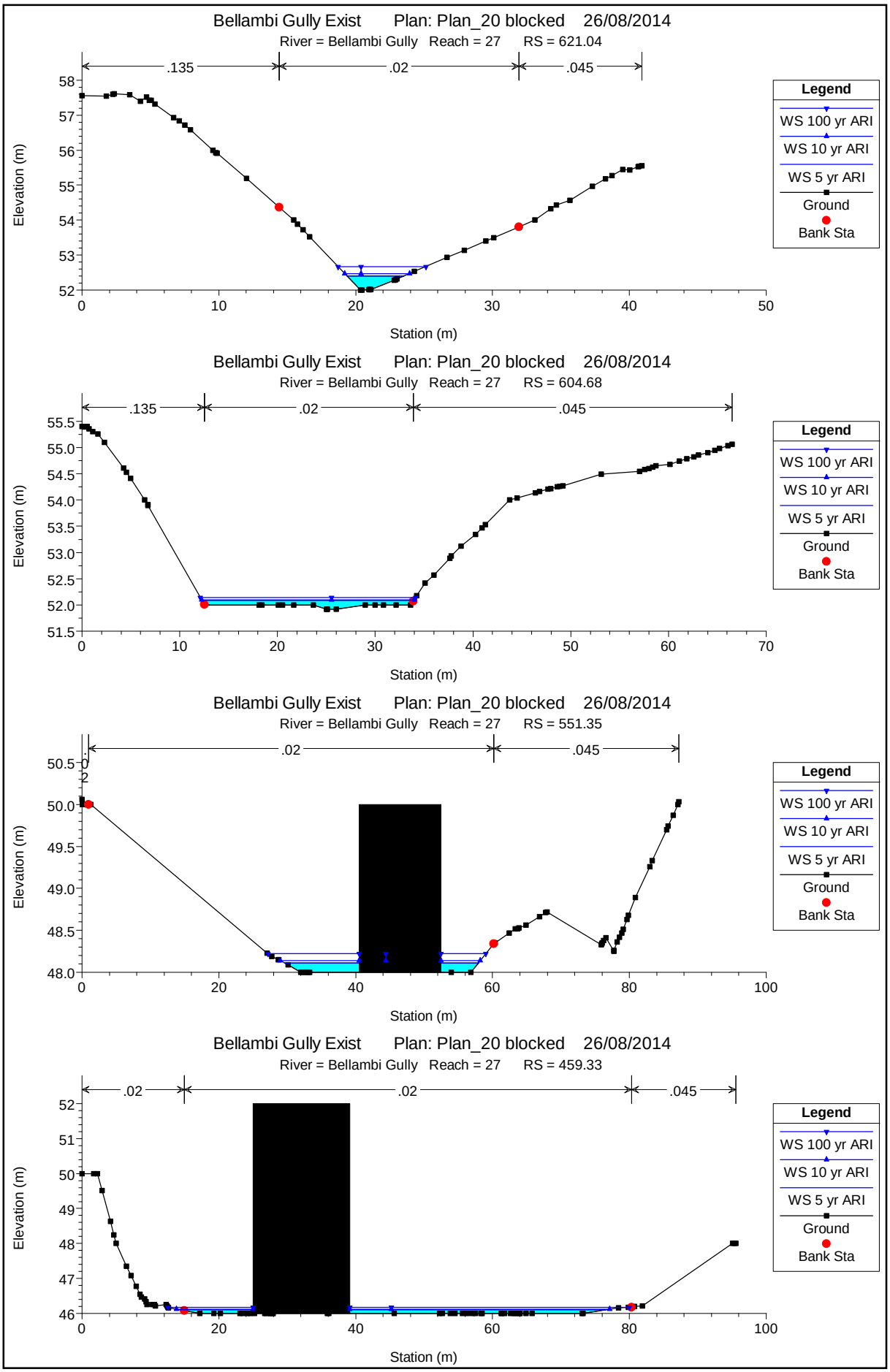
River = Bellambi Gully Reach = 709 RS = 748.19
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 708.99
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 641.72
.135
.02
.02
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 630.79
.135
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta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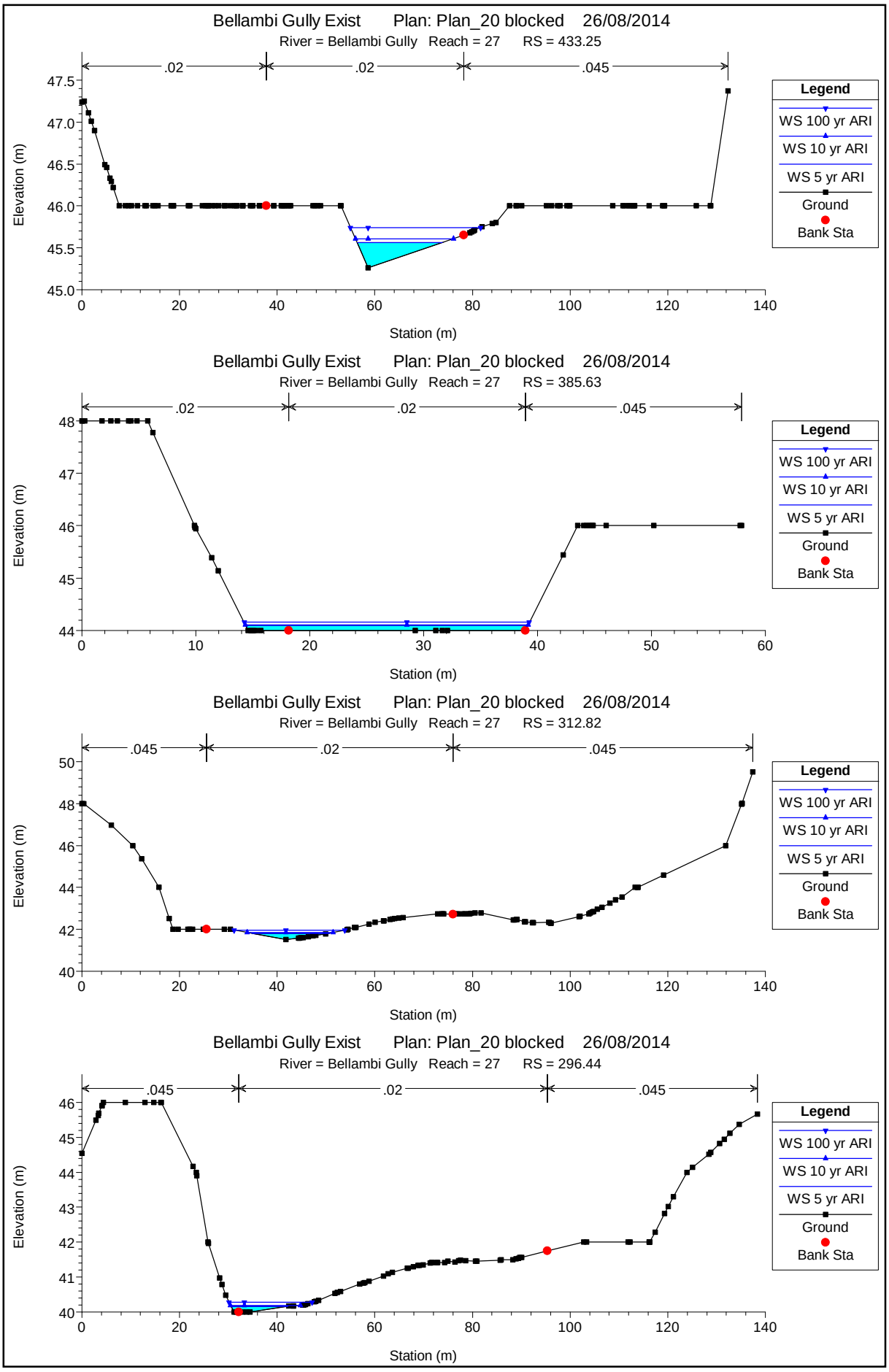
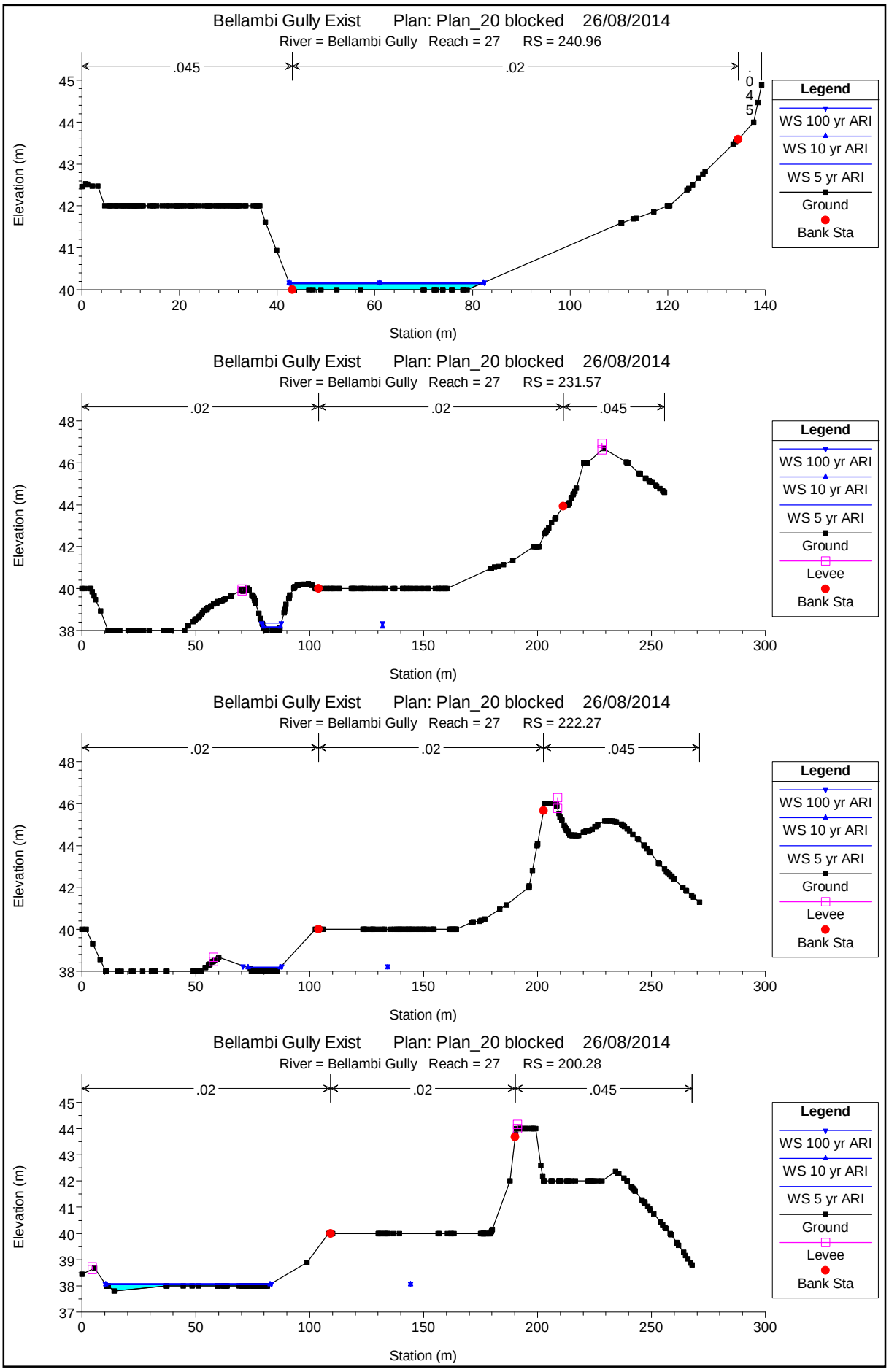
River = Bellambi Gully Reach = 27 RS = 621.04
.135
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 604.68
.135
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 551.35
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 459.33
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta


Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 433.25
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 385.63
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 312.82
.045
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 296.44
.045
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta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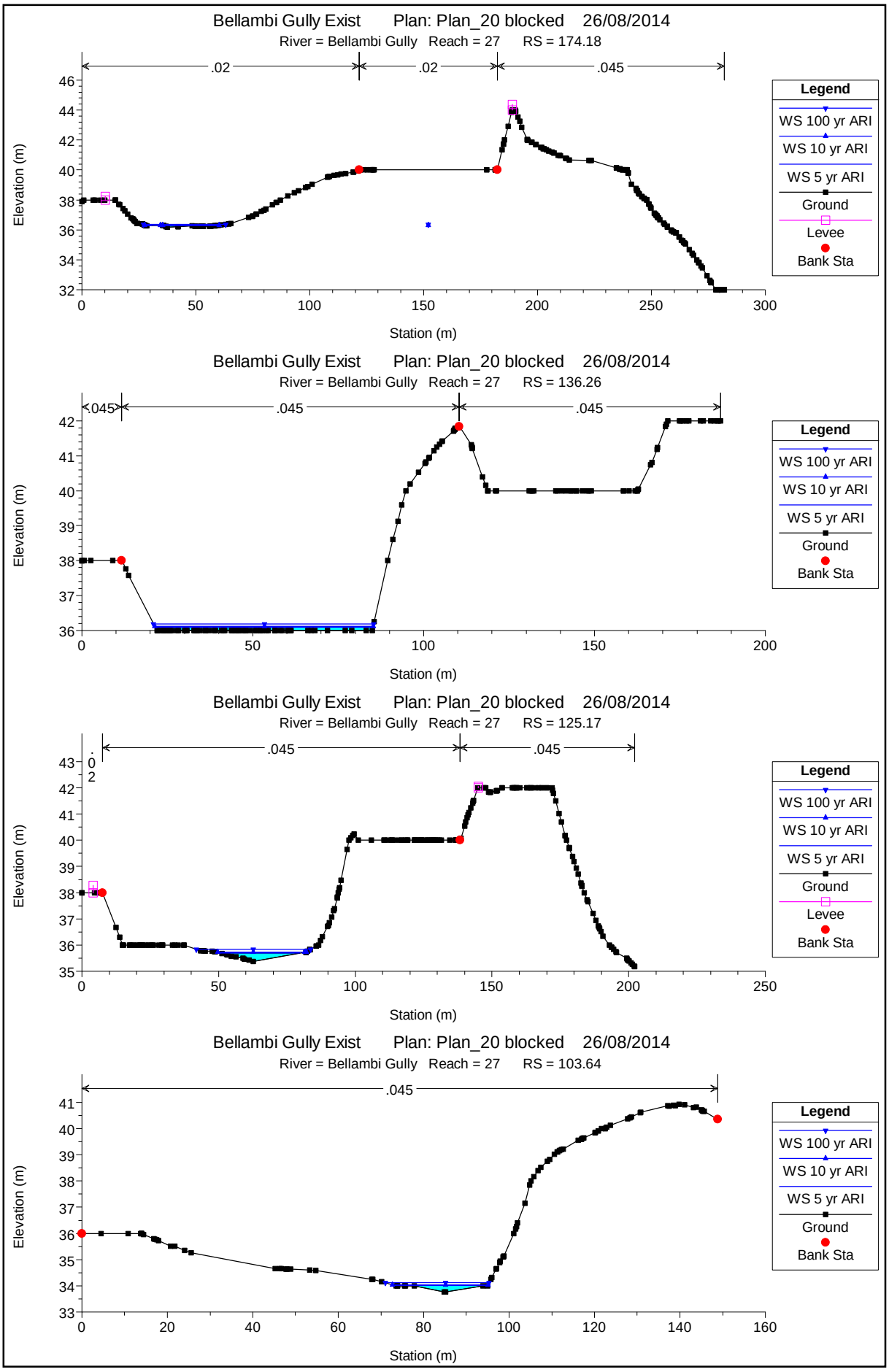
River = Bellambi Gully Reach = 27 RS = 240.96
.045
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 231.57
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Levee
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 222.27
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Levee
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 200.28
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Levee
Bank Sta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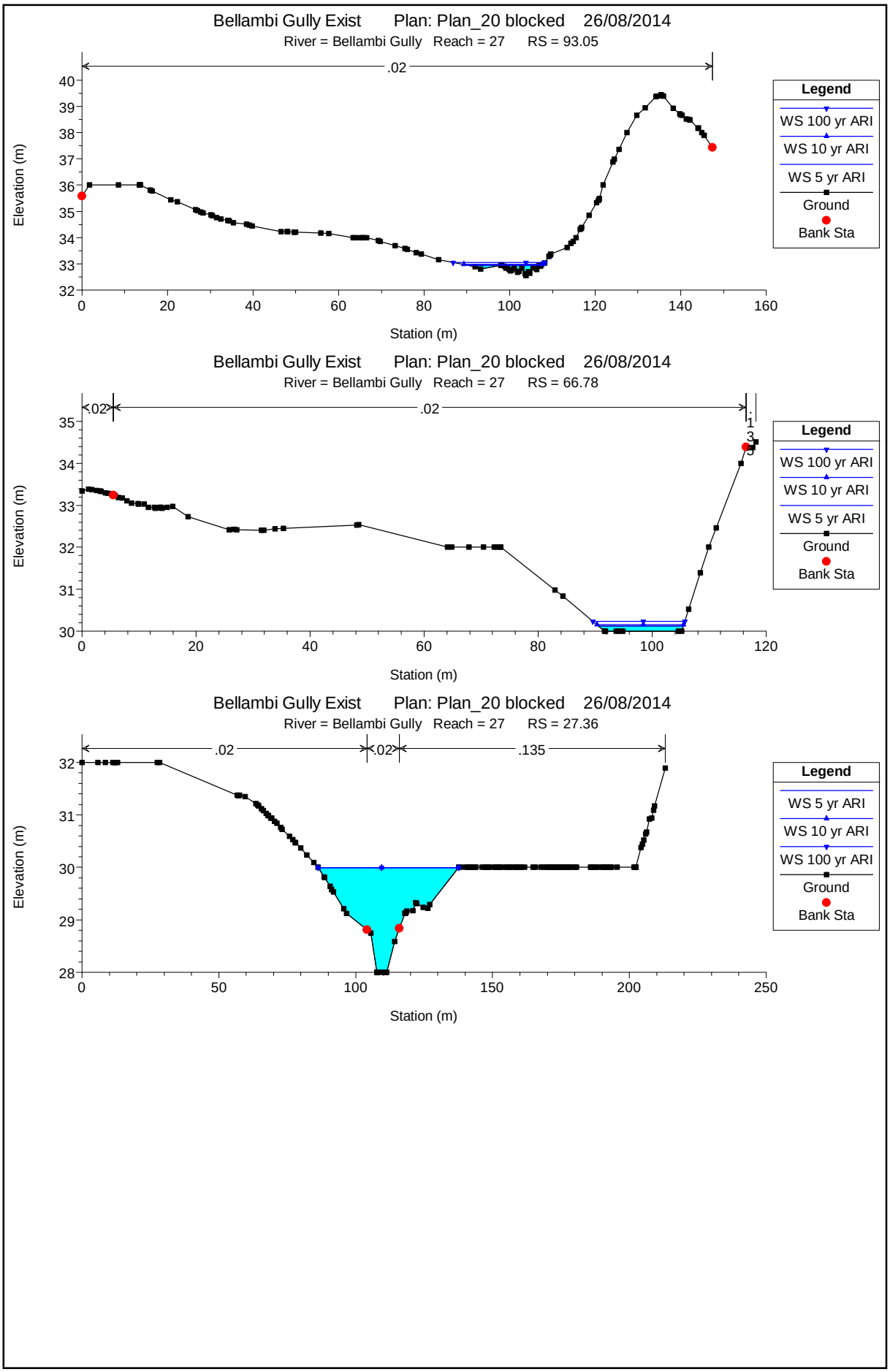
River = Bellambi Gully Reach = 27 RS = 174.18
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Levee
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 136.26
.045
.045
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 125.17
.02
.045
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Levee
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 103.64
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta


Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 93.05
.02
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 66.78
.02
.02
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_20 blocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 27.36
.02
.02
.135
Elevation (m)
Station (m)
Legend
WS 5 yr ARI
WS 10 yr ARI
WS 100 yr ARI
Ground
Bank Sta

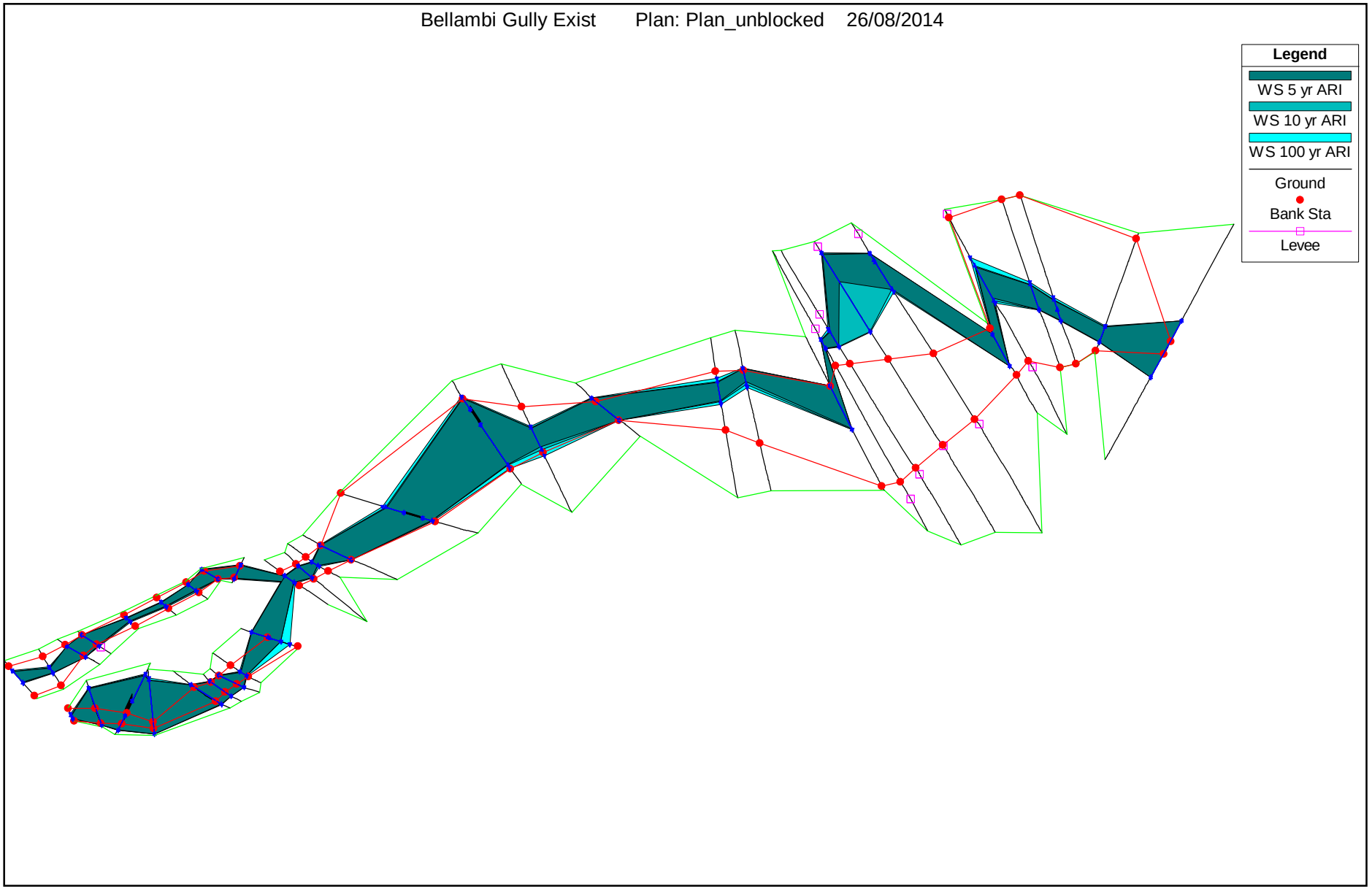
HEC-RAS Plan: 20block

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Hydr Depth
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)
26	193.90	5 yr ARI	3.58	68.83	69.04	69.14	69.43	0.050030	2.76	1.30	0.12
26	193.90	10 yr ARI	4.60	68.83	69.06	69.18	69.52	0.050066	2.99	1.54	0.14
26	193.90	100 yr ARI	9.09	68.83	69.14	69.32	69.84	0.050041	3.71	2.45	0.19
26	173.65	5 yr ARI	3.58	66.23	66.50	66.74	67.83	0.122719	5.12	0.70	0.16
26	173.65	10 yr ARI	4.60	66.23	66.53	66.80	67.96	0.111586	5.30	0.87	0.18
26	173.65	100 yr ARI	9.09	66.23	66.66	67.00	68.41	0.089055	5.87	1.55	0.25
26	151.48	5 yr ARI	3.58	66.00	66.32	66.20	66.36	0.001501	0.89	4.30	0.30
26	151.48	10 yr ARI	4.60	66.00	66.37	66.24	66.42	0.001555	0.99	4.99	0.34
26	151.48	100 yr ARI	9.09	66.00	66.21	66.38	66.80	0.038499	3.44	2.78	0.20
26	138.91	5 yr ARI	3.58	66.00	66.21	66.21	66.32	0.006889	1.46	2.57	0.20
26	138.91	10 yr ARI	4.60	66.00	66.25	66.25	66.37	0.006126	1.56	3.13	0.23
26	138.91	100 yr ARI	9.09	66.00	66.35	66.39	66.59	0.007947	2.20	4.47	0.31
26	109.29	5 yr ARI	3.58	62.00	62.23	62.56	65.38	0.339075	7.86	0.46	0.14
26	109.29	10 yr ARI	4.60	62.00	62.27	62.63	65.51	0.295906	7.97	0.58	0.16
26	109.29	100 yr ARI	9.09	62.00	62.40	62.84	65.65	0.176263	7.99	1.14	0.24
26	84.50	5 yr ARI	3.58	60.00	60.35	60.58	61.37	0.072849	4.46	0.80	0.19
26	84.50	10 yr ARI	4.60	60.00	60.39	60.65	61.58	0.075821	4.83	0.95	0.21
26	84.50	100 yr ARI	9.09	60.00	60.50	60.86	62.30	0.083950	5.95	1.53	0.27
26	62.17	5 yr ARI	3.58	58.38	58.67	58.85	59.49	0.092625	4.02	0.89	0.14
26	62.17	10 yr ARI	4.60	58.38	58.70	58.90	59.64	0.092428	4.30	1.07	0.15
26	62.17	100 yr ARI	9.09	58.38	58.78	59.07	60.25	0.091302	5.36	1.69	0.22
26	45.90	5 yr ARI	3.58	56.00	56.07	56.20	57.04	0.282651	4.39	0.82	0.07
26	45.90	10 yr ARI	4.60	56.00	56.08	56.24	57.24	0.268676	4.78	0.97	0.08
26	45.90	100 yr ARI	9.09	56.00	56.12	56.38	57.96	0.235598	6.04	1.52	0.12
26	25.76	5 yr ARI	3.58	56.00	56.25	56.26	56.37	0.006557	1.51	2.41	0.21
26	25.76	10 yr ARI	4.60	56.00	56.27	56.30	56.43	0.008378	1.79	2.61	0.22
26	25.76	100 yr ARI	9.09	56.00	56.33	56.46	56.73	0.015097	2.80	3.37	0.27
709	869.12	5 yr ARI	1.72	68.43	68.79	68.95	69.39	0.050041	3.43	0.50	0.18
709	869.12	10 yr ARI	2.48	68.43	68.84	69.03	69.56	0.050044	3.77	0.66	0.20
709	869.12	100 yr ARI	5.41	68.43	68.98	69.25	70.05	0.050064	4.59	1.18	0.27
709	853.66	5 yr ARI	1.72	64.00	66.20	64.12	66.20	0.000000	0.04	47.86	1.50
709	853.66	10 yr ARI	2.48	64.00	66.24	64.15	66.24	0.000001	0.06	49.38	1.53
709	853.66	100 yr ARI	5.41	64.00	66.39	64.26	66.39	0.000002	0.12	54.09	1.64
709	838.25	5 yr ARI	1.72	64.00	66.20		66.20	0.000002	0.10	28.20	0.79
709	838.25	10 yr ARI	2.48	64.00	66.24		66.24	0.000004	0.13	29.91	0.82
709	838.25	100 yr ARI	5.41	64.00	66.39		66.39	0.000012	0.25	35.20	0.94
709	820.54	5 yr ARI	1.72	64.00	66.19		66.20	0.000002	0.11	27.47	0.60
709	820.54	10 yr ARI	2.48	64.00	66.24		66.24	0.000003	0.15	29.64	0.64
709	820.54	100 yr ARI	5.41	64.00	66.39		66.39	0.000010	0.27	36.39	0.76
709	776.73	5 yr ARI	1.72	64.01	66.19		66.20	0.000001	0.06	30.34	1.27
709	776.73	10 yr ARI	2.48	64.01	66.24		66.24	0.000002	0.09	31.47	1.31
709	776.73	100 yr ARI	5.41	64.01	66.39		66.39	0.000006	0.17	34.96	1.41
709	767.44	5 yr ARI	1.72	66.00	66.17		66.19	0.002145	0.71	2.90	0.17
709	767.44	10 yr ARI	2.48	66.00	66.21		66.24	0.002280	0.84	3.56	0.20
709	767.44	100 yr ARI	5.41	66.00	66.32		66.38	0.002639	1.20	5.50	0.31
709	758.43	5 yr ARI	1.72	65.99	66.10	66.10	66.15	0.010115	1.11	1.85	0.11
709	758.43	10 yr ARI	2.48	65.99	66.13	66.13	66.20	0.009045	1.24	2.38	0.13
709	758.43	100 yr ARI	5.41	65.99	66.22	66.22	66.34	0.007387	1.60	4.06	0.22
709	748.19	5 yr ARI	1.72	64.00	64.09	64.26	65.69	0.430529	5.61	0.31	0.07
709	748.19	10 yr ARI	2.48	64.00	64.11	64.31	65.77	0.319950	5.70	0.44	0.09
709	748.19	100 yr ARI	5.41	64.00	64.20	64.47	65.96	0.176676	5.88	0.92	0.15
709	708.99	5 yr ARI	1.72	58.00	58.05	58.11	58.28	0.102314	2.10	0.82	0.05
709	708.99	10 yr ARI	2.48	58.00	58.06	58.14	58.39	0.119898	2.47	0.98	0.06
709	708.99	100 yr ARI	5.41	58.00	58.08	58.21	58.82	0.185242	3.44	1.43	0.07
27	641.72	5 yr ARI	5.30	54.00	54.14	54.38	55.60	0.171448	5.35	0.99	0.13
27	641.72	10 yr ARI	7.08	54.00	54.19	54.45	55.61	0.118479	5.28	1.34	0.17
27	641.72	100 yr ARI	14.50	54.00	54.35	54.69	55.82	0.058963	5.37	2.70	0.30
27	630.79	5 yr ARI	5.30	53.85	54.14	54.25	54.52	0.037012	2.75	1.93	0.15
27	630.79	10 yr ARI	7.08	53.85	54.17	54.30	54.65	0.037720	3.09	2.29	0.18

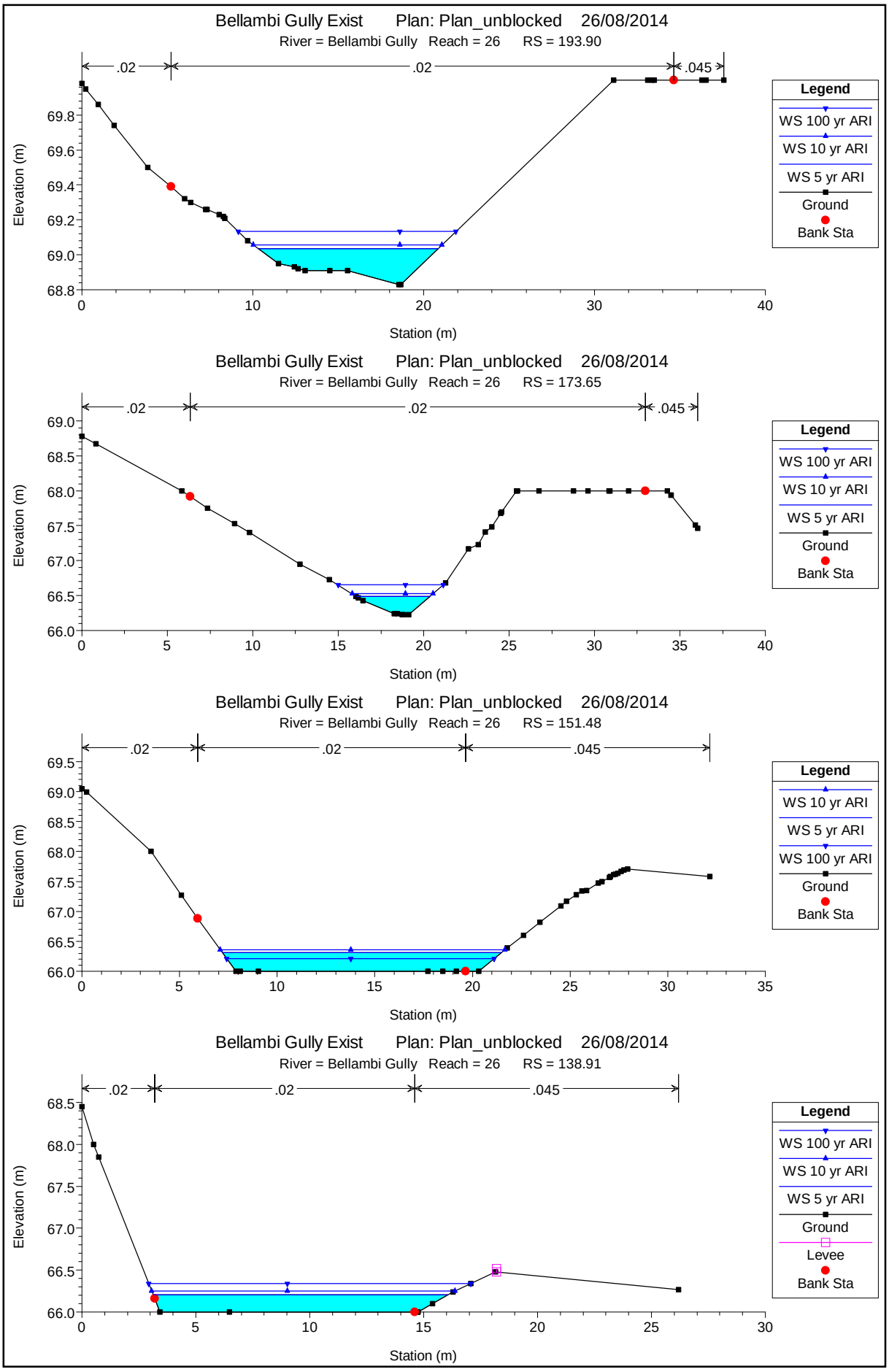
HEC-RAS Plan: 20block (Continued)

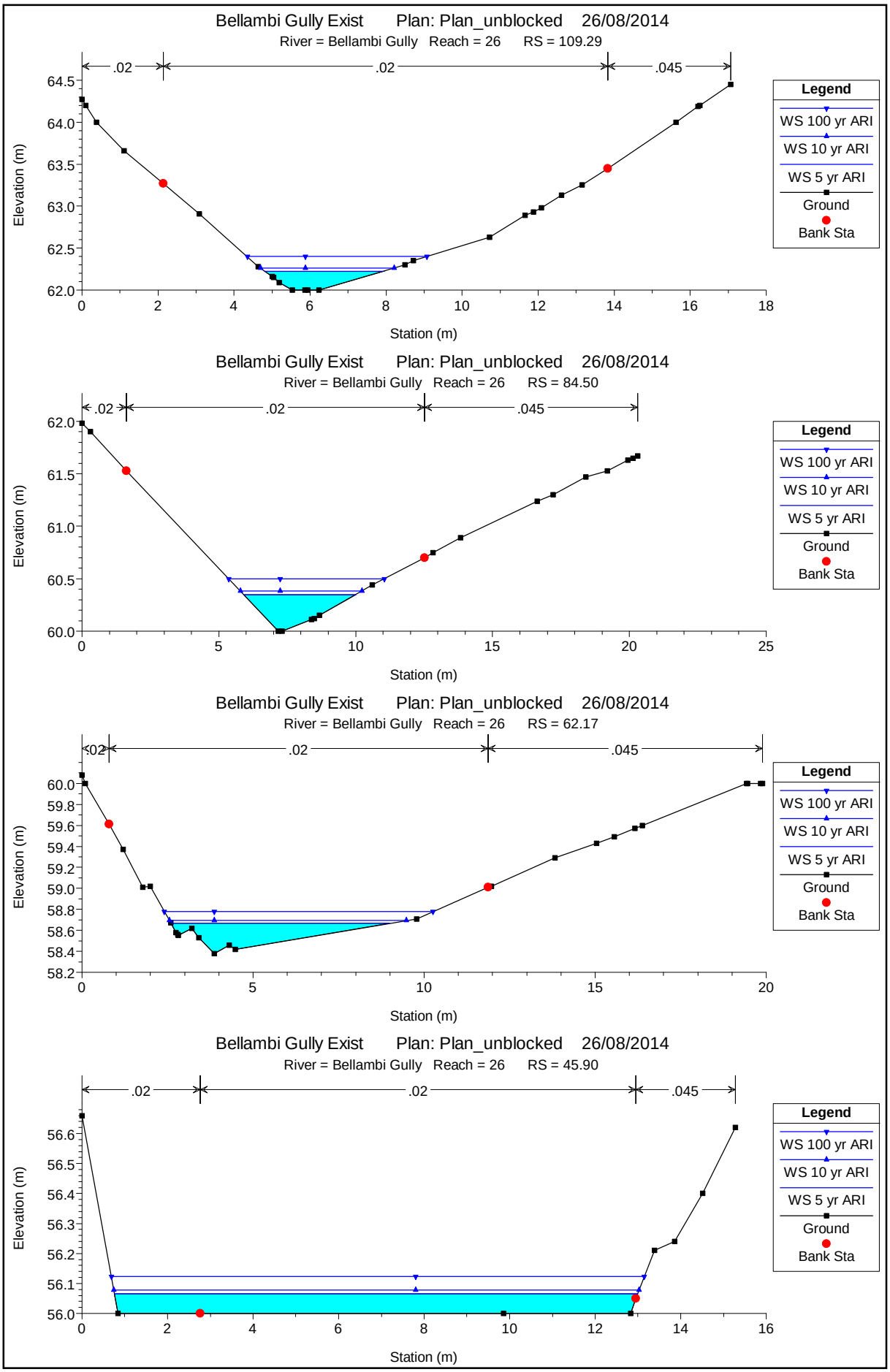
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Hydr Depth
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)
27	630.79	100 yr ARI	14.50	53.85	54.26	54.49	55.12	0.039578	4.09	3.54	0.27
27	621.04	5 yr ARI	5.30	52.00	52.40	52.72	53.90	0.083871	5.41	0.98	0.23
27	621.04	10 yr ARI	7.08	52.00	52.47	52.81	54.05	0.074143	5.57	1.27	0.27
27	621.04	100 yr ARI	14.50	52.00	52.67	53.11	54.55	0.057382	6.08	2.39	0.37
27	604.68	5 yr ARI	5.30	51.92	52.09	52.17	52.42	0.058724	2.56	2.08	0.10
27	604.68	10 yr ARI	7.08	51.92	52.10	52.21	52.56	0.067605	3.00	2.38	0.11
27	604.68	100 yr ARI	14.50	51.92	52.14	52.35	53.11	0.091387	4.37	3.35	0.15
27	551.35	5 yr ARI	5.30	48.00	48.11	48.23	48.63	0.086963	3.18	1.67	0.10
27	551.35	10 yr ARI	7.08	48.00	48.14	48.28	48.72	0.076743	3.36	2.10	0.12
27	551.35	100 yr ARI	14.50	48.00	48.22	48.42	49.03	0.063627	4.00	3.63	0.18
27	459.33	5 yr ARI	5.30	46.00	46.10	46.11	46.17	0.011831	1.15	4.63	0.10
27	459.33	10 yr ARI	7.08	46.00	46.12	46.14	46.21	0.012630	1.31	5.43	0.11
27	459.33	100 yr ARI	14.50	46.00	46.17	46.22	46.34	0.015071	1.79	8.18	0.15
27	433.25	5 yr ARI	5.30	45.26	45.56	45.63	45.77	0.020119	2.01	2.64	0.15
27	433.25	10 yr ARI	7.08	45.26	45.61	45.67	45.82	0.017003	2.03	3.49	0.17
27	433.25	100 yr ARI	14.50	45.26	45.74	45.81	45.99	0.010850	2.23	6.65	0.25
27	385.63	5 yr ARI	5.30	44.00	44.10	44.17	44.36	0.047300	2.27	2.35	0.09
27	385.63	10 yr ARI	7.08	44.00	44.11	44.20	44.47	0.053817	2.65	2.69	0.11
27	385.63	100 yr ARI	14.50	44.00	44.16	44.33	44.88	0.068267	3.80	3.86	0.15
27	312.82	5 yr ARI	5.30	41.52	41.81	41.89	42.05	0.022389	2.16	2.45	0.16
27	312.82	10 yr ARI	7.08	41.52	41.85	41.94	42.12	0.020901	2.28	3.11	0.18
27	312.82	100 yr ARI	14.50	41.52	41.97	42.09	42.34	0.019680	2.69	5.38	0.24
27	296.44	5 yr ARI	5.30	40.00	40.17	40.33	41.18	0.178800	4.63	1.25	0.11
27	296.44	10 yr ARI	7.08	40.00	40.19	40.38	41.28	0.183063	4.78	1.60	0.11
27	296.44	100 yr ARI	14.50	40.00	40.28	40.54	41.59	0.116120	5.23	2.98	0.17
27	240.96	5 yr ARI	5.30	40.00	40.14	40.13	40.19	0.005797	1.01	5.29	0.14
27	240.96	10 yr ARI	7.08	40.00	40.17	40.17	40.23	0.005382	1.10	6.49	0.16
27	240.96	100 yr ARI	14.50	40.00	40.18	40.25	40.41	0.019383	2.15	6.80	0.17
27	231.57	5 yr ARI	5.30	40.00	38.14	38.39	39.73	0.188640		0.95	0.13
27	231.57	10 yr ARI	7.08	40.00	38.18	38.46	39.85	0.146789		1.23	0.16
27	231.57	100 yr ARI	14.50	40.00	38.36	38.72	39.85	0.056404		2.68	0.31
27	222.27	5 yr ARI	5.30	40.00	38.15	38.27	38.61	0.053661		1.76	0.13
27	222.27	10 yr ARI	7.08	40.00	38.17	38.32	38.76	0.060023		2.08	0.15
27	222.27	100 yr ARI	14.50	40.00	38.26	38.48	39.17	0.060834		3.43	0.20
27	200.28	5 yr ARI	5.30	40.00	38.05	38.05	38.09	0.008308		6.06	0.08
27	200.28	10 yr ARI	7.08	40.00	38.06	38.07	38.12	0.011087		6.62	0.09
27	200.28	100 yr ARI	14.50	40.00	38.09	38.12	38.23	0.019257		8.66	0.12
27	174.18	5 yr ARI	5.30	40.00	36.29	36.39	37.31	0.436637		1.19	0.05
27	174.18	10 yr ARI	7.08	40.00	36.31	36.42	37.20	0.294531		1.69	0.05
27	174.18	100 yr ARI	14.50	40.00	36.37	36.51	37.12	0.119257		3.78	0.10
27	136.26	5 yr ARI	5.30	36.00	36.10	36.09	36.14	0.031770	0.84	6.28	0.10
27	136.26	10 yr ARI	7.08	36.00	36.12	36.11	36.16	0.027507	0.91	7.81	0.12
27	136.26	100 yr ARI	14.50	36.00	36.19	36.17	36.26	0.025537	1.18	12.32	0.19
27	125.17	5 yr ARI	5.30	35.38	35.69	35.69	35.76	0.036826	1.21	4.37	0.15
27	125.17	10 yr ARI	7.08	35.38	35.72	35.72	35.81	0.036059	1.30	5.45	0.17
27	125.17	100 yr ARI	14.50	35.38	35.84	35.84	35.95	0.031962	1.50	9.68	0.23
27	103.64	5 yr ARI	5.30	33.76	34.02	34.10	34.29	0.214165	2.30	2.31	0.11
27	103.64	10 yr ARI	7.08	33.76	34.04	34.13	34.36	0.203872	2.52	2.81	0.13
27	103.64	100 yr ARI	14.50	33.76	34.11	34.26	34.63	0.191088	3.18	4.55	0.19
27	93.05	5 yr ARI	5.30	32.56	32.94	33.06	33.31	0.050775	2.69	1.97	0.12
27	93.05	10 yr ARI	7.08	32.56	32.97	33.09	33.40	0.050237	2.91	2.43	0.13
27	93.05	100 yr ARI	14.50	32.56	33.05	33.22	33.71	0.048446	3.59	4.04	0.19
27	66.78	5 yr ARI	5.30	30.00	30.13	30.24	30.57	0.058172	2.94	1.80	0.12
27	66.78	10 yr ARI	7.08	30.00	30.15	30.29	30.69	0.057089	3.26	2.17	0.14
27	66.78	100 yr ARI	14.50	30.00	30.24	30.46	31.11	0.053451	4.15	3.49	0.22
27	27.36	5 yr ARI	5.30	28.00	30.00	28.49	30.00	0.000008	0.19	44.69	0.87
27	27.36	10 yr ARI	7.08	28.00	30.00	28.58	30.00	0.000014	0.26	44.69	0.87
27	27.36	100 yr ARI	14.50	28.00	30.00	28.87	30.01	0.000058	0.53	44.69	0.87

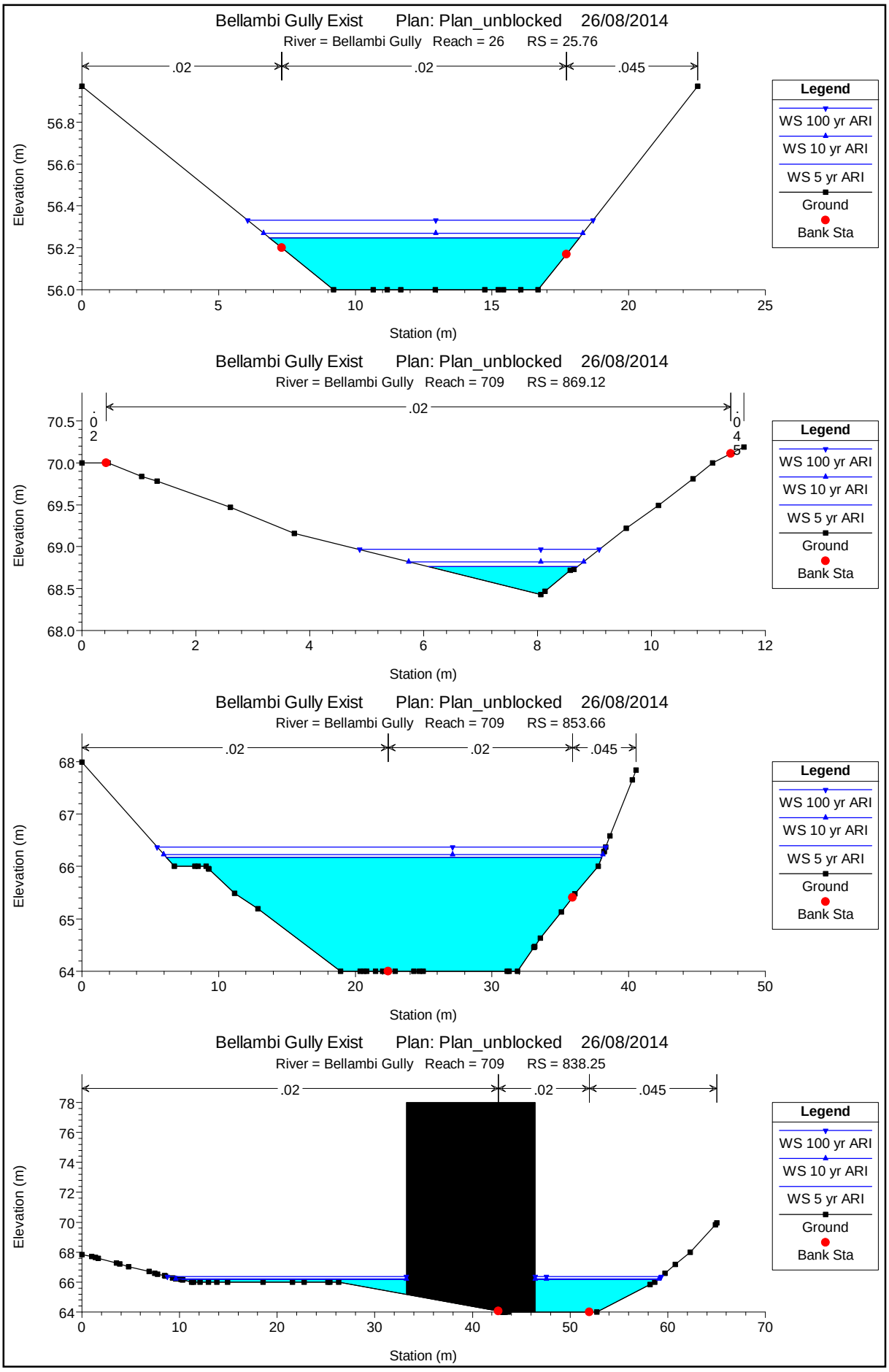
Plan View Scenario 3



Cross Sections




Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 26 RS = 109.29
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 26 RS = 84.50
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 26 RS = 62.17
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 26 RS = 45.90
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta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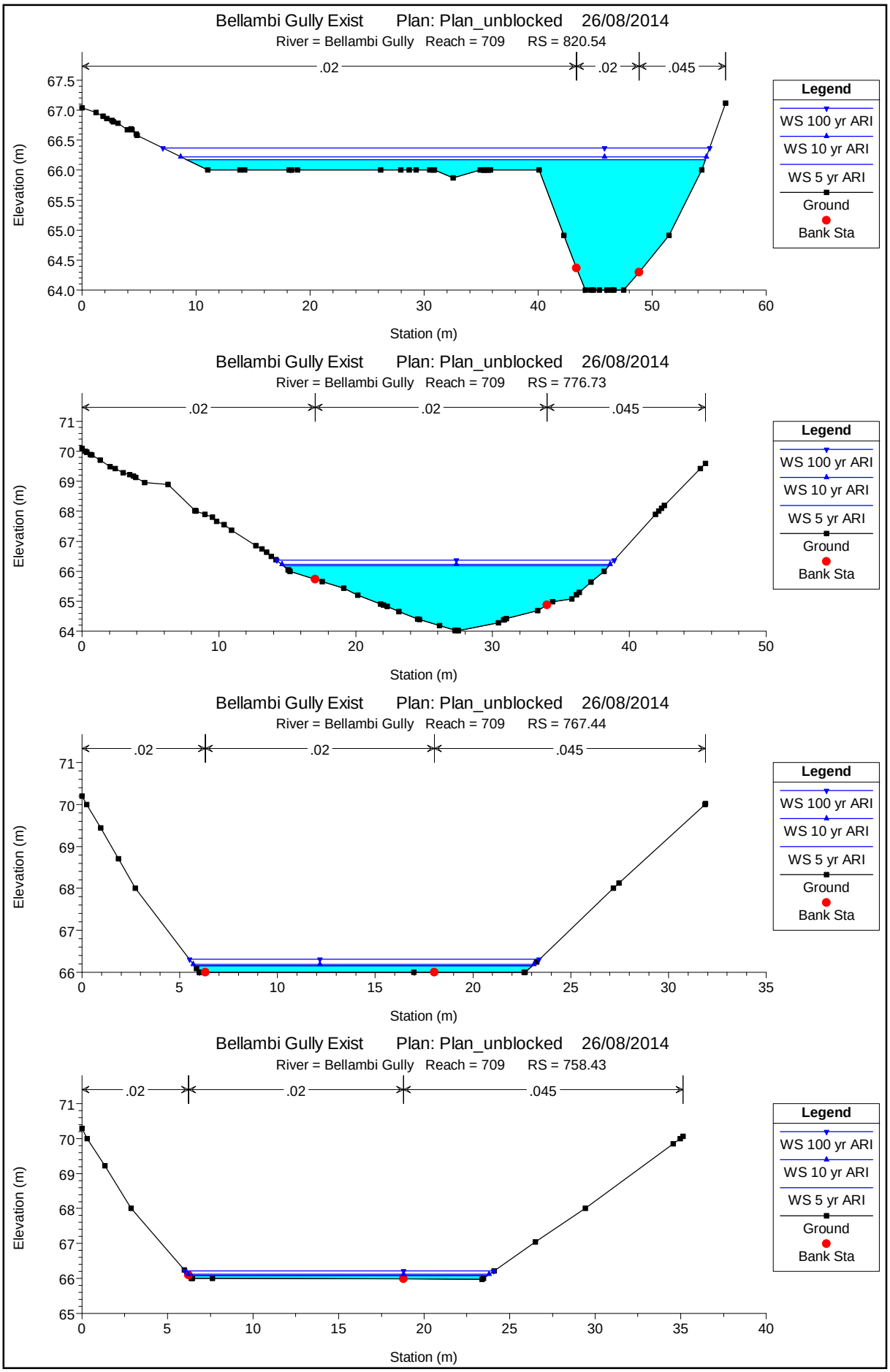
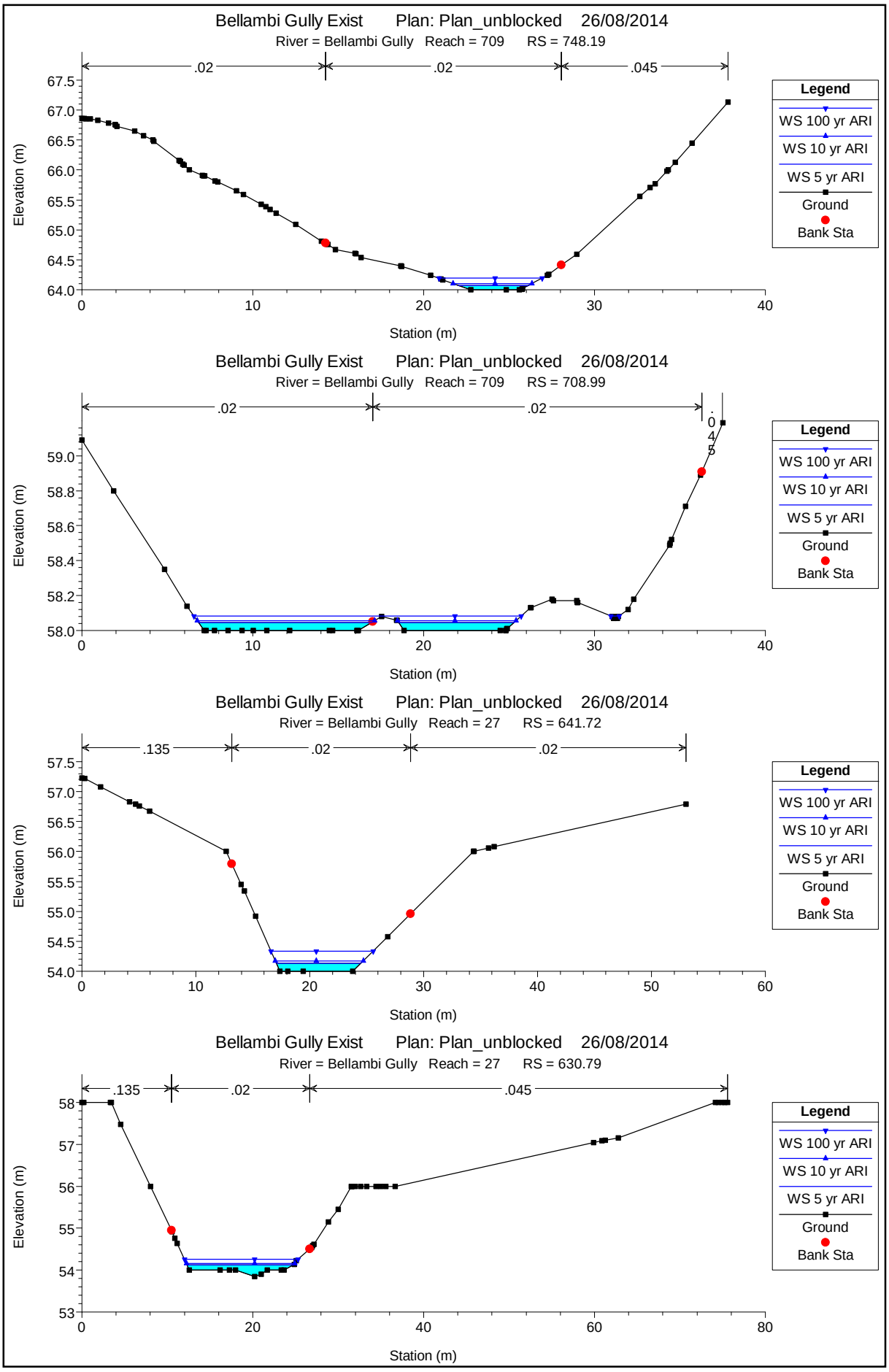
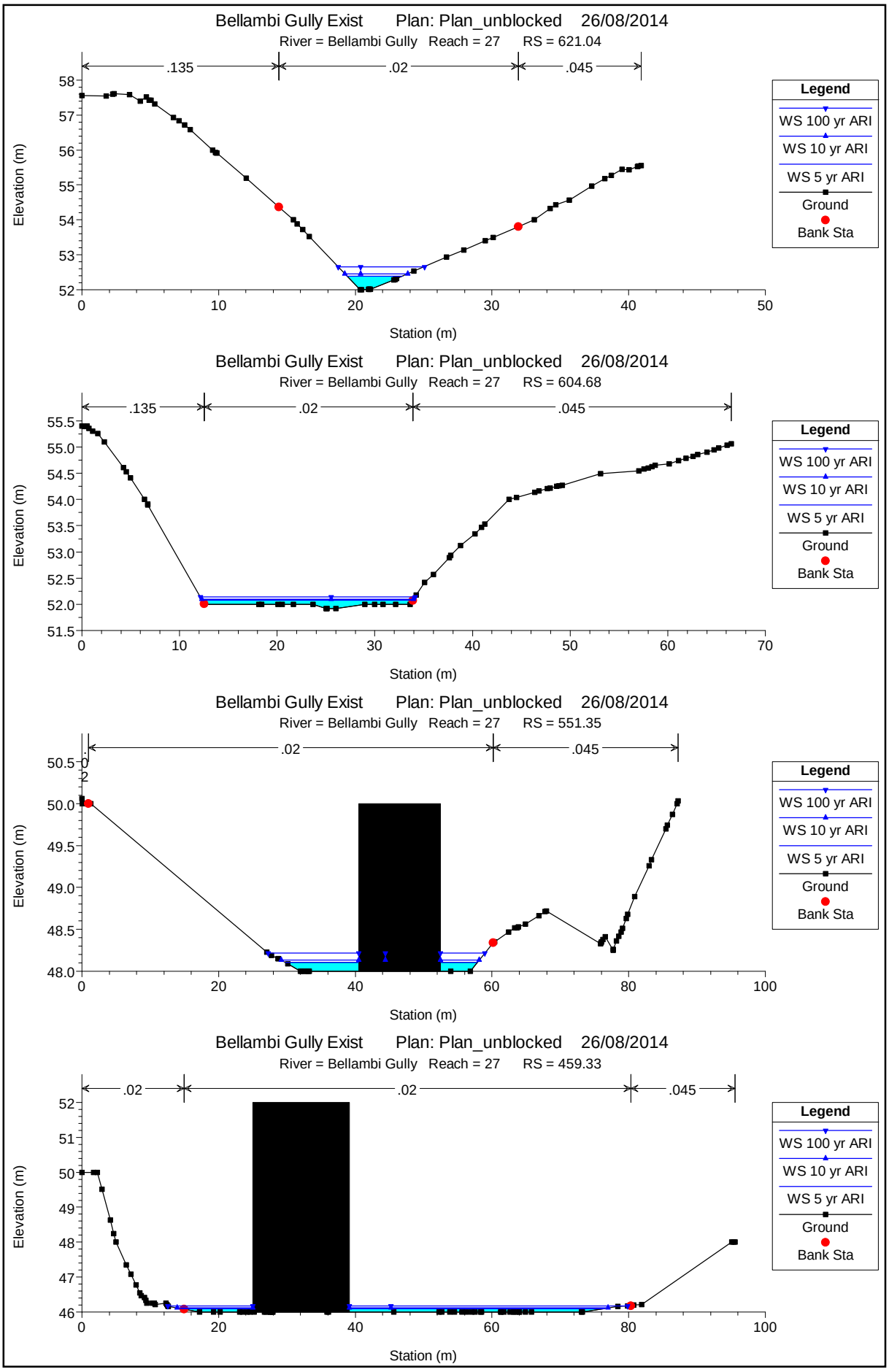
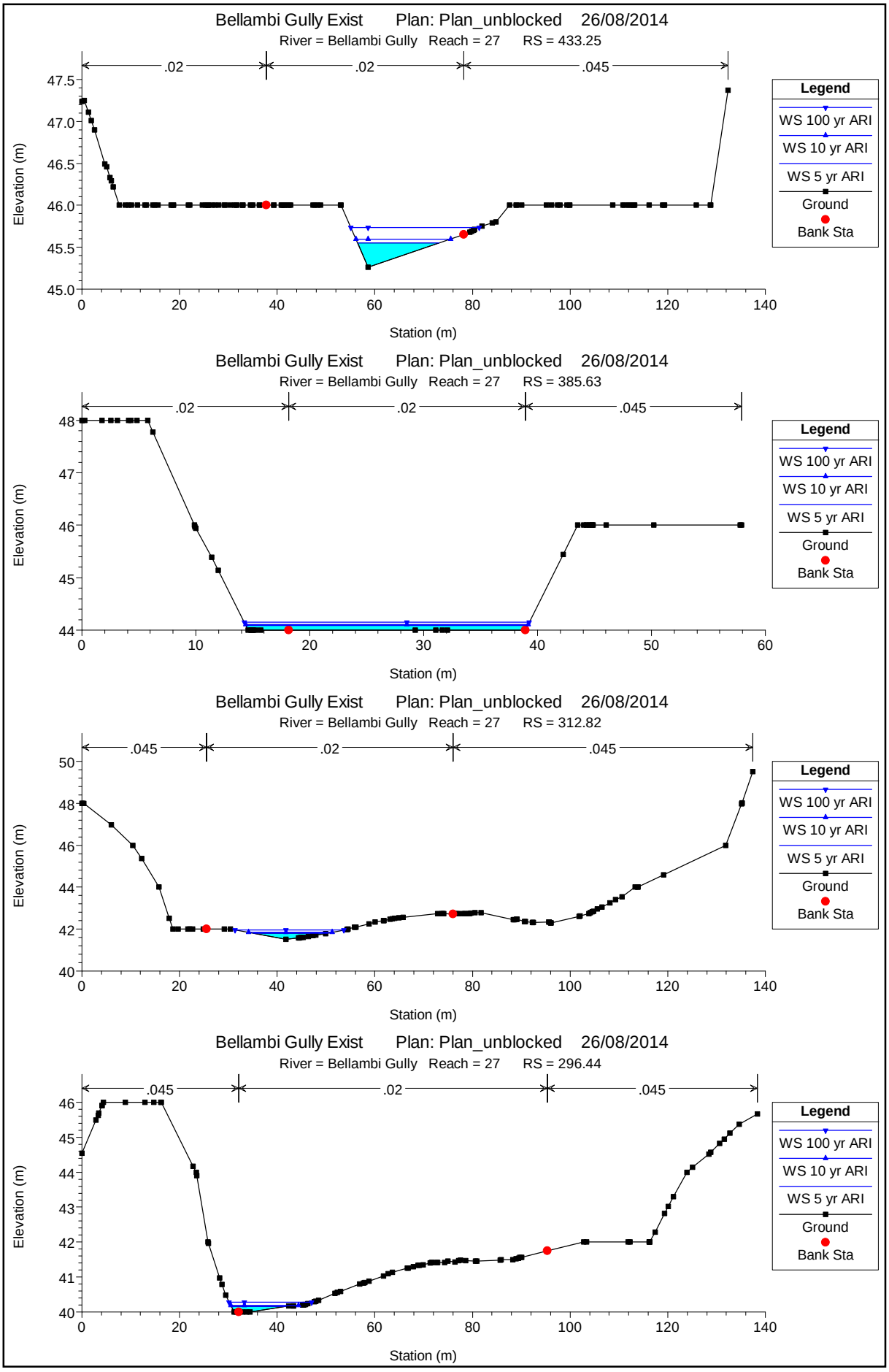
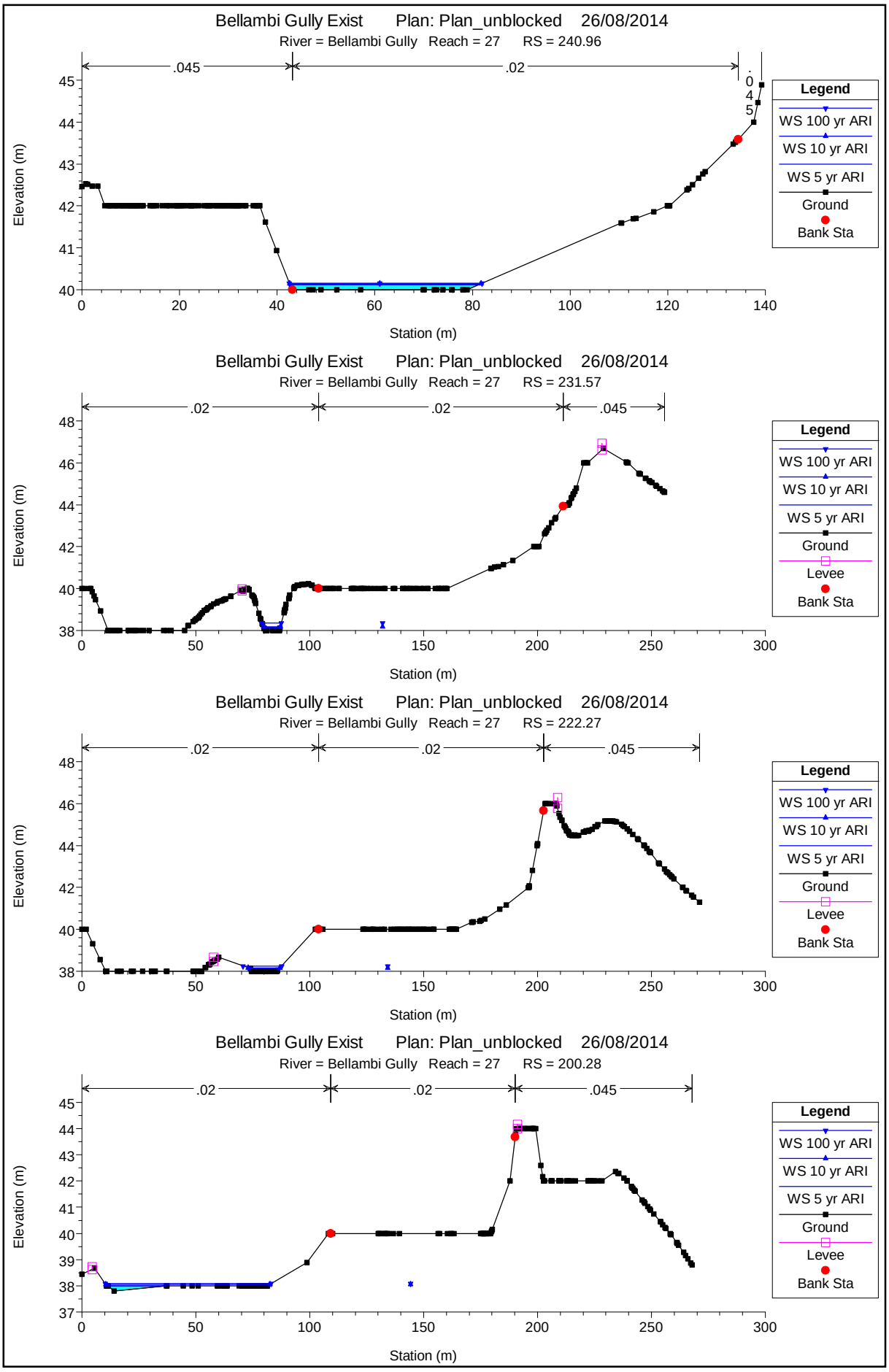
River = Bellambi Gully Reach = 26 RS = 25.76
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 869.12
.02
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 853.66
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 838.25
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta

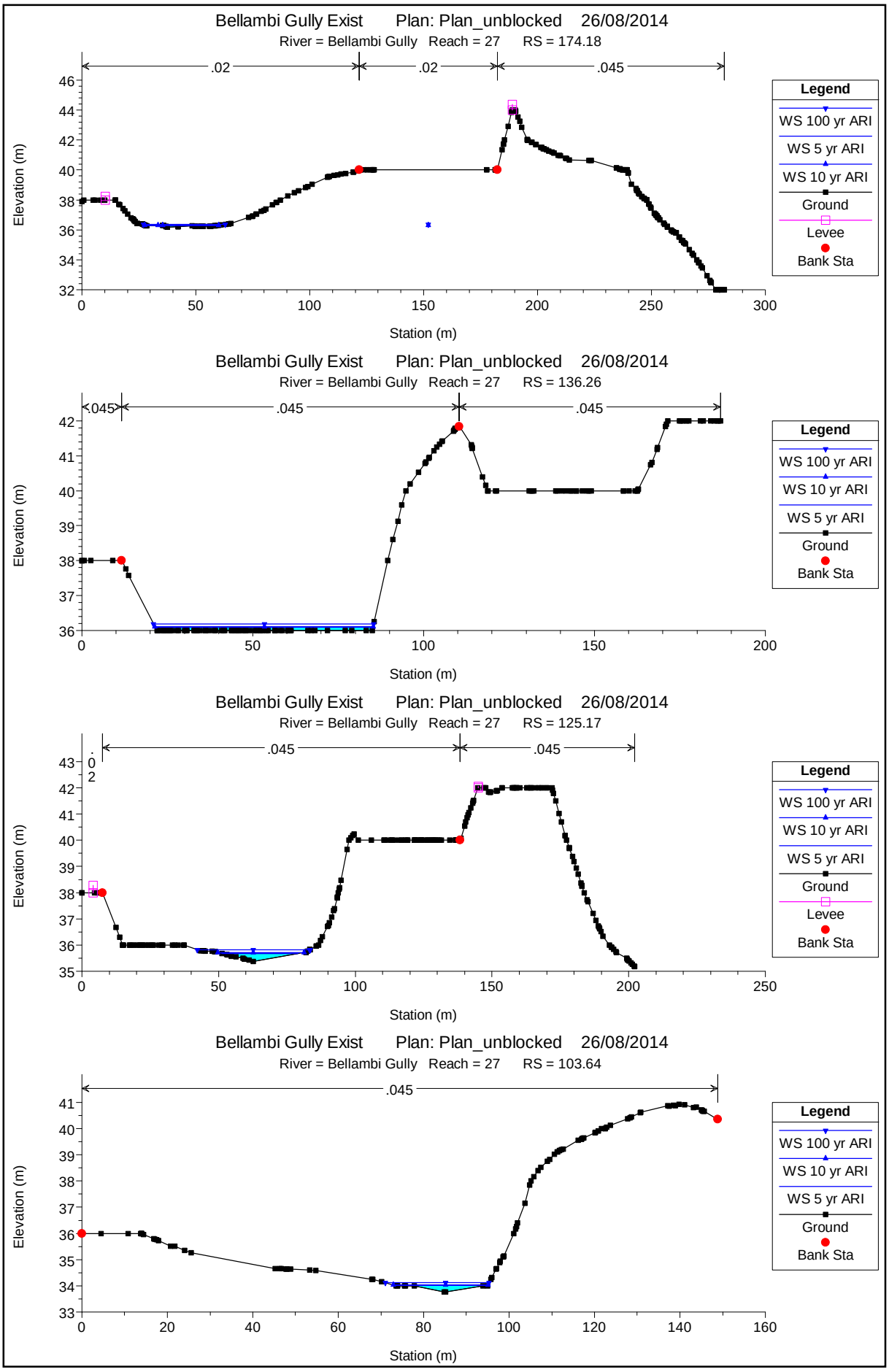

Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 820.54
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 776.73
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 767.44
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 758.43
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta

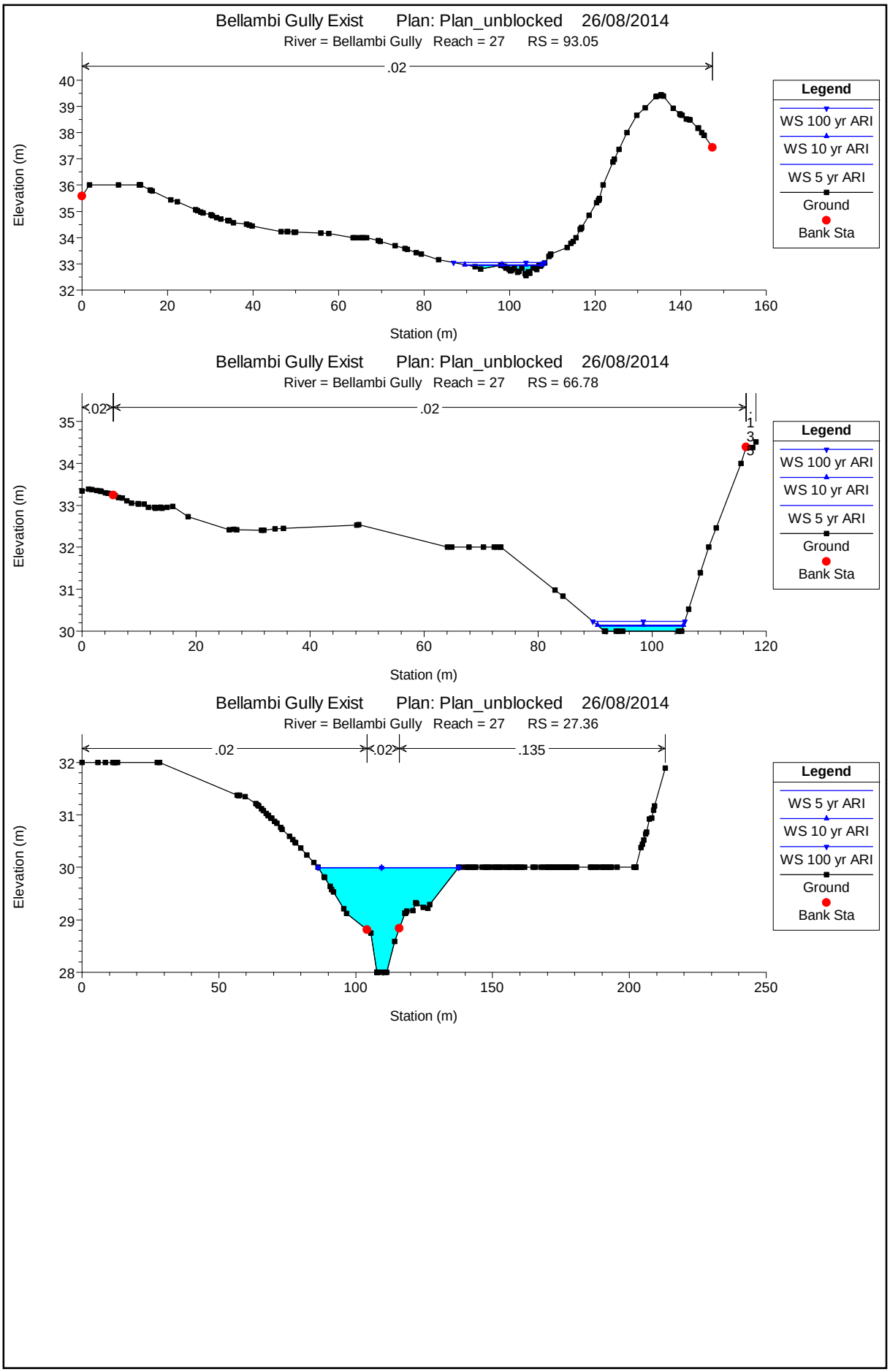

Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 748.19
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 709 RS = 708.99
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 641.72
.135
.02
.02
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 630.79
.135
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta


Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 621.04
.135
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 604.68
.135
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 551.35
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 459.33
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta


Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 433.25
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 385.63
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 312.82
.045
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 296.44
.045
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta


Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 240.96
.045
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 231.57
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Levee
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 222.27
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Levee
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 200.28
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Levee
Bank Sta


Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 174.18
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 5 yr ARI
WS 10 yr ARI
Ground
Levee
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 136.26
.045
.045
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 125.17
.045
.045
.02
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Levee
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 103.64
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta


Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 93.05
.02
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 66.78
.02
.02
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
WS 10 yr ARI
WS 5 yr ARI
Ground
Bank Sta
Bellambi Gully Exist Plan: Plan_unblocked 26/08/2014
River = Bellambi Gully Reach = 27 RS = 27.36
.02
.02
.135
Elevation (m)
Station (m)
Legend
WS 5 yr ARI
WS 10 yr ARI
WS 100 yr ARI
Ground
Bank Sta

HEC-RAS Plan: unblock

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Hydr Depth
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)
26	193.90	5 yr ARI	3.42	68.83	69.03	69.14	69.41	0.050026	2.72	1.26	0.12
26	193.90	10 yr ARI	4.43	68.83	69.06	69.18	69.50	0.050066	2.95	1.50	0.14
26	193.90	100 yr ARI	8.92	68.83	69.13	69.32	69.83	0.050039	3.69	2.42	0.19
26	173.65	5 yr ARI	3.42	66.23	66.49	66.73	67.80	0.124755	5.08	0.67	0.16
26	173.65	10 yr ARI	4.43	66.23	66.53	66.79	67.94	0.113084	5.27	0.84	0.18
26	173.65	100 yr ARI	8.92	66.23	66.65	66.99	68.40	0.089580	5.85	1.52	0.25
26	151.48	5 yr ARI	3.42	66.00	66.31	66.19	66.35	0.001488	0.87	4.19	0.29
26	151.48	10 yr ARI	4.43	66.00	66.36	66.23	66.41	0.001558	0.97	4.87	0.33
26	151.48	100 yr ARI	8.92	66.00	66.21	66.37	66.79	0.038292	3.41	2.76	0.20
26	138.91	5 yr ARI	3.42	66.00	66.20	66.20	66.31	0.007016	1.44	2.49	0.19
26	138.91	10 yr ARI	4.43	66.00	66.25	66.25	66.37	0.005991	1.52	3.08	0.23
26	138.91	100 yr ARI	8.92	66.00	66.34	66.39	66.59	0.008359	2.22	4.34	0.31
26	109.29	5 yr ARI	3.42	62.00	62.23	62.55	65.37	0.349035	7.85	0.44	0.14
26	109.29	10 yr ARI	4.43	62.00	62.26	62.62	65.50	0.304257	7.98	0.56	0.16
26	109.29	100 yr ARI	8.92	62.00	62.40	62.84	65.62	0.176648	7.95	1.12	0.24
26	84.50	5 yr ARI	3.42	60.00	60.35	60.57	61.33	0.072360	4.40	0.78	0.19
26	84.50	10 yr ARI	4.43	60.00	60.38	60.64	61.55	0.075484	4.78	0.93	0.21
26	84.50	100 yr ARI	8.92	60.00	60.50	60.85	62.28	0.083659	5.91	1.51	0.27
26	62.17	5 yr ARI	3.42	58.38	58.67	58.83	59.46	0.092117	3.96	0.86	0.14
26	62.17	10 yr ARI	4.43	58.38	58.69	58.89	59.61	0.092271	4.25	1.04	0.15
26	62.17	100 yr ARI	8.92	58.38	58.78	59.07	60.23	0.091352	5.33	1.67	0.21
26	45.90	5 yr ARI	3.42	56.00	56.07	56.20	57.01	0.285735	4.33	0.79	0.06
26	45.90	10 yr ARI	4.43	56.00	56.08	56.24	57.21	0.271267	4.72	0.94	0.08
26	45.90	100 yr ARI	8.92	56.00	56.12	56.38	57.93	0.236518	6.00	1.50	0.12
26	25.76	5 yr ARI	3.42	56.00	56.25	56.25	56.36	0.006542	1.48	2.34	0.21
26	25.76	10 yr ARI	4.43	56.00	56.27	56.29	56.42	0.007971	1.74	2.59	0.22
26	25.76	100 yr ARI	8.92	56.00	56.33	56.45	56.72	0.014866	2.76	3.35	0.26
709	869.12	5 yr ARI	1.40	68.43	68.76	68.91	69.30	0.050032	3.26	0.43	0.16
709	869.12	10 yr ARI	2.16	68.43	68.82	69.00	69.49	0.050041	3.64	0.59	0.19
709	869.12	100 yr ARI	5.08	68.43	68.97	69.23	70.00	0.050062	4.51	1.13	0.27
709	853.66	5 yr ARI	1.40	64.00	66.18	64.12	66.18	0.000000	0.03	47.23	1.48
709	853.66	10 yr ARI	2.16	64.00	66.22	64.14	66.22	0.000000	0.05	48.77	1.52
709	853.66	100 yr ARI	5.08	64.00	66.37	64.24	66.37	0.000002	0.11	53.61	1.63
709	838.25	5 yr ARI	1.40	64.00	66.18		66.18	0.000001	0.08	27.50	0.77
709	838.25	10 yr ARI	2.16	64.00	66.22		66.22	0.000003	0.12	29.22	0.81
709	838.25	100 yr ARI	5.08	64.00	66.37		66.37	0.000011	0.23	34.66	0.93
709	820.54	5 yr ARI	1.40	64.00	66.18		66.18	0.000001	0.09	26.57	0.58
709	820.54	10 yr ARI	2.16	64.00	66.22		66.22	0.000003	0.13	28.77	0.62
709	820.54	100 yr ARI	5.08	64.00	66.37		66.37	0.000009	0.26	35.71	0.74
709	776.73	5 yr ARI	1.40	64.01	66.18		66.18	0.000001	0.05	29.87	1.26
709	776.73	10 yr ARI	2.16	64.01	66.22		66.22	0.000001	0.08	31.01	1.29
709	776.73	100 yr ARI	5.08	64.01	66.37		66.37	0.000005	0.17	34.61	1.40
709	767.44	5 yr ARI	1.40	66.00	66.16		66.17	0.001921	0.63	2.65	0.15
709	767.44	10 yr ARI	2.16	66.00	66.19		66.22	0.002214	0.79	3.30	0.19
709	767.44	100 yr ARI	5.08	66.00	66.31		66.37	0.002609	1.16	5.30	0.30
709	758.43	5 yr ARI	1.40	65.99	66.08	66.08	66.13	0.013062	1.10	1.51	0.09
709	758.43	10 yr ARI	2.16	65.99	66.12	66.12	66.18	0.009437	1.19	2.16	0.12
709	758.43	100 yr ARI	5.08	65.99	66.21	66.21	66.32	0.007560	1.57	3.88	0.21
709	748.19	5 yr ARI	1.40	64.00	64.07	64.23	65.59	0.485661	5.46	0.26	0.06
709	748.19	10 yr ARI	2.16	64.00	64.10	64.29	65.73	0.355905	5.66	0.38	0.08
709	748.19	100 yr ARI	5.08	64.00	64.19	64.45	65.95	0.184210	5.87	0.87	0.14
709	708.99	5 yr ARI	1.40	58.00	58.05	58.09	58.23	0.095911	1.91	0.73	0.04
709	708.99	10 yr ARI	2.16	58.00	58.06	58.12	58.34	0.112844	2.33	0.91	0.05
709	708.99	100 yr ARI	5.08	58.00	58.08	58.20	58.77	0.178725	3.33	1.39	0.07
27	641.72	5 yr ARI	4.81	54.00	54.13	54.36	55.61	0.195907	5.39	0.89	0.12
27	641.72	10 yr ARI	6.59	54.00	54.18	54.43	55.61	0.131291	5.32	1.24	0.16
27	641.72	100 yr ARI	14.01	54.00	54.34	54.68	55.80	0.060685	5.36	2.61	0.29
27	630.79	5 yr ARI	4.81	53.85	54.13	54.23	54.49	0.036651	2.65	1.82	0.15
27	630.79	10 yr ARI	6.59	53.85	54.16	54.29	54.62	0.037734	3.01	2.19	0.17

HEC-RAS Plan: unblock (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Hydr Depth
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)
27	630.79	100 yr ARI	14.01	53.85	54.26	54.48	55.09	0.039707	4.05	3.46	0.26
27	621.04	5 yr ARI	4.81	52.00	52.38	52.69	53.85	0.087769	5.36	0.90	0.22
27	621.04	10 yr ARI	6.59	52.00	52.45	52.79	54.01	0.076318	5.53	1.19	0.26
27	621.04	100 yr ARI	14.01	52.00	52.66	53.09	54.52	0.058029	6.05	2.32	0.37
27	604.68	5 yr ARI	4.81	51.92	52.08	52.16	52.38	0.055159	2.41	2.00	0.09
27	604.68	10 yr ARI	6.59	51.92	52.10	52.20	52.52	0.064594	2.87	2.31	0.11
27	604.68	100 yr ARI	14.01	51.92	52.14	52.34	53.08	0.090517	4.29	3.29	0.15
27	551.35	5 yr ARI	4.81	48.00	48.11	48.22	48.61	0.092437	3.13	1.53	0.09
27	551.35	10 yr ARI	6.59	48.00	48.13	48.27	48.70	0.079565	3.32	1.98	0.12
27	551.35	100 yr ARI	14.01	48.00	48.22	48.41	49.01	0.063880	3.96	3.54	0.18
27	459.33	5 yr ARI	4.81	46.00	46.10	46.11	46.16	0.011510	1.10	4.39	0.09
27	459.33	10 yr ARI	6.59	46.00	46.12	46.13	46.20	0.012458	1.27	5.22	0.11
27	459.33	100 yr ARI	14.01	46.00	46.17	46.21	46.33	0.014932	1.76	8.02	0.15
27	433.25	5 yr ARI	4.81	45.26	45.55	45.61	45.75	0.021091	2.00	2.41	0.14
27	433.25	10 yr ARI	6.59	45.26	45.60	45.66	45.80	0.017580	2.02	3.27	0.17
27	433.25	100 yr ARI	14.01	45.26	45.73	45.80	45.98	0.011105	2.21	6.45	0.25
27	385.63	5 yr ARI	4.81	44.00	44.09	44.16	44.33	0.045342	2.16	2.24	0.09
27	385.63	10 yr ARI	6.59	44.00	44.11	44.19	44.44	0.052556	2.56	2.59	0.10
27	385.63	100 yr ARI	14.01	44.00	44.15	44.32	44.86	0.067870	3.74	3.79	0.15
27	312.82	5 yr ARI	4.81	41.52	41.80	41.88	42.03	0.022984	2.12	2.27	0.15
27	312.82	10 yr ARI	6.59	41.52	41.84	41.93	42.10	0.021131	2.24	2.94	0.17
27	312.82	100 yr ARI	14.01	41.52	41.96	42.08	42.32	0.019622	2.67	5.25	0.24
27	296.44	5 yr ARI	4.81	40.00	40.16	40.32	41.14	0.183366	4.55	1.15	0.10
27	296.44	10 yr ARI	6.59	40.00	40.19	40.36	41.25	0.186988	4.73	1.50	0.11
27	296.44	100 yr ARI	14.01	40.00	40.27	40.53	41.58	0.118899	5.21	2.89	0.17
27	240.96	5 yr ARI	4.81	40.00	40.12	40.12	40.18	0.007994	1.07	4.51	0.12
27	240.96	10 yr ARI	6.59	40.00	40.15	40.15	40.22	0.007971	1.21	5.49	0.14
27	240.96	100 yr ARI	14.01	40.00	40.16	40.24	40.45	0.028918	2.40	5.88	0.15
27	231.57	5 yr ARI	4.81	40.00	38.13	38.37	39.71	0.208884		0.86	0.12
27	231.57	10 yr ARI	6.59	40.00	38.17	38.45	39.78	0.150244		1.17	0.16
27	231.57	100 yr ARI	14.01	40.00	38.36	38.70	39.78	0.054503		2.65	0.31
27	222.27	5 yr ARI	4.81	40.00	38.14	38.25	38.57	0.051850		1.66	0.13
27	222.27	10 yr ARI	6.59	40.00	38.16	38.31	38.71	0.056651		2.02	0.14
27	222.27	100 yr ARI	14.01	40.00	38.25	38.47	39.12	0.058484		3.40	0.20
27	200.28	5 yr ARI	4.81	40.00	38.00	38.04	38.21	0.038634		2.37	0.09
27	200.28	10 yr ARI	6.59	40.00	38.06	38.06	38.11	0.010414		6.45	0.09
27	200.28	100 yr ARI	14.01	40.00	38.09	38.12	38.22	0.018578		8.57	0.12
27	174.18	5 yr ARI	4.81	40.00	36.32	36.38	36.61	0.100700		1.99	0.06
27	174.18	10 yr ARI	6.59	40.00	36.30	36.41	37.22	0.324145		1.55	0.05
27	174.18	100 yr ARI	14.01	40.00	36.36	36.51	37.12	0.125849		3.63	0.10
27	136.26	5 yr ARI	4.81	36.00	36.09	36.09	36.13	0.033032	0.82	5.85	0.09
27	136.26	10 yr ARI	6.59	36.00	36.11	36.10	36.16	0.031175	0.92	7.20	0.11
27	136.26	100 yr ARI	14.01	36.00	36.19	36.17	36.26	0.024786	1.15	12.17	0.19
27	125.17	5 yr ARI	4.81	35.38	35.68	35.68	35.75	0.035713	1.17	4.12	0.15
27	125.17	10 yr ARI	6.59	35.38	35.72	35.72	35.80	0.033435	1.24	5.32	0.17
27	125.17	100 yr ARI	14.01	35.38	35.83	35.83	35.94	0.034098	1.51	9.25	0.22
27	103.64	5 yr ARI	4.81	33.76	34.01	34.08	34.27	0.230352	2.27	2.12	0.10
27	103.64	10 yr ARI	6.59	33.76	34.03	34.12	34.37	0.237968	2.57	2.56	0.12
27	103.64	100 yr ARI	14.01	33.76	34.12	34.26	34.60	0.178161	3.08	4.56	0.19
27	93.05	5 yr ARI	4.81	32.56	32.94	33.04	33.28	0.049739	2.60	1.85	0.11
27	93.05	10 yr ARI	6.59	32.56	32.97	33.08	33.37	0.049349	2.83	2.33	0.13
27	93.05	100 yr ARI	14.01	32.56	33.05	33.22	33.69	0.048616	3.55	3.94	0.18
27	66.78	5 yr ARI	4.81	30.00	30.12	30.23	30.53	0.059605	2.86	1.68	0.11
27	66.78	10 yr ARI	6.59	30.00	30.14	30.28	30.66	0.058243	3.19	2.06	0.14
27	66.78	100 yr ARI	14.01	30.00	30.23	30.45	31.09	0.053628	4.11	3.41	0.21
27	27.36	5 yr ARI	4.81	28.00	30.00	28.47	30.00	0.000006	0.18	44.69	0.87
27	27.36	10 yr ARI	6.59	28.00	30.00	28.56	30.00	0.000012	0.24	44.69	0.87
27	27.36	100 yr ARI	14.01	28.00	30.00	28.86	30.01	0.000054	0.51	44.69	0.87

Bellambi Gully Flood Study

APPENDIX C
EXISTING SCENARIO FLOOD MAPS

Cardno
Shaping the Future

WOLLONGONG COAL

Scenario 1 (100% blocked pipes)

BELLAMBI GULLY FLOOD STUDY

1:2,500 Scale at A3

Metres

0 40 80 120 160

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2014-06-27
Coordinate System: GDA 1994 MGA Zone 56
Project: 82014089-01
Map: G1001_Scenario1_100perc.mxd 02
Aerial imagery supplied by nearmap (July 2013)

WOLLONGONG COAL

Scenario 2 (20% blocked pipes)

BELLAMBI GULLY FLOOD STUDY

1:2,500 Scale at A3

Metres

0 40 80 120 160

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2014-06-27
Coordinate System: GDA 1994 MGA Zone 56
Project: 82014089-01
Map: G1002_Scenario2_20perc.mxd 02
Aerial imagery supplied by nearmap (July 2013)

WOLLONGONG COAL

Scenario 3 (Unblocked)

BELLAMBI GULLY FLOOD STUDY

1:2,500 Scale at A3

Metres

0 40 80 120 160

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2014-06-27
Coordinate System: GDA 1994 MGA Zone 56
Project: 82014089-01
Map: G1003_Scenario3_unblocked.mxd 02
Aerial imagery supplied by nearmap (July 2013)

Bellambi Gully Flood Study

APPENDIX D
PROPOSED MITIGATION MEASURES

Cardno
Shaping the Future

WOLLONGONG COAL

Proposed Flood Mitigation

BELLAMBI GULLY FLOOD STUDY

1:3,000 Scale at A3

Metres

0 50 100 150 200

N

Cardno

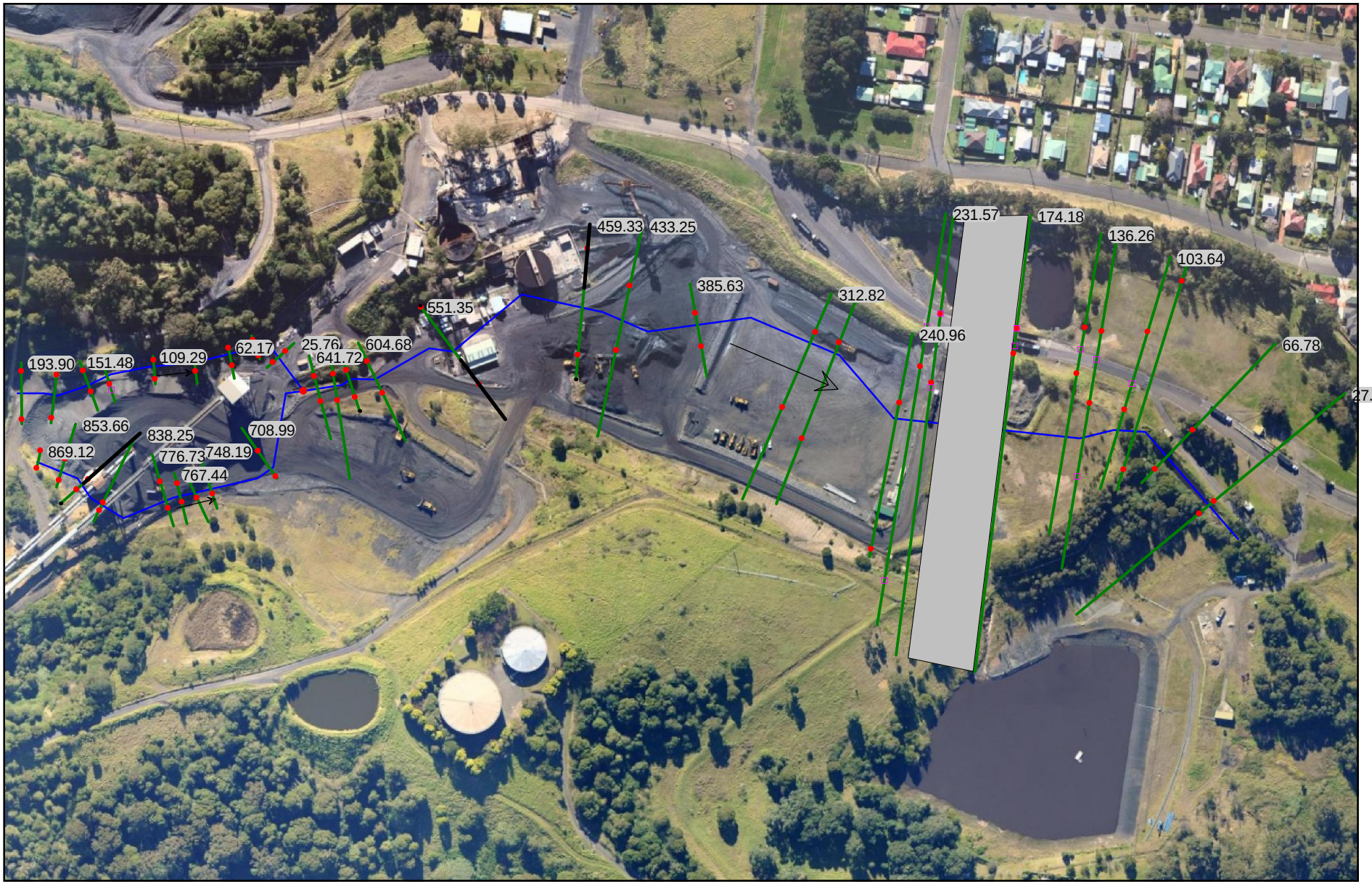
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2014-07-01
Coordinate System: GDA 1994 MGA Zone 56
Project: 82014089-01
Map: G1004_ProposedFloodMitigation.mxd 02
Aerial imagery supplied by nearmap (July 2013)

Bellambi Gully Flood Study

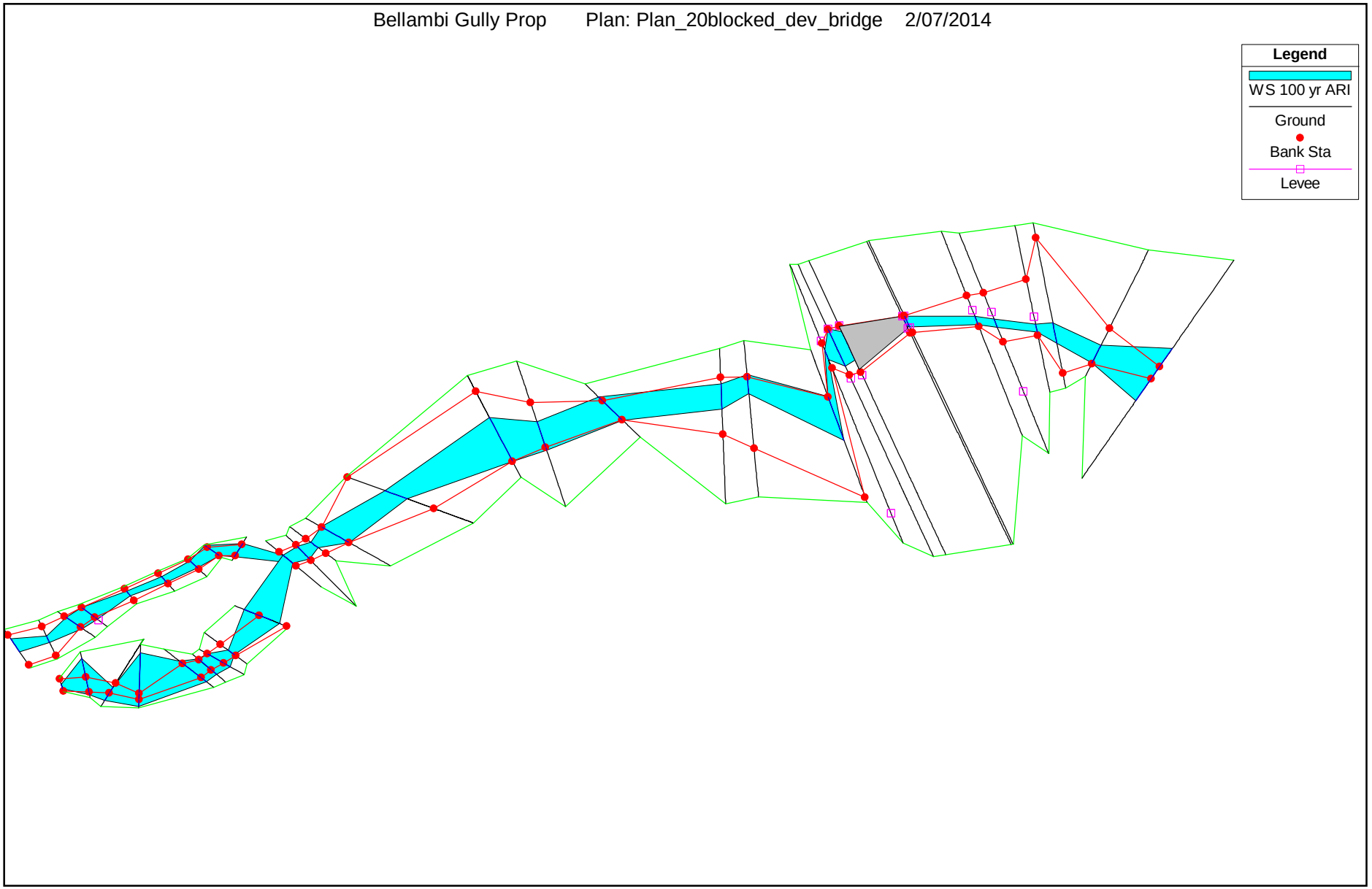
APPENDIX E
PROPOSED SCENARIO HYDRAULIC MODEL

Cardno
Shaping the Future

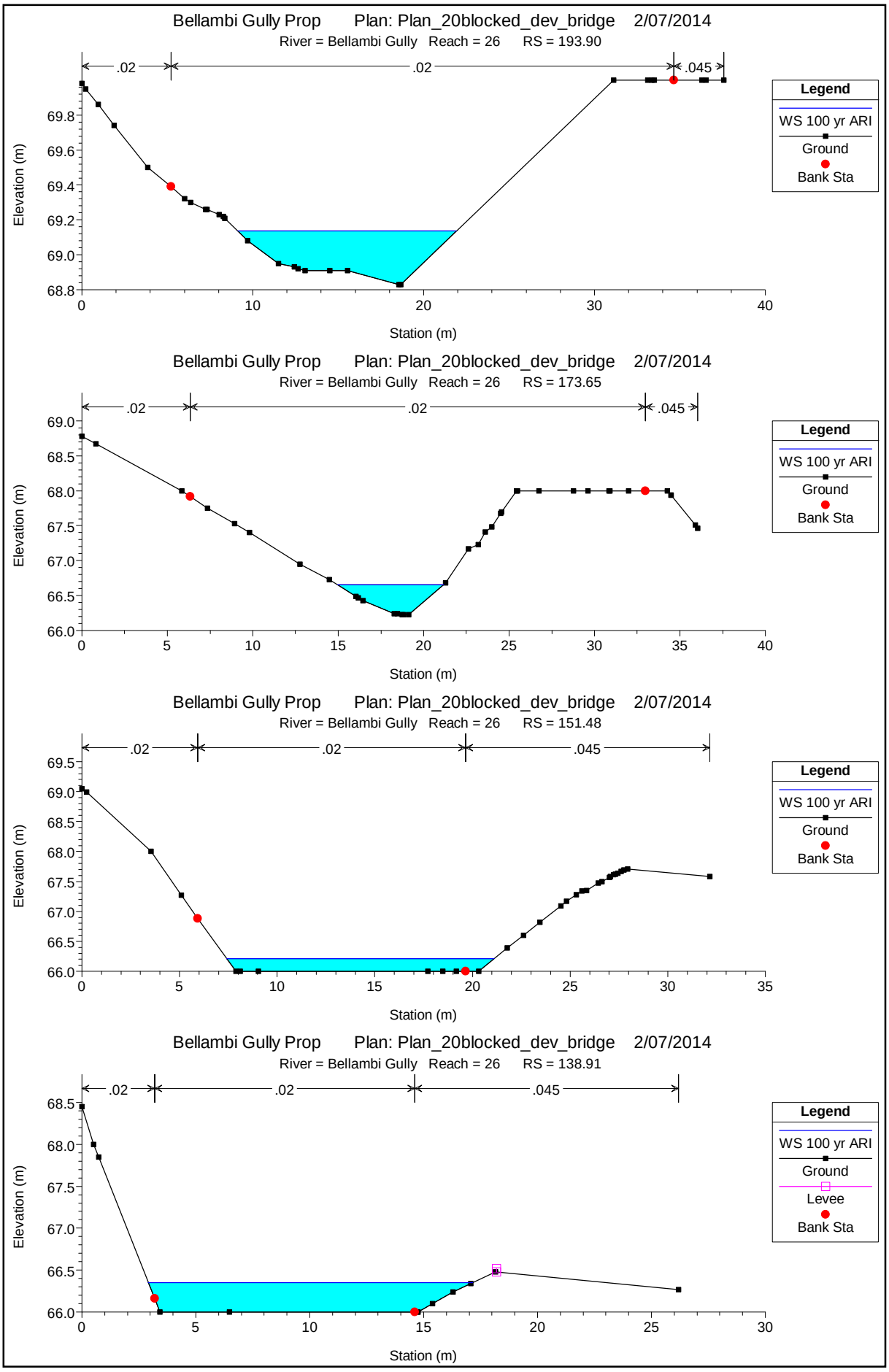
HECRAS Model View

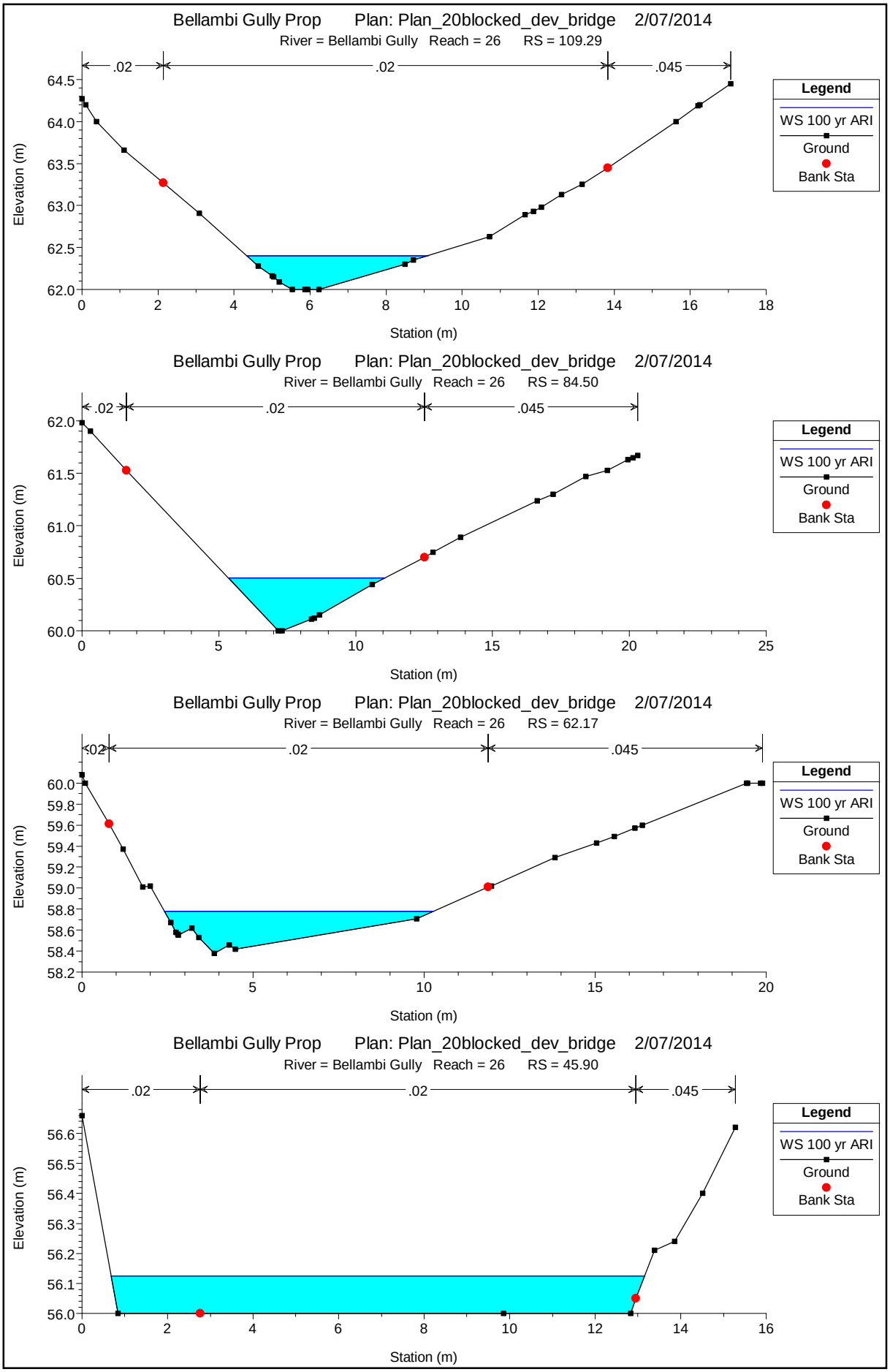


Plan View Proposed Scenario



Cross sections




Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 26 RS = 109.29
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 26 RS = 84.50
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 26 RS = 62.17
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
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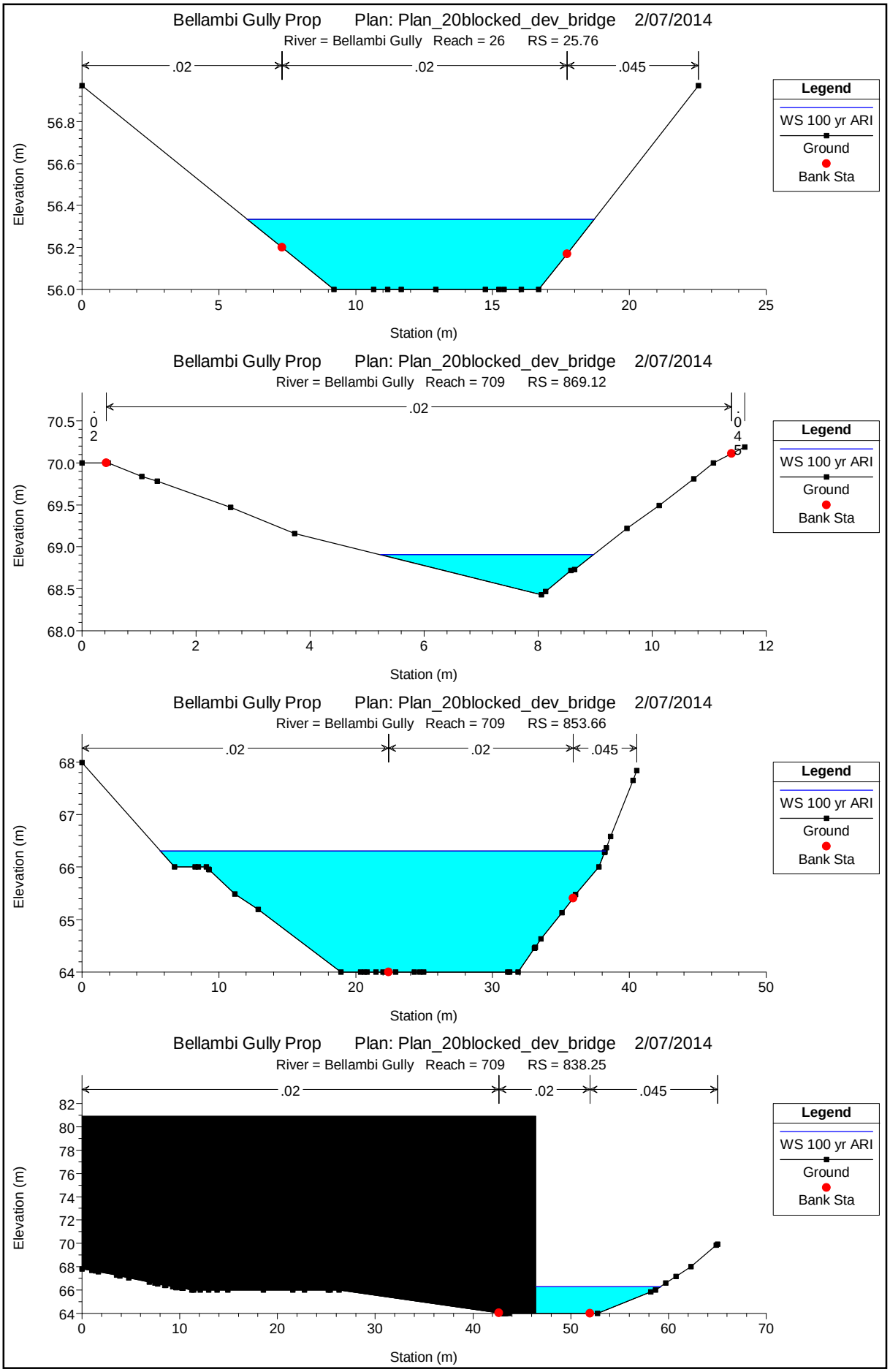
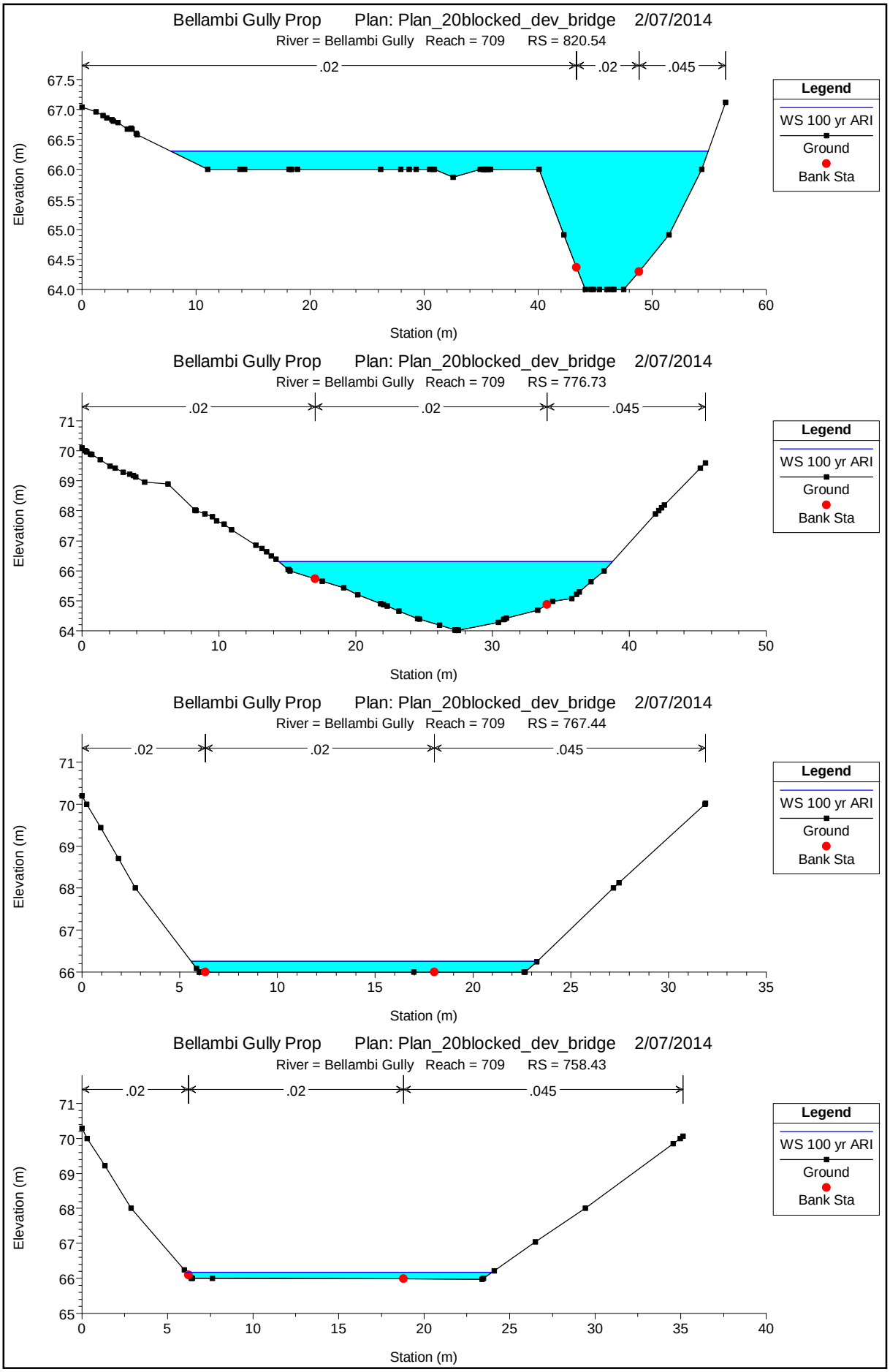
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta


Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 26 RS = 25.76
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 709 RS = 869.12
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 709 RS = 853.66
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 709 RS = 838.25
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta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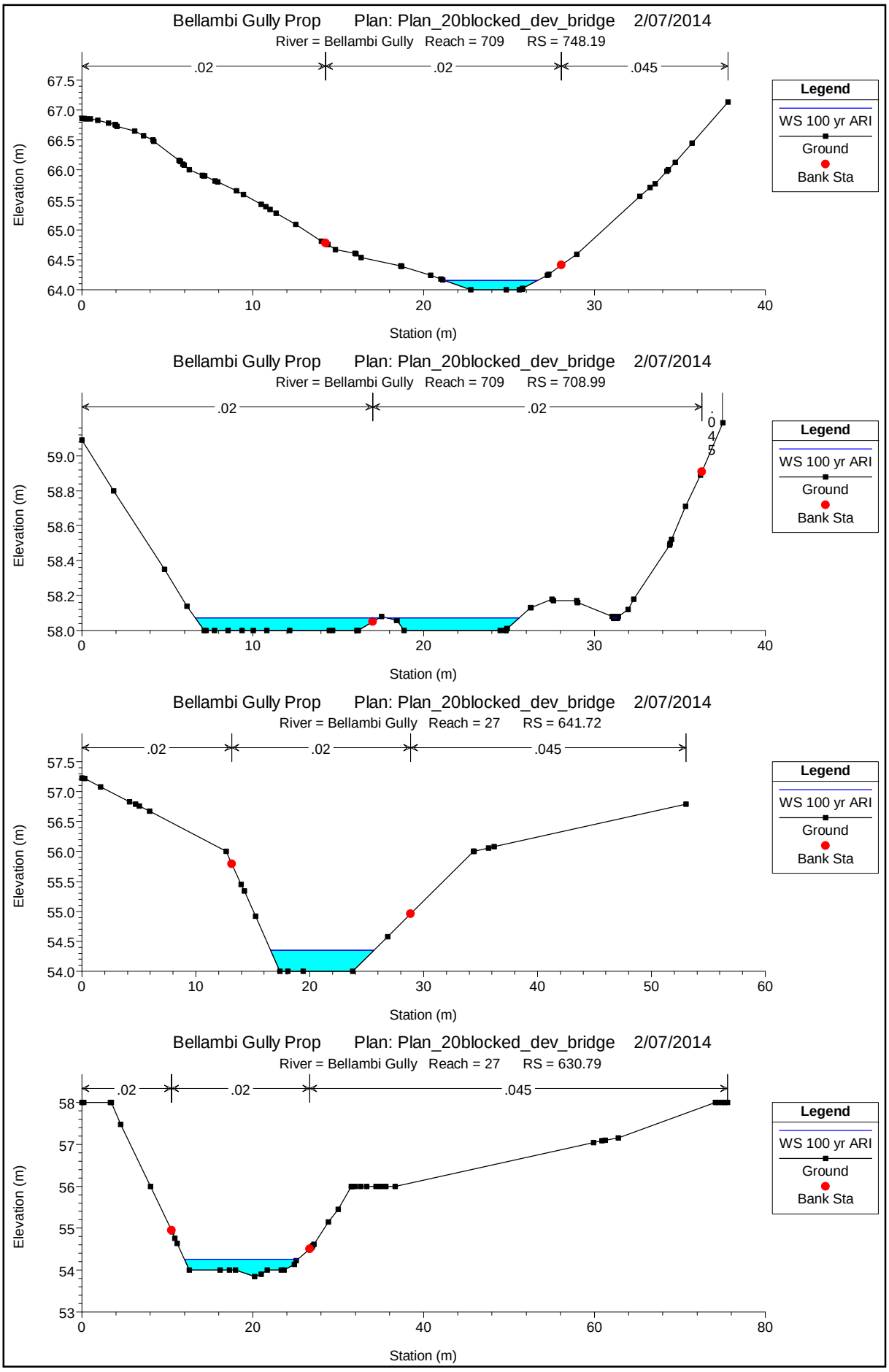
River = Bellambi Gully Reach = 709 RS = 820.54
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 709 RS = 776.73
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 709 RS = 767.44
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 709 RS = 758.43
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta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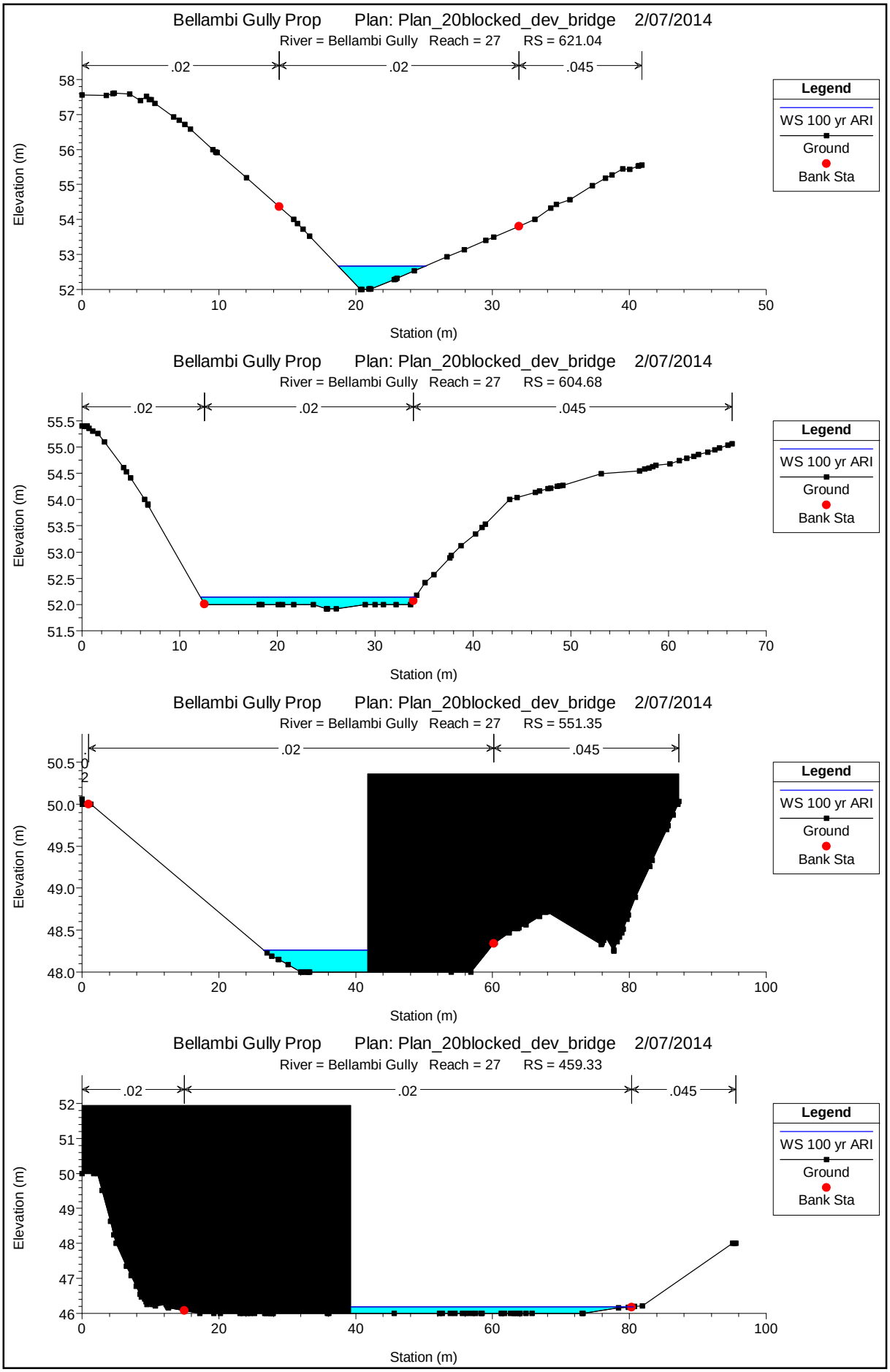
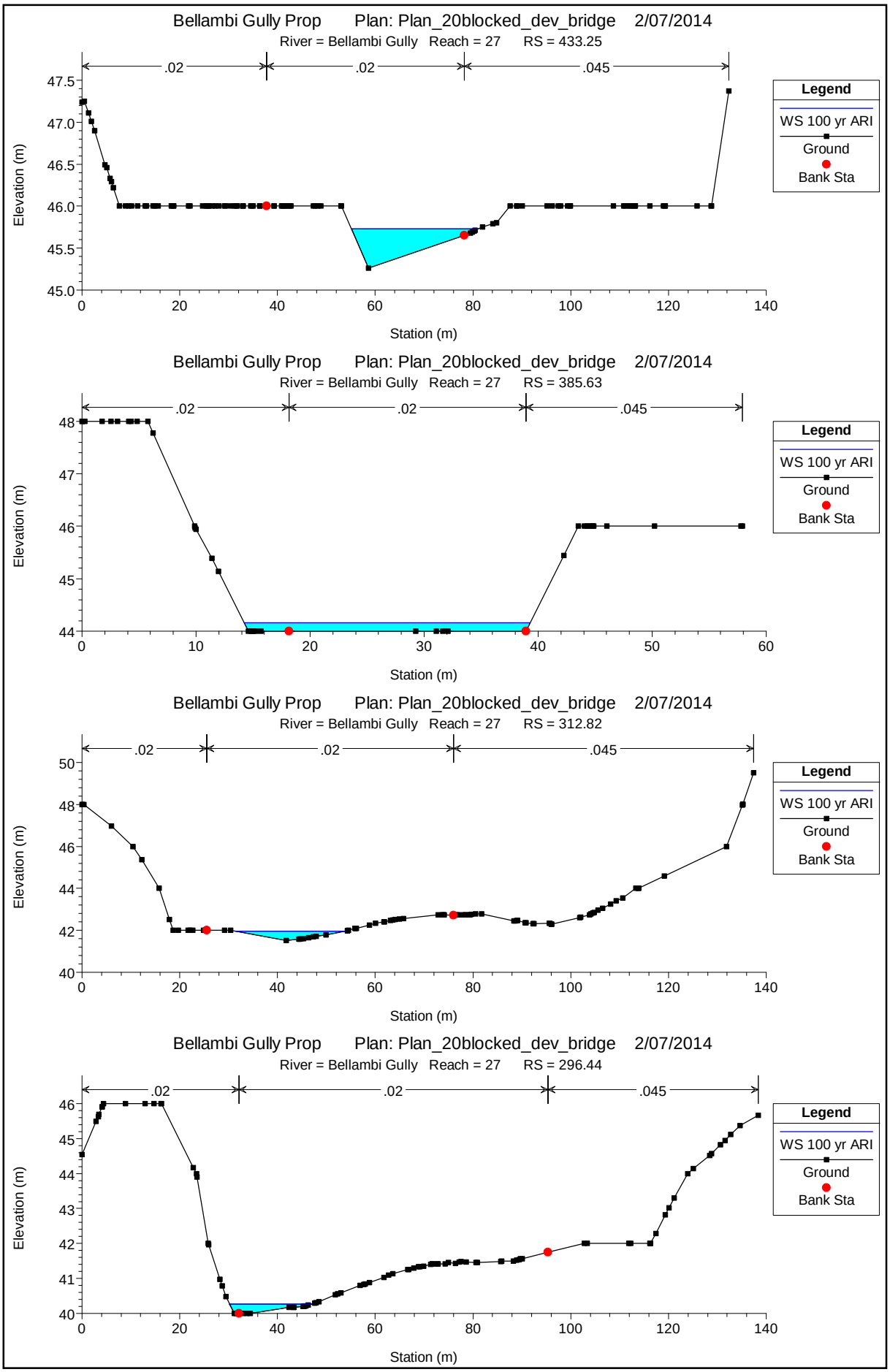
River = Bellambi Gully Reach = 709 RS = 748.19
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 709 RS = 708.99
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 27 RS = 641.72
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 27 RS = 630.79
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta


Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 27 RS = 621.04
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 27 RS = 604.68
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 27 RS = 551.35
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 27 RS = 459.33
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta


Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 27 RS = 433.25
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 27 RS = 385.63
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 27 RS = 312.82
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
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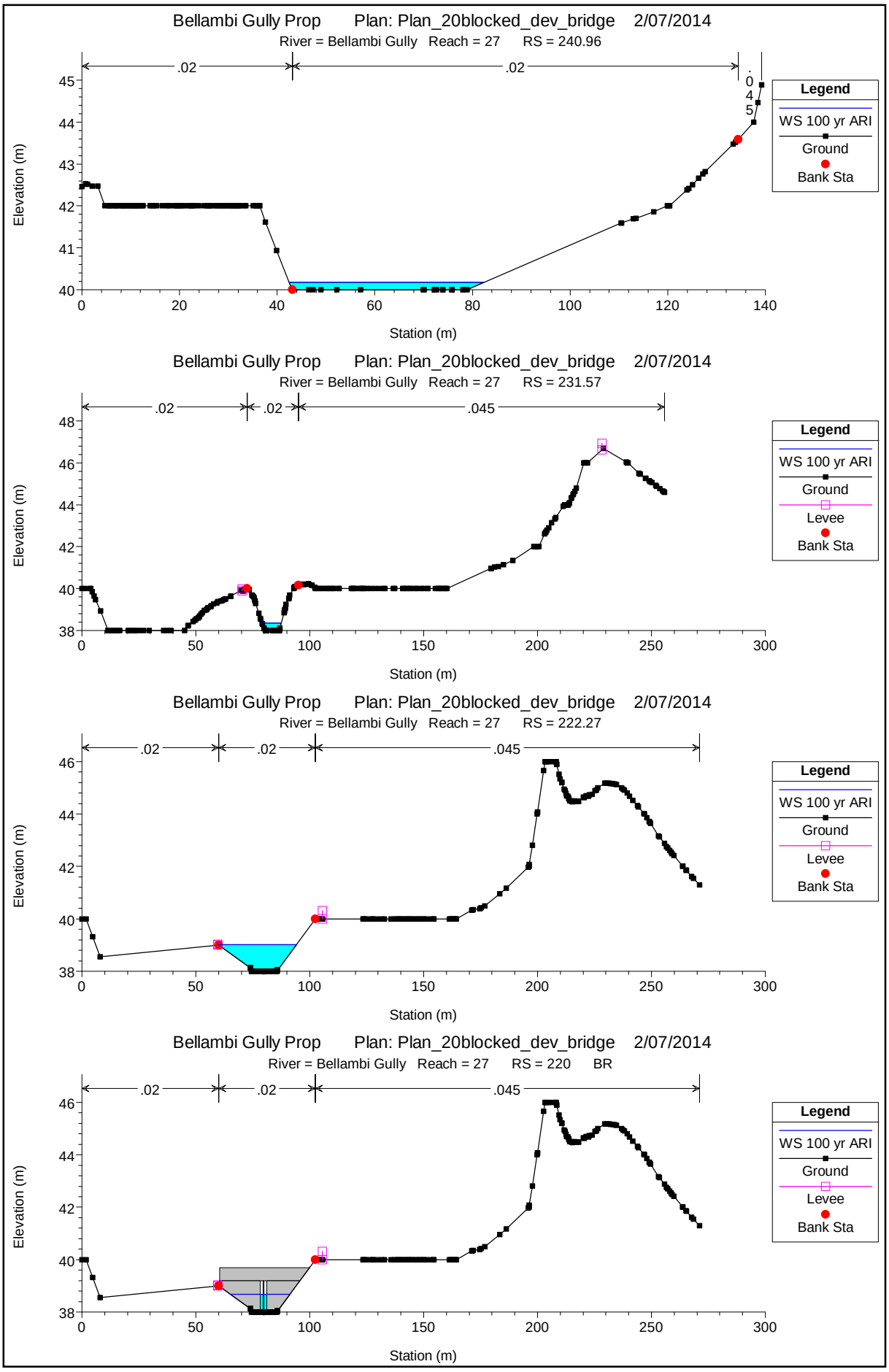
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta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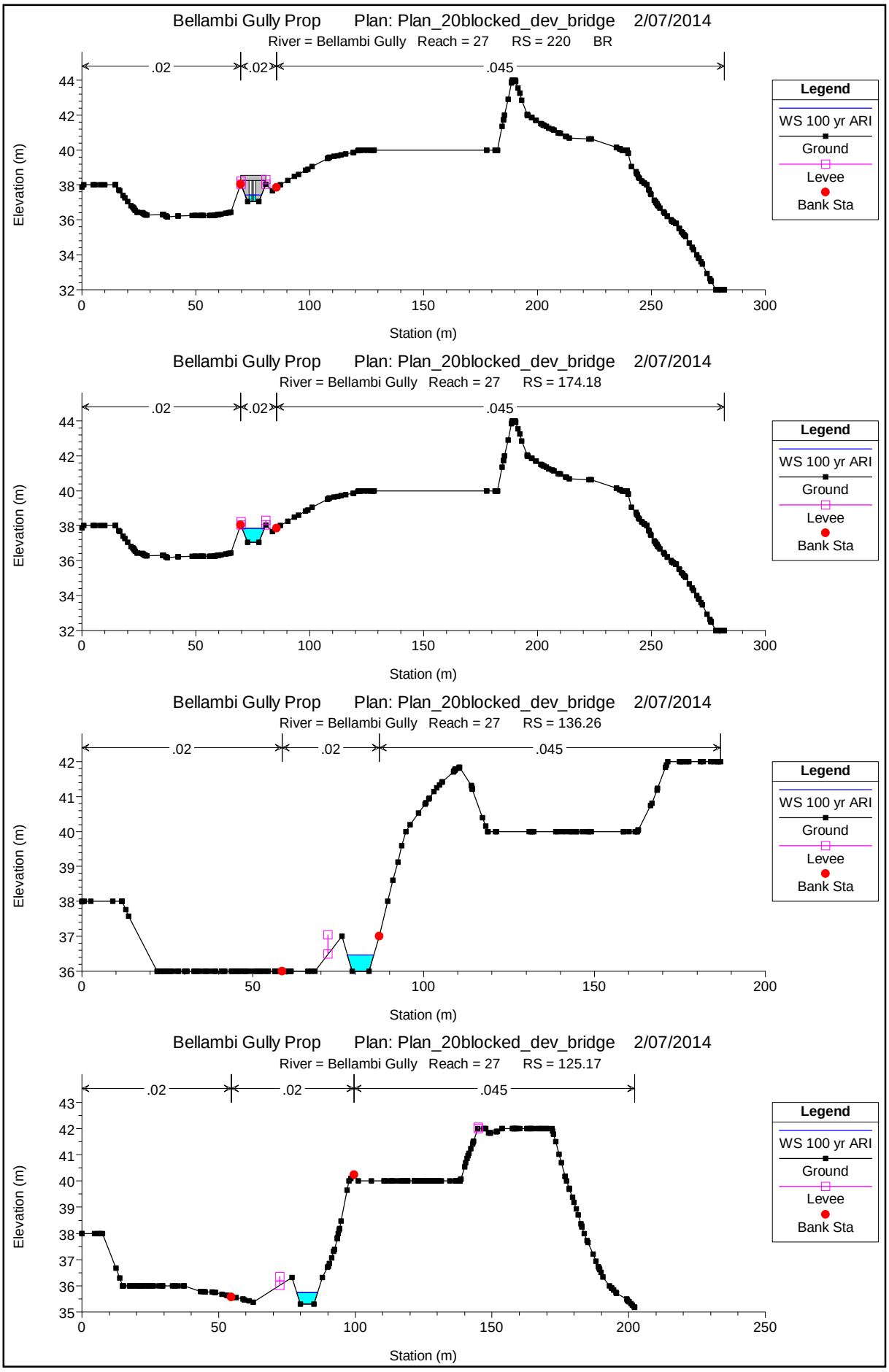
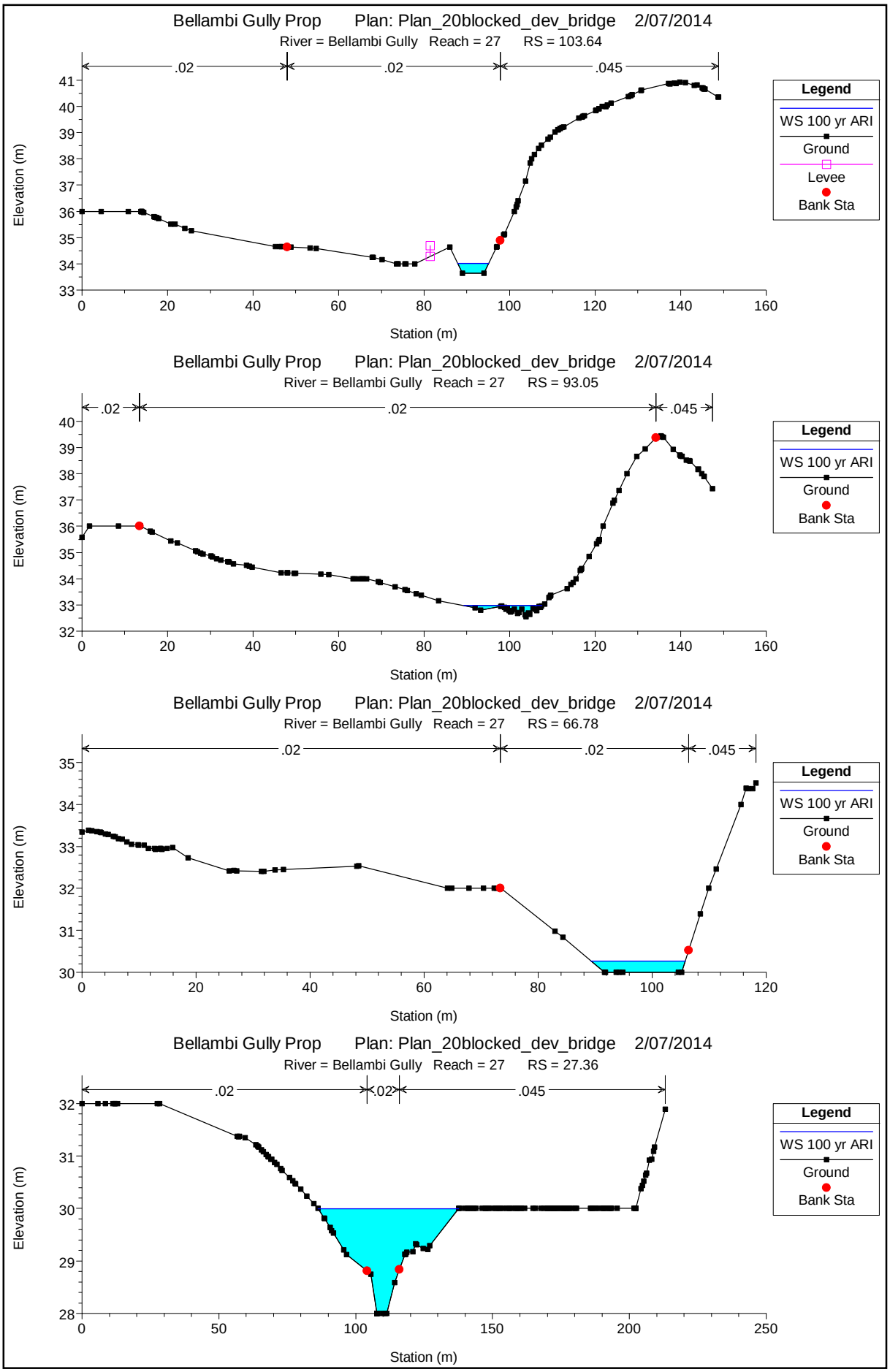
River = Bellambi Gully Reach = 27 RS = 240.96
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 27 RS = 231.57
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Levee
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 27 RS = 222.27
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Levee
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 27 RS = 220 BR
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Levee
Bank Sta


Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 27 RS = 220 BR
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Levee
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 27 RS = 174.18
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Levee
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 27 RS = 136.26
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Levee
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 27 RS = 125.17
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Levee
Bank Sta


Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 27 RS = 103.64
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Levee
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 27 RS = 93.05
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 27 RS = 66.78
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta
Bellambi Gully Prop Plan: Plan_20blocked_dev_bridge 2/07/2014
River = Bellambi Gully Reach = 27 RS = 27.36
.02
.02
.045
Elevation (m)
Station (m)
Legend
WS 100 yr ARI
Ground
Bank Sta

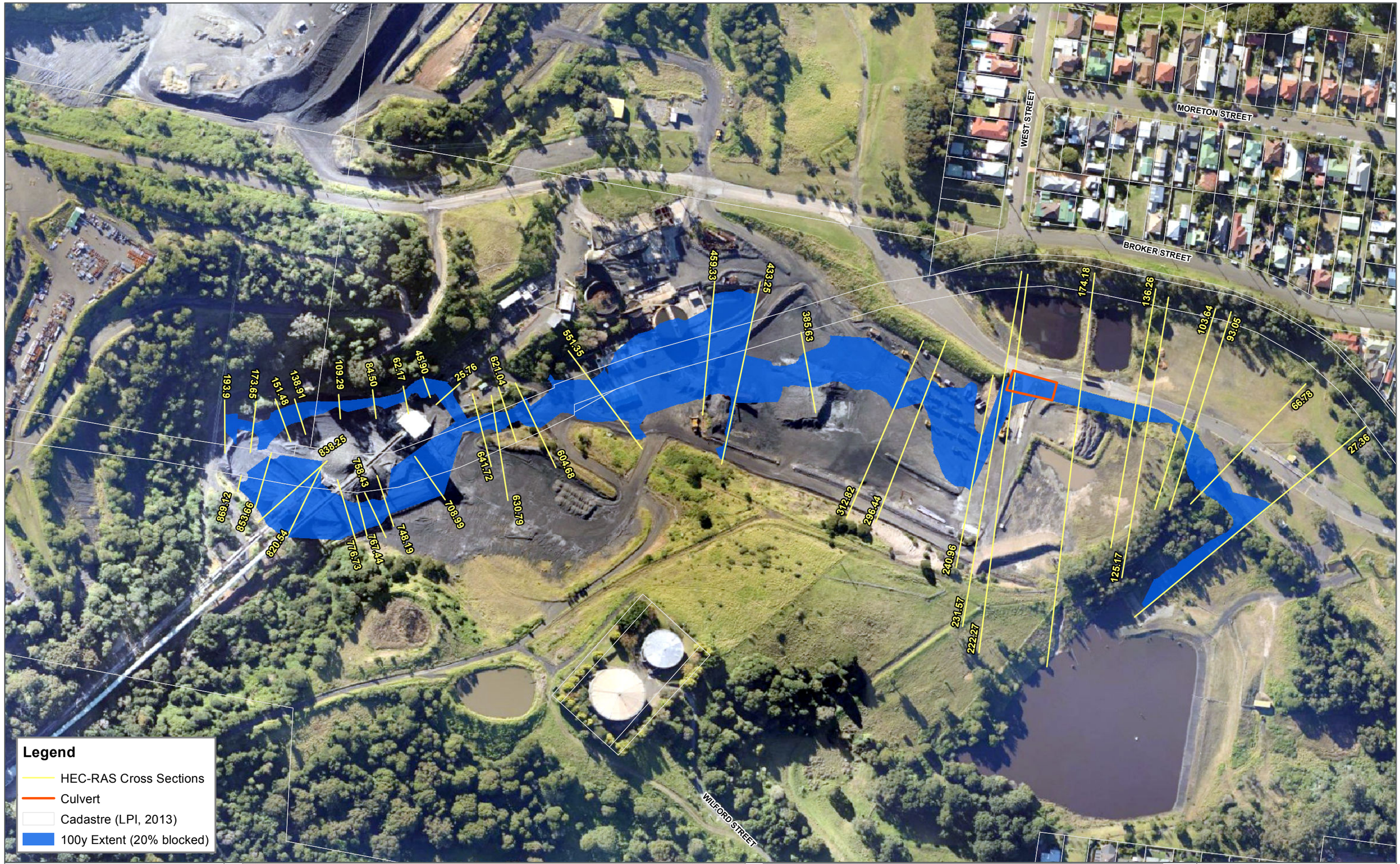
HEC-RAS Plan: Dev_bridge River: Bellambi Gully Reach: 26 Profile: 100 yr ARI

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Hydr Depth
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)
26	193.90	100 yr ARI	9.09	68.83	69.14	69.32	69.84	0.050041	3.71	2.45	0.19
26	173.65	100 yr ARI	9.09	66.23	66.66	67.00	68.41	0.089055	5.87	1.55	0.25
26	151.48	100 yr ARI	9.09	66.00	66.21	66.38	66.80	0.038499	3.44	2.78	0.20
26	138.91	100 yr ARI	9.09	66.00	66.35	66.39	66.59	0.007947	2.20	4.47	0.31
26	109.29	100 yr ARI	9.09	62.00	62.40	62.84	65.65	0.176263	7.99	1.14	0.24
26	84.50	100 yr ARI	9.09	60.00	60.50	60.86	62.30	0.083950	5.95	1.53	0.27
26	62.17	100 yr ARI	9.09	58.38	58.78	59.07	60.25	0.091302	5.36	1.69	0.22
26	45.90	100 yr ARI	9.09	56.00	56.12	56.38	57.96	0.235598	6.04	1.52	0.12
26	25.76	100 yr ARI	9.09	56.00	56.33	56.46	56.73	0.015097	2.80	3.37	0.27

Bellambi Gully Flood Study

APPENDIX F
PROPOSED SCENARIO FLOOD MAP

Cardno
Shaping the Future


MORETON STREET
WEST STREET
BROKER STREET
WILFORD STREET
193.9
173.65
151.48
138.91
109.29
84.50
62.17
45.90
25.76
621.04
641.72
604.68
630.79
708.99
743.19
767.44
776.73
758.43
838.25
853.66
869.12
820.54
551.35
459.33
433.25
385.63
312.82
296.44
240.96
231.57
222.27
174.18
136.26
103.64
93.05
66.78
27.36
125.17
Legend
HEC-RAS Cross Sections
Culvert
Cadastre (LPI, 2013)
100y Extent (20% blocked)
WOLLONGONG COAL
Proposed Scenario
BELLAMBI GULLY FLOOD STUDY
1:2,500 Scale at A3
Metres
0
40
80
120
160
N
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2014-06-27
Coordinate System: GDA 1994 MGA Zone 56
Project: 82014089-01
Map: G1005_ProposedScenario.mxd 01
Aerial imagery supplied by nearmap (July 2013)

Wollongong Coal Ltd

ACN 111 244 896
ABN 28 111 244 896

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CORRIMAL NSW 2518

PO Box 281
FAIRY MEADOW NSW 2519

Phone +61 2 4223 6800
Fax +61 2 4283 7449
www.wollongongcoal.com.au

26 September 2014

Manager – Mining Projects
Department of Planning and Environment
22-33 Bridge Street
SYDNEY NSW 2000

Attention: Mr Howard Reed

Dear Howard,

RE: WOLLONGONG COAL LTD – UNDERGROUND EXPANSION PROJECT GROUNDWATER ASSESSMENT

On 20 June 2014, Wollongong Coal Limited (WCL) submitted a Residual Matters Report containing the *Russell Vale Colliery Underground Expansion Project Preferred Project Report Wonga East Groundwater Assessment* (2014) prepared by GeoTerra and Groundwater Exploration Services (GES). GeoTerra and GES have since reviewed the information in the *Groundwater Assessment* and advised that further information should be provided to fully describe the total groundwater inflow and assess the impacts of the Russell Vale Colliery.

Section 10.7 of the *Groundwater Assessment* (GeoTerra / GES, 2014) predicts the groundwater inflow to the proposed Wonga East workings.

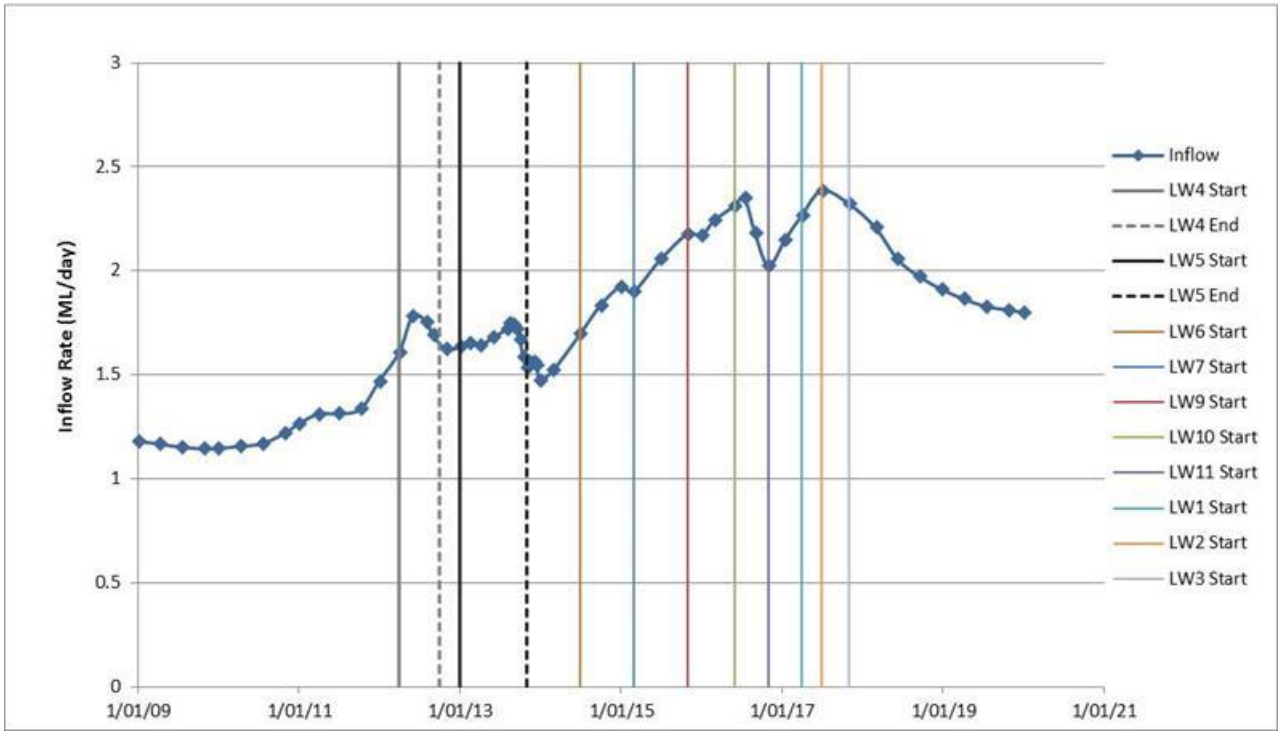
The groundwater inflow values presented in Table 13 and Figure 63 of GeoTerra / GES (2014) correctly represent the impacts of the Underground Expansion Project (which includes only the Wonga East workings). Following a recent internal review, it was noted that although the model also incorporates the groundwater inflows to the Wonga West workings, the inflow volumes for the Wonga West area were not reported in the *Groundwater Assessment*.

To provide an indication of cumulative groundwater impacts, **Table 1** and **Figure *1*** present the total predicted groundwater inflows for Russell Vale Colliery, including the completed Bulli Seam workings in the Wonga West area.

Table 1
Predicted Cumulative Groundwater Inflows for Russell Vale Colliery

Stage	Measured Inflow (ML/day)	Predicted Inflow (ML/day)	Predicted Inflow (ML/year)
Pre Longwall 4	n/a	1.14	416
Post Longwall 5	1.05	1.58	577
Post Longwalls 6 and 7	-	1.90	694
Post Longwalls 8 to 11	-	2.31	834
Post Longwalls 1 to 3	-	1.18	661

Figure 1
Predicted Cumulative Groundwater Inflows for Russell Vale Colliery



It should be noted that the assessed and reported impacts of the proposed Underground Expansion Project are unchanged. The inflows to the completed Wonga West workings are not directly related to the impacts of the Underground Expansion Project. However, the Wonga West inflow volumes are relevant to water licensing. WCL will obtain the necessary licences under the *Water Management Act 2000* for any water taken by Russell Vale Colliery, including inflows to the completed Bulli seam workings in the Wonga West area.

If wish to discuss this matter, please feel free to contact me on (02) 4223 6800.

Yours sincerely,
WOLLONGONG COAL LIMITED

David Clarkson
Group Environment Manager

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ACOUSTICS AND AIR

RUSSELL VALE COLLIERY

NOISE IMPACT ASSESSMENT

REPORT NO. 14141
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SEPTEMBER 2014

PREPARED FOR

WOLLONGONG COAL LIMITED
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GLOSSARY OF ACOUSTIC TERMS

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph below, are here defined.

L_{A1} – The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

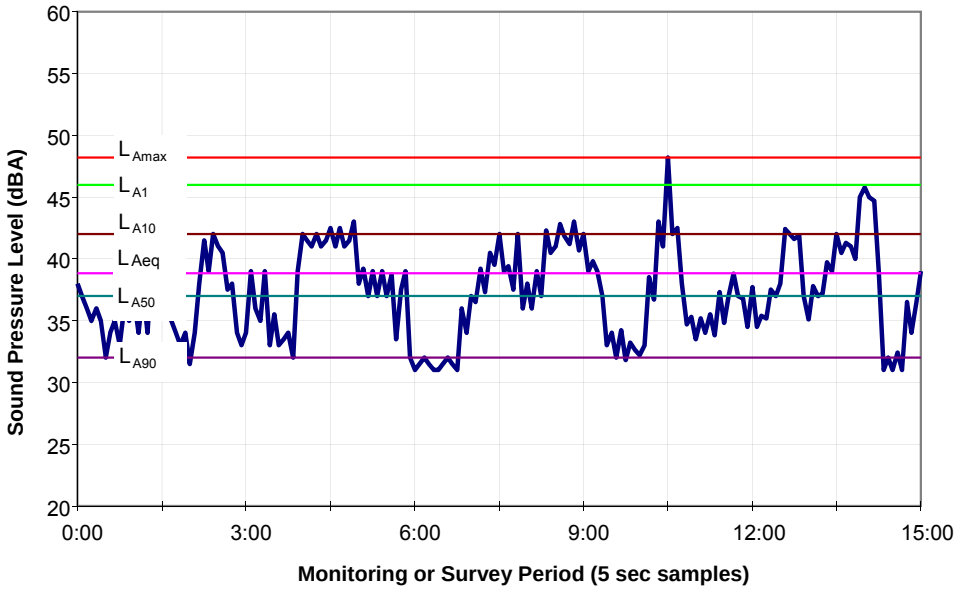
L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

L_{Amax} (Maximum Noise Level) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

ABL – The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10th percentile (lowest 10th percent) background level (L_{A90}) for each period.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night time.

Typical Graph of Sound Pressure Level vs Time



1 INTRODUCTION

Wollongong Coal Limited (WCL) is proposing to develop its Underground Expansion Project (UEP) (as modified by the *Underground Expansion Project Pt3A Preferred Project Report*, WCL, October 2013) over five years at the Russell Vale Colliery site (the Project).

Wilkinson Murray (WM) has been commissioned to prepare a noise impact assessment for the Project.

1.1 Objectives of this Study

This assessment replaces in full the previous noise impact assessment for the UEP (*NRE No.1 Colliery – Noise Assessment Major Works Project*, ERM, November 2012). It has been revised for updated assumptions (including meteorological data) and mitigation commitments.

The primary objective of this study is to assess the potential noise associated with the Project by addressing the Director-General's Requirements (DGRs) (09_0013, dated 2009), outlined as follows:

> ***Noise*** *- including on-site construction and operational noise and off site road noise and vibration impacts from the haulage of coal along the coal transport corridor to Port Kembla Coal Terminal.*

The noise assessment includes a two-year transitional phase (Year 2) between the existing operations and the proposed operations during which coal throughput will gradually ramp up. For comparison purposes, the existing operations and the previous operations have been included in this assessment.

In addition to industrial noise, the assessment addresses noise generated by truck movements associated with transport of coal from the Site to the Port Kembla Coal Terminal (PKCT).

1.2 Policies

This report was written in accordance with the following New South Wales Government policies:

- *Industrial Noise Policy (INP)* (Environment Protection Agency [EPA], 2000)*;*
- *Road Noise Policy (RNP)* (Environment Protection Agency [EPA], 2011)*;* and
- *Noise Guide for Local Government (NGLG)* (Environment Protection Agency [EPA], 2013).

1.3 Locality Map

Figure 1-1 shows a locality map of the Russell Vale Colliery.

Figure 1-1 Locality Map of Russell Vale Colliery

Locality Map

Aerial Imagery: Google

2 SENSITIVE NOISE RECEIVERS

The Site is located on the lower slopes of the Illawarra Escarpment approximately 2km from the coast with residential areas generally to the north-northeast (Russell Vale) and south-southeast (Corrimal).

The potentially most exposed residential receivers are located in Russell Vale along Broker Street and West Street; and in Corrimal along Midgley Street, Wilford Street, Lyndon Street and Taylor Place.

Table 2-1 provides a summary of a selection of residential receivers deemed representative of the potentially most impacted receivers surrounding the Site. These receivers are addressed in this assessment. For completeness, additional residential receivers along Princes Highway (R6 and R7) have also been included.

Table 2-1 Noise Sensitive Receivers Considered in Assessment

Receiver ID	Dwelling Address
R1	16 West St, Russell Vale
R2	30 West St, Russell Vale
R3	13 West St, Russell Vale
R4	13 Broker St, Russell Vale
R5	4 Broker St, Russell Vale
R6	659 Princes Hwy, Russell Vale
R7	34 Princes Hwy, Corrimal
R8	95 Midgley St, Corrimal
R9	109 Midgley St, Corrimal
R10	6 Lyndon St, Corrimal
R11	22 Lyndon St, Corrimal
R12	46 Lyndon St, Corrimal
R13	6 Taylor Pl, Corrimal
R14	15 Taylor Pl, Corrimal

The identified receivers are shown in Figure 2-1.

Figure 2-1 Noise Sensitive Receivers Considered in Assessment

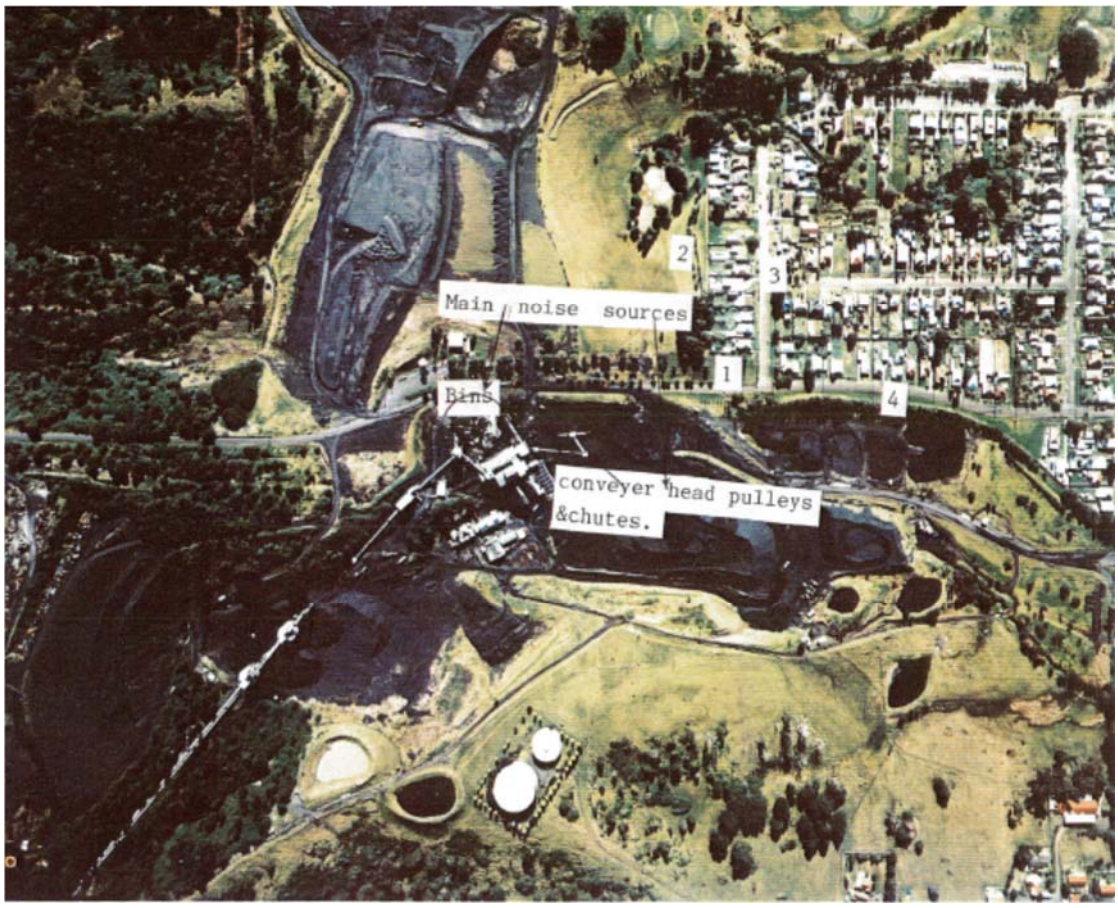
3 HISTORICAL OPERATIONS

The Russell Vale Colliery was originally known as the South Bulli Colliery. The South Bulli Coal Mining Company was established in 1887 and commenced underground mining beneath the Illawarra Escarpment. The surface facilities (now known as the Russell Vale Site) were also established in 1887. Mining operations commenced in the form of hand workings in the Bulli and Balgownie seams. As mechanised extraction techniques were developed, the mining method transitioned from hand workings to continuous mining, and ultimately to longwall mining. South Bulli Colliery was one of the first operations in Australia to utilise longwall mining, which was undertaken in the Balgownie seam from 1970 to 1982.

Bathhouse facilities were constructed in 1928. A coal handling and preparation plant (CHPP) was constructed at the Russell Vale Site in the 1960s and included a washery building, a series of bins and a gantry area. Beside the CHPP, the site infrastructure included a main decline conveyor system and vibratory feeders, large gear drives and transfer stations in the vicinity of the conveyor portal area. Operation of the CHPP was discontinued in 2003. Unwashed coal has since been transported from the site for export.

Figure 3-1 provides an aerial showing the colliery and the Russell Vale receivers obtained from a 1991 noise report for the site (*Final Report Noise Compliance and Noise Control Options for Bellambi Colliery, Corrimal*, Dick Benbow & Associates Pty Ltd, December 1991).

Figure 3-1 Aerial of Colliery in 1991



4 EXISTING NOISE ENVIRONMENT

Existing background noise levels were monitored around the Site in order to establish Project-specific noise criteria in accordance with the *INP*.

The Policy recommends in situations with existing premises the project specific noise criteria should be developed "without the existing premises operating". The existing background noise levels were measured in the absence of noise generated by mining operations.

4.1 Monitoring and Analysis Procedure

Background noise monitoring was conducted between 6 June 2014 and 18 June 2014.

The noise monitoring equipment used for these measurements consisted of environmental noise loggers set to A-weighted, fast response, continuously monitoring over 15-minute sampling periods. This equipment is capable of remotely monitoring and storing noise level descriptors for later detailed analysis. The equipment calibration was checked before and after the survey and no significant drift was noted.

The logger determines L_{A1}, L_{A10}, L_{A90} and L_{Aeq} levels of the ambient noise. L_{A1}, L_{A10} and L_{A90} are the levels exceeded for 1%, 10% and 90% of the sample time respectively (see Glossary of Acoustic Terms for definitions). The L_{A1} is indicative of maximum noise levels due to individual noise events such as the occasional pass-by of a heavy vehicle. This is used for assessment of sleep disturbance. The L_{A90} level is normally taken as the background noise level during the relevant period.

To describe background noise levels, the measure currently recommended by the *INP* is the Rating Background Level (RBL). This is based on the L_{A90} as defined in the *INP*. An RBL was established for each of the three assessment periods, namely the day, evening and night time periods. A glossary of terms is provided at the beginning of the report.

Meteorological data for the relevant periods were obtained from the on-site weather station at the Russell Vale Colliery. Periods in which it was likely to be raining, or when wind speeds exceeded five (5) metres per second (m/s) at microphone height, were excluded from analysis, in accordance with the *INP*.

The background noise monitoring survey was carried out at three locations representative of the residential receivers potentially most impacted by noise from the colliery. The three locations are described below and shown in Figure 4-1:

- M1 11 Doncaster Street, Corrimal;
- M2 28 Moreton Street, Russell Vale; and
- M3 49 Robson Street, Corrimal.

The RBLs measured at M1 are considered to be representative of an acoustic environment dominated by Princes Highway traffic noise. As such, the RBLs measured at M1 have been selected as the relevant RBLs for R5, R6, R7 and R8.

The RBLs measured at M2 are considered as representative of the acoustic environment at the Russell Vale residences set back from the Princes Highway (i.e. in the vicinity of West Street). Similarly, those measured at M3 are deemed representative of the Corrimal residences set back from the Princes Highway (i.e. in the vicinity of Lyndon Street and Taylor Place).

Figure 4-1 Noise Monitoring Locations

4.2 Summary of Monitoring Results

Table 4-1 shows a summary of the measured background noise levels (RBLs).

Table 4-1 Summary of Logger Survey Results

Monitoring Location		Measured RBLs (dBA)		
ID	Address	Day (7.00am – 6.00pm)	Evening (6.00pm – 10.00pm)	Night (10.00pm – 7.00am)
M1	11 Doncaster St, Corrimal	43	40	37
M2	28 Moreton St, Russell Vale	37	36	35
M3	49 Robson St, Corrimal	35	35 *	33

* Note: The evening RBL at this location was established at 36dBA. According to *INP Application Notes*, if the evening RBL is found to be higher than the daytime RBL then the latter should be used for the evening assessment period.

A graphical representation of the measured background noise levels is included in Appendix A.

Table 4-2 provides a summary of the representative RBLs for each identified receiver.

Table 4-2 Receivers and RBLs

Receiver		Measured RBLs (dBA)		
ID	Address	Day (7.00am – 6.00pm)	Evening (6.00pm – 10.00pm)	Night (10.00pm – 7.00am)
R1	16 West St, Russell Vale	37	36	35
R2	30 West St, Russell Vale			
R3	13 West St, Russell Vale			
R4	13 Broker St, Russell Vale			
R5	4 Broker St, Russell Vale	43	40	37
R6	659 Princes Hwy, Russell Vale			
R7	34 Princes Hwy, Corrimal			
R8	95 Midgley St, Corrimal			
R9	109 Midgley St, Corrimal	35	35	33
R10	6 Lyndon St, Corrimal			
R11	22 Lyndon St, Corrimal			
R12	46 Lyndon St, Corrimal			
R13	6 Taylor Pl, Corrimal			
R14	15 Taylor Pl, Corrimal			

5 OPERATIONAL NOISE ASSESSMENT CRITERIA

This section discusses the various noise criteria and guidelines relevant to the Project.

5.1 Operational Noise Criteria

The *INP* sets out two forms of noise criterion. In assessing noise levels at residences, the criteria should be assessed at the most-affected point on or within the residential property boundary or, if this is more than 30m from the residence, at the most-affected point within 30m of the residence. The two criteria are described below.

5.1.1 Intrusiveness Criterion

The intrusiveness criterion specifies that the $L_{Aeq,15min}$ noise level from any new source should not exceed the RBL by more than 5dB. These criteria apply to $L_{Aeq,15min}$ noise levels measured under certain specific wind and temperature inversion conditions, as outlined in the *INP*.

The *INP* requires that where noise sources contain certain characteristics, such as tonality, dominating low frequency content, impulsiveness or intermittency a modifying factor of +5dB should be applied because this type of noise typically causes greater annoyance to the community.

The overall noise at any of the identified residences due to all mining activities would be dominated by continuous or quasi-continuous sources (i.e. haul trucks) that are not expected to generate tonal or low-frequency noise, as described in the *INP*. As such, it is unlikely mining noise generated by the Site would attract such modifying factor adjustments. Hence, the criterion noise level is set equal to the RBL + 5dB. Table 5-1 provides a summary of the intrusiveness criteria at the identified receivers.

Table 5-1 Intrusiveness Criteria

Receiver		Intrusiveness Criteria, $L_{Aeq,15min}$ (dBA)		
ID	Address	Day (7.00am – 6.00pm)	Evening (6.00pm – 10.00pm)	Night (10.00pm – 7.00am)
R1	16 West St, Russell Vale	42	41	40
R2	30 West St, Russell Vale			
R3	13 West St, Russell Vale			
R4	13 Broker St, Russell Vale			
R5	4 Broker St, Russell Vale	48	45	42
R6	659 Princes Hwy, Russell Vale			
R7	34 Princes Hwy, Corrimal			
R8	95 Midgley St, Corrimal			
R9	109 Midgley St, Corrimal	40	40	38
R10	6 Lyndon St, Corrimal			
R11	22 Lyndon St, Corrimal			
R12	46 Lyndon St, Corrimal			
R13	6 Taylor Pl, Corrimal			
R14	15 Taylor Pl, Corrimal			

5.1.2 Amenity Criterion

The second type of criterion is an amenity criterion, and is intended to ensure that the total L_{Aeq} noise level from all industrial sources does not exceed specified levels. For suburban residences such as the identified receivers, the relevant recommended "acceptable" levels are:

- Daytime (7.00am-6.00pm) 55dBA L_{Aeq}
- Evening (6.00pm-10.00pm) 45dBA L_{Aeq}
- Night Time (10.00pm-7.00am) 40dBA L_{Aeq}

However, the *INP* recognises that where a suburban/industrial interface occurs that an increase of 5dB on the relevant amenity level is appropriate. As such, the appropriate amenity criteria for a suburban/industrial interface would be:

- Daytime (7.00am-6.00pm) 60dBA L_{Aeq}
- Evening (6.00pm-10.00pm) 50dBA L_{Aeq}
- Night Time (10.00pm-7.00am) 45dBA L_{Aeq}

The amenity criterion represents the cumulative impact of all existing and potential industrial noise sources affecting a location, and the appropriate criterion for a new source depends on the existing and future noise levels from other existing or approved industrial sources.

The Policy specifies explicitly how the above values should be reduced if the existing noise level from other industrial sources is known. Surveys have not identified any other existing industrial noise other than the mine at the potentially affected residences, and hence the values above represent the amenity criterion for noise from the Project.

5.1.3 Summary of Operational Noise Criteria

The intrusiveness criterion is found to be more stringent than the amenity criterion for all assessment periods and for all the identified receivers.

Table 5-2 summarises the Project-specific operational criteria.

Table 5-2 Project-Specific Operational Noise Criteria

Receiver		Project-Specific Operational Noise Criteria, $L_{Aeq,15min}$ (dBA)		
ID	Address	Day (7.00am – 6.00pm)	Evening (6.00pm – 10.00pm)	Night (10.00pm – 7.00am)
R1	16 West St, Russell Vale	42	41	40
R2	30 West St, Russell Vale			
R3	13 West St, Russell Vale			
R4	13 Broker St, Russell Vale			
R5	4 Broker St, Russell Vale	48	45	42
R6	659 Princes Hwy, Russell Vale			
R7	34 Princes Hwy, Corrimal			
R8	95 Midgley St, Corrimal			

Receiver		Project-Specific Operational Noise Criteria, $L_{Aeq,15min}$ (dBA)		
ID	Address	Day (7.00am – 6.00pm)	Evening (6.00pm – 10.00pm)	Night (10.00pm – 7.00am)
R9	109 Midgley St, Corrimal	40	40	38
R10	6 Lyndon St, Corrimal			
R11	22 Lyndon St, Corrimal			
R12	46 Lyndon St, Corrimal			
R13	6 Taylor Pl, Corrimal			
R14	15 Taylor Pl, Corrimal			

5.2 Construction Noise Criteria

This assessment addresses a two-year transitional phase between the existing operations and the Project with all proposed infrastructure completed.

It is considered reasonable to assess this transitional phase as being a phase of general operations for the following two reasons:

- The proposed construction of the truck loading facility and associated infrastructure has been estimated to take an extended period of time (i.e. approximately 24 months).
- More importantly, the colliery will maintain a constant coal throughput during the construction period and as such, construction activities will co-exist with operational activities. It is unlikely both types of activities will be discernable from one another at the surrounding receivers.

As such, it is proposed that the criteria for operational noise outlined in Section 5.1 should also be used to assess the transitional phase. This methodology has proved acceptable to EPA on similar projects.

5.3 Sleep Disturbance Criteria for Intermittent Night Time Noise Events

For site noise generated between 10.00pm to 7.00am, it is necessary to assess the potential impact of sleep disturbance. Appropriate criteria are provided in the *NGLG* to address sleep disturbance, which states:

> *"Where sleep disturbance is being assessed, the $L_{A1(60\ seconds)}$ or L_{Amax} noise level is most appropriate, and the measurement position might be outside the bedroom window. Sleep may be disturbed if the source noise level exceeds the background noise by more than 15 dB(A)."*

Based on the measured night time RBLs, sleep disturbance criteria have been established and are summarised in Table 5-3.

Table 5-3 Project-Specific Sleep Disturbance Criteria

Receiver		Sleep Disturbance Noise Criteria, L_{Amax}
ID	Address	(dBA)
R1	16 West St, Russell Vale	50
R2	30 West St, Russell Vale	
R3	13 West St, Russell Vale	
R4	13 Broker St, Russell Vale	
R5	4 Broker St, Russell Vale	52
R6	659 Princes Hwy, Russell Vale	
R7	34 Princes Hwy, Corrimal	
R8	95 Midgley St, Corrimal	
R9	109 Midgley St, Corrimal	48
R10	6 Lyndon St, Corrimal	
R11	22 Lyndon St, Corrimal	
R12	46 Lyndon St, Corrimal	
R13	6 Taylor Pl, Corrimal	
R14	15 Taylor Pl, Corrimal	

The EPA's Application Notes state:

"Research on sleep disturbance is reviewed in the NSW Road Noise Policy. This review concluded that the range of results is sufficiently diverse that it was not reasonable to issue new noise criteria for sleep disturbance.

From the research, the EPA recognised that the current sleep disturbance criterion of an $L_{A1,(1\ min)}$ not exceeding the $L_{A90,(15\ min)}$ by more than 15 dB(A) is not ideal. Nevertheless, as there is insufficient evidence to determine what should replace it, the EPA will continue to use it as a guide to identify the likelihood of sleep disturbance. This means that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required."

Additionally the NSW Road Noise Policy states from the research on sleep disturbance to date it can be concluded that:

- Maximum internal noise levels below 50-55dBA are unlikely to cause awakening reactions; and
- One or two noise events per night, with maximum internal noise levels of 65-70dBA, are not likely to affect health and wellbeing significantly.

Assuming that the typical noise reduction through a bedroom facade with normally open windows is 10dBA, then an external noise level of 60-65dBA is unlikely to cause sleep disturbance. As such it should be noted that the Project-specific sleep disturbance criteria are considerably lower than 60-65dBA.

6 NOISE ASSESSMENT METHODOLOGY & ASSUMPTIONS

6.1 Noise Modelling Methodology

Operational noise levels at nearby receivers have been calculated using the Environmental Noise Model (ENM) a proprietary computer program from RTA Technology Pty Ltd. This modelling software is recommended by the *INP* and has been previously accepted by the EPA for use in environmental noise assessments. The assessment models the total noise at each receiver from the operation of the Project. Total predicted operational noise levels are then compared with the operational noise criteria presented in Table 5-2.

6.2 Noise Assessment Scenarios

Noise modelling was undertaken for the day, evening and night operating scenarios for the following scenarios:

- 'Existing' operations (pre-August 2014);
- 'Existing Mitigated' operations (August 2014 - May 2015);
- 'Year 2' operations (June 2015 – June 2017); and
- 'Year 4' operations (July 2017 onwards).

These four (4) scenarios are described as follows:

- Existing: This scenario (Figure 6-6) considers the existing arrangements without the use of the reclaim conveyor system or the truck loading bins. Currently, coal is taken through the primary sizer building near the conveyor portal, transported downhill via the decline conveyor, and distributed throughout the SP1 stockpile area using the tripper system. There, a dozer (CAT D11) manages the stockpile and a front end loader (CAT 970) loads a small fleet of trucks ranging 14t-40t which transports the coal to the screening area. At the screening area, an excavator (CAT 345B) shifts coal into the mobile screening plant (FINLAY 693+ Supertrack). The screened coal is then moved to the loading area and placed into road trucks using two (2) front end loaders (CAT 988B). While all mobile plant is currently only operating between the hours of 7.00am and 10.00pm, all infrastructure is running on a 24 hour basis.

- Existing Mitigated: This scenario (Figure 6-6) also considers the existing arrangements. However, it accounts for mitigation works recently conducted on the existing tripper system. Details about the mitigation works are included in Section 6.4. The Existing scenario before mitigation measures were implemented on the existing tripper arrangement was included to provide additional understanding of how noise levels from the Project have evolved in time.

- Year 2: This scenario (Figure 6-7) considers similar arrangements as the 'Existing Operations' scenario in terms of the primary sizer building, decline conveyor and tripper system. Although the proposed truck loading facility will not be completed by then, it is expected that the (partially) underground reclaim conveyor system will be operating during that time. It is assumed that a dozer (CAT D11) operating at the SP1 stockpile area will push coal into the underground conveyor system which will transport coal to the existing truck loading bins via a 600t surge bin. All mobile plant (dozer and road trucks) as well as the reclaim conveyor system (including the surge bin and truck loading bins) are expected to be operating between the hours of 7.00am and 10.00pm. The rest of the infrastructure will operate on a 24 hour basis.

- Year 4: This scenario (Figure 6-8) considers site operations with all the proposed upgrades. Once all proposed upgrades are completed, it is expected the reclaim conveyor system will transport coal to the new truck loading facility (i.e. the existing truck loading bins and 600t surge bin will be decommissioned). This scenario also differs from the Year 2 scenario in that it will have extended its stockpile capacity with two (2) new stackout conveyors, tripper systems and reclaim conveyors servicing two (2) new stockpiles areas, namely SP2 and SP3. It should be noted that only one of the three (3) stackout conveyors and tripper systems will be operating at any one time. The associated SP2 and SP3 reclaim conveyors will run in underground tunnels.

6.3 Meteorological Environment for Noise Assessment Purposes

The *INP* generally directs the use of a single set of adverse meteorological data in the assessment of noise impacts (EPA, 2000). However, for noise modelling in this and other projects, Wilkinson Murray has adopted the more rigorous approach of predicting noise levels at nearby receivers for a range of meteorological conditions based on meteorological data obtained from the locality. The noise modelling presented in this assessment is partly based on data provided by the on-site weather station - seven (7) months' worth (May 2013 – November 2013) - and partly from data generated by the TAPM model and based on the on-site weather station data. TAPM data developed for the Project has been used as it includes a contiguous dataset of wind speed, direction and temperature inversion (based on sigma theta data) which is not available from the local weather stations. Statistical occurrences of meteorological conditions are used to calculate a 10th percentile exceedance noise level (i.e. the level that is exceeded 10% of the time), which is then compared with relevant criteria. Note that the 10th percentile exceedance noise level is sometimes referred to as the "P10" noise level.

This alternative assessment procedure involves significantly greater computational complexity than the use of a single set of meteorological conditions. However, Wilkinson Murray believes it provides a more rigorous method of assessing noise exposure, and one that is more easily understood by the community. The approach of using the 10th percentile calculated noise level as a measure of noise impacts has been considered acceptable by the Department of Planning and Environment (DPE) and the EPA for previous similar mining project assessments.

The data for wind direction and wind speed are classified into eight directional intervals and five speed intervals (between 0.5 m/s and 3 m/s - with all other instances of wind speed described as "calm") in accordance with the *INP*.

The above procedure considers all meteorological conditions at all receivers, and the conditions which determine the 10th percentile noise level would differ between receivers.

Based on the meteorological data used in this assessment, wind roses were generated for each assessment period (day/evening/night) and for each season. Figures 6-1, 6-2 and 6-3 show wind roses produced for the daytime, evening and night time periods, respectively.

Review of the windroses show that strong westerly and north-westerly winds are present during the day, evening and night time periods. This is explained by the presence of drainage-flow winds resulting from cold air travelling down the escarpment in the easterly and south-easterly directions.

In accordance with the EPA's (2000) *INP Application Notes*, noise levels at nearby receivers were also predicted for calm isothermal meteorological conditions.

Figure 6-1 Windroses – Daytime (7.00am – 6.00pm)

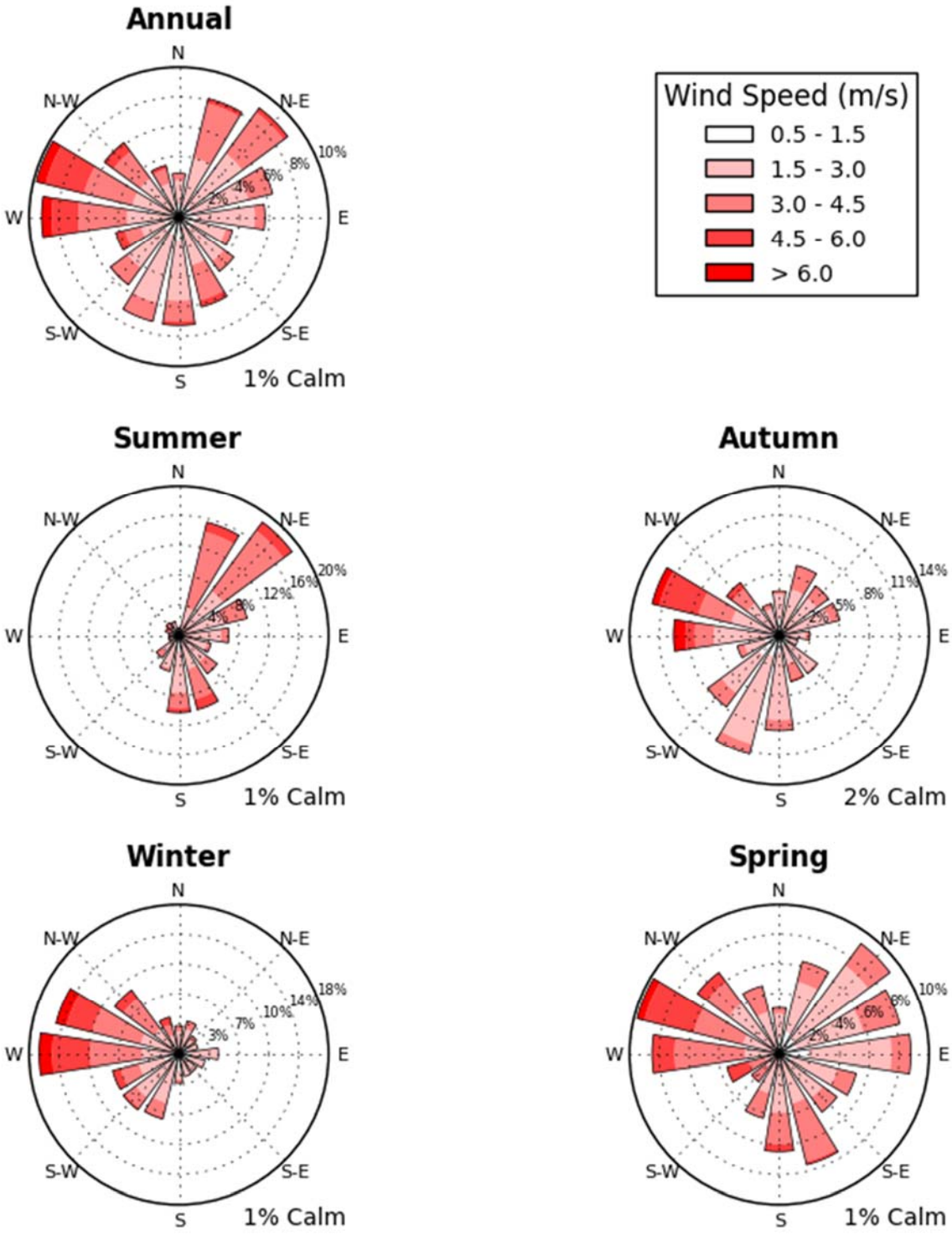


Figure 6-2 Windroses – Evening (6.00pm – 10.00pm)

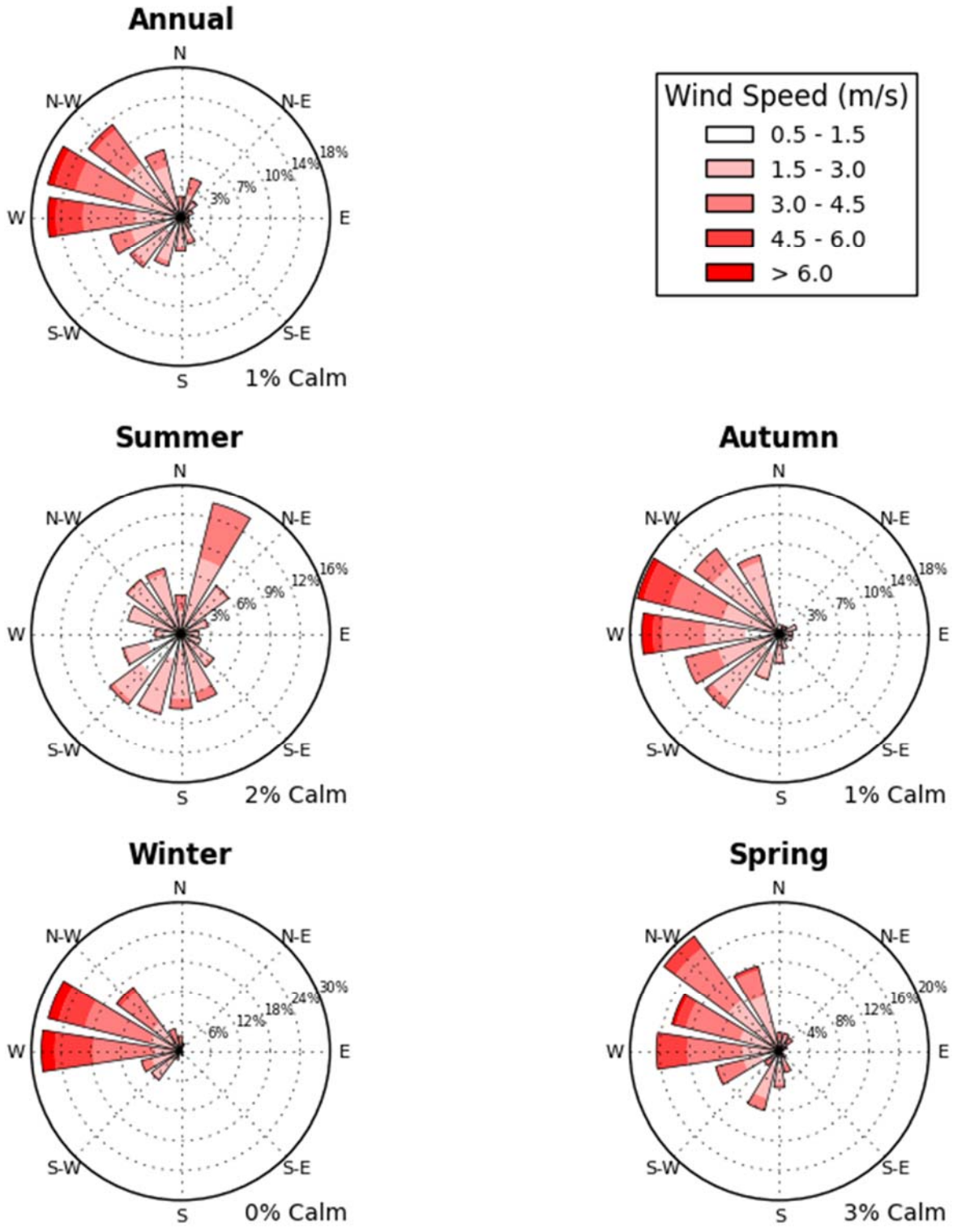
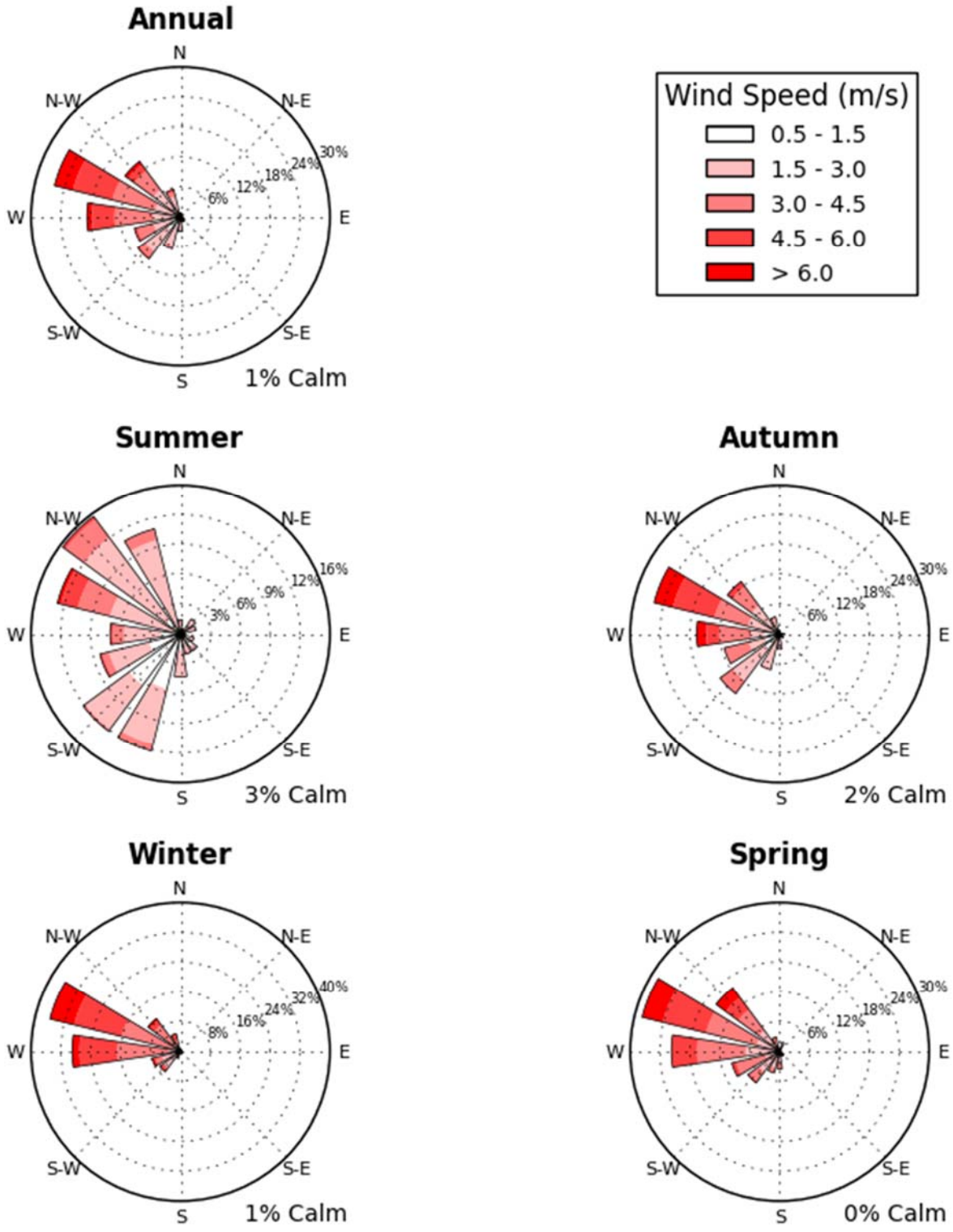


Figure 6-3 Windroses – Night Time (10.00pm – 7.00am)



6.4 Reasonable & Feasible Noise Mitigation Measures

In addition to internal identification, WCL engaged Hatch to attend site to identify opportunities to reduce noise generated from the Russell Vale Colliery. Reasonable and feasible recommendations have been implemented on site or included as commitments going forward and as such have been included in modelling assumptions for this impact assessment.

6.4.1 Primary Sizer Building

All the modelled scenarios (Existing / Existing Mitigated / Year 2 / Year 4) presented in this report have taken into account noise mitigations measures recently implemented on the primary sizer building. Those mitigations include the erecting of side sheeting lined with absorption material around all facades of the building (except for the northern façade where an opening had to be left for ventilation purposes).

6.4.2 Tripper System

Some of the modelled scenarios (Existing Mitigated / Year 2 / Year 4) also accounted for mitigation works recently conducted on the existing tripper system. The works included internal lining and vibration isolation of tripper impact plates and hangers as well as internal lining and top covering of trouser leg chutes. The additional tripper systems proposed for stockpiles SP2 and SP3 (Year 4) will also similar noise controls in place.

6.4.3 Noise Bunds – Existing

All scenarios (Existing / Existing Mitigated / Year 2 / Year 4) incorporate the three (3) existing 5m high noise bunds used to minimise site noise at the nearby receivers located directly to the north, north-east and east of the colliery.

The existing 2.5m high bund built near the Rubber Tyred Vehicle (RTV) and rail portal area has also been incorporated in all scenarios (Existing / Existing Mitigated / Year 2 / Year 4).

The approximate location of the existing bunds is shown in Figure 6-4.

Figure 6-4 Indicative Existing Noise Bunds (All Scenarios)

6.4.4 Noise Walls – Conceptual

WCL has commissioned WM to conduct a study of noise control efficacy of several 4m high concrete (or similar materials) walls along exposed sections of the internal haul road to examine if placement of bunds in this location would reduce noise generated by on-site truck movements at the Russell Vale receivers.

The approximate location of the conceptual noise walls is shown in Figure 6-5.

Figure 6-5 Conceptual Concrete Walls

Table 6-1 summarises the reduction achieved at the identified receivers with the noise walls in place in the Year 4 scenario under relevant weather conditions. Where a range is provided, levels represent the reduction achieved with two (2) different sound power levels assumed for the tripper arrangements. This is further explained in Section 7.

Table 6-1 Reduction Achieved with Conceptual Noise Walls in Place

Rec ID	Noise Reduction Achieved with Concrete Walls in Place (dB)		
	Day (7.00am – 6.00pm)	Evening (6.00pm – 10.00pm)	Night (10.00pm – 7.00am)
R1	1	0-1	0
R2	1-2	1	0
R3	2	1	1
R4	0-1	2	0
R5	0	0	0
R6	0	0	0
R7	0	0	0
R8	0	0	0
R9	0	0	0
R10	0	0	0
R11	0	0	0
R12	0	0	0
R13	0	0	0
R14	0	0	0

A review of the Table 6-1 shows that the reduction achieved by the implementation of noise walls ranges between 0-1dB for the majority of receivers (with 2dB reduction predicted at R2, R3 and R4 only) at the Russell Vale receivers. A difference of 2dB is considered marginal and that of 1dB is negligible. Therefore, the option of building several 4m high concrete walls along exposed sections of the internal haul road is not considered reasonable as the overall noise benefits do not outweigh the considerable costs of the construction of the noise walls.

6.4.5 Summary of Mitigation Measures in Assessment Scenarios

Table 6-2 provides a summary of the mitigation measures which have been included in the four (4) different noise assessment scenarios.

Table 6-2 Summary of Mitigation Measures in Assessment Scenarios

Mitigation Measures	Have Mitigation Measures Been Implemented (Y/N) ?			
	Existing	Existing Mitigated	Year 2	Year 4
Acoustic Treatment of Primary Sizer Building	Y	Y	Y	Y
Acoustic Treatment of Existing Tripper System (SP1)	Y	Y	Y	Y
Acoustic Treatment of Proposed Tripper Systems (SP2 & SP3)	n/a	n/a	n/a	Y

Mitigation Measures	Have Mitigation Measures Been Implemented (Y/N) ?			
	Existing	Existing Mitigated	Year 2	Year 4
Noise Bunds (2.5m & 5m)	Y	Y	Y	Y
Access Road Concrete Noise Walls (4m)	N	N	N	N

6.5 Fleet List and Period of Operation

6.5.1 Fleet List and Period of Operation – Existing & Existing Mitigated

Table 6-3 presents the schedule of equipment representing the main noise contributors assumed in the noise models for the Existing and Existing Mitigated scenarios. Other noise sources present on site have not been included in the noise models as it is believed they do not contribute to the overall site noise emissions.

Table 6-3 Indicative Equipment & Period of Operation – Existing & Existing Mitigated

Area	Fleet/ Infrastructure Item	Source ID (Fig. 5-6)	Period	Number of Items	Function
Coal Transport Infrastructure	Primary sizer building	S1	Day, evening & night	1	Crush coal to smaller size
	Decline conveyor	S2	Day, evening & night	1	Transport coal from portal area to SP1 area
	SP1 stackout conveyor	S3	Day, evening & night	1	Transport coal from decline conveyor to SP1 area
	SP1 tripper system	S4	Day, evening & night	1	Distribute coal within SP1 area
	Drive tower	S5	Day, evening & night	1	Drive conveyor and tripper system
Coal Reclaim	D11 dozer	S6	Day & evening	1	Manage SP1 stockpile
	CAT970 front end loader	S7	Day & evening	1	Load dump trucks at SP1
	D300E 30t dump trucks	S8	Day & evening	4 (1 every 2.5mins)	Transport coal from SP1 area to mobile screening area
Screening Area	CAT345B excavator	S9	Day & evening	1	Load coal into mobile screening plant
	Mobile Screening Plant (693+ Supertrack FINLAY)	S10	Day & evening	1	Screen coal
	CAT988B front end loader	S11	Day & evening	2	Manage and load screened coal into trucks and dogs
Coal Haulage	Truck and dog	S12	Day & evening	1 every 7.5mins	Load screened coal to transport off-site
RTV Portal Area	Compressor House	S13	Day, evening & night	1	Generate power for underground facilities
	Main Ventilation Fans	S14	Day, evening & night	2	Provide underground ventilation

Area	Fleet/ Infrastructure Item	Source ID (Fig. 5-6)	Period	Number of Items	Function
	Hyster116 forklift	S15	Day, evening & night	1	General maintenance work
	Hyster117 forklift	S16	Day, evening & night	1	General maintenance work
	Juggonaut	S17	Day & night	1	Transport men and material down portal. Assumed to be operating for 5mins at shift change during the day and at night (i.e. not evening period)
	Men Transporter	S18	Day & night	3	Transport men down portal. Assumed 3 to be operating for 3mins at shift change during the day and at night (i.e. not evening period)

Figure 6-6 shows the location of all the identified noise sources assumed for the Existing and Existing Mitigated scenarios.

Figure 6-6 Location of Identified Sources – Existing & Existing Mitigated

6.5.2 Fleet List and Period of Operation – Year 2

Table 6-4 presents the schedule of equipment representing the main noise contributors assumed in the noise models for the Year 2 scenario.

Table 6-4 Indicative Equipment & Period of Operation – Year 2

Area	Fleet / Infrastructure Item	Source ID (Fig. 5-7)	Period	Number of Items	Function
Coal Transport Infrastructure	Primary sizer building	S1	Day, evening & night	1	Crush coal to smaller size
	Decline conveyor	S2	Day, evening & night	1	Transport coal from portal area to SP1 area
	SP1 stackout conveyor	S3	Day, evening & night	1	Transport coal from decline conveyor to SP1 area
	SP1 tripper system	S4	Day, evening & night	1	Distribute coal within SP1 area
	Drive tower	S5	Day, evening & night	1	Drive conveyor and tripper system
Coal Reclaim	D11 dozer	S6	Day & evening	1	Manage SP1 stockpile
	Reclaim conveyor	S7	Day & evening	1	Transport coal from SP1 area to existing truck loading bins
	Reclaim tunnel fans	S8	Day & evening	1	Provide ventilation for reclaim tunnels
	Existing 600t surge bin	S9	Day & evening	1	Regulate coal being transferred to existing truck loading bins
	Existing truck loading bins	S10	Day & evening	1	Load coal into road trucks to transport off-site
Coal Haulage	Truck and dog	S11	Day & evening	1 every 5mins	Transport off-site
RTV Portal Area	Compressor House	S12	Day, evening & night	1	Generate power for underground facilities
	Main Ventilation Fans	S13	Day, evening & night	2	Provide underground ventilation
	Hyster116 forklift	S14	Day, evening & night	1	General maintenance work
	Hyster117 forklift	S15	Day, evening & night	1	General maintenance work
	Juggonaut	S16	Day & night	1	Transport men and material down portal. Assumed to be operating for 5mins at shift change during the day and at night (i.e. not evening period)
	Men Transporter	S17	Day & night	3	Transport men down portal. Assumed 3 to be operating for 3mins at shift change during the day and at night (i.e. not evening period)

Figure 6-7 shows the location of all the identified noise sources assumed for the Year 2 scenario.

Figure 6-7 Location of Identified Sources – Year 2

6.5.3 Fleet List and Period of Operation – Year 4

Table 6-5 presents the schedule of equipment representing the main noise contributors assumed in the noise models for the Year 4 scenario.

It is important to note that although all three (3) tripper arrangements (incl. tripper system and stackout conveyor) for SP1, SP2 and SP3 have been listed, only one would be operating at any one time. The SP1 stackout conveyor is the only stackout conveyor assumed to be operating all the time regardless of which tripper system is in use as coal needs to be transferred from the decline conveyor to the SP2/SP3 stackout conveyors.

Similarly, only one (1) D11 dozer will be operating at once and it is assumed to be operating near the tripper arrangement in operation at the time.

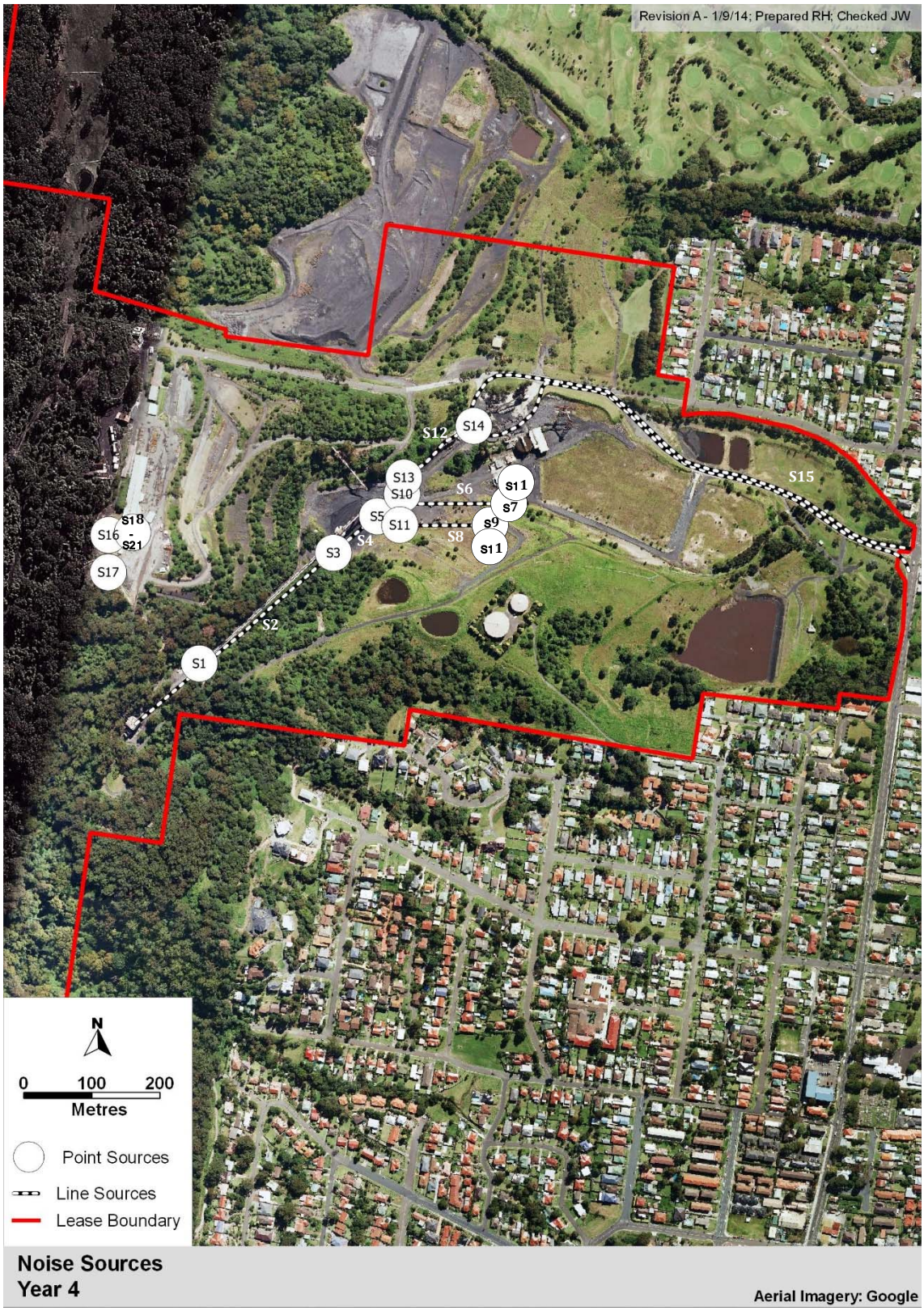
Table 6-5 Indicative Equipment & Period of Operation – Year 4

Area	Fleet / Infrastructure Item	Source ID (Fig. 5-8)	Period	Number of Items	Function
	Primary sizer building	S1	Day, evening & night	1	Crush coal to smaller size
Coal Transport Infrastructure	Decline conveyor	S2	Day, evening & night	1	Transport coal from portal area to SP1, SP2 or SP3 areas
	New secondary sizer building	S3	Day, evening & night	1	Crush coal to smaller size
	SP1 stackout conveyor	S4	Day, evening & night	1	Transport coal from decline conveyor to SP1, SP2 or SP3 areas
	SP1 tripper system	S5	Day, evening & night	1	Distribute coal within SP1 area
	SP2 stackout conveyor	S6	Day, evening & night	1	Transport coal to SP2 area
	SP2 tripper system	S7	Day, evening & night	1	Distribute coal within SP2 area
	SP3 stackout conveyor	S8	Day, evening & night	1	Transport coal to SP3 area
	SP3 tripper system	S9	Day, evening & night	1	Distribute coal within SP3 area
	Drive tower	S10	Day, evening & night	1	Drive conveyor and tripper system
Coal Reclaim	D11 dozer	S11	Day & evening	1	Manage SP1, SP2 or SP3 stockpile
	Reclaim conveyor	S12	Day & evening	1	Transport coal from SP1, SP2 or SP3 area to existing truck loading bins
	Reclaim tunnel fans	S13	Day & evening	1	Provide ventilation for reclaim tunnels
	New truck loading bins	S14	Day & evening	1	Load coal into road trucks to transport off-site
Coal Haulage	Truck and dog	S15	Day & evening	1 every 3.5mins	Transport off-site
RTV Portal Area	Compressor House	S16	Day, evening & night	1	Generate power for underground facilities
	Main Ventilation Fans	S17	Day, evening & night	2	Provide underground ventilation

Area	Fleet / Infrastructure Item	Source ID (Fig. 5-8)	Period	Number of Items	Function
	Hyster116 forklift	S18	Day, evening & night	1	General maintenance work
	Hyster117 forklift	S19	Day, evening & night	1	General maintenance work
	Juggonaut	S20	Day & night	1	Transport men and material down portal. Assumed to be operating for 5mins at shift change during the day and at night (i.e. not evening period)
	Men Transporter	S21	Day & night	3	Transport men down portal. Assumed 3 to be operating for 3mins at shift change during the day and at night (i.e. not evening period)

Figure 6-8 shows the location of all the identified noise sources assumed for the Year 4 scenario. As mentioned above, all noise sources associated with the 3 stockpile areas (namely, SP1, SP2 and SP3) will be exclusive of each other.

Figure 6-8 Location of Identified Sources – Year 4



6.6 Indicative Equipment Sound Power Levels (SWLs)

The conservative Sound Power Levels (SWLs) assumed for this assessment are summarised in Table 6-6. The table also specifies where plant items have already been mitigated and provides a source reference for each SWL used.

Table 6-6 Indicative Equipment Sound Power Levels

Fleet/ Infrastructure Item	Sound Power Level (dBA)	Reference
Primary sizer building	104 (partially mitigated)	*Russell Vale Tripper Conveyor and Surface Noise Source Management*, Hatch, July 2014 (SWL of 104dBA after partial mitigation).
New secondary sizer building	99	*NRE No.1 Colliery - Noise Assessment Major Works Project*, ERM, Nov 2012
Decline conveyor	70/m	*NRE No.1 Colliery - Noise Assessment Major Works Project*, ERM, Nov 2012
SP1/SP2/SP3 stackout conveyor	70/m	*NRE No.1 Colliery - Noise Assessment Major Works Project*, ERM, Nov 2012
SP1/SP2/SP3 tripper system	100-105 (partially mitigated)	*Russell Vale Tripper Conveyor and Surface Noise Source Management*, Hatch, July 2014 (SWL of 108dBA unmitigated). Based on advice from Hatch, a conservative but achievable 3dB reduction (i.e. 105dBA SWL) was assumed as a result of the mitigation works recently conducted on the existing tripper arrangement. It is believed an 8dB reduction (i.e. 100dBA SWL), if not achieved as a result of the recent works, would be achievable through further mitigation works. Therefore, the assessment was conducted using a range of 100-105dBA for the tripper system.
Drive tower	94	*Russell Vale Tripper Conveyor and Surface Noise Source Management*, Hatch, July 2014
D11 dozer	115	Wilkinson Murray site measurements (8 July 2014)
Reclaim conveyor	70/m	*NRE No.1 Colliery - Noise Assessment Major Works Project*, ERM, Nov 2012
Reclaim tunnel fans	108 (105 each)	*NRE No.1 Colliery - Noise Assessment Major Works Project*, ERM, Nov 2012
Existing truck loading bins	105	Wilkinson Murray database
Existing 600t surge bin	105	Wilkinson Murray database
New truck loading bins	105	Wilkinson Murray database
Truck and dog	102 (40kph), 97 (10kph)	Wilkinson Murray database
Compressor House	105	*Russell Vale Tripper Conveyor and Surface Noise Source Management*, Hatch, July 2014
Main Ventilation Fans	104	*Russell Vale Tripper Conveyor and Surface Noise Source Management*, Hatch, July 2014
Hyster116 forklift	84	Wilkinson Murray site measurements (8 July 2014)
Hyster117 forklift	95	Wilkinson Murray site measurements (8 July 2014)
Juggonaut	104	*Noise Levels of Mobile Equipment, BGMA*, July 2010
Men Transporter	104	Derived from Juggonaut SWL (*Noise Levels of Mobile Equipment, BGMA*, July 2010)
CAT970 front end loader	110	Wilkinson Murray site measurements (8 July 2014)
D300E 30t dump truck	105	Wilkinson Murray site measurements (8 July 2014)
CAT345B excavator	103	Wilkinson Murray site measurements (8 July 2014)

Fleet / Infrastructure Item	Sound Power Level (dBA)	Reference
Mobile Screening Plant (693+ Supertrack FINLAY)	112	Wilkinson Murray site measurements (8 July 2014)
CAT988B front end loader	113	Wilkinson Murray site measurements (8 July 2014)

7 INDUSTRIAL NOISE PREDICTIONS & DISCUSSION

7.1 Predicted Noise Levels

The predicted $L_{Aeq,15min}$ operational noise levels at each receiver are presented in Tables 7-1 to 7-4. Results are presented for the four (4) identified assessment scenarios (Existing / Existing Mitigated / Year 2 / Year 4) as $L_{Aeq,15min}$ levels under calm weather conditions and as 10th percentile exceedance $L_{Aeq,15min}$ noise levels (or P10) under relevant weather conditions (Section 6.3). Noise criteria are shown in yellow shading.

Since the mitigated tripper arrangement could not be measured prior to this assessment, the resultant reduction in levels cannot be quantified accurately. As such, the assessment of the Existing Mitigated, Year 2 and Year 4 scenarios is based on a range of levels with the highest level within the range representing the prediction based on a conservative but achievable 3dB reduction (i.e. tripper system with a SWL of 105dBA) and the lowest level representing the prediction based on a 8dB reduction (i.e. tripper system with a SWL of 100dBA) which, if not already achieved, can be achieved with further mitigation works. In cases where the tripper arrangement is not a relatively important contributor to the overall site noise, the prediction is reported as one level (i.e. not a range of levels).

A detailed discussion on historical noise levels at Russell Vale Colliery are included in Section 7.3.

7.1.1 Predicted Noise Levels – Existing

The predicted $L_{Aeq,15min}$ operational noise levels at each receiver for the Existing scenario are presented in Tables 7-1.

Table 7-1 Predicted $L_{Aeq,15min}$ Noise Levels from Project – Existing

Rec ID	$L_{Aeq,15min}$ Noise Level (dBA)								
	Day (7.00am – 6.00pm)			Evening (6.00pm – 10.00pm)			Night (10.00pm – 7.00am)		
	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion
R1	48	51	42	48	54	41	39	45	40
R2	52	54	42	52	56	41	40	47	40
R3	51	53	42	51	55	41	39	46	40
R4	48	51	42	48	55	41	39	45	40
R5	50	52	48	50	55	45	37	43	42
R6	46	51	48	46	56	45	36	43	42
R7	47	52	48	47	56	45	34	44	42
R8	47	51	48	47	56	45	36	46	42
R9	42	44	40	42	47	40	33	42	38
R10	40	42	40	40	45	40	35	42	38
R11	39	40	40	39	43	40	35	40	38
R12	41	42	40	41	43	40	37	40	38

Rec ID	$L_{Aeq,15min}$ Noise Level (dBA)								
	Day (7.00am – 6.00pm)			Evening (6.00pm – 10.00pm)			Night (10.00pm – 7.00am)		
	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion
R13	44	45	40	44	46	40	40	42	38
R14	41	44	40	41	46	40	38	42	38

Daytime noise levels under relevant weather conditions are predicted to exceed the noise criteria at most of the identified receivers with exceedances ranging up to 12dB. The worst affected receivers during the day are located in Russell Vale (R1-R4).

In the evening, noise levels under relevant weather conditions are found to exceed the noise criteria at all identified receivers with exceedances ranging up to 15dB. The worst affected receivers in the evening are generally located in Russell Vale (R1-R8).

At night, noise predictions under calm weather conditions are found to comply with the relevant criteria at all the identified receivers except R13. However, 10th percentile noise levels are found to exceed the night time criteria all the identified receivers with exceedances ranging up to 7dB.

7.1.2 Predicted Noise Levels – Existing Mitigated

The predicted $L_{Aeq,15min}$ operational noise levels at each receiver for the Existing Mitigated scenario are presented in Tables 7-2.

Table 7-2 Predicted $L_{Aeq,15min}$ Noise Levels from Project - Existing Mitigated

Rec ID	$L_{Aeq,15min}$ Noise Level[(1)] (dBA)								
	Day (7.00am – 6.00pm)			Evening (6.00pm – 10.00pm)			Night (10.00pm – 7.00am)		
	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion
R1	48	51	42	48	53	41	35-37	41-43	40
R2	52	54	42	52	56	41	36-38	42-44	40
R3	50-51	53	42	50-51	55	41	35-37	41-44	40
R4	47	51	42	47	55	41	34-37	41-43	40
R5	50	52	48	50	55	45	33-35	39-41	42
R6	46	51	48	46	55	45	32-34	40-42	42
R7	46	52	48	46	56	45	31-33	41-43	42
R8	47	51	48	47	55-56	45	33-34	42-44	42
R9	41	43	40	41	47	40	31-32	41	38
R10	40	41	40	40	45	40	33-34	41	38
R11	39	40	40	38-39	42	40	32-34	38-39	38
R12	40-41	41	40	40	42-43	40	33-35	37-38	38
R13	43	44	40	43	45	40	36-38	38-40	38

Rec ID	$L_{Aeq,15min}$ Noise Level[1] (dBA)								
	Day (7.00am – 6.00pm)			Evening (6.00pm – 10.00pm)			Night (10.00pm – 7.00am)		
	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion
R14	40	43-44	40	39-40	46	40	35-36	39-40	38

(1) Scenario is based on tripper system with a SWL of 105dBA and the lowest level representing a tripper system with a SWL of 100dBA.

Daytime noise levels under relevant weather conditions generally exceed the noise criteria at the identified receivers with exceedances ranging up to 12dB. The worst affected receivers during the day are located in Russell Vale (R1-R4).

In the evening, noise levels under relevant weather conditions are found to exceed the noise criteria at all identified receivers with exceedances ranging up to 15dB. The worst affected receivers in the evening are generally located in Russell Vale (R1-R8).

At night, noise predictions under calm weather conditions are found to comply with the relevant criteria at all the identified receivers. However, 10th percentile noise levels are generally found to exceed the night time criteria with exceedances ranging up to 4dB. It should be noted that if we assume a tripper SWL of 100dBA, P10 levels would fall within the criteria at R7, R8, R11 and R13.

7.1.3 Predicted Noise Levels – Year 2

The predicted $L_{Aeq,15min}$ operational noise levels at each receiver for the Year 2 scenario are presented in Tables 7-3.

Table 7-3 Predicted $L_{Aeq,15min}$ Noise Levels from Project – Year 2

Rec ID	$L_{Aeq,15min}$ Noise Level[1] (dBA)								
	Day (7.00am – 6.00pm)			Evening (6.00pm – 10.00pm)			Night (10.00pm – 7.00am)		
	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion
R1	47	50	42	47	52-53	41	35-37	41-43	40
R2	50	52	42	50	54	41	36-38	42-44	40
R3	49	51	42	49	54	41	35-37	41-44	40
R4	46	49-50	42	46	54	41	34-37	41-43	40
R5	46	48	48	46	52	45	33-35	39-41	42
R6	45	49	48	45	52-53	45	32-34	40-42	42
R7	40-41	43	48	40	47-48	45	31-33	41-43	42
R8	42	44-45	48	42	48-49	45	33-34	42-44	42
R9	38	41	40	37-38	45	40	31-32	41	38
R10	37	39-40	40	37	43	40	33-34	41	38
R11	36-37	38	40	36-37	41	40	32-34	38-39	38
R12	37-38	38-39	40	37-38	40-41	40	33-35	37-38	38

Rec ID	$L_{Aeq,15min}$ Noise Level[1] (dBA)								
	Day (7.00am – 6.00pm)			Evening (6.00pm – 10.00pm)			Night (10.00pm – 7.00am)		
	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion
R13	41-42	42-43	40	41-42	43-44	40	36-38	38-40	38
R14	38	40	40	37-38	41-42	40	35-36	39-40	38

(1) Scenario is based on tripper system with a SWL of 105dBA and the lowest level representing a tripper system with a SWL of 100dBA.

Daytime noise levels under relevant weather conditions generally exceed the noise criteria at the identified receivers with exceedances ranging up to 10dB. The worst affected receivers during the day are located in Russell Vale (R1-R4).

In the evening, noise levels under relevant weather conditions are found to exceed the noise criteria at all identified receivers with exceedances ranging up to 13dB. The worst affected receivers in the evening are located in Russell Vale (R1-R4). It should be noted that if we assume a tripper SWL of 100dBA, P10 levels would fall within the criterion at R12.

At night, noise predictions under relevant weather conditions are found to exceed the relevant criteria at most of the identified receivers with exceedances ranging up to 4dB if assuming a tripper SWL of 105dBA. Only seven (7) exceedances would be expected with a tripper SWL of 100dBA.

7.1.4 Predicted Noise Levels – Year 4

The predicted $L_{Aeq,15min}$ operational noise levels at each receiver for the Year 4 scenario are presented in Tables 7-4.

As mentioned above, only one tripper arrangement will be operating at any one time. As such, the reported levels in Table 7-4 represent the worst case noise levels assuming not only that the closest and most exposed tripper system is in use but that the tripper in use and the associated D11 dozer operates at the closest end of the stockpile in question in relation to each receiver.

Table 7-4 Predicted $L_{Aeq,15min}$ Noise Levels from Project – Year 4

Rec ID	$L_{Aeq,15min}$ Noise Level[1] (dBA)								
	Day (7.00am – 6.00pm)			Evening (6.00pm – 10.00pm)			Night (10.00pm – 7.00am)		
	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion
R1	48	50-51	42	48	52	41	40-44	43-46	40
R2	51	52-53	42	51	54	41	42-46	44-48	40
R3	50	52	42	50	53-54	41	41-45	44-47	40
R4	46-47	49	42	46-47	53	41	38-42	43-46	40
R5	47	49-50	48	47	52	45	35-38	41-44	42
R6	46-47	48-49	48	46-47	54	45	36-39	41-44	42
R7	41-42	43-44	48	41-42	49	45	35-38	42-44	42

Rec ID	$L_{Aeq,15min}$ Noise Level[1] (dBA)								
	Day (7.00am – 6.00pm)			Evening (6.00pm – 10.00pm)			Night (10.00pm – 7.00am)		
	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion
R8	42-44	44-46	48	42-44	48-49	45	37-41	43-46	42
R9	41-44	43-45	40	41-43	46-48	40	38-42	43-47	38
R10	38-40	40-42	40	38-40	44-47	40	36-39	43-46	38
R11	37-38	38-39	40	37-38	41-42	40	34-36	39-40	38
R12	39-41	40-42	40	39-41	42-44	40	36-39	39-42	38
R13	41-42	42	40	41	43-44	40	37-39	39-40	38
R14	40-42	42-44	40	39-41	44-46	40	37-40	40-43	38

(1) Scenario is based on tripper system with a SWL of 105dBA and the lowest level representing a tripper system with a SWL of 100dBA.

Daytime noise levels under relevant weather conditions generally exceed the noise criteria at the identified receivers with exceedances ranging up to 11dB. The worst affected receivers during the day are located in Russell Vale (R1-R4). It should be noted that if we assume a tripper SWL of 100dBA, P10 levels would fall within the criterion at R6, R7, R8, R10, R11 and R12.

In the evening, noise levels under relevant weather conditions are found to exceed the noise criteria at all identified receivers with exceedances ranging up to 13dB. The worst affected receivers in the evening are located in Russell Vale (R1-R4).

At night, 10th percentile noise levels are generally found to exceed the criteria with exceedances ranging up to 9dB. If we assume a tripper SWL of 100dBA, P10 levels would fall within the criterion at R5, R6 and R7.

7.2 Comparison with ERM Noise Predictions

As mentioned in the introduction, a noise assessment for the original Underground Expansion Project (UEP) has previously been prepared by ERM (*NRE No.1 Colliery – Noise Assessment Major Works Project*, ERM, November 2012). The ERM assessment corresponds with the Year 4 assessment scenario.

With the revision of the project as presented in the PPR, WCL has engaged Wilkinson Murray to revise this assessment. This revision amended the assumptions made in the 2012 ERM assessment, including:

- updating current meteorological data (gained largely from a new onsite meteorological station);
- updating background noise levels; and
- implementation of additional noise bunding and other noise mitigation commitments made by WCL.

This section compares the predicted levels reported as part of this assessment to the ERM predictions and provides a summary of the differences in assumptions.

Table 7-5 summarises ERM's noise predictions for the Year 4 scenario and compares them with the noise predictions reported in this assessment. Only noise predictions at comparable noise receivers have been included.

It is important to note that the ERM noise predictions have only been provided for calm isothermal meteorological conditions.

Table 7-5 Comparison between ERM and WM Noise Predictions (Year 4)

ERM Rec ID	WM Rec ID	$L_{Aeq,15min}$ Noise Level[1] (dBA)								
		Day (7.00am – 6.00pm)			Evening (6.00pm – 10.00pm)			Night (10.00pm – 7.00am)		
		ERM	WM		ERM	WM		ERM	WM	
		Calm $L_{Aeq,15min}$	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Calm $L_{Aeq,15min}$	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Calm $L_{Aeq,15min}$	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$
R2	R2	42	51	52-53	41	51	54	32	42-46	44-48
R1	R3	41	50	52	40	50	53-54	31	41-45	44-47
R4	R5	41	47	49-50	41	47	52	31	35-38	41-44
C3	R9	40	41-44	43-45	39	41-43	46-48	31	38-42	43-47
C2	R12	38	39-41	40-42	37	39-41	42-44	34	36-39	39-42
C1	R13	37	41-42	42	36	41	43-44	34	37-39	39-40
C5	R14	39	40-42	42-44	38	39-41	44-46	35	37-40	40-43

(1) Scenario is based on tripper system with a SWL of 105dBA and the lowest level representing a tripper system with a SWL of 100dBA.

A review of Table 7-5 shows that the ERM noise predictions are consistently lower than the WM predictions with differences ranging up to 14dB when comparing levels under calm isothermal meteorological conditions and 16dB if comparing the ERM predictions to WM's 10th percentile noise levels.

After reviewing ERM's noise assessment report, it is believed a combination of several factors would have resulted in the differences in predicted noise levels, namely meteorological conditions not considered and different noise source assumptions.

7.2.1 Meteorological Parameters

The most significant difference stems from the fact that the meteorological parameters assumed in making the predictions differ. ERM used data from the Bellambi Weather Station (Bureau of Meteorological station 068228) to determine prevailing winds and temperature inversions for the Project. ERM's analysis of the data established that the Project was not subject to prevailing winds (with occurrences found to be less than 30 per cent of any assessment period and during any season) or temperature inversions (with occurrences found to be less than 30 per cent of the night time period in winter) and therefore those adverse meteorological conditions were not modelled in the ERM noise assessment.

The Bellambi Weather Station is a coastal station located on the Bellambi peninsula where temperature inversions and drainage-flow winds would not occur. As mentioned earlier, the Site is located on the lower slopes of the Illawarra Escarpment approximately 2km from the coast.

In consideration of the above, it was determined from analysis of the data provided by the on-site weather station and data generated by the TAPM model that the Project is prone to drainage-flow winds travelling down the escarpment in the easterly and south-easterly directions where most of the surrounding receivers are located. This assessment considers these meteorological conditions which are considered to be more representative of actual conditions on site.

The 10th percentile exceedance approach adopted by WM for this assessment (Section 6.3) is also believed to have contributed to a small extent to the differences in predicted noise levels as this approach is more conservative than the use of a single set of adverse meteorological data (*INP*).

7.2.2 Noise Sources Assumptions

Table 7-5 shows that the ERM noise predictions are consistently lower than the WM predictions even when comparing levels under calm isothermal meteorological conditions. This can only be explained by the selection of noise sources included in the noise model (i.e. exclusion of one or more noise sources from the ERM noise models that were included in the WM noise models) and the SWL assumed for each source item.

Review of the ERM noise assessment report suggests several possible reasons may have contributed to the lower predicted levels. However, possible discrepancies in the assumptions made are often hard to ascertain due to the lack of information made available in the report. The following points are suggested as possible reasons:

- ERM may have omitted to include the tripper arrangements for SP1, SP2 and SP3. Although discussed in the description of the proposed operations, the trippers were not included in the list of acoustically significant plant and equipment requiring acoustic design (Table 6.1). It is possible they were only accounted for with the inclusion of new stackout conveyors. As part of this assessment, tripper arrangements have been established as a major noise contributor with an estimated SWL of 100-105dBA (depending on the level of noise reduction achieved with the recently implemented and potentially further mitigation measures).

- Review of the ERM daytime noise contours would suggest ERM has included the primary sizer building in its noise models. However, there is no indication as to what SWL they assign to the sizer building. It is possible ERM assumed the same SWL of 99dBA for the primary sizer building as for the new secondary sizer building (referred to as 'Sizing Tower (enclosed)' in Table 6.1). WM has assumed a SWL of 104dBA (based on measurements conducted by Hatch) for the primary sizer building which is significantly higher than 99dBA.

- ERM assumed the D11 dozer is acoustically treated with a SWL of 109dBA. WM has assumed an unmitigated SWL of 115dBA.

- ERM assumed a total SWL of 80dBA for the compressor house. WM assumed a SWL of 105dBA (based on measurements conducted by Hatch).

Some negligible discrepancies also exist between the SWL used for other noise sources. However, those are unlikely to have resulted in discernable differences in overall site noise levels.

7.4 Historical Noise Monitoring Results

Site noise has been assessed against the *INP* which provides a good understanding of the potential noise impact the Project has on the community. However, for this Project we believe it is necessary to look at the history of the site.

Review of past monitoring reports prepared between 1980 and 1991 have provided some understanding of the Site's noise impact on the surrounding community during the time of the washery (which was in operation until 2002). A summary of the measurement results is provided in Table 7-6.

Most of the measurements were conducted along West Street and Broker Street in Russell Vale with monitoring locations corresponding to receivers R1, R2 and R4. However, some measurements were also undertaken on Lyndon Street in Corrimal. The monitoring location in Corrimal corresponds best with identified receiver R12.

While all noise levels measured in Russell Vale refer to noise associated with the processing area, those measured at R12 represent a combination of processing area and portal area noise.

Table 7-6 Historical Monitoring Results

Rec ID	Period of Monitoring	Measured Levels due to Site Noise (dBA)	Reference
R1	Nov 1991	56 (night)	*Final Report Noise Compliance and Noise Control Options for Bellambi Colliery, Corrimal*, Dick Benbow & Associates Pty Ltd, December 1991
R2	May 1980	55-57 (day)	*Noise Emission Prediction Report for Coal Preparation Plant Bellambi Coal Company South Bulli Colliery*, Louis A Challis and Associates Pty Ltd, June 1980
	Nov 1991	56 (night)	*Final Report Noise Compliance and Noise Control Options for Bellambi Colliery, Corrimal*, Dick Benbow & Associates Pty Ltd, December 1991
	May-June 1984	55-58	*Environmental Impact Statement - Coal Washery Reject Emplacement in the Southern Gully, Russell Vale, NSW - Stage 3*, Johnstone Environmental Technology Pty Ltd, August 1989
	Sep 1986	54 (L_{A90}) (eve)	*Environmental Impact Statement - Coal Washery Reject Emplacement in the Southern Gully, Russell Vale, NSW - Stage 3*, Johnstone Environmental Technology Pty Ltd, August 1989
	Aug 1989	52-59 (L_{A90})	*Environmental Impact Statement - Coal Washery Reject Emplacement in the Southern Gully, Russell Vale, NSW - Stage 3*, Johnstone Environmental Technology Pty Ltd, August 1989
	Dec 1989	52-59 (eve & night)	*Night Time Noise Level Survey in Vicinity of South Bulli Coal Washery – December 1989 & March 1990*, Johnstone Environmental Technology Pty Ltd, April 1990.
R4	Nov 1991	48 (night)	*Final Report Noise Compliance and Noise Control Options for Bellambi Colliery, Corrimal*, Dick Benbow & Associates Pty Ltd, December 1991
R12	May 1980	Low 40's-47 (day & night)	*Noise Emission Prediction Report for Coal Preparation Plant Bellambi Coal Company South Bulli Colliery*, Louis A Challis and Associates Pty Ltd, June 1980
	Nov 1991	43 (night)	*Final Report Noise Compliance and Noise Control Options for Bellambi Colliery, Corrimal*, Dick Benbow & Associates Pty Ltd, December 1991

In summary, night time noise levels during the time of the washery were measured at:

- 56dBA at R1;
- 52-59dBA at R2;
- 48dBA at R4; and
- low 40's-47dBA at R12.

7.5 Discussion of Noise Levels throughout History of Project

A review of the predicted and measured noise levels presented in Sections 7.1 and 7.3 provides an understanding of how noise levels associated with the Project have evolved throughout the years.

Table 7-7 presents a timeline of predicted night time noise levels for the four (4) assessment scenarios (Section 7.1) at a selection of representative receivers, namely R1, R2, R4, R9 and R12. Where possible, measured noise levels during the time of the washery were also presented for completeness. Noise criteria are shown in yellow shading.

Table 7-7 Comparison of Historical Measured Levels & Project Noise Predictions

Rec ID	Measured Night Time Noise Levels from Site with Washery (dBA)	10th percentile $L_{Aeq,15min\ Night}$ Predicted Night Time Noise Level (dBA)(1)				Night Time Criterion (dBA)
		Existing	Existing Mitigated	Year 2	Year 4	
R1	56	45	41-43	41-43	43-46	40
R2	52-59	47	42-44	42-44	44-48	40
R4	48	45	41-43	41-43	43-46	40
R9	n/a	42	41	41	43-47	38
R12	Low 40's-47	40	37-38	37-38	39-42	38

(1) Scenario is based on tripper system with a SWL of 105dBA and the lowest level representing a tripper system with a SWL of 100dBA.

Historical noise levels as measured during the time of the washery were considerably higher than any of the predictions based on the existing or proposed scenarios, especially at the West Street receivers.

Noise levels along West Street (R1 and R2) used to be 11-12dB and 10-11dB higher (with the washery) than the predictions associated with the Existing and Year 4 scenarios, respectively (assuming a tripper SWL of 105dBA). Similarly, measured levels along Broker Street (R4) were 3dB and 2dB higher (with the washery) than the expected levels with the Existing and Year 4 scenarios, respectively (assuming a tripper SWL of 105dBA). Finally, noise levels measured on Lyndon Street (R12) were found to be 7dB and 5dB higher (with the washery) than levels associated with the Existing and Year 4 scenarios, respectively (assuming a tripper SWL of 105dBA).

Before mitigation measures were implemented on the existing tripper arrangement (i.e. Existing to Existing Mitigated), night time noise levels were 1-3dB higher at the identified receivers (assuming a tripper SWL of 105dBA).

Night time noise levels for the Existing Mitigated and Year 2 scenarios are predicted to remain comparable as no changes are expected to the infrastructure operating at night.

The Project (i.e. Year 4) includes a new secondary sizer building and several tripper arrangements potentially operating at night and when considering the closest and most exposed tripper system to a receiver is in use, night time noise levels are predicted to increase at some of the identified receivers by up to 6dB when compared with the Existing Mitigated scenario predictions (assuming a tripper SWL of 105dBA).

7.6 Discussion of Further Mitigation and Management Measures

Although during the time of the washery the colliery had more noise impact on the surrounding community than today's operations, the assessment demonstrates that predicted noise impacts determined in accordance with the *INP* are expected with the proposed operations (i.e. *INP* criteria are expected to be exceeded) during the day, evening and night time periods. As such, WCL's has investigated feasible and reasonable noise mitigation measures.

Daytime and evening noise exceedances are found to be due to key contributing noise sources including the D11 dozer, the tripper arrangement, the primary sizer building, the new truck loading bins, and the truck and dogs travelling along the internal haul road. Processing of the modelling results determined that it is difficult to reduce the overall site noise levels at the receivers by only addressing one of the main noise contributors listed above.

At night, noise levels are dominated by the tripper arrangement in use. As mentioned in Section 6.4, WCL has implemented measures to mitigate noise generated by the existing tripper arrangement (SP1) and has committed to implementing the same controls on the proposed tripper arrangements (SP2 and SP3) in Year 4. Since the mitigated tripper arrangement could not be measured prior to this assessment, the resultant reduction in levels (tripper SWL) cannot be quantified accurately and is estimated to be at least 3dB and possibly up to 8dB. WCL has committed to commissioning further noise mitigation measures on all tripper systems if needed to achieve a reduction of 8dB (tripper SWL).

Assuming the necessary controls are installed to achieve an 8dB reduction (in terms of tripper SWL), the predicted day, evening and night time noise levels under relevant meteorological conditions (P10) are presented in Table 7-8.

Table 7-8 Predicted $L_{Aeq,15min}$ Noise Levels from Project – Year 4 assuming Tripper SWL of 100dBA

Rec ID	$L_{Aeq,15min}$ Noise Level[(1)] (dBA)								
	Day (7.00am – 6.00pm)			Evening (6.00pm – 10.00pm)			Night (10.00pm – 7.00am)		
	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion
R1	48	50	42	48	52	41	40	43	40
R2	51	52	42	51	54	41	42	44	40
R3	50	52	42	50	53	41	41	44	40
R4	46	49	42	46	53	41	38	43	40
R5	47	49	48	47	52	45	35	41	42
R6	46	48	48	46	54	45	36	41	42

Rec ID	$L_{Aeq,15min}$ Noise Level[1] (dBA)								
	Day (7.00am – 6.00pm)			Evening (6.00pm – 10.00pm)			Night (10.00pm – 7.00am)		
	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion
R7	41	43	48	41	49	45	35	42	42
R8	42	44	48	42	48	45	37	43	42
R9	41	43	40	41	46	40	38	43	38
R10	38	40	40	38	44	40	36	43	38
R11	37	38	40	37	41	40	34	39	38
R12	39	40	40	39	42	40	36	39	38
R13	41	42	40	41	43	40	37	39	38
R14	40	42	40	39	44	40	37	40	38

It should be noted that the daytime and night time predicted noise levels are below the suburban/industrial interface levels adopted for this project of:

- Daytime (7.00am-6.00pm) 60dBA L_{Aeq}
- Evening (6.00pm-10.00pm) 50dBA L_{Aeq}
- Night Time (10.00pm-7.00am) 45dBA L_{Aeq}

The evening interface criterion would at times be exceeded by up to 4dB at R1 to R6 (Russell Vale).

7.7 SWL Measurements

A considerable number of sources used in the noise models are based on assumptions. On-site noise sound power level measurements will be conducted as soon as practical to ascertain actual site SWLs.

The SWL measurements should also determine the actual noise reduction achieved with the noise controls recently implemented on the existing tripper arrangement. As such, the measurements will indicate whether further noise controls are required to achieve the 8dB reduction.

WCL has committed to revising the model in consultation with relevant regulators once actual site SWLs have been ascertained to enable revised noise predictions to be applied to the Project.

8 NIGHT TIME IMPACT NOISE ASSESSMENT

Intermittent noise from coal pieces and rocks impacting the tripper trouser leg chutes has the potential to trigger sleep arousal at night. Therefore, intermittent noise associated with the Proposed Operation scenario has been addressed in the assessment.

Based on measurements conducted between April and June 2014, Hatch has established $L_{A1,1min}$ noise levels from the existing tripper arrangement to range up to 111dBA (*Russell Vale Tripper Conveyor and Surface Noise Source Management*, Hatch, July 2014).

As mentioned in Section 6.4, mitigation works recently conducted on the existing tripper system and planned for the additional SP2 and SP3 tripper systems include internal lining and vibration isolation of the tripper impact plates and hangers. As such, it is expected that impact noise associated with the tripper arrangements be reduced by at least 3dB (i.e. 108dBA). The mitigated sound power level of 108dBA is used for the night time impact noise assessment.

The night time noise models for the Proposed Operation scenario were used to analyse potential $L_{A1,1min}$ likely to arise from the Project's night time operations. The $L_{A1,1min}$ predictions were modelled using the same plant locations used for the modelling of operational noise impacts. The predictions are based on a typical adverse weather condition of no wind and a temperature inversion of 4ºC/100 m.

The predicted night time $L_{A1,1min}$ noise levels at receivers surrounding the Project are indicated in Table 8-1. Noise criteria are shown in yellow shading.

Table 8-1 $L_{A1,1min}$ Levels from Night Time Operations

ID	Predicted $L_{A1,1min}$ Noise Level (dBA)	$L_{A1,1min}$ Sleep Disturbance Criterion (dBA)
R1	49	50
R2	51	50
R3	50	50
R4	48	50
R5	42	52
R6	45	52
R7	44	52
R8	47	52
R9	48	48
R10	45	48
R11	41	48
R12	44	48
R13	43	48
R14	44	48

Table 8-1 indicates that $L_{A1,1min}$ noise levels due to night operations from the Project are predicted to be below the sleep disturbance criterion at most the identified receivers with only one 1dB exceedance expected at R2. Such an exceedance of the screening criterion is considered negligible and compliance is therefore assumed at all the identified receivers.

9 ROAD TRAFFIC NOISE

9.1 Background

Coal from Russell Vale Colliery is currently delivered to Port Kembla Coal Terminal (PKCT) using trucks travelling primarily along Bellambi Lane, Northern Distributor (now Memorial Drive), Southern Freeway, Masters Road, Springhill Road (left hand turn from Masters Road) and then into PKCT via Port Kembla Road. This route has been used by the Colliery since the Northern Distributor opened in December 1992 which resulted in the Princes Highway south of Bellambi Lane to be reclassified to a local road.

Considering all the above mentioned roads, the noise impact to residences associated with traffic along Bellambi Lane would likely be most sensitive to movements associated with coal trucks from the Colliery. This is particularly the case given that in December 2009 Bellambi Lane was reclassified to a local road following the opening of the Northern Distributor Extension (now Memorial Drive). This was to the benefit of adjoining residential receivers as it resulted in a considerable reduction in traffic volumes along Bellambi Lane as well as corresponding traffic noise.

During this time the Colliery was seeking approval to increase the coal production from 1Mtpa to 3Mtpa.

9.2 Identification of Receivers

Residential receivers are located on both sides of Bellambi Lane. Those to the north have their rear yards facing Bellambi Lane, are setback and are accessed via Keerong Avenue. In accordance with Wollongong Local Environmental Plan (LEP) 2009, this area is zoned R2 Low Density Residential. To the South, fronting Bellambi Lane are residences in amongst light industrial (generally to the rear of residences). With reference to the LEP this area is zoned IN2 Light Industrial Zone.

9.3 Suitable Noise Criteria

On the basis of the above Sections, Bellambi Lane has been identified as a 'principal haulage route' as per the RNP. The following is extracted from Section 2.2.2 of the *RNP* in support of this decision. This approach is consistent with the Environmental Assessment by PKCT in 2008 that assessed 10Mtpa coal haulage by the public road network. That assessment referred to a similar section within the EPA guideline titled, Environmental Criteria for Road Traffic Noise which is now superseded by the RNP.

> *"Some industries such as mines and extractive industries are, by necessity, in locations that are often not served by arterial roads. Heavy vehicles must be able to access these often more remote sites and this may mean travelling on local public roads. Good planning practice acknowledges this type of road use and develop ways of managing any associated adverse noise impacts. Where local authorities identify a 'principal haulage route', the noise criteria for the route should match those for arterial/sub arterial roads, recognising that they carry a different level and mix of traffic to local roads."*

Notwithstanding this definition, a more suitable approach is to consider the increase in noise levels from the existing traffic volumes that include coal truck movements associated with the existing approval of 1Mtpa. As per the *RNP*, an increase of 2dB represents a minor impact that is considered barely perceptible to the average person.

9.4 Methodology and Assessment

In order to assess the impact along Bellambi Lane, a model using CadnaA modelling software incorporating the *CoRTN* algorithm has been constructed.

With respect to the inputs, the following information has been derived with the assistance of Cardno Traffic and Transport Planning.

Table 9-1 Assumptions Regarding Truck Movements

		2017	
		Average	**Peak**
Output	Annual (Mtpa)	3	3
	Weekly (tonnes)	60,000	80,000
Truck Delivery Operation		15/5-10/2	15/5-10/2
Average Truck Haulage Capacity (tonnes)		38	38
No. of Coal Trucks (50km/hr vs 60km/hr posted)	Per year	78,947	78,947
	Per week	1,579	2,105
	Per day – Weekday	256	341
	Per day – Weekend	150	200

Notes: The coal truck movements are one way only.
50km/hr for WCL fleet assumed as per PKCT's Management Driver Code of Conduct Implementation Plan.
Provided to WM by Cardno – Email dated 6 June 2014.

In order to approximate the volumes associated with 1Mtpa, these numbers have been divided by three (3). It should be noted that average truck haulage capacity from the above table conservatively represents the number of existing truck movements that form part of the "Base Case".

Traffic volumes were collected during a two (2) week period in May 2014 and excluded any coal truck associated with the Colliery. Therefore in order to provide a "base case" our modelling included coal truck movements associated with 1Mtpa of coal. This value was extrapolated to the 2017 base case assuming 1% linear growth as provided by Cardno.

Table 9-2 Base Case Traffic Volumes – 15hr Day Period

	2017	
	Weekday	**Weekend**
Bellambi Lane	5,290	4,052

Notes: Derived from information provided to WM by Cardno via Emails dated 6 and 12 June 2014.

Table 9-3 provides the maximum calculated increase of all residential receivers along Bellambi Lane.

Table 9-3 Predicted Increase in Road Traffic Noise in 2017 - 1Mtpa to 3Mtpa

Bellambi Lane	Predicted Increase ($L_{Aeq\ (15hr)}$ dBA)	
	Weekday	Weekend
Average Output	1.4	1.5
Peak Output	1.6	1.7

The modelling undertaken in considering the above methodology has found that the increase in traffic noise levels are less than 2dB (Table 9-3). On this basis, it is considered that the impact associated with increasing the haulage from 1Mtpa to 3Mtpa is considered to be a minor impact that would be barely perceptible.

It is important to note that irrespective of the modelling, traffic noise impacts are also being managed as follows:

- Haulage is restricted (as per Condition 6 of Major Project Approval 08_0009 for PKCT) such that no movements are to occur during the night time period.
- The haulage contractor to Russell Vale is committed to replacing its fleet with larger trucks and trailers that comply with Euro 5 specifications. These trucks are quieter and can haul more coal reducing the amount of trips needed to and from Russell Vale.

10 CONCLUSION

10.1 Site Historical Noise Levels

Review of historical noise measurements conducted during the operation of a washery at site revealed that noise levels were considerably higher than any of the predictions (Existing / Existing Mitigated / Year 2 / Year 4).

Noise levels along West Street (R1 and R2) used to be 11-12dB and 10-11dB higher (with the washery) than the predictions associated with the Existing and Year 4 scenarios, respectively (assuming a conservative tripper SWL of 105dBA). Similarly, measured levels along Broker Street (R4) were 3dB and 2dB higher (with the washery) than the expected levels with the Existing and Year 4 scenarios, respectively (with tripper SWL of 105dBA). Finally, noise levels measured on Lyndon Street (R12) were found to be 7dB and 5dB higher (with the washery) than levels associated with the Existing and Year 4 scenarios, respectively (with tripper SWL of 105dBA).

Before mitigation measures were implemented on the existing tripper arrangement (i.e. Existing to Existing Mitigated), night time noise levels were 1-3dB higher at the identified receivers (assuming a conservative tripper SWL of 105dBA).

10.2 Predicted Noise Levels

A noise assessment was prepared for the following scenarios:

- Existing (pre-August 2014);
- Existing Mitigated (August 2014 - May 2015);
- Year 2 (June 2015 – June 2017); and
- Year 4 (July 2017).

Noise predictions under adopted weather conditions were generally found to exceed the noise criteria at the identified receivers for all the above scenarios.

The predicted 'worst case' combined $L_{Aeq,15min}$ operational noise levels across all assessed scenarios are presented in Table 10-1. Day and evening noise levels are generally controlled by the Existing scenario while night time worst case noise levels are generally controlled by the Year 4 scenario.

Table 10-1 Predicted 'Worst Case' Combined $L_{Aeq,15min}$ Noise Levels from Project

Rec ID	$L_{Aeq,15min}$ Noise Level [1] (dBA)								
	Day (7.00am – 6.00pm)			Evening (6.00pm – 10.00pm)			Night (10.00pm – 7.00am)		
	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion
R1	48	51	42	48	54	41	40-44	43-46	40
R2	52	54	42	52	56	41	42-46	44-48	40
R3	51	53	42	51	55	41	41-45	44-47	40
R4	48	51	42	48	55	41	38-42	43-46	40

Rec ID	$L_{Aeq,15min}$ Noise Level (1) (dBA)								
	Day (7.00am – 6.00pm)			Evening (6.00pm – 10.00pm)			Night (10.00pm – 7.00am)		
	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion	Calm $L_{Aeq,15min}$	P10 $L_{Aeq,15min}$	Criterion
R5	50	52	48	50	55	45	35-38	41-44	42
R6	46-47	51	48	46-47	56	45	36-39	41-44	42
R7	47	52	48	47	56	45	35-38	44	42
R8	47	51	48	47	56	45	37-41	46	42
R9	41-44	43-45	40	41-43	46-48	40	38-42	43-47	38
R10	40	42	40	40	44-47	40	36-39	43-46	38
R11	39	40	40	39	43	40	34-36	40	38
R12	41	42	40	41	42-44	40	36-39	39-42	38
R13	44	45	40	44	46	40	40	42	38
R14	40-42	44	40	41	46	40	37-40	40-43	38

(1) Where a range is given, highest level is based on tripper system with a SWL of 105dBA and lowest level represents a tripper system with a SWL of 100dBA.

The Year 4 operations are expected to generate considerable exceedances at some of the receivers ranging up to 11dB, 13dB and 9dB during the day, evening and night time periods, respectively (assuming a conservative tripper SWL of 105dBA).

The Project (Year 4) includes a new secondary sizer building and several tripper arrangements potentially operating at night and when considering the closest and most exposed tripper system to a receiver is in use, night time noise levels are predicted to increase at some of the identified receivers by 1-5dB when compared with the existing operations (assuming a conservative tripper SWL of 105dBA).

10.3 Comparison with Previous Noise Predictions

This assessment replaces in full the previous noise impact assessment for the UEP (*NRE No.1 Colliery – Noise Assessment Major Works Project*, ERM, November 2012). It has been revised for updated assumptions (including meteorological data) and mitigation commitments.

The ERM noise predictions were found to be consistently lower than the WM predictions with differences ranging up to 16dB.

The main difference stems from the fact that the meteorological parameters assumed in making the predictions differ. ERM used data from the coastal Bellambi Weather Station which showed no prevailing winds or temperature inversions and therefore those adverse meteorological conditions were discarded in their noise assessment. The Site is located on the lower slopes of the Illawarra Escarpment approximately 2km from the coast and it was determined from analysis of the data provided by the on-site weather station and data generated by the TAPM model that the Project is prone to drainage-flow winds travelling down the escarpment in the easterly and south-easterly directions where most of the surrounding receivers are located.

The conservative nature of the 10th percentile exceedance approach adopted by WM for this assessment is also believed to have contributed to the differences in predicted noise levels (*INP*).

10.4 Future Mitigation and Management Measures

Although during the time of the washery the colliery had more noise impact on the surrounding community than today's operations, the assessment demonstrates that predicted noise impacts determined in accordance with the *INP* are expected with the proposed operations (i.e. *INP* criteria are expected to be exceeded) during the day, evening and night time periods. As such, WCL's has investigated feasible and reasonable noise mitigation measures.

Daytime and evening noise exceedances are found to be due to key contributing noise sources including the D11 dozer, the tripper arrangement, the primary sizer building, the new truck loading bins, and the truck and dogs travelling along the internal haul road. Processing of the modelling results determined that it is difficult to reduce the overall site noise levels at the receivers by only addressing one of the main noise contributors listed above.

At night, noise levels are dominated by the tripper arrangement in use. WCL has implemented measures to mitigate noise generated by the existing tripper arrangement (SP1) and has committed to implementing the same controls on the proposed tripper arrangements (SP2 and SP3) in Year 4. Since the mitigated tripper arrangement could not be measured/verified prior to this assessment, the resultant reduction in levels (tripper SWL) cannot be quantified accurately and is estimated to be at least 3dB and possibly up to 8dB.

Assuming the necessary controls are installed to achieve an 8dB reduction (in terms of tripper SWL), the predicted day and night time noise levels under relevant meteorological conditions (P10) would be below the suburban/industrial interface levels adopted for this project of:

- Daytime (7.00am-6.00pm) 60dBA L_{Aeq}
- Evening (6.00pm-10.00pm) 50dBA L_{Aeq}
- Night Time (10.00pm-7.00am) 45dBA L_{Aeq}

However, the evening interface criterion would at time be exceeded by up to 4dB at R1-R6 (Russell Vale).

WCL has committed to revising the model in consultation with relevant regulators once actual site SWLs have been ascertained to enable revised noise predictions to be applied to the Project.

10.5 Sleep Disturbance

Modelling of $L_{A1,1min}$ noise levels at nearby receivers was undertaken for intermittent noise from coal pieces and rocks impacting the tripper trouser leg chutes. This analysis indicates that $L_{A1,1min}$ noise levels due to night operations from the Project are predicted to be below the sleep disturbance criterion at most the identified receivers with only one 1dB exceedance expected at R2. Such an exceedance of the screening criterion is considered negligible and compliance is therefore assumed at all the identified receivers.

10.6 Road Traffic Noise

The modelling undertaken in considering the above methodology has found that the increase in traffic noise levels are less than 2dB (Table 9-3). On this basis, it is considered that the impact associated with increasing the haulage from 1Mtpa to 3Mtpa is considered to be a minor impact that would be barely perceptible.

APPENDIX A

BACKGROUND NOISE MEASUREMENT RESULTS

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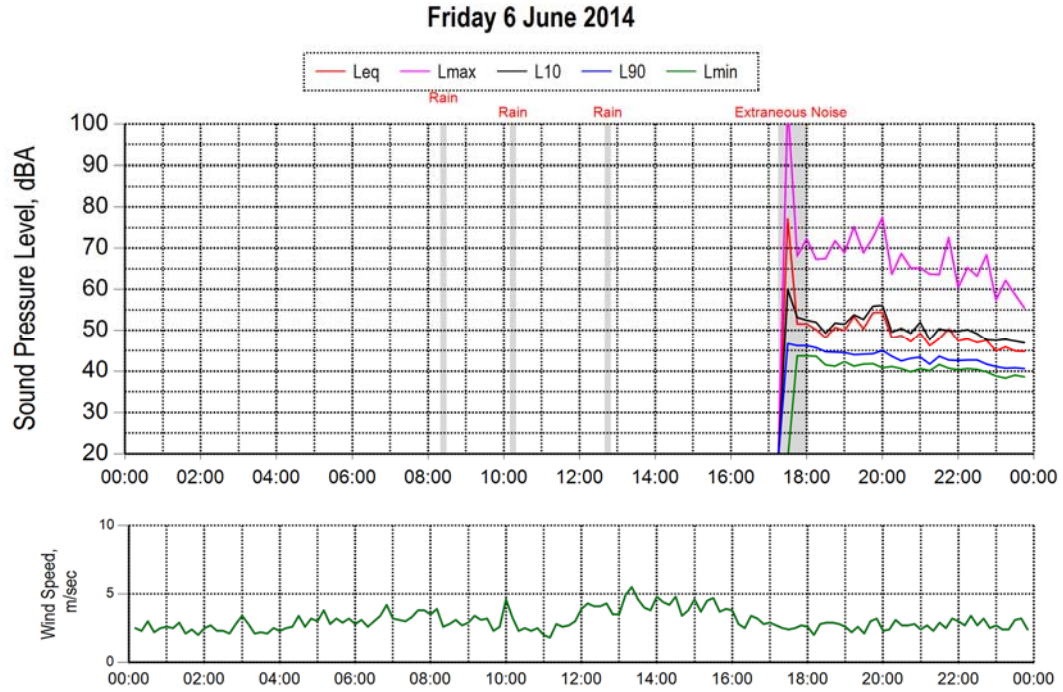

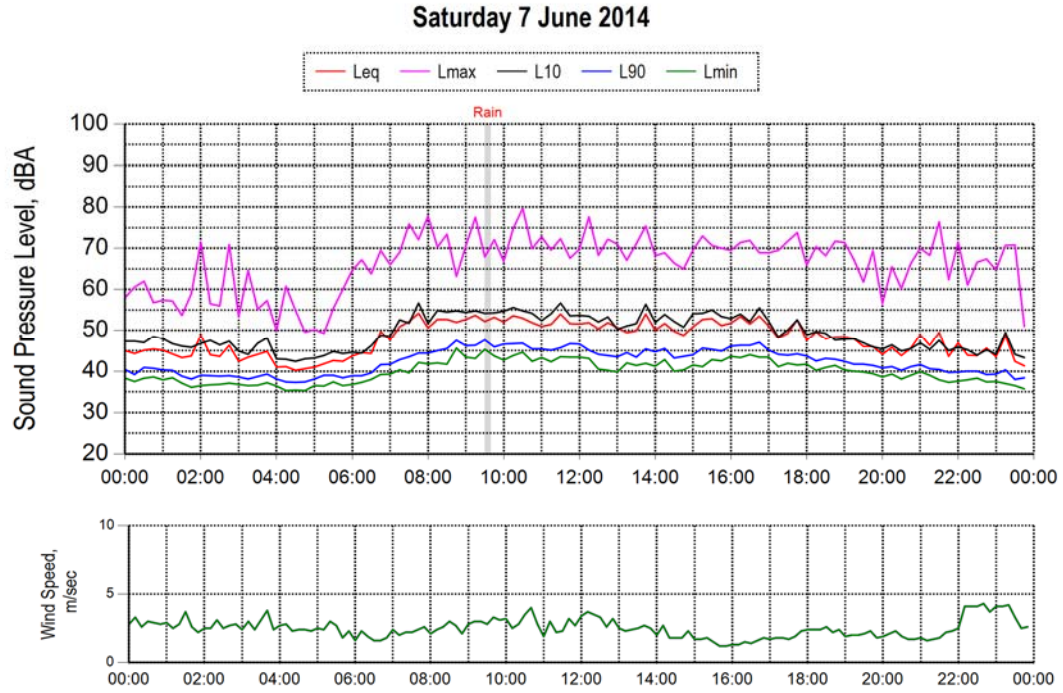

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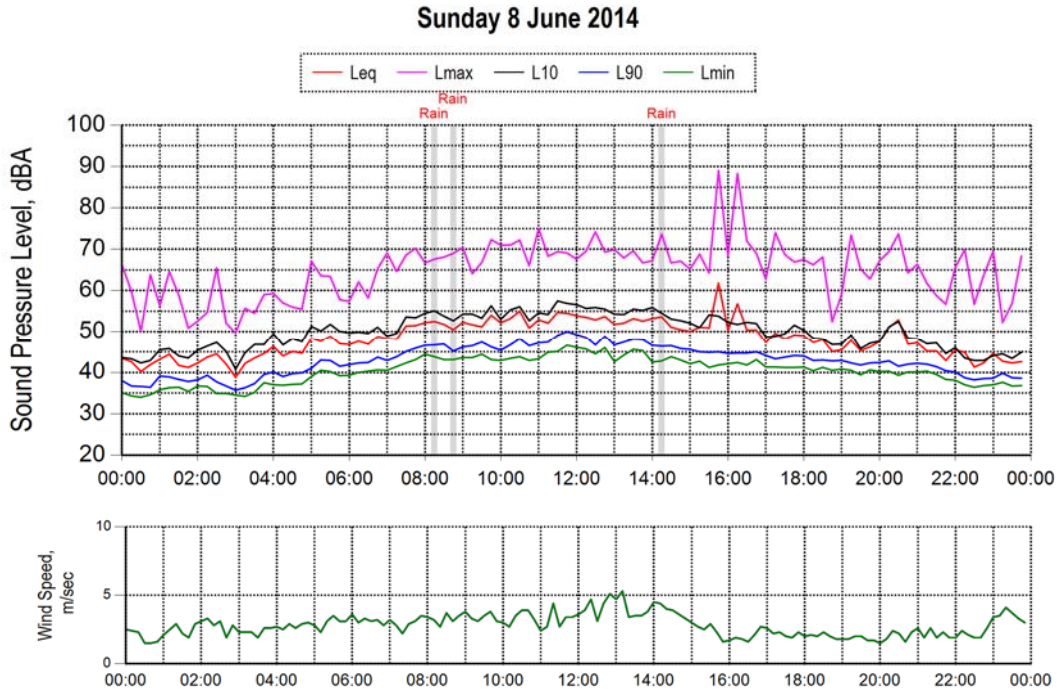

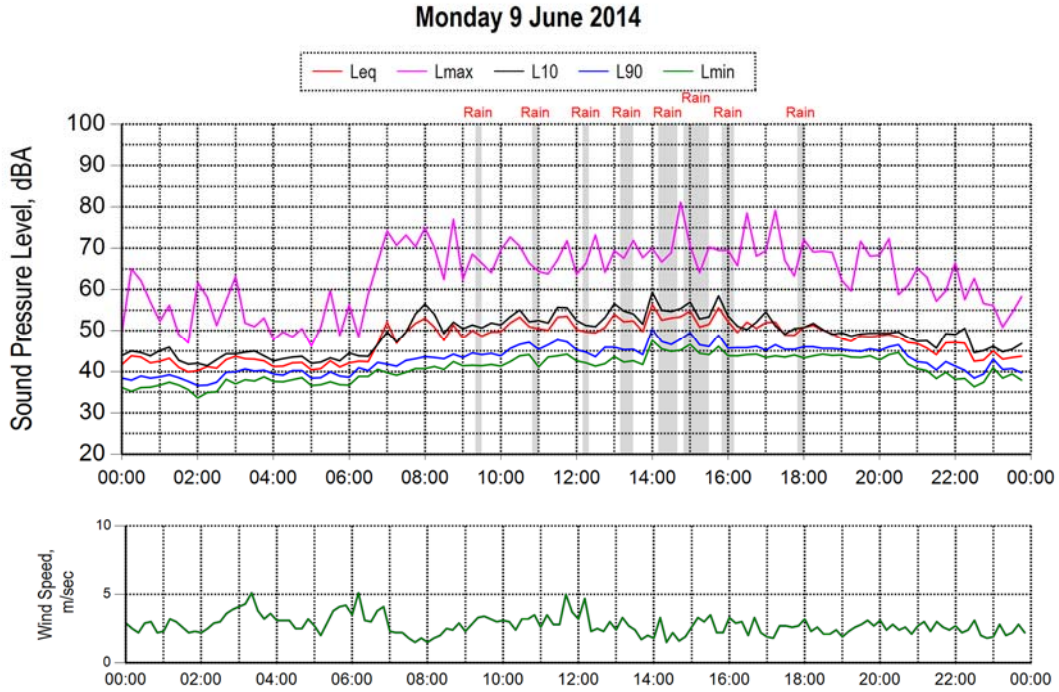

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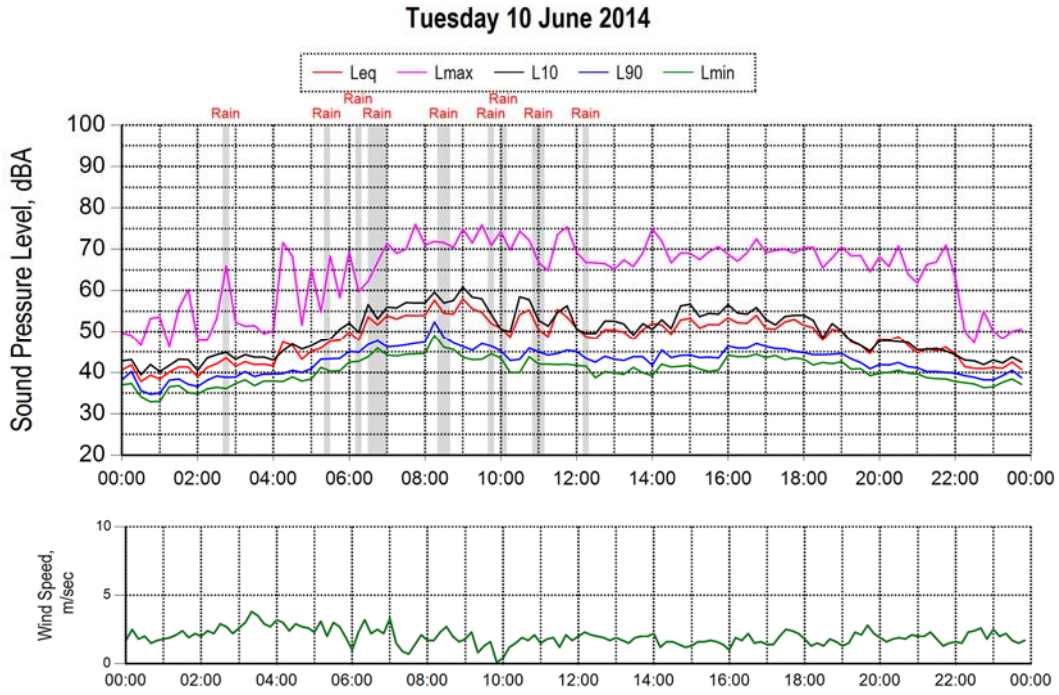

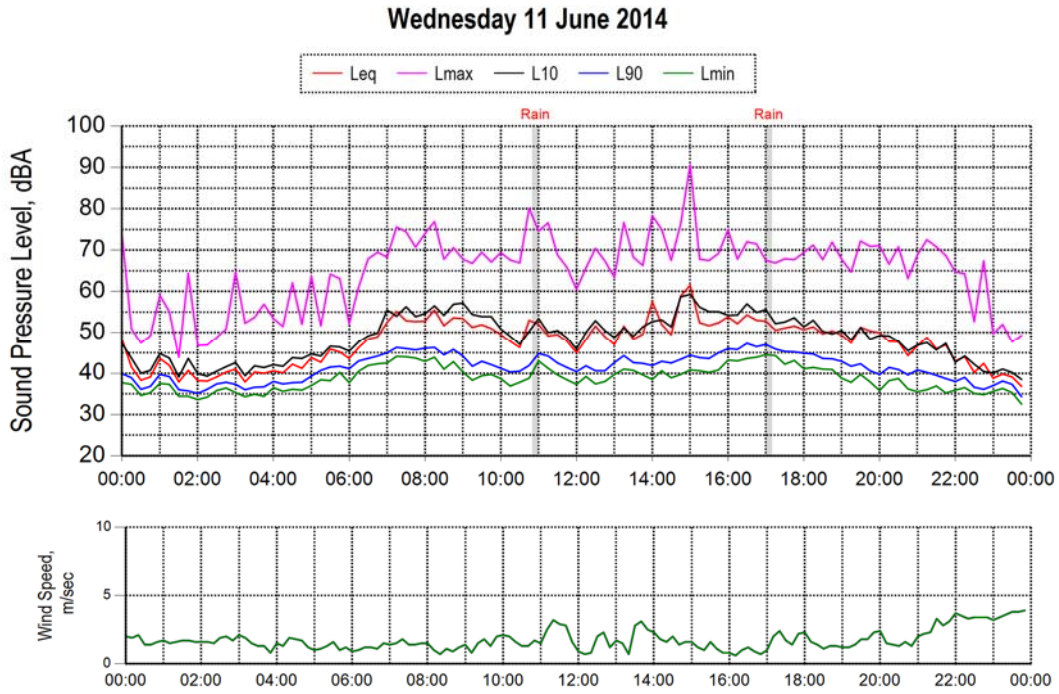

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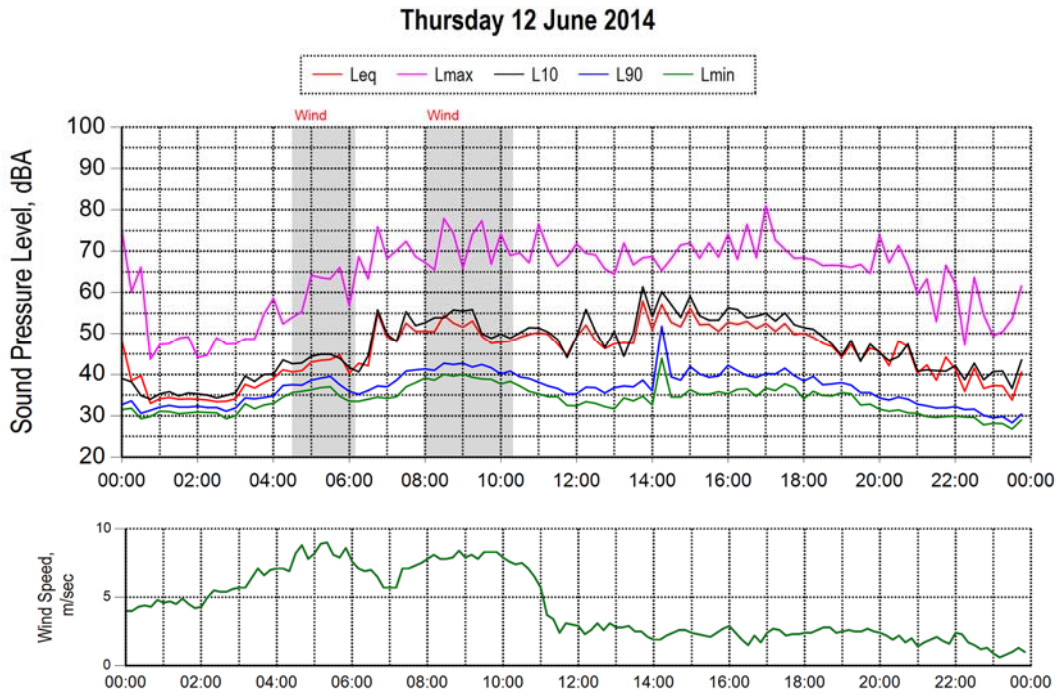

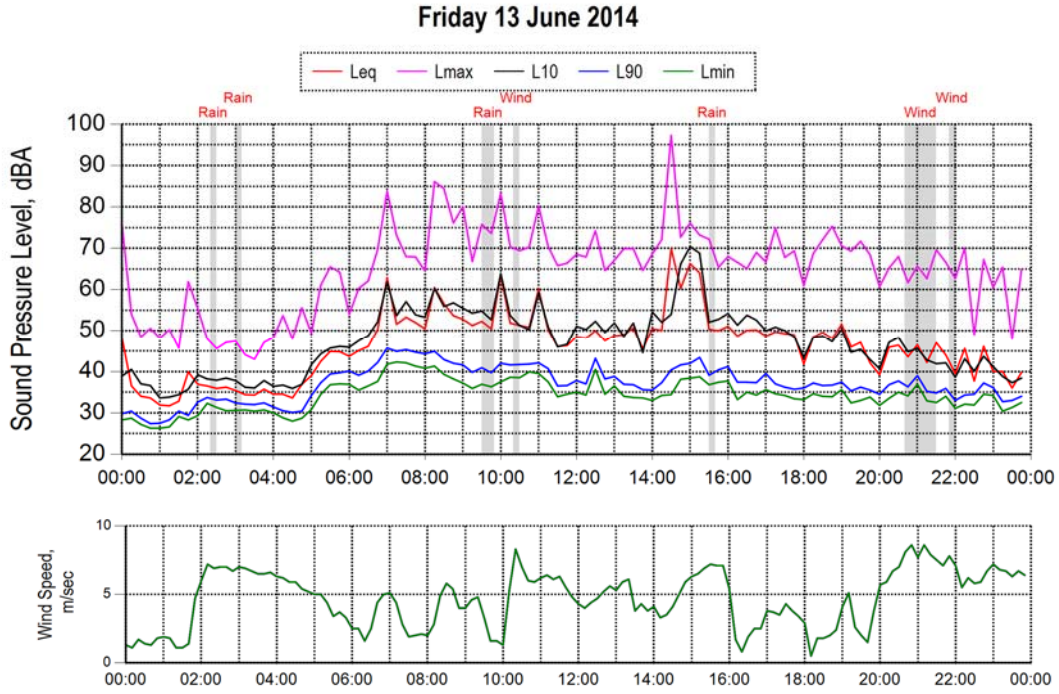

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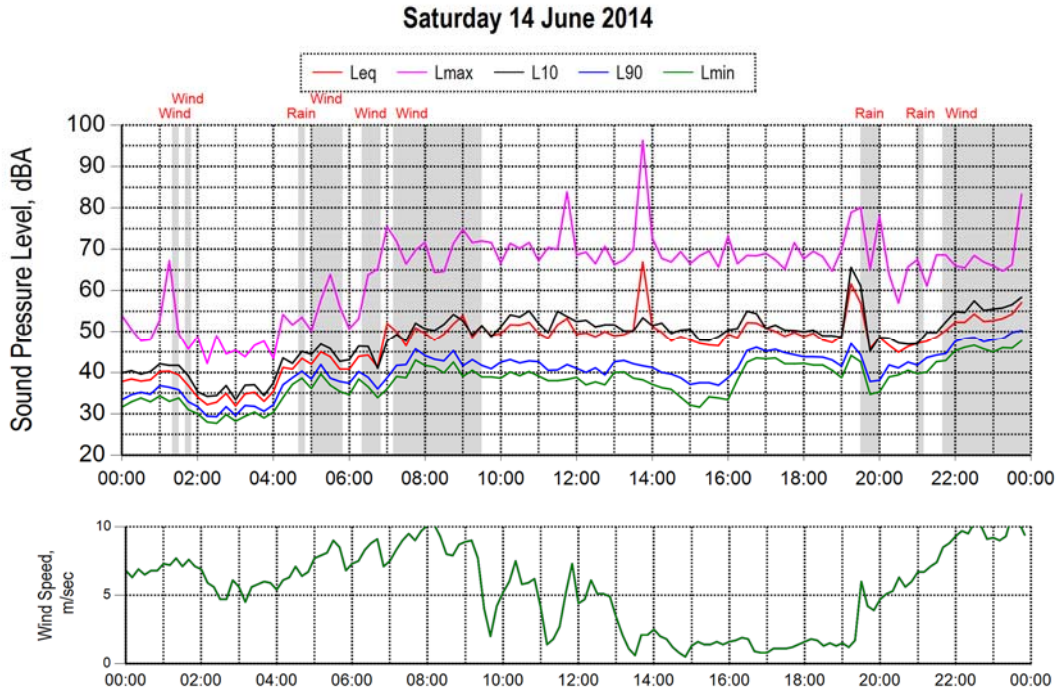

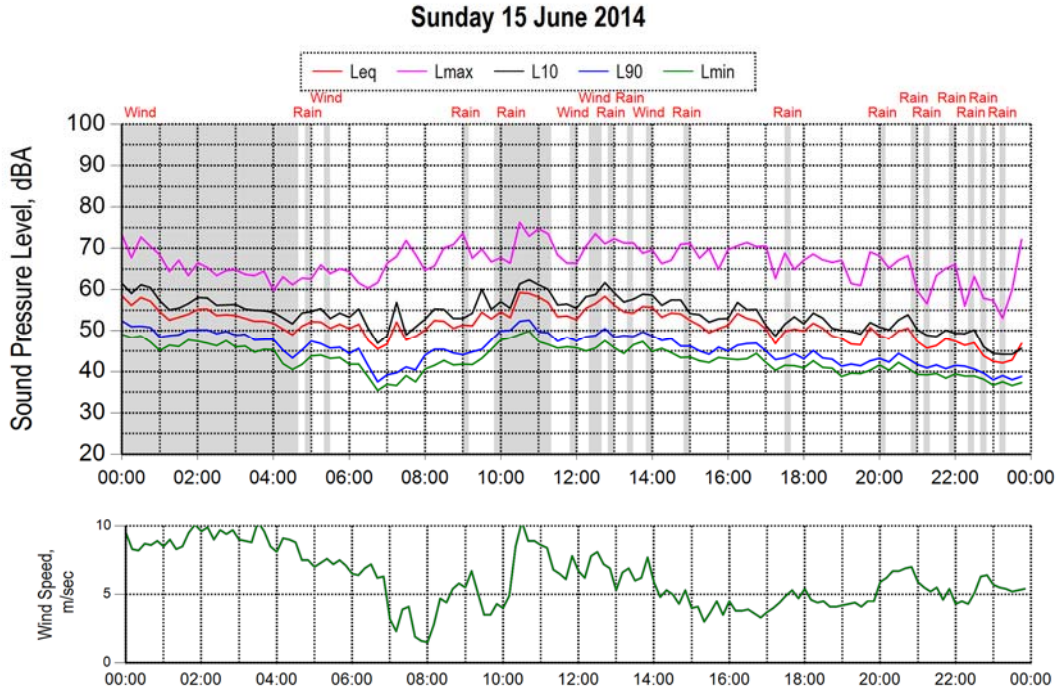

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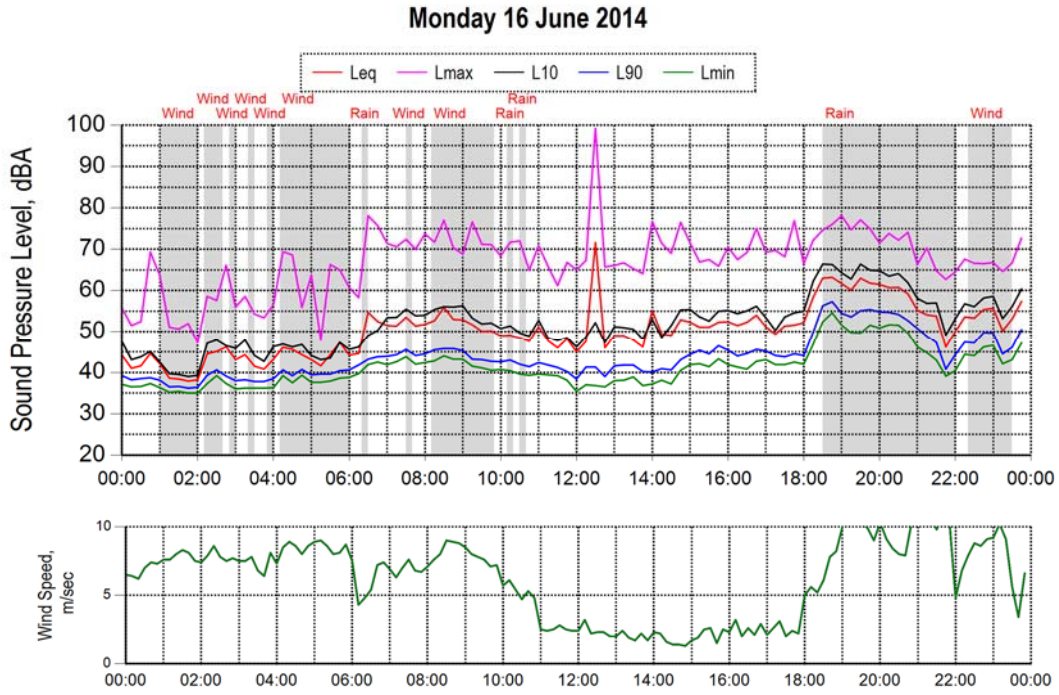

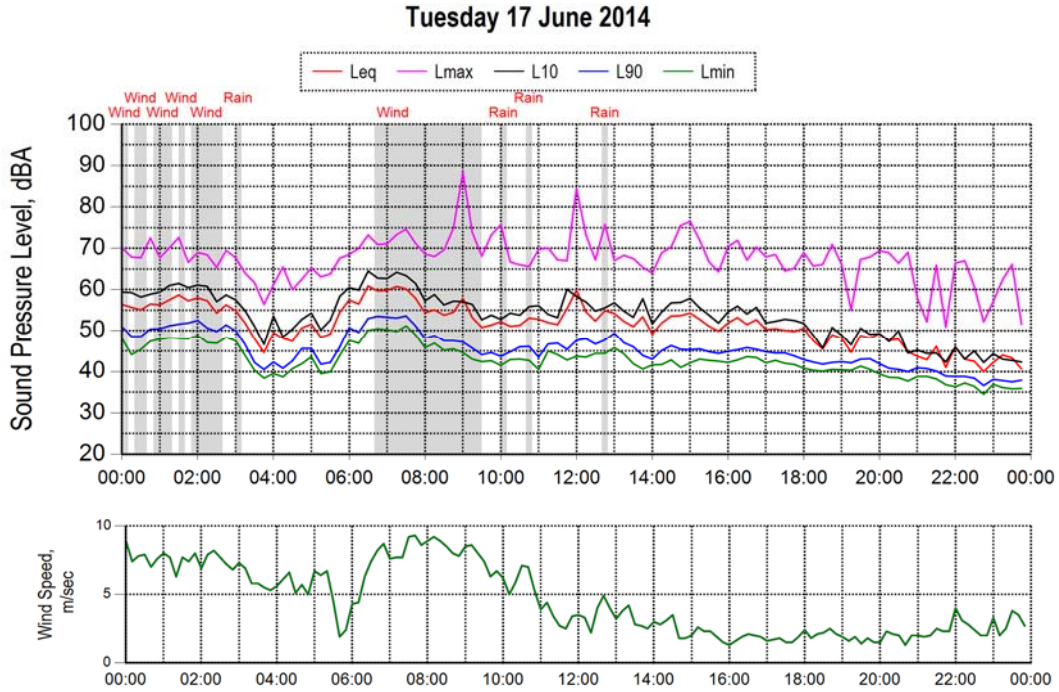

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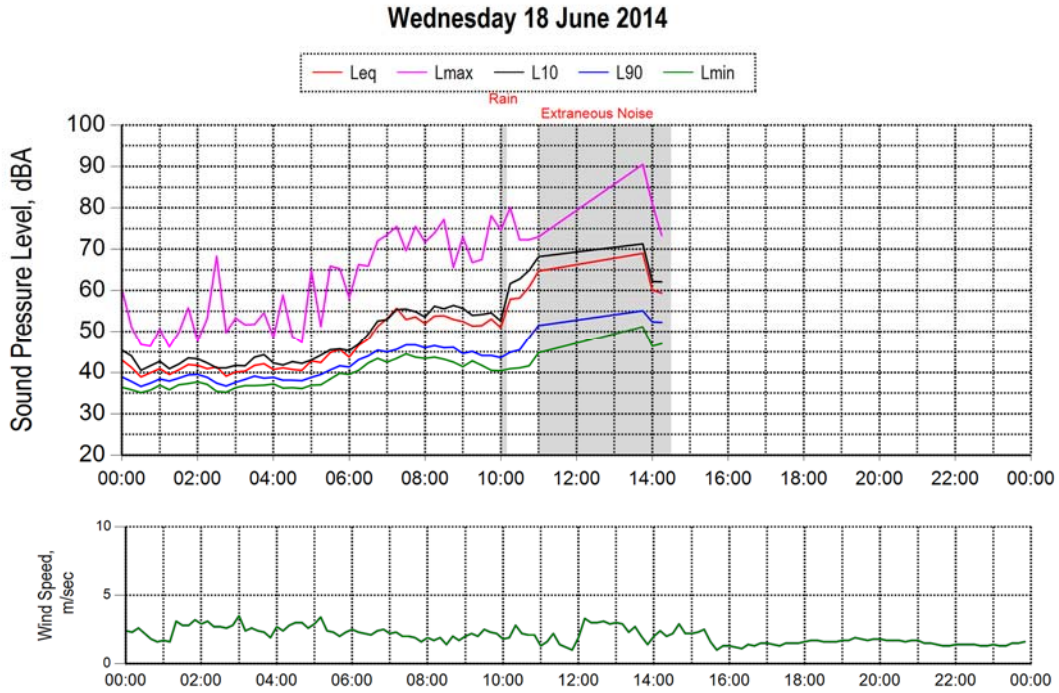

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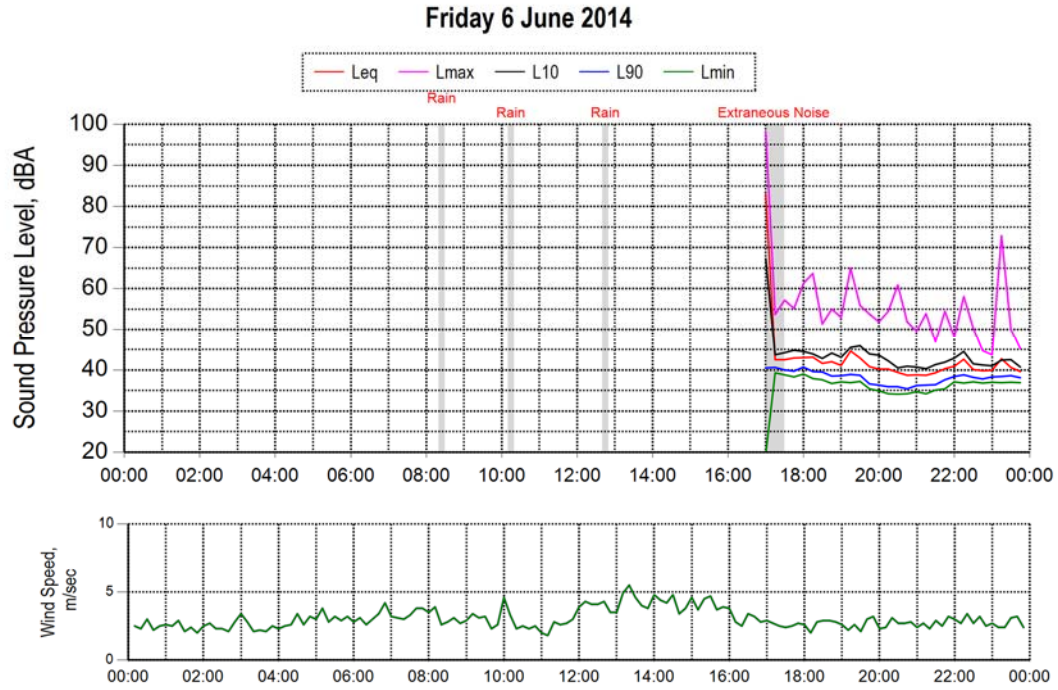

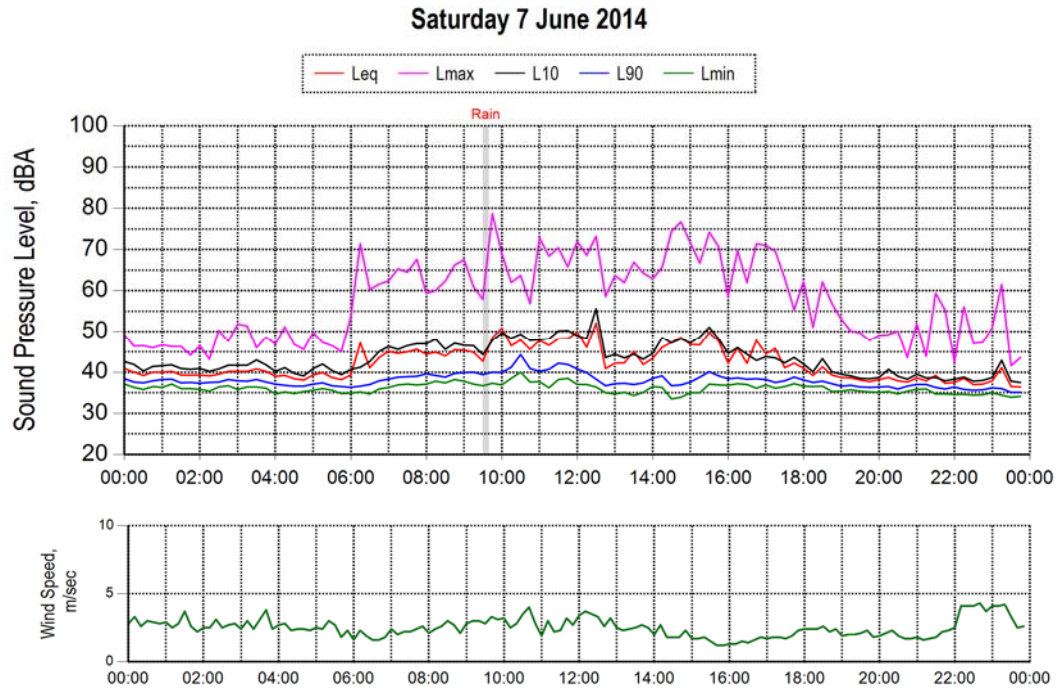

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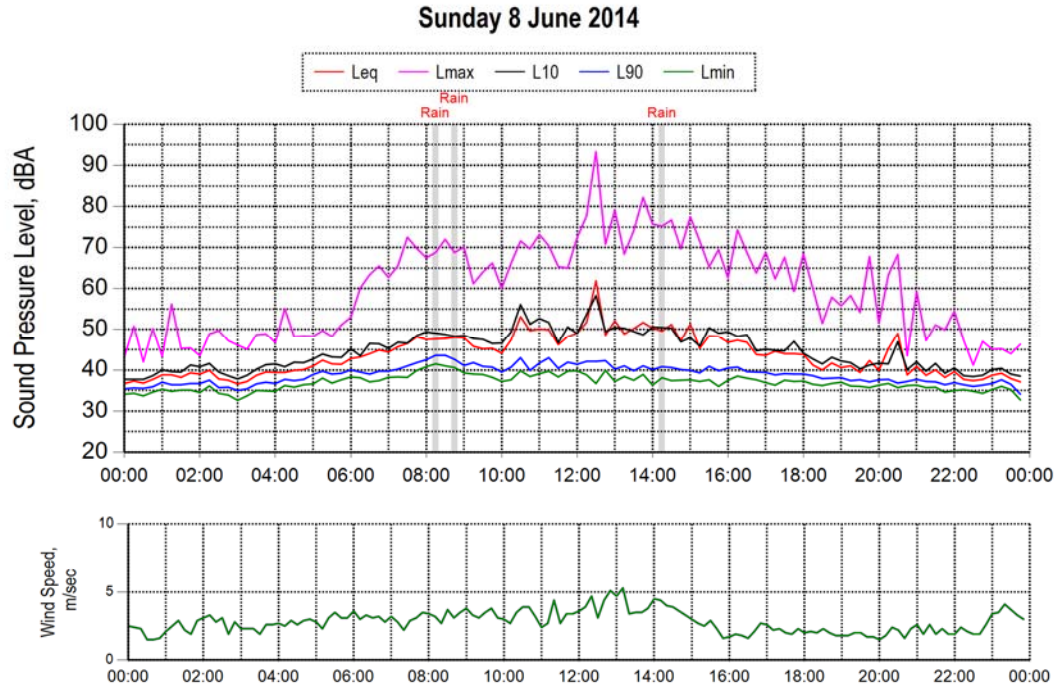

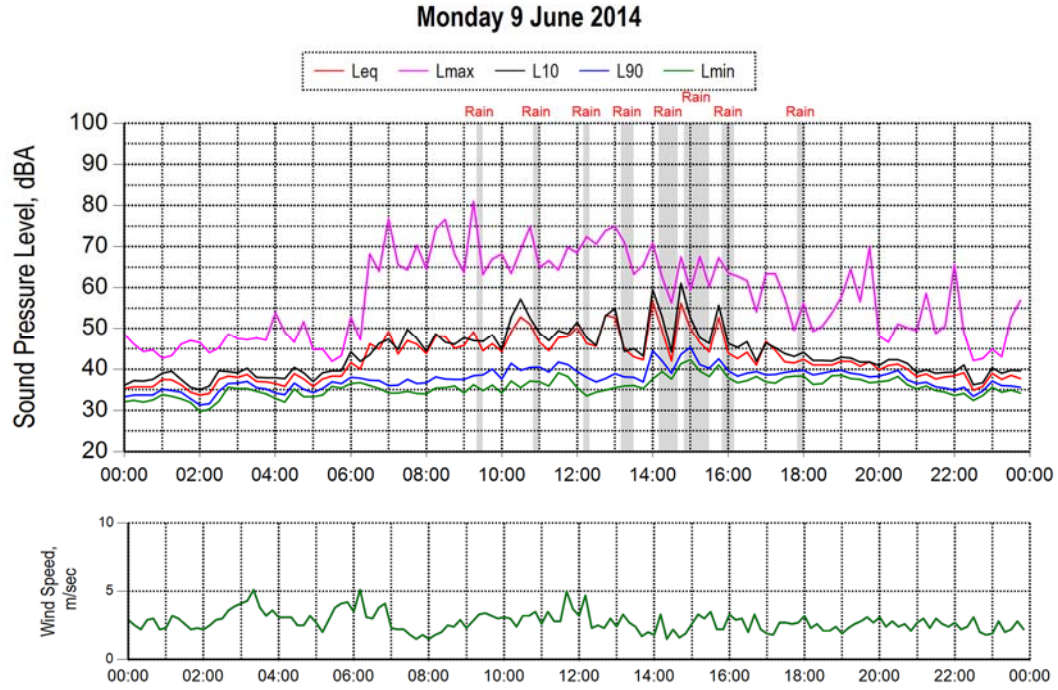

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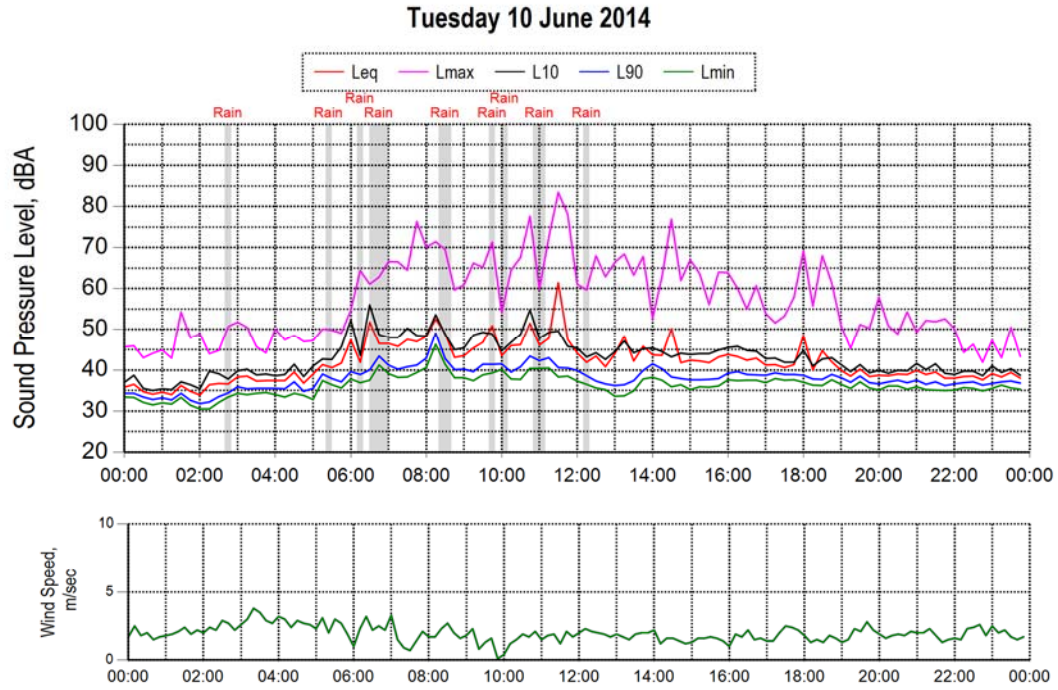

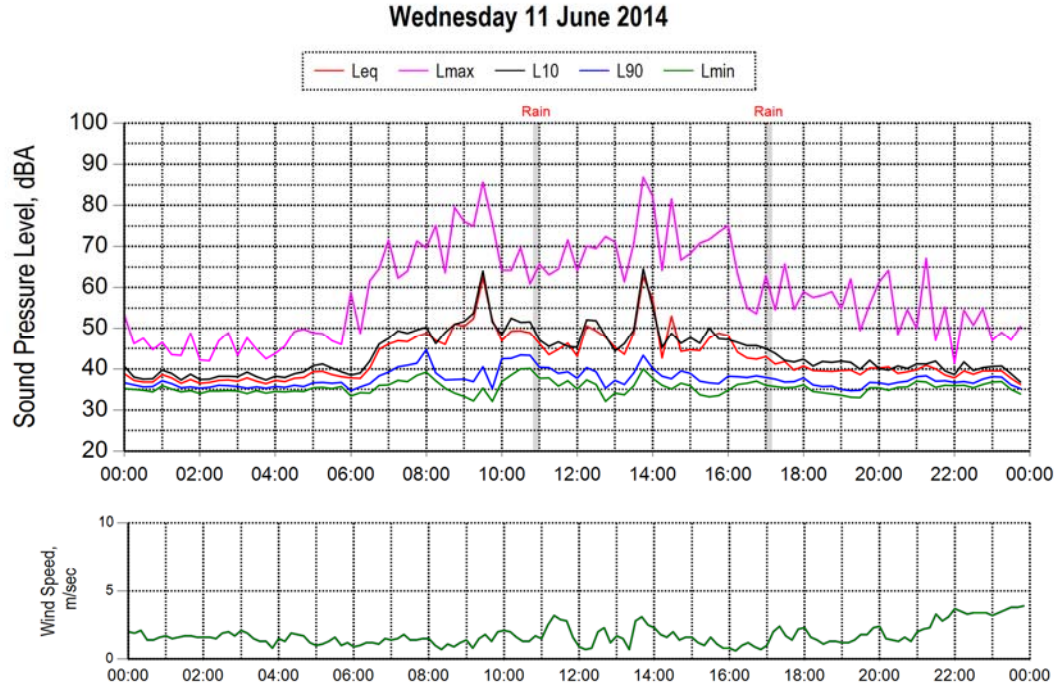

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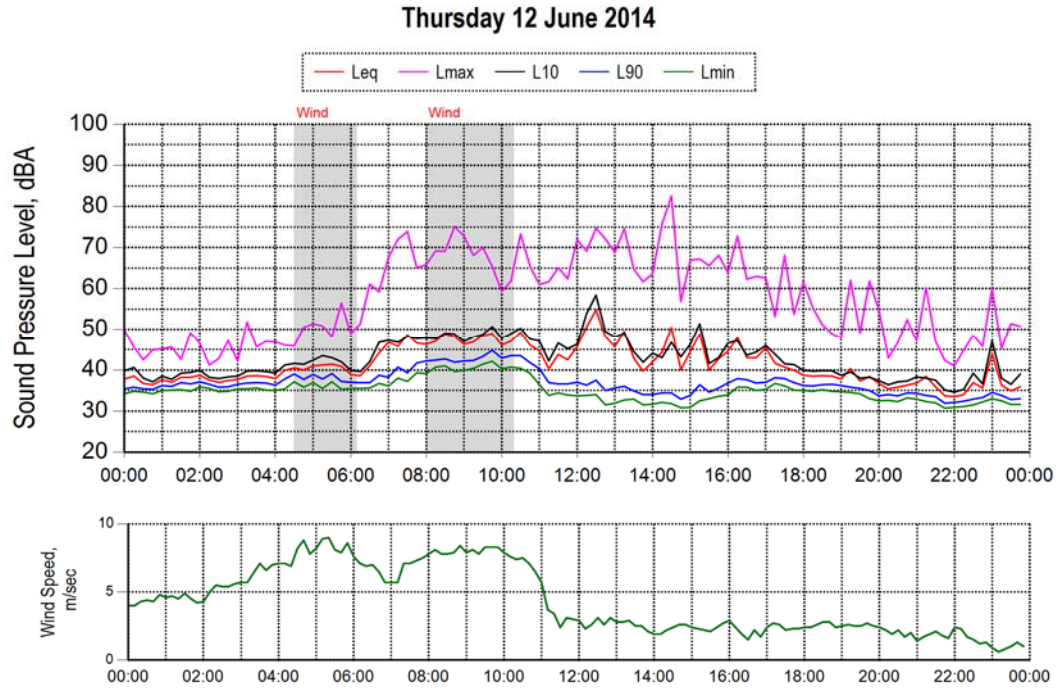

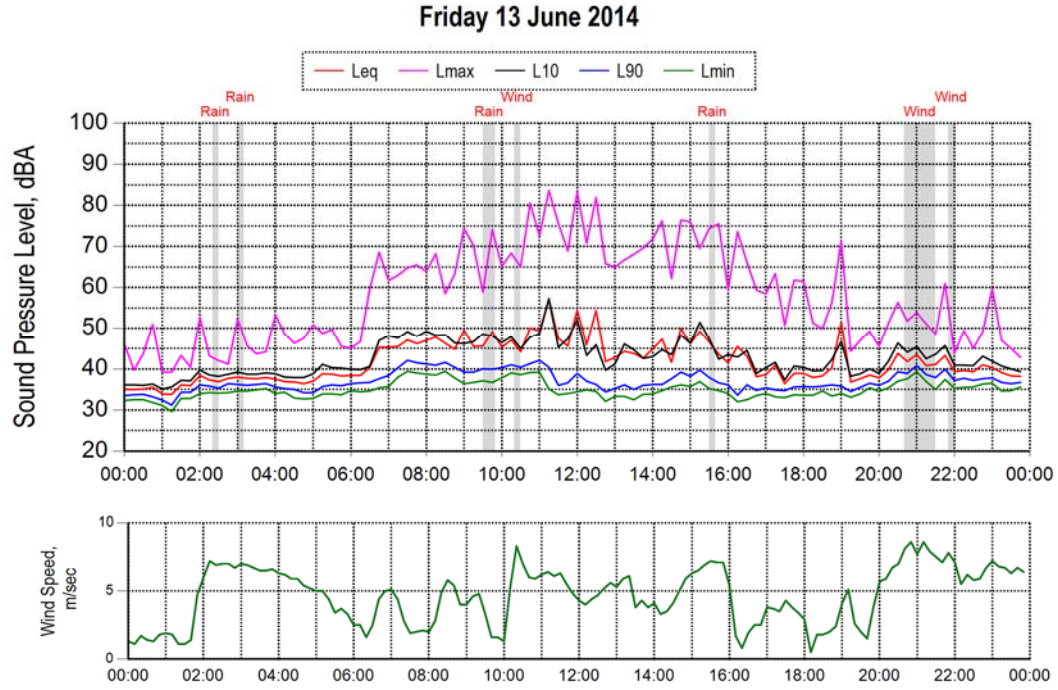

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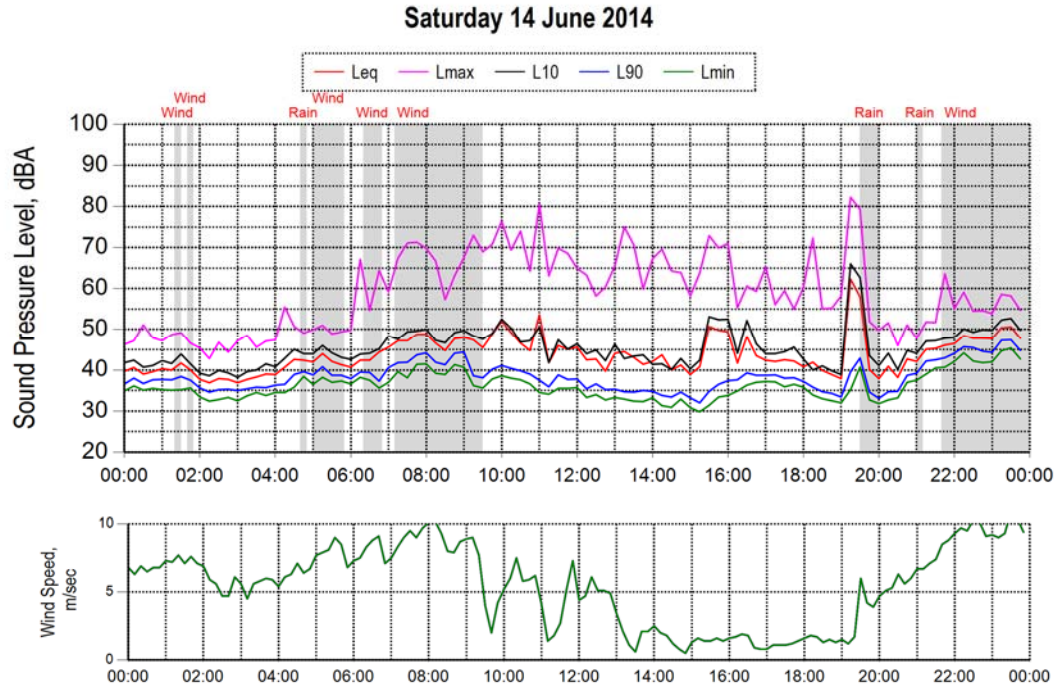

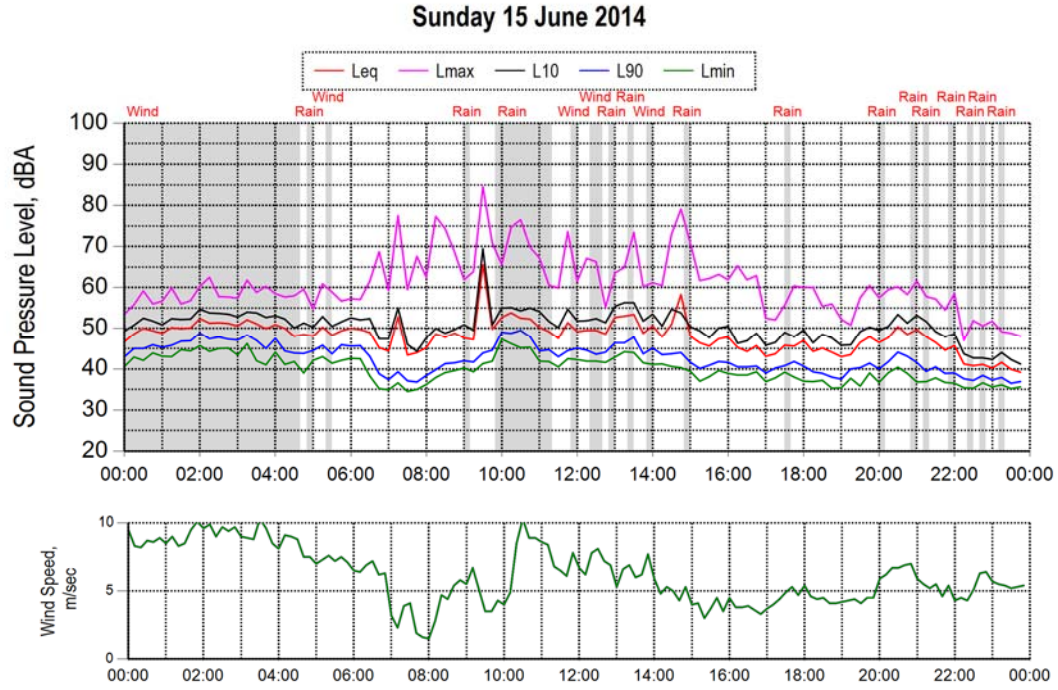

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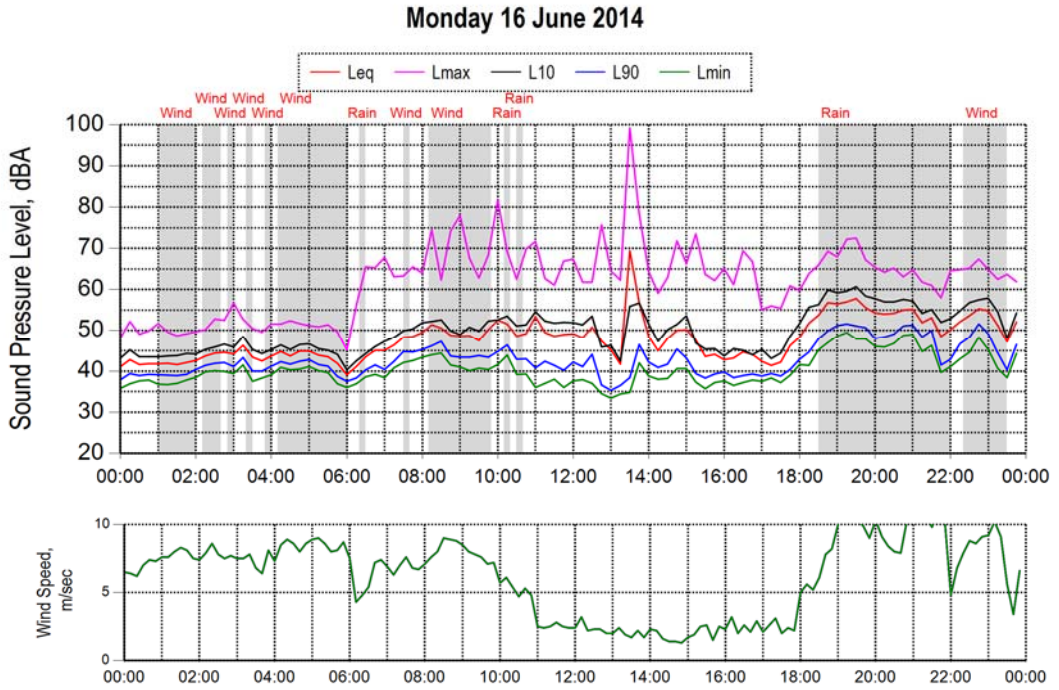

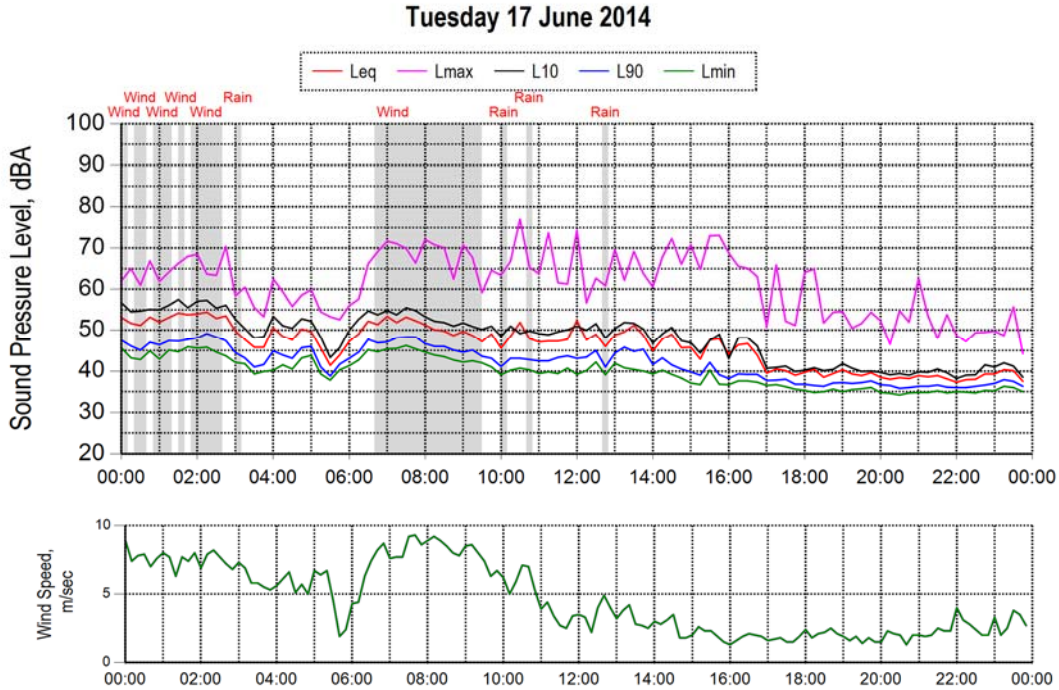

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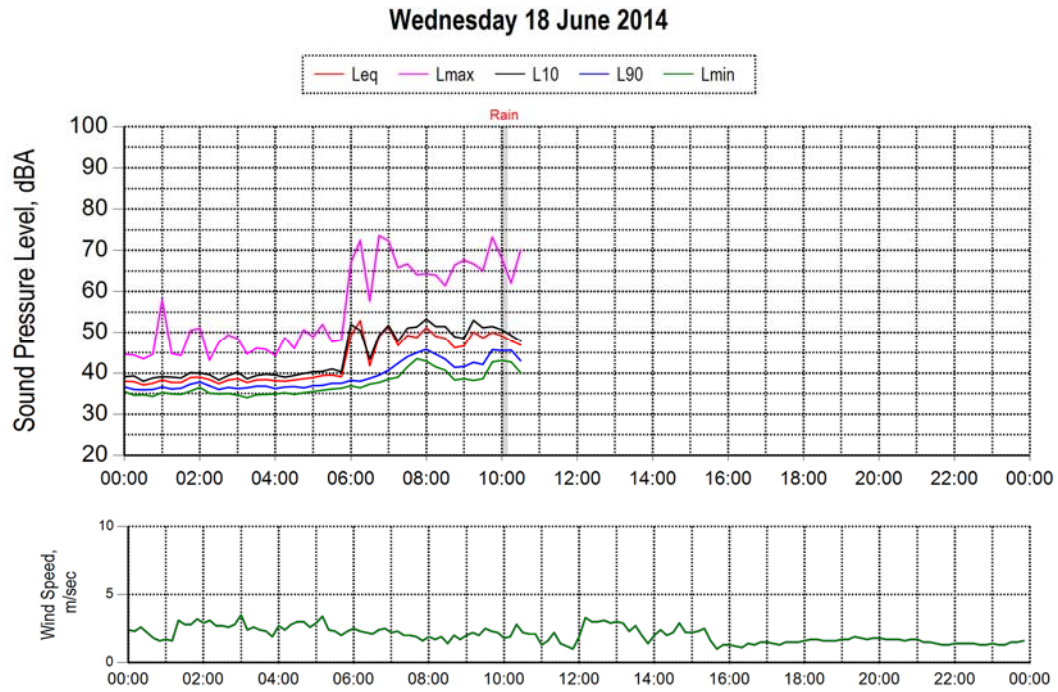

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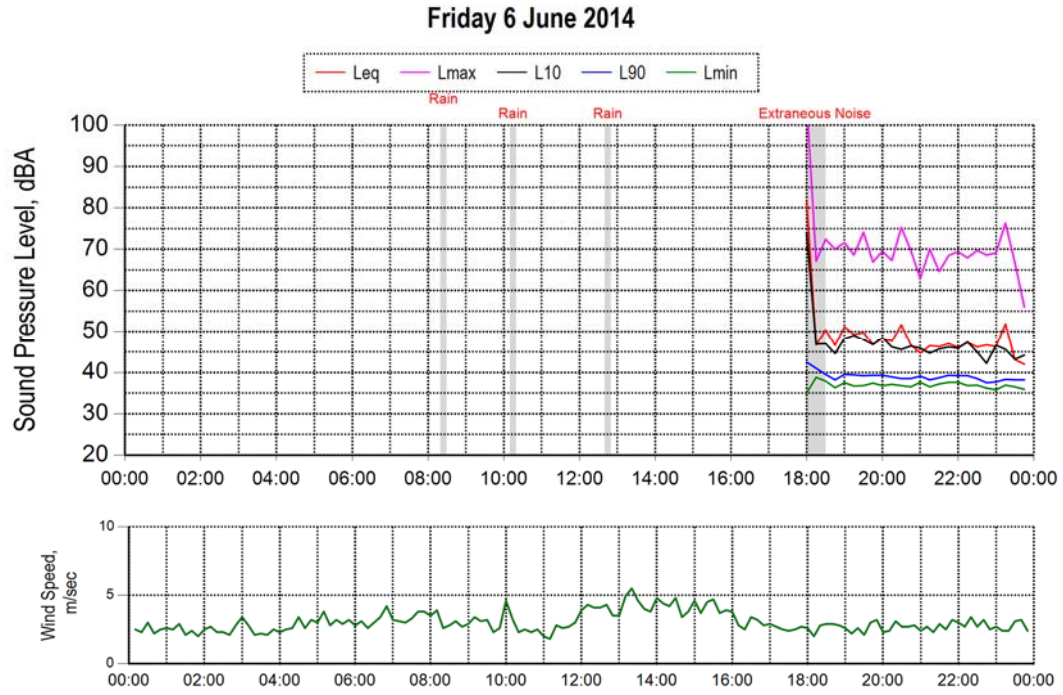

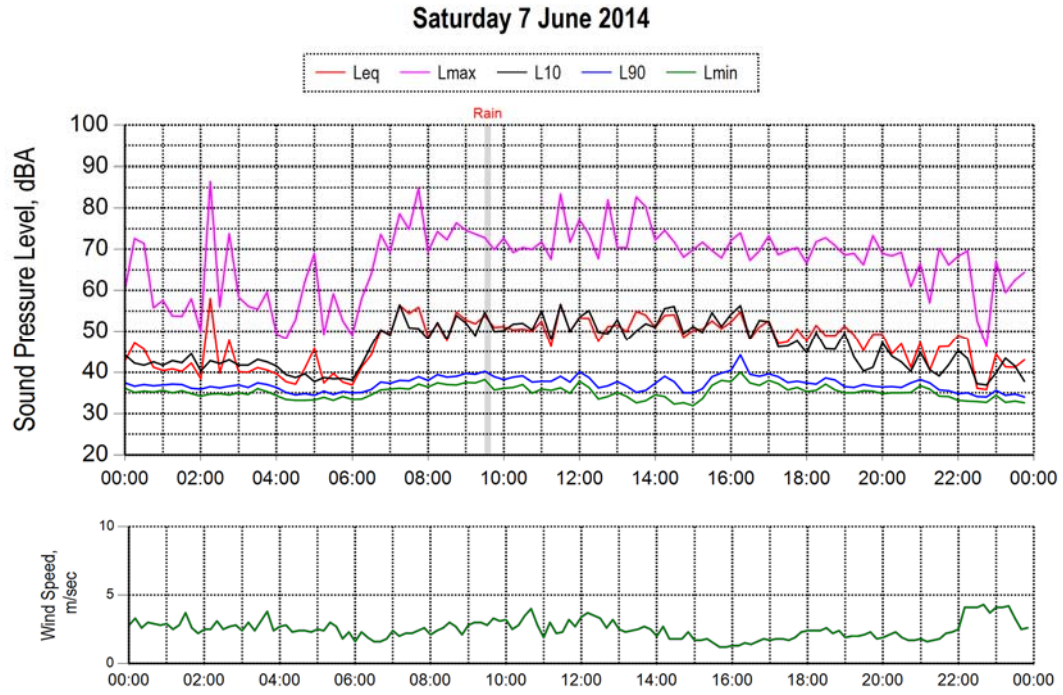

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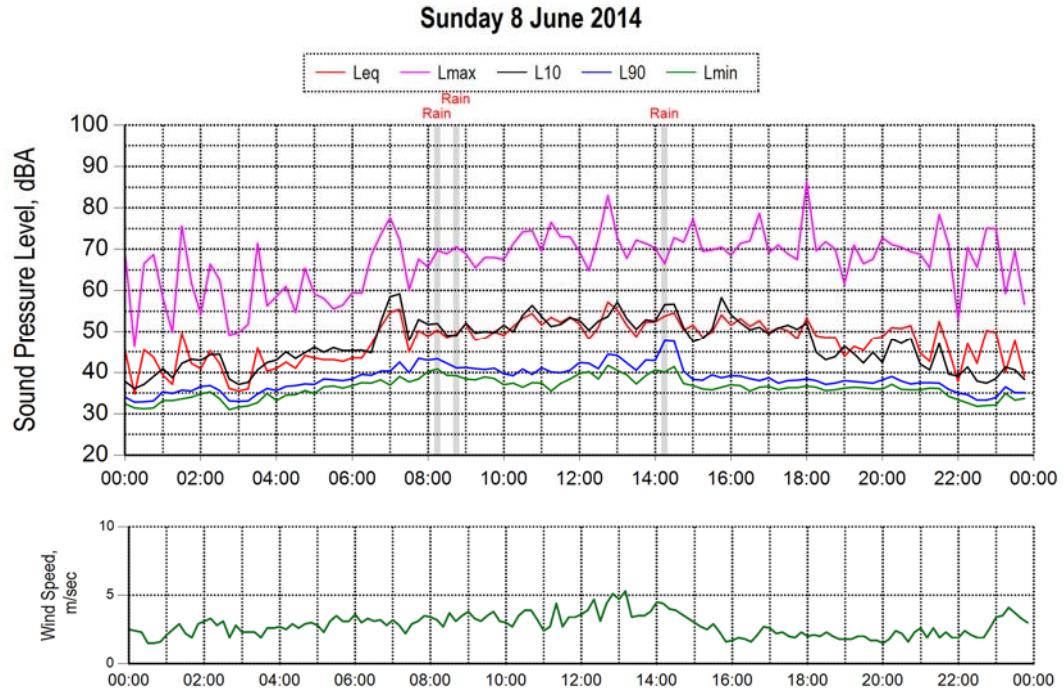

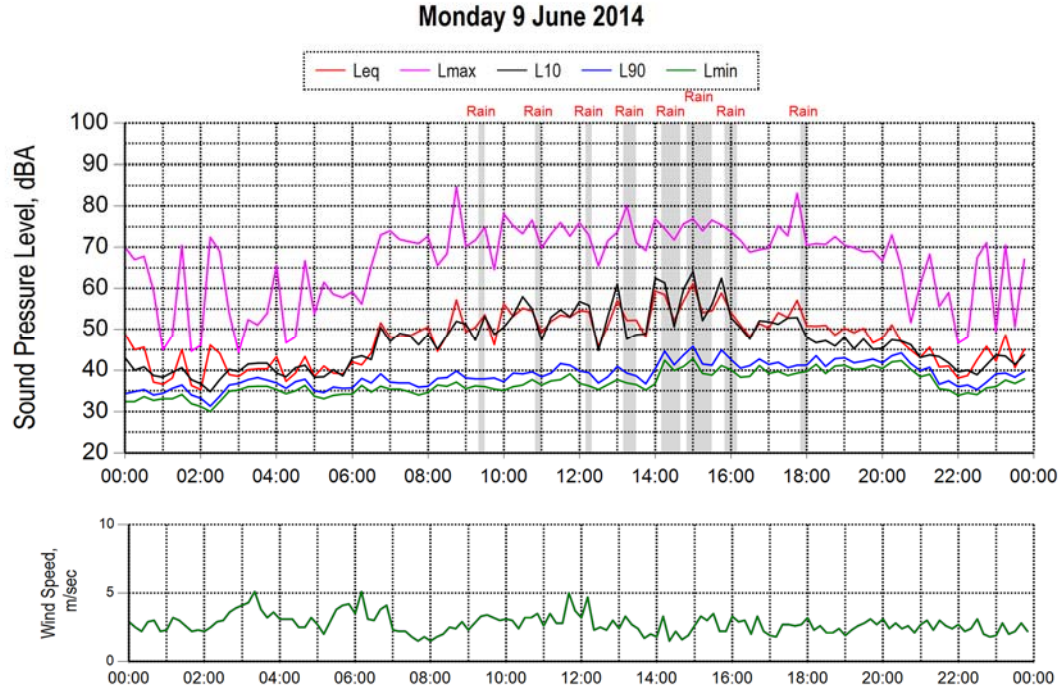

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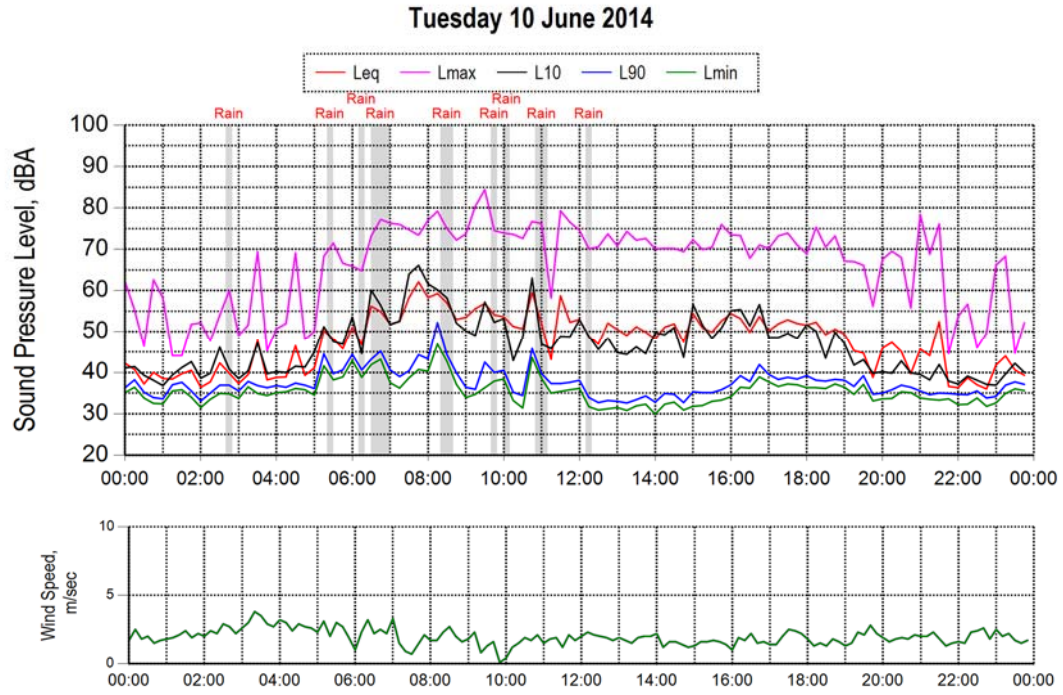

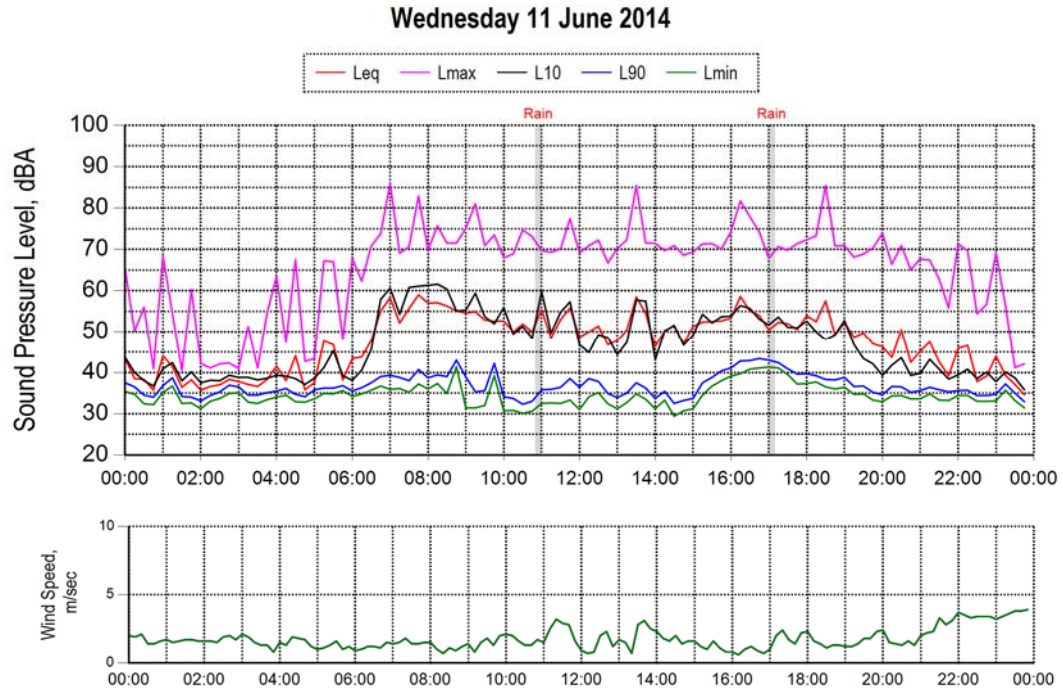

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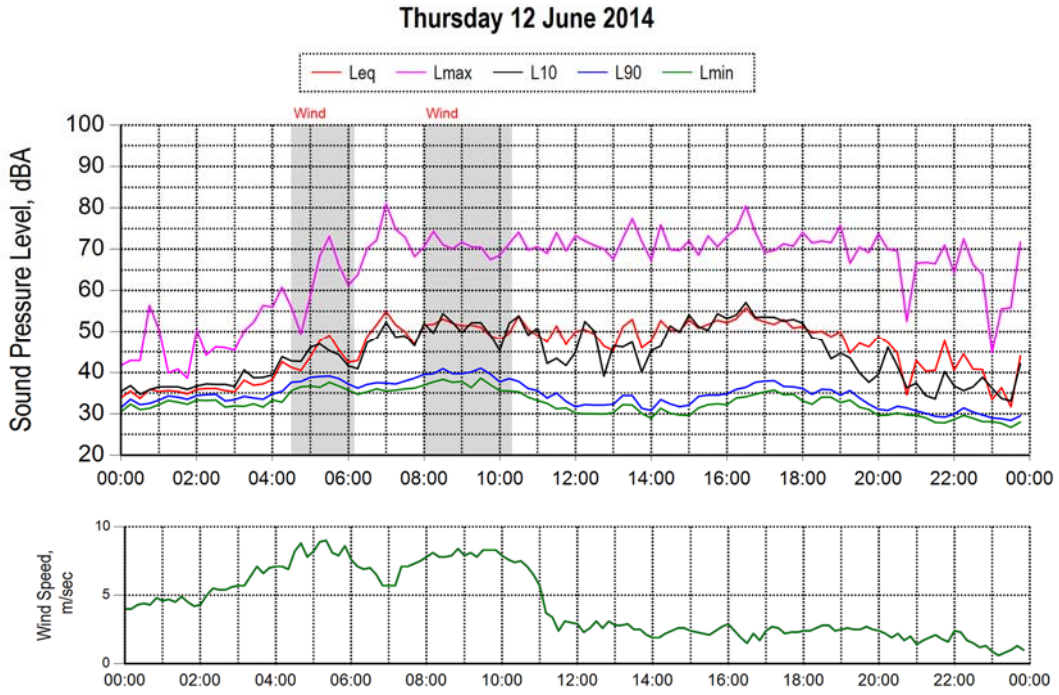

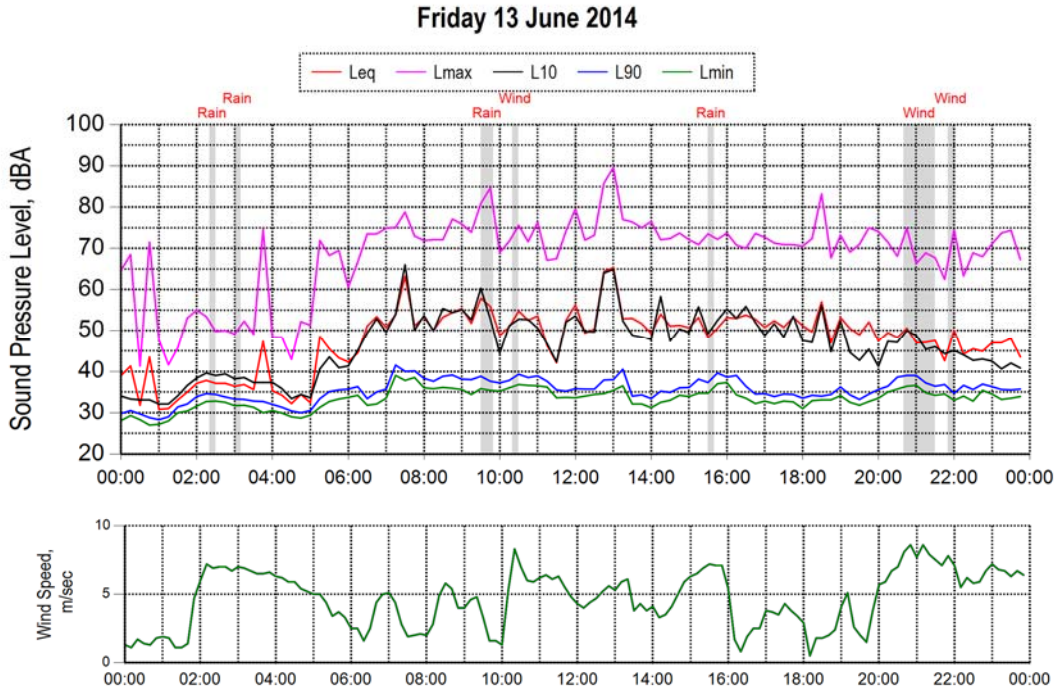

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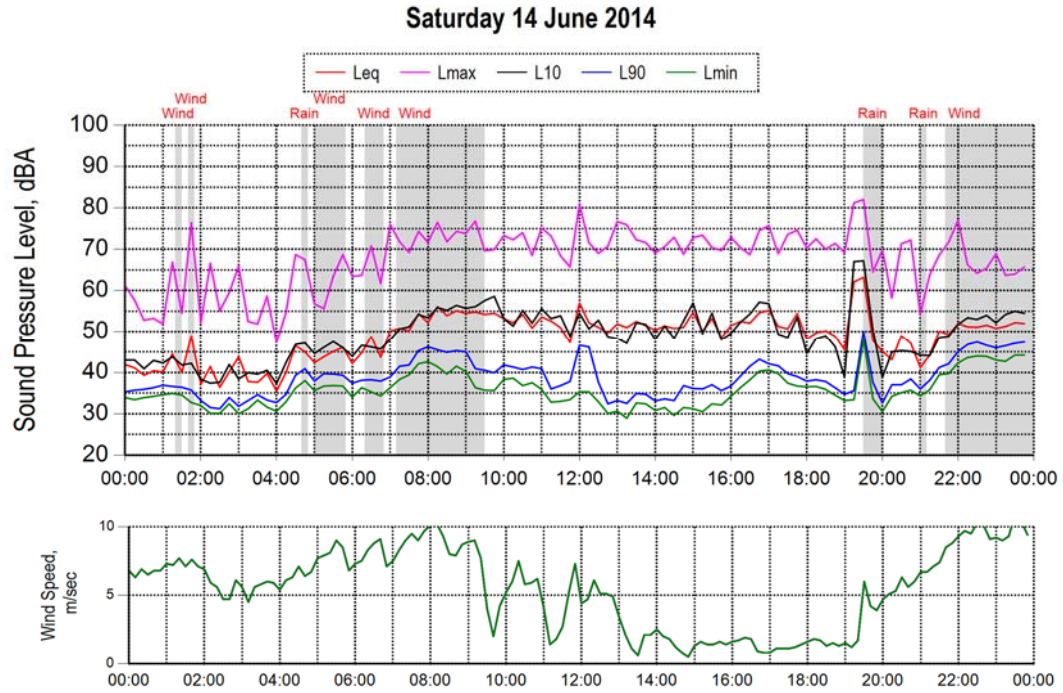

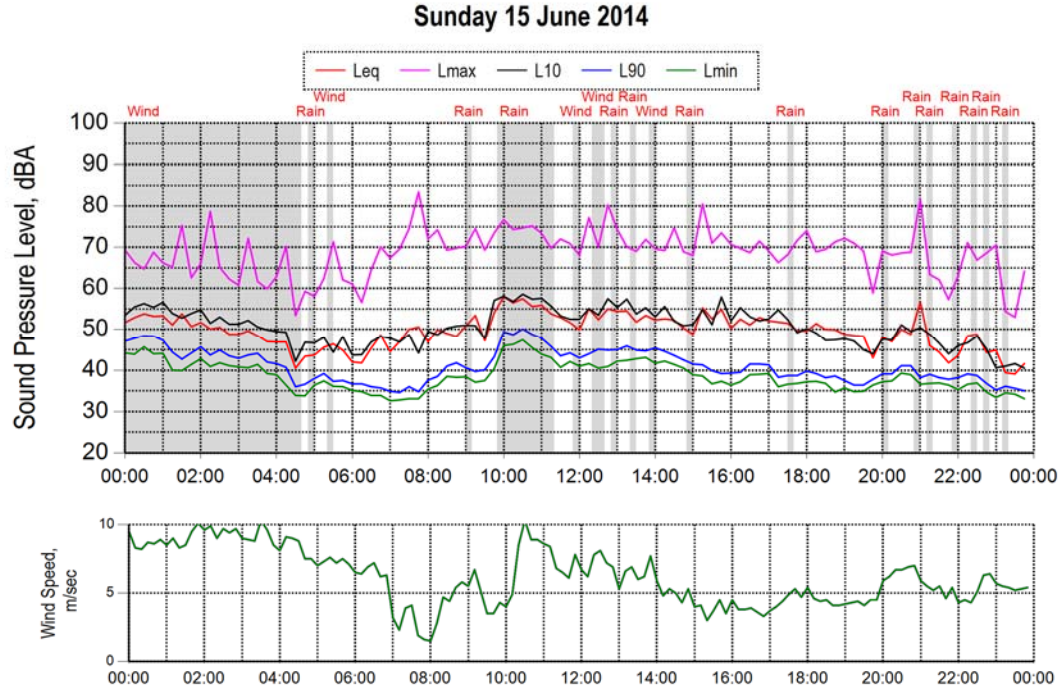

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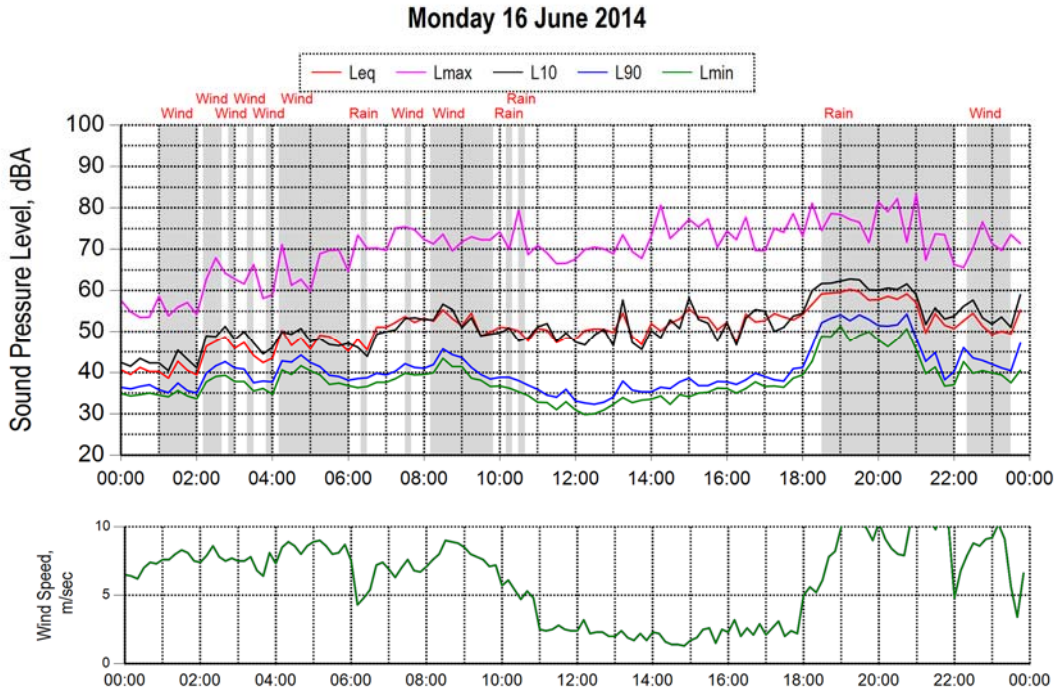

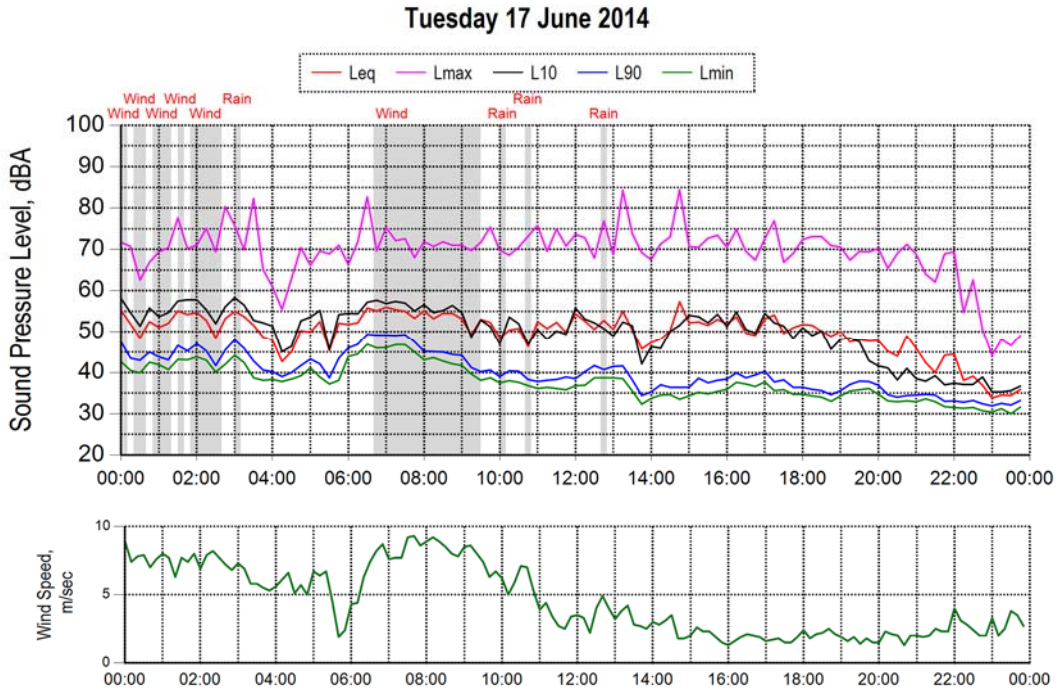

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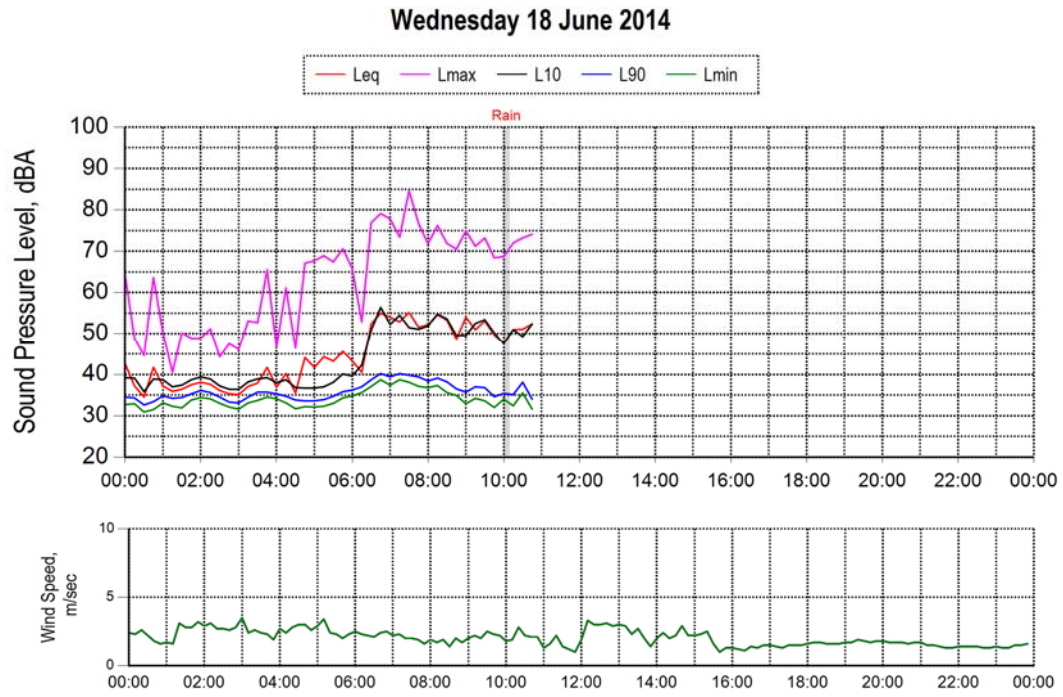


Project Approval

Section 75J of the *Environmental Planning and Assessment Act 1979*

As delegate for the Minister for Planning, the Planning Assessment Commission approves the project application referred to in Schedule 1, subject to the conditions in Schedules 2 to 6.

These conditions are required to:
- prevent, minimise, and/or offset adverse environmental impacts;
- set standards and performance measures for acceptable environmental performance;
- require regular monitoring and reporting; and
- provide for the ongoing environmental management of the project.

Member of the Commission	**Member of the Commission**
Sydney	2015

SCHEDULE 1

Project Application:	09_0013
Proponent:	Wollongong Coal Limited
Approval Authority:	Minister for Planning
Land:	See Appendix 1
Project:	Russell Vale Colliery Underground Expansion Project

TABLE OF CONTENTS

DEFINITIONS

Adaptive management	Adaptive management includes monitoring subsidence effects and impacts and, based on the results, modifying the mine plan as mining proceeds to ensure that the effects, impacts and/or associated environmental consequences remain within the predicted and/or designated ranges and in compliance with the conditions of this approval
Annual Review	The review required by condition 4 of Schedule 6
Approval	This Project Approval
Approved Mine Plan	The mine plan depicted in the figure in Appendix 2
BCA	Building Code of Australia
Built features	Includes any building or work erected or constructed on land, and includes dwellings and infrastructure such as any formed road, street, path, walk, or driveway; and any pipeline, water, sewer, telephone, gas or other service main
CCC	Community Consultative Committee
Conditions of this approval	Conditions contained in Schedules 2 to 6 inclusive
Construction	The demolition of buildings or works, carrying out of works and erection of buildings covered by this approval
Day	The period from 7 am to 6 pm on Monday to Saturday, and 8 am to 6 pm on Sundays and Public Holidays
Department	Department of Planning and Environment
DSC	Dams Safety Committee
EA	Environmental Assessment prepared for NRE No. 1 Colliery Underground Expansion Project entitled *NRE No. 1 Colliery Project Application (09_0013) Environmental Assessment* (dated February 2013) including the Preferred Project Report and associated Response to Submissions (dated September 2013), the Residual Matters Report (dated June 2014) and the following additional information: - *Bellambi Gully Flood Study* (25 November 2014) undertaken by Cardno Pty Ltd; - letter report from Wollongong Coal Ltd (26 September 2014) to the Department providing additional information in relation to total groundwater inflow; and - *Noise Impact Assessment* (September 2014) undertaken by Wilkinson Murray Pty Ltd.
Environmental consequences	The environmental consequences of subsidence impacts, including: damage to built features; loss of surface water flows to the subsurface; loss of standing pools; adverse water quality impacts; cliff falls; rock falls; damage to Aboriginal heritage sites; impacts on aquatic ecology; and ponding.
EPA	Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Regulation	*Environmental Planning and Assessment Regulation 2000*
EPL	Environment Protection Licence issued under the *Protection of the Environment Operations Act 1997*
Evening	The period from 6 pm to 10 pm
Feasible	Feasible relates to engineering considerations and what is practical to build or to implement
First workings	Extraction of coal by bord and pillar workings and the like
Incident	A set of circumstances that causes or threatens to cause material harm to the environment, and/or breaches or exceeds the limits or performance measures/criteria in this approval
INP	*NSW Industrial Noise Policy* (NSW EPA, 2000)
Land	In general, the definition of land is consistent with the definition in the EP&A Act. However, in relation to the noise and air quality conditions in Schedule 4 it means the whole of a lot, or contiguous lots owned by the same landowner, in a current plan registered at the Land Titles Office at the date of this approval
Material harm to the environment	Harm to the environment is material if it involves actual or potential harm to the health or safety of human beings or to ecosystems that is not trivial
Mining operations	Extraction, processing, handling and storage of coal on the site
Minister	Minister for Planning, or delegate
Mitigation	Activities associated with reducing the impacts of the project prior to or during those impacts occurring
MSB	Mine Subsidence Board
Negligible	Small and unimportant, such as to be not worth considering
Night	The period from 10 pm to 7 am, Monday to Saturday, 10 pm to 8 am on Sundays and Public Holidays
NOW	New South Wales Office of Water

NSW Trade & Investment	Department of Trade & Investment, Regional Infrastructure & Services
OEH	Office of Environment and Heritage
PKCT	Port Kembla Coal Terminal
POEO Act	*Protection of the Environment Operations Act 1997*
Privately-owned land	Land that is not owned by a public agency, or a mining company (or its subsidiary)
Project	Russell Vale Colliery Underground Expansion Project as described in the EA
Proponent	Wollongong Coal or any other person or persons who rely on this approval to carry out the project that is subject to this approval
Reasonable	Reasonable relates to the application of judgement in arriving at a decision, taking into account: mitigation benefits, cost of mitigation versus benefits provided, community views and the nature and extent of potential improvements
Reasonable costs	The costs agreed between the Department and the Proponent for obtaining independent experts to review the adequacy of any aspects of the extraction plan, or where such costs cannot be agreed, the costs determined by a dispute resolution process
ROM coal	Run-of-mine coal
RMS	Roads and Maritime Services
Safe, serviceable & repairable	Safe means no danger to users who are present, serviceable means available for its intended use, and repairable means damaged components can be repaired economically
Second workings	Extraction of coal from longwall panels, mini-wall panels or pillar extraction
Secretary	Secretary of the Department, or nominee
Secretary, NSW Trade & Investment	Secretary of NSW Trade & Investment, or nominee
Site	Land to which the project approval applies (see Appendix 1)
SCA	Sydney Catchment Authority
Statement of Commitments	The commitments by Wollongong Coal set out in Appendix 3
Subsidence	The totality of subsidence effects and impacts and their associated environmental consequences
Subsidence effects	Deformation of the ground mass due to mining, including all mining-induced ground movements, including both vertical and horizontal displacement, tilt, strain and curvature
Subsidence impacts	Physical changes to the ground and its surface caused by subsidence effects, including tensile and shear cracking of the rock mass, localised buckling of strata caused by valley closure and upsidence and surface depressions or troughs
Surface facilities sites	The Russell Vale site; all ventilation shaft sites; sites used for gas drainage or for other mining purposes infrastructure; and any other site subject to existing or proposed surface disturbance associated with the project
WCC	Wollongong City Council
Wollongong Coal	Wollongong Coal Limited

SCHEDULE 2
ADMINISTRATIVE CONDITIONS

OBLIGATION TO MINIMISE HARM TO THE ENVIRONMENT

1. In addition to meeting the specific performance criteria established under this approval, the Proponent shall implement all reasonable and feasible measures to prevent and/or minimise any material harm to the environment that may result from the construction, operation, or rehabilitation of the project.

TERMS OF APPROVAL

2. The Proponent shall:
   (a) carry out the project generally in accordance with the EA;
   (b) Statement of Commitments (see Appendix 3); and
   (c) conditions of this approval.

   Note: The general layout of the project is shown in Appendix 2.

3. If there is any inconsistency between the above documents, the more recent document shall prevail to the extent of the inconsistency. However, the conditions of this approval shall prevail to the extent of any inconsistency.

4. The Proponent shall comply with any reasonable requirement/s of the Secretary arising from the Department's assessment of:
   (a) any strategies, plans, programs, reviews, audits, reports or correspondence that are submitted in accordance with this approval;
   (b) any reviews, reports or audits undertaken or commissioned by the Department regarding compliance with this approval; and
   (c) the implementation of any actions or measures contained in these documents.

LIMITS ON APPROVAL

Mining Operations

5. The Proponent may carry out mining operations on the site until 31 December 2019.

   Note: Under this Approval, the Proponent is required to rehabilitate the site to the satisfaction of the Secretary, NSW Trade & Investment. Consequently this approval will continue to apply in all other respects other than the right to conduct mining operations until the site has been rehabilitated to a satisfactory standard.

Coal Extraction

6. The Proponent shall not extract more than 3 million tonnes of ROM coal from the site per calendar year.

Hours of Operation

7. The Proponent may undertake mining operations 24 hours a day, 7 days a week.

COMMENCEMENT OF DEVELOPMENT UNDER THIS APPROVAL

8. The Proponent:
   (a) shall notify the Secretary in writing of the proposed date of commencement of development under this approval; and
   (b) may only commence development under this approval once the Secretary has agreed in writing that all prerequisites to the commencement of that development have been met.

SURRENDER OF EXISTING PROJECT APPROVAL

9. By the end of June 2016, or as otherwise agreed by the Secretary, the Proponent shall surrender the existing project approval for the site in accordance with Section 104A of the EP&A Act.

   Prior to the surrender of the existing project approval, the conditions of this approval shall prevail to the extent of any inconsistency with the conditions of the existing project approval.

APPLICATION OF EXISTING MANAGEMENT PLANS

10. Prior to the approval of management plans under this approval, the Proponent shall manage development undertaken pursuant to this approval in accordance with any equivalent or similar management plan/s required under the existing project approval.

STRUCTURAL ADEQUACY

11. The Proponent shall ensure that all new buildings and structures, and any alterations or additions to existing buildings and structures, are constructed in accordance with the relevant requirements of the BCA.

Notes:

- *Under Part 4A of the EP&A Act, the Proponent is required to obtain construction and occupation certificates for the proposed building works; and*
- *Part 8 of the EP&A Regulation sets out the requirements for the certification of the project.*

DEMOLITION

12. The Proponent shall ensure that all demolition work is carried out in accordance with *Australian Standard AS 2601-2001: The Demolition of Structures*, or its latest version.

PROTECTION OF PUBLIC INFRASTRUCTURE

13. Unless the Proponent and the applicable authority agree otherwise, the Proponent shall:
    (a) repair, or pay the full costs associated with repairing, any public infrastructure that is damaged by the project; and
    (b) relocate, or pay the full costs associated with relocating, any public infrastructure that needs to be relocated as a result of the project.

Note: This condition does not apply to any damage to public infrastructure subject to compensation payable under the Mine Subsidence Compensation Act 1961, or to damage to roads caused as a result of general road usage.

OPERATION OF PLANT AND EQUIPMENT

14. The Proponent shall ensure that all plant and equipment used on site is:
    (a) maintained in a proper and efficient condition; and
    (b) operated in a proper and efficient manner.

UPDATING & STAGING STRATEGIES, PLANS OR PROGRAMS

15. With the approval of the Secretary, the Proponent may:
    (a) submit any strategy, plan or program required by this approval on a progressive basis; and
    (b) combine any strategy, plan or program required by this approval with any similar strategy, plan or program required for the project.

To ensure these strategies, plans or programs are updated on a regular basis, the Proponent may at any time submit revised strategies, plans or programs to the Secretary for approval.

With the agreement of the Secretary, the Proponent may prepare any revised strategy, plan or program without undertaking consultation with all parties under the applicable condition of this approval.

Notes:

- *While any strategy, plan or program may be submitted on a progressive basis, the Proponent will need to ensure that the existing operations on site are covered by suitable strategies, plans or programs at all times.*
- *If the submission of any strategy, plan or program is to be staged, then the relevant strategy, plan or program must clearly describe the specific stage to which the strategy, plan or program applies, the relationship of this stage to any future stages, and the trigger for updating the strategy, plan or program.*

SCHEDULE 3
ENVIRONMENTAL CONDITIONS – UNDERGROUND MINING

SUBSIDENCE

Performance Measures – Natural and Heritage Features

1. The Proponent shall ensure that the project does not cause any exceedance of the performance measures in Table 1, to the satisfaction of the Secretary.

Table 1: Subsidence Impact Performance Measures

Water resources	
Cataract Creek Cataract River	Negligible environmental consequences including: • *negligible* diversion of flows or changes in the natural drainage behaviour of pools; • *negligible* gas releases and iron staining; • *negligible* increase in water cloudiness; • *negligible* increase in bank erosion; • *negligible* increase in sediment load; and • *negligible* reduction in the volume of water reporting to the reservoir.
Cataract Reservoir	Negligible leakage from the reservoir and negligible reduction in the water quality of the reservoir.
Other watercourses	No greater subsidence impact or environmental consequences than predicted in the EA.
Swamps	
Upland Swamp CRUS1 and CCUS1	Negligible environmental consequences including: • *negligible* erosion of the surface of the swamp; • *negligible* change in the size of the swamp; • *negligible* change in the ecosystem functionality of the swamp; • *negligible* change to the composition or distribution of species within the swamp; and • *negligible* change to the structural integrity of any controlling rockbar/s for the swamp.
Land	
Cliffs	No greater subsidence impacts or environmental consequences than predicted in the EA.
Biodiversity	
Threatened species, populations or their habitats and endangered ecological communities (except Upland Swamps CCUS2, CCUS4, CCUS5, CCUS10, CCUS11, CCUS12, BCUS4 and BCUS11)	Negligible environmental consequences.
Heritage Features	
Aboriginal heritage sites 52-2-0083, 52-2-0233, 52-2-0310, 52-2-0311, 52-2-0312, 52-2-0313, 52-2-0314, 52-2-0317, 52-2-0319, 52-2-0322, 52-2-0323, Wonga East 4 and Wonga East 5	Negligible impact or environmental consequences.
Aboriginal heritage sites 52-2-0099, 52-2-0229, 52-2-0603, 52-2-3939, 52-2-3940, 52-2-3941, 52-2-0320 and 52-3-0325.	No greater subsidence impact or environmental consequences than predicted in the EA.
Historic heritage sites	Negligible impact or environmental consequences.

Notes:

1) The Proponent will be required to define more detailed performance indicators (including impact assessment criteria) for each of these performance measures in the various management plans that are required under this approval (see eg condition 8 below).

2) Measurement and/or monitoring of compliance with performance measures and performance indicators is to be undertaken using generally accepted methods that are appropriate to the environment and circumstances in which the feature or characteristic is located. These methods are to be fully described in the relevant management plans. In the event of a dispute over the appropriateness of proposed methods, the Secretary will be the final arbiter.

3) The requirements of this condition only apply to the impacts and consequences of mining operations, construction or demolition undertaken following the date of this approval.

2. The Proponent must assess and manage project-related risks to ensure that there are no exceedances of the performance measures in Table 1. Any exceedance of these performance measures constitutes a breach of this approval and may be subject to penalty or offence provisions under the EP&A Act or EP&A Regulation, notwithstanding actions taken pursuant to paragraphs (a)-(c) or condition 3 below. Where any exceedance of these performance measures has occurred, the Proponent must, at the earliest opportunity:
   (a) take all reasonable and feasible steps to ensure that the exceedance ceases and does not recur;
   (b) consider all reasonable and feasible options for remediation and submit a report to the Department describing those options and any preferred remediation measures or other course of action; and
   (c) implement remediation measures as directed by the Secretary,

   to the satisfaction of the Secretary.

Offsets

3. If the Proponent exceeds the performance measures in Table 1 and the Secretary determines that:
   (a) it is not reasonable or feasible to remediate the impact or environmental consequence; or
   (b) remediation measures implemented by the Proponent have failed to satisfactorily remediate the impact or environmental consequence;

   then the Proponent shall provide a suitable offset to compensate for the impact or environmental consequence, to the satisfaction of the Secretary.

   The offset must give priority to like-for-like physical environmental offsets, but may also consider payment into any NSW Offset Fund established by OEH, or funding or implementation of supplementary measures such as:
   - actions outlines in threatened species recovery programs;
   - actions that contribute to threat abatement programs;
   - biodiversity research and survey programs; and/or
   - rehabilitating degraded habitat.

   Note: Any offset required under this condition must be proportionate with the significance of the impact or environmental consequence.

4. If mining under this approval causes impacts on Upland Swamps CCUS2, CCUS4, CCUS5, CCUS10, CCUS11, CCUS12, BCUS4 or BCUS11 which exceed 'negligible environmental consequences', and the Secretary determines that:
   (a) it is not reasonable or feasible to remediate the impact or environmental consequences; or
   (b) remediation measures implemented by the Proponent have failed to satisfactorily remediate the impact or environmental consequences;

   then the Proponent shall provide a suitable offset to compensate for the environmental consequences in accordance with the requirements of condition 3 above, to the satisfaction of the Secretary.

   Exceedances of 'negligible environmental consequences' under this condition are defined as:
   - greater than negligible erosion of the surface of the swamp;
   - greater than negligible changes in the size of the swamp;
   - greater than negligible changes in the ecosystem functionality of the swamp;
   - greater than negligible change to the composition or distribution of species within the swamp; and
   - greater than negligible change to the structural integrity of controlling rockbar/s for the swamp.

Performance Measures – Built Features

5. The Proponent shall ensure that the project does not cause any exceedances of the performance measures in Table 2, to the satisfaction of the Secretary.

Table 2: Subsidence Impact Performance Measures

Built Features	
Key public infrastructure: Mount Ousley Road; Picton Road Interchange; 330 and 132 kV power transmission lines and associated towers; and telecommunication infrastructure on Brokers Nose.	Always safe and serviceable. Damage that does not affect safety or serviceability must be fully repairable, and must be fully repaired.
Access road to Vent Shaft No. 4, fire trails, other public infrastructure, other built features	Always safe. Serviceability should be maintained wherever practicable. Loss of serviceability must be fully compensated. Damage must be fully repairable, and must be fully repaired or else replaced or fully compensated.
Public safety	
Public Safety	No additional risk

Notes:

1) *The Proponent will be required to define more detailed performance indicators (including impact assessment criteria) for each of these performance measures in Built Features Management Plans or Public Safety Management Plan (see condition 8 below).*
2) *Measurement and/or monitoring of compliance with performance measures and performance indicators is to be undertaken using generally accepted methods that are appropriate to the environment and circumstances in which the feature or characteristic is located. These methods are to be fully described in the relevant management plans. In the event of a dispute over the appropriateness of proposed methods, the Secretary will be the final arbiter.*
3) *The requirements of this condition only apply to the impacts and consequences of mining operations undertaken following the date of this approval.*
4) *Any breach of this condition is taken to be a breach of this approval, and may be subject to penalty or offence provisions under the EP&A Act or EP&A Regulation.*
5) *Requirements regarding safety or serviceability do not prevent preventative or mitigatory actions being taken prior to or during mining in order to achieve or maintain these outcomes.*

6. Any dispute between the Proponent and the owner of any built feature over the interpretation, application or implementation of the performance measures in Table 2 is to be settled by the Secretary, following consultation with the MSB and the Secretary, NSW Trade & Investment. Any decision by the Secretary shall be final and not subject to further dispute resolution under this approval.

First Workings

7. The Proponent may carry out first workings within the underground mining area, other than in accordance with an approved Extraction Plan, provided that Secretary, NSW Trade & Investment is satisfied that the first workings are designed to remain stable and non-subsiding in the long-term, except insofar as they may be impacted by approved second workings.

Note: The intent of this condition is not to require an additional approval for first workings, but to ensure that first workings are built to geotechnical and engineering standards sufficient to ensure long term stability, with negligible resulting direct subsidence impacts.

Extraction Plan

8. The Proponent shall prepare and implement an Extraction Plan for all second workings on site to the satisfaction of the Secretary. Each extraction plan must:
   (a) be prepared by suitably qualified and experienced persons whose appointment has been endorsed by the Secretary;
   (b) be approved by the Secretary before the Proponent carries out any of the second workings covered by the plan;
   (c) include detailed plans of existing and proposed first and second workings and any associated surface development;
   (d) include detailed performance indicators for each of the performance measures in Tables 1 and 2;
   (e) provide revised predictions of the potential subsidence effects, subsidence impacts and environmental consequences of the proposed second workings, incorporating any relevant information obtained since this approval;
   (f) describe the measures that would be implemented to ensure compliance with the performance measures in Tables 1 and 2, and manage or remediate any impacts and/or environmental consequences;
   (g) include a Built Features Management Plan, which has been prepared in consultation with the Secretary, NSW Trade & Investment and the owners of affected infrastructure, to manage the potential subsidence impacts and/or environmental consequences of the proposed second workings, and which:
      - addresses in appropriate detail all items of key public infrastructure, other public infrastructure and all classes of other built features;
      - has been prepared following appropriate consultation with the owner/s of potentially affected feature/s;
      - recommends appropriate remedial measures and includes commitments to mitigate, repair, replace or compensate all predicted impacts on potentially affected built features in a timely manner; and
      - in the case of all key public infrastructure, and other public infrastructure except roads, trails and associated structures, reports external auditing for compliance with ISO 31000 (or alternative standard agreed with the infrastructure owner) and provides for annual auditing of compliance and effectiveness during extraction of longwalls which may impact the infrastructure;
   (h) include a Water Management Plan, which has been prepared in consultation with SCA and NOW, which provides for the management of the potential impacts and/or environmental consequences of the proposed second workings on watercourses and aquifers, including:
      - detailed baseline data on:
         - surface water flows and quality in water bodies that could be affected by subsidence, including Cataract Creek, Cataract River and all major associated tributaries ;
         - groundwater levels, yield and quality in the region;
      - surface and groundwater impact assessment criteria, including trigger levels for investigating any potentially adverse impacts on water resources or water quality;

- a surface water monitoring program to monitor and report on:
  - stream flows and quality;
  - stream and riparian vegetation health;
  - channel and bank stability;
- a groundwater monitoring program to monitor and report on:
  - groundwater inflows to the underground mining operations;
  - leakage from Cataract Reservoir;
  - the height of groundwater depressurisation in the area between Longwalls 6 and 7 and the Cataract Reservoir;
  - background changes in groundwater yield/quality against mine-induced changes;
  - permeability, hydraulic gradient, flow direction and connectivity of the deep and shallow groundwater aquifers;
  - impacts of the project on upland swamps (refer to condition 9 below) and other groundwater dependent ecosystems;
- a program to validate the surface water and groundwater models for the project, and compare monitoring results with modelled predictions; and
- a plan to respond to any exceedances of the surface water and groundwater assessment criteria;

(i) include a Biodiversity Management Plan, which has been prepared in consultation with OEH, which provides for the management of the potential impacts and/or environmental consequences of the proposed second workings on aquatic and terrestrial flora and fauna, with a specific focus on threatened species, populations and their habitats; endangered ecological communities; upland swamps and other groundwater dependent ecosystems;

(j) include a Land Management Plan, which has been prepared in consultation with any affected public authorities, to manage the potential impacts and/or environmental consequences of the proposed second workings on land in general;

(k) include a Heritage Management Plan, which has been prepared in consultation with OEH and relevant stakeholders for both Aboriginal and historic heritage, to manage the potential environmental consequences of the proposed second workings on both Aboriginal and non-Aboriginal heritage items. This plan must reflect all requirements under condition 19 of Schedule 4;

(l) include a Public Safety Management Plan, which has been prepared in consultation with the Secretary, NSW Trade & Investment, to ensure public safety in the mining area;

(m) include a Subsidence Monitoring Program, which has been prepared in consultation with the Secretary, NSW Trade & Investment, to:
- describe the on-going subsidence monitoring program;
- provide data to assist with the management of the risks associated with subsidence;
- validate the subsidence predictions;
- analyse the relationship between the predicted and resulting subsidence effects and predicted and resulting impacts under the plan and any ensuing environmental consequences; and
- inform the contingency plan and adaptive management process;

(n) include Trigger Action Response Plans, or equivalent, to address potential subsidence impacts and environmental consequences that may result from mining subsidence;

(o) include a contingency plan that expressly provides for adaptive management where monitoring indicates that there has been an exceedance of any performance measure in Tables 1 and 2, or where any such exceedance appears likely;

(p) proposes appropriate revisions to the Rehabilitation Management Plan required under condition 25 of Schedule 3; and

(q) include a program to collect sufficient baseline data for future Extraction Plans.

Notes:
- *To identify the longwall mining domains referred to in this condition, see Appendix 2;*
- *This condition does not apply to second workings for other underground mine workings which are covered by a Subsidence Management Plan or Extraction Plan approved as at the date of this approval.*

Upland Swamp Monitoring Program

9. The Proponent shall prepare and implement an Upland Swamp Monitoring Program for the project to the satisfaction of the Secretary. This plan must:

(a) be prepared in consultation with OEH, NOW and SCA, and submitted to the Secretary for approval prior to the commencement of second workings under this approval;

(b) detail the proposed swamp monitoring program, including (as a minimum):
- upslope and downslope piezometers in at least two swamps in order to better understand the down-slope movement of shallow groundwater;
- two flow monitoring points in swamps in which pairs of piezometers (upslope and downslope) are installed;
- measures to record the nature and condition of terrestrial and aquatic flora and fauna within the swamps;

- measures to characterise soils within the swamps to determine:
  - porosity;
  - a basis for relating piezometer water levels to rainfall and evapotranspiration; and
  - the presence, or absence, of clay materials at the interface with the underlying sandstone;

(c) include a program for monthly review of the water balance of all monitored swamps based on recorded rainfall, estimated evapotranspiration and recorded surface and shallow groundwater levels and outflow measurements; and

(d) include detailed performance indicators for the relevant performance measures in Table 1 and the requirements of condition 4 above, including performance indicators relating to surface and shallow groundwater levels and outflow measurements.

PAYMENT OF REASONABLE COSTS

10. The Proponent shall pay all reasonable costs incurred by the Department to engage suitably qualified, experienced and independent persons to review the adequacy of any aspect of an Extraction Plan.

SCHEDULE 4
ENVIRONMENTAL CONDITIONS – GENERAL

NOISE

Noise Criteria

1. The Proponent shall ensure that the noise generated by the project does not exceed the criteria in Table 3 at any residence on privately-owned land.

Table 3: Noise Criteria dB(A)

Location		***Day***	***Evening***	***Night***	
Area	***Receiver Number***	$L_{Aeq\ (15\ min)}$	$L_{Aeq\ (15\ min)}$	$L_{Aeq\ (15\ min)}$	$L_{A1\ (1\ min)}$
16 West Street, Russell Vale	R1	53	53	43	50
30 West Street, Russell Vale	R2	54	53	44	51
13 West Street, Russell Vale	R3	53	53	44	50
13 Broker Street, Russell Vale	R4	53	53	43	50
4 Broker Street, Russell Vale	R5	53	53	41	52
659 Princes Highway, Russell Vale	R6	53	53	41	52
34 Princes Highway, Corrimal	R7	53	53	44	52
95 Midgley Street, Corrimal	R8	53	53	46	52
109 Midgley Street, Corrimal	R9	46	46	43	48
6 Lyndon Street, Corrimal	R10	44	44	43	48
22 Lyndon Street, Corrimal	R11	43	43	40	48
46 Lyndon Street, Corrimal	R12	42	42	39	48
6 Taylor Place, Corrimal	R13	46	46	42	48
15 Taylor Place, Corrimal	R14	46	46	40	48
All other privately-owned land		63	53	48	52

Note: To interpret the land referred to in Table 3 see the applicable figures in Appendix 4.

Noise generated by the project is to be measured in accordance with the relevant requirements of the NSW Industrial Noise Policy (as may be updated from time-to-time). Appendix 5 details the meteorological conditions under which these criteria apply and the requirements for evaluating compliance with these criteria.

However, these criteria do not apply if the Proponent has an agreement with the owner/s of the relevant residence or land to generate higher noise levels, and the Proponent has advised the Department in writing of the terms of this agreement.

Operating Conditions

2. The Proponent shall:
   (a) implement best management practice to minimise the operational and coal transport noise generated by the project, including any restrictions on the loading and transport of coal described in conditions 14 to 16 below;
   (b) not operate dozers or front end loaders between the hours of 10 pm and 7 am Monday to Friday, or between the hours of 10 pm and 8 am on Saturdays, Sundays and Public Holidays. Start-up checks may be undertaken up to 30 minutes prior to operations, where this is undertaken in a designated area selected to minimise noise impacts;
   (c) ensure that delivery of known igneous dyke or sill material to surface stockpiles only occurs between the hours of 7 am and 6 pm;

(d) ensure that seam floor and roof material and any unmapped igneous dyke or sill material delivered to surface stockpiles between the hours of 10 pm and 7 am comprises less than 10% of the ROM product by volume;
(e) not operate Trippers 2 or 3 between the hours of 10 pm and 7 am, unless the Trippers are re-engineered to demonstrably achieve the criteria in Table 3;
(f) only use noise-attenuated mobile fleet on the surface stockpile site;
(g) operate a comprehensive noise management system that uses real-time noise monitoring data to guide day to day planning of mining operations and the implementation of both proactive and reactive noise mitigation measures to ensure compliance with the relevant conditions of this approval;
(h) minimise the noise impacts of the project during meteorological conditions when the noise limits in this approval do not apply (see Appendix 5); and
(i) carry out regular monitoring to determine whether the project is complying with the relevant conditions of this approval and, if necessary, adjust the scale of operations on site to meet the criteria in this approval.

to the satisfaction of the Secretary.

Note: During emergencies (see condition 15 below), the Proponent may exceed the restrictions in condition 2 above with the written approval of the Secretary.

Noise Management Plan

3. The Proponent shall prepare and implement a Noise Management Plan for the project to the satisfaction of the Secretary. This plan must:
   (a) be prepared in consultation with EPA, and submitted to the Secretary for approval prior to the delivery of igneous dyke material to surface stockpiles;
   (b) describe the noise mitigation measures that would be implemented to ensure compliance with the relevant conditions of this approval;
   (c) outline procedures to manage responses to any complaints or issues raised by the owners of affected residences;
   (d) describe the proposed noise management system in detail; and
   (e) include a noise monitoring program that:
      - evaluates and reports on:
        - the effectiveness of the noise management system;
        - compliance against the noise criteria in this approval; and
        - compliance against the operating conditions in condition 2 above;
      - includes a program to calibrate and validate the real-time noise monitoring results with the attended monitoring results over time (so the real-time noise monitoring program can be used as a better indicator of compliance with the noise criteria in this approval and trigger for further attended monitoring); and
      - defines what constitutes a noise incident, and includes a protocol for identifying and notifying the Department and relevant stakeholders of any noise incidents.

AIR QUALITY

Air Quality Criteria

4. The Proponent shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that particulate matter emissions generated by the project do not exceed, or contribute to exceedances of, the criteria listed in Tables 4, 5 or 6 at any residence on privately-owned land.

Table 4: Long term impact assessment criteria for particulate matter

Pollutant	***Averaging period***	***[d] Criterion***
Total suspended particulate (TSP) matter	Annual	[a] 90 µg/m^3
Particulate matter < 10 µm (PM_{10})	Annual	[a] 30 µg/m^3

Table 5: Short term impact assessment criterion for particulate matter

Pollutant	***Averaging period***	***[d] Criterion***
Particulate matter < 10 µm (PM_{10})	24 hour	[a] 50 µg/m^3

Table 6: Long term impact assessment criteria for deposited dust

Pollutant	***Averaging period***	***Maximum increase in deposited dust level***	***Maximum total deposited dust level***

[c] Deposited dust	Annual	[b] 2 g/m^2/month	[a] 4 g/m^2/month

Notes to Tables 4-6:

[a] *Total impact (i.e. incremental increase in concentrations due to the complex plus background concentrations due to all other sources);*

[b] *Incremental impact (i.e. incremental increase in concentrations due to the complex on its own);*

[c] *Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method; and*

[d] *Excludes extraordinary events such as bushfires, prescribed burning, dust storms, fire incidents, illegal activities or any other activity agreed by the Secretary.*

Operating Conditions

5. The Proponent shall:
   (a) implement all reasonable and feasible measures to minimise the:
      - odour, fume and dust emissions of the project; and
      - release of greenhouse gas emissions from the project;
   (b) implement all reasonable and feasible measures to minimise the release of greenhouse gas emissions from the site;
   (c) minimise any visible off-site air pollution generated by the project;
   (d) minimise the surface disturbance of the site;
   (e) operate a comprehensive air quality management system that uses a combination of predictive meteorological forecasting and real-time air quality monitoring data to guide the day to day planning of mining operations and the implementation of both proactive and reactive air quality mitigation measures to ensure compliance with the relevant conditions of this approval; and
   (f) minimise the air quality impacts of the project during adverse meteorological conditions and extraordinary events (see Note d above under Table 6),

   to the satisfaction of the Secretary.

Air Quality & Greenhouse Gas Management Plan

6. The Proponent shall prepare and implement an Air Quality Management Plan for the project to the satisfaction of the Secretary. This plan must:
   (a) be prepared in consultation with the EPA, and submitted to the Secretary within 6 months of the date of this approval;
   (b) describe the measures that would be implemented to ensure compliance with the relevant conditions of this approval;
   (c) describe the measures that would be implemented to minimise the release of greenhouse gas emissions from the site;
   (d) describe the air quality management system;
   (e) include an air quality monitoring program that:
      - uses a combination of real-time and supplementary monitors to evaluate the performance of the project against the air quality criteria in this approval;
      - adequately supports the air quality management system;
      - evaluates and reports on the:
         - the effectiveness of the air quality management system;
         - compliance with the air quality criteria;
         - compliance with the operating conditions in condition 5 above; and
      - defines what constitutes an air quality incident, and includes a protocol for identifying and notifying the Department and relevant stakeholders of any air quality incidents.

Meteorological Monitoring

7. For the life of the project, the Proponent shall ensure that there is a meteorological station operating in the vicinity of the site that:
   (a) complies with the requirements in the *Approved Methods for Sampling of Air Pollutants in New South Wales* guideline; and
   (b) is capable of continuous real-time measurement of temperature lapse rate in accordance with the NSW Industrial Noise Policy, unless a suitable alternative is approved by the Secretary following consultation with the EPA.

WATER

Water Supply

8. The Proponent shall ensure that it has sufficient water for all stages of the project, and if necessary, adjust the scale of operations on site to match its available water supply.

Note: Under the Water Act 1912 and/or the Water Management Act 2000, the Proponent is required to obtain the necessary water licences for the project.

Water Pollution

9. Unless an EPL authorises otherwise, the Proponent shall comply with section 120 of the POEO Act.

Water Management Performance Measures

10. The Proponent shall comply with the performance measures in Table 7 to the satisfaction of the Secretary.

Table 7: Water Management Performance Measures

Feature	***Performance Measure***
Water Management – General	• Minimise the use of clean water on site • Minimise the use of make-up water from external sources
Construction and operation of infrastructure	• Design, install and maintain erosion and sediment controls generally in accordance with the series Managing Urban Stormwater: Soils and Construction including Volume 1, Volume 2A – Installation of Services and Volume 2C – Unsealed Roads • Design, install and maintain the infrastructure within 40 m of watercourses generally in accordance with the *Guidelines for Controlled Activities on Waterfront Land (DPI 2007)*, or its latest version • Design, install and maintain creek crossings generally in accordance with the Policy and Guidelines for *Fish Friendly Waterway Crossings* (NSW Fisheries, 2003) and *Why Do Fish Need To Cross The Road? Fish Passage Requirements for Waterway Crossings* (NSW Fisheries 2003), or their latest versions
Clean water diversion & storage infrastructure	• Maximise as far as reasonable and feasible the diversion of clean water around disturbed areas on site
Sediment Dams	• Design, install and maintain the dams generally in accordance with the series Managing Urban Stormwater: Soils and Construction – Volume 1 and Volume 2E Mines and Quarries
Mine water storages	• Design, install and maintain mine water storage infrastructure to ensure no unlicensed or uncontrolled discharge of mine water off-site • New on-site storages (including tailings dams, mine infrastructure dams, groundwater storage and treatment dams) are suitably lined to comply with a permeability standard of $< 1 \times 10^{-9}$ m/s
Chemical and hydrocarbon storage	• Chemical and hydrocarbon products to be stored in bunded areas in accordance with the relevant Australian Standards
Aquatic and riparian ecosystems	• Maintain or improve baseline channel stability • Develop site-specific water quality objectives in accordance with ANZECC 2000 and *Using the ANZECC Guidelines and Water Quality Objectives in NSW* procedures (DECC 2006), or its latest version
Bellambi Gully Channel and Diversion	• Design, install and maintain the main channel and culvert to convey the 100 year ARI flood or greater using the WCC 'policy based' conduit blockage criteria • Design, install and maintain the swale alongside the stockpile access road to convey the 100 year ARI flood or greater

Bellambi Gully Channelisation Works

11. The Proponent shall implement the recommended mitigation measures detailed in Section 6 of the *Bellambi Gully Flood Study* (Cardno Pty Ltd, 25 November 2014) within 6 months of the date of this approval.

Water Management Plan

12. The Proponent shall prepare and implement a Water Management Plan for the project to the satisfaction of the Secretary. This plan must:
    (a) be prepared in consultation with NOW and the EPA, by suitably qualified and experienced persons whose appointment has been approved by the Secretary;
    (b) be submitted to the Secretary for approval within 6 months of the date of this approval;
    (c) include reference to the National Water Quality Management Strategy;
    (d) include detailed performance criteria and describes measure to ensure that the Proponent complies with the Water Management Performance Measures (see Table 7);
    (e) in addition to the standard requirements for management plans (see condition 3 of Schedule 6), this plan must include a:
        (i) Site Water Balance that:

- includes details of:
  - sources and security of water supply, including contingency planning for future reporting periods;
  - water use and management on site;
  - reporting procedures, including the preparation of a site water balance for each calendar year;
- describes the measures that would be implemented to minimise clean water use on site;

(ii) Surface Water Management Plan, that includes:

- detailed baseline data on water flows and quality in the waterbodies that could be affected by the surface facilities associated with the project, including Bellambi Creek and Lizard Creek;
- a detailed description of the water management systems on site, including the pit top and all shaft sites and associated facilities;
- detailed plans, including design objectives and performance criteria;
- detailed performance criteria for the following, including trigger levels for investigating any potentially adverse impacts associated with the project:
  - the water management system;
  - downstream surface water quality;
  - downstream flooding impacts; and
  - stream and riparian vegetation health for Bellambi Creek and Lizard Creek;
- a program to monitor and report on:
  - the effectiveness of the water management system;
  - surface water flows and quality, stream and riparian vegetation health in the watercourses that could be affected by the surface facilities associated with the project;
  - the seepage/leachate from on-site water storages; and
  - downstream flooding impacts;
- reporting procedures for the results of the monitoring program; and
- a plan to respond to any exceedances of the performance criteria, and mitigate any adverse surface water impacts of the project.

TRANSPORT

Monitoring of Coal Transport

13. The Proponent shall:
    (a) keep accurate records of the amount of coal transported from the site (on a daily basis);
    (b) make these records publicly available on its website at the end of each calendar quarter.

Road Transport Restrictions

14. The Proponent shall only load coal or coal reject onto trucks, or transport it off site by road between 7 am to 10 pm, Monday to Friday and between and 8 am to 6 pm on Saturdays, Sundays and public holidays.

15. During emergencies, the Proponent may exceed the restrictions in condition 14 above with the written approval of the Secretary.

    Note: The kind of circumstances which may constitute an emergency include major traffic disruptions on the transport route and major loading equipment failure or critical port need at PKCT.

16. The Proponent shall ensure that any truck leaving the site:
    (a) does not carry dirt or mud onto public roads; and
    (b) is free of material that may fall on the road and create a road safety hazard or public nuisance,
    to the satisfaction of the Secretary.

Traffic Management Plan

17. The Proponent shall prepare and implement a Traffic Management Plan for the project to the satisfaction of the Secretary. This Plan must:
    (a) be prepared in consultation with RMS, EPA, WCC and PKCT;
    (b) be submitted for approval to the Secretary within 6 months of the date of this approval;
    (c) aim to minimise the traffic impacts of the project on the residential areas surrounding the surface facilities site, and in particular the residences located along Bellambi Lane;
    (d) include a traffic management protocol, which must consider:
        - appropriate speed limits;
        - truck separation distances;

- minimisation of compression braking and other noisy practices, especially on the approach to Port Kembla Road/Springhill Road traffic lights when entering or exiting PKCT;
- reporting of vehicle faults; and
- reporting of all traffic incidents; and

(e) include a Traffic Noise Management Strategy, which must consider, but is not limited to:
- the selection and maintenance of vehicle fleets;
- movement scheduling to reduce noise impacts during sensitive times of the day; and
- procedures to minimise impacts at identified sensitive areas along the haulage routes; and

(f) include a drivers' code of conduct to minimise the impacts of project-related trucks on local residences and road users; and

(g) describe the measures that would be put in place to ensure compliance with the drivers' code of conduct.

HERITAGE

Protection of Aboriginal Heritage Items

18. Unless otherwise authorised under the *National Parks and Wildlife Act 1974*, the Proponent shall ensure that the project does not cause any direct or indirect impact on the identified Aboriginal heritage items located outside the approved disturbance area of the project.

Note: Identified Aboriginal heritage items are listed in Appendix 6.

Heritage Management Plan

19. The Proponent shall prepare and implement a Heritage Management Plan for the project to the satisfaction of the Secretary. This Plan must:

(a) be prepared by suitably qualified and experienced persons whose appointment has been endorsed by the Secretary;

(b) be prepared in consultation with OEH, WCC, any relevant local historical organisations and Aboriginal stakeholders;

(c) be submitted to the Secretary for approval within 6 months of the date of this approval, unless the Secretary agrees otherwise;

(d) include a description of the measures that would be implemented for:
- managing the discovery of human remains or previously unidentified heritage items on site; and
- ensuring any workers on site receive suitable heritage inductions prior to carrying out any development on site, and that suitable records are kept of these inductions;

(e) include the following for the management of Aboriginal Heritage:
- a description of the measures that would be implemented for:
  - protecting, monitoring and/or managing (including any proposed archaeological investigations and/or salvage measures) the heritage items identified in Table 1;
  - managing the discovery of previously unidentified Aboriginal items on site;
  - conserving the sites outside the surface disturbance area (see Appendix 6), including measures that would be implemented to secure, analyse and record the sites at risk of subsidence;
  - maintaining and managing reasonable access for Aboriginal stakeholders to heritage items on site;
  - ongoing consultation with the Aboriginal stakeholders in the conservation and management of Aboriginal cultural heritage on site; and
- a strategy for the storage of any heritage items salvaged on site, both during the project and in the long term;

(f) include the following for the management of cultural heritage items:
- a description of the measures that would be implemented for:
  - protecting, monitoring and managing the heritage items identified in Appendix 7;
  - managing the discovery of previously unidentified cultural heritage items on site;
  - undertaking archival and photographic recording of the site, including the 1887 portal and all moveable heritage items; and
  - ensuring for the long-term storage of moveable heritage items.

VISUAL

Visual and Lighting

20. The Proponent shall:

(a) implement all reasonable and feasible measures to minimise the visual and off-site lighting impacts of the project;

(b) ensure no fixed outdoor lights shine above the horizontal or above the building line or any illuminated structure;
(c) ensure that all external lighting associated with the project complies with *Australian Standard AS4282 (INT) 1997 – Control of Obtrusive Effects of Outdoor Lighting*, or its latest version;
(d) take all practical measures to shield views of mining operations from users of public roads and privately-owned residences,

to the satisfaction of the Secretary.

WASTE

21. The Proponent shall:
(a) implement all reasonable and feasible measures to minimise the waste generated by the project;
(b) ensure that the waste generated by the project is appropriately stored, handled and disposed of; and
(c) monitor and report on effectiveness of the waste minimisation and management measures each calendar year,

to the satisfaction of the Secretary.

Underground Tailings Storage Trials

22. The Proponent may conduct trials of underground emplacement and storage of coal tailings, subject to the prior approval of the Secretary.

BUSHFIRE MANAGEMENT

23. The Proponent shall:
(a) ensure that the project is suitably equipped to respond to any fires on site; and
(b) assist the Rural Fire Service and emergency services as much as possible if there is a fire in the surrounding area.

PROJECT SURFACE INFRASTRUCTURE MANAGEMENT

Service Boreholes Management Plan

24. The Proponent shall prepare and implement a Service Boreholes Management Plan in respect of construction and use of future service boreholes (ie any service boreholes not subject to approval at the date of this instrument) to the satisfaction of the Secretary. This plan must be submitted to the Secretary for approval prior to the construction of any future service borehole and must include commitments regarding:
(a) community consultation;
(b) landholder agreements;
(c) assessment of noise, air quality, traffic, biodiversity, heritage, public safety and other impacts in accordance with approved methods;
(d) avoidance of significant impacts and minimisation of impacts generally;
(e) achievement of applicable standards and goals;
(f) mitigation and/or compensation for significant noise, air quality and visual impacts; and
(g) rehabilitation of disturbed sites.

REHABILITATION

Rehabilitation Objectives

25. The Proponent shall rehabilitate the site to the satisfaction of the Secretary, NSW Trade & Investment. This rehabilitation must be generally consistent with the proposed rehabilitation strategy described in the EA, and comply with the objectives in Table 8.

Table 8: Rehabilitation Objectives

Feature	***Objective***
Mine site (as a whole)	• Safe, stable & non-polluting. • Final landforms to: - use compatible with surrounding land uses; - be designed to minimise the visual impacts of the project; - be in keeping with the natural terrain features of the area; and - avoid straight run drainage drop structures.
Project surface infrastructure	• To be decommissioned, and subject to the Heritage Management Plan, removed (unless the Secretary. NSW Trade & Investment agrees otherwise).
Portals and vent shafts	• To be decommissioned and made safe and stable. • Retain habitat for threatened species (eg bats), where practicable

Watercourses of 2nd order or higher subject to subsidence impacts	• Hydraulically and geomorphologically stable.
Cliffs	• No additional risk to public safety compared to prior to mining
Other land affected by the project	• Restore ecosystem function, including maintaining or establishing self-sustaining ecosystems comprised of local native plant species (unless the Secretary, NSW Trade & Investment agrees otherwise).
Built features damaged by mining operations	• Repair to pre-mining condition or equivalent unless the: - owner agrees otherwise; or - damage is fully restored, repaired or compensated for under the *Mine Subsidence Compensation Act 1961*.
Community	• Ensure public safety. • Minimise the adverse socio-economic effects associated with mine closure.

Notes:

- *These rehabilitation objectives apply to all subsidence impacts and environmental consequences caused by mining taking place after the date of this approval; and to all project surface infrastructure part of the project, whether constructed prior to or following the date of this approval.*
- *Rehabilitation of subsidence impacts and environmental consequences caused by mining which took place prior to the date of this approval may be subject to the requirements of other approvals (eg an existing project approval, mining lease, or Subsidence Management Plan approval) or the Proponent's commitments.*

Progressive Rehabilitation

26. The Proponent shall rehabilitate the site progressively, that is, as soon as reasonably practicable following disturbance. All reasonable and feasible measures must be taken to minimise the total area exposed for dust generation at any time. Interim rehabilitation strategies shall be employed when areas prone to dust generation cannot yet be permanently rehabilitated.

Rehabilitation Management Plan

27. The Proponent shall prepare and implement a Rehabilitation Management Plan for the project to the satisfaction of the Secretary, NSW Trade & Investment. This plan must:
    (a) be prepared in consultation with the Department, NOW, OEH, Council and the CCC;
    (b) be submitted to the Secretary, NSW Trade & Investment for approval within 6 months of the commencement of development under this approval;
    (c) be prepared in accordance with any relevant NSW Trade & Investment guideline;
    (d) include detailed performance and completion criteria for evaluating the performance of the rehabilitation of the site, and triggering remedial action (if necessary);
    (e) describe the measures that would be implemented to ensure compliance with the relevant conditions of this approval, and address all aspects of rehabilitation including mine closure, final landform, and final land use;
    (f) provide for detailed mine closure planning, including measures to minimise socio-economic effects due to mine closure, to be conducted prior to the site being placed on care and maintenance;
    (g) include interim rehabilitation where necessary to minimise the area exposed for dust generation;
    (h) include a program to monitor and report on the effectiveness of the measures, and progress against the detailed performance and completion criteria; and
    (i) build to the maximum extent practicable on the other management plans required under this approval.

SCHEDULE 5
ADDITIONAL PROCEDURES

NOTIFICATION OF LANDOWNERS

1. As soon as practicable after obtaining monitoring results showing:
   (a) an exceedance of any relevant criteria in Schedule 4, the Proponent shall notify the affected landowners in writing of the exceedance, and provide regular monitoring results to these landowners until the project is again complying with the relevant criteria; and
   (b) an exceedance of any relevant air quality criteria in Schedule 4, the Proponent shall send a copy of the NSW Health fact sheet entitled "Mine Dust and You" (as may be updated from time to time) to the affected landowners and/or existing tenants of the land (including the tenants of any mine-owned land).

INDEPENDENT REVIEW

2. If an owner of privately-owned land considers the project to be exceeding the relevant criteria in Schedule 4, then he/she may ask the Secretary in writing for an independent review of the impacts of the project on his/her land.

   If the Secretary is satisfied that an independent review is warranted, then within 2 months of the Secretary's decision the Proponent shall:
   (a) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Secretary, to:
      - consult with the landowner to determine his/her concerns;
      - conduct monitoring to determine whether the project is complying with the relevant criteria in Schedule 4;
      - if the project is not complying with these criteria then identify the measures that could be implemented to ensure compliance with the relevant criteria; and
   (b) give the Secretary and landowner a copy of the independent review.

SCHEDULE 6
ENVIRONMENTAL MANAGEMENT, REPORTING AND AUDITING

ENVIRONMENTAL MANAGEMENT

Environmental Management Strategy

1. The Proponent shall prepare and implement an Environmental Management Strategy for the project to the satisfaction of the Secretary. This strategy must:
   (a) be submitted to the Secretary for approval within 6 months of the date of this approval;
   (b) provide the strategic framework for the environmental management of the project;
   (c) identify the statutory approvals that apply to the project;
   (d) describe the role, responsibility, authority and accountability of all key personnel involved in the environmental management of the project;
   (e) describe the procedures that would be implemented to:
      - keep the local community and relevant agencies informed about the operation and environmental performance of the project;
      - receive, handle, respond to, and record complaints;
      - resolve any disputes that may arise during the course of the project;
      - respond to any non-compliance;
      - respond to emergencies; and
   (f) include:
      - copies of any strategies, plans and programs approved under the conditions of this approval; and
      - a clear plan depicting all the monitoring required to be carried out under the conditions of this approval.

Adaptive Management

2. The Proponent shall assess and manage project-related risks to ensure that there are no exceedances of the criteria and/or performance measures in Schedules 3 and 4. Any exceedance of these criteria and/or performance measures constitutes a breach of this approval and may be subject to penalty or offence provisions under the EP&A Act or EP&A Regulation.

   Where any exceedance of these criteria and/or performance measures has occurred, the Proponent must, at the earliest opportunity:
   (a) take all reasonable and feasible steps to ensure that the exceedance ceases and does not recur;
   (b) consider all reasonable and feasible options for remediation (where relevant) and submit a report to the Department describing those options and any preferred remediation measures or other course of action; and
   (c) implement remediation measures as directed by the Secretary,
   to the satisfaction of the Secretary.

Management Plan Requirements

3. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:
   (a) detailed baseline data;
   (b) a description of:
      - the relevant statutory requirements (including any relevant approval, licence or lease conditions);
      - any relevant limits or performance measures/criteria;
      - the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;
   (c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;
   (d) a program to monitor and report on the:
      - impacts and environmental performance of the project;
      - effectiveness of any management measures (see c above);
   (e) a contingency plan to manage any unpredicted impacts and their consequences;
   (f) a program to investigate and implement ways to improve the environmental performance of the project over time;
   (g) a protocol for managing and reporting any:
      - incidents;
      - complaints;
      - non-compliances with statutory requirements; and
      - exceedances of the impact assessment criteria and/or performance criteria; and
   (h) a protocol for periodic review of the plan.

Annual Review

4. By the end of March each year, unless the Secretary agrees otherwise, the Proponent shall review the environmental performance of the project to the satisfaction of the Secretary. This review must:
   (a) describe the development (including any rehabilitation) that was carried out in the past calendar year, and the development that is proposed to be carried out over the current calendar year;
   (b) include a comprehensive review of the monitoring results and complaints records of the project over the past calendar year, which includes a comparison of these results against the:
      - the relevant statutory requirements, limits or performance measures/criteria;
      - requirement of any plan or program required under this approval;
      - the monitoring results of previous years; and
      - the relevant predictions in the EA;
   (c) identify any non-compliance over the past year, and describe what actions were (or are being) taken to ensure compliance;
   (d) identify any trends in the monitoring data over the life of the project;
   (e) identify any discrepancies between the predicted and actual impacts of the project, and analyse the potential cause of any significant discrepancies; and
   (f) describe what measures will be implemented over the next year to improve the environmental performance of the project.

Revision of Strategies, Plans and Programs

5. Within 3 months of:
   (a) the submission of an annual review under condition 4 above;
   (b) the submission of an incident report under condition 7 below;
   (c) the submission of an audit under condition 9 below; or
   (d) any modification to the conditions of this approval (unless the conditions require otherwise),

   the Proponent shall review, and if necessary revise, the strategies, plans, and programs required under this approval to the satisfaction of the Secretary.

   Where this review leads to revisions in any such document, then within 4 weeks of the review, unless the Secretary agrees otherwise, the revised document must be submitted to the Secretary for approval.

   Note: This is to ensure the strategies, plans and programs are updated on a regular basis, and incorporate any recommended measures to improve the environmental performance of the project.

Community Consultative Committee

6. The Proponent shall operate a Community Consultative Committee (CCC) for the project to the satisfaction of the Secretary. This CCC must be operated in accordance with the *Guidelines for Establishing and Operating Community Consultative Committees for Mining Developments* (Department of Planning, 2007, or its latest version.

   Notes:
   - *The CCC is an advisory committee. The Department and other relevant agencies are responsible for ensuring that the Proponent complies with this approval;*
   - *In accordance with the guideline, the Committee should be comprised of an independent chair and appropriate representation from the Proponent, Council, recognised environmental groups and the local community; and*

REPORTING

Incident Reporting

7. The Proponent shall immediately notify the Secretary and any other relevant agencies of any incident. Within 7 days of the date of the incident, the Proponent shall provide the Secretary and any relevant agencies with a detailed report on the incident, and such further reports as may be requested.

Regular Reporting

8. The Proponent shall provide regular reporting on the environmental performance of the project on its website, in accordance with the reporting arrangements in any plans or programs approved under the conditions of this approval, and to the satisfaction of the Secretary.

INDEPENDENT ENVIRONMENTAL AUDIT

9. Within 1 year of the commencement of development under this approval, and every 3 years thereafter, unless the Secretary directs otherwise, the Proponent shall commission and pay the full cost of an Independent Environmental Audit of the project. This audit must:
   (a) be conducted by a suitably qualified, experienced and independent team of experts whose appointment has been endorsed by the Secretary;

(b) include consultation with the relevant agencies;
(c) assess the environmental performance of the project and assess whether it is complying with the requirements in this approval and any relevant EPL or Mining Lease (including any assessment, plan or program required under these approvals);
(d) review the adequacy of strategies, plans or programs required under the abovementioned approvals; and
(e) recommend appropriate measures or actions to improve the environmental performance of the project, and/or any assessment, plan or program required under the abovementioned approvals.

Note: This audit team must be led by a suitably qualified auditor and include experts in any fields specified by the Secretary.

10. Within 6 weeks of the completion of this audit, or as otherwise agreed by the Secretary, the Proponent shall submit a copy of the audit report to the Secretary, together with its response to any recommendations contained in the audit report.

ACCESS TO INFORMATION

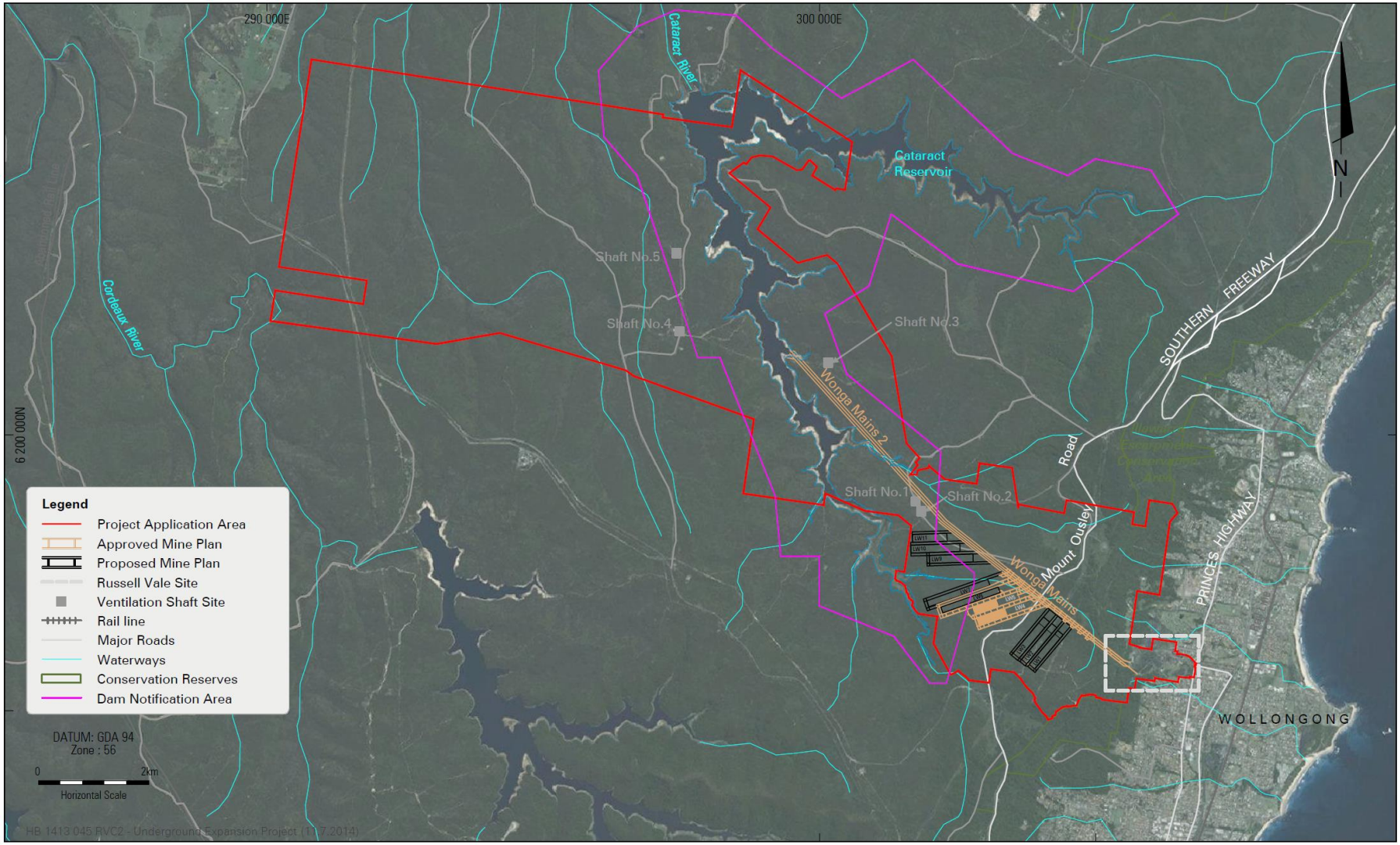
11. From the commencement of development under this approval, the Proponent shall:
(a) make copies of the following publicly available on its website:
- the EA;
- current statutory approvals for the project;
- approved strategies, plans and programs required under the conditions of this approval;
- a comprehensive summary of the monitoring results of the project, reported in accordance with the specifications in any conditions of this approval, or any approved plans and programs;
- a complaints register, which is to be updated monthly;
- minutes of CCC meetings;
- the annual reviews of the project (for the last 5 years, if applicable);
- any independent environmental audit of the project, and the Proponent's response to the recommendations in any audit;
- any other matter required by the Secretary; and

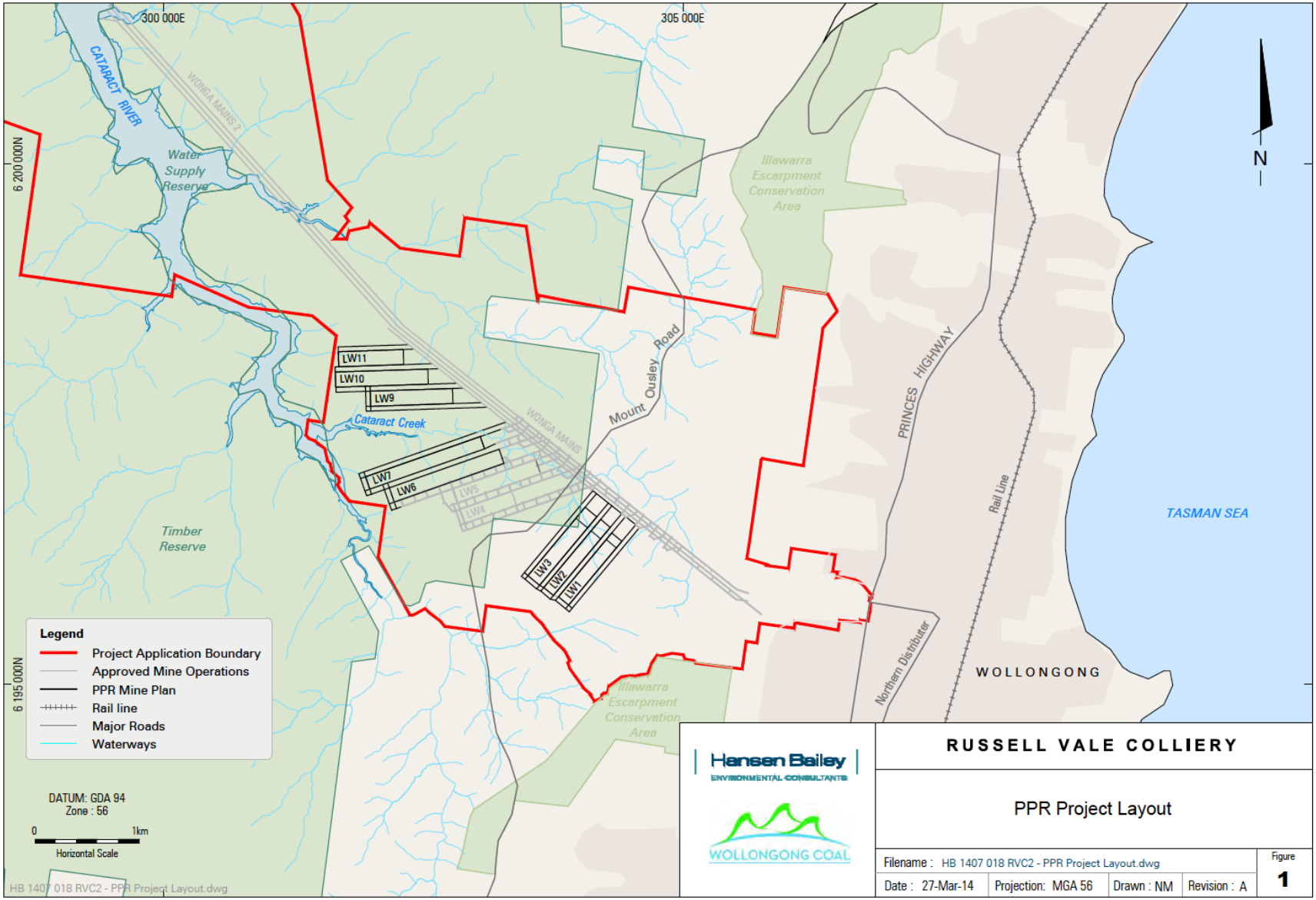
(b) keep this information up-to-date,
to the satisfaction of the Secretary.

APPENDIX 1: SCHEDULE OF LAND

Property ID / Lot Number	DP Plan Number	Owner
Auto Consol 1833-110		Wollongong Coal Ltd
Auto Consol 1644-66		Wollongong Coal Ltd
Auto consol 5333-243 includes:		Wollongong Coal Ltd
Lot 3	DP 60975	Wollongong Coal Ltd
Lot 30 to 32	DP 751301	Wollongong Coal Ltd
Lot 63&68 -71	DP 751301	Wollongong Coal Ltd
Lot 1-2	DP 1046069	Wollongong Coal Ltd
Lot 1	DP 1046070	Wollongong Coal Ltd
Lot 130	DP 751301	Wollongong Coal Ltd
Lot 31	DP 1006012	Wollongong Coal Ltd
Lot 1	DP 630761	Wollongong Coal Ltd
Lot 1	DP 986675	Wollongong Coal Ltd
Lot 1	DP 986676	Wollongong Coal Ltd
Lot 1	DP 534522	Wollongong Coal Ltd
Lot 95 to 96	DP 4414	Wollongong Coal Ltd
Lot 97	DP 4414	The Council of the City of Wollongong
Lots 1 to 4	DP 225021	Wollongong Coal Ltd
Lot 34	DP 751301	Wollongong Coal Ltd
Lot 6	DP 793358	Wollongong Coal Ltd
Lot 66	DP 751301	Wollongong Coal Ltd
Lot 67	DP 751301	Wollongong Coal Ltd
Lot 1	DP 652833	Wollongong Coal Ltd
Lot 6001	DP 1077301	Wollongong Coal Ltd
Lot 1	DP 77407	Wollongong Coal Ltd
Lot 1	DP 1052074	Wollongong Coal Ltd
Lot 2	DP 1052074	Wollongong Coal Ltd
Lot 151	DP 667029	Wollongong Coal Ltd
Part Lot 6000	DP 1077301	Illawarra Land Pty Ltd
Lot 6500	DP 1083715	Illawarra Land Pty Ltd
Lot 6502	DP 1083715	Ronald Edward Devitt & Jane Wilson
Part Lot 6501	DP 1083715	Barbara Jean Williams
Lot 12	DP 736121	Integral Energy Australia
Lot 32	DP 1138149	Sydney Catchment Authority

APPENDIX 2: PROJECT LAYOUT PLAN

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305 000E
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WONGA MAINS 2
Water Supply Reserve
Illawarra Escarpment Conservation Area
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LW11
LW10
LW9
Cataract Creek
WONGA MAINS
Mount Ousley Road
PRINCES HIGHWAY
Rail Line
TASMAN SEA
LW7
LW6
LW5
LW4
LW3
LW2
LW1
Timber Reserve
Northern Distributer
WOLLONGONG
Illawarra Escarpment Conservation Area
Legend
Project Application Boundary
Approved Mine Operations
PPR Mine Plan
Rail line
Major Roads
Waterways
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Horizontal Scale
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Hansen Bailey
ENVIRONMENTAL CONSULTANTS
WOLLONGONG COAL
RUSSELL VALE COLLIERY
PPR Project Layout
Filename : HB 1407 018 RVC2 - PPR Project Layout.dwg
Figure
1
Date : 27-Mar-14
Projection: MGA 56
Drawn : NM
Revision : A

Pit Top Surface Facility

APPENDIX 3: STATEMENT OF COMMITMENTS

The following table contains Wollongong Coal's Statement of Commitments (SoC) for the Russell Vale Colliery Underground Expansion Project. The Project Approval takes precedence over any commitments in this table.

Ref	Commitment
General	
1.	WCL will conduct regular community consultation and provide updates to the community during operation of the UEP.
2.	WCL will regularly review and revise (if necessary) the existing Environmental Management System and its supporting management plans and procedures. This will be undertaken in consultation with relevant regulators.
3.	The existing Environmental Monitoring Program shall be revised and updated in consultation with relevant regulators in consideration of operations and impacts. The monitoring program will be included in Extraction Plans.
4.	WCL will provide regular and relevant training to all employees and contractors to ensure that environmental outcomes are achieved.
5.	WCL will continue to coordinate the Community Consultative Committee for the Russell Vale Colliery.
6.	All environmental management and monitoring outcomes will be reported in an Annual Review.
Subsidence	
7.	Establish a technical committee comprising representatives from Wollongong Coal, the power utility company and government regulators to monitor and manage potential impacts of mining on the power transmission towers.
8.	All secondary workings will be undertaken in accordance with approved Extraction Plans developed in consultation with relevant regulatory authorities and infrastructure owners.
9.	The Extraction Plan will include Trigger Action Response Plans (TARPs) to allow WCL to respond to impacts as they arise and to facilitate adaptive management over the life of the Project. TARPs will be developed for built features and natural features.
10.	The Extraction Plan will include a protocol for monitoring of subsidence effects. Monitoring will be conducted before, during and after secondary extraction.
11.	If necessary, adaptive management measures will be undertaken to reduce impacts on Cataract Creek and swamps of special significance. Adaptive management measures will determined in consultation with relevant regulators.
Water	
12.	WCL will revise the Water Management Plan (including a TARP and water monitoring program) in consultation with the relevant regulators.
13.	WCL will revise the existing water monitoring program in consultation with the relevant authorities. This will include monitoring of streams, swamps and groundwater systems.
14.	Monitoring of stream flows will be conducted to determine the potential for connectivity of surface water and groundwater systems.
15.	To assess mine water make, WCL will continue to monitor volumes of water pumped into and out of the underground mine workings.
16.	WCL will continue to treat stormwater and mine water prior to discharge. Treated water will continue to be discharged to Bellambi Creek in accordance with WCL's EPL.
17.	An Erosion and Sediment Control Plan will be implemented during construction activities at the Russell Vale Site.
18.	WCL will obtain and hold water licences as required.

Ref	Commitment
Air Quality and Greenhouse Gas	
19.	WCL will review and revise the existing Air Quality Management Plan in consultation with the relevant authorities. The Plan will include feasible and reasonable air quality controls.
20.	The existing air quality monitoring network will be reviewed.
Acoustics	
21.	WCL will review and revise the existing Noise Management Plan in consultation with the relevant authorities. The Plan will include feasible and reasonable noise controls.
22.	The environmental monitoring program will include continuous monitoring of operational noise, including attended monitoring of road traffic noise.
23.	Construction activities will be limited to between 7 am to 6 pm on weekdays and 8 am to 1 pm on Saturdays.
24.	The site noise model will be revised (in consultation with relevant regulators) once site specific sound power levels have been measured.
Biodiversity	
25.	The existing Biodiversity Management Plan (BMP) will be reviewed and revised in consultation with the relevant authorities.
26.	Monitoring of the swamps will be undertaken in consultation with relevant regulators in accordance with the BMP.
Heritage	
27.	A Heritage Management Plan (HMP) will be developed in consultation with the relevant authorities and Aboriginal stakeholders. The Plan will include management strategies for identified Aboriginal items.
28.	Photographic recordings of the existing site will be conducted prior to the proposed infrastructure upgrades. Moveable items of heritage significance will be documented, collated and catalogued. All recording work will be conducted to Heritage Archival Recording standards.
Visual and Lighting	
29.	Colour treatments for surface facilities will minimise visual contrast with the surrounding environment.
30.	Lighting will be directed away from nearby residences through the use of directional lightning and shielding.
Waste	
31.	The existing Waste Management System will reviewed and revised (if necessary) to promote waste avoidance and resource recovery.
Hazards	
32.	To protect public safety, WCL will continue to manage public access to the site using boundary fences, warning signs, surveillance and security personnel.
33.	A driver code of conduct will be enforced to avoid risks to public safety arising from coal transportation including complying with the 60 km/hr speed limit along Bellambi Lane.
Rehabilitation and Mine Closure	
34.	A Mine Closure Plan will be developed in consultation with the relevant authorities. The mine closure strategy will consider previous land uses, land zonings and potential uses for the existing infrastructure at the site.
35.	Areas that are no longer required for operations will be progressively rehabilitated.

APPENDIX 4: RECEIVER LOCATION PLAN

APPENDIX 5
NOISE COMPLIANCE ASSESSMENT

Applicable Meteorological Conditions

1. The noise criteria in Table 3 of Schedule 4 are to apply under all meteorological conditions except the following:
   (a) wind speeds greater than 3 m/s at 10 metres above ground level; or
   (b) stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 m above ground level; or
   (c) stability category G temperature inversion conditions.

Determination of Meteorological Conditions

2. Except for wind speed at microphone height, the data to be used for determining meteorological conditions shall be that recorded by the meteorological station located on the site.

Compliance Monitoring

3. Attended monitoring is to be used to evaluate compliance with the relevant conditions of this consent.

4. This monitoring must be carried out at least 4 times a year, unless the Secretary directs otherwise.

5. Unless otherwise agreed with the Secretary, this monitoring is to be carried out in accordance with the relevant requirements for reviewing performance set out in the *NSW Industrial Noise Policy* (as amended from time to time), in particular the requirements relating to:
   (a) monitoring locations for the collection of representative noise data;
   (b) meteorological conditions during which collection of noise data is not appropriate;
   (c) equipment used to collect noise data, and conformance with Australian Standards relevant to such equipment; and
   (d) modifications to noise data collected, including for the exclusion of extraneous noise and/or penalties for modifying factors apart from adjustments for duration.

APPENDIX 6: ABORIGINAL HERITAGE SITES

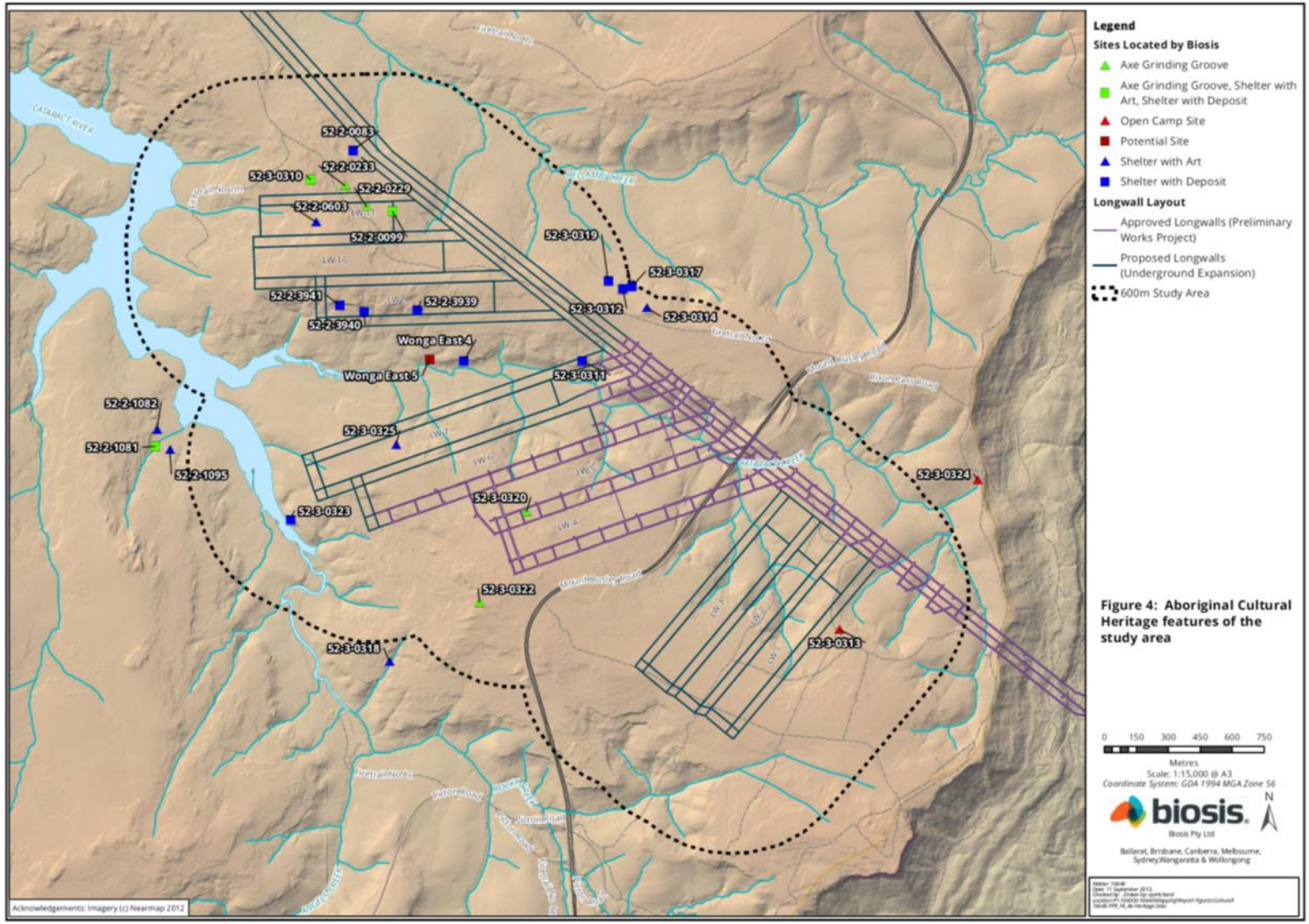

Figure 4: Aboriginal Cultural Heritage features of the study area

APPENDIX 7: CULTURAL HERITAGE SITES